Attachment 1

Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>

BA Support Material

1 message

Howard Brown - NOAA Federal <howard.brown@noaa.gov> Sun, Nov 4, 2018 at 8:35 AM
To: David Mooney <dmmooney@usbr.gov>, kharrison@usbr.gov
Cc: "Barajas, Federico" <fbarajas@usbr.gov>, Maria Rea <maria.rea@noaa.gov>, Garwin Yip <garwin.yip@noaa.gov>

Dave and Katrina,
We thought it might be helpful to share some materials with you that we believe would be helpful as you prepare the BA for LTO. Attached, please find the following:
1. A proposed outline for the BA that is consistent with the content and format of NMFS' West Coast Regional BiOp Template. If you are able to use this format, it would greatly contribute to the support the transition of certain sections of the BA into the BiOp.
2. A compilation of Delta Science that we think should be considered in developing the effects analysis. It's basically in an annotated form with key points summarized that capture the NMFS perspective on them. We can pull more science summaries together from the upper Sacramento and American River if you think it would be helpful, but we wanted to get this to you as quickly as possible.
3. A list of relevant models and the locations and species life stages that we believe they would apply to. They are not prioritized and there could certainly be some redundancy across applications, species and life stages, but we felt it would be a good starting point for us to have a conversation over.

We can only imagine that you are incredibly busy, but if there is any thing we can do to help out, please let us know. We can make ourselves available if you want to coordinate.
Howard

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3 attachments

NMFS PROPOSED BA OUTLINE FORMAT.docx
16K

ROCON model matrix (sum).pdf
37K

2018.11.01_Delta Science compilation for reinitiation effort_revised_FINAL.docx
1353K

NMFS PROPOSED OUTLINE FORMAT
FOR THE
BUREAU OF RECLAMATION'S BIOLOGICAL ASSESSMENT
Draft for discussion purposes only
10/31/2018

DATE: 11/1/18

TO: Maria Rea, Assistant Regional Administrator, California Central Valley Office, West Coast Region, NOAA Fisheries

FROM: Barb Byrne, Fishery Biologist, Water Operations and Delta Consultations Branch, California Central Valley Office, West Coast Region, NOAA Fisheries
[*barbara.byrne@noaa.gov, 916-930-5612]*

RE: Selected science review for the reinitiation effort

Maria,

Per your request, I have compiled some materials that summarize some of the key recent science relevant for the reinitiation effort, with a focus on materials that relate to evaluation of Central Valley Project- and State Water Project-related effects in the Delta.

One of the most thorough compilations of recent science relevant to Delta operations is the Salmonid Scoping Team's January 2017 report (2017 SST Report):

> *Salmonid Scoping Team (2017). Effects of Water Project Operations on Juvenile Salmonid Migration and Survival in the South Delta. Volume 1: Findings and Recommendations. January 2017.*

The 2017 SST Report not only summarizes what is known and not known about project-related effects on salmonids in the south Delta, its findings are the consensus of a technical team including representatives from agencies, water users, and non-governmental organizations that participate in the Collaborative Adaptive Management Team (CAMT) effort. Because the report is so large, it is not enclosed in this compilation, but is available online at: https://www.westcoast.fisheries.noaa.gov/central_valley/water_operations/OCAPreports.html

Materials that are enclosed in this compilation include:

- **Enclosure A (27 pages):** Briefing materials on the "Six Year Study" results on routing and survival of Central Valley steelhead migrating from the San Joaquin basin.
    - *Erratum:* The final San Joaquin yeartype for WY 2016 should be "Dry"; not "Critical" in Table 1 on page A-3.
- **Enclosure B (6 pages):** Annotated literature review prepared by me in August 2018.
- **Enclosure C (10 pages):** Annotated literature review prepared by Jeff Stuart (Fishery Biologist, Water Operations and Delta Consultations Branch, California Central Valley Office, West Coast Region, NOAA Fisheries) in August 2018.
- **Enclosure D (2 pages):** Assorted references (without annotation), prepared by me on November 1, 2018.

Briefing on Six-year Study
June 26, 2018

Key Messages

Six-Year Study

- Four years of the total six years of studies have been written up as either final (2011-2013) or draft (2014) reports. Final reports just released in May/June 2018.
- Conditions during study years dominated by drought conditions.
- Survival results *(more details in Attachment 1, prepared by Jeff Stuart)*:
    - Through-Delta steelhead survival (for all routes combined) was highest in the Wet year (2011), and ranged from 15% (in 2013) to 54% (in 2011).
    - Absolute survival through the San Joaquin River route was better than the Old River route in three of the four analyzed study years (2011, 2012, and 2014) but not statistically significant (some power limitations?).
    - Reports do not provide analysis of survival as a function of the I:E ratio or OMR flow[1], though do evaluate total Delta survival as a function of Vernalis flow and some routing proportions as a function of local flows.
- Routing results:
    - The proportion of study fish in the San Joaquin River route was highest in the years when the HORB was installed.

SWFSC mini-project on Six-Year Study data

- SWFSC did a mini-analysis *(more details in Attachment 2, prepared by Caren Barceló)* to understand the relationship between detections at different receivers (detections being a surrogate for fish movement) and environmental variables (e.g. flow, turbidity, temperature, diel phase).
    - Preliminary results were that flow, conductivity and turbidity were the variables that most often had the strongest relationship (positive or negative) with the arrival rate of steelhead; associations differed for specific receivers.

Chinook releases in the San Joaquin River

- USFWS led studies of Chinook releases in the San Joaquin River, and measured through-Delta survival, in 2009-2015.
- For 2010-2013, through-Delta Chinook survival was <5% for all releases and survival was often higher in the Old River route (*see Attachment 3, prepared by Barb Byrne).*

[1] The 2013 report notes, for example, that "[The NMFS 2009 BiOp] identified flow at Vernalis, export volume, and the ratio of Vernalis flow-to-export as variables to test during this study as priority variables. Separating the effects of these covariates is difficult because the variables are likely to be correlated."

Overview of Six-year Study

- Studies released acoustically tagged **hatchery steelhead** into the San Joaquin River at Durham Ferry (most releases were from **late March to late May**) and tracked them through the Delta system using multiple releases and multiple acoustic receiver locations throughout the lower San Joaquin River and Delta (Figure 1).

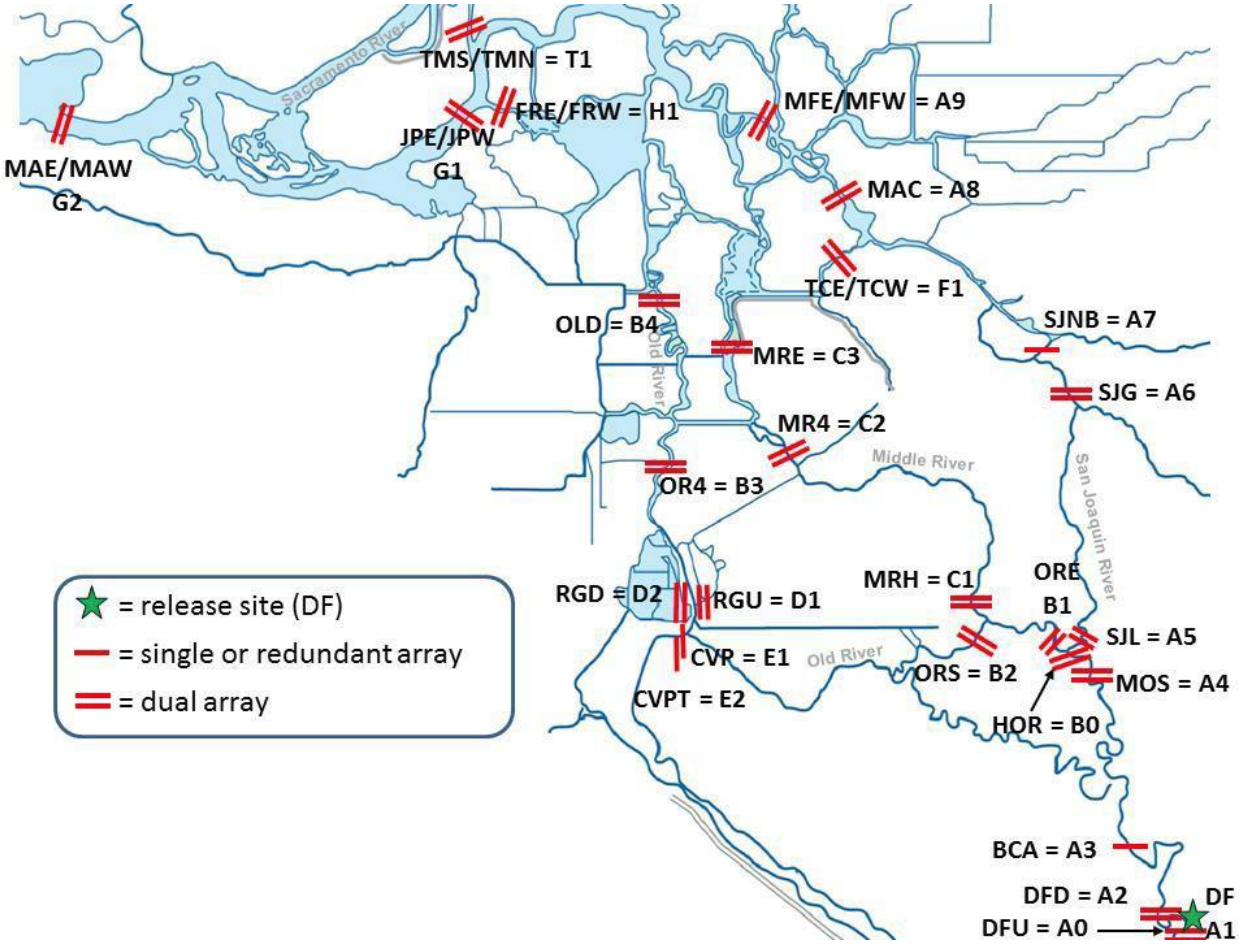


Figure 1*: Locations of Acoustic Receivers for the 2012 study. Each year's study had a small number of additional/ removed or relocated acoustic receiver locations but the release location at Durham Ferry (DF) and westernmost receivers near Chipps Island (MAE & MAW) were consistent throughout.*

- Studies occurred during a Wet year (2011) and five Dry or Critical years (2012-2016), as summarized in Table 1.

Table 1: *Overview of hydrologic conditions and report status for the Six-year Study*

Water Year	HORB status	San Joaquin yeartype	I:E ratio in effect	14-day OMR range (in cfs, 4/1-5/31)	Vernalis flow range (in cfs, 4/1-5/31)	Status of report
2011	Out	Wet	Vernalis flow offramp 4/1-5/10; 4:1 from 5/11-5/31	2,391 to 9,520	9635 to 28,575	Final (May 2018)
2012	In	Dry	Joint Stipulation Study* in lieu of I:E ratio	-4,218 to -1,710	1,577 to 4,418	Final (May 2018)
2013	Out	Critical	1:1	-4,050 to -130	859 to 4,176	Final (June 2018)
2014	In	Critical	1:1	-4,750 to -1,650 *(based on Index)*	510 to 3,035	Draft (May 2018)
2015	In	Critical	1:1	-1,860 to -1,170 *(based on Index)*	254 to 1,433	*No report available*
2016	In	Critical	1:1	-3,720 to -1,860 *(based on Index)*	733 to 3,215	*No report available*

*OMR limits in Joint Stipulation Study ranged from -1,250 cfs to -5,000 cfs.

- Survival and routing estimates (Table 2) show that:
  - Through-Delta steelhead survival (for all routes combined) was highest in the Wet year (2011), and ranged from 15% (in 2013) to 54% (in 2011). See Figure 2.
  - Absolute survival through the San Joaquin River route was better than the Old River route in three of the four study years (2011, 2012, and 2014) but not statistically significant[2].
  - The proportion of study fish in the San Joaquin River route was highest in the years when the HORB was installed.

[2] Power to detect survival differences between routes (excerpt from p.11 of the 2012 Report): "Buchanan (2010) recommended a sample size of 475 for estimating survival to Chipps down the Old River and San Joaquin routes if survival in the Old River route was low (0.05). Additionally, if survival between Durham Ferry and Chipps Island was higher (0.15) and survival between Durham Ferry and the Old River junction was high (0.9), a release of 475 at Durham Ferry would be able to detect a 50% difference between survival in the San Joaquin River and Old River routes. Thus, a release group of 475 at Durham Ferry was expected to provide accurate information about route entrainment and survival for examining biotic and abiotic factors influencing juvenile steelhead survival."

***Table 2**: Summary of hatchery steelhead survival estimates from Six-Year Study: 2011 - 2014*

Study Year	Proportion using Route		Survival Probability Estimate			HORB Status	Water Year Type
	San Joaquin River route	Old River route	San Joaquin River Route	Old River route	Total Survival (any route)		
2011	0.51	0.49	0.55	0.52	0.54	Out	Wet
2012	0.94	0.06	0.33	0.07	0.32	In	Dry
2013	0.12	0.88	0.11	0.15	0.15	Out	Critical
2014	0.92	0.08	0.25	0.19	0.24	In	Critical

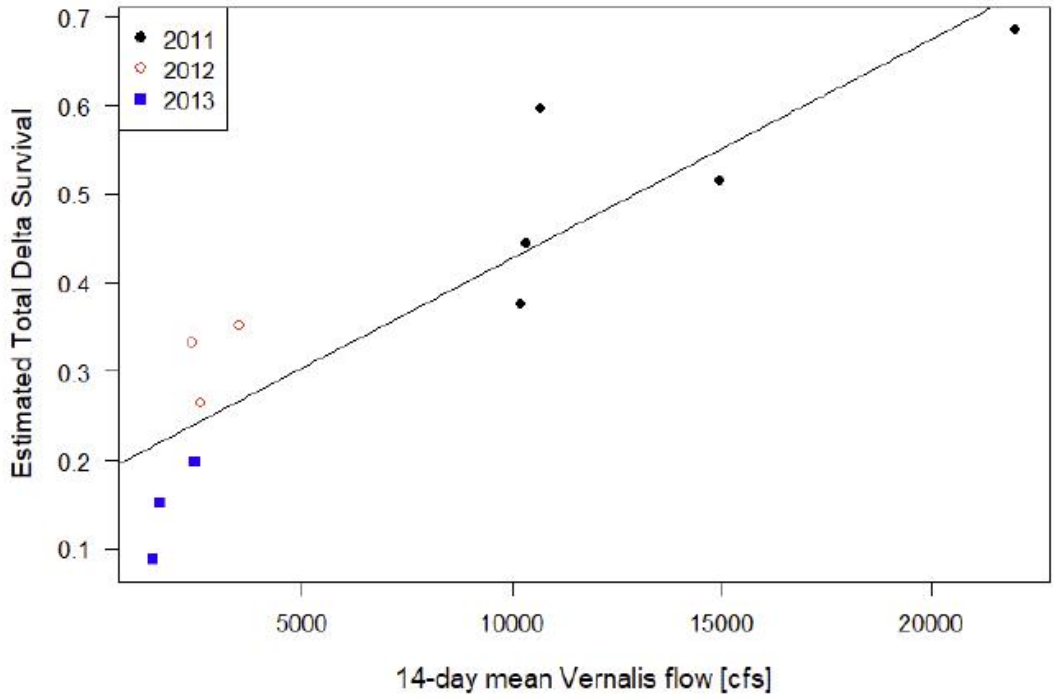


Figure 27. Estimated total delta survival (Mossdale to Chipps Island) for acoustic-tagged steelhead in the 2011, 2012, and 2013 Six-Year Study, versus 14-day mean San Joaquin River flow at Vernalis. Survival and flow data are from Tables 26 and 27. The line is the best fit linear predictor of survival as a function of 14-day Vernalis flow for these data ($r^2 = 0.8007$).

***Figure 2**: Estimated total Delta survival for hatchery steelhead from the 2011-2013 study years. (Figure 27 from the 2013 report)*

- Other details available in Attachment 1:
  - Water temperatures were elevated (59 degrees F or higher) in three out of the four analyzed study years (2012-2014) during the fish releases.
  - Survival estimates by release group are provided in "heat-map" tables.
  - Releases are plotted along Vernalis flows and Mossdale water temperatures.

Highlights from 2011-2014 results from Six-Year Study

(summarizing 689 pages of draft and final reports)

- Four years of the total six years of studies have been written up as either final or draft reports
    - Final Reports available for 2011-2013
    - Draft report available for 2014
- Studies released acoustically tagged hatchery steelhead into the San Joaquin River at Durham Ferry and tracked them through the Delta system using multiple releases and multiple acoustic receiver locations throughout the lower San Joaquin River and Delta. (see Table 1 and Figure 1)
    - 2011 – Five releases, total of 2,196 fish tagged and released at Durham Ferry from late March through mid-June.
    - 2012 – Three release, total of 1,435 fish tagged and released at Durham Ferry from early April through mid-May.
    - 2013 – Three releases, total of 1,425 fish tagged and released at Durham Ferry from early March through early May.
    - 2014 – Three release, total of 1,432 fish tagged and released at Durham Ferry from late March through late May.
- Studies occurred during a wet year (2011) and three dry/critically dry years (2012-2014; the first three years of the 5-year drought) (see Figure 2).
    - Flows during the wet year (2011) were typically above 10,000 cfs at Vernalis, and peaked at approximately 29,000 cfs.
    - Flows during 2012 through 2014 were considerably less, never exceeding 5,000 cfs at Vernalis, and typically less than 2,500 cfs for most of the period of interest.
    - The HOR barrier was installed during 2012 and 2014. In 2014 the HOR barrier went in after the first release of fish occurred. With the barrier in, few fish were entrained into the Old River route at the junction of Old River and the San Joaquin River (see Table 2 and Table 3a and 3b).
- During the wet year (2011) survival was better than the drought years (2012-2014) for both the San Joaquin River route (S_A) and the Old River route (S_B), as well as total survival (S_{total}) through the system. See Tables 2 and 3a and b.
    - Absolute survival through the San Joaquin River route was better than the Old River route in 3 of the 4 study years (2011, 2012, and 2014) but not statistically significant.
    - Survival through the sub-routes; south Delta and middle Delta (S_{SD} and S_{MD}), were variable and release group dependent. Clear distinctions between the Old river and San Joaquin River routes were not consistent.
- The presence of the HOR barrier was important in determining the proportion of fish entering Old River (see Tables 2 and 3a, 3b) in relation to those remaining in the San Joaquin River route.
    - During low flow years, when the barrier was out (2013, first release in 2014), and fish were released into the system at Durham Ferry, higher numbers of fish entered the Old River route at the HOR junction. This appears to be a function of river stage, tides, and shunting of flow into the Old River channel.

  - When flows were high (2011) the distribution of fish into Old River and the San Joaquin were nearly equal.
- Water temperatures were elevated in 3 out of the 4 study years (2012-2014) during the fish releases (see Figures 3-6).
  - Waters temperatures (as measured at Mossdale) were consistently lower in 2011 compared to 2012-2014 during fish releases.
  - Water temperatures in 2012 were consistently above 18ºC for the second and third releases. Water temperatures following the first release were between 15 and 18ºC.
  - Water temperatures in 2013 were slightly below 15ºC during the first release, but were above 15ºC during the second and third releases.
  - Water temperatures in 2014 were between 15 and 18ºC during the three releases, with spikes following the first and third releases.
- Survival, as measured per kilometer travelled, is depicted in Tables 4 and 5, cumulative mortality /survival in Figures 7-12.
  - Overall cumulative mortality is higher in the reaches between Durham Ferry and Mossdale (Figures 7-12), which is common between the Old River route and the San Joaquin River route. The survival per kilometer is approximately 96% or higher (Table 4) but accounts for approximately 40-60% of overall mortality (Figures 7-12).
  - Cumulative mortality in the San Joaquin River route is inconsistent, with some years having high mortality in the reach between Mossdale and the Stockton Deepwater Ship Channel (Garwood Bridge/ Navy Bridge) and again in the lower reaches of the San Joaquin River route (MacDonald Island to Chipps Island).
  - Increased cumulative mortality in the Old River route occurs between the entrance to the Old River corridor (Old River south) and Chipps Island via the fish collection facilities (Figures 8, 10, and12).

Table 1: Number of steelhead with acoustic tags released for each study year. Note that because of differences in routing with HORB in vs. out, the sample size for the survival estimates in the San Joaquin River route vs. the Old River route is very different.

Study Year	Total # Tags Released	Release Groups	Date of Release	Number Tags Released	Number Assigned to Old River Route	Number Assigned to San Joaquin River route
2011	2,196	1	3/22 – 3/26	477		
HORB out		2	5/3 – 5/7	474		
		3	5/17 – 5/21	477		
		4	5/22 – 5/26	480		
		5	6/15 – 6/17	285		
2012	1,435	1	4/4 – 4/7	477	20	304
HORB in		2	5/1 – 5/6	478	11	297
		3	5/17 – 5/23	480	17	150
2013	1,425	1	3/6 – 3/9	476	278	16
HORB out		2	4/3 – 4/6	477	279	31
		3	5/8 – 5/11	472	265	40
2014	1,432	1	~3/26 – 3/29	474		
HORB in		2	~4/26 -4/29	480		
		3	~5/20 -5/23	478		

Table 2: Summary of 6-Year Steelhead Parameters: 2011 - 2014

Study Year	Proportion using Route		Survival Probability Estimate			HORB Status	Water Year Type
	SJR (ψ_A)	OR (ψ_B)	SJR Route (S_A)	Old River Route (S_B)	Total Survival (S_{Total})		
2011	0.51	0.49	0.55	0.52	0.54	Out	Wet
2012	0.94	0.06	0.33	0.07	0.32	In	Dry
2013	0.12	0.88	0.11	0.15	0.15	Out	Critical
2014	0.92	0.08	0.25	0.19	0.24	In	Critical

Model Parameters estimated:

$\boldsymbol{P_{hi}}$ = detection probability: probability of detection at telemetry station i within route h, conditional on surviving to station i, where i = ia, ib for the upstream, downstream receivers in a dual array, respectively.

$\boldsymbol{S_{hi}}$ = perceived survival probability: joint probability of migration and survival from telemetry station i to i+1 within route h, conditional on surviving to station i.

$\boldsymbol{\Psi_{hi}}$ = route selection probability: probability of a fish entering route h at junction l (l =1, 2, 3), conditional on fish surviving to junction l.

$\boldsymbol{\Phi_{kj,\ hi}}$ = transition probability: joint probability of migration, route selection, and survival; the probability of migrating, surviving, and moving from station j in route k to station i in route h, conditional on survival to station j in route k.

$\boldsymbol{\lambda}$ = joint transition and detection probability: joint probability of moving downstream from Chipps Island, surviving to Benicia Bridge, and detection at Benicia Bridge, conditional on survival to Chipps Island.

Table 3a: Performance metric estimates for tagged juvenile steelhead for study years 2011 -2012, excluding predator – type detections. Standard errors in parentheses.

Parameter	Year										
	2011							2012			
	Release Group							Release Group			
	1	2	3	4	5	Pop Est.		1	2	3	Pop Est
Ψ_{AA}	0.47 (0.03)	0.35 90.03)	0.37 (0.03)	0.36 (003)		0.39 (0.02)		0.72 (0.04)	0.75 (0.03)	0.58 (0.04)	0.68 (0.02)
Ψ_{AF}	0.05 (0.01)	0.16 (0.02)	0.12 (0.02)	0.17 (0.02)		0.12 (0.01)		0.21 (0.04)	0.23 (0.03)	0.26 (0.02)	0.26 (0.02)
Ψ_{BB}	0.44 (0.0)	0.46 (0.03)	0.49 (0.03)	0.45 (0.03)		0.46 (0.02)		0.06 (0.01)[a]	0.03 (0.01)[a]	0.06 (0.01)[a]	0.06 (0.01)[a]
Ψ_{BC}	0.04 (0.01)	0.03 (0.01)	0.01 (0.01)	0.03 (0.02)		0.03 (0.01)		0.00[a]	0.00[a]	0.00 [a]	0.00 [a]
S_{AA}	0.72 (0.04)	0.68 (0.05)	0.51 (0.05)	0.69 (0.05)		0.65 (0.02)		0.33 (0.03)	0.43 (0.03)	0.45 (0.05)	0.40 (0.02)
S_{AF}	0.33 (0.12)	0.27 (0.07)	0.26 (0.07)	0.59 (0.07)		0.36 (0.04)		0.10 (0.04)	0.14 (0.04)	0.21 (0.05)	0.15 (0.03)
S_{BB}	0.68 (0.04)	0.50 (0.05)	0.44 (0.04)	0.55 (0.05)		0.54 (0.02)		0.07 (0.04)	0.10 (0.07)	0.05 (0.03)	0.07 (0.03)
S_{BC}	0.67 (0.08)	0.30 (0.13)	0.48 (0.06)	0.22 (0.17)		0.42 (0.06)		NA	NA	NA	NA
Ψ_{A}	0.52 (0.03)	0.51 (0.03)	0.49 (0.03)	0.53 (0.03)	0.52 (0.05)	0.51 (0.02)		0.94 (0.01)*	0.97 (0.01)*	0.92 (0.02)*	0.94 (0.01)*
Ψ_{B}	0.48 (0.03)	0.49 (003)	0.51 (0.03)	0.47 (0.03)	0.48 (0.05)	0.49 (0.02)		0.06 (0.01)*	0.03 (0.01)*	0.08 (0.02)*	0.06 (0.01)*
S_{A}	0.69 (0.04)	0.55 (0.04)	0.45 (0.04)	0.66 (0.04)*	0.32 (0.06)	0.55 (0.02)		0.28 (0.03)	0.33 (0.03)	0.36 (0.04)	0.33 (0.02)
S_{B}	0.68 (0.04)	0.48 (0.04)	0.44 (0.04)	0.53 (0.05)*	0.44 (0.07)	0.52 (0.02)		0.07 (0.04)	0.10 (0.07)	0.05 (0.03)	0.07 (0.03)
S_{Total}	0.69 (0.03)	0.52 (0.03)	0.44 (0.03)	0.60 (0.03)	0.38 (0.05)	0.54 (0.01)		0.26 (0.02)	0.35 (0.03)	0.33 (0.04)	0.32 (0.02)
$S_{A(MD)}$	0.82 (0.03)*	0.50 (0.04)*	0.39 (0.04)*	0.52 (0.04)*		0.56 (0.02)		0.32 (0.03)	0.46 (0.03)	0.45 (0.04)	0.41 (0.02)
$S_{B(MD)}$	0.53 (0.04)*	0.05 (0.02)*	0.09 (0.03)*	0.06 (0.02)*		0.18 (0.01)		0.00[a]	0.00	0.00	0.00
$S_{Total(MD)}$	0.68 (0.03)	0.28 (0.03)	0.24 (0.03)	0.30 (0.03)		0.37 (0.01)		0.30 (0.03)	0.45 (0.03)	0.41 (0.04)	0.39 (0.02)
$S_{A(SD)}$	0.89 (0.03)	0.83 (0.03)	0.74 (0.04)	0.85 (0.03)		0.83 (0.02)		0.78 (0.04)	0.82 (0.02)	0.89 (0.03)	0.83 (0.02)
$S_{B(SD)}$	0.91 (0.03)	0.75 (0.04)	0.71 (0.04)	0.77 (0.04)		0.78 (0.02)		0.80 (0.08)	0.62 (0.17)	0.23 (0.11)	0.55 (0.07)
$S_{Total(SD)}$	0.90 (0.02)	0.79 (0.03)	0.72 (0.03)	0.81 (0.03)		0.81 (0.01)		0.78 (0.04)	0.81 (0.02)	0.84 (0.03)	0.81 (0.02)

* Significantly different at $\alpha = 0.05$

[a] No tags were detected in subroute "C" or insufficient tags were detected to subroute "C" for use in analysis. No estimate for survival in subroute C was available.

Table 3b: Performance metric estimates for tagged juvenile steelhead for study years 2013 -2014, excluding predator – type detections. Standard errors in parentheses.

Parameter	Year							
	2013				2014			
	Release Groups				Release Groups			
	1	2	3	Pop Est.	1	2	3	Pop Est
Ψ_{AA}	NA[a]	0.07(0.02)	0.11 (0.02)	NA[a]	NA[a]	0.66 (0.03)	0.77 (0.08)	0.71 (0.04)
Ψ_{AF}	NA[a]	0.06 (0.02)	0.05 (0.02)	NA[a]	NA[a]	0.30 (0.03)	0.11 (0.07)	0.21 (0.04)
Ψ_{BB}	0.89 (0.02)	0.85 (0.02)	0.83 (0.02)	0.86 (0.01)	0.87 (0.03)	0.04 (0.01)	NA[a]	NA[a]
Ψ_{BC}	0.03 (0.01)	0.02 (0.01)	0.01 (0.01)	0.02 (<0.01)	0.04 (0.02)	0.00 (<0.01)	NA[a]	NA[a]
S_{AA}	NA[a]	0.19 (0.07)	0.31 (0.07)	NA[a]	NA[a]	0.57 (0.03)	0.07)0.03)	0.32 (0.02)
S_{AF}	NA[a]	0.06 (0.05)	0.00	NA[a]	NA[a]	0.13 (0.03)	NA[a]	NA[a]
S_{BB}	0.17 (0.02)	0.08 (0.02)	0.20 (0.03)	0.15 (0.01)	0.20 (0.04)	0.33 (0.09)	NA[a]	NA[a]
S_{BC}	0.07 (0.05)	0.06 (0.04)	0.06 (0.06)	0.06 (0.03)	0	NA[a]	NA[a]	NA[a]
Ψ_{A}	0.08 (0.02)	0.12 (0.02)	0.16 (0.02)	0.12 (0.01)	0.09 (0.02)	0.96 (0.01)	0.88 (0.03)	0.92 (0.02)
Ψ_{B}	0.92 (0.02)	0.88 (0.02)	0.84 (0.02)	0.88 (0.01)	0.91 (0.02)	0.04 (0.01)	0.12 (0.03)	0.08 (0.02)
S_{A}	0.00	0.13 (0.05)	0.20 (0.06)	0.11 (0.03)	0	0.43 (0.03)	0.06 (0.02)	0.25 (0.02)
S_{B}	0.16 (0.02)	0.08 (0.02)	0.20 (0.02)	0.15 (0.01)	0.19 (0.03)	0.31 (0.09)	0.07 (0.07)	0.19 (0.06)
S_{Total}	0.15 (0.02)	0.09 (0.02)	0.20 (0.02)	0.15 (0.01)	0.18 (0.03)	0.43 (0.03)	0.06 (0.02)	0.24 (0.02)
$S_{A(MD)}$	0.00	0.13 (0.05)	0.24 (0.06)	0.12 (0.03)	NA[a]	0.44 (0.03)	0.07 (0.03)	0.26 (0.02)
$S_{B(MD)}$	0.01 (0.01)	0.01 (0.1)	0.06 (0.02)	0.03 (0.01)	NA[a]	0	NA[a]	NA[a]
$S_{Total(MD)}$	0.01 (0.01)	0.03 (0.01)	0.09 (0.02)	0.04 (0.01)	NA[a]	0.43 (0.03)	NA[a]	NA[a]
$S_{A(SD)}$	NA[a]	0.23 (0.07)	0.37 (0.07)	NA[a]	NA[a]	0.77 (0.02)	0.16 (0.04)	0.46 (0.02)
$S_{B(SD)}$	0.53 (0.03)	0.56 (0.03)	0.75 (0.03)	0.61 (0.02)	0.56 (0.04)	0.83 (0.09)	NA[a]	NA[a]
$S_{Total(SD)}$	NA[a]	0.52 (0.03)	0.69 (0.03)	NA[a]	NA[a]	0.77 (0.02)	NA[a]	NA[a]

[a] NA estimates resulted when there were too few tags detected in the route to estimate route selection and/or survival.

Table 4: Heat Map Depicting Steelhead Survival Rates ($S^{(1/km)}$) Through San Joaquin River Reaches to Chipps Island.

Reach Name		Survival Estimate per km ($S^{(1/km)}$)					
	km	2011		2012		2013	2014
		CAMT SST	6-year Rpt	CAMP SST	6-year Rpt	6-year Rpt	6-year Rpt
Durham Ferry to Banta Carbona	11	0.962	0.9765	0.967	0.986	0.988	0.973
Banta Carbona to Mossdale	10	0.982	0.985	0.978	0.980	0.985	0.980
Mossdale to Lathrop/Old River	4	0.985	0.985	0.995	0.995	0.995	0.966
Lathrop to Garwood Bridge (SJR)	18	0.995	0.995	0.997	0.997	0.948	0.974
Garwood Bridge to Navy Bridge	3	0.993	0.993	0.990	0.990	0.958	0.976
Navy Bridge to Turner Cut/MacDonald Island	15	0.997	0.997	0.994	0.994	0.984	0.984
MacDonald Island to Medford Island	5	0.942	0.949	0.923	0.941		
Turner Cut to Jersey Point (includes interior Delta route but not SJR route)	28	0.958	0.957	0.934	0.933		
Medford to Jersey Point	21	0.992		0.987			
Jersey Point to Chipps Island	22	0.997		0.989			

Note: Darker red boxes have lower survival values and lighter boxes indicate higher survival rates (white ≥ 99% survival/km). Missing values reflect sparse data in the reach in question or the study had deficiencies that prevented estimates to be made.

Table 5: Heat Map depicting Survival Rates ($S^{(1/km)}$) through Old River Reaches to Chipps Island.

Reach Name		Survival Estimate per km ($S^{(1/km)}$)					
	km	2011		2012		2013	2014
		CAMT SST	6-year Rpt	CAMP SST	6-year Rpt	6-year Rpt	6-year Rpt
Old River (Head) to Middle River Head/ Old River (south)	6	0.990	0.9897	0.977	0.977	0.990	0.948
Old River (South) to CVP/CCF/HWY4	20	0.994	0.988	0.977	0.977	0.981	0.983
Old River (HWY4) to Jersey Point	60	0.992	0.992	0.958		0.972	0.978
CVP Holding Tank to Chipps Island	15	0.988	0.992	0.973	0.965	0.987	1.0/0.98
CCF Radial Gate (interior) to Chipps Island	24	0.979	0.983	0.924	0.914	0.957	0/ 0.95

Note: Darker red boxes have lower survival values and lighter boxes indicate higher survival rates (white ≥ 99% survival/km). Missing values reflect sparse data in the reach in question or the study had deficiencies that prevented estimates to be made.

Yellow highlighted cells have two survival estimates. Estimate from the first release in 2014 have a survival rate of 98% from the CVP holding tank to Chipps Island, and a survival rate of 95% from the CCFB interior radial gates to Chipps Island based on a joint tag survival and fish survival estimates due to premature tag failures occurring in the first release group. The 100 % survival for the CVP estimate is based on the second and third releases with a total of 12 fish detected in the holding tank and 12 fish detected at Chipps Island. The zero survival for the CCFB radial gate to Chipps Island is based on 3 fish detected at the interior radial gate with none subsequently detected at Chipps Island.

Figure 1: Locations of Acoustic Receivers (general locations) as each study had a small number of additional/ removed or relocated acoustic receiver locations. (2012 study locations used as an example).

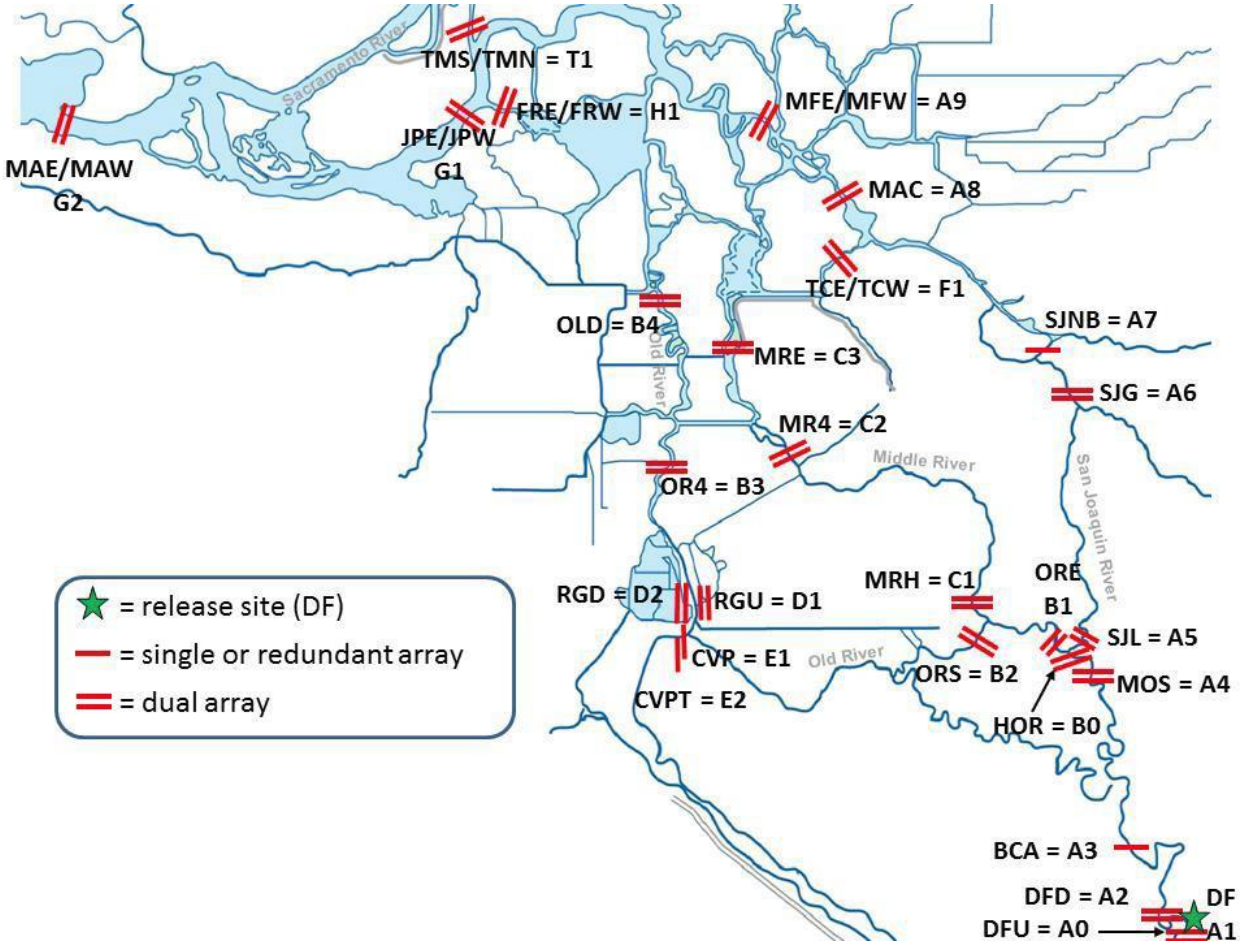


Figure 2: March through June Vernalis Flows for Study Years 2011 – 2014 with release groups.

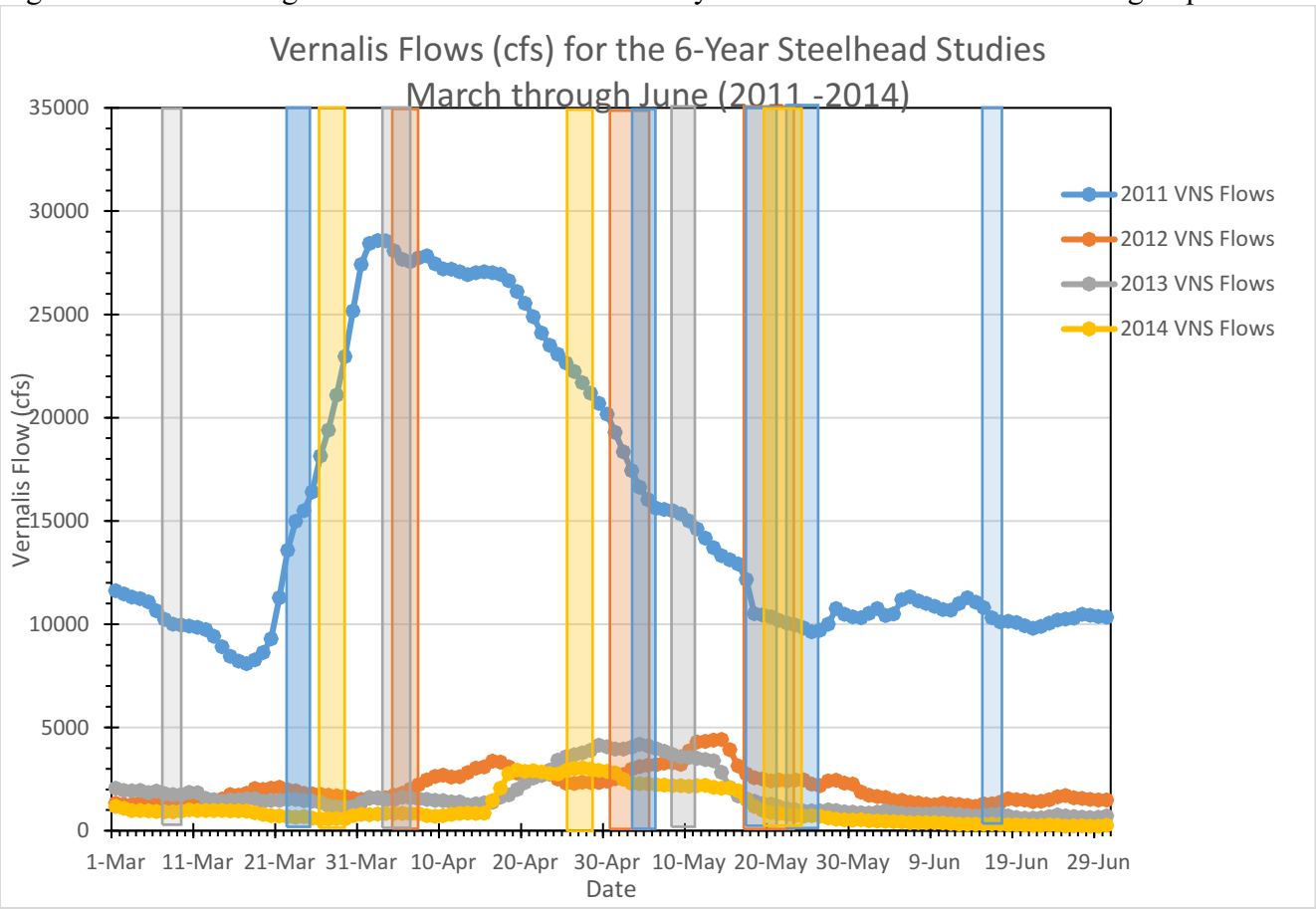
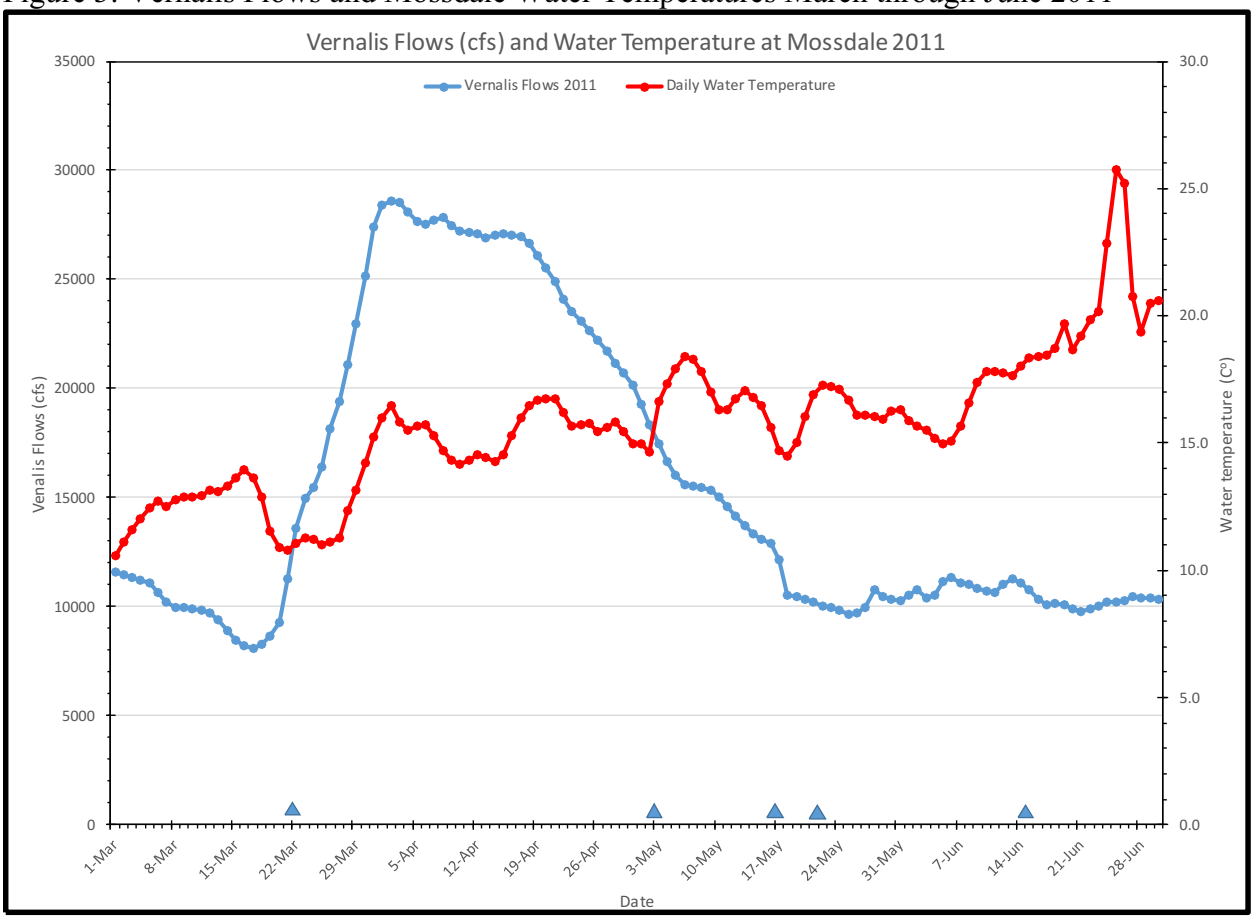
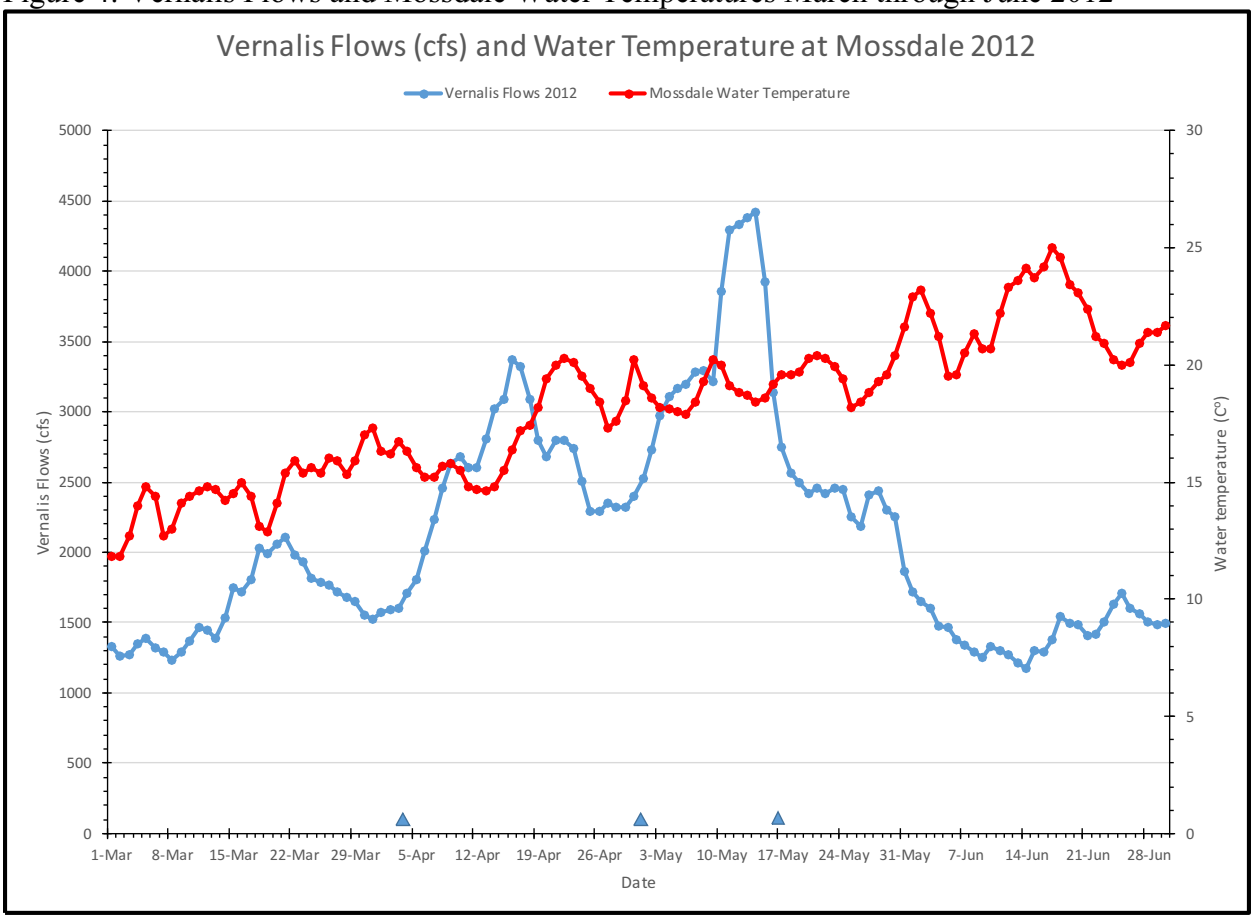


Figure 3: Vernalis Flows and Mossdale Water Temperatures March through June 2011



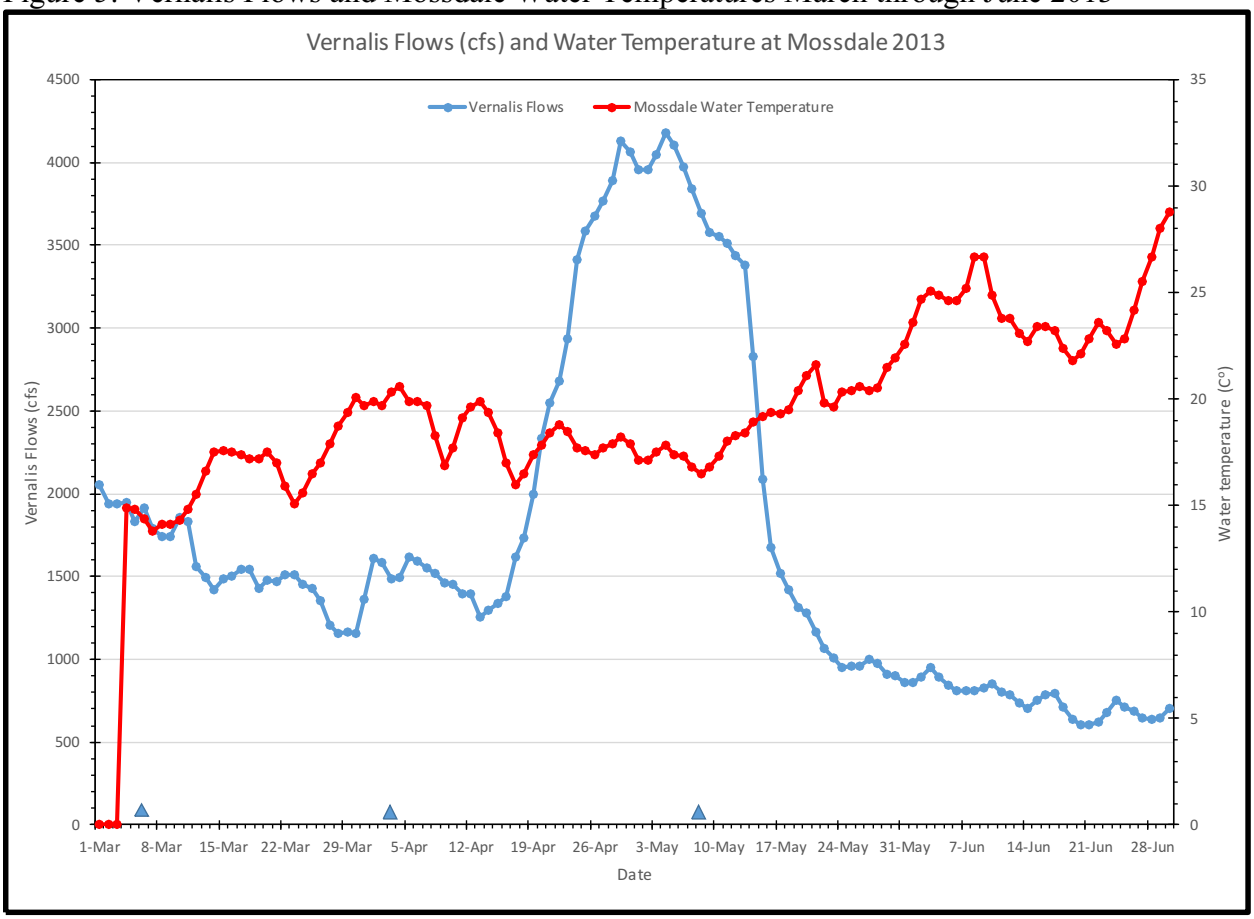
Triangles depict the initial date of releases for each release groups

Figure 4: Vernalis Flows and Mossdale Water Temperatures March through June 2012



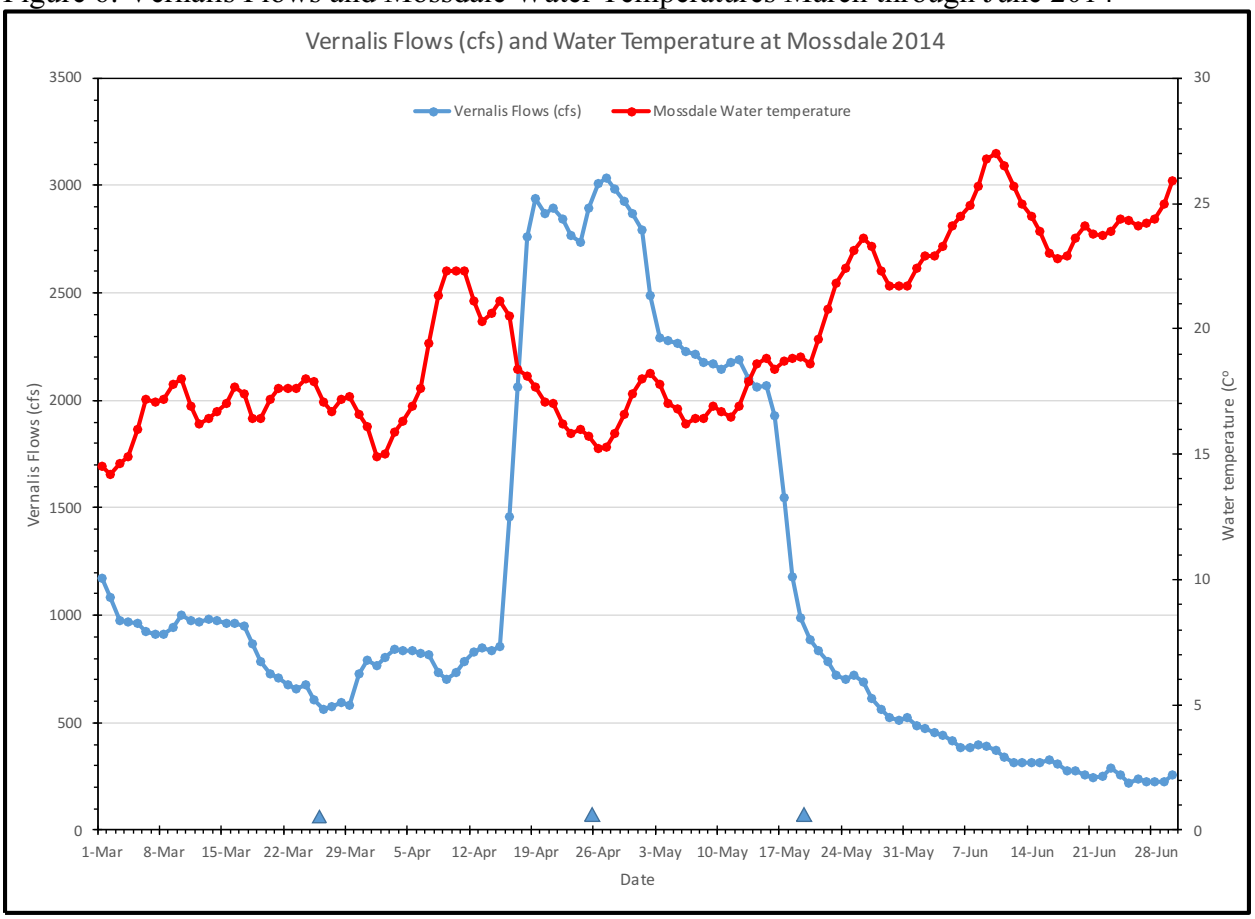
Triangles depict the initial date of releases for each release groups

Figure 5: Vernalis Flows and Mossdale Water Temperatures March through June 2013



Triangles depict the initial date of releases for each release groups

Figure 6: Vernalis Flows and Mossdale Water Temperatures March through June 2014



Triangles depict the initial date of releases for each release groups

Figure 7: Cumulative survival from releases at Durham Ferry to various points along the San Joaquin River route to Chipps Island by surgeon (2012 study). Error bars are 95% confidence intervals.

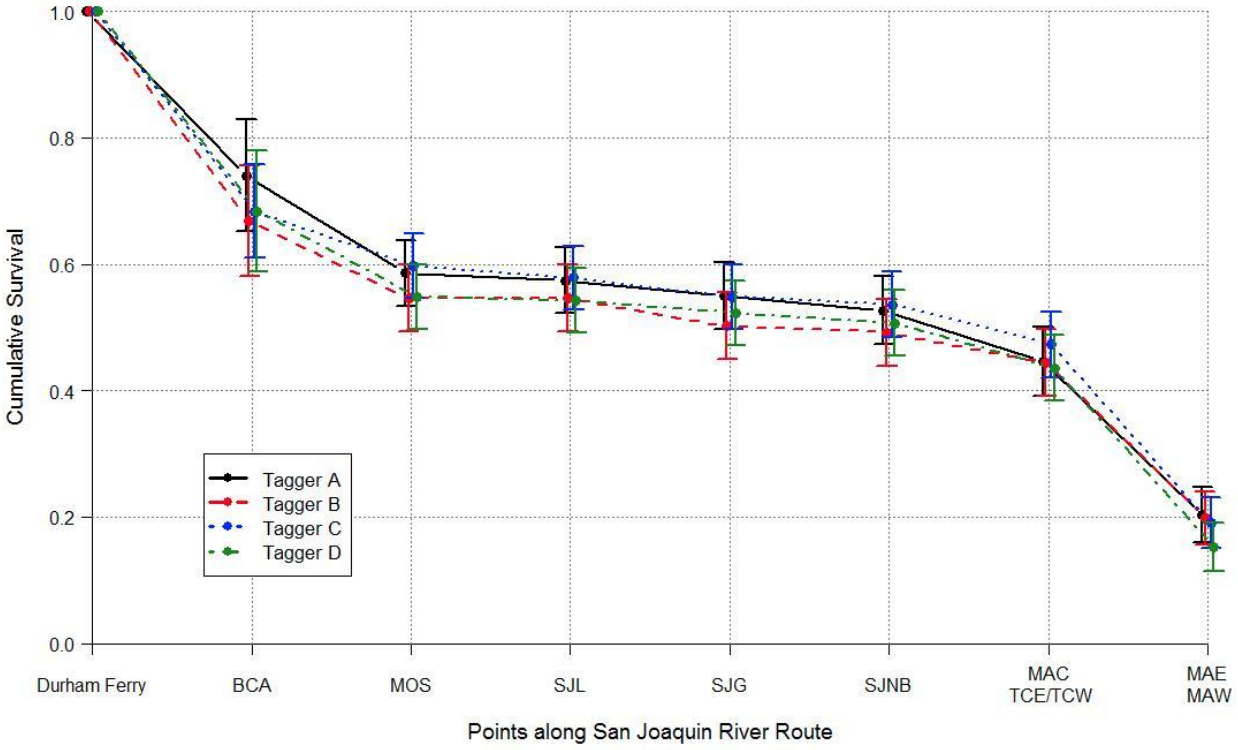


Figure 8: Cumulative survival from releases at Durham Ferry to various points along the Old River route to Chipps Island by surgeon (2012 study). Error bars are 95% confidence intervals.

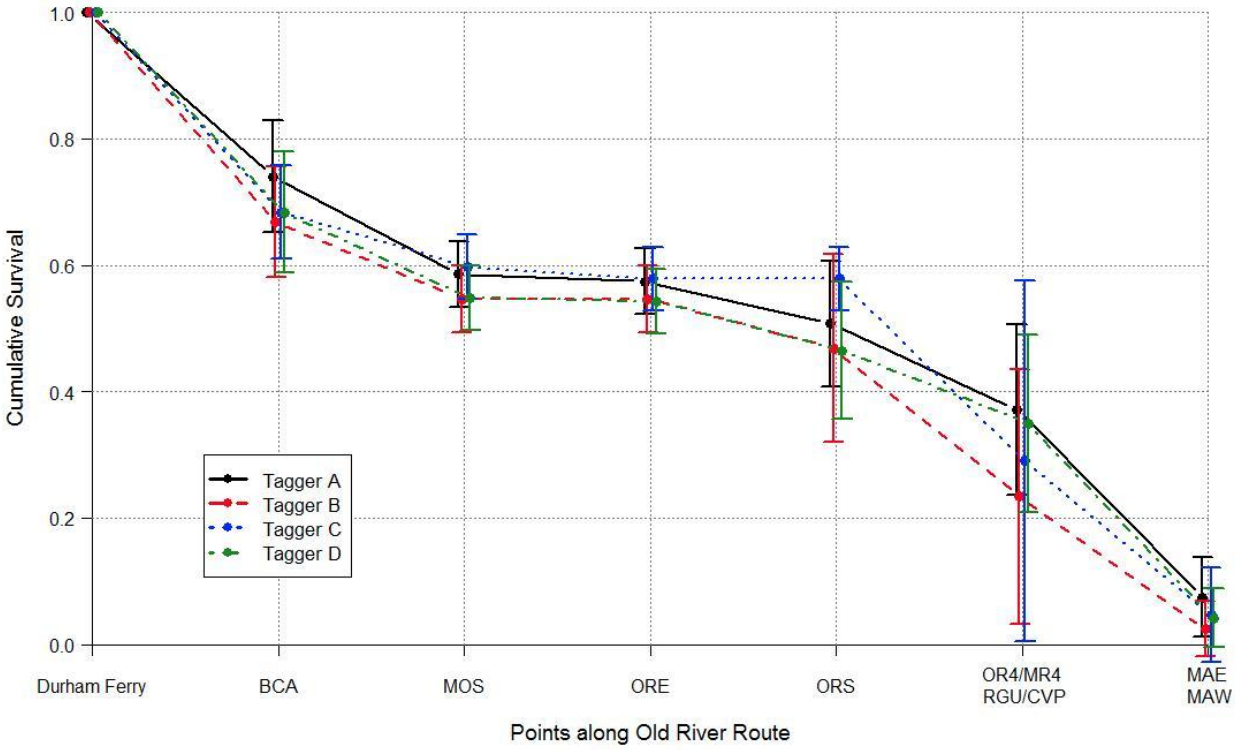


Figure 9: Cumulative survival from releases at Durham Ferry to various points along the San Joaquin River route to Chipps Island by surgeon (2013 study). Error bars are 95% confidence intervals.

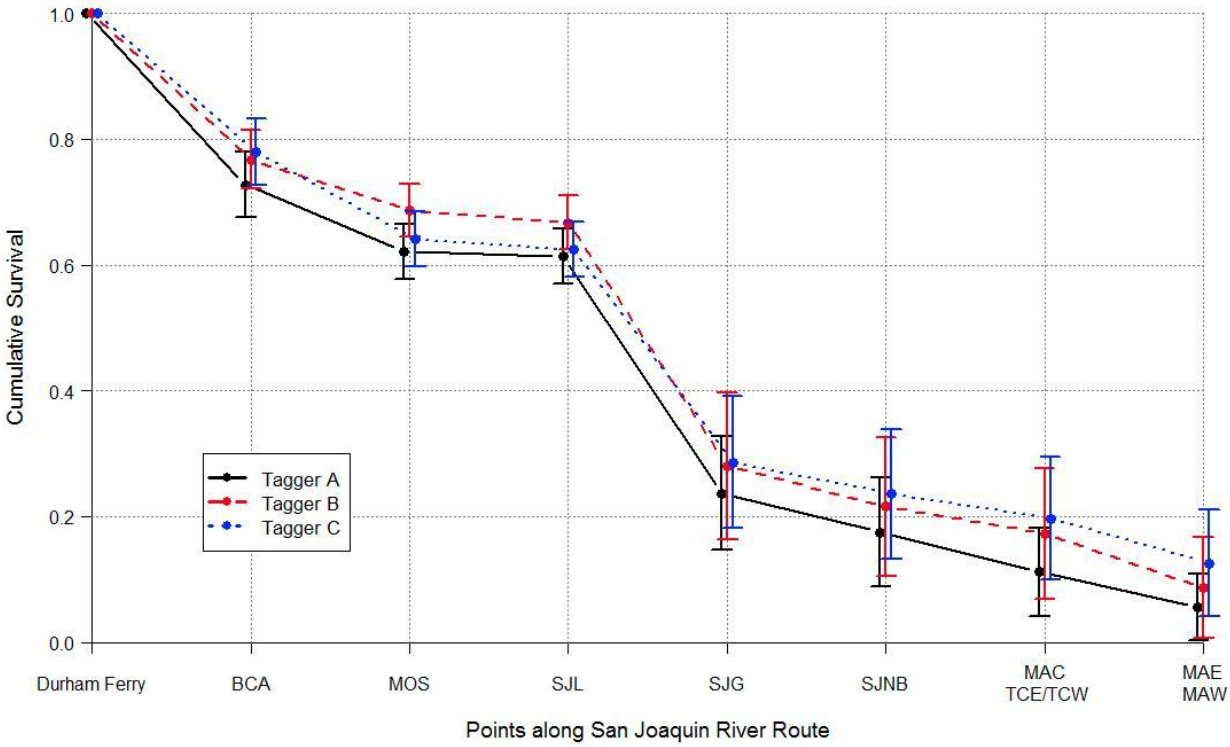


Figure 10: Cumulative survival from releases at Durham Ferry to various points along the Old River route to Chipps Island by sturgeon (2013 study). Error bars are 95% confidence intervals.

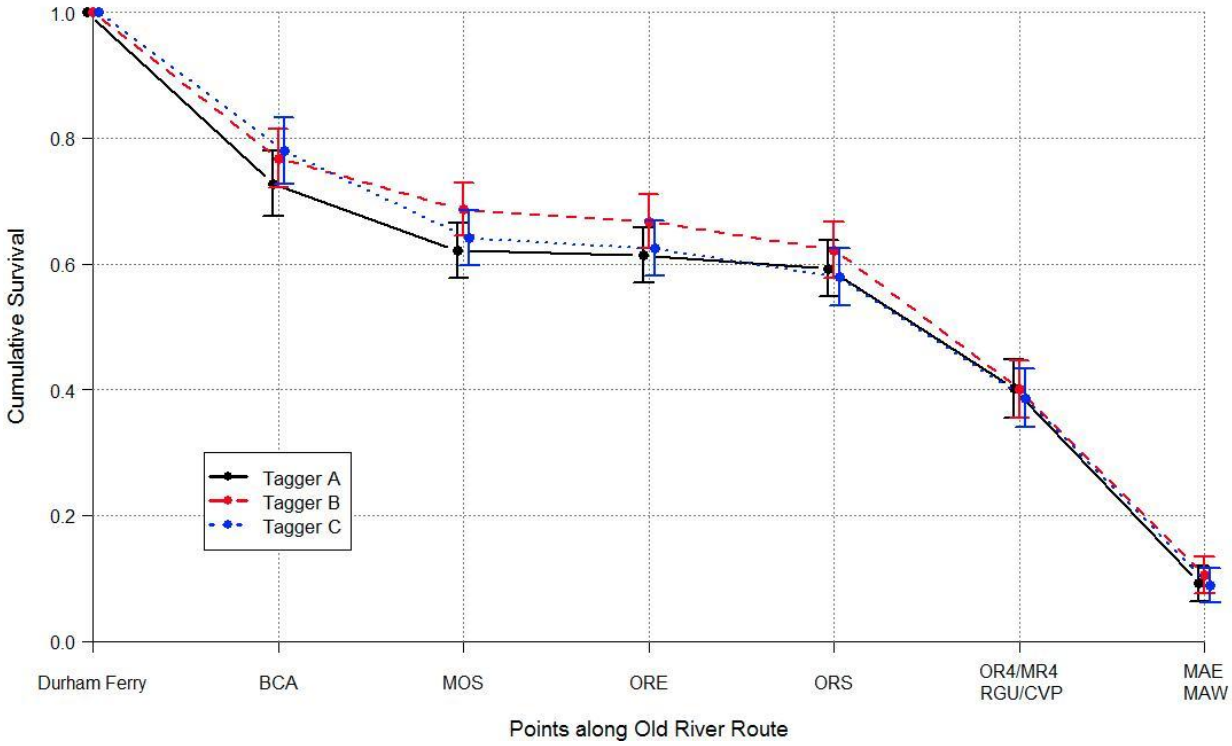


Figure 11: Cumulative survival from releases at Durham Ferry to various points along the San Joaquin River route to Chipps Island by sturgeon (2014 study). Error bars are 95% confidence intervals. Estimates are of joint fish-tag survival.

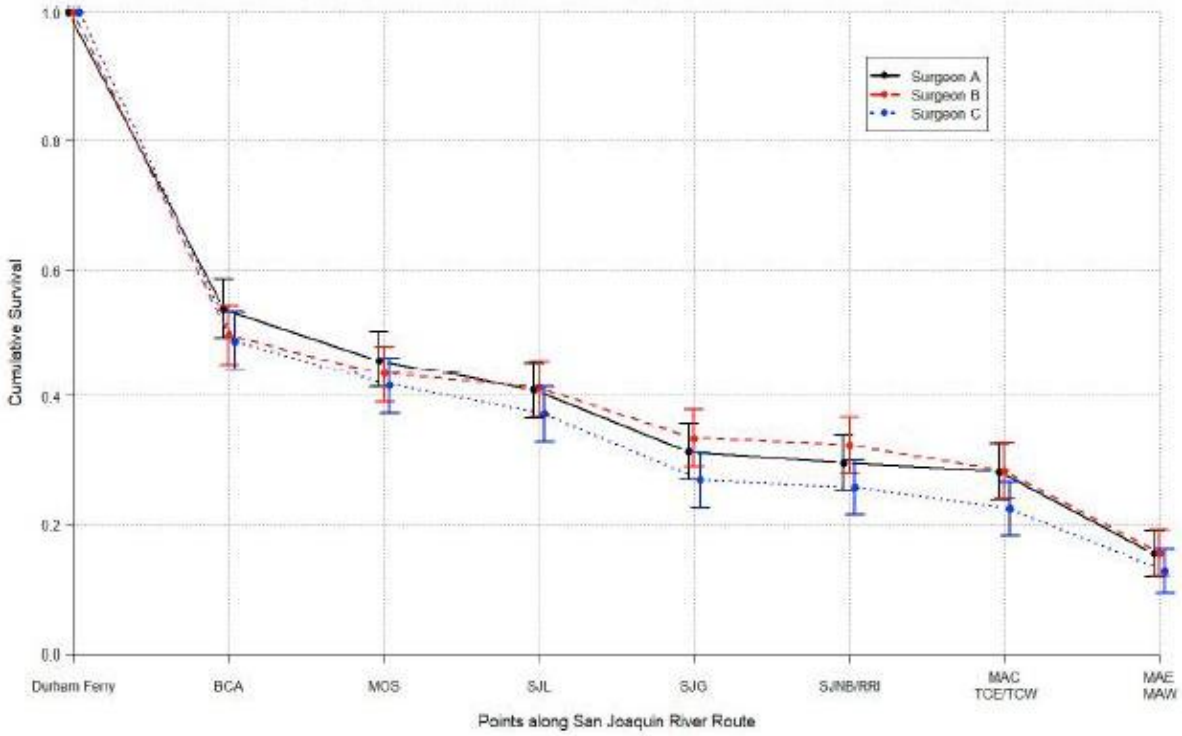
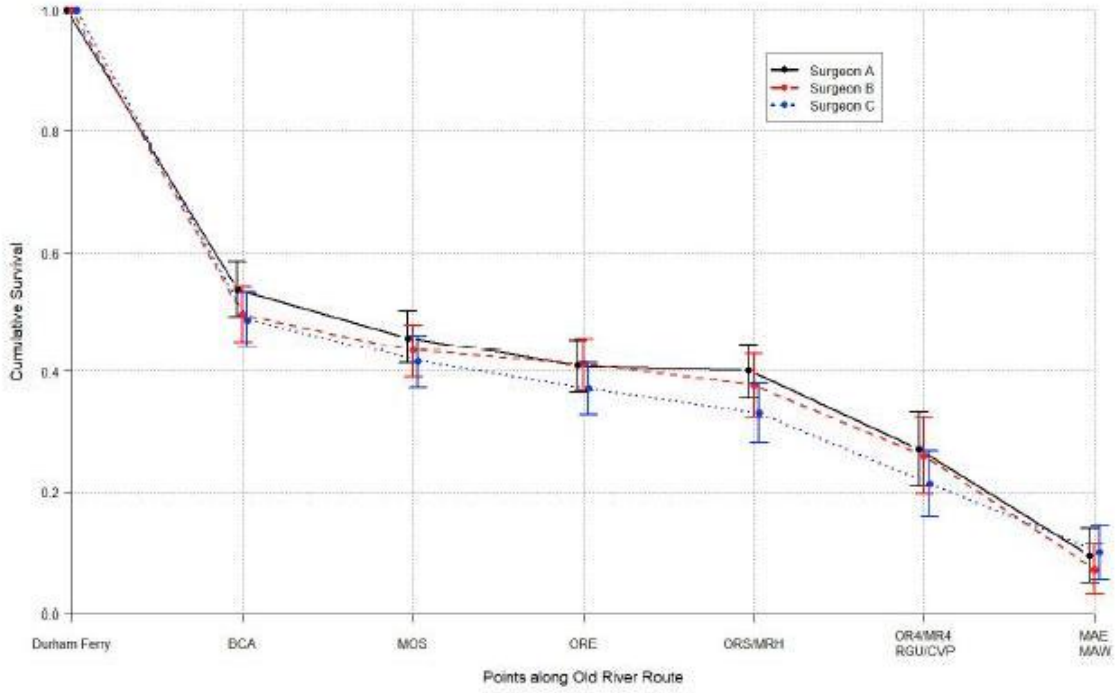


Figure 12: Cumulative survival from releases at Durham Ferry to various points along the Old River route to Chipps Island by sturgeon (2014 study). Error bars are 95% confidence intervals. Estimates are of joint fish-tag survival.



Summary of SWFSC report to USBR on analysis on subset of Steelhead "6-year Study" acoustic telemetry data

Background: The SWFSC (Dr. Andrew Hein) used a subset of six-year study steelhead acoustic telemetry data at five hydrophone arrays in the Delta to understand the relationship between the instantaneous migration rate and environmental variables using a novel point process statistical model framework. The instantaneous migration rate refers to the minute-by-minute fish movements into the zone within range of detection by a hydrophone array, rather than the long-term movements of fish throughout the system.

Methods (refer to Fig. 1): Acoustically tagged fish were released at Durham Ferry (release location) and subset for analysis purposes to include mostly 2011 data. The environmental variables of interest were turbidity, conductivity, temperature, diel phase, discharge, and the rate of discharge over time. These data were subjected to a symbolic regression (point process model) aimed at generating a variety of models to predict the instantaneous movement behavior in response to different environmental variables, specifically the expected arrival of fish at location x and time t.

Results (refer to Fig. 2): Discharge, conductivity and turbidity were the variables that most often had the strongest relationship with the arrival rate of steelhead at the subset of hydrophone arrays investigated. The conditional effects of each environmental variable (varying one variable at a time while holding all others at their mean value) for each hydrophone array location are described below:

- At **BCA** (near release site), arrivals of fish were negatively related to discharge, and positively related with warmer and more turbid water conditions.
- At **SJL,** turbidity and temperature exerted dominant effects on arrival rates with a slightly less pronounced effect of water conductivity, however discharge did not have a strong influence. The conductivity effect was stronger than at other arrays higher in the river.
- At **Turner Cut (C18/16),** a more tidally influenced region, the fish moved most with high conductivity, discharge, temperature and turbidity – with discharge and conductivity having the strongest positive relationship with arrivals. (More tidal region)
- At **Jersey Point (JPT),** arrival rates were positively correlated with conductivity with less influence to no relationship with other variables. (More tidal region)
- At the **Old River (ORN)** hydrophone array, there was a different pattern in arrivals in relation to environmental variables than at other arrays investigated here. Specifically, predicted fish arrival rates increased with strong negative flows and with positive flows (a non-linear relationship) with also a small net positive effect of turbidity.

Caveats: The analysis in this report was done as a proof of concept for the modelling framework, not to answer specific management related questions. Only one full year of data was used (2011) and as such results only provide a partial understanding of conditions that might affect steelhead movement during dry years. Further, models assume that detection probability for a given hydrophone array are constant but there is likely different detection probabilities through time for each array. The models also do not necessarily use the most representative

(closest) gauge data for environmental data to model with arrival detections. Other gauges or hydrological models might be appropriate to use here to couple environmental conditions with arrival detections at hydrophone locations.

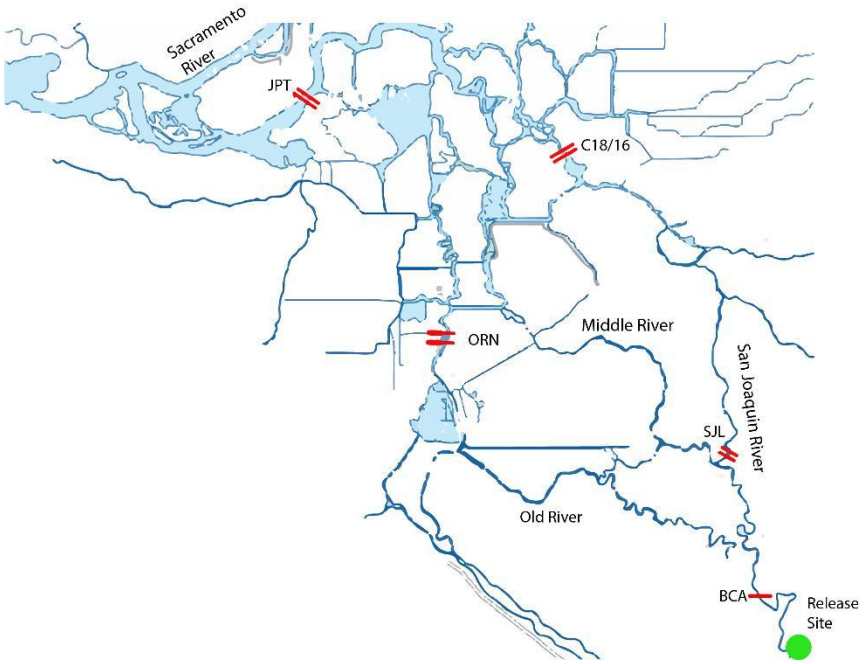


Figure 1. Map of the Sacramento/San-Joaquin Delta with locations of single or dual hydrophone arrays (represented by one and two red bars, respectively) used in the analysis.

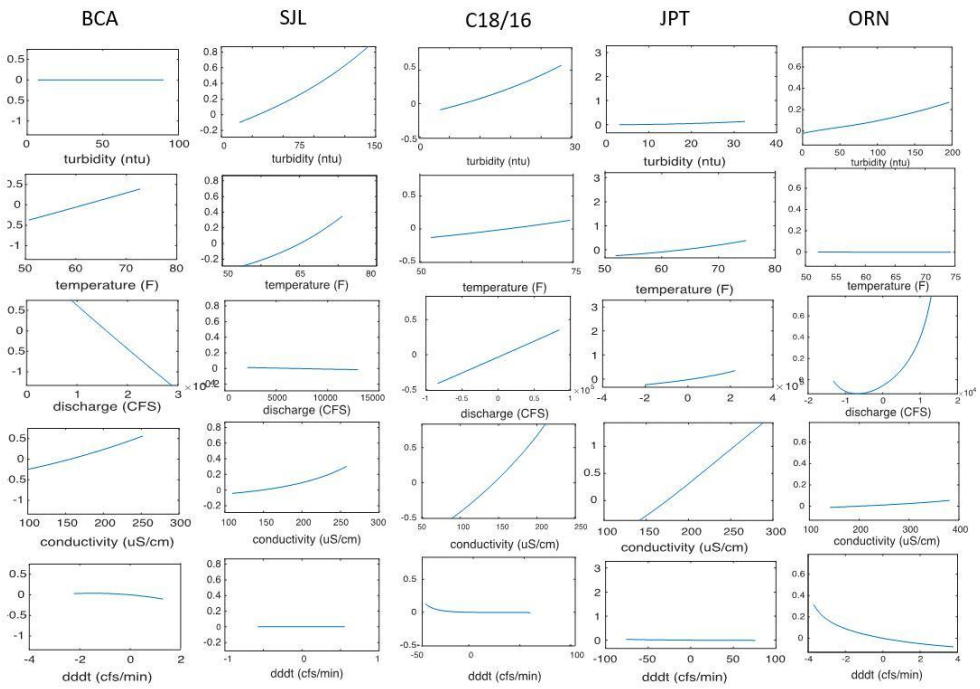


Figure 2. Model averaged conditional effect of each environmental variable (holding others constant at mean values) on arrival rates for each hydrophone array within the Delta. Column names (BCA, SJL, C18/16, JPT, ORN) refer to individual hydrophone arrays within the Delta identified in Fig 1.

Chinook survival results

Results from:

Brandes et al. 2017, Multivariate San Joaquin River Chinook Salmon Survival Investigation, 2012-2013. USFWS report. 6 October 2017.

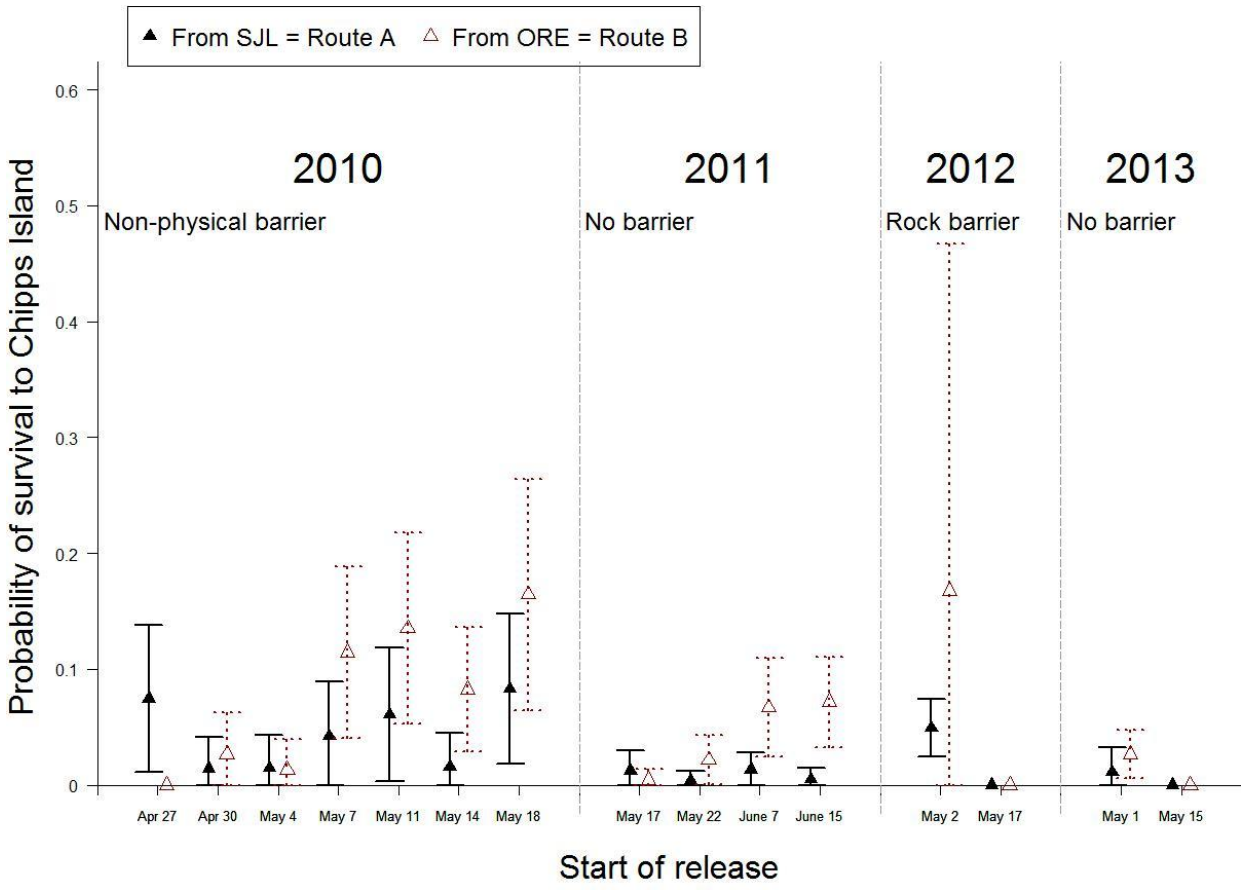


Figure 1. Estimated probabilities of surviving from the head of Old River (SJL or ORE receivers) to Chipps Island for the San Joaquin River route (Route A) and the Old River route (Route B), for each study year and release group; bars indicate asymptotic 95% confidence intervals. Route is determined at the head of Old River; salmon in the San Joaquin River route may enter the interior Delta further downstream.

Annotated Lit Review I to E ratio_Byrne
August 2018

Selected Delta-related references relevant to water project-related effects in the south Delta

Prepared by Barb Byrne, NMFS California Central Valley Office
August 2018

Note: *Takeaway bullets and quotes have been selected as being most relevant to the recently proposed draft Initial Actions in the reinitiation effort related to OMR management or the I:E ratio and do not represent all key conclusions of the citations.*

1) California Department of Water Resources (2014). Stipulation Study: Steelhead Movement and Survival in the South Delta with Adaptive Management of Old and Middle River Flows. Prepared by David Delaney, Paul Bergman, Brad Cavallo, and Jenny Melgo (Cramer Fish Sciences) under the direction of Kevin Clark (DWR). February 2014.

http://baydeltaoffice.water.ca.gov/announcement/Final_Stipulation_Study_Report_7Feb2014.pdf

Takeaway Bullet: I believe that the conclusions drawn in this report are overbroad and only weakly caveated in the report. Analysis focused primarily on junctions with the San Joaquin River rather than on movement behavior within south Delta channels yet draws broad conclusions about effects of OMR in general.

Quote (p. ES-4): The statement "Under the OMR flow treatments tested in this study, there appeared to be little influence of OMR flows tested on steelhead tag travel times on the route-level and steelhead tag movement at the junctions and routes examined in this study (p. ES-3)" is technically correct but may be misleading to those not aware that the bulk of the analysis was in the mainstem San Joaquin River route and thus not necessarily applicable to the OMR corridor itself. Despite the limited range of OMR flows, small sample sizes, and focus on conditions in the mainstem San Joaquin River, the executive summary goes on to conclude (in my opinion, improperly) that "There is little evidence that altering OMR flows within the range that we examined in this study would alter fish behavior in a meaningful way".

Caveat: Limitations in the range of OMR conditions tested, changes to OMR within treatment periods, and relatively low power tests should be taken into consideration when interpreting the results of the stipulation study. The report reflects the outcomes of the statistical analysis of selected hypotheses at a few locations in the south Delta and, in my opinion, does not support broad conclusions about fish movement in the interior Delta in relation to OMR flows.

2) del Rosario, R. B., Y. J. Redler, K. Newman, P. L. Brandes, T. Sommer, K. Reece and R. Vincik (2013). "Migration Patterns of Juvenile Winter-run-sized Chinook Salmon (*Oncorhynchus tshawytscha*) through the Sacramento–San Joaquin Delta." San Francisco Estuary and Watershed Science 11(1).

https://escholarship.org/uc/item/36d88128

Takeaway Bullet: Winter-run Chinook salmon enter the Delta as early as October in some years and may make their way to the south Delta and be exposed to water-project-related hydrodynamic effects.

*Quote (from abstract): "*Winter-run passed Knights Landing…between October and April, with substantial variation in peak time of entry that was strongly associated with the first high flows of the migration season. Specifically, the first day of flows of at least 400 m3 s-1 [~14,000 cfs] at Wilkins Slough (rkm 190) coincided with the first day that at least 5% of the annual total catch was observed at Knights Landing. … Differences in timing of cumulative catch at Knights Landing and Chipps Island indicate that apparent residence time in the Delta ranges from 41 to 117 days, with longer apparent residence times for juveniles arriving earlier at Knights Landing."

Caveat: Juvenile Chinook salmon were identified to race based on the length-at-date classification system, which has some uncertainty, but probably less so in the October and November time-frame when winter-run Chinook are essentially the only young-of-year Chinook run present in the system.

3) Hankin, D., D. Dauble, J. Pizzimenti, and P. Smith (2010). The Vernalis Adaptive Management Program (VAMP): Report of the 2010 Review Panel. Prepared for the Delta Science Program. May 13, 2010.

http://www.sjrg.org/peerreview/review_vamp_panel_report_final_051110.pdf

Takeaway Bullet: Complex hydrodynamics in the Delta, multiple stressors affecting salmonid survival, and a limited range of experimental conditions limit the inferences possible from the VAMP studies.

Quotes:
(p. 9) "Regarding export objectives, our feeling is that it makes sense during VAMP to continue limiting exports to some fraction of San Joaquin River flow at Vernalis so that the entire flow of the San Joaquin River is not diverted and so that reverse flows, if they occur, are not large. We cannot, however, offer any guidance as to what the Vernalis flow/export ratio should be…However, we do not believe that migration through Old River and subsequent salvage trucking and release is a desirable route for downstream migrating smolts. To the maximum extent possible, migration through the mainstem San Joaquin channel should be encouraged."

(p. 3) "The complexities of Delta hydraulics in a strongly tidal environment, and high and likely highly variable impacts of predation, appear to affect survival rates more than the river flow, by itself, and greatly complicate the assessment of effects of flow on survival rates of smolts. And overlaying these complexities is an apparent strong trend toward reduced survival rates at all flows over the past ten years in the Delta. Nevertheless, the evidence supports a conclusion that increased flows generally have a positive effect on survival and that it is desirable, to the extent feasible, to reduce or eliminate downstream passage through the Old River channel. The panel understands, of course, that flow, exports, and the placement of barriers in the Delta are the variables affecting survival that are most easily managed."

Caveat: See takeaway bullet.

4) Johnson, R. C., S. Windell, P. L. Brandes, J. L. Conrad, J. Ferguson, P. A. L. Goertler, B. N. Harvey, J. Heublein, J. A. Israel, D. W. Kratville, J. E. Kirsch, R. W. Perry, J.

Pisciotto, W. R. Poytress, K. Reece and B. G. Swart (2017). "Science Advancements Key to Increasing Management Value of Life Stage Monitoring Networks for Endangered Sacramento River Winter-Run Chinook Salmon in California." San Francisco Estuary and Watershed Science 15(3).

https://doi.org/10.15447/sfews.2017v15iss3art1

Takeaway Bullet: Our ability to evaluate risks to listed salmonids at finer spatial and temporal scales may require changes to our monitoring.

*Quote (from abstract): "*We concluded that the current monitoring network was insufficient to diagnose when (life stage) and where (geographic domain) chronic or episodic reductions in SRWRC cohorts occur, precluding within- and among-year comparisons. …We identified six system-wide recommended actions to strengthen the value of data generated from the existing monitoring network to assess resource management actions: (1) incorporate genetic run identification; (2) develop juvenile abundance estimates; (3) collect data for life history diversity metrics at multiple life stages; (4) expand and enhance real-time fish survival and movement monitoring; (5) collect fish condition data; and (6) provide timely public access to monitoring data in open data formats."

Caveat: Most of the recommended actions will require additional resources for implementation.

5) Monismith, S., M. Fabrizio, M. Healey, J. Nestler, K. Rose and J. Van Sickle (2014). Workshop on the Interior Delta Flows and Related Stressors: Panel Summary Report. Prepared for the Delta Science Program. July 2014.

http://deltacouncil.ca.gov/sites/default/files/documents/files/Int-Flows-and-Related-Stressors-Report.pdf

Takeaway Bullet: The migration of both Chinook fry and smolts may be disrupted by interior Delta flow fields; steelhead may also be affected but less so given their larger size.

Quotes:
(p. 37): "Chinook salmon fry are not strong swimmers and typically hold in shallow embayments or use structures to keep from being carried along by the prevailing current. Kjelson et al. (1982) noted that beach seine catches of Chinook salmon fry in the Delta dropped significantly at night, suggesting fry were moving away from shallow nearshore areas at night. Larger fry were captured further offshore, near the surface during the day but broadly distributed in the water column at night. If the fry move away from shore at night they would lose visual and tactile clues to their position and would likely simply be carried by the currents. This is characteristic of salmon fry (and smolt) behavior during downstream migration, which occurs primarily at night due to passive drift, but may be less functional in the tidal Delta. In the historic Delta, with its extensive marshes and many blind ending dendritic channels, simply drifting at night might not take the fry very far. In the modern Delta, however, with open trapezoidal channels and high-velocity tidal currents, fry might be carried a considerable distance in the Delta and find themselves in unfavorable habitats when light returns."

(p. 39-40): "Although Chinook salmon smolts do not go with the flow strictly in proportion to discharge they do make use of flow during migration. This raises the possibility that they could be confused by reverse flows in OMR. Because of the reverse flows in OMR when exports are large, the smolts are likely to receive mixed signals from tidal flux as water could be moving toward the pumps on both flood and ebb tides depending on the operation of the gates to Clifton Court Forebay (CCF). In this case, smolts may find themselves virtually trapped within OMR over several tidal cycles and potentially attracted into CCF because of inappropriate signals from water chemistry and flow. Since conveyance through the Delta is designed to ensure high quality of export waters (i.e., low salinity) it may be that near the pumps there is insufficient salinity signal on the tidal flow to direct the smolts and they simply go with the flow toward the pumps expecting that it is carrying them downstream. Salmon also make use of compass orientation during their migrations although the extent to which they might use this ability in the Delta is uncertain. It is possible that they might recognize that moving southward in OMR was inappropriate but whether they would be motivated to make some kind of corrective action is unknown."

(p. 44): "It appears that steelhead, which are larger than Chinook salmon smolts, are less affected by interior Delta flow fields, move through the Delta more quickly than Chinook salmon and experience greater survival. Nevertheless, steelhead are entrained into CCF and into the export pumps suggesting that some of the cues and clues they receive during their migration through the Delta lead them in the wrong direction."

Caveat: The report notes that "*(p. 74)* the vast majority of inferences about the effects of flows in the Delta on listed species are based on correlation analyses. Although correlation analysis is a useful first step when searching for relationships among variables, it often tells little or nothing about cause and effect" and "*(p. 75)* Fish in the Delta are subject to a large number of stressors and untangling the independent effects of these stressors has proven very difficult."

6) Perry, R. W., R. A. Buchanan, P. L. Brandes, J. R. Burau and J. A. Israel (2016). "Anadromous Salmonids in the Delta: New Science 2006–2016." San Francisco Estuary and Watershed Science 14(2).

http://dx.doi.org/10.15447/sfews.2016v14iss2art7

Takeaway Bullet: This paper covers a lot of topics relevant to the draft proposed Initial Action so have not selected a single takeaway bullet. My selected quote emphasizes the point that more is known about the behavior of salmonid smolts compared to salmonid parr or fry.

Quotes:
(from abstract) "Although much has been learned, knowledge gaps remain about how very small juvenile salmon (fry and parr) use the Delta. Understanding how all life stages of juvenile salmon grow, rear, and survive in the Delta is critical for devising management strategies that support a diversity of life history strategies."

Caveat: None specific to this paper; each of the studies summarized in this paper have their own associated caveats.

7) Salmonid Scoping Team (2017). Effects of Water Project Operations on Juvenile Salmonid Migration and Survival in the South Delta. Volume 1: Findings and Recommendations. January 2017.

http://www.westcoast.fisheries.noaa.gov/central_valley/water_operations/OCAPreports.html

Takeaway Bullet: See selected quotes for key takeaways.

Quotes:
(p. ES-6): "Water export operations contribute to salmonid mortality in the Delta via direct mortality at the facilities, but direct mortality does not account for the majority of the mortality experienced in the Delta; the mechanism and magnitude of indirect effects of water project operations on Delta mortality outside the facilities is uncertain."

(p. ES-6): "The evidence of a relationship between exports and through-Delta survival is inconclusive; the key findings presented in this table are supported by medium or high basis of knowledge, but our basis of knowledge on the relationship between exports and through-Delta survival is low (Appendix E, Section E.6.2.1)."

(p. ES-7): "It is unknown whether equivocal findings regarding the existence and nature of a relationship between exports and through-Delta survival is due to the lack of a relationship, the concurrent and confounding influence of other variables, or the effect of low overall survival in recent years. These data gaps support a recommendation for further analysis of available data, as well as additional investigations to test hypotheses regarding export effects on migration and survival of Sacramento and San Joaquin River origin salmonids migrating through the Delta."

(p. ES-10): "Uncertainty in the relationships between I:E, E:I, and OMR reverse flows and through-Delta survival may be caused by the concurrent and confounding influence of correlated variables, overall low survival, and low power to detect differences (Appendix E, Section E.2.3)."

(p. ES-10):

"• I:E: The relationship between Delta survival of San Joaquin River Chinook salmon and I:E is variable but generally positive for lower I:E values (e.g., I:E less than 3) (Appendix E, Section E.11, Figure E.11-1). Results of these studies are confounded by the use of flow ratios since the same I:E ratio can represent different absolute flow and export rates. These results are further confounded by installation and operations of various South Delta barriers. Data are available from only two years of AT studies using steelhead (Appendix E, Section E.11-4).

• Exports: There was a weak positive association between the through-Delta survival of San Joaquin Chinook salmon and combined exports using the CWT data set, but comparisons are complicated by the correlation between exports and San Joaquin River inflow (Appendix E, Section E.6.2.1)."

Caveat (p. ES-12): "Current understanding of juvenile salmon and steelhead survival in the Delta is constrained by a variety of factors…" [See the list of "Constraints on Understanding" on pages ES-12 to ES-13]

8) Salmonid Scoping Team (2017). Effects of Water Project Operations on Juvenile Salmonid Migration and Survival in the South Delta. Volume 2: Responses to Management Questions. January 2017.

http://www.westcoast.fisheries.noaa.gov/central_valley/water_operations/OCAPreports.html

Takeaway Bullet: If the in-season risk assessments in the draft proposed Initial Actions result in a start to OMR management later than January 1, ESA-listed salmonids (winter-run in most years, spring-run in many years, and steelhead in some years) may not have protection equal to that provided by implementation of the 2009 NMFS BiOp.

Quote (p. ES-2): "Although not capturing the seasonal variation in juvenile movement, the January 1 onset of Old and Middle rivers (OMR) reverse flow management coincides with the presence of winter-run Chinook salmon in most years, spring-run Chinook salmon in many years, and steelhead in some years (Figures 4-1, 4-2, 4-3, and 4-4 in Section 4). If OMR reverse flow management were initiated based on first detection in the Delta rather than a fixed date, OMR reverse flow management would often begin earlier than January 1 for the protection of winter-run or spring-run Chinook salmon, and later than January 1 for the protection of steelhead. The January 1 trigger date provides a general approximation of a date by which juvenile winter-run Chinook have likely entered the Delta and, based on its simplicity for triggering management actions, has utility."

Caveat: See some technical disagreements about OMR management described on pages ES-2 to ES-3

1). **Vogel, D. 2002. Juvenile Chinook salmon radio-telemetry study in the Southern Sacramento-San Joaquin Delta, December 2000-January 2001.**

Take Home Bullet: Fish released at Woodward Island on Old River during higher export conditions (~8,000 to 11,000 cfs) encountered more negative ambient flow conditions in Old River and consistently moved farther south towards the Projects than fish released under low export conditions (2,000 to 4,700 cfs) with more positive net flow conditions in Old River.

Quote: "The single most evident difference in results between the two medium export experiments and the two low export experiments was the behavior of radio-tagged fish during the first day after release. Radio-tagged salmon in releases 1 and 2 (medium export) experienced minimal or no positive (downstream) flow on the first day whereas fish releases 3 and 4 (low export) experienced long periods of high positive flow. The medium export levels dampened out or nearly eliminated any positive or north flows in Old River. Most fish in releases 1 and 2 exhibited a rapid, southerly migration responding to the high negative flow conditions. In contrast, most fish in releases 3 and 4 moved back and forth (i.e. north and south in Old River in response to the ebb (positive) and flood (negative) flow conditions and remained detectable in Old River for a longer duration than those fish in releases 1 and 2."(Page 20)

Caveat: Final disposition of the radio tagged fish was difficult to discern using mobile tracking only during the day. Night time tracking was not feasible in this study. However, if fish were last detected in close proximity to the Projects, it was assumed that they were entrained either into Clifton Court Forebay or the CVP if they were not detected the next morning.

2) **Vogel, D. 2005. The effects of Delta hydrodynamics conditions on San Joaquin River juvenile salmon.**

Take Home Bullets:
1) The overwhelming effects of tidal flows and site specific hydrodynamic conditions at critical channel junctions are likely masking any relationships between survival based solely on Vernalis flows or export levels.
2) Environmental noise overwhelms any survival relationship signal and makes detection of a statistical relationship between physical parameters nearly impossible without increasing sample size or replicates (i.e. low recovery of CWT fish in the VAMP experiments).
3) Fish moved into junctions in proportions that were not anticipated based on flow splits, and that once fish had left the mainstem San Joaquin River into one of the South Delta distributaries, they typically did not re-enter the mainstem at a later date. The lowest entrainment of fish occurred when the net reverse flows and SWP and CVP exports were lowest.

Quote:

"The "zone of influence" delineating exactly where in the central and south Delta that exports have an overriding influence on salmon "entrainment" into the south Delta is presently unknown and would vary depending on export levels. The smolt telemetry study conducted in December 2000-January 2001 provided empirical evidence that the zone of influence extends at least as far north as the northwestern tip of Woodward Island, a distance of approximately nine river miles

north of the CC gates. The two smolt telemetry studies conducted in the mainstem San Joaquin River suggest that the zone of influence is probably much further north (e.g., Turner Cut and Columbia Cut) but the unknown specific regions would depend on many complex and interrelated hydrodynamic variables (e.g., exports, river flows, tides, tidal prisms, localized channel velocities, channel geometry, etc.) combined with fish behavior." (Page 11).

"Also it appears that some smolts, once they move into those south channels do not re-emerge back into the San Joaquin to continue normal migration toward salt water. This latter phenomenon is also not understood. Because of net reverse flows that fish encounter in specific channels south of the San Joaquin River, outmigrating salmon apparently have difficulty re-emerging back into the mainstem. The magnitude of the net reverse flows increases with closer proximity to the south Delta export facilities. Once salmon enter this region of the Delta, the fish likely experience high mortality rates caused by predation and entrainment into unscreened diversions and the export facilities. Some fish are known to be survive the migration all the way to the export facilities, are salvaged, and transported out to the western Delta or San Francisco Bay. However, the proportion of total numbers of salmon unsuccessfully navigating these interior Delta channels is unknown." (Pages 15-16)

Caveats: The report utilizes data from both CWT fish and radio-tagged fish to draw conclusions. It was pointed out that the CWT studies were of low resolution due to the low recovery rates at the terminal sampling location and the lack of internal sampling locations – it could only draw conclusions from point A (release site) to point B (terminal sampling site) with no information regarding what happened in between those two points. The radio tag telemetry studies had higher resolution due to active mobile tracking, but also had issues with low sample numbers and difficulty of tracking fish during the night. However, radio telemetry provided much greater information regarding the movements of fish within the overall migratory route. This initial data reflects the trends of information gained in later studies using acoustic tag technology.

3.) San Joaquin River Group Authority 2007. 2006 Annual Technical Report.

Take Home Bullets:

1) Data reinforces the benefit of installing a temporary barrier at the head of Old River which provides protection to juvenile salmon migrating out of the SJ River basin and prevents them from entering the Old River channel.
2) San Joaquin River flows, and flows relative to exports, between April 15 and June 15 was positively correlated to adult escapement in the San Joaquin River basin 2.5 years later. Both relationships were statistically significant ($p<0.01$) with the ratio of flow to exports accounting for slightly more of the variability in escapement than flow alone ($r^2 = 0.58$, vs. $r^2 = 0.42$).
3) With HORB in place, increasing Vernalis flows increased survival of upstream release groups relative to downstream release groups and was statistically significant ($p< 0.01$).
4) Without the HORB in place, there was no clear relationship between the survival rates as measured by differential recovery rates/ combined differential recovery rates for upstream versus downstream releases and flow using the Chipps Island, Antioch, and ocean recoveries for the Mossdale and Durham Ferry releases relative to the Jersey Point releases. There was more variability associated with smolt survival at any given flow without the HORB since the

flow and proportion of fish moving into the Old River channel varies more without the HORB.

5) Flows alone explained survival better than flows relative to exports alone, but the flow/export ratio did increase the fit of the survival correlation and reduced variability in the model.
6) Total absolute prediction error is about 15% less using the model that incorporated the flow/export variable, indicating that it better predicts the survival data than the model using flow alone.
7) Increasing temperature in the San Joaquin River appears to be a confounding factor in determining the role of exports and flow, particularly in late season releases.

Quotes:

"One potential explanation for these results is that the level of exports were low and did not vary enough during these experiments to provide sufficient differences to be detected in our measurements of smolt survival. Exports ranged between 1,450 and 2,350 cfs during these experiments which is much lower than those incorporated into the adult escapement relationships. Another complication is that exports and San Joaquin River flows were correlated with higher exports observed during times of higher flows (Figure 5-16). It is also likely the relationship of exports to smolt survival is different with the HORB in place than when it is absent…..the HORB was not installed during the majority of the years incorporated into the adult relationships." (page 60)

"These adult relationships would indicate that as you increase flows and decrease exports relative to flows there should be corresponding increases in smolt survival and adult escapement 2 ½ years later." (page 63).

"It is not surprising that there is some uncertainty and noise in these relationships because escapement data does not incorporate the varying age classes within annual escapement, the impact of declining ocean harvest in recent years, and the imprecision in the escapement estimates." (page 63).

Caveats:
As indicated in the report, the lack of recoveries of fish at the terminal sampling points decreases the sensitivity of the study to detect relationships between the different parameters of interest. Statistically significant relationships are typically only seen for "strong" relationships where the signal of the relationship can be detected over the "noise" in the environment, subtle relationships are typically not seen as statistically significant due to the signal being overwhelmed by the environmental noise. Likewise, the VAMP studies did not test all of the flow and export combinations that were initially proposed, thus the ability to discriminate the nature of relationships between the parameters of interest are diminished due to an over representation of only a few parameter pairings, and a lack of pairings at the extremes of the parameter pairings, which would allow for better resolution of parameter effects and relationships.

4) **Newman, K.B., 2008, An Evaluation of Four Sacramento-San Joaquin River Delta juvenile salmon survival studies.**

Take Home Bullets:
1) Newman used Bayesian Hierarchical models (BHMs) to reanalyze data from the four different studies (DCC gate operations, Interior Delta survival, Delta Action 8, and VAMP). The BHMs accounted for unequal sampling variation and between release variations. Recoveries from multiple locations were analyzed in combination. The BHM framework is more statistically efficient and coherent compared to previous analyses.

2) Results from the reanalysis of the Delta Action 8 studies indicate that there was a negative association between export volume and relative survival; that is a 98% chance that as exports increased, relative survival decreased. Environmental variation in the relative survival was very large, however, and a paired low export release could have a high probability of a lower relative survival than a paired high export release due to differences in the environmental parameters and their influence on the relative survival of the paired release.

3) For the VAMP studies, (a) The expected probability of surviving to Jersey Point was consistently larger for fish staying in the San Joaquin River (i.e., passing Dos Reis) than fish entering Old River, but the magnitude of the difference varied between models some-what; (b) thus if the HORB effectively keeps fish from entering Old River, survival of out-migrants should increase; (c) there was a positive association between flow at Dos Reis and subsequent survival from Dos Reis and Jersey Point release sites, and if data from 2003 and later were eliminated from analysis the strength of the association increased and a positive association between flow in Old River and survival in Old River appeared; (d) associations between water export levels and survival probabilities were weak to negligible given the magnitude of environmental noise.

4) In general, data limitations inherent to release-recovery data, i.e., that only one capture is possible, relatively low capture probabilities, relatively high environmental variation, and in the case of VAMP the lack of balance in the release strategy, affect the accuracy of estimates of effects on survival.

5) Given the apparently high environmental variation, it may take many replications of temporally paired releases to more accurately quantify the effects of DCC gate position, exports, flow, and HORB on survival.

Quotes:
1) (For the Delta Action 8 Studies) “The key parameter is β_1 (the coefficient for exports in the logistic regression of θ; see equation 29). It had a 98% probability of being negative, indicative of a negative association between the relative survival of Georgiana Slough and Ryde releases (θ) and exports.” And “The plot shows the decline in mean θ as exports increases (when exports are at 2000 cfs, mean θ is 0.62, and when exports are at 10,000 cfs, mean θ is 0.31).” (Page 59)

2) (For the VAMP Studies) “The expected survival probability down Old River was always less than the survival down the San Joaquin River. Different models yielded somewhat different expected values, but the survival down Old River was generally, if not always, lower than those for the San Joaquin.” (Page 62).

3) "Covariate values affect precision, too. For the DA 8 studies, increasing the number of observations at the "extremes" of export levels will increase the precision in the estimate of the slope parameter (β_1 in Equation 29). Similarly, for the VAMP studies, increasing the number of observations at the "extremes" of flow and exports will increase the precision of the related (partial) slope parameters (Equations 43-46)." (Page 68).

4) "However, with HORB in, survival of releases made above the head of Old River was significantly related to flow, but the relationship with exports and flow/exports was inconsistent and sometimes paradoxical (e.g., exports were positively associated with survival, weakly statistically significant using Antioch and Chipps Island recoveries and insignificant using ocean recoveries). The fact that the presence of the HORB affected the relationships with flow suggests an interaction between flow and HORB." (Page 75).

5) "For the various models fitted, there were two in-common conclusions: (1) flow is positively associated with the probability of surviving from Dos Reis to Jersey Point and (2) the survival probability for that reach is generally greater than the survival probability for fish traveling down Old River. Assuming that the HORB effectively keeps out-migrating salmon from entering Old River, the second conclusion implies that the HORB can increase salmon survival. For fish that do enter Old River, there was some evidence that flow in Old River was positively associated with survival between Old River and Jersey Point, but the evidence was not as consistently strong as for the Dos Reis to Jersey Point reach. There was little evidence for any association between exports and survival, and what evidence there was pointed towards a somewhat surprising positive association with exports." (Page 75-76).

Caveats:

There is an apparent paradoxical relationship for export effects and survival – it is a negative relationship for salmon coming from the Sacramento River side of the Delta as depicted in the results for the Delta Action 8 studies, yet has either a negligible or slightly positive relationship for fish migrating out of the San Joaquin River basin. This may be an artifact of the relationship between higher flows in the San Joaquin River fostering higher survival for SJ basin fish, and the relationship between high flows in the SJ River and increased export levels at the Projects. It is possible that the higher survival is due mainly to higher flows, and not do to a positive relationship with exports.

5) **Newman and Brandes, 2010. Hierarchical modeling of juvenile Chinook salmon survival as a function of Sacramento-San Joaquin Delta water exports.**

Take Home Bullets:

1) Study used temporally paired releases of LFR Chinook salmon in the Delta: Sacramento River at Ryde and within Georgiana Slough, downstream from its junction with the Sacramento River (15 paired releases over the period between 1993 and 2005).

2) Reanalysis of earlier work (Brandes and McLain, 2001), this time only using the LFR Chinook salmon releases; and using Bayesian hierarchical modeling for the statistical analysis.

3) Analysis looked for the relationship of exports by the south Delta Projects on survival of fish released at the different release points using Chipps Island trawl recoveries (recaptured relatively immediately after release) and the ocean and inland recovery data of study fish over the next 2-4 years.

4) Analysis of the data found a consistently negative relationship between the level of exports and survival of fish released in Georgiana Slough (which are presumed to enter the central and south Delta waterways where the effects of the exports are manifested). There is an 86 – 92% probability that the relationship is negative based on the Bayesian modeling.

5) A consistently greater fraction of fish that were released in Georgiana Slough were recovered in salvage at the Projects compared to those fish released at the Ryde location, and this fraction increased with greater export levels.

6) The analysis of this data also pointed out how the low signal to environmental noise ratio diminishes the sensitivity of the analysis to detect the relationships between the parameters of interest and find statistically significant relationships. There was very little difference between models that had exports and those which did not.

Quotes:
1) "The recovery fractions for the Georgiana Slough releases were consistently less than those for the Ryde releases, with the exception of the fraction recovered at the fish facilities."

2) "(A)t the fish facilities, Georgiana Slough releases were about 16 times more likely to be recovered. Also, the fraction of fish facility recoveries from the Georgiana Slough releases tended to increase (from about 0.001 to 0.025) as exports increased from 2,000 cfs to 10,000 cfs (1 cfs = 0.028 m3/s), although there was considerable variability at any given level of exports (Figure 3). This suggested a higher probability of ending up at the pumps with greater exports."

3) "Regarding the relationship between relative survival and export level, the point estimates of the effects of exports were consistently negative and for the BHMs the probability that the effects are negative was 86–92%. However, as a result of the low signal-to-noise ratio, the DIC values and posterior model probabilities indicate that the predictive ability of models without exports is equivalent to that of models with exports."

Caveats:
As with other studies using CWT fish, the low absolute number of fish recovered in monitoring efforts impacts the ability of the study to detect relationships between the parameters of interest. These studies are limited by the low signal to environmental noise ratios that are typically present in these types of studies. Improving the sensitivity of these studies requires either using better methods (i.e. better/newer technology) or increasing the sample sizes/replications substantially to detect relationships, which would likely require many more years of studies to have a sufficient number of replicates to increase the sensitivity of the study. The failure to reach a statistically significant relationship does not automatically exclude that a true relationship exists between the parameters, it could very likely be obscured by the low signal to noise ratio.

6) Dauble et al. 2010. The Vernalis Adaptive Management Program (VAMP): Report of the 2010 Review Panel.

Take Home Bullets:

1) Simple solutions are unlikely to consistently enhance survival of salmon smolts through the Delta over time. The Delta has complex hydraulics in a strongly tidal environment, and high and likely variable predation effects, that are likely to affect survival rates more than river flow by itself.

2) The panel, however, found that increasing flows in the San Joaquin generally has a positive effect on smolt survival through the Delta and that reducing or eliminating downstream passage through the Old River channel was desirable. The Panel also understood that flow, exports, and the placement of a barrier at the Head of Old River were the variables affecting survival that were most easily manipulated and managed.

3) Apparent downstream migration survival of juvenile Chinook salmon was very poor during 2005 and 2006 even though Vernalis flows were unusually high (10,390 cfs and 26,020 cfs, respectively). These recent data serve as an important indicator that high Vernalis flow, by itself, cannot guarantee strong downstream migrant survival.

4) The panel observed that there is an apparent decline in smolt survival over the 10 year period between 2000 and 2010 at several different levels of San Joaquin River flows ranging from very low to high and that this may be the "new" future smolt survival environment.

5) The panel found that although exports did not have a detectable statistical relationship with survival, that the study results should still be considered inconclusive due to the abbreviated range of conditions under which the data was collected.

6) The panel found that both the empirical evidence and logical inference support the conclusion that installation of a barrier at the head of Old River improves survival of downstream migrating Chinook salmon smolts.

Quotes:

1) "(R)ecent data serve as an important indicator that high Vernalis flow, by *itself*, cannot guarantee strong downstream migrant survival."

2) "analyses (summarized in SRJTC, 2008) and Bayesian hierarchical modeling (BHM) analyses (Newman, 2008) were unable to detect any statistical associations between exports and smolt survival through the Delta using the VAMP CWT study data. For a number of reasons, however, we do not believe these findings should be interpreted as meaning that exports, especially at high levels, have no effect on survival rates. CWT study data were not collected over an adequate range of export levels to achieve enough statistical power to identify an export effect."

3) "The five years (2000-2004) of actual VAMP CWT studies done with a HORB in place investigated a range of exports only between 1,450 and 2,250 cfs. We believe this is much too narrow a range in exports to allow detection of a statistically significant export-survival relationship for the San Joaquin River."

4) "We believe that any "Export" effect must be masked by this "Old River" effect, and that the lower survival observed for the Old River route is at least partially attributable to export effects, both direct and indirect. One reason we believe this is that while predation might naturally be higher along Old River, the export facilities themselves seem to attract additional predators to the south Delta. A second reason is that the data show that the numbers of CWT study smolts detected in the salvage at the fish facilities are always higher for releases on upper Old River versus Dos Reis. Thus there are clear differences in direct entrainment losses between the two routes. Finally, if a fish traveling the Old River route does successfully navigate past the fish facilities during periods of high exports, it is then subjected to the reverse net flows, caused by exports, in the reaches of Old and Middle Rivers north of the facilities. It is difficult to imagine that migrating salmon smolts, cueing mostly on flow direction, will not have greater difficulty navigating to the north through these reaches to San Francisco Bay in a direction that might appear as "upstream" to their senses. Losses of smolts due to altered hydrodynamic conditions or migration cues in the Delta related to exports are referred to as "indirect" losses or mortality."

5) "Although lack of an ability to detect an "Export effect" on survival rates can be in large part attributed to lack of variation in recent export flows, we are reluctant to recommend substantial increases in export flows so as to improve the ability to detect an export effect. Among other things, the potential negative consequences of increased exports during downstream migration of juvenile Chinook salmon (and also on survival of juvenile delta smelt) probably outweigh any possible increase in knowledge."

Caveats:
These comments and findings are the results of deliberations by an independent science review panel convened to assess the VAMP studies.

7) **High level Summary of the Six-year Steelhead Study for the years 2011-2015**

- Four years of the total six years of studies have been written up as either final or draft reports
    - Final Reports available for 2011-2015
    - Finals for years 2014 and 2015 sent July 30, 2018
- Studies released acoustically tagged hatchery steelhead into the San Joaquin River at Durham Ferry and tracked them through the Delta system using multiple releases and multiple acoustic receiver locations throughout the lower San Joaquin River and Delta.
    - 2011 – Five releases, total of 2,196 fish tagged and released at Durham Ferry from late March through mid-June.
    - 2012 – Three release, total of 1,435 fish tagged and released at Durham Ferry from early April through mid-May.
    - 2013 – Three releases, total of 1,425 fish tagged and released at Durham Ferry from early March through early May.

  - 2014 – Three release, total of 1,432 fish tagged and released at Durham Ferry from late March through late May.
  - 2015 – Three releases, total of 1,427 fish tagged and released at Durham Ferry from early March to late April.
- Studies occurred during a wet year (2011) and four dry/critically dry years (2012-2015; the first four years of the 5-year drought).
  - Flows during the wet year (2011) were typically above 10,000 cfs at Vernalis, and peaked at approximately 29,000 cfs.
  - Flows during 2012 through 2015 were considerably less, never exceeding 5,000 cfs at at Vernalis, and typically less than 2,500 cfs for most of the period of interest.
  - The HOR barrier was installed during 2012, 2014, and 2015. In 2014 the HOR barrier went in after the first release of fish occurred. With the barrier in, few fish were entrained into the Old River route at the junction of Old River and the San Joaquin River. In 2015, the barrier went in shortly after the second release of fish in late March, being present for the passage of approximately 35% of the released fish past the bifurcation of Old River and the mainstem San Joaquin River.
- During the wet year (2011) survival was better than the drought years (2012-2015) for both the San Joaquin River route (S_A) and the Old River route (S_B), as well as total survival (S_{total}) through the system.
  - Absolute survival through the San Joaquin River route was better than the Old River route in 4 of the 5 study years (2011, 2012, 2014, and 2015).
  - Survival through the sub-routes; south Delta and middle Delta (S_{SD} and S_{MD}), were variable and release group dependent. Clear distinctions between the Old River and San Joaquin River routes were not consistent.
- The presence of the HOR barrier was important in determining the proportion of fish entering Old River in relation to those remaining in the San Joaquin River route.
  - During low flow years, when the barrier was out, (2013, first release in 2014, first and second release in 2015), and fish were released into the system at Durham Ferry, higher numbers of fish entered the Old River route at the HOR junction. This appears to be a function of river stage, tides, and shunting of flow into the Old River channel.
  - When flows were high (2011) the distribution of fish into Old River and the San Joaquin were nearly equal.
- Water temperatures were elevated in 4 out of the 5 study years (2012-2015) during the fish releases.
  - Waters temperatures (as measured at Mossdale) were consistently lower in 2011 compared to 2012-2015 during fish releases.
  - Water temperatures in 2012 were consistently above 18ºC for the second and third releases. Water temperatures following the first release were between 15 and 18ºC.
  - Water temperatures in 2013 were slightly below 15ºC during the first release, but were above 15ºC during the second and third releases.
  - Water temperatures in 2014 were between 15 and 18ºC during the three releases, with spikes following the first and third releases.

  - Water temperatures in 2015 were between 16 and 20ºC for the first release in early March, between 17 and 20 ºC for the late March release, and 19 and 23ºC for the late April release.
- Survival, as measured per kilometer travelled, is generally as follows:
  - Overall cumulative mortality is higher in the reaches between Durham Ferry and Mossdale, which is common between the Old River route and the San Joaquin River route. The survival per kilometer is approximately 96% or higher but accounts for approximately 40-60% of overall mortality.
  - Cumulative mortality in the San Joaquin River route is inconsistent, with some years having high mortality in the reach between Mossdale and the Stockton Deepwater Ship Channel (Garwood Bridge/ Navy Bridge) and again in the lower reaches of the San Joaquin River route (MacDonald Island to Chipps Island).
  - Increased cumulative mortality in the Old River route occurs between the entrance to the Old River corridor (Old River south) and Chipps Island via the fish collection facilities.

Assorted references
Prepared 11/1/18 by Barb Byrne

Independent Review Panel reports from the Long-Term Operations Biological Opinions (LOBO) Science Reviews

Water Year	Dates of event	URL for event materials
2010	11/8-9/10	http://deltacouncil.ca.gov/events/science-program-workshop/workshop-ocap-integrated-annual-review
2011	11/8-9/11	http://deltacouncil.ca.gov/events/science-program-review/2011-operations-criteria-and-plan-ocap-annual-review
2012	10/31/12-11/1/12	http://deltacouncil.ca.gov/events/science-program-review/2012-long-term-operations-opinions-annual-review
2013	11/6-7/13	http://deltacouncil.ca.gov/events/science-program-review/2013-long-term-operations-biological-opinions-annual-science-review
2014	11/6-7/14	http://deltacouncil.ca.gov/event-detail/11198
2015	11/5-6/15	http://deltacouncil.ca.gov/event-detail/12645
2017	12/4-7/17	http://deltacouncil.ca.gov/events/2017-long-term-operations-biological-opinions-lobo-biennial-science-review

Links to the 2010-2015 Annual Science Reviews are compiled at: http://deltacouncil.ca.gov/science-program/long-term-operations-biological-opinions-annual-science-review

South Delta Chinook salmon survival studies

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Model/Analysis	Location	Type/ Criteria	Life-stage	Species	Description
CalSim-II	CVP/SWP-wide	Hydrologic	NA	NA	A hydrological planning scenario tool that provides monthly average flows for the entire SWP and CVP system based on an 82-year record.
DSM2-HYDRO	Delta and Suisun Marsh	Hydrologic	NA	NA	One-dimensional hydraulic model used to predict flow rate, stage, and water velocity.
DSM2-PTM	Delta and Suisun Marsh	Hydrologic (Particle tracking)	NA	NA	Simulates fate and transport of neutrally buoyant particles through space and time.
DSM2-ePTM (DWR)	Delta and Suisun Marsh	Hydrologic (Particle tracking)	model calibration based on smolt data; uncertain how applicable to rearing fry	model calibration based on Chinook smolt data; uncertain how applicable to steelhead.	Simulates fate and transport of "behaving" particles through space and time. Seven behavioral parameters; calibration method is based on particle swarm optimization
ePTM (SWFSC)	Delta	Hydrologic (Particle tracking)	model calibration based on smolt data; uncertain how applicable to rearing fry	model calibration based on Chinook smolt data; uncertain how applicable to steelhead.	Simulates fate and transport of "behaving" particles through space and time. Seven behavioral parameters (same seven as in DWR model, though exact interpretation a bit different because of different model structures); calibration method is based on <Barb will track down calibration method>
HEC-5Q	Sacramento and American Rivers	Water Quality	NA	NA	Water quality simulation tool used to provide water temperatures.
DSM2-QUAL	Delta and Suisun Marsh	Water Quality	NA	NA	Used to predict water temperature, dissolved oxygen, and salinity.
DSM2-QUAL Fingerprinting	Delta and Suisun Marsh	Water Quality (Olfactory Cues)	Adults	Chinook, steelhead	Models "source" of water at any location to indicate proportion coming from different upstream locations, and therefore incidates how homing capabilities of fish can be affected by changes in operations.
Reclamation Egg Mort. Model	Trinity, Feather, American, and Stanislaus Rivers	Biological	Egg	?	Uses CalSimII flow and climatic model output to predict monthly water temperature in River basins and upstream reservoirs.
SALMOD	Sacramento River	Biological	Returning Adult, Egg, Alevin	All Chinook	Predicts effects of flows on habitat suitability and quantity for all races of Chinook salmon.
SALSIM	San Joaquin River	Biological	All	Fall-run Chinook	Total life history population simulation model for fall-run Chinook salmon.
OBAN	Sacramento River	Biological	?	All Chinook	Statistical modeling approach to evaluating scenarios effects.
DPM	Delta to Chipps Island	Biological	Juvenile (migration)	All Chinook	Simulates migration and mortality of Chinook salmon smolts entering the Delta from the Sacramento, Mokelumne, and San Joaquin rivers through a simplified Delta channel network, and provides quantitative estimates of relative Chinook salmon smolt survival.

Model/Analysis	Location	Type/ Criteria	Life-stage	Species	Description
IOS	Sacramento River	Biological	All	Winter-run Chinook	A stochastic life cycle model for winter-run Chinook salmon.
Salvage-density Analysis	South Delta facilities	Biological (Flow relation)	Juvenile	All Chinook	A model of entrainment into the south Delta facilities as a function of flow based on historical salvage data.
USGS Flow-survival Model	North Delta (Sacramento R.)	Biological (Flow relation)	Juvenile (migration)	Fall-run Chinook (?)	A model that combines equations from statistical models estimating the relationship of Sacramento River inflows on reach-specific travel time, survival, and routing of salmonids to allow assessment of travel time and survival for different operational scenarios.
USGS Entrainment Model	North Delta (Sacramento R.)	Hydrologic (?)	Juvenile (migration)	Fall-run Chinook (?)	A statistical model of probability of entrainment into the central Delta as a function of hydrodynamic variables in the Sacramento River.
SWFSC Temp. Dependent Egg Mort Model	Sacramento River	Biological	Egg	All Chinook	A temperature-dependent mortality model for Chinook salmon embryos that accounts for the effect of flow and dissolved oxygen on the thermal tolerance of developing eggs.
SWFSC WRLCM	Sacramento River	Biological	All	Winter-run Chinook	A state-space and spatially explicit life cycle model of eggs, fry, smolts, juveniles in the ocean, and mature adults that includes density-dependent movement among
ICF loss analysis	South Delta facilities	Salvage and loss	Juvenile	Chinook, steelhead (mostly certain),sturgeon (?)	
SWFSC RAFT/CVTemp	Sacramento River		Juvenile	Chinook	Models water temperatures at various locations and estimates egg survival based on Reclamation's operations
Habitat Suitability Index (HSI) Modeling	NA	Habitat	All	Chinook	This would likely only be needed if some type of habitat restoration were included in the PA. And would need to be specific. HSI components are worked into other methods, like SALMOD.
Yolo Bypass Fry Rearing Model	Delta	Biological	Juvenile	Chinook	The Yolo Bypass Fry Rearing Model links growth to survival at ocean entry using the few existing relevant studies. May want to look into how updated this model is (don't recall it being used for CWF so may be due for refresh or replaced by something else).
Newman 2008	Delta	Biological	Juvenile	Chinook	Through-Delta survival method. Used in CWF but not relied upon extensively.
DSM2	Delta	Physical	Juvenile	Chinook, steelhead	Daily flow metrics, 15-minute velocity frequency: percentage positive flow, frequency of velocities above sustained swimming speeds; used in CWF but very data
6-year study work	Delta	Biological	Juvenile	Chinook, steelhead	Perry under contract with NMFS to begin some work on results from this data, but likley won't meet provided timeline. Rec has contract to complete reports for completed years.
SRKW Analysis	Ocean	Biological	All	SRKW	See CWF. Is largely based on effects to non-listed salmonids, in addition to those on listed salmonids (which are not as large a part of the diet).
CCC Steelhead Analysis		Biological	All	CCC Steelhead	
Eulachon Analysis		Biological	All	Eulachon	

Model/Analysis	Location	Type/ Criteria	Life-stage	Species	Description
Mean end-of-May and end-of-Sep reservoir storage changes from baseline	Sacramento, Feather, American, Stanislaus, San Joaquin Rivers	Physical	Spawner, Egg, Juv	(River dpendant) WR, SR, and FR/LFR Chinook, CV steelhead and GS	
Mean flow changes from baseline (daily data)	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear Creek	Physical	Spawner, Egg, Juv	(River dpendant) SONCC, WR, SR, and FR/LFR Chinook, CV steelhead and GS	
Flow threshold exceedance (daily data)	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear creek	Physical	Spawner, Egg, Juv	(River dpendant) SONCC, WR, SR, and FR/LFR Chinook, CV steelhead and GS	
Water temperature changes from baseline (daily data)	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear creek	Water Quality	Spawner, Egg, Juv	(River dpendant) SONCC, WR, SR, and FR/LFR Chinook, CV steelhead and GS	
Water temperature threshold exceedance (daily data)	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear creek	Water Quality	Spawner, Egg, Juv	(River dpendant) SONCC, WR, SR, and FR/LFR Chinook, CV steelhead and GS	
Spawning WUA	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear creek	Habitat	Spawner,	(River dpendant) SONCC, WR, SR, and FR/LFR Chinook, CV steelhead and GS	

Model/Analysis	Location	Type/ Criteria	Life-stage	Species	Description
Rearing WUA	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear creek	Habitat	Juvenile	(River dpendant) SONCC, WR, SR, and FR/LFR Chinook, CV steelhead and GS	
Redd dewatering (qualitative or greatest monthly flow reduction)	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear creek	Habitat	Egg	(River dpendant) SONCC, WR, SR, and FR/LFR Chinook, CV steelhead and GS	
Hatchery assessment (lit review and CFM analysis)	Sacramento, Feather, American, Stanislaus, San Joaquin and Trinity Rivers, and Clear creek	Hatchery	Spawner, Juvenile	SR, FR Chinook and CV Steelhead	

Attachment 2

NMFS DRAFT - 11/28/18
For distribution to Five Agency Section 7 consultation team members only

High Level Comments on the Proposed Action for the ROC on LTO

CONSULTATION APPROACH

1. We know this consultation is a huge undertaking, and we are prepared to engage in the "Tiger Team" meetings with the goal that the meetings are a "safe space" to share ideas and openly discuss disagreements, keeping in mind always the intent to be constructive and take a problem-solving approach.
2. We understand that it is Reclamation's goal to develop a Proposed Action that results in a no-jeopardy biological opinion. NMFS comments are intended to support that goal.
3. NMFS appreciates the need to take a "fresh look" at science and operations, and we hope we can use this team process to develop a joint understanding of current science and how that informs operational decisions. We think that our long-time engagement in CSAMP and CAMT will be very important to shaping our understanding of science, especially as it relates to South Delta operations.
4. We understand the overall desire to incorporate more of the CVPIA restoration program components into the consultation. We agree that this makes sense given that Congress authorized that program in part to offset effects of CVP operations. We want to engage with you on the details of how to do this, and will need to be careful that the Proposed Action does not include restoration projects that are already required mitigation in other consultations; this would result in "double counting" of the restoration.
5. We hope the team can embrace the foundational challenges of the declining status of winter-run Chinook salmon, spring-run Chinook salmon, and possibly other species' needs, due to drought and other factors. The decline of winter-run Chinook salmon specifically was one of the main triggers for reinitiation in August of 2016, and we will need to see additional measures and protections for this species over and above what was in the 2009 BiOp. Additional population declines since the last species status review have occurred. We recommend a separate presentation by Reclamation to indicate how those protections are included in this Proposed Action.
6. The five agency Adaptive Management Plan for the California WaterFix and Current Biological Opinions on the Coordinated Operations of the Central Valley and State Water Projects that was developed and negotiated between all parties during the final stages of CWF is very important to NMFS. It needs to be incorporated into the Proposed Action, as it is already required in terms and conditions from a previously-consulted on project, and there was interagency and stakeholder agreement that it applied not only to future operations, but also to current operations. We suggest fully pulling it into this action and developing any additional adaptive management components that you would like to see as a sub-set of that program. Likewise, that document sets up the expectation for CSAMP to continue and a governance process for making decisions. It would be very confusing to have two conflicting governance processes for the same operations.

7. We know that the overall desire is to increase water supply reliability while protecting species, and with that in mind, we hope through these meetings to be able to fully understand where Reclamation sees the highest potential for increasing water supply. The more we understand the operations you are trying to achieve the more we can be successful in finding new approaches (e.g., potentially more fall transfers and deliveries).
8. We have identified what we believe are the most challenging topics; we suggest separate meetings on each of these later this week or next week:
    a. Shasta operations - We need to build on the operational studies we have been jointly conducting, and the four joint workshops we did on NMFS proposed RPA amendment that concluded last February, including the ongoing Upper Sacramento River science collaborative. We recommend a separate meeting on this topic with subject matter experts in the room.
    b. April-May action for San Joaquin steelhead (e.g., I:E ratio or replacement) - Similarly, we need to build on CAMT science. We shared an "Alternatives to I:E Ratio" document with Reclamation in July. We need a separate discussion on this topic, with subject matter experts in the room.
    c. Reintroduction above Shasta/fish passage - NMFS believes continuation and acceleration of this pilot program is necessary. Again, we recommend a separate discussion on this topic with subject matter experts in the room to see if we can reach agreement.
    d. Drought contingency planning - We don't see this component in the Proposed Action and think that it needs to be included at least to model and evaluate how the project was operated during the last drought. We want to understand Reclamation's approach to drought planning, and that should be identified in the Proposed Action.
    e. Old and Middle River - OMR proposed operations rely upon metrics that we do not currently know how to measure or define and the mechanism to clarify or rectify that is not identified in the Proposed Action.
    f. Adaptive Management - The approach to adaptive management to gain flexibility in water operations needs to be clarified. Before flexibilities can be entertained, sustainable positive changes to target populations related to actions need to be validated.
9. We anticipate an analysis of winter-run Chinook, CV spring-run Chinook, CCV steelhead, sDPS green sturgeon, CCC steelhead, SONCC coho, Pacific Eulachon, and Southern Resident Killer Whales (fall- and late-fall analysis in support of killer whale analysis), and, for EFH, Pacific Coast salmon species, coastal pelagic species, and Pacific groundfish species.

GENERAL

1. The Proposed Action, as currently written, is very vague and lacking details that are needed to complete an effects analysis. NMFS' approach to a section 7 ESA analysis evaluates the exposure, response, and risk at the individual, population, and species levels to Proposed Action-related stressors. Without information regarding the potential exposure (for instance, the frequency of a particular condition occurring) or stressor

magnitude, NMFS will either need to make assumptions regarding exposure, stressor magnitude, and risk, and/or provide protections that ensure that the risk will not be borne by the species.

2. As currently described, the action appears much less protective than what is covered in the NMFS 2009 BiOp and RPA. Similarly, most of the RPA actions from the 2009 are not integrated into the Proposed Action.
3. There are great number of actions included in the Proposed Action (most of these are in Section 4.11 Programmatic Adaptive Management of Water Deliver Improvements) that technically meet the current definition of Environmental Baseline. We feel that these actions should be removed from the Proposed Action and described and included in the Environmental Baseline section of the BA.
4. While CALSIM modeling is already being executed to adhere to the accelerated timeline, a revised CALSIM run that better approximates the final PA (including changes to Shasta temperature management in some years) should be conducted (either by Reclamation as supplemental material or by NMFS/FWS/CDFW) for the purposes of BiOp/ITP preparation. However, the schedule implications of this need to be understood and weighted against the risk of evaluating a scenario that may not best characterize the final PA.
5. There are operational components of CVP/SWP operations that we expected to see described but were not, including:
    a. I:E ratio
    b. Head of Old River and Georgiana Slough barriers
    c. Interrelated and Interdependent Actions: Hatchery Operations (e.g., Nimbus)
    d. February Forecast
    e. End-of-September Storage
    f. Salvage facility improvements
6. We noticed a lack of description of operations related to the Shasta Dam raise. Please clarify whether this action is going to be covered in this consultation or a later consultation. If it will be a later consultation, it should be addressed in section 4.10 *Items not Consulted on.*
7. There are a number of proposed actions based on emerging science (e.g. life-stage specific temperature operations, trap and haul) that introduce uncertainty as to their potential effect. Use of novel management approaches may be considered but would require additional testing and evaluation, which may be best evaluated through an adaptive management approach.

COORDINATED OPERATING AGREEMENT

1. This is not specifically a comment on the Proposed Action, but for full understanding of the revisions to COA, NMFS would like to see modeling that captures system-wide effects (such as flows, storages, and associated temperature) due to the proposed new COA rules.

SHASTA-SACRAMENTO DIVISIONS

1. Given the consultation history (winter-run Chinook salmon reintroduction being a major factor in reaching a non-jeopardy determination in 2009) and certainty of the next prolonged drought (and devastating impacts to Shasta Reservoir coldwater pool and winter-run Chinook salmon survival), a CVP/SWP Proposed Action that does not include reintroduction of winter-run Chinook salmon upstream of Shasta Reservoir is likely to greatly diminish the chances of the persistence of this ESU.
2. We are concerned that not operating for temperature compliance in some years (Method #4) is likely to greatly diminish the chances of the winter-run Chinook salmon ESU's persistence. This is not consistent with SWRCB 90-5.
3. There is a general lack of specificity as to how the February forecast will be used to develop a spring-fall temperature management plan. Similarly, there is a lack of specificity regarding End-of-September carry over storage that will be used to manage fall flows. How will operations and temperature management be coordinated with NMFS? It is critical to describe the management/coordination details in the PA.
4. There needs to be a relationship between spring storage numbers and the ability to meet temperatures. An option is to use Jeff Rieker's "Rule of Thumb" chart initially but support development of a more robust method. Our understanding is that the modeling being conducted does NOT include operations according to these alternate methods, which is a fundamental flaw.
5. The proposal to increase hatchery production, as described, is problematic. NMFS needs more details on the specific circumstances in which this effort would be implemented. More specifically, the proposed expansion of hatchery practices is not consistent with the Livingston Stone HGMP.
6. NMFS has concerns about the trap and haul program as described. Details on circumstances under which this program would be implemented are needed to evaluate the effects of this program. Measures to reduce straying, such as barging, would need to be considered since straying for winter-run Chinook salmon is much more serious than for other runs, since they need cold summer water temperatures that are actively managed only on the Sacramento River.

TRINITY DIVISION

1. The proposed action, based mostly on the Trinity ROD, is a good start. However, there are concerns with shortcomings with the ROD, such as lack of flow variability, low winter flows, minimum reservoir storage, and water temperature management.
2. We are concerned that flow releases in the Trinity River in the fall and winter months are simplified and static, and do not reflect natural river hydrographs. The PA should include sub-daily flow variability that is synchronized with storm events.
3. The PA provides very low flows during autumn to early spring, (i.e., 300 cfs from mid Oct –April 22). We recommend more flow volume released into the Trinity River during winter months (Nov-March).
4. The PA needs a better description of minimum reservoir storage and bypass vs power outlet use at storages less than 1.0 MAF, as well as the frequency of EOS storage at various levels. Based on data, we recommend blended use of the auxiliary outlet at storages less than 1.0 MAF.

5. Flow releases should be included with temperature management for habitat, and similar considerations to Sacramento River for colder requirements for egg incubation. A temperature control device would allow for more nuanced temperature control, and conservation of the cold water pool in Trinity Reservoir which would benefit Trinity and Sacramento river species.
6. We recommend completion of temperature modeling for Trinity and Whiskeytown for cold water pool management. The criteria for how Clear Creek is integrated into Sacramento operations needs to be explained in greater detail.
7. Spring attraction flow and geomorphic flows have been combined on Clear Creek. They should have different objectives, magnitudes, and timing to be effective.
8. The PA should clarify how Reclamation will integrate the Lower Klamath Long Term Plan with CVP operations, as well as Humboldt County's water contract with Reclamation for not less than 50 TAF of Trinity River.

FEATHER RIVER

1. Because the FERC license hasn't yet been issued, the most recent NMFS BiOp is in limbo. The Proposed Action should clarify what is intended for Feather River operations.

AMERICAN RIVER DIVISION

1. The 2008 OCAP BA modeled present level water demands at 325 TAF per year and 2030 demands at 800 TAF per year. This PA should quantitatively describe the current and projected level of water demands throughout the PA timeframe, and how those increasing demands on top of climate change projections will impact American River flows and water temperatures.
2. Currently the Proposed Action states, "*Reclamation proposes to implement the 2006 Flow Management Standard (FMS), subject to updates and improvements from ongoing discussions*." The Proposed Action description needs a lot more clarity and specifics regarding what elements from the modified Flow Management Standard are in the PA.
3. As currently described, the PA seems to imply that the conservation measures will provide operational flexibility beyond the operations that are described in the PA. The PA states that the American River Division conservation measures, "*...are designed to increase operational flexibility associated with the Proposed Action to maximize water deliveries and power generation*."

DELTA DIVISION

1. The proposal to manage OMR flow operations to maximize exports while staying within the provided incidental take limit is flawed because the amount and extent of take have not been defined for this consultation.
2. Proposed operations for OMR rely upon metrics that we do not yet know how to define/measure. Specifically, the on-ramp/off-ramp conditions are not currently able to be quantified. We will need to see clarifications on how population-based actions will be implemented for species that lack population metrics (spring-run Chinook salmon, CV

steelhead, and green sturgeon). Additionally, there is no description of how the risk assessment will be conducted or how the monitoring information will be utilized.

3. The risk assessment procedures that will be used for DCC operations should be clarified. The uncertainty in the current description has will make it difficult for us to interpret and analyze the effect. Also, because the proposed DCC operations are different than the D-1641 procedures for operations for May 21 - June 15 operations, the process for working this out with the SWRCB should be specified.
4. The cumulative salvage thresholds need to specified for each species, and more clarity should be provided regarding how operations will be altered when thresholds are approached; specifically, we need to know if the changes are permanent for the remainder of the emigration season.
5. The flexibilities in OMR that are or could be expected during storm-related events should be more clearly identified.

EAST SIDE (Stanislaus River) DIVISION

1. We need confirmation on whether or not the draft New Melones RPO provides appropriate water temperatures for different life stages of salmonids in the Stanislaus River depends on the implementation of the flexible blocks of water and also on flood releases. Will any temperature modeling be provided? Ideally, based on implementation of the flexible blocks of water in different patterns.
2. We note that a 1,500 cfs monthly flow cap and 3,000 cfs daily flow cap constrain outmigration flows and geomorphic flows. Low spring flows in “low storage” years are a concern.
3. If the New Melones RPO intended to replace the 1987 Agreement between Reclamation and CDFW, then CDFW will need to buy-in on fall-run Chinook salmon needs.

WATER OPERATIONS GOVERNANCE

1. NMFS has fundamental concerns about the risk analysis approach. This brings a tremendous amount of uncertainty that is difficult for us to interpret and analyze.
2. NMFS is open to revisions to governance, but note the need to keep the important professional expertise and judgment from the existing technical team members, including timely information on real-time fish distributions and risk assessments.

ITEMS NOT CONSULTED ON

1. We believe the operational effects associated with flood control should be included in the this consultation.
2. We are unclear as to why Reclamation is proposing not to consult on Settlement contracts and agreements and exchange contractor deliveries from Friant.
3. It is unclear whether Shasta Dam Raise operations are being consulted on or not. This is unclear to us.

PROGRAMMATIC ADAPTIVE MANAGEMENT

1. We are unclear about what this section adds to the consultation. As written this section introduces more uncertainty and complexity to the consultation.
2. See Consultation Approach #6 above.
3. Reclamation needs to provide more detail about how the adaptive management program would work. If the following actions are proposed as "trade offs" for operational flexibility, it only seems logical that these actions should have pre-determined performance targets tied to a specific trade off and that the trade would only occur after the performance standard was met.
4. There are a number of actions included in the Proposed Action (most of these are in Section 4.11 Programmatic Adaptive Management of Water Deliver Improvements) that technically meet the current definition of Environmental Baseline. We feel that these actions should be removed from the Proposed Action and described and included in the Environmental Baseline section of the BA.

Attachment 3

Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>

Comments from NMFS on ROConLTO BA: Proposed Action and Effects Analysis.

1 message

Barbara Byrne - NOAA Federal <barbara.byrne@noaa.gov> Fri, Feb 22, 2019 at 8:34 AM
To: "Naman, Seth" <seth.naman@noaa.gov>, Janice Pinero <jpinero@usbr.gov>, "Howard.Brown" <howard.brown@noaa.gov>, Katrina Harrison <kharrison@usbr.gov>, "Ellrott, Brian" <brian.ellrott@noaa.gov>, "Manza, Peggy" <pmanza@usbr.gov>, "Jacobs, Brooke@Wildlife" <brooke.jacobs@wildlife.ca.gov>, Michelle Banonis <mbanonis@usbr.gov>, "Wilkinson, Chris@DWR" <christopher.wilkinson@water.ca.gov>, "Banonis, Michelle" <michelle.banonis@water.ca.gov>, matt_nobriga@fws.gov, Maria Rea <maria.rea@noaa.gov>, Kristin Begun - NOAA Affiliate <kristin.begun@noaa.gov>, Sarah Gallagher - NOAA Federal <sarah.gallagher@noaa.gov>, Jana Affonso <jana_affonso@fws.gov>, "J. Stuart" <j.stuart@noaa.gov>, "Israel, Joshua A" <jaisrael@usbr.gov>, Russ Callejo <rcallejo@usbr.gov>, Dan Lawson - NOAA Federal <dan.lawson@noaa.gov>, Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>, Justin Ly - NOAA Federal <justin.ly@noaa.gov>, "Mooney, David" <dmmooney@usbr.gov>, cheryll.dobson@sol.doi.gov, Katherine Sun <katherine_sun@fws.gov>, Kaylee Allen <kaylee_allen@fws.gov>, jelica.arsenijevic@hdrinc.com, Joe Heublein - NOAA Federal <joe.heublein@noaa.gov>, Evan Sawyer - NOAA Affiliate <evan.sawyer@noaa.gov>, lori.caramanian@sol.doi.gov, Cathy Marcinkevage <cathy.marcinkevage@noaa.gov>

Subject docs attached for discussion today. NMFS will bring hard copies to the meeting.

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2 attachments

2019-02-22_Effects Analysis Review_NMFS.pdf
88K

2019-02-22_Proposed Action Review_NMFS.pdf
134K

NMFS Comments on the Proposed Action (BA Table 4-6)

Table 4-6. Components of the Proposed Action *(Modified with some additional columns)*

	Title	Site Specific or Programmatic?	Core Operation or Adaptive Management?	NMFS Comment	Proposed Resolution or Path Forward	Resolution
	CVP/SWP Wide					
1	Divert and store water consistent with obligations under water rights and decisions by the State Water Resources Control Board	Site-specific	Core	No specific comment		
2	Shasta Critical Determinations and Allocations to Water Service and Water Repayment Contractors (p.4-14)	Site-specific	Core	The proposed action does not mention how fish factor into allocation decisions. Details are needed on how the Shasta storage and temperature management for winter-run is considered in the "shortage policy" (p. 4-10).	Reclamation articulates how allocations are managed to ensure temperatures are met for winter-run.	
3	2018 Revised Coordinated Operations Agreement (p. 4-8)	NCO	NCO	(1) COA needs to be consulted on because they are are embedded in and drive the operations. (2) Need more detail about balancing		

				Shasta, Folsom and Oroville to meet D-1641 requirements based on conditions and COA.		
	Upper Sacramento					
4	Seasonal Operations (p. 4-26)	Site-specific	Core	We need more information on what actions (rather than goals, targets, and examples) are being taken to manage storage in the context of water temperature management. Cold water pool considerations are mentioned without sufficient detail in the following PA components: "spring pulse flows", "cold water pool management", and "Fall and Winter refill and redd maintenance". Reclamation should provide details regarding its analysis and decisions regarding seasonal operations leading up to temperature management in the summer. For example, provide, by July 1 of each year, an analysis (using, e.g, the Deas model and SWFSC coupled reservoir model) showing how differing assumptions on runoff, temperatures and operations affect storage, Keswick releases, runoff, lake stratification, and resulting cold water pool.	Need a presentation from Reclamation next week to walk us through the details and modeling on Shasta.	
5	Spring Pulse Flows (p. 4-27)	Site-specific	AM	What's the frequency of (1) projected Shasta >4 MAF, (2) a spring pulse flow resulting in lowering a Tier, and (3) a spring pulse flow interfering with the ability to meet other anticipated demands on the reservoir?		

6	Shasta Cold Water Pool Management (p. 4-27)	Site-specific	Core	(1) There is insufficient detail to consult on temperature management as a site-specific action. The action is described programmatically but it still does not provide enough information to estimate/understand the range of operations (and their potential effects). (2) The tiered approach based on the Anderson model appears to be experimental and based on unproven methodologies. How much evidence is there behind the Anderson model of varying temperatures? Perhaps this should be an adaptive management element to try this operation in a year when then 53.5 is not attainable. But not ready to have in PA as a hard-wired action. Under tier 3 and 4, NMFS predicts lots of lethality. Why is there no provision for demand shifting until tier 4? (3) There is no description of ops. within a "tier." There is insufficient information on the proposed relationship between available cold water and duration of temperature management. (4) The strategy to build Shasta storage not clear in the proposed action. Similarly, how is the shortage policy or contract allocations managed to build or maintain storage to meet WR temperature criteria and maximize the frequency of meeting tier 1 and 2 years?	(1) Provide more details. (2) We believe that the Anderson model may be lab-tested and applied through adaptive management but should not be relied upon for site-specific, core operations. (3) Provide more details. (4) (for understanding) How is "build storage" modeled in CalSim II? What is the priority relative to other demands? re: (5 & 6) (5)Provide more details.	

				(5) Similarly, how are Keswick release schedules, reductions in deliveries and preferential releases from Oroville and Folsom, etc. managed to build Storage and manage for summer water temperatures? (6) Reclamation needs to document how current tiers in operations were input into Calsim (e.g., preferential use of Oroville and Folsom for meeting D-1641, and restricted Keswick release schedule). (7) How is demand shifting defined? Why is demand shifting not considered as a strategy to to increase the likelihood of reaching tier 1 and 2 conditions?	(6) Provide more details. (7) Provide more details.	
7	Fall and Winter Refill and Redd Maintenance (p. 4-32)	Site-specific	Core	We are unclear about how the 10% risk assessment works. 10% or **less** risk of **what**, in order to rebuild storage for the following year? Does Reclamation mean 10% or more? If the 10% threshold is exceeded, what happens?	Provide more details.	
8	Operation of a Shasta Dam Raise (p. 4-33)	Site-specific	Core	Description of this action is too vague to consult on either as a site-specific action or a programmatic action	Significant details on the proposed action and its effects are needed to consult on this action:	

					Specifically, modeling of of the PA which includes the dam raise (18.5 feet and ~634 TAF of increased storage) so that not only the Sac flows, storages, and associated temp outputs, but flows and temperatures throughout the Sacramento Basin and Delta are representative of the PA.	
9	Rice Decomposition Smoothing* (p.4-34)	Site-specific	Core	Assumes "propose to work to synchronize" will be implemented.		
10	Spring Management of Spawning Locations* (p.4-34)	Site-specific	AM	NMFS believes the adaptive management of this action should not be separate from the 5-agency adaptive management framework.	NMFS recommends a commitment to use the adaptive management framework agreed to by the five agencies for CWF.	
11	Cold Water Management Tools (e.g., Battle Creek Restoration, Intake Lowering near Wilkins Slough, Shasta TCD Improvements)*(p.4-34 to 4-35)	Programmatic	AM			

12	Spawning and Rearing Habitat Restoration*(p. 4-35)	Programmatic	AM	What is being proposed above and beyond what NMFS has already consulted on through the B-13 program?	Move to the Environmental Baseline? As an alternative, consider drawing from the State's Salmon Resiliency Strategy or other efforts that are ongoing with Battle Creek and Butte Creek PG&E license transfers and orphaned project pursuits.	
13	Small Screen Program* (p. 4-35)	Programmatic	AM			
14	Winter-Run Conservation Hatchery Production* (p. 4-35)	Programmatic	AM	Generally agree with increasing LSNFH production during extreme drought conditions, however, the use of New Zealand or Great Lake Chinook salmon stocks to improve heterozygosity is an experimental concept that should not be relied on as part of the proposed action.	Develop alternative language for coordinating with the NMFS SWFSC and the USFWS on emergency hatchery management practices.	
15	Adult Rescue* (p. 4-35)	Programmatic	AM	The adult rescue proposal is experimental needs further discussion through 5-agency AMF	NMFS recommends a commitment to	

					use the adaptive management framework agreed to by the five agencies for CWF.	
16	Juvenile Trap and Haul* (p. 4-35)	Programmatic	AM	The juvenile trap and haul proposal is experimental and needs further discussion through 5-agency AMF	NMFS recommends a commitment to use the adaptive management framework agreed to by the five agencies for CWF.	
	Trinity					
17	Seasonal Operations (p. 4-36)	Site-specific	Core	Unclear how Trinity Reservoir end of September storage will be maintained (no minimums), and how water temperature objectives in the Trinity River will be complied with. No description of cold water pool management. No description of how the reservoir would be managed during successive drought years.		
18	Trinity River Record of Decision (p. 4-37)	NCO	NCO	Table 4-6 shows Trinity River ROD and Long Term Plan to protect adult salmon in the lower Klamath River as "Not Consulted On", yet proposed action section (4.9.2.2) has discussion of Trinity River ROD and the Long Term Plan for the lower Klamath River. Section 4.10 also shows TRRP flows not included in this consultation, but should be.		

19	Long-Term Plan to Protect Adult Salmon in the Lower Klamath River (p. 4-37)	NCO	NCO			
20	Grass Valley Creek Flows from Buckhorn Dam (p. 4-38)	Site-specific	Core			
21	Whiskeytown Reservoir Operations (p. 4-38)	Site-specific	Core	Unclear how the cold water pool will be managed to comply with temperature objectives in Clear Creek, particularly in drought/critical years. Proposed temperature management at 56 F for spring-run spawning at the compliance point is described as suboptimal survival.		
22	Clear Creek Flows (p. 4-38)	Site-specific	Core			
23	Spring Creek Debris Dam (p. 4-39)	Site-specific	Core			
24	Clear Creek Restoration Program* (p. 4-39)	NCO	NCO			
	Feather River					
25	FERC Project #2100-134	NCO	NCO			
	American River					
26	Seasonal Operations (p. 4-41)	Site-specific	Core			
27	2017 Flow Management Standard Releases and "Planning Minimum" (p. 4-41)	Site-specific	Core	Need details about which elements of the 2017 Water Forum proposal are being committed to.	Reclamation to provide specific commitments.	
28	Spawning and Rearing Habitat Restoration* (p. 4-42)	Programmatic	AM			

29	Drought Temperature Facility Improvements* (p. 4-43)	Programmatic	AM			
	Stanislaus					
30	Seasonal Operations	Site-specific	Core	Not clear what is assumed for Vernalis flows, year-round, in COS and PA scenarios.	Reclamation to provide details.	
31	Stanislaus Stepped Release Plan	Site-specific	Core			
32	Alteration of Stanislaus DO Requirement	Site-specific	Core			
33	Spawning and Rearing Habitat Restoration*	Programmatic	AM			
34	Temperature Management Study*	Programmatic	AM			
	San Joaquin					
35	San Joaquin River Restoration Program	NCO	NCO			
36	Lower SJR Habitat*	Programmatic	AM			
	Bay-Delta					
37	Seasonal Operations (p. 4-43)	Site-specific	Core	Jones and Banks Pumping Plants: Description of operations should be more detailed to clearly describe what is proposed, in particular: -- how the Clifton Court radial gates will be operated on the tidal cycles and Delta water elevations, -- how frequently joint points of diversion will be used (water year type, seasons, preference for which facility will be used,	NMFS needs more details by March 1 to understand operations by. Reclamation should copy details, as appropriate,	

				impacts to salvage, etc.), -- information on standard operating procedures for fish salvage (i.e. count durations, frequency of counts, what happens during outages or louver cleanings, etc.). North Bay Aqueduct and Barker Slough Pumping Plant: Minimal information is given regarding the Barker Slough Pumping Plant and its operations - Need details on permitted pumping rates versus the frequency and volumes of historical pumping rates - information over an average given year and by water year type. Contra Costa Water District Rock Slough Pumping Plant and Intake Canal: No information on the operations of this facility, particularly permitted export rates and volumes, historical usage patterns, etc. What is Reclamation proposing, how is the proposed action the same or different from the previous operations?. This is not very clear - operations, infrastructure construction, both, or something else. More detail as to what is proposed and what is different than the Current Ops.	from the 2008 BA and 2009 RPA.	
38	Minimum Export Rate (p. 4-44)	Site-specific	Core			
39	Delta Cross Channel Operations (p. 4-44 and A-95)	Site-specific	Core	Reclamation proposes to open up the gates up to two times for 5 days during the period between December 1 and May 20 if needed for water quality. This is in	Reclamation should confirm that the proposed action	

				conflict with D-1641 which requires the gates to be closed between Feb 1 and May 20. Details are needed on how the risk assessment is conducted and resolution if the fish agencies do not agree with Reclamation's decision. Should also include the aspects of the lower Mokelumne River attraction flow operations.	is consistent with D-1641. Provide more details on the risk assessment and decision making/elevation process.	
40	Agricultural Barriers (p. 4-46 and A-97)	Site-specific	Core	Is the proposed action asking for coverage for operations, construction, or both? The proposed project description is too vague as to the actual project details. Separate BiOps are typically written that cover construction and operations for a multi-year period. No information regarding what is going to happen with the HORB. Is it going to be installed per the CWF BiOp as an operable barrier, or is the HORB not going in under the proposed project and Reclamation will defer until the CWF project is implemented?	Ag barrier construction is a separate section 7 consultation, should not be consulted on in ROC on LTO. Reclamation should determine the fate of the HORB in this consultation.	
41	Contra Costa Water District Rock Slough Operations (p. 4-46 and A-110)	Site-specific	Core			
42	North Bay Aqueduct (p. 4-46)	Site-specific	Core			
43	Water Transfers (p. 4.47 and A-127)	Site-specific	Core			
44	Clifton Court Aquatic Weed Removal (p. 4-48 and A-101)	Site-specific	Core	Need to clarify that it is water temperature that is the basis of the start dates for treatment. Need to clearly explain that listed green sturgeon are present during	Reclamation should copy details, as appropriate,	

				the herbicide treatment window, even though salmonids and Delta smelt may be absent in the area. Clarify whether both aerial application and boat application are to be made or is it just by boat. Clarify what the target concentration of copper herbicide is for treatments with different compounds proposed. Clarify what concentrations of copper (and what copper species is being measured in WQ testing) will be the threshold for re-opening the CCFB gates and continuing operations. Clarify what the pre-application procedure is for gate operations - is it closure at least 24 hours prior to herbicide application? Clarify whether it is a 24 hour minimum after herbicide application before gate re-opening or the 12-24 hours also stated in the project element description. No mention of other methods for weed removal - mechanical harvesting is mentioned in the effects analysis as a potential method - clarify. What about use of Aquathol?	from the 2008 BA and 2009 RPA.	
45	Suisun Marsh Preservation Agreement (p. 4-50 and A-130)	NCO	NCO			
46	OMR Management (p. 4-51 and A-122)	Site-specific	Core	Overall more detail is required for this project element. How will "real time monitoring" of salmonids and green sturgeon (e.g., fish distribution, turbidity, temperature, hydrodynamic models, and entrainment models) be used? What are the rationales for delaying changes in operations for 3 days before implementing changes to exports when triggers are	Reclamation should provide more details, including use of current monitoring capabilities for action triggers.	

				exceeded? This does not make "real time" protections viable. Will distribution of wild YOY spring-run and steelhead from the SJ River basin be done separately as distinct population groups? Regarding the wild CV steelhead Protection criteria - how will 5% of population in Delta be determined? Impossible to differentiate Sac basin from SJ basin fish by visual means so the Sac basin fish will dominate this metric and will be the population that will "trip" the triggers, not SJ River fish. Also, how will differences in the timing of emigration for the two basins be addressed? SJ River fish tend to emigrate later than Sac Basin fish (based on Mossdale data) and may not be in sufficiently high numbers to ever trip the 10 fish/TAF threshold. How does this protective action for steelhead compare to the previously used I:E ratio at protecting SJ River steelhead? What evidence supports the proposed trigger threshold? Why switch to May 31 as the end of the protective action? Why not use a temperature metric for the SJ River as the end of protective triggers for steelhead after May 31 - this would reflect current hydrologic/water year conditions? Rationales should be presented for the components of the trigger. **Salvage or Loss Thresholds** - these triggers should clearly indicate whether loss or salvage is being used. Loss is used for WRCS and surrogate spring-run triggers. Salvage is used for steelhead. Both loss and salvage was used for GS in the 2009 opinion. Since the WR JPE does		

				not come out until late January or early February, what "limit" will be used during this interim period? There are currently no estimates for spring run-JPE, so the trigger for this group is not valid. What is the justification for the steelhead and green sturgeon limits? The implementation of the storm-related flexibility should be clearly described in the fish facilities operations, including how off ramps to exports due to fish salvage events or elevated risks to entrainment be implemented. If a cumulative trigger is met, does this preclude any more storm flexibility for the remainder of the fish migratory period for that water year? **End of OMR Management** - No current assessment of population distribution is done for steelhead, thus no ability to determine if 95% of the population has exited the Delta. How will Reclamation and DWR determine that protective measures are not warranted? Will the Services and CDFW have any authority to disagree with this determination? If the Services and CDFW have the authority to authorize more negative OMR levels, why not the opposite too, if they deem it necessary to protect listed fish?		
47	Tracy Fish Collection Facility* (p. 4-55 and A-109)	Site-specific	Core	The description of the TFCF operations is inadequate. Project description should detail operating protocols used for salvage, collection, trucking, and releases. Should also explain the efficiency of the facility, the louver and secondary cleaning	Reclamation should copy details, as appropriate, from the 2008 BA and 2009	

				operations and additional loss associated with those events, and operations during fish facility outages at a minimum.	RPA.	
48	Skinner Fish Facility* (p. 4-55 and A-107)	Site-specific	Core	Same comments as Tracy fish facility.	Reclamation should copy details, as appropriate, from the 2008 BA and 2009 RPA.	
	Operations					
49	Suisun Marsh Salinity Control Gates Operation* (p. 4-55 and A-130)	Site-specific	Core	More details are needed to understand how upstream releases are proposed for this operation. For any project requiring construction, some details regarding location, number of sites, the types of construction required, in-water work windows, and duration and frequency should be provided.	Reclamation should provide more details.	
50	Fall Delta Smelt Habitat* (p. 4-55 and A-127)	Site-specific	AM			
51	Clifton Court Predator Management* (didn't see separately in Chapter 4; is mentioned on p. 4-57 under "Skinner Fish Facility Improvements"; a list of studies and interim measures is provided on A-107; studies provided in Appendix G)	Site-specific	Core			
52	San Joaquin Basin Steelhead Telemetry Study* (p. 4-56)	Site-specific	AM			

53	Sacramento Deepwater Ship Channel Food Study* (p. 4-56)	Programmatic	AM			
54	North Delta Food Subsidies/Colusa Basin Drain Study* (p. 4-56)	Programmatic	AM			
55	Suisun Marsh Roaring River Distribution System Food Subsidies Study* (p. 4-56)	Programmatic	AM			
	Habitat Restoration					
56	Tidal Habitat Restoration (Complete 8,000 acres from 2008 BiOp)* (p. 4-57)	Programmatic	AM			
57	Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project* (p. 4-57)	NCO	NCO			
58	Predator Hot Spot Removal* (p. 4-57)	Programmatic	AM			
	Facility Improvements					
59	Delta Cross Channel Gate Improvements* (p. 4-57)	Programmatic	AM			
60	Tracy Fish Facility Improvements* (p. 4-57)	Programmatic	AM			
61	Skinner Fish Facility Improvements* (p. 4-57)	Programmatic	AM	Not enough details to consult on		
62	Small Screen Program* (p. 4-57)	Programmatic	AM			
	Fish Intervention					
63	Reintroduction efforts from Fish	Site-specific	AM			

	Conservation and Culture Laboratory* (p. 4-58)					
64	Delta Fish Species Conservation Hatchery* (p. 4-58)	Programmatic	AM			
	*Denotes a Conservation Measure					

Other Elements regarding the Proposed Action (either referenced in BA or not in BA but NMFS is tracking)

	Appendix C: Water Operations Charter			The role of this "charter" is not clear. It seems to have some components of the previous AM framework that the agencies advised against including in the PA. NFMS concern that it requires a sort of "signature" of the agencies. The section claims to "describe how the 5 Agencies and stakeholders will plan, communicate, and coordinate real-time water operations decisions on the Core Water Operation for the ROC on LTO. However, it provides no process for adaptive management implementation; it does not refer at all to the previous 5-Agency AMP developed for the CWF and existing CVP/SWP BiOps; it rearranges and reassigns roles and tasks of existing groups without authority to do so. NMFS would also point out the misleading name of "core monitoring" that is implemented to support the "core operations". This is a potentially misleading name, since it could easily imply that this monitoring (which is really just the	A commitment to use the adaptive management framework agreed to by the five agencies for CWF.	

				existing compliance monitoring), is akin to the"Core Array" championed by the SAIL. It is not at all akin to that.		

	Adaptive Management (1-2) "Adaptively managed actions will require additional coordination prior to implementation through program-specific teams established by Reclamation and DWR with input and participation from partner agencies and stakeholders."			Reclamations proposal on adaptive management is something different than the previously agreed to 5-agency AMF. This is confusing and creates the possibility of conflicting and redundant AM programs.	A commitment to use the adaptive management framework agreed to by the five agencies for CWF.	
	Fish Passage Program - Not in the proposed action			A successfully reintroduced population of Sacramento River winter-run Chinook salmon above Shasta Reservoir in California is anticipated to have a water supply benefit and mitigate risks to the species that currently exists below Shasta reservoir.		
	Discretionary Allocations			No real discussion of discretionary allocations, shortages and how these decisions will be made when necessary to meet key ESA or SWRCB metrics, storage management, Keswick releases and connection to allocations, shortages, and temperatures Preferential releases from Folsom and Oroville to meet Delta standards when necessary to preserve	Propose a transparent approach for exercising discretion where ESA listed fish could be affected.	

				storage at Shasta		
	I:E			Did not see a proposed spring SJ steelhead protection in PA.		

NMFS Comments on the Effects Determinations (Chapter 7) and Effects Analysis (BA Chapter 5)

	Title	Topic	NMFS Comment	Proposed Resolution or Path Forward	Resolution
	Effects Determinations	**Reclamation's Determination**			
1	Winter-run Chinook salmon	Overall Beneficial, Likely to Adversely Affect	Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative NMFS assumes this is LAA		
2	Winter-run Chinook salmon - Critical Habitat	Beneficial to No Effect, provides benefits to critical habitat	Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Determination is not clear. Is the determination NLAA or LAA for critical habitat?	Clarify Reclamation's determination	
3	CV spring-run Chinook salmon	Overall Beneficial, Likely to Adversely Affect	Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative NMFS assumes this is LAA		

4	CV spring-run Chinook salmon - Critical Habitat	2 determinations provided: (1) Overall long-term beneficial effects (2)temporary localized adverse effects but long-term beneficial effects	Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Need to clarify determination. NMFS assumes LAA	Clarify Reclamation's determination	
5	CCV steelhead	Overall beneficial to the population of the DPS, but likely to adversely affect	Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative NMFS assumes this is LAA		
6	CCV steelhead - Critical Habitat	Overall long-term beneficial effects	Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Does Reclamation mean NLAA? Need to clarify	Clarify Reclamation's determination	
7	Southern Oregon / Northern California Coho Salmon	Overall beneficial, but likely to adversely affect	Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative NMFS assumes this is LAA		
8	Southern Oregon / Northern California Coho Salmon - Critical Habitat	Although there may be adverse effects to certain PBFs, Reclamation's determination is overall beneficial	Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Need to clarify determination? LAA or NLAA?	Clarify Reclamation's determination	

9	North American Green Sturgeon	Overall beneficial, but likely to adversely affect	Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative NMFS assumes this is LAA		
10	North American Green Sturgeon - Critical Habitat	May adverse components of critical habitat while also resulting in benefits	NMFS assumes this is LAA		
11	Eulachon	May Affect, Not Likely to Adversely Affect			
12	Eulachon - Critical Habitat	May Affect, Not Likely to Adversely Affect			
13	Southern Resident Killer Whale	May Affect, Not Likely to Adversely Affect	NMFS disagrees with this determination	NMFS will address in the BiOp, but see information needs below.	
14	Southern Resident Killer Whale - Critical Habitat	May Affect, Not Likely to Adversely Affect	NMFS disagrees with this determination	NMFS will address in the BiOp	
15	CCC steelhead	No Effect	NMFS does not consult on No Effect determinations	Defer to Reclamation on their determination	
16	CCC steelhead - Critical Habitat	There is no determination made by Reclamation	Clarify if Reclamation's determination for the species also applies to critical habitat. NMFS does not consult on No Effect determinations	Clarify Reclamation's determination. Defer to Reclamation on their determination	

	General				
17	Effects Analysis	Level of detail and support	Most effects descriptions provide only a qualitative description of risk (for both COS and PA) relative to the WOA[1]. General statements such as "overall effects are beneficial" are often made with no or limited support. Effects descriptions even less robust for the "conservation measures" or programmatic actions. Some conclusive statements appear to be inconsistent with the data provided. For example, temperature modeling in the American River shows water temperatures in the PA that are not suitable for steelhead, despite the statement on page 5-133 that, "*The implementation of the proposed 2017 FMS measures under the proposed action would provide suitable habitat conditions in the lower American River for CV Steelhead, particularly during drought conditions and improve conditions for this life stage*."	Provide supporting rationale and/or updated analysis as appropriate. Ultimately, NMFS will draw own effects conclusions.	
18	Biological Modeling	Biological modeling needed to support the effects analysis	The lack of biological modeling limits our ability to assess magnitude of effects. One major gap is non-use of the winter-run life cycle model	NMFS SWFSC is carrying out the WR life-cycle modeling. ICF conducting additional modeling. Cathy Marcinkevage is coordinating this with SWFSC and Katrina Harrison at Reclamation.	
19	Figures	Interpretation of standard flow figures	For example, in Figure 5.6-8 on p. 5-16: How are error bands determined? Does "Long-term	Reclamation to clarify.	

[1] For example (p. 5-17) "Therefore, all potential adverse effects of low flows on Winter-run Chinook Salmon spawning and incubation listed above are expected to be much less severe under the proposed action or COS than under the WOA."

			average" mean over all years in the CALSIM record?		
	Southern Resident Killer Whale	Southern Resident Killer Whale			
20	Southern Resident Killer Whale Analysis	Analytical Needs	No quantitative estimates of fall-run Chinook production in the Central Valley or Trinity in the PA or other scenarios; these estimates are necessary to assess how the prey base is affected by the PA.	Estimate Chinook salmon production under the PA with support from Reclamation staff	
	Shasta/Sacramento	Shasta/Sacramento			
21		Seasonal Operations	What are the assumptions that went into the baseline modeling?	Provide additional detail.	
22		Shasta Cold Water Pool Management (p. 4-27)	No specific effects provided on results under 4-tiers of cold water management, including examples of duration of 56 at CCR. Not sure what is happening in Tiers 2 and 3. Is "Model II" from Anderson 2018 what is used as "the Anderson model"? The insufficiency in this section is that here is not enough information to determine how often (% of years) Reclamation expects to be in a particular "tier" (There is some information in Appendix D from which to infer based on historic occurance of a particular water-year-type but that is all). Although the % of years in a tier is described on page 5-20 (based on total storage May 1, 1922-2003: (tier 1 = 69%, t2 = 17%, t3 = 7%, and t4 = 8%), this does not necessarily reflect future conditions.	Provide additional detail.	

			Given that there is no provision in PA to build storage to meet any targets, how is this brought into the modeling and analysis?		
23	Spring pulse flow	Spring pulse flows (p. 5-41)	No description % or # of years where Reclamation would expect to satisfy the constraints regarding implementing a spring pulse flow.	Provide additional detail.	
24	Shasta Dam Raise	Shasta Dam Raise (p. 5-52)	Hard to understand the various models compared here -- CP4, CP4A, Full Obligation, and how they relate to the COS and PA. Seems like the PA modeling results are used throughout rest of effects section, so assumed flows/temps may not be consistent throughout. How does the revised COA fit into the various runs?	Provide additional detail.	
25		5.6.4 (Effects of Conservation Measures)	This whole section should be organized around an adaptive management framework, where Reclamation identifies a particular management/science uncertainty and then defines a range of relevant operations that will be tested to reduce that uncertainty. Once the range of operations is defined reclamation may then provide the expected range of effects. This is not the case here.	NMFS recommends a commitment to use the adaptive management framework agreed to by the five agencies for CWF.	
26		Appendix D (4.3 HEC5Q PA assumptions)	It is unclear from the description of Shasta temperature management assumptions under the PA, if the "tactical approach" was actually modeled? No details on how temperature schedules were updated to match the strategy identified in the PA.	Provide additional detail.	
27	Figures	Interpretation of Cold Water Capabilities figures (p. 5-19 to 5-20).	For example, in Figure 5.6-10 on p. 5-19, what are the yellow dots? To tell which tier would be implemented, need to "subtract the outflow from	Reclamation to clarify.	

			the inflow, correct? Are all results on 5-19 to 5-20 from the PA scenario?		
	Trinity				
28	Seasonal Operations (p. 5-447 to 5-449)	Temperature modeling outputs	No temperature modeling for compliance locations. Only Lewiston temp modeling provided. Lesiston is not a compliance point, nor does it provide insight into rearing habitat or adult migration conditions in the river. Results of temperature modeling at Douglas City and North Fork-Helena are needed	Provide additional detail.	NMFS and Reclamation may have lined up some RBM-10 modeling which would provide the necessary information
29	Seasonal Operations (p. 5-447 to 5-449)	Modeling	No habitat modeling or fish production modeling for SONCC coho salmon. Without one or the other can't estimate population effects and associate the proposed action with effects to the species, or use habitat as a surrogate.	Provide additional detail.	
	Stanislaus	Stanislaus			
30	Appendix D, Attachment 3-1, 3-2, and 3-4	All Stanislaus River-related COS results	COS flow requirements are implemented based on the New Melones yeartype. However, all COS results (storage, flow, temperature) are summarized based on the yeartype defined by the 60-20-20 Index (the method in the PA). These 60-20-20 yeartype bins for the COS results do not accurately capture the modeled operations. For example, The Critical year bin in the COS results might include years in which the modeling implemented the Dry or Below Normal year schedule, because the 60-20-20 Index was Critical while the New Melones yeartype was Dry or Below Normal. Additional information is needed to (a) summarize	Provide additional detail or direct NMFS to where the information can be found.	

			the observed flows in the COS scenario based on New Melones yeartype, and (b) some sort of crosswalk to compare yeartypes for all years in the CALSIM record according to the two yeartype determination methods.		
	Bay-Delta				
31	Flow effects to rearing/outmigrating salmonids	(p-5-42)	BA states "The SST concluded altered 'Channel Velocity' and altered 'Flow Direction' were the only two hydrodynamic mechanisms by which exports and river inflows could affect juvenile salmonids im the Delta", and provides a version of Figure 2-2 from p. 5 of the SST report. This completely mischaracterizes the SST's conclusion and ignores the identification of diverse effects pathways on pages 4 and 6 of the SST report.	One example of how NMFS may have different interpretations of reports.	
32	5.6.3.4.1.1 Rearing to outmigrating juveniles in Bay-Delta - Entrainment (winter-run)	(p. 5-43 to 5-44)	Qualitative assessment using the modeled average exports over 3-4 month blocks from Cal Sim for the Dec-Feb and Mar-June periods of entrainment. The export rates were then inputted into the Zueg/Cavallo entrainment model to generate a range of entrainment values based on WR population percentages without providing the actual values. The effects assessment concludes that entrainment under the PA will go up compared to the COS, but that the restrictions to exports based on the population cumulative loss will be protective by limiting the OMR flows to no more negative than -3500 cfs for the remainder of the season (50% of take limit). Section doesnot describe how much additional salvage and loss will occur compared to the COS. It also mistakenly infers that this is a salvage metric rather than a loss metric for WR.	Provide additional detail.	
33	5.6.3.4.1.2. Routing (of	p. 5-45 to 5-46	Qualitative assessment of routing and survival based on the "overlap" figures in Appendix H.	Provide additional	

	WR in the Delta)		This section does not provide the actual numbers or magnitude of routing / survival estimates based on the differences in velocity, which would help in assessing potential additional (or reduced) take for the proposed project with a quantifiable metric. Discrepancies between values for % overlap in text and figures in appx. H, differences may be greater than reported in text. Using the survival models for acoustic tagged fish (i.e., work by Perry and others), survival estimates for these channel reaches and routing could be generated giving a more quantitative evaluation of survival due to routing and velocity changes related to the differnt actions.	details. Some entrainment modeling could be done using USGS model?	
34	5.6.3.4.4.3 Through Delta Survival - WRCS		Section describes through reach survival as a function of the channel velocities in the mainstem Sac River between Walnut Grove (DCC gates) and upstream near Sutter/Steamboatboat sloughs using DSM2. The percentage overlap of channel velocities was used as a surrogate for the differences in survival between WOA, COS, and PA.	Using the calculated channel velocities from DSM2, it should be possible to calculate the changes in survival rates for these reaches, which then gives a quantitative comparison rather than a qualitative one, such as reach survival changes "x" percentage in a wet year type between the WOA and the PA, or between the PA and COS scenarios.	
35	DCC5.6.3.5 Delta Cross	Lack of modeling	PA states that Reclamation will make final	Provide additional	

	Channel Operations (WRCS) -- p. 5-47		determination for gate closures to protect fish following their risk assessment, which could lead to more WR lost earlier in the season due to gates remaining open longer based on Reclamation's discretion. Reclamation has not provided any details regarding the procedure for their risk assessment process. Have not seen any modeling results to indicate that impacts to emigrating listed fish will be equivalent or different to what was in the 2009 opinion. Have not seen the results of any hydrodynamic modeling indicating how operations of the DCC gates will alleviate any water quality issues in the interior or southern Delta when exceedances of the water quality standards has been forecasted to occur. Reclamation has increased the time to make gate closures from 24 hours to 48 hours - this needs explanation and a risk assessment for how much additonal risk listed fish will see with an additional day of delay in gate operations. Should also include the aspects of the lower Mokelumne RIver attraction flow operations as this is new to the DCC operations.	details.	
36	Suisun Marsh Salinity Control Gates Operation*	(p. 4-55 and A-130)	If water from the managed wetlands is discharged to Suisun Bay and surrounding waters, how does this impact water quality, including DO, P, N, and any contaminants from the wetlands such as herbicides or mercury? How will the boat locks reoperation impact listed fish moving through the Sacramento River adjacent to the locks. Most of these elements were only described in cursory fashion without any scientific support or	Provide additional details.	

			analysis provided in the description. If scientific studies are available, then that information should be provided with the project proposal. For example showing how flows through the restored ship locks at the upper end of the Sacramento DWSC might affect flows in the DWSC over the year with the gates in both the open/closed positions, and how Sacramento mainstem conditions may be impacted during those same operations. This could help inform how flows/velocities might change in each channel and how survival may be altered based on flows and velocity factors.		
37	5.6.3.11 OMR Management (WRCS)	Beginning on p. 5-51	Very qualitative assessment of entrainment for the effects analysis with no "numbers" given. No comparison between the different operational scenarios provided. No justification or evidence provided for the conclusion that the PA will be "similar or less" to the COS. Where are effects due to storm flexes described?		
	5.6.4.12 Clifton Court Predator Management (WRCS)		Very minimal analysis. No description as to how this will be done, when it will be done, and what level of predator control is targeted.		

Attachment 4

INTERNAL. FOR DISCUSSION PURPOSES ONLY.

ROC LTO Directors Meeting
NMFS Internal Notes
March 8, 2019

Attendees

- Ernest Conant, Russ Callejo, Dave Mooney, Mike Ryan, Don Bader, Jeff Rieker, Katrina Harrison, Kristen White; Reclamation
- Paul Souza, Dan Castleberry, Kaylee Allen, Jana Affonso; USFWS
- Barry Thom, Maria Rea, Howard Brown (ph), Garwin Yip, Justin Ly (ph), Cathy Marcinkevage; NMFS

Decision Items and Action Items

DC Updates: Potential review of schedule by DC counsel from both Departments.

BA Revision Documentation: Reclamation indicated that a table of issues and resolution status is/will be generated and potentially included in submission of a supplemental BA.

*Trinity ROD Flows***:** Agreement reached that Trinity flows are really no change to existing, and that Reclamation desires to consult on those. Final reiteration that Trinity flows are included because Reclamation wants coverage for the Trinity. All in attendance agreed. Table 4.6 of BA regarding Trinity ROD flows from "NCO" to "No Change" or something similar.

COA: NMFS can assume that Reclamation won't go to Oroville for temperature management, and will operate to avoid accrual of COA debt. "NCO" in Table 4-6 for COA will be replaced with "No Change From Current Operations" or removed completely. Reclamation to provide documentation of no effect determination to NMFS.

Shortage Policy: The effect is a small sliver of allocation and therefore warrants a lower level technical discussion.

Shasta Dam Raise: Development of a reinitiation trigger identifying that reconsultation would be required if Shasta Dam raise results in effects to the habitat condition and species outside of the bounds (positive or negative) of those covered by this consultation. NMFS and FWS will work with Russ to identify this reinitiation trigger.

Adaptive Management: Reclamation could commit to trying to work out revisions to the existing five-agency plan to better suit their desires, and agencies can provide identification of the (non-CWF-associated) uncertainties associated with existing/PA operations that they would like to be addressed by this AMP. Agencies will outline the uncertainties that they have regarding current operations and PA operations (i.e., without CWF). NMFS will provide a "CWF-free" version of the five-agency program to Reclamation, and will also provide suggestions for approaches to marrying the PA with a revised five-agency plan.

I:E Action: Analysis will be completed on the PA as provided; concerns about extent of effect will later be discussed and evaluated for being addressed by relating to adaptive management. NMFS noted that we see changes in the PA that we expect to have a more negative effect, and that this decision has potential affect the schedule. NMFS to identify associated uncertainties that can be related/incorporated into adaptive management uncertainties.

Meetings: Wednesday 10 AM meetings will now be directors meetings reflecting this group. Additionally, this group plans to meet again on April 4, 12-2, for updates and address of new issues.

Introduction and Opening Remarks

Paul noted ambitious agenda (developed jointly by Russ, Howard, and Jana) and suggested prioritizing discussion on items for which decisions could be made today, noting that he expected additional meetings may be necessary to address other items. Attendees generally agreed but no immediate revisions were made to the agenda.

Paul and Ernest both praised the effort to date and acknowledged the challenge of the remaining effort.

Status of Consultation

Kaylee noted that FWS has identified many issues that they believe can be resolved. They have set a schedule of major milestones (distributed at meeting), which include stakeholder meetings.

Paul noted that he told DC about this schedule and that he requested/expects counsel from Interior and perhaps NOAA/DOC to go over it in prep for any review of documents.

Maria noted that the NMFS effort is quite active and there have been many productive meetings/discussions in the last two weeks in the follow-up "focus group" meetings. She noted that we are still waiting on a table that populates responses to questions as a form of documentation of conversations and clarification of the BA.

Discussed the April 1, 2019, entry on the schedule indicating no further changes to the proposed action. Barry asked if NMFS had the same date, and Paul suggested reserving the right to change the project later than that if it led to needed improvement. Generally accepted, but Kaylee noted the need to include that to prevent problematic changes to the PA late in the biop drafting process.

Russ acknowledged changes to the PA resulting from focus groups. Indicated that a table of issues and resolution status is/will be generated and potentially included in submission of a supplemental BA.

Elevation Topics

Discussion on agenda, with Reclamation noting that they thought I:E and Shortage topics were not ready for elevation due to lack of staff level discussion. NMFS agreed that the Shortage topic could be short or included with the COA topic. However, NMFS advocated for director-level discussion of I:E given that there were many conversations on this topic in summer 2018 (which produced the alternatives paper that was distributed then and at this meeting). Maria noted that I:E has fallen out of recent discussions, which is most explicitly demonstrated by a lack of inclusion of it or any proposed alternative in the PA. NMFS has been and is still committed to a fresh look at alternatives, but notes that it is very challenging to move forward on the consultation without it or a commitment to a proposed alternative protection for San Joaquin steelhead. It therefore remained as an elevated topic.

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Topic discussion order shifted slightly from the agenda and is reflected in the order captured below.

Trinity ROD Flows

Decision: Agreement reached that Trinity flows are really no change to existing, and that Reclamation desires to consult on those. Final reiteration that Trinity flows are included because Reclamation wants coverage for the Trinity. All in attendance agreed. Action item to change the line in Table 4.6 of BA regarding Trinity ROD flows from "NCO" to "No Change" or something similar.

Discussion: NMFS reviewed some of the history on this topic, noting that the Trinity has needed reconsultation for quite a while, and it keeps getting passed back-and-forth between Trinity and CVP. The need to reconsult because of a new species is a known issue, and Trinity flows have long expected to be covered in a "next" CVP ops consultation. The 2012 BiOp did include reinitiation triggers, but did not have consultation on coho; because the 2009 BiOp was on CV species and NMFS was under a court-ordered timeline, coho was segmented out and not included in that consultation. Therefore there is no take coverage for coho. NMFS advocated for incorporating Trinity ROD flows into the BA. Justin and Barry indicated that they did not expect this to be a notable impact on the schedule, and would require minimal BA revisions.

Paul expressed repeated concern incorporating Trinity ROD flows could affect schedule or "reopen" the ROD, noting the complicated process considering tribes and other stakeholders who may request other changes to the ROD flows; suggested separate consultation that focuses on coho, perhaps as part of the CESA or VSA. Dave noted the desire to separate this consultation from reopening the ROD, but noted seeing the Trinity as part of the CVO ops so sees best path is to get coverage for all of the CVP with this consultation. Russ clarified that they wanted the Trinity ROD flows to move forward as is, to have the transbasin diversions, and want take coverage for that transfer.

Agreement reached that Trinity flows are really no change to existing, and that Reclamation desires to consult on those. Final reiteration that Trinity flows are included because Reclamation wants coverage for the Trinity. All in attendance agreed. Action item to change the line in Table 4.6 of BA regarding Trinity ROD flows from "NCO" to "No Change" or something similar.

COA

NMFS started with indication that we need to understand where it affects protective actions, and whether avoidance of accruing COA debt supersedes operations for temperature management. Also noted need to understand how COA reaches back to affect Delta operations – whether calls to Oroville for Delta operations needs are not granted because of potential COA debt is in conflict/contradiction with the state asking for take coverage for coordinated operations.

Reclamation reviewed that they did an environmental assessment resulting in FONSI – that the effect of the changed COA was within the effects of the consultations of the record at the time.

Maria noted that that was for NEPA, but what about ESA compliance? Reclamation responded that the changes are to reduce reliance on CVP storage, resulting in increased CVP storage in wetter years to be

used for better temperature management when needed; also changes in export sharing to increase use of Jones, and therefore the effects were not expected to be worse for the species. NMFS requested documentation of that be provided by Reclamation to NMFS for our record.

Reclamation said that terms and conditions on COA-related actions are likely ok, and that resolution may be to replace "NCO" in Table 4-6 for COA to "No Change From Current Operations".

Maria said that change would be very helpful to us, and that we will make assumptions. When asked by NMFS if we could assume that Reclamation won't go to Oroville for temperature management, and won't try to accrue COA debt, Jeff agreed, noting that this is more of a water rights issue than an operations issue. Kristen noted that long-term/programmatic debt accrual could be seen as not adhering to the "spirit" of COA.

Decision was reached to either replace "NCO" in Table 4-6 for COA to "No Change From Current Operations" or to remove it completely.

Shortage Policy

Attendees noted that Jeff and Howard had recently spoken about this. The effect is a small sliver of allocation and therefore warrants a lower level technical discussion.

Fish Passage Program

NMFS presented its case that the Fish Passage Program was included in the 2009 BiOp, and that NMFS believes it having multiple populations of winter-run Chinook salmon could allow for more flexibility in operations. Acknowledged that there is a concerted effort to not move it forward, and noted this as a poor decision with regards to risk management to not further the program.

Maria provided the issue paper from July 2018 that had been provided at that time. It documents the flexibility. NMFS continues to talk with water users on this topic, recognizing the opposition at the DOI level. Maria pointed to recent drought experience and how passage would have provided an opportunity to take a different temperature management approach than what was done, and that all parties suffered by not having this tool in the box. NMFS is doing science and modeling to show the alleviation of constraints on Shasta during drought due to benefits realized from reintroduction.

Paul noted that DOI did not think that this action was consistent with the baseline approach.

NMFS recognizes that this is a Reclamation decision and issue, and doesn't expect movement, but wanted to be sure the new director heard the utility of this approach to consider for future decisions.

Shasta Dam Raise

NMFS introduced concerns that the BA includes a raised Shasta dam and requests consultation at a site-specific level, but that the information is lacking for perhaps even a programmatic level consultation (i.e. it is not included in the CalSim modeling, there's no indication of how temperature management would

change, no characterization of changes in releases during different times of year). NMFS recommended that it be included in a future iteration of CVP operations consultation (expected within the next year due to NEPA/CEQA and VSA) because otherwise it would be a notable schedule impact.

The discussion noted that Reclamation believes that the required information is included in the Feasibility Study. However, Paul noted that that is 7 years old and may not be most reliable/reflective of likely action – and that he thinks the inclusion of the Feasibility Study in this consultation is confusing (and that it would be wise to look into whether it requires its own BiOp). Discussion did include question of how operations (and effects to species) could be expected to be the same as effects of current infrastructure if, for instance, flows are detained in the additional 634 TAF of new storage instead of being allowed to enter the river. However, Reclamation and Paul clarified that the existing operational constraints would be maintained and therefore it was expected that in-river conditions would not be different than what is characterized by the modeling in the BA (which does not include characterization of increased storage or resulting change in operations).

FWS noted that they preferred that it be included in this consultation in some capacity.

Agreement that this could be managed with a reinitiation trigger identifying that reconsultation would be required if Shasta Dam raise results in effects to the habitat condition and species outside of the bounds (positive or negative) of those covered by this consultation. NMFS and FWS will work with Russ to identify this reinitiation trigger.

Adaptive Management

Reclamation began discussion by noting desire to avoid the term “adaptive management” and instead wanting to discuss how the PA and ITS could adjust over time by looking at effects of implementation. Dave noted that Reclamation looks across the CV and sees many groups, and wants to work with those structures.

Dan noted that this topic was the hardest topic to wrestle during the CWF development; it was one of the longest components of development; and that it is one of the few components that connects the state and Federal entities. He stressed the desire to revisit that framework and, acknowledging Reclamation’s desire for increased autonomy, attempt to revise that rather than try to develop a new process.

Maria noted that one key efficiency of the five-agency plan is that it can stand as a framework into which actions can be implemented; and that otherwise, each of those actions would require their own standalone section 7 ESA consultations. So from an efficiency perspective, this is a much more effective approach to being able to adjust the PA and ITS.

Paul offered that the five-agency plan exists, and while there is some discomfort with it, suggested that Reclamation take a look at remove what is alarming. Dave offered that the five-agency program was developed to address uncertainties related to operations with a new point of diversion, and that the uncertainties of existing (or PA) operations were not reflected in that program. Cathy offered that the drafters were very careful to make it applicable to the existing (and anticipated future) operations consultations rather than just to CWF-oriented operations. Dan commented that the five-agency plan

was not developed because of CWF, but because it was needed to guide how the projects are operated today. Dave asked that the agencies outline the uncertainties that they have regarding current operations and PA operations (i.e., without CWF), and Maria said that those will start to surface was we get more into our effects analysis, and we could do so in a generic way and work those needs into a revised five-agency program.

Paul reiterated that it was better to start with the existing work, and Russ agreed that Reclamation could commit to trying to hash it out. Reclamation would like to see some removal of risk-management/decision-making authority from the existing document, and also see how other groups can fit into the five-agency approach.

Mike noted that this was useful on the Platte, and that it can be useful in understanding assumptions.

I:E Action

NMFS introduced noting that it was the biggest issue in the 2009 BiOp, having the least consensus, and was a main litigation topic. Noted that since then there has been a lot of work, including multistakeholder efforts such as the SST report, attempting to address this issue. NMFS therefore thought that the PA would include more experimental actions as alternative for how to protect San Joaquin steelhead.

NMFS noted that the PA includes lower triggers, more negative flows than existing, and that the HORB is not included in the PA. NMFS is asking whether to use what is proposed, or whether there is opportunity to discuss something different, noting that if NMFS is expected to analyze what is proposed, Reclamation should be prepared to see unfavorable effects. Perhaps this could be addressed in a future amendment.

Dave requested that Reclamation's lack of control of many SJR facilities be given consideration, along with the studies on the effects of exports and survival through the facilities. There was some disagreement between NMFS and Reclamation of the shown effectiveness of the HORB based on Buchanan studies.

When asked by Paul how big of an issue this is, Maria offered that she suggested an experimental approach, recommending that group be convened to recommend approach to study and development of an alternative to protect SJR steelhead.

Russ expressed discomfort at the comparison of the PA component to the existing protections/operations, asking that the project be evaluated for its effects as written, and not in comparison to the previous. Paul suggested doing the analysis and seeing the result, and whether it can be connected to the AM uncertainties and addressed that way if leaning towards jeopardy effect, but not to change anything in the PA now. Barry noted that we see changes in the PA that we expect to have a more negative effect, and that by making this decision we are consciously deciding to potential affect the schedule.

Attachment 5

Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>

ROC on LTO BA Updates Tracking Table

1 message

Harrison, Katrina <kharrison@usbr.gov> Mon, Mar 18, 2019 at 6:47 PM
To: Jana Affonso <jana_affonso@fws.gov>, Katherine Sun <katherine_sun@fws.gov>, Kaylee Allen <kaylee_allen@fws.gov>, Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>, Barbara Byrne - NOAA Federal <Barbara.byrne@noaa.gov>, Cathy Marcinkevage - NOAA Federal <cathy.marcinkevage@noaa.gov>, Howard Brown - NOAA Federal <Howard.Brown@noaa.gov>, "Wilkinson, Chris@DWR" <Christopher.Wilkinson@water.ca.gov>, "Jacobs, Brooke@Wildlife" <brooke.jacobs@wildlife.ca.gov>, "Ford, John@DWR" <John.Ford2@water.ca.gov>
Cc: "Callejo, Russell" <rcallejo@usbr.gov>, David Mooney <dmmooney@usbr.gov>, "Buckman, Carolyn" <BuckmanCM@cdmsmith.com>, "Ellis, Gregg" <Gregg.Ellis@icf.com>, "Pinero, Janice" <jpinero@usbr.gov>, Armin Halston <ahalston@usbr.gov>, Benjamin Nelson <bcnelson@usbr.gov>, Luke Davis <ldavis@usbr.gov>, Peggy Manza <pmanza@usbr.gov>

Hello all -

Attached is a draft tracking table for the ROC on LTO BA clarifications / updates. It includes the issue as well as resolution, and also identifies when the information was previously provided where applicable. It is still draft - a few outstanding issues to resolve.

Thank you,

Katrina Harrison
Bay-Delta Office
Bureau of Reclamation
Office: (916) 414-2425
Cell: (916) 606-8793

ROC BA Updates Tracking DRAFT 20190318.xlsx
169K

River	PA Topic / BA Pag	Detailed Issue	DRAFT Resolution	Assigned	Due Date	DRAFT Revised BA Text	Additional Resolution
American	2017 Flow Management Standard Releases and "Planning Minimum" (p. 4-41)	Need details about which elements of the 2017 Water Forum proposal are being committed to.	Reclamation to provide 2017 FMS and "Planning minimum" language.	Katrina	2017 FMS languge provided on Wednesday, 3/6 in email from Katrina Harrison to NMFS and USFWS.		
American	Planning Minimum	NMFS states: Related to the "planning minimum", on p. 4-40, the BA says "Reclamation proposes to work together with the American River Stakeholders to define an appropriate amount of storage in Folsom Reservoir…". Does that include NMFS, FWS, and CDFW?	Fish agency involvement in the planning minimum is envisioned in the implementation process through the American River Group. The Folsom Planning Minimum is an attempt to bring Reclamation's forecasting process together with potential local actions that either increase Folsom storage or reduce demand out of Folsom Reservoir. It is an attempt to define a working number that represents an increased level of risk for the American River contractors. The implementation of a planning minimum allows Reclamation to work with the American River Group to identify conditions when water actions may be necessary to ensure storage is adequate for diversion from the municipal water intake at the Dam and/or the extreme hydrology		Answered in email on 3/6		
American	Modeling	NMFS states: How was the "planning minimum" incorporated in the CALSIM modeling?	Reclamation modeled the "planning minimum" in the PA as an end-of-September 275 TAF storage target.		Answered at meeting on 2/26		
American	Planning Minimum	NMFS states: If Reclamation commits to a "planning minimum" rather than the storage targets in the "2017 Flow Management Standard", how does that change the feasibility of the flow/temperature schedules in the "2017	NMFS should review the flow/temp outputs for the PA scenario in Appendix D for projected flows/temps under the PA. Flow/temp outputs projected within 2017 Flow Management Standard may not be applicable given the use of a "planning minimum" and other changes in the PA.		Answered at meeting on 2/26		
American	RPAs	NMFS states: Is Reclamation proposing anything within the 2009 RPA (e.g. structural improvements, ramping protocols to reduce stranding)? If so,	Redd dewatering and ramping rates proposed in "Seasonal operations" on p. 4-41. In general, if not listed explicitly in the PA, not proposed.		Answered at meeting on 2/26		
American	Redd dewatering	CDFW Question / Comment: Redd dewatering flows (and habitat assessments) are based on assumption that flow/inundation relationship is static; but the channel changes. Is there a component to adjust minimum flow	Reclamation doesn't believe the 2017 FMS has that sort of component. CDFW noted that FMS flows may be less protective than originally thought after, for example, the high 2017 flows.		Answered at meeting on 2/26		
American	Nimbus Hatchery	NMFS states: Is it correct that the Nimbus Hatchery and associated RPA actions from 2009 BO (including a steelhead HGMP and fall-run hatchery management plan) are not assumed in the baseline and not included in the proposed action?	Nimbus Hatchery would continue under PA (see p. 3-21). Reclamation will complete a HGMP for steelhead and HMP for Fall-run and implement the plans as part of Nimbus Fish Hatchery management. Reclamation will work with USFWS and NMFS to establish clear goals, appropriate time horizons, and reasonable cost estimates for this effort to ensure it		Answered in email on 3/6		
American	2017 FMS	NMFS states: Can Reclamation send us the "2017 Flow Management Standard"?	Yes, Reclamation will send.		Sent on 3/6		
American	2017 FMS	NMFS states: Is it correct that Reclamation is committing to all elements of the "2017 Flow Management Standard" except for the carryover storage targets?	Reclamation is commiting to the 2017 Flow Management Standard, the document provided titled "Lower American River - Standards for Minimum Flows". Reclamation will use a "planning minimum" as an indicator that local water districts may decide		Answered at meeting on 2/26		

Delta	Agricultural Barriers (p. 4-46 and A-97)	NMFS states: Is the proposed action asking for coverage for operations, construction, or both? The proposed project description is too vague as to the actual project details. Separate BiOps are typically written that cover construction and operations for a multi-year period. No information regarding what is going to happen with the HORB. Is it going to be installed per the CWF BiOp as an operable barrier, or is the HORB not	Consulting on the operation of the 3 ag barriers, but HORB is not in the proposed action. The proposed action is asking for coverage for operations of the 3 ag barriers with the CVP / SWP. Check Appendix A for HORB – make sure that it is not in Appendix A.		Resolved at 2/22 meeting		
Clear Creek	Restoration Action	The Clear Creek Restoration Program includes several components but it appears as if Reclamation is only proposing channel maintenance in the PA, and evaluating placement of large woody debris, and gravel augmentation in the Effects Analysis (see relevant BA excerpts below). Question: What exactly is being proposed in the PA under the Clear Creek Restoration Program conservation measure? Question: If the Restoration Program is not being consulted on; why is it in the effects	Response: Reclamation is not intending to change anything related to the Clear Creek Restoration Program. We are intending to propose continuing to do Clear Creek Restoration Program physical actions as we do today. We will delete the Clear Creek Restoration Program row from Table 4-6, or change "NCO" to "as current" or similar text.		Answered at meeting on 2/28		
Clear Creek	Clear Creek Baseflows	On page 54 of the Appendix D PDF file (in Attachment 2-2), the PA assumption for "Minimum flow below Whiskeytown Dam" says "Same as COS". On page 35 of the Appendix D PDF file (in Attachment 2-1), the PA Assumption for "Clear Creek Flows" is similarly described as"The regulated condition under the PA is assumed to be similar to the COS, therefore the model implementation has been assumed to be same as the COS Scenario." The PA assumption on p. 35 goes on to note "However, … Reclamation proposes a minimum baseflow in Clear Creek of 150 cfs year-round in all year types except Critical year types. In Critical years, Clear Creek base flows may be reduced below 150 cfs	Response: Reclamation proposes revising the text in the PA to clarify that our proposed action is minimum flows of 200 cfs from October to May, and 150 cfs from June to September, in all water years except for Critical years, with pulse flows and releases for temperature management on top of these minimum flows.		Answered in email from Katrina on 3/12. Text finalized.		
Clear Creek	Whiskeytown Reservoir Operations (p. 4-38)	NMFS states: Unclear how the cold water pool will be managed to comply with temperature objectives in Clear Creek, particularly in drought/critical years. Proposed temperature management at 56 F for spring-run spawning at the	Same temperature targets and management as it is now.		Answered at meeting on 2/28		
Clear Creek	Minimum Flows	FWS states: Assumptions say Clear Creek flows will be 25% lower than they are now during certain months, but they were not modeled this way. Were riparian inundation effects considered despite the	Reclamation revised the Clear Creek proposed action via finalized text in email from Katrina Harrison on 3/12. Reclamation is proposing the same flows as current.		Done		

Clear Creek	Temperature Compliance	Can the PA wording be changed to say meet a daily average temperature for June 1-Sept 15, and be less than 56 F from September 15-October 31? Clear Creek Flows: “Whiskeytown releases to meet a daily average water temperature of: (1) 60°F at the IGO gage from June 1 through September 15; and (2) 56°F at the IGO gage from September 15 to October 31."Question: Can the proposed action be more specific to say 60 °F and 56° F degrees or less? For example, in the summer, there is a desire to have temperatures closer to 60 F for cold water pool conservation, and keeping temperatures close to 60 °F to encourage	Response: Yes.			Proposed Revised PA Text: “Whiskeytown releases to meet a daily average water temperature of: (1) 60°F at the IGO gage from June 1 through September 15; and (2) 56°F or less at the IGO gage from September 15 to October 31.”	
Clear Creek	Clear Creek Pulse Flows	Proposed action includes 20 TAF for pulse flows (10 TAF for spring attraction; 10 TAF for geomorphic; occurrence and timing depending on water year types). CALSIM model run only includes 10 TAF (Appendix D) and effects analysis combines pulse flows into one action 10	Resolution during call: Verified 20 TAF total (10 TAF each type) for pulse flows annually except in Dry years (10 TAF for spring attraction only) and Critical years (no spring attraction or geomorphic flows). Asked if the Calsim model should be run with the 20 TAF, Reclamation said this small amount would not change things.		Resolved during call		
Clear Creek	Clear Creek Gravel Mobilization	Please describe mechanical methods to mobilize gravel for a year without geomorphic flows. Follow up question: Mechanical mobilization of gravel is not included in effects analysis for spring-run or steelhead, but is evaluated for fall and late/fall. Gravel mobilization is considered a conservation measure under 5.7.2.1 and put under the Clear Creek Restoration Program in 5.14.5.5. Can you please clarify these sections, and the distinguish when effects analysis is for gravel mobilization and the Clear Creek Restoration Program?	Discussion during call: Discussion of mechanical methods and requested more details of what this means. Reclamation clarified that it was for years when geomorphic flows did not occur and to mechanically move gravel (via ripping techniques). Some discussion of how, when, and where it should occur, and if more measures should be taken to plan and reshape the channel because the proposed flows would be much less than the 3,000 cfs needed to reshape and form the channel. Preparation the summer before would be necessary in anticipation, and within the normal work window for Clear Creek in-channel activities. Resolution during call: Yes, we would do mechanical gravel mobilization or channel re-forming based on a plan developed by an interagency team that USFWS and NMFS would be		Done		
Delta	Delta Seasonal Operations (p. 4-43)	Jones and Banks Pumping Plants: Description of operations should be more detailed to clearly describe what is proposed, in particular: -- how the Clifton Court radial gates will be operated on the tidal cycles and Delta water elevations, -- how frequently joint points of diversion will be used (water year type, seasons, preference for which facility will be used, impacts to salvage, etc.), -- information on standard operating procedures for fish	JPOD – No changes. Reclamation will provide text on Tracy Fish Facility operations on Tuesday 3/12.		Fish Facility Text provided Monday 3/11 in email from Katrina Harrison	Text to be incorporated into revised BA	
Delta	Storm-related OMR Flexibility (pg 4-52)	No information on possible scenarios for effects analysis.	Reclamation agreed to follow process in the January 17, 2019 DOI/DOC letter	Reclamation to send out the letter and clarify the language.	Done	Final Revised BA text sent on 3/15 in email from Katrina Harrison.	
Delta	Fish salvage facility protocols	Appendix A (Facility Descriptions) is more descriptive of proposed operations. The PA states that Skinner facility sampling will mirror Tracy facility sampling, but this	Chris Wilkinson to provide text on Tracy Fish Facility sampling operations. Reclamation will update PA text.	DWR and Reclamation	Provided via email on 3/11		

Delta	Larval delta smelt detection	Recommend removing the station 716 larval delta smelt detection as a trigger for reduction to Barker Slough pumping. Using a catch-based delta smelt trigger will become very difficult to implement given record low abundance.	USFWS does not want to rely on catch based data for delta smelt triggers given low abundances. Some of these items are legacy. USFWS would like to get away from some of these legacy items. 4.9.5.5 North Bay Aqueduct. DWR agrees to remove this section. This is incorrectly applied to delta smelt from longfin smelt ITP. Will revise text to state that North Bay Aqueduct will continue to operate under other	DWR and Reclamation	Done	Will revise text to state that North Bay Aqueduct will continue to operate under other regulatory requirements.	
Delta	OMR Trigger	• Resolution of spring-run JPE metric,	Resolution during call: NMFS and CDFW to consider alternative criteria/approach for spring-run. (Non-	NMFS			
Delta	OMR Trigger	• Steelhead population presence for initiating/ending protections for those species.	Resolution during call: NMFS and CDFW to consider alternative criteria/approach for steelhead. (Non-urgent)	NMFS			
Delta	Modeling	• Provide any quantitative modeling (based on 2014 Zeug and Cavallo) done for salvage and entrainment of fish under the COS and PA scenarios to support the qualitative effects assessment in the BA.	Resolution during call: Reclamation to follow up with Cramer Fish Science (CFS); CFS thinks they can complete the modeling within two weeks.		Backup data provided on 3/1 via email and Cathy Marcinkevage's Google Drive		
Delta	Exports	(High Priority) Description of the operations from both the Skinner and Tracy Fish salvage facilities. This will include the following: • Current louver efficiencies; • Current estimates of prescreen loss; • Louver cleaning procedures and operations, including whether exports will be shut down if louvers are damaged, cleaning takes too long, or other maintenance scenarios where the facilities are not capable of salvaging fish; • Current collection, handling, trucking, and release information, including post-release survival/mortality,	Resolution: Reclamation to respond to specific questions if there are any in addition to the above. Regarding studies, Reclamation to draft and NMFS to review text to cover TFFIP studies into the future in the proposed action for studies at both Tracy and Skinner. Send text to Katherine and Barb.		Answered in email from Katrina on 3/11 and 3/12		
Delta	Modeling	(High Priority) More description of flow effects on fish including: • Provide any additional quantitative information regarding the effects of flow and water velocity on fish routing and entrainment into channel junctions in the Delta that were completed for the BA (note: based on the information in the BA it is primarily only the north Delta region	Resolution during call: CVPIA SIT model provides additional information on South Delta, see recent modeling results. Delta Passage Model also was completed and sent to NMFS.		Delta Passage Model Results provided via email on 2/25.		
Delta	Modeling	• Include any survival modeling completed by Reclamation. • Clarify differences in the percentage overlap numbers given in the BA text with the values given in the	Resolution during call: If numbers in text conflict with Appendix H, Appendix H is accurate. Appendix H includes the maximum difference. ICF team to provide numbers that underlie Appendix H figures.		Cramer provided backup data on 3/1		

Delta	Sacramento Deep	• Provide any hydrodynamic modeling for the proposed opening of the Sacramento Boat locks including proportion of flow into the Sacramento DWSC, and the velocities expected to be seen in the DWSC. Compare differences in the mainstem Sacramento River flow and velocity parameters between the operations of the boat locks and when they are closed. Seek to identify any	Resolution: What is the seasonality and frequency of opening the DWSC? What flows do we expect through the SDWXC? Is SDWSC is in DSM2? Katrina to discuss with Erwin and modelers and get back with information for NMFS.		Report and presentation provided on 3/6		
Delta	DCC	(High Priority) DCC gate operations under proposed action with respect to frequency of opening for water quality during the fall/early winter seasons (Oct –Jan). Reclamation indicated that they would pull together the historical exceedances of WQ and the gate operations for the last 10 years Clarification of the timing of the two gate closures for 5-days (Dec 1 – May 20 or is it only December and January?) (Progress update).	Resolution: Proposed action text revised as stated below: From December 1 to January 31, the DCC gates will be closed, unless Reclamation determines that it can avoid D-1641 water quality exceedances by opening the DCC gates for up to 5 days for up to two events within this period. Reclamation will provide. During a critical year following a dry or critical year, if there is a conflict between water quality and species between December 1 to January 31 period,		Data provided 3/8		
Delta	OMR Storm Flexib	FWS states: Please clarify how Storm-Related OMR Flexibility will be addressed as there is no information on the possible resulting scenarios.	OMR Storm Flexibility text clarified.		Revised text provided in email on 3/15	Incorporates Secretary Letter	
Delta	HORB	FWS states: Please clarify if the absence of HORB installation in this project will be inconsistent with Corps/DWR's existing barrier consultation and CDFW/NMFS	Discuss with NMFS tomorrow (2/20) . ESA procedural issue.		Resolved at meeting on 2/21	Remove the parentheses about HORG from Table 4-1	
Delta	Fish Facilities	(High priority) General overall question as to the lack of details of proposed operations and actions in Chapter 4 of the BA. How is NMFS supposed to analyze the effects of actions that have a sparse description? For example there are no descriptions of the fish salvage facilities and their operations regarding salvage (i.e. louver efficiency, cleaning of primary louvers and secondary bypasses, CHTR operations, etc.). There are no or limited descriptions of what is being consulted on for other facilities such as the Rock Slough/ Contra Costa Canal, North Bay Aqueduct/ Barker Slough Pumps, Suisun Marsh Salinity Gates. If the operations of the facilities are what is being consulted on, then clearly state that, and provide the operational characteristics of the facilities (i.e., annual volumes to be exported – actual and permitted, seasonal break down of exports, current restrictions on	Resolution: Reclamation not currently open to sharing the SOPs. Reclamation is open to responding to a specific list of questions. NMFS will follow-up with a specific list of questions. Questions will include: Are we proposing to do the same CHTR as the RPA? Is this different than the 2008 BO RPAs? Summarize Contra Costa fish monitoring data – Reclamation to ask Deanna Sereno. Barker Slough and North Bay Aqueduct – DFW to send ITP information and fish monitoring information from Jim Starr to NMFS. DWR (Mike Ford) to pull out actual Barker Slough and North Bay Aqueduct exports and permitted exports, as well as the seasonal breakdown of exports.		TFF text provided 3/11. CCWD data summary provided by Deanna Sereno on 3/12. Barker Slough and North Bay Aqueduct text provided by Chris Wilkinson on 3/8.		

Delta	(p-5-42)	BA states "The SST concluded altered 'Channel Velocity' and altered 'Flow Direction' were the only two hydrodynamic mechanisms by which exports and river inflows could affect juvenile salmonids im the Delta", and provides a version of Figure 2-2 from p. 5 of the SST report. This completely mischaracterizes the SST's conclusion	Noted.				
Delta	(p. 5-43 to 5-44)	NMFS states: Qualitative assessment using the modeled average exports over 3-4 month blocks from Cal Sim for the Dec-Feb and Mar-June periods of entrainment. The export rates were then inputted into the Zueg/Cavallo entrainment model to generate a range of entrainment values based on WR population percentages without providing the actual values. The effects assessment concludes that entrainment under the PA will go up compared to the COS, but that the restrictions to exports based on the population cumulative loss will be protective by limiting the OMR flows to no more negative than -3500 cfs for the remainder of the season (50% of	Provide underlying data underlying Zeug / Cavallo plots in the appendix for COS and PA by month. DSM2 results.		Data provided 3/1		
Delta	p. 5-45 to 5-46	NMFS states: Qualitative assessment of routing and survival based on the "overlap" figures in Appendix H. This section does not provide the actual numbers or magnitude of routing / survival estimates based on the differences in velocity, which would help in assessing potential additional (or reduced) take for the proposed project with a quantifiable metric. Discrepancies between values for % overlap in text and figures in appx. H, differences may be greater than reported in text. Using the survival models for acoustic tagged fish (i.e., work by Perry and others), survival estimates for these	Provide underlying data underlying Zeug / Cavallo plots in the appendix for COS and PA by month. Not the percentage overlap. DSM2 results. Derek Hilts to do things. Fix the text.		Data provided 3/1	Fix salvage / loss text	
Delta	5.6.3.4.4.3 Through Delta Survival - WRCS	NMFS states: Section describes through reach survival as a function of the channel velocities in the mainstem Sac River between Walnut Grove (DCC gates) and upstream near Sutter/Steamboatboat sloughs using DSM2. The percentage overlap of channel velocities was used as a surrogate for the differences in survival between WOA, COS, and PA.	Derek Hilts to do things. Provide underlying data. Also DPM runs will help.		DSM2 Velocity results provided 3/13. Delta Passage Model results provided 2/25. % overlap data provided 3/1.		

Delta	DCC5.6.3.5 Delta Cross Channel Operations (WRCS) -- p. 5-47	NMFS states: PA states that Reclamation will make final determination for gate closures to protect fish following their risk assessment, which could lead to more WR lost earlier in the season due to gates remaining open longer based on Reclamation's discretion. Reclamation has not provided any details regarding the procedure for their risk assessment process. Have not seen any modeling results to indicate that impacts to emigrating listed fish will be equivalent or different to what was in the 2009 opinion. Have not seen the results of any hydrodynamic modeling indicating how operations of the DCC gates will alleviate any water quality issues in the interior or southern Delta when exceedances of the water quality standards has been forecasted to occur. Reclamation has increased the time to make gate closures from 24 hours to 48 hours - this needs explanation and a risk assessment for how much additonal risk	Look at the past 10 years of D-1641 exceedances assume that additional number of days of DCC open.		D-1641 exceedance data provided on 3/8. DSM2 velocity, DPM, CVPIA SIT, etc modeling also provided.		
Delta	(p. 4-55 and A-130	NMFS states: If water from the managed wetlands is discharged to Suisun Bay and surrounding waters, how does this impact water quality, including DO, P, N, and any contaminants from the wetlands such as herbicides or mercury? How will the boat locks reoperation impact listed fish moving through the Sacramento River adjacent to the locks. Most of these elements were only described in cursory fashion without any scientific support or analysis provided in the description. If scientific studies are available, then that information should be provided with the project proposal. For example showing how flows through the restored ship locks at the upper end of the Sacramento DWSC might affect flows in the DWSC over the year with the gates in both the open/closed positions, and how Sacramento mainstem conditions may be impacted during those same	Ted Sommer study results are what we have to inform this. Matt Nobriga says water quality concerns are likely minor and not an issue. Sacramento Deepwater Ship Channel: Erwin to provide information to Jeff Stuart		SDWSC information provided 3/6.		
Delta	Beginning on p. 5-51	NMFS states: Very qualitative assessment of entrainment for the effects analysis with no "numbers" given. No comparison between the different operational scenarios provided. No justification or evidence provided for the conclusion that the PA will be "similar or	In the effects analysis section. Note that storm flexes were part of the OMR assumptions and so form part of the DSM2 results that underlie the effects analysis.				

Delta	385.6.4.12 Clifton Court Predator Management	NMFS states: Very minimal analysis. No description as to how this will be done, when it will be done, and what level of predator control is targeted.	NMFS to meet with DWR to identify specific procedures to use. Chris to set up meeting to discuss predator management.		Meeting held Monday 2/26		
Delta	Clifton Court Aquatic Weed Removal (p. 4-48 and A-101)	NMFS states: Need to clarify that it is water temperature that is the basis of the start dates for treatment. Need to clearly explain that listed green sturgeon are present during the herbicide treatment window, even though salmonids and Delta smelt may be absent in the area. Clarify whether both aerial application and boat application are to be made or is it just by boat. Clarify what the target concentration of copper herbicide is for treatments with different compounds proposed. Clarify what concentrations of copper (and what copper species is being measured in WQ testing) will be the threshold for re-opening the CCFB gates and continuing operations. Clarify what the pre-application procedure is for gate operations - is it closure at least 24 hours prior to herbicide application? Clarify whether it is a 24 hour minimum after herbicide application before gate re-opening or the 12-24 hours also stated in the project element description. No mention of other methods for weed			Resolved via email from Chris Wilkinson on 3/8		
Delta	Tracy Fish Collection Facility" (p. 4-55 and A-109)	The description of the TFCF operations is inadequate. Project description should detail operating protocols used for salvage, collection, trucking, and releases. Should also explain the efficiency of the facility, the louver and secondary cleaning operations and additional loss associated with those	Protocols provided by email on 3/11		Resolved via email on 3/11		
Delta	2018 Revised Coordinated Operations Agreement (p. 4-8)	consulted on because they are are embedded in and drive the operations. (2) Need more detail about balancing Shasta, Folsom and Oroville to meet D-1641 requirements based on conditions and COA.	Send COA EA to the services		COA EA sent; will remove "NCO" for COA from Table 4-6	Remove "NCO" from Table 4-6 for COA	
Delta	Approval language for more negative OMR (pg. 4-53 thru 4-54)	Clarify language related to water operations decisions that are outside of the provided modeling results since we cannot analyze the effects (i.e. agencies conferring on the Director's level when PA will not be implemented)	Reclamation will submit an analysis to the Services to justify not doing the protective measures and instead operating to -5,000 cfs for the Directors. FWS will addres why this is a legal vulnerability.	Russ Callejo	Finalized 3/16/2019	"Reclamation and DWR may confer with the Directors of NMFS, USFWS, and CDFW if they desire to operate to a more negative OMR than what is specified in Additional Real-Time OMR Restrictions. Upon mutual agreement, the Directors of NMFS and USFWS may authorize Reclamation to operate to a more negative OMR than the Additional Real-Time OMR Restrictions,	

Delta	Ag Barriers	(High Priority) Delta Agricultural Barriers. Reclamation confirmed that the HORB will not be installed and operated during the spring or during the fall seasons. Reclamation confirmed that consultation is for the operations of barriers only, not construction. Still outstanding questions as to the impacts of the barriers on flow characteristics and transit times of fish using the Old River migratory corridor when barriers are out, installed but with tidal flap gates tied open, and installed with gates operated tidally. BA cites to DWR meta-data analysis and provides a qualitative effects assessment. Need to clarify how BA states that flows are < than 4000 cfs 80% of time when the flows at Vernalis in Appendix D attachment 3-2 have flows consistently > than 4000 cfs from March through May (pages 613-615	Resolution during call: Katrina to send velocities from DSM2 results to Jeff. Reclamation to send underlying equations to the Chinook survival figure related to HORB. NMFS to pull Vernalis flows from current modeling results; will check with Reclamation if can't find them.	Katrina	DSM2 Velocity Results sent 3/13. Underlying data provided.		
Delta	OMR	(High Priority) More thorough explanation of how the OMR Management criteria will be implemented. • This will include how frequently the expected OMR actions will be implemented under the COS and PA for comparison purposes to show relative protective values under each scenario. • A description of how the storm flex rules for OMR will be implemented, such as a decision tree indicating when a storm flex will be implemented and how long it will last including whatever current restrictions would lead to restrictions of the storm flex (D-1641 criteria, fish entrainment, etc).	Middle River Flows" section in the PA scenario in Attachment 2-1 of Appendix D. (Modeling Appendix), below are the OMR modeling assumptions: - Turbidity Bridge Avoidance: For January and February in any water year type, if the Turbidity trigger is reached (SAC_RI greater than or equal to 20,000 cfs), Projects operate to 14-day average OMR Index if -2000 cfs for five days. For March through June of Wet and Above Normal years, it is assumed that there will be one event of turbidity bridge avoidance in each month (-2000 cfs for five days). - WIIN Act Storm-Related OMR Flexibility: It is assumed that there may be storm-related OMR management flexibility in January and February. In wet years, it is assumed that storm events will coincide with turbidity bridge events and no OMR flexibility is modeled. In Above Normal and Below Normal years, it is assumed that there will be one opportunity in January and one opportunity in February to operate to a more negative OMR index than -5000 cfs. This is modeled as 14-day OMR index of -6000 cfs for 7 days in each month. In dry years, it is assumed that one opportunity occurs either in January or February but not both months. - Species-specific cumulative salvage or loss		OMR storm text clarified via email on 3/15		
Delta	OMR Triggers	• Clarification of whether loss or salvage is being used for each of the trigger metrics proposed.	Resolution during call: Reclamation will clarify for each species.		Barb clarified in email, Katrina to respond confirming		
Determinations	Effects Determination - CCC Steelhead	NMFS states: NMFS does not consult on No Effect Determinations	No effect, correct.		Answered in meeting on 2/22		

Determinations	Effects Determination - CCC Steelhead - Critical Habitat	NMFS states: Clarify if Reclamation's determination for the species also applies to critical habitat. NMFS does not consult on No Effect	No effect, correct.		Answered in meeting on 2/22		
Determinations	Effects Analysis	NMFS states: Most effects descriptions provide only a qualitative description of risk (for both COS and PA) relative to the WOA . General statements such as "overall effects are beneficial" are often made with no or limited support. Effects descriptions even less robust for the "conservation measures" or programmatic actions. Some conclusive statements appear to be inconsistent with the data provided. For example, temperature modeling in the American River shows water temperatures in the PA that are not suitable for steelhead, despite the statement on page 5-133 that, "The implementation of the proposed 2017 FMS measures under the proposed	Comment noted		Answered in meeting on 2/22		
Determinations	Effects Determination - South Resident Killer Whale	NMFS states: NMFS disagrees with this determination	Comment noted				
Determinations	Effects Determination - South Resident Killer Whale - Critical Habitat	NMFS states: NMFS disagrees with this determination	Comment noted				
Determinations	Effects Determination - Souther Oregon/Norther California Coho Salmon	NMFS states: Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative	LAA is the determination.				
Determinations	Effects Determination - North American Green Sturgeon	NMFS states: Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative	LAA is the determination.				
Determinations	Effects Determination - CCV steelhead	NMFS states: Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative	LAA is the determination.				
Determinations	Effects Determination - CV spring-run Chinook salmon	NMFS states: Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis,	LAA is the determination.				

Determinations	Effects Determination - Winter-run Chinnok salmon	NMFS states: Overall Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative	Correct, Winter-run is LAA.				
Feather	Modeling	NMFS states: Is it correct that Feather River operations are modeled the same in the COS and PA?	Yes		Answered at meeting on 2/26		
Feather	FERC BO	NMFS states: Is it correct that modeled Feather River operations are based on the BiOp associated with the current license, and thus not the most recent BiOp (related to the proceeding for which	The modeled Feather flows do have the new FERC rules in there, even though FERC has not formally adopted them yet. The FERC flows (700/800) in the low flow section have been included in the CalSim model and have been for probably 10 years		Answered in email on 3/6		
Feather	Water Transfer Wi	CDFW states: How was the extension of the water transfer from July-September to July-November modeled, and could there be changes in Feather River releases because of that? The extension of the transfer window could result in flow changes in tributaries such as the Feather River during fall-run Chinook	The BA didn't model any water transfers in the PA because of uncertainty about where the water would come from. However, Reclamation did post-process modeling results to assess capacity at Delta export facilities (and thus the potential timing and volume of additional transfers) under the PA. The effects analysis talks about the timing and quantity of potential increase in transfers which was estimated		Answered at meeting on 2/26		
Feather	Water Transfer Wi	CDFW states: Will the relevant parties seek approval from the SWRCB for transfers?	BA is focused on ESA compliance and doesn't address other regulatory processes.		Answered at meeting on 2/26		
Killer Whale	Modeling	NMFS states: No quantitative estimates of fall-run Chinook production in the Central Valley or Trinity in the PA or other scenarios; these estimates are necessary to assess how the prey base is affected	SSS is being done by USFWS. SALMOD and Rec Mortality Modeling will be done by Jacobs / Reclamation. Also John Hannon to help.		Answered at meeting on 2/22		
Overall	2018 Revised Coordinated Operations Agreement (p. 4-8)	consulted on because they are are embedded in and drive the operations. (2) Need more detail about balancing Shasta, Folsom and Oroville to meet D-1641 requirements based on conditions and COA.	Send COA EA to the services	Russ Callejo	3/8/2019	Removed "NCO" from Table 4-6 for COA.	COA EA Sent. COA EA relied on 2008 / 2009 BOs. COA is part of the LTO of the CVP and SWP. BA text will be clarified.
Overall	Clarify timeframe for ROC	Timeframe was not included in BA Chapter 4. It was not clear what Reclamation was proposing for the	Reclamation said that 2030 is the duration of the consultation.	Reclamation	Done		
Overall	Is the expansion of the water transfers window modeled in	Unclear if water transfers were included in CalSim modeling.	Update table caption to be more specific …Table 4-13 refers to annual volumes of water, not just the expanded months.	Reclamation		Update table caption to be more specific …Table 4-13 refers to annual volumes of water, not just the expanded months.	
Overall	Developing supplies for water transfers (Section 4.9.5.7)	From the BA: "The effects of developing supplies for water transfers in any individual year or a multi-year transfer is evaluated outside of this proposed action." Where are these effects evaluated and is it a separate consultation?	Reclamation didn't model where water transfers are coming from or going to. Consultation is just for pumping aspect of it, need separate consultation (long term transfer) to capture specifics. USFWS suggests that Reclamation needs to make clearer. Restate what is currently happening, provide more detail. Suggested language: "Reclamation and DWR propose to continue water transfers….but would not	Reclamation		Suggested language: "Reclamation and DWR propose to continue water transfers….but would not exceed the annual volumes already agreed upon in Table 4-13."	
Overall	Extent of effects to FWS species	The BA lacks figures and maps for terrestrial species. There are places where it is noted a map should be placed or a calculate figure inserted, but the information is missing.	Add figures show extent…supplemental information. Delta smelt more pressing since its more complicated. Peer review scheduled in April. Delta smelt needs to be done by then. Terrestrial delayed but don't want to linger. Provide graphics by March	ICF	Done		Maps provided, but after discussion programmatic actions will be addressed at a high level and no additional maps are needed.

Overall	Appendix E Avoida	FWS states: Some species are LAA because of mitigation and others are NLAA but still speak to effects of mitigation. Clarify which are already covered by other consultations at a programmatic and project level.	For all the 8,000 acres that are in Suisun, we would follow the Suisun programmatic for any Suisun habitat restoration actions. Add this under the Delta conservation measures for the 8,000 acres: Consistent with the current regulatory process, future separate consultations would address the effects to listed species from habitat restoration. And then: Remove any of the numbers for terrestrials for programmatic habitat restoration. Only keep numbers for project-specific habitat restoration. Add to the NCO list: Suisun Marsh Habitat Management, Preservation, and Restoration Plan			BA Edits needed	
Overall	Modeling	NMFS states: The lack of biological modeling limits our ability to assess magnitude of effects. One major gap is	Comment noted. Biological modeling underway for several pieces.		Answered in meeting on 2/22		
Overall	Modeling	NMFS states: (Interpretation of standard flow figures) For example, in Figure 5.6-8 on p. 5-16: How are error bands determined? Does “Long-term average”	Yes, long-term average means over the 82 year with climate change period of record from CalSim. The fuzziness is not error bars, rather a estimate of the magnitude of error (but not a calculated error).		Answered at meeting on 2/22		
Overall	Discretionary Allocations	NMFS states: No real discussion of discretionary allocations, shortages and how these decisions will be made when necessary to meet key ESA or SWRCB metrics, storage management, Keswick releases and connection to allocations, shortages, and temperatures Preferential releases from Folsom and Oroville to meet Delta standards when necessary to preserve storage at Shasta	Response: As discussed by Peggy Manza and Jeff Rieker on 3/5/2019 with NMFS at 650 Capitol Mall, allocations decisions are made after determining, month by month for the entire year, anticipated inflows, releases (including releases for Delta and in-stream fish requirements), and storage changes. North of Delta diversions are part of the accretion / depletion timeseries that DWR puts together that operations uses for planning. This is because there are a variety of ungaged tributaries in the Sacramento Basin, and therefore unpredictable changes in inflow and diversions from the upper Sacramento River. South of Delta allocations are determined after determining possible releases for the rest of the system, determining exports that could occur if all assumptions made are exactly accurate, determining San Luis Reservoir storage change based on these exports, and then the change in allocation. This is an iterative process, whereby Reclamation checks San Luis Reservoir storage at the end of the year at each month’s forecast and allocation meeting, and adjusts				
Overall	Appendix E Avoida	FWS states: Some species have affected habitat acreages identified (e.g. GGS). Where did these acreages come from and how much is associated with restoration? Restoration will have its own BOs and mitigation for each site. For habitat lost due to flow alterations, such as in the Colusa Basin and Yolo Bypass,	Reclamation will remove habitat acres from programmatic actions.		Maps and explanation of calculations provided on 3/6.		
Overall	High level comme	FWS states: FWS will be clarifying projects that have existing consultations in the ROC BiOp. Projects with existing consultations will be considered as baseline. We could not discern why some actions that have consultations were included in this consultation and others were excluded as items “not in this consultation”. For instance, there is a programmatic consultation for restoration	USFWS will mention in their table that part of the 8,000 acres that is in Suisun will be covered under existing Suisun consultations.		Resolved at meeting on 2/21		

Overall	FWS Tying Effects to Conservation Measures	Please specify which adverse effects of the proposed action each habitat restoration action is intended to mitigate for so we can determine if programmatic or standard consultation is appropriate.	measure sections to tie temporal impacts. USWFS will do this linkage in draft BO and have Reclamation review. Have further discussions with other solicitors to capture programmatic actions	Reclamation and FWS	Done	"by 2030" to conservation measure sections	
Overall	Table 4-1	(High Priority) In general, a description of what is proposed in the future action and how it is different than what is currently being implemented for each element. This could be an annotated table or a	Resolution: Table 4-1 in the Proposed Action provides a comparison of flow actions currently to under the Proposed Action. Reclamation is not going to prepare any additional comparison of the Proposed Action to the current operations.		Resolved at meeting on 2/22		
Overall	Appendix E Avoidance and Minimization Measures	Appendix E-AMMS should be revised to be specific to ROC project actions. It includes measures from CWF and intake/tunnel construction (e.g. AMMS for pile driving and barge operations). We cannot connect a good portion of the	Reclamation (ICF) will remove nonapplicable AMMs.	Katrina	3/15	Appendix E revised	
Overall	Restoration and M	FWS states: Please articulate which restoration projects are proposed for this action or carryover from the 2008 RPA.	USFWS is going to do this in their BO				
Overall	Restoration and M	FWS states: We recommend that Reclamation propose to append restoration projects to the Suisun Marsh Programmatic Biological Opinion if they meet the criteria of that BiOp. This will	Yes, USFWS will fix in their BO.				
Overall	Appendix E Avoidance and Minimization Measures	FWS species-specific survey protocols should be used if they are available. Cite any protocols that will be used.	Reclamation will pull together list and coordinate "informally" with USFWS to solidify list. Reclamation will update species protocol by using USFWS approved protocols. Protocols can be taken from Sacramento and Bay-Delta website (rail, cuckoo, least bell's vireo). Informal list to be sent to Service	Katrina and USFWS	Done		
Overall	Incomplete Literature Cited	Literature Cited was not complete.	Reclamation to send over complete lit cited.	Reclamation	Done		
Overall	Species Considered (pg. 1-18, section 1.31)	Need to reconcile terrestrial species considered and not considered. Some species are on both lists (California least tern, California tiger salamander, vernal	All these species are analyzed in the document. Reclamation will revise Tables 1-1 (species considered) and Section 1.3.1 to be correct. California tiger salamander, vernal pool fairy shrimp,	Reclamation		Need to revise BA	
Sacramento	Shasta Seasonal Operations (p. 4-26)	NMFS: We need more information on what actions (rather than goals, targets, and examples) are being taken to manage storage in the context of water temperature management. Cold water pool considerations are mentioned without sufficient detail in the following PA components: "spring pulse flows", "cold water pool management", and "Fall and Winter refill and redd maintenance". Reclamation should provide details regarding its analysis and decisions regarding seasonal operations leading up to temperature management in the summer. For example, provide, by July 1 of each year, an analysis (using, e.g, the Deas model and SWFSC coupled reservoir model) showing how differing assumptions on runoff, temperatures and	Discuss on 3/5 along with allocation discussion.		Meeting scheduled for 3/5	None.	Summer temperature management is part of the process of determining Sacramento River releases, which are determined before determining any allocations. In its allocation process, Reclamation attempts to meet all obligations – flood control, ESA, minimum flows, D-1641, etc – prior to making any allocations. Estimated Shasta releases are necessary to determine Delta exports and San Luis Reservoir storage change. However, Reclamation's proposed action for the ROC on LTO does not state that Reclamation will adjust releases during the forecasting process to attempt to keep Shasta Reservoir in Tier 1 for temperature management. As stated in the proposed action, Reclamation will consider temperature effects when making fall baseflow decisions and spring pulse decisions, and avoid making those releases if they will impact cold water pool. The Shasta TCD is

Sacramento	Shasta Cold Water Pool Management (p. 4-27)	NMFS states: (1) There is insufficient detail to consult on temperature management as a site-specific action. The action is described programmatically but it still does not provide enough information to estimate/understand the range of operations (and their potential effects).No specific effects provided on results under 4-tiers of cold water management, including examples of duration of 56 at CCR. Not sure what is happening in Tiers 2 and 3. Is "Model II" from Anderson 2018 what is used as "the Anderson model"? The insufficiency in this section is that here is not enough information to determine how often (% of years) Reclamation expects to be in a particular "tier" (There is some information in Appendix D from which to infer based on historic occurance of a particular water-year-type but that is all). Although the % of years in a tier is described on page 5-20 (based on total storage May 1, 1922-2003: (tier 1 = 69%, t2 = 17%, t3 = 7%, and t4 = 8%), this does not necessarily	In the Proposed Action modeling, Reclamation is in Tier 1 68.3% of the years, and during Tier 1 years, would anticipate temperatures in the Sacramento River at Clear Creek of 53.5 degrees or colder 77% of the time between May 15 and October 31. For Tier 2: 17% of the years, in Tier 2 years, 53.5 or colder 67% of the days. For Tier 3: 7.3% of the years, within Tier 3 years, 53.5 of colder for 35% of the days. Tier 4 years are expected under the PA modeling 7.3% of the years, and in Tier 4 years, modeling shows temperatures at CCR of 53.5 of colder 14% of the days. Yes, "Model II" from Anderson 2018 is the Anderson Model. Reclamation's Shasta temperature action is modeled through shutter operations in HEC-5Q, as the proposed action does not set storage targets to try to meet Tier 1.	Katrina	Provided in email on 3/8	None.	
Sacramento	Shasta Cold Water Pool Management (p. 4-27)	NMFS States: (2) The tiered approach based on the Anderson model appears to be experimental and based on unproven methodologies. How much evidence is there behind the Anderson model of varying temperatures? Perhaps this should be an adaptive management element to try this operation in a year when then 53.5 is not attainable. But not ready to have in PA as a hard-wired	Tier 2: Line goes down to 53.5 degrees. Fix the graphic.	Katrina	3/8		Response: Anderson approach to temperature management modeled in the ROC BA obtains better egg mortalities based on the Martin equation. The PA optimizes temperature management for Winter-run Chinook salmon based on available cold water pool.
Sacramento	Shasta Cold Water Pool Management (p. 4-27)	NMFS States: (3) There is no description of ops. within a "tier." There is insufficient information on the proposed relationship between available cold water and	Please see the PA description. Additionally, meetings held on 2/22, 3/5, and 3/12 to discuss.				
Sacramento	Shasta Cold Water Pool Management (p. 4-27)	NMFS States: (4) The strategy to build Shasta storage not clear in the proposed action. Similarly, how is the shortage policy or contract allocations managed to build or maintain storage to meet WR temperature criteria and maximize the	Response: Reclamation would not maintain higher fall flows in order to build storage. Other than this action, Reclamation would not operate to try to reach a Tier 1 year. Rather, available cold water pool would be managed appropriately in that year. "Build storage" is not explicitly modeled in CalSim, the				
Sacramento	Shasta Cold Water Pool Management (p. 4-27)	NMFS States: (5) Similarly, how are Keswick release schedules, reductions in deliveries and preferential releases from Oroville and Folsom, etc. managed to build Storage	Response: See above. Also, "Build storage" is not explicitly modeled in CalSim, the temperature management tiers are not in CalSim, just in HEC-5Q.				
Sacramento	Shasta Cold Water Pool Management (p. 4-27)	document how current tiers in operations were input into Calsim (e.g., preferential use of Oroville and Folsom for meeting D-1641, and restricted Keswick release schedule).	Tiers are not in CalSim. Tiers are implemented in HEC-5Q. Meeting held on 3/12 to explain the HEC-5Q modeling of the Shasta temperature tiers.				

Sacramento	Shasta Cold Water Pool Management (p. 4-27)	NMFS States: (7) How is demand shifting defined? Why is demand shifting not considered as a strategy to to increase the likelihood of reaching tier 1 and 2	Demand shifting requires working with CVP contractors, and isn't Reclamation's action.				
Sacramento	Spring pulse flows (p. 5-41)	NMFS states: No description % or # of years where Reclamation would expect to satisfy the constraints regarding implementing a spring pulse flow.	Under ROC on LTO CalSim modeling results, May 1 storage is greater than 4 MAF in 75% of years. However, this is perfect foresight, and we would expect with forecasting, the spring pulses to occur		Resolved in email on 3/8		
Sacramento	Operation of a Shasta Dam Raise (p. 4-33)	NMFS States: Description of this action is too vague to consult on either as a site-specific action or a programmatic action. FWS: Operations of the raised Shasta Dam are not reflected in the BA modeling. The BA needs to reconcile any differences from the provided modeling. Need effects analysis for Sacramento riparian species if there is a difference in	Send NMFS the link to the feasibility report. Reclamation to send FWS a few pages of effects analysis for Shasta Dam raise on Yellow-billed cuckoo. Ben to coordinate with Jana to get cuckoo person to review our analysis before we send it over.	Ben Nelson - Katrina Harrison	Sent updated info on 3/8 to go along with spreadsheet and winter-run info previously provided.	Removed feasibility study references in the BA.	Feasibility Report Sent. Ben met with USFWS person and provided details on Sacramento River flow frequency changes. It was decided at the March 8 RD elevation meeting for Shasta Dam raise ops to be addressed as a standard/site-specific level in the BiOps. Analyze proposed action (without the feasibility study) with no additional storage or otherwise change in operations of Shasta Dam. FWS and
Sacramento	Shasta Dam Raise (p. 5-52)	NMFS states: Hard to understand the various models compared here -- CP4, CP4A, Full Obligation, and how they relate to the COS and PA. Seems like the PA modeling results are used throughout rest of effects section, so assumed flows/temps may not be	Discussed at meeting on 2/22. Shasta Dam raise feasibility study being removed from BA per director decision.				
Sacramento	Allocation Considerations	How are allocation decisions made? The considerations are listed, but a description of how factors are considered in making those allocations is not described. We need a description to evaluate risk of temperature operations for the duration of the project. How do allocations considerations and decisions differ between north-of-Delta and south-of-Delta allocations?	Response: As discussed by Peggy Manza and Jeff Rieker on 3/5/2019 with NMFS at 650 Capitol Mall, allocations decisions are made after determining, month by month for the entire year, anticipated inflows, releases (including releases for Delta and in-stream fish requirements), and storage changes. North of Delta diversions are part of the accretion / depletion timeseries that DWR puts together that operations uses for planning. This is because there are a variety of ungaged tributaries in the Sacramento Basin, and therefore unpredictable changes in inflow and diversions from the upper Sacramento River. South of Delta allocations are determined after determining possible releases for the rest of the system, determining exports that could occur if all assumptions made are exactly accurate, determining San Luis Reservoir storage change based on these exports, and then the change in allocation. This is an iterative process, whereby Reclamation checks San Luis Reservoir storage at the end of the year at each month's forecast and allocation meeting, and adjusts		Answered via email on 3/8		

Sacramento	Allocation Considerations	Summer water temperature management is a factor considered in allocations, however we need more details on how it is considered relative to priorities or other objectives.	Response: Summer temperature management is part of the process of determining Sacramento River releases, which are determined before determining any allocations. In its allocation process, Reclamation attempts to meet all obligations – flood control, ESA, minimum flows, D-1641, etc – prior to making any allocations. Estimated Shasta releases are necessary to determine Delta exports and San Luis Reservoir storage change. However, Reclamation's proposed action for the ROC on LTO does not state that Reclamation will adjust releases during the forecasting process to attempt to keep Shasta Reservoir in Tier 1 for temperature management. As stated in the proposed action, Reclamation will consider temperature effects when making fall baseflow decisions and spring pulse decisions, and avoid making those releases if they will impact cold water pool. The Shasta TCD is instrumental in allowing Reclamation to meet the		Answered via email on 3/8		
Sacramento	Spring Pulse Flows	How often will spring pulse flows occur, and at what duration, magnitude and volume? "Under the Core Water Operation, Reclamation would not release spring pulse flows unless the projected May 1 Shasta Reservoir storage is greater than 4 MAF. If Shasta Reservoir total storage on May 1 is projected to be greater than 4 MAF, Reclamation would make a Spring pulse release as long as the release would not cause Reclamation to drop into a lower Tier of the Shasta summer temperature management or interfere with the ability to meet other anticipated demands on the reservoir. (pg. 4-27)" Would similar/the same operational guidance for pulse flows on the American River (section 4.9.4.1) be applied to the Sacramento River?	general, but much of it is specific to the American River. Under ROC on LTO CalSim modeling results, May 1 storage is greater than 4 MAF in 75% of years. However, this is perfect foresight, and we would expect with forecasting, the spring pulses to occur slightly less frequently. Results from Henderson et al. 2018 and Michel et al. 2015 suggest that a threshold of 9,100 to 12,000 cfs should be targeted to increase smolt outmigration survival on the Sacramento River. Reclamation anticipates the inter-agency team scheduling 0 to 2 flow pulse(s) of approximately 10,000 cfs at Wilkins Slough for 3 days each depending on Shasta storage conditions, and whether wet hydrology meets the need for pulse flows. Pulse flows on the Sacramento River would occur sometime between March 1st and May 15th to coincide with the peak smolt out-migration from Mill and Deer Creek, and would be high enough to result in a 3-day sustained 10,000 cfs flow event at Wilkins Slough gauge. A target of 10,000 cfs is suggested to assure that the flow event is above the 9,100 cfs threshold. Following the initial three-day pulse targeting 10,000 cfs at Wilkins, Keswick flows would reduce by approximately no more than 15% per night for flows greater than 6,000 cfs, and no more than 200 cfs per day for flows between 4,000 and 5,999 cfs. The total number of days for proposed pulse flow(s), including modified ramping, is dependent on the base flow before the pulse. To minimize water costs, water		Answered via email on 3/8		
Sacramento	Cold Water Pool Management	What is meant by a "drop into a lower Tier of the Shasta summer temperature management or interfere with the ability to meet other anticipated demands on the reservoir"?	If Reclamation forecasts that the release of the up to 150 TAF for spring pulse flows would result in a decrease in cold water pool such that the May 1 cold water pool volume (trigger for summer temperature management) would drop to Tier 4, Reclamation would not do a spring pulse flow. In addition, if there are other impacts of the spring pulse flow on meeting anticipated demands on the reservoir, then		Answered via email on 3/8		

Sacramento	Spring Pulse Flows	What is the expected effect of the pulse flows [Section 5.6.3.2 (Spring Pulse Flows)] and what is the quantifiable benefit [Section 5.8.3.3.2 (Rearing to Out-migrating Juveniles)]?	See effects analysis and literature. Also, Miles Daniels presented on the effects of spring pulses at IEP on 3/7/2019. Please check with him to verify and get more information. He calculated the anticipated mortality to Winter-run from the spring pulse, and		Answered via email on 3/8		
Sacramento	Fall and Winter Redd Maintenance	Is Reclamation proposing to operate to these example flows? Please provide specific commitments or a potential range of operations. The minimum fall flows provided in Table 4-9 are only "examples of possible Keswick Releases", and we would have to assume that some number of redds would be	These example flows are examples of Reclamation's operation. As it says in the PA, they could be refined with modeling, but they are our initial start.		Answered via email on 3/8		
Sacramento	Fall and Winter Refill and Redd Maintenance (p. 4-32)	NMFS States: We are unclear about how the 10% risk assessment works. 10% or less risk of what, in order to rebuild storage for the following year? Does Reclamation mean 10% or more? If the 10% threshold is exceeded, what happens?	BA text to be revised. 10% risk or more of getting into the Tier 4 of Shasta temperature management.	Katrina	3/18	Reclamation proposes to rebuild storage and cold water pool for the subsequent year. Maintaining releases to keep late spawning Winter-Run Chinook Salmon redds underwater may drawdown storage necessary for temperature management in a subsequent year. Reclamation will minimize effects with a risk analysis of the remaining Winter-Run Chinook Salmon redds, the probability of sufficient cold water in a subsequent year, and a conservative distribution and timing of subsequent Winter-Run Chinook Salmon redds. If the combined productivity of the remaining redds plus a conservative scenario for the following year is less than the productivity of maintaining releases, Reclamation will reduce releases to rebuild storage. The conservative scenario for the following year would include a 75% (dry) hydrology; 75% (warm) climate; a median distribution for the timing of redds, and the ability to remain within Tier 3 or higher (colder) tiers. Demands by the National Wildlife Refuges, upstream CVP contractors, and the Sacramento River Settlement Contractors in October result in Keswick Dam releases that are generally not maintained throughout the winter due to needs to store water for beneficial uses the following year. These releases result in some early fall Chinook redds being dewatered at winter base flows. If, based on the above analysis, Reclamation determines reduces need to be released to rebuild storage, targets for winter base flows (December 1 through the end of	
Sacramento	Fall and Winter Refill and Redd Maintenance (p. 4-32)	Please describe how Reclamation will determine fall flows, and the likelihood of winter-run and fall-run redd dewatering occurrence after October 31. (pg. 4-32) "Reclamation will minimize effects with a risk analysis of the remaining Winter-Run Chinook Salmon redds, the probability of sufficient cold water in a subsequent year, and conservative distribution and timing of subsequent Winter-Run Chinook Salmon redds. If maintaining flows puts the subsequent year class at a 10 percent or less risk, Reclamation will reduce releases to rebuild storage." We are unclear about how the 10% risk assessment works. 10% or less risk of what, in order to rebuild storage for the	BA Text revised. In most years, it is likely the determination results in dropping flows to build storage. Below is a plot showing end of September Shasta storage exceedance under the proposed action. About 17 % of the time end of September Shasta storage would be less than 2.2 MAF, leading to flows of 3,250 cfs. 23% of the time end of September Shasta storage would be less than 2.8 MAF, for releases of 4,000 cfs. 28% of the time end of September Shasta storage would be between 3.2 and 2.8 MAF, for releases of 4,500 cfs. 32% of the time end of September Shasta storage would be more than 3.2 MAF, leading to release of 5,000 cfs.		Resolved above		

Sacramento	Fall and Winter Refill and Redd Maintenance (p. 4-32)	How is putting a subsequent year class at 10% or less risk determined when maintaining flows? Please clarify as to what 10 percent means. This risk analysis conflicts with other statements in the BA including the (1) inability to determine cold water pool until April, and (2) that "end of September storage shows	Resolved with revised BA text	Katrina	Resoved above		
Sacramento	Cold Water Pool Management	Please provide a description and analysis of operations within Tiers 2 and 3 to estimate the level of impact to species. Without it, we will have to make assumptions about the temperature dependent mortality (pg. 5-20, ~24% of years).	Based on HEC-5Q modeling of the proposed action, in Tier 2, the Sacramento River temperatures are modeled to be 53.5 degrees Fahrenheit or less at Clear Creek in 67% of the days between March 15 – October 31. In Tier 3, Sacramento River temperatures are modeled to be 53.5 degrees Fahrenheit or less at Clear Creek in 35% of the days between March 15 – October 31. Keep in mind that the temperature target schedule and TCD operations completed in HEC-5Q were developed by observing monthly average temperature at Sacramento River below Clear Creek. With this averaging, we expect to see some days exceed our target thresholds. We also should note that the model applies many assumptions, represents long-term operations, and is best analyzed in comparison to the other scenarios. Real-time operations would have the advantage of more operational flexibility, meteorological forecasts, snowpack, etc. If we consider these real-time advantages in terms of an additional 0.5 or 1.0 degree F threshold, we would		Answered via email on 3/8		
Sacramento	Cold Water Pool Management	How can Reclamation operate to these examples? For Tier 2, an example of 2.79 MAF cold water pool is used as fitting within Tier 2, so it seems as though the examples are storage criteria.	Reclamation's temperature compliance changes based on May 1 cold water pool. At the highest cold water pool (Tier 1), Reclamation anticipates being able to meet 53.5 degrees at Clear Creek nearly all the time between May 15 and October 31 (modeled at 77% of days in Tier 1, but compliance should be greater in reality for the reasons discussed in the response to Q9 above). With less cold water pool, Reclamation would start temperature compliance at Clear Creek at 56 degrees in the beginning and end of the temperature management season, and decrease the amount of time at 53.5 degrees as cold water pool decreases. At the highest cold water pool volume within Tier 2, at 2.79 MAF of cold water pool, Reclamation would operate to 56 degrees from May 15 to approximately 30 days after the first observed redd, then ramp down to 53.5 degrees over approximately a week, then operate to 53.5 degrees at CCR from 37 days after the first observed redd to		Answered via email on 3/8		
Sacramento	Cold Water Pool Management	CalSim II, run on a monthly time-step, provides the input for HEC5Q. Are Tiers 2 and 3 modeled in HEC5Q. If so, how would a mid-month change in the temperature target be modeled or forecasted? Because the magnitude of effect is only addressed qualitatively and relative to the WOA (5.6.3.1 Upper Sacramento River Seasonal Operations including Shasta Cold Water Pool Management, and 5.6.3.1.1 Egg to Fry	Yes, Tiers 2 and 3 are modeled in HEC-5Q. HEC-5Q is a daily temperature model, so it does have daily flows and temperatures. However, as you mention, its inputs are CalSim monthly average flows, and the temperature targets used to refine the TCD operations were monthly average temperatures. Please see the results spreadsheets and Modeling Appendix (Appendix D) for the difference between the PA and COS. This is represented in the modeling results.		Answered via email on 3/8		

Sacramento	Temperature Compliance	Need clarification on the modeled difference in upstream Sacramento River temperature between the PA and COS. Is it due to the change in temperature compliance location , or the difference in cold water available at the start of the temperature management season between the PA and COS? "The main difference in flow and water temperature management between the proposed action and COS during the June through September Winter-run Chinook Salmon spawning and incubation period would be	The PA has reduced Delta outflow, which results in slightly higher Shasta storages and therefore improved Cold Water Pool. In addition, the HEC-5Q temperature model includes a different TCD shutter operation to implement the ROC proposed action for summer Shasta cold water pool management (i.e. CCR compliance point, changes in compliance based on May 1 storage) than the COS model. The combination of both of these factors results in the differences in observed temperatures between the PA and COS in the modeling results.		Answered via email on 3/8		
Sacramento	Cold Water Pool Management	We would like a clarifying discussion of the Anderson Model and approach to provide optimal temperatures at 53.5 F for Days 37-67 post spawn, and not greater than 56 F during Tiers 2 & 3 scenarios. Is “Model 2” of the Anderson paper being used?	Yes, in the egg mortality modeling results, when we say “Anderson” that means Model 2 of the Anderson Paper. Model 2 is being used, but it should be emphasized that, like the Martin model, we are calculating only what the Anderson model calls "thermal survival", as opposed to "background survival", which is density-dependent. Only temperature-dependent egg mortality is measured in this analysis. In the paper, that means we're using Eq. 6. Also, our parameters were taken not from Table 2 of the paper but from SacPAS; http://www.cbr.washington.edu/sacramento/fishmodel/. Dr. Anderson made it clear that the BT parameter from the paper was for a one-day critical period, while the parameters on SacPAS are fitted to the 5-day critical period used in this analysis. Also, because the Martin and Anderson models use the same equation structure Reclamation felt it would be best to only vary the BT parameter along with the number of days across which mortality is calculated, so both Martin and Anderson use Anderson's T_crit		Answered via email on 3/8		
Sacramento	Temperature Compliance	On p.2 of Appendix D Attachment 2-6 in the “Anderson Model” section, it suggests that mortality for the Anderson model is only applied on the five days before hatching. Is this accurate?	Yes. The Anderson model takes the temperature from the 5-days immediately prior to hatch, which per Rombough (1986, 1994) is the time period of highest dissolved oxygen requirement for the eggs and therefore when they are the most temperature sensitive. As stated in Anderson (2018), "Thus, the duration of low oxygen vulnerability is expected to occur just over a few days around hatching since a few days before hatching the egg oxygen demand would be significantly below the maximum diffusive		Answered via email on 3/8		
Sacramento	Cold Water Pool Management	Do all the figures in Appendix D, Attachment 3-8 include a mix of Tiers?	Yes. We did not separate out the Tiers in the exceedance plots. However, see the attached excel file for additional data split out by tiers.		Answered at call and via email on 3/8		
Sacramento	Cold Water Pool Management	What is the distribution of “# of days at 53.5 days” in Tiers 2 and 3 in all modeled years?	Based on HEC-5Q modeling of the proposed action, in Tier 2, we would meet 53.5 at Clear Creek in 67% of the days between March 15 – October 31. In Tier 3, we would meet 53.5 at Clear Creek in 35% of the days between March 15 – October 31. See		Answered via email on 3/8		
Sacramento	Fish Passage Program - Not in the proposed action	NMFS states: A successfully reintroduced population of Sacramento River winter-run Chinook salmon above Shasta Reservoir in California is anticipated to have a water supply benefit and mitigate	Discussed at Directors elevation meeting on 3/8. Reclamation RD stated: "duly noted".		Done		

Sacramento	Winter-Run Conservation Hatchery Production* (p. 4-35)	NMFS states: Generally agree with increasing LSNFH production during extreme drought conditions, however, the use of New Zealand or Great Lake Chinook salmon stocks to improve heterozygosity is an experimental concept that should not be relied on as	Comment noted				
Sacramento	Spawning and Rearing Habitat Restoration*(p. 4-	NMFS states: What is being proposed above and beyond what NMFS has already consulted on through the B-13	USFWS will split this out in their BO				
Sacramento	Rice Decomposition	NMFS states: Assumes "propose to work to synchronize" will be implemented.	Yes.				
Sacramento	Shasta Cold Water Pool Management (p. 4-27)	detail to consult on temperature management as a site-specific action. The action is described programmatically but it still does not provide enough information to estimate/understand the range of operations (and their potential effects). (2) The tiered approach based on the Anderson model appears to be experimental and based on unproven methodologies. How much evidence is there behind the Anderson model of varying temperatures? Perhaps this should be an adaptive management element to try this operation in a year when then 53.5 is not attainable. But not ready to have in PA as a hard-wired action. Under tier 3 and 4, NMFS predicts lots of lethality. Why is there no provision for demand shifting until tier 4? (3) There is no description of ops. within a "tier." There is insufficient information on the proposed relationship between available cold water and duration of temperature management. (4) The strategy to build Shasta storage	Temperature spreadsheet and statistics provided via email on 3/8				
Sacramento	Appendix D (4.3 HEC5Q PA assumptions)	NMFS states: It is unclear from the description of Shasta temperature management assumptions under the PA, if the "tactical approach" was actually modeled? No details on how temperature schedules were updated to match the strategy	Meeting held 3/12 to explain example year operations and explain shutter operation.				
Sacramento	Effects Analysis - Shasta/Sacramento	NMFS states: (Seasonal Operations) What are the assumptions that went into the baseline modeling?	Meeting held on 3/12 to describe baseline and PA temperature modeling. Also see Appendix D.		Meeting held 3/12, resolved.		
Sacramento	Adult Rescue* (p. 4-35)	NMFS States: The adult rescue proposal is experimental needs further discussion through 5-agency AMF	Would be collaboratively planned in a group with USFWS and NMFS.		Meeting held 2/27		
Sacramento	Juvenile Trap and Haul* (p. 4-35)	NMFS States: The juvenile trap and haul proposal is experimental and needs further discussion through 5-agency AMF	Would be collaboratively planned in a group with USFWS and NMFS.		Meeting held 2/27		

Sacramento	Spawning and Rearing Habitat Restoration*(p. 4-	NMFS States: What is being proposed above and beyond what NMFS has already consulted on through the B-13	USFWS is going to split out what has already been consulted on in their BO process.	USFWS	6/17/2019		
Sacramento	Spring Management of Spawning	NMFS believes the adaptive management of this action should not be separate from the 5-agency adaptive	Would be collaboratively planned in a group with USFWS and NMFS.		Meeting held 2/27		
San Joaquin	I:E	• More thorough explanation of how the proposed steelhead protective measure will benefit/ be protective of SJ River basin steelhead, particularly compared to current practices (I:E ratio	Resolution during call: Reclamation avoided comparisons to BiOp RPA actions in the BA.				
Shasta	Allocations	The proposed action does not mention how fish factor into allocation decisions. Details are needed on how the Shasta storage and temperature management for winter-run is considered in the "shortage policy" (p. 4-10).	Clarify the types of regulations that we are considering as we make our allocation decisions. And what assumptions are made for temperature management, if any. Follow-up meeting with Jeff Rieker.	Jeff Rieker	Meeting Held 3/5	None	As discussed by Peggy Manza and Jeff Rieker on 3/5/2019 with NMFS at 650 Capitol Mall, allocations decisions are made after determining, month by month for the entire year, anticipated inflows, releases (including releases for Delta and in-stream fish requirements), and storage changes. North of Delta diversions are part of the accretion / depletion timeseries that DWR puts together that operations uses for planning. This is because there are a variety of ungaged tributaries in the Sacramento Basin, and therefore unpredictable changes in inflow and diversions from the upper Sacramento River. South of Delta allocations are determined after determining possible releases for the rest of the system, determining exports that could occur if all assumptions made are exactly accurate, determining San Luis Reservoir storage change based on these exports, and
Stanislaus	Vernalis EC	NMFS states: What is assumed for Vernalis EC requirements in the COS and PA scenarios?	COS: D1641 Vernalis water quality requirements are implemented with no annual volumetric cap. Pdf page 29 reads "Water quality releases include releases to meet the State Water Resources Control Board (SWRCB) Decision 1641 (D-1641) salinity objectives at Vernalis and the Decision 1422 (D1422) dissolved oxygen objectives at Ripon. The Vernalis water quality requirement (SWRCB D-1641) is an electrical conductivity (EC) requirement of 700 and 1000 micromhos/cm for the irrigation (Apr-Aug) and non-irrigation (Sep-Mar) seasons, respectively." PA: Under the PA, the New Melones operations (pdf page 38) follow the "Stepped Release Plan". New Melones is not operated for 1641 requirements (flow		Provided in email on 2/26		

Stanislaus	Vernalis Flows	NMFS states: What is assumed for Vernalis flows, year-round, in COS and PA scenarios? For example, does Table 7 for the COS scenario on PDF page 30 of Appendix D in Attachment 2-1 (excerpted below) describe required flows Feb 1-Apr 15 and May 16-June 3 or for the entire Feb-June period? What flows are assumed Apr 15-May 15?			Provided in email on 2/26		COS: Vernalis base flows as required by D1641 Table 3 are included in the model. D-1641 Vernalis pulse flow requirements are not included. Flows required by NMFS BO (Jun, 2009) Action III.1.3 are included in the model (including the April-May pulse flow). Table 7 shows the minimum flows at Vernalis for Feb-Jun in the COS. The text just above Table 7 reads (pdf page 29): "Bay-Delta flow requirements are defined by D-1641 flow requirements at Vernalis (not including pulse flows during the April 15 -May 16 period). These flows are met through releases from New Melones without any annual volumetric limit. D-1641 requires the flow at Vernalis to be maintained during the February through June period. The flow requirement is based on the required location of "X2" and the San Joaquin Valley water year hydrologic classification (60-20-20 Index) as summarized
Stanislaus	1987 DFG Agreem	NMFS states: COS assumes 1987 USBR-DFG agreement; PA scenario does not. Was this approach agreed to by CDFW?	Issue still under discussion between Reclamation and CDFW. PDF page 53 of Appendix D (within Attachment 2-2) notes that COS assumes both '87 agreement and NMFS BO flows while PA assumes just SRP flows. However, modeling for COS assumes that 2-E flows cover the '87 agreement and		Provided in email on 2/26		
Stanislaus	Stanislaus Yeartyp	1, PDF page 27-28 indicates that the COS flow requirements are implemented based on the New Melones yeartype. However, all Stanislaus-River-related COS results in 3-1 (Storage), 3-2 (flow), and 3-4 (temp) are summarized based on the yeartype defined by the 60-20-20 Index (the method in the PA), NOT the New Melones yeartype. While that summary is useful in that the yeartype bins for the COS results contain the same set of years as in the PA scenario, the yeartype bins for the COS results do not accurately represent the modeled operations. For example, The Critical year bin in the COS results might include years in which the modeling implemented the Dry or Below Normal year schedule, because the 60-20-20 Index was Critical while the New Melones yeartype was Dry or Below Normal. The bottom table of Table 37-3 (Appendix D, PDF page 559), which shows a lot of differences in modeled flows in the Critical, Dry, and Below Normal years even though the PA and COS share identical flow schedules for those yeartypes. My guess is that much of that difference is because, for example, PA flows for a Critical yeartype are being	Derek Hilts (FWS) will prepare requested summaries for NMFS and provide to Barb Byrne.		Resolved at meeting on 2/26		

Stanislaus	Tulloch and Goody	Tulloch Dam and Goodwin Dam are non-CVP facilities located on the Stanislaus River downstream of New Melones Reservoir. What is assumed for Tulloch operations in the WOA scenario, and how does that modify the flows coming out of	Tulloch is not operated per any criteria in CalSim. It only passes the flow from New Melones to downstream. Its operations are only guided by pre-set reservoir levels by month and these levels are not altered for any scenario. So, there are no changes to Tulloch operations under the WOA		Provided in email on 2/26		
Stanislaus	Tulloch Modeling	NMFS states: What is assumed about the outlet capacity at New Melones and about how downstream channel capacity might limit the release at New Melones in the WOA scenario?	Stanislaus reaches. New Melones and Tulloch releases are controlled through limiting releases (discharge) from the reservoirs (and the modeled flow requirements). The storage-discharge relationship in CalSim is provided below. The model uses a linear interpolation based on storage. reservoirstorage (AF)discharge (CFS) New Melones00 97533 500001700 539041750 1000001800 1605481982 2000002100 2500002900 29951712110 30000012200 84652412200 139883112200 196950412200 241952312200 257183531040 2871000125676 Tulloch01100 200001740 300002040 400008000 500008000 570008000		Provided in email on 2/26		
Stanislaus	Bio Modeling	NMFS states: No biological modeling (including for FR relevant to SRKW analysis); no assessment of floodplain inundation/spawning/rearing areas. Very high-level, qualitative description of effects. Absent this information, we have limited scope for our effects analysis for CV steelhead and for the SRKW	Byrne (NMFS) acknowledged ongoing discussions about getting some estimates of Chinook production under the PA scenario for the Trinity and Central Valley. Reclamation pointed out figures on p. 5-362 and 5-363 (based on the CVPIA SIT model) showing spawning habitat needs on the Stanislaus River as a function of adult escapement. Since the discussion on 2/22, Reclamation has performed an additional 8	Reclamation	Modeling provided from 2/25 to 3/15 as it was completed		
Stanislaus	Spawning and Rea	NMFS states: Conservation measures for the East Side Divison on p. 4-60 of the Proposed Action describes an annual gravel placement goal of 4,500 tons and an additional 50 acres of rearing habitat. How does the 4,500 ton commitment relate to the 14.58 acres of "current	There is no relation – the current spawning habitat from the CVPIA SIT model charts is determined by depths and velocities, not substrate.				
Trinity	Trinity Seasonal Operations (p. 4-36)	NMFS States: Unclear how Trinity Reservoir end of September storage will be maintained (no minimums), and how water temperature objectives in the Trinity River will be complied with. No description of cold water pool management. No description of how the	Trinity temperature management would still be done as it is today.		Answered at meeting on 2/28		

Trinity	Trinity River Record of Decision (p. 4-37)	NMFS States: Table 4-6 shows Trinity River ROD and Long Term Plan to protect adult salmon in the lower Klamath River as "Not Consulted On", yet proposed action section (4.9.2.2) has discussion of Trinity River ROD and the Long Term Plan for the lower Klamath	Reclamation is not intending to re-consult on the TRRP, as there is already consultation.		Resolved via Directors week of 3/11		
Trinity	Trinity Storage	NMFS states: How will Trinity Reservoir end of September storage will be maintained? How will the reservoir be managed during successive drought	No end-of-September storage targets in the BA; reservoir managed the way it is now.		Answered at meeting on 2/28		
Trinity	Temperature Mod	NMFS states: No temperature modeling for compliance locations. Only Lewiston temp modeling provided. Lesiston is not a compliance point, nor does it provide insight into rearing habitat or adult migration conditions in the river. Can results of temperature modeling at	Reclamation has done RBM-10 modeling		Provided 3/15		
Trinity	Trinity CWP	NMFS states: No description of cold water pool management -- how will water temperature objectives in the Trinity River	BA doesn't include any new compliance measures; management under PA will be same as current operations.		Answered at meeting on 2/28		
Trinity	SSS Modeling	NMFS states: UKTR chinook salmon not included in SRKW analysis. Can SSS (stream salmonid simulator) chinook population modeling for Trinity or lower Klamath be conducted to determine effects of the action on Chinook salmon production? Effects to SRKW from TRD	Justin and Seth has been in discussion with Nick Som (FWS) about getting SSS results. Results likely not available until end of March at best.		Answered at meeting on 2/28		
Trinity	Climate change	NMFS states: No climate change scenarios modeled or discussed or the likely combined effects of the action and the effects of climate change or how their effects might compound threats to species.	All modeling uses the ELT Q5 climate change scenario, which includes 15 cm of sea level rise and represents projected Year 2030 climate conditions. See some key page refs, below. Chapter 3 of BA (Environmental Baseline): •p. 3-17: "...the operational model (CalSim) was run using the standard hydrologic period of record (1922-2003) and projected climate,..." Appendix D (Modeling): No page numbers in Appendix D, so page references are to the page of the PDF file •PDF page 8 (in Attachment 2-1, Section 1): The three scenarios (Without Action, Current Operations, and Proposed Action) "evaluate the impacts of different project operations at projected Year 2030 climate conditions....Section 5 describes the assumptions used for Year 2030 climate conditions...."		Answered at meeting on 2/28		

Overall	CVPIA B2	Not included in ROC modeling or achknowledged in the BA text.	Text drafted with services.		Email sent with finalized text on Friday, 3/15	Action Section – 4.7? Right after D-1641. Title of Section: CVPIA Reclamation proposes to operate in accordance with its obligations under the CVPIA, including but not limited to CVPIA 3406 (b)(2). DOI accounts for the following actions in meeting the 3406 (b)(2) requirement: 1. Primary Purposes: Any fish action (export reduction or upstream release) that predominantly contributes to one of the enumerated 3406(b) programs identified by the courts, including 3406(b)(1), (4), (5), (8), (9), (12), (18) and (19), must be counted against the up to 800 TAF of (b)(2) water. Thus, any upstream release or export reduction that predominantly contributes to one of those purposes will be deducted from the 3406(b)(2) account. 2. Secondary Purposes: Water operations in accordance with ESA and fish and wildlife objectives of D-1641 water quality actions may also be included in (b)(2) accounting. Upstream releases mandated by ESA Biological Opinions may also count towards 3406 (b)(2). Export reductions in ESA Biological Opinions or specified under D-1641 for fish and wildlife objectives may also count towards 3406 (b)(2). Releases for other water quality actions (i.e., net delta outflow) under D-1641 may also count towards 3406 (b)(2).	
Overall	Species-specific and general conservation measures	Cannot discern which species the habitat restoration is targetting (e.g. spawning/rearing habitat). Recommend that the conservation measures are organized into general (measures that	Reclamation to clarify in proposed action for which species “spawning habitat”. Reclamation will update table (table 4-6) and include check list which conservation measures apply by species.		Email sent 3/18 clarifying	None	
Trinity	Humboldt County	NMFS states: Humboldt County's no less than 50,000 AF of water contract is briefly acknowledged in the proposed action section. Does the proposed action incorporate the county's water contract? Does the CalSim modeling incorporate	Humboldt County’s water contract is part of the PA, but not incorporated in the CALSIM modeling.		Answered at meeting on 2/28 - Directors may change this	Reclamation will move this text out of the lower klamath augmentation flows section of the BA as they are two separate issues.	
Determinations	Effects Determination - Winter-run Chinnok salmon - Critical Habitat	NMFS states: Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Determination is not clear. Is the determination NLAA or LAA for critical	Determination is LAA. Text will be clarified - sentence added to explain it is LAA for critical habitat as we adversely affect some PCEs, although overall the proposed action is beneficial for critical habitat.			Text will be revised to clarify LAA determination	
Determinations	Effects Determination - CV spring-run Chinook salmon - Critical Habitat	NMFS states: Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Need to clarify determination. NMFS	Determination is LAA. Text will be clarified - sentence added to explain it is LAA for critical habitat as we adversely affect some PCEs, although overall the proposed action is beneficial for critical habitat.			Text will be revised to clarify LAA determination	

Determinations	Effects Determination - CCV steelhead - Critical Habitat	NMFS states: Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Does Reclamation mean NLAA? Need to	Determination is LAA. Text will be clarified - sentence added to explain it is LAA for critical habitat as we adversely affect some PCEs, although overall the proposed action is beneficial for critical habitat.			Text will be revised to clarify LAA determination	
Determinations	Effects Determination - Souther Oregon/Norther California Coho Salmon - Critical Habitat	NMFS states: Beneficial determination appears based on comparative analysis to the WOA scenarios. The NMFS BiOp conclusions must be based on an aggregate analysis, not comparative Need to clarify determination? LAA or	Determination is LAA. Text will be clarified - sentence added to explain it is LAA for critical habitat as we adversely affect some PCEs, although overall the proposed action is beneficial for critical habitat.			Text will be revised to clarify LAA determination	
Determinations	Effects Determination - North American Green Sturgeon - Critcal Habitat	NMFS states: NMFS assumes this is LAA	Determination is LAA. Text will be clarified - sentence added to explain it is LAA for critical habitat as we adversely affect some PCEs, although overall the proposed action is beneficial for critical habitat.			Text will be revised to clarify LAA determination	
Sacramento	Interpretation of Cold Water Capabilities figures (p. 5-19 to 5-20).	NMFS states: For example, in Figure 5.6-10 on p. 5-19, what are the yellow dots? To tell which tier would be implemented, need to "subtract the outflow from the inflow, correct? Are all results on 5-19 to	Katrina to talk to Barb.		Katrina and Barb clarified 3/18		

Attachment 6

Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>

Re: Water User Forum - 8:30-9:45 am, April 2

1 message

Callejo, Russell <rcallejo@usbr.gov> Mon, Apr 1, 2019 at 11:03 PM
To: "Meredith, Lauren" <lmeredith@usbr.gov>
Cc: Chelsea Cullen <ccullen@kearnswest.com>, phelliker@sjwd.org, Dave Mooney <dmmooney@usbr.gov>, Ellen Wehr <ewehr@gwdwater.org>, Andy Fecko <afecko@pcwa.net>, Steve Chedester <stevechedester@sjrecwa.net>, Curtis Creel <ccreel@kcwa.com>, jgutierrez@westlandswater.org, jphillips@friantwater.org, Elizabeth Hadley <ehadley@usbr.gov>, Tom Boardman <tboardman@apex.net>, Jennifer Pierre <jpierre@swc.org>, Karen Clark <kclark@westlandswater.org>, jason.peltier@sldmwa.org, "Nelson, Benjamin" <bcnelson@usbr.gov>, Kristin White <knwhite@usbr.gov>, Mario Manzo <mmanzo@usbr.gov>, "Bigley, Sean" <sbigley@roseville.ca.us>, Kevin Tanaka <kevin.tanaka@sol.doi.gov>, Derya Sumer <dsumer@usbr.gov>, "Corcoran, Daniel" <dcorcoran@eid.org>, Paul Zedonis <pzedonis@usbr.gov>, Greg Zlotnick <gzlotnick@sjwd.org>, "Catherine.McCalvin@water.ca.gov" <catherine.mccalvin@water.ca.gov>, Jeff Sutton <jsutton@tccanal.com>, Marguerite Patil <mpatil@ccwater.com>, "Wilkinson, Chris@DWR" <christopher.wilkinson@water.ca.gov>, Armin Halston <ahalston@usbr.gov>, Kaylee Allen <kaylee_allen@fws.gov>, Jeffrey Rieker <jrieker@usbr.gov>, scott.petersen@sldmwa.org, DONALD BADER <dbader@usbr.gov>, plewis@olaughlinparis.com, "Rebecca R. Akroyd" <rebecca.akroyd@sldmwa.org>, "Nevills,Jennifer C" <jnevills@mwdh2o.com>, nhawk@valleywater.org, Tom Boardman <tboardman@westlandswater.org>, apeltzer@prlawcorp.com, jtb@bkslawfirm.com, Christie Kalkowski <ckalkowski@usbr.gov>, "BuckmanCM@cdmsmith.com" <buckmancm@cdmsmith.com>, ckao@valleywater.org, dvink@svwater.org, Karna Harrigfeld <kharrigfeld@herumcrabtree.com>, sostrowski@westlandswater.org, michael.tognolini@ebmud.com, "Arakawa,Stephen N" <sarakawa@mwdh2o.com>, Frances Brewster <fbrewster@valleywater.org>, Christopher White <cwhite@ccidwater.org>, "Roger K. Patterson" <rpatterson@mwdh2o.com>, Paul Souza <paul_souza@fws.gov>, William Paris III <bparis@olaughlinparis.com>, tbettner@gcid.net, Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>, frances.mizuno@sldmwa.org, jpayne@friantwater.org, Ric Ortega <rortega@gwdwater.org>, lbair@rd108.org, "Abdullah, Hasan" <hasan.abdullah@ebmud.com>, "Ford, John@DWR" <john.ford2@water.ca.gov>, marin.greenwood@icf.com, Terra Alpaugh <talpaugh@kearnswest.com>, ghall@valleywater.org, underwoodd@saccounty.net, Michelle Banonis <michelle.banonis@water.ca.gov>, Joshua Israel <jaisrael@usbr.gov>, Angelique Hinesley <ahinesley@usbr.gov>, rplecker@roseville.ca.us, Jim Peifer <jpeifer@cityofsacramento.org>, "Chilmakuri,Chandra Sekhar" <cchilmakuri@mwdh2o.com>, Glenn-Colusa Irrigation District <khightower@gcid.net>, "Aaron@DWR Miller" <aaron.miller@water.ca.gov>, Jana Affonso <jana_affonso@fws.gov>, john.bezdek@dentons.com, Howard Brown - NOAA Federal <howard.brown@noaa.gov>, tbirmingham@westlandswater.org, Fernando Ponce <fponce@usbr.gov>, Deanna Sereno <dsereno@ccwater.com>, Rebecca Sheehan <rsheehan@mwdh2o.com>, Luke Davis <ldavis@usbr.gov>, schmitzk@saccounty.net, "Ellis, Gregg" <gregg.ellis@icf.com>, Lori Caramanian <lori.caramanian@sol.doi.gov>, Brent Walthall <bwalthall@kcwa.com>, Melih Ozbilgin <mozbilgin@valleywater.org>, abiering@friantwater.org, Katrina Harrison <kharrison@usbr.gov>, "Kirkland, Marianne@DWR" <marianne.kirkland@water.ca.gov>, Tim Wasiewski <tw@olaughlinparis.com>, "Jon D. Rubin" <jrubin@westlandswater.org>, lorloff@ccwater.com, "Paul S. Weiland" <pweiland@nossaman.com>, Janice Pinero <jpinero@usbr.gov>

Hello All,

For discussion purposes tomorrow, please find attached a draft revised Chapter 4 (Proposed Action) of the ROC on LTO Biological Assessment. These suggested edits reflect Reclamation's ongoing work with the Services since early February to clarify the proposed action for analysis in the biological opinions. I plan to walk through the document at high-level during the last half of our meeting.

Thanks,
Russ

Russell Callejo
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On Mon, Apr 1, 2019 at 3:24 PM Meredith, Lauren <lmeredith@usbr.gov> wrote:

Good afternoon,

Friendly reminder tomorrow's Water User Forum will take place from 8:30 to 9:45 am. We will begin the meeting promptly at 8:30 am.

For those planning to call-in, please find the conference line and WebEx login below.

Webex
Please join the meeting here.
Meeting Number: 901 157 526
Meeting Password: aaMqB6zU
Conference Line
Conference Line: 877-973-8503
Passcode: 9128356

Thank you!

--
Lauren Meredith

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Chapter_4_ProposedAction_ROC on LTO BA_draft revisions 040119_redline.pdf
1001K

Chapter 4 Proposed Action

Reclamation and DWR propose to continue the coordinated long-term operation of the CVP and SWP to maximize water supply delivery and optimize power generation consistent with applicable laws, contractual obligations, and agreements; and to increase operational flexibility by focusing on non-operational measures to avoid significant adverse effects. based on the conditions estimated to occur through 2030. Reclamation and DWR propose to store, divert, and convey water in accordance with existing water contracts and agreements, including water service and repayment contracts, settlement contracts, exchange contracts, and refuge deliveries, consistent with water rights and applicable laws and regulations. The "Current Operation" shows the applicable criteria for operation of the CVP and SWP today. Although not part of the effects of operating the project into the future, the Current Operation provides a reference for the changes under the proposed action to assist in understanding the proposed action. Table 4-1 below identifies specific changes from current operations that are part of this proposed action. The proposed action includes habitat restoration that would not occur under the without action scenario and provides specific commitments for habitat restoration.

Table 4-1. Comparison of Select Components Across Without Action, Current Operation, and Proposed Action

Without Action	Current Operation	Proposed Action
Sacramento		
No temperature management	NMFS RPA I.2.1-I.2.4: Shasta Temperature Management, WRO 90-5 downstream temperature targets	Temperature management based on use of Shasta cold water pool for Winter-Run survival, including WRO 90-5.
No spring pulses	No spring pulses	Spring pulses if projected May 1 storage > 4 MAF
No fall base flows	3,250 cfs minimum flow	Measures to reduce Fall-Run redd dewatering and rebuild cold water pool, e.g., when end-of-September storage is: ≤ 2.2 MAF, flow is 3,250 cfs; ≤ 2.8 MAF, flow is 4,000 cfs; ≤ 3.2 MAF, flow is 4,500 cfs; > 3.2 MAF, flow is 5,000 cfs.
No Winter-Run Conservation Hatchery	Livingston-Stone National Fish Hatchery	Increased use of Livingston-Stone National Fish Hatchery during droughts
Trinity		
No flow control	Trinity ROD Flows + Lower Klamath Augmentation Flows	Trinity ROD Flows + Lower Klamath Augmentation Flows

Without Action	Current Operation	Proposed Action
~~No fish flows in Grass Valley Creek~~	~~No fish flows in Grass Valley Creek~~	~~Pulse flows between March 1 and April 15 to mobilize gravel, and October and November releases for Coho spawning, to the extent feasible~~
Clear Creek		
No base flows	Base flow of 50–100 cfs based on 1960 CDFG MOA	Base flow of 200 cfs October to May, 150 cfs from June to September in all except critical years. In critical years, base flows may be reduced below 150 cfs based on available water from Trinity Reservoir.
No channel maintenance flows	Channel maintenance flows when flood operations occur	10 TAF for channel maintenance, unless flood control operations provide similar releases, using the river release outlets, in all but dry and critical years
No pulse flows	Two pulse flows in Clear Creek in May and June of at least 600 cfs for at least 3 days for each pulse per year	10 TAF for pulse flows, using the river release, in all but critical years
No temperature management	Daily water temperature of: (1) 60º F at the Igo gage from June 1 through September 15; and (2) 56ºF at the Igo gage from September 15 to October 31.	Daily water temperature in below normal and wetter years of: (1) 60ºF at the Igo gage from June 1 through September 15; and (2) 56ºF or less at the Igo gage from September 15 to October 31; operate as close as possible to these targets in dry and critical years.
Feather		
No minimum flow	FERC License flows	FERC License flows
American River		
No minimum flows	2006 Flow Management Standard	2017 Flow Management Standard: Flows range from 500 to 2,000 cfs based on time of year and annual hydrology, and "planning minimum"
No temperature management	Daily average water temperature of 65°F or lower at Watt Avenue Bridge from May 15 through October 31. 56°F temperature target November 1 through December 31.	May 15 through October 31 daily average water temperature of 65°F (or target temperature determined by temperature model) or lower at Watt Avenue Bridge. When the target temperature requirement cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at Watt Avenue may be increased

Without Action	Current Operation	Proposed Action
		incrementally (i.e., no more than 1°F every 12 hours) to as high as 68°F. November 1 through Dececember 31 daily average water temperature of 56°F target if cold water pool allows. A temperature higher than 56°F may be targeted based on temperature modeling results.
Delta		
No exports	D-1641 requirements; and OMR requirements based on USFWS RPA Actions 1-3 and NMFS RPA Action IV.2.3	D-1641 requirements; and ~~Risk~~risk-based OMR management incorporating real-time monitoring and models ~~where possible~~
DCC closed	DCC operations based on NMFS RPA that requires consultation to avoid exceeding water quality standards	DCC operations based on D-1641, closures for fish protections, and operations that avoid exceeding water quality standards
No Delta Outflow requirement	D-1641 requirements; and maintain average X2 for September and October no greater (more eastward) than 74 km in the fall following wet years and 81 km in the fall following above normal years	Delta outflow to meet D-1641 requirements; ~~and~~ Suisun Marsh Salinity Control Gate ~~Operation~~operation for up to 60 days ~~between June~~in the summer and/or fall depending on year type; increased Delta outflow in wet and ~~September of~~ above ~~normal and below~~ -normal year types when conditions warrant.
No management of reverse flows	Old and Middle River Reverse Flows based on calendar date and workgroups per USFWS RPA Actions 1-3 and NMFS RPA Action IV.2.3	Old and Middle River Reverse flows based on species distribution, modeling, and risk analysis with provisions for capturing storm flows
No Head of Old River Barrier (HORB)	HORB installed between September 15 and November 30 of most years when flows at Vernalis is <5,000 cfs; occasionally also between April 15 and May 30 if Delta Smelt entrainment is not a concern	No HORB installed ~~(WaterFix proposed action continues)~~
No Delta Smelt conservation hatchery	U.C. Davis Fish Culture Center Refugial Population	Increased use of the U.C. Davis Fish Culture Center and a Delta Fish Species Conservation Hatchery ~~and~~for the introduction of cultured fish into the wild
No COA	1986 COA with 2018 Addendum	1986 COA with 2018 Addendum
Stanislaus		

Without Action	Current Operation	Proposed Action
No base flows	Appendix 2-E flows from NMFS RPA III.1.3	Stepped ~~release plan~~Release Plan
San Joaquin		
No base flows	San Joaquin River Restoration Program flows	San Joaquin River Restoration Program flows

4.1 Decreasing Operational Discretion

In the 1920s, farmers and municipalities relied upon intermittent surface flows and groundwater for water supply. Over time, as land in California was reclaimed and demand for water increased, over-pumping caused groundwater-level declines in the Sacramento and San Joaquin Valleys and associated aquifer-system compaction and land subsidence. The concept of a statewide water development project was first raised in 1919 by Lieutenant Robert B. Marshall of the U.S. Geological Survey, in large part to meet the demands of California's economy and prevent ongoing impacts resulting from water shortages, including land subsidence. He proposed transporting water from the Sacramento River system to the San Joaquin Valley then moving some of it over the Tehachapi Mountains into Southern California. His proposal led to the first plan for a state-operated water project.

In 1931, State Engineer Edward Hyatt introduced a report identifying the facilities required and the economic means to accomplish the north-to-south water transfer. Called the "State Water Plan," the report took 9 years and $1 million to prepare. To implement the plan, the Legislature passed the Central Valley Act of 1933, which authorized the project. A $170 million bond act was subsequently approved by the voters of the State of California in a special election on December 19, 1933. In the midst of the Great Depression, revenue bonds were unmarketable, so the State was unable to secure funding to begin construction of the CVP. The State then sought the assistance of the federal government. Following the issuance of a feasibility report, President Franklin Roosevelt's administration agreed to take over the CVP as a public works project.

In the Rivers and Harbors Act of 1935, Congress originally authorized the CVP and provided initial funding. The Rivers and Harbors Act of 1937 reauthorized the CVP for the purposes of "improving navigation, regulating the flow of the San Joaquin River and the Sacramento River, controlling floods, providing for storage and for the delivery of the stored waters thereof, for construction under the provisions of the Federal Reclamation Laws of such distribution systems as the Secretary of the Interior (Secretary) deems necessary in connection with lands for which said stored waters are to be delivered, for the reclamation of arid and semiarid lands and lands of Indian reservations, and other beneficial uses, and for the generation and sale of electric energy as a means of financially aiding and assisting such undertakings and in order to permit the full utilization of the works constructed." Congress gave Reclamation broad authority to operate the dams and reservoirs of the CVP "first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses; and, third, for power." Reclamation had substantial flexibility in determining how to balance the three original project purposes.

Reclamation and DWR's operation of the CVP and SWP changed significantly in 1978 with the issuance of the WQCP under the SWRCB Water Right Decision 1485 (D-1485). D-1485 imposed on the water

rights for the CVP and SWP new terms and conditions that required Reclamation and DWR to meet certain standards for water quality protection for agricultural, M&I, and fish and wildlife purposes; incorporated a variety of Delta flow actions; and set salinity standards in the Delta while allowing the diversion of flows into the Delta during the winter/spring. Generally, during the time D-1485 was in effect, natural flows met water supply needs in normal and wetter years and reservoir releases generally served to meet export needs in drier years.

The D-1485 requirements applied jointly to both the CVP and SWP, requiring a joint understanding between the projects of how to share this new responsibility. To ensure operations of the CVP and SWP were coordinated, the COA was negotiated and approved by Congress in 1986, establishing terms and conditions by which Reclamation and DWR would coordinate operations of the CVP and SWP, respectively. The 1986 COA envisioned Delta salinity requirements but did not address export restrictions during excess conditions.

In 1992, the CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement as having an equal priority with power generation. The CVPIA included a number of other provisions that represented additional Congressional direction for operation of the CVP, and overlaid a more complex statutory framework. These overlapping and sometimes competing requirements create challenges in how to address and balance the myriad of obligations Reclamation has in operating the CVP, and how to coordinate with the SWP.

In 1995, the SWRCB issued an update to the WQCP for the Bay-Delta. In 1999 (revised in 2000) the SWRCB issued D-1641 to implement those elements of the 1995 WQCP that were to be implemented through water rights. The 1995 WQCP and D-1641 included a new export to total Delta inflow (E/I) ratio of 35 percent from February through June. The 35 percent E/I from February to June was a significant change from D-1485. The 1995 WQCP and D-1641 also imposed Spring X2, pumping limitations based on San Joaquin River flow, which in combination with the E/I ratio, reduced the availability of "unstored" flow for the CVP and SWP. February to June became an unreliable season for conveying water across the Delta. The effect of D-1641 was a shift in the export season, in part, to the summer, and the CVP and SWP entered the fall with lower reservoir levels and less need for flood releases in the fall and winter.

In addition, D-1641 imposed a flow requirement for the San Joaquin Basin at Vernalis which included both base flows and a large spring pulse flow. However, it did not address how the requirement would be shared between the three major San Joaquin tributaries. In lieu of the SWRCB assigning responsibility, a number of interested parties entered into the San Joaquin River Agreement, which included flow commitments from all three tributaries, funding commitments, transfers, and voluntary demand reductions. The agreement was initially set to expire in 2009 but was extended to 2012, when it expired and was not replaced.

In 2000, Reclamation signed the Trinity ROD. This defined a minimum flow regime of 369,000 acre-feet in critical dry years ranging to 816,000 acre-feet in wet years in the Trinity River. The ROD decreased the amount of water Reclamation could bring from the Trinity River over to the Sacramento River, reducing water supplies for Delta outflow and salinity and reducing the Shasta Reservoir cold water pool flexibility. This was intended to benefit Trinity River listed fish species, but it complicated Reclamation's ability to meet requirements imposed for the protection of Sacramento River listed fish.

4.2 Operational Tradeoffs

Operation of the CVP and SWP involves a balancing of various laws, regulations, contracts, and agreements. The overlapping and often conflicting requirements necessitate tradeoffs among watersheds, among fish species, among authorized purposes, and among water users. The tradeoffs occur within a season, between seasons, and across water years. Summarized below are examples of these conflicts and resulting tradeoffs that inform this proposed action.

To help protect against drought, Reclamation traditionally operated the CVP to achieve higher end-of-water-year storage that provided for increased carryover into the next year. Over time, the CVP has come under increasing pressure to provide water for environmental purposes which has resulted in decreased water supply reliability (see Figure 4-1 below). To meet state permit conditions, contractual demands, and environmental obligations, more demand has been placed on storage, resulting in lower end-of-water-year storage than was typical in the past. Significant tradeoffs in operational decision making now arise due to overlapping and conflicting regulations that make it difficult to meet congressionally authorized CVP purposes, including those for fish and wildlife.

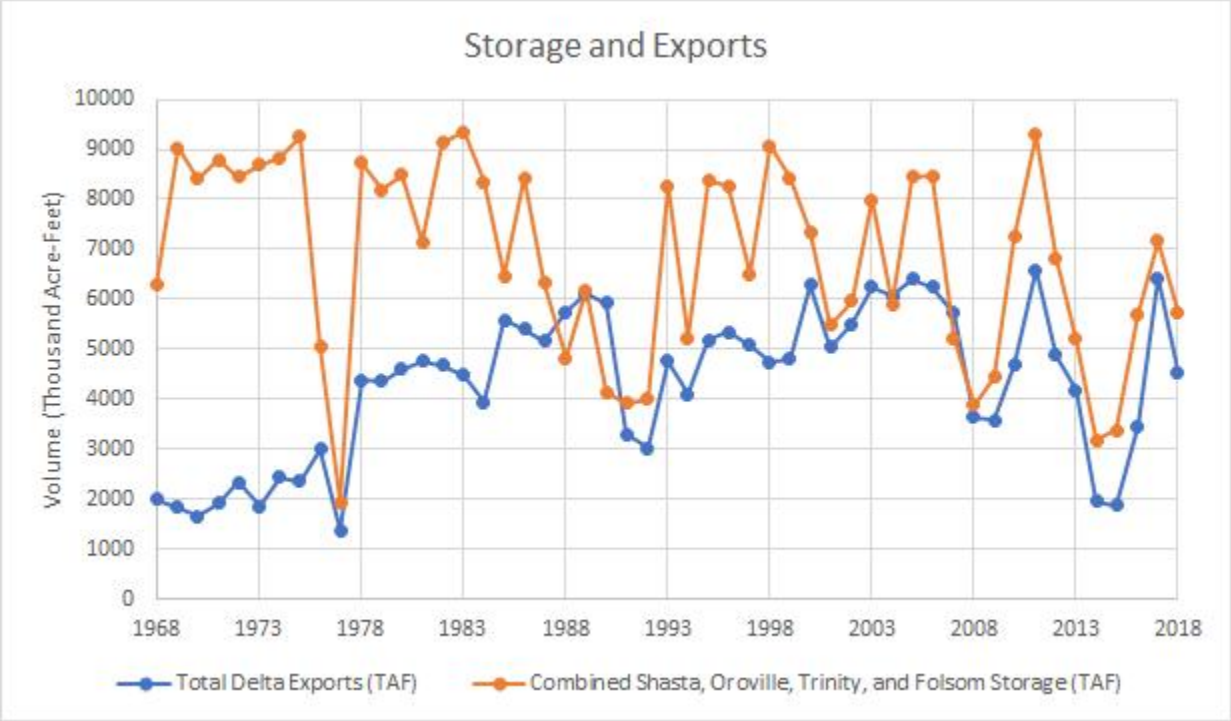


Figure 4-1. Delta Exports and Reservoir End-of-September Storage, 1968–2018

If releases are reduced during some timeframes to maintain higher storage levels in reservoirs, that has a corresponding effect of reducing inflows to the Delta, which then reduces Delta outflows. The benefit of increased reservoir storage has to be weighed against the potential negative downstream impacts on fisheries. In addition, maintaining a higher carryover storage increases the risk of having to make flood control releases early in the season to draw down to the required maximum flood conservation space. Making flood control releases in October and November to draw down to the required maximum storage conflicts with needs to reduce flows rapidly during the fall to encourage development of the cold water pool for the following year.

At Shasta Reservoir, Reclamation seeks to build cold water pool for providing suitable temperatures for Winter-Run Chinook Salmon spawning and incubation in the summer. Releases earlier in the year may reduce this cold water pool. To avoid Winter-Run Chinook Salmon and Fall-Run Chinook Salmon redd dewatering, releases higher than what is needed for instream requirements or Delta requirements may occur. Releases may also occur to facilitate spring pulses for juvenile outmigration, or increased releases to meet Delta outflow or salinity requirements per D-1641. Water temperature management strategies that deplete cold water pool early in the year come at the expense of later season temperatures.

The Trinity ROD and lower Klamath fall augmentation flows limit Reclamation's transbasin diversions and impact Reclamation's temperature operations and CVP deliveries on the Sacramento River. Increases in Trinity River releases in the late summer and fall result in lower storage in Trinity Reservoir at the end of the water year. The decreases in storage accumulate from water year to water year when the reservoir does not refill. Hydrologic conditions that do not refill the reservoir result in lower end-of-summer storages, negative impacts on cold water pool, and potentially warmer stream temperatures for Fall-Run Chinook Salmon spawning in the Trinity River.

Reclamation and DWR coordinate regarding downstream requirements (Delta outflow, Delta salinity, etc). The amount of water from each reservoir depends upon reservoir storage, channel capacity, fishery concerns, projected inflows, and projected end-of-September storage. With its several upstream reservoirs, Reclamation balances releases so that no one reservoir bears the full burden of meeting its share of the downstream requirements.

On the American River, temperature targets during the summer are intended to benefit Steelhead. Meeting this requirement typically uses nearly the full volume of cold water pool. As a result, there is typically a limited cold water pool remaining in the fall to provide suitable spawning and incubation temperatures for Fall-Run Chinook Salmon. There is rarely enough cold water to provide optimal conditions for both species. Water transfers through Folsom from upstream senior water right holders that occur after Folsom Reservoir has stratified (typically early June) also may have small negative impacts on the cold water pool.

Demands for higher outflow directly conflict with fishery agency requests to maintain substantial cold water pool storage in the reservoirs through the summer for temperature operations in the summer and fall. There are also tradeoffs between species; for example, spring pulse flows on the Sacramento River to benefit Spring-Run Chinook Salmon could negatively impact temperature operations for Winter-Run Chinook Salmon.

San Luis Reservoir is an off-stream storage facility primarily fed by water pumped from the Delta. This supply is used annually to meet south of Delta contractor demands. In the past (prior to major seasonal restrictions of Delta pumping), Delta exports were utilized heavily during the rainy season to capture excess flows in the Delta and store that additional water supply in San Luis Reservoir. The developed water supply (i.e., stored water) was then used during the summer months to provide water to the south of Delta contractors. Now, however, because of significant export restrictions during the precipitation season imposed by the 1995/2006 WQCP and the 2008/2009 biological opinions, the bulk of the joint CVP/SWP Delta export capability is timed during the summer months, resulting in a higher percentage of south of Delta deliveries relying on upstream storage. Ideally, San Luis Reservoir would be as full as possible by April 1 of each water year, then operated to meet south of Delta needs throughout the summer. San Luis Reservoir low point generally occurs the end of August of each water year. If San Luis low point is too low, there can be algae problems for users of water through the San Felipe Project, particularly Santa Clara Valley Water District. Those users have expressed a need to have a plan to prevent San Luis Reservoir from becoming so low that water supplies are negatively impacted by algal growth.

With respect to hydropower generation, the use of direct river release outlets to access colder water below the power penstock intakes for fishery purposes causes the releases to bypasses hydropower production. This impacts ~~the preferential~~ power customers and represents a loss of revenue to Reclamation. In addition, increased requirements and regulations over the years have impacted the ability to deliver CVP water, resulting in lower allocations. The lower allocations result in lower revenues for the restoration fund and increase power customer costs to make up the difference.

4.3 Coordinated Operation Agreement

Reclamation and DWR propose to operate their respective facilities in accordance with the COA. The COA defines the project facilities and their water supplies, sets forth procedures for coordinating operations, and identifies formulas for sharing joint responsibilities for meeting Delta standards and other legal uses of water. It further identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the projects, and provides for periodic review of the agreement.

Through the COA, Reclamation and DWR share the obligation for meeting in-basin uses. In-basin uses are defined in the COA as legal uses of water in the Sacramento Basin, including the water required under the provisions of Exhibit A of the COA [SWRCB Delta standards]. Each project is obligated to ensure water is available for these uses. The respective degree of obligation is dependent on several factors, as described below.

Balanced water conditions are defined in the COA as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus exports. Excess water conditions are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses plus exports. Reclamation's Central Valley Operations Office (CVO) and DWR's SWP Operations Control Office jointly decide when balanced or excess water conditions exist. During balanced water conditions, the projects share the responsibility in meeting in-basin uses.

During excess water conditions, sufficient water is available to meet all beneficial needs, and the CVP and SWP are not required to supplement the supply with water from reservoir storage. Under Article 6(g) of the COA, Reclamation and DWR have the responsibility (during excess water conditions) to store and export as much water as possible, within physical, legal, and contractual limits.

Implementation of the COA principles has continuously evolved since 1986 as changes have occurred to CVP and SWP facilities, to operating criteria, and to the overall physical and regulatory environment. For example, updated water quality and flow standards adopted by the SWRCB, CVPIA, and ESA responsibilities have affected both CVP and SWP operations. The 1986 COA incorporated D-1485 provisions regarding Delta salinity, outflow, and export restrictions. It also envisioned and provided a methodology to incorporate future regulatory changes, like Delta salinity requirements, but did not explicitly envision (or explicitly address) sharing of export restrictions. Both D-1641 and the 2008 and 2009 biological opinions included various export restrictions that were not explicitly addressed in the 1986 COA; however, the available export capacity as a result of these export restrictions was shared between the projects in the absence of a formal update.

In 2018, Reclamation and DWR modified four key elements of the COA to address changes since COA was originally signed: (1) in-basin uses; (2) export restrictions; (3) CVP use of Banks Pumping Plant up to 195,000 acre-feet per year; and (4) the periodic review. COA sharing percentages for meeting Sacramento Valley in-basin uses now vary from 80 percent responsibility of the United States and 20

percent responsibility of the State of California in wet year types to 60 percent responsibility of the United States and 40 percent responsibility of the State of California in critical year types. In a dry or critical year following two dry or critical years, the United States and State will meet to discuss additional changes to the percentage sharing of responsibility to meet in-basin use. When exports are constrained and the Delta is in balanced conditions, Reclamation may pump up to 65 percent of the allowable total exports with DWR pumping the remaining capacity. In excess conditions, these percentages change to 60/40.

4.4 CVP Water Contracts

Based on the provisions of federal reclamation law, the CVP delivers water pursuant to water service and water repayment contracts, as well as settlement, exchange, and refuge contracts. Reclamation also delivers water pursuant to temporary, not to exceed 1 year, "Section 215 Contracts," when there are surplus flood flows. Pursuant to the Warren Act, Reclamation provides for the conveyance of non-CVP (which includes SWP water) when there is excess capacity available in CVP facilities. This consultation covers the operation of the CVP and SWP to deliver water under the terms of all existing contracts up to full contract amounts, which includes the impacts of maximum water deliveries and diversions under the terms of existing contracts and agreements, including timing and allocation. Reclamation is not proposing to execute any new contracts or amend any existing contracts as part of this consultation.

Reclamation proposes to operate the CVP to meet its obligations to deliver water to senior water right holders who received water prior to construction of the CVP, to wildlife refuge areas identified in the CVPIA, and to water service contractors.

Many senior water right holders executed contracts with Reclamation, such as the Sacramento River Settlement Contractors and San Joaquin River Exchange Contractors. The terms of those contracts differ significantly from water service contracts. The pattern of diversion of water under a water service contract depends on the use of the water, with irrigation water typically diverted and used during the irrigation season (March through October), and M&I water diverted and used year-round. All water service contracts contain a shortage provision allowing Reclamation to reduce the amount of water made available for a variety of reasons, such as droughts. Table 4-2 summarizes the number of CVP water service and repayment contracts and the amount of water under contract.

Table 4-2. CVP Water Service and Repayment Contracts

CVP Division	Number of Contracts	Contract Quantity[1] (Acre-Feet)
Tehama-Colusa Canal, Corning Canal, Redding Area, and Trinity River Division	36	468,890
American ~~River[2]~~River	9	~~313,765~~328,750
New Melones/Eastside Contracts	2	155,000
South of Delta	44	2,112,898
Friant Division	27	2,249,475
Contra Costa Water District	1	195,000

[1] Contract quantities do not reflect actual deliveries due to system conditions.

~~[2] Includes foreseeable long-term water service contract actions currently under review through separate consultation processes (i.e., pending contract pursuant to Fazio legislation for the El Dorado County Water Agency and contract renewals for the City of Roseville, Sacramento Municipal Utility District, Sacramento County Water Agency, and Placer County Water Agency).~~

This consultation covers Reclamation's operational actions to meet the terms of its existing CVP water supply contracts (i.e., water service contracts, and settlement, exchange, and refuge contract).

CVP Water service and repayment contracts include shortage provisions as follows: Article 12, Constraints on the Availability of Water, provides for a Condition of Shortage, which is defined in Article 1(c) as "...a condition respecting the Project during any Year such that the Contracting Officer is unable to deliver sufficient water to meet the Contract Total." Article 12(c) provides "In any Year in which there may occur a shortage for any of the reasons specified in subdivision 12(b) above, the Contracting Officer shall apportion Project Water among the Contractor and others entitled, under existing contracts and future contracts (to the extent such future contracts are permitted under subsections (a) and (b) of Section 3404 of the CVPIA) and renewals thereof, to receive Irrigation Water consistent with the contractual obligations of the United States." Article 12(d) states, "Project Water furnished under this Contract will be allocated in accordance with the then-existing Project M&I Water Shortage Policy. Such policy shall be amended, modified, or superseded only through a public notice and comment procedure."

The largest contracts belong to the Sacramento River Settlement Contractors (approximately 2.1 MAF) and the San Joaquin River Exchange contractors (approximately 840 TAF). In very dry years, Reclamation and DWR are often limited to operating the CVP and SWP solely to meet these, and other senior water right requirements, along with refuge water supply requirements and minimum instream and Delta flows, M&I deliveries pursuant to the CVP M&I Shortage Policy, and SWP exports for health and safety. In recent drought years, limited water supplies, dry hydrology, and regulatory restrictions made it difficult for Reclamation to make water available to satisfy contracts already reduced by 25 percent in those years. Reclamation delivers Level 2 refuge water primarily from the CVP and acquires Incremental Level 4 water from voluntary measures which include water conservation, conjunctive use, purchase,

lease, donations, or similar activities, or a combination of such activities which do not require involuntary reallocations of project yield. This proposed action covers the operation to deliver up to full contract amounts, including full Level 4 refuge contract amounts. Table 4-3 summarizes senior CVP water rights holders and the amount of water under contract.

Table 4-3. CVP Settlement Agreements

Contractor	Number of Contracts	Contract Quantity (Acre-Feet)
Sacramento River Settlement (SRS)	132	2,112,194 (1,775,313 Base + 336,881 Project)
San Joaquin River Exchange	4	840,000
Oakdale/S. San Joaquin ID Agreement and Stipulation	1	≤ 600,000
American River Contracts	13	578,441
Friant Division Riparian Holding Contracts	n/a	5 cfs past each diversion
South of Delta Settlement Contractors	9	35,623
North of Delta Refuges—Level 2 CVP	2	179,000
South of Delta Refuges—Level 2 CVP	3	376,515

Note: Contract quantities do not reflect actual deliveries due to system conditions.

The contracts referenced above usually include articles such as Article 5, Constraints on the Availability of Water, which states that "in a Critical Year, the Contractor's Base Supply and Project Water agreed to be diverted during the period April through October of the Year in which the principal portion of the Critical Year occurs and, each monthly quantity of said period shall be reduced by 25 percent."

4.5 SWP Water Contracts

The SWP has signed long-term contracts with 29 water agencies statewide to deliver water supplies developed from the SWP system. These contracts are with both M&I water users and agricultural water users. The contracts specify the charges that will be made to the water agency for both: (1) Conservation of Water, and (2) Conveyance of Water. The foundational allocation of water to each contractor is based on their respective "Table A" entitlement, which is the maximum amount of water delivered to them by the SWP, on an annual basis. Typically, annual water deliveries to individual agencies are less than their maximum Table A amount, due to a wide variety of reasons.

DWR proposes to operate the SWP in accordance with contracts with senior water right holders in the Feather River Service Area (approximately 983 TAF). Further, under State Water Contracts, DWR allocates Table A water as an annual supply made available for scheduled delivery throughout the year. Table A contracts total 4,173 TAF, with over 3 MAF for San Joaquin Valley and Southern California water users.

Article 21 of the long-term SWP water supply contracts provides an interruptible water supply made available only when certain conditions exist: (1) the SWP share of San Luis Reservoir is physically full, or projected to be physically full; (2) other SWP reservoirs south of the Delta are at their storage targets or the conveyance capacity to fill these reservoirs is maximized; (3) the Delta is in excess condition; (4) current Table A demand is being fully met; and (5) Banks has export capacity beyond that which is needed to meet current Table A and other SWP operational demands.

4.5.1 SWP Settlement Agreements

DWR has water rights settlement agreements to provide water supplies with entities north of Oroville, along the Feather River, Bear River, and in the Delta. These agreements provide users with water supplies that they were entitled to prior to the construction of the SWP's Oroville Complex. Collectively, these agreements provide over 1 MAF of water each year. DWR also has agreements with several (more than 60) riparian diverters along the Feather, Yuba, and Bear Rivers to provide water for diversion. Table 4-4 summarizes the volumes under the water rights settlement agreements.

Table 4-4. SWP Settlement Agreements

Location	Entity	Amount (Acre-Feet)
North of Oroville	Andrew Valberde	135
North of Oroville	Jane Ramelli	800
North of Oroville	Last Chance Creek WD	12,000
Feather River	Garden Highway Mutual Water	18,000
Feather River	Joint Water Districts Board	620,000
Feather River	South Feather Water & Power	17,555
Feather River	Oswald WD	3,000
Feather River	Plumas Mutual Water	14,000
Feather River	Thermalito Irrigation District	8,200
Feather River	Tudor Mutual Water	5,000
Feather River	Western Canal/PG&E	295,000
Bear River	South Sutter/Camp Far West	4,400
Delta	Byron-Bethany ID	50,000
Delta	East Contra Costa ID	50,000
Delta	Solano Co./Fairfield, Vacaville and Benicia	31,620

4.5.2 SWP Contracting Agencies

The SWP has signed contracts with 29 parties to provide water supplies developed by the SWP. Table 4-5 shows the maximum contracted annual water supply per DWR's most recent water supply reliability report.

Table 4-5. SWP Water Service Contracts

Contracting Agency	Maximum Supply (Acre-Feet)
Butte County	27,500
Plumas County	2,700
Yuba City	9,600
Napa County Flood Control and Water Conservation District	29,025
Solano County	47,756
Alameda County—Zone 7	80,619
Alameda County Water District	42,000
Santa Clara Valley Water District	100,000
Oak Flat Water District	5,700
Kings County	9,305
Dudley Ridge Water District	45,350
Empire West Side Irrigation District	3,000
Kern County Water Agency	982,730
Tulare Lake Water Storage District	87,471
San Luis Obispo County	25,000
Santa Barbara County	45,486
Antelope Valley-East Kern Water Agency	144,844
Santa Clarita Valley Water Agency	95,200
Coachella Valley Water District	138,350
Crestline-Lake Arrowhead Water Agency	5,800

Contracting Agency	Maximum Supply (Acre-Feet)
Desert Water Agency	55,750
Littlerock Creek Irrigation District	2,300
Metropolitan Water District of Southern California	1,911,500
Mojave Water Agency	85,800
Palmdale Water District	21,300
San Bernardino Valley Municipal Water District	102,600
San Gabriel Valley Municipal Water District	28,800
San Gorgonio Pass Water Agency	17,300
Ventura County Watershed Protection District	20,000

4.6 D-1641

Reclamation and DWR propose to operate in accordance with obligations under D-1641, which provides protection for fish and wildlife, M&I water quality, agricultural water quality, and Suisun Marsh salinity. D-1641 granted Reclamation and DWR the ability to use or exchange each project's diversion capacity capabilities to maximize the beneficial uses of the CVP and SWP. The SWRCB conditioned the use of Joint Point of Diversion capabilities based on staged implementation and conditional requirements for each stage of implementation.

4.7 CVPIA

Reclamation proposes to operate in accordance with its obligations under the CVPIA, including but not limited to CVPIA 3406 (b)(2). DOI accounts for the following actions in meeting the 3406 (b)(2) requirement:

1) Primary Purposes: Any fish action (export reduction or upstream release) that predominantly contributes to one of the enumerated 3406(b) programs identified by the courts, including 3406(b)(1), (4), (5), (8), (9), (12), (18) and (19), must be counted against the up to 800 TAF of (b)(2) water. Thus, any upstream release or export reduction that predominantly contributes to one of those purposes will be deducted from the 3406(b)(2) account.

2) Secondary Purposes: Water operations in accordance with ESA and fish and wildlife objectives of D-1641 water quality actions may also be included in (b)(2) accounting. Upstream releases mandated by ESA Biological Opinions may also count towards 3406 (b)(2). Export reductions in ESA Biological Opinions or specified under D-1641 for fish and wildlife objectives may also count towards 3406 (b)(2). Releases for other water quality actions (i.e., net delta outflow) under D-1641 may also count towards 3406 (b)(2).

Pursuant to section 3406(b)(2)(C) the Secretary of the Interior may temporarily reduce deliveries of the quantity of water dedicated under this paragraph up to 25 percent of such total whenever reductions due to hydrologic circumstances are imposed upon agricultural deliveries of Central Valley Project water. The Secretary may also make water available for other purposes if the Secretary determines that the 800,000 acre-feet identified in section 3406(b)(2) is not needed to fulfill the purposes of section 3406.

~~4.7~~4.8 Allocation and Forecasts

Reclamation proposes to allocate CVP water on an annual basis in accordance with contracts. Reclamation bases north of Delta allocations primarily on available water supply within the north of Delta system along with expected controlling regulations throughout the year. For south of Delta allocations, Reclamation relies on upstream water supply, previously stored water south of the Delta (in San Luis Reservoir) and conveyance capability through the Delta. Flows on the San Joaquin River often limit conveyance, as these flows are a driver of the flow direction within the Delta and through their influence on Old and Middle net reverse flow, can affect entrainment levels at the State and federal pumps.

The water allocation process for the CVP begins in the fall when Reclamation makes preliminary assessments of the next year's water supply possibilities, given current storage conditions combined with a range of hydrologic conditions. Reclamation may refine these preliminary assessments as the water year progresses. Beginning February 1, Reclamation prepares forecasts of water year runoff using precipitation to date, snow water content accumulation, and runoff to date. All of the CVP's Sacramento River Settlement water rights contracts and San Joaquin River Exchange contracts require that contractors be informed no later than February 15 of any possible deficiency in their supplies. Reclamation targets February 20 as the date for the first announcement of all CVP contractors' forecasted water allocations for the upcoming contract year. Reclamation updates forecasts of runoff and operations plans at least monthly between February and May.

Reclamation performs operations forecasting on a 12-month ahead cycle each month to determine how the available water resources can best be used to meet project objectives and requirements. Reclamation bases forecasts on the 12-month projected runoff volumes that would occur naturally and considers potential upstream operations where relevant. For October and November, projected runoff is based entirely on historical hydrology as no snowpack data are available yet. In December and January, inflow forecasts may include snow pillow information and precipitation as well as historical hydrology. For the February through May period, the runoff volume estimates are based on the observed inflow to date and current snowpack measurements made at the end of each preceding month, projections through September, and historical hydrology for the next water year. These forecasts represent the uncertainty inherent in making runoff predictions. This uncertainty may include sources such as unknown future weather conditions, the various prediction methodologies, and the spatial coverage of the data network in a given basin.

In most years, the combination of carryover storage and runoff into CVP reservoirs and the Central Valley is not enough to provide sufficient water to meet all CVP contractors' contractual demands. Multiple legislative, contractual, and settlement obligations have created an increased tension in Reclamation's ability to make contractual deliveries of water to water users and to meet other legal obligations. As provided in Section 9 of the Reclamation Projects Act of 1939, Section 215 of the Reclamation Reform Act of 1982, and Section 3404(b) of CVPIA, Reclamation is authorized to enter into temporary contracts, not to exceed 1 year, for delivery of surplus flood flows.

~~4.7.1~~4.8.1 SWP Allocation and Forecasting

At the beginning of each new water year, there is significant uncertainty as to the hydrologic conditions that will exist in the future several months, and hence, the water supplies that will be allocated by the SWP to its water contractors. In recognition of this, DWR utilizes a forecasting-water supply allocation process that is updated monthly, incorporates known conditions in the Central Valley watershed to-date, and forecasts future hydrologic conditions in a conservative manner to provide an accurate estimate of SWP water supplies that can be delivered to SWP contractors as the water year progresses.

There are many factors considered in the forecast-supply process. Some of these factors are the following:

- Water storage in Lake Oroville (both updated and end-of-water-year (September 30))
- Water storage in San Luis Reservoir (both updated and end-of-calendar-year)
- Flood operations constraints at Lake Oroville
- Snowpack surveys (updated monthly from February through May)
- Forecasted runoff in the Central Valley (reflects both snowpack and precipitation)
- Feather River settlement agreement obligations
- Feather River fishery flows and temperature obligations
- Anticipated depletions in the Sacramento and Delta basins
- Anticipated Delta standards and conditions
- Anticipated CVP operations for joint responsibilities
- Contractor supply requests and delivery patterns

Staff from both the Operations Control Office (OCO) and the State Water Projects Analysis Office (SWPAO) coordinate their efforts to determine the current water supply allocations. OCO primarily focuses on runoff/operations models to determine allocations. SWPAO requests updated information from the contractors on supply requests and delivery patterns to determine allocations. Both OCO and SWPAO staff meet at least once a month with the DWR Director to make final decisions on staff's proposed allocations.

The Initial Allocation for SWP Deliveries is made by December 1 of each year with a conservative assumption of future precipitation to avoid over-allocating water before the hydrologic conditions are well defined for the year. As the water year unfolds, Central Valley hydrology and water supply delivery estimates are updated using measured/known information and conservative forecasts of future hydrology. Monthly briefings are held with the DWR Director to determine formal approvals of delivery commitments announced by DWR.

Another water supply consideration is the contractual ability of SWP contractors to "carry over" allocated (but undelivered) Table A from 1 year to the next if space is available in San Luis Reservoir. The carryover storage is often used to supplement an individual contractor's current year Table A allocations if conditions are dry. Carryover supplies left in San Luis Reservoir by SWP contractors can result in higher storage levels in San Luis Reservoir. As project pumping fills San Luis Reservoir, the contractors are notified to take, or lose, their carryover supplies. Carryover water not taken, after notice is given to remove it, then becomes project water available for reallocation to all contractors in a given year.

Article 21 (surplus to Table A) water which is delivered early in the calendar year may be reclassified as Table A later in the year depending on final allocations, hydrology, and contractor requests. Reclassification does not affect the amount of water carried over in San Luis Reservoir, nor does it alter pumping volumes or schedules.

~~4.7.2~~4.8.2 Daily Operations

After the allocations and forecasting process, Reclamation and DWR coordinate their operations on a daily basis. Some factors which Reclamation and DWR consider when coordinating their joint operations include required in-Delta flows, Delta outflow, water quality, schedules for the joint use facilities, pumping/wheeling arrangements, and any facility limitations. Both projects must meet the flood obligations of individual reservoirs. CVP operations must also consider navigational flows at Wilkins Slough (see Upper Sacramento River for additional details).

During balanced water conditions, Reclamation and DWR maintain a daily water accounting of CVP and SWP obligations. This accounting allows for flexible operations and avoids the need to change reservoir releases made several days in advance (due to travel time from the Delta). Therefore, adjustments can be made "after the fact," using actual observed data rather than by prediction for the variables of reservoir inflow, storage withdrawals, and in-basin uses. This iterative process of observation and adjustment results in a continuous truing up of the running COA account. The project that is "owed" water (i.e., the project that provided more or exported less than its COA-defined share) may request the other project adjust its operations to reduce or eliminate the accumulated account within a reasonable time.

The COA provides the mechanism for determining each project's responsibility for meeting in-basin use, but real-time conditions dictate real-time actions. Conditions in the Delta can change rapidly. For example, weather conditions combined with tidal action can quickly affect Delta salinity conditions and, therefore, the Delta outflow required to maintain joint salinity standards under D-1641.

Increasing or decreasing project exports can achieve changes to Delta outflow immediately. Imbalances in meeting each project's initial shared obligations are captured by the COA accounting and balanced out later.

When more reaction time is available, reservoir release changes are used adjust to changing in-basin conditions. If Reclamation decides the reasonable course of action is to increase upstream reservoir releases, then the response may be to increase Folsom Reservoir releases first because the released water will reach the Delta before flows released from other CVP and SWP reservoirs. DWR's Lake Oroville water releases require about 3 days to reach the Delta, while water released from Reclamation's Shasta Reservoir requires 5 days to travel from Keswick Reservoir to the Delta. As water from another reservoir arrives in the Delta, Reclamation can adjust Folsom Reservoir releases downward. Alternatively, if sufficient time exists for water to reach the Delta, Reclamation may choose to make initial releases from Shasta Reservoir. Each occurrence is evaluated on an individual basis, and appropriate action is taken based on multiple factors. Again, the COA accounting captures imbalances in meeting each project's initial shared obligation.

One of the principal considerations when determining which reservoir to make releases from is the reservoir refill potential, i.e., the probability that a reservoir will, over the course of a year's inflow and releases, return to a desirable carryover storage. The refill potential is approximated by the average annual runoff divided by the total reservoir storage. Reservoirs that are large compared to the average runoff of their watershed, such as New Melones, have a small refill potential (0.5). Reservoirs that are small compared to the average runoff of their watershed, such as Folsom, have a large refill potential (2.5).

Folsom Reservoir generally has the best refill potential of the CVP reservoirs. Refill potential also is a consideration when evaluating how much water to move from Trinity Reservoir (0.5) to the Sacramento River side. Shasta Reservoir currently has an average annual runoff of approximately 8,476 TAF, with 4,500 TAF of storage, meaning an approximate refill potential of 2, so releases from Shasta Reservoir are more likely to be replaced with new inflow and bring storage back up than releases from Trinity Reservoir.

The duration of balanced water conditions varies from year to year. Balanced conditions never occur in some very wet years, while very dry years may have long continuous periods of balanced conditions, and still other years may have had several periods of balanced conditions interspersed with excess water conditions. Account balances continue from one balanced water condition through the excess water condition and into the next balanced water condition. When the project that is owed water enters into flood control operations, which could be Shasta Reservoir for the CVP or Lake Oroville for the SWP, the accounting is zeroed out for that project.

Reclamation and DWR staff meet daily to discuss and coordinate CVP and SWP system operations. A number of items are discussed at this daily meeting, including:

- Current reservoir conditions
- Pumping status and current outages (for both the CVP and the SWP and how they are affecting project operations)
- Upcoming planned outages (CVP and SWP) and what that means for future operations
- Current reservoir releases and what changes may be planned
- Current regulatory requirements and compliance status
- Delta conditions to determine if CVP and SWP pumping make use of all available water

Reclamation and DWR also coordinate with Hydrosystem Controllers and Area Offices to ensure that, if necessary, personnel are available to make the desired changes. Once Reclamation and DWR each decide on a plan for that day and complete all coordination, each issue change orders to effectuate the decisions, if necessary.

Reclamation and DWR are co-located in the Joint Operations Center. Additionally, the California Data Exchange Center, California-Nevada River Forecast Center and the DWR Flood Management Group are also co-located in the Joint Operations Center. This enables efficient and timely communication, particularly during flood events.

~~4.8~~4.9 New Science

Reclamation reinitiated consultation on the coordinated long-term operation of the CVP and SWP, in part because of new information. A substantial amount of new information and science has occurred since the 2008 and 2009 biological opinions. The following selected studies particularly inform the proposed action described in this biological assessment, but do not form a comprehensive list:

- Martin, 2017: A phenomenological assessment of temperature-related Chinook Salmon egg mortality modeling, calibrated to fry survival to Red Bluff, Martin et al. concluded the ideal incubation temperature for eggs in the river was 12C or 53.6°F. Below 53.6°F, there is no mortality due to temperature according to Martin. Biophysical models of oxygen transfer across

the egg membrane corroborated the difference between temperature-dependent egg mortality predicted in the laboratory versus fry survival to Red Bluff. The 2017 LOBO review (Gore 2018), stated that the Martin approach represents a powerful predictive model for salmon vulnerability to temperature exposure but that the predictions of the oxygen diffusion model should be tested under field conditions because of the model's apparent sensitivity to extremely small changes in flow velocity, and it may be problematic to apply a density dependent model that lacks any mechanistic basis or site-specific information. Additionally, new laboratory studies from UC Davis (Del Rio et al. In Press) affirm earlier findings (USFWS 1999) that embryo survival is not appreciably impaired at daily mean water temperatures at or near 56ºF.

- Anderson 2018: Anderson reviewed Martin 2017 and found that for Chinook Salmon egg incubation shifting the focus of management from meeting a compliance temperature of 53.6°F on the Sacramento River all season long to releasing cold water for just the life stage specific requirements of eggs yields efficiencies for when cold water from Shasta Reservoir is needed and when water from Shasta Reservoir can be saved.
- Grimaldo 2017: Models of Delta Smelt and salmonids at both CVP and SWP showed salvage of adult Delta Smelt increased at OMR more negative than -5,000 cfs, when all other variables were held at their averages. While OMR flow was an important predictor of CVP salvage, more important than even CVP exports, the OMR threshold of -5,000 cfs was most notable in SWP salvage.
- Perry 2018: Statistical modeling revealed that survival was positively related to inflow only in reaches that transitioned from bidirectional tidal flows to unidirectional flow with increasing inflows. Bidirectional to unidirectional transitions occurred in Sutter, Steamboat, and Georgiana Sloughs, and in the Sacramento River from the DCC to Rio Vista, and in the Mokelumne Rivers between the DCC and the San Joaquin River.
- SST 2017: Neither Coded Wire Tag (CWT) nor acoustic tag (AT) data for juvenile Fall-Run Chinook Salmon show a strong and consistent relationship between survival of fish from the San Joaquin River and exports at Jones and Banks Pumping Plants. The evidence of relationship between exports and through-Delta survival is inconclusive, however, the authors stated that their basis of knowledge is low. "It is unknown whether equivocal findings regarding the existence and nature of a relationship between exports and through-Delta survival is due to the lack of a relationship, the concurrent and confounding influence of other variables, or the effect of low overall survival in recent years."
- Six-Year Acoustic Telemetry Study: The Six-Year Steelhead Acoustic Telemetry Study monitored yearling Steelhead migrating through the San Joaquin River and Old River during 2011 to 2016. Estimated survival was no different between the two routes in 2011, 2012, and 2014, but was greater for Steelhead that migrated through the San Joaquin River route in 2015 (average for all release groups was 0.30 [range, 0.19–0.46]), and 2016 (average was 0.45 for all release groups [range, 0.23–0.61]) (statistically significant for 2015 and 2016 survival estimates at alpha = 0.05; Reclamation 2018a,b,c; Buchanan 2018a,b,c).
- Buchanan 2018. Buchanan et al. summarized results of the Fall-Run Chinook acoustic tag studies in the San Joaquin River from 2010 through 2015. The results were survival of Fall-Run Chinook Salmon has been low since 2002, ranging between 0 and 0.05. Even in the high flow year of 201, survival was only 0.02, suggesting increased flows alone are not sufficient to resolve low survival. Over half of the Fall-Run Chinook Salmon that made it through the San Joaquin part of the Delta to Chipps Island were salvaged at the CVP and transported to Chipps.
- Hammock 2017 and Kimmerer and Rose 2018: These studies have used field research and modeling respectively to improve the scientific understanding of food limitation in Delta Smelt.

Hammock et al. (2015, 2017) showed that feeding success is variable in space and time. Kimmerer and Rose (2018) used an individual-based life cycle model to show that if it were possible to achieve, a return to pre-overbite clam historical prey densities might increase the Delta Smelt's population growth rate by 14 percent to 81 percent.

- MAST / FLaSH Reports: "According to the FLaSH conceptual model, conditions are supposed to be favorable for Delta Smelt when fall X2 is approximately 74 km or less, unfavorable when X2 is approximately 85 km or greater, and intermediate in between (Reclamation 2011, 2012). The data generally supported the idea that lower X2 and greater area of the LSZ would support more subadult Delta Smelt. The greatest LSZ area and lowest X2 occurred in September and October 2011 and were associated with a high FMWT index which was followed by the highest SKT index on record, although survival from subadults to adults was actually lower in 2011 than in 2010 and 2006. There was little separation between the other years on the basis of X2, LSZ area, or FMWT index. The position and area of the LSZ is a key factor determining the quantity and quality of low salinity rearing habitat available to Delta Smelt and other estuarine species…" Any perceived benefit to the Delta Smelt population of having X2 in the 'favorable area' throughout most of 2017 due to high outflows remains unclear, with the Delta Smelt Fall Midwater Trawl index showing a decrease from that in 2016 and remaining near all-time lows.
- Bush 2017: Using isotopic analysis of otoliths from over a thousand Delta Smelt, Bush (2017) found the species exhibits partial migration through three different life history phenotypes, which include a freshwater resident fish, a brackish water resident fish, and a migratory phenotype, hatching in fresh water then occurring in brackish water during the juvenile and sub-adult stage. The relative abundance of each life history phenotype varied inter-annually with the latter most abundant, but not always dominant, in all years studied. The yearly contributions from each phenotype were found to vary with freshwater flows and temperature.
- CAMT Delta Smelt Entrainment Studies: New research shows that when Delta Smelt salvage is analyzed independently for SWP and CVP fish facility data, OMR flow has smaller explanatory influence on salvage than some other variables (Grimaldo et al. 2017). Population abundance, as indexed by the CDFW FMWT program, and turbidity have high explanatory power for adult Delta Smelt salvage at the SWP and CVP, particularly during the era of OMR management per the 2008 USFWS Biological Opinion. The basis for OMR flow management partially stems for earlier work showing that adult Delta Smelt salvage (Grimaldo et al. 2009) and proportional losses (Kimmerer 2008) increased as net OMR flow increased southward towards the Projects. New statistical techniques suggests a number of factors to minimize salvage or entrainment risk. However, given the correlation of OMR and SWP and CVP models, salvage and entrainment risk could be achieved through management of either indexes of the hydrodynamic influence from Project exports. It is worth noting that the ultimate objective for managing Delta Smelt entrainment should not focus on observed salvage. Rather, the management objective should be to target entrainment losses, in a traditional fisheries sense, to sustainable levels that do not compromise population growth rates (Maunder and Deriso 2011; Rose et al. 2013). New research preformed under CAMT, can help scientists and resource managers identify circumstances when those large entrainment losses are likely to occur, which can ultimately be used to develop population risk assessment models (Grimaldo et al. 2017; Gross et al. 2018; Korman et al. 2018; Smith et al. 2018). The question about whether the Delta Smelt population can rebound from record-low abundances, even with improved entrainment management during the winter, remains outstanding given the importance of other factors at play (i.e., poor food supply, growth, water temperatures; see Maunder and Deriso 2011; Rose et al. 2013).

~~4.9~~4.10 Proposed Action by Basin

Table 4-6 shows each of the components of the proposed action for this consultation, including ~~both~~ operational changes ~~and,~~ non-flow habitat, and facility improvements. The table also shows whether each action is covered at a site-specific or a programmatic level in this biological assessment and ~~whether the action is part of the Core Water Operations of the CVP and SWP, subject to periodic review after implementation, or whether it is an action to be coordinated prior to implementation (i.e., adaptively managed). The actions identified as a conservation measure represent firm commitments believed necessary to address adverse effects of the ongoing operation of the CVP and SWP and are indicated by an asterisk in the table below. Conservation measures may include habitat restoration, facility improvements, or intervention measures – hands on measures to affect fish directly, rather than affecting their habitat.~~ the proposed implementation approach. The three proposed implementation approaches are generally described as follows (further details are provided in section 4.12 and Appendix C):

- "Core" – the action is part of the Core Water Operations of the CVP and SWP.
- "Scheduling" – agencies and water users provide recommendations to Reclamation on scheduling and shaping specific flow actions.
- "Collaborative Planning" – agencies and water users work collaboratively to define, plan, and implement an action.

Completed consultations with existing biological opinions that address the effects of long-term operations~~,~~ and do not trigger reinitiation under this consultation are identified by "NCO" (Not Consulted On).

Table 4-6. Components of the Proposed Action

Title	Site Specific or Programmatic?	~~Core Operation or Adaptive Management?~~Implementation Approach
CVP/SWP Wide		
Divert and store water consistent with obligations under water rights and decisions by the State Water Resources Control Board	Site-specific	Core
Shasta Critical Determinations and Allocations to Water Service and Water Repayment Contractors	Site-specific	Core
~~2018 Revised Coordinated Operations Agreement~~	~~NCO~~	~~NCO~~
Upper Sacramento		
Seasonal Operations	Site-specific	Core
Spring Pulse Flows	Site-specific	~~AM~~Scheduling
Shasta Cold Water Pool Management	Site-specific	Core

Title	Site Specific or Programmatic?	~~Core Operation or Adaptive Management?~~Implementation Approach
Fall and Winter Refill and Redd Maintenance	Site-specific	Core
Operation of a Shasta Dam Raise	Site-specific	Core
Rice Decomposition Smoothing~~*~~	Site-specific	Core
Spring Management of Spawning Locations~~*~~	Site-specific	~~AM~~Collaborative Planning
Cold Water Management Tools (e.g., Battle Creek Restoration, Intake Lowering near Wilkins Slough, Shasta TCD Improvements~~)*~~)	Programmatic	~~AM~~Collaborative Planning
Spawning and Rearing Habitat Restoration~~*~~	Programmatic	~~AM~~Collaborative Planning
Small Screen Program~~*~~	Programmatic	~~AM~~Collaborative Planning
Winter-Run Conservation Hatchery Production~~*~~	Programmatic	~~AM~~Collaborative Planning
Adult Rescue~~*~~	Programmatic	~~AM~~Collaborative Planning
Juvenile Trap and Haul~~*~~	Programmatic	~~AM~~Collaborative Planning
Trinity		
Seasonal Operations	Site-specific	Core
Trinity River Record of Decision	NCO	NCO
Long-Term Plan to Protect Adult Salmon in the Lower Klamath River	NCO	NCO
~~Grass Valley Creek Flows from Buckhorn Dam~~	~~Site-specific~~	~~Core~~
Whiskeytown Reservoir Operations	Site-specific	Core
Clear Creek Minimum Flows	Site-specific	Core
Clear Creek Geomorphic and Spring Attraction Pulse Flows	Site-specific	Scheduling

Title	Site Specific or Programmatic?	~~Core Operation or Adaptive Management?~~Implementation Approach
Spring Creek Debris Dam	Site-specific	Core
~~Clear Creek Restoration Program*~~	~~NCO~~	~~NCO~~
Feather ~~River~~		
FERC Project #2100-134	NCO	NCO
American ~~River~~		
Seasonal Operations	Site-specific	Core
2017 Flow Management Standard Releases and "Planning Minimum"	Site-specific	Core
American River Pulse Flows	Site-specific	Scheduling
Spawning and Rearing Habitat Restoration*	Programmatic	~~AM~~Collaborative Planning
Drought Temperature Facility Improvements*	Programmatic	~~AM~~Collaborative Planning
Stanislaus		
Seasonal Operations	Site-specific	Core
Stanislaus River Stepped Release Plan	Site-specific	Core
Stanislaus River Pulse Flows	Site-specific	Scheduling
Alteration of Stanislaus DO Requirement	Site-specific	Core
Spawning and Rearing Habitat Restoration*	Programmatic	~~AM~~Collaborative Planning
Temperature Management Study*	Programmatic	~~AM~~Collaborative Planning
San Joaquin		
San Joaquin River Restoration Program	NCO	NCO
Lower ~~SJR~~San Joaquin River Habitat*	Programmatic	~~AM~~Collaborative Planning

Title	Site Specific or Programmatic?	~~Core Operation or Adaptive Management?~~Implementation Approach
~~Bay-~~Delta		
Seasonal Operations	Site-specific	Core
Minimum Export Rate	Site-specific	Core
Delta Cross Channel Operations	Site-specific	Core
Agricultural Barriers	Site-specific	Core
Contra Costa Water District Rock Slough Operations	Site-specific	Core
North Bay Aqueduct	Site-specific	Core
Water Transfers	Site-specific	Core
Clifton Court Aquatic Weed Removal	Site-specific	Core
Suisun Marsh Preservation Agreement	NCO	NCO
OMR Management	Site-specific	Core
Tracy Fish Collection Facility* Operations	Site-specific	Core
Skinner Fish Facility* Operations	Site-specific	Core
~~Operations~~		
~~Suisun Marsh Salinity Control Gates Operation*~~	~~Site-specific~~	~~Core~~
~~Fall~~ Delta Smelt Habitat~~*~~	Site-specific	~~AM~~Collaborative Planning
Clifton Court Predator Management~~*~~	Site-specific	Core
San Joaquin Basin Steelhead Telemetry Study~~*~~	Site-specific	~~AM~~Collaborative Planning
Sacramento Deepwater Ship Channel Food Study~~*~~	Programmatic	~~AM~~Collaborative Planning
North Delta Food Subsidies/Colusa Basin Drain Study~~*~~	Programmatic	~~AM~~Collaborative Planning

Title	Site Specific or Programmatic?	~~Core Operation or Adaptive Management?~~Implementation Approach
Suisun Marsh Roaring River Distribution System Food Subsidies Study*	Programmatic	~~AM~~Collaborative Planning
~~Habitat Restoration~~		
Tidal Habitat Restoration (Complete 8,000 acres from 2008 ~~BiOp)*~~biological opinion)	Programmatic	~~AM~~Collaborative Planning
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project*	NCO	NCO
Predator Hot Spot Removal*	Programmatic	~~AM~~Collaborative Planning
~~Facility Improvements~~		
Delta Cross Channel Gate Improvements*	Programmatic	~~AM~~Collaborative Planning
Tracy Fish Facility Improvements*	Programmatic	~~AM~~Collaborative Planning
Skinner Fish Facility Improvements*	Programmatic	~~AM~~Collaborative Planning
Small Screen Program*	Programmatic	~~AM~~Collaborative Planning
~~Fish Intervention~~		
Reintroduction efforts from Fish Conservation and Culture Laboratory*	Site-specific	~~AM~~Collaborative Planning
Delta Fish Species Conservation Hatchery*	Programmatic	~~AM~~Collaborative Planning

~~*Denotes a Conservation Measure~~

The proposed action for each basin is described in more detail below. These sections give some background for context along with a description of the proposed seasonal operations and proposed action.

~~4.9.1~~4.10.1 Upper Sacramento River (Shasta and Sacramento Divisions)

Reclamation operates the CVP Shasta Division for flood control, navigation, agricultural water supplies, M&I water supplies, fish and wildlife, hydroelectric power generation, Delta water quality, and water quality in the upper Sacramento River. Water rights, contracts, and agreements specific to the Upper Sacramento include SWRCB Decisions 990, 90-5, 91-1, and 1641, Settlement Contracts, Exchange

Contract, and Water Service Contracts. Facilities include the Shasta Dam, Lake (4.552 MAF capacity), and Power Plant; Keswick Dam, Reservoir, and Power Plant, and the Shasta TCD. The Sacramento Division includes the Red Bluff Pumping Plant, the Corning Pumping Plant, and the Corning and Tehama-Colusa Canals, for the irrigation of over 150,000 acres of land in Tehama, Glenn Colusa, and Yolo Counties.

Flood control limits releases to less than 79,000 cfs at the tailwater of Keswick Dam and a stage of 39.2 feet in the Sacramento River at Bend Bridge gauging station (~100,000 cfs) to avoid inundating populated areas downstream. Flood control operations are based on regulating criteria developed by the USACE pursuant to the provisions of the Flood Control Act of 1944. Flood control may reserve up to 1.3 MAF of storage behind Shasta, leaving 3.2 MAF for storage management.

Historical commerce on the Sacramento River resulted in a CVP authorization to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation in accordance with the River and Harbors Acts of 1935 and 1937. Although no commercial traffic persists, long-time water users diverting from the river have set their pump intakes based on minimum navigation flows; therefore, the CVP operates to approximately 5,000 cfs at the Wilkins Slough gage during periods when the intakes are being operated. This flow is often a challenge to meet under critical water supply conditions due to both water supply and cold water pool limitations, in which cases Reclamation has operated to approximately 4,000 cfs although impacts on senior diverters occur.

The intake for the Tehama-Colusa Canal and the Corning Canal is located on the Sacramento River approximately 2 miles southeast of Red Bluff. Water is diverted from the Sacramento River through a 2,000 cfs pumping plant (with ability to expand to 2,500 cfs) into a settling basin for continued conveyance in the Tehama-Colusa Canal and the Corning Canal.

The ACID holds senior water rights and has a settlement contract with Reclamation. Water is diverted to its main canal (on the right bank of the river) from a diversion dam located in Redding about 5 miles downstream from Keswick Dam. Reclamation will coordinate with ACID to ensure safe operation of the diversion dam during the irrigation season, from April through October.

In 1990 and 1991, SWRCB issued Water Rights Orders 90-05 and 91-01 modifying Reclamation's water rights for the Sacramento River. The orders stated that Reclamation shall operate Keswick and Shasta Dams and the Spring Creek Power Plant to meet a daily average water temperature of 56°F as far downstream in the Sacramento River as practicable during periods when higher temperature would be harmful to Winter-Run Chinook Salmon. Under the orders, the water temperature compliance point may be modified to an upstream location when the objective cannot be met at Red Bluff Pumping Plant. In addition, Order 90-05 modified the minimum flow requirements initially established in the 1960 MOA for the Sacramento River below Keswick Dam. The water right orders also recommended the construction of a Shasta TCD to improve the management of the limited cold water resources, and monitoring and coordination.

As a result, Shasta Dam is equipped with a TCD that allows temperature operations without impacting power generation. The TCD allows Reclamation to control the temperature of the water released from Shasta Dam. The TCD has four levels of gates from which water can be drawn, upper gates, middle gates, PRG gates (e.g., lower gates) and the Side Gates (coldest configuration). The last tool to reduce temperatures is to operate the TCD in the full side gate position, drawing the lowest (and coldest) possible water from the reservoir. Reclamation must balance the objectives of pulse flows or water supply releases early in the season which can conflict with the goal of maintaining a cold water pool sufficient to meet species' needs toward end of spawning and incubation season in the fall.

To operate the Shasta TCD, a defined amount of reservoir elevation above each set of gates is required to ensure safe operation. This requirement is reflected in Table 4-7 as 35 feet of submergence above the top of the gates.

Table 4-7. Shasta Temperature Control Device Gates with Elevation and Storage

TCD Gates	Shasta Elevation with 35 feet of Submergence of the TCD Gates (feet)	Shasta Storage (MAF)
Upper Gates	1,035	~3.66
Middle Gates	935	~1.64
Pressure Relief Gates	840	~0.59
Side Gates	720[1]	~0.08

[1]Low level intake bottom

~~4.9.1.1~~4.10.1.1 *Seasonal Operations*

Reclamation operates in the winter for flood control, including both the channel capacity within the Sacramento River and Shasta Reservoir flood conservation space. The USACE is responsible for developing and maintaining the Water Control Manual (WCM) for Shasta Reservoir. The WCM provides that the top of conservation pool (TOC) will set the storage amount that Reclamation is not to exceed on a given date. Releases for flood control will vary dependent upon the current storage, the forecasted inflow, and the flow in the mainstem Sacramento River at Bend Bridge. Reclamation operates Shasta Dam releases to keep flows at Bend Bridge below 100,000 cfs, and therefore reservoir elevations may temporarily exceed the TOC storage to protect downstream populated areas. During the winter period, there can be significant flow fluctuations from Keswick Dam due to the flood control operations. When not operating for flood control, Shasta Dam is operated primarily to conserve storage while meeting minimum flows both down the Sacramento River and in the Delta. These minimum flows are held until irrigation demands require increased releases.

During the winter to spring period there are accretions (flows from unregulated creeks) into the Sacramento River below Shasta Dam. These local accretions help to meet both instream demands and outflow requirements, minimizing the need for additional releases from Shasta and Folsom Reservoirs. In wetter year types, Reclamation may be able to operate mostly for flood control and minimum instream requirements because of the large volumes of accretions to the Sacramento River. In drier years, these accretions may be lower and, therefore, require Reclamation to release a higher level of releases from the upstream reservoirs to meet state permit requirements as well as project exports in the Delta.

In the spring, releases are fairly steady (unless Shasta Reservoir is in flood control operations) until flows are needed to support instream demands on the mainstem Sacramento River and Delta Outflow requirements. Releases for Delta Outflow requirements are balanced between Shasta Reservoir and Folsom Reservoir. Both reservoirs have substantial temperature control requirements, and both need to substantially fill to be able to fully meet their temperature control requirements. Therefore, releases must be carefully balanced to allow each reservoir to fill without negatively impacting the other. An

overarching goal for Reclamation when operating the CVP is to fill the reservoirs as much as possible by the end of the flood control season (end of May), while still meeting all other authorized project purposes.

Currently, the seasonal operation of the TCD is generally as follows: during mid-winter and early spring the highest possible elevation gates are utilized to draw from the upper portions of the lake to conserve deeper colder resources. During late spring and summer, the operators begin the seasonal progression of opening deeper gates as Shasta Reservoir elevation decreases and cold water resources are utilized. In late summer and fall, the TCD side gates are opened to utilize the remaining cold water resource.

During the summer, operational considerations are mainly flows required for Delta outflows, instream demands, and temperature control. In river temperatures below Shasta Dam can be controlled via two methods. First is changing release volume or shifting releases between Trinity and Sacramento reservoirs, and the second is selective withdrawal through the TCD. Determination of which method to use is made on a daily basis as operators balance releases from multiple reservoirs to meet downsteam needs.

Fall operations are dominated by temperature control and provision of fish spawning habitat. By late fall, the remaining cold water pool in Shasta Reservoir is usually limited. This can be a delicate balancing act in that if the early fall flows are too high then the fish may make their redds higher up on the edge of the river, and they become subject to the possibility of dewatering when the flows are reduced later in the fall. Sacramento River releases cannot be too low early in the fall as there are still significant instream diversion demands on the mainstem of the Sacramento River between Keswick Dam and Wilkins Slough, and depending on conditions, SWRCB Delta requirements may require upstream reservoir releases. This necessitates maintaining higher releases to support the instream demands until they fall off later in the season. At that time, Reclamation's objective is to drop Keswick releases to a lower level to conserve storage.

~~4.9.1.2~~4.10.1.2 *Spring Pulse Flows*

Under the Core Water Operation, Reclamation would ~~not~~ release spring pulse flows ~~unless~~when the projected total May 1 Shasta Reservoir storage ~~is greater than 4 MAF.~~indicates a likelihood of sufficient cold water to support summer cold water pool management. Total storage provides a surrogate for the likely cold water pool and would inform the decision in addition to monthly winter reservoir temperature measurements and climate forecasts. Reclamation would evaluate the projected May 1 Shasta Reservoir storage at the time of the February forecast to determine whether a spring pulse would be allowed in March, and would evaluate the projected May 1 Shasta Reservoir storage at the time of the March forecast to determine whether a spring pulse would be allowed in April. If Shasta Reservoir total storage on May 1 is projected to be sufficient for cold water pool management (e.g., greater than 4 MAF~~,~~), Reclamation ~~would~~could make a ~~Spring~~spring pulse release ~~as long as the~~ of up to 150 TAF in coordination with the Upper Sacramento scheduling team. Reclamation would not make a spring pulse release if the release would ~~not~~ cause Reclamation to drop into a ~~lower~~ Tier ~~of the~~4 Shasta summer cold water pool management (i.e., the additional flow releases would decrease cold water pool such that summer Shasta temperature management drops in Tier 4) or interfere with the ability to meet other anticipated demands on the reservoir. Appendix C provides for an interagency and stakeholder group to determine the timing, duration, and frequency of the spring pulse within the 150 TAF volume.

~~4.9.1.3~~4.10.1.3 *Cold Water Pool Management*

The closer Shasta Reservoir is to full by the end of May, the greater the likelihood of being able to meet the Winter Run Chinook Salmon temperature control criteria throughout the entire temperature control season. If Shasta Reservoir storage is high enough to use the Shasta TCD upper shutters by the end of

May, Reclamation can maximize the cold water pool potential. Storage of 3.66 MAF allows water to pass through the upper gates of the Shasta TCD, but historical relationships suggest that a storage of 4 MAF on May 1st generally provides enough storage to continue operating through the upper gates and develop a sufficient cold water pool to meet 53.5°F on the Sacramento River above Clear Creek (at the CCR gaging station) for Winter-Run Chinook Salmon spawning and egg incubation. Figure 4-2 provides an approximate rule of thumb for the relationship between temperature compliance, total storage in Shasta Reservoir, and cold water pool in Shasta Reservoir.

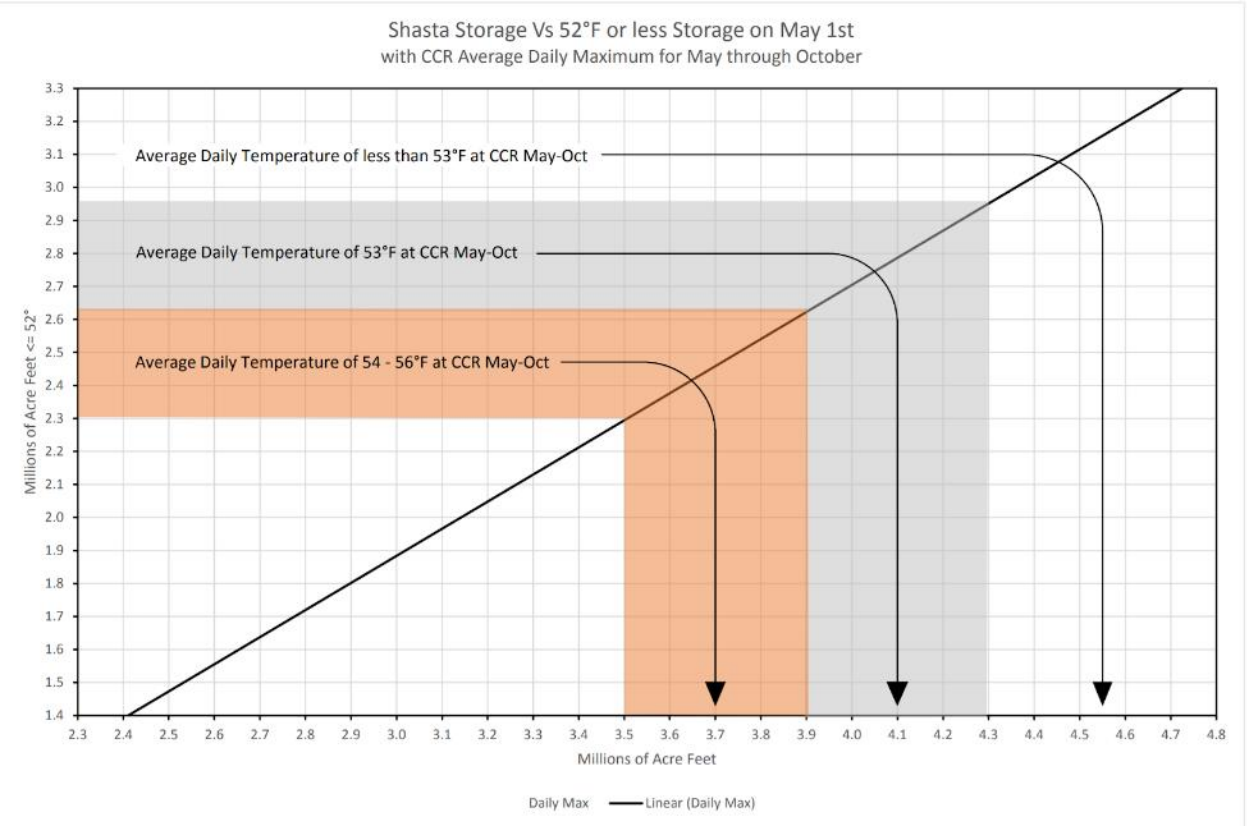
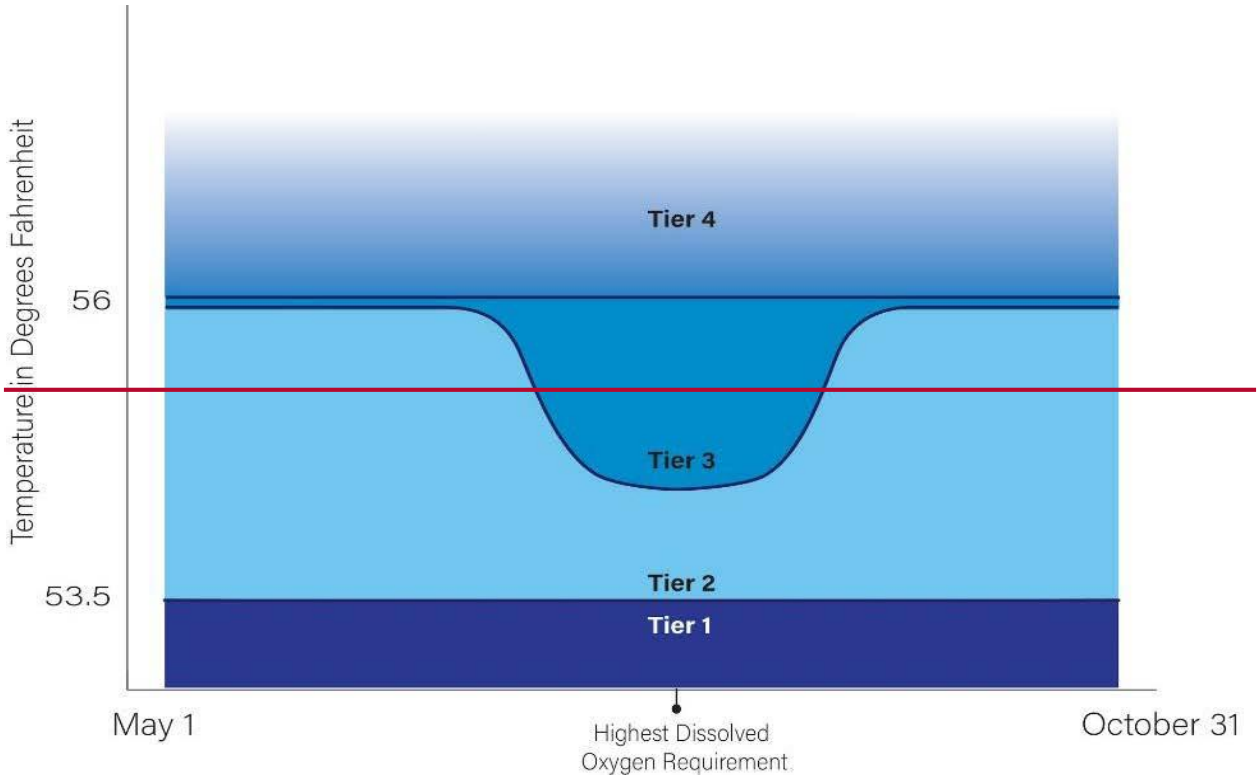


Figure 4-2. Relationship between Temperature Compliance, Total Storage in Shasta Reservoir, and Cold Water Pool in Shasta Reservoir

~~4.9.1.3.1~~4.10.1.3.1 Summer Cold Water Pool Management

Reclamation proposes to operate the TCD at Shasta Dam to continue providing temperature management in accordance with CVPIA 3406(b)(6) while minimizing impacts on power generation. Cold water pool is defined as the volume of water in Shasta Reservoir that is less than 52°F, which Reclamation would determine based on monthly (or more frequent) reservoir temperature profiles. The Sacramento River above Clear Creek (CCR) gage is a surrogate for the downstream extent of most Winter-Run Chinook Salmon redds. Temperature management would start after May 15, or when the monitoring working group determines, based on real-time information, that Winter-Run Chinook Salmon have spawned, whichever is later. Temperature management would end October 31, or when the monitoring working group determines based on real-time monitoring that 95 percent of Winter-Run Chinook Salmon eggs have hatched, and aelvin have emerged, whichever is earlier.

Reclamation proposes to address cold water management utilizing a tiered strategy that allows for strategically selected temperature objectives, based on projected total storage and cold water pool, meteorology, Delta conditions, and habitat suitability for incoming fish population size and location. The tiered strategy recognizes that cold water is a scarce resource that can be managed to achieve desired water temperatures for fisheries objectives. Figure 4-3 below shows examples of water temperatures at CCR under the four tiers. The proposed tiers are described below, along with storage levels that are likely to provide for cold water management within the tier. Actual operations will depend upon the available cold water and modeling. In any given year, cold water pool and storage could result in Reclamation switching between tiers within the year if needed to optimally use the cold water pool.



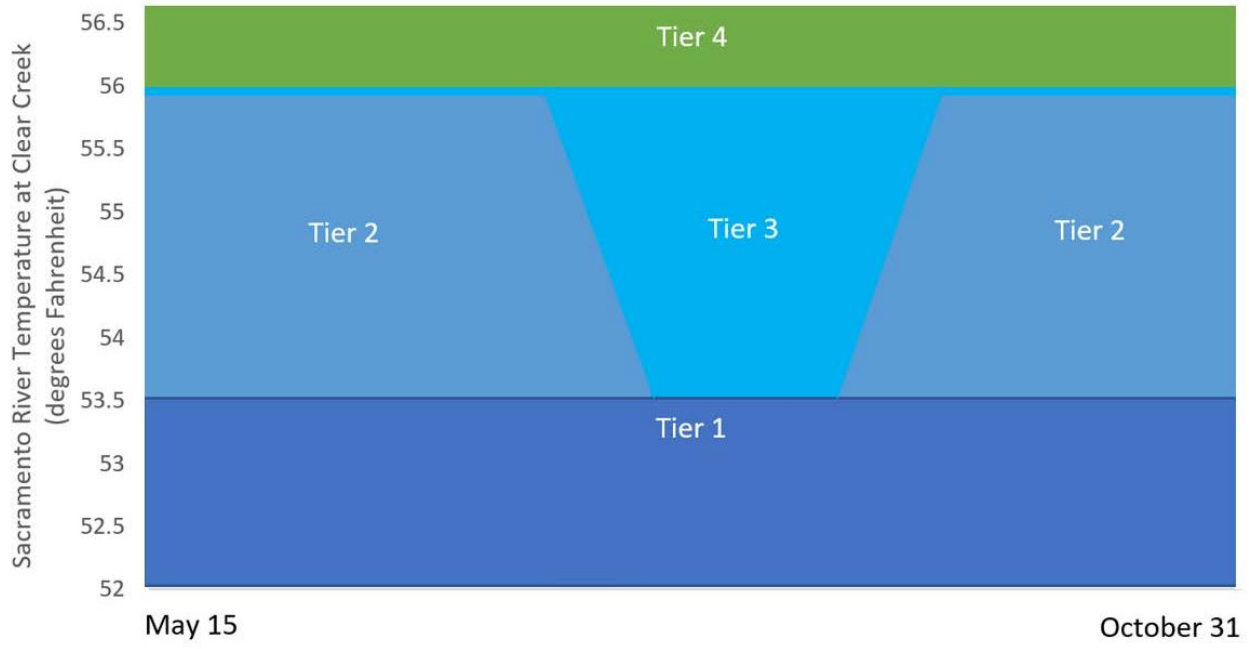


Figure 4-3. Tiered Temperature Management Strategy

- Tier 1. In years when Reclamation determines that cold water pool is sufficient (e.g., more than 2.8 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that a daily average temperature of 53.5°F at CCR can be maintained from May 15 to October 31), Reclamation proposes to operate to a daily average temperature of 53.5°F at the CCR gaging station to minimize temperature dependent mortality.
- Tier 2. In years when cold water pool is insufficient to allow Tier 1 (e.g., less than 2.8 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that the 53.5°F at CCR cannot be maintained from May 15 to October 31), Reclamation would optimize use of cold water for Winter-Run Chinook Salmon eggs based on life-stage-specific requirements, reducing the duration of time of operating to 53.5°F target temperatures. Water temperatures at CCR would vary based on real-time monitoring of redd timing and lifestage-specific temperature dependent mortality models, for example, Anderson (2017). The time period of 53.5°F at CCR would be centered ~~around~~on the projected time period when the Winter-Run eggs have the highest dissolved oxygen requirement (37–67 days post fertilization). At 2.79 MAF of cold water pool, Reclamation would operate to 53.5°F from 37 days after the first observed redd to 67 days after the last observed redd, as long as this is earlier than October 31. The duration of the 53.5°F protection will decrease in proportion to the available cold water pool on May 1. Reclamation will determine this time period by running different temperature scenarios through the latest egg mortality model(s) and real-time monitoring of redds. Reclamation would operate to daily average temperatures at CCR during the temperature management season outside of the stage-specific critical window no warmer than 56°F.
- Tier 3. When Reclamation determines that life-stage-specific temperature targets cannot be met per (2) above (e.g., less than 2.3 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that maintaining 53.5°F at CCR would have higher mortality than a warmer temperature), Reclamation proposes to use cold water pool releases to maximize Winter-Run Chinook Salmon redd survival by increasing the coldest water temperature target (see Figure 4-4 below). At the highest storage levels in Tier 3, the targeted temperature at CCR will be daily

average 53.5°F and as storage decreases would warm in the life-stage-specific critical period up to 56°F. Reclamation would increase the temperature while minimizing adverse effects to the greatest extent possible, as determined by the latest egg mortality models, real-time monitoring, and expected and current water availability. This tier would be in effect until Reclamation could no longer meet 56°F at CCR at which point Reclamation would shift to tier 4.

- Tier 4. If there is less than 2.5 MAF of total storage (note the use of "total" storage as opposed to the "cold water pool" used in the previous criteria) in Shasta Reservoir at the beginning of May, or if Reclamation cannot meet 56°F at CCR, Reclamation will attempt to operate to a less than optimal temperature target and period that is determined in real-time with technical assistance from NMFS and USFWS. Reclamation will explore improved coordination of downstream diversions, and the potential for demand shifting. In addition, Reclamation proposes to implement intervention measures (e.g., increasing hatchery intake and trap and haul, as described below).

At the March forecast (mid-March), if the forecasted Shasta Reservoir total storage is projected to be below 2.5 MAF at the end of May, Reclamation would initiate discussions with USFWS and NMFS on potential intervention measures should this low storage condition continue into April and May, as described in Tier 4. Reclamation proposes to perform the first temperature model run in April after the DWR Bulletin 120 has been received and the operations forecast completed. This is the first month that a temperature model run is feasible based on temperature profiles. Prior to April, there is insufficient stratification in Shasta Reservoir to allow a temperature model to provide meaningful results. The April temperature model scenario is used to develop an initial temperature plan for submittal to the SWRCB. This temperature plan may be updated as Reclamation has improved data on reservoir storage and cold water pool via the reservoir profiles at the end of May, and throughout the temperature control season. Figure 4-4 provides a decision tree explaining the decision points for Shasta Reservoir temperature management.

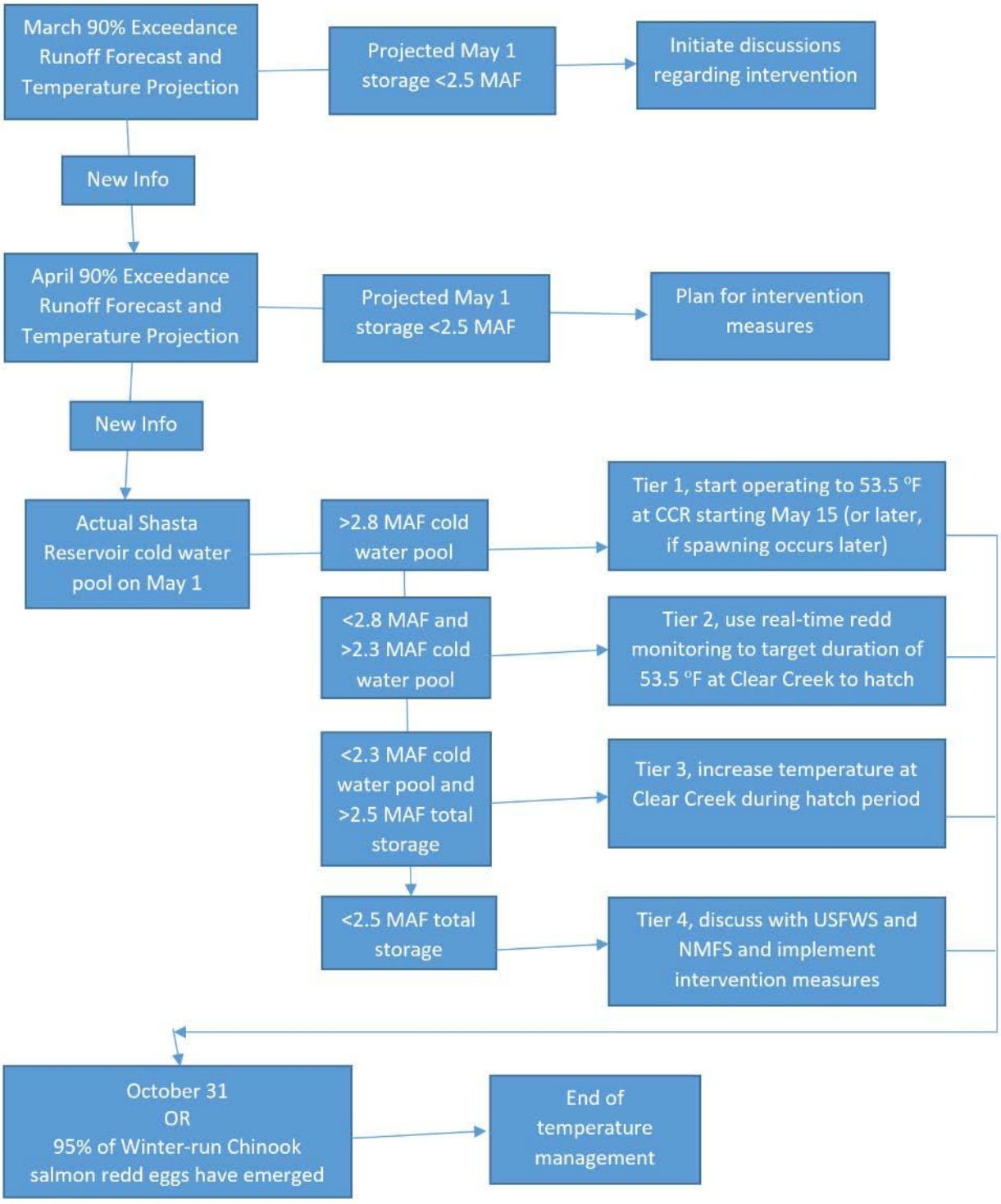


Figure 4-4. Decision Tree for Shasta Reservoir Temperature Management

Reclamation intends to provide temperature profile measurements for Shasta, Whiskeytown, and Trinity Reservoirs as shown in Table 4-8.

Table 4-8. Temperature Profile Measurements for Shasta, Whiskeytown, and Trinity Reservoirs

Reservoir	Every Month	Every 2 Weeks	Every Week	Comment
Shasta	01/01–03/01 12/1–12/31	03/01–05/01 11/15–12/01	05/01–11/15	25 ft intervals for "Every Month," otherwise 5 ft intervals
Whiskeytown	01/01–12/31			25 ft intervals
Trinity	01/01–12/31			25 ft intervals

Reclamation proposes to provide a draft temperature management plan to the SRTTG in April for its review and comment, consistent with WRO 90-5. Reclamation's proposed April temperature management plan will describe which of the four tiers Reclamation forecasts for that year's summer temperature management season, along with a temperature modeling scenario and the operations forecast. The SWRCB has overall authority to determine if the plan is sufficient to meet water right permit requirements.

~~4.9.1.4~~4.10.1.4 *Fall and Winter Refill and Redd Maintenance*

Reclamation proposes to rebuild storage and cold water pool for the subsequent year. Maintaining releases to keep late spawning Winter-Run Chinook Salmon redds underwater may drawdown storage necessary for temperature management in a subsequent year. Reclamation will minimize effects with a risk analysis of the remaining Winter-Run Chinook Salmon redds, the probability of sufficient cold water in a subsequent year, and a conservative distribution and timing of subsequent Winter-Run Chinook Salmon redds. ~~If~~If the combined productivity of the remaining redds plus a conservative scenario for the following year is less than the productivity of maintaining ~~flows puts the subsequent year class at a 10 percent or less risk~~releases, Reclamation will reduce releases to rebuild storage.

~~Demands by the National Wildlife Refuges, upstream CVP contractors, and the Sacramento River Settlement Contractors in October result in Keswick Dam releases that are generally not maintained throughout the winter due to needs to store water for beneficial uses~~ The conservative scenario for the following year~~. These releases result in some early fall Chinook redds being dewatered at winter base flows. Targets~~ would include a 75% (dry) hydrology; 75% (warm) climate; a median distribution for the timing of redds, and the ability to remain within Tier 3 or higher (colder) tiers.

If, based on the above analysis, Reclamation determines reduced releases are needed to rebuild storage, targets for winter base flows (December 1 through the end of February) from Keswick would be set in October ~~and would be~~ based on ~~the previous months'~~ Shasta Reservoir end-of-September storage. These targets would be set based on end-of-September storage and the current hydrology~~.~~ after accounting for winter-run red stranding. Base flows would be set based on historic performance to accomplish improved refill capabilities for Shasta Reservoir to build cold water pool for the following year. Table 4-9 shows examples of possible Keswick Releases based on Shasta Reservoir storage condition; these would be refined through future modeling efforts as part of the seasonal operations planning.

Table 4-9. Keswick Dam Release Schedule for End-of-September Storage

Keswick Release (cfs)	Shasta End-of-September Storage
3,250	≤ 2.2 MAF
4,000	≤ 2.8 MAF
4,500	≤ 3.2
5,000	> 3.2 MAF

~~4.9.1.5~~4.10.1.5 *Operations of Shasta Dam Raise*

Reclamation proposes to enlarge Shasta Dam and Reservoir by raising the dam crest 18.5 feet under a separate ESA consultation for construction. The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for salmonids during drought years and increase water supply reliability. Reclamation would operate a raised Shasta Dam consistent with the operations described in this proposed action.

~~Reclamation would operate a raised Shasta Dam consistent with scenario CP4A in the 2015 Shasta Lake Water Resources Investigation Feasibility Report, for CVP operation only. CP4A focuses on increasing anadromous fish survival, while also increasing water supply reliability. An 18.5-foot raise would increase storage by approximately 634 TAF. Operation under scenario CP4A would include a dedicated cold water storage of 191 TAF. Operations for the remaining portion of increased storage (approximately 443 TAF) would be 120 TAF reserved in dry years and 60 TAF reserved in critical years to focus on CVP deliveries. Reclamation conducted modeling for CP4A that looked at CVP only, as shown in Table 4-10 below.~~

~~**Table 4-10. Increases in Deliveries (average all years)**~~

	~~CP4A (acre-feet) CVP and SWP~~	~~CP4A CVP Only (acre-feet) (approximate)~~
~~Agriculture~~	~~31,700~~	~~65,500~~
~~M&I~~	~~19,900~~	~~4,700~~

~~4.9.1.6~~4.10.1.6 *Conservation Measures*

Conservation measures are included to avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include actions that benefit listed species without impacting water supply or other beneficial uses.

- ~~Water Operations~~

- ~~Rice Decomposition Smoothing: Demands by the National Wildlife Refuges, upstream CVP contractors, and the Sacramento River Settlement Contractors in October result in Keswick Dam releases that are generally not maintained throughout the winter due to needs to store water for beneficial uses the following year. These releases result in some early Fall-Run Chinook Salmon redds being dewatered at winter base flows.~~Rice Decomposition Smoothing: Following the emergence of Winter-Run Chinook Salmon and prior to the majority of Fall-Run Chinook Salmon spawning, upstream Sacramento Valley CVP contractors and the Sacramento River Settlement Contractors propose to work to synchronize their diversions to lower peak rice decomposition demand. With lower late October and early November flows, Fall-Run Chinook Salmon are less likely to spawn in shallow areas that would be subject to dewatering during winter base flows. Early reductions (late October–early November) would balance the potential for dewatering late spawning Winter-Run Chinook Salmon redds and early Fall-Run Chinook Salmon dewatering.
- Spring Management of Spawning Locations: Reclamation will coordinate with NMFS ~~as part of adaptive management~~ to establish experiments to refine the state of the science and determine if keeping water colder earlier induces earlier spawning, or if keeping April/May Sacramento River temperatures warmer induces later spawning~~, to refine the state of the science~~.
- Cold Water Management Tools: Reclamation will explore additional opportunities ~~as part of adaptive management~~ to extend the cold water pool, options include~~:~~
    - *Battle Creek Restoration:* Reclamation would accelerate implementation of the Battle Creek Salmon and Steelhead Restoration Project, which is intended reestablish approximately 42 miles of prime salmon and Steelhead habitat on Battle Creek, and an additional 6 miles on its tributaries. Winter-Run Chinook Salmon are currently limited to a single population that spawns in a 5-mile stretch of the Sacramento River, but they are being reintroduced to Battle Creek (around 200,000 juveniles were released in Battle Creek in 2018), and this new population would benefit from the restoration efforts. ~~An additional population of Winter-Run Chinook Salmon on Battle Creek would provide temperature compliance flexibility.~~
    - *Lower Intakes near Wilkins Slough:* Due to temperature requirements, Sacramento River flows at or near Wilkins Slough can drop below the 5,000 cfs minimum navigational flow set by Congress. As many of the fish screens at diversions in this region were designed to meet the 5,000 cfs minimum, they may not function properly at the lower flows and as a result, not meet state and federal fish screening requirements during the lower flows (NCWA 2014). This could result in take of state and federally protected species that use this section of the river. This action would provide grants to water users within this area to install new diversions and screens that would operate at lower flows, which would allow Reclamation to have greater flexibility in managing Sacramento River flows and temperatures for both water users and wildlife, including listed salmonids (NCWA 2014). The authority for this action is 3406(b)(21). One example project under this program is screening of Meridian Farms.
    - *Shasta Temperature Control Device Improvements:* ~~Depending upon~~Reclamation proposes to study the ~~type~~feasibility of ~~dam raise proposed, the~~ infrasture improvements to enhance TCD ~~would be either modified or replaced by Reclamation, informed by updated modeling. For relatively small raises of Shasta Dam, the existing TCD structure would be retrofitted to account for additional dam height, and to reduce~~ performance, including reducing the leakage of warm water into the structure~~, but no new structure would be needed. However, modifications to, or replacement of, the existing structure are~~

~~more likely to be necessary for increasingly higher dam raises. The authority for this action is 3406(b)(6).~~.

- ~~Habitat Restoration~~

- Spawning Habitat: Reclamation proposes to create additional spawning habitat by injecting ~~40–55~~approximately 15,000 – 40,000 tons of gravel annually into the Sacramento River ~~by~~to 2030, using the following sites: ~~Salt Creek Gravel Injection Site,~~ Keswick Dam Gravel Injection Site, ~~South Shea Levee, Shea Levee, and~~ Market Street Injection Site, Redding Riffle, Turtle Bay, Tobiasson Island ~~Side Channel.~~, Shea Levee sites, and Kapusta.

- Rearing Habitat: Reclamation ~~and~~ , in coordination with the Sacramento River Settlement Contractors ~~propose~~, proposes to create 40–60 acres of side channel and floodplain habitat at approximately 10 sites in ~~Shasta and Tehama County~~ the Sacramento River by 2030~~, including Cypress Avenue, Shea~~. The potential sites include Salt Creek, Turtle Bay Island, ~~Anderson River Park; South Sand Slough; Rancheria Island;~~Kutras Lake Rearing Structures, Painter's Riffle maintenance, North Cypress maintenance, Cypress South, North Tobiasson Rearing Structures maintenance, Tobiasson Side Channel, Shea Side Channel~~; and Turtle Bay~~, Kapusta Side Channel, Kapusta 1-A Side Channel maintenance, Kapusta 1-B Side Channel, Anderson River Park Side Channels, Cow Creek Side Channel, I-5 Side Channel, China Gardens, Rancheria Island Side Channel, Rancho Breisgau, Lake California Side Channel maintenance, Rio Vista Side Channel, East Sand Slough Side Channel, La Barranca Side Channel, Woodson Bridge Bank Rearing Improvement, Jellys Ferry, Dog Island, Altube Island, Blackberry Island, Oklahoma Avenue, Mooney Island, McClure Creek, Blethen Island, Wilsons Landing, McIntosh Island, Shaw, Larkins, Reilly Island, Hanson Island, and Broderick.

- Small Screen Program: ~~As part of adaptive management,~~ Reclamation and DWR propose to continue to work within existing authorities (e.g., Anadromous Fish Screen Program) to screen small diversions throughout Central Valley CVP/SWP streams and the Bay-Delta.

- ~~Intervention~~

- Winter-Run Chinook Salmon Conservation Hatchery Production: In a Tier 4 year, Reclamation proposes to increase production of Winter-Run Chinook Salmon. Increased production during drought could help populations continue over multiple years. Increased production would aim to offset temperature dependent mortality on the Sacramento River. Reclamation would consider New Zealand or Great Lake Winter-Run Chinook Salmon stock for augmenting conservation hatchery stock to improve heterozygosity.

- Adult Rescue: Reclamation proposes to trap and haul adult salmonids and sturgeon from Yolo and Sutter bypasses during droughts and after periods of bypass flooding, when flows from the bypasses are most likely to attract upstream migrating adults, and move them up the Sacramento River to spawning grounds. This trap and haul is in addition to weir fish passage projects that are part of the proposed action elsewhere. This would improve survival of the adults, leading to increased juvenile production in the following year and more flexibility with salvage.

- Trap and Haul: If Reclamation projects a Tier 4 year (less than 2.5 MAF of storage at the beginning of May), Reclamation proposes implementation of a downstream trap and haul strategy for the capture and transport of juvenile Chinook Salmon and Steelhead in the Sacramento River watershed in drought years when low flows and resulting high water temperatures are unsuitable for volitional downstream migration and survival. Reclamation proposes to place temporary juvenile salmon collection traps (e.g., rotary screw traps, fyke nets, floating juvenile collectors, weirs, trawls, seines), at key feasible locations, downstream of spawning areas in the Sacramento River. Reclamation would transport collected fish to a safe release location or locations in the

Delta upstream of Chipps Island~~.~~ or in the bay. Juvenile trap and haul activities would occur from December 1 through May 31, consistent with the migration period for juvenile Chinook Salmon and Steelhead (NMFS 2014~~),~~), depending on hydrologic conditions. In the event of high river flows or potential flooding, ~~the fish weirs~~trapping operations would cease and traps would be removed~~.~~ as appropriate.

~~4.9.2~~4.10.2 Trinity River Division

Congress authorized the Trinity River Division in 1955 as an integrated component of the CVP in order to increase water supplies for irrigation and other beneficial uses in the Central Valley, recognizing that water "surplus" to the present and future needs of the Trinity and Klamath Basins could be diverted to the Central Valley "without detrimental effect to the [Klamath-Trinity Basin's] fishery resources." Accordingly, Reclamation operates the Trinity River Division both to export water to the Sacramento River system and to ensure necessary flow releases into the Trinity-Klamath Basin, such as through implementation of the Department of the Interior's Trinity River Mainstem Fishery Restoration ROD (2000 ROD). Trans-basin exports transfer water from the Trinity River to the Sacramento River system through Lewiston Reservoir, Carr Tunnel, Whiskeytown Reservoir, and Spring Creek tunnel.

~~4.9.2.1~~4.10.2.1 *Seasonal Operations*

Diversion of Trinity Basin water to the Sacramento Basin (transbasin diversion) provides water supply and major hydroelectric power generation for the CVP and plays a key role in water temperature control in the Trinity River and upper Sacramento River. Transbasin diversions are managed to support water supply and temperature objectives within the Sacramento system and are regulated by the ROD and Trinity Reservoir supply. The 2000 Trinity ROD strictly limits Reclamation's transbasin diversions to 55 percent of annual inflow on a 10-year average basis to legal and trust mandates for the restoration and protection of the Trinity fishery which restrict the amount of water authorized for exportation to the Central Valley. Reducing transbasin diversions was intended to improve the cold water pool in Trinity Reservoir to improve conditions for fall spawning down the Trinity River. This limitation on transbasin diversions significantly impacts Reclamation's temperature operations on the Sacramento River and Reclamation's ability to satisfy senior water right holder and/or Settlement contractor commitments within the CVP system.

Trinity River exports are first conveyed through Carr Power Plant which flows directly into Whiskeytown Lake, a heavily used recreation facility. From Whiskeytown Lake, the exported water continues to flow into Spring Creek Power Plant and ultimately outflows into the Sacramento River below Keswick, or water is released from Whiskeytown to Clear Creek. Although Whiskeytown Lake is primarily used as conveyance system for transbasin transfers, operations at both Carr and Spring Power plants are done in a manner to maintain specified elevations for supporting recreation (based on season).

The amounts and timing of Trinity River basin exports into the Sacramento River basin are determined by subtracting Trinity River scheduled flow and targeted carryover storage from the forecasted Trinity water supply. Reclamation maintains at least 600 TAF in Trinity Reservoir, except during the 10–15 percent of water years when Shasta Reservoir is also drawn down. Reclamation proposes to address end-of-water-year carryover on a case-by-case basis in dry and critically dry water year types described in the Water Operations Governance process below.

The seasonal timing of Trinity River exports is a result of determining how to make best use of a limited volume of Trinity River export (in concert with releases from Shasta Reservoir) to help conserve cold

water pools and meet water temperature objectives on the upper Sacramento and Trinity Rivers, as well as power production economics.

These exports support better Trinity River temperatures by maintaining cold water and reducing residence time within Lewiston Reservoir. Transbasin diversions also typically help meet Sacramento River temperatures by providing additional cold water resources to the Sacramento River. As a result, Trinity River export operations are completely integrated with Shasta Dam operations.

~~4.9.2.2~~4.10.2.2 *Trinity River Record of Decision*

The 2000 ROD prescribed increase flows to meet federal statutory and other responsibilities to protect and restore the basin's fishery resources, to be released from Lewiston Dam down the Trinity River. Specifically, it entails: (1) variable annual instream flows for the Trinity River from the Trinity River Division based on forecasted hydrology for the Trinity River Basin; (2) mechanical habitat rehabilitation projects along with sediment management and watershed restoration efforts; and (3) an adaptive management program. The 2000 ROD flow release schedules vary among water-year classes and were designed to address the environmental requirements of anadromous fish and fluvial geomorphic function. The following five water year classes and associated annual water volumes for release to the Trinity River are identified as: Critically Dry (369 TAF); Dry (453 TAF); Normal (636 TAF); Wet (701 TAF); and Extremely Wet (815 TAF).

Total river release can reach up to 11,000 cfs below Lewiston Dam (flood criteria) due to local high water concerns in the floodplain and local bridge flow capacities. Flood criteria provides seasonal storage targets and recommended releases November 1 to March 31.

~~4.9.2.2.1~~4.10.2.2.1 Long-Term Plan to Protect Adult Salmon in the Lower Klamath River

In addition, in various years since 2003, and particularly since 2013, certain fishery agencies, together with the Tribal Governments, have ~~been requesting~~requested additional late-season flows in the Trinity River above the 2000 ROD baseline flows (primarily in August and September) to prevent fish illness from instream crowding and warm waters in the lower Klamath River in drier years. In some cases, these releases were made in successive dry years and therefore had cumulative effects year to year, leading to lower storage in Trinity Reservoir and water supply and temperature impacts in the Sacramento and Trinity Rivers and Clear Creek.

Reclamation released a Record of Decision for the Long Term Plan to Protect Adult Salmon in the Lower Klamath River in 2017 (2017 ROD), which identified a process and criteria for Reclamation to provide supplemental flows from mid-August to late September from Lewiston Dam to prevent an episodic disease outbreak in the lower Klamath River in years when the criteria for such flows are met. These flows include a Preventative Base Flow component of a supplemental release of up to 40 TAF from Lewiston Dam over the course of approximately 30 days, beginning on or about August 23, with the intent of meeting and/or maintaining a target of up to 2,800 cfs in the lower Klamath River; a Preventative Pulse Flow component of up to 10 TAF release over 4 days to achieve a peak of 5,000 cfs in the lower Klamath River; and an Emergency Flow component which would be up to 34 TAF from Lewiston Dam over no more than 8 days, beginning on or about September 20 to meet a target of 5,000 cfs in the lower Klamath River. The 2017 ROD cited proviso 1 of Section 2 of the 1955 Act as authority for the releases. ~~Another proviso of Section 2 states that "not less than 50,000 acre-feet shall be released annually from the Trinity Reservoir and made available to Humboldt County and downstream water users."~~

~~4.9.2.3 Grass Valley Creek Flows from Buckhorn Dam~~

~~Reclamation proposes to release water from Buckhorn Dam to Grass Valley Creek in accordance with requirements published in the Buckhorn dam and reservoir standard operating procedures manual for water rights permit 18879 issued to DWR, which establishes the timing and magnitude of minimum flows and flushing flows from the dam.~~

~~In addition, Reclamation proposes to increase flow from the dam outlet works for maintenance of the outlet channel and to cue juvenile salmonids in the reach to begin their downstream migration to the Trinity River. Reclamation proposes to release pulse flows when the reservoir water elevation exceeds 2,803.13 ft above sea level between March 1 and April 15 to the extent feasible.~~

~~Reclamation also proposes to increase flow in the outlet channel when necessary in October and November to provide adult Coho sufficient flow for upstream migration and spawning, to the extent feasible.~~

~~4.9.2.4~~4.10.2.3 *Whiskeytown Reservoir Operations*

Reclamation proposes to operate Whiskeytown Reservoir to: (1) regulate inflows for power generation and recreation; (2) support upper Sacramento River temperature objectives; and (3) provide for releases to Clear Creek, as proposed below. Two temperature curtains in Whiskeytown Reservoir were installed to pass cold water through the bottom layer of the reservoir and limit warming from Carr power plant to Clear Creek or Spring Creek Power Plant.

Whiskeytown Lake is annually drawn down by approximately 35 TAF of storage space during November through April to regulate flows for winter and spring flood management. Heavy rainfall events occasionally result in spillway discharges to Clear Creek. Operations at Whiskeytown Lake during flood conditions are complicated by its operational relationship with the Trinity River, Sacramento River, and Clear Creek. On occasion, imports of Trinity River water to Whiskeytown Reservoir may be suspended to avoid aggravating high flow conditions in the Sacramento Basin. Joint temperature control objectives also similarly interact among the Trinity River, Clear Creek, and Sacramento River.

~~4.9.2.5~~4.10.2.4 *Clear Creek Flows*

Reclamation proposes to release Clear Creek flows in accordance with the 1960 MOA with CDFW, and the April 15, 2002 SWRCB permit, which established minimum flows to be released to Clear Creek at Whiskeytown Dam. Reclamation proposes a minimum base flow in Clear Creek of 200 cfs from October through May and 150 cfs ~~year-round~~from June to September in all year types except Critical year types. In Critical years, Clear Creek base flows may be reduced below 150 cfs based on available water from Trinity Reservoir. Additional flow may be required for temperature management during the fall.

In addition, Reclamation proposes to create pulse flows for both channel maintenance and spring attraction flows. For spring attraction flows, Reclamation would release 10 TAF (measured at the release), with daily release up to the safe release capacity (approximately 900 cfs, depending on reservoir elevation and downstream capacity), in all year-types except for Critical year-types to be shaped by the Clear Creek Implementation Team in coordination with CVO. For channel maintenance flows, Reclamation would release 10 TAF from Whiskeytown, with a daily release up to the safe release capacity, in all year-types except for Dry and Critical year-types (based on the Sacramento Valley index) to be shaped by the Clear Creek Implementation Team in coordination with CVO. Pulses would be scheduled with CVO. No channel maintenance flows would be scheduled before January 1. For each

storm event that results in a Whiskeytown Gloryhole spill of at least 3,000 cfs for 3 days, Reclamation will reduce the channel maintenance flow volume for this year or the following year by 5,000 acre-feet. If two Gloryhole spills occur that meet this criterion in a year, additional channel maintenance flows would not be released in that year. In Critical years, Reclamation would release one spring attraction flow of up to the safe release capacity (approximately 900 cfs) for up to 3 days and would not release any channel maintenance flows. Reclamation could instead, or in addition, use mechanical methods to mobilize gravel or shape the channel if needed to meet biological objectives ~~as part of adaptive management~~.

The outlet from Whiskeytown Reservoir to Clear Creek is equipped with outlets at two different elevations. Releases can be made from either or both outlets to manage downstream temperature releases. Reclamation proposes to manage Whiskeytown releases to meet a daily average water temperature of: (1) 60°F at the IGO gage from June 1 through September 15; and (2) 56°F or less at the IGO gage from September 15 to October 31. Reclamation may not be able to meet these temperatures in Critical or Dry water year types. In these years, Reclamation will operate to as close to these temperatures to the extent possible.

~~4.9.2.6~~4.10.2.5 *Spring Creek Debris Dam*

The Spring Creek Debris Dam (SCDD) was constructed to regulate runoff containing debris and acid mine drainage from Spring Creek, a tributary to the Sacramento River that enters Keswick Reservoir. The SCDD can store approximately 5,800 acre-feet of water. Operation of SCDD and Shasta Dam has allowed some control of the toxic wastes with dilution criteria. In January 1980, Reclamation, CDFW, and SWRCB executed an MOU to implement actions that protect the Sacramento River system from heavy metal pollution from Spring Creek and adjacent watersheds. In the operational situation when heavy rainfall events will fill SCDD and Shasta Reservoir will not reach flood control conditions, increased releases from CVP storage may be required to maintain desired dilution ratios for metal concentrations. Since water released for dilution of toxic spills is likely to be in excess of other CVP requirements, such releases increase the risk of a loss of water for other beneficial purposes.

~~4.9.2.7~~4.10.2.6 *Clear Creek Restoration Program*

Reclamation and DWR propose to continue channel maintenance under the Clear Creek Restoration Program.

~~4.9.3~~4.10.3 Feather River

DWR will operate Oroville Dam consistent with the NMFS, USFWS, and CDFW environmental requirements applicable for the current FERC License for the Oroville Complex (FERC Project #2100-134). The downstream boundary of FERC's Oroville Project area is the Feather River above the city of Gridley. During the summer, DWR typically releases water from Lake Oroville to meet the requirements of instream flows and D-1641. Additional releases are made for local deliveries and exports at Banks Pumping Plant. DWR balances the cumulative storage between Lake Oroville and San Luis Reservoirs so as to meet its flood control requirements, Sacramento–San Joaquin Delta requirements, and deliver water supplies to its contracted water agencies consistent with all environmental constraints. Lake Oroville may be operated to convey water through the Delta to San Luis Reservoir via Banks under different schedules depending on Delta conditions, reservoir storage volumes, storage targets and regulatory requirements. Decisions as to when to move water from Lake Oroville to San Luis Reservoir are based on many real-time factors.

~~4.9.4~~4.10.4 American River Division

Reclamation operates the CVP American River Division for flood control, M&I and agricultural water supplies, hydroelectric power generation, fish and wildlife protection, recreation, and Delta water quality. Facilities include the Folsom Dam, reservoir (977 TAF capacity), power plant, urban water supply temperature control device, and the Joint Federal Project auxiliary spillway as well as the Nimbus Dam, Lake Natoma, Nimbus Power Plant, and Folsom South Canal.

Folsom Reservoir is the main storage and flood control reservoir on the American River. Numerous other smaller reservoirs in the upper basin provide hydroelectric generation and water supply without specific flood control responsibilities. The total upstream reservoir storage above Folsom Reservoir is approximately 820 TAF and these reservoirs are operated primarily for hydropower production. Ninety percent of this upstream storage is contained by five reservoirs: French Meadows (136 TAF); Hell Hole (208 TAF); Loon Lake (76 TAF); Union Valley (271 TAF); and Ice House (46 TAF). Reclamation coordinates with the operators of these reservoirs to aid in planning for Folsom Reservoir operations. Releases from Folsom Dam are re-regulated approximately 7 miles downstream by Nimbus Dam. Nimbus Dam creates Lake Natoma, which serves as a forebay for diversions to the Folsom South Canal. Releases from Nimbus Dam to the American River pass through the Nimbus Power Plant, or the spillway gates at flows in excess of 5,000 cfs. Because Folsom Reservoir is the closest reservoir to the Delta, releases from Folsom can more quickly address Delta water quality requirements under D-1641.

Reclamation proposes to meet water rights, contracts and agreements that are both specific to the American River Division as well as those that apply to the entire CVP, including the Delta Division. For lower American River flows (below Nimbus Dam), Reclamation proposes to adopt the minimum flow schedule and approach proposed by the Water Forum in 2017~~.~~ in the document titled "Lower American River – Standards for Minimum Flows" dated December 2018. Flows range from 500 to 2000 cfs based on time of year and annual hydrology. The flow schedule is intended to improve cold water pool and habitat conditions for Steelhead and Fall-Run Chinook Salmon. Specific flows are determined using an index intended to define the current and recent hydrology. Although Reclamation has assumed the index proposed by the Water Forum in 2017 for the purposes of modeling and analysis within this biological assessment, Reclamation intends to continue discussions with the Water Forum to ensure the index used for implementation is appropriate to meet the intended objectives under continuously changing hydrology.

Reclamation proposes to work together with the American River ~~Stakeholders~~water agencies to define an appropriate amount of storage in Folsom Reservoir that represents the lower bound for typical forecasting processes at the end of calendar year (the "planning minimum"). ~~The objective of the planning minimum is to preserve storage to protect against future drought conditions and to facilitate the development of the cold water pool when possible.~~The planning minimum brings Reclamation's forecasting process together with potential local actions that either increase Folsom storage or reduce demand out of Folsom Reservoir. The implementation of a planning minimum allows Reclamation to work with the American River Group to identify conditions when local water actions may be necessary to ensure storage is adequate for diversion from the municipal water intake at Folsom Dam and/or the extreme hydrology presents a risk that needs to be properly communicated to the public and surrounding communities. This planning minimum will be a single value (or potentially a series of values for different hydrologic year types) to be used for each year's forecasting process into the future. The objective of incorporating the planning minimum into the forecasting process is to provide releases of salmonid-suitable temperatures to the lower American River and reliable deliveries (using the existing water supply intakes and conveyance systems) to American River water agencies that are dependent on deliveries or releases from Folsom

Reservoir. This planning minimum is expected to be initially defined in 2019; however, it will be continuously evaluated between Reclamation and the Water Forum throughout implementation.

Reclamation expects infrequent scenarios where the forecasted storage may fall below the ~~"~~planning minimum~~"~~ due to a variety of circumstances and causes. In those instances, Reclamation and the American River ~~stakeholders~~water agencies will develop a list of potential off-ramp actions that may be taken to either improve forecasted storage or decrease demand on Folsom Reservoir. In its forecasting process for guiding seasonal operations, Reclamation will plan to maintain or exceed the planning minimum at the end of the calendar year. Reclamation has no legal liability should it fall below the planning minimum. When Reclamation estimates, using the forecasting process, that it would not be able to maintain Folsom Reservoir storage at or above the ~~end-of-December "~~planning minimum~~"~~ for that year type (such as in extreme hydrologic conditions~~))~~), or unexpected events cause the storage level to be at risk, American River ~~Division contractors~~water agencies would coordinate with Reclamation to identify and implement appropriate actions to improve forecasted storage conditions, and the American River ~~stakeholders~~water agencies would work together to educate the public on the actions that have been agreed upon and implemented and the reasons and basis for them. If potential changes to Folsom Dam operations would have impacts on other aspects of the CVP and SWP or the entire integrated system, Reclamation will meet and discuss these potential changes and impacts with water contractors. Reclamation would ramp down to the revised minimum flows from Folsom Reservoir as soon as possible in the fall and maintain these flows, where possible.

~~4.9.4.1~~4.10.4.1 *Seasonal Operations*

In the winter and spring, flood control releases typically dominate the flow regime in the American River Division. Flood control operations occur to safely pass large storm events without exceeding the identified downstream levee capacity. This includes making dry-weather releases to ensure that the maximum storage adheres to the flood control elevation identified in the applicable Water Control Manual. Reclamation proposes to not reduce flows more than 500 cfs/day and not more than 100 cfs per hour except if necessary for flood control operations. Reclamation will minimize releases above 4,000 cfs during sensitive life stages (e.g, eggs, incubation, rearing) of salmonids and Steelhead to the extent feasible.

As part of implementing the 2017 Flow Management Standard, Reclamation proposes redd dewatering protective adjustments to limit potential redd dewatering due to reductions in the minimum release during the January through May period. Redd dewatering protective adjustments should limit the amount of dewatering due to a reduction of the minimum release, not the actual river release, and, as such, would not always minimize dewatering impacts to the same extent. In January and February, there is a Chinook Salmon redd dewatering protective adjustment, and in February through May there is a Steelhead redd dewatering protective adjustment.

During non-flood control operations within the fall and winter months, Reclamation proposes to operate to build storage by making minimum releases and capturing inflows, although drier conditions may also require releases for Delta requirements. To the extent possible, releases will be held relatively consistent to minimize potential redd dewatering.

Spring releases will be controlled by flood control requirements or, in drier hydrology, Delta requirements and water supply. Reclamation proposes to operate Folsom Dam in a manner designed to maximize capture of the spring runoff to fill as close to full as possible. To the extent practicable, Reclamation proposes to accommodate requests for spring pulse flows by re-shaping previously planned releases; however, these requests will not be accommodated in times when they may compromise temperature

operations later in the year. Reclamation proposes to follow the 2017 Flow Management Standard, which includes a pulse flow event at some time during the period extending from March 15 to April 15 by supplementing normal operational releases from Folsom Dam under certain conditions when no such flow event has occurred between the preceding February 1 and March 1 timeframe. This spring pulse flow provides a juvenile salmonid emigration cue before relatively low flow conditions and associated unsuitable thermal conditions later in the spring, and downstream in the lower Sacramento River.

Reclamation proposes to continue to make summer releases for instream temperature control, Delta outflow, and exports, typically above the planning minimum flows. By late October, it is typical for Folsom Reservoir to have depleted the cold water pool. The primary way to provide additional instream cooling is to release water from the lower outlet works. This operation bypasses the power penstocks and has a significant impact on power generation. In order to optimize power generation, Reclamation proposes to limit power bypass operations solely to respond to emergency or unexpected events or during extreme drought years when a drought emergency has been declared by the Governor of California.

~~4.9.4.2~~4.10.4.2 *Temperature Management*

Reclamation proposes to prepare a draft Temperature Management Plan by May 15 for the summer through fall temperature management season using the best available (as determined by Reclamation) decision support tools. The information provided by the Operations Forecast will be used in the development of the Temperature Plan. The draft plan will contain: (1) forecasts of hydrology and storage; and (2) a modeling run or runs, using these forecasts, demonstrating what temperature compliance schedule can be attained. Reclamation will use an iterative approach, varying shutter configurations, with the objective to attain the best possible temperature schedule for the compliance point at Watt Avenue Bridge. The draft plan will be shared with the American River Group ~~(ARG)~~ before finalization, and may be updated monthly based on system conditions.

Reclamation proposes to manage the Folsom/Nimbus Dam complex and the water temperature control shutters at Folsom Dam to maintain a daily average water temperature of 65°F (or other temperature as determined by the temperature modeling) or lower at Watt Avenue Bridge from May 15 through October 31, to provide suitable conditions for juvenile Steelhead rearing in the lower American River. If the temperature is exceeded for 3 consecutive days, Reclamation will notify NMFS and outline steps being taken to bring the water temperature back into compliance. During the May 15 to October 31 period, if the Temperature Plan defined temperature requirement cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at Watt Avenue may be increased incrementally (i.e., no more than 1°F every 12 hours) to as high as 68°F. The priority for use of the lowest water temperature control shutters at Folsom Dam shall be to achieve the water temperature requirement for listed species (i.e., Steelhead), and thereafter may also be used to provide cold water for Fall-Run Chinook Salmon spawning.

~~4.9.4.3~~4.10.4.3 *Conservation Measures*

Conservation measures are included to avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include non-flow actions that benefit listed species without impacting water supply or other beneficial uses.

- Spawning and Rearing Habitat Named Projects: Project activities include primarily side channel and floodplain creation, expansion, and grading, spawning gravel and large cobble additions, and woody material additions. Pursuant to CVPIA 3406(b)(13), Reclamation proposes to implement the ~~Cordova Creek Phase II and Carmichael Creek Restoration~~ following projects~~, and increase~~

~~woody material in the American River. Reclamation also proposes to conduct gravel augmentation and floodplain work at:~~: Paradise Beach, Howe ~~Ave, Howe~~ Avenue to Watt Avenue rearing habitat, William Pond Outlet, Upper River Bend, Ancil Hoffman, ~~Sacramento Bar—North,~~ El Manto, Sacramento Bar—North, Sacramento Bar—South, Lower Sunrise, Sunrise, Upper Sunrise, Lower Sailor Bar, Upper Sailor Bar, Nimbus main channel and side channel, Discovery Park, Cordova Creek Phase II, Carmichael Creek Restoration and Sunrise Stranding Reduction.

- Reclamation proposes to continue maintenance activities at Nimbus Basin, Upper Sailor Bar, Lower Sailor Bar, Upper Sunrise, Lower Sunrise and River Bend restoration sites.
- Nimbus Hatchery: Reclamation will complete a Hatchery Genetics Management Plan for Steelhead and a Hatchery Management Plan for Fall-run Chinook Salmon as part of Nimbus Fish Hatchery management. Reclamation will work with CDFW and NMFS to establish clear goals, appropriate time horizons, and reasonable cost estimates for this effort.
- Drought Temperature Management: In severe or worse droughts, Reclamation proposes to evaluate and implement alternative shutter configurations at Folsom Dam to allow temperature flexibility ~~as part of adaptive management~~.

~~4.9.5~~4.10.5 Delta

CVP and SWP facilities in the Delta provide for delivery of water supply to areas within and immediately adjacent to the Delta, and to regions south of the Delta. The major CVP features are the DCC, Contra Costa Canal and Rock Slough Intake facilities, Jones Pumping Plant, and TFCF. The main SWP Delta features are Suisun Marsh facilities, Banks Pumping Plant, CCF, Skinner Fish Facility, and Barker Slough Pumping Plant. These facilities and their operation under the proposed action are described in subsequent sections.

The CVP Jones Pumping Plant, located about 5 miles north of Tracy, has six fixed-speed pumps. It has a permitted diversion capacity of 4,600 cfs and sits at the end of an earth-lined intake channel about 2.5 miles long. The Jones Pumping Plant discharges into the head of the Delta Mendota Canal (DMC). The upper portion of the DMC is heavily impacted by subsidence which limits the maximum pumping rates to less than the permitted capacity. The SWP Banks Pumping Plant, located near the Jones Pumping Plant, has 11 variable speed pumps that allow for more control over the diversion rate. Pumping is limited to a maximum permitted capacity of 10,300 cfs per day. The Banks Pumping Plant discharges into the California Aqueduct. The Delta Mendota Canal Intertie (capacity 467 cfs from DMC to California Aqueduct; Capacity 900 cfs from California Aqueduct to DMC) is used to move water between the California Aqueduct and the Delta Mendota Canal. This structure was built to help both projects more effectively move water from the Delta into the San Luis Reservoir. This helps both projects when there are system restrictions that may prevent one party from moving water.

Banks pumps water directly from storage in CCF. The CCF radial gates are closed during critical periods of the ebb/flood tidal cycle to protect water levels experienced by local agricultural water diverters in the south Delta area. As a practical matter, Banks pumping rates are constrained operationally by limits on Clifton Court diversions from the Delta. The maximum daily diversion limit from the Delta into CCF is 13,870 acre-feet per day (6,990 cfs/day) and the maximum averaged diversion limit over any 3 days is 13,250 acre-feet per day (6,680 cfs/day). In addition to these requirements, DWR may increase diversions from the Delta into CCF by one-third of the San Joaquin River flow at Vernalis from mid-December through mid-March when flows at Vernalis exceed 1,000 cfs. These limits are listed in the USACE Public Notice 5820A Amended (Oct. 13, 1981).

During July through September, the maximum daily diversion limit from the Delta into CCF is increased from 13,870 acre-feet per day (6,990 cfs/day) to 14,860 acre-feet per day (7,490 cfs/day) and the maximum averaged diversion limit over any 3 days is increased from 13,250 acre-feet per day (6,680 cfs/day) to 14,240 acre-feet per day (7,180 cfs/day). These increases are for the purpose of recovering water supply losses incurred earlier in the same year to protect ESA-listed fish species. Those increases are a separate action permitted for short-term time periods. Further, Banks Pumping Plant will pump 195,000 acre-feet to the CVP in accordance with the 2018 COA Addendum.

The Barker Slough Pumping Plant diverts water from Barker Slough into the North Bay Aqueduct for delivery to the Solano County Water Agency (SCWA) and the Napa County Flood Control and Water Conservation District (Napa County FC&WCD) (NBA entitlement holders).

~~4.9.5.1~~4.10.5.1 *Seasonal Operations*

Winter and spring pumping operations generally maximize exports of excess, unregulated, unstored water to help meet project demands later in the seasonand for Delta water quality. In order to minimize and avoid adverse effects on listed species, actions have been taken or imposed in the past to protect fish migration and minimize fish entrainment at Jones and Banks Pumping Plants. These restrictions limit the projects' ability to export excess water in the winter and spring and place a higher reliance on exporting previously stored water in the summer and fall.

Summer is generally a period of higher export potential. During the summer the CVP and SWP typically operate to convey previously stored water across the Delta for exporting at the Project pumps or other Delta facilities. Delta concerns during the summer are typically focused on maintaining salinity and meeting outflow objectives while maximizing exports with the available water supply.

Fall Delta operations typically begin as demands decrease, accretions increase within the system, and reservoir releases are decreasing to start conserving water. Exports are typically maximized to export available water in the system and may decrease if the fall remains dry. As precipitation begins to fall within the Sacramento and San Joaquin Basins, the reservoirs focus on building storage and managing for flood control. The enactment of D-1641 required higher spring releases; as a result, reservoir storage levels were lower in the fall and Reclamation and DWR had less need for flood releases. The 2008 biological opinion included an adaptive management action requiring an increase in fall flows to manage salinity in years following wet and above-normal years. However, lower fall outflows would better mimic historical (pre-project) conditions, and analyses indicate that the CVP and SWP have had negligible effects on fall outflows measured using X2 as a proxy (Hutton et al. 2017).

~~4.9.5.2~~4.10.5.2 *Minimum Export Rates*

Water rights, contracts, and agreements specific to the Delta include D-1641, COA and other related agreements pertaining to CVP and SWP operations and Delta watershed users. In order to meet health and safety needs, critical refuge supplies, and obligations to senior water rights holders, the combined CVP and SWP export rates at Jones Pumping Plant and Banks Pumping Plant will not be required to drop below 1,500 cfs. Reclamation and DWR propose to use the Sacramento River, San Joaquin River, and Delta channels to transport water to export pumping plants located in the south Delta.

~~4.9.5.3~~4.10.5.3 *Delta Cross Channel*

The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. When DCC gates are open, water is diverted from the Sacramento River through a short excavated channel into

Snodgrass Slough and then flows through natural channels for about 50 miles to the vicinity of Banks and Jones Pumping Plants.

Reclamation operates the DCC in the open position to (1) improve the movement of water from the Sacramento River to the export facilities at the Banks and Jones Pumping Plants; (2) improve water quality in the central and southern Delta; and (3) reduce salinity intrusion rates in the western Delta. During the late fall, winter, and spring, the gates are often periodically closed to protect out-migrating salmonids from entering the interior Delta and to facilitate meeting the D-1641 Rio Vista flow objectives for fish passage. In addition, whenever flows in the Sacramento River at Sacramento reach 20,000 to 25,000 cfs (on a sustained basis), the gates are closed to reduce potential scouring and flooding that might occur in the channels on the downstream side of the gates.

Reclamation proposes to operate the DCC gates to reduce juvenile salmonid entrainment risk beyond actions described in D-1641, consistent with Delta water quality requirements in D-1641. From October 1 to November 30, if the Knights Landing Catch Index or Sacramento Catch Index are greater than three fish per day Reclamation proposes to operate in accordance with Table 4-~~11~~10 and Table 4-~~12~~11 to determine whether to close the DCC gates and for how long. From December 1 to ~~May 20~~January 31, the DCC gates will be closed, unless Reclamation determines that it can avoid D-1641 water quality exceedances by opening the DCC gates for up to 5 days for up to two events within this period. ~~If~~During a critical year following a dry or critical year, if there is a conflict between water quality and species ~~in the~~between December ~~/~~1 to January 31 period ~~due to drought~~, Reclamation and DWR propose to coordinate with USFWS and NMFS ~~through the Fish Monitoring Working Group.~~ .

From May 21 to June 15, Reclamation will close the DCC gates for 14 days during this period, consistent with D-1641. Reclamation and DWR's risk assessment will consider the Knights Landing RST, Delta juvenile fish monitoring program (Sacramento trawl, beach seines), Rio Vista flow standards, acoustic telemetered fish monitoring information as well as DSM2 modeling informed with recent hydrology, salinity, and tidal data. Reclamation will evaluate this information to determine if fish responses may be altered by DCC operations. If the risk assessment determines that survival, route entrainment, or behavior change to create a new adverse effect not considered under this proposed action, Reclamation will not open the DCC.

Table 4-~~11~~10. Delta Cross Channel October 1–November 30 Action

Date	Action Triggers	Action Responses
October 1–November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index or Sacramento Catch Index is greater than five fish per day	Within 48 hours, close the DCC gates and keep closed until the catch index is less than three fish per day at both the Knights Landing and Sacramento monitoring sites
	Water quality criteria per D-1641 are met, either Knights Landing Catch Index or the Sacramento Catch Index are greater than three fish per day but less than or equal to five fish per day	Within 48 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days
	Water quality criteria per D-1641 are met, real-time hydrodynamic and salinity modeling shows water quality concern level targets are not exceeded during	Within 48 hours of start of LMR attraction flow release, close the DCC gates for up to 5 days

Date	Action Triggers	Action Responses
	28-day period following DCC closure and there is no observed deterioration of interior Delta water quality	(dependent upon continuity of favorable water quality conditions)
	Water quality criteria per D-1641 are met, real time hydrodynamic and salinity modeling shows water quality concern level targets are exceeded during 14-day period following DCC closure	No closure of DCC gates
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria	Monitoring groups review monitoring data and provide to Reclamation. Reclamation and DWR determine what to do with a risk assessment

Table 4-~~12~~11. Water Quality Concern Level Targets

Water Quality Concern Level Targets (Water Quality Model simulated 14-day average Electrical Conductivity)	Water Quality Concern Level Targets (Water Quality Model simulated 14-day average Electrical Conductivity)
Jersey Point	1800 umhos/cm
Bethel Island	1000 umhos/cm
Holland Cut	800 umhos/cm
Bacon Island	700 umhos/cm

~~4.9.5.4~~4.10.5.4 *Agricultural Barriers*

DWR proposes to continue to install three agricultural barriers at the Old River at Tracy, Middle River, and Grant Line Canal each year when necessary. The barriers are installed between April to July and removed in November. Barriers would include at least one culvert open to allow for fish migration when water temperatures are less than 22°C. The barriers provide an adequate agricultural water supply in terms of quantity, quality, and channel water levels to meet the needs of water users in the south Delta area.

~~4.9.5.5~~4.10.5.5 *North Bay Aqueduct*

~~The proposed operation of Barker Slough Pumping Plant is a maximum 7-day average diversion rate that shall not exceed 50 cfs from January 15 through March 31 of dry and critically dry years (per the current forecast based on D-1641) if larval Delta Smelt are detected at Station 716 during the annual Smelt Larval Survey.~~The North Bay Aqueduct and Barker Slough Pumping Plant will continue to operate under applicable regulatory requirements.

~~4.9.5.6~~4.10.5.6 *Contra Costa Water District Operations*

The CCWD diverts water from the Delta for irrigation and M&I uses under its CVP contract, under its own water right permits and license issued by the SWRCB, and under East Contra Costa Irrigation District's pre-1914 water right. The CCWD water system includes the Mallard Slough, Rock Slough, Old River, and Middle River (on Victoria Canal) intakes; the Rock Slough Fish Screen (constructed in 2011 under the authority of CVPIA 3406(b)(5)); the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir. The Rock Slough Intake, Contra Costa Canal, and shortcut pipeline are owned by Reclamation, and operated and maintained by CCWD under contract with Reclamation. Mallard Slough Intake, Old River Intake, Middle River Intake, and Los Vaqueros Reservoir are owned and operated by CCWD. Operations at CCWD's intakes and Los Vaqueros Reservoir are governed by biological opinions from NMFS (NMFS 1993, 2007, 2010, 2017) and USFWS (USFWS 1993a, 1993b, 2000; 2007, 2010, 2017), an MOU with CDFW (CDFG 1994), and an incidental take permit from CDFW (CDFW 2009), which are separate from the biological opinions for the coordinated long-term operation of the CVP and SWP. Reclamation is not consulting on the biological opinions that govern CCWD's intakes and Los Vaqueros Reservoir, nor will this consultation amend or supersede those separate biological opinions. For the proposed action in this consultation, CCWD's operations are consistent with the current implementation of the operational criteria specified in those separate biological opinions.

Reclamation will work with CCWD to ensure that implementation of the proposed action will not restrict CCWD operations beyond the restrictions of the separate biological opinions, allowing CCWD to have opportunities to fill Los Vaqueros Reservoir that are at least comparable to the current conditions.

Rock Slough Intake is located on Rock Slough at the head of the Contra Costa Canal, approximately 3.5 miles west of the junction of Rock Slough and Old River. The Rock Slough Fish Screen (RSFS) was constructed in 2011 at the Rock Slough Intake for the protection of listed species, in accordance with provisions specified in the 1993 USFWS biological opinion for the Los Vaqueros Project (USFWS 1993).

The 2008 USFWS biological opinion for the coordinated long-term operation of the CVP and SWP (USFWS 2008) and the 2009 CDFW ITP for the CCWD operations (CDFG 2009) considered the effects of the diversion of water at Rock Slough intake before the RSFS was constructed. In accordance with the 2009 ITP, CCWD obtained 36 acres of aquatic species habitat mitigation credits intended to address all of CCWD's intakes, assuming that Rock Slough was unscreened. Aquatic species impacts are now less given that the RSFS has been constructed (Reclamation 2016).

USFWS 2008 quantified incidental take and exempted prohibitions associated with all CCWD diversions as all Delta Smelt inhabiting the water diverted in the assumed 195 thousand acre-~~-~~feet (TAF) maximum diversion amount (USFWS 2008, 2017). In a 2009 letter from USFWS regarding the effects of the RSFS on ~~delta smelt~~Delta Smelt and its critical habitat, USFWS acknowledges that "[s]ince the Rock Slough diversion will now be screened, less entrainment will be expected than what was described in the 2008 biological opinion and the expected incidental take remains the same."

In the proposed action, CCWD's operations are consistent with the operational criteria specified in separate biological opinions and permits that govern operations at CCWD's intakes and Los Vaqueros Reservoir (NMFS 1993, 2007, 2010, 2017; USFWS 1993a, 1993b, 2000, 2007, 2010, 2017; CDFG 1994, 2009) and remain unchanged from the current operations scenario.

Reclamation is not consulting on the NMFS 2017 biological opinion at this time and is not requesting any amendments to that biological opinion. However, the NMFS 2017 biological opinion indicates that the NMFS 2009 biological opinion on the long-term coordinated operations of the CVP and SWP, which is

the subject of this consultation, analyzed the actual diversion of water through the Rock Slough Intake (NMFS 2017: 87). Consistent with the 2008 USFWS biological opinion, Reclamation is requesting incidental take coverage for all water diverted at the Rock Slough Intake up to the maximum capacity of the intake (350 cfs) for the maximum annual diversion of 195 TAF.

~~4.9.5.7~~4.10.5.7 *Water Transfers*

Reclamation and DWR propose to transfer project and non-project water supplies through CVP and SWP facilities. Water transfers would occur through various methods, including, but not limited to, groundwater substitution, release from storage, and cropland idling, and would include individual and multi-year transfers. The effects of developing supplies for water transfers in any individual year or a multi-year transfer is evaluated outside of this proposed action. Water transfers would occur from July through November in total annual volumes up to those described in Table 4-~~13~~12.

Table 4-~~13~~12. Proposed Annual Water ~~Transfers~~Transfer Volume

Water Year Type	Maximum Transfer Amount (TAF)
Critical	Up to 600
Dry (following Critical)	Up to 600
Dry (following Dry)	Up to 600
All other years	Up to 360

As part of this proposed action, Reclamation and DWR will provide a transfer window from July 1 through November 30. Allowing fall transfers is expected to have water supply benefits and may provide flexibility to improve Sacramento River temperature operations, such as occurred during the 2014–2015 drought conditions. Real-time operations may restrict transfers within the transfer window so that Reclamation and DWR can meet other authorized project purposes, e.g., when pumping capacity is needed for CVP or SWP water.

~~4.9.5.8~~4.10.5.8 *Clifton Court Aquatic Weed Removal*

DWR will apply herbicides or will use mechanical harvesters on an as-needed basis to control aquatic weeds and algal blooms in CCF. Herbicides may include Aquathol K, Komeen®, a chelated copper herbicide (copper-ethylenediamine complex and copper sulfate pentahydrate) and Nautique®, a copper carbonate compound, or other copper-based herbicides. Algaecides may include peroxygen-based algaecides (e.g~~.~~., PAK 27). These products are used to control algal blooms that can degrade drinking water quality through tastes and odors and production of algal toxins. Dense growth of submerged aquatic weeds, predominantly Egeria densa, can cause severe head loss and pump cavitation at Banks Pumping Plant when the stems of the rooted plant break free and drift into the trashracks. This mass of uprooted and broken vegetation essentially forms a watertight plug at the trashracks and vertical louver array. The resulting blockage necessitates a reduction in the pumping rate of water to prevent potential equipment damage through cavitation at the pumps. Cavitation creates excessive wear and deterioration of the pump impeller blades. Excessive floating weed mats also reduce the efficiency of fish salvage at the Skinner Fish Facility. Ultimately, this all results in a reduction in the volume of water diverted by the SWP. In addition, dense stands of aquatic weeds provide cover for unwanted predators that prey on listed species within the CCF.

Aquatic weed and algae treatments would occur on an as-needed basis depending upon the level of vegetation biomass, the cyanotoxin concentration from the harmful algal blooms (HAB), or concentration of taste and odor compounds. The following are operational procedures to minimize impacts on listed species during aquatic herbicide treatment for application of Aquathol K and copper-based products and algaecide treatment for application of peroxide-based algaecides in CCF:

- Apply aquatic pesticides, as needed, after temperatures within CCF are above 25°C or after June 28 (as July 1 is a critical operational timeframe) and prior to the activation of Delta Smelt and salmonid protective measures following the first flush rainfall event in fall/winter.
- Apply aquatic pesticides within CCF during periods of activated Delta Smelt and salmonid protective measures if the following conditions are met:

  - The herbicide application begins after the radial gates have been closed for 24 hours or after the period of predicted Delta Smelt and salmonid survival within CCF (e.g., temperatures within CCF are above 25°C) has been exceeded, and
  - The radial gates remain closed for 24 hours after the completion of the application, or
  - The applied herbicide is PAK 27. There are no anticipated impacts on fish with the use of PAK 27 during or following treatment.
- Monitor the salvage of listed fish at the Skinner Fish Facility prior to the application of the aquatic herbicides and algaecides in CCF.
- Close the radial intake gates at the entrance to CCF prior to the application of herbicides to allow fish to move out of the proposed treatment areas and toward the salvage facility and to prevent any possibility of aquatic herbicide diffusing into the Delta.
- For Aquathol K and copper compounds, the radial gates will remain closed for 12–24 hours after treatment to allow for the recommended duration of contact time between the aquatic herbicide or algaecide and the treated vegetation or cyanobacteria in the forebay. (Contact time is dependent upon herbicide type, applied concentration, and weed assemblage). Radial gates would be reopened after a minimum of 24 hours.
- For peroxide-based algaecides, the radial gates may reopen immediately after the treatment as the required contact time is less than 1 minute and there is no residual by-product.
- Application would be made by a licensed applicator under the supervision of a California Certified Pest Control Advisor.
- Aquatic herbicides and algaecides would be applied by boat, starting at the shore and moving systematically farther offshore in its application.
- Application would be to the smallest area possible that provides relief to SWP operations or water quality.
- Monitoring of copper and endothall concentration in the water column will occur during and after application. No monitoring of copper or endothall concentrations in the sediment or detritus is proposed.
- No monitoring of peroxide (PAK 27) concentration in the water column will occur during and after application as the reaction is immediate and there is no residual. Dissolved oxygen concentration will be measured immediately following application within and adjacent to the treatment zone.
- No aerial spray applications will occur during rain or within 48 hours of forecasted precipitation.
- A spill prevention plan will be implemented in the event of an accidental spill.

Aquatic weed and algae treatments would occur on an as-needed basis. The timing of application is an avoidance measure and is based on the life history of Chinook Salmon and Steelhead in the Central Valley's Delta region and of Delta Smelt. Migrations of juvenile Winter-Run Chinook Salmon and Spring-Run Chinook Salmon primarily occur outside of the summer period in the Delta. Central Valley Steelhead have a low probability of being in the south Delta during late June when temperatures exceed 25°C through the first rainfall flush event, which can occur as late at December in some years (Grimaldo 2009). Delta Smelt are not expected to be in CCF during this time period. Delta Smelt are not likely to survive when temperatures reach a daily average of 25°C, and they are not expected to occur in the Delta prior to the first flush event. Therefore, the likelihood of herbicide exposure to Chinook Salmon, Central

Valley Steelhead, and Delta Smelt during the proposed herbicide treatment timeframe in CCF is negligible.

Additional protective measures will be implemented to prevent or minimize adverse effects from herbicide applications. As described above, applications of aquatic herbicides and algaecides will be contained within CCF. The radial intake gates to CCF will be closed prior to, during, and following the application. The radial gates will remain closed during the recommended minimum contact time based on herbicide type, application rate, and aquatic weed assemblage. Additionally, prior to aquatic herbicide applications following gate closures, the water is drawn down in the CCF via the Banks Pumping Plant. This drawdown helps facilitate the movement of fish in the CCF toward the fish diversion screens and into the fish protection facility, and it lowers the water level in the CCF to decrease the total amount of herbicide that would need to be applied, per volume of water.

~~4.9.5.9~~4.10.5.9 *Suisun Marsh Preservation Agreement*

The SMPA among DWR, Reclamation, CDFW, and Suisun Resource Conservation District (SRCD) contains provisions for DWR and Reclamation to mitigate the effects on Suisun Marsh channel water salinity from SWP and CVP operations and other upstream diversions. The SMPA requires DWR and Reclamation to meet salinity standards in accordance with D-1641, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements.

There are two primary physical mechanisms for meeting salinity standards set forth in D-1641 and the SMPA: (1) the implementation and operation of physical facilities in the Marsh; and (2) management of Delta outflow (i.e., facility operations are driven largely by salinity levels upstream of Montezuma Slough and salinity levels are highly sensitive to Delta outflow). Physical facilities (described below) have been operating since 1988 and have proven to be a highly reliable method for meeting standards.

The SMSCG are located on Montezuma Slough about 2 miles downstream from the confluence of the Sacramento and San Joaquin Rivers, near Collinsville. The objective of Suisun Marsh Salinity Control Gate operation is to decrease the salinity of the water in Montezuma Slough. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west through Suisun Marsh.

The SMSCG are operated during the salinity control season, which spans from October to May. Operational frequency is affected by hydrologic conditions, weather, Delta outflow, tide, fishery considerations, and other factors. The boat lock portion of the gate is now held open at all times during SMSCG operation to allow for continuous salmon passage opportunity. However, the boat lock gates may be closed temporarily to stabilize flows to facilitate safe passage of watercraft through the facility. Assuming no significant long-term changes in the drivers mentioned above, it is expected that gate operations will remain at current levels (17–69 days per year) except perhaps during the most critical hydrologic conditions.

The Roaring River Distribution System (RRDS) was constructed to provide lower salinity water to 5,000 acres of private and 3,000 acres of CDFW managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands. The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Water is diverted through a bank of eight 60-inch-diameter culverts equipped with fish screens into the Roaring River intake pond on high tides to raise the water surface elevation in RRDS above the adjacent managed wetlands. The intake to the RRDS is screened to prevent entrainment of fish

larger than approximately 25 mm. After the listing of Delta Smelt, RRDS diversion rates have been controlled to maintain an average approach velocity below 0.7 ft/second at the intake fish screen.

The Morrow Island Distribution System (MIDS) allows Reclamation and DWR to provide water to the ownerships so that lands may be managed according to approved local management plans. The system was constructed primarily to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough. The MIDS is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor.

~~4.9.5.10~~4.10.5.10 *OMR Management*

Reclamation and DWR propose to operate the CVP and SWP in a manner that maximizes exports while minimizing entrainment of fish and protecting critical habitat. Net flow OMR provides a surrogate indicator for how export pumping at Banks and Jones Pumping Plants influence hydrodynamics in the south Delta. The management of OMR, in combination with other environmental variables, can minimize or avoid the entrainment of fish in the south Delta and at CVP and SWP salvage facilities. Reclamation and DWR propose to maximize exports by incorporating real-time monitoring of fish distribution, turbidity, temperature, hydrodynamic models, and entrainment models into the decision support for the management of OMR to focus protections for fish when necessary and provide flexibility where possible, consistent with the WIIN Act Sections 4002 and 4003, as described below. Estimates of species distribution will be described by multi-agency Delta-focused technical teams. Reclamation and DWR will make a change to exports within 3 days of the trigger when monitoring, modeling, and criteria indicate protection for fish is necessary.

- Reclamation and DWR propose to operate to an OMR index computed using an equation. An OMR index allows for short-term operational planning and real-time adjustments.

~~OMR Management:~~ From the onset of OMR management to the end, Reclamation and DWR will operate to an OMR index no more negative than a 14-day moving average of -5,000 cfs unless a storm event occurs (~~see~~described below ~~for storm-related OMR flexibility~~). Grimaldo et al. (2017) indicate that -5,000 cfs is an inflection point in OMR for fish entrainment. OMR could be more positive than -~~5000~~5,000 cfs if additional real-time OMR restrictions are triggered as described below.

4.10.5.10.1 Onset of OMR Management~~:~~

Reclamation and DWR shall start OMR management when one or more of the following conditions have occurred:

- Integrated Early Winter Pulse Protection (“First Flush” Turbidity Event): The population-scale migration of ~~delta smelt~~Delta Smelt is believed to occur quickly in response to inflowing freshwater and turbidity (Grimaldo et al. 2009; Sommer et al. 2011). Thereafter, best available scientific information suggests that fish make local movements, but there is no evidence for further population-scale migration (Polanksy et al. 2018). As it relates to ~~delta smelt~~Delta Smelt, the Integrated Early Winter Pulse Protection action is intended to minimize ~~Project~~project influence on migration (or dispersal) that occurs coincident with “First Flush” conditions in the Delta. When the running 3-day average of the daily flows at Freeport is greater than 25,000 cfs and the running 3-day average of the daily turbidity at Freeport is 50 NTU or greater for the period from December 1 through January 31, Reclamation and DWR propose to reduce exports for 14 consecutive days so that the 14-day averaged OMR index for the period shall not be more negative than -3,500 cfs. This “First Flush” action may

only be initiated once during the December through January period to limit the CVP/SWP influence on ~~delta smelt's~~Delta Smelt population-scale migration/dispersal. The action will not be required if: 1) the Freeport flow and turbidity conditions are met after January 31, or 2) water temperature reaches 12 degrees Celsius based on a three station daily mean at Honker Bay, Antioch, and Rio Vista, or 3) when ripe or spent ~~delta smelt~~Delta Smelt are collected in a monitoring survey.

- Salmonids: After January 1, if more than 5 percent of any one or more salmonid species (wild young-of-year Winter-Run, wild young-of-year Spring-Run, or wild Central Valley Steelhead) are estimated to be present in the Delta as determined by their appropriate monitoring working group based on available real-time data, historical information, and modeling.

4.10.5.10.2 Additional Real-Time OMR Restrictions~~:~~

Reclamation and DWR shall manage to a more positive OMR than -5,000 cfs based on the following conditions~~:~~.

- Turbidity Bridge Avoidance ("South Delta Turbidity"): In years when a "First Flush" occurs, once ~~delta smelt~~Delta Smelt have dispersed, there is not evidence that large, population-scale movements continue. The turbidity avoidance action described below reflects current understanding about how to protect ~~delta smelt~~Delta Smelt from damaging levels of entrainment after a Flush Flush and in years when a First Flush does not occur. The proposed additional OMR Management is meant to supplement the protection provided to pre-spawning adult Delta ~~smelt~~Smelt that have migrated up the San Joaquin River shipping channel. This action begins after the completion of the Integrated Early Winter Pulse Protection (above) or February 1, whichever comes first. The purpose of this action is to avoid the formation of a continuous turbidity bridge from the San Joaquin River shipping channel to the fish facilities, which historically has been associated with elevated salvage of ~~delta smelt~~Delta Smelt. Reclamation and DWR propose to manage exports in order to maintain daily average turbidity in Old River at Bacon Island (OBI) at a level of less than 12 NTU. If turbidity does not exceed 12 NTU at OBI, then there will be no explicit limit on OMR flow for the purposes of protecting ~~delta smelt~~Delta Smelt. If daily average turbidity at OBI cannot be maintained less than 12 NTU, the 3-day averaged OMR index shall not be more negative than -5000 cfs, until the 3-day average turbidity at OBI drops below 12 NTU. The OBI site shall be redundantly telemetered to avoid data gaps. The action is to be taken from February 1-March 31 even if the Integrated Early Winter Pulse Protection action has not occurred earlier in the water year. The action will no longer be required on or after April 1.
- Larval and Juvenile Delta Smelt: When Q-West is negative and larval or juvenile ~~smelt~~Delta Smelt are within the entrainment zone of the pumps based on real-time sampling, Reclamation and/or DWR propose to run hydrodynamic models informed by the EDSM, 20 mm or other relevant survey data to estimate the percentage of larval and juvenile ~~smelt~~Delta Smelt that could be entrained, and operate to avoid no greater than 10 percent loss of modeled larval and juvenile cohort Delta Smelt (~~Typically~~typically this would come into effect beginning the middle of March).
- Wild Central Valley Steelhead Protection: Reclamation and DWR would operate to OMR of -2,500 cfs for 5 days whenever more than 5 percent of Steelhead are present in the Delta and the natural-origin Steelhead loss trigger exceeds 10 Steelhead per TAF. The timing of this action is intended to provide protections to San Joaquin origin Central Valley Steelhead, but the loss-density trigger is based on loss of all Steelhead since there is currently no protocol to distinguish San Joaquin-basin and Sacramento-basin Steelhead in salvage. Reclamation would use the current loss equation for Steelhead or a surrogate. This action will no longer be required after May 31.
- Salvage or Loss Thresholds: Reclamation and DWR propose a cumulative annual salvage or loss threshold equal to 1 percent of the abundance estimate based on EDSM for adult Delta Smelt; loss

equal to 1 percent of the Winter-Run Chinook Salmon JPE (genetically confirmed) or 2 percent of the Winter-Run Chinook Salmon JPE (based on length--at--date); loss equal to 1 percent of the Spring-Run Chinook Salmon JPE (or 0.5 percent of Spring-Run surrogates); salvage equal to 3,000 juvenile Central Valley Steelhead, and salavage equal to 100 juvenile Green Sturgeon. Reclamation and DWR ~~may~~propose to operate ~~to a more positive OMR when the daily salvage loss indicates that continued OMR of -5,000 cfs may exceed the cumulative salvage loss thresholds~~ as described below:

- Restrict OMR to a 14-day moving average OMR index of -3,500 cfs when a species-specific cumulative salvage or loss threshold exceeds 50 percent of the threshold. The OMR restriction to -3,500 cfs will persist until the species-specific offramp is met.
- Restrict OMR to a 14-day moving average OMR index of -2,500 cfs (or more positive if determined by Reclamation) when cumulative salvage or loss threshold for any of the above species exceeds 75 percent of the threshold. The OMR restriction to -2,500 cfs will persist until the species-specific offramp is met.

Species specific OMR restrictions will end when the individual species-specific off ramp from "End of OMR management criteria," below, are met.

4.10.5.10.3 Storm-Related OMR Flexibility~~:~~

If Reclamation and DWR are not implementing additional real-time OMR restrictions, consistent with other applicable legal requirements, Reclamation and DWR may operate to a more negative OMR up to a maximum (otherwise-permitted) export rate at Banks and Jones Pumping Plants of 14,900 cfs (which could result in a range of OMR values) to capture peak flows during storm-related events. Reclamation and DWR will continue to monitor fish in real-time and will operate in accordance with "Additional Real-time OMR Restrictions," above.

Under the following conditions, Reclamation and DWR would not cause OMR to be more negative for capturing peak flows from storm-related events.

- Additional real-time OMR restrictions, above, are triggered, then Reclamation would operate in accordance with those additional real-time OMR restrictions and would not cause OMR to be more negative for capturing peak flows from storm-related events.
- Actual cumulative expanded salvage of Delta Smelt is greater than 50% of the average smelt index over the prior three years of non-zero FMWT surveys and a Cumulative Salvage Index of 7.98 during December 1 – January 20 or cumulative expanded salvage of Delta Smelt is greater than or equal to 75% of the average smelt index calculated described above.
- Predicted adult or juvenile Delta Smelt salvage would exceed 50% during December 1 – January 20 or cumulative expanded salvage is greater than or equal to 75% as determined above, based on the data sources in the Secretarial Memo dated January 17, 2019.
- Measured cumulative loss to date since October 1 for winter-run Chinook salmon (based on length-at-date criteria) is greater than the percentage below of a loss threshold calculated as 2% of the JPE:
  - January 1 – 15 2%
  - January 16 – 31 4%
  - February 1 – 14 6%
  - February 15 – 28 9%
  - March 1 – 15 21%

- March 16 – 31 26%
- April 1 – End of OMR 30%

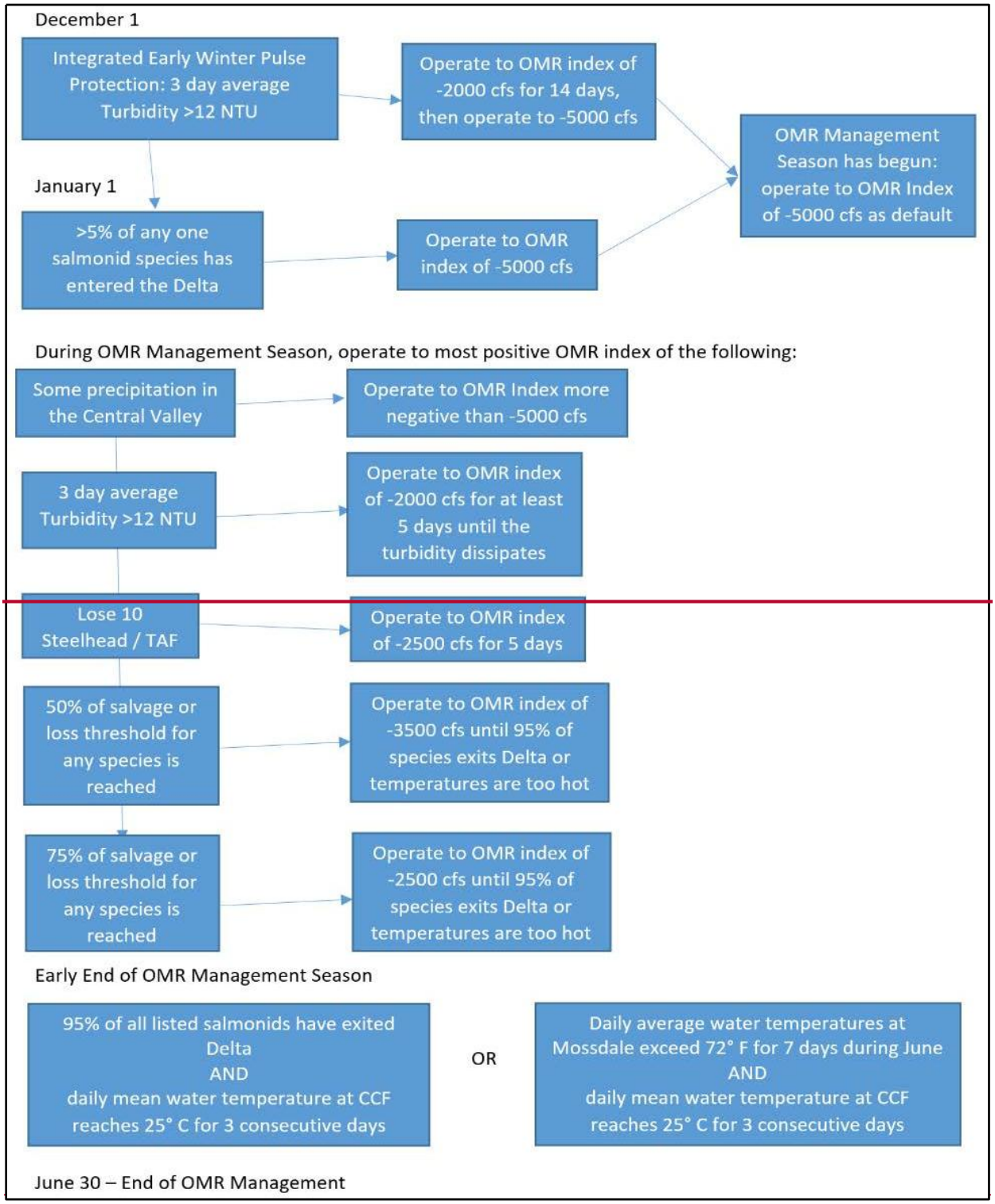
- Predicted cumulative loss for winter-run Chinook salmon is greater than 30% of the loss threshold described above in "Additional Real-Time OMR Restrictions" [1 percent of the Winter-Run Chinook Salmon JPE (genetically confirmed) or 2 percent of the Winter-Run Chinook Salmon JPE (based on length-at-date)] or salvage for steelhead is greater than 50% of the salvage threshold described above in "Additional Real-Time OMR Restrictions".
- Changes in spawning, rearing, foraging, sheltering, or migration behavior beyond those described in the forthcoming biological opinion for this project.

4.10.5.10.4 End of OMR Management~~:~~

OMR criteria may control operations until June 30, or when both of the following have occurred, whichever is earlier:

- Delta Smelt: when the daily mean water temperature at CCF reaches 25°C for 3 consecutive days.
- Salmonids: when more than 95 percent of salmonids have migrated past Chipps Island, as determined by their monitoring working group, OR after daily average water temperatures at Mossdale exceed 72°F for 7 days during June (the 7 days do not have to be consecutive).

Figure 4-5 shows OMR management in a decision tree.


December 1
Integrated Early Winter Pulse Protection: 3 day average Turbidity >12 NTU
Operate to OMR index of -2000 cfs for 14 days, then operate to -5000 cfs
OMR Management Season has begun: operate to OMR Index of -5000 cfs as default
January 1
>5% of any one salmonid species has entered the Delta
Operate to OMR index of -5000 cfs
During OMR Management Season, operate to most positive OMR index of the following:
Some precipitation in the Central Valley
Operate to OMR Index more negative than -5000 cfs
3 day average Turbidity >12 NTU
Operate to OMR index of -2000 cfs for at least 5 days until the turbidity dissipates
Lose 10 Steelhead / TAF
Operate to OMR index of -2500 cfs for 5 days
50% of salvage or loss threshold for any species is reached
Operate to OMR index of -3500 cfs until 95% of species exits Delta or temperatures are too hot
75% of salvage or loss threshold for any species is reached
Operate to OMR index of -2500 cfs until 95% of species exits Delta or temperatures are too hot
Early End of OMR Management Season
95% of all listed salmonids have exited Delta
AND
daily mean water temperature at CCF reaches 25° C for 3 consecutive days
OR
Daily average water temperatures at Mossdale exceed 72° F for 7 days during June
AND
daily mean water temperature at CCF reaches 25° C for 3 consecutive days
June 30 – End of OMR Management

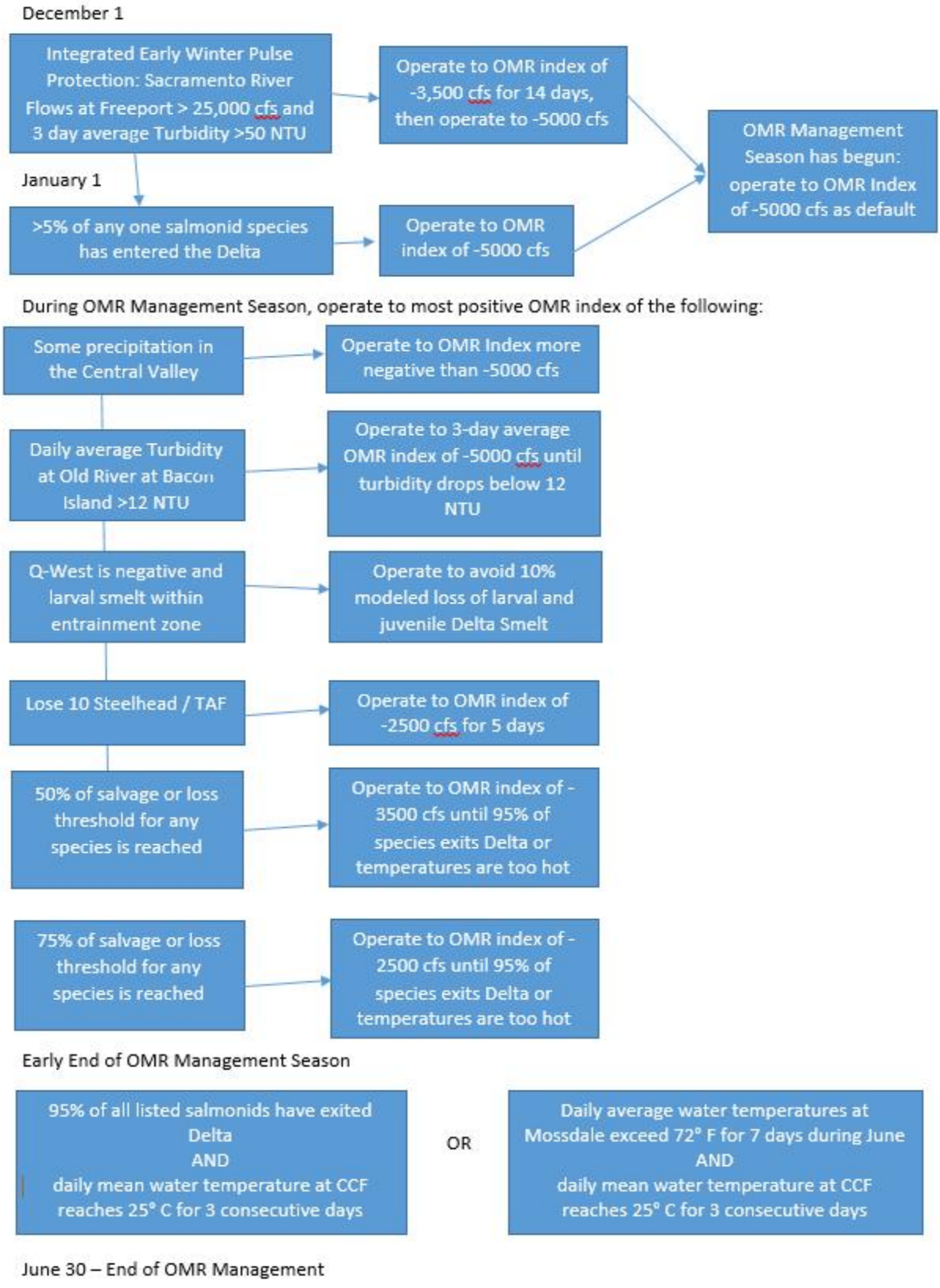

December 1
Integrated Early Winter Pulse Protection: Sacramento River Flows at Freeport > 25,000 cfs and 3 day average Turbidity >50 NTU
Operate to OMR index of -3,500 cfs for 14 days, then operate to -5000 cfs
January 1
>5% of any one salmonid species has entered the Delta
Operate to OMR index of -5000 cfs
OMR Management Season has begun: operate to OMR Index of -5000 cfs as default
During OMR Management Season, operate to most positive OMR index of the following:
Some precipitation in the Central Valley
Operate to OMR Index more negative than -5000 cfs
Daily average Turbidity at Old River at Bacon Island >12 NTU
Operate to 3-day average OMR index of -5000 cfs until turbidity drops below 12 NTU
Q-West is negative and larval smelt within entrainment zone
Operate to avoid 10% modeled loss of larval and juvenile Delta Smelt
Lose 10 Steelhead / TAF
Operate to OMR index of -2500 cfs for 5 days
50% of salvage or loss threshold for any species is reached
Operate to OMR index of -3500 cfs until 95% of species exits Delta or temperatures are too hot
75% of salvage or loss threshold for any species is reached
Operate to OMR index of -2500 cfs until 95% of species exits Delta or temperatures are too hot
Early End of OMR Management Season
95% of all listed salmonids have exited Delta
AND
daily mean water temperature at CCF reaches 25° C for 3 consecutive days
OR
Daily average water temperatures at Mossdale exceed 72° F for 7 days during June
AND
daily mean water temperature at CCF reaches 25° C for 3 consecutive days
June 30 – End of OMR Management

Figure 4-5. Decision Tree for Old and Middle River Reverse Flow Management

Reclamation and DWR may confer with the Directors of NMFS, USFWS, and CDFW if ~~the Additional Real-Time OMR Restrictions are not required for the protection of species and Reclamation and DWR~~ they desire to operate to a more negative OMR~~. The~~ than what is specified in "Additional Real-Time OMR Restrictions". Upon mutual agreement, the Directors of NMFS and USFWS may authorize Reclamation to operate to a more negative OMR~~.~~ than the "Additional Real-Time OMR Restrictions", but no more negative than -5000 cfs. The Director of CDFW may authorize DWR to operate to a more negative OMR~~.~~ than the "Additional Real-Time OMR Restrictions", but no more negative than -5000cfs.

4.10.5.11 *Delta Smelt Summer-Fall Habitat*

Reclamation and DWR propose to use structured decision making to identify and use a variety of actions to achieve the environmental and biological goals below, as described further in Appendix C. The Delta Smelt Habitat Action shall take actions to meet these environmental and biological goals in the summer and fall (June through October) of below normal, above normal, and wet water years according to the Sacramento Valley Index. The Delta Smelt Habitat Action may improve Delta Smelt habitat while contributing to the recruitment of Delta Smelt, providing enhancement of food supply and expansion of low salinity habitat.

The environmental and biological goals of the Delta Smelt Habitat Action are to: Maintain a 14-day average low salinity habitat of between 0 ppt to 6 ppt in Suisun Marsh and Grizzly Bay based on data from Belden's Landing (or other station(s) and averaging periods, as appropriate) from June to October of below normal, above normal, and wet year years, when water temperatures are suitable; manage the low salinity zone to overlap with turbid water (12 NTU) and available food supplies; establish contiguous low salinity habitat from Cache Slough Complex to the Suisun Marsh; and contribute to the recruitment of Delta Smelt.The current conceptual model is that Delta Smelt habitat should include low salinity conditions of 0-6 ppt, turbidity of approximately 12 NTU, temperatures below 25°C, food availability, and littoral or open water physical habitats (FLaSH Synthesis, pp. 15-23). The goal of the Delta Smelt Habitat Action is to provide these habitat components in the same geographic area through a range of actions to improve water quality and food supplies. These actions include, but are not limited to:

- Suisun Marsh Salinity Control Gate (SMSCG) operations for up to 60 days (not necessarily consecutive);
- Delta outflow up to the quantity that would have been required to meet a 2 ppt isohaline at 80 km from the Golden Gate Bridge in above normal and wet water years in September and October;
- Enhancement actions, e.g., those included in the Delta Smelt Resiliency Plan to enhance food supply, the North Delta food-web project, Sacramento River Deepwater Ship Channel lock reoperation, and Roaring River distribution system reoperation.

In below normal, above normal, and wet water year types, actions would focus on non-flow measures, such as operation of the SMSCG for up to 60 days (not necessarily consecutive) in the summer and fall. In below normal years, initial actions would include operating the SMSCG in the summer with no additional Delta outflow augmentation above that which is necessary to comply with D-1641. In above normal and wet years, initial actions would include operation of the SMSCG in the summer and fall. In addition, if necessary and helpful to meet the environmental and biological goals described above, Delta outflow may be augmented in above normal and wet years up to the flow volume that would have supported a 2 ppt isohaline at 80 kilometers from the Golden Gate Bridge in September and October. The water cost of operating the SMSCG in above normal years would be subtracted from the Delta outflow augmentation flow volume.

~~4.9.5.11~~4.10.5.12 *Conservation Measures*

Conservation measures are included to further avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include non-flow actions that benefit listed species without impacting water supply or other beneficial uses. The TFCF and the Skinner Fish Facility are identified specifically due to their significance as project features and then additional measures are listed.

~~4.9.5.11.1~~4.10.5.12.1 Tracy Fish Collection Facility

Reclamation proposes to continue to screen fish from Jones Pumping Plant with the TFCF. The TFCF uses behavioral barriers consisting of primary louvers and four rotating traveling screens aligned in a single row 7 degrees to the ~~secondary channel,~~flow of the water to guide entrained fish into holding tanks before transport by truck to release sites ~~within~~at the confluence of the Delta. The TFCF was designed to handle smaller fish (less than 200 mm) that would have difficulty fighting the strong pumping plant-induced flows, as the intake is essentially open to the Delta and impacted by tidal action. The number of pumps (units) running at the Jones Pumping Plant (JPP) dictates the flow and velocity at the TFCF. There are 6 units at JPP but a maximum of 5 can used; each unit increases the velocity through the TFCF primary channel by approximately 0.5 ft/sec.

The primary louvers are located in the primary channel just downstream of the trashrack structure. The ~~secondary~~ traveling ~~screens are~~ water screen is located in the secondary channel.

~~Hauling trucks used to transport salvaged fish to release sites inject oxygen and contain an eight parts per thousand salt solution to reduce stress.~~ The ~~CVP uses two release sites, one on~~louvers allow water to pass through onto the ~~Sacramento River near Horseshoe Bend and~~ pumping plant, but the ~~other on~~openings between the ~~San Joaquin River immediately upstream~~slats are tight enough and angled against the flow of ~~the Antioch Bridge. As a conservation measure, Reclamation proposes to increase~~water to prevent most fish from passing between them and to enable the ~~number~~ fish to enter one of ~~release sites to reduce predation.~~

~~Predator Removal:~~four bypass entrances along the louver arrays. Reclamation proposes to install a carbon dioxide injection device to allow remote controlled anesthetization of predators in the secondary channels of the TFCF.

The current primary louver cleaning procedures and operations involve lifting each individual louver panel, 36 total, out of the water in order to spray wash the debris. Generally, each primary louver panel is lifted and lowered back into place three times per day, although frequency of cleaning may be increased or decreased according to pumping rate and debris loads. It takes approximately 3-7 minutes to lift, spray clean, and lower each louver panel back into place. While export pumping may be reduced to address damaged louver panels, issues during cleaning, or other maintenance scenarios where facilities are not capable of effectively salvaging fish, complete shutdown of pumping usually does not occur due to issues related to the primary louvers. At 5 Jones Pumping Plant units running, louvers are cleaned before the incoming tide as much as possible. The morning day shift usually begin cleaning as soon as they start their work, around 0600. During high debris periods, operators monitor differentials and clean before any problems arise. At a minimum, all 36 louver panels are cleaned 2-3 times a day but during heavy debris loads, operators clean 3-6 times a day. At 2-4 JPP units, operators determine when to clean and making sure the louvers do not reach 1 ft differential. At 1 JPP unit, operators will normally clean periodically

during the incoming tide. Generally, less frequent cleaning is required in early summer (low averages of 60 minutes per day) and much higher during the winter months (high averages of 440 minutes per day). This means that there is a louver panel lifted 1-7.5 hours per day depending on season, pumping rates, and debris loads.

When south Delta hydraulic conditions allow, and conditions within the original design criteria for the TFCF, the louvers are operated to achieve water approach velocities for striped bass of approximately 1 foot per second from May 15 through October 31 and for salmon of approximately 3 feet per second from November 1 through May 14.

Fish passing through the facility are sampled at intervals of 30 minutes every 2 hours year-round. Approximately 52 different species of fish are entrained into the TFCF each year; however, the total numbers are significantly different for the various species salvaged. Fish observed during sampling intervals are identified by species, measured to fork length, examined for marks or tags, and placed in the collection facilities for transport by tanker truck to the release sites in the north Delta away from the pumps. Hauling trucks used to transport salvaged fish to release sites inject oxygen and contain an 8 parts per thousand salt solution to reduce stress. In addition, TFCF personnel monitor for the presence of spent female Delta Smelt in anticipation of expanding the salvage operations to include sub-20 mm larval Delta Smelt detection.

TFCF personnel monitor for the presence of spent female Delta Smelt by euthanizing all adult Delta Smelt that are collected in the 30-minute fish count, determine the gender and the gonadal or sexual maturation stage of the Delta Smelt, and determine if the eggs have reached Stage IV, the stage when eggs are ready for release (0.9 to 10 mm in diameter and easily stripped). Stages V (i.e., postvitellogenic stage) and VI (i.e., postovulatory, or spent stage) are expected soon after Stage IV observation. Stages are determined and reported real-time when a biologist is present or the following morning after smelt detection and collection. Stage or gonad maturation is determined using egg stage descriptions from Mager (1996).

Larval smelt sampling at the TFCF commences once a trigger is met (detection of a spent female at CVP and SWP being one of three triggers). Fish count screen with a 2.4 mm mesh size opening is replaced with one that has a mesh size of 0.5 mm to retain larval fish. Sampling is done four times a day (04:00, 10:00, 16:00, 22:00) and all larval smelt are identified to species and reported the day after collection.

Salvage of fish occurs at the TFCF 24 hours per day, 365 days per year. Fish are salvaged in flow-through holding tanks (6.1-m diameter, 4.7-m deep) that provide continuous flows of water (Sutphin and Wu 2008). Fish are maintained in these holding tanks for 8-24 hours depending on the species of fish that are being salvaged, the number of fish salvaged, and debris load. The number of fish that are salvaged in TFCF holding tanks is generally estimated by performing a 30 minute fish-count subsample every 120 minutes (2 hours). The number of each species of fish collected in the subsample is determined and then multiplied by 4 (120 pumping minutes/30 minute fish-count subsample = expansion factor of 4) to estimate the total number of each species of fish, as well as the total number of fish, that were salvaged in TFCF holding tanks during the 120 minute period. Pumping minutes and fish-count minutes could potentially deviate from 120 minutes and 30 minutes, respectively, which would change the expansion factor used to estimate total fish salvage.

If no Chinook Salmon, Steelhead, or Delta Smelt are salvaged, fish can be maintained in TFCF holding tank for up to 24 hours. If a Chinook Salmon or Steelhead is collected during fish-counts, fish can only be maintained in TFCF holding tanks for up to 12 hours. If a Delta Smelt is collected during fish-count, salvaged fish may only be held in TFCF holding tanks for up to 8 hours. When fish can be maintained in

TFCF holding tanks for 24 hours, fish transport (fish-haul) generally occurs each morning. When 2 fish-hauls per day are necessary, a night fish haul is added. When 3 fish-hauls are necessary, they are usually completed at 7 am, 3pm, and 9:30 pm each day. Fish-haul is also dictated by the Bates Tables which uses size classes, species, and water temperature as indicators for when to conduct a fish-haul.

During normal operations, salvaged fish are transported approximately 49.9 km and released at one of two Reclamation release sites near the confluence of the Sacramento and San Joaquin Rivers (Antioch Fish Release Site and Emmaton Fish Release Site). In general, the Emmaton Fish Release Site is used for fish-hauls performed during daytime hours and the Antioch Fish Release Site is used for fish-hauls performed during nighttime hours. This is done for safety and security reasons as the Antioch Fish release Site has a gate that can be locked behind the operator after he/she enters the release site area. Upon arrival at release sites, operators measure certain important water quality parameters (dissolved oxygen, salinity, and temperature) prior to releasing fish. This is done to verify that water quality parameters remain acceptable during fish transport. As a conservation measure, Reclamation proposes to increase the number of release sites to reduce predation.

Reclamation would conduct studies and physical improvements aimed to improve fish survival and improve TFCF efficiency, reducting mortality through the facility, fish hauling and release operations through the Tracy Fish Facility Improvement Program. Activities include louver improvement and replacement, predation studies and piscivorous predator control, improvement of hydrologic monitoring and telemetry systems, holding area improvements including fish count automation and tank aeration and screening, improvement of data management as well as aquaculture facility maintenance, operation and improvements. TFCF studies are established at annual multi-agency meetings of the Tracy Tech Advisory Team. Reclamation would provide written reports of study results on the TFFIP website.

~~4.9.5.11.2~~4.10.5.12.2 Skinner Fish Facility

DWR proposes to continue to screen fish from Banks Pumping Plant with the~~.~~ Skinner Fish Facility, located west of the CCF, 2 miles upstream of the Banks Pumping Plant. The Skinner Fish Facility has behavioral barriers to keep fish away from the pumps that lift water into the California Aqueduct. Large fish and debris are directed away from the facility by a 388-foot-long trash rack. Smaller fish are diverted from the intake channel into bypasses by a series of behavioral barriers (metal louvers), while the main flow of water continues through the louvers and toward the pumps. These fish pass through a secondary system of louvers or screens and pipes into seven holding tanks, where a subsample is counted and recorded. The salvaged fish are then returned to the Delta in oxygenated tank trucks. The sampling frequency at TFCF will be maintained at the Skinner Fish Facility.

~~4.9.5.11.3~~4.10.5.12.3 Additional Measures

- ~~Operations~~
  - ~~*Suisun Marsh Salinity Control Gates Operation*: In addition to the October through May operation to meet Suisun water quality standards, Reclamation and DWR propose operating the SMSCG on the tidal cycle to meet the physical and biological features of Delta Smelt critical habitat in below-normal and above-normal Sacramento Valley Index year types in June through September for 60 days, not necessarily consecutive, as part of the adaptive management framework, based on data gathered over time to allow for assessment of the action. A Delta scheduling group would meet to provide scheduling recommendations to Reclamation and DWR in late spring. Slater and Baxter (2014) posit that food is limited for Delta Smelt in August and September. Reclamation and DWR would increase tidal operations of the SMSCG to direct more fresh water in Suisun Marsh, which is intended to~~

~~reduce salinities in Suisun Marsh, increase food, and improve habitat conditions for Delta Smelt in the region. This would be combined with Roaring River Distribution System management for food production and flushing fresh water through the Roaring River Distribution System to increase the low salinity habitat in Grizzly and Honker Bays. Reclamation and DWR will continue to meet existing D-1641 salinity requirements in the Delta and Suisun Marsh, which will require additional Delta outflow. Reclamation and DWR would implement monitoring of physical factors to evaluate this action as part of the adaptive management plan.~~

- ~~*Fall Delta Smelt Habitat*: Reclamation proposes to manage for Delta Smelt habitat in the fall of Above Normal and Wet years (between D-1641 and the 2008 biological opinion). Delta Smelt habitat would be defined in terms of all of the physical and biological features of critical habitat.~~

- *San Joaquin Basin Steelhead Telemetry Study*: Continuation of the 6-Year Steelhead telemetry study for the migration and survival of San Joaquin Origin Central Valley Steelhead.
- *Sacramento Deepwater Ship Channel:* Reclamation proposes to partner with the City of West Sacramento and West Sacramento Area Flood Control Agency to repair or replace the West Sacramento lock system to hydraulically reconnect the ship channel with the mainstem of the Sacramento River. When combined with an ongoing foodweb study, the reconnected ship channel has the potential to flush food production into the north Delta. An increase in food supply is likely to benefit Delta Smelt and their habitat.
- *North Delta Food Subsidies / Colusa Basin Drain:* DWR, Reclamation, and water users propose to increase food entering the north Delta through flushing nutrients from the Colusa Basin into the Yolo Bypass and north Delta. DWR, Reclamation, and water users would work with partners to flush agricultural drainage (i.e., nutrients) from the Colusa Basin Drain through Knight's Landing Ridge Cut and the Tule Canal to Cache Slough, improving the aquatic foodweb in the north Delta for fish species. Reclamation would work with DWR and partners to augment flow in the Yolo Bypass in July and/or September by closing Knights Landing Outfall Gates and routing water from Colusa Basin into Yolo Bypass to promote fish food production.
- *Suisun Marsh Food Subsidies:* Water users propose to add fish food to Suisun Marsh through coordinating managed wetland flood and drain operations in Suisun Marsh, Roaring River Distribution System food production, and reoperation of the Suisun Marsh Salinity Control Gates. As noted in the Delta Smelt Resiliency Strategy, this management action may attract Delta Smelt into the high-quality Suisun Marsh habitat in greater numbers, reducing use of the less food-rich Suisun Bay habitat (California Natural Resources Agency 2016). Infrastructure in the Roaring River Distribution System may help drain food-rich water from the canal into Grizzly Bay to augment Delta Smelt food supplies in that area. In addition, managed wetland flood and drain operations can promote food export from the managed wetlands to adjacent tidal sloughs and bays.
- Habitat Restoration: DWR and Reclamation propose to continue to implement existing restoration efforts that are part of the environmental baseline but are not yet complete, including:
    - Completing, by 2030, the remaining approximately 6,000 acres of tidal habitat restoration in the Delta of the 8,000 acres DWR has begun. Reclamation and/or DWR would monitor, operate, and maintain the tidal habitat restoration, including obtaining permanent land rights. Consistent with the current regulatory process, future separate consultations would address the effects to listed species from habitat restoration.

- *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project*: Reclamation and DWR will provide increased acreage of seasonal floodplain rearing habitat available in the lower Sacramento River basin by 2030.
- Reclamation would coordinate with water users to remove predator hot spots in the Bay-Delta. This includes minimizing lighting at fish screens and bridges, and possibly removing abandoned structures.

~~• Facility Improvements: Reclamation and DWR would continue implementation of projects to reduce mortality of ESA-listed fish species:~~

- *Delta Cross-Channel Gate Improvements:* The DCC is more than 65 years old and its gates rely on remote operators to travel to the facility to change their position. When the gates are open, they provide a critical diversion structure for freshwater reaching the CVP south Delta pumping station. The gates are closed to prevent scouring (during high flows), reduce salinity intrusion in the western Delta, and protect Sacramento River ESA-listed and non-listed salmonids. Additional DCC operation would allow for improved exports and water quality without additional adverse effects on salmonids. Reclamation proposes to evaluate improvements to automate and streamline operation of the Delta Cross-Channel gates. Reclamation would modernize DCC's gate materials and mechanics to include adding industrial control systems, increasing additional staff time, and improve physical and biological monitoring associated with the DCC daily and/or tidal operations as necessary to maximize water supply deliveries.
- *Tracy Fish Facility Improvements:* Reclamation would improve the TFCF to reduce loss by: (1) incorporating additional fish exclusion barrier technology into the primary fish removal barriers, (2) incorporating additional debris removal systems at each trash removal barrier, screen, and fish barrier, (3) Constructing additional channels to distribute the fish collection and debris removal among redundant paths through the facility, (4) Construct additional fish handling systems and holding tanks to improve system reliability; and (5) Incorporate remote operation into the design and construction of the facility. Facility improvements will improve survival of fish salvaged and potentially reduce the loss factors to allow for additional certainty on OMR management with low impacts from salvaging salmonids.
- *Skinner Fish Facility Improvements:* DWR would continue implementation of projects to reduce mortality of ESA-listed fish species. These measures that would be implemented include: (a) electro-shocking and relocating predators; (b) controlling aquatic weeds; (c) developing a fishing incentives or reward program for predators; and (d) operational changes when listed species are present. Please see Appendix G~~, *Clifton Court Forebay Predation Studies*~~ for study results from the last decade.
- *Release Sites:* Reclamation proposes to continue work with DWR to incorporate flexibility in salvage release sites, using DWR's sites, or sites on a barge.
- *Small Screen Program*: Reclamation and DWR propose to continue to work with existing authorities (Anadromous Fish Screen Program) to screen small diversions throughout Central Valley CVP/SWP streams and the Bay-Delta.~~—~~

~~• Intervention~~

- *Delta Fish Species Conservation Hatchery:* Reclamation proposes to partner with DWR to construct and operate a conservation hatchery for Delta Smelt, by 2030. The conservation hatchery would breed and propagate a stock of fish with equivalent genetic resources of the native stock and at sufficient quantities to effectively augment the existing wild population, so that they can be returned to the wild to reproduce naturally in their native habitat.

- ~~The existing~~ *Fish Conservation and Culture Laboratory (FCCL~~))~~:* The existing FCCL will be used in the interim to begin supplementation prior to construction of the new conservation hatchery. Reclamation will support development of a supplementation strategy in coordination with and subject to approval by USFWS. This strategy will include studies to develop necessary information to begin a supplementation program, a focus on capturing existing genetic diversity and expansion of FCCL to produce maximum numbers of Delta Smelt. Current production is approximately 50,000 adult Delta Smelt; the strategy will have a goal of increasing production by 2025 to a number and the life stages necessary to effectively augment the population as determined by USFWS. The strategy will be in place 1 year from issuance of the biological opinion. Work done at the FCCL will guide construction and operation of the Conservation Hatchery described above.

~~4.9.6~~4.10.6 Stanislaus River (East Side Division)

Reclamation operates the CVP East Side Division for flood control, agricultural water supplies, hydroelectric power generation, fish and wildlife protection, and recreation. In the Stanislaus River watershed, Reclamation owns and operates New Melones Dam and Reservoir (2.4 MAF capacity). The Tri-Dam Project, a partnership between the Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID), consists of Donnells and Beardsley Dams, located upstream of New Melones Reservoir on the middle fork Stanislaus River, and Tulloch Dam and Powerplant, located approximately 6 miles downstream of New Melones Dam on the mainstem Stanislaus River. Releases from Donnells and Beardsley Dams affect inflows to New Melones Reservoir. The main water diversion point on the Stanislaus River is Goodwin Dam, located approximately 2 miles downstream of Tulloch Dam. OID and SSJID manage the Tulloch and Goodwin Dam infrastructure through separate agreements with both Reclamation and Reclamation's CVP water service contractors (Stockton East Water District and the Central San Joaquin Water Conservation District) to meet Reclamation's Stanislaus River objectives, CVP contractor deliveries, and deliveries to the OID and SSJID service areas.

The Stanislaus River watershed has annual obligations that exceed the average annual runoff in a given year due to a number of factors, including SWRCB water rights decisions D-1641, D-1422 and D-1616, the 1987 CDFG agreement, CVPIA objectives, the 2009 biological opinion, the 1988 Agreement and Stipulation with OID and SSJID, riparian water right diverters, and CVP water delivery contracts.

Over the past decade, Reclamation has worked with Stanislaus River water users and related agencies in developing a revised operating plan for New Melones Reservoir that addresses multiple objectives, including a more predictable and sustainable operation, minimizing low storage conditions in successive drought years, and providing flows to support listed species and critical habitat. These efforts have allowed multiple agencies and stakeholders to provide input on potential solutions; however, a final plan has not been completed.

The operating plan described below is intended to replace often overlapping and conflicting operational components of previous federal and state flow requirements, and is representative of Reclamation's contribution to any current or future flow objectives on the Lower San Joaquin River at Vernalis.

~~4.9.6.1~~4.10.6.1 *Seasonal Operations*

Reclamation proposes to meet water rights, contracts, and agreements that are specific to the East Side Division and Stanislaus River. Senior water right holders (OID and SSJID) will receive annual water deliveries consistent with the 1988 Agreement and Stipulation, and water will be made available to CVP contractors in accordance with their contracts and applicable shortage provisions.

In high storage, high inflow conditions, Reclamation will operate for flood control in accordance with the USACE flood control manual. Because New Melones is a large reservoir relative to its annual inflow, flood control is relatively infrequent; however, Tulloch Lake, located downstream of New Melones Reservoir, is subject to high local inflows, and may be in flood control operations for brief periods when New Melones Reservoir is not. During these periods, releases from Tulloch may be used to meet flow objectives, schedules, or requirements on the lower Stanislaus River below Goodwin Dam.

Reclamation proposes to operate New Melones Reservoir (as measured at Goodwin Dam) in accordance with a Stepped Release Plan (SRP) that varies by hydrologic condition/water year type as shown in Table 4-~~14~~13.

Table 4-~~14~~13. New Melones SRP Annual Releases by Water Year Type

Water Year Type	Annual Release (TAF)
Critical	184.3
Dry	233.3
Below normal	344.6
Above normal	344.6
Wet	476.3

The New Melones SRP will be implemented similarly to current operations under the 2009 biological opinion with a default daily hydrograph, and the ability to shape monthly and seasonal flow volumes to meet specific biological objectives. The default daily hydrograph is the same as prescribed under current operations for critical, dry, and below normal water year types. The difference occurs in above normal and wet years, where the minimum requirement for larger releases is reduced from current operations to promote storage for potential future droughts and preserve cold water pool. When compared to minimum daily flows from Appendix 2-E of the 2009 biological opinion (2-E), the daily hydrograph for the New Melones SRP is identical for critical, dry, and below normal year types; above normal and wet year types follow daily hydrographs for below normal and above normal year types from 2-E, respectively. The complete daily hydrograph for the New Melones SRP is available in Appendix B~~, *New Melones Stepped Release Plan Daily Hydrographs for Critical, Dry, Below Normal, Above Normal, and Wet Year Types*~~.

For the New Melones SRP, Reclamation proposes to classify water year types using the San Joaquin Valley "60-20-20" Water Year Hydrologic Classification (60-20-20) developed for D-1641 implementation. Previous operating plans for New Melones Reservoir relied on the New Melones Index (NMI) to determine water year type, calculated by summing end-of-February storage and forecasted inflow through September. Because the reservoir can store more than twice its average inflow, the NMI resulted in a water year type determination that was more closely tied to storage rather than hydrology. Changing from the NMI to 60-20-20 is expected to provide operations that better represent current hydrology and correlate more closely to water year types for other nearby tributaries.

Reclamation proposes to convene the Stanislaus Watershed Team (successor to the Stanislaus Operating Group), consisting of agency representatives and local stakeholders having direct interest on the Stanislaus River, at least monthly to share operational information and improve technical dialogue on the

implementation of the New Melones SRP. The Stanislaus Watershed Team will also provide input on the shaping and timing of monthly or seasonal flow volumes to optimize biological benefits.

During the summer, Reclamation is required to maintain applicable dissolved oxygen standards on the lower Stanislaus River for species protection. Reclamation currently operates to a 7.0 mg/L dissolved oxygen requirement at Ripon from June 1 to September 30. Reclamation proposes to move the compliance location to Orange Blossom Bridge, where the species are primarily located at that time of year.

~~4.9.6.2~~4.10.6.2 *Conservation Measures*

Conservation measures are included to avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include non-flow actions that benefit listed species without impacting water supply or other beneficial uses.

- Spawning Habitat: Under the CVPIA (b)(13) program, Reclamation's annual goal of gravel placement is approximately 4,500 tons in the Stanislaus River.
- Rearing Habitat: Reclamation proposes to construct an additional 50 acres of rearing habitat adjacent to the Stanislaus River by 2030.
- Temperature Management: Reclamation will study approaches to improving temperature for listed species on the lower Stanislaus River, to include evaluating the utility of conducting temperature measurements/profiles in New Melones Reservoir.

~~4.9.7~~4.10.7 San Joaquin River (Friant Division)

Reclamation operates the Friant Division for flood control, irrigation, M&I, and fish and wildlife purposes. Facilities include Friant Dam, Millerton Reservoir, and the Friant-Kern and Madera Canals. Friant Dam provides flood control on the San Joaquin River, provides downstream releases to meet senior water rights requirements above Gravelly Ford, provides Restoration Flow releases under Title X of Public Law 111-11, and provides conservation storage as well as diversion into Madera and Friant-Kern Canals for water supply. Water is delivered to about a million acres of agricultural land in Fresno, Kern, Madera, and Tulare Counties in the San Joaquin Valley via the Friant-Kern Canal south into Tulare Lake Basin and via the Madera Canal northerly to Madera and Chowchilla Irrigation Districts. A minimum of 5 cfs is required to pass the last holding contract diversion located about 40 miles downstream of Friant Dam near Gravelly Ford.

The SJRRP implements the San Joaquin River Restoration Settlement Act in Title X of Public Law 111-11. USFWS and NMFS issued programmatic biological opinions in 2012 that included project-level consultation for SJRRP flow releases. Programmatic ESA coverage is provided for flow releases up to a certain level, recapture of those flows in the Lower San Joaquin River and the Delta, and all physical restoration and water management actions listed in the Settlement.

The Stipulation of Settlement of NRDC vs. Rogers, is based on two goals—the Restoration Goal and the Water Management Goal. To achieve the Restoration Goal, the Settlement calls for, among other things, releases of water from Friant Dam to the confluence of the Merced River (referred to as Restoration Flows) according to the hydrographs in Settlement Exhibit B. To achieve the Water Management Goal, the Settlement calls for the development and implementation of a plan for recirculation, recapture, reuse, exchange or transfer of Restoration Flows for the purpose of reducing or avoiding impacts on water deliveries to all of the Friant Contractors caused by Restoration Flows. Recapture of Restoration Flows

may occur upstream of a capacity restricted reach, or downstream of the Merced River confluence. Recapture can occur at Banta-Carbona, Patterson, or West Stanislaus Irrigation District facilities, or at Jones or Banks Pumping Plants. Recapture of Restoration Flows in the Sacramento San Joaquin Delta under this proposed action would average 65 TAF, ranging from approximately 25 TAF to 78 TAF depending on the yeartype.

~~4.9.7.1~~4.10.7.1 *Conservation Measures*

Lower SJR Rearing Habitat: Reclamation may work with private landowners to create a bottom-up, locally driven regional partnership to define and implement a large-scale floodplain habitat restoration effort in the Lower San Joaquin River. This stretch of the San Joaquin River is cut-off from its floodplain due to an extensive levee system, with two notable exceptions at Dos Rios Ranch (1,600 acres) and the San Joaquin River National Wildlife Refuge (2,200 acres). In recent years, there has been growing interest in multi-benefit floodplain habitat restoration projects in the Central Valley that can provide increased flood protection for urban and agricultural lands, improved riparian corridors for terrestrial plants and wildlife, and enhanced floodplain habitat for fish. The resulting restoration could include thousands of acres of interconnected (or closely spaced) floodplain areas with coordinated and/or collaborative funding and management. Such a large scale effort along this corridor would require significant support from a variety of stakeholders, which could be facilitated through a regional partnership.

~~4.9.8~~4.10.8 South of Delta

San Luis Reservoir is an offstream storage facility located along the California Aqueduct downstream of Jones and Banks Pumping Plants. The CVP and SWP share San Luis Reservoir storage roughly 50/50 (CVP has 966 TAF of storage, SWP has 1062 TAF of storage). San Luis Reservoir is used by both Projects to meet deliveries to their contractors during periods when Delta pumping is insufficient to meet demands. San Luis Reservoir is also operated as a conveyance facility to supply water to the CVP San Felipe Division in San Benito and Santa Clara Counties.

San Luis Reservoir operates as a regulator on the CVP/SWP system, accepting any water pumped from Banks and Jones that exceeds contractor demands, then releasing that water back to the aqueduct system when the pumping at Jones and Banks is insufficient to meet demands. The reservoir allows the CVP/SWP to meet peak-season demands that are seldom balanced by Jones and Banks pumping.

As San Luis Reservoir is drawn down to meet contractor demands, it usually reaches its low point in late August or early September. From September through early October, demand for deliveries usually drops to be less than the Jones and Banks diversions from the Delta, and the difference in Jones and Banks pumping is then added to San Luis Reservoir, reversing its spring and summer decline and eventually filling the San Luis Reservoir - typically before April of the following year.

~~4.10~~4.11 Items Not Included in This Consultation

This document includes context on the entirety of operations of the CVP and SWP. However, not all of these actions are being consulted on, either because they were the subject of prior consultations or due to other legal authority. Reclamation and DWR are consulting on the exercise of discretion in operational decision making, including how to comply with the terms of their respective existing water supply and settlement contracts (which includes the impacts of maximum water diversions under the terms of these contracts), and other legal obligations. Reclamation and DWR are not consulting on:

- Flood control
- Folsom Water Control Manual
- Oroville Dam and Feather River operations
- Execution of new CVP water service or repayment contracts, or the prior execution of existing contracts that were the subject of separate but parallel prior consultations
- Execution of new settlement contracts and agreements, or the prior execution of existing contracts that were the subject of separate but parallel prior consultations
- Contract conversion
- Operations and maintenance activities of CVP minor facilities
- Exchange Contractor deliveries from Friant Dam
- SJRRP flows and lower SJR recapture
- TRRP flows
- Coordinated Operation Agreement
- D-1641
- Contra Costa Water District Operations
- Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project
- Suisun Marsh Habitat Management, Preservation, and Restoration Plan
- Suisun Marsh Preservation Agreement
- California WaterFix
- Battle Creek Restoration Program

~~4.11~~4.12 Governance

Reclamation anticipates three implementation approaches for the proposed action. The first, Core Water Operation, involves Reclamation and DWR operating the projects within the bounds of the proposed action with regular performance monitoring and reporting. The second, Scheduling, includes water-shed based groups of the five agencies (i.e., Reclamation, DWR, USFWS, NMFS, CDFW) and water users providing input to Reclamation and DWR on scheduling and routing specific blocks of water identified in the proposed action (i.e., pulse flows). The third, Collaborative Planning, involves program teams of the five agencies and water users working together to define, study, and implement specific components of the proposed action.

The Core Water Operation serves as the foundation for meeting ~~the~~regulatory requirements ~~of D-1641~~ and providing for Reclamation and DWR to operate the CVP and SWP, while reducing the stressors on listed species influenced by those ongoing operations~~.~~ through real-time monitoring. The Core Water Operation consists of operational actions that do not require subsequent concurrence ~~or extensive coordination~~ to define annual operation. For the Core Water Operation, Reclamation would implement activities, monitor performance, and report on compliance with the commitments in the proposed action. The ~~CVP and SWP Water Operations Charter, Appendix C, *ROC* Real-~~Time Water Operations Charter~~,~~ (Charter) described in Appendix C describes how Reclamation and DWR will monitor and report on ESA Section 7 commitments under the proposed action and how the five agencies, public water agencies, and

other participants will ~~plan,~~ communicate~~,~~ and coordinate real-time water operations decisions ~~on the Core Water Operation.~~ The Charter also describes the deliverables, schedule, and decision making processes.

~~Portions of the Core Water Operation rely upon real-time monitoring to inform Reclamation and DWR on how to minimize and/or avoid stressors on listed species. Some elements of the Core Water Operation provide for seasonal input by the federal and state fish agencies on the scheduling and routing of certain flow volumes to benefit fisheries.~~ The Core Water Operation also provides for regulatory coordination in the event conditions exceed the ability to anticipate how Reclamation and DWR would operate (~~i.e., "outliers")~~.e.g., Tier 4 Shasta Cold Water Pool management). Reclamation and DWR must demonstrate compliance with the commitments in the proposed action and provide sufficient information for an evaluation of reinitiation triggers through regular monitoring and reporting.

~~Aspects of the proposed action that are adaptively managed will require additional coordination that occurs more than once, for example, implementing spawning and rearing projects annually. Reclamation and DWR will form program teams with fish agency and stakeholder representatives on adaptively managed commitments. The governance of project teams will remain consistent with requirements under the ESA and CESA; however, within the program teams, fish agencies may also participate in a capacity as action agencies for specific projects under their authorities and resources, where appropriate.~~

~~Within the Core Water Operation, several different types of coordination occur on different time scales:~~

~~Real-Time Species Distribution and Life Stage Monitoring: Fish agencies~~As part of Core Water Operation, fishery agencies would provide information to Reclamation and DWR on the real-time disposition of species through specific monitoring workgroups. This information ~~informs~~would inform the risk analysis performed by Reclamation and DWR. ~~This coordination occurs seasonally. Examples: OMR Management, Shasta cold water pool management.~~

~~Flow~~For components of the proposed action identified as part of the Scheduling~~: Fish~~ implementation approach, fishery agencies and ~~other stakeholders~~water users in watershed-based groups would provide scheduling recommendations to Reclamation and DWR on duration, timing, and magnitude of specific blocks of water. Reclamation and DWR will evaluate and consider the recommendations and operate the CVP and SWP to ~~these~~those schedules as feasible. ~~Examples: Clear Creek, Stanislaus River, Suisun Marsh Salinity Control Gates.~~

- ~~Outlier Years: In outlier years, fish agencies would work with Reclamation and DWR to identify options and intervention measures. Examples: Tier 4~~For apects of ~~Shasta cold water pool management, extreme drought, emergency conditions.~~
- ~~Seasonal and Annual Reviews:~~the proposed action that are implemented through Collaboratively Planning, Reclamation and DWR will ~~report on activities to fish agencies and determine whether to reinitiate on one or more components (although either party may also trigger reinitiation in real-time).~~
- ~~Project Teams: Programmatic activities will have~~form program teams ~~that develop the specific project descriptions and obtain the appropriate permits. Examples: Spawning~~comprised of fishery agency and stakeholder representatives that inform Reclamation and DWR decisions on all aspects of the action. Example collaborative planning actions include spawning and rearing habitat, Delta Fish Conservation Hatchery~~.~~

~~Under~~, and the ~~CVP and SWP Water Operation Charter, decisions shall be made consistent with authorizing legislation and the regulations and policies under the ESA and CESA, as appropriate.~~

~~Reclamation and DWR shall retain sole discretion for:~~

- ~~Water operations of the CVP and SWP, including allocations, under Reclamation Law and the SWP authorization.~~
- ~~Agency appropriations (budget requests, fund alignment, contracting, etc.).~~
- ~~Section 7 action agency and applicant (consultation).~~
- ~~Coordination and cooperation with PWAs as required by contracts and agreements.~~

~~CDFW, USFWS, and NMFS shall retain sole discretion for:~~

- ~~Consultation under Section 7 of the federal ESA and California Fish and Game Code, as appropriate, Incidental Take Statements/Permits, and enforcement.~~
- ~~Agency appropriations.~~

~~SWRCB~~

- ~~Enforcement as allowable under federal and state law.~~

~~Operating Entities other than CVP and SWP shall retain sole discretion for:~~

- ~~Operation of non-CVP and non-SWP diversion facilities.~~
- ~~Meeting the the terms of contracts and/or agreements.~~

~~Participating in the cooperation and coordination provisions under the WIIN Act~~Delta Smelt Habitat Action.

Reclamation and DWR will annually report on water operations and fish performance seasonally and in an annual summary. The monitoring programs and schedule for reporting are described in ~~the Charter~~Appendix C. Changes to the proposed action would occur based on the reinitiation triggers provided by 50 CFR 402.16. These triggers include:

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

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

Reclamation will monitor take for the purpose of evaluating trigger ~~(~~a) above; Reclamation will monitor the effects of the proposed action for the purpose of evaluating trigger ~~(~~b) above. If~~, through adaptive management,~~ Reclamation decides to modify the proposed action, Reclamation will evaluate the changes to the proposed action based on trigger ~~(~~c) above. Consistent with 50 CFR 402.16, the USFWS and/or NMFS may also reinitiate formal consultation as appropriate. Reclamation will coordinate with DWR as an “applicant” and support DWR’s coordination with CDFW.

Attachment 7

MENU

Bay-Delta Office

Welcome to the Bureau of Reclamation's Mid-Pacific Region

Reclamation / Mid-Pacific Region / Area Offices / BDO / Reinitiation of Consultation on the LTO

MP REGION

Updates to the Coordinated Long-Term Operation of the CVP and SWP and Related Facilities

On August 2, 2016, Reclamation requested reinitiation of Endangered Species Act (ESA) Section 7 consultation with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) on the Coordinated Long-Term Operation (LTO) of the Central Valley Project (CVP) and State Water Project (SWP). Several factors resulted in Reclamation requesting reinitiation of consultation under the ESA, including the apparent decline in the status of several listed species, new information related to recent multiple years of drought, and the evolution of best available science.

Reclamation proposes to maximize water deliveries and optimize marketable power generation consistent with applicable laws, contractual obligations, and agreements, and to augment operational flexibility by addressing the status of listed species.

- Biological Assessment - January 31, 2019 (PDF - 26 MB)
  - Cover Page and Table of Contents (PDF - 527 KB)
  - Chapter 1 - Introduction (PDF - 822 KB)
  - Chapter 2 - Status of Aquatic and Terrestrial (PDF - 2.9 MB)
  - Chapter 3 - Environmental Baseline (PDF - 170 KB)

    - Chapter 4 - Proposed Action (PDF - 861 KB)
    - Chapter 5 - Effects (PDF - 13 MB)
    - Chapter 6 - Cumulative Effects (PDF - 54 KB)
    - Chapter 7 - Conclusion (PDF - 201 KB)
    - Chapter 8 - Literature Cited (PDF - 484 KB)
    - Appendix A - Facility Descriptions and Operations (PDF - 12 MB)
    - Appendix B - New Melones Stepped Release Plan (PDF - 142 KB)
    - Appendix C - Real Time Water Operations Charter (PDF - 303 KB)
    - Appendix D - Modeling (PDF - 60 MB)
    - Appendix E - Avoidance and Minimization Measures (PDF - 474 KB)
    - Appendix F - Juvenile Salmonid Monitoring, Sampling, and Salvage Timing Summary from SacPAS (PDF - 2.4 MB)
    - Appendix G - Clifton Court Forebay Predation Studies (PDF - 29 MB)
    - Appendix H - Bay-Delta Aquatics Effects Figures (PDF - 3.3 MB)
- Memorandum of Understanding on the Reinitiation - December 30, 2016 (PDF - 182 KB)
- Request to FWS on Reinitiation of Section 7 Consultation - August 2, 2016 (PDF - 581 KB)
    - Response to Request for Reinitiation - August 3, 2016 (PDF - 557 KB)
- Request to NMFS on Reinitiation of Section 7 Consultation - August 2, 2016 (PDF - 512 KB)
    - NMFS Response to Request for Reinitation - August 17, 2016 (PDF - 761 KB)
- Notice of Intent to prepare a draft Environmental Impact Statement: Revisions to the coordinated LTO of the CVP and SWP and related facilities. (PDF - 315 KB)
- ROC on LTO Scoping Report
    - ROC on LTO Attachment A (PDF - 600 KB)
    - ROC on LTO Attachment B (PDF - 50 KB)
    - ROC on LTO Attachment C (PDF - 380 KB)

Meetings/Workshops

- Analysis Workshop - June 21, 2018
    - Agenda (PDF - 127 KB)
    - Attendee List (PDF - 44 KB)
    - Presentation (PDF - 707 KB)
    - Compiled Notes (PDF - 102 KB)
- Alternatives Workshop - June 7, 2018

    - Agenda (PDF - 715 KB)
    - Attendee List (PDF - 976 KB)
    - Presentation (PDF - 1,584 KB)
    - Compiled Notes (PDF - 217 KB)
- Sacramento River Brainstorming Workshop - May 23, 2018
    - Agenda (PDF - 135 KB)
    - Attendee List (PDF - 738 KB)
    - Presentation (PDF - 965 KB)
    - Compiled Notes (PDF - 182 KB)
- Alternative Workshop - April 26, 2018
    - Agenda (PDF - 153 KB)
    - Presentation (PDF - 1,593 KB)
    - Presentation (printer-friendly) (PDF - 1,332 KB)
    - Attendee List (PDF - 53 KB)
    - Table summary notes (PDF - 201 KB)
- Delta Technical Brainstorming Workshop, January 19, 2018
    - Agenda (PDF - 154 KB)
    - Biology Presentation (PDF - 4,161 KB)
    - Operations Presentation (PDF - 5,685 KB)
    - Overview Presentation (PDF - 356 KB)
    - Compiled Notes (PDF - 244 KB)
- American River Technical Brainstorming Workshop, November 21, 2017
    - Agenda (PDF 759 KB)
    - American River Workshop - Overview Presentation (PDF 242 KB)
    - Biology Presentation (PDF 6 MB)
    - Folsom Overview Presentation (PDF 1.1 MB)
    - Compiled Notes (PDF 600 KB)
- Stakeholder Kickoff Meeting - February 14, 2017
    - Agenda (PDF - 43 KB)
    - Presentation (PDF - 1.6 MB)
    - Presentation (Printer friendly version) (PDF - 6.7 MB)
    - Meeting Minutes (PDF - 488 KB)
    - Poster - Environmental Compliance Process (PDF - 30 KB)

- Poster - Stakeholder Engagement Process (PDF - 37 KB)

Note: documents in Portable Document Format (PDF) require Adobe Acrobat Reader 5.0 or higher to view download Adobe Acrobat Reader.

Last Updated: 3/1/19

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Chapter 4 Proposed Action

Reclamation and DWR propose to continue the coordinated long-term operation of the CVP and SWP to maximize water supply delivery and optimize power generation consistent with applicable laws, contractual obligations, and agreements; and to increase operational flexibility by focusing on non- operational measures to avoid significant adverse effects based on the conditions estimated to occur through 2030. Reclamation and DWR propose tto store, divert, and convey water in accordance with existing water contracts and agreements, including water service and repayment contracts, settlement contracts, exchange contracts, and refuge deliveries, consistent with water rights and applicable laws and regulations. The "Current Operation" shows the applicable criteria for operation of the CVP and SWP today. Although not part of the effects of operating the project into the future, the Current Operation provides a reference for the changes under the proposed action to assist in understanding the proposed action. Table 4-1 below identifies specific changes from current operations that are part of this proposed action. The proposed action includes habitat restoration that would not occur under the without action scenario and provides specific commitments for habitat restoration.

In preparing this Proposed Action, Reclamation and DWR considered conditions estimated to occur through 2030. If conditions past 2030 are similar to the analysis period, this BA can remain in effect. If, in accordance with the ESA, 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 the amount or extent of taking specified in the incidental take statement is exceeded, formal consultation will be reinitiated.

Table 4-1. Comparison of Select Components Across Without Action, Current Operation, and Proposed Action

Without Action	Current Operation	Proposed Action
Sacramento		
No temperature management	NMFS RPA I.2.1-I.2.4: Shasta Temperature Management, WRO 90-5 downstream temperature targets	Temperature management based on use of Shasta cold water pool for Winter-Run survival, including WRO 90-5.
No spring pulses	No spring pulses	Spring pulses if projected May 1 storage > 4 MAF
No fall base flows	3,250 cfs minimum flow	Measures to reduce Fall-Run redd dewatering and rebuild cold water pool, e.g., when end-of-September storage is: ≤ 2.2 MAF, flow is 3,250 cfs; ≤ 2.8 MAF, flow is 4,000 cfs; ≤ 3.2 MAF, flow is 4,500 cfs; > 3.2 MAF, flow is 5,000 cfs.
No Winter-Run Conservation Hatchery	Livingston-Stone National Fish Hatchery	Increased use of Livingston-Stone National Fish Hatchery during droughts
Trinity		
No flow control	Trinity ROD Flows + Lower Klamath Augmentation Flows	Trinity ROD Flows + Lower Klamath Augmentation Flows

Without Action	Current Operation	Proposed Action
Clear Creek		
No base flows	Base flow of 50–100 cfs based on 1960 CDFG MOA	Base flow of 200 cfs October to May, 150 cfs from June to September in all except critical years. In critical years, base flows may be reduced below 150 cfs based on the available water from Trinity Reservoir.
No channel maintenance flows	Channel maintenance flows when flood operations occur	10 TAF for channel maintenance, unless flood control operations provide similar releases, using the river release outlets, in all but dry and critical years
No pulse flows	Two pulse flows in Clear Creek in May and June of at least 600 cfs for at least 3 days for each pulse per year	10 TAF for pulse flows, using the river release, in all but critical years
No temperature management	Daily water temperature of: (1) 60º F at the Igo gage from June 1 through September 15; and (2) 56ºF at the Igo gage from September 15 to October 31.	Daily water temperature in below normal and wetter years of: (1) 60ºF at the Igo gage from June 1 through September 15; and (2) 56ºF or less at the Igo gage from September 15 to October 31; operate as close as possible to these targets in dry and critical years.
Feather		
No minimum flow	FERC License flows	FERC License flows
American River		
No minimum flows	2006 Flow Management Standard	2017 Flow Management Standard: Flows range from 500 to 2,000 cfs based on time of year and annual hydrology, and "planning minimum"
No temperature management	Daily average water temperature of 65°F or lower at Watt Avenue Bridge from May 15 through October 31. 56°F temperature target November 1 through December 31.	May 15 through October 31 daily average water temperature of 65°F (or target temperature determined by temperature model) or lower at Watt Avenue Bridge. When the target temperature requirement cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at Watt Avenue may be increased incrementally (i.e., no more than 1°F every 12 hours) to as high as 68°F. November 1 through December 31 daily average water temperature of 56°F target if cold water pool allows. A temperature higher than 56°F may be targeted based on temperature modeling results.
Delta		
No exports	D-1641 requirements; and OMR requirements based on USFWS RPA Actions 1-3 and NMFS RPA Action IV.2.3	D-1641 requirements; and risk-based OMR management incorporating real-time monitoring and models
DCC closed	DCC operations based on NMFS RPA that requires consultation to	DCC operations based on D-1641, closures for fish protections, and operations that avoid exceeding water quality standards

Without Action	Current Operation	Proposed Action
	avoid exceeding water quality standards	
No Delta Outflow requirement	D-1641 requirements; and maintain average X2 for September and October no greater (more eastward) than 74 km in the fall following wet years and 81 km in the fall following above normal years	Delta outflow to meet D-1641 requirements; Suisun Marsh Salinity Control Gate operation for up to 60 days in the summer and/or fall depending on year type; increased Delta outflow in wet and above normal year types in certain conditions.
No management of reverse flows	Old and Middle River Reverse Flows based on calendar date and workgroups per USFWS RPA Actions 1-3 and NMFS RPA Action 1V.2.3.	Old and Middle River Reverse flows based on species distribution, modeling, and risk analysis with provisions for capturing storm flows
No Head of Old River Barrier (HORB)	HORB installed between September 15 and November 30 of most years when flows at Vernalis is <5,000 cfs; occasionally also between April 15 and May 30 if Delta Smelt entrainment is not a concern	No HORB installed
No Delta Smelt conservation hatchery	U.C. Davis Fish Culture Center Refugial Population	Increased use of the U.C. Davis Fish Culture Center and a Delta Fish Species Conservation Hatchery for the introduction of cultured fish into the wild
No COA	1986 COA with 2018 Addendum	1986 COA with 2018 Addendum
Stanislaus		
No base flows	Appendix 2-E flows from NMFS RPA III.1.3	Stepped Release Plan
San Joaquin		
No base flows	San Joaquin River Restoration Program flows	San Joaquin River Restoration Program flows

4.1 Decreasing Operational Discretion

In the 1920s, farmers and municipalities relied upon intermittent surface flows and groundwater for water supply. Over time, as land in California was reclaimed and demand for water increased, over-pumping caused groundwater-level declines in the Sacramento and San Joaquin Valleys and associated aquifer- system compaction and land subsidence. The concept of a statewide water development project was first raised in 1919 by Lieutenant Robert B. Marshall of the U.S. Geological Survey, in large part to meet the demands of California's economy and prevent ongoing impacts resulting from water shortages, including land subsidence. He proposed transporting water from the Sacramento River system to the San Joaquin Valley then moving some of it over the Tehachapi Mountains into Southern California. His proposal led to the first plan for a state-operated water project.

In 1931, State Engineer Edward Hyatt introduced a report identifying the facilities required and the economic means to accomplish the north-to-south water transfer. Called the "State Water Plan," the report took 9 years and $1 million to prepare. To implement the plan, the Legislature passed the Central Valley Act of 1933, which authorized the project. A $170 million bond act was subsequently

approved by the voters of the State of California in a special election on December 19, 1933. In the midst of the Great Depression, revenue bonds were unmarketable, so the State was unable to secure funding to begin construction of the CVP. The State then sought the assistance of the federal government. Following the issuance of a feasibility report, President Franklin Roosevelt's administration agreed to take over the CVP as a public works project.

In the Rivers and Harbors Act of 1935, Congress originally authorized the CVP and provided initial funding. The Rivers and Harbors Act of 1937 reauthorized the CVP for the purposes of "improving navigation, regulating the flow of the San Joaquin River and the Sacramento River, controlling floods, providing for storage and for the delivery of the stored waters thereof, for construction under the provisions of the Federal Reclamation Laws of such distribution systems as the Secretary of the Interior (Secretary) deems necessary in connection with lands for which said stored waters are to be delivered, for the reclamation of arid and semiarid lands and lands of Indian reservations, and other beneficial uses, and for the generation and sale of electric energy as a means of financially aiding and assisting such undertakings and in order to permit the full utilization of the works constructed." Congress gave Reclamation broad authority to operate the dams and reservoirs of the CVP "first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses; and, third, for power." Reclamation had substantial flexibility in determining how to balance the three original project purposes.

Reclamation and DWR's operation of the CVP and SWP changed significantly in 1978 with the issuance of the WQCP under the SWRCB Water Right Decision 1485 (D-1485). D-1485 imposed on the water rights for the CVP and SWP new terms and conditions that required Reclamation and DWR to meet certain standards for water quality protection for agricultural, M&I, and fish and wildlife purposes; incorporated a variety of Delta flow actions; and set salinity standards in the Delta while allowing the diversion of flows into the Delta during the winter/spring. Generally, during the time D-1485 was in effect, natural flows met water supply needs in normal and wetter years and reservoir releases generally served to meet export needs in drier years.

The D-1485 requirements applied jointly to both the CVP and SWP, requiring a joint understanding between the projects of how to share this new responsibility. To ensure operations of the CVP and SWP were coordinated, the COA was negotiated and approved by Congress in 1986, establishing terms and conditions by which Reclamation and DWR would coordinate operations of the CVP and SWP, respectively. The 1986 COA envisioned Delta salinity requirements but did not address export restrictions during excess conditions.

In 1992, the CVPIA amended previous authorizations of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply uses, and fish and wildlife enhancement as having an equal priority with power generation. The CVPIA included a number of other provisions that represented additional Congressional direction for operation of the CVP, and overlaid a more complex statutory framework. These overlapping and sometimes competing requirements create challenges in how to address and balance the myriad of obligations Reclamation has in operating the CVP, and how to coordinate with the SWP.

In 1995, the SWRCB issued an update to the WQCP for the Bay-Delta. In 1999 (revised in 2000) the SWRCB issued D-1641 to implement those elements of the 1995 WQCP that were to be implemented through water rights. The 1995 WQCP and D-1641 included a new export to total Delta inflow (E/I) ratio of 35 percent from February through June. The 35 percent E/I from February to June was a significant change from D-1485. The 1995 WQCP and D-1641 also imposed Spring X2,

pumping limitations based on San Joaquin River flow, which in combination with the E/I ratio, reduced the availability of "unstored" flow for the CVP and SWP. February to June became an unreliable season for conveying water across the Delta. The effect of D-1641 was a shift in the export season, in part, to the summer, and the CVP and SWP entered the fall with lower reservoir levels and less need for flood releases in the fall and winter.

In addition, D-1641 imposed a flow requirement for the San Joaquin Basin at Vernalis which included both base flows and a large spring pulse flow. However, it did not address how the requirement would be shared between the three major San Joaquin tributaries. In lieu of the SWRCB assigning responsibility, a number of interested parties entered into the San Joaquin River Agreement, which included flow commitments from all three tributaries, funding commitments, transfers, and voluntary demand reductions. The agreement was initially set to expire in 2009 but was extended to 2012, when it expired and was not replaced.

In 2000, Reclamation signed the Trinity ROD. This defined a minimum flow regime of 369,000 acre-feet in critical dry years ranging to 816,000 acre-feet in wet years in the Trinity River. The ROD decreased the amount of water Reclamation could bring from the Trinity River over to the Sacramento River, reducing water supplies for Delta outflow and salinity and reducing the Shasta Reservoir cold water pool flexibility. This was intended to benefit Trinity River listed fish species, but it complicated Reclamation's ability to meet requirements imposed for the protection of Sacramento River listed fish.

4.2 Operational Tradeoffs

Operation of the CVP and SWP involves a balancing of various laws, regulations, contracts, and agreements. The overlapping and often conflicting requirements necessitate tradeoffs among watersheds, among fish species, among authorized purposes, and among water users. The tradeoffs occur within a season, between seasons, and across water years. Summarized below are examples of these conflicts and resulting tradeoffs that inform this proposed action.

To help protect against drought, Reclamation traditionally operated the CVP to achieve higher end-of- water-year storage that provided for increased carryover into the next year. Over time, the CVP has come under increasing pressure to provide water for environmental purposes which has resulted in decreased water supply reliability (see Figure 4-1 below). To meet state permit conditions, contractual demands, and environmental obligations, more demand has been placed on storage, resulting in lower end-of-water-year storage than was typical in the past. Significant tradeoffs in operational decision making now arise due to overlapping and conflicting regulations that make it difficult to meet congressionally authorized CVP purposes, including those for fish and wildlife.

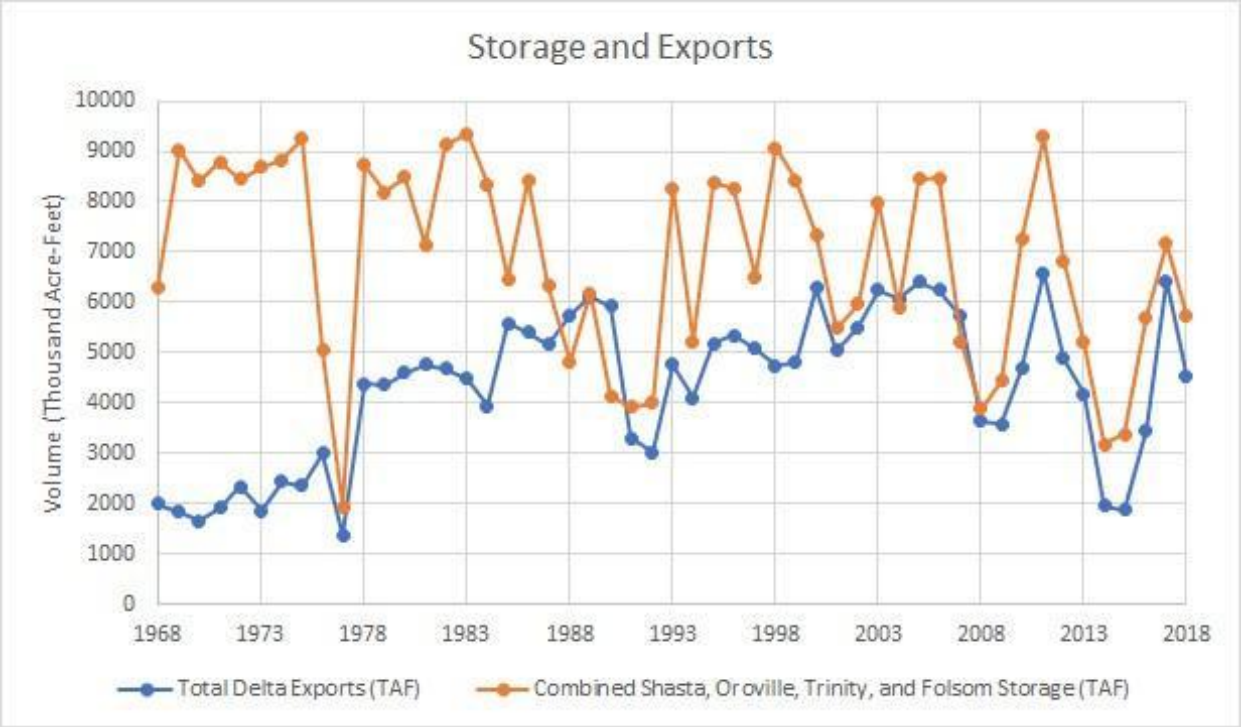

Figure 4-1. Delta Exports and Reservoir End-of-September Storage, 1968–2018

If releases are reduced during some timeframes to maintain higher storage levels in reservoirs, that has a corresponding effect of reducing inflows to the Delta, which then reduces Delta outflows. The benefit of increased reservoir storage has to be weighed against the potential negative downstream impacts on fisheries. In addition, maintaining a higher carryover storage increases the risk of having to make flood control releases early in the season to draw down to the required maximum flood conservation space. Making flood control releases in October and November to draw down to the required maximum storage conflicts with needs to reduce flows rapidly during the fall to encourage development of the cold water pool for the following year.

At Shasta Reservoir, Reclamation seeks to build cold water pool for providing suitable temperatures for Winter-Run Chinook Salmon spawning and incubation in the summer. Releases earlier in the year may reduce this cold water pool. To avoid Winter-Run Chinook Salmon and Fall-Run Chinook Salmon redd dewatering, releases higher than what is needed for instream requirements or Delta requirements may occur. Releases may also occur to facilitate spring pulses for juvenile outmigration, or increased releases to meet Delta outflow or salinity requirements per D-1641. Water temperature management strategies that deplete cold water pool early in the year come at the expense of later season temperatures.

The Trinity ROD and lower Klamath fall augmentation flows limit Reclamation's transbasin diversions and impact Reclamation's temperature operations and CVP deliveries on the Sacramento River. Increases in Trinity River releases in the late summer and fall result in lower storage in Trinity Reservoir at the end of the water year. The decreases in storage accumulate from water year to water year when the reservoir does not refill. Hydrologic conditions that do not refill the reservoir result in lower end-of-summer storages, negative impacts on cold water pool, and potentially warmer stream temperatures for Fall-Run Chinook Salmon spawning in the Trinity River.

Reclamation and DWR coordinate regarding downstream requirements (Delta outflow, Delta salinity, etc.). The amount of water from each reservoir depends upon reservoir storage, channel capacity, fishery concerns, projected inflows, and projected end-of-September storage. With its several upstream reservoirs, Reclamation balances releases so that no one reservoir bears the full burden of meeting its share of the downstream requirements.

On the American River, temperature targets during the summer are intended to benefit Steelhead. Meeting this requirement typically uses nearly the full volume of cold water pool. As a result, there is typically a limited cold water pool remaining in the fall to provide suitable spawning and incubation temperatures for Fall-Run Chinook Salmon. There is rarely enough cold water to provide optimal conditions for both species. Water transfers through Folsom from upstream senior water right holders that occur after Folsom Reservoir has stratified (typically early June) also may have small negative impacts on the cold water pool.

Demands for higher outflow directly conflict with fishery agency requests to maintain substantial cold water pool storage in the reservoirs through the summer for temperature operations in the summer and fall. There are also tradeoffs between species; for example, spring pulse flows on the Sacramento River to benefit Spring-Run Chinook Salmon could negatively impact temperature operations for Winter-Run Chinook Salmon.

San Luis Reservoir is an off-stream storage facility primarily fed by water pumped from the Delta. This supply is used annually to meet south of Delta contractor demands. In the past (prior to major seasonal restrictions of Delta pumping), Delta exports were utilized heavily during the rainy season to capture excess flows in the Delta and store that additional water supply in San Luis Reservoir. The developed water supply (i.e., stored water) was then used during the summer months to provide water to the south of Delta contractors. Now, however, because of significant export restrictions during the precipitation season imposed by the 1995/2006 WQCP and the 2008/2009 biological opinions, the bulk of the joint CVP/SWP Delta export capability is timed during the summer months, resulting in a higher percentage of south of Delta deliveries relying on upstream storage. Ideally, San Luis Reservoir would be as full as possible by April 1 of each water year, then operated to meet south of Delta needs throughout the summer. San Luis Reservoir low point generally occurs the end of August of each water year. If San Luis low point is too low, there can be algae problems for users of water through the San Felipe Project, particularly Santa Clara Valley Water District. Those users have expressed a need to have a plan to prevent San Luis Reservoir from becoming so low that water supplies are negatively impacted by algal growth.

With respect to hydropower generation, the use of direct river release outlets to access colder water below the power penstock intakes for fishery purposes causes the releases to bypasses hydropower production. This impacts power customers and represents a loss of revenue to Reclamation. In addition, increased requirements and regulations over the years have impacted the ability to deliver CVP water, resulting in lower allocations. The lower allocations result in lower revenues for the restoration fund and increase power customer costs to make up the difference.

4.3 Coordinated Operation Agreement

Reclamation and DWR propose to operate their respective facilities in accordance with the COA. The COA defines the project facilities and their water supplies, sets forth procedures for coordinating operations, and identifies formulas for sharing joint responsibilities for meeting Delta standards and other legal uses of water. It further identifies how unstored flow will be shared, sets up a framework

for exchange of water and services between the projects, and provides for periodic review of the agreement.

Through the COA, Reclamation and DWR share the obligation for meeting in-basin uses. In-basin uses are defined in the COA as legal uses of water in the Sacramento Basin, including the water required under the provisions of Exhibit A of the COA [SWRCB Delta standards]. Each project is obligated to ensure water is available for these uses. The respective degree of obligation is dependent on several factors, as described below.

Balanced water conditions are defined in the COA as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus exports. Excess water conditions are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses plus exports. Reclamation's Central Valley Operations Office (CVO) and DWR's SWP Operations Control Office jointly decide when balanced or excess water conditions exist. During balanced water conditions, the projects share the responsibility in meeting in-basin uses.

During excess water conditions, sufficient water is available to meet all beneficial needs, and the CVP and SWP are not required to supplement the supply with water from reservoir storage. Under Article 6(g) of the COA, Reclamation and DWR have the responsibility (during excess water conditions) to store and export as much water as possible, within physical, legal, and contractual limits.

Implementation of the COA principles has continuously evolved since 1986 as changes have occurred to CVP and SWP facilities, to operating criteria, and to the overall physical and regulatory environment. For example, updated water quality and flow standards adopted by the SWRCB, CVPIA, and ESA responsibilities have affected both CVP and SWP operations. The 1986 COA incorporated D-1485 provisions regarding Delta salinity, outflow, and export restrictions. It also envisioned and provided a methodology to incorporate future regulatory changes, like Delta salinity requirements, but did not explicitly envision (or explicitly address) sharing of export restrictions. Both D-1641 and the 2008 and 2009 biological opinions included various export restrictions that were not explicitly addressed in the 1986 COA; however, the available export capacity as a result of these export restrictions was shared between the projects in the absence of a formal update.

In 2018, Reclamation and DWR modified four key elements of the COA to address changes since COA was originally signed: (1) in-basin uses; (2) export restrictions; (3) CVP use of Banks Pumping Plant up to 195,000 acre-feet per year; and (4) the periodic review. COA sharing percentages for meeting Sacramento Valley in-basin uses now vary from 80 percent responsibility of the United States and 20 percent responsibility of the State of California in wet year types to 60 percent responsibility of the United States and 40 percent responsibility of the State of California in critical year types. In a dry or critical year following two dry or critical years, the United States and State will meet to discuss additional changes to the percentage sharing of responsibility to meet in-basin use. When exports are constrained, and the Delta is in balanced conditions, Reclamation may pump up to 65 percent of the allowable total exports with DWR pumping the remaining capacity. In excess conditions, these percentages change to 60/40.

4.4 CVP Water Contracts

Based on the provisions of federal reclamation law, the CVP delivers water pursuant to water service and water repayment contracts, as well as settlement, exchange, and refuge contracts. Reclamation also delivers water pursuant to temporary, not to exceed 1 year, "Section 215 Contracts," when there are surplus flood flows. Pursuant to the Warren Act, Reclamation provides for the conveyance of non-CVP (which includes SWP water) when there is excess capacity available in CVP facilities. This consultation covers the operation of the CVP and SWP to deliver water under the terms of all existing contracts up to full contract amounts, which includes the impacts of maximum water deliveries and diversions under the terms of existing contracts and agreements, including timing and allocation. Reclamation is not proposing to execute any new contracts or amend any existing contracts as part of this consultation.

Reclamation proposes to operate the CVP to meet its obligations to deliver water to senior water right holders who received water prior to construction of the CVP, to wildlife refuge areas identified in the CVPIA, and to water service contractors.

Many senior water right holders executed contracts with Reclamation, such as the Sacramento River Settlement Contractors and San Joaquin River Exchange Contractors. The terms of those contracts differ significantly from water service contracts. The pattern of diversion of water under a water service contract depends on the use of the water, with irrigation water typically diverted and used during the irrigation season (March through October), and M&I water diverted and used year-round. All water service contracts contain a shortage provision allowing Reclamation to reduce the amount of water made available for a variety of reasons, such as droughts. Table 4-2 summarizes the number of CVP water service and repayment contracts and the amount of water under contract.

Table 4-2. CVP Water Service and Repayment Contracts

[1] Contract quantities do not reflect actual deliveries due to system conditions.

CVP Division	Number of Contracts	Contract Quantity[1] (Acre-Feet)
Tehama-Colusa Canal, Corning Canal, Redding Area, and Trinity River Division	36	468,890
American River	9	328,750
New Melones/Eastside Contracts	2	155,000
South of Delta	44	2,112,898
Friant Division	27	2,249,475
Contra Costa Water District	1	195,000

This consultation covers Reclamation's operational actions to meet the terms of its existing CVP water supply contracts (i.e., water service contracts, and settlement, exchange, and refuge contract).

CVP Water service and repayment contracts include shortage provisions as follows: Article 12, Constraints on the Availability of Water, provides for a Condition of Shortage, which is defined in Article 1(c) as "...a condition respecting the Project during any Year such that the Contracting Officer is unable to deliver sufficient water to meet the Contract Total." Article 12(c) provides "In any Year in which there may occur a shortage for any of the reasons specified in subdivision 12(b) above, the Contracting Officer shall apportion Project Water among the Contractor and others entitled, under

existing contracts and future contracts (to the extent such future contracts are permitted under subsections (a) and (b) of Section 3404 of the CVPIA) and renewals thereof, to receive Irrigation Water consistent with the contractual obligations of the United States." Article 12(d) states, "Project Water furnished under this Contract will be allocated in accordance with the then-existing Project M&I Water Shortage Policy. Such policy shall be amended, modified, or superseded only through a public notice and comment procedure."

The largest contracts belong to the Sacramento River Settlement Contractors (approximately 2.1 MAF) and the San Joaquin River Exchange contractors (approximately 840 TAF). In very dry years, Reclamation and DWR are often limited to operating the CVP and SWP solely to meet these, and other senior water right requirements, along with refuge water supply requirements and minimum instream and Delta flows, M&I deliveries pursuant to the CVP M&I Shortage Policy, and SWP exports for health and safety. In recent drought years, limited water supplies, dry hydrology, and regulatory restrictions made it difficult for Reclamation to make water available to satisfy contracts already reduced by 25 percent in those years. Reclamation delivers Level 2 refuge water primarily from the CVP and acquires Incremental Level 4 water from voluntary measures which include water conservation, conjunctive use, purchase, lease, donations, or similar activities, or a combination of such activities which do not require involuntary reallocations of project yield. This proposed action covers the operation to deliver up to full contract amounts, including full Level 4 refuge contract amounts. Table 4-3 summarizes senior CVP water rights holders and the amount of water under contract.

Table 4-3. CVP Settlement Agreements

Contractor	Number of Contracts	Contract Quantity (Acre-Feet)
Sacramento River Settlement (SRS)	132	2,112,194 (1,775,313 Base + 336,881 Project)
San Joaquin River Exchange	4	840,000
Oakdale/S. San Joaquin ID Agreement and Stipulation	1	≤ 600,000
American River Contracts	13	578,441
Friant Division Riparian Holding Contracts	n/a	5 cfs past each diversion
South of Delta Settlement Contractors	9	35,623
North of Delta Refuges—Level 2 CVP	2	179,000
South of Delta Refuges—Level 2 CVP	3	376,515

Note: Contract quantities do not reflect actual deliveries due to system conditions.

The contracts referenced above usually include articles such as Article 5, Constraints on the Availability of Water, which states that "in a Critical Year, the Contractor's Base Supply and Project Water agreed to be diverted during the period April through October of the Year in which the principal portion of the Critical Year occurs and, each monthly quantity of said period shall be reduced by 25 percent."

4.5 SWP Water Contracts

The SWP has signed long-term contracts with 29 water agencies statewide to deliver water supplies developed from the SWP system. These contracts are with both M&I water users and agricultural water users. The contracts specify the charges that will be made to the water agency for both: (1) Conservation of Water, and (2) Conveyance of Water. The foundational allocation of water to each contractor is based on their respective "Table A" entitlement, which is the maximum amount of water delivered to them by the SWP, on an annual basis. Typically, annual water deliveries to individual agencies are less than their maximum Table A amount, due to a wide variety of reasons.

DWR proposes to operate the SWP in accordance with contracts with senior water right holders in the Feather River Service Area (approximately 983 TAF). Further, under State Water Contracts, DWR allocates Table A water as an annual supply made available for scheduled delivery throughout the year. Table A contracts total 4,173 TAF, with over 3 MAF for San Joaquin Valley and Southern California water users.

Article 21 of the long-term SWP water supply contracts provides an interruptible water supply made available only when certain conditions exist: (1) the SWP share of San Luis Reservoir is physically full, or projected to be physically full; (2) other SWP reservoirs south of the Delta are at their storage targets or the conveyance capacity to fill these reservoirs is maximized; (3) the Delta is in excess condition; (4) current Table A demand is being fully met; and (5) Banks has export capacity beyond that which is needed to meet current Table A and other SWP operational demands.

4.5.1 SWP Settlement Agreements

DWR has water rights settlement agreements to provide water supplies with entities north of Oroville, along the Feather River, Bear River, and in the Delta. These agreements provide users with water supplies that they were entitled to prior to the construction of the SWP's Oroville Complex. Collectively, these agreements provide over 1 MAF of water each year. DWR also has agreements with several (more than 60) riparian diverters along the Feather, Yuba, and Bear Rivers to provide water for diversion. Table 4-4 summarizes the volumes under the water rights settlement agreements.

Table 4-4. SWP Settlement Agreements

Location	Entity	Amount (Acre-Feet)
North of Oroville	Andrew Valberde	135
North of Oroville	Jane Ramelli	800
North of Oroville	Last Chance Creek WD	12,000
Feather River	Garden Highway Mutual Water	18,000
Feather River	Joint Water Districts Board	620,000
Feather River	South Feather Water & Power	17,555
Feather River	Oswald WD	3,000
Feather River	Plumas Mutual Water	14,000
Feather River	Thermalito Irrigation District	8,200
Feather River	Tudor Mutual Water	5,000
Feather River	Western Canal/PG&E	295,000
Bear River	South Sutter/Camp Far West	4,400
Delta	Byron-Bethany ID	50,000

Location	Entity	Amount (Acre-Feet)
Delta	East Contra Costa ID	50,000
Delta	Solano Co./Fairfield, Vacaville and Benicia	31,620

4.5.2 SWP Contracting Agencies

The SWP has signed contracts with 29 parties to provide water supplies developed by the SWP. Table 4-5 shows the maximum contracted annual water supply per DWR's most recent water supply reliability report.

Table 4-5. SWP Water Service Contracts

Contracting Agency	Maximum Supply (Acre-Feet)
Butte County	27,500
Plumas County	2,700
Yuba City	9,600
Napa County Flood Control and Water Conservation District	29,025
Solano County	47,756
Alameda County—Zone 7	80,619
Alameda County Water District	42,000
Santa Clara Valley Water District	100,000
Oak Flat Water District	5,700
Kings County	9,305
Dudley Ridge Water District	45,350
Empire West Side Irrigation District	3,000
Kern County Water Agency	982,730
Tulare Lake Water Storage District	87,471
San Luis Obispo County	25,000
Santa Barbara County	45,486
Antelope Valley-East Kern Water Agency	144,844
Santa Clarita Valley Water Agency	95,200
Coachella Valley Water District	138,350
Crestline-Lake Arrowhead Water Agency	5,800
Desert Water Agency	55,750
Littlerock Creek Irrigation District	2,300
Metropolitan Water District of Southern California	1,911,500
Mojave Water Agency	85,800
Palmdale Water District	21,300
San Bernardino Valley Municipal Water District	102,600
San Gabriel Valley Municipal Water District	28,800
San Gorgonio Pass Water Agency	17,300
Ventura County Watershed Protection District	20,000

4.6 D-1641

Reclamation and DWR propose to operate in accordance with obligations under D-1641, which provides protection for fish and wildlife, M&I water quality, agricultural water quality, and Suisun Marsh salinity. D-1641 granted Reclamation and DWR the ability to use or exchange each project's diversion capacity capabilities to maximize the beneficial uses of the CVP and SWP. The SWRCB conditioned the use of Joint Point of Diversion capabilities based on staged implementation and conditional requirements for each stage of implementation.

4.7 CVPIA

Reclamation proposes to operate in accordance with its obligations under the CVPIA, including but not limited to CVPIA 3406 (b)(2). DOI accounts for the following actions in meeting the 3406 (b)(2) requirement:

1. Primary Purposes: Any fish action (export reduction or upstream release) that predominantly contributes to one of the enumerated 3406(b) programs identified by the courts, including 3406(b)(1), (4), (5), (8), (9), (12), (18) and (19), must be counted against the up to 800 TAF of (b)(2) water. Thus, any upstream release or export reduction that predominantly contributes to one of those purposes will be deducted from the 3406(b)(2) account.
2. Secondary Purposes: Water operations in accordance with ESA and fish and wildlife objectives of D-1641 water quality actions may also be included in (b)(2) accounting. Upstream releases mandated by ESA Biological Opinions may also count towards 3406 (b)(2). Export reductions in ESA Biological Opinions or specified under D-1641 for fish and wildlife objectives may also count towards 3406 (b)(2). Releases for other water quality actions (i.e., net delta outflow) under D-1641 may also count towards 3406 (b)(2).

Pursuant to section 3406(b)(2)(C) the Secretary of the Interior may temporarily reduce deliveries of the quantity of water dedicated under this paragraph up to 25 percent of such total whenever reductions due to hydrologic circumstances are imposed upon agricultural deliveries of Central Valley Project water. The Secretary may also make water available for other purposes if the Secretary determines that the 800,000 acre-feet identified in section 3406(b)(2) is not needed to fulfill the purposes of section 3406.

4.8 Allocation and Forecasts

Reclamation proposes to allocate CVP water on an annual basis in accordance with contracts. Reclamation bases north of Delta allocations primarily on available water supply within the north of Delta system along with expected controlling regulations throughout the year. For south of Delta allocations, Reclamation relies on upstream water supply, previously stored water south of the Delta (in San Luis Reservoir) and conveyance capability through the Delta. Flows on the San Joaquin River often limit conveyance, as these flows are a driver of the flow direction within the Delta and through their influence on Old and Middle net reverse flow, can affect entrainment levels at the State and federal pumps.

The water allocation process for the CVP begins in the fall when Reclamation makes preliminary assessments of the next year's water supply possibilities, given current storage conditions combined

with a range of hydrologic conditions. Reclamation may refine these preliminary assessments as the water year progresses. Beginning February 1, Reclamation prepares forecasts of water year runoff using precipitation to date, snow water content accumulation, and runoff to date. All of the CVP's Sacramento River Settlement water rights contracts and San Joaquin River Exchange contracts require that contractors be informed no later than February 15 of any possible deficiency in their supplies. Reclamation targets February 20 as the date for the first announcement of all CVP contractors' forecasted water allocations for the upcoming contract year. Reclamation updates forecasts of runoff and operations plans at least monthly between February and May.

Reclamation performs operations forecasting on a 12-month ahead cycle each month to determine how the available water resources can best be used to meet project objectives and requirements. Reclamation bases forecasts on the 12-month projected runoff volumes that would occur naturally and considers potential upstream operations where relevant. For October and November, projected runoff is based entirely on historical hydrology as no snowpack data are available yet. In December and January, inflow forecasts may include snow pillow information and precipitation as well as historical hydrology. For the February through May period, the runoff volume estimates are based on the observed inflow to date and current snowpack measurements made at the end of each preceding month, projections through September, and historical hydrology for the next water year. These forecasts represent the uncertainty inherent in making runoff predictions. This uncertainty may include sources such as unknown future weather conditions, the various prediction methodologies, and the spatial coverage of the data network in a given basin.

In most years, the combination of carryover storage and runoff into CVP reservoirs and the Central Valley is not enough to provide sufficient water to meet all CVP contractors' contractual demands. Multiple legislative, contractual, and settlement obligations have created an increased tension in Reclamation's ability to make contractual deliveries of water to water users and to meet other legal obligations. As provided in Section 9 of the Reclamation Projects Act of 1939, Section 215 of the Reclamation Reform Act of 1982, and Section 3404(b) of CVPIA, Reclamation is authorized to enter into temporary contracts, not to exceed 1 year, for delivery of surplus flood flows.

4.8.1 SWP Allocation and Forecasting

At the beginning of each new water year, there is significant uncertainty as to the hydrologic conditions that will exist in the future several months, and hence, the water supplies that will be allocated by the SWP to its water contractors. In recognition of this, DWR utilizes a forecasting-water supply allocation process that is updated monthly, incorporates known conditions in the Central Valley watershed to-date, and forecasts future hydrologic conditions in a conservative manner to provide an accurate estimate of SWP water supplies that can be delivered to SWP contractors as the water year progresses.

There are many factors considered in the forecast-supply process. Some of these factors are the following:

- Water storage in Lake Oroville (both updated and end-of-water-year (September 30))
- Water storage in San Luis Reservoir (both updated and end-of-calendar-year)
- Flood operations constraints at Lake Oroville
- Snowpack surveys (updated monthly from February through May)
- Forecasted runoff in the Central Valley (reflects both snowpack and precipitation)

- Feather River settlement agreement obligations
- Feather River fishery flows and temperature obligations
- Anticipated depletions in the Sacramento and Delta basins
- Anticipated Delta standards and conditions
- Anticipated CVP operations for joint responsibilities
- Contractor supply requests and delivery patterns

Staff from both the Operations Control Office (OCO) and the State Water Projects Analysis Office (SWPAO) coordinate their efforts to determine the current water supply allocations. OCO primarily focuses on runoff/operations models to determine allocations. SWPAO requests updated information from the contractors on supply requests and delivery patterns to determine allocations. Both OCO and SWPAO staff meet at least once a month with the DWR Director to make final decisions on staff's proposed allocations.

The Initial Allocation for SWP Deliveries is made by December 1 of each year with a conservative assumption of future precipitation to avoid over-allocating water before the hydrologic conditions are well defined for the year. As the water year unfolds, Central Valley hydrology and water supply delivery estimates are updated using measured/known information and conservative forecasts of future hydrology. Monthly briefings are held with the DWR Director to determine formal approvals of delivery commitments announced by DWR.

Another water supply consideration is the contractual ability of SWP contractors to "carry over" allocated (but undelivered) Table A from 1 year to the next if space is available in San Luis Reservoir. The carryover storage is often used to supplement an individual contractor's current year Table A allocations if conditions are dry. Carryover supplies left in San Luis Reservoir by SWP contractors can result in higher storage levels in San Luis Reservoir. As project pumping fills San Luis Reservoir, the contractors are notified to take, or lose, their carryover supplies. Carryover water not taken, after notice is given to remove it, then becomes project water available for reallocation to all contractors in a given year.

Article 21 (surplus to Table A) water which is delivered early in the calendar year may be reclassified as Table A later in the year depending on final allocations, hydrology, and contractor requests.

Reclassification does not affect the amount of water carried over in San Luis Reservoir, nor does it alter pumping volumes or schedules.

4.8.2 Daily Operations

After the allocations and forecasting process, Reclamation and DWR coordinate their operations on a daily basis. Some factors which Reclamation and DWR consider when coordinating their joint operations include required in-Delta flows, Delta outflow, water quality, schedules for the joint use facilities, pumping/wheeling arrangements, and any facility limitations. Both projects must meet the flood obligations of individual reservoirs. CVP operations must also consider navigational flows at Wilkins Slough (see Upper Sacramento River for additional details).

During balanced water conditions, Reclamation and DWR maintain a daily water accounting of CVP and SWP obligations. This accounting allows for flexible operations and avoids the need to change

reservoir releases made several days in advance (due to travel time from the Delta). Therefore, adjustments can be made "after the fact," using actual observed data rather than by prediction for the variables of reservoir inflow, storage withdrawals, and in-basin uses. This iterative process of observation and adjustment results in a continuous truing up of the running COA account. The project that is "owed" water (i.e., the project that provided more or exported less than its COA-defined share) may request the other project adjust its operations to reduce or eliminate the accumulated account within a reasonable time.

The COA provides the mechanism for determining each project's responsibility for meeting in-basin use, but real-time conditions dictate real-time actions. Conditions in the Delta can change rapidly. For example, weather conditions combined with tidal action can quickly affect Delta salinity conditions and, therefore, the Delta outflow required to maintain joint salinity standards under D-1641.

Increasing or decreasing project exports can achieve changes to Delta outflow immediately. Imbalances in meeting each project's initial shared obligations are captured by the COA accounting and balanced out later.

When more reaction time is available, reservoir release changes are used to adjust to changing in-basin conditions. If Reclamation decides the reasonable course of action is to increase upstream reservoir releases, then the response may be to increase Folsom Reservoir releases first because the released water will reach the Delta before flows released from other CVP and SWP reservoirs. DWR's Lake Oroville water releases require about 3 days to reach the Delta, while water released from Reclamation's Shasta Reservoir requires 5 days to travel from Keswick Reservoir to the Delta. As water from another reservoir arrives in the Delta, Reclamation can adjust Folsom Reservoir releases downward. Alternatively, if sufficient time exists for water to reach the Delta, Reclamation may choose to make initial releases from Shasta Reservoir. Each occurrence is evaluated on an individual basis, and appropriate action is taken based on multiple factors. Again, the COA accounting captures imbalances in meeting each project's initial shared obligation.

One of the principal considerations when determining which reservoir to make releases from is the reservoir refill potential, i.e., the probability that a reservoir will, over the course of a year's inflow and releases, return to a desirable carryover storage. The refill potential is approximated by the average annual runoff divided by the total reservoir storage. Reservoirs that are large compared to the average runoff of their watershed, such as New Melones, have a small refill potential (0.5). Reservoirs that are small compared to the average runoff of their watershed, such as Folsom, have a large refill potential (2.5).

Folsom Reservoir generally has the best refill potential of the CVP reservoirs. Refill potential also is a consideration when evaluating how much water to move from Trinity Reservoir (0.5) to the Sacramento River side. Shasta Reservoir currently has an average annual runoff of approximately 8,476 TAF, with 4,500 TAF of storage, meaning an approximate refill potential of 2, so releases from Shasta Reservoir are more likely to be replaced with new inflow and bring storage back up than releases from Trinity Reservoir.

The duration of balanced water conditions varies from year to year. Balanced conditions never occur in some very wet years, while very dry years may have long continuous periods of balanced conditions, and still other years may have had several periods of balanced conditions interspersed with excess water conditions. Account balances continue from one balanced water condition through the excess water condition and into the next balanced water condition. When the project that is owed

water enters into flood control operations, which could be Shasta Reservoir for the CVP or Lake Oroville for the SWP, the accounting is zeroed out for that project.

Reclamation and DWR staff meet daily to discuss and coordinate CVP and SWP system operations. A number of items are discussed at this daily meeting, including:

- Current reservoir conditions
- Pumping status and current outages (for both the CVP and the SWP and how they are affecting project operations)
- Upcoming planned outages (CVP and SWP) and what that means for future operations
- Current reservoir releases and what changes may be planned
- Current regulatory requirements and compliance status
- Delta conditions to determine if CVP and SWP pumping make use of all available water

Reclamation and DWR also coordinate with Hydrosystem Controllers and Area Offices to ensure that, if necessary, personnel are available to make the desired changes. Once Reclamation and DWR each decide on a plan for that day and complete all coordination, each issue change orders to effectuate the decisions, if necessary.

Reclamation and DWR are co-located in the Joint Operations Center. Additionally, the California Data Exchange Center, California-Nevada River Forecast Center and the DWR Flood Management Group are also co-located in the Joint Operations Center. This enables efficient and timely communication, particularly during flood events.

4.9 New Science

Reclamation reinitiated consultation on the coordinated long-term operation of the CVP and SWP, in part because of new information. A substantial amount of new information and science has occurred since the 2008 and 2009 biological opinions. The following selected studies particularly inform the proposed action described in this biological assessment, but do not form a comprehensive list:

- Martin, 2017: A phenomenological assessment of temperature-related Chinook Salmon egg mortality modeling, calibrated to fry survival to Red Bluff, Martin et al. concluded the ideal incubation temperature for eggs in the river was 12C or 53.6°F. Below 53.6°F, there is no mortality due to temperature according to Martin. Biophysical models of oxygen transfer across the egg membrane corroborated the difference between temperature-dependent egg mortality predicted in the laboratory versus fry survival to Red Bluff. The 2017 LOBO review (Gore 2018), stated that the Martin approach represents a powerful predictive model for salmon vulnerability to temperature exposure but that the predictions of the oxygen diffusion model should be tested under field conditions because of the model's apparent sensitivity to extremely small changes in flow velocity, and it may be problematic to apply a density dependent model that lacks any mechanistic basis or site-specific information. Additionally, new laboratory studies from UC Davis (Del Rio et al. In Press) affirm earlier findings (USFWS 1999) that embryo survival is not appreciably impaired at daily mean water temperatures at or near 56^{o}F.
- Anderson 2018: Anderson reviewed Martin 2017 and found that for Chinook Salmon egg incubation shifting the focus of management from meeting a compliance temperature of 53.6°F on the Sacramento River all season long to releasing cold water for just the life stage specific

requirements of eggs yields efficiencies for when cold water from Shasta Reservoir is needed and when water from Shasta Reservoir can be saved.

- Grimaldo 2017: Models of Delta Smelt and salmonids at both CVP and SWP showed salvage of adult Delta Smelt increased at OMR more negative than -5,000 cfs, when all other variables were held at their averages. While OMR flow was an important predictor of CVP salvage, more important than even CVP exports, the OMR threshold of -5,000 cfs was most notable in SWP salvage.
- Perry 2018: Statistical modeling revealed that survival was positively related to inflow only in reaches that transitioned from bidirectional tidal flows to unidirectional flow with increasing inflows. Bidirectional to unidirectional transitions occurred in Sutter, Steamboat, and Georgiana Sloughs, and in the Sacramento River from the DCC to Rio Vista, and in the Mokelumne Rivers between the DCC and the San Joaquin River.
- SST 2017: Neither Coded Wire Tag (CWT) nor acoustic tag (AT) data for juvenile Fall-Run Chinook Salmon show a strong and consistent relationship between survival of fish from the San Joaquin River and exports at Jones and Banks Pumping Plants. The evidence of relationship between exports and through-Delta survival is inconclusive, however, the authors stated that their basis of knowledge is low. “It is unknown whether equivocal findings regarding the existence and nature of a relationship between exports and through-Delta survival is due to the lack of a relationship, the concurrent and confounding influence of other variables, or the effect of low overall survival in recent years.”
- Six-Year Acoustic Telemetry Study: The Six-Year Steelhead Acoustic Telemetry Study monitored yearling Steelhead migrating through the San Joaquin River and Old River during 2011 to 2016. Estimated survival was no different between the two routes in 2011, 2012, and 2014, but was greater for Steelhead that migrated through the San Joaquin River route in 2015 (average for all release groups was 0.30 [range, 0.19–0.46]), and 2016 (average was 0.45 for all release groups [range, 0.23–0.61]) (statistically significant for 2015 and 2016 survival estimates at alpha = 0.05; Reclamation 2018a,b,c; Buchanan 2018a,b,c).
- Buchanan 2018. Buchanan et al. summarized results of the Fall-Run Chinook acoustic tag studies in the San Joaquin River from 2010 through 2015. The results were survival of Fall-Run Chinook Salmon has been low since 2002, ranging between 0 and 0.05. Even in the high flow year of 201, survival was only 0.02, suggesting increased flows alone are not sufficient to resolve low survival. Over half of the Fall-Run Chinook Salmon that made it through the San Joaquin part of the Delta to Chipps Island were salvaged at the CVP and transported to Chipps.
- Hammock 2017 and Kimmerer and Rose 2018: These studies have used field research and modeling respectively to improve the scientific understanding of food limitation in Delta Smelt. Hammock et al. (2015, 2017) showed that feeding success is variable in space and time. Kimmerer and Rose (2018) used an individual-based life cycle model to show that if it were possible to achieve, a return to pre-overbite clam historical prey densities might increase the Delta Smelt’s population growth rate by 14 percent to 81 percent.
- MAST / FLaSH Reports: “According to the FLaSH conceptual model, conditions are supposed to be favorable for Delta Smelt when fall X2 is approximately 74 km or less, unfavorable when X2 is approximately 85 km or greater, and intermediate in between (Reclamation 2011, 2012). The data generally supported the idea that lower X2 and greater area of the LSZ would support more subadult Delta Smelt. The greatest LSZ area and lowest X2 occurred in September and October 2011 and were associated with a high FMWT index which was followed by the highest SKT index on record, although survival from subadults to adults was actually lower in 2011 than in 2010 and 2006. There was little separation between the other years on the basis of X2, LSZ area,

or FMWT index. The position and area of the LSZ is a key factor determining the quantity and quality of low salinity rearing habitat available to Delta Smelt and other estuarine species…" Any perceived benefit to the Delta Smelt population of having X2 in the 'favorable area' throughout most of 2017 due to high outflows remains unclear, with the Delta Smelt Fall Midwater Trawl index showing a decrease from that in 2016 and remaining near all-time lows.

- Bush 2017: Using isotopic analysis of otoliths from over a thousand Delta Smelt, Bush (2017) found the species exhibits partial migration through three different life history phenotypes, which include a freshwater resident fish, a brackish water resident fish, and a migratory phenotype, hatching in fresh water then occurring in brackish water during the juvenile and sub-adult stage. The relative abundance of each life history phenotype varied inter-annually with the latter most abundant, but not always dominant, in all years studied. The yearly contributions from each phenotype were found to vary with freshwater flows and temperature.
- CAMT Delta Smelt Entrainment Studies: New research shows that when Delta Smelt salvage is analyzed independently for SWP and CVP fish facility data, OMR flow has smaller explanatory influence on salvage than some other variables (Grimaldo et al. 2017). Population abundance, as indexed by the CDFW FMWT program, and turbidity have high explanatory power for adult Delta Smelt salvage at the SWP and CVP, particularly during the era of OMR management per the 2008 USFWS Biological Opinion. The basis for OMR flow management partially stems for earlier work showing that adult Delta Smelt salvage (Grimaldo et al. 2009) and proportional losses (Kimmerer 2008) increased as net OMR flow increased southward towards the Projects. New statistical techniques suggest a number of factors to minimize salvage or entrainment risk. However, given the correlation of OMR and SWP and CVP models, salvage and entrainment risk could be achieved through management of either indexes of the hydrodynamic influence from Project exports. It is worth noting that the ultimate objective for managing Delta Smelt entrainment should not focus on observed salvage. Rather, the management objective should be to target entrainment losses, in a traditional fisheries sense, to sustainable levels that do not compromise population growth rates (Maunder and Deriso 2011; Rose et al. 2013). New research performed under CAMT, can help scientists and resource managers identify circumstances when those large entrainment losses are likely to occur, which can ultimately be used to develop population risk assessment models (Grimaldo et al. 2017; Gross et al. 2018; Korman et al. 2018; Smith et al. 2018). The question about whether the Delta Smelt population can rebound from record-low abundances, even with improved entrainment management during the winter, remains outstanding given the importance of other factors at play (i.e., poor food supply, growth, water temperatures; see Maunder and Deriso 2011; Rose et al. 2013).

4.10 Proposed Action by Basin

Table 4-6 shows each of the components of the proposed action for this consultation, including operational changes, non-flow habitat, and facility improvements. The table also shows whether each action is covered at a site-specific or a programmatic level in this biological assessment and the proposed implementation approach. The three proposed implementation approaches are generally described as follows (further details are provided in section 4.12 and Appendix C):

- "Core" – the action is part of the Core Water Operations of the CVP and SWP.
- "Scheduling" – agencies and water users provide recommendations to Reclamation on scheduling and shaping specific flow actions.

- "Collaborative Planning" – agencies and water users work collaboratively to define, plan, and implement an action.

Completed consultations with existing biological opinions that address the effects of long-term operations, and do not trigger reinitiation under this consultation are identified by "NCO" (Not Consulted On).

Table 4-6. Components of the Proposed Action

Title	Site Specific or Programmatic	Implementation Approach
CVP/SWP Wide		
Divert and store water consistent with obligations under water rights and decisions by the State Water Resources Control Board	Site-specific	Core
Shasta Critical Determinations and Allocations to Water Service and Water Repayment Contractors	Site-specific	Core
Upper Sacramento		
Seasonal Operations	Site-specific	Core
Spring Pulse Flows	Site-specific	Scheduling
Shasta Cold Water Pool Management	Site-specific	Core
Fall and Winter Refill and Redd Maintenance	Site-specific	Core
Operation of a Shasta Dam Raise	Site-specific	Core
Rice Decomposition Smoothing*	Site-specific	Core
Spring Management of Spawning Locations*	Site-specific	Collaborative Planning
Cold Water Management Tools (e.g., Battle Creek Restoration, Intake Lowering near Wilkins Slough, Shasta TCD Improvements*)	Programmatic	Collaborative Planning
Spawning and Rearing Habitat Restoration*	Programmatic	Collaborative Planning
Small Screen Program*	Programmatic	Collaborative Planning
Winter-Run Conservation Hatchery Production*	Programmatic	Collaborative Planning
Adult Rescue*	Programmatic	Collaborative Planning
Juvenile Trap and Haul*	Programmatic	Collaborative Planning
Trinity		
Seasonal Operations	Site-specific	Core
Trinity River Record of Decision	NCO	NCO
Long-Term Plan to Protect Adult Salmon in the Lower Klamath River	NCO	NCO
Whiskeytown Reservoir Operations	Site-specific	Core
Clear Creek Minimum Flows	Site-specific	Core
Clear Creek Geomorphic and Spring Attraction Pulse Flows	Site-specific	Scheduling
Spring Creek Debris Dam	Site-specific	Core

Title	Site Specific or Programmatic	Implementation Approach
Feather		
FERC Project #2100-134	NCO	NCO
American		
Seasonal Operations	Site-specific	Core
2017 Flow Management Standard Releases and "Planning Minimum"	Site-specific	Core
American River Pulse Flows	Site-specific	Scheduling
Spawning and Rearing Habitat Restoration*	Programmatic	Collaborative Planning
Drought Temperature Facility Improvements*	Programmatic	Collaborative Planning
Stanislaus		
Seasonal Operations	Site-specific	Core
Stanislaus River Stepped Release Plan	Site-specific	Core
Stanislaus River Pulse Flows	Site-specific	Scheduling
Alteration of Stanislaus DO Requirement	Site-specific	Core
Spawning and Rearing Habitat Restoration*	Programmatic	Collaborative Planning
Temperature Management Study*	Programmatic	Collaborative Planning
San Joaquin		
San Joaquin River Restoration Program	NCO	NCO
Lower San Joaquin River Habitat*	Programmatic	Collaborative Planning
Delta		
Seasonal Operations	Site-specific	Core
Minimum Export Rate	Site-specific	Core
Delta Cross Channel Operations	Site-specific	Core
Agricultural Barriers	Site-specific	Core
Contra Costa Water District Rock Slough Operations	Site-specific	Core
North Bay Aqueduct	Site-specific	Core
Water Transfers	Site-specific	Core
Clifton Court Aquatic Weed Removal	Site-specific	Core
Suisun Marsh Preservation Agreement	NCO	NCO
OMR Management	Site-specific	Core
Tracy Fish Collection Facility* Operations	Site-specific	Core
Skinner Fish Facility* Operations	Site-specific	Core
Delta Smelt Habitat*	Site-specific	Collaborative Planning
Clifton Court Predator Management*	Site-specific	Core

Title	Site Specific or Programmatic	Implementation Approach
San Joaquin Basin Steelhead Telemetry Study*	Site-specific	Collaborative Planning
Sacramento Deepwater Ship Channel Food Study*	Programmatic	Collaborative Planning
North Delta Food Subsidies/Colusa Basin Drain Study*	Programmatic	Collaborative Planning
Suisun Marsh Roaring River Distribution System Food Subsidies Study*	Programmatic	Collaborative Planning
Tidal Habitat Restoration (Complete 8,000 acres from 2008 biological opinion)	Programmatic	Collaborative Planning
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project*	NCO	NCO
Predator Hot Spot Removal*	Programmatic	Collaborative Planning
Delta Cross Channel Gate Improvements*	Programmatic	Collaborative Planning
Tracy Fish Facility Improvements*	Programmatic	Collaborative Planning
Skinner Fish Facility Improvements*	Programmatic	Collaborative Planning
Small Screen Program*	Programmatic	Collaborative Planning
Reintroduction efforts from Fish Conservation and Culture Laboratory*	Site-specific	Collaborative Planning
Delta Fish Species Conservation Hatchery*	Programmatic	Collaborative Planning

The proposed action for each basin is described in more detail below. These sections give some background for context along with a description of the proposed seasonal operations and proposed action.

4.10.1 Upper Sacramento River (Shasta and Sacramento Divisions)

Reclamation operates the CVP Shasta Division for flood control, navigation, agricultural water supplies, M&I water supplies, fish and wildlife, hydroelectric power generation, Delta water quality, and water quality in the upper Sacramento River. Water rights, contracts, and agreements specific to the Upper Sacramento include SWRCB Decisions 990, 90-5, 91-1, and 1641, Settlement Contracts, Exchange Contract, and Water Service Contracts. Facilities include the Shasta Dam, Lake (4.552 MAF capacity), and Power Plant; Keswick Dam, Reservoir, and Power Plant, and the Shasta TCD. The Sacramento Division includes the Red Bluff Pumping Plant, the Corning Pumping Plant, and the Corning and Tehama-Colusa Canals, for the irrigation of over 150,000 acres of land in Tehama, Glenn Colusa, and Yolo Counties.

Flood control limits releases to less than 79,000 cfs at the tailwater of Keswick Dam and a stage of 39.2 feet in the Sacramento River at Bend Bridge gauging station (~100,000 cfs) to avoid inundating populated areas downstream. Flood control operations are based on regulating criteria developed by

the USACE pursuant to the provisions of the Flood Control Act of 1944. Flood control may reserve up to 1.3 MAF of storage behind Shasta, leaving 3.2 MAF for storage management.

Historical commerce on the Sacramento River resulted in a CVP authorization to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation in accordance with the River and Harbors Acts of 1935 and 1937. Although no commercial traffic persists, long-time water users diverting from the river have set their pump intakes based on minimum navigation flows; therefore, the CVP operates to approximately 5,000 cfs at the Wilkins Slough gage during periods when the intakes are being operated. This flow is often a challenge to meet under critical water supply conditions due to both water supply and cold water pool limitations, in which cases Reclamation has operated to approximately 4,000 cfs although impacts on senior diverters occur.

The intake for the Tehama-Colusa Canal and the Corning Canal is located on the Sacramento River approximately 2 miles southeast of Red Bluff. Water is diverted from the Sacramento River through a 2,000 cfs pumping plant (with ability to expand to 2,500 cfs) into a settling basin for continued conveyance in the Tehama-Colusa Canal and the Corning Canal.

The ACID holds senior water rights and has a settlement contract with Reclamation. Water is diverted to its main canal (on the right bank of the river) from a diversion dam located in Redding about 5 miles downstream from Keswick Dam. Reclamation will coordinate with ACID to ensure safe operation of the diversion dam during the irrigation season, from April through October.

In 1990 and 1991, SWRCB issued Water Rights Orders 90-05 and 91-01 modifying Reclamation's water rights for the Sacramento River. The orders stated that Reclamation shall operate Keswick and Shasta Dams and the Spring Creek Power Plant to meet a daily average water temperature of 56°F as far downstream in the Sacramento River as practicable during periods when higher temperature would be harmful to Winter-Run Chinook Salmon. Under the orders, the water temperature compliance point may be modified to an upstream location when the objective cannot be met at Red Bluff Pumping Plant. In addition, Order 90-05 modified the minimum flow requirements initially established in the 1960 MOA for the Sacramento River below Keswick Dam. The water right orders also recommended the construction of a Shasta TCD to improve the management of the limited cold water resources, and monitoring and coordination.

As a result, Shasta Dam is equipped with a TCD that allows temperature operations without impacting power generation. The TCD allows Reclamation to control the temperature of the water released from Shasta Dam. The TCD has four levels of gates from which water can be drawn, upper gates, middle gates, PRG gates (e.g., lower gates) and the Side Gates (coldest configuration). The last tool to reduce temperatures is to operate the TCD in the full side gate position, drawing the lowest (and coldest) possible water from the reservoir. Reclamation must balance the objectives of pulse flows or water supply releases early in the season which can conflict with the goal of maintaining a cold water pool sufficient to meet species' needs toward end of spawning and incubation season in the fall.

To operate the Shasta TCD, a defined amount of reservoir elevation above each set of gates is required to ensure safe operation. This requirement is reflected in Table 4-7 as 35 feet of submergence above the top of the gates.

Table 4-7. Shasta Temperature Control Device Gates with Elevation and Storage

TCD Gates	Shasta Elevation with 35 feet of Submergence of the TCD Gates (feet)	Shasta Storage (MAF)
Upper Gates	1,035	~3.66
Middle Gates	935	~1.64
Pressure Relief Gates	840	~0.59
Side Gates	720[1]	~0.08

[1]Low level intake bottom

4.10.1.1 *Seasonal Operations*

Reclamation operates in the winter for flood control, including both the channel capacity within the Sacramento River and Shasta Reservoir flood conservation space. The USACE is responsible for developing and maintaining the Water Control Manual (WCM) for Shasta Reservoir. The WCM provides that the top of conservation pool (TOC) will set the storage amount that Reclamation is not to exceed on a given date. Releases for flood control will vary dependent upon the current storage, the forecasted inflow, and the flow in the mainstem Sacramento River at Bend Bridge. Reclamation operates Shasta Dam releases to keep flows at Bend Bridge below 100,000 cfs, and therefore reservoir elevations may temporarily exceed the TOC storage to protect downstream populated areas. During the winter period, there can be significant flow fluctuations from Keswick Dam due to the flood control operations. When not operating for flood control, Shasta Dam is operated primarily to conserve storage while meeting minimum flows both down the Sacramento River and in the Delta. These minimum flows are held until irrigation demands require increased releases.

During the winter to spring period there are accretions (flows from unregulated creeks) into the Sacramento River below Shasta Dam. These local accretions help to meet both instream demands and outflow requirements, minimizing the need for additional releases from Shasta and Folsom Reservoirs. In wetter year types, Reclamation may be able to operate mostly for flood control and minimum instream requirements because of the large volumes of accretions to the Sacramento River. In drier years, these accretions may be lower and, therefore, require Reclamation to release a higher level of releases from the upstream reservoirs to meet state permit requirements as well as project exports in the Delta.

In the spring, releases are fairly steady (unless Shasta Reservoir is in flood control operations) until flows are needed to support instream demands on the mainstem Sacramento River and Delta Outflow requirements. Releases for Delta Outflow requirements are balanced between Shasta Reservoir and Folsom Reservoir. Both reservoirs have substantial temperature control requirements, and both need to substantially fill to be able to fully meet their temperature control requirements. Therefore, releases must be carefully balanced to allow each reservoir to fill without negatively impacting the other. An overarching goal for Reclamation when operating the CVP is to fill the reservoirs as much as possible by the end of the flood control season (end of May), while still meeting all other authorized project purposes.

Currently, the seasonal operation of the TCD is generally as follows: during mid-winter and early spring the highest possible elevation gates are utilized to draw from the upper portions of the lake to conserve deeper colder resources. During late spring and summer, the operators begin the seasonal progression of opening deeper gates as Shasta Reservoir elevation decreases and cold water resources

are utilized. In late summer and fall, the TCD side gates are opened to utilize the remaining cold water resource.

During the summer, operational considerations are mainly flows required for Delta outflows, instream demands, and temperature control. In river temperatures below Shasta Dam can be controlled via two methods. First is changing release volume or shifting releases between Trinity and Sacramento reservoirs, and the second is selective withdrawal through the TCD. Determination of which method to use is made on a daily basis as operators balance releases from multiple reservoirs to meet downstream needs.

Fall operations are dominated by temperature control and provision of fish spawning habitat. By late fall, the remaining cold water pool in Shasta Reservoir is usually limited. This can be a delicate balancing act in that if the early fall flows are too high then the fish may make their redds higher up on the edge of the river, and they become subject to the possibility of dewatering when the flows are reduced later in the fall. Sacramento River releases cannot be too low early in the fall as there are still significant instream diversion demands on the mainstem of the Sacramento River between Keswick Dam and Wilkins Slough, and depending on conditions, SWRCB Delta requirements may require upstream reservoir releases. This necessitates maintaining higher releases to support the instream demands until they fall off later in the season. At that time, Reclamation's objective is to drop Keswick releases to a lower level to conserve storage.

4.10.1.2 *Spring Pulse Flows*

Under the Core Water Operation, Reclamation would release spring pulse flows when the projected total May 1 Shasta Reservoir storage indicates a likelihood of sufficient cold water to support summer cold water pool management. Total storage provides a surrogate for the likely cold water pool and would inform the decision in addition to monthly winter reservoir temperature measurements and climate forecasts. Reclamation would evaluate the projected May 1 Shasta Reservoir storage at the time of the February forecast to determine whether a spring pulse would be allowed in March, and would evaluate the projected May 1 Shasta Reservoir storage at the time of the March forecast to determine whether a spring pulse would be allowed in April. If Shasta Reservoir total storage on May 1 is projected to be sufficient for cold water pool management (e.g., greater than 4 MAF), Reclamation could make a spring pulse release of up to 150 TAF in coordination with the Upper Sacramento scheduling team. Reclamation would not make a spring pulse release if the release would cause Reclamation to drop into a Tier 4 Shasta summer cold water pool management (i.e., the additional flow releases would decrease cold water pool such that summer Shasta temperature management drops in Tier 4) or interfere with the ability to meet other anticipated demands on the reservoir. Appendix C provides for an interagency and stakeholder group to determine the timing, duration, and frequency of the spring pulse within the 150 TAF volume.

4.10.1.3 *Cold Water Pool Management*

The closer Shasta Reservoir is to full by the end of May, the greater the likelihood of being able to meet the Winter Run Chinook Salmon temperature control criteria throughout the entire temperature control season. If Shasta Reservoir storage is high enough to use the Shasta TCD upper shutters by the end of May, Reclamation can maximize the cold water pool potential. Storage of 3.66 MAF allows water to pass through the upper gates of the Shasta TCD, but historical relationships suggest that a storage of 4 MAF on May 1st generally provides enough storage to continue operating through the upper gates and develop a sufficient cold water pool to meet 53.5°F on the Sacramento River above Clear Creek (at the CCR gaging station) for Winter-Run Chinook Salmon spawning and egg

incubation. Figure 4-2 provides an approximate rule of thumb for the relationship between temperature compliance, total storage in Shasta Reservoir, and cold water pool in Shasta Reservoir.

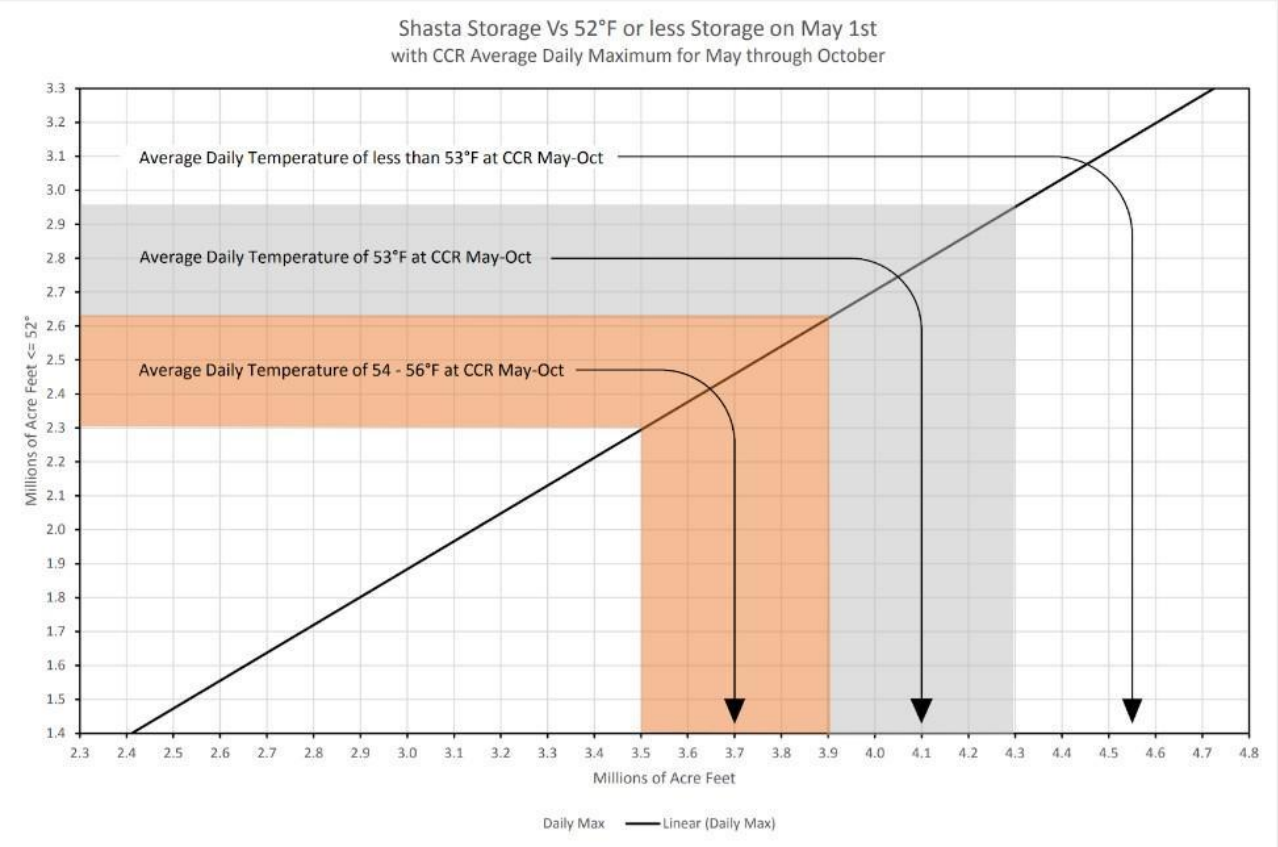

Figure 4-2. Relationship between Temperature Compliance, Total Storage in Shasta Reservoir, and Cold Water Pool in Shasta Reservoir

4.10.1.3.1 Summer Cold Water Pool Management

Reclamation proposes to operate the TCD at Shasta Dam to continue providing temperature management in accordance with CVPIA 3406(b)(6) while minimizing impacts on power generation. Cold water pool is defined as the volume of water in Shasta Reservoir that is less than 52°F, which Reclamation would determine based on monthly (or more frequent) reservoir temperature profiles. The Sacramento River above Clear Creek (CCR) gage is a surrogate for the downstream extent of most Winter-Run Chinook Salmon redds. Temperature management would start after May 15, or when the monitoring working group determines, based on real-time information, that Winter-Run Chinook Salmon have spawned, whichever is later. Temperature management would end October 31, or when the monitoring working group determines based on real-time monitoring that 95 percent of Winter-Run Chinook Salmon eggs have hatched, and aelvin have emerged, whichever is earlier.

Reclamation proposes to address cold water management utilizing a tiered strategy that allows for strategically selected temperature objectives, based on projected total storage and cold water pool, meteorology, Delta conditions, and habitat suitability for incoming fish population size and location. The tiered strategy recognizes that cold water is a scarce resource that can be managed to achieve desired water temperatures for fisheries objectives. Figure 4-3 below shows examples of water temperatures at CCR under the four tiers. The proposed tiers are described below, along with storage

levels that are likely to provide for cold water management within the tier. Actual operations will depend upon the available cold water and modeling. In any given year, cold water pool and storage could result in Reclamation switching between tiers within the year if needed to optimally use the cold water pool.

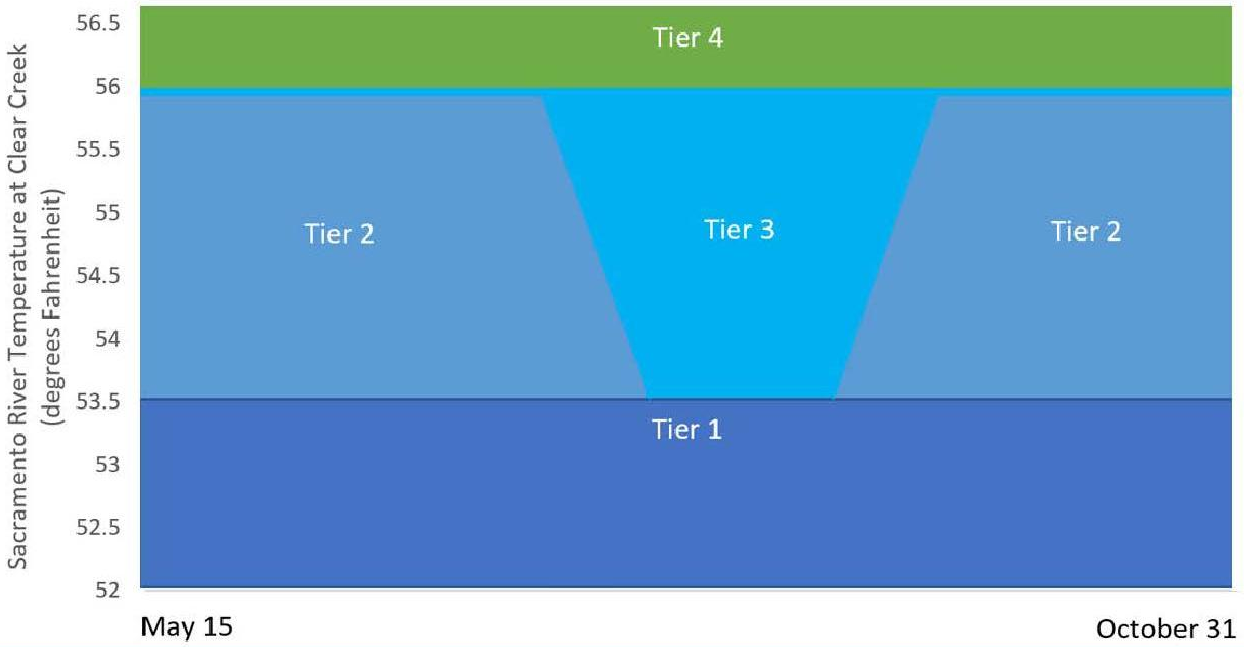

Figure 4-3. Tiered Temperature Management Strategy

- Tier 1. In years when Reclamation determines that cold water pool is sufficient (e.g., more than 2.8 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that a daily average temperature of 53.5°F at CCR can be maintained from May 15 to October 31), Reclamation proposes to operate to a daily average temperature of 53.5°F at the CCR gaging station to minimize temperature dependent mortality.
- Tier 2. In years when cold water pool is insufficient to allow Tier 1 (e.g., less than 2.8 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that the 53.5°F at CCR cannot be maintained from May 15 to October 31), Reclamation would optimize use of cold water for Winter-Run Chinook Salmon eggs based on life-stage-specific requirements, reducing the duration of time of operating to 53.5°F target temperatures. Water temperatures at CCR would vary based on real-time monitoring of redd timing and lifestage-specific temperature dependent mortality models, for example, Anderson (2017). The time period of 53.5°F at CCR would be centered on the projected time period when the Winter-Run eggs have the highest dissolved oxygen requirement (37–67 days post fertilization). At 2.79 MAF of cold water pool, Reclamation would operate to 53.5°F from 37 days after the first observed redd to 67 days after the last observed redd, as long as this is earlier than October 31. The duration of the 53.5°F protection will decrease in proportion to the available cold water pool on May 1. Reclamation will determine this time period by running different temperature scenarios through the latest egg mortality model(s) and real-time monitoring of redds. Reclamation would operate to daily average temperatures at CCR during the temperature management season outside of the stage-specific critical window no warmer than 56°F.

- Tier 3. When Reclamation determines that life-stage-specific temperature targets cannot be met per (2) above (e.g., less than 2.3 MAF of cold water pool in Shasta Reservoir at the beginning of May or modeling suggests that maintaining 53.5°F at CCR would have higher mortality than a warmer temperature), Reclamation proposes to use cold water pool releases to maximize Winter-Run Chinook Salmon redd survival by increasing the coldest water temperature target (see Figure 4-4 below). At the highest storage levels in Tier 3, the targeted temperature at CCR will be daily average 53.5°F and as storage decreases would warm in the life-stage-specific critical period up to 56°F. Reclamation would increase the temperature while minimizing adverse effects to the greatest extent possible, as determined by the latest egg mortality models, real-time monitoring, and expected and current water availability. This tier would be in effect until Reclamation could no longer meet 56°F at CCR at which point Reclamation would shift to tier 4.
- Tier 4. If there is less than 2.5 MAF of total storage (note the use of "total" storage as opposed to the "cold water pool" used in the previous criteria) in Shasta Reservoir at the beginning of May, or if Reclamation cannot meet 56°F at CCR, Reclamation will attempt to operate to a less than optimal temperature target and period that is determined in real-time with technical assistance from NMFS and USFWS. Reclamation will explore improved coordination of downstream diversions, and the potential for demand shifting. In addition, Reclamation proposes to implement intervention measures (e.g., increasing hatchery intake and trap and haul, as described below).

At the March forecast (mid-March), if the forecasted Shasta Reservoir total storage is projected to be below 2.5 MAF at the end of May, Reclamation would initiate discussions with USFWS and NMFS on potential intervention measures should this low storage condition continue into April and May, as described in Tier 4. Reclamation proposes to perform the first temperature model run in April after the DWR Bulletin 120 has been received and the operations forecast completed. This is the first month that a temperature model run is feasible based on temperature profiles. Prior to April, there is insufficient stratification in Shasta Reservoir to allow a temperature model to provide meaningful results. The April temperature model scenario is used to develop an initial temperature plan for submittal to the SWRCB. This temperature plan may be updated as Reclamation has improved data on reservoir storage and cold water pool via the reservoir profiles at the end of May, and throughout the temperature control season. Figure 4-4 provides a decision tree explaining the decision points for Shasta Reservoir temperature management.

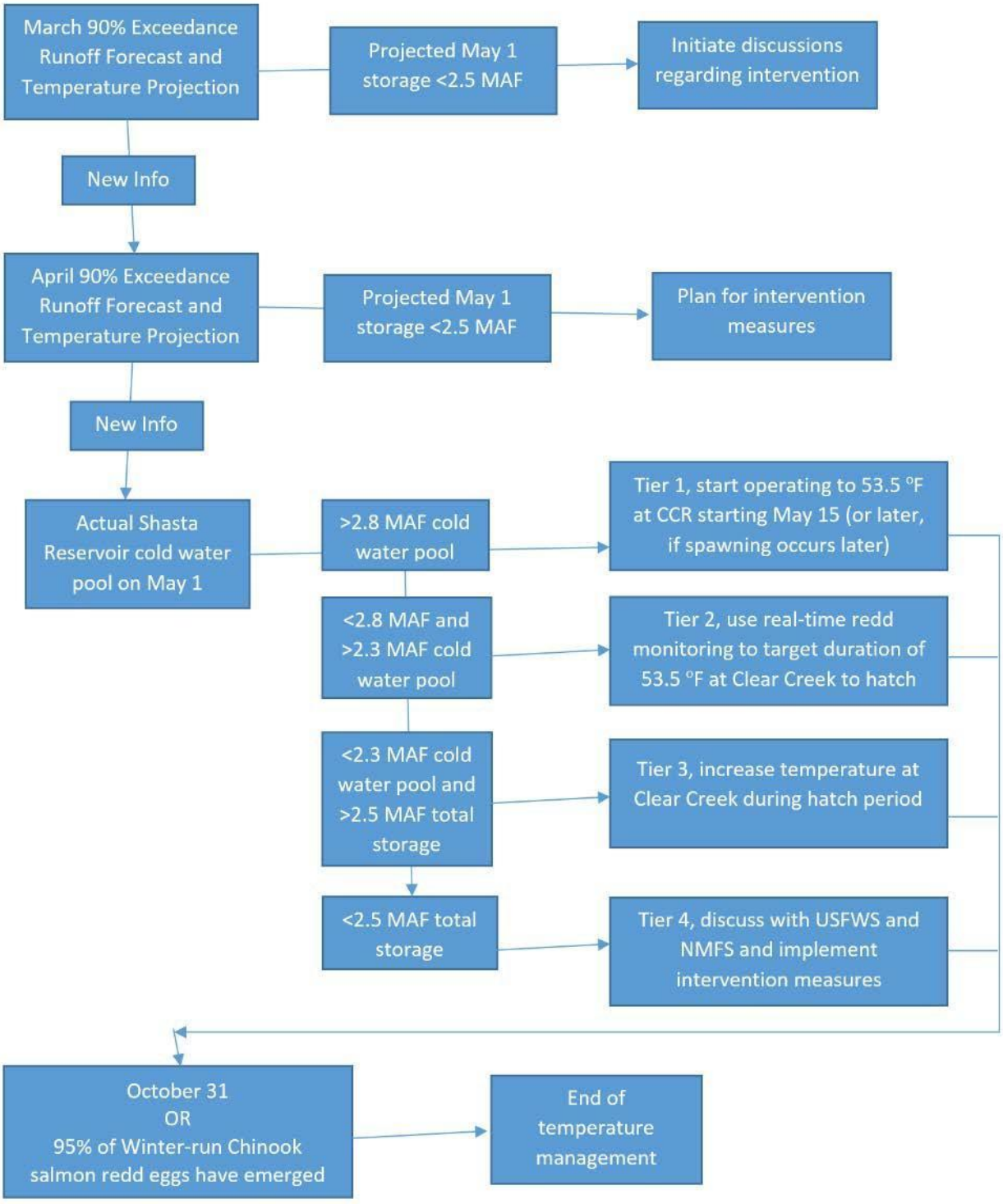

Figure 4-4. Decision Tree for Shasta Reservoir Temperature Management

Reclamation intends to provide temperature profile measurements for Shasta, Whiskeytown, and Trinity Reservoirs as shown in Table 4-8.

Table 4-8. Temperature Profile Measurements for Shasta, Whiskeytown, and Trinity Reservoirs

Reservoir	Every Month	Every 2 Weeks	Every Week	Comment
Shasta	01/01–03/01 12/1–12/31	03/01–05/01 11/15–12/01	05/01–11/15	25 ft intervals for "Every Month," otherwise 5 ft intervals
Whiskeytown	01/01–12/31			25 ft intervals
Trinity	01/01–12/31			25 ft intervals

Reclamation proposes to provide a draft temperature management plan to the SRTTG in April for its review and comment, consistent with WRO 90-5. Reclamation's proposed April temperature management plan will describe which of the four tiers Reclamation forecasts for that year's summer temperature management season, along with a temperature modeling scenario and the operations forecast. The SWRCB has overall authority to determine if the plan is sufficient to meet water right permit requirements.

4.10.1.4 *Fall and Winter Refill and Redd Maintenance*

Reclamation proposes to rebuild storage and cold water pool for the subsequent year. Maintaining releases to keep late spawning Winter-Run Chinook Salmon redds underwater may drawdown storage necessary for temperature management in a subsequent year. Reclamation will minimize effects with a risk analysis of the remaining Winter-Run Chinook Salmon redds, the probability of sufficient cold water in a subsequent year, and a conservative distribution and timing of subsequent Winter-Run Chinook Salmon redds. If the combined productivity of the remaining redds plus a conservative scenario for the following year is less than the productivity of maintaining, Reclamation will reduce releases to rebuild storage.

The conservative scenario for the following year would include a 75% (dry) hydrology; 75% (warm) climate; a median distribution for the timing of redds, and the ability to remain within Tier 3 or higher (colder) tiers.

If, based on the above analysis, Reclamation determines reduced releases are needed to rebuild storage, targets for winter base flows (December 1 through the end of February) from Keswick would be set in October based on-Shasta Reservoir end-of-September storage. These targets would be set based on end-of-September storage and the current hydrology, after accounting for winter-run red stranding. Base flows would be set based on historic performance to accomplish improved refill capabilities for Shasta Reservoir to build cold water pool for the following year. Table 4-9 shows examples of possible Keswick Releases based on Shasta Reservoir storage condition; these would be refined through future modeling efforts as part of the seasonal operations planning.

Table 4-9. Keswick Dam Release Schedule for End-of-September Storage

Keswick Release (cfs)	Shasta End-of-September Storage
3,250	≤ 2.2 MAF
4,000	≤ 2.8 MAF
4,500	≤ 3.2
5,000	> 3.2 MAF

4.10.1.4.1 Operation of Shasta Dam Raise

Reclamation proposes to enlarge Shasta Dam and Reservoir by raising the dam crest 18.5 feet under a separate ESA consultation for construction. The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet water temperature objectives and habitat requirements for salmonids during drought years and increase water supply reliability. Reclamation would operate a raised Shasta Dam consistent with the downstream requirements and operations described in this proposed action.

4.10.1.4.2 Conservation Measures

Conservation measures are included to avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include actions that benefit listed species without impacting water supply or other beneficial uses.

- Rice Decomposition Smoothing: Following the emergence of Winter-Run Chinook Salmon and prior to the majority of Fall-Run Chinook Salmon spawning, upstream Sacramento Valley CVP contractors and the Sacramento River Settlement Contractors propose to work to synchronize their diversions to lower peak rice decomposition demand. With lower late October and early November flows, Fall-Run Chinook Salmon are less likely to spawn in shallow areas that would be subject to dewatering during winter base flows. Early reductions (late October–early November) would balance the potential for dewatering late spawning Winter-Run Chinook Salmon redds and early Fall-Run Chinook Salmon dewatering.
- Spring Management of Spawning Locations: Reclamation will coordinate with NMFS to establish experiments to refine the state of the science and determine if keeping water colder earlier induces earlier spawning, or if keeping April/May Sacramento River temperatures warmer induces later spawning.
- Cold Water Management Tools: Reclamation will explore additional opportunities to extend the cold water pool, options include:
    - *Battle Creek Restoration:* Reclamation would accelerate implementation of the Battle Creek Salmon and Steelhead Restoration Project, which is intended reestablish approximately 42 miles of prime salmon and Steelhead habitat on Battle Creek, and an additional 6 miles on its tributaries. Winter-Run Chinook Salmon are currently limited to a single population that spawns in a 5-mile stretch of the Sacramento River, but they are being reintroduced to Battle Creek (around 200,000 juveniles were released in Battle Creek in 2018), and this new population would benefit from the restoration efforts.
    - *Lower Intakes near Wilkins Slough:* Due to temperature requirements, Sacramento River flows at or near Wilkins Slough can drop below the 5,000 cfs minimum navigational flow set by Congress. As many of the fish screens at diversions in this region were designed to meet the 5,000 cfs minimum, they may not function properly at the lower flows and as a result, not meet state and federal fish screening requirements during the lower flows (NCWA 2014). This could result in take of state and federally protected species that use this section of the river. This action would provide grants to water users within this area to install new diversions and screens that would operate at lower flows, which would allow Reclamation to have greater flexibility in managing Sacramento River flows and temperatures for both water users and wildlife, including listed salmonids (NCWA 2014). The authority for this action is 3406(b)(21). One example project under this program is screening of Meridian Farms.

  - *Shasta Temperature Control Device Improvements:* Reclamation proposes to study the feasibility of infrastructure improvements to enhance TCD performance, including reducing the leakage of warm water into the structure.

- Spawning Habitat: Reclamation proposes to create additional spawning habitat by injecting approximately 15,000 – 40,000 tons of gravel annually into the Sacramento River to 2030, using the following sites: Keswick Dam Gravel Injection Site, Market Street Injection Site, Redding Riffle, Turtle Bay, Tobiasson Island, Shea Levee sites, and Kapusta.
- Rearing Habitat: Reclamation, in coordination with the Sacramento River Settlement Contractors proposes to create 40–60 acres of side channel and floodplain habitat at approximately 10 sites in the Sacramento River by 2030. The potential sites include Salt Creek, Turtle Bay Island, Kutras Lake Rearing Structures, Painter's Riffle maintenance, North Cypress maintenance, Cypress South, North Tobiasson Rearing Structures maintenance, Tobiasson Side Channel, Shea Side Channel, Kapusta Side Channel, Kapusta 1-A Side Channel maintenance, Kapusta 1-B Side Channel, Anderson River Park Side Channels, Cow Creek Side Channel, I-5 Side Channel, China Gardens, Rancheria Island Side Channel, Rancho Breisgau, Lake California Side Channel maintenance, Rio Vista Side Channel, East Sand Slough Side Channel, La Barranca Side Channel, Woodson Bridge Bank Rearing Improvement, Jellys Ferry, Dog Island, Altube Island, Blackberry Island, Oklahoma Avenue, Mooney Island, McClure Creek, Blethen Island, Wilsons Landing, McIntosh Island, Shaw, Larkins, Reilly Island, Hanson Island, and Broderick.
- Small Screen Program: Reclamation and DWR propose to continue to work within existing authorities (e.g., Anadromous Fish Screen Program) to screen small diversions throughout Central Valley CVP/SWP streams and the Bay-Delta.
- Winter-Run Chinook Salmon Conservation Hatchery Production: In a Tier 4 year, Reclamation proposes to increase production of Winter-Run Chinook Salmon. Increased production during drought could help populations continue over multiple years. Increased production would aim to offset temperature dependent mortality on the Sacramento River. Reclamation would consider New Zealand or Great Lake Winter-Run Chinook Salmon stock for augmenting conservation hatchery stock to improve heterozygosity.
- Adult Rescue: Reclamation proposes to trap and haul adult salmonids and sturgeon from Yolo and Sutter bypasses during droughts and after periods of bypass flooding, when flows from the bypasses are most likely to attract upstream migrating adults and move them up the Sacramento River to spawning grounds. This trap and haul is in addition to weir fish passage projects that are part of the proposed action elsewhere. This would improve survival of the adults, leading to increased juvenile production in the following year and more flexibility with salvage.
- Trap and Haul: If Reclamation projects a Tier 4 year (less than 2.5 MAF of storage at the beginning of May), Reclamation proposes implementation of a downstream trap and haul strategy for the capture and transport of juvenile Chinook Salmon and Steelhead in the Sacramento River watershed in drought years when low flows and resulting high water temperatures are unsuitable for volitional downstream migration and survival. Reclamation proposes to place temporary juvenile salmon collection traps (e.g., rotary screw traps, fyke nets, floating juvenile collectors, weirs, trawls, seines), at key feasible locations, downstream of spawning areas in the Sacramento River. Reclamation would transport collected fish to a safe release location or locations in the Delta upstream of Chipps Island. or in the bay. Juvenile trap and haul activities would occur from December 1 through May 31, consistent with the migration period for juvenile Chinook Salmon and Steelhead (NMFS 2014) depending on hydrologic conditions. In the event of high river flows or potential flooding, trapping operations would cease and traps would be removed, as appropriate.

4.10.2 Trinity River Division

Congress authorized the Trinity River Division in 1955 as an integrated component of the CVP in order to increase water supplies for irrigation and other beneficial uses in the Central Valley, recognizing that water "surplus" to the present and future needs of the Trinity and Klamath Basins could be diverted to the Central Valley "without detrimental effect to the [Klamath-Trinity Basin's] fishery resources." Accordingly, Reclamation operates the Trinity River Division both to export water to the Sacramento River system and to ensure necessary flow releases into the Trinity-Klamath Basin, such as through implementation of the Department of the Interior's Trinity River Mainstem Fishery Restoration ROD (2000 ROD). Trans-basin exports transfer water from the Trinity River to the Sacramento River system through Lewiston Reservoir, Carr Tunnel, Whiskeytown Reservoir, and Spring Creek tunnel.

4.10.2.1 *Seasonal Operations*

Diversion of Trinity Basin water to the Sacramento Basin (transbasin diversion) provides water supply and major hydroelectric power generation for the CVP and plays a key role in water temperature control in the Trinity River and upper Sacramento River. Transbasin diversions are managed to support water supply and temperature objectives within the Sacramento system and are regulated by the ROD and Trinity Reservoir supply. The 2000 Trinity ROD strictly limits Reclamation's transbasin diversions to 55 percent of annual inflow on a 10-year average basis to legal and trust mandates for the restoration and protection of the Trinity fishery which restrict the amount of water authorized for exportation to the Central Valley. Reducing transbasin diversions was intended to improve the cold water pool in Trinity Reservoir to improve conditions for fall spawning down the Trinity River. This limitation on transbasin diversions significantly impacts Reclamation's temperature operations on the Sacramento River and Reclamation's ability to satisfy senior water right holder and/or Settlement contractor commitments within the CVP system.

Trinity River exports are first conveyed through Carr Power Plant which flows directly into Whiskeytown Lake, a heavily used recreation facility. From Whiskeytown Lake, the exported water continues to flow into Spring Creek Power Plant and ultimately outflows into the Sacramento River below Keswick, or water is released from Whiskeytown to Clear Creek. Although Whiskeytown Lake is primarily used as conveyance system for transbasin transfers, operations at both Carr and Spring Power plants are done in a manner to maintain specified elevations for supporting recreation (based on season).

The amounts and timing of Trinity River basin exports into the Sacramento River basin are determined by subtracting Trinity River scheduled flow and targeted carryover storage from the forecasted Trinity water supply. Reclamation maintains at least 600 TAF in Trinity Reservoir, except during the 10–15 percent of water years when Shasta Reservoir is also drawn down. Reclamation proposes to address end-of-water- year carryover on a case-by-case basis in dry and critically dry water year types described in the Water Operations Governance process below.

The seasonal timing of Trinity River exports is a result of determining how to make best use of a limited volume of Trinity River export (in concert with releases from Shasta Reservoir) to help conserve cold water pools and meet water temperature objectives on the upper Sacramento and Trinity Rivers, as well as power production economics.

These exports support better Trinity River temperatures by maintaining cold water and reducing residence time within Lewiston Reservoir. Transbasin diversions also typically help meet Sacramento

River temperatures by providing additional cold water resources to the Sacramento River. As a result, Trinity River export operations are completely integrated with Shasta Dam operations.

4.10.2.2 *Trinity River Record of Decision*

The 2000 ROD prescribed increase flows to meet federal statutory and other responsibilities to protect and restore the basin's fishery resources, to be released from Lewiston Dam down the Trinity River. Specifically, it entails: (1) variable annual instream flows for the Trinity River from the Trinity River Division based on forecasted hydrology for the Trinity River Basin; (2) mechanical habitat rehabilitation projects along with sediment management and watershed restoration efforts; and (3) an adaptive management program. The 2000 ROD flow release schedules vary among water-year classes and were designed to address the environmental requirements of anadromous fish and fluvial geomorphic function. The following five water year classes and associated annual water volumes for release to the Trinity River are identified as: Critically Dry (369 TAF); Dry (453 TAF); Normal (636 TAF); Wet (701 TAF); and Extremely Wet (815 TAF).

Total river release can reach up to 11,000 cfs below Lewiston Dam (flood criteria) due to local high water concerns in the floodplain and local bridge flow capacities. Flood criteria provides seasonal storage targets and recommended releases November 1 to March 31.

4.10.2.2.1 **Long-Term Plan to Protect Adult Salmon in the Lower Klamath River**

In addition, in various years since 2003, and particularly since 2013, certain fishery agencies, together with the Tribal Governments, have requested additional late-season flows in the Trinity River above the 2000 ROD baseline flows (primarily in August and September) to prevent fish illness from instream crowding and warm waters in the lower Klamath River in drier years. In some cases, these releases were made in successive dry years and therefore had cumulative effects year to year, leading to lower storage in Trinity Reservoir and water supply and temperature impacts in the Sacramento and Trinity Rivers and Clear Creek.

Reclamation released a Record of Decision for the Long Term Plan to Protect Adult Salmon in the Lower Klamath River in 2017 (2017 ROD), which identified an adaptive management approach, a process, and criteria for Reclamation to determine if and when to provide supplemental flows from mid-August to late September from Lewiston Dam to prevent an episodic disease outbreak in the lower Klamath River in years when the criteria for such flows are met. These flows include a Preventative Base Flow component of a supplemental release of up to 40 TAF from Lewiston Dam over the course of approximately 30 days, beginning on or about August 23, with the intent of meeting and/or maintaining a target of up to 2,800 cfs in the lower Klamath River; a Preventative Pulse Flow component of up to 10 TAF release over 4 days to achieve a peak of 5,000 cfs in the lower Klamath River; and an Emergency Flow component which would be up to 34 TAF from Lewiston Dam over no more than 8 days, beginning on or about September 20 to meet a target of 5,000 cfs in the lower Klamath River. The 2017 ROD cited proviso 1 of Section 2 of the 1955 Act as authority for the releases.

4.10.2.3 *Whiskeytown Reservoir Operations*

Reclamation proposes to operate Whiskeytown Reservoir to: (1) regulate inflows for power generation and recreation; (2) support upper Sacramento River temperature objectives; and (3) provide for releases to Clear Creek, as proposed below. Two temperature curtains in Whiskeytown

Reservoir were installed to pass cold water through the bottom layer of the reservoir and limit warming from Carr power plant to Clear Creek or Spring Creek Power Plant.

Whiskeytown Lake is annually drawn down by approximately 35 TAF of storage space during November through April to regulate flows for winter and spring flood management. Heavy rainfall events occasionally result in spillway discharges to Clear Creek. Operations at Whiskeytown Lake during flood conditions are complicated by its operational relationship with the Trinity River, Sacramento River, and Clear Creek. On occasion, imports of Trinity River water to Whiskeytown Reservoir may be suspended to avoid aggravating high flow conditions in the Sacramento Basin. Joint temperature control objectives also similarly interact among the Trinity River, Clear Creek, and Sacramento River.

4.10.2.4 *Clear Creek Flows*

Reclamation proposes to release Clear Creek flows in accordance with the 1960 MOA with CDFW, and the April 15, 2002 SWRCB permit, which established minimum flows to be released to Clear Creek at Whiskeytown Dam. Reclamation proposes a minimum base flow in Clear Creek of 200 cfs from October through May and 150 cfs from June to September in all year types except Critical year types. In Critical years, Clear Creek base flows may be reduced below 150 cfs based on available water from Trinity Reservoir. Additional flow may be required for temperature management during the fall.

In addition, Reclamation proposes to create pulse flows for both channel maintenance and spring attraction flows. For spring attraction flows, Reclamation would release 10 TAF (measured at the release), with daily release up to the safe release capacity (approximately 900 cfs, depending on reservoir elevation and downstream capacity), in all year-types except for Critical year-types to be shaped by the Clear Creek Implementation Team in coordination with CVO. For channel maintenance flows, Reclamation would release 10 TAF from Whiskeytown, with a daily release up to the safe release capacity, in all year-types except for Dry and Critical year-types (based on the Sacramento Valley index) to be shaped by the Clear Creek Implementation Team in coordination with CVO. Pulses would be scheduled with CVO. No channel maintenance flows would be scheduled before January 1. For each storm event that results in a Whiskeytown Gloryhole spill of at least 3,000 cfs for 3 days, Reclamation will reduce the channel maintenance flow volume for this year or the following year by 5,000 acre-feet. If two Gloryhole spills occur that meet this criterion in a year, additional channel maintenance flows would not be released in that year. In Critical years, Reclamation would release one spring attraction flow of up to the safe release capacity (approximately 900 cfs) for up to 3 days and would not release any channel maintenance flows. Reclamation could instead, or in addition, use mechanical methods to mobilize gravel or shape the channel if needed to meet biological objectives.

The outlet from Whiskeytown Reservoir to Clear Creek is equipped with outlets at two different elevations. Releases can be made from either or both outlets to manage downstream temperature releases. Reclamation proposes to manage Whiskeytown releases to meet a daily average water temperature of: (1) 60°F at the IGO gage from June 1 through September 15; and (2) 56°F or less at the IGO gage from September 15 to October 31. Reclamation may not be able to meet these temperatures in Critical or Dry water year types. In these years, Reclamation will operate to as close to these temperatures to the extent possible.

4.10.2.5 *Spring Creek Debris Dam*

The Spring Creek Debris Dam (SCDD) was constructed to regulate runoff containing debris and acid mine drainage from Spring Creek, a tributary to the Sacramento River that enters Keswick Reservoir. The SCDD can store approximately 5,800 acre-feet of water. Operation of SCDD and Shasta Dam has allowed some control of the toxic wastes with dilution criteria. In January 1980, Reclamation, CDFW, and SWRCB executed an MOU to implement actions that protect the Sacramento River system from heavy metal pollution from Spring Creek and adjacent watersheds. In the operational situation when heavy rainfall events will fill SCDD and Shasta Reservoir will not reach flood control conditions, increased releases from CVP storage may be required to maintain desired dilution ratios for metal concentrations. Since water released for dilution of toxic spills is likely to be in excess of other CVP requirements, such releases increase the risk of a loss of water for other beneficial purposes.

4.10.2.6 *Clear Creek Restoration Program*

Reclamation and DWR propose to continue channel maintenance under the Clear Creek Restoration Program.

4.10.3 Feather River

DWR will operate Oroville Dam consistent with the NMFS, USFWS, and CDFW environmental requirements applicable for the current FERC License for the Oroville Complex (FERC Project #2100- 134). The downstream boundary of FERC's Oroville Project area is the Feather River above the city of Gridley. During the summer, DWR typically releases water from Lake Oroville to meet the requirements of instream flows and D-1641. Additional releases are made for local deliveries and exports at Banks Pumping Plant. DWR balances the cumulative storage between Lake Oroville and San Luis Reservoirs so as to meet its flood control requirements, Sacramento–San Joaquin Delta requirements, and deliver water supplies to its contracted water agencies consistent with all environmental constraints. Lake Oroville may be operated to convey water through the Delta to San Luis Reservoir via Banks under different schedules depending on Delta conditions, reservoir storage volumes, storage targets and regulatory requirements.

Decisions as to when to move water from Lake Oroville to San Luis Reservoir are based on many real- time factors.

4.10.4 American River Division

Reclamation operates the CVP American River Division for flood control, M&I and agricultural water supplies, hydroelectric power generation, fish and wildlife protection, recreation, and Delta water quality. Facilities include the Folsom Dam, reservoir (977 TAF capacity), power plant, urban water supply temperature control device, and the Joint Federal Project auxiliary spillway as well as the Nimbus Dam, Lake Natoma, Nimbus Power Plant, and Folsom South Canal.

Folsom Reservoir is the main storage and flood control reservoir on the American River. Numerous other smaller reservoirs in the upper basin provide hydroelectric generation and water supply without specific flood control responsibilities. The total upstream reservoir storage above Folsom Reservoir is approximately 820 TAF and these reservoirs are operated primarily for hydropower production. Ninety percent of this upstream storage is contained by five reservoirs: French Meadows (136 TAF); Hell Hole (208 TAF); Loon Lake (76 TAF); Union Valley (271 TAF); and Ice House (46 TAF).

Reclamation coordinates with the operators of these reservoirs to aid in planning for Folsom Reservoir operations.

Releases from Folsom Dam are re-regulated approximately 7 miles downstream by Nimbus Dam. Nimbus Dam creates Lake Natoma, which serves as a forebay for diversions to the Folsom South Canal. Releases from Nimbus Dam to the American River pass through the Nimbus Power Plant, or the spillway gates at flows in excess of 5,000 cfs. Because Folsom Reservoir is the closest reservoir to the Delta, releases from Folsom can more quickly address Delta water quality requirements under D-1641.

Reclamation proposes to meet water rights, contracts and agreements that are both specific to the American River Division as well as those that apply to the entire CVP, including the Delta Division. For lower American River flows (below Nimbus Dam), Reclamation proposes to adopt the minimum flow schedule and approach proposed by the Water Forum in 2017. in the document titled "Lower American River – Standards for Minimum Flows" dated December 2018. Flows range from 500 to 2000 cfs based on time of year and annual hydrology. The flow schedule is intended to improve cold water pool and habitat conditions for Steelhead and Fall-Run Chinook Salmon. Specific flows are determined using an index intended to define the current and recent hydrology. Although Reclamation has assumed the index proposed by the Water Forum in 2017 for the purposes of modeling and analysis within this biological assessment, Reclamation intends to continue discussions with the Water Forum to ensure the index used for implementation is appropriate to meet the intended objectives under continuously changing hydrology.

Reclamation proposes to work together with the American River water agencies to define an appropriate amount of storage in Folsom Reservoir that represents the lower bound for typical forecasting processes at the end of calendar year (the "planning minimum"). The planning minimum brings Reclamation's forecasting process together with potential local actions that either increase Folsom storage or reduce demand out of Folsom Reservoir. The implementation of a planning minimum allows Reclamation to work with the American River Group to identify conditions when local water actions may be necessary to ensure storage is adequate for diversion from the municipal water intake at Folsom Dam and/or the extreme hydrology presents a risk that needs to be properly communicated to the public and surrounding communities. This planning minimum will be a single value (or potentially a series of values for different hydrologic year types) to be used for each year's forecasting process into the future. The objective of incorporating the planning minimum into the forecasting process is to provide releases of salmonid-suitable temperatures to the lower American River and reliable deliveries (using the existing water supply intakes and conveyance systems) to American River water agencies that are dependent on deliveries or releases from Folsom Reservoir. This planning minimum is expected to be initially defined in 2019; however, it will be continuously evaluated between Reclamation and the Water Forum throughout implementation.

Reclamation expects infrequent scenarios where the forecasted storage may fall below the "planning minimum" due to a variety of circumstances and causes. In those instances, Reclamation and the American River water agencies will develop a list of potential off-ramp actions that may be taken to either improve forecasted storage or decrease demand on Folsom Reservoir. In its forecasting process for guiding seasonal operations, Reclamation will plan to maintain or exceed the planning minimum at the end of the calendar year. Reclamation has no legal liability should it fall below the planning minimum. When Reclamation estimates, using the forecasting process, that it would not be able to maintain Folsom Reservoir storage at or above the planning minimum for that year type (such as in extreme hydrologic conditions) or unexpected events cause the storage level to be at risk, American River water agencies would coordinate with Reclamation to identify and implement appropriate

actions to improve forecasted storage conditions, and the American River water agencies would work together to educate the public on the actions that have been agreed upon and implemented and the reasons and basis for them. If potential changes to Folsom Dam operations would have impacts on other aspects of the CVP and SWP or the entire integrated system, Reclamation will meet and discuss these potential changes and impacts with water contractors.

Reclamation would ramp down to the revised minimum flows from Folsom Reservoir as soon as possible in the fall and maintain these flows, where possible.

4.10.4.1 *Seasonal Operations*

In the winter and spring, flood control releases typically dominate the flow regime in the American River Division. Flood control operations occur to safely pass large storm events without exceeding the identified downstream levee capacity. This includes making dry-weather releases to ensure that the maximum storage adheres to the flood control elevation identified in the applicable Water Control Manual. Reclamation proposes to not reduce flows more than 500 cfs/day and not more than 100 cfs per hour except if necessary for flood control operations. Reclamation will minimize releases above 4,000 cfs during sensitive life stages (e.g., eggs, incubation, rearing) of salmonids and Steelhead to the extent feasible.

As part of implementing the 2017 Flow Management Standard, Reclamation proposes redd dewatering protective adjustments to limit potential redd dewatering due to reductions in the minimum release during the January through May period. Redd dewatering protective adjustments should limit the amount of dewatering due to a reduction of the minimum release, not the actual river release, and, as such, would not always minimize dewatering impacts to the same extent. In January and February, there is a Chinook Salmon redd dewatering protective adjustment, and in February through May there is a Steelhead redd dewatering protective adjustment.

During non-flood control operations within the fall and winter months, Reclamation proposes to operate to build storage by making minimum releases and capturing inflows, although drier conditions may also require releases for Delta requirements. To the extent possible, releases will be held relatively consistent to minimize potential redd dewatering.

Spring releases will be controlled by flood control requirements or, in drier hydrology, Delta requirements and water supply. Reclamation proposes to operate Folsom Dam in a manner designed to maximize capture of the spring runoff to fill as close to full as possible. To the extent practicable, Reclamation proposes to accommodate requests for spring pulse flows by re-shaping previously planned releases; however, these requests will not be accommodated in times when they may compromise temperature operations later in the year. Reclamation proposes to follow the 2017 Flow Management Standard, which includes a pulse flow event at some time during the period extending from March 15 to April 15 by supplementing normal operational releases from Folsom Dam under certain conditions when no such flow event has occurred between the preceding February 1 and March 1 timeframe. This spring pulse flow provides a juvenile salmonid emigration cue before relatively low flow conditions and associated unsuitable thermal conditions later in the spring, and downstream in the lower Sacramento River.

Reclamation proposes to continue to make summer releases for instream temperature control, Delta outflow, and exports, typically above the planning minimum flows. By late October, it is typical for Folsom Reservoir to have depleted the cold water pool. The primary way to provide additional instream cooling is to release water from the lower outlet works. This operation bypasses the power

penstocks and has a significant impact on power generation. In order to optimize power generation, Reclamation proposes to limit power bypass operations solely to respond to emergency or unexpected events or during extreme drought years when a drought emergency has been declared by the Governor of California.

4.10.4.2 *Temperature Management*

Reclamation proposes to prepare a draft Temperature Management Plan by May 15 for the summer through fall temperature management season using the best available (as determined by Reclamation) decision support tools. The information provided by the Operations Forecast will be used in the development of the Temperature Plan. The draft plan will contain: (1) forecasts of hydrology and storage; and (2) a modeling run or runs, using these forecasts, demonstrating what temperature compliance schedule can be attained. Reclamation will use an iterative approach, varying shutter configurations, with the objective to attain the best possible temperature schedule for the compliance point at Watt Avenue Bridge. The draft plan will be shared with the American River Group before finalization and may be updated monthly based on system conditions.

Reclamation proposes to manage the Folsom/Nimbus Dam complex and the water temperature control shutters at Folsom Dam to maintain a daily average water temperature of 65°F (or other temperature as determined by the temperature modeling) or lower at Watt Avenue Bridge from May 15 through October 31, to provide suitable conditions for juvenile Steelhead rearing in the lower American River. If the temperature is exceeded for 3 consecutive days, Reclamation will notify NMFS and outline steps being taken to bring the water temperature back into compliance. During the May 15 to October 31 period, if the Temperature Plan defined temperature requirement cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at Watt Avenue may be increased incrementally (i.e., no more than 1°F every 12 hours) to as high as 68°F. The priority for use of the lowest water temperature control shutters at Folsom Dam shall be to achieve the water temperature requirement for listed species (i.e., Steelhead), and thereafter may also be used to provide cold water for Fall-Run Chinook Salmon spawning.

4.10.4.3 *Conservation Measures*

Conservation measures are included to avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include non-flow actions that benefit listed species without impacting water supply or other beneficial uses.

- Spawning and Rearing Habitat Named Projects: Project activities include primarily side channel and floodplain creation, expansion, and grading, spawning gravel and large cobble additions, and woody material additions. Pursuant to CVPIA 3406(b)(13), Reclamation proposes to implement the following projects: Paradise Beach, Howe Avenue to Watt Avenue rearing habitat, William Pond Outlet, Upper River Bend, Ancil Hoffman, El Manto, Sacramento Bar North, Sacramento Bar South, Lower Sunrise, Sunrise, Upper Sunrise, Lower Sailor Bar, Upper Sailor Bar, Nimbus main channel and side channel, Discovery Park, Cordova Creek Phase II, Carmichael Creek Restoration and Sunrise Stranding Reduction.
- Reclamation proposes to continue maintenance activities at Nimbus Basin, Upper Sailor Bar, Lower Sailor Bar, Upper Sunrise, Lower Sunrise and River Bend restoration sites.
- Nimbus Hatchery: Reclamation will complete a Hatchery Genetics Management Plan for Steelhead and a Hatchery Management Plan for Fall-run Chinook Salmon as part of Nimbus Fish

Hatchery management. Reclamation will work with CDFW and NMFS to establish clear goals, appropriate time horizons, and reasonable cost estimates for this effort.

- Drought Temperature Management: In severe or worse droughts, Reclamation proposes to evaluate and implement alternative shutter configurations at Folsom Dam to allow temperature flexibility.

4.10.5 Delta

CVP and SWP facilities in the Delta provide for delivery of water supply to areas within and immediately adjacent to the Delta, and to regions south of the Delta. The major CVP features are the DCC, Contra Costa Canal and Rock Slough Intake facilities, Jones Pumping Plant, and TFCF. The main SWP Delta features are Suisun Marsh facilities, Banks Pumping Plant, CCF, Skinner Fish Facility, and Barker Slough Pumping Plant. These facilities and their operation under the proposed action are described in subsequent sections.

The CVP Jones Pumping Plant, located about 5 miles north of Tracy, has six fixed-speed pumps. It has a permitted diversion capacity of 4,600 cfs and sits at the end of an earth-lined intake channel about 2.5 miles long. The Jones Pumping Plant discharges into the head of the Delta Mendota Canal (DMC). The upper portion of the DMC is heavily impacted by subsidence which limits the maximum pumping rates to less than the permitted capacity. The SWP Banks Pumping Plant, located near the Jones Pumping Plant, has 11 variable speed pumps that allow for more control over the diversion rate. Pumping is limited to a maximum permitted capacity of 10,300 cfs per day. The Banks Pumping Plant discharges into the California Aqueduct. The Delta Mendota Canal Intertie (capacity 467 cfs from DMC to California Aqueduct; Capacity 900 cfs from California Aqueduct to DMC) is used to move water between the California Aqueduct and the Delta Mendota Canal. This structure was built to help both projects more effectively move water from the Delta into the San Luis Reservoir. This helps both projects when there are system restrictions that may prevent one party from moving water.

Banks pumps water directly from storage in CCF. The CCF radial gates are closed during critical periods of the ebb/flood tidal cycle to protect water levels experienced by local agricultural water diverters in the south Delta area. As a practical matter, Banks pumping rates are constrained operationally by limits on Clifton Court diversions from the Delta. The maximum daily diversion limit from the Delta into CCF is 13,870 acre-feet per day (6,990 cfs/day) and the maximum averaged diversion limit over any 3 days is 13,250 acre-feet per day (6,680 cfs/day). In addition to these requirements, DWR may increase diversions from the Delta into CCF by one-third of the San Joaquin River flow at Vernalis from mid-December through mid-March when flows at Vernalis exceed 1,000 cfs. These limits are listed in the USACE Public Notice 5820A Amended (Oct. 13, 1981).

During July through September, the maximum daily diversion limit from the Delta into CCF is increased from 13,870 acre-feet per day (6,990 cfs/day) to 14,860 acre-feet per day (7,490 cfs/day) and the maximum averaged diversion limit over any 3 days is increased from 13,250 acre-feet per day (6,680 cfs/day) to 14,240 acre-feet per day (7,180 cfs/day). These increases are for the purpose of recovering water supply losses incurred earlier in the same year to protect ESA-listed fish species. Those increases are a separate action permitted for short-term time periods. Further, Banks Pumping Plant will pump 195,000 acre-feet to the CVP in accordance with the 2018 COA Addendum.

The Barker Slough Pumping Plant diverts water from Barker Slough into the North Bay Aqueduct for delivery to the Solano County Water Agency (SCWA) and the Napa County Flood Control and Water Conservation District (Napa County FC&WCD) (NBA entitlement holders).

4.10.5.1 *Seasonal Operations*

Winter and spring pumping operations generally maximize exports of excess, unregulated, unstored water to help meet project demands later in the season and for Delta water quality. In order to minimize and avoid adverse effects on listed species, actions have been taken or imposed in the past to protect fish migration and minimize fish entrainment at Jones and Banks Pumping Plants. These restrictions limit the projects' ability to export excess water in the winter and spring and place a higher reliance on exporting previously stored water in the summer and fall.

Summer is generally a period of higher export potential. During the summer the CVP and SWP typically operate to convey previously stored water across the Delta for exporting at the Project pumps or other Delta facilities. Delta concerns during the summer are typically focused on maintaining salinity and meeting outflow objectives while maximizing exports with the available water supply.

Fall Delta operations typically begin as demands decrease, accretions increase within the system, and reservoir releases are decreasing to start conserving water. Exports are typically maximized to export available water in the system and may decrease if the fall remains dry. As precipitation begins to fall within the Sacramento and San Joaquin Basins, the reservoirs focus on building storage and managing for flood control. The enactment of D-1641 required higher spring releases; as a result, reservoir storage levels were lower in the fall and Reclamation and DWR had less need for flood releases. The 2008 biological opinion included an adaptive management action requiring an increase in fall flows to manage salinity in years following wet and above-normal years. However, lower fall outflows would better mimic historical (pre-project) conditions, and analyses indicate that the CVP and SWP have had negligible effects on fall outflows measured using X2 as a proxy (Hutton et al. 2017).

4.10.5.2 *Minimum Export Rates*

Water rights, contracts, and agreements specific to the Delta include D-1641, COA and other related agreements pertaining to CVP and SWP operations and Delta watershed users. In order to meet health and safety needs, critical refuge supplies, and obligations to senior water rights holders, the combined CVP and SWP export rates at Jones Pumping Plant and Banks Pumping Plant will not be required to drop below 1,500 cfs. Reclamation and DWR propose to use the Sacramento River, San Joaquin River, and Delta channels to transport water to export pumping plants located in the south Delta.

4.10.5.3 *Delta Cross Channel*

The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. When DCC gates are open, water is diverted from the Sacramento River through a short excavated channel into Snodgrass Slough and then flows through natural channels for about 50 miles to the vicinity of Banks and Jones Pumping Plants.

Reclamation operates the DCC in the open position to (1) improve the movement of water from the Sacramento River to the export facilities at the Banks and Jones Pumping Plants; (2) improve water quality in the central and southern Delta; and (3) reduce salinity intrusion rates in the western Delta. During the late fall, winter, and spring, the gates are often periodically closed to protect out-migrating salmonids from entering the interior Delta and to facilitate meeting the D-1641 Rio Vista flow objectives for fish passage. In addition, whenever flows in the Sacramento River at Sacramento

reach 20,000 to 25,000 cfs (on a sustained basis), the gates are closed to reduce potential scouring and flooding that might occur in the channels on the downstream side of the gates.

Reclamation proposes to operate the DCC gates to reduce juvenile salmonid entrainment risk beyond actions described in D-1641, consistent with Delta water quality requirements in D-1641. From October 1 to November 30, if the Knights Landing Catch Index or Sacramento Catch Index are greater than three fish per day Reclamation proposes to operate in accordance with Table 4-10 and Table 4-11 to determine whether to close the DCC gates and for how long. From December 1 to January 31, the DCC gates will be closed, unless Reclamation determines that it can avoid D-1641 water quality exceedances by opening the DCC gates for up to 5 days for up to two events within this period. During a critical year following a dry or critical year, if there is a conflict between water quality and species between December /1 to January 31 period, Reclamation and DWR propose to coordinate with USFWS, NMFS and the SWRCB on how to balance competing requirements.

From May 21 to June 15, Reclamation will close the DCC gates for 14 days during this period, consistent with D-1641. Reclamation and DWR's risk assessment will consider the Knights Landing RST, Delta juvenile fish monitoring program (Sacramento trawl, beach seines), Rio Vista flow standards, acoustic telemetered fish monitoring information as well as DSM2 modeling informed with recent hydrology, salinity, and tidal data. Reclamation will evaluate this information to determine if fish responses may be altered by DCC operations. If the risk assessment determines that survival, route entrainment, or behavior change to create a new adverse effect not considered under this proposed action, Reclamation will not open the DCC.

Table 4-10. Delta Cross Channel October 1–November 30 Action

Date	Action Triggers	Action Responses
October 1–November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index or Sacramento Catch Index is greater than five fish per day	Within 48 hours, close the DCC gates and keep closed until the catch index is less than three fish per day at both the Knights Landing and Sacramento monitoring sites
	Water quality criteria per D-1641 are met, either Knights Landing Catch Index or the Sacramento Catch Index are greater than three fish per day but less than or equal to five fish per day	Within 48 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days
	Water quality criteria per D-1641 are met, real-time hydrodynamic and salinity modeling shows water quality concern level targets are not exceeded during	Within 48 hours of start of LMR attraction flow release, close the DCC gates for up to 5 days
	28-day period following DCC closure and there is no observed deterioration of interior Delta water quality	(dependent upon continuity of favorable water quality conditions)
	Water quality criteria per D-1641 are met, real time hydrodynamic and salinity modeling shows water quality concern level targets are exceeded during 14- day period following DCC closure	No closure of DCC gates
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria	Monitoring groups review monitoring data and provide to Reclamation. Reclamation and DWR determine what to do with a risk assessment

Table 4-11. Water Quality Concern Level Targets

Water Quality Concern Level Targets (Water Quality Model simulated 14-day average Electrical Conductivity)	Water Quality Concern Level Targets (Water Quality Model simulated 14-day average Electrical Conductivity)
Jersey Point	1800 umhos/cm
Bethel Island	1000 umhos/cm
Holland Cut	800 umhos/cm
Bacon Island	700 umhos/cm

4.10.5.4 *Agricultural Barriers*

DWR proposes to continue to install three agricultural barriers at the Old River at Tracy, Middle River, and Grant Line Canal each year when necessary to improve quality and channel water levels in the south Delta area. The barriers are installed between April to July and removed in November. Barriers would include at least one culvert open to allow for fish migration when water temperatures are less than 22°C. The barriers provide an adequate agricultural water supply in terms of quantity, quality, and channel water levels to meet the needs of water users in the south Delta area.

4.10.5.5 *North Bay Aqueduct*

The North Bay Aqueduct and Barker Slough Pumping Plant will continue to operate under applicable regulatory requirements.

4.10.5.5.1 Sediment Removal

Sediment accumulates in the concrete apron sediment trap in front of the BSPP fish screens and within the pump wells behind the fish screens. Sediment removal from the sediment trap and the pump wells will be removed as needed.

4.10.5.5.2 Aquatic Weed Removal

Aquatic weeds will be removed, as needed, from in front of the fish screens at BSPP. Aquatic weeds accumulate on the fish screens, blocking water flow, and causing water levels to drop behind the screens in the pump wells. The low water level inside of the pump wells causes the pumps to automatically shut off to protect the pumps from cavitation. Aquatic weed removal system consists of grappling hooks attached by chains to an aluminum frame. A boom truck, staged on the platform in front of the BSPP pumps, will lower the grappling system into the water to retrieve the accumulated aquatic vegetation. The removed aquatic weeds will be transported to two aggregate base spoil sites located near the pumping plant.

4.10.5.6 *Contra Costa Water District Operations*

The CCWD diverts water from the Delta for irrigation and M&I uses under its CVP contract, under its own water right permits and license issued by the SWRCB, and under East Contra Costa Irrigation District's pre-1914 water right. The CCWD water system includes the Mallard Slough, Rock Slough, Old River, and Middle River (on Victoria Canal) intakes; the Rock Slough Fish Screen (constructed in 2011 under the authority of CVPIA 3406(b)(5)); the Contra Costa Canal and shortcut pipeline; and the Los Vaqueros Reservoir. The Rock Slough Intake, Contra Costa Canal, and shortcut pipeline are

owned by Reclamation, and operated and maintained by CCWD under contract with Reclamation. Mallard Slough Intake, Old River Intake, Middle River Intake, and Los Vaqueros Reservoir are owned and operated by CCWD. The Rock Slough Intake, Contra Costa Canal, and shortcut pipeline are owned by Reclamation" add a footnote that says "Federal legislation providing the authority for Reclamation to transfer title of the facilities was passed by Congress and signed by the President in March 2019. CCWD and Reclamation are beginning the title transfer process, which includes conducting the required environmetal and property record review to execute the transfer.

Operations at CCWD's intakes and Los Vaqueros Reservoir are governed by biological opinions from NMFS (NMFS 1993, 2007, 2010, 2017) and USFWS (USFWS 1993a, 1993b, 2000; 2007, 2010, 2017), an MOU with CDFW (CDFG 1994), and an incidental take permit from CDFW (CDFW 2009), which are separate from the biological opinions for the coordinated long-term operation of the CVP and SWP. Reclamation is not consulting on the biological opinions that govern CCWD's intakes and Los Vaqueros Reservoir, nor will this consultation amend or supersede those separate biological opinions. For the proposed action in this consultation, CCWD's operations are consistent with the current implementation of the operational criteria specified in those separate biological opinions. Reclamation will work with CCWD to ensure that implementation of the proposed action will not restrict CCWD operations beyond the restrictions of the separate biological opinions, allowing CCWD to have opportunities to fill Los Vaqueros Reservoir that are at least comparable to the current conditions.

Rock Slough Intake is located on Rock Slough at the head of the Contra Costa Canal, approximately 3.5 miles west of the junction of Rock Slough and Old River. The Rock Slough Fish Screen (RSFS) was constructed in 2011 at the Rock Slough Intake for the protection of listed species, in accordance with provisions specified in the 1993 USFWS biological opinion for the Los Vaqueros Project (USFWS 1993).

The 2008 USFWS biological opinion for the coordinated long-term operation of the CVP and SWP (USFWS 2008) and the 2009 CDFW ITP for the CCWD operations (CDFG 2009) considered the effects of the diversion of water at Rock Slough intake before the RSFS was constructed. In accordance with the 2009 ITP, CCWD obtained 36 acres of aquatic species habitat mitigation credits intended to address all of CCWD's intakes, assuming that Rock Slough was unscreened. Aquatic species impacts are now less given that the RSFS has been constructed (Reclamation 2016).

USFWS 2008 quantified incidental take and exempted prohibitions associated with all CCWD diversions as all Delta Smelt inhabiting the water diverted in the assumed 195 thousand acre -feet (TAF) maximum diversion amount (USFWS 2008, 2017). In a 2009 letter from USFWS regarding the effects of the RSFS on Delta Smelt and its critical habitat, USFWS acknowledges that "[s]ince the Rock Slough diversion will now be screened, less entrainment will be expected than what was described in the 2008 biological opinion and the expected incidental take remains the same."

In the proposed action, CCWD's operations are consistent with the operational criteria specified in separate biological opinions and permits that govern operations at CCWD's intakes and Los Vaqueros Reservoir (NMFS 1993, 2007, 2010, 2017; USFWS 1993a, 1993b, 2000, 2007, 2010, 2017; CDFG 1994, 2009) and remain unchanged from the current operations scenario.

Reclamation is not consulting on the NMFS 2017 biological opinion at this time and is not requesting any amendments to that biological opinion. However, the NMFS 2017 biological opinion indicates that the NMFS 2009 biological opinion on the long-term coordinated operations of the CVP and SWP, which is the subject of this consultation, analyzed the actual diversion of water through the

Rock Slough Intake (NMFS 2017: 87). Consistent with the 2008 USFWS biological opinion, Reclamation is requesting incidental take coverage for all water diverted at the Rock Slough Intake up to the maximum capacity of the intake (350 cfs) for the maximum annual diversion of 195 TAF.

4.10.5.7 *Water Transfers*

Reclamation and DWR propose to transfer project and non-project water supplies through CVP and SWP facilities. Water transfers would occur through various methods, including, but not limited to, groundwater substitution, release from storage, and cropland idling, and would include individual and multi-year transfers. The effects of developing supplies for water transfers in any individual year or a multi-year transfer is evaluated outside of this proposed action. Water transfers would occur from July through November in total annual volumes up to those described in Table 4-12.

Table 4-12. Proposed Annual Water Transfer Volume

Water Year Type	Maximum Transfer Amount (TAF)
Critical	Up to 600
Dry (following Critical)	Up to 600
Dry (following Dry)	Up to 600
All other years	Up to 360

As part of this proposed action, Reclamation and DWR will provide a transfer window from July 1 through November 30. Allowing fall transfers is expected to have water supply benefits and may provide flexibility to improve Sacramento River temperature operations, such as occurred during the 2014–2015 drought conditions. Real-time operations may restrict transfers within the transfer window so that Reclamation and DWR can meet other authorized project purposes, e.g., when pumping capacity is needed for CVP or SWP water.

4.10.5.8 *Clifton Court Aquatic Weed and Algal Bloom Management*

DWR will apply herbicides or will use mechanical harvesters on an as-needed basis to control aquatic weeds and algal blooms in CCF. Herbicides may include Aquathol K, a chelated copper herbicide (copper-ethylenediamine complex and copper sulfate pentahydrate) and, a copper carbonate compound, or other copper-based herbicides. Algaecides may include peroxygen-based algaecides (e.g.., PAK 27). These products are used to control algal blooms that can degrade drinking water quality through production of taste and odor compounds of algal toxins. Dense growth of submerged aquatic weeds can cause severe head loss and pump cavitation at Banks Pumping Plant when the stems of the rooted plant break free and drift into the trashracks. This mass of uprooted and broken vegetation essentially forms a watertight plug at the trashracks and vertical louver array. The resulting blockage necessitates a reduction in the pumping rate of water to prevent potential equipment damage through cavitation at the pumps and excessive weight on the louver array causing collapse of the structure. Cavitation creates excessive wear and deterioration of the pump impeller blades. Excessive floating weed mats also reduce the efficiency of fish salvage at the Skinner Fish Facility. Ultimately, this all results in a reduction in the volume of water diverted by the SWP. In addition, dense stands of aquatic weeds provide cover for unwanted predators that prey on listed species within the CCF. Aquatic weed control is included as a conservation measure to reduce mortality of ESA-listed fish species within the CCF (see section *4.95.11.3 Skinner Fish Facility Improvements*).

Mechanical methods are utilized to manually remove aquatic weeds. A debris boom and an automated weed rake system continuously remove weeds entrained on the trashracks. During high weed load periods such as late summer and fall when the plants senesce and fragment or during periods of hyacinth entrainment, boat-mounted harvesters are operated on an as-needed basis to remove aquatic weeds in the Forebay and the intake channel upstream of the trashracks and louvers. The objective is to decrease the weed load on the trashracks and to improve flows in the channel. Effectiveness is limited due to the sheer volume of aquatic weeds and the limited capacity and speed of the harvesters. Harvesting rate for a typical weed harvester ranges from 0.5 to 1.5 acres per hour or 4 to 12 acres per day. Actual harvest rates may be lower due to travel time to off-loading sites, unsafe field conditions such as high winds, and equipment maintenance.

Aquatic weed and algae treatments would occur on an as-needed basis depending upon the level of vegetation biomass, the cyanotoxin concentration from the harmful algal blooms (HAB), or concentration of taste and odor compounds . The frequency of aquatic herbicide applications to control aquatic weeds is not expected to occur more than twice per year, as demonstrated by the history of past applications. Aquatic herbicides are ideally applied early in the growing season when plants are susceptible to them during rapid growth and formation of plant tissues; or later in the season, when plants are mobilizing energy stores from their leaves towards their roots for overwintering senescence. The frequency of algaecide applications to control HABs is not expected to occur more than once every few years, as indicated by monitoring data and demonstrated by the history of past applications. Treatment areas are typically about 900 acres, and no more than 50% of the 2,180 total surface acres.

Aquatic weed assemblages change from year to year in the CCF from predominantly *Egeria densa* to one dominated by curly-leaf pondweed, sago pondweed, and southern naiad. To effectively treat a dynamic aquatic weed assemblage and harmful algal blooms, multiple aquatic pesticide compounds are required to control aquatic weeds and algal blooms in CCF. The preferred products are:

- Aquathol K, an endothall-based aquatic herbicide, that is effective on pondweeds;
- copper-based compounds that are effective on *E. densa*, cyanobacteria and green algae. The copper-based aquatic herbicides include copper sulfate pentahydrate and chelated copper herbicides; and
- peroxygen-based algaecides (e.g., PAK 27) that are effective on cyanobacteria.
- Aquathol K

The dipotassium salt of endothall is used for control of aquatic weeds and is the active ingredient in Aquathol® K (liquid formulation). Aquathol K is a widely used herbicide to control submerged weeds in lakes and ponds, and the short residual contact time (12-48 hours) makes it effective in both still and slow-moving water. Aquathol K is effective on many weeds, including hydrilla, milfoil, and curly-leaf pondweed, and begins working on contact to break down cell structure and inhibit protein synthesis. Without the ability to grow, the weed dies. Full kill takes place in 1 to 2 weeks. As weeds die, they sink to the bottom and decompose. Aquathol K is not effective at controlling E. densa.

Aquathol K is registered for use in California and has effectively controlled pondweeds and southern naiad in CCF and in other lakes. Endothall has low acute and chronic toxicity effects to fish. The LC50 for salmonids is 20-40 times greater than the maximum concentration allowed to treat aquatic weeds. The EPA maximum concentration allowed for Aquathol K is 5 ppm. A recent study (Courter et al. 2012) of the effect of Cascade® (same endothall formulation as Aquathol K) on salmon and steelhead smolts showed no sublethal effects until exposed to 9-12 ppm, that is, 2-3 times greater

than the 5 ppm maximum concentration allowed by the EPA and about 4-6 times greater than the 2-3 ppm applied in past CCF treatments. In the study, steelhead and salmon smolts showed no statistical difference in mean survival between the control group and treatment groups, however, steelhead showed slightly lower survival after 9 days at 9-12 ppm. Based on the studies with salmonids, Aquathol K applied at or below the EPA maximum allowable concentration of 5 ppm poses a low to no toxicity risk to salmon, steelhead and other fish. No studies have assessed the exposure risk to green sturgeon.

When aquatic plant survey results indicate that pondweeds are the dominant species in CCF, Aquathol K will be selected due to its effectiveness in controlling these species. Aquathol K will be applied according to the label instructions, with a target concentration dependent upon plant biomass, water volume, and forebay depth. The target concentration of treatments is 2- to 3 ppm, which is well below the concentration of 9-12 ppm where sublethal effects have been observed (Courter et al. 2012). DWR monitors herbicide concentration levels during and after treatment to ensure levels do not exceed the Aquathol K application limit of 5 ppm. Additional water quality testing may occur following treatment for drinking water intake purposes. Samples are submitted to a laboratory for analysis. There is no "real time" field test for endothall. No more than 50% of the surface area of CCF will be treated at one time. A minimum contact time of 12 hours is needed for biological uptake and treatment effectiveness, but the contact time may be extended up to 24 hours to reduce the residual endothall concentration for NPDES compliance purposes.

4.10.5.8.1 Copper-based Aquatic Herbicides and Algaecides

Copper herbicides and algaecides include chelated copper products and copper sulfate pentahydrate crystals. When aquatic plant survey results indicate that E. densa is the dominant species, copper-based compounds will be selected due to their effectiveness in controlling this species. E. densa is not affected by application of Aquathol K. Copper-based algaecides are effective at controlling algal blooms (cyanobacteria) that produce cyanotoxins or taste and odor compounds.

Copper herbicides and algaecides will be applied in a manner consistent with the label instructions, with a target concentration dependent upon target species and biomass, water volume and the depth of the forebay. Applications of copper herbicides for aquatic weed control will be applied at a concentration of 1 ppm with an expected dilution to 0.75 ppm upon dispersal in the water column. Applications for algal control will be applied at a concentration of 0.2 to 1 ppm with expected dilution within the water column. DWR will monitor dissolved copper concentration levels during and after treatment to ensure levels do not exceed the application limit of 1 ppm, per NPDES permit required procedures. Treatment contact time will be up to 24 hours. If the dissolved copper concentration falls below 0.25 ppm during an aquatic weed treatment, DWR may opt to open the radial gates after 12 hours but before 24 hours to resume operations. Opening the radial gates prior to 24 hours would enable the rapid dilution of residual copper and thereby shorten the exposure duration of ESA-listed fish to the treatment. No more than 50% of the surface area of CCF will be treated at one time.

4.10.5.8.2 Peroxygen-Based Algaecides

PAK 27 algaecide active ingredient is sodium carbonate peroxyhydrate. An oxidation reaction occurs immediately upon contact with the water destroying algal cell membranes and chlorophyll. There is no contact or holding time requirement, as the oxidation reaction occurs immediately and the byproducts are hydrogen peroxide and oxygen. There are no fishing, drinking, swimming, or irrigation restrictions following the use of this product. PAK 27 has NSF/ANSI Standard 60

Certification for use in drinking water supplies at maximum-labeled rates and is certified for organic use by the Organic Materials Reviews Institute (OMRI).

PAK 27, or equivalent product, will be applied in a manner consistent with the label instructions, with permissible concentrations in the range of 0.3 to 10.2 ppm hydrogen peroxide. No more than 50% of the surface area of CCF will be treated at one time.

The following are operational procedures to minimize impacts on listed species during aquatic herbicide treatment for application of Aquathol K and copper-based products and algaecide treatment for application of peroxide-based algaecides in CCF:

- Apply Aquathol K and copper-based aquatic pesticides, as needed, from June 28 to August 31.
- Apply Aquathol K and copper-based aquatic pesticides, as needed, prior to June 28 or after August 31 if the average daily water temperatures within CCF is at or above above 25°C and if Delta smelt, salmonids, and green sturgeon are not at additional risk from the treatment as conferred by NMFS and USFWS.
    - Prior to treatment outside of the June 28 to August 31 timeframe, DWR will notify and confer with NMFS and USFWS on whether ESA-listed fish species are present and at risk from the proposed treatment.
- Apply Aquathol K and copper-based aquatic pesticides, as needed, during periods of activated Delta Smelt and salmonid protective measures and when average daily water temperature in CCF is below 25°C if the following conditions are met:
    - Prior to treatment outside of the June 28 to August 31 timeframe, DWR will notify and confer with NMFS and USFWS on whether ESA-listed fish species are present and at risk from the proposed treatment.
    - The herbicide application does not begin until after the radial gates have been closed for 24 hours or after the period of predicted Delta Smelt and salmonid survival within CCF (e.g. after predicted mortality has occurred due to predation or other factors) has been exceeded, and
    - The radial gates remain closed for 24 hours after the completion of the application, unless it is conferred that rapid dilution of the herbicide would be beneficial to reduce the exposure duration to listed fishes present within the CCF.
- Apply peroxygen-based aquatic algaecides, as needed, year-round.
- There are no anticipated impacts on fish with the use of peroxygen-based aquatic algaecides in CCF during or following treatment.
- Monitor the salvage of listed fish at the Skinner Fish Facility prior to the application of the aquatic herbicides and algaecides in CCF.
- For Aquathol K and copper compounds, the radial intake gates will be closed at the entrance to CCF prior to the application of pesticides to allow fish to move out of the targeted treatment areas and toward the salvage facility and to prevent any possibility of aquatic pesticide diffusing into the Delta.
- For Aquathol K and copper compounds, the radial gates will remain closed for a minimum of 12and up to 24 hours after treatment to allow for the recommended duration of contact time between the aquatic pesticide and the treated vegetation or cyanobacteria in the forebay, and to reduce residual endothall concentration for drinking water compliance purposes. (Contact time is

dependent upon pesticide type, applied concentration, and weed or algae assemblage). Radial gates would be reopened after a minimum of 36 hours (24 hours pre-treatment closure plus 12 hours post-treatment closure).

- For peroxide-based algaecides, the radial gates will be closed prior to the application of the algaecide to prevent any possibility of the algaecide diffusing into the Delta. The radial gates may reopen immediately after the treatment as the required contact time is less than 1 minute and there is no residual by-product of concern.
- Application will be made by a licensed applicator under the supervision of a California Certified Pest Control Advisor.
- Aquatic herbicides and algaecides will be applied by boat or by aircraft.
    - Boat applications will be by subsurface injection system for liquid formulations and boat-mounted hopper dispensing system for granular formulations. Applications would start at the shoreline and move systematically farther offshore, enabling fish to move out of the treatment area.
    - Aerial applications of granular and liquid formulations will be by helicopter or aircraft. No aerial spray applications will occur during windspeeds above 15 mph to prevent spray drift.
- Application would be to the smallest area possible that provides relief to SWP operations or water quality. No more than 50% of CCF will be treated at one time.
- Water quality samples to monitor copper and endothall concentrations within or adjacent to the treatment area, per the NPDES permit requirements, will be collected before, during and after application. Additional water quality samples may be collected during the following treatment for drinking water compliance purposes. No monitoring of copper or endothall concentrations in the sediment or detritus is proposed.
- No monitoring of peroxide concentration in the water column will occur during and after application as the reaction is immediate and there is no residual. Dissolved oxygen concentration will be measured prior to and immediately following application within and adjacent to the treatment zone.
- A spill prevention plan will be implemented in the event of an accidental spill.

Aquatic weed and algae treatments would occur on an as-needed basis. The timing of application is an avoidance measure and is based on the life history of Chinook Salmon and Steelhead in the Central Valley's Delta region and of Delta Smelt. Green sturgeon are present in the area year-round. Migrations of juvenile Winter-Run Chinook Salmon and Spring-Run Chinook Salmon primarily occur outside of the summer period in the Delta. Central Valley Steelhead have a low probability of being in the south Delta during late June when temperatures exceed 25°C through the first rainfall flush event, which can occur as late at December in some years (Grimaldo 2009). Delta Smelt are not expected to be in CCF during this time period. Delta Smelt are not likely to survive when water temperatures reach a daily average of 25°C, and they are not expected to occur in the Delta prior to the first flush event. Therefore, the likelihood of herbicide exposure to Chinook Salmon, Central Valley Steelhead, and Delta Smelt during the proposed herbicide treatment timeframe in CCF is negligible.

Additional protective measures will be implemented to prevent or minimize adverse effects from herbicide applications. As described above, applications of aquatic herbicides and algaecides will be contained within CCF. The radial intake gates to CCF will be closed prior to, during, and following the application. The radial gates will remain closed during the recommended minimum contact time

based on herbicide type, application rate, and aquatic weed or algae assemblage. Additionally, following the gatge closure and prior to the applications of Aquathol K and copper-based pesticides, the water is drawn down in the CCF via the Banks Pumping Plant. This drawdown helps facilitate the movement of fish in the CCF toward the fish diversion screens and into the fish protection facility, lowers the water level in the CCF to decrease the total amount of herbicide needed to be applied, per volume of water, and aides in the dilution of any residual pesticide post-treatment. Following reopening of the gates and refilling of CCF, the rapid dilution of any residual pesticide and the downstream dispersal of the treated water into the California Aquaduct via Banks PP will reduce the exposure time of any ESA-listed fish species present in CCF.

4.10.5.9 *Suisun Marsh Preservation Agreement*

The SMPA among DWR, Reclamation, CDFW, and Suisun Resource Conservation District (SRCD) contains provisions for DWR and Reclamation to mitigate the effects on Suisun Marsh channel water salinity from SWP and CVP operations and other upstream diversions. The SMPA requires DWR and Reclamation to meet salinity standards in accordance with D-1641, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements.

There are two primary physical mechanisms for meeting salinity standards set forth in D-1641 and the SMPA: (1) the implementation and operation of physical facilities in the Marsh; and (2) management of Delta outflow (i.e., facility operations are driven largely by salinity levels upstream of Montezuma Slough and salinity levels are highly sensitive to Delta outflow). Physical facilities (described below) have been operating since 1988 and have proven to be a highly reliable method for meeting standards.

The SMSCG are located on Montezuma Slough about 2 miles downstream from the confluence of the Sacramento and San Joaquin Rivers, near Collinsville. The objective of Suisun Marsh Salinity Control Gate operation is to decrease the salinity of the water in Montezuma Slough. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west through Suisun Marsh.

The SMSCG are operated during the salinity control season, which spans from October to May. Operational frequency is affected by hydrologic conditions, weather, Delta outflow, tide, fishery considerations, and other factors. The boat lock portion of the gate is now held open at all times during SMSCG operation to allow for continuous salmon passage opportunity. However, the boat lock gates may be closed temporarily to stabilize flows to facilitate safe passage of watercraft through the facility.

Assuming no significant long-term changes in the drivers mentioned above, it is expected that gate operations will remain at current levels (17–69 days per year) except perhaps during the most critical hydrologic conditions.

The Roaring River Distribution System (RRDS) was constructed to provide lower salinity water to 5,000 acres of private and 3,000 acres of CDFW managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands. The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Water is diverted through a bank of eight 60-inch-diameter culverts equipped with fish screens into the Roaring River intake pond on high tides to raise the water surface elevation in RRDS above the adjacent managed wetlands. The intake to the RRDS is screened to

prevent entrainment of fish larger than approximately 25 mm. After the listing of Delta Smelt, RRDS diversion rates have been controlled to maintain an average approach velocity below 0.7 ft/second at the intake fish screen.

The Morrow Island Distribution System (MIDS) allows Reclamation and DWR to provide water to the ownerships so that lands may be managed according to approved local management plans. The system was constructed primarily to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough. The MIDS is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor.

4.10.5.10 *OMR Management*

Reclamation and DWR propose to operate the CVP and SWP in a manner that maximizes exports while minimizing entrainment of fish and protecting critical habitat. Net flow OMR provides a surrogate indicator for how export pumping at Banks and Jones Pumping Plants influence hydrodynamics in the south Delta. The management of OMR, in combination with other environmental variables, can minimize or avoid the entrainment of fish in the south Delta and at CVP and SWP salvage facilities. Reclamation and DWR propose to maximize exports by incorporating real-time monitoring of fish distribution, turbidity, temperature, hydrodynamic models, and entrainment models into the decision support for the management of OMR to focus protections for fish when necessary and provide flexibility where possible, consistent with the WIIN Act Sections 4002 and 4003, as described below. Estimates of species distribution will be described by multi-agency Delta-focused technical teams. Reclamation and DWR will make a change to exports within 3 days of the trigger when monitoring, modeling, and criteria indicate protection for fish is necessary.

Reclamation and DWR propose to operate to an OMR index computed using an equation. An OMR index allows for short-term operational planning and real-time adjustments.

From the onset of OMR management to the end, Reclamation and DWR will operate to an OMR index no more negative than a 14-day moving average of -5,000 cfs unless a storm event occurs (described below). Grimaldo et al. (2017) indicate that -5,000 cfs is an inflection point in OMR for fish entrainment. OMR could be more positive than -5,000 cfs if additional real-time OMR restrictions are triggered as described below.

4.10.5.10.1 **Onset of OMR Management:**

Reclamation and DWR shall start OMR management when one or more of the following conditions have occurred:

- Integrated Early Winter Pulse Protection (“First Flush” Turbidity Event): The population-scale migration of Delta Smelt is believed to occur quickly in response to inflowing freshwater and turbidity (Grimaldo et al. 2009; Sommer et al. 2011). Thereafter, best available scientific information suggests that fish make local movements, but there is no evidence for further population- scale migration (Polanksy et al. 2018). As it relates to Delta Smelt, the Integrated Early Winter Pulse Protection action is intended to minimize project influence on migration (or dispersal) that occurs coincident with “First Flush” conditions in the Delta. When the running 3-day average of the daily flows at Freeport is greater than 25,000 cfs and the running 3-day average of the daily turbidity at Freeport is 50 NTU or greater for the period from December 1 through January 31, Reclamation and DWR propose to reduce exports for 14 consecutive days so

that the 14-day averaged OMR index for the period shall not be more negative than -3,500 cfs. This "First Flush" action may only be initiated once during the December through January period to limit the CVP/SWP influence on Delta Smelt population-scale migration/dispersal. The action will not be required if:

- the Freeport flow and turbidity conditions are met after January 31, or
- water temperature reaches 12 degrees Celsius based on a three station daily mean at Honker Bay, Antioch, and Rio Vista, or
- when ripe or spent Delta Smelt are collected in a monitoring survey.

- Salmonids: After January 1, if more than 5 percent of any one or more salmonid species (wild young- of-year Winter-Run, wild young-of-year Spring-Run, or wild Central Valley Steelhead) are estimated to be present in the Delta as determined by their appropriate monitoring working group based on available real-time data, historical information, and modeling.

4.10.5.10.2 **Additional Real-Time OMR Restrictions:**

Reclamation and DWR shall manage to a more positive OMR than -5,000 cfs based on the following conditions:

- Turbidity Bridge Avoidance ("South Delta Turbidity"): In years when a "First Flush" occurs, once-Delta Smelt have dispersed, there is not evidence that large, population-scale movements continue. The turbidity avoidance action described below reflects current understanding about how to protect Delta Smelt from damaging levels of entrainment after a First Flush and in years when a First Flush does not occur. The proposed additional OMR Management is meant to supplement the protection provided to pre-spawning adult Delta Smelt that have migrated up the San Joaquin River shipping channel. This action begins after the completion of the Integrated Early Winter Pulse Protection (above) or February 1, whichever comes first. The purpose of this action is to avoid the formation of a continuous turbidity bridge from the San Joaquin River shipping channel to the fish facilities, which historically has been associated with elevated salvage of Delta Smelt. Reclamation and DWR propose to manage exports in order to maintain daily average turbidity in Old River at Bacon Island (OBI) at a level of less than 12 NTU. If turbidity does not exceed 12 NTU at OBI, then there will be no explicit limit on OMR flow for the purposes of protecting Delta Smelt. If daily average turbidity at OBI cannot be maintained less than 12 NTU, the 3-day averaged OMR index shall not be more negative than -5000 cfs, until the 3-day average turbidity at OBI drops below 12 NTU. The action is to be taken from February 1-March 31 even if the Integrated Early Winter Pulse Protection action has not occurred earlier in the water year. The action will no longer be required on or after April 1.
- Larval and Juvenile Delta Smelt: When Q-West is negative and larval or juvenile Delta Smelt are within the entrainment zone of the pumps based on real-time sampling, Reclamation and/or DWR propose to run hydrodynamic models informed by the EDSM, 20 mm or other relevant survey data to estimate the percentage of larval and juvenile Delta Smelt that could be entrained, and operate to avoid greater than 10 percent loss of modeled larval and juvenile cohort Delta Smelt (typically this would come into effect beginning the middle of March).
- Wild Central Valley Steelhead Protection: Reclamation and DWR would operate to OMR of -2,500 cfs for 5 days whenever more than 5 percent of Steelhead are present in the Delta and the natural- origin Steelhead loss trigger exceeds 10 Steelhead per TAF. The timing of this action is intended to provide protections to San Joaquin origin Central Valley Steelhead, but the loss-density trigger is based on loss of all Steelhead since there is currently no protocol to distinguish

San Joaquin-basin and Sacramento-basin Steelhead in salvage. Reclamation would use the current loss equation for Steelhead or a surrogate. This action will no longer be required after May 31.

- Salvage or Loss Thresholds: Reclamation and DWR propose a cumulative annual salvage or loss threshold equal to 1 percent of the abundance estimate based on EDSM for adult Delta Smelt, as modified; loss equal to 1 percent of the Winter-Run Chinook Salmon JPE (genetically confirmed) or 2 percent of the Winter-Run Chinook Salmon JPE (based on length -at -date); loss equal to 1 percent of the Spring- Run Chinook Salmon JPE (or 0.5 percent of yearling Coleman NFH late-fall run as yearling Spring-Run Chinook Salmon surrogates); salvage equal to 3,000 juvenile Central Valley Steelhead, and salvage equal to 100 juvenile Green Sturgeon. Reclamation and DWR propose to operate to a more positive OMR, as described below, when the daily salvage loss indicates that continued OMR of -5,000 cfs is likely to exceed the cumulative salvage loss thresholds:
    - Restrict OMR to a 14-day moving average OMR index of -3,500 cfs when a species-specific cumulative salvage or loss threshold exceeds 50 percent of the threshold. The OMR restriction to -3,500 cfs will persist until the species-specific offramp is met.
    - Restrict OMR to a 14-day moving average OMR index of -2,500 cfs (or more positive if determined by Reclamation) when cumulative salvage or loss threshold for any of the above species exceeds 75 percent of the threshold. The OMR restriction to -2,500 cfs will persist until the species-specific offramp is met.

  Species specific OMR restrictions will end when the individual species-specific off ramp from "End of OMR management criteria," below, are met.

4.10.5.10.3 Storm-Related OMR Flexibility:

Reclamation and DWR may operate to a more negative OMR up to a maximum (otherwise-permitted) export rate at Banks and Jones Pumping Plants of 14,900 cfs (which could result in a range of OMR values) to capture peak flows during storm-related events. Reclamation and DWR will continue to monitor fish in real-time and will operate in accordance with "Additional Real- time OMR Restrictions," above.

Under the following conditions, Reclamation and DWR would not cause OMR to be more negative for capturing peak flows from storm-related events.

- Additional real-time OMR restrictions, above, are triggered, then Reclamation would operate in accordance with those additional real-time OMR restrictions and would not cause OMR to be more negative for capturing peak flows from storm-related events.
- Actual cumulative expanded salvage of Delta Smelt is greater than 50% of the average smelt index over the prior three years of non-zero FMWT surveys and a Cumulative Salvage Index of 7.98 during December 1 – January 20 or cumulative expanded salvage of Delta Smelt is greater than or equal to 75% of the average smelt index calculated described above.
- Predicted adult or juvenile Delta Smelt salvage would exceed 50% during December 1 – January 20 or cumulative expanded salvage is greater than or equal to 75% as determined above, based on the data sources in the Secretarial Memo dated January 17, 2019.
- Measured cumulative loss to date since October 1 for winter-run Chinook salmon (based on length-at- date criteria) is greater than the percentage below of a loss threshold calculated as 2% of the JPE:
    - January 1 – 15 2%

- January 16 – 31 4%
- February 1 – 14 6%
- February 15 – 28 9%
- March 1 – 15 21%
- March 16 – 31 26%
- April 1 – End of OMR 30%

- Predicted cumulative loss for winter-run Chinook salmon is greater than 30% of the loss threshold described above in "Additional Real-Time OMR Restrictions" [1 percent of the Winter-Run Chinook Salmon JPE (genetically confirmed) or 2 percent of the Winter-Run Chinook Salmon JPE (based on length-at-date)] or salvage for steelhead is greater than 50% of the salvage threshold described above in "Additional Real-Time OMR Restrictions".
- Changes in spawning, rearing, foraging, sheltering, or migration behavior beyond those described in the forthcoming biological opinion for this project.

4.10.5.10.4 End of OMR Management:

OMR criteria may control operations until June 30, or when both of the following have occurred, whichever is earlier:

- Delta Smelt: when the daily mean water temperature at CCF reaches 25°C for 3 consecutive days.
- Salmonids: when more than 95 percent of salmonids have migrated past Chipps Island, as determined by their monitoring working group, OR after daily average water temperatures at Mossdale exceed 72°F for 7 days during June (the 7 days do not have to be consecutive).

Figure 4-5 shows OMR management in a decision tree.

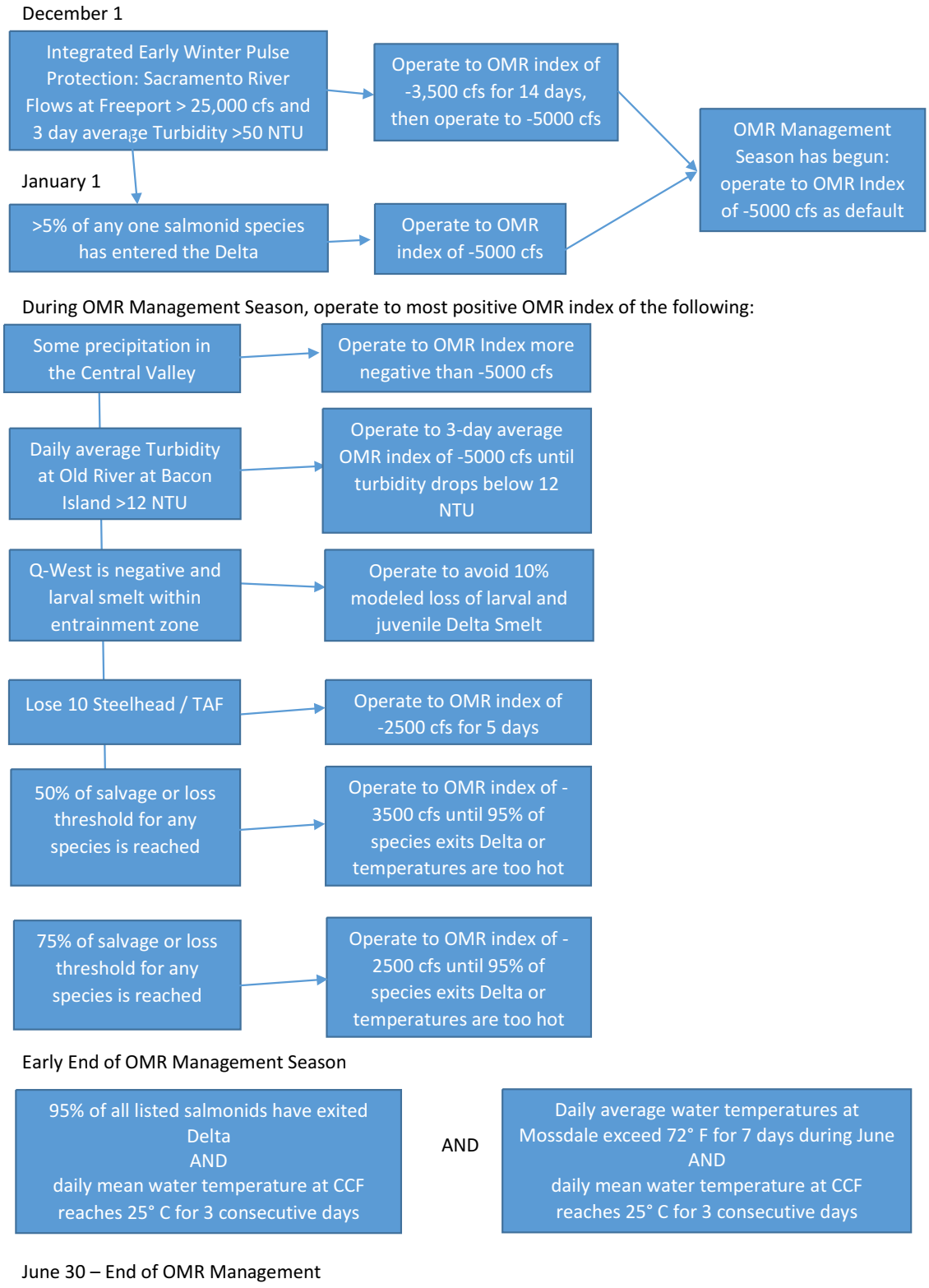

Figure 4-5. Decision Tree for Old and Middle River Reverse Flow Management

Reclamation and DWR may confer with the Directors of NMFS, USFWS, and CDFW if they desire to operate to a more negative OMR than what is specified in "Additional Real-Time OMR Restrictions". Upon mutual agreement, the Directors of NMFS and USFWS may authorize Reclamation to operate to a more negative OMR. than the "Additional Real-Time OMR Restrictions", but no more negative than -5000 cfs. The Director of CDFW may authorize DWR to operate to a more negative OMR. than the "Additional Real-Time OMR Restrictions", but no more negative than -5000cfs.

4.10.5.11 *Delta Smelt Summer-Fall Habitat*

Reclamation and DWR propose to use structured decision making to identify and use a variety of actions to achieve the environmental and biological goals below, as described further in Appendix C. The Delta Smelt Habitat Action shall take actions to meet these environmental and biological goals in the summer and fall (June through October) of below normal, above normal, and wet water years according to the Sacramento Valley Index. The Delta Smelt Habitat Action is intended to improve Delta Smelt food supply and habitat, thereby contributing to the recruitment, growth, and survival of Delta Smelt.

The environmental and biological goals of the Delta Smelt Habitat Action are: maintain low salinity habitat in Suisun marsh and Grizzly Bay for as many days as possible in June through October of below normal, above normal, and wet years, when water temperatures are suitable; manage the low salinity zone to overlap with turbid water and available food supplies; and establish contiguous low salinity habitat from Cache Slough Complex to the Suisun Marsh.

The current conceptual model is that Delta Smelt habitat should include low salinity conditions of 0-6 ppt, turbidity of approximately 12 NTU, temperatures below 25°C, food availability, and littoral or open water physical habitats (FLaSH Synthesis, pp. 15-23). The Delta Smelt Habitat Action is being undertaken recognizing that the highest quality habitat in this large geographical region includes areas with complex bathymetry, in deep channels close to shoals and shallows, and in proximity to extensive tidal or freshwater marshlands and other wetlands. Low salinity would be measured as a 14-day average based on data from Belden's Landing (or other station(s) and averaging periods, as appropriate)

The Delta Smelt Habitat Action is to provide these habitat components in the same geographic area through a range of actions to improve water quality and food supplies. The action may include, but is not limited to the following components:

- Suisun Marsh Salinity Control Gate (SMSCG) operations for up to 60 days (not necessarily consecutive) in below normal, above normal, and wet years;
- Delta outflow up to the quantity that would have been required to meet a 2 ppt isohaline at 80 km from the Golden Gate Bridge in above normal and wet water years in September and October to the extent that such action would advance the biological goals identified above;
- Enhancement actions, e.g., those included in the Delta Smelt Resiliency Plan to enhance food supply, the North Delta food-web project, Sacramento River Deepwater Ship Channel lock reoperation, and Roaring River distribution system reoperation.

In below normal, above normal, and wet water year types, actions would focus on non-flow measures, such as operation of the SMSCG for up to 60 days (not necessarily consecutive) in the summer and fall. In below normal years, initial actions would include operating the SMSCG in the summer with no additional Delta outflow augmentation above that which is necessary to comply with

D-1641. In above normal and wet years, initial actions would include operation of the SMSCG in the summer and fall. In addition, if necessary and helpful to meet the environmental and biological goals described above, Delta outflow may be augmented in above normal and wet years based on scientific information on the relationship of the low-salinity zone as an appropriate proxy of delta smelt habitat. In the event that both the SMSCG and Delta outflow components are implemented in the same year, the water cost of operating the SMSCG would be subtracted from the Delta outflow augmentation flow volume.

4.10.5.12 *Conservation Measures*

Conservation measures are included to further avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include non-flow actions that benefit listed species without impacting water supply or other beneficial uses. The TFCF and the Skinner Fish Facility are identified specifically due to their significance as project features and then additional measures are listed.

4.10.5.12.1 Tracy Fish Collection Facility

Reclamation proposes to continue to screen fish from Jones Pumping Plant with the TFCF. The TFCF uses behavioral barriers consisting of primary louvers and four rotating traveling screens aligned in a single row 7 degrees to the flow of the water to guide entrained fish into holding tanks before transport by truck to release sites at the confluence of the Delta. The TFCF was designed to handle smaller fish (less than 200 mm) that would have difficulty fighting the strong pumping plant-induced flows, as the intake is essentially open to the Delta and impacted by tidal action. The number of pumps (units) running at the Jones Pumping Plant (JPP) dictates the flow and velocity at the TFCF. There are 6 units at JPP but a maximum of 5 can used; each unit increases the velocity through the TFCF primary channel by approximately 0.5 ft/sec.

The primary louvers are located in the primary channel just downstream of the trashrack structure. The traveling water screen is located in the secondary channel.

The louvers allow water to pass through onto the pumping plant, but the openings between the slats are tight enough and angled against the flow of water to prevent most fish from passing between them and to enable the fish to enter one of four bypass entrances along the louver arrays. Reclamation proposes to install a carbon dioxide injection device to allow remote controlled anesthetization of predators in the secondary channels of the TFCF.

The current primary louver cleaning procedures and operations involve lifting each individual louver panel, 36 total, out of the water in order to spray wash the debris. Generally, each primary louver panel is lifted and lowered back into place three times per day, although frequency of cleaning may be increased or decreased according to pumping rate and debris loads. It takes approximately 3-7 minutes to lift, spray clean, and lower each louver panel back into place. While export pumping may be reduced to address damaged louver panels, issues during cleaning, or other maintenance scenarios where facilities are not capable of effectively salvaging fish, complete shutdown of pumping usually does not occur due to issues related to the primary louvers. At 5 Jones Pumping Plant units running, louvers are cleaned before the incoming tide as much as possible. The morning day shift usually begin cleaning as soon as they start their work, around 0600. During high debris periods, operators monitor differentials and clean before any problems arise. At a minimum, all 36 louver panels are cleaned 2-3 times a day but during heavy debris loads, operators clean 3-6 times a day. At 2-4 JPP units, operators determine when to clean and making sure the louvers do not reach 1 ft differential.

At 1 JPP unit, operators will normally clean periodically during the incoming tide. Generally, less frequent cleaning is required in early summer (low averages of 60 minutes per day) and much higher during the winter months (high averages of 440 minutes per day). This means that there is a louver panel lifted 1-7.5 hours per day depending on season, pumping rates, and debris loads.

When south Delta hydraulic conditions allow, and conditions within the original design criteria for the TFCF, the louvers are operated to achieve water approach velocities for striped bass of approximately 1 foot per second from May 15 through October 31 and for salmon of approximately 3 feet per second from November 1 through May 14.

Fish passing through the facility are sampled at intervals of 30 minutes every 2 hours year-round. Approximately 52 different species of fish are entrained into the TFCF each year; however, the total numbers are significantly different for the various species salvaged. Fish observed during sampling intervals are identified by species, measured to fork length, examined for marks or tags, and placed in the collection facilities for transport by tanker truck to the release sites in the north Delta away from the pumps. Hauling trucks used to transport salvaged fish to release sites inject oxygen and contain an 8 parts per thousand salt solution to reduce stress. In addition, TFCF personnel monitor for the presence of spent female Delta Smelt in anticipation of expanding the salvage operations to include sub-20 mm larval Delta Smelt detection.

TFCF personnel monitor for the presence of spent female Delta Smelt by euthanizing all adult Delta Smelt that are collected in the 30-minute fish count, determine the gender and the gonadal or sexual maturation stage of the Delta Smelt, and determine if the eggs have reached Stage IV, the stage when eggs are ready for release (0.9 to 10 mm in diameter and easily stripped). Stages V (i.e., postvitellogenic stage) and VI (i.e., postovulatory, or spent stage) are expected soon after Stage IV observation. Stages are determined and reported real-time when a biologist is present or the following morning after smelt detection and collection. Stage or gonad maturation is determined using egg stage descriptions from Mager (1996).

Larval smelt sampling at the TFCF commences once a trigger is met (detection of a spent female at CVP and SWP being one of three triggers). Fish count screen with a 2.4 mm mesh size opening is replaced with one that has a mesh size of 0.5 mm to retain larval fish. Sampling is done four times a day (04:00, 10:00, 16:00, 22:00) and all larval smelt are identified to species and reported the day after collection.

Salvage of fish occurs at the TFCF 24 hours per day, 365 days per year. Fish are salvaged in flow-through holding tanks (6.1-m diameter, 4.7-m deep) that provide continuous flows of water (Sutphin and Wu 2008). Fish are maintained in these holding tanks for 8-24 hours depending on the species of fish that are being salvaged, the number of fish salvaged, and debris load. The number of fish that are salvaged in TFCF holding tanks is generally estimated by performing a 30 minute fish-count subsample every 120 minutes (2 hours). The number of each species of fish collected in the subsample is determined and then multiplied by 4 (120 pumping minutes/30 minute fish-count subsample = expansion factor of 4) to estimate the total number of each species of fish, as well as the total number of fish, that were salvaged in TFCF holding tanks during the 120 minute period. Pumping minutes and fish-count minutes could potentially deviate from 120 minutes and 30 minutes, respectively, which would change the expansion factor used to estimate total fish salvage.

If no Chinook Salmon, Steelhead, or Delta Smelt are salvaged, fish can be maintained in TFCF holding tank for up to 24 hours. If a Chinook Salmon or Steelhead is collected during fish-counts, fish can only be maintained in TFCF holding tanks for up to 12 hours. If a Delta Smelt is collected

during fish-count, salvaged fish may only be held in TFCF holding tanks for up to 8 hours. When fish can be maintained in TFCF holding tanks for 24 hours, fish transport (fish-haul) generally occurs each morning. When 2 fish- hauls per day are necessary, a night fish haul is added. When 3 fish-hauls are necessary, they are usually completed at 7 am, 3pm, and 9:30 pm each day. Fish-haul is also dictated by the Bates Tables which uses size classes, species, and water temperature as indicators for when to conduct a fish-haul.

During normal operations, salvaged fish are transported approximately 49.9 km and released at one of two Reclamation release sites near the confluence of the Sacramento and San Joaquin Rivers (Antioch Fish Release Site and Emmaton Fish Release Site). In general, the Emmaton Fish Release Site is used for fish-hauls performed during daytime hours and the Antioch Fish Release Site is used for fish-hauls performed during nighttime hours. This is done for safety and security reasons as the Antioch Fish release Site has a gate that can be locked behind the operator after he/she enters the release site area. Upon arrival at release sites, operators measure certain important water quality parameters (dissolved oxygen, salinity, and temperature) prior to releasing fish. This is done to verify that water quality parameters remain acceptable during fish transport. As a conservation measure, Reclamation proposes to increase the number of release sites to reduce predation.

Reclamation would conduct studies and physical improvements aimed to improve fish survival and improve TFCF efficiency, reducing mortality through the facility, fish hauling and release operations through the Tracy Fish Facility Improvement Program. Activities include louver improvement and replacement, predation studies and piscivorous predator control, improvement of hydrologic monitoring and telemetry systems, holding area improvements including fish count automation and tank aeration and screening, improvement of data management as well as aquaculture facility maintenance, operation and improvements. TFCF studies are established at annual multi-agency meetings of the Tracy Tech Advisory Team. Reclamation would provide written reports of study results on the TFFIP website.

4.10.5.12.2 Skinner Fish Facility

DWR proposes to continue to screen fish from Banks Pumping Plant with the. Skinner Fish Facility, located west of the CCF, 2 miles upstream of the Banks Pumping Plant. The Skinner Fish Facility has behavioral barriers to keep fish away from the pumps that lift water into the California Aqueduct. Large fish and debris are directed away from the facility by a 388-foot-long trash rack. Smaller fish are diverted from the intake channel into bypasses by a series of behavioral barriers (metal louvers), while the main flow of water continues through the louvers and toward the pumps. These fish pass through a secondary system of louvers or screens and pipes into seven holding tanks, where a subsample is counted and recorded. The salvaged fish are then returned to the Delta in oxygenated tank trucks. The sampling frequency at TFCF will be maintained at the Skinner Fish Facility.

4.10.5.12.3 Additional Measures

- *San Joaquin Basin Steelhead Telemetry Study*: Continuation of the 6-Year Steelhead telemetry study for the migration and survival of San Joaquin Origin Central Valley Steelhead
- *Sacramento Deepwater Ship Channel:* Reclamation proposes to partner with the City of West Sacramento and West Sacramento Area Flood Control Agency to repair or replace the West Sacramento lock system to hydraulically reconnect the ship channel with the mainstem of the Sacramento River. When combined with an ongoing foodweb study, the reconnected ship channel has the potential to flush food production into the north Delta. An increase in food supply is likely to benefit Delta Smelt and their habitat.

- *North Delta Food Subsidies / Colusa Basin Drain:* DWR, Reclamation, and water users propose to increase food entering the north Delta through flushing nutrients from the Colusa Basin into the Yolo Bypass and north Delta. DWR, Reclamation, and water users would work with partners to flush agricultural drainage (i.e., nutrients) from the Colusa Basin Drain through Knight's Landing Ridge Cut and the Tule Canal to Cache Slough, improving the aquatic foodweb in the north Delta for fish species. Reclamation would work with DWR and partners to augment flow in the Yolo Bypass in July and/or September by closing Knights Landing Outfall Gates and routing water from Colusa Basin into Yolo Bypass to promote fish food production.
- *Suisun Marsh Food Subsidies:* Water users propose to add fish food to Suisun Marsh through coordinating managed wetland flood and drain operations in Suisun Marsh, Roaring River Distribution System food production, and reoperation of the Suisun Marsh Salinity Control Gates. As noted in the Delta Smelt Resiliency Strategy, this management action may attract Delta Smelt into the high-quality Suisun Marsh habitat in greater numbers, reducing use of the less food-rich Suisun Bay habitat (California Natural Resources Agency 2016). Infrastructure in the Roaring River Distribution System may help drain food-rich water from the canal into Grizzly Bay to augment Delta Smelt food supplies in that area. In addition, managed wetland flood and drain operations can promote food export from the managed wetlands to adjacent tidal sloughs and bays.
- Habitat Restoration: DWR and Reclamation propose to continue to implement existing restoration efforts that are part of the environmental baseline but are not yet complete, including:
    - Completing, by 2030, the remaining approximately 6,000 acres of tidal habitat restoration in the Delta of the 8,000 acres DWR has begun. Reclamation and/or DWR would monitor, operate, and maintain the tidal habitat restoration, including obtaining permanent land rights. Consistent with the current regulatory process, future separate consultations would address the effects to listed species from habitat restoration.
    - *Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project*: Reclamation and DWR will provide increased acreage of seasonal floodplain rearing habitat available in the lower Sacramento River basin by 2030.
    - Reclamation would coordinate with water users to remove predator hot spots in the Bay-Delta. This includes minimizing lighting at fish screens and bridges, and possibly removing abandoned structures.
    - *Delta Cross-Channel Gate Improvements:* The DCC is more than 65 years old and its gates rely on remote operators to travel to the facility to change their position. When the gates are open, they provide a critical diversion structure for freshwater reaching the CVP south Delta pumping station. The gates are closed to prevent scouring (during high flows), reduce salinity intrusion in the western Delta, and protect Sacramento River ESA-listed and non-listed salmonids. Additional DCC operation would allow for improved exports and water quality without additional adverse effects on salmonids. Reclamation proposes to evaluate improvements to automate and streamline operation of the Delta Cross-Channel gates. Reclamation would modernize DCC's gate materials and mechanics to include adding industrial control systems, increasing additional staff time, and improve physical and biological monitoring associated with the DCC daily and/or tidal operations as necessary to maximize water supply deliveries.
    - *Tracy Fish Facility Improvements:* Reclamation would improve the TFCF to reduce loss by: (1) incorporating additional fish exclusion barrier technology into the primary fish removal barriers, (2) incorporating additional debris removal systems at each trash removal barrier, screen, and fish barrier, (3) Constructing additional channels to distribute the fish collection

and debris removal among redundant paths through the facility, (4) Construct additional fish handling systems and holding tanks to improve system reliability; and (5) Incorporate remote operation into the design and construction of the facility. Facility improvements will improve survival of fish salvaged and potentially reduce the loss factors to allow for additional certainty on OMR management with low impacts from salvaging salmonids.

- *Skinner Fish Facility Improvements:* DWR would continue implementation of projects to reduce mortality of ESA-listed fish species. These measures that would be implemented include: (a) electro-shocking and relocating predators; (b) controlling aquatic weeds; (c) developing a fishing incentives or reward program for predators; and (d) operational changes when listed species are present. Please see Appendix G for study results from the last decade.
- *Release Sites:* Reclamation proposes to continue work with DWR to incorporate flexibility in salvage release sites, using DWR's sites, or sites on a barge.
- *Small Screen Program*: Reclamation and DWR propose to continue to work with existing authorities (Anadromous Fish Screen Program) to screen small diversions throughout Central Valley CVP/SWP streams and the Bay-Delta.
- *Delta Fish Species Conservation Hatchery:* Reclamation proposes to partner with DWR to construct and operate a conservation hatchery for Delta Smelt, by 2030. The conservation hatchery would breed and propagate a stock of fish with equivalent genetic resources of the native stock and at sufficient quantities to effectively augment the existing wild population, so that they can be returned to the wild to reproduce naturally in their native habitat.
- *Conservation and Culture Laboratory (FCCL):* The existing FCCL will be used in the interim to begin supplementation prior to construction of the new conservation hatchery. Reclamation will support development of a supplementation strategy in coordination with and subject to approval by USFWS. This strategy will include studies to develop necessary information to begin a supplementation program, a focus on capturing existing genetic diversity and expansion of FCCL to produce maximum numbers of Delta Smelt. Current production is approximately 50,000 adult Delta Smelt; the strategy will have a goal of increasing production by 2025 to a number and the life stages necessary to effectively augment the population as determined by USFWS. The strategy will be in place 1 year from issuance of the biological opinion. Work done at the FCCL will guide construction and operation of the Conservation Hatchery described above.

4.10.6 Stanislaus River (East Side Division)

Reclamation operates the CVP East Side Division for flood control, agricultural water supplies, hydroelectric power generation, fish and wildlife protection, and recreation. In the Stanislaus River watershed, Reclamation owns and operates New Melones Dam and Reservoir (2.4 MAF capacity). The Tri-Dam Project, a partnership between the Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID), consists of Donnells and Beardsley Dams, located upstream of New Melones Reservoir on the middle fork Stanislaus River, and Tulloch Dam and Powerplant, located approximately 6 miles downstream of New Melones Dam on the mainstem Stanislaus River. Releases from Donnells and Beardsley Dams affect inflows to New Melones Reservoir. The main water diversion point on the Stanislaus River is Goodwin Dam, located approximately 2 miles downstream of Tulloch Dam. OID and SSJID manage the Tulloch and Goodwin Dam infrastructure through separate agreements with both Reclamation and Reclamation's CVP water service contractors (Stockton East Water District and the Central San Joaquin Water Conservation District) to meet Reclamation's Stanislaus River objectives, CVP contractor deliveries, and deliveries to the OID and SSJID service areas.

The Stanislaus River watershed has annual obligations that exceed the average annual runoff in a given year due to a number of factors, including SWRCB water rights decisions D-1641, D-1422 and D-1616, the 1987 CDFG agreement, CVPIA objectives, the 2009 biological opinion, the 1988 Agreement and Stipulation with OID and SSJID, riparian water right diverters, and CVP water delivery contracts.

Over the past decade, Reclamation has worked with Stanislaus River water users and related agencies in developing a revised operating plan for New Melones Reservoir that addresses multiple objectives, including a more predictable and sustainable operation, minimizing low storage conditions in successive drought years, and providing flows to support listed species and critical habitat. These efforts have allowed multiple agencies and stakeholders to provide input on potential solutions; however, a final plan has not been completed.

The operating plan described below is intended to replace often overlapping and conflicting operational components of previous federal and state flow requirements, and is representative of Reclamation's contribution to any current or future flow objectives on the Lower San Joaquin River at Vernalis.

4.10.6.1 *Seasonal Operations*

Reclamation proposes to meet water rights, contracts, and agreements that are specific to the East Side Division and Stanislaus River. Senior water right holders (OID and SSJID) will receive annual water deliveries consistent with the 1988 Agreement and Stipulation, and water will be made available to CVP contractors in accordance with their contracts and applicable shortage provisions.

In high storage, high inflow conditions, Reclamation will operate for flood control in accordance with the USACE flood control manual. Because New Melones is a large reservoir relative to its annual inflow, flood control is relatively infrequent; however, Tulloch Lake, located downstream of New Melones Reservoir, is subject to high local inflows, and may be in flood control operations for brief periods when New Melones Reservoir is not. During these periods, releases from Tulloch may be used to meet flow objectives, schedules, or requirements on the lower Stanislaus River below Goodwin Dam.

Reclamation proposes to operate New Melones Reservoir (as measured at Goodwin Dam) in accordance with a Stepped Release Plan (SRP) that varies by hydrologic condition/water year type as shown in Table 4-13.

Table 4-13. New Melones SRP Annual Releases by Water Year Type

Water Year Type	Annual Release (TAF)
Critical	184.3
Dry	233.3
Below normal	344.6
Above normal	344.6
Wet	476.3

The New Melones SRP will be implemented similarly to current operations under the 2009 biological opinion with a default daily hydrograph, and the ability to shape monthly and seasonal flow volumes to meet specific biological objectives. The default daily hydrograph is the same as

prescribed under current operations for critical, dry, and below normal water year types. The difference occurs in above normal and wet years, where the minimum requirement for larger releases is reduced from current operations to promote storage for potential future droughts and preserve cold water pool. When compared to minimum daily flows from Appendix 2-E of the 2009 biological opinion (2-E), the daily hydrograph for the New Melones SRP is identical for critical, dry, and below normal year types; above normal and wet year types follow daily hydrographs for below normal and above normal year types from 2-E, respectively. The complete daily hydrograph for the New Melones SRP is available in Appendix B.

For the New Melones SRP, Reclamation proposes to classify water year types using the San Joaquin Valley "60-20-20" Water Year Hydrologic Classification (60-20-20) developed for D-1641 implementation. Previous operating plans for New Melones Reservoir relied on the New Melones Index (NMI) to determine water year type, calculated by summing end-of-February storage and forecasted inflow through September. Because the reservoir can store more than twice its average inflow, the NMI resulted in a water year type determination that was more closely tied to storage rather than hydrology. Changing from the NMI to 60-20-20 is expected to provide operations that better represent current hydrology and correlate more closely to water year types for other nearby tributaries.

Reclamation proposes to convene the Stanislaus Watershed Team (successor to the Stanislaus Operating Group), consisting of agency representatives and local stakeholders having direct interest on the Stanislaus River, at least monthly to share operational information and improve technical dialogue on the implementation of the New Melones SRP. The Stanislaus Watershed Team will also provide input on the shaping and timing of monthly or seasonal flow volumes to optimize biological benefits.

During the summer, Reclamation is required to maintain applicable dissolved oxygen standards on the lower Stanislaus River for species protection. Reclamation currently operates to a 7.0 mg/L dissolved oxygen requirement at Ripon from June 1 to September 30. Reclamation proposes to move the compliance location to Orange Blossom Bridge, where the species are primarily located at that time of year.

4.10.6.2 *Conservation Measures*

Conservation measures are included to avoid and minimize or compensate for CVP and SWP project effects, including take, on the species under review in this biological assessment. These conservation measures include non-flow actions that benefit listed species without impacting water supply or other beneficial uses.

- Spawning Habitat: Under the CVPIA (b)(13) program, Reclamation's annual goal of gravel placement is approximately 4,500 tons in the Stanislaus River.
- Rearing Habitat: Reclamation proposes to construct an additional 50 acres of rearing habitat adjacent to the Stanislaus River by 2030.
- Temperature Management: Reclamation will study approaches to improving temperature for listed species on the lower Stanislaus River, to include evaluating the utility of conducting temperature measurements/profiles in New Melones Reservoir.

4.10.7 San Joaquin River (Friant Division)

Reclamation operates the Friant Division for flood control, irrigation, M&I, and fish and wildlife purposes. Facilities include Friant Dam, Millerton Reservoir, and the Friant-Kern and Madera Canals. Friant Dam provides flood control on the San Joaquin River, provides downstream releases to meet senior water rights requirements above Gravelly Ford, provides Restoration Flow releases under Title X of Public Law 111-11, and provides conservation storage as well as diversion into Madera and Friant-Kern Canals for water supply. Water is delivered to about a million acres of agricultural land in Fresno, Kern, Madera, and Tulare Counties in the San Joaquin Valley via the Friant-Kern Canal south into Tulare Lake Basin and via the Madera Canal northerly to Madera and Chowchilla Irrigation Districts. A minimum of 5 cfs is required to pass the last holding contract diversion located about 40 miles downstream of Friant Dam near Gravelly Ford.

The SJRRP implements the San Joaquin River Restoration Settlement Act in Title X of Public Law 111-11. USFWS and NMFS issued programmatic biological opinions in 2012 that included project-level consultation for SJRRP flow releases. Programmatic ESA coverage is provided for flow releases up to a certain level, recapture of those flows in the Lower San Joaquin River and the Delta, and all physical restoration and water management actions listed in the Settlement.

The Stipulation of Settlement of NRDC vs. Rogers, is based on two goals—the Restoration Goal and the Water Management Goal. To achieve the Restoration Goal, the Settlement calls for, among other things, releases of water from Friant Dam to the confluence of the Merced River (referred to as Restoration Flows) according to the hydrographs in Settlement Exhibit B. To achieve the Water Management Goal, the Settlement calls for the development and implementation of a plan for recirculation, recapture, reuse, exchange or transfer of Restoration Flows for the purpose of reducing or avoiding impacts on water deliveries to all of the Friant Contractors caused by Restoration Flows. Recapture of Restoration Flows may occur upstream of a capacity restricted reach, or downstream of the Merced River confluence. Recapture can occur at Banta-Carbona, Patterson, or West Stanislaus Irrigation District facilities, or at Jones or Banks Pumping Plants. Recapture of Restoration Flows in the Sacramento San Joaquin Delta under this proposed action would average 65 TAF, ranging from approximately 25 TAF to 78 TAF depending on the year type.

4.10.7.1 *Conservation Measures*

Lower SJR Rearing Habitat: Reclamation may work with private landowners to create a bottom-up, locally driven regional partnership to define and implement a large-scale floodplain habitat restoration effort in the Lower San Joaquin River. This stretch of the San Joaquin River is cut-off from its floodplain due to an extensive levee system, with two notable exceptions at Dos Rios Ranch (1,600 acres) and the San Joaquin River National Wildlife Refuge (2,200 acres). In recent years, there has been growing interest in multi-benefit floodplain habitat restoration projects in the Central Valley that can provide increased flood protection for urban and agricultural lands, improved riparian corridors for terrestrial plants and wildlife, and enhanced floodplain habitat for fish. The resulting restoration could include thousands of acres of interconnected (or closely spaced) floodplain areas with coordinated and/or collaborative funding and management. Such a large scale effort along this corridor would require significant support from a variety of stakeholders, which could be facilitated through a regional partnership.

4.10.8 South of Delta

San Luis Reservoir is an offstream storage facility located along the California Aqueduct downstream of Jones and Banks Pumping Plants. The CVP and SWP share San Luis Reservoir storage roughly 50/50 (CVP has 966 TAF of storage, SWP has 1062 TAF of storage). San Luis Reservoir is used by both Projects to meet deliveries to their contractors during periods when Delta pumping is insufficient to meet demands. San Luis Reservoir is also operated as a conveyance facility to supply water to the CVP San Felipe Division in San Benito and Santa Clara Counties.

San Luis Reservoir operates as a regulator on the CVP/SWP system, accepting any water pumped from Banks and Jones that exceeds contractor demands, then releasing that water back to the aqueduct system when the pumping at Jones and Banks is insufficient to meet demands. The reservoir allows the CVP/SWP to meet peak-season demands that are seldom balanced by Jones and Banks pumping.

As San Luis Reservoir is drawn down to meet contractor demands, it usually reaches its low point in late August or early September. From September through early October, demand for deliveries usually drops to be less than the Jones and Banks diversions from the Delta, and the difference in Jones and Banks pumping is then added to San Luis Reservoir, reversing its spring and summer decline and eventually filling the San Luis Reservoir - typically before April of the following year.

4.11 Items Not Included in This Consultation

This document includes context on the entirety of operations of the CVP and SWP. However, not all of these actions are being consulted on, either because they were the subject of prior consultations or due to other legal authority. Reclamation and DWR are consulting on the exercise of discretion in operational decision making, including how to comply with the terms of their respective existing water supply and settlement contracts (which includes the impacts of maximum water diversions under the terms of these contracts), and other legal obligations. Reclamation and DWR are not consulting on:

- Flood control
- Folsom Water Control Manual
- Oroville Dam and Feather River operations
- Execution of new CVP water service or repayment contracts, or the prior execution of existing contracts that were the subject of separate but parallel prior consultations
- Execution of new settlement contracts and agreements, or the prior execution of existing contracts that were the subject of separate but parallel prior consultations
- Contract conversion
- Operations and maintenance activities of CVP minor facilities
- Exchange Contractor deliveries from Friant Dam
- SJRRP flows and lower SJR recapture
- TRRP flows
- Coordinated Operation Agreement

- D-1641
- Contra Costa Water District Operations
- Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project
- Suisun Marsh Habitat Management, Preservation, and Restoration Plan
- Suisun Marsh Preservation Agreement
- California WaterFix
- Battle Creek Restoration Program

4.12 Governance

Reclamation anticipates three implementation approaches for the proposed action. The first, Core Water Operation, involves Reclamation and DWR operating the projects within the bounds of the proposed action with regular performance monitoring and reporting. The second, Scheduling, includes water-shed based groups of the five agencies (i.e., Reclamation, DWR, USFWS, NMFS, CDFW) and water users providing input to Reclamation and DWR on scheduling and routing specific blocks of water identified in the proposed action (i.e., pulse flows). The third, Collaborative Planning, involves program teams of the five agencies and water users working together to define, study, and implement specific components of the proposed action.

The Core Water Operation serves as the foundation for meeting regulatory requirements and providing for Reclamation and DWR to operate the CVP and SWP, while reducing the stressors on listed species influenced by those ongoing operations. through real-time monitoring. The Core Water Operation consists of operational actions that do not require subsequent concurrence to define annual operation. For the Core Water Operation, Reclamation would implement activities, monitor performance, and report on compliance with the commitments in the proposed action. The Real - Time Water Operations Charter, (Charter) described in Appendix C describes how Reclamation and DWR will monitor and report on ESA Section 7 commitments under the proposed action and how the five agencies, public water agencies, and other participants will communicate, and coordinate real-time water operations decisions. The Charter also describes the deliverables, schedule, and decision making processes.

The Core Water Operation also provides for regulatory coordination in the event conditions exceed the ability to anticipate how Reclamation and DWR would operate (e.g., Tier 4 Shasta Cold Water Pool management). Reclamation and DWR must demonstrate compliance with the commitments in the proposed action and provide sufficient information for an evaluation of reinitiation triggers through regular monitoring and reporting.

As part of Core Water Operation, fishery agencies would provide information to Reclamation and DWR on the real-time disposition of species through specific monitoring workgroups. This information would inform the risk analysis performed by Reclamation and DWR.

For components of the proposed action identified as part of the Scheduling implementation approach, fishery agencies and water users in watershed-based groups would provide scheduling recommendations to Reclamation and DWR on duration, timing, and magnitude of specific blocks of water. Reclamation and DWR will evaluate and consider the recommendations and operate the CVP and SWP to those schedules as feasible. For aspects of the proposed action that are implemented

through Collaboratively Planning, Reclamation and DWR will form program teams comprised of fishery agency and stakeholder representatives that inform Reclamation and DWR decisions on all aspects of the action. Example collaborative planning actions include spawning and rearing habitat, Delta Fish Conservation Hatchery, and the Delta Smelt Habitat Action.

Reclamation and DWR will annually report on water operations and fish performance seasonally and in an annual summary. The monitoring programs and schedule for reporting are described in Appendix C. Changes to the proposed action would occur based on the reinitiation triggers provided by 50 CFR 402.16. 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.

Reclamation will monitor take for the purpose of evaluating trigger (a) above; Reclamation will monitor the effects of the proposed action for the purpose of evaluating trigger (b) above. If Reclamation decides to modify the proposed action, Reclamation will evaluate the changes to the proposed action based on trigger (c) above. Consistent with 50 CFR 402.16, the USFWS and/or NMFS may also reinitiate formal consultation as appropriate. Reclamation will coordinate with DWR as an “applicant” and support DWR’s coordination with CDFW.