Topic: Barriers

Region: Delta/Lower Sacramento River

Type of Idea: Study

Timeframe: Five-year study (2020-2025)

Species and Lifestage: Protects juvenile, out-migrating salmonids

Current Requirement

–NMFS 2009 BO, RPA IV.1.3: Reclamation and/or DWR shall consider engineering solutions to further reduce diversion of emigrating juvenile salmonids to the interior and southern delta, and reduce exposure to CVP and SWP export facilities.

–WIIN Act, 4001 (b)(3): Collaborate with DWR to install a deflection barrier at Georgian Slough and the Delta Cross Channel Gate to protect migrating salmonids, consistent with knowledge gained from activities carried out during 2014 and 2015.

Idea – Reclamation will work with DWR to conduct a pilot study similar to those conducted by DWR in 2011, 2012, and 2014. The pilot study will focus on multiple non-physical barrier technologies including; bioacoustic fish fence (BAFF), floating fish guidance structure (FFGS), and infrasound fish fence (IFF). The barriers will be setup in an array of different combinations at Georgiana Slough, Steamboat Slough, Sutter Slough, and potentially the Delta Cross Channel gates throughout the multi-year pilot study. Tagged salmonids will be released upstream and their entrainment/predation into Georgiana Slough, Sutter Slough, and Steamboat Slough will be tracked as the barriers are position "on" or "off." It is anticipated that barriers at Steamboat Slough and Sutter Slough will be tested in a combination of "on" or "off", while Georgiana Slough may or may not remain primarily in the "on" position as opposed to a combination of "on" or "off." Steamboat Slough and Sutter Slough may provide increased survival for outmigrating salmonids when compared to the southern portion of the main-stem of the Sacramento River by Georgiana Slough.

Past Implementation – No permanent barrier at Georgiana Slough currently exists. DWR conducted a study utilizing the BAFF in 2011 and 2012, and the FFGS in 2014.

Current Science –

The study supports RPA IV.1.3 and the WIIN Act, 4001 (b)(13). Previous studies conducted in 2011, 2012, and 2014 (DWR 2011, 2012) (DWR 2014) show supporting evidence that non-physical barriers reduce entrainment of outmigrating, juvenile salmonids into Georgiana Slough. This proposed study will further determine the best combination of non-physical barrier technologies, as well as their preferred locations.

Modeling Assumptions –

Non-Applicable

Sources

California Department of Water Resources 2012. 2011 *Georgiana Slough Non-Physical Barrier Performance Evaluation Project Report*. California Department of Water Resources, Sacramento, CA.

California Department of Water Resources 2014. *Georgiana Slough Floating Fish Guidance Structure Performance Evaluation Project Report*. California Department of Water Resources, Sacramento, CA.

Topic: Fall X2

Region: Delta **Type of Idea:** Operations/Adaptive Management

Timeframe: September through November; Following Above Normal and Wet Years

Species and Life stage: Delta Smelt

Current Requirement

2008 FWS BO – RPA Component 3 – Action 4: Estuarine Habitat During Fall

Objective: Improve fall habitat for delta smelt by managing of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal. This will help return ecological conditions of the estuary to that which occurred in the late 1990s when smelt populations were much larger. Flows provided by this action are expected to provide direct and indirect benefits to delta smelt. Both the direct and indirect benefits to delta smelt are considered equally important to minimize adverse effects.

Action: Subject to adaptive management as described below, provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than 74 km in the fall following wet years and 81km in the fall following above normal years. The monthly average X2 must be maintained at or seaward of these values for each individual month and not averaged over the two month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall target. The action will be evaluated and may be modified or as determined by the Service.

Background

Action 4 expressly requires that the Fall X2 action be adaptively managed, to ensure that the implementation of the action addresses the uncertainties of its effectiveness and water-efficiency. The action also states that as new information is developed and as circumstances warrant, changes to the Fall X2 action itself may be necessary. In 2011 Reclamation provided the Service with an updated Adaptive Management Plan that provided a framework to implement Fall X2. The AMP includes a review of Action 4 and evaluates habitat, X2 as a surrogate, evidence for the link between habitat and abundance, hydrology, and specifics of action. The key questions identified in the AMP that remain unanswered include ecological mechanisms that link outflow to abundance, other drivers of abundance, and if there are more water-efficient ways to provide the necessary benefits.

New scientific information has been developed since the 2008 BO. In 2011, the Interagency Ecological Program (IEP) Management, Analysis, and Synthesis Team (MAST) released the Fall Low Salinity Habitat (FLaSH) report to suggest studies to explore the importance of fall low-salinity habitat for Delta Smelt (Brown et al. 2014). The IEP MAST also developed the Final MAST Report in 2015, which included an updated Delta Smelt conceptual model.

As part of Action 4, FWS will be conducting a comprehensive 10-year review of the outcomes and effectiveness, including an independent peer review. This is anticipated to be completed in early 2019.

Ideas

1) Flexible Operation of Fall X2
    a. Modify averaging period to two months to allow for more flexible operations.
    b. Allow for 1-3 km variations based on hydrologic conditions, air temperatures, other factors
    c. Define future Adaptive Management actions for different scenarios
2) Suisun Marsh Salinity Control Gates (SMSCG) Re-operation
    a. Use SMSCG and Roaring River Distribution System (RRDS) in September and October to achieve habitat in Grizzly and Honker Bays following Above Normal and Wet Years
3) Remove December requirement

Any flexibility in operation gained from this proposal would need to be implemented in accordance with CDFW's Consistency Determination on the 2008 and 2009 BOs. Due to coordination in operation of the CVP and SWP, DWR would also need approval to implement an Adaptive Management flexibility in Fall X2.

Past Implementation

Since 2008 only two years have been classified as Above Normal or Wet Water Year types. In 2011, X2 for the months of September and October was at approximately 74 km. In 2017, the X2 location for September was 74 km. In October 2017, through coordination with FWS, Reclamation operated to 80 km (Delta Smelt Fall Outflow in 2017 Environmental Assessment [EA]). The two-month average for X2 in 2017 was planned as approximately 77 km. CDFW Consistency Determination

Current Science

Spawning Habitat – PCE 4 Salinity (2008 BO)
The LSZ expands and moves downstream when river flows are high. By capturing river flows, reservoirs can contribute to upstream movement of the LSZ which reduces habitat quality and quantity. Banks and Jones pumping likewise can result in upstream movement of the LSZ. Model results in the biological assessment show that in the future the location of the LSZ will generally be further upstream than occurred historically. This will result in a reduction in the amount and quality of spawning habitat available to delta smelt. These changes are primarily due to proposed future increases in upstream depletions and changes to reservoir operations and export pumping from the CVP/SWP.

Using lookup tables from the FLaSH Report (Table 2-1 in Brown et al. 2014) an X2 of 74 km would give a low salinity zone (LSZ) area of approximately 8,408 hectares (20,777 acres) and an X2 location of 81 km would give a LSZ area of approximately 5,313 hectares (13,129 acres) (Table A). In the lookup table, the largest increase in habitat between X2 kilometers is from 81 km (5313 hectares) to 80 km (6653 hectares). This represents an approximately 25.5% increase in habitat from a km difference in X2. This is seen as an inflection point that reaches habitat in

Grizzly Bay and Honker Bay, two key areas for delta smelt habitat. Figure 1 shows the same data in a plot. The line between 80 km and 81 km has the greatest slope, showing the greatest increase in habitat for a 1km difference in X2 location.

Table A – Lookup Table (Table 2-1) from Brown et al. 2014

X2 (km)	Area of LSZ (hectares)
73	8,585
74	8,408
75	8,231
76	8,380
77	8,162
78	7,959
79	7,369
80	6,653
81	5,313
82	5,051
83	5,075
84	4,753
85	4,483
86	4,492
87	4,456
88	4,463

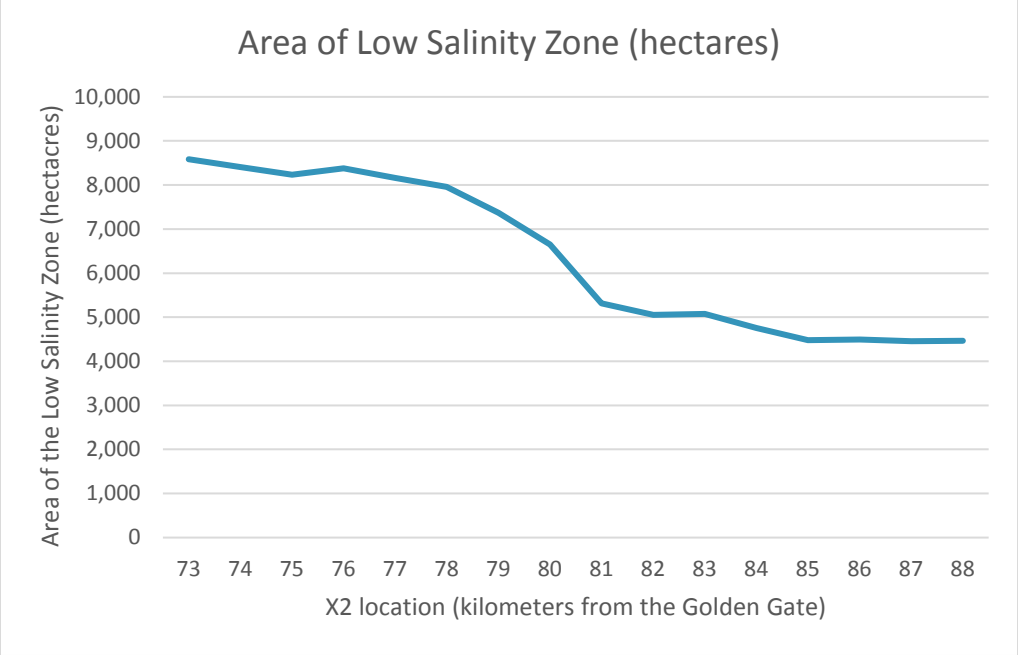


Figure 1: X2 location versus Area of the Low Salinity Zone

Justification

Idea 1: Flexible Operation of Fall X2

The UnTRIM Bay-Delta model, along with the lookup table, show effects from the location of X2 are not linear. The UnTRIM model shows a change in salinity between 80 and 81 km (Figures 2 and 3). As described in Bever et al (2016), Grizzly Bay and Honker Bay are key regions for Delta Smelt.

Figure 2. Percentage of time with salinity <6 for X2 = 80 km

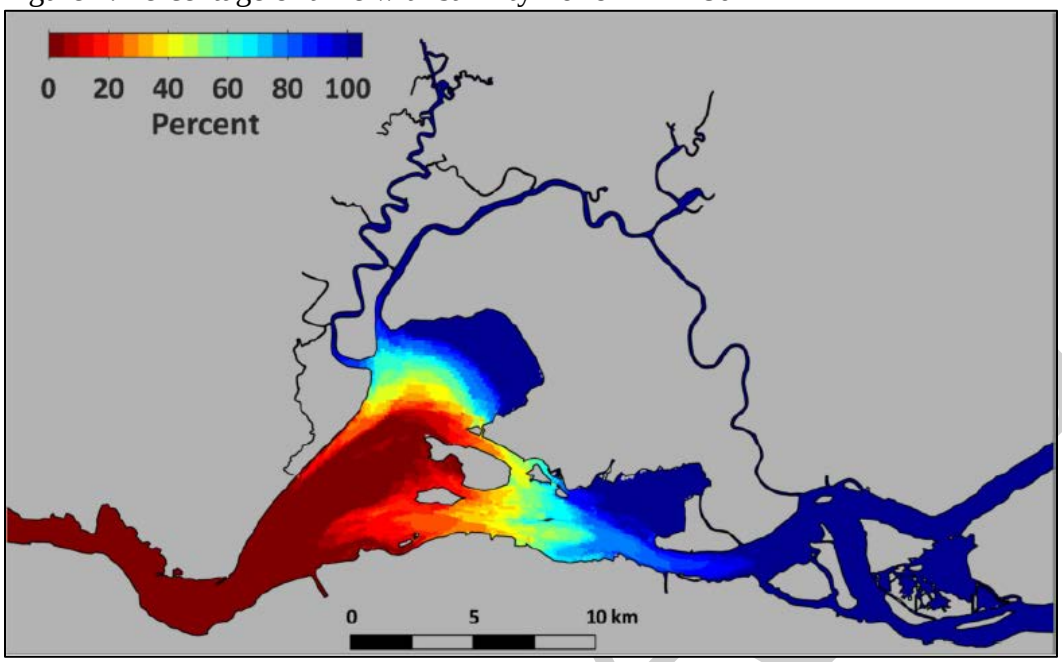
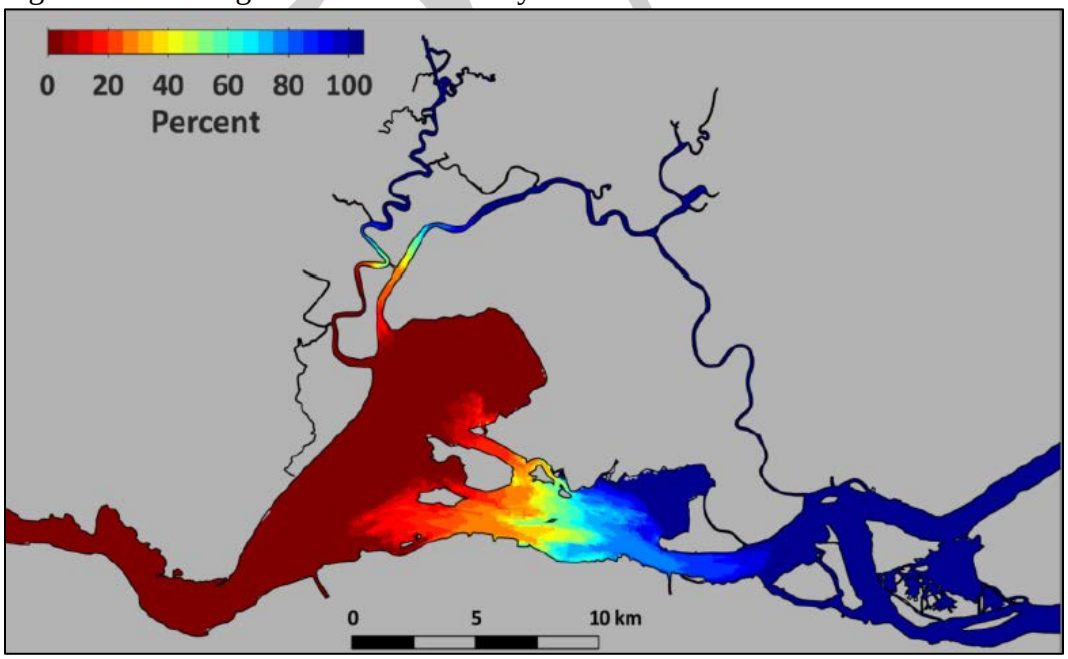


Figure 3. Percentage of time with salinity <6 for X2 = 81 km



The 2015 Environmental Impact Statement (EIS) on the Coordinated Long-term Operation of the Central Valley Project (CVP) and State Water Project (SWP) (LTO) found the X2 position ranged from 85.6 km to 92.3 km, depending on the water year type, with a long term average X2

position of 88.1 km (page 9-343). Using the lookup table, an X2 position of 88 km provides for approximately 4,463 hectares of LSZ.

Changing the AN Year (81 km) to two-month average may result in an increase of approximately 10-20% total hectares of LSZ compared to 81 km alone (Table B). Using the lookup table and a two-month average of 80 km (with up to 3 km variation) may result in an increase of approximately 20-25% total hectares of LSZ. A two-month average could also allow for more flexibility in operation. A similar exercise for W years (74 km) yielded less meaningful differences in LSZ.

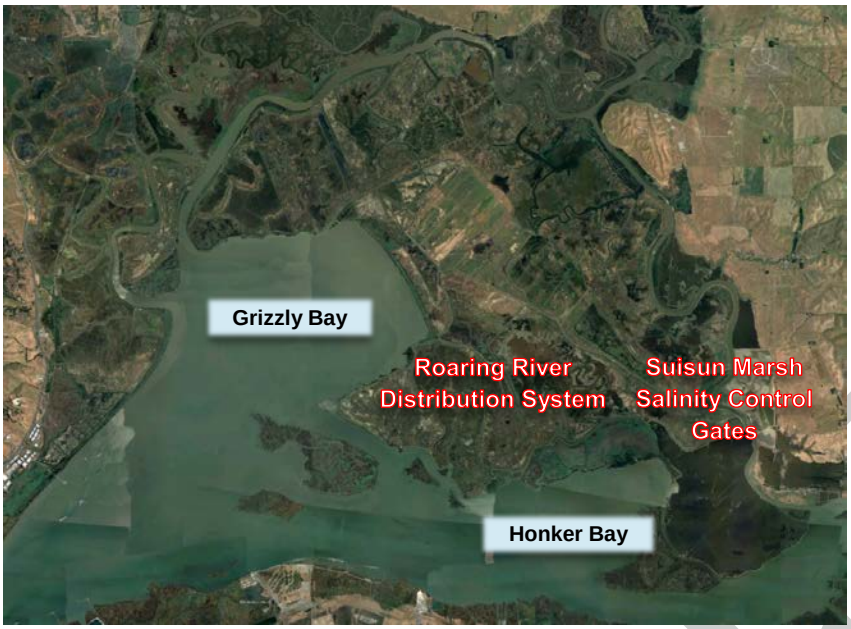
Table B – Low Salinity Zone averages based on lookup table

Above Normal Water Year					
September X2 (km)	October X2 (km)	Hectares of LSZ	Hectares of LSZ	Average (Hectares of LSZ)	Difference (Compared to 81 km)
80	82	6,653	5,051	5852	10.1%
79	83	7,369	5,075	6222	17.1%
78	84	7,959	4,753	6356	19.6%
81	81	5,313	5,313	5,313	N/A
82	80	5,051	6,653	5852	10.1%
83	79	5,075	7,369	6222	17.1%
84	78	4,753	7,959	6356	19.6%

The 2008 BO discusses that although habitat space may not be a limiting factor, habitat has become increasingly limited over time and has contributed to low population numbers.
Action 4 of the RPA specifically states that 74 km and 81 km prescriptions are monthly averages and not to be averaged over the two months. This is presumably to avoid a large swing over the course of the each month. However, there could be another option: averaging the monthly averages. Taking the monthly averages and averaging them would be much less variable than taking the average of two months together.

Idea 2: Suisun Marsh Salinity Control Gates re-operation
Reclamation is looking at how water routed through Montezuma Slough by changing the operations of the SMSCG or different operations in the Roaring River Distribution System could help meet habitat objectives in Grizzly Bay and Honker Bay.

Flow management will be more effective in confined regions where existing flows are small, rather than broadly across the entire Delta (Brown et al. 2008).



Modeling Assumptions

Idea 1: Flexible Operation of Fall X2
Reclamation has completed some initial model runs looking at a two-month average. The CalSim II model runs looked at 82 years Q5E – September to end of May Mean "Annual" difference (TAF) from NAA – W or AN years (which occurred 38 times). The model runs looked at 1, 2, and 3 km variations in each direction for September and October for 74 km and 81 km. The initial model runs look like changing the Wet Year (74 km) to two-month average doesn't really change the amount of LSZ or provide much water supply benefit. Next steps for modeling may include looking average differences in acre-feet in Wet and Above Normal years separately.

Table C – Modeling Assumptions

September allowed extra 1km in, Pushed out 1 km in October
September allowed extra 2km in, Pushed out 2 km in October
September allowed extra 3km in, Pushed out 3 km in October
September pushed out 1km, allowed extra 1km in October
September pushed out 2km, allowed extra 2km in October
September pushed out 3km, allowed extra 3km in October

Idea 2: Suisun Marsh Salinity Control Gates re-operation
The modeling assumptions for Idea 2 would be to release 30 TAF over the months of September and October following AN and W years in place of Fall X2 requirements. SMSCG and RRDS would be operated to maximize the amount of the additional 30 TAF of water that moves into Grizzly and Honker Bays. Proposed modeling includes CalSim II and DSM2 with specific assumptions and scenarios still being discussed.

References

Bever, Aaron J.; MacWilliams, Michael L.; Herbold, Bruce; Brown, Larry R.; and Feyrer, Frederick V. (2016). Linking Hydrodynamic Complexity to Delta Smelt (Hypomesus transpacificus) Distribution in the San Francisco Estuary, USA. San Francisco Estuary and Watershed Science, 14(1).

Brown, L. R., W. Kimmerer, and R. Brown. 2008. Managing Water to Protect Fish: A Review of California's Environmental Water Account. *Environ. Manage.* 43: 357-368.

Brown, L. R., R. Baxter, G. Castillo, L. Conrad, S. Culberson, G. Erickson, F. Feyrer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, J. Kirsch, A. Mueller-Solger, S. Slater, K. Souza, and E. Van Nieuwenhuyse. 2014. Synthesis of studies in the fall low-salinity zone of the San Francisco Estuary, September–December 2011: U.S. Geological Survey Scientific Investigations Report 2014–5041. U.S. Geological Survey, Reston, VA.

Interagency Ecological Program, Management, Analysis, and Synthesis Team (IEP MAST). 2015. An updated conceptual model of Delta Smelt biology: our evolving understanding of an estuarine fish. Technical Report 90. January. Interagency Ecological Program for the San Francisco Bay/Delta Estuary, Sacramento, CA.

Topic: Inflow to Export (I:E) Ratio on the San Joaquin River

Region: Delta / San Joaquin Watershed Type of Idea: Operational / Study

Timeframe: April thru May; Above normal and Wet years

Species and Lifestage: Steelhead (Out-Migration)

Current Requirement – Reclamation and DWR shall implement starting in 2012, a minimum of 4:1 for the Vernalis flow-to-combined export ratio (6,000 cfs inflow to 1,500 cfs export), based on a 14-day running average, from April 1st through May 31st, during above normal and wet years.

Idea – With the HORB in place, implement a 1:1 Vernalis flow-to-combined export ratio, based on a 14-day running average, from April 1st through May 31st, during above normal and wet years, when flows at Vernalis are greater than 5,000 or 7,000 cfs.

Past Implementation – Since 2012, it has either been critical dry or dry, as defined by the San Joaquin Valley Classification. Therefore the 4:1 ratio has never been implemented.

Current Science –

- Similar outflows as in Baker and Morhartdt 2001, which indicated that flows over 5,000 to 6,000 cfs were required to move into the linear phase of increasing fish escapement
- Relies on the Mainstem of the San Joaquin as the preferred route to Chipps Island, which is supported by Holbrook, Perry, and Adams 2008, and DWR 2014 Stipulation Study.
- Still awaiting the results from Reclamation's Six- Year Steelhead Acoustic Tag Study, however, the Final 2011 Report indicted while there was some variation in export rates during the tagging study in 2011, there was no apparent relationship between export rates and the probability of remaining in the San Joaquin River at the head of Old River, or, conversely, of entering Old River. Also, preliminary results of Final Six-Year Steelhead Study indicate as Vernalis flows increased, survival increased. Vernalis flows accounted for more of the variation (i.e. had higher coefficients of determination) in steelhead survival than the other variables; exports, inflow/export ratio, flow at the head of Old River, and OMR flows.
- Supported by DWR 2014 Stipulation Study that found that "overall, under the OMR flows tested and the conditions that occurred during the field study, there was little influence of OMR flows on steelhead tag movement during the study."

Modeling Assumptions –

IE Ratio of 1:1 when Vernalis is Greater Than 5,000 or 7,000 cfs

Based on some preliminary draft CalSim modeling, by allowing a 1:1 ratio when flows at Vernalis are greater than 5,000 or 7,000 cfs, the projects experience an increase in water supply. The largest benefits come from the 5,000 cfs limit, since that flow is more typical than 7,000 cfs. Under the 5,000 cfs limit, the projects combined are able to capture an average additional 231 TAF across all water year types. Under the 7,000 cfs limit, the projects would be able to capture more water than the 5,000 cfs but would occur less often.

Topic: Inflow to Export (I:E) Ratio on the San Joaquin River

Region: Delta / San Joaquin Watershed **Type of Idea**: Operational / Study

Timeframe: April 1st to May 31st

Species and Lifestage: Juvenile Steelhead (Out-Migration)

Current Requirement – Reclamation and DWR shall implement starting in 2012, a minimum of 4:1 for the Vernalis flow-to-combined export ratio (6,000 cfs inflow to 1,500 cfs export), based on a 14-day running average, from April 1st through May 31st, during above normal and wet years.

Ideas – With the HORB in place, a 3.3: 1 Ratio Vernalis flow-to-combined export ratio, based on a 14-day running average, from April 1st through May 31st, during above normal and wet years.

Past Implementation – Since 2012, as defined by the San Joaquin Valley Classification, the San Joaquin has been Critically Dry, Dry or Flood Conditions. Therefore the 4:1 ratio has never been implemented.

Related Science –

- The 3.3 equates to 4,950 cfs measured at Vernalis to 1,500 cfs export pumping, which is within the real time median flows of San Joaquin River flows (cfs) measured at Vernalis for water years 1922 through 1992 for the months of April and May;
- 4,950 cfs measured at Vernalis is similar outflow as in Baker and Morhartdt 2001, which indicated that flows over 5,000 to 6,000 cfs at Vernalis were required to move into the linear phase of increasing fish escapement to the ocean;
- Relies on the Mainstem of the San Joaquin as the preferred route to Chipps Island, which is supported by Holbrook, Perry, and Adams 2008, and DWR 2014 Stipulation Study;
- Idea aligns with 2006 VAMP Annual Technical Report, that indicated increase flows and decreased exports relative to the flows should correspond to increased smolt survival and adult escapement 2.5 years later.

Past comments of Current Requirement

1) "The BiOp does not clearly explain the rationale for imposing a 4:1 ratio in above normal and wet years" Consolidated Salmonid Cases' 2011 Summary Judgement;

2) "Overall, under the OMR flows tested and the conditions that occurred during the field study, there was little influence of OMR flows on steelhead tag movement during the study." 2014 DWR- Stipulation Study;

3) "The extent to which management actions such as reduced negative Old and Middle River (OMR) reverse flows, ratio of San Joaquin River inflow to exports (I:E), and ratio of exports to Delta inflow (E:I) affect through-Delta survival is uncertain. " 2017 Salmon Scoping Team

Modeling-

Reclamation has performed some preliminary draft CalSim modeling of this idea. Changing the San Joaquin River Inflow to Export pumping ratio in Wet and Above Normal Years to 3.3 to 1 instead of 4 to 1 has a possible water supply benefit of between 30 and 60 Thousand Acre-feet in Above Normal and Wet water year types. It is anticipated that the average annual water supply benefit of this action could total around 20 Thousand-Acre Feet of additional CVP / SWP supplies, with an equivalent reduction in Delta outflow in April and May.

However, there is a slight increase in Delta outflow required in the months just beyond this action, of up to 5 thousand-acre-feet in May or June of Above Normal or Wet water years.

Topic: Storm Event OMR Flexibility

Region: Delta **Type of Idea**: Operations

Timeframe: January 1 through June 15, every year

Species and Life stage: Delta Smelt and Chinook salmon outmigrating juveniles

Current Requirement

2008 USFWS Biological Opinion (2008 BiOp) – RPA Actions 1, 2, and 3

The 2008 BiOp prescribes OMR flows in three of its Actions: Action 1 protects pre-spawning adult Delta Smelt from entrainment during the first flush; Action 2 protects pre-spawning adults from entrainment and from adverse hydrodynamic conditions; and Action 3 protects larval Delta Smelt from entrainment.

2009 NMFS 2009 Biological Opinion (2009 BiOp) – RPA Action IV.2.3

The 2009 BiOp RPA Action IV.2.3 is intended to reduce the vulnerability of emigrating juvenile winter-run, yearling spring-run, and CV steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta. This action is also intended to enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the mainstem of the San Joaquin River for emigrating fish, including greater net downstream flows. This actions require CVP/SWP to reduce exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids, from January 1 through June 15.

Background

The Water Infrastructure Improvements for the Nation Act, Section 4003 titled Temporary Flexibility for Storm Events, calls for maximizing water supplies for CVP and SWP contractors through an operations plan. The Secretary of the Interior and the Secretary of Commerce (collectively, "Secretaries") shall evaluate and may authorize the CVP and SWP to operate at levels that result in OMR flows more negative than the most negative reverse flow rate prescribed by the RPA actions detailed above to capture peak flows during storm-related events, provided that the action would result in no additional adverse effects on listed species beyond the range of the effects anticipated to occur to the listed species for the duration of the smelt biological opinion (i.e. 2008 BiOp) or salmonid biological opinion (i.e. 2009 BiOp).

Further, Section 4005(b)(1) of the WIIN Act requires consistency with State law, including California Fish and Game Code section 2080.1. Section 4005(b)(3) requires the Secretaries to

notify the State regarding any changes in the manner in which the 2008 and 2009 BiOps are implemented; and that the Secretaries confirm that those changes are consistent with ESA.

Past Implementation

In March 2018, Reclamation implemented a brief storm flexibility operation in accordance with WIIN Act. Currently, upon identification of precipitation within the Central Valley, Reclamation, in coordination with DWR, evaluates the storm event for eligibility under the WIIN Act Section 4003 and proposes OMR rates accordingly while assessing real-time biological conditions that would warrant not proceeding with an operations plan. The operations plan and biological reviews are used to determine if the proposed WIIN Act action would be expected result in additional adverse effects on the species, beyond the effects analyzed for the BiOps. These plans considers the factors identified in the WIIN act the may be utilized to determine additional adverse effects. The operations plans are then forwarded to the Secretaries for approval, prior to implementation of proposed OMR rates.

Ideas

Criteria have been proposed on how to implement the WIIN Act in accordance with the Endangered Species Act and California Endangered Species Act, as well as other regulations. Reclamation seeks to find a process that allows for the implementation of WIIN Act Storm Flexibilities based on a defined process that reduces the need for significant staff effort and coordination at every eligible storm event. This process would formalize storm flexibility as part of the biological opinions currently regulating CVP and SWP long-term operations. Rather, the process outlines when an event is eligible or not and Reclamation may proceed based on its Operations Plan.

Pursuant to Section 4003(c)(4), a Storm Event Monitoring and Agreements describes the expanded monitoring programs and other data gathering to improve the efficiency of operations for federally listed species protections and CVP and SWP water supply to ensure no additional adverse effects on listed species beyond the range of the effects anticipated to occur to the listed species for the duration of the smelt biological opinion or salmonid biological opinion, using the best scientific and commercial data available.. The monitoring is the best scientific and commercial data available, feasible within the short timeframe permitted for real-time decision making, and sufficient for assessing the potential for additional adverse effects. A Storm Decision Tree, would identify the applicability of Section 4003 and real-time decision making to determine when Reclamation would initiate Section 4003 of the WIIN Act and prepare information for a decision.

Based on precipitation events that meet the criteria in the Decision Tree, Reclamation would undergo development of a Storm Event Operations Plan Template as described in Section 4003(2). This would be filled out to describe the current and forecasted conditions to be input into Delta Simulation Model II (DSM2) modeling. This would give Reclamation the operational information on the specific action such as number of days, cubic feet per second (cfs) of Delta

inflow and outflow, and resulting OMR flows. A template would provide for how Reclamation, upon identification of precipitation that may result in conditions where a Delta outflow index indicates a higher level of flow available for diversion, would operate in coordination with the SWP if authorized. The information gathered would be utilized in filling out the Biological Review Template. Utilizing this template Reclamation would assess the potential for additional adverse effects to federally listed species over the duration of the BOs.

In consideration of the language of the WIIN Act and the information in the appendices, the Secretaries, on a case-by-case basis, would determine whether or not the storm event may result in precipitation that allows for maximizing water supplies for CVP and SWP contractors under Section 4003. Under the Proposed Action, Reclamation would operate to the decision by the Secretaries.

Current Science

Below is a list of in-season monitoring, supporting information, and modeling approaches that are used to determine if the proposed WIIN Act action would be expected result in additional adverse effects on the species, beyond the effects analyzed for the BiOps:

- Regularly updated documentation on hydrologic, physical, and biological conditions
    - WOMT (Water Operations Management Team)
    - DOSS (Delta Operations for Salmonids and Sturgeon)
    - SWG (Smelt Working Group)
    - DCT (Delta Conditions Team)
- Supporting information from:
    - Enhanced Delta Smelt Monitoring (EDSM)
    - Delta Juvenile Fish Monitoring Program (DJFMP)
    - Salmon and Sturgeon Assessment of Indicators by Life-stage (SAIL)
    - Turbidity Transects
    - Status and Trends Monitoring
- Modeling of Difference between Current and Proposed Operation Plan
    - DSM2 (Delta Simulation Model II)
    - Particle Tracking Model
    - Salvage Efficiency

Justification

Section 4003(b) of the WIIN Act specifies the factors that may be considered include: 1) degree to which the Delta outflow index indicates a higher level of flow available for diversion; 2) relevant physical parameters including projected inflows, turbidity, salinities, and tidal cycles; and 3) real-time distribution of listed species. Section 4003(e) prohibits requiring a greater level of supporting detail for the analysis than feasible to provide within the short timeframe permitted for timely real-time decision making in response to changing conditions in the Delta.

Clifton Court Forebay-Predator Reduction Electrofishing Study (CCF-PRES)

Region: Delta

Type of Idea: Study

Timeframe: Three years

Species and Lifestage: Protected fish species with an emphasis on Chinook Salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*)

Current Requirement – The Clifton Court Forebay (CCF) Predator Reduction Electrofishing Study (PRES) was implemented in response to the National Marine Fisheries Service (NMFS) letter dated April 9, 2015, requiring that the California Department of Water Resources (DWR) immediately implement interim measure (a) of condition 3 as part of the larger effort to comply with Reasonable and Prudent Alternative (RPA) Action IV.4.2(2) of the 2009 Biological Opinion and Conference Opinion on the Long-term Operations of the Central Valley Project and State Water Project (NMFS BiOp).

Idea –The PRES began with a pilot year effort in 2016, a 2017 effort to refine methods and determine the main factors affecting predator catch, particularly spatial patterns, and a 2018 effort focused on maximizing predator removal based on knowledge gained during the 2016 and 2017 campaigns. The PRES involves electroshocking and removing predators from CCF and transporting them to Bethany Reservoir with the goal of decreasing pre-screen loss of protected fish species with an emphasis on Chinook Salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*). Additionally, concurrent with the PRES, releases of Passive Integrated Transponder (PIT) and acoustically tagged juvenile Chinook Salmon are occurring in an effort to determine rates of pre-screen loss in the Skinner Evaluation and Improvement Study (SEIS).

Reclamation would assist DWR with NEPA and/or ESA compliance, as necessary for the study. Combining this compliance with Track 1 of the ROC could be efficient to avoid a separate NEPA and ESA document. This is an existing RPA action but could help improve water supply by reducing take through CCF.

Past Implementation – a pilot year effort occurred in 2016.

Current Science – monitoring will occur to evaluate the effectiveness of predator removal and determine pre-screen loss.

Modeling Assumptions – Not Applicable

Rapid Genetic Protocol

Region: Delta **Type of Idea**: Operational (salvage triggers)

Timeframe: January through June

Species and Lifestage: young-of-year Winter-Run Chinook salmon

Current Requirement – Action IV.2.3 uses wild fish loss or CNFH hatchery surrogate loss thresholds to reduce ESA-listed fish entrainment between January 1 and June 15, by managing Old and Middle River flows to -5,000 cfs (14-day average). When a loss-based trigger is exceeded OMR flows are required to be managed less negative than the most negative allowed under RPA Action IV.2.3 (see tables below).

Idea – Establish rapid genetic analysis protocol as a long-term commitment. Implementation of rapid genetic protocol is currently determined on an annual basis. Previous implementation has demonstrated a water supply benefit by avoiding pumping restrictions when fish that are captured appeared to be winter-run based on their size but genetic results determined that they were not actually winter-run.

Past Implementation – This procedure was used as a pilot effort in 2015 and has been implemented on an annual basis during 2016-2018. NMFS supported the use of this protocol during the last two water years, with the two additional conditions that all unclipped Chinook salmon have tissue samples collected for subsequent analysis, and that the annual incidental take limit was set at 1% of natural winter-run.

Reclamation and the Department of Water Resources, in consultation with the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and NMFS, developed this procedure to genetically identify ESA-listed fish species that fit within the older juvenile size-at-date criteria at the fish salvage facilities. Standard operating procedures have been developed to describe a timeline for preliminary and final loss estimation based on updated genetic information to achieve salmonid protection and water reliability during periods when ESA-listed species are present in the Sacramento-San Joaquin Delta.

Current Science – Genetic identification aids in a more accurate estimation of loss at the CVP and SWP fish salvage facilities for Sacramento River winter-run Chinook salmon. Rapid genetic analysis allows for timely discrimination of different races of Chinook salmon that may overlap within the older juvenile size-at-date criteria used at the fish salvage facilities, some of which are listed under the ESA (e.g. winter-run and spring-run Chinook salmon) and some of which are non-listed races under the ESA (e.g., fall-run and late fall-run Chinook salmon).

Table on back extracted from NMFS response letter to USBR. Re: Rapid Genetic Analysis of the Central Valley Project and State Water Project salvaged older juvenile Chinook salmon in Water Year 2018. http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/nmfs_response_to_reclamation_s_request_to_implement_rapid_genetic_analysis_in_wy_2018_-_december_18__2017.pdf)

DRAFT subject to revision - Last updated 4/25/2018

Date	Action Triggers per 2009 RPA with 2011 Amendment	Action Triggers Applying Rapid Genetic Analysis	Action Responses
January 1 – June 15 First Stage Trigger (increasing level of concern)	(1) Daily SWP/CVP older juvenile Chinook salmon[1] loss density (fish per taf) is greater than incidental take limit divided by 2000 (2 percent WR JPE ÷ 2000), with a minimum value of 2.5 fish per taf, or (2) daily SWP/CVP older juvenile Chinook salmon loss is greater than 8 fish/taf multiplied by volume exported (in taf) or (3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5% for each surrogate release group, or (4) daily loss of wild steelhead (intact adipose fin) is greater than 8 fish/taf multiplied by volume exported (in taf)	(1) Daily SWP/CVP genetic winter-run[2] loss density (fish per taf) is greater than incidental take limit divided by 2000 (1 percent WR JPE ÷ 2000), with a minimum value of 2.5 fish per taf, or (2) daily SWP/CVP genetic winter-run loss is greater than 8 fish/taf multiplied by volume exported (in taf) or (3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5% for each surrogate release group, or (4) daily loss of wild steelhead (intact adipose fin) is greater than 12 fish/taf multiplied by volume exported (in taf)	Reduce exports to achieve an average net OMR flow of (minus) -3,500 cfs for a minimum of 5 consecutive days. The five day running average OMR flows shall be no more than 25 percent more negative than the targeted flow level at any time during the 5-day running average period (*e.g.*, -4,375 cfs average over five days). Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction. Reductions are required when any one criterion is met.

[1] "Older juvenile Chinook salmon" is defined as any Chinook salmon that is above the minimum length for winter-run Chinook salmon, according to the "Delta Model" length-at-date table used to assign individuals to race.

[2] Genetic winter-run within the older juvenile Chinook salmon length-at-date category

January 1 - June 15 Second Stage Trigger (analogous to high concern level)	(1) Daily SWP/CVP older juvenile Chinook salmon loss density (fish per taf) is greater than incidental take limit (2 percent of WR JPE) divided by 1000 (2 percent of WR JPE ÷ 1000), with a minimum value of 5.0[3] fish per taf, or (2) daily SWP/CVP older juvenile Chinook salmon loss is greater than 12 fish/taf multiplied by volume exported (in taf), or (3) daily loss of wild steelhead (intact adipose fin) is greater than 12 fish/taf multiplied by volume exported (in taf)	(1) Daily SWP/CVP genetic winter-run loss density (fish per taf) is greater than incidental take limit (1 percent of WR JPE) divided by 1000 (1 percent of WR JPE ÷ 1000), with a minimum value of 5.0 fish per taf, or (2) daily SWP/CVP genetic winter-run loss is greater than 12 fish/taf multiplied by volume exported (in taf), or (3) daily loss of wild steelhead (intact adipose fin) is greater than 12 fish/taf multiplied by volume exported (in taf)	Reduce exports to achieve an average net OMR flow of (minus) -2,500 cfs for a minimum 5 consecutive days. Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction. Reductions are required when any one criterion is met.

Topic: Smelt Monitoring

Region: Delta

Type of Idea: Study

Timeframe: Study periods, or indefinite

Species and Lifestage: Delta Smelt – all life stages, primarily adult

Current Requirement / Action

The USFWS 2008 BO bases OMR action triggers on, in part, the Fall Mid-water Trawl, Spring Kodiak Trawl, and delta smelt salvage at the Jones and Banks pumping plants. Recent enhanced Delta Smelt Monitoring (EDSM) also provides information to inform entrainment risk. As indicated in the USFWS BO, "abundances near the detection threshold of the sampling techniques makes it very difficult to draw reliable inferences about how many delta smelt there are, and where they are located". The BO also allows the Smelt Working Group to use "available physical and biological real-time monitoring data" to decide whether a large fraction of the Delta smelt population is at a high entrainment risk.

Idea

All of the current sampling efforts require physical handling of Delta Smelt, which requires take. Non-invasive methods of determining smelt presence could greatly expand our knowledge of Delta smelt presence and locations, while avoiding the need for physical handling or capture of the smelt. These include environmental DNA as well as scent dogs.

Past Implementation

As stated in the 2008 USFWS BO, "the Fall Midwater Trawl Survey (FMWT) and the Summer Townet Survey (TNS) are the two longest running IEP fish monitoring programs that are used to index delta smelt abundance. They work well because they were originally designed to target age-0 striped bass, which have similar habitat requirements to delta smelt. Two more recent programs, the 20-mm Survey and the Spring Kodiak Trawl Survey (SKT), were designed specifically to sample delta smelt and are also commonly used to evaluate relative abundance and distribution. Each of these four sampling programs targets different life stages and encompasses the entire distribution of delta smelt for the given life stage and time of year. The efficiency of sampling gears used for delta smelt is unknown. However, they were all designed to target open-water pelagic fishes and data from these programs have been used extensively in prior studies of delta smelt abundance and distribution (e.g., Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995; Dege and Brown 2004; Bennett 2005; Feyrer et al. 2007).

Data from the FMWT are used to calculate indices of relative abundance for delta smelt. The program has been conducted each year since 1967, except that no sampling was done in 1974 or 1979. Samples (10-minute tows) are collected at 116 sites each month from September to December throughout the Bay-Delta. Detailed descriptions of the sampling program are available from Stevens and Miller (1983) and Feyrer et al. (2007). The delta smelt recovery index includes distribution and abundance components and is calculated from a subset of the September and October FMWT sampling (http://www.delta.dfg.ca.gov/). The details on the calculation of the recovery index can be found in the Delta Native Fishes Recovery Plan (Service 1995).

Data from the TNS are used to calculate indices of abundance for young-of-year delta smelt during the summer. The TNS has been conducted annually since 1959 (Turner and Chadwick 1972). It involves sampling at up to 32 stations with three replicate tows to complete a survey. A minimum of two surveys is conducted each year. The delta smelt index is generated from the first two TNS surveys (Moyle et al. 1992). The TNS sampling has had an average survey starting date of July 13, but surveys have been conducted as early as June 4 and as late as August 28 in some years (Nobriga et al. 2008).

Data from the 20-mm survey are used to examine the abundance and distribution of young post-larval/early juvenile delta smelt during the spring (Dege and Brown 2004). The survey has been conducted each year since 1995, and involves the collection of three replicate samples at up to 48 sites; additional sites have been added in recent years. A complete set of samples from each site is termed a survey and 5-9 surveys are completed 144 each year from approximately March though June. This survey also simultaneously samples zooplankton with a Clarke-Bumpus net during one of the three sampling tows at each site.

Data from the SKT are used to monitor and provide information on the pre-spawning and spawning distributions of delta smelt. The survey also quantifies the reproductive maturity status of all adult delta smelt collected. SKT sampling has been done since 2002 at approximately 39 stations. Sampling at each station is completed five or more times per year from January to May. Supplemental surveys are often completed when additional information is requested by managers to assist with decisions relating to water project operations."

The Enhanced Delta Smelt Monitoring (EDSM) program, which began in November 2016, is a year-round weekly sampling program administered by the US Fish and Wildlife Service (USFWS) that samples nearly all life stages of Delta Smelt and produces weekly estimates of abundance for several spatially-defined, and temporally dynamic, strata. The original motivation for the survey was to acquire finer temporal resolution information than existing surveys provided about the spatial distribution and abundance of adult Delta Smelt during the December through March period when State Water Project (SWP) and the federal Central Valley Project (CVP) are exporting water that leads to the entrainment of Delta Smelt and other fish species. Beginning December 2017, the Enhanced Delta Smelt Monitoring (EDSM) program started its Phase 1 sampling program for adult delta smelt. The Bay-Delta has been divided into ten geographic strata. Sampling locations are generated using a generalized random-tessellation stratified (GRTS) design with stratification and equal probability sampling. Trawling gear similar to that used in the California Department of Fish and Wildlife's Spring Kodiak Trawl Survey is used to conduct multiple tows per location.

The sampling locations of the EDSM change from week to week and are randomly selected using a probabilistic procedure aimed at providing a spatially dispersed sample. This is in contrast to existing long-term fish monitoring programs, such as the USFWS's Beach Seine Survey and the California Department of Fish and Wildlife's 20mm Survey (20mm), Summer Townet Survey (STN), Fall Midwater Trawl Survey (FMWT), and Spring Kodiak Trawl Survey (SKT), that sample the same non-randomly selected locations over and over. Another key difference from existing surveys is the use of a stopping rule for sampling of life stages that can be readily identified at the time of capture, which includes all life stages but small larvae that require a microscope to identify. Tows are repeated until a fish is caught or an upper limit on the number of tows is reached. The motivation behind the stopping rule is to lower the probability of a "False Zero", i.e., failing to catch fish when fish are present, while aiming to minimize the "take" of a threatened species.

Current Science

Science is ongoing related to environmental DNA and scent dogs, see below.

Environmental DNA

Identification of aqueous environmental DNA (eDNA) allows determination of presence without direct observation of organisms. Environmental DNA decomposes quickly, and degrades with UV radiation exposure. Thus, identifying Delta Smelt eDNA in water samples may provide a way to determine smelt presence in a specific location at a time within several days. DNA detectability decreases with time after the removal of the species source of DNA. DNA fragments may persist up to one week at 18 degrees C in lake water (Matsui, 2001). In another study, DNA was detectable for less than one month in the lab and field conditions (Dejean, 2011). The density of individuals also influences the dynamics of DNA detectability in water samples, but methods exist to obtain eDNA information even at low densities (Ficetola, 2008).

Samples persist longer in sediments than in the water column, so for overall Delta smelt presence geographically, sediment sampling could be done instead of water sampling (Turner 2014). Water sampling would instead provide more real-time information.

Scent Dogs

Scent dogs are currently being used and developed in several applications to identify rare aquatic species, including Giant Garter Snake in California (unpublished data referred to in Hansen, 2017), and quagga mussels in Lake Mead (DeShon, 2016).

Modeling Assumptions

Not applicable.

Sources

Dejean T, Valentini A, Duparc A, Pellier-Cuit S, Pompanon F, et al. (2011). Persistence of Environmental DNA in Freshwater Ecosystems. PLoS ONE 6(8): e23398. doi:10.1371/journal.pone.0023398

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Hansen E, Scherer R, Fleishman E, Dickson B, Krolick D. (2017). Relations between Environmental Attributes and Contemporary Occupancy of Threatened Giant Gartersnakes (*Thamnophis gigas*). Journal of Herpetology, Vol. 51, No. 2, 274-283

Newman K. (2008). Sample design-based methodology for estimating delta smelt abundance. San Francisco Estuary and Watershed Science 6(3): article 3. Available from: http://repositories.cdlib.org/jmie/sfews/vol6/iss3/art3

Matsui K, Ishii N, Kawabata Z (2001). Survival of genetically modified Escherichia coli carrying extraneous antibiotic resistance gene through microbial interactions. Bull Environ Contam Toxicol 66:139–145

Turner C, Uy K, Everhart R (2014). Fish environmental DNA is more concentrated in aquatic sediments than surface water. Biological Conservation. 183:93-102

Track 1 Proposed Action Workshop
AGENDA

MEETING DATE AND TIME:	Thursday, April 26, 2018, 9:00 am – 3:30 pm
MEETING LOCATION:	River City Room – 16th Floor Holiday Inn, 300 J St, Sacramento, CA 95814
MEETING OBJECTIVES:	▪ Solicit input and further develop specific ideas for Track 1, Projects to Advance Water Supply ▪ Share existing information and build the scientific basis for possible actions

Agenda Items

Item	Time	Topic	Lead
	9:00 am	ARRIVAL & CHECK-IN	
#1	9:15 am	• Intro to the Three Tracks	Katrina Harrison
#2	9:30 am	• Overview of Track 1	Ben Nelson
#3	9:50 am	• High Level Topic Overview	Ben Nelson
	10:30 am	BREAK	
#4	10:40 am	• Idea Generation Round 1	Small Group Leaders
#5	11:20 pm	• Idea Generation Round 2	Small Group Leaders
	12:00 pm	LUNCH BREAK	
#6	1:00 pm	• Idea Generation Round 3	Small Group Leaders
#7	1:40 pm	• Idea Generation Round 4	Small Group Leaders
	2:20 pm	BREAK	
#8	2:30 pm	• Idea Generation Round 5	Small Group Leaders
#9	3:10 pm	• Wrap-Up	All
	3:30 pm	ADJOURN	

Note: Agenda times are estimates and may be adjusted

Track 1 – Projects to Advance Water Supply Workshop

April 26, 2018

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1

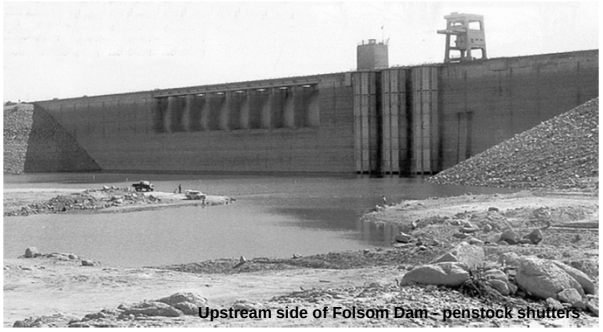
Background

- **Jan 2016 – Signed Record of Decision (ROD) on implementing the No Action Alternative in the Environmental Impact Statement (EIS) mandated by Court**
- **The ROD included 2008 and 2009 Biological Opinion Reasonable and Prudent Alternative (RPA) Actions**
- **Aug 2016 – Requested reinitiation of consultation for Coordinated Long-term Operation (LTO) of the CVP and SWP**
- **Dec 2017 – Published Notice of Intent (NOI) to develop EIS on Revisions to the LTO**

2 DRAFT, Subject to Revision

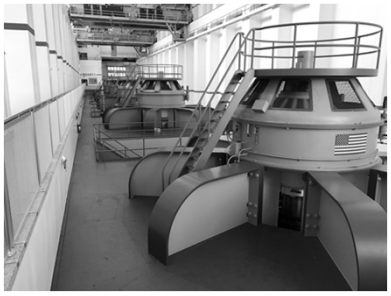
Reinitiation Drivers

- **Multiple years of drought**
- **Low populations of ESA listed species**
- **New information as a result of collaborative science processes.**



3 DRAFT, Subject to Revision

Overall Objectives



- **Fresh Look Concept**
- **Biological objectives**
- **Best available science**
- **Transparency**
- **Data-driven adaptive management**
- **Collaborative Science Coordination**
- **Climate change**
- **Joint (or highly coordinated) non-jeopardy Biological Opinion(s)**

4 DRAFT, Subject to Revision

Three Track Approach

- **Track 1: Near-term actions for water supply**
  - **Completion within a year**
  - **Prior work and limited controversy support the schedule**
- **Track 2: ~18 month programmatic analysis to maximize water deliveries and marketable power**
  - **New storage facilities,**
  - **New conveyance facilities,**
  - **Modifications to existing facilities,**
  - **Changes to regulations, and/or**
  - **Addressing other stressors.**
- **Track 3: Complete the ROC on LTO with one or more site-specific efforts**

5 DRAFT, Subject to Revision

Track 1 Action Development

- **January 19 - Delta Brainstorming Workshop held to generate ideas for this near-term effort**
- **February 22 – Meeting with water users to brainstorm initial ideas**
- **Meetings to develop ideas**
- **April 26 – Quarterly Workshop to share list of actions and develop ideas further**

6 DRAFT, Subject to Revision

Track 2 Action Development

- **Scoping**
  - **Jan. 23, in Sacramento (~100 attendees / 20 verbal comments)**
  - **Jan. 24 in Los Banos (~30 attendees / 3 verbal comments)**
  - **Jan. 25 in Chico (~100 attendees / 30 verbal comments)**
  - **711 combined written and verbal comments**
- **February 28 – Workshop to brainstorm ideas**
- **Meetings to share and develop ideas**
- **June 7 – Quarterly Workshop to share list of actions and develop ideas**

7 DRAFT, Subject to Revision

Schedule

Date	Track 1	Track 2	Track 3
January		Scoping	Workshops by Division Integration Workshop
February	Stakeholder and interested party discussions on potential actions.		
March			
April			
May	Proposed Action		
June		Alternatives	
July			
August			
September	Draft NEPA Evaluation		
October			
November			
December	Final NEPA Biological Assessment	Public Draft EIS	
//		//	//
June of 2019		Final EIS Biological Assessment	

8 DRAFT, Subject to Revision

Initial Thoughts on Potential Scope(s)

Track 1	Track 2	Track 3
Operations San Joaquin I:E Ratio OMR Flexibility Barriers Fall X2 Studies and Methods Survey Methods Predator Control Rapid Genetics	Programmatic New Storage New Conveyance Existing Facility Modifications Changes to Regulations Other Stressors Process Adaptive Management Incidental Take Methodology Decision Support Groups Site-Specific Potential Additional Operations	System Re-Operation Site-Specific Construction New Biological Opinion(s)

9 DRAFT, Subject to Revision

Track 1 – PAWS

DRAFT, Subject to Revision 10

Track 1

- Projects to Advance Water Supply (PAWS) 🐾
  - Near-term actions for water supply
  - Completion within a year
    - Final Environmental Assessment and Endangered Species Act Consultation by the end of December 2018
  - Prior work and limited controversy to support the schedule
- **Objective:** Improve water supply in a way that does not create additional adverse effects to listed species

11 DRAFT, Subject to Revision

Track 1 Outreach and Schedule

- January – March: Generate ideas with interested parties
  - Delta Brainstorming Workshop – January 19
- **Today – Workshop**
- June: Workshop on Analysis
- August: Workshop on Environmental Assessment (EA)
- October: Workshop on comments on draft document
- December: Final EA and ESA package

12 DRAFT, Subject to Revision

Objectives for Today

- Additional ideas
- Additional science / background material
- Opportunities (advantages)
- Risks (disadvantages)
- Idea refinement

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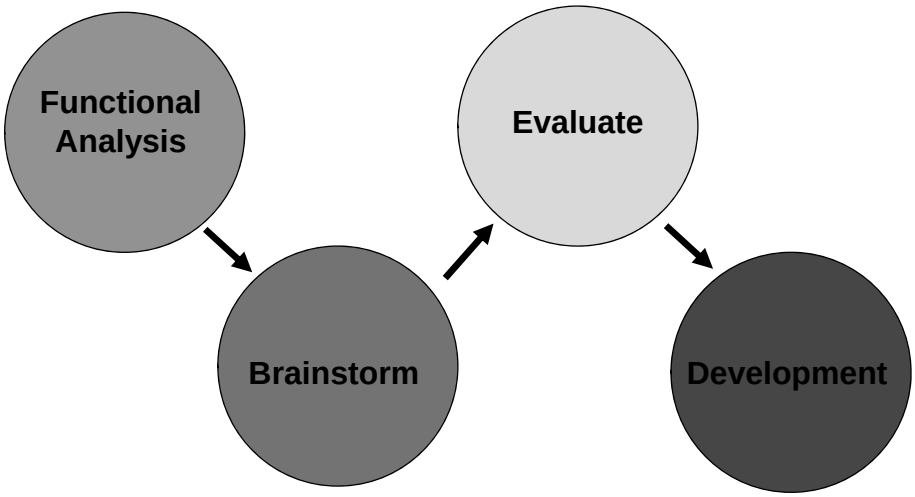
Process



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Functional Analysis

HOW – how do you achieve this function

WHY – why do you do this function

WHEN – when you do this function,
what other functions must you do

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Brainstorming

Divergent thinking

- Creative process, use imagination
- Initial brainstorming – no bad ideas

Convergent thinking

- Critical thinking, use logic
- Develop and evaluate

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Evaluate and Develop

- Think objectively
- Define, simplify and clarify the problem
- Improve communication and consensus
- Discuss advantages and disadvantages
- Develop solutions and refine ideas

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Table Topics

- Non-Physical Barriers
- San Joaquin River I:E
- OMR Storm Flexibility
- Studies and Methodologies
  - rapid genetics, predation, eDNA/EDSM
- Fall x2

18

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Table Format

- Explain objective
- Idea proposal
  - Would this proposal cause additional adverse effects?
- Current science/background
- Any modeling results
- Additional ideas/refinements

Track 1 – Ideas

Table Topics

- Non-Physical Barriers
- San Joaquin River I:E
- OMR Storm Flexibility
- Studies and Methodologies
  - rapid genetics, predation, eDNA/EDSM
- Fall x2

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Georgiana Slough Non-Physical Barriers

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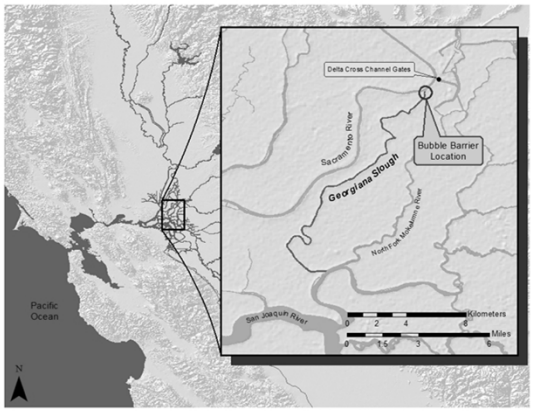
Georgiana Slough Non-Physical Barriers

- High levels of entrainment and predation of out migrating juveniles
- Result in reduced through-Delta juvenile Salmonid survival



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Barriers Background

- **NMFS 2009 BO - RPA IV.1.3**
  - "Consider engineering solutions to further reduce diversion of emigrating juvenile salmonids to the interior and southern delta, and reduce exposure to CVP and SWP export facilities."
- **WIIN Act - 4001(b)(3)**
  - "Collaborate with the California DWR to install a deflection barrier at Georgiana Slough and the Delta Cross Channel Gate to protect migrating salmonids, consistent with knowledge gained from activities carried out during 2014 and 2016."

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Bio Acoustic Fish Fence (BAFF)

- DWR: Pilot study 2011 and 2012
- Low-frequency sound generators
- Bubble curtain
- Strobe lights

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BAFF Study Results

- 2011: BAFF on - reduction of roughly 2/3 of the fish that would have been entrained.
- 2012: BAFF on - reduction of roughly 1/2 of the fish that would have been entrained.
- River flow and cross-stream fish position are the largest influence on entrainment risk
- BAFF operation effects cross-stream fish position by promoting avoidance response (away from BAFF)

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Floating Fish Guidance Structure (FFGS) Results

- DWR Pilot study 2014
- Intermediate flows (~7,000-14,000 CFS): About 1/5 reduction in entrainment
- Higher and Lower flows: resulted in negligible entrainment improvement to measurable entrainment increases
- Overall, flows were considerable lower than anticipated for the study year and may have explained some of the limited effectiveness

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Barrier Ideas

- Other Potential Options
  - Electric barrier/guidance system
  - Light/Auditory
  - Infrasound Fish Fence
  - Fish Screen
  - Fish Guidance Wall
  - Rock Barrier
  - Chemical Toxicants
- Idea for Track 1: Routing through Other Sloughs
  - Steamboat and Sutter sloughs

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San Joaquin River Inflow:Export Ratio

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I:E Ratio Background

- **NMFS RPA Action IV.2.1**

Objective - To reduce the vulnerability of emigrating CV steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

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What is an "I:E Ratio"

- **Water Flow at the Vernalis USGS Water Gage on the San Joaquin River–to- combined exports of the CVP/SWP**

San Joaquin Valley Classification	Vernalis flow: CVP/SWP combined export ratio	Targeted Minimum flow at Vernalis: Minimum export (cfs)
Critically dry	1:1	1,500 : 1,500
Dry	2:1	3,000 : 1,500
Below normal	3:1	4,500 : 1,500
Above normal	**4:1**	**6,000 : 1,500**
Wet	**4:1**	**6,000 : 1,500**
Vernalis flow equal to or greater than 21,750 cfs	N/A	Unrestricted exports until flood recedes below 21,750 cfs

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Baker and Morhardt 2001
Survival of Chinook Salmon Smolts in the Sacramento-San Joaquin Delta and Pacific Ocean

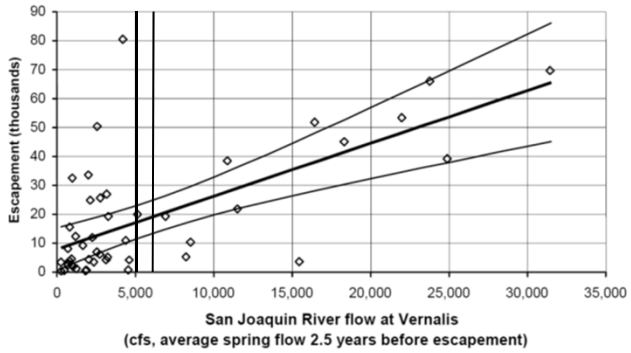

Figure 11 Total escapement to San Joaquin tributaries, 1951 through 1996, and spring flow in the San Joaquin River at Vernalis 2.5 years earlier. Fitted regression line and envelope of 95% confidence region for fitted line are shown.

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I:E Ratio Ideas

- Alternative Ratio
  - 3.3:1 Inflow:Export
    - Approximately 5,000 cfs San Joaquin River flow - 1,500 cfs export
- Minimum flows in San Joaquin River
  - 5,000 cfs – 7,000 cfs

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I:E Ratio

- Science since 2009
  - Inflow: What is needed to move fish out of the system?
  - Exports: What effects are they having on inflow?
  - Which route has the best survival? Predation?
  - What barriers are needed to improve system?
- Knowledge Gaps??
- Other ideas??

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Old and Middle River (OMR) Storm Flexibility

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OMR Background

2008 FWS BO Actions 1,2, 3:

- Action 1 to protect pre-spawning adult Delta Smelt from entrainment during the first flush, Action 2 to protect pre-spawning adults from entrainment and from adverse hydrodynamic conditions, and Action 3 to protect larval Delta Smelt from entrainment.

2009 NMFS 2009 BO Action IV.2.3

- Requires OMR flow management to protect emigrating juvenile winter-run, yearling spring-run, and Central Valley Steelhead within the lower Sacramento and San Joaquin rivers from entrainment into south Delta channels and at the export facilities in the south Delta. Action IV.2.3 requires reducing exports from January 1 through June 15 to limit negative OMR flows to -2,500 to -5,000 cfs.

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OMR Storm Flexibility

- **WIIN Act 4003 – Temporary Flexibility for Storm Events**
  - Maximizing water supplies for CVP and SWP contractors through an operations plan.
  - Operate at levels that result in OMR flows more negative than those prescribed in the 2008 and 2009 BOs to capture peak flows during storm-related events
  - No additional adverse effects on federally listed species
- **Idea** – Develop process to implement storm flexibility operations

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Studies and Methodologies

DRAFT, Subject to Revision

Rapid Genetic Protocol

- NMFS RPA Action IV.2.3 – OMR Flow Management
  - Includes daily older juvenile Chinook density loss thresholds that when exceeded exports are reduced for at least 5 days
  - Based on length-at-date
- Genetic identification is a more accurate estimation of loss at CVP and SWP fish salvage facilities for winter-run Chinook
- Rapid genetic analysis allows for timely discrimination of different races of Chinook salmon that may overlap within the older juvenile size-at-date criteria

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Rapid Genetic Protocol

- NMFS supported the use of this protocol during 2016-2018, with additional conditions:
  - all unclipped Chinook collected at fish salvage facilities were analyzed for genetics
  - annual incidental take limit was set at 1% of natural winter-run
- Currently, the protocol is approved on annual basis
- Idea: establish Genetic Protocol as a long-term commitment
- Allows for more reliable water deliveries when older juvenile Chinook threshold is exceeded, and genetic identification confirms that few fish salvaged are actually winter-run

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Rapid Genetic Protocol – Outcomes

WY 2018

- Older juvenile Chinook loss exceeded 7 times
- Genetics confirmed most were not winter-run
- Loss density was re-calculated to be less than action threshold for all but 1
- Resulting in additional estimated 54 TAF water pumped

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Clifton Court Predator Studies

- DWR removes predators from Clifton Court
  - In compliance with NMFS RPA Action IV.4.2(2)
  - To reduce pre-screen loss at the SWP
- Studies:
  - Determine main factors affecting predator catch
  - Determine pre-screen loss using PIT and acoustic tagging
- Improves water supply reliability by reducing take
- Track 1 ROC: Reclamation assists DWR with NEPA and ESA compliance

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Studies: Clifton Court Forebay Predation

- DWR removes predators from Clifton Court
  - In compliance with NMFS RPA Action IV.4.2(2)
  - To reduce pre-screen loss at the SWP
- Studies:
  - Determine main factors affecting predator catch
  - Determine pre-screen loss using PIT and acoustic tagging
- Improves water supply reliability by reducing take
- Track 1 ROC: Reclamation assists DWR with NEPA and ESA compliance

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Studies: Delta Smelt Monitoring

- Enhanced Delta Smelt Monitoring (USFWS)
- Environmental DNA (eDNA)
  - Sediment monitoring
  - Scent-detection dogs
    - Complimentary surveys
    - Pair with trawls
    - Reach shallower areas/sloughs

Photo: H.T. Harvey & Associates

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Fall X2

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Fall X2 Background

2008 FWS BO – RPA Component 3 – Action 4: Estuarine Habitat During Fall

- **Objective:** Improve fall habitat for delta smelt by managing of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal. This will help return ecological conditions of the estuary to that which occurred in the late 1990s when smelt populations were much larger. Flows provided by this action are expected to provide direct and indirect benefits to delta smelt. Both the direct and indirect benefits to delta smelt are considered equally important to minimize adverse effects.

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Fall X2 Ideas

- Flexible Operation of Fall X2
  - Modify averaging period to two months to allow for more flexible operations.
  - Allow for 1-3 km variations based on hydrologic conditions, air temperatures, other factors
  - Define future Adaptive Management actions for different scenarios
- Remove December requirement

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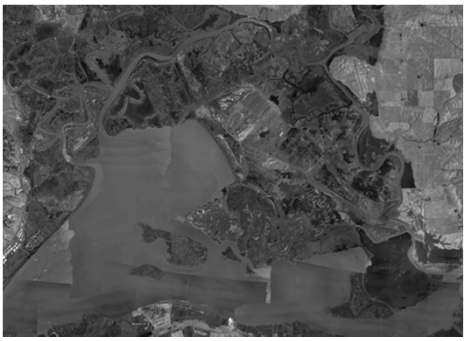
Fall X2 Ideas – Suisun Marsh Salinity Control Gates

- Re-operate Suisun Marsh Salinity Control Gates and Roaring River Distribution System
- Focus on Sept-Oct Grizzly and Honker Bay habitat following Above Normal and Wet Years



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Questions?

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MATERIAL RELATED TO WATER OPERATIONS