United States Department of the Interior

BUREAU OF RECLAMATION
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IN REPLY REFER TO:

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NAT'L MARINE FISHERIES SVS
SACRAMENTO, CA

Ms. Maria Rea
Assistant Regional Administrator
California Central Valley Area Office
National Marine Fisheries Service
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Sacramento, CA 95814

Subject: Contingency Plan for Water Year 2014 (WY 2014) Pursuant to Reasonable and Prudent Alternative (RPA) Action 1.2.3.C of the 2009 Coordinated Long-term Operation of the Central Valley Project (CVP) and State Water Project (SWP) Biological Opinion (2009 BiOp)

Dear Ms. Rea:

By letter dated February 28, 2014, the National Marine Fisheries Service (NMFS) concurred that the Bureau of Reclamation's (Reclamation) and the Department of Water Resources' (DWR) Interim Contingency Plan for March 2014, as modified by revised Delta Cross Channel Gate closure criteria, is consistent with RPA Action I.2.3.C, and later concurred with adjustments to the Interim Contingency Plan made on March 14, 2014. Reclamation now requests concurrence from NMFS that the operations described in the attached CVP and SWP Drought Operations Plan and Operational Forecast (Plan) are within the limits of the Incidental Take Statement of the BiOp and serves as the Contingency Plan for the remainder of WY 2014 in accordance with RPA Action I.2.3.C. Additional, Reclamation requests concurrence that CVP and SWP operations described in the Plan concerning RPA Action IV.2.1 are within the limits of the Incidental Take Statement.

The Plan developed in coordination with DWR, NMFS, the Fish and Wildlife Service, the California Department of Fish and Wildlife, and the State Water Resources Control Board, outlines proposed actions and a likely range of coordinated operation of the CVP and SWP through November 15, 2014. Severe drought conditions continue in California and Reclamation and DWR recognize that it is essential that the CVP and SWP operate to provide for, at a minimum, essential human health and safety needs for the remainder of WY 2014. In addition to health and safety needs the Plan's purposes include controlling of salinity intrusion in the Sacramento-San Joaquin Delta, preserving cold water storage in project reservoirs, and maintaining minimum protections for endangered species and other fish and wildlife resources suffering from the ongoing drought. The Plan will be modified based on evolving information which could include additional conditions in the State Water Resources Control Board regulatory approvals as well as Federal Endangered Species Act and California Endangered Species Act requirements. DWR and Reclamation also intend to continue to refine the Plan as hydrological and biological information become available.

Reclamation and DWR will be submitting a revised Temporary Urgency Change Petition (TUC) to the State Water Resources Control Board to incorporate these drought response actions as needed. Both the revised TUC and the Plan propose to utilize the Real Time Drought Operations Management Team for management of drought operational activities throughout WY 2014.

We appreciate the assistance we have received from NMFS and look forward to your response. Please contact me at 916-979-2199 if you have any questions.

Sincerely,

Ronald Milligan
Manager, Operations

Enclosure -1

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Central Valley Project and State Water Project Drought Operations Plan and Operational Forecast April 1, 2014 through November 15, 2014

Balancing Multiple Needs in a Third Dry Year

April 8, 2014

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Central Valley Project and State Water Project
Drought Operations Plan and Operational Forecast
April 1, 2014 through November 15, 2014

Balancing Multiple Needs in a Third Dry Year

This Drought Operations Plan and Operational Forecast (the Plan) is based on collaborative discussions between the U.S. Bureau of Reclamation (Reclamation), California Department of Water Resources (DWR), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), and the State Water Resources Control Board (State Water Board). The Plan will be modified based on evolving information which could include additional conditions in State Water Board regulatory approvals as well as federal Endangered Species Act (FESA) and California Endangered Species Act (CESA) requirements. Most importantly, the Plan, as described below, is based upon hydrologic conditions as of early March including recent storms. Reclamation and DWR intend to continue to refine the Plan in collaboration with other agencies as ongoing weather changes current conditions and forecasts for the Sierra snowpack, reservoir storage, and river flow.

I. Introduction and Purposes of the Plan

As California approaches the summer of a third consecutive dry year, economic and environmental challenges for our State are mounting. Limited water supplies create a crisis that will require extraordinary management measures on the part of water project operators, water quality and environmental regulators, the hundreds of local water agencies that supply most Californians with water, and State residents themselves. The latest National Weather Service data continue to show nearly the entire State in severe drought and over two-thirds in extreme drought. According to this same data, more of the State is in exceptional or extreme drought than when the Governor issued his drought proclamation on January 17, 2014. In this extraordinarily dry year, all water users, including agricultural, municipal, and fish and wildlife uses will suffer hardship.

Since December of 2013, State and Federal agencies that supply water, protect fish and wildlife, and regulate water quality have worked together daily to cope with drought. Together, these agencies have maximized regulatory flexibility to adjust quickly to changes in the weather and environment and bolster water supplies when possible while minimizing impacts to fish and wildlife.

These agencies also are currently charting a collaborative course for the coming summer and fall of 2014. This Plan and Operational Forecast was developed in coordination with Reclamation and DWR, USFWS, NMFS, CDFW, and the State Water Board. The Plan outlines proposed actions and a likely range of coordinated operations of the Central Valley Project (CVP) and State Water Project

(SWP) from April 1 through November 15, 2014, and is based on the conservative but prudent assumption that conditions will remain dry, and that drought may persist into 2015.

The following are the purposes of the Plan:

1. During this extreme drought year, operate the CVP and SWP to provide for, at a minimum, essential human health and safety needs throughout the CVP and SWP service areas from April 1 through November 15, 2014, and retain the capability to provide for such minimum needs in water year 2015 if the drought continues. For clarity, Reclamation and DWR's consideration of these essential human health and safety needs includes adequate water supplies for drinking water, sanitation, and fire suppression, but does not extend to other urban water demands such as outdoor landscape irrigation. While most Californian communities have adequate reserve supplies, some will require continued delivery of limited amounts of water through the CVP and SWP systems to meet these basic needs.

2. Another primary purpose is control of saltwater intrusion in the Sacramento-San Joaquin Delta. The Delta drains roughly 40 percent of California. Enough fresh water must flow into the Delta throughout dry months to repel saltwater that pushes inland on ocean-driven tides from San Francisco Bay. If there is not enough water in upstream reservoirs to release to rivers to repel the saltwater, it can contaminate the channels from which water supplies are drawn, not just for the SWP and CVP, but also for Delta farmers and water districts in nearby Contra Costa, Alameda, and San Joaquin counties. Maintaining enough reservoir storage to control Delta salinity this spring through the fall is critical. Therefore, this Plan balances the need to protect upstream storage, the need to maintain minimal exports from the Delta in the spring and summer, and the need to maintain salinity control in the Delta for future deliveries later in the year and into 2015.

3. A third major purpose in crafting a plan for water project operations this spring through the fall involves the need to preserve enough cold water deep in Shasta Lake and other reservoirs to maintain cool water temperatures in the Sacramento River for different runs of Chinook salmon. These same water supplies may be needed to provide for critical needs in 2015, if conditions remain dry.

4. A fourth major purpose is the continued need to maintain minimum protections for endangered species and other fish and wildlife resources that are suffering from unavoidable impacts due to a drought of this magnitude and necessary drought-related actions. Most elements of the controlling regulations that provide protection will be fully implemented this year. This Plan calls out those elements that have been or could be modified in order to balance all needs, while providing minimum protections required by law. As such, Reclamation and DWR propose this Plan to ensure compliance with applicable laws and requirements of the regulatory agencies for operations through November 15, 2014. The Plan will be submitted by Reclamation and DWR for concurrent review under applicable laws, including the Federal ESA, CESA, and the California Water Code.

An underlying objective is to maximize regulatory flexibility while still remaining within the boundaries of existing law and regulations. Maximizing such flexibility allows the project operators to adjust quickly to changes in the weather and environment and to maximize the beneficial use of water to the greatest extent possible within the law. This goal of improving water supply includes facilitating water transfers to ensure the most critical supply needs are met throughout the service areas of the CVP and SWP.

II. 2014 Water Conditions and CVP/SWP Operations for January through March

Three years have passed since sufficient rain and snow fell on California to classify the year as "wet." In 2012, precipitation was below average, and 2013 was classified as dry. So far, 2014, has proven abnormally dry and will be classified as critically dry. The months of December and January – typically the wettest of the year – featured a record-breaking lack of precipitation. February and March brought several storms, but not enough precipitation to make up the deficit.

The State's April 1 snow survey found a Sierra Nevada snowpack that is still well below average in terms of water content for this time of year. Storage in major reservoirs is below average, too, and less than a month remains in California's typical "wet" season.

In January, after weeks with no precipitation, Reclamation and DWR grew concerned that CVP and SWP reservoirs would be depleted if they met Delta outflow levels as water rights permits required starting February 1. Depletion of reservoirs would compromise the long-term ability of the CVP and SWP to supply basic human needs, continue repelling saltwater in the Delta, and provide adequate carry over storage for cold water needs of Chinook salmon.

On January 29, Reclamation and DWR sought a temporary modification to their water rights permits and licenses. On January 31, 2014, the Executive Director of the State Water Board issued an Order that granted temporary modification for the next 180 days in response to drought conditions. The modification allowed the Projects to reduce Delta outflow and thus conserve upstream storage for use later. It also allowed the Projects to pump at a minimal level – a combined 1,500 cubic feet per second (cfs) – to supply essential public health and safety needs when Delta outflow was lower than would typically allow such pumping. According to the petition and subsequent acknowledgement in the Order, Reclamation and DWR convened a Real Time Drought Operations Management Team (RTDOMT) comprised of representatives from Reclamation, DWR, fisheries agencies, and the State Water Board to discuss more flexible operations of the Projects while protecting beneficial uses. The same day the temporary modifications were granted, DWR announced that the 29 public water agencies that contract for SWP supplies could expect no allocation in 2014. Reclamation, operator of the CVP, similarly announced that no supplies would be available to CVP agricultural water service contractors south of the Delta. Additionally, Reclamation informed the State and Federal wildlife refuges, Grasslands Ecological Area, and long-time water rights holders along the Sacramento and San Joaquin rivers would receive 40 percent of their contract totals.

The January Order has been amended three times by the State Water Board's Executive Director to give water project operators the flexibility to respond to storms.

- On February 7, 2014, the Order was amended to allow project operators to pump at higher levels to capture storm runoff. Pumping rose to roughly 6,000 cfs and stayed there until February 18.

- On February 28, 2014, the Order was amended to extend the adjusted Delta outflow into March.

- On March 18, 2014, the Executive Director of the State Water Board issued an Order allowing the SWP and CVP to reduce outflow by allowing a reference salinity level known as X2 position to move upstream from Chipps Island. This change allowed the Projects to maintain pumping levels when X2 was west of Collinsville. The March order also restored the full latitude of the CVP and SWP to use all the water exported from the Delta for the full range of uses. It allowed for the captured and stored water to be used for purposes other than human consumption, sanitation, and fire suppression, once those basic needs are met.

Along a similar timeline over these months, the Federal and State fish and wildlife agencies worked in close coordination with Reclamation and DWR to receive, analyze, and respond to the water project operators' requests for additional operational flexibility while still remaining within the boundaries of the applicable environmental laws and regulations. USFWS, NMFS, and CDFW coordination efforts included the following:

- On January 31, 2014, Reclamation submitted to the NMFS and USFWS the measures included in their TUC Petition as a contingency plan and outlined their and DWR requested approval from the State Water Board for temporary modification to the Water Rights Decision 1641 (D-1641) permit terms related to the Delta outflow and Delta Cross Channel (DCC) standards. In the TUC Petition, Reclamation and DWR requested that the D-1641 Delta outflow standard be changed from a 3-day average of net delta outflow of 7,100 cfs at Collinsville to allow for the necessary 1,500 cfs minimum health and safety deliveries while also allowing additional preservation of cold water pool. Reclamation and DWR indicated that this operation might result in a Delta outflow in the 3,000 cfs to 4,500 cfs range. Reclamation and DWR also requested permission to open the DCC gates for human health and safety purposes based on the consultation process with the fishery agencies.

- On January 31, 2014, in response to the January 31, 2014, request from Reclamation, USFWS issued a memo concurring that the proposed modifications described in the January TUC Order issued by the State Water Board would have no additional adverse effects on delta smelt or its critical habitat.

- On January 31, 2014, in response to the request from Reclamation submitting the TUC Petition, the NMFS issued a letter concluding that the TUC Petition was consistent with Action 1.2.3.C of the NMFS 2009 BiOp and met the specified criteria for a drought contingency plan for February. An a set of operational criteria was developed that provided for initial DCC gate opening on February 1, 2014, and a set of monitoring triggers that would result in DCC gate closures or diurnal gate openings for various durations. In addition, a team of managers from Reclamation, DWR, State Water Board, DFW, NMFS, and the USFWS was established to meet weekly, in order to coordinate management of water supplies and protection of natural resources during the course of the declared drought emergency.

- On February 4, 2014, Reclamation submitted a letter to NMFS requesting an early determination of the Vernalis flow-to-combined export (I:E) ratio of 1:1, due to the unlikelihood that the current dry hydrology would change considerably and the need to plan in advance and accommodate water transfers.

- On February 7, 2014, in response to the February 4, 2014, request from Reclamation, NMFS issued a letter agreeing that an early determination of the I:E ratio of 1:1 was warranted for this year. Furthermore, that water transfers that increase flow down the San Joaquin River would be beneficial to out-migrating salmonids.

- On February 27, 2014, Reclamation submitted a proposal to the NMFS and USFWS to extend the provisions of the TUC Petition through March 31 as their interim drought contingency plan for March, as they will still be unable to meet 1.9 MAF of storage in Shasta Reservoir at the end of September 2014.

- On February 28, 2014, in response to a February 27, 2014, request from Reclamation, USFWS issued a memo concurring that the proposed extension of the modifications described in the January TUC Order and February amendment to the Order would have no additional adverse effects on delta smelt or its critical habitat.

- On February 28, 2014, in response to a February 27, 2014, request from Reclamation, NMFS provided a letter, concluding that they agreed that Action I.2.3.C of the NMFS 2009 BiOp is still in effect, that a drought contingency plan is warranted, and that the proposal is consistent with Action I.2.3.C and met the specified criteria for a drought contingency plan for March. Under the proposed drought contingency plan, Reclamation and DWR would continue to maintain minimum releases during March from Shasta Reservoir, which should meet a Wilkins Slough flow not to exceed 4,000 cfs, and the minimum 3,000 cfs Delta outflow required by the State Water Board's revised Order. It was agreed that modified operations of the DCC gates may still be required to maintain water quality standards in the Delta.

- On March 14, 2014, Reclamation submitted to the NMFS and USFWS a proposal to adjust the provisions of their March contingency plan through the end of March. Specifically, they proposed D-1641 Delta Outflow objective compliance to be achieved through a 7,100 cfs outflow on a 3day average and/or X2 position at Collinsville, and to capture additional natural flow in the Delta due to recent storm events by adjusting implementation of action IV.2.3 in the NMFS 2009 BiOp so that the 14-day running average Old and Middle River (OMR) flow shall be calculated and be no more than 25% more negative than -5000 cfs for the next 7 days. Reclamation and DWR would then be operated to OMRs more positive than -5000 cfs for 10 days to the end of the month.

- On March 14, 2014, in response to a March 14, 2014, request from Reclamation, USFWS issued a memo on the proposed modifications to the TUC Order and BiOp Reasonable and Prudent Alternative (RPA) that concluded while additional adverse effects may occur, those effects were considered minimal and the jeopardy determination and incidental take statement from the 2008 BiOp remain unchanged.

- On March 14, 2014, in response to a March 14, 2014, request from Reclamation, NMFS issued a letter that concluded the proposed modifications were consistent with Action I.2.3.C of the NMFS 2009 BiOp and met the specified criteria for a drought contingency plan. Furthermore, effects would be minimized through 1) planned operations from March 20-31 that result in less negative OMRs than -5000 cfs, including minimum combined health and safety exports from March 26-31; and 2) the continued implementation of the action triggers provided in action IV.2.3. This conclusion was based on real-time physical and biological data and the recognition in the RPA that Reclamation may not be able to operate to all RPA elements in the case of severe drought.

- CDFW coordinated closely with USFWS and NMFS on the biological analysis and decision-making. In addition, DWR consulted with CDFW on each of these proposed urgency changes, and CDFW found them to be consistent with the California Endangered Species Act, as a result of the findings by both NMFS and USFWS that the actions were consistent with the biological opinions.

Importantly, this rapid intra- and inter-agency coordination sought to make real-time decisions within the existing regulatory framework rather than waive or overrun applicable law.

Storms in February and March have helped to increase Delta outflow (see Attachment A) above applicable restrictions, so that most project operations since February 1 occurred in compliance with unmodified State and Federal water quality and environmental rules. Restrictions that limited pumping to health and safety purposes were in place only 11 days during the first six weeks after the January 31 TUC Order issued by the State Water Board's Executive Director. As a result, most of the water pumped from the Delta through March 2014 by the SWP and CVP and stored in San Luis Reservoir is available for all highest priority beneficial purposes, including providing for the most critical needs of agriculture, industry, manufacturing, fish and wildlife, environmental protection, and municipalities.

Similarly, even though the State Water Board and NMFS have allowed for potential opening of the Delta Cross Channel (DCC) gates since February 1, the DCC gates were opened from February 1 through February 9 but have been closed, per usual implementation of D-1641 and the 2009 NMFS BiOp, since February 10. The adjusted implementation of the -5,000 cfs OMR reverse flow, based on the OMR-index demonstration project values, limit allowed for (and resulted in) seven days on which the 14-day OMR limit could be more negative than -5,000 cfs – a period during which the DCC gates were closed and Delta outflow per D-1641 was being met. The more negative OMR was balanced with more positive OMR from March 22-31, 2014, including minimum health and safety combined exports at 1500 cfs from March 27-31, 2014. The averaging period for the export/inflow (E/I) ratio has been one of the most active modifications, with the calculation regularly shifting between the 3-day (as storm flows rise) and 14-day inflow (as storm flows recede) averaging periods.

III. Critical CVP/SWP Operational Considerations

The operational forecasts developed for this Plan are designed to make the most efficient use of the limited water resources in 2014 for multiple beneficial uses while managing the potential risks of continued drought conditions into 2015. As discussed above, the general Plan objectives are to improve cold water pool storage in upstream reservoirs through May, continue operation of the Delta pumping facilities while taking advantage of opportunities to export natural or abandoned flow while maintaining Delta water quality and minimizing adverse effects of listed fish, and to manage reservoir releases in June through September to concurrently benefit in-stream temperature objectives, meet Sacramento Valley in-basin needs, and preserve carry over storage.

The Plan includes considerations on how the Projects propose to operate under different hydrologic conditions. The actual operation is still uncertain at this time because of changing hydrologic conditions. The 90 percent exceedance hydrology assumes inflows from rainfall and snowmelt at levels that are likely to be exceeded with a 90 percent probability, or in other words, there is a ten percent or less chance of actual conditions turning out to be this dry or drier. The 50 percent probability is the 50/50 assumption-- it is just as likely to be drier or wetter. It has been relatively wet recently-- more precipitation has occurred than projected under both the 90 and 50 percent exceedance hydrology forecasts. This means there will likely be more water available than described in the 90 percent hydrologic forecast. Forecasts are updated monthly and account for recent storm events. These updates are generally provided by the 3rd week of the month.

A. Essential Human Health and Safety

At DWR's request, the 29 public water agencies that buy from the SWP quantified their needs to meet demands for drinking, hygiene, and sanitation (collectively 55 gallons per person per day), plus fire protection. Most SWP contractors have alternative sources of water, including groundwater and local reservoirs. The remaining estimated needs not met by those alternative sources in 2014 are less than 10,000 acre-feet and about 260,000 acre-feet in 2015. Those totals will fluctuate based on precipitation.

Reclamation has used a figure of 50 percent of the historical municipal and industrial CVP water use as an estimate of health and safety needs. Reclamation reviewed data furnished by their contractors and currently estimates that the south of Delta CVP contractors would need about 260 TAF of water for health and safety annually. In water year 2014, about 65 TAF of that annual quantity would be needed from the CVP. This estimate will vary from year to year depending on the availability of other supplies including SWP supply and groundwater use. This health and safety estimate is based on 50 gallons per day per capita and 80 percent of historical commercial\industrial use.

B. Maintaining Salinity Control and Emergency Drought Barriers

Another primary concern is control of saltwater intrusion in the Delta. As of today, Reclamation and DWR's planning assumptions for 2014 include the possibility of installing rock barriers temporarily across three Delta waterways to conserve reservoir storage by physically restricting the movement of saltwater. The three likely barriers would be constructed at Steamboat and Sutter sloughs and West False River. With the barriers in place, releases from Shasta, Oroville, and other reservoirs to provide sufficient Delta outflow to repel salt and protect Delta water may be reduced. If the barriers are determined to be necessary, DWR would complete installation by early June, delaying construction as long as possible to minimize effects on fish. The rock barriers would be removed by November 1 at Steamboat and Sutter sloughs and by November 15 at West False River. A decision on whether to install the barriers could be made as late as the end of April, depending on snowpack, precipitation, and runoff. This decision will include consideration of the trade-offs between water supply, water quality, and species protections. However, in the event that the barriers are needed, preliminary permitting steps are being taken now subject to the contingency of final decisions later.

C. Reserves for 2015

DWR estimates that the forecasted carryover storage of approximately one million acre-feet in Lake Oroville by the end of water year 2014 (September 30, 2014) will be sufficient to meet human health and safety needs in 2015 (projected as 260,000 af) and other project purposes, including maintaining Delta salinity control. This level of storage should be sufficient under a conservative 90% exceedance hydrologic assumption for water year 2015, while still meeting regulatory and contractual commitments. This level of carryover storage would also be sufficient under even drier conditions assuming the implementation of management actions in 2015 similar to those being put into practice this year. These actions have included modifications to implementation of D-1641 standards, planned construction of Delta Salinity Barriers, and potential curtailments to other non-human health and safety uses in the Sacramento-San Joaquin River Basins.

Reclamation estimates that current projected cumulative end of September storages of CVP reservoirs (Shasta, Trinity, and Folsom) will range from about 1.4 maf (90 percent hydrology with barriers) and 1.9 maf (50 percent hydrology without barriers). Reclamation believes these storages are adequate to meet the 2015 water year needs for the CVP. This assumes implementation of the same drought management actions as specified above. Drier conditions could entail further drought management activities.

D. Coldwater Species' Needs

Reclamation and DWR, working in close collaboration with other State and Federal agencies, are committed to ensuring sufficient cold water to meet species needs. A primary concern is the preservation of cold water pool in Shasta Reservoir. Winter-run Chinook salmon in the Sacramento River below Keswick Dam depend on cold water stored in Shasta Reservoir, and low reservoir levels result in less cold water available. Under the 90 percent exceedance (with barriers) forecast included in this Plan, storage projections and associated temperature modeling demonstrate that winter-run Chinook spawning areas are at risk. The 50 percent exceedance forecast illustrates improved conditions for temperatures in the upper Sacramento River.

E. CVP and SWP Water Supplies for 2014

Based on conditions in late March, DWR expects to maintain a zero allocation for its 29 water contractors. Long-time water rights holders along the Feather River ("settlement contractors") would receive 50 percent of their contract water quantities, which is the least amount of water that can be delivered to them under their contracts with DWR.

Based on conditions in late March, Reclamation, at this time is not changing its earlier announcement that proposed to provide no supplies to CVP agricultural water service contractors, while Federal wildlife refuges and senior water rights holders along the Sacramento and San Joaquin rivers would receive 40 percent of their contract totals.

Importantly, updated hydrologic information will continue to inform these water supply decisions. Any changes in water supply availability will be coordinated through and made within the existing agency protocols and coordination structures and in consideration of the other project operations priorities outlined in this Plan.

F. Refuge Water Supply

Water will be provided, including 4,000 AF of summer water that is currently identified as rescheduled/carryover water for south of Delta, to keep conveyance channels charged, support seasonal, riparian, permanent and semi-permanent wetlands and to provide critical ESA habitat for the giant garter snake (GGS) for both north and south of the Delta refuges. Deliveries for summer, fall, and winter water would be consistent with the schedules submitted by the refuges and adjusted as allocations are modified.

For south of Delta refuges, when total demand from direct diversions from the Delta are not feasible, water from San Luis Reservoir can be made to meet refuge needs. Refuges need flexibility to transfer water from refuges both within basin as well as north of the Delta to south of the Delta as allowed in CVPIA and refuge water supply contracts. Water transfers from north of Delta refuges to south of Delta refuges would only occur when habitat needs of north of Delta refuges are met. This water would be directly diverted or could be stored in San Luis Reservoir and used when most needed by south of the Delta refuges.

These managed wetland areas will receive 40 percent of their Level 2 allocation. In fact, that amount is only 15-30 percent of their total water supply needs (Level 4), identified within the CVPIA.

CVPIA refuge water supplies will be provided within the operations described in this Plan. CVPIA refuge managers will be involved regularly throughout the water supply reevaluation/adjustment process. Refuge deliveries are included in CVP operational scenarios and forecasts, and calculations regarding anticipated reservoir levels into the late fall and early winter.

G. Operational Flexibility, Exchanges, and Transfers

Now is the time for all water agencies statewide to be creative in implementing innovative water management measures. Some agencies may have relatively better water supplies and could implement extraordinary one-year transfers or multi-year exchange agreements with other agencies. Reclamation and DWR encourage agencies to jointly investigate and pursue these kinds of opportunities to help move water to regions of critical need in coming months.

The attached operational forecasts highlight the movement of project water for the CVP and SWP. The movement of transfer water is not explicitly included or identified in the operations outlined here. The anticipated transfers this year will not reduce CVP or SWP reservoir storage or increase reservoir releases. The Delta pumping rates identified also do not include the conveyance of transfer water. Individual transfers will be evaluated and approved through separate, but expedited procedures.

In order to facilitate transfers and exchanges, the State Water Board approved a petition from the DWR and Reclamation to allow the SWP and the CVP to combine their place of use in their water right permits. This action allows water to be transferred between the SWP and the CVP without further regulatory action by the State Water Board. Additionally, DWR and Reclamation, in cooperation with the fishery agencies, will consider transfer requests on an individual basis following the Vernalis Pulse Flow period. The Interagency 2014 Drought Transfers Group will help facilitate the approval of proposed transfers.

Federal and State agencies will also continue to encourage individual Californians to do their part to stretch this year’s limited supplies. Every drop of water conserved will make a positive difference.

IV. Overview of 2014 Operations and Forecasts

A. Overview

Reclamation and DWR's proposed Drought Operations Plan for 2014 incorporates the following components, to be implemented as needed based on hydrology, to support the combined drought operations of the CVP and SWP for the remainder of Water Year 2014:

- Operational forecasts based on the March 1 90 percent (with and without barriers) and 50 percent exceedance runoff forecasts and assumptions outlined in the Plan (see CVP and SWP Operational Forecasts below);
- Upstream flow and temperature management actions for Feather River, Sacramento River, Trinity River, Clear Creek, American River, and Stanislaus River. This includes Sacramento River Temperature Analysis of potential cold-water management objectives as described in NMFS RPA Action 1.2.3.C;
- A suite of proposed modifications to Delta criteria for April and May, including modified DCC gate operations to protect water quality, an export regime designed to take advantage of natural or abandoned flow in those months, and some actions to offset adverse effects to out-migrating San Joaquin River steelhead and salmon;
- A contingency for placement of emergency drought barriers in the Delta and corresponding modification to Delta water quality objectives; and,
- A suite of proposed modifications to Delta criteria for June through November 15, including modifications to some State Water Board D-1641 requirements.

Overall, this Plan addresses both proposed operations in April and May of 2014, as well as monthly objectives through November 15, 2014. The general CVP and SWP operational objectives for both periods are to improve cold water pool storage in upstream reservoirs through May, continue some water deliveries, operation of the Delta pumping facilities while taking advantage of opportunities to export natural or abandoned flow while maintaining Delta water quality and minimizing adverse effects to listed fish, and to manage reservoir releases in June through September to concurrently benefit in-stream temperature objectives and to meet Sacramento Valley in-basin needs and preserve carryover storage. April and May operations include temporary modifications to the San Joaquin River inflow to export ratio objective (NMFS RPA IV.2.1), San Joaquin River flow objectives (D-1641), the Delta export to inflow (E/I) ratio objective (D-1641), and the X2 Delta Outflow objectives (D-1641).

Delta inflow conditions can change very quickly and are difficult to accurately forecast beyond five to ten days – sometimes less. The water project operations will depend on quickly adapting to observed hydrologic and biological conditions within the operating parameters described below. To facilitate this goal, and the goals outlined in this Plan, Reclamation and DWR will continue to coordinate operations through the typical agency processes and protocols including the existing Water Operations Management Team (WOMT) and RTDOMT processes.

The Plan will continue to be refined as April forecasts are finalized and future weather conditions continue to change the Sierra snowpack, reservoir storage, and river flows. Changing precipitation could also lead to a reassessment of water supply availability and/or the need for extraordinary measures, including temporary rock barriers (Emergency Drought Barriers) on three channels in the Sacramento-San Joaquin Delta. While many of the planning assumptions used are conservative based on hydrologic conditions remaining dry, the approach outlined also allows for adapting decisions to changing hydrology and water availability. The Plan is based on current (March 2014) operations forecasts. If the operations change in such a way that is not considered in this Plan, Reclamation and DWR will alert the regulatory agencies and reinitiate Section 7 consultation, as necessary.

B. CVP and SWP Operational Forecasts

The combined operational forecasts for CVP and SWP operations through November 2014 are summarized in Attachment B. These forecasts take into account observed March reservoir inflows and the projected runoff estimates developed by DWR. The operational outlooks for the 90 percent exceedance (both with and without the proposed emergency drought barriers) and 50 percent exceedance forecasts provide a range of anticipated monthly averaged flow rates and estimated end-of-month reservoir storage levels These operational forecasts are based on the following:

- Hydrology is based on the March 1, 2014, DWR runoff forecasts at the 90 percent exceedance and 50 percent exceedance levels. These runoff forecasts, to be updated monthly through June, include reservoir inflows as well as estimates of accretions and depletions in the Sacramento River Basin;
- Installation, operation, and removal of emergency drought barriers in one of the 90 percent exceedance forecast;
- Operating to a Sacramento River flow at Wilkins Slough target of 4,000 cfs;
- Stanislaus River operations coordinated through the Stanislaus Operations Group (SOG). River releases of Table 2E flows (NMFS BiOp) will be closely coordinated to also achieve benefits as a pulse flow on the San Joaquin River. The action will be coordinated with modified D1641 San Joaquin River flow requirements.

The coordination of Jones Pumping Plant and Banks Pumping Plant operations in April and May to offset effects to San Joaquin River steelhead (see Section VIII, the majority of exports will be exported through the CVP's Jones Pumping Plant to the extent possible, as fish loss is lower at the CVP facility) are not reflected in the monthly operations summary tables. This coordination will be done on a real time basis to best respond to observed hydrological and operational conditions.

The availability of water supplies for municipal, industrial, agricultural, and refuge customers of the CVP and SWP will be reevaluated over the coming weeks and any adjustments will be based on updated hydrologic conditions, snow surveys, reservoir storage quantities in the CVP and SWP systems; and projected export levels achieved under the observed inflow and environmental conditions.

At this time, most CVP agricultural water service contractors and SWP Table A water supply remains at or near zero even for the 50 percent exceedance forecast, and senior water right deliveries remain at 40 percent. Additionally, SWP Feather River Settlement contracts remain at 50 percent. It is intended that the management of the CVP and SWP will be within the purposes outlined in this Plan and continue to be carried out in coordination with the existing WOMT and RTDOMT processes. As stated above, if hydrologic conditions improve, forecasts will be updated, available water supply amounts will be reassessed, and additional ESA Section 7 consultation will be completed, as necessary.

V. Proposed Upstream Tributary Operations - April Through November 15

A. Upper Sacramento River, Trinity River, and Clear Creek Flows and Temperature Management Planning – NMFS RPA Action I.2.3.C

Reclamation intends to integrate to the fullest extent possible the operations of the Trinity, Clear Creek, and Shasta complex to make maximum use of the limited cold water reserves. The highest priority for this ongoing cold water management will be to improve water temperatures on the upper Sacramento River to protect winter-run Chinook salmon.

In addition, Reclamation is working with Sacramento River Settlement Contractors on options to shift a significant portion of their diversions this year out of the April and May period and into the time frame where Keswick releases are higher to achieve temperature objectives on the upper Sacramento River. The willingness and cooperation of the settlement contractors in this effort would allow a modified diversion pattern and create the benefit of increased Shasta Reservoir storage at the beginning of the temperature control operations and increased availability of water to these senior water rights holders in this critically-dry year.

Trinity Operations

Reclamation will operate the Trinity River Division to meet the critically dry year flow schedule of the Trinity River Restoration Project Record of Decision (ROD). End of September storage for Trinity Lake is projected to range from 457 TAF (90% exceedance) to 546 TAF (50% exceedance). This unavoidable low storage may result in additional adverse effects due to elevated water temperatures for Trinity River salmonids. Low-level release from Trinity Reservoir for temperature management will be implemented if necessary to meet species needs and State Water Board basin plan objectives. Pursuant to Government-to-Government obligations, Reclamation will continue to consult with Trinity Basin tribes.

Clear Creek Operations

The Clear Creek population of spring-run Chinook salmon provides an important buffer to other Central Valley populations, but the limited cold water supplies this year, and the priority to protect winter-run Chinook salmon on the Sacramento River, may limit the ability to manage temperatures and flows on Clear Creek.

Reclamation commits to providing the two attraction pulse flows in Clear Creek, per advice from the Clear Creek Technical Team on the timing, duration, and flow, as provided in NMFS RPA Action I.1.1. These pulse flows are, per the RPA Action, requested in April or May and June, however in an effort to preserve cold water pool storage, the technical team may provide recommendations to modify implementation.

The current temperature modeling for Clear Creek (see Attachment C) shows some limited exceedances of the I.1.5 objectives in August (60 degrees Fahrenheit (F) for both the 90% and 50% exceedance forecasts, but the modeled temperature spikes generally appear manageable in real-time. Modeled temperature results for the period after September 15, indicate that the 56 degree F target at Igo will not be achieved. Temperature conditions will generally improve with improving hydrology, but will also be highly dependent on the ultimate temperature management strategy for the upper Sacramento River that will ultimately be implemented with advice from the Sacramento River Temperature Task Group (SRTTG).

Shasta Operations/Keswick Release Schedule

As stated previously, a major goal of this Plan is to conserve as much storage at Shasta Reservoir as possible to provide for cold water for salmonids, and provide carryover storage in the event of a prolonged drought.

Current temperature modeling based on the March 90 percent forecast (Attachment C) indicates that 56 degrees F can be achieved to a Sacramento River compliance point approximately 2 miles upstream of the confluence with Clear Creek until the middle of August. For the remainder of the temperature control season, cold water would only be accessible via power bypass, which has not been modeled. This operation would result in temperatures greater than 60 degrees F being released from Shasta and Keswick through most of September and into October, as the remaining cold water is utilized. Preliminary temperature analysis for the 50 percent forecast projects achievable temperatures through the end of September at the location identified above, and any adverse effects depend on the location and timing of spawning. The potential inability to meet essential temperatures in late August and September for incubating eggs and emerging fry would cause adverse effects. In order to offset these potential effects, a winter-run Chinook salmon contingency plan has been prepared includes measures to maintain winter-run Chinook juvenile productivity (Attachment D). Regardless, the Plan strives to increase the likelihood of meeting essential protective temperatures by including measures that increase cold water accessibility and storage.

Given the severe drought conditions and limited availability of cold water resources this year, this Plan incorporates the following operational actions:

- Keswick releases will be held to no greater than 3,250 cfs, or as determined necessary to reasonably target no more than 4,000 cfs at Wilkins Slough, unless necessary to meet nondiscretionary obligations or legal requirements;
- Keswick releases will not be increased to directly support CVP Delta diversions;
- Reclamation and DWR have worked with the State Water Board to modify a number of standards that help limit the need for increased Keswick releases to meet Delta objectives. Reclamation will continue to rely to the extent possible on other CVP reservoirs to meet overall CVP obligations;
- Reclamation will bypass the power penstocks at times this year if such operation will help access remaining cold water pool or would help preserve cold water if blending with warmer water early in the season;
- The delivery of water for the purpose of decomposition of rice straw will not be made available from the CVP this year unless hydrologic conditions change substantially;
- Reclamation will continue to develop monthly operational forecasts and temperature analyses to facilitate the ongoing monthly consultation under NMFS RPA Action I.2.3 and I.2.4.

The attached operational forecasts (see Attachment B) were developed using the estimated Sacramento Valley depletion forecasts calculated by DWR as part of their monthly hydrologic updates. These depletion forecasts are based on a regression analysis of historic accessions and depletions data in the Sacramento Valley taken over a long period.

Based on more current projected inflow data and potential in-basin depletions, productive discussions with Sacramento River Settlement Contractors about significant modifications to diversion patterns, and the bulleted parameters outlined above; a more likely estimated range of average monthly releases from Keswick Reservoir are presented below:

Range of Keswick Reservoir Release (in cubic feet per second)

	90% Exceedance With Salinity Barriers	90% Exceedance Without Salinity Barriers	50% Exceedance
April	4000-6500	4000-6500	3800-6500
May	4500-7000	4500-7200	4500-7000
June	9000-10000	10000-11000	9000-10000
July	9000-10000	10000-11000	9000-10000
August	7000-8000	7000-8000	8000-9000
September	4000-5000	4000-5000	5000-6000

A release of 9,000 cfs is considered the minimum to reasonably maintain stable water temperatures in June and July due to daily air temperature fluctuations, and given the shutter configuration on the temperature control structure. Using a lower base flow (for example 8,000 cfs) results in needing to release more cold water relying on the cold water pool more and requiring higher releases when air temperatures are high. Higher base flow allows more stable operations and the ability to blend warmer and cooler water, helping to conserve cold water pool longer through the summer.

These flow schedules were calculated based on the estimated Sacramento Valley depletion forecasts developed by DWR as part of their monthly hydrologic updates.

In addition, the cold water management of Shasta, Trinity and Whiskeytown reservoirs will be carried out in coordination with the SRTTG to meet temperature objectives on the Sacramento River, Clear Creek, and the Trinity River, and to meet in-basin water supply needs. The temperature operations will be conducted in accordance with Water Rights Order 90-05. The SRTTG has requested additional modeling from Reclamation based on shaping of delivering schedules in addition to temperature release locations in order to extend the duration of cold water availability into August and September. Per the RPA, Reclamation will by-pass power generation to improve temperatures if needed for the protection of the winter-run or spring-run Chinook salmon.

As required by the NMFS BiOp, operations of other CVP reservoirs will be scheduled to support Shasta Reservoir cold water pool needs to the extent possible, provided such action would not unnecessarily cause other adverse fishery effect.

The SRTTG will continue to meet and provide advice to WOMT and RTDOMT on updated temperature modeling results based on April and May conditions on how to best meet temperature objectives. The ultimate goal will be to balance the various factors to provide the best possible, given the constraints, conditions on the Sacramento River for winter-run Chinook salmon. The winter-run Chinook salmon contingency plan (see Attachment D) contains additional detail on augmented modeling, monitoring, hatchery operations and rescues and relocations that are planned.

B. Folsom/American River Operations

The estimated flow schedule for the American River is shown in Attachment B for both the 90 percent (with and without barriers) and 50 percent exceedance forecasts. Current forecasts show year-end reservoir storage greater than 200 TAF. As hydrology improves the minimum flows included in the current forecasts may increase in the coming months. Consistent with NMFS RPA Action II.2, a preliminary temperature plan will be developed for the American River based on the April forecast data.

C. New Melones/Stanislaus River Operations

The estimated flow schedule for the Stanislaus River is shown in Attachment B for both the 90 percent (with and without barriers) and 50 percent exceedance forecasts. Reclamation commits to provide for the required Appendix 2-E flows per NMFS RPA Action III.1.3 and to coordinate the pulse flow schedule with the SOG, with consideration of the other flow actions in the San Joaquin River basin this spring. This pulse flow will be initiated between April 7 and April 15. Reclamation will, to the extent possible, provide flows necessary to meet the Vernalis salinity objective and any dissolved oxygen requirements on the Stanislaus River. Proposed modifications to Table 3 of D-1641 are described in more detail below, but in general would include “shoulder” flows in April and May, a 31-day pulse flow (coordinated as possible with other San Joaquin River tributaries to meet modified San Joaquin River flow requirements at Vernalis.

To address D-1641 April-June flow requirements in 2014 on the San Joaquin River, Reclamation proposes the flows at Vernalis as described below. The D-1641 pulse is separate from the NMFS BiOp pulse flow and measures to offset the effects to steelhead described in Section VIII, but will be coordinated with it to maximize benefits. Water released for this D-1641 pulse flow will be available for export subject to other applicable limitations.

D. Feather River Operations

DWR plans to meet all flow requirements on the Low Flow Channel and High Flow Channel on the Feather River and all temperature requirements at the Feather River Fish Hatchery and Robinson’s Riffle for all periods as designated in the current FERC license which includes consultation by NMFS and USFWS, and the 1983 agreement between DWR and CDFW.

In light of the need for storage to meet all reasonable Lake Oroville project purposes in 2015, the suitability of water deliveries for the purpose of decomposition of rice straw beginning in the fall would not be reasonable unless hydrologic conditions improve substantially.

VI. Proposed Delta Operations – April and May

The intent of the proposed modifications to operating criteria in April and May is to take advantage of natural or abandoned flows during wet periods to increase storage in San Luis Reservoir to provide for multiple beneficial uses including, high quality water to reduce potential disinfection byproduct threats to public drinking water supplies, wildlife refuges, water for irrigation, and critical needs. Even with the current and predicted precipitation, drought conditions in the southern Sierra and San Joaquin Valley are expected to be more extreme than in the northern part of the state. The proposed operating criteria are also designed to reduce adverse effects on endangered species and other fish and wildlife commensurate with the unavoidable negative effects of a drought of this magnitude. Where possible, the agencies have attempted to offset further adverse effects on the species originating from these planned operations by shifting higher exports to Jones Pumping Plant and providing for an additional pulse in a future year (see Section VIII, below). This is especially critical for juvenile San Joaquin steelhead that are the target species for NMFS RPA Action IV.2.1.

The proposed suite of April/May modifications includes continuation of a number of provisions in the current TUC Order and existing flexibility allowed under D-1641, including compliance specifications for outflow requirements and averaging periods for E/I ratio requirements, respectively. Export limitations during the San Joaquin River pulse flow period would comport with D-1641 requirements. The Vernalis flow-to-combined export (I:E) ratio of 1:1 associated with San Joaquin River flows for a critically-dry San Joaquin Valley classification (NMFS RPA Action IV.2.1) will be implemented during most of the April 1 through May 31 period, with the modification noted below under BiOps (1). The D-1641 San Joaquin River flow objectives would also be modified in April through June (as described Sections VI.C and VII.D below). In addition, some actions will be implemented to offset adverse effects to out-migrating San Joaquin River steelhead and salmon (see Section VIII, below). Specific elements of the proposal for April and May relative to NMFS BiOp provisions, USFWS BiOp provisions, CDFW longfin smelt incidental take permit, and D-1641 provisions are defined below. A biological review of this suite of actions is provided in Attachment E for salmonids and sturgeon and F for delta smelt and longfin smelt.

A. NMFS BiOp Provisions

1. NMFS RPA Action IV.2.1 will be implemented with the following modification:

   Before the approximately 31-day Stanislaus River pulse flow (to be initiated between April 7-15, 2014), Action IV.2.1 would be modified to allow for increased export pumping to capture abandoned or natural flows in the Delta, up to OMR limits, as provided in the NMFS BiOp (Action IV.2.3) and USFWS BiOp (Action 3). Action IV.2.1 will be implemented during the 31-day pulse flow period. Action IV.2.1 will likely be implemented following the Stanislaus River pulse flow, through May 31. However, in the unlikely event that there is abandoned or natural flows in the Delta during the latter half of May; exports would increase to capture those flows.

2. Schedule the Stanislaus River pulse flow release in coordination with releases from other San Joaquin River tributaries for 31 days, to begin sometime between April 7 and April 15. The exact timing and duration will be developed through the SOG in coordination with the WOMT and RTDOMT processes. Reclamation and DWR will maintain a San Joaquin River inflow-to-export ratio of 1:1 (with a minimum combined export of 1,500 cfs), for the duration of the pulse.

3. All OMR flow related actions, including those based on the NMFS salmonid density triggers, remain in place. The OMR Index Demonstration Project as specified in the NMFS concurrence letter continues.

4. Modification of DCC gate operations (NMFS RPA Action IV.1.2): If the Projects determine that the DCC gates must open to provide for salinity management in the Delta, the Projects will provide at least a 5-day notice to the fish and wildlife agencies so that enhanced monitoring can begin. The Projects will implement enhanced monitoring and triggers to open and close the gates, as needed for protection of listed species (see Attachment G).

B. USFWS BiOp Provisions

No additional modifications, beyond March 31, to the USFWS BiOp RPA actions are currently proposed under this Plan. All OMR flow related actions, including USFWS determinations based on entrainment risk, remain in place[1]. The OMR Index Demonstration Project as specified in the USFWS concurrence letter continues.

C. D-1641 Provisions

Reclamation and DWR are requesting further modifications of requirements contained in D-1641. Below is a description of those anticipated requests. These requests would be subject to approval by the State Water Board's Executive Director and potentially the State Water Board members. D-1641 provisions #1 and #2 (below) are intended to be an extension of existing TUC Order provisions 1(a) and 1(b), which terminate on March 31, 2014. D-1641 provisions #3 and #4 are considered within existing D-1641 flexibility and within the process of implementation defined therein. D-1641 provision #5 (below) will be defined through coordination with the BiOps provision #2 (above).

1. The minimum Delta Outflow levels specified in Table 3 are modified as follows:

   The minimum monthly Net Delta Outflow Index (NDOI) described in Figure 3 of D-1641 during the months of April and May shall be no less than 3,000 average (mean) cubic-feet per second (cfs).

2. The maximum Export Limits included in Table 3 of D-1641 are modified as follows:

[1] The CDFW 2081 permit criteria associated with longfin smelt remain in place.

During April and May when footnote 10 of D-1641 is not being met, or the DCC gates are open during a period inconsistent with footnote 23 of D-1641, the combined maximum SWP and CVP export rate for SWP and CVP contractors at the Harvey O. Banks and C.W. "Bill" Jones Pumping Plants will be no greater than 1,500 cfs on a 3-day running average. When precipitation and runoff events occur that allow the DCC to be closed and footnote 10 of D-1641 is being met [3-day average Delta Outflow of 7,100 cfs or electrical conductivity of 2.64 millimhos per centimeter on a daily or 14-day running average at the confluence of the Sacramento and the San Joaquin rivers (Collinsville station C2) if applicable[2]], but any additional Delta Outflow requirements contained in Table 4 of D-1641 are not being met, then exports of natural and abandoned flows are permitted up to D-1641 Export Limits contained in Table 3 and under the existing Biological Opinions (with implementation modifications or limits, as specified in BiOps section, above).

3. Continue to vary the averaging period of the Delta E/I ratio pursuant to Footnotes 18, 19, and 20 of D-1641 as was approved in the March TUC Order. Operate to a 35 percent E/I ratio with a 3-day averaging period on the rising limb of a Delta inflow hydrograph, and operate to a 14-day averaging period on the falling limb of the Delta inflow hydrograph.

4. Implement combined export limitations as specified in Table 3, Footnotes 17 and 18 of D-1641. The timing and duration of this action is to be coincident with a coordinated pulse flow on the San Joaquin River system as described under BiOps (1) and (2) of up to but not to exceed 31 days.

5. D-1641 (5) Vernalis base flow and pulse flow are modified as follows:

   - April 1 to the start of the pulse flow period – maintain Vernalis flow at or above 700 cfs (3-day running average);
   - For the 31-day pulse flow period, create a 16-day pulse averaging 3,300 cfs at Vernalis with flows averaging 1,500 cfs at Vernalis for the remainder of the 31 days. The start date and flow schedule for the overall pulse flow volume of water may be modified (with concurrence with the fishery agencies);
   - From the end of the pulse flow period through May 31– maintain an average flow of 500 cfs for the period.

6. The compliance location for the D-1641 Agricultural Western Delta Salinity Standard at Emmaton (14-day running average of 2.78 millimhos per centimeter through August 15) is moved to Three Mile Slough on the Sacramento River.

[2] The Standard does not apply in May if the best available estimate of the Sacramento River Index for the water year is less than 8.1 MAF at the 90% exceedence level.

The attached export and hydrodynamic forecasted operations for the Delta hydrodynamics are based on the specific proposed operating criteria outlined above (BiOp provisions #1 through #4, and D-1641 provisions #1 through #6). These forecasted values are the current best estimate of resulting exports and flows for the purposes of analysis, but should not be construed as specific proposals (see Attachment H).

VII. Proposed Delta Operations - June Through November 15

During the June through November 15 period, operations would be focused on conserving as much water as possible in upstream reservoirs while meeting in-basin needs. The conservation of storage will help meet fall Sacramento River temperature requirements and minimize potential impacts from a continuation of drought into 2015, including for the benefit of Chinook salmon. A salient component of operations during this period includes the construction and operation of emergency drought barriers in three locations in the Delta, which would reduce the need for reservoir releases to meet salinity objectives. See Attachment B for 90 percent forecasts with and without the proposed barriers. These two forecasts show a gain of 149,000 AF in cumulative end of September carryover storage between all reservoirs as a result of implementing the emergency drought barriers. However, as described below, this savings in storage would only be achieved if the D-1641 requirement for Agricultural Western Delta Salinity at Emmaton is set aside while the emergency drought barriers are in place. If hydrologic conditions warrant that sufficient water is available in upstream reservoirs to maintain the this Emmaton standard, or a modification of the standard that would move the compliance point to Three Mile Slough on the Sacramento River, emergency drought barriers would not provide any savings in Delta outflow needs or end of September carryover storage in upstream reservoirs. For this reason, the 50 percent forecast does not include proposed barriers.

In addition, the proposed suite of operational modifications in June through November 15 includes continuation of some provisions in the current TUC Order regarding compliance specifications for outflow requirements and averaging periods for E/I ratio requirements. Specific elements of the proposal for June through November 15 relative to NMFS BiOp provisions, USFWS BiOp provisions, and D-1641 provisions are defined below. A biological review of this suite of actions is provided in Attachments E and F.

A. Emergency Drought Barriers

If hydrologic conditions continue to be forecasted at a level of dryness similar to what is expressed in the March 90 percent forecast, emergency drought barriers would be constructed on West False River, Steamboat Slough, and Sutter Slough during May. The West False River barrier would be constructed first, with construction beginning approximately May 7. The Sutter and Steamboat slough barriers would be constructed second, with in-water construction starting no earlier than May 22. The barriers would be constructed primarily with rock fill. Four 48-inch culverts will be operable at the barriers in Sutter and Steamboat sloughs to allow fish passage and downstream flow when needed to improve water quality and stage. A boat portage facility will be operated at the Steamboat Slough barrier to allow boats less than 22 feet long to cross the barrier. Water quality and stage will be continuously monitored upstream and downstream of the barriers. The barriers will also be monitored for their effects on migrating adult and juvenile salmon and sturgeon and their designated critical habitats, as well as effects on delta smelt distribution and habitat and longfin smelt habitat. Initiation of barrier removal will begin no later than October 15, 2014, with the complete removal of the Sutter and Steamboat slough barriers by November 1, and complete removal of the West False River barrier by November 15.

The state and federal agencies will employ a contingency approach to salinity barrier construction, which would allow a decision to be made as late as the end of April concerning the construction of the barriers. Should runoff projections and water quality conditions warrant, installation of the salinity barriers could be delayed or halted. Site-specific ESA compliance for construction and operation of the salinity barriers will be achieved through DWR's application for a 404 Corps permit, and accompanying ESA Section 7 consultation between NMFS and USFWS and the Corps, and applicable permits from CDFW. A petition for construction and operation of the emergency drought barriers has been advanced to the State Water Board.

The proposed modifications to CVP and SWP operations with the salinity barriers in place related to Delta outflow and water quality are addressed as part of this Plan. With the salinity barriers in place, it is estimated that a minimum monthly Delta outflow of 2,000 cfs, would be sufficient to maintain water quality for in-Delta uses and Project diversions, thereby conserving upstream storage that would have been necessary under a higher outflow requirement. However, this range of projected Delta outflow with barrier operation is estimated to be insufficient to meet the D-1641 Agricultural Western Delta Salinity Standard at Emmaton for critical year types (14-day running average of 2.78 millimhos per centimeter through August 15). Additional upstream releases would needed to be expended in order to meet the Emmaton standard. In fact, due to the hydrodynamic changes associated with the operation of the proposed salinity barriers, slightly higher upstream releases would need to be expended to meet the Emmaton standard than if the barriers were not installed at all. Therefore, one of the primary objectives of barrier operation (conservation of upstream storage), can only be achieved if barrier implementation is carried out in concert with modifications of various Delta salinity D-1641 requirements (see below).

B. NMFS BiOp Provisions

1. Modification of DCC gate operations (NMFS RPA Action IV.1.2): If the Projects determine that the DCC gates must open to provide for salinity management in the Delta, the Projects will provide at least a 5 day notice to the fish and wildlife agencies so that enhanced monitoring can begin. The Projects will implement enhanced monitoring and triggers to open and close the gates, as needed for protection of listed species (see Attachment XX).

C. USFWS BiOp Provisions

No modifications to the USFWS BiOp RPA actions are currently proposed during June through November 15.

D. D-1641 Provisions

Reclamation and DWR may request further modifications of requirements contained in D-1641. Below is a description of those anticipated requests. These requests would be subject to approval by the State Water Board's Executive Director.

Scenario 1: With Emergency Drought Barriers in Place June through November 15

1. The minimum monthly Net Delta Outflow Index (NDOI) described in Figure 3 of D-1641 during the months of June through October shall be no less than 2,000 mean cfs.

2. During the month of June, continue to vary the averaging period of the Delta E/I ratio pursuant to Footnotes 18, 19, and 20 of D-1641 as was approved in the March TUC Order. Operate to a 35 percent E/I ratio with a 3-day averaging period on the rising limb of a Delta inflow hydrograph when storm runoff is occurring, and operate to a 14-day averaging period on the falling limb of the Delta inflow hydrograph.

3. Set aside the critical year D-1641 Agricultural Western Delta Salinity Standard at Emmaton (14-day running average of 2.78 millimhos per centimeter through August 15).

4. The number of required days for 150 mg/l Cl at Contra Costa Canal Intake shall be 56 days.

5. The mean monthly Rio Vista flow standard in September, October, and November shall be no less than 2,000 cfs.

Scenario 2: Without Emergency Drought Barriers in Place

1. The minimum monthly NDOI described in Figure 3 of D-1641 during the month of July shall be no less than 3,000 cfs.

2. The number of required days for 150 mg/l Cl at Contra Costa Canal Intake shall be 56 days.

3. The compliance location of the D-1641 Agricultural Western Delta Salinity Standard at Emmaton (14-day running average of 2.78 millimhos per centimeter through August 15) is moved to Three Mile Slough on the Sacramento River.

4. The mean monthly Rio Vista flow standard in September, October, and November shall be no less than 2,000 cfs.

5. Vernalis Base Flow: For June 1 through June 30, no specific minimum flows are required; flows will be maintained sufficient to meet D-1641 San Joaquin River EC requirements at Vernalis.

VIII. Measures to Offset Effects to San Joaquin River Steelhead

The NMFS BiOp RPA protections for juvenile San Joaquin steelhead (Action IV.2.1) rely on 61 days of minimum protections in April and May. This Plan proposes to reduce this action by 10-30 days to a minimum of 31 days, depending on the start date of the pulse flow and hydrology in late May. At a minimum the I:E action will occur during the 31-day pulse flow period, approximately April 15 through May 15, with a possible start date as early as April 7. Steelhead emigration generally occurs throughout the February to June period, and does not tend to occur in pulses that can be seen in data. The attached biological review qualitatively assesses the additional adverse effects to steelhead that will occur due to shortening this window.

In order to provide additional protections that would not occur otherwise, the Plan proposes the following:

1. Provide for additional flows in the San Joaquin River in a subsequent year to benefit outmigration of San Joaquin steelhead: Reclamation and DWR will make an amount of water equivalent to half the volume of increased exports realized over the April/May 2014 period available to provide for a larger pulse flow, for the fishery agencies to shape, in the next "dry" or better water year type based on the San Joaquin Valley Index. For example, if there is a 60 TAF gain in exports above the minimum health and safety diversion of 1,500 cfs, then 30 TAF of additional water (from some source within the San Joaquin River Basin in addition to the Appendix 2-E flows or that required to meet in-river regulatory obligations on the other tributaries) would be made available in a future year for the spring pulse flow on the San Joaquin River. The release timing of this additional flow would be scheduled at the discretion of the fishery agencies.

2. Shift exports to Jones Pumping Plant for all of April and May up to the federal capacity (either pumping or canal capacity); remainder of exports to be pumped by the State up to operable constraint (OMR limit outside of pulse period). Slight adjustments would be allowed to maintain minimal deliveries to the SWP South Bay Aqueduct, if necessary. The rationale for this action is that loss at the Banks Pumping Plant is much higher than at the Jones Pumping Plant, therefore the shift in exports is expected to minimize take associated with increased exports. This action was developed and vetted by a team of interagency staff in 2011.

IX. Emergency Fisheries Monitoring, Technology Improvement, and Science Planning

The state and federal agencies commit to developing, and implementing as appropriate, a multi-objective emergency fisheries monitoring, technology improvement, and science plan to minimize, and to the extent possible, measure effects to listed species and improve understanding of biological effects associated with water operations during drought conditions. Drought year effects to be studied include, but are not necessarily limited to, effects associated with Delta Cross Channel gate and export facility operations, salinity barrier influence on smelt and associated habitat, and upstream flows and temperature management for anadromous fishes. This planning process will:

1. Identify near-term extraordinary fish (salmonid, steelhead, sturgeon, and smelt) monitoring necessary to support and inform water operations during 2014 drought conditions;
2. Develop a winter-run Chinook salmon contingency plan (see Attachment D) that includes: a) infrastructure needs at Livingston Stone National Fish Hatchery, b) increased monitoring of redds and temperature impacts, and c) rescue and relocation to more suitable habitats including Battle Creek (see Attachment I);
3. Identify monitoring and studies to document the environmental effects of the drought, including: a) the effects of the proposed temporary salinity barriers and associated CVP/SWP operation on smelt habitat throughout the timeframe that the barriers are in place and b) the effect of the barriers on migrating salmon, steelhead, sturgeon, delta smelt, and longfin smelt and their habitats; and
4. Identify opportunities for longer-term anadromous fish monitoring to improve operations decision-making during drought as well as other year types (see Attachment J).

This planning process is currently under development. Draft and final plans will be completed collaboratively by the USFWS, NMFS, CDFW, DWR, and Reclamation. It is expected that specific "action plans" for items 1, 2, and 3 above, because they are time sensitive due to drought operations, will be developed by April 15th so that implementation, as appropriate, can begin. Action plans for longer-term actions, such as item 4, will be developed by October 1, 2014, through a collaborative process led by NMFS and CDFW in coordination with the other agencies. The action planning process will include stakeholder input and scientific-peer review. The newly formed IEP Salmon MAST and the South Delta Salmonid Research Collaborative subgroup of the Collaborative Science and Adaptive Management Program (CSAMP) will be engaged prior to final decisions being made specific to long-term anadromous fish monitoring. Additionally, the CSAMP could be engaged if appropriate to address smelt issues that arise during implementation of these plans.

Additional adverse effects including take resulting from the final monitoring program will be addressed under existing authorizations or separate consultation.

Please see additional smelt monitoring requests from USFWS and CDFW included as an attachment to this document (see Attachment I).

ATTACHMENT A

FEBRUARY AND MARCH 2014 – ACTUAL DELTA OPERATIONS

Attachment X-1

	Releases			Wilkins	Exports		OMR Index			DCC		NDOI		Chipps EC		Collinsville EC	
Date	Oroville	Keswick	Folsom	Slough	CCF	Jones	Daily	5 Day	14 Day	%	QWEST	Daily	3-Day	Daily	14 Day	Daily	14 Day
	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	Open	cfs	cfs	cfs	mS/cm	mS/cm	mS/cm	mS/cm
2/1/2014	987	3,349	619	4130	393	248	-333	-261	-790	58	1970	7,149		15.68	15.68	11.27	11.07
2/2/2014	980	3,350	623	3832	391	251	-382	-287	-728	100	1966	7,243		15.25	15.72	10.66	11.12
2/3/2014	980	3,340	638	3798	397	257	-360	-309	-667	100	5115	8,205	7,532	14.97	15.75	10.63	11.18
2/4/2014	976	3,307	648	3780	392	252	-342	-330	-606	100	4985	7,898	7,782	13.90	15.75	9.90	11.21
2/5/2014	975	3,275	648	3842	395	252	-342	-352	-545	100	4772	7,712	7,938	13.01	15.65	9.25	11.19
2/6/2014	980	3,316	655	4193	389	247	-341	-354	-485	100	4875	7,767	7,792	12.67	15.49	8.60	11.11
2/7/2014	1,007	3,411	647	4330	392	242	-334	-344	-425	100	6063	9,662	8,380	12.83	15.34	8.34	11.00
2/8/2014	1,034	3,709	648	4750	398	254	-329	-338	-366	100	6336	10,420	9,283	13.36	15.19	8.26	10.82
2/9/2014	981	3,453	1,053	5620	397	809	-814	-432	-364	100	7904	13,680	11,254	12.63	14.93	8.00	10.57
2/10/2014	1,105	3,529	686	7688	394	804	-778	-519	-381	42	13420	23,585	15,895	10.45	14.43	6.61	10.12
2/11/2014	1,240	3,312	629	13838	2491	1604	-3414	-1134	-607	0	12633	26,919	21,395	8.01	13.81	4.81	9.56
2/12/2014	1,240	3,174	629	12113	3345	2269	-4024	-1872	-876	0	9919	26,566	25,690	6.34	13.07	3.44	8.91
2/13/2014	1,171	3,075	620	8806	2998	2591	-4781	-2762	-1200	0	8504	25,382	26,289	5.18	12.21	2.58	8.19
2/14/2014	1,038	2,994	619	7388	2998	2588	-4786	-3557	-1526	0	5414	18,527	23,492	4.51	11.34	2.23	7.47
2/15/2014	964	2,890	617	7007	2991	2592	-4798	-4361	-1845	0	1904	10,741	18,217	4.40	10.54	2.08	6.81
2/16/2014	961	2,890	613	6831	2993	2596	-4827	-4643	-2162	0	1064	8,097	12,455	4.30	9.75	1.96	6.19
2/17/2014	956	2,889	617	6483	2996	2608	-4850	-4808	-2483	0	841	7,467	8,768	3.93	8.97	1.85	5.56
2/18/2014	957	2,894	620	6827	2496	2601	-4400	-4732	-2773	0	1067	7,075	7,546	3.75	8.24	1.79	4.99
2/19/2014	958	2,932	610	6235	1497	2605	-3510	-4477	-2999	0	1837	7,339	7,294	3.91	7.59	1.85	4.46
2/20/2014	958	2,897	567	5535	1495	1975	-2965	-4110	-3186	0	2160	7,273	7,229	3.61	6.94	1.55	3.95
2/21/2014	956	2,751	630	5122	991	1714	-2306	-3606	-3327	0	2630	7,319	7,310	3.92	6.31	1.87	3.49
2/22/2014	954	2,773	610	4708	990	1715	-2328	-3102	-3470	0	2373	6,611	7,068	4.70	5.69	2.50	3.08
2/23/2014	951	2,731	585	4524	288	1074	-1122	-2446	-3492	0	3393	6,976	6,969	5.45	5.18	2.97	2.72
2/24/2014	955	2,708	590	4468	696	798	-1250	-1994	-3526	0	3112	6,256	6,614	5.51	4.82	2.92	2.46
2/25/2014	960	2,712	551	4284	693	801	-1258	-1653	-3372	0	2955	5,867	6,366	6.64	4.72	3.83	2.39
2/26/2014	964	2,710	563	4290	698	800	-1249	-1441	-3174	0	463	5,531	5,885	7.15	4.78	3.66	2.40
2/27/2014	960	2,618	650	4420	693	805	-1251	-1226	-2921	0	1815	7,724	6,374	8.22	5.00	4.45	2.54
2/28/2014	965	2,688	690	6924	691	827	-1250	-1252	-2669	0	1921	8,126	7,127	8.59	5.29	4.45	2.69

* Per D-1641 No Chipps days required in February

7 Chipps Island Carryover Days From February Applied to March

Days with modified D-1641 implementation covered by TUCP order

Parameters under modified D-1641 implementation covered by TUCP order

Days with modified OMR Implementation

Parameters affected by modified OMR Implementation

Attachment X-2

	Releases			Wilkins	Exports		OMR Index			DCC		NDOI		Chipps EC		Collinsville EC	
Date	Oroville	Keswick	Folsom	Slough	CCF	Jones	Daily	5 Day	14 Day	%	QWEST	Daily	3-Day	Daily	14 Day	Daily	14 Day
	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	Open	cfs	cfs	cfs	mS/cm	mS/cm	mS/cm	mS/cm
3/1/2014	880	2,684	718	11167	694	811	-1150	-1232	-2408	0	7357	17,041	10,964	8.10	5.56	3.86	2.82
3/2/2014	829	2,687	711	12838	2496	1458	-3240	-1628	-2295	0	6147	21,315	15,494	7.24	5.77	3.72	2.95
3/3/2014	836	2,544	659	12513	2198	2085	-3594	-2097	-2205	0	5949	25,935	21,430	5.22	5.86	2.49	2.99
3/4/2014	821	2,602	638	10272	2195	2447	-3973	-2641	-2175	0	4719	24,917	24,056	4.14	5.89	1.84	3.00
3/5/2014	823	2,661	660	17754	2792	2871	-4919	-3375	-2275	0	3845	22,513	24,455	3.60	5.86	1.50	2.97
3/6/2014	820	2,595	1,031	18238	2493	3312	-5045	-4154	-2424	0	-49	16,878	21,436	3.09	5.83	1.41	2.96
3/7/2014	818	2,648	632	15529	3488	3297	-5981	-4703	-2686	0	433	22,913	20,768	2.13	5.70	0.87	2.89
3/8/2014	821	2,543	642	15075	3487	3301	-6016	-5187	-2950	0	420	24,316	21,369	1.46	5.47	0.62	2.76
3/9/2014	819	2,448	594	12517	3351	3195	-5791	-5551	-3283	0	-507	21,275	22,835	1.17	5.16	0.41	2.57
3/10/2014	816	2,644	598	10309	3496	3326	-6020	-5771	-3624	0	-1400	17,820	21,137	1.32	4.86	0.46	2.40
3/11/2014	799	2,641	550	15615	3499	3273	-5963	-5954	-3960	0	-2384	13,936	17,677	1.29	4.48	0.39	2.15
3/12/2014	798	2,619	555	19025	2994	3361	-5601	-5878	-4271	0	-2481	11,916	14,557	1.24	4.06	0.42	1.92
3/13/2014	800	2,631	561	14038	3694	3356	-6249	-5925	-4628	0	-2801	14,763	13,538	2.28	3.63	0.48	1.64
3/14/2014	800	2,629	556	10861	3492	2736	-5518	-5870	-4933	0	-1875	16,694	14,457	2.67	3.21	0.59	1.36
3/15/2014	801	2,670	554	9105	3498	2891	-5658	-5798	-5255	0	-2507	13,344	14,933	2.18	2.79	0.56	1.12
3/16/2014	803	2,684	545	7998	3288	3338	-5896	-5785	-5445	0	-3333	9,129	13,056	2.15	2.42	0.64	0.90
3/17/2014	813	2,692	546	7253	2090	3345	-4809	-5626	-5531	0	-2383	7,726	10,067	2.64	2.24	0.88	0.79
3/18/2014	815	2,637	545	6420	2283	3350	-4995	-5376	-5605	0	-2893	6,030	7,629	3.03	2.16	1.12	0.74
3/19/2014	814	2,713	546	5531	1488	3346	-4323	-5136	-5562	0	-2379	5,513	6,423	3.49	2.15	1.32	0.73
3/20/2014	811	3,321	543	5211	1486	2753	-3826	-4770	-5475	0	-2014	4,969	5,504	4.22	2.23	1.92	0.76
3/21/2014	810	3,166	545	4986	1194	1448	-2421	-4075	-5221	0	-1777	5,441	5,308	5.29	2.46	2.70	0.89
3/22/2014	809	3,072	544	5173	1191	1001	-2031	-3519	-4936	0	-393	5,276	5,229	5.38	2.74	2.94	1.06
3/23/2014	809	3,095	543	5235	705	1000	-1612	-2843	-4637	0	-322	5,703	5,473	5.19	3.03	2.95	1.24
3/24/2014	812	3,095	548	5153	689	998	-1616	-2301	-4323	0	192	5,861	5,613	5.10	3.30	2.82	1.41
3/25/2014	814	3,077	541	4944	998	1004	-1895	-1915	-4032	0	-292	5,287	5,617	6.29	3.65	2.93	1.59
3/26/2014	819	3,068	529	4988	993	1004	-1922	-1815	-3770	0	-470	4,476	5,208	5.93	3.99	3.11	1.78
3/27/2014	817	2,935	528	5091	694	866	-1551	-1719	-3434	0	1213	6,532	5,432	5.71	4.23	2.85	1.95
3/28/2014	814	2,863	528	5314	699	801	-1498	-1697	-3147	0	1631	8,017	6,341	5.52	4.44	2.84	2.11
3/29/2014	820	2,702	529	5673	692	804	-1481	-1669	-2848	0	937	8,056	7,535	6.18	4.72	3.02	2.29
3/30/2014	815	2,699	528	6732	694	805	-1483	-1587	-2533	0	4014	12,141	9,405	6.11	5.01	3.15	2.47
3/31/2014	812	2,546	528	13867	692	804	-1430	-1489	-2292	0	4742	13,962	11,386	5.80	5.23	2.77	2.60

* Per D-1641 29 Chipps days required in March

7 Chipps Island Carryover Days From February Applied to March

Days with modified D-1641 implementation covered by TUCP order

Parameters under modified D-1641 implementation covered by TUCP order

Days with modified OMR Implementation

Parameters affected by modified OMR Implementation

ATTACHMENT B

MARCH OPERATIONS FORECASTS – 90% WITH BARRIERS, 90% WITHOUT BARRIERS, 50% WITHOUT BARRIERS

Storages

Federal End of the Month Storage/Elevation (TAF/Feet)

			Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Trinity		**1187**	**1382**	**1416**	**1271**	**1084**	**907**	**725**	**546**	**522**	**519**
	Elev.		2293	2296	2283	2264	2244	2221	2193	2189	2188
Whiskeytown		**206**	**206**	**238**	**238**	**238**	**238**	**238**	**238**	**206**	**206**
	Elev.		1199	1209	1209	1209	1209	1209	1209	1199	1199
Shasta		**1773**	**2105**	**1977**	**1819**	**1599**	**1346**	**1141**	**1081**	**1102**	**1217**
	Elev.		963	956	946	932	914	898	893	894	904
Folsom		**305**	**435**	**509**	**525**	**446**	**382**	**339**	**305**	**329**	**368**
	Elev.		408	418	420	409	400	394	388	392	398
New Melones		**1060**	**1070**	**1028**	**949**	**855**	**760**	**665**	**597**	**586**	**606**
	Elev.		952	946	935	921	906	890	877	875	879
San Luis		**369**	**470**	**431**	**347**	**190**	**93**	**155**	**290**	**426**	**583**
	Elev.		448	437	422	399	376	376	392	418	452
Total			5667	5600	5148	4412	3725	3263	3058	3171	3498

State End of the Month Reservoir Storage (TAF)

			Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Oroville		**1407**	**1630**	**1696**	**1583**	**1373**	**1197**	**1096**	**1072**	**1102**	**1110**
	Elev.		745	752	740	715	693	678	675	679	681
San Luis		**307**	**478**	**414**	**358**	**324**	**254**	**192**	**173**	**250**	**413**
Total San Luis (TAF)		**676**	**948**	**845**	**705**	**513**	**347**	**347**	**464**	**676**	**996**

Monthly River Releases (TAF/cfs)

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Trinity	TAF	18	36	92	47	28	28	27	28	18
	cfs	**300**	**600**	**1,498**	**783**	**450**	**450**	**450**	**450**	**300**
Clear Creek	TAF	12	11	12	12	5	5	9	12	13
	cfs	**200**	**190**	**190**	**200**	**85**	**85**	**150**	**200**	**225**
Sacramento	TAF	200	461	530	550	562	505	357	246	193
	cfs	**3250**	**7750**	**8615**	**9250**	**9149**	**8214**	**6000**	**4000**	**3250**
American	TAF	37	71	92	131	105	83	72	52	51
	cfs	**600**	**1200**	**1500**	**2201**	**1710**	**1357**	**1202**	**850**	**850**
Stanislaus	TAF	15	29	25	32	22	23	14	35	12
	cfs	**243**	**480**	**410**	**536**	**364**	**368**	**240**	**577**	**200**
Feather	TAF	49	48	68	94	137	108	65	58	57
	cfs	**800**	**800**	**1100**	**1575**	**2225**	**1750**	**1100**	**950**	**950**

Trinity Diversions (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Carr PP	10	50	117	156	155	156	154	8	17
Spring Crk. PP	**35**	**30**	**120**	**150**	**150**	**150**	**145**	**30**	**10**

Delta Summary (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Tracy	185	59	71	50	50	180	265	227	200
USBR Banks	0	0	0	0	0	0	0	0	0
Contra Costa	6.35	6.35	6.35	4.9	5.55	6.35	7	8.4	9.2
Total USBR	191	65	78	55	56	186	272	235	209
State Export	185	33	71	71	30	29	45	183	208
Total Export	376	98	149	126	86	215	317	418	417
COA Balance	0	0	0	0	-1	4	5	5	5
Old/Middle R. std.									
Old/Middle R. calc.	-4,404	-974	-1,556	-1,623	-1,212	-2,851	-4,260	-5,000	-5,242
Computed DOI	12444	8438	5303	4001	4002	2993	3009	3367	4270
Excess Outflow	2294	50	1301	0	0	0	0	374	773
% Export/Inflow	31%	13%	23%	20%	15%	39%	53%	63%	63%
% Export/Inflow std.	35%	35%	35%	35%	65%	65%	65%	65%	65%

Hydrology

		Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)		544	2,732	1,017	413
Year to Date + Forecasted	% of mean	45%	49%	37%	39%

90% -

Minimum Regulatory Standards - No Salinity Barriers

Storages

Federal End of the Month Storage/Elevation (TAF/Feet)

			Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity		**1187**	**1374**	**1264**	**1076**	**913**	**761**	**606**	**457**	**400**	**395**			
	Elev.		2292	2282	2263	2245	2226	2203	2177	2165	2164			
Whiskeytown		**206**	**206**	**238**	**238**	**238**	**238**	**238**	**230**	**230**	**201**			
	Elev.		1199	1209	1209	1209	1209	1209	1207	1207	1197			
Shasta		**1773**	**2053**	**1897**	**1669**	**1329**	**957**	**711**	**656**	**603**	**620**			
	Elev.		960	951	937	913	881	855	849	842	844			
Folsom		**305**	**422**	**440**	**455**	**430**	**381**	**316**	**293**	**285**	**280**			
	Elev.		406	409	411	407	400	390	386	384	384			
New Melones		**1060**	**1064**	**994**	**894**	**789**	**672**	**559**	**474**	**454**	**459**			
	Elev.		951	942	927	911	891	870	852	847	849			
San Luis		**369**	**444**	**412**	**344**	**246**	**117**	**39**	**95**	**234**	**369**			
	Elev.		442	433	415	396	370	347	351	388	419			
Total			5563	5246	4676	3945	3127	2468	2205	2205	2324			

State End of the Month Reservoir Storage (TAF)

Oroville		**1407**	**1625**	**1637**	**1509**	**1326**	**1150**	**1012**	**971**	**943**	**944**
	Elev.		745	746	732	709	686	666	660	655	655
San Luis		**307**	**449**	**392**	**301**	**249**	**188**	**130**	**99**	**194**	**317**
Total San Luis (TAF)		**676**	**893**	**805**	**645**	**495**	**305**	**169**	**194**	**428**	**686**

Monthly River Releases (TAF/cfs)

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Trinity	TAF	18	36	92	47	28	28	27	23	18
	cfs	**300**	**600**	**1,498**	**783**	**450**	**450**	**450**	**373**	**300**
Clear Creek	TAF	12	11	12	9	7	5	9	12	12
	cfs	**200**	**190**	**190**	**150**	**120**	**85**	**150**	**200**	**200**
Sacramento	TAF	200	464	510	601	627	483	294	281	230
	cfs	**3250**	**7800**	**8300**	**10100**	**10200**	**7860**	**4945**	**4573**	**3874**
American	TAF	34	30	31	39	61	84	36	44	45
	cfs	**550**	**500**	**500**	**647**	**991**	**1368**	**613**	**714**	**749**
Stanislaus	TAF	23	29	25	34	26	21	14	35	12
	cfs	**368**	**480**	**410**	**564**	**425**	**346**	**240**	**577**	**200**
Feather	TAF	49	48	49	59	86	77	71	59	57
	cfs	**800**	**800**	**800**	**1000**	**1400**	**1250**	**1200**	**960**	**960**

Trinity Diversions (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Carr PP	1	149	125	127	128	127	122	41	0
Spring Crk. PP	**8**	**120**	**120**	**120**	**120**	**120**	**120**	**30**	**19**

Delta Summary (TAF)

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov			
Tracy		153	60	61	55	53	50	130	185	160			
USBR Banks		0	0	0	0	0	0	0	0	0			
Contra Costa		7	6.4	6.4	6.4	4.9	5.6	6.4	7	8.4			
Total USBR		160	66	68	61	58	56	136	192	168			
State Export		153	60	54	41	12	10	16	104	125			
Total Export		313	126	122	102	70	66	152	296	293			
COA Balance		0	0	0	0	0	0	0	0	1			
Old/Middle River Std.													
Old/Middle R. calc.		-4,052	-1,614	-1,561	-1,442	-1,062	-1,066	-2,213	-3,518	-3,829			
Computed DOI		10411	5194	4360	4001	2993	2993	3009	2993	3496			
Excess Outflow		1220	1193	358	0	0	0	0	0	0			
% Export/Inflow		32%	24%	24%	19%	13%	13%	30%	51%	53%			
% Export/Inflow std.		35%	35%	35%	35%	65%	65%	65%	65%	65%			

Hydrology

		Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)		433	2,367	727	275
Year to Date + Forecasted	% of mean	36%	43%	27%	26%

Storages

Federal End of the Month Storage/Elevation (TAF/Feet)

			Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity		**1187**	**1374**	**1264**	**1075**	**912**	**760**	**605**	**455**	**399**	**394**			
	Elev.		2292	2282	2263	2245	2225	2203	2176	2165	2164			
Whiskeytown		**206**	**206**	**238**	**238**	**238**	**238**	**238**	**230**	**230**	**201**			
	Elev.		1199	1209	1209	1209	1209	1209	1207	1207	1197			
Shasta		**1773**	**2053**	**1897**	**1669**	**1371**	**1029**	**783**	**728**	**674**	**691**			
	Elev.		960	951	937	916	888	864	857	851	853			
Folsom		**305**	**422**	**440**	**455**	**439**	**389**	**335**	**297**	**286**	**296**			
	Elev.		406	409	411	409	401	393	387	385	386			
New Melones		**1060**	**1064**	**994**	**894**	**789**	**672**	**559**	**474**	**454**	**459**			
	Elev.		951	942	927	911	891	870	852	847	849			
San Luis		**369**	**444**	**417**	**352**	**276**	**153**	**84**	**170**	**329**	**450**			
	Elev.		442	433	416	403	378	358	368	405	432			
Total			5563	5250	4682	4024	3241	2604	2354	2371	2490			

State End of the Month Reservoir Storage (TAF)

Oroville		**1407**	**1625**	**1637**	**1508**	**1330**	**1163**	**1032**	**1003**	**975**	**976**
	Elev.		745	746	731	710	688	669	665	660	660
San Luis		**307**	**449**	**394**	**304**	**268**	**206**	**150**	**122**	**230**	**353**
Total San Luis (TAF)		**676**	**893**	**810**	**655**	**543**	**359**	**234**	**292**	**559**	**802**

Monthly River Releases (TAF/cfs)

Trinity	TAF	18	36	92	47	28	28	27	23	18
	cfs	**300**	**600**	**1,498**	**783**	**450**	**450**	**450**	**373**	**300**
Clear Creek	TAF	12	12	12	9	7	5	9	12	12
	cfs	**200**	**200**	**200**	**150**	**120**	**85**	**150**	**200**	**200**
Sacramento	TAF	200	464	510	559	596	483	294	281	230
	cfs	**3250**	**7800**	**8300**	**9400**	**9700**	**7860**	**4945**	**4573**	**3874**
American	TAF	34	30	31	30	62	72	52	47	30
	cfs	**550**	**500**	**500**	**506**	**1007**	**1176**	**880**	**763**	**500**
Stanislaus	TAF	23	29	25	34	26	21	14	35	12
	cfs	**368**	**480**	**410**	**564**	**425**	**346**	**240**	**577**	**200**
Feather	TAF	49	48	51	54	77	71	59	59	57
	cfs	**800**	**800**	**822**	**900**	**1250**	**1150**	**1000**	**960**	**960**

Trinity Diversions (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Carr PP	1	149	126	127	128	127	122	41	0
Spring Crk. PP	**8**	**120**	**120**	**120**	**120**	**120**	**120**	**30**	**19**

Delta Summary (TAF)

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov			
Tracy		153	64	65	72	45	60	160	205	145			
USBR Banks		0	0	0	0	0	0	0	0	0			
Contra Costa		7	6.4	6.4	6.4	4.9	5.6	6.4	7	8.4			
Total USBR		160	71	71	78	50	66	166	212	153			
State Export		153	61	56	57	11	12	20	117	125			
Total Export		313	132	127	135	61	78	186	329	278			
COA Balance		0	0	0	0	1	1	9	9	10			
Old/Middle River Std.													
Old/Middle R. calc.		-4,052	-1,685	-1,624	-1,869	-949	-1,216	-2,653	-3,932	-3,634			
Computed DOI		10411	5110	4311	2505	2505	2505	2505	2505	3496			
Excess Outflow		1220	1109	309	0	0	0	0	0	0			
% Export/Inflow		32%	25%	25%	28%	12%	16%	37%	56%	52%			
% Export/Inflow std.		35%	35%	35%	35%	65%	65%	65%	65%	65%			

Hydrology

		Trinity		Shasta		Folsom			
Water Year Inflow (TAF)		433		2,367		727			
Year to Date + Forecasted	% of mean	36%		43%		27%			

ATTACHMENT C

TEMPERATURE MODELING (INCLUDING CLEAR CREEK)

March 25, 2014

Upper Sacramento River – March 2014 Preliminary Temperature Analysis

Summary of Temperature Target Results by Month

Initial Target Location	JUN	JUL	AUG	SEP	OCT
90%-Exceedance Outlook (Figure 1)					
Sac. R. above Clear Creek (CCR)	**CCR**	**CCR**	**Keswick ~** 56˚F to 62˚F		
50%-Exceedance Outlook (Figure 4)					
Sac. R. above Clear Creek (CCR)	**CCR**	**CCR**	**CCR**	**CCR**	**Kwk**~56˚F

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

1. Operation is based on the March 2014 Operation Outlooks (monthly flows, reservoir release, and end-of-month reservoir storage) for the 90% and 50% exceedances.
2. The profiles used for Shasta, Trinity and Whiskeytown were taken on March 12, March 18, and March 12, respectively.
3. Guidance on forecasted flows from the creeks (e.g., Cow, Cottonwood, Battle, etc.) between Keswick Dam and Bend Bridge is not available beyond 5 days. Model input side flows (Cottonwood Cr & Bend Bridge local flow w/o Cottonwood Cr) were selected from the historical record, and are consistent with the forecast exceedance frequency. During spring, the relatively warm creek flows can be a significant percentage of the flows at Bend Bridge.
4. Although mean daily flows and releases are temperature model inputs, they are based on the mean monthly values from the operation outlooks. Mean daily flow patterns are user defined.
5. Cottonwood Creek flows, Keswick to Bend Bridge local flows, and diversions are mean daily synthesized flows based on the available historical record for a 1922-2002 study period.
6. Meteorological inputs were derived from a database of 86 years of meteorological data (1920-2005). The meteorological inputs in the model represent "Average" meteorological conditions.
7. Meteorology, as well as flow volume and pattern, significantly influences reservoir inflow temperatures and downstream tributary temperatures; and consequently, the development of the cold-water pool during winter and early spring.

Temperature Analysis Results:

Note that for all exceedances, Lake Shasta storage is too low to utilize the upper gates of the TCD. This TCD limitation, along with the relatively small cold-water pool volume, significantly impacts temperature management.

<u>90%-Exceedance</u>:
A temperature target location at the Sacramento River above Clear Creek gauge is possible through about mid-August (Figure 1). By early August, the TCD intake level will be through the side gates. Shasta Dam release temperature is expected to exceed 56˚F by late August, nearing 62˚F by mid-September.

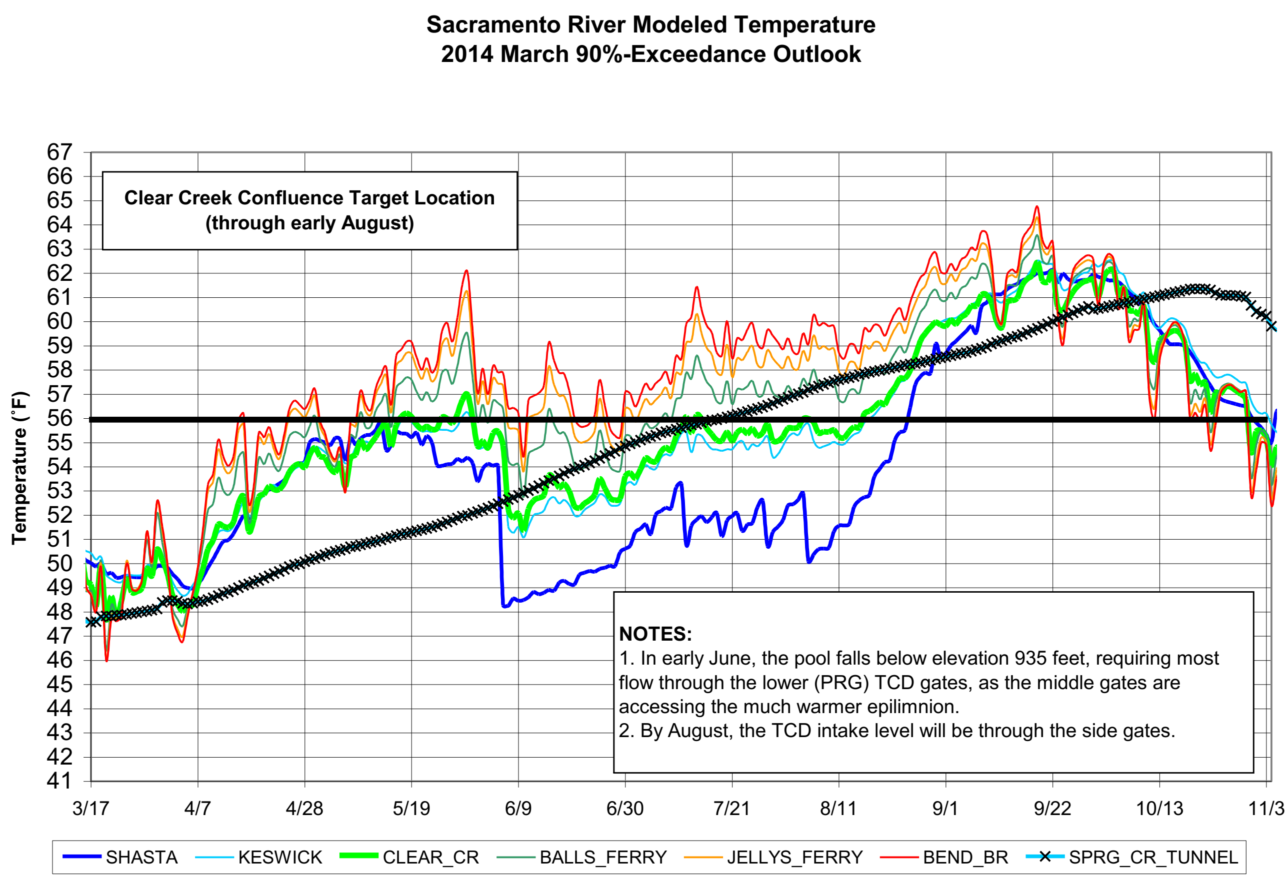
Figure 2 shows temperature results for Clear Creek at Igo.

Figure 3 includes results for the Trinity River at Lewiston Dam. The dashed lines are the 2009 mean daily temperatures at selected locations. **NOTE**: There are no releases through the auxiliary outlet works (AOW) in this analysis.

<u>50%-Exceedance</u>:
A temperature target location at the Sacramento River above Clear Creek gauge is possible through September (Figure 4). By September, the TCD intake will be through the side gates. Shasta Dam release temperature is expected to approach 56˚F by mid-October.

Figure 5 shows temperature results for Clear Creek at Igo.

Figure 6 includes results for the Trinity River at Lewiston Dam. The dashed lines are the 2009 mean daily temperatures at selected locations. **NOTE**: There are no releases through the auxiliary outlet works (AOW) in this analysis.



Sacramento River Modeled Temperature
2014 March 90%-Exceedance Outlook
Clear Creek Confluence Target Location
(through early August)
NOTES:
1. In early June, the pool falls below elevation 935 feet, requiring most flow through the lower (PRG) TCD gates, as the middle gates are accessing the much warmer epilimnion.
2. By August, the TCD intake level will be through the side gates.
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
3/17
4/7
4/28
5/19
6/9
6/30
7/21
8/11
9/1
9/22
10/13
11/3
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
JELLYS_FERRY
BEND_BR
SPRG_CR_TUNNEL

Figure 1

Clear Creek - Igo Modeled Temperature
2014 March 90%-Exceedance Outlook

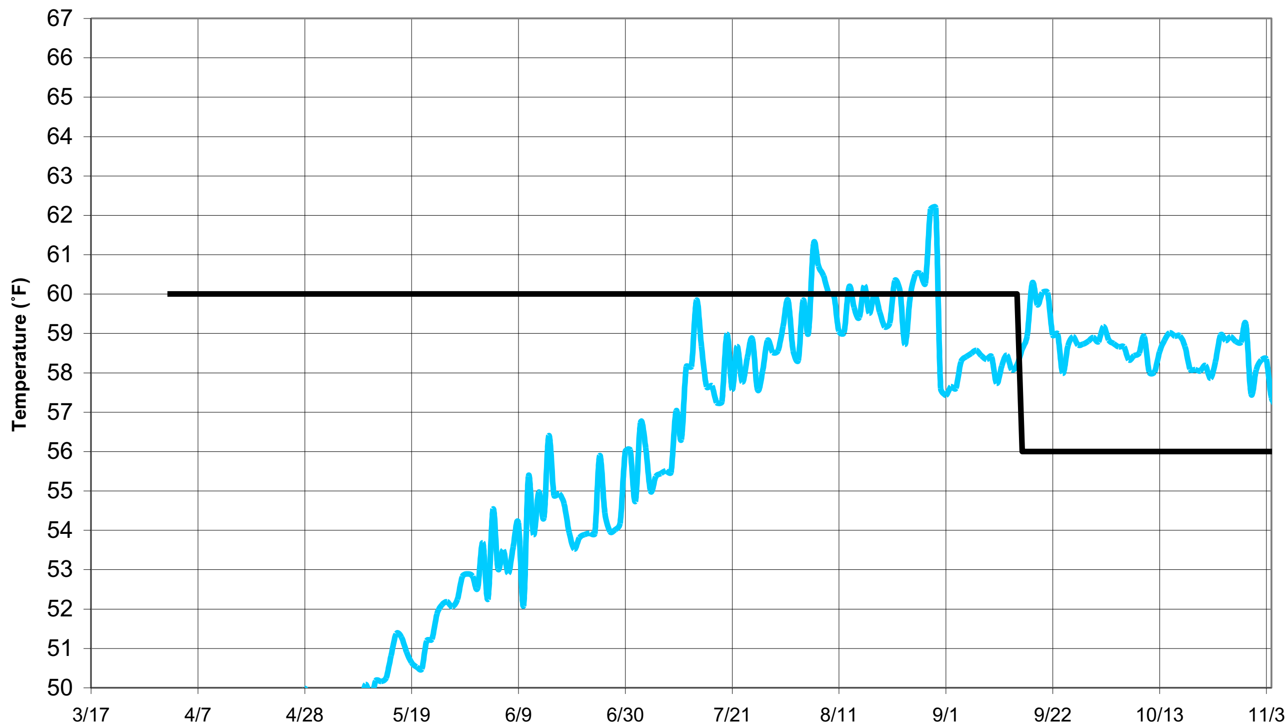
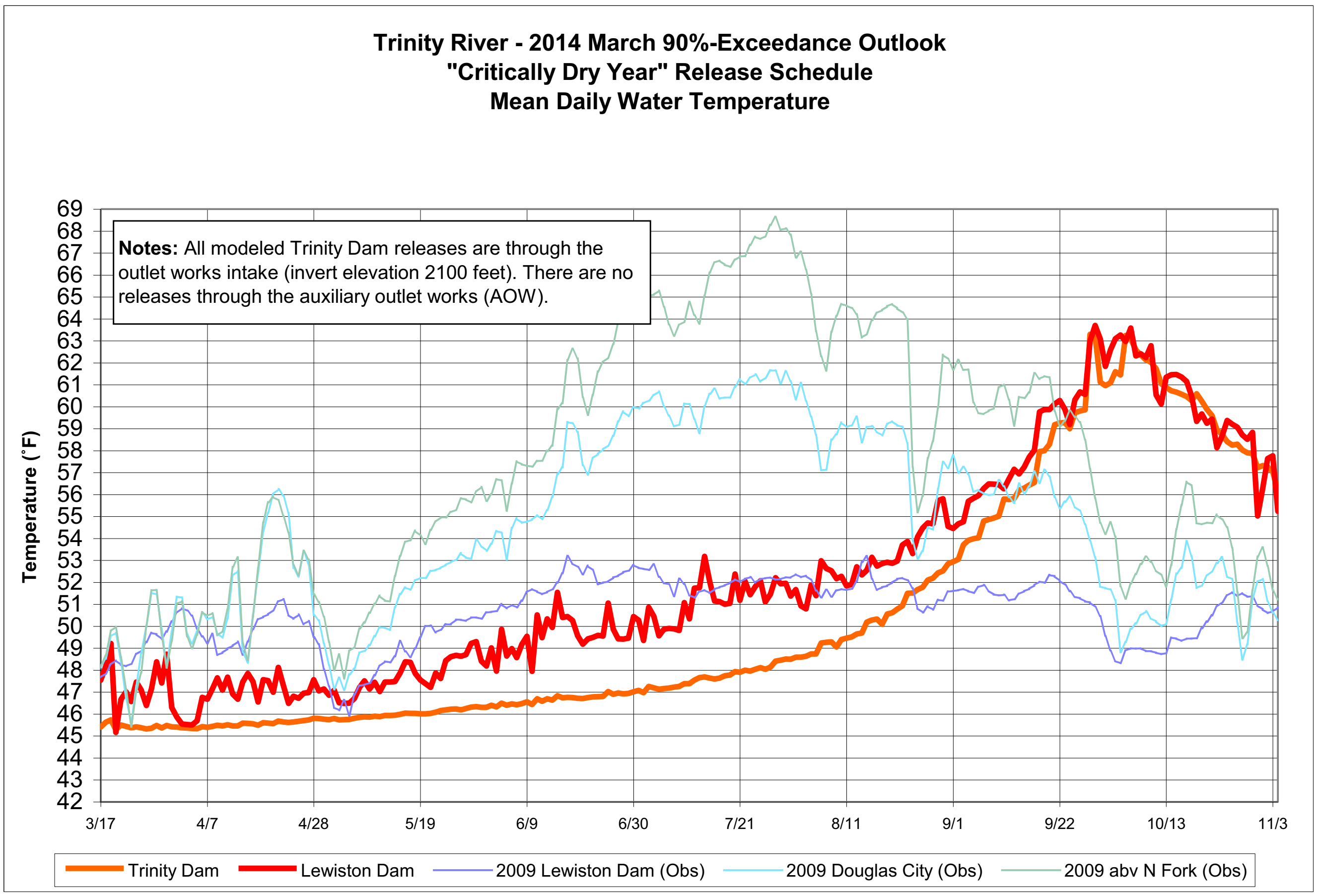
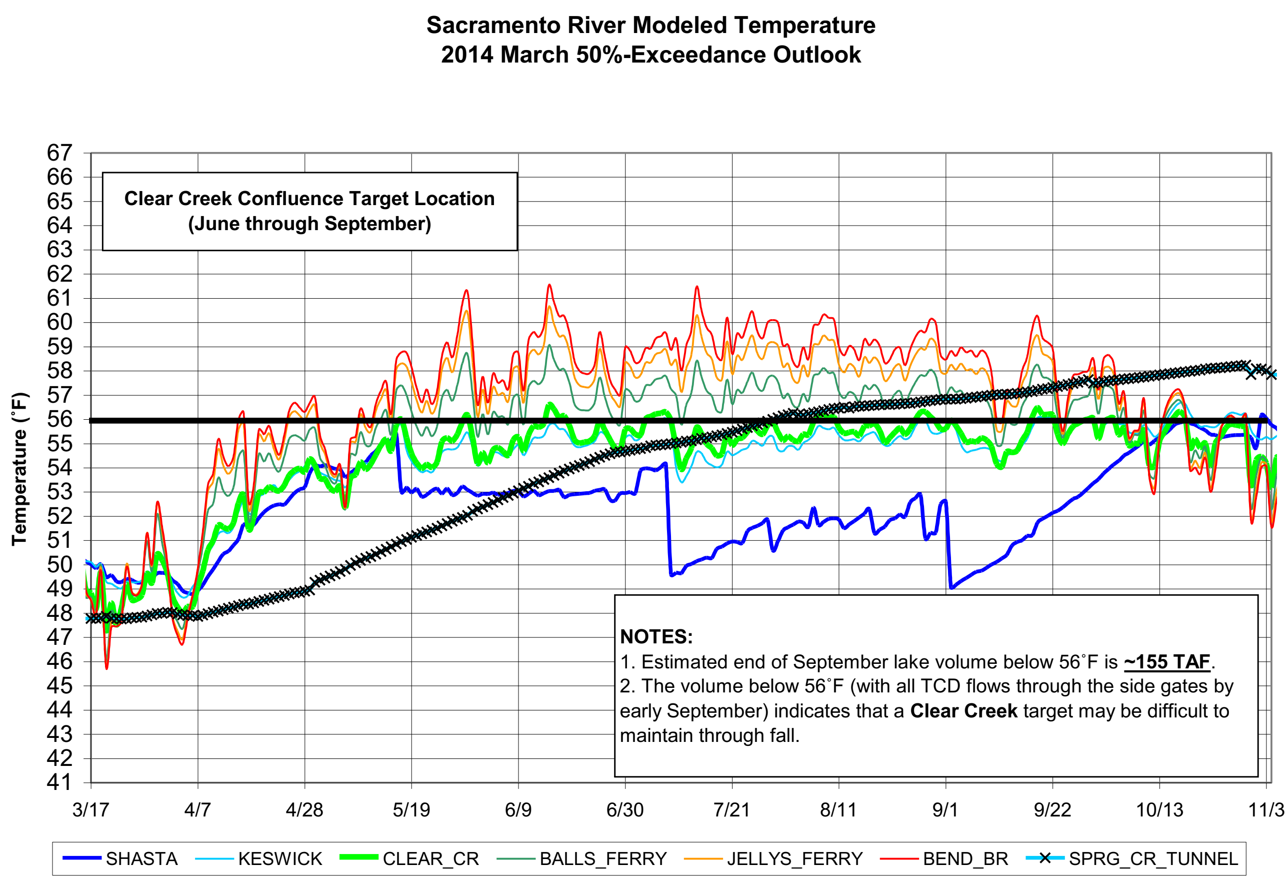


Figure 2



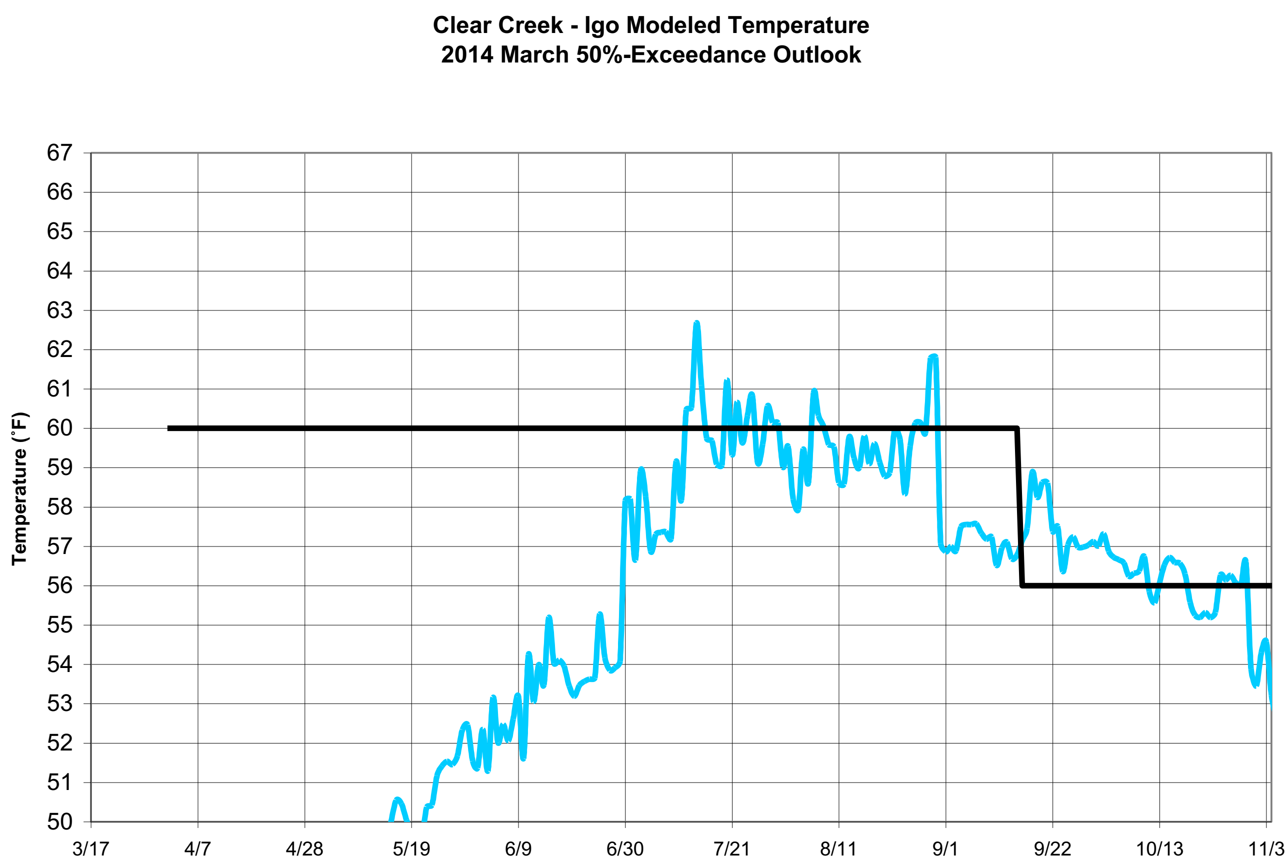
Trinity River - 2014 March 90%-Exceedance Outlook
"Critically Dry Year" Release Schedule
Mean Daily Water Temperature
Notes: All modeled Trinity Dam releases are through the outlet works intake (invert elevation 2100 feet). There are no releases through the auxiliary outlet works (AOW).
Temperature (˚F)
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
3/17
4/7
4/28
5/19
6/9
6/30
7/21
8/11
9/1
9/22
10/13
11/3
Trinity Dam
Lewiston Dam
2009 Lewiston Dam (Obs)
2009 Douglas City (Obs)
2009 abv N Fork (Obs)

Figure 3



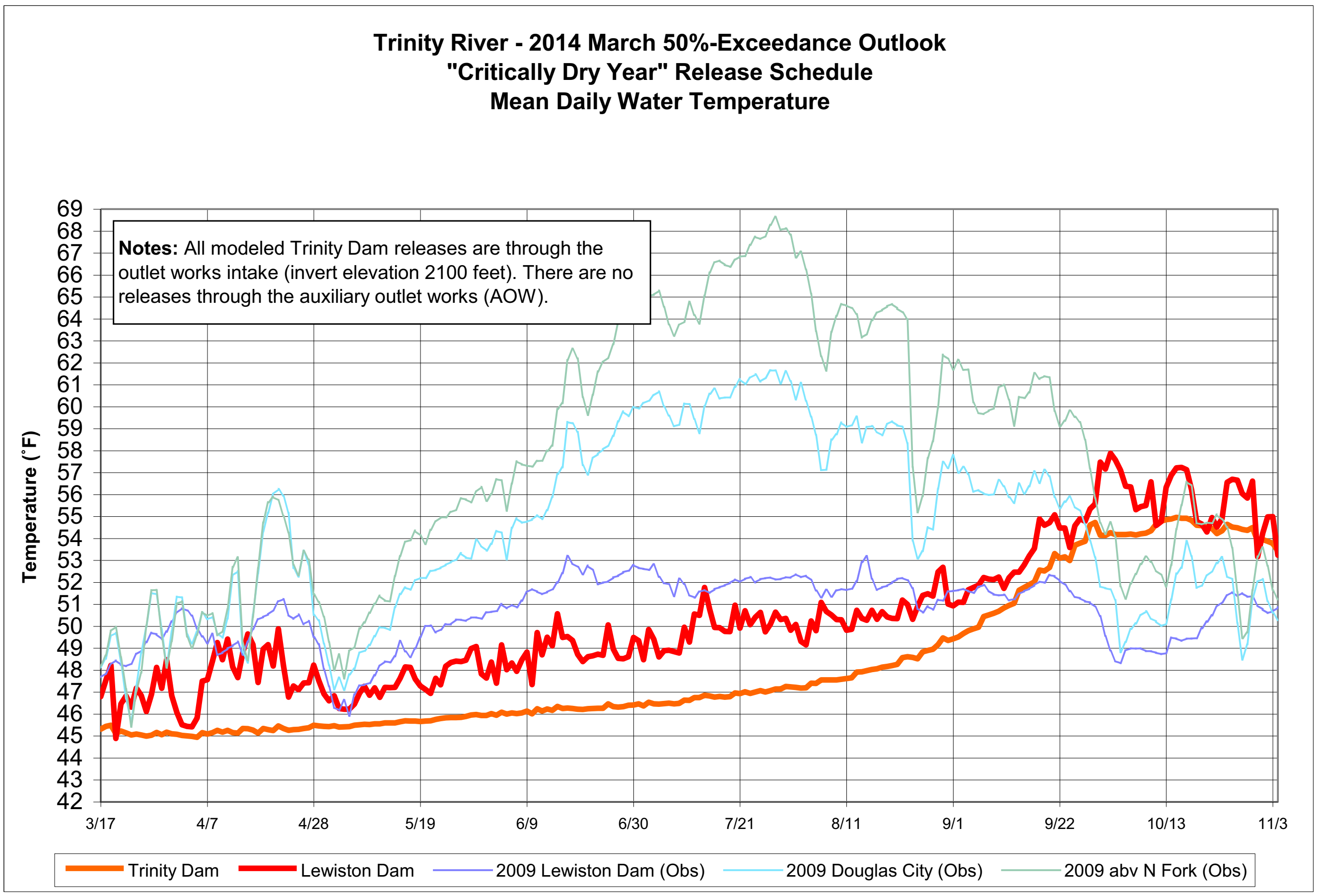
Sacramento River Modeled Temperature
2014 March 50%-Exceedance Outlook
Clear Creek Confluence Target Location
(June through September)
Temperature (˚F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
3/17
4/7
4/28
5/19
6/9
6/30
7/21
8/11
9/1
9/22
10/13
11/3
NOTES:
1. Estimated end of September lake volume below 56˚F is ~155 TAF.
2. The volume below 56˚F (with all TCD flows through the side gates by early September) indicates that a Clear Creek target may be difficult to maintain through fall.
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
JELLYS_FERRY
BEND_BR
SPRG_CR_TUNNEL

Figure 4



Clear Creek - Igo Modeled Temperature
2014 March 50%-Exceedance Outlook
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
3/17
4/7
4/28
5/19
6/9
6/30
7/21
8/11
9/1
9/22
10/13
11/3

Figure 5


Trinity River - 2014 March 50%-Exceedance Outlook
"Critically Dry Year" Release Schedule
Mean Daily Water Temperature
Notes: All modeled Trinity Dam releases are through the outlet works intake (invert elevation 2100 feet). There are no releases through the auxiliary outlet works (AOW).
Temperature (°F)
69
68
67
66
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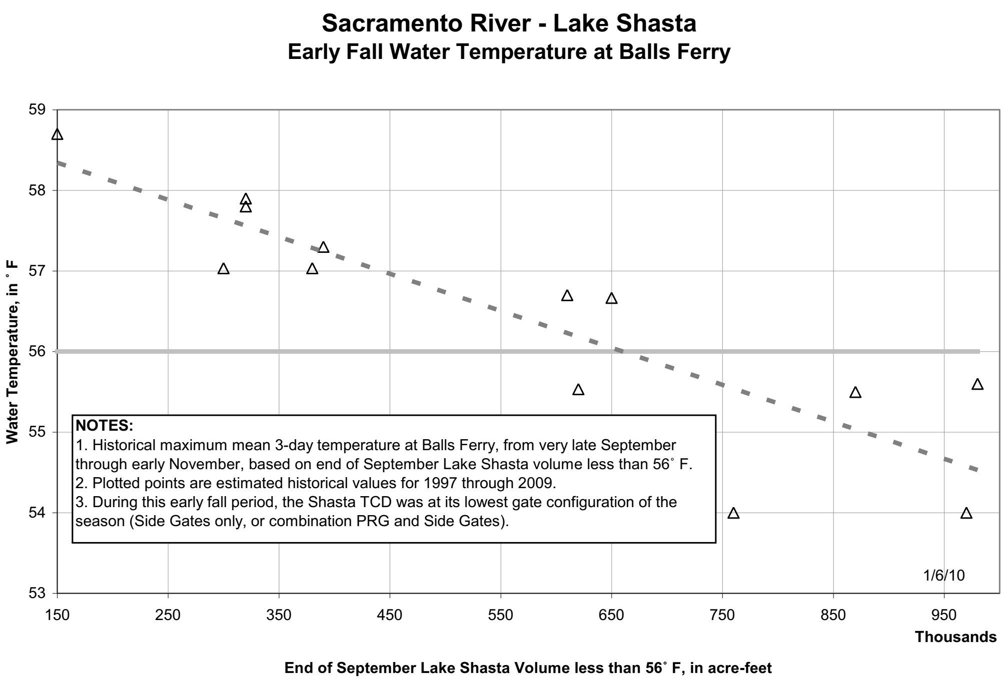
4/7
4/28
5/19
6/9
6/30
7/21
8/11
9/1
9/22
10/13
11/3
Trinity Dam
Lewiston Dam
2009 Lewiston Dam (Obs)
2009 Douglas City (Obs)
2009 abv N Fork (Obs)

Figure 6

Model Performance and Fall Temperature Index:

1. Based on past analyses, the temperature model does not perform well from late September through fall. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.
2. Based on historical records, the end-of-September Lake Shasta volume below 56˚F is a reasonable indicator of fall water temperature in the river reach to Balls Ferry.
3. For river temperatures not to exceed 56 ˚F downstream to Balls Ferry, the end-of-September lake volume less than 56˚F should be greater than about 650 TAF, see figure below:



ATTACHMENT D

WINTER-RUN CONTINGENCY PLAN

Winter-run Drought Contingency Plan for 2014

Background

The March forecast indicated that Shasta End-of-September storage would still be too low (662-thousand-acre-feet in the 90% forecast) to maintain winter-run egg incubation and fry production through August and September in the Sacramento River. Recent rains have increased Shasta Reservoir storage to 1.7 million-acre-feet, however, temperature modeling showed greater than 50% of the eggs may be lost due to high temperatures in the 90% forecast (driest). However, temperature modeling using the 50% forecast (wet, or average condition) showed that a temperature of 56-Fahrenheit as required by NOAA's National Marine Fisheries Service (NMFS) to support successful egg and fry incubation could be maintained all summer until mid-October down to South Bonneyview Road Bridge/Clear Creek gauge (ten miles below Keswick Dam).

The Livingston Stone National Fish Hatchery (LSNFH) winter–run production would also be subject to these projected high temperatures since it relies on its water supply through Shasta Dam. The LSNFH will also likely lose their water intake located on the powerhouse penstock if the forecast shows that the reservoir elevation will drop below the powerhouse intake on Shasta Dam.

Components

1) Enhanced Temperature, Flow, and Egg Survival Monitoring Program for assessing naturally spawned winter-run egg survival in the upper Sacramento River.
2) Increasing production at LSNFH: Infrastructure needs for normal operations, and additional needs for increasing production.
3) Collecting winter-run out of the Sacramento for additional LSNFH broodstock or relocation into Battle Creek (see #5).
4) Releasing unfed fry from LSNFH at alternative locations.
5) Relocating winter-run to suitable spawning and rearing habitat outside of the Sacramento River.

Key Actions

1) Enhanced Temperature, Flow, and Egg Survival Monitoring [implemented by US Bureau of Reclamation (BOR) and Department of Water Resources].

   a. Implement a permanent temperature monitoring station at Airport Road Bridge.
   b. Place temperature and water level sensors in redds and primary juvenile rearing habitat (in place by May 15).
   c. Monitor temperatures in the secondary channels, within spawning gravel areas, and tributaries (Cow, Cottonwood, and Clear creeks).
   d. Monitor 7-Day Average Daily Maximum.
   e. Incorporate weekly (or daily as needed) winter-run redd dewatering and juvenile stranding real-time monitoring data into water level management and temperature modeling (in

place by May 15). This may be part of the existing California Department of Fish & Wildlife (CDFW) monitoring, and will be reported to NMFS as part of this program.

i. NMFS will use this data to make operational recommendations to the Sacramento River Temperature Task Group.
    1. **TRIGGER**[1] for flow recommendation: Documentation of 5 or more dewatered winter-run redds.

ii. **TRIGGER** for implementing fish stranding relocation: One observation of an isolated area of stranded juveniles.

f. Calibrate long-term temperature forecast models to reduce uncertainty.
g. Evaluate the likelihood of critical depletions through coordination with water contractors more than 30 days in advance of forecasted operations.
h. Use an existing, more current model than HEC-5Q, such as CE-QUAL-W2, to increase forecast accuracy of long-term temperature forecasts.
i. Monitor redds at the downstream end of the spawning distribution (near the temperature compliance point) to determine whether healthy fry emerge. Redds located close to the temperature compliance point may be more susceptible to lethal temperatures. This may be incorporated as part of existing CDFW monitoring.

2) Increase production at LSNFH: US Fish & Wildlife Service has requested funds from the US Bureau of Reclamation for infrastructure needs for increasing production at LSNFH. Multi-agency agreement (winter-run PWT subgroup) to implement this action, and to increase spawned adults from 120 to 400.
    a. Date broodstock collection completed (June 1)
    b. Date spawning begins (May 1-15, depending on condition)
    c. Infrastructure improvements have been addressed (funding pending)
    d. NMFS Permits and approvals - completed

3) Collecting winter-run out of the Sacramento for additional LSNFH broodstock or relocation into Battle Creek (see #5). Decision deadline: May 1, 2014.

TRIGGER: Close communication with LSNFH, and temperature modeling for the Sacramento River (and #5), will determine the need for this action. Recommended methods:
    a. Rescued winter-run from Colusa Basin Drainage Canal (Section 10(a)(1)(A) Permit 18181). Will be genetically identified as winter-run prior to transporting
    b. Hook and line sampling

Permitting for a. and b. above, could be achieved by modification of existing Section 10(a)(1)(A) Permits (1415 [RBFWO] or 18181 [CDFW])

4) Rearing unfed fry at alternative locations. If LSNFH successfully spawns 400 adults, capacity for rearing fry is only 200 adults, therefore, half of the production (~200,000 to 400,000) will need to be released into Sacramento River as unfed fry, or raised at another facility.

[1] **TRIGGER** is defined as a biological condition that warrants an operational change or action implementation.

TRIGGER: Decision will need to be made by June 15 based on how many fish are spawned at LSNFH, this will be a joint decision by the Interagency Winter-run PWT sub Group.

a. Relocate to Battle Creek to rear (25% survival based on literature)
    i. Directly into creek as unfed fry
b. Relocate to alternative hatchery and rear until September-February (e.g., Mt. Shasta Trout Hatchery, or CNFH), (80-90% survival based on LSNFH data)

5) Relocating winter-run to suitable spawning and rearing habitat outside of the Sacramento River (Decision deadline: May 1 for adults, June 15 for juveniles).

TRIGGER: Only if forecast shows <50% survival or less in the Sacramento River, and temperatures in Battle Creek demonstrate improved survival.

a. Battle Creek – temperatures/egg survival (spawning capacity for 150 adults)
    i. Monitoring components are to be determined
    ii. NMFS section 10 Permit has not been modified/completed

ATTACHMENT E

BIOLOGICAL REVIEW – SALMONIDS AND STURGEON

Status of Species

Winter-run Chinook salmon

An estimate of 6,075 Winter-run Chinook salmon returned to the upper Sacramento River in 2013 [broodyear (BY)], which was larger than the spawning run that produced these fish in the Sacramento River during the summer of 2010. Redd surveys detected 1 of the 569 Winter-run Chinook salmon redds built in 2013 to be downstream of the 2013 temperature compliance point at Airport Bridge. Typically a pulse of fry outmigrates from the upper Sacramento River in early October and rear in the middle Sacramento River. In fact, a pulse of Winter-run Chinook fry appeared to have moved downstream of Red Bluff Diversion Dam (RBDD) during early October, although monitoring of this pattern is uncertain due to the federal government shutdown that kept biologists from monitoring this site (Figure 1 and 2). Of the estimated 4.3 million juvenile Winter-run Chinook expected to migrate past RBDD (based on the 2013 spawner escapement and JPE survival values), approximately 1.8 million fish were estimated to have migrated past RBDD by March 26, 2014 [United States Fish and Wildlife Service (USFWS), Red Bluff, biweekly data]. Based on these monitoring data, it is hypothesized that a significant proportion of the juvenile Winter-run Chinook salmon migrated out of the upper Sacramento River during the lapse in RBDD fish monitoring.

Typically, Keswick releases are high in the fall and a substantial proportion of Winter-run Chinook are transported downstream of RBDD. However, during WY2014 fall and winter Sacramento River flows downstream of RBDD have been low due to a seasonal lack of precipitation and minimal releases to conserve Shasta Reservoir storage since February 2014 (Figure 3). While a substantial portion of juvenile Winter-run Chinook salmon appear to have passed RBDD during fall, numerous larger-sized Winter-run Chinook were observed weekly in fish monitoring at RBDD during the winter months than compared to other years (Figure 2). Of 179 stranding sites along the Sacramento River from Tehama (Los Molinos) to Keswick Dam (about RM70), 21 completely isolated sites have been identified to have winter-run salmon trapped in them [Doug Killam, California Department of Fish and Wildlife (CDFW), pers. comm.]. Based on these monitoring data, it is hypothesized that a larger proportion of Winter-run Chinook salmon underwent a longer residency and rearing period in the upper Sacramento River between Keswick Dam and RBDD than during years with higher fall and winter Keswick releases and/or natural flows. On recent weekly DOSS calls, the topic of the position of Winter-run Chinook salmon has been discussed. There has been agreement that between 10-15% of BY13 Winter-run Chinook salmon remains upstream of Knights Landing. It is hypothesized that an extremely small proportion of these fish remain above RBDD.

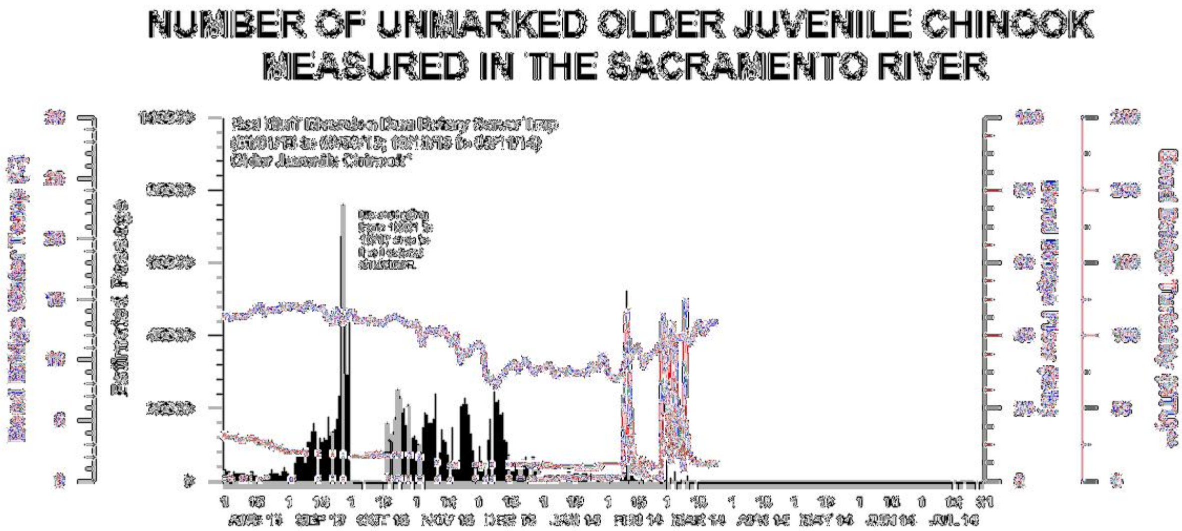


Figure 1. Red Bluff Diversion Dam Passage of Juvenile Older Chinook Salmon and Associated Environmental Data. [1]

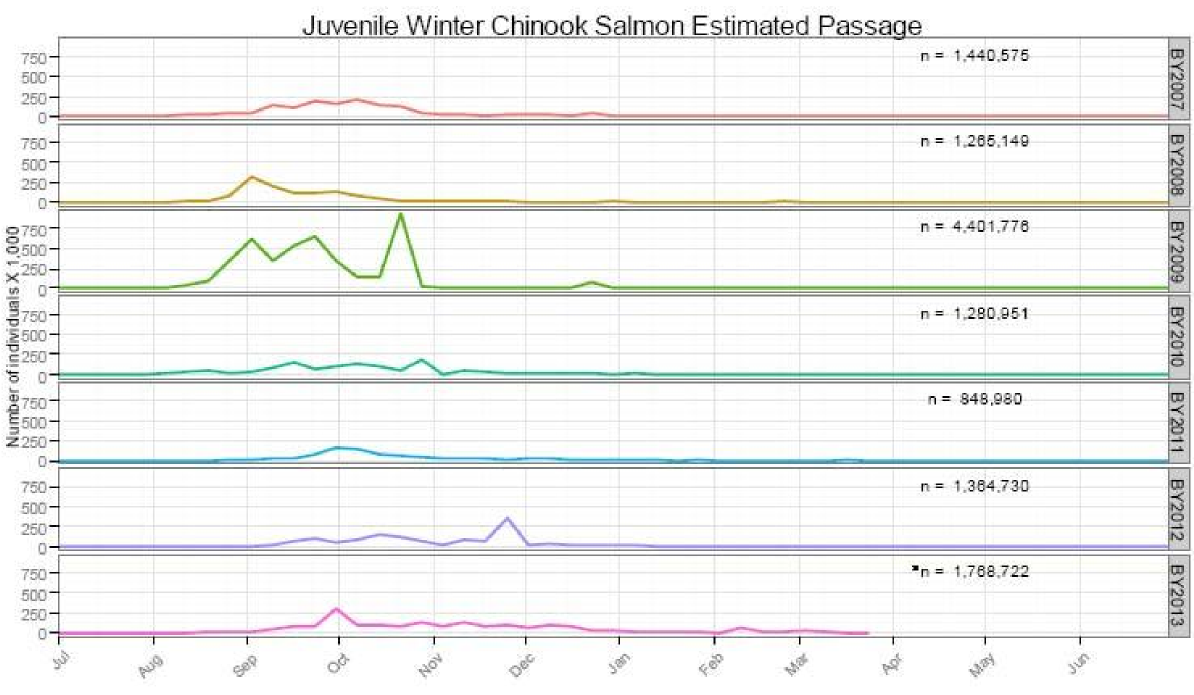


Figure 2. Weekly Estimated Passage of Juvenile Winter-run Chinook Salmon at Red Bluff Diversion Dam (RK 391) by Brood-Year (BY). [2]

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[1] Figure supplied by DWR on March 25, 2014.

[2] Fish were sampled using rotary-screw traps for the period July 1, 2007 to present. Winter-run passage value interpolated using a monthly mean for the period of October 1 through October 17, 2013, due to partial federal government shutdown. Figure supplied by USFWS on March 26, 2014.

Winter-run Chinook juveniles have been passing the location of the rotary screw trap monitoring station at the Glen-Colusa Irrigation District (GCID) intake canal in the middle section of the Sacramento River since October 2013 (Figure 4). It is hypothesized that the steady recovery trend of outmigrating Winter-run Chinook in GCID's screw traps during the majority of the winter was caused by a prolonged residency period of juvenile Winter-run Chinook, which passed RBDD earlier in the fall and winter as fry and parr, having abandoned outmigration to rear between RBDD and GCID. Typically, fry and parr that cannot sustain territories in river flows outmigrate past Knights Landing and into the Lower Sacramento River with late fall/early winter Sacramento Valley rainstorms increase flows to greater than 7,500 cfs at Wilkins Slough. Rosario et al (2013) described multiple pulses of distinctly different sized Winter-run Chinook salmon typically moving through the Lower Sacramento River at Knights Landing between November and January. Juvenile Winter-run Chinook were infrequently observed at the Tisdale Weir (Figure 5) and Knights Landing (Figure 6) fish monitoring station on the Middle and Lower Sacramento River, respectively, until this winter's February and March storms caused Sacramento River flows greater than 7,500 cfs at Wilkins Slough. It is hypothesized that in WY 2014, a significantly greater proportion of juvenile Winter-run Chinook salmon reared as parr and smolts in the Sacramento River between Hamilton City (close to the GCID intake) and Knights Landing waiting for physiological or environmental cues to emigrate into the Delta than reared in the upper Sacramento River or Delta.

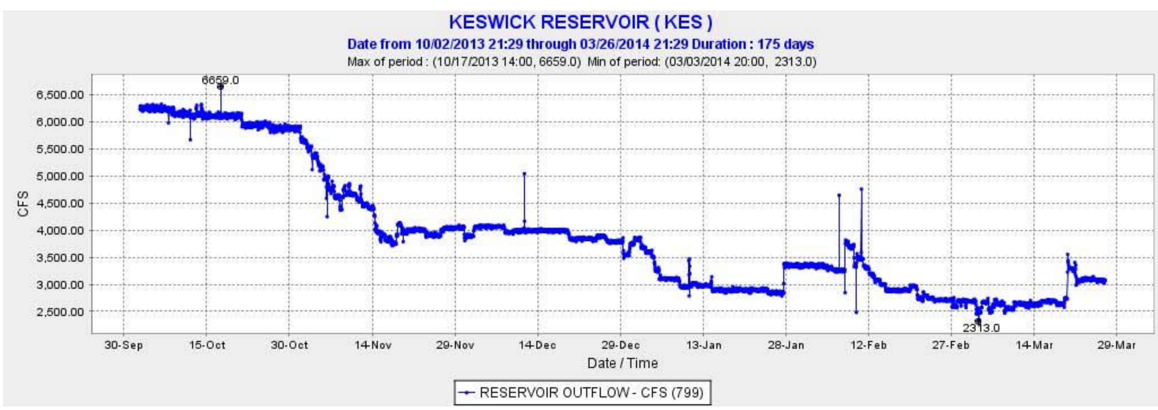

Figure 3. Keswick Reservoir Outflow for WY 2014.[3]

[3] Downloaded from CDEC on March 26, 2014.

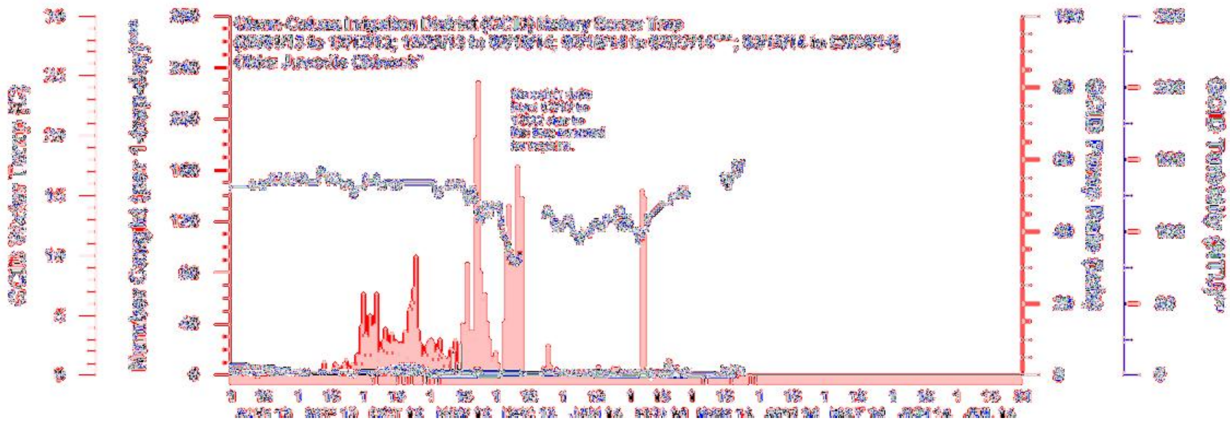

Figure 4. Glen-Colusa Irrigation District Rotary Screw Trap older juvenile Chinook salmon catch data and associated environmental data. No catch data from 2/28 to 3/14 since trap cone was raised due to high flow and debris.[4]

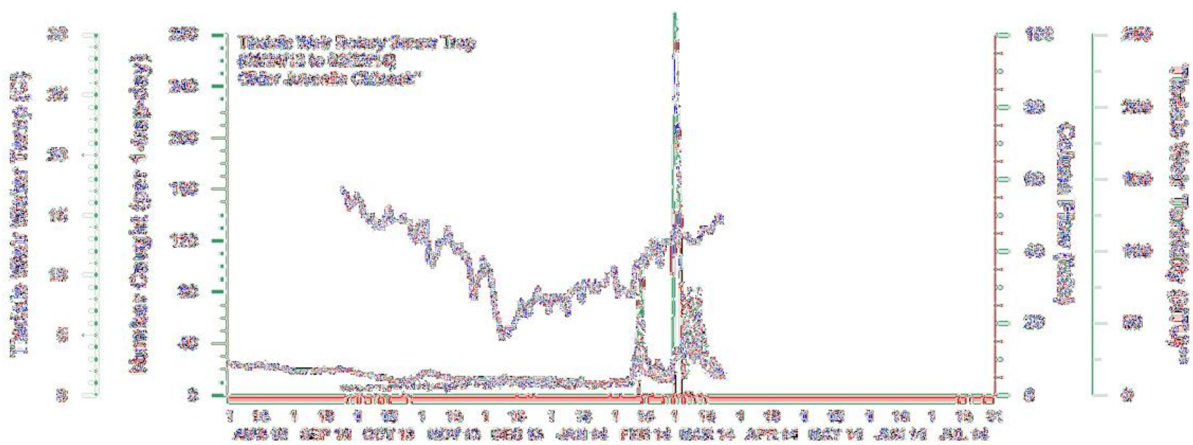

Figure 5. Tisdale Weir Rotary Screw Trap older juvenile Chinook salmon catch data and associated environmental data.[5]

[4] Figure supplied by DWR on March 26, 2014.

[5] Figure supplied by DWR on March 26, 2014.

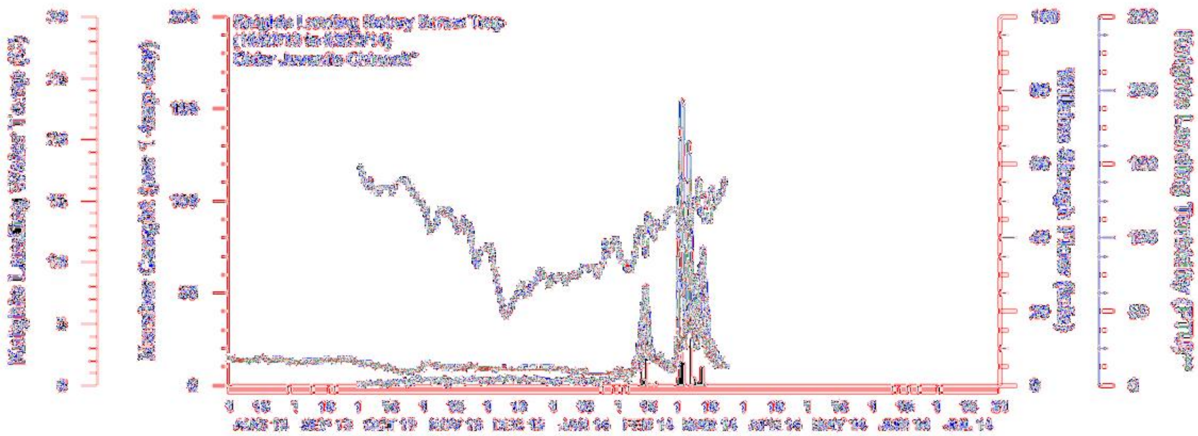

Figure 6. Knights Landing Rotary Screw Trap older juvenile Chinook salmon catch data and associated environmental data.[6]

Juvenile Winter-run Chinook salmon have been observed in lower Sacramento River and Delta beach seine and trawl fish monitoring surveys during storm periods in February and March when river outmigration flows stimulated migration into the Delta (Figure 7). Through March 20, 2014 expanded salvages of 106.5 natural origin juvenile Winter-run sized Chinook salmon have been estimated at the federal fish collection facility at the South Delta CVP export pumps and 50 natural origin juvenile Winter-run sized juvenile Chinook have been estimated at the state fish collection facility at the South Delta SWP export pumps through March 20. All of these fish were recovered since March 3rd. No hatchery Winter-run sized juvenile Chinook have been salvaged as of March 26, 2014. As of March 24, an estimated cumulative loss of 346 Winter-run Chinook salmon has occurred. The incidental take limit for WY 2014 is 23,928 natural Winter-run Chinook salmon. On the April 1 DOSS calls, multiple opinions suggest that 60-70% of the BY 2013 juvenile population of Winter-run Chinook remains in the Delta as of April 1. It was hypothesized that the remainder of the population rearing in the Sacramento River will enter the Delta in the next ten days during the current storm period (Figure 8).

On the weekly DOSS calls, the topic of the proportion of the population of Winter-run Chinook salmon that has exited the Delta has also been discussed. Based on data from Chipps Island (Figure 9), DOSS estimated that 20-25% of the BY13 juvenile Winter-run Chinook salmon have exited the Delta region.

[6] Figure supplied by DWR on March 26, 2014.

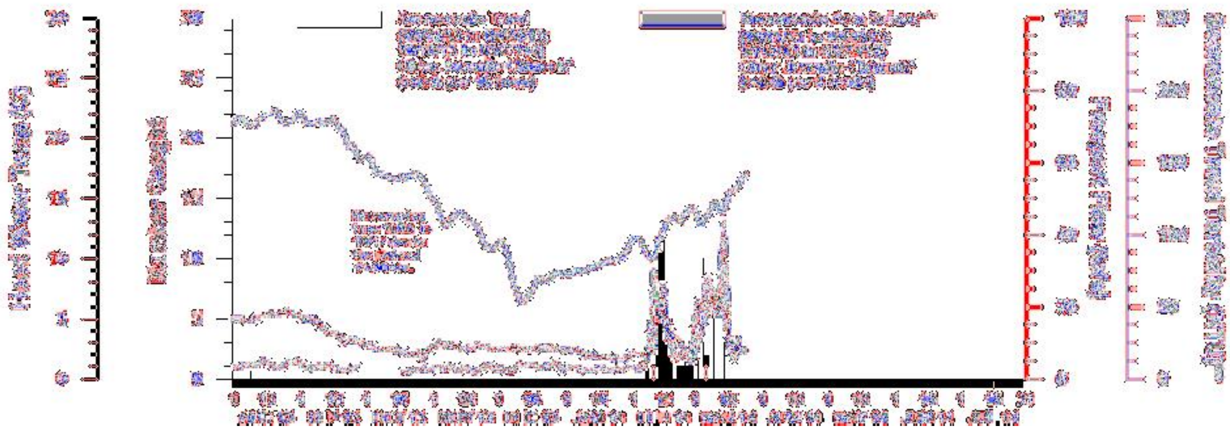

Figure 7. Sacramento Trawl and Sacramento Area Seines older juvenile Chinook salmon catch data and associated environmental data.[7]

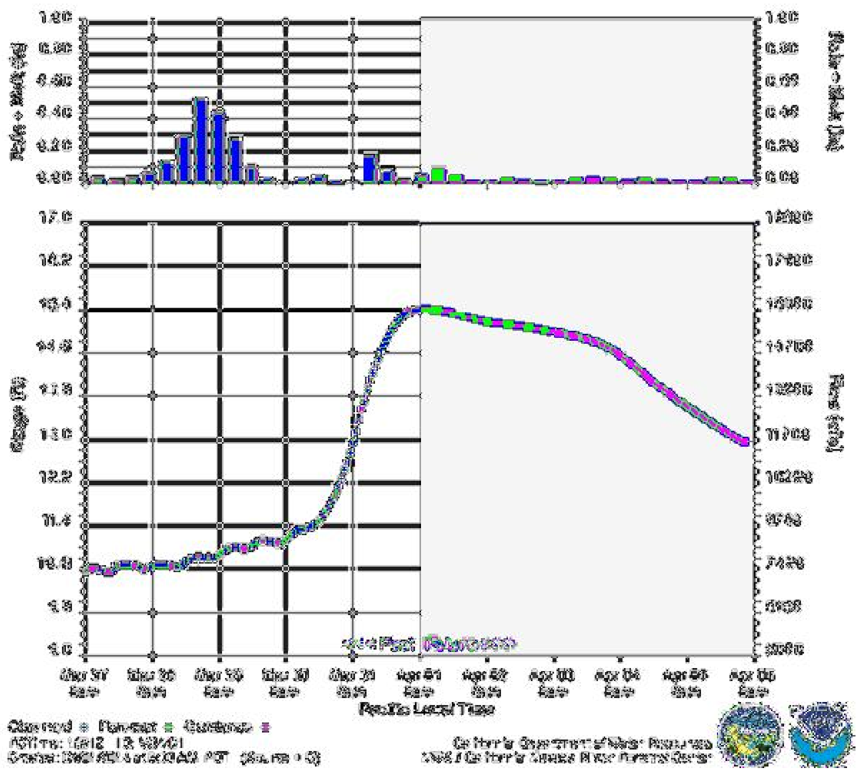

Figure 8. Observed and forecasted precipitation and Sacramento River flows for Verona on the Lower Sacramento River. [8]

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[7] Figure supplied by DWR on March 26, 2014.

[8] Figure downloaded on April 1, 2014.

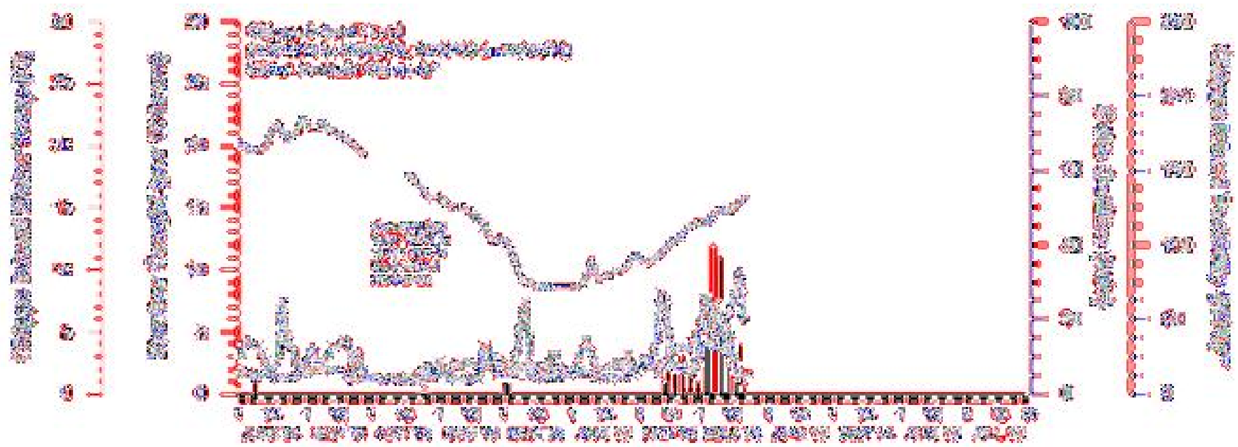

Figure 9. Chipps Island Trawl older juvenile Chinook salmon catch data and associated environmental data.[9]

Adult winter-run Chinook salmon are currently entering the Sacramento River and migrating to the upper reaches of the river in preparation for spawning during the summer of 2014 (Table 1). These adult Winter-run Chinook will hold in the upper Sacramento River between RBDD and Keswick Dam until they are ready to spawn during the summer. These fish require coldwater holding habitat for several months prior to spawning as their gonads mature, and then require cold water to ensure the proper development of their fertilized eggs, which are highly sensitive to thermal conditions during this embryo development period. As of March 26, 82 adult Winter run Chinook have been collected and retained at the Keswick Dam Fish Trap for Livington Stone National Fish Hatchery. These fish include 26 wild males, 7 adipose-clipped males, 48 wild females, 17 adipose-clipped females. Also, eight prespawn mortalities have been collected, sampled, but were not retained.

[9] Figure supplied by DWR on March 26, 2014.

Month	Fall-run	Late fall-run	Winter-run	Spring-run	Steelhead	Green sturgeon
January	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
February	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
March	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
April	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
June	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
August	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
September	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
October	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
November	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
December	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table 1. Percentage of adult Chinook salmon passing above Red Bluff Diversion Dam, percentage of adult Steelhead passing above Fremont Weir, and percentage of adult green sturgeon passing above the Middle Sacrament River.

Adults returning to the river in 2014 are predominantly members of the cohort from brood year 2011. Based on cohort replacement rate (CRR) estimates, the 2011 brood year was the third lowest CRR since 1992. It is likely that the escapement of Winter-run Chinook in 2014 will be approximately half the number of adults that spawned in 2013 or less, based on the smaller number of adults that returned in 2011 compared to 2010. Fewer returning adults will typically result in lower juvenile production for that year, thus the juvenile production for 2014 is expected to be lower than in 2013.

Spring-run Chinook salmon

In 2013, a small, but greater than average spawning run of Spring-run Chinook returned to the upper Sacramento River. This greater-than-average return of spawners was observed across many tributaries supporting Spring-run Chinook salmon. The adult escapement estimate for Central Valley Spring-run in 2013 was 20,057 fish returning to the Feather River Fish Hatchery and 18,499 fish returning to the tributaries. This is the largest return in the past 25 years. Spring-run Chinook will be entering Clear Creek in the spring and into summer and then holding until they spawn starting in September. Spawning in Clear Creek occurs upstream of a barrier weir installed at river mile 7 to separate Spring-run and fall-run spawning and protect Spring-run eggs from superimposition by fall-run spawners. Table 2 shows Spring-run spawning distribution in Clear Creek. Distribution has shifted upstream somewhat through the years after removal of McCormick-Seltzer diversion dam (approximately RM 6.2) in 2000 and with repeated gravel additions.

Table 6. Distribution of spring Chinook salmon redds (SCS) in Clear Creek, 2003–2011. River miles (RM) begin at the confluence at RM 0, and end at Whiskeytown Dam at RM 18.3. River miles 11–18 are upstream of IGO. Both RM 7 (0.6 miles) and RM 18 (0.3 miles) are incomplete miles. The SCS redd count is redds upstream of the picket weir location. From 2003 through 2005, and in 2011, the picket weir was located at RM 8.2 (Reading Bar), so RM 7 was not available for SCS spawning. From 2006 through 2009, the location of the picket weir was at RM 7.4 (Shooting Gallery). In 2010, weirs were installed at both sites.

Year	RM 7	RM 8	RM 9	RM 10	RM 11	RM 12	RM 13	RM 14	RM 15	RM 16	RM 17	RM 18	Total
2003	NA	4	5	9	2	3	0	15	3	4	5	3	**53**
2004	NA	9	1	9	2	0	2	4	3	3	4	0	**37**
2005	NA	4	2	11	4	0	1	4	10	3	11	2	**52**
2006	4	11	8	12	13	7	0	4	8	10	5	0	**82**
2007	0	6	1	5	0	2	1	1	7	15	11	0	**49**
2008	8	18	3	11	4	6	0	11	5	13	6	1	**86**
2009	3	8	2	15	4	1	4	6	4	4	13	0	**64**
2010	1 [a]	1	0	3	0	0	0	1	1	2	1	0	**10**
2011	NA	1	0	5	0	2	1	5	0	2	0	0	**16**

[a] The SCS redd count includes one redd from Reach 5b (between weirs). Other redds in Reach 5b were counted as fall Chinook and not included here.

Table 2. Clear Creek spring Chinook spawning distribution, copied from Giovannetti and Brown (2013).

Juvenile Spring-run begin emigration from Clear Creek soon after emergence, with passage near the mouth peaking in November through December and continuing to around May. Recent year passage indices are shown in Table 3. Unlike fall-run Chinook in Clear Creek, Spring-run have not appeared to show population increases relative to other central valley populations.

Broodyear	95% LCI	90% LCI	Passage Index	90% UCI	95% UCI
1999	272,930	275,736	292,323	310,697	314,778
2000	90,576	92,331	101,347	113,299	116,274
2001	68,446	70,733	86,836	107,359	112,386
2002	156,297	158,835	172,708	189,998	192,685
2003	29,432	30,130	33,902	38,705	39,638
2004	9,570	9,915	11,906	14,701	15,644
2005	17,808	18,163	20,401	22,733	23,384
2006	70,716	72,560	86,918	105,130	113,960
2007	149,395	155,897	202,011	279,553	319,016
2008	39,129	39,999	45,903	53,145	54,452
2009	61,181	61,979	68,624	76,913	79,425
2010	19,929	20,231	22,853	26,166	27,111

Table 3. Spring-run Chinook passage indices at a rotary screw trap at river mile 1.7 on Clear Creek, in Shasta County, CA from Early et al (2013).

Rain events during mid-November 2013 increased daily average flows in upper Sacramento River tributaries conducive to triggering outmigration of yearling Spring-run Chinook into the mainstem, although the rapid return to stable tributary flows and low temperatures may have limited the extent to which yearling Spring-run Chinook exited these watersheds. There were short periods of the winter, when Mill and Deer creeks were not connected to the Sacramento River due to lack of tributary flows. A substantial outmigration of young-of-year Spring-run Chinook salmon juveniles passed RBDD with an increase in Sacramento River flows during the February 2014 storm and thousands continue to be observed daily in fish monitoring at RBDD (Figure 10). These smaller sized Spring-run Chinook may have been subjected to stranding risks during reservoir release reductions earlier this winter similar to juvenile Winter-run Chinook salmon.

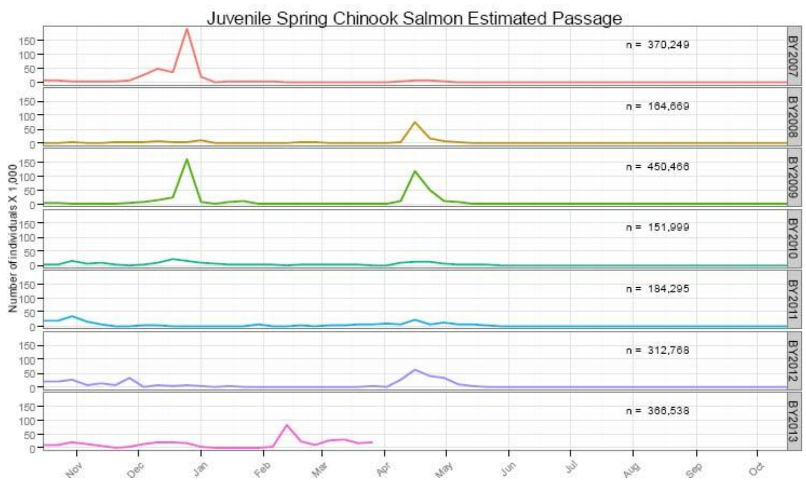

Figure 10. Weekly Estimated Passage of Juvenile Spring-run Chinook Salmon at Red Bluff Diversion Dam (RK 391) by Brood-Year (BY).[10]

Recovery of juvenile Spring-run Chinook salmon migrating past Tisdale and Knights Landing rotary screw trap monitoring stations in the middle and lower Sacramento River has been increasing. Between October 1, 2013 and January 30, 2014, 95 juvenile, but no smolting, Spring-run Chinook salmon were observed at GCID's rotary screw trap. In February, 310 young-of-year Spring-run Chinook salmon were recovered in GCID's rotary screw trap. In March, reduced monitoring effort occurred ten days, and 180 juvenile Spring-run Chinook were recovered in the GCID rotary screw trap. At the Tisdale Weir and Knights Landing fish monitoring stations, greater catches of older juvenile Chinook salmon, which would include

[10] Fish were sampled using rotary-screw traps for the period July 1, 2007 to present. Figure supplied by USFWS (March 26, 2014).

yearling Spring-run Chinook salmon, were observed during the February and March storms than had been observed prior to the storms (Figures 5-6). Similar to February, Spring-run Chinook salmon from Butte Creek, and the Feather and Yuba rivers are outmigrating into the Delta during March. Since February, Spring-run Chinook salmon have been observed in the lower Sacramento and Delta beach seine and trawl fish monitoring surveys in addition to being observed exiting at Chipps Island (Table 4).

	[illegible]				[illegible]			
[illegible]	Fall	Late fall	Spring	Winter	Steelhead	Steelhead	Chinook	Region Total
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Table 4. Lower Sacramento River and Delta beach seine recoveries of salmonids during WY 2014.[11]

The first Spring-run Chinook salmon salvage occurred at the state and federal fish collection facilities at the South Delta CVP/SWP export pumps on March 13, 2014. As of March 24, there has been a combined expanded salvage of 55 and combined loss of 67 young-of-the-year Spring-run Chinook, respectively. As of March 23, no Spring-run surrogate, adipose-clipped Late fall Chinook salmon have been recovered at the fish collection facilities. Of 25 salvaged Winter-run sized, which were genetically tested, close to 50% (12 samples) were genetically identified as yearling Spring-run Chinook from the Upper Sacramento River. It is hypothesized that the dry spring of WY2013 and resultant lack of spring natural flow variability increased the proportion of Upper Sacramento River Spring-run Chinook that oversummered and reared in the coldwater refugia below Keswick Dam compared to normal conditions. It is hypothesized that this is the mechanism behind the substantial misclassification of juvenile Spring-run Chinook as Winter-run Chinook at the state and federal fish collection facilities during the earliest portion (March 3-20, 2014) of the WY2014 salvage season. On the weekly DOSS calls, the topic of the proportion of the population of Spring-run Chinook salmon that have entered the Delta has been discussed. DOSS

[11] Trawl and beach seine data updated through March 10, 2014. Provided by USFWS Delta Juvenile Fish Monitoring Program.

participants agreed that most yearling Spring-run Chinook salmon have entered and exited the Delta. Regarding young-of-year Spring-run Chinook salmon, on the April 1 DOSS call, participants estimated between 30% and 60% are in the Delta with 5-10% having exited the Delta past Chipps Island.

Adult Spring-run Chinook will migrate into the upper Sacramento River from May to July 2014. These adults oversummer in the upper Sacramento River before spawning and require coldwater holding habitat for the maturation of their gonads before spawning in September and October. Lack of cold water habitat will decrease the viability of their gametes as they mature and exposes adult fish to increased mortality through other avenues, such as disease and thermal stress. Additionally, the brood year 2014 eggs will require continued cold water thermal conditions as they develop in the gravel during the September through November 2014 incubation period.

Steelhead

American River

Steelhead spawning in the American River occurs from late December to about late March or early April. Reclamation conducts bi-weekly steelhead spawning surveys throughout the spawning period. Seining surveys conducted by CDFW throughout the summer and fall have shown that summer rearing distribution for steelhead essentially mirrors the spawning distribution. Mark and recapture of rearing steelhead has shown strong natal site fidelity. Although few recaptures of marked fish occur, the recaptures that do occur all happen within close proximity to the marking site (i.e. at the same riffle or the next riffle upstream or downstream). No thermal refugia have ever been found in the lower American River. The coolest water is essentially in the faster flowing sections of the river and the steelhead rear and feed primarily in the faster water areas (riffles predominantly) of the river through the summer. The American River in-river steelhead population consists primarily of hatchery-produced fish that spawn in the river, and the steelhead return is dominated by fish that return to the hatchery or are harvested prior to spawning in the river (Figure 11).

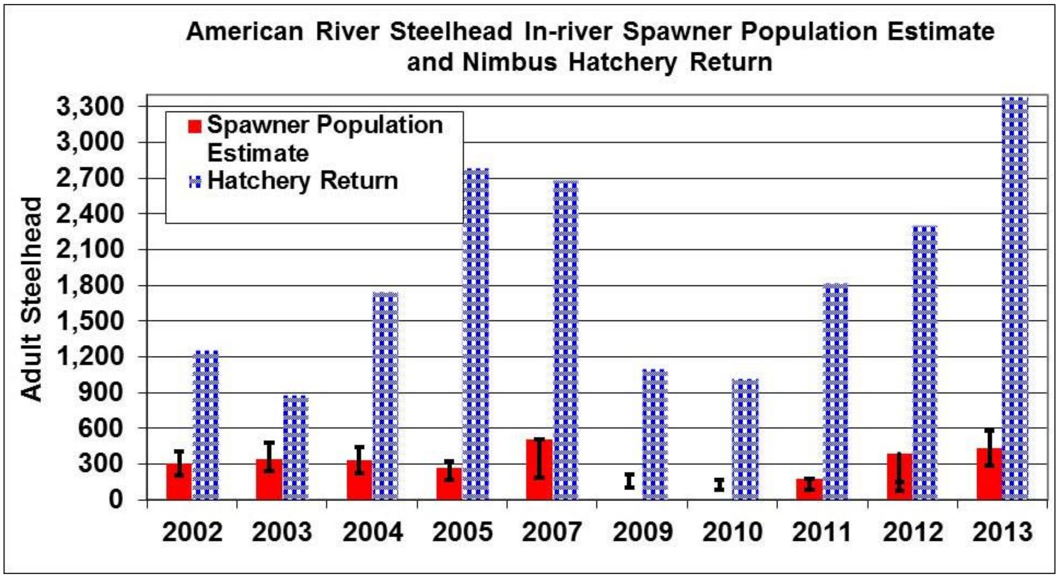

Figure 11. American River steelhead spawner population estimates compared to Nimbus hatchery steelhead return (from Hannon 2013). The red bars are area under the curve population estimates (based on observations of adults holding on redds) and the error bars are the redd count based estimates. No 'area under the curve' based estimates are available for 2009 and 2010.

Steelhead spawning survey surveys have identified 110 steelhead redds in the American River in 2014 from January through March 21. Nimbus release flows were dropped from 1,300 cfs at the end of December 2013 down to 500 cfs by January 10. The flow drop was conducted at a time to minimize effects on steelhead by dropping prior to most spawning. No steelhead redd dewatering was documented as a result of this flow drop. The change in stage at the Fair Oaks USGS gauge for this flow drop was about 10 inches. The majority of spawning is now complete based on the timing of spawning from past surveys (Hannon 2013). Figure 13 shows a comparison of spawning timing and distribution between the years surveys occurred. The 2014 redd count has been slightly below the median redd count.

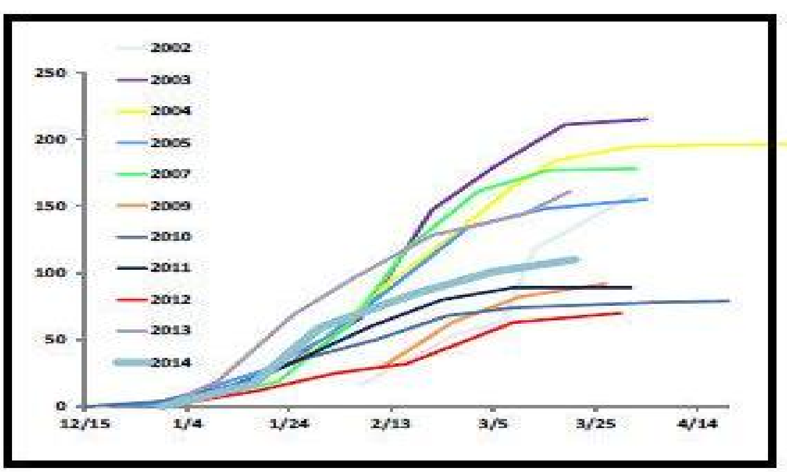

Figure 13. American River steelhead redd timing and abundance, 2002 - 2014.

Stanislaus River

A weir on the Stanislaus near Riverbank identifies trout passage using a VAKI camera. A total of 25 *O. mykiss* > 16" and 14 *O. mykiss* <16" were counted at the weir between October 15, 2013 and March 23, 2014 with 26% of the total identified as being adipose clipped indicating hatchery origin. Assuming a 50/50 sex distribution for the assumed steelhead (those *O. mykiss* > 16") approximately 60,000 eggs could be produced at 5,000 eggs/female. A 25% egg to fry survival would produce 15,000 emergent fry. A much larger number of fry would be produced from the resident trout in the Stanislaus River.

Bergman et al. (2014) estimated a population of *O. mykiss* in an approximately 300 meter reach of the river immediately below Goodwin Dam to be 3,427 (SE =1,522) (95% CI = 1,492-7,873) using mark and recapture of trout identified using spot pattern recognition. This reach probably represents the highest density of trout in the river (based on snorkel survey observations) but indicates a much greater resident than anadromous component to the population. The stable cool water conditions in this area should allow at least the resident component of the population to persist through most drought conditions.

Steelhead in the Stanislaus River likely spawn at a timing similar to other CVP rivers. Formal spawning surveys have not been conducted, but a trial survey was conducted by Reclamation and CDFW on February 5, 2014 between Knights Ferry and Horseshoe Bar and near Goodwin Dam. Ten redds were found in the Knights Ferry reach (Figure 14) and two were found in Goodwin Canyon at the cable crossing area. The redds are likely a mixture of resident and potentially anadromous *O.mykiss*. One of the redds was occupied by spawners with estimated lengths of 25 cm (10 inches) and 35 cm (14 inches). The California regulatory cutoff between steelhead and rainbow trout is 40 cm (16 inches) for anglers. The absence of abundant spawning near Goodwin Dam during this survey probably indicates mostly resident (later spawning) fish in that area.

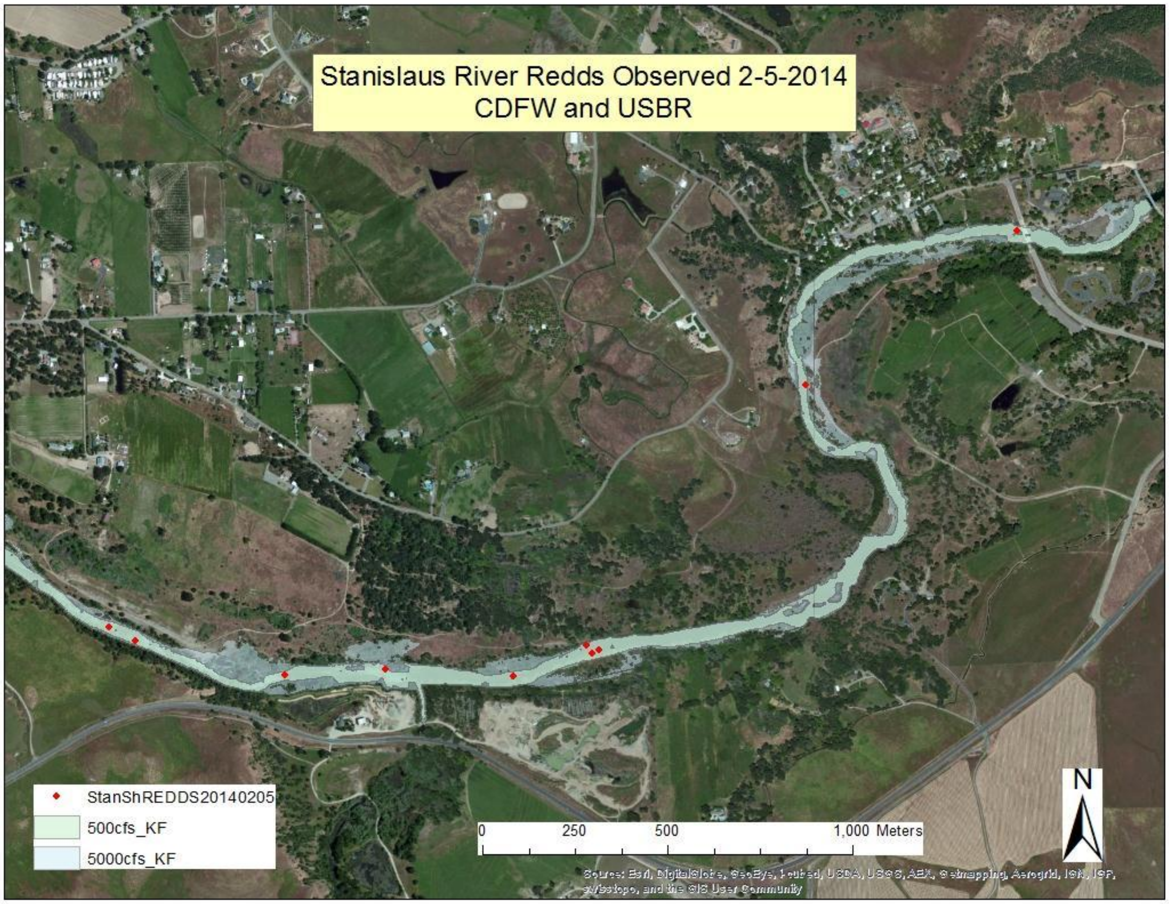

Figure 14. Fresh redd locations identified in a redd survey conducted February 5, 2014 by CDFW and Reclamation between Knights Ferry and Horsheshoe Bar.

Snorkel surveys conducted in 2003 – 2005 identified the first steelhead fry observations around mid-March to early April each year. Fry were observed between Goodwin Dam and Orange Blossom with observations in one year down to Valley Oak. None were observed below Valley Oak. This indicates that spawning was limited to the area mostly upstream of Orange Blossom Bridge. Higher rearing densities were always found from Goodwin Dam down to the Lover's Leap area. This probably coincides with the area of most spawning for both resident trout and steelhead. A majority of outmigrating steelhead smolts leave the Stanislaus River during the late winter and early spring. Based on recoveries of steelhead in the Caswell and Oakdale rotary screw traps, approximately 70% of steelhead smolts have exited the Stanislaus River by the end of March (Figure 15).

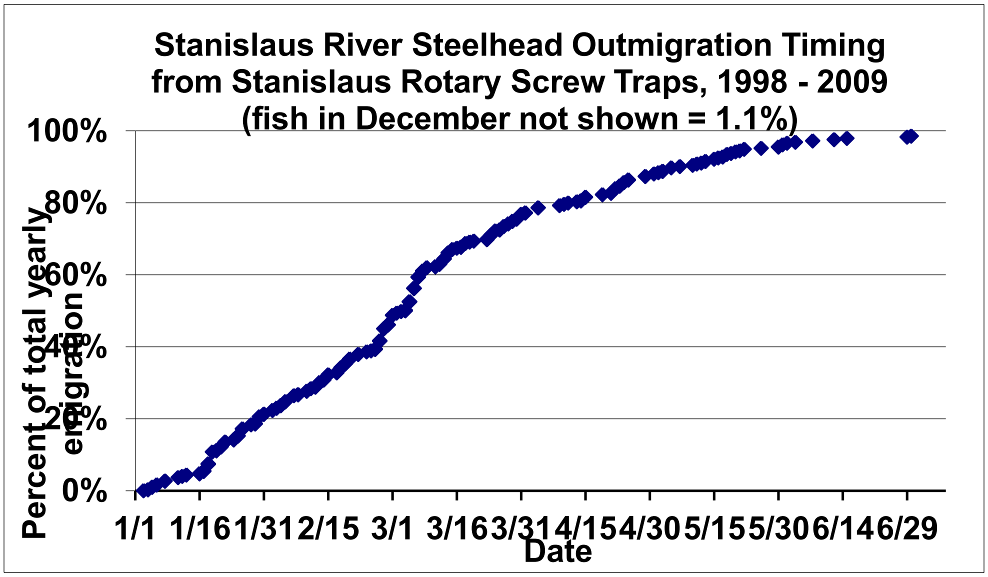

Figure 15. Stanislaus River *O. mykiss* timing from Caswell Park and Oakdale screw traps, 1998-2009 (includes only fish rated as smolt index 5). Fish leaving in December constitute 1.1% of migrants and are not shown.

Clear Creek

Steelhead spawning has completed for the 2014 season in Clear Creek as of March 26, 2014. The steelhead redd index count for 2014 was 432 which is the highest ever observed in Clear Creek. Figure 16 shows redd index results for prior years up through 2011. The redd index values include some mix of resident and anadromous *O.mykiss*.

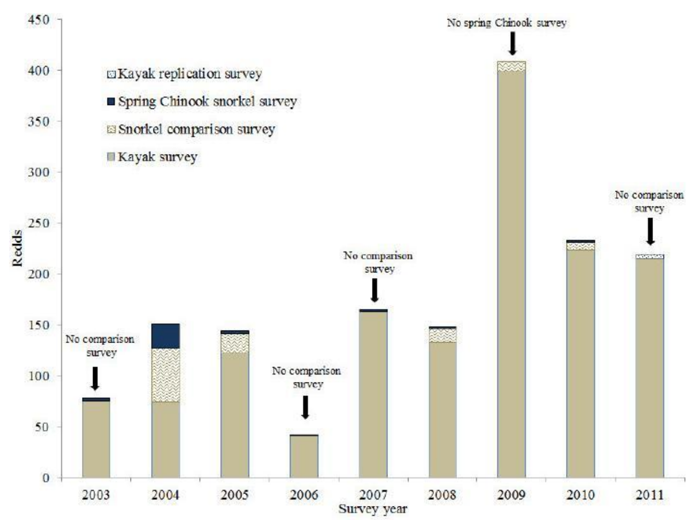

Figure 4. Clear Creek steelhead redd index, 2003–2011. Redd index includes redds counted during (1) kayak surveys (approximately two surveys per month from December through April), (2) snorkel comparison surveys or kayak replication surveys (single survey in January or February in select reaches and years), and (3) spring Chinook salmon snorkel surveys (monthly surveys generally April–June).

Figure 16. Clear Creek steelhead redd index 2003 – 2011, copied from Giovannetti et al, 2012.

Delta

Information on steelhead in the Delta is extremely limited. Observed 2013 patterns of outmigrating *O. mykiss* parr (young of year) during the summer at RBDD were similar to previously observed patterns, although a greater abundance appears to have passed than in the past previous five years (Figure 17). Steelhead smolts are seldom observed in Sacramento River and Delta fish monitoring due to sampling biases related to their larger fish size and their enhanced swimming ability. False negatives are more likely with steelhead smolts than smaller older juvenile Chinook salmon, but historic data can be assessed to consider their typical periodicity in Delta monitoring efforts. Since October 2013, GCID fish monitoring has detected 10 wild steelhead, eight of which were in October. The temporal occurrence of Sacramento steelhead around the Delta is informed by recovery of natural steelhead in various monitoring surveys (Table 5). Numerous steelhead smolts were recovered in American River fish monitoring and will not be observed anywhere before entering the Delta due to the American River confluence being downstream of the mainstem rotary screw traps.

Month	Knights Landing	DJFMP Beach Seines	Chipps Island
January	5	25	5
Febraury	32	20	10
March	60	30	15
April	0	5	30
May	0	10	35
June	0	0	5
July	0	>5	0
August	0	0	0
September	1	0	0
October	0	0	0
November	1	0	0
December	1	<5	0

Table 5. Percentage of Juvenile Sacramento River steelhead entering the Delta, as recovered at various monitoring locations, by month.

As of March 22, 2014, 16 wild steelhead (7 in Sacramento trawl, 9 in Chipps trawl) and 319 adipose-clipped steelhead (262 in Sacramento trawl, 57 in Chipps trawl) have been recovered. As of March 22, an expanded salvage of 137 natural origin and 242 clipped steelhead have been estimated at the state and federal fish collection facilities at the South Delta CVP/SWP export pumps. As of March 22, 1 outmigrating steelhead has been observed in the Mossdale trawl this water year. A majority of steelhead smolts recovered at Mossdale pass this location during April and May (Figure 18).

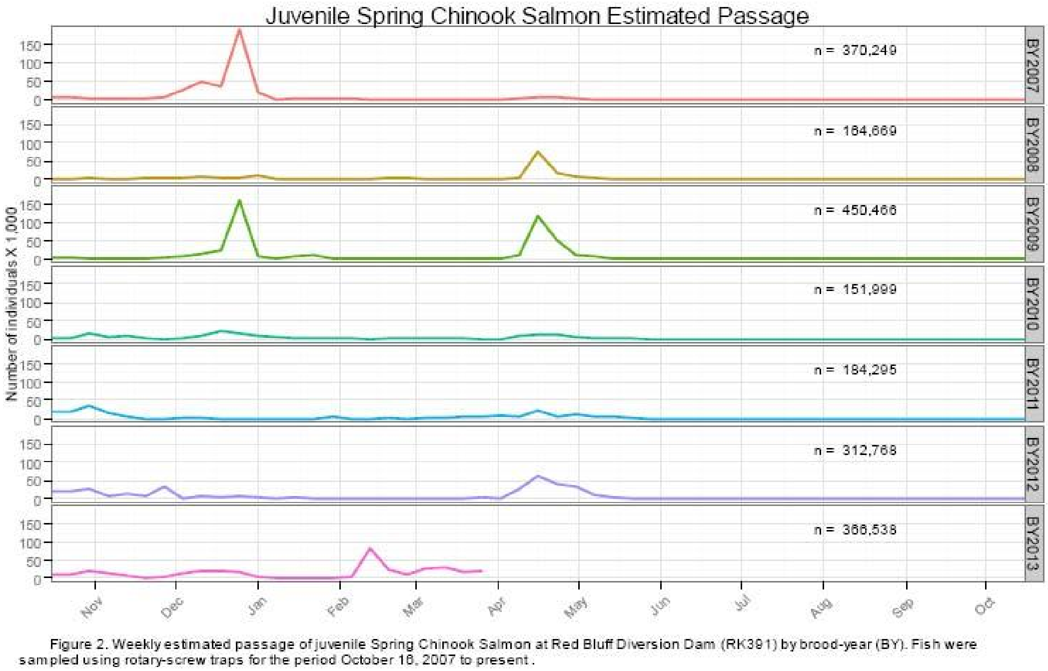

Figure 17. Weekly Estimated Passage of *O. mykiss* at Red Bluff Diversion Dam (RK 391) by Brood-Year (BY).[12]

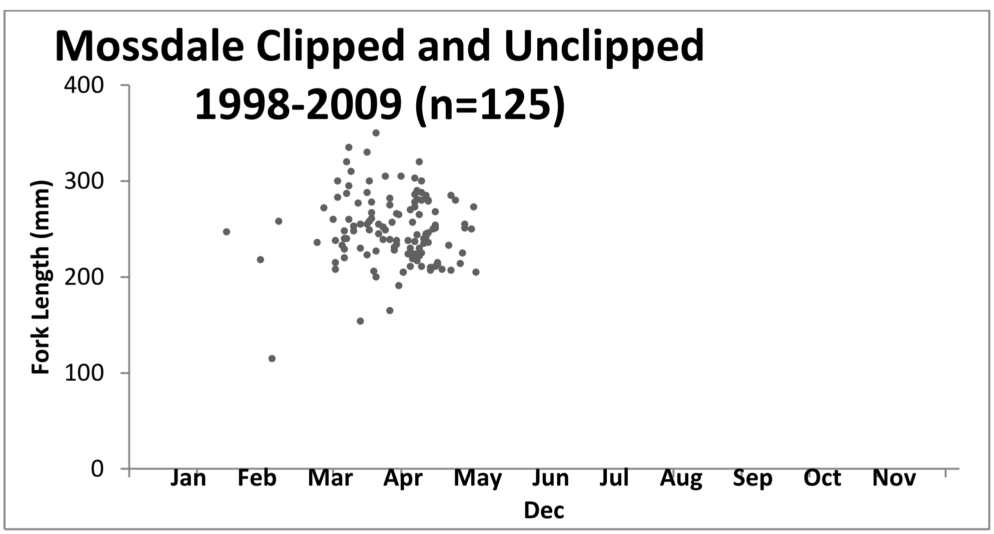

Figure 18. Fork length by date of clipped and unclipped juvenile steelhead captured in the USFWS and CDFG Mossdale trawl fish monitoring study.

[12] Fish were sampled using rotary-screw traps for the period July 1, 2007 to present. Figure supplied by USFWS (March 26, 2014).

Green sturgeon

Information on green sturgeon is extremely limited and their recovery in current fish monitoring efforts is limited due to their low vulnerability to monitoring techniques. In 2013, more juveniles were observed at RBDD (n=443) than the long-term average of 426 fishes (Figure 19). At the GCID rotary screw trap, two green sturgeon were observed during June 2013. Green sturgeon observations are extremely rare in the Delta and none have been observed in lower Sacramento and Delta fish monitoring surveys or at the state and federal fish collection facilities at the South Delta CVP/SWP export pumps in recent years. In 2011, over a thousand juvenile green sturgeons were enumerated at RBDD and none were observed in river, Delta, or Bay fish monitoring. While this absence in the monitoring may suggest no impact due to Delta Cross Channel operations or outflow operations, it may also suggest the recruitment of juveniles may be limited before the species reaches one year old due to habitat, predation, or multiple stressors; which is a phenomenon that has been observed in other North American sturgeon species. More monitoring needs to be conducted in order to reduce this uncertainty.

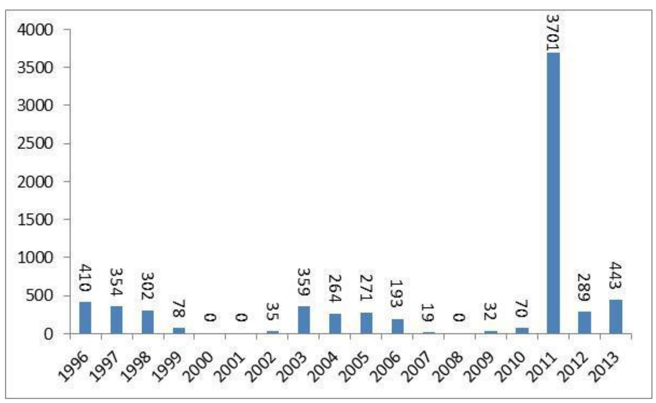

Figure 19. Juvenile green sturgeon counted at Red Bluff Diversion Dam rotary screw traps.[13]

On February 9, 2014, one juvenile green sturgeon (212mm TL) was recovered in RBDD fish monitoring. As of March 22, no green sturgeon were observed in lower Sacramento and Delta fish monitoring surveys or at the state and federal fish collection facilities at the South Delta CVP/SWP export pumps. Based on Israel and Klimley (2009), BY 2013 juvenile green

[13] The dataset annual average is 426 fish. In 2011, an egg was observed directly above the rotary screw traps, thus the large number of fish in 2011 is a unique annual sampling of a spawning event (Josh Gruber, USFWS, pers comm.) If these data are removed, the annual average of fish counted in 183 fishes.

sturgeon have likely migrated downstream from their natal spawning areas and are overwintering in the Lower Sacramento River and Delta.

Adult green sturgeon will emigrate through the Delta and into the upper Sacramento River through the Delta from March to June to spawn. Spawning in the upper Sacramento River was documented during 2013. Already in 2014, four acoustically tagged green sturgeon have been recorded in the Sacramento River between Deer Creek and RBDD.

Southern Oregon and Northern California Coast Coho (SONCC) Salmon

Artificial propagation (62 FR 24588, May 6, 1997), predation by marine mammals (60 FR 38011, July 25, 1995) and disease are the most prevalent factors affecting SONCC coho salmon. Factors affecting Critical Habitat of SONCC coho salmon and related to the proposed action are the water temperatures and flows released into the Trinity River at Lewiston Dam. Three population units of SONCC coho salmon are in the Trinity River including the Upper Trinity, Lower Trinity, and South Fork Trinity River population units. The Upper Trinity River population unit is currently at a moderate risk of extinction, while the Lower Trinity River and South Fork Trinity River population units are at a high risk of extinction (NMFS 2012).

Adult coho salmon pass upstream past the Willow Creek weir predominantly in late September through November. During fall of 2012, 15,288 coho passed upstream at the Willow Creek weir (location where marking occurs for population estimation) with 88% of them having right maxillary clips indicating they were of hatchery origin. This passage is more than in the 2009 parent brood of 4,633 adults. At Trinity Hatchery 7,356 coho returned in 2012 and 97% of them had right maxillary clips indicating hatchery origin. The return to the hatchery was greater than the 2009 return of 2,477 coho (CDFW, unpublished data). Trinity River coho salmon spawn in November and December and fry emerge three to four months after spawning.

Juvenile rearing occurs mostly upstream of Canyon Creek, with the highest densities upstream of Douglas City, close to the dam. The upstream concentration of spawning and rearing is likely due to the preponderance of hatchery produced spawners making up the returning adult population. Based on repeated sampling and snorkel surveys, juvenile densities decrease from summer through fall and by winter densities are low. High survival of juveniles has been found in pools isolated from access to the main river during summer through winter. It is hypothesized that factors in the main channel, such as predation, may be reducing juvenile survival in comparison with these isolated pools where the coho are not exposed to the same predation as in the main channel. Juvenile coho rear in the river for about a year and emigrate during winter and spring as yearlings at around 100 mm. Chase et.al. (2013) found apparent survival of emigrating yearlings to be much lower in the first 10 km downstream of the dam than in other areas between Lewiston Dam and the Klamath River estuary. Apparent survival was generally lowest in areas upstream from the North Fork of the Trinity River. The Trinity River Restoration Program has been implementing yearly habitat restoration projects to increase habitat capacity and survival of coho salmon.

Proposed Action

See Drought Operation Plan (Reclamation 2014).

Analytical Framework

Methods and Metrics

To evaluate impacts to listed species due to Delta hydrodynamics caused by the proposed action's changes in outflow and exports, DSM2 output from between 1991 and 2011 for Freeport, Vernalis, and Old and Middle flows were examined for those that fell into relevant ranges for comparison. There were no Freeport flows for less than 4,000cfs, restricting our analysis from this portion of the proposed action range potentially lower than this during the action's period. It is likely the patterns observed in the results will extend further upstream and could be amplified in some locations as outflow is reduced. Since the full range of the proposed action's NDOI includes values less than 4,000 cfs, assessments of these effects have greater uncertainty regarding their conclusion. The range of flows at Vernalis evaluated when Vernalis flows are greater than 1000cfs averaged 2616 cfs with 75% of the values between 1000 and 2824 cfs. In the South Delta, the evaluation of hydrodynamics was limited to DSM2 outputs from periods when a physical barrier was present at Head of Old River. Because the physical Head of Old River barrier (HORB) is not expected to be completed until April 10, 2014, there is greater uncertainty regarding conclusions about the effect of the proposed actions modification to RPA IV.2.2 regarding San Joaquin River steelhead. Hydrodynamics metrics such as daily proportion positive velocity and daily mean velocity were used to assess changes in the Delta caused by Sacramento and San Joaquin outflow reduction independently. Also, distributions of these metrics under different outflow and export ranges are examined to qualitatively describe comparisons between different operational conditions likely to occur under the proposed action.

To evaluate impacts to listed species dues to tributary outflow changes, DCC gate configuration, and Delta hydrodynamics caused by the proposed drought operational plan relevant peer-reviewed literature on these factors and fish biology, behavior, and survival are reported. Results from these sources were used to describe modified operation of the DCC gates on reach-specific and through Delta survival. The NMFS BiOp (2009) was reviewed regarding biological rationale for various RPA actions. Review of the development of relevant biological and physical triggers regarding historic DCC gate operations was compared to the current status of the species.

We discuss effects within the tributaries using currently available species distribution and abundance data along with expected upcoming lifestage periodicity information and made comparisons to projected flows and temperature conditions available from monthly forecasts and historical temperature conditions. Where available, spawning timing and distribution was used to estimate fry emergence timing based on past and estimated near future incubation temperatures. The spawning distributions were used to approximate likely juvenile rearing distribution over the summer for steelhead.

Effects Analysis

Sacramento River Actions

CDFW and USFWS will conduct regular carcass surveys and aerial redd surveys during the summer. Surveys will be conducted in close proximity to spawning areas and will enable an assessment of egg and alevin survival in the expected stressful water temperatures. Discussions on fish distribution and temperature management will occur throughout the year in the Sacramento River Temperature Task Group to iteratively inform and update temperature control operations. Temperature plan submittals to NMFS will be made according to what is laid out in RPA Action I.2.4- May 14 Through October Keswick Release Schedule (Summer Action). Regardless, temperature operations during the drought, described in the March operation forecasts, may cause river temperatures below Keswick Dam to affect incubating brood year 2014 Winter-run Chinook salmon.

Based on the 90% operations forecast with salinity barriers, temperature control at 56°F may be feasible through the end of July at the Clear Creek temperature compliance point, with projected temperatures below Keswick Dam between 56°F and 62°F during the remainder of the temperature control season (August until October). Based on the 50% operation forecast with salinity barriers, a temperature control criterion of 56°F may be met through the end of September at the Clear Creek temperature compliance point, with projected temperatures below Keswick Dam to be approximately 56°F in October. Although these projected forecasts do not assume an evaluation of temperature operations including power bypass or a relaxation of the Wilkin Slough flow standard, these operational actions are incorporated into the proposed action and should further improve temperature management. The 90% operations forecast with salinity barriers used a range of NDOI values to project operations between 2505 and 5110 cfs, required to meet outflows and other Delta regulatory standard included in the DOP (Reclamation 2014). It is unknown where and when Winter-run Chinook salmon will spawn in 2014, but the potential to lose control of temperature below Keswick Dam during the egg incubation stage (i.e., 90% forecast) could lead to complete loss of the BY 2014

Winter run Chinook salmon. Since it is unknown where Winter-run Chinook salmon may spawn in 2014, it is hypothesized that meeting a temperature compliance point with a restricted spawning area only above Clear Creek (i.e., 50% forecast) may still lead to substantial egg mortality, possibly as significant as 50%. There is a moderate level of uncertainty in these conclusions based on uncertainty in the winter run spawning distribution and the assumptions in the temperature modeling.

American River Actions

As part of the proposed action described in the March operational forecasts, monthly flows in the American are projected to be greater than 500 cfs and may increase during the summer months. Currently, the lower than normal flows now may preserve storage and enable cold water releases from Folsom to be maintained as long as possible through the summer but will also result in an increase in the rate of heating as water moves downstream. It is hypothesized that at higher flows, the rate of heating downstream would be reduced potentially providing greater habitat, although possibly for the shorter time period.

Operations during the drought, described in the March operation forecasts, may cause river temperatures below Folsom Dam to affect American River steelhead. American River water temperatures were modeled using the automated temperature selection procedure of the coldwater pool management model based on the March 90% forecast with barriers. The model was unable to meet the highest (warmest) temperature schedule (schedule 78). The model indicated that temperature could exceed 70°F at Nimbus Dam by the end of September. Reclamation will submit a draft temperature management plan to NMFS by May 1 per RPA Action II.2.

American River at Hazel Avenue water temperatures were used to estimate steelhead emergence timing based on spawning timing (Figure 20). Temperatures after March 26 were estimated based on the near term weather forecast and additional warming expected to occur through April. The spawning timing for 2014 based on the bi-weekly spawning surveys is shown in Table 6. Nimbus release flows were dropped from 1,300 cfs at the end of December 2013 down to 500 cfs by January 10. The flow drop was conducted at a time to minimize effects on steelhead by dropping prior to most spawning. No steelhead redd dewatering was documented as a result of this flow drop. The change in stage at the Fair Oaks USGS gauge for this flow drop was about 10 inches. The emergence timing estimate used 600 accumulated temperature units to emergence (degrees C). Hazel Avenue temperatures reflect the coolest temperatures in the American River, thus emergence will be slightly earlier further downstream as water temperatures increase downstream outside of the limited locality of American River coolwater refugia. The difference will be around a three to four day earlier emergence at Watt Avenue for the later season redds. Emergence of fry from current year spawners should be completed by about May 3 (Table 6).

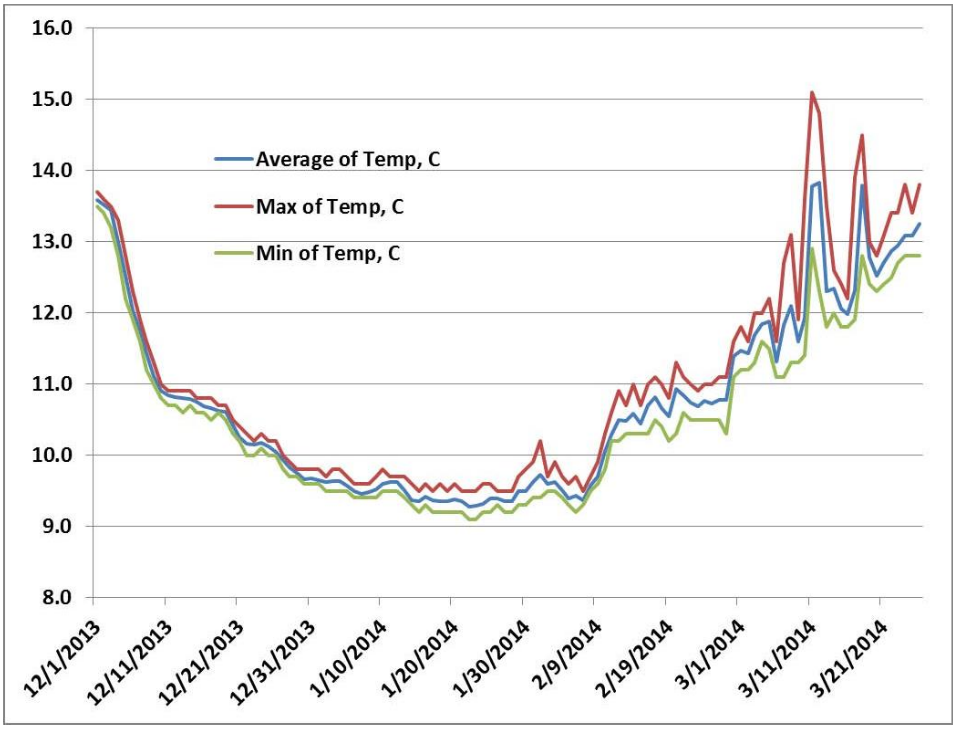

Figure 20. American River at Hazel Avenue daily water temperature, December 2013 – March 26, 2014.

Survey Date	Nimbus to Sunrise	Sunrise to below Ancil Hoffman	Ancil Hoffman to Gristmill	Gristmill to Watt	Below Watt	Cumulative Redds	Fry Emerged by
1/15 - 1/17	1	1	14	1	0	17	14-Mar
1/30 - 1/31	22	7	15	0	0	61	24-Mar
2/18 - 2/19	14	5	8	0	0	88	8-Apr
3/5 - 3/6	5	2	6	0	0	101	20-Apr
3/14 - 3/21	2	1	6	0	0	110	3-May

Table 6. American River steelhead spawning distribution (number of redds by date and reach) for 2014 based on ground spawning surveys and emergence dates calculated using Hazel Avenue temperatures (estimated past March 26). Note: surveys were generally not conducted downstream of Watt Avenue.

The spawning data should still be considered preliminary for 2014 but based on the current results at a 50/50 sex ratio and fecundity of 6,200 eggs/ female (based on recent past hatchery data) about 682,000 eggs would be produced by the observed redds. A 25% egg to fry survival (lower than typically assumed due to currently warmer water that will reach levels that may affect egg to fry survival for later spawners this year) would produce about 170,500 emergent fry. The spawning distribution in 2014 showed a higher than typical proportion in the reach between Ancil Hoffman and Gristmill. This will likely result in a higher than typical proportion of juvenile steelhead rearing occurring in this reach. A downstream rearing distribution is not ideal for achieving survival under drought temperature and flow operations. CDFW is planning to conduct juvenile steelhead monitoring during the summer. Surveys would be conducted in close proximity to spawning areas and would enable an assessment of survival in the expected stressful water temperatures. There is a moderate level of uncertainty in the conclusions about American River steelhead.

The steelhead smolts leaving the American River in spring of 2014 are expected to complete emigration by around the end of April when temperatures are expected to begin affecting survival for fish leaving the river later. Under the 90% and 50% forecasts, releases into the American River are equivalent to or greater than current flows, and juvenile stranding should not occur under these release patterns. Monitoring for stranding when flows dropped from 1,300 cfs down to 500 cfs in early January found no isolated steelhead. The steelhead were large (~200 mm) at that time and not highly prone to isolation at the level of flow drop that occurred. Little spawning had occurred and no steelhead fry were present. Estimates of fry to smolt survival for naturally spawned steelhead have ranged from 4% to 11% between 2002 and 2010 brood years (Table 7). The survival rate is likely to be lower under the drought conditions.

Adult Spawning Year	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**
Year smolts released or outmigrated	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**
Hatchery smolts released in Jan/Feb. of above year	426,920	439,490	250,440	422,380	394,292	454,570	410,330	455,140	419,160	281,705	467,023	402,300	400,060	385,887
In-river spawning adults	437	389	172	121	155		504		266	330	343	300		
Total Hatchery Produced Adult Return[1]	4,449	3,124	2,318	1,905	1,885	853	3,613	2,660	3,472	2,425	1,386	1,745	3,392	2,057
Unclipped Adults in hatchery	57	41	34	34	58	47	116		118	17	27	69	50	
Percent return of hatchery fish (clipped adult return divided by smolts released two years prior)	1.04%	0.71%	0.93%	0.45%	0.48%	0.19%	0.88%	0.58%	0.83%	0.86%	0.30%	0.43%	0.85%	0.53%
Wild smolts that outmigrated (two years prior)[2]	9,664	11,241	5,531	10,222	15,374	25,041	18,900		17,457	5,808	20,661	22,827	5,896	
Estimate of fry produced based on redd surveys[3]	825,864	182,125	181,323	175,564	246,592		272,340		230,640	402,931	447,057	325,897		
Fry to smolt survival estimated	In 2016	In 2015	In 2014	6%	5%	No Estir	4%	No Estir	11%	5%	No Estir	5%		
[1] assumes 20% recreational harvest based on angler surveys in 1999 and 2001 except 2009 and 2010 use actual creel survey estimates														
[2] assumes same smolt to adult survival of wild smolts as for hatchery released smolts and that 10% of in-river spawners are naturally produced fish														
[3] no adjustments made for potential missed redds														

Table 7. Estimates of American River wild smolt production and hatchery smolt survival based on adult hatchery counts, spawner surveys and hatchery yearling releases (from Hannon 2013).

Stanislaus River Actions

Current flows on the Stanislaus River fall within the range of operations per the NMFS BiOp and the spring pulse flow will incorporate recommendation from the Stanislaus Operations Group, as described in RPA III.1.3. Monthly flows in the Stanislaus are described in the March monthly operations forecasts. The projected summer flows along with the reservoir storage should be protective of juvenile steelhead rearing conditions through the summer in the highest density upstream rearing reaches. Summer operations on the Stanislaus may not be able to meet the temperature compliance schedule described in NMFS RPA III.1.2, and the RPA will be followed regarding notification and SOG recommendation. There is a moderate uncertainty in these conclusions.

As of March 26, the steelhead eggs that were spawned up through February 3 are projected to have emerged based on Orange Blossom Bridge water temperatures (Figure 21) and 600 accumulated temperature units (degrees C) to emergence. We expect that spawning of steelhead will be complete by the end of March based on observations in other watersheds. At a temperature of 56 F (13.3°C) emergence of steelhead fry should be completed by May 15. If water temperature becomes greater than a mean daily temperature of 56°F in the redd locations, then emergence would be completed sooner. Resident trout often spawn later than steelhead, so it is likely that the fry from resident fish will continue to emerge past the May 15 date. Since temperature operation should provide some summer coolwater refugia , it is hypothesized that *O. mykiss* populations will remain stable as the resident population continues to maintain spawner abundance and juvenile productivity of *O. mykiss* on the Stanislaus River. There is a moderate level of uncertainty in conclusions regarding Stanislaus River steelhead.

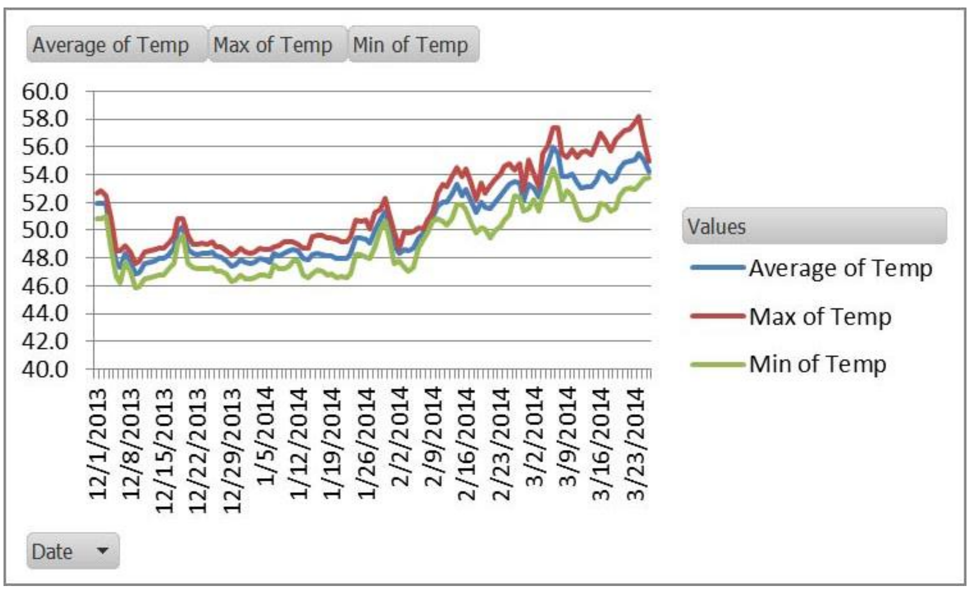

Figure 21. Stanislaus River at Orange Blossom Bridge water temperature 12/1/2013 – 3/26/2014.

Steelhead outmigration timing is not linked to emergence date, and Central Valley steelhead typically rear for a few seasons in their natal tributaries and migrate a year or more after emergence. Rotary screw traps in the Stanislaus at Caswell provide information on size and timing of steelhead emigrating from the Stanislaus. During late 2013 through March 26, 2014 one steelhead smolt was caught in the in the traps, on 3/11/14, 250mm long and weighing

103.9g. The most recent efficiency calibration for the Caswell trap was 14.1% for Chinook salmon and the calibrations from 1996 – 2012 had a mean efficiency of 6.9% (SE = 0.54%). Calibrations are not conducted for *O.mykiss* but since capture rate is size-dependent for Chinook, larger steelhead are likely much less susceptible (Joe Merz, pers comm). Therefore the one steelhead captured likely represents close to 20 additional fish. The median date of steelhead exit from the Stanislaus based on screw trap data was about March 1 for the period between the mid-1990s and mid-2000s (NMFS 2009).

A pulse flow as specified in the NMFS BiOp (2011) will be scheduled to occur during April and May to provide migratory cues and flows for the last of the emigrating juvenile steelhead before downstream temperatures become too inhospitable. The timing is being coordinated between the San Joaquin tributaries. The low quality habitat along routes to the ocean likely results in low emigration survival, especially in critically dry years such as this and is likely a large contributor to why the steelhead component of the *O. mykiss* population in the San Joaquin basin is small. It is hypothesized that steelhead escapement in two years will be lower than during previous wetter years due to poorer steelhead survival through the lower San Joaquin River between Durham Ferry (proximal to the confluence of the Stanislaus River) and Lathrop than during previous wetter years (see San Joaquin River I:E ratio and San Joaquin River flow downstream of the Head of Old River section).

Part of the action includes a measure to provide an additional Spring pulse of water down the San Joaquin River in a future year to benefit outmigration of San Joaquin steelhead. The release timing would be scheduled at the discretion of the fishery agencies. This measure will have no effect on steelhead in WY 2014, but could increase run-time diversity and outmigration survival down the San Joaquin through the Delta to benefit the emigrating cohort in the year that it occurs.

Clear Creek Actions

Temperature management on Clear Creek attempts to achieve a temperature compliance schedule to reduce thermal stress to over-summering steelhead and Spring run Chinook salmon during the holding, spawning, and incubation periods. Under the March 90% forecast, the proposed action is predicted to not meet a 60°F temperature criterion starting in early August or a 56°F temperature criterion starting in mid-September. Under the March 50% forecast, the proposed action is predicted to exceed a 60°F temperature criterion starting in early July and the 56°F temperature criterion starting with in mid- September. There is low uncertainty in this conclusion. The temperature management for Clear Creek will be coordinated through the Sacramento River Temperature Task Group under the SWRCB 90-5 requirements and as outlined in RPA Action I.1.5.

The temperature criteria are based on the Spring-run requirements and are expected to be protective of steelhead rearing through the summer. If these criteria are not met, juvenile steelhead habitat will be further restricted, predation by nonnatives may reduce survival, and disease may become more prevalent. Adults Spring-run Chinook salmon may experience higher pre-spawn mortality, and those surviving may have reduced egg viability. Spring –run Chinook are just now entering Clear Creek and will be holding through the summer. If temperatures exceed 56°F after September 15, there will be greater mortality of incubating eggs and pre-emergent fry. There is a moderate level of uncertainty in the Clear Creek effects discussion. USFWS adult and juvenile monitoring in Clear Creek during WY14 may provide useful information to evaluate the magnitude of possible temperature criteria exceedances due to drought operations and conditions.

Trinity River Actions

Preliminary water temperature modeling provides forecasted release temperatures at Lewiston Dam for the current period until the end of October 2014 under the critically dry year release schedule. Although the 50% forecast is used for Trinity River temperature planning and modeling, contingency planning for a Critical Dry year, suggest the 90% forecast may be more conservative for evaluating effects. The modeled end of September carry-over storage level of Trinity Reservoir for the 90 exceedance forecast is 455 TAF, the second lowest level on record. Given the low refill probability of Trinity Reservoir, the effects of low end-of-September reservoir storage in 2014 are likely to affect WY2015 operations. Starting in early November, natural cooling is expected to dominate mechanisms influencing water temperature. Temperature objectives for the Trinity River are to meet a 60°F mean daily temperature at Douglas City (RM 93.8) July 1 – September 14 for coho over-summer rearing. For the period September 15-30 the objective drops to 56°F and for October 1 – December 1 the 56°F temperature objective point changes to the confluence with the North Fork of the Trinity. Temperature modeling is showing that temperature is likely to exceed compliance temperatures by September and remain above into November. Releases through the auxiliary outlet works have not been modeled for the March forecast but are expected to be needed in order to meet the temperature targets. Current modeling is showing that stressful temperatures for juvenile rearing and adult migration could occur by September and extend through October, reducing the conservation value of critical habitat in the Trinity River. Discussions on fish distribution and temperature management will occur throughout the year in the Sacramento River Temperature Task Group to iteratively inform and update temperature control operations in the Trinity and Sacramento Rivers.

Delta Drought Barriers

Current planning and permitting efforts have identified possible scenarios where up to three physical barriers may be implemented between Jun1 and November 30 in the North and Central Delta as part of this proposed drought operation plan. Deployments of these barriers will be determined by the Real Time Drought Operation Management Team, and implementation is more likely if observed precipitation and reservoir storage reflect the characteristics of the March 90% forecasted operational plan. If implemented, construction of the first barriers, at West False River, may start as soon as May 1, 2014 with operation of the barriers as early as June 1, 2014. While juvenile listed Winter-run and Spring-run Chinook salmon are expected to have completed their outmigration by this time, less than 5% of juvenile steelhead may still be migrating out of the Delta (Table 5). Greater than 25% of adult Spring-run Chinook salmon and less than 5% of adult green sturgeon may still be emigrating to holding habitats in tributaries and spawning ground in the Sacramento River, respectively after June 1. Migration of these adult fish migration may be delayed by operation of these barriers through Sutter and Steamboat slough. Water quality effects are not likely to affect any listed salmonid, due to their absence from the Delta during the summer, or green sturgeon, due to their mobility and ability to seek broadly-optimal conditions. There is a moderate level of uncertainty in this conclusion.

Sacramento River Outflow

Drought operational actions impacting Sacramento River outflow proposed during the remainder of WY2014 are intended to preserve storage in Shasta Reservoir and increase the coldwater pool available for management of temperatures for Winter-run and Spring-run Chinook salmon. However, the reduction in Keswick release to meet modified spring D-1641 Outflow standards may affect outmigrating salmonids during the remainder of spring 2014 and, to a lesser extent, green sturgeon. These effects have been described previously (NMFS 2014a, USBR 2014a, USBR 2014b), but are reviewed here again since the distribution and proportion of listed salmonids in the Delta and Sacramento River have changed since these prior assessments. These changes in hydrodynamics are representative of a range of conditions possible during April and May, and do not reflect potential barriers. The barriers will be operated starting in June, once listed salmonids are no longer outmigrating through the Sacramento and San Joaquin river migration corridors.

Although the NMFS BiOp (2009) does not contain outflow standards, the BiOp assumed that D-1641 standards would be met, which would afford protection to listed species and their critical habitat. The reduction in outflow standards, which is a continuation of the Temporary Urgency Change Order's provision (SWRCB 2014) and included in this proposed action may impact juvenile salmonids migrating through the North Delta between Sacramento and Rio Vista, where Sacramento River flows meet the tidally dominated western Delta. This reduction in Delta inflow to as low as 3000 cfs may reduce survival of outmigrating Winter-run Chinook salmon, rearing and migrating Spring-run Chinook salmon, and juvenile salmonids migrating through the North Delta through increased predation mediated by hydrodynamic and habitat mechanisms. Once outmigrating fish reach the tidally dominated western Delta (i.e. Rio Vista towards Chipps Island) or San Joaquin River under the minimum outflows identified in the drought operational action (3000 cfs), they are likely to encounter daily proportion of positive velocities and mean velocity that are similar to outflow conditions observed when D-1641 delta outflow standards are being achieved (Figure 22-23). There is a moderate level of uncertainty in these conclusions.

In the North Delta, a decrease in outflow will reduce survival due to changing juvenile salmonids exposure to predators through the North Delta and other relevant reaches (i.e. Georgiana Slough, Delta Cross Channel). First, reduced outflow may increase tidal excursion (reduced daily proportion of positive velocities) into the North Delta region, which may increase the duration of reverse flows into Georgiana Slough and/or an open Delta Cross Channel (Figure 22). Increased reverse flows and slower mean velocities result in longer travel times for migrating fish, which has been shown to reduce outmigration survival (Singer et al 2013, Perry 2010, Romine et al 2013). Georgiana Slough flows become less positive as tidal excursion causes reversal in this channel when outflow is reduced. Reducing outflow also causes a decrease in the daily proportion of positive velocities through the Sacramento River downstream of Sutter and Steamboat sloughs confluence with the Sacramento River (Figure 23). These increased tidal excursions are likely to increase juvenile entrainment into Georgiana Slough and, if open, the Delta Cross Channel. When the DCC gates are open, the daily mean channel velocity becomes even less positive in these reaches (Figure 23). When the DCC gates are open, the daily proportion of positive velocities further decreases in the Sacramento River upstream of the DCC gates and more noticeably between the DCC gate and Georgiana Slough. When the DCC is open, there is a reduction in the daily proportion of positive flows through Georgiana Slough. There is a low level of uncertainty in this conclusion. The possible reductions in outflow through multiple distributaries in the North Delta may increase straying and travel time of adult Winter-run and Spring-run Chinook salmon and green sturgeon in this region during April and May. During these months, a substantial portion of all three of these populations will migrate through the North Delta (Table 4).

At low outflow, channel margin habitat is lost below the surface of the water. This lack of cover may reduce juvenile survival. It is hypothesized lower outflow may intensify the density of littoral predators into a smaller, shallower area and/or decrease the quantity of cover available to outmigrating salmonids to avoid predators. There is a high level of uncertainty in this conclusion. Decreased daily mean velocities may result in increased residence time of Winter-run and Spring-run Chinook salmon, which is hypothesized to result in an increased size at ocean entry. There is a high level of uncertainty in this conclusion.

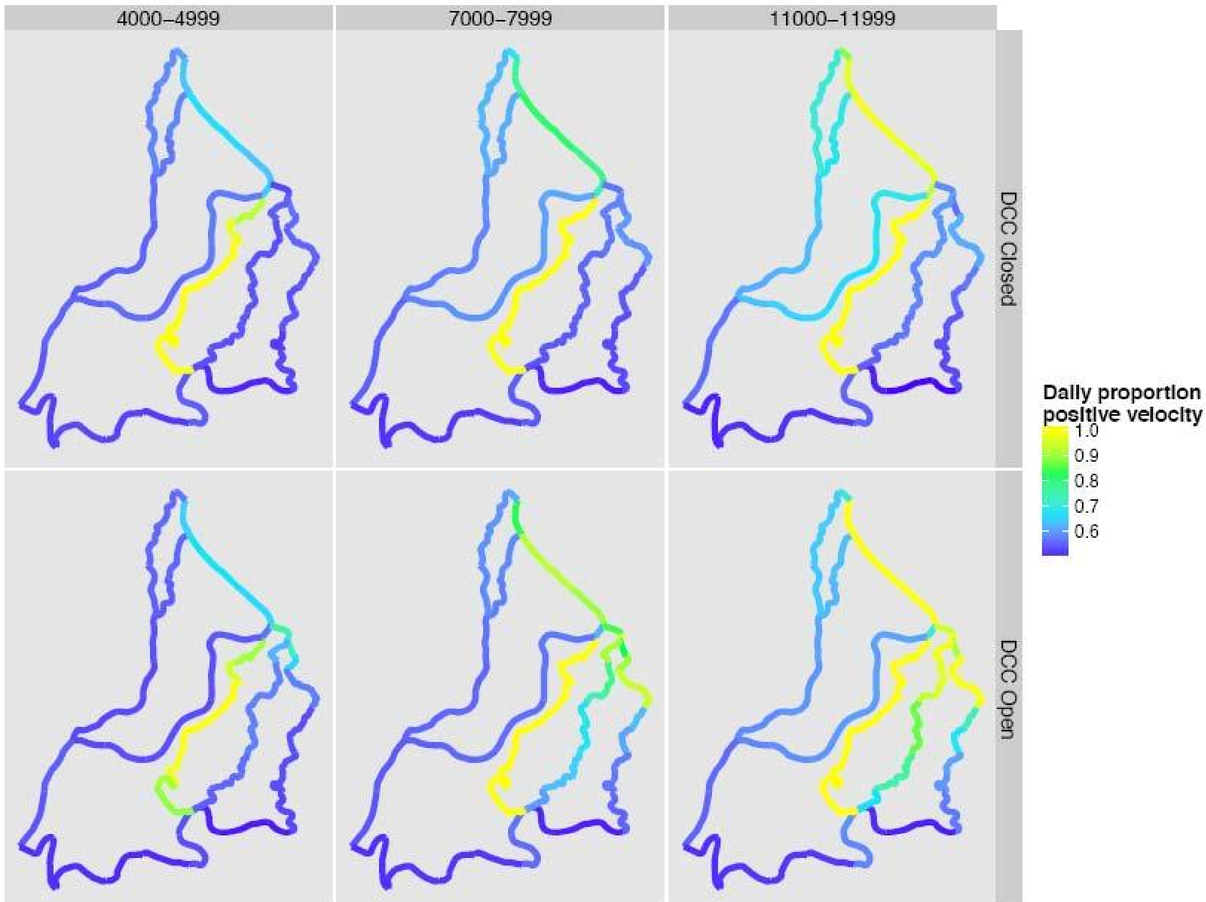

Figure 22. Maps of the North, Interior, and western Delta regions with the channels color coded for daily proportion positive velocity. Columns represent range of outflow values for that panel.

Since February 1, 2014, Sacramento River outflow and Delta hydrodynamics have differed from what would be realized under the NMFS BiOp (2011) and D-1641 outflow standards for multiple periods of various durations due to drought contingency operations (Attachment B. February and March Actual Delta Operations). During these periods, outmigrating and rearing Winter-run and Spring-run Chinook and steelhead in the Sacramento River and Delta have experienced lower survival rates than if the D-1641 outflow standard could be met. As these lower outflow conditions persist into April and May greater proportions of these populations will experience these effects. There is a low level of uncertainty in this conclusion.

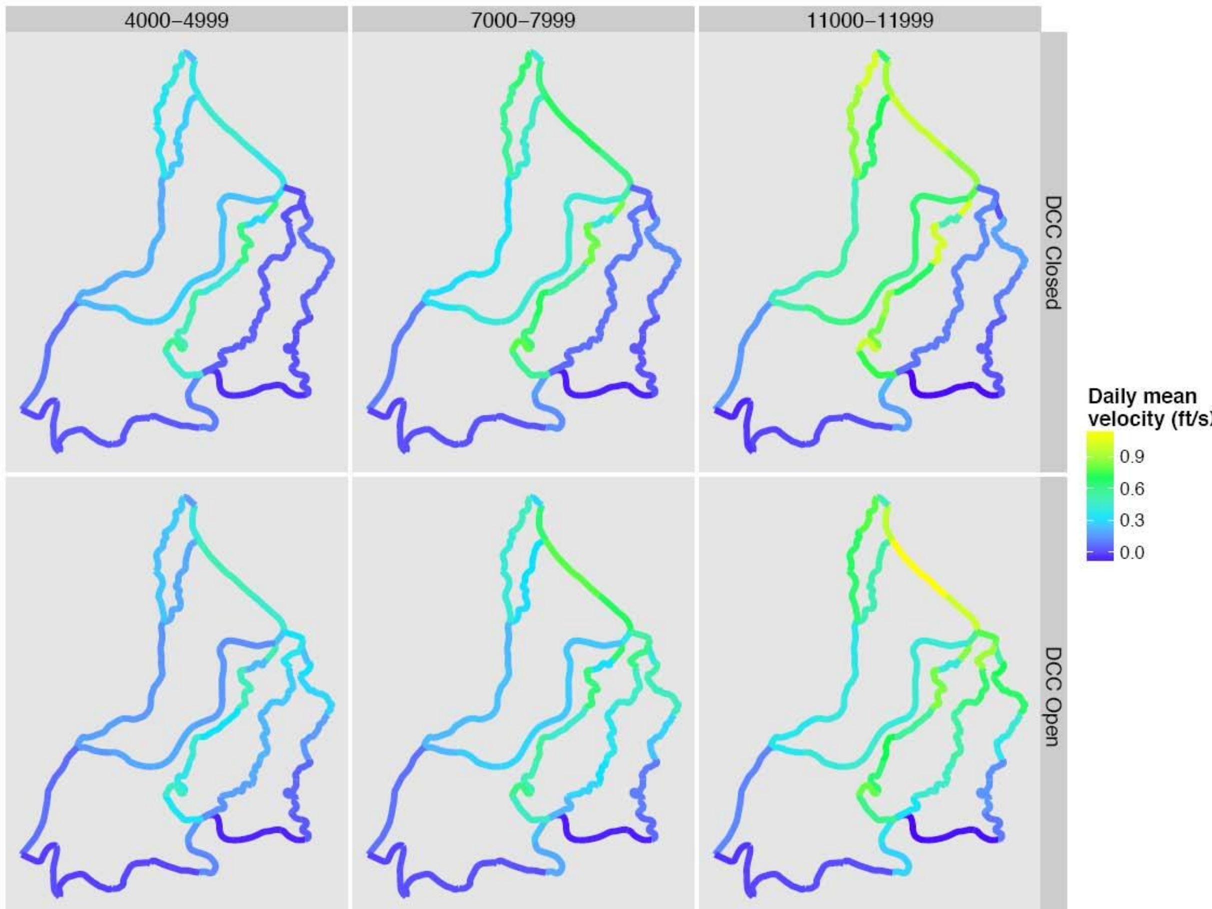

Figure 23. Maps of the North, Interior, and western Delta regions with the channels color coded for daily mean velocity.

The frequency of 15-minute velocities under flow ranges similar to D-1641 outflow objective (>7100 cfs) and the continuation of outflow objectives in the TUC Order (>3000 cfs), which may be observed during April and May are similar in the western Delta downstream of Freeport, the Lower San Joaquin, and Three Mile Slough (Figure 24-26). In these western and central regions of the Delta, hydrodynamic effects are dominated by tidal conditions and thus fish in these regions will not experience an appreciable change in outflow. There is a low level of uncertainty in these conclusions.

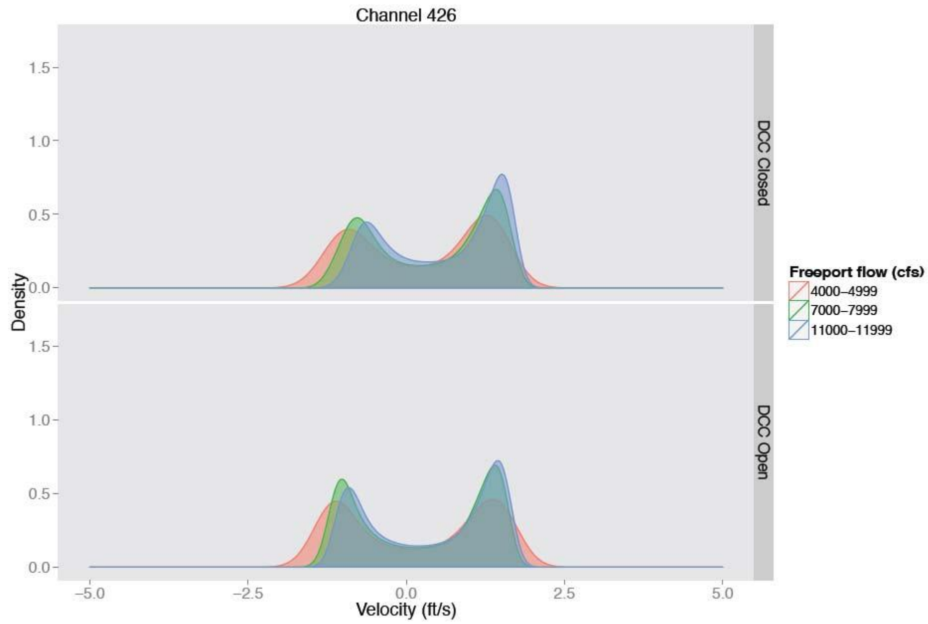

Figure 24. Density plot of velocity (ft/s) observed at DSM2 node 426 (approximately Rio Vista) for three outflow ranges.

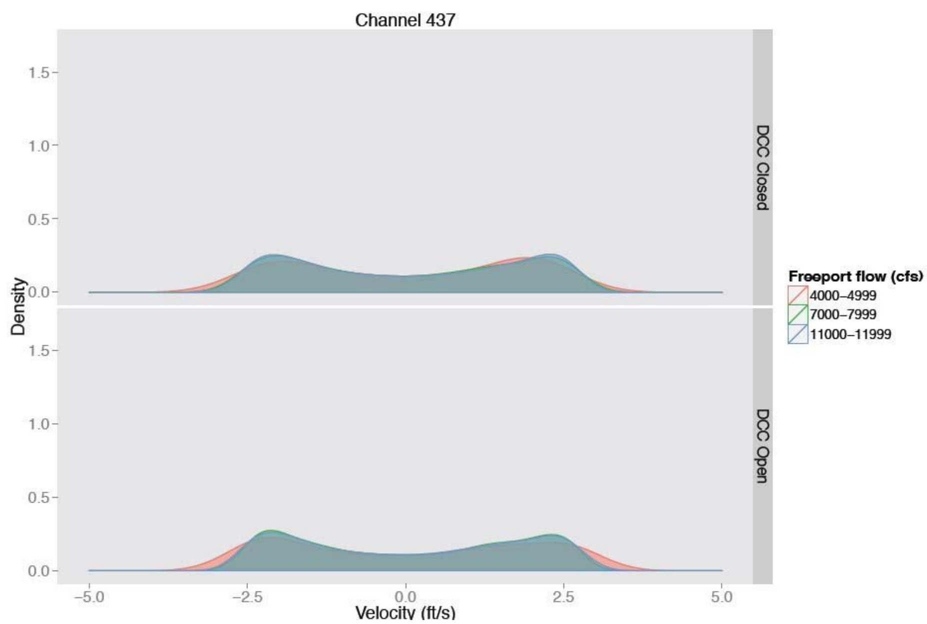

Figure 25. Density plot of velocity (ft/s) observed at DSM2 node 437 (approximately Chipps Island) for three outflow ranges.

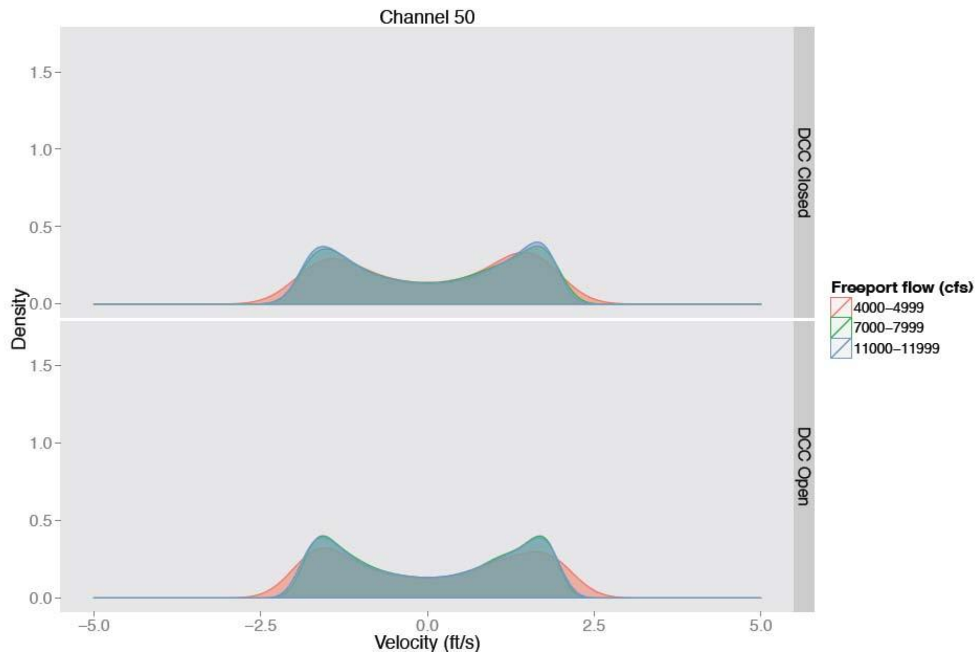

Figure 26. Density plot of velocity (ft/s) observed at DSM2 node 50 (approximately West False River) for three outflow ranges.

San Joaquin River I:E ratio and San Joaquin River flow downstream of the Head of Old River

Steelhead in the San Joaquin River basin were once abundant and widely distributed, but currently face numerous limiting factors. The NMFS Public Draft Central Valley Recovery Plan identified that 'Very High' stressors for juvenile steelhead outmigration on the San Joaquin River include habitat availability, changes in hydrology, water temperature, reverse flow conditions, contaminants, habitat degradation, and entrainment. It is possible that reduced survival of emigrating smolts may be the greatest management concern to preserving anadromy in *O. mykiss* (Satterthwaite et al. 2010). A conceptual model, developed by the South Delta Salmonid Research Collaborative (Anchor QEA 2016), demonstrates how multiple stressors may affect physical and biological processes in the Delta that influence the steelhead population through multiple mechanisms (i.e. entrainment, predation, survival, Figure 27).

The NMFS Biological Opinion includes two actions that influence CVP/SWP export and flows through the Old and Middle River corridors during April and May, when outmigrating listed juvenile salmonids and green sturgeon are present. Action IV.2.1 identifies maximum levels of export volume as a function of San Joaquin discharge at Vernalis. This action is calendar based and occurs from April 1 to May 31. The action hypothesizes to increase survival of emigrating salmonids by reducing fishes' vulnerability to entrainment into the south Delta and at the CVP/SWP facilities by limiting export to less than 100% of San

Joaquin River inflow, except in critical years. In the proposed drought operation plan for April and May 2014, implementation of this action is projected to be limited to the period of coordinated San Joaquin River pulse flows. Action IV.2.3 limits the extent of reverse negative flows through the South Delta along Old and Middle rivers and adjacent channels. Similar to Action IV.2.1, this action attempts to increase survival of emigrating Sacramento and San Joaquin origin listed salmonids by reducing their vulnerability to entrainment into the south Delta and pumps. The initial OMR limit of -5,000 cfs is calendar-based and runs between January 1 and June 15, but increased entrainment of listed salmon ESUs and steelhead can trigger more positive OMR limits of -3,500cfs or -2,500cfs. Action IV.2.3's implementation will not be modified as part of the proposed drought operation plan, but OMR flow calculations will continue to utilize the Index equation methodology described in the OMR Index Demonstration Project (USBR 2014c, NMFS 2014b).

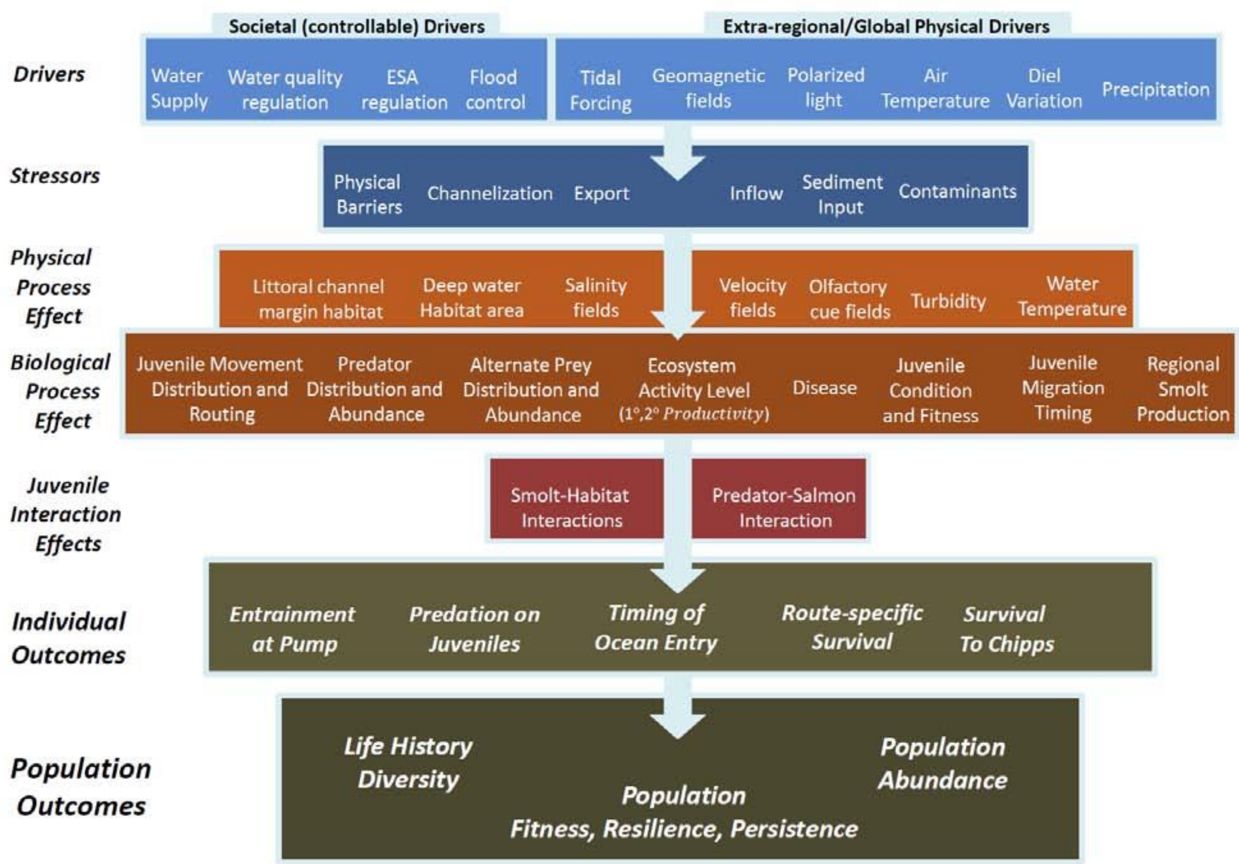

Figure 27. Conceptual Model for South Delta Salmonid Smolt Survival

The portions of the juvenile Central Valley steelhead, Winter-run and Spring-run Chinook still migrating through the Delta will be affected by more unfavorable hydrodynamic conditions in the South and Central Delta than under unmodified implementation of NMFS RPA IV.2.1.

Based on the conceptual model, the proposed drought operation plan to have greater exports with minimal San Joaquin and Sacramento River outflow than would have been allowed under the 1:1 I:E ratios required in a Critical WY may reduce outmigration survival of Winter-run and Spring-run Chinook salmon and Sacramento River origin steelhead that have entered the Interior Delta by entraining them into the South Delta and exposing them to loss at the CVP/SWP export facilities and increasing their travel time and exposure to degraded habitats and predators. There is moderate uncertainty in this conclusion. The modified I:E ratio of the proposed drought operation plan may also reduce outmigration survival of San Joaquin River steelhead through the same set of mechanisms. Since all San Joaquin steelhead emigrate through the South Delta, all San Joaquin emigrants that transit the delta during the implementation of the proposed modified operations will experience these poorer hydrodynamic conditions. There is a low level of uncertainty in this conclusion.

The increase in exports expected under the proposed modification of the I:E ratio and operation of the HORB may result in hydrodynamic changes in the daily proportion of positive velocity and daily mean velocity in the Central and South Delta (Figure 28 and 29). Although no data is available to compare the proposed action's modified I:E ratio to the RPA's 1:1 ratio at the Vernalis flows likely to be achieved in WY2014, Figure 28 shows the substantial tidal portions of the Central Delta start to show a minority of daily proportion of positive flows at nodes along the Old and Middle River as negative flows in these channels increase with increased export. Figure 29 shows the substantial tidal portions of the Central Delta have greater negative mean daily flows along the Old and Middle River and into the Central Delta as negative OMR flows increase with increased exports. These hydrodynamic characteristics may reduce juvenile salmonid survival as fish are exposed to increased travel duration and longer exposure times in highly degraded habitat impacted by invasive plants and aquatic predators along the lower San Joaquin River and Central Delta. There is a high level of uncertainty in this conclusion given actual operations during April and May are within a range of potential effects and the mechanisms causing reduced survival of salmonids in relationship to South and Central hydrodynamics are just beginning to be understood (Anchor 2014, DWR 2014, RPA Action IV.2.2).

The increase in exports expected under the proposed modification of the I:E ratio may affect juvenile fish that enter the South Delta to be exposed to greater mean daily negative velocities through Old and Middle rivers, which may shorten travel times to the fish collection facilities and increase survival of these fishes to the western Delta compared to fish outmigrating along the San Joaquin River or through the Central Delta. There is a high level of uncertainty in this conclusion. An element of the proposed action to offset potentially greater exports during April and May 2014 than would occur under an unmodified RPA Action IV.2.1 is a facility shift in exports so that minimal pumping will occur at the SWP Banks Pumping Plant and the majority will occur at the CVP Jones Pumping Plant. This export shift, because it will not increase combined exports and is not expected to increase overall entrainment, will increase survival of salmonids through these facilities, since fewer fish will enter the SWP, where loss has been measured to range between 63-99% for Chinook (Gingras 1997) and 44-100% for steelhead (Clark et al. 2009). Loss at the SWP is higher due to substantial pre-screen mortality associated with Clifton Court. Based on the values and equations used by agencies to estimate loss, shifting exports from equivalent (e.g. 700 SWP and 800 CVP) to six-times greater exports at the CVP than SWP (e.g. 700 SWP and 4200CVP) may increase overall survival from 42% to 59% (an approximately 40% increase in survival). There is a low level of uncertainty in this conclusion.

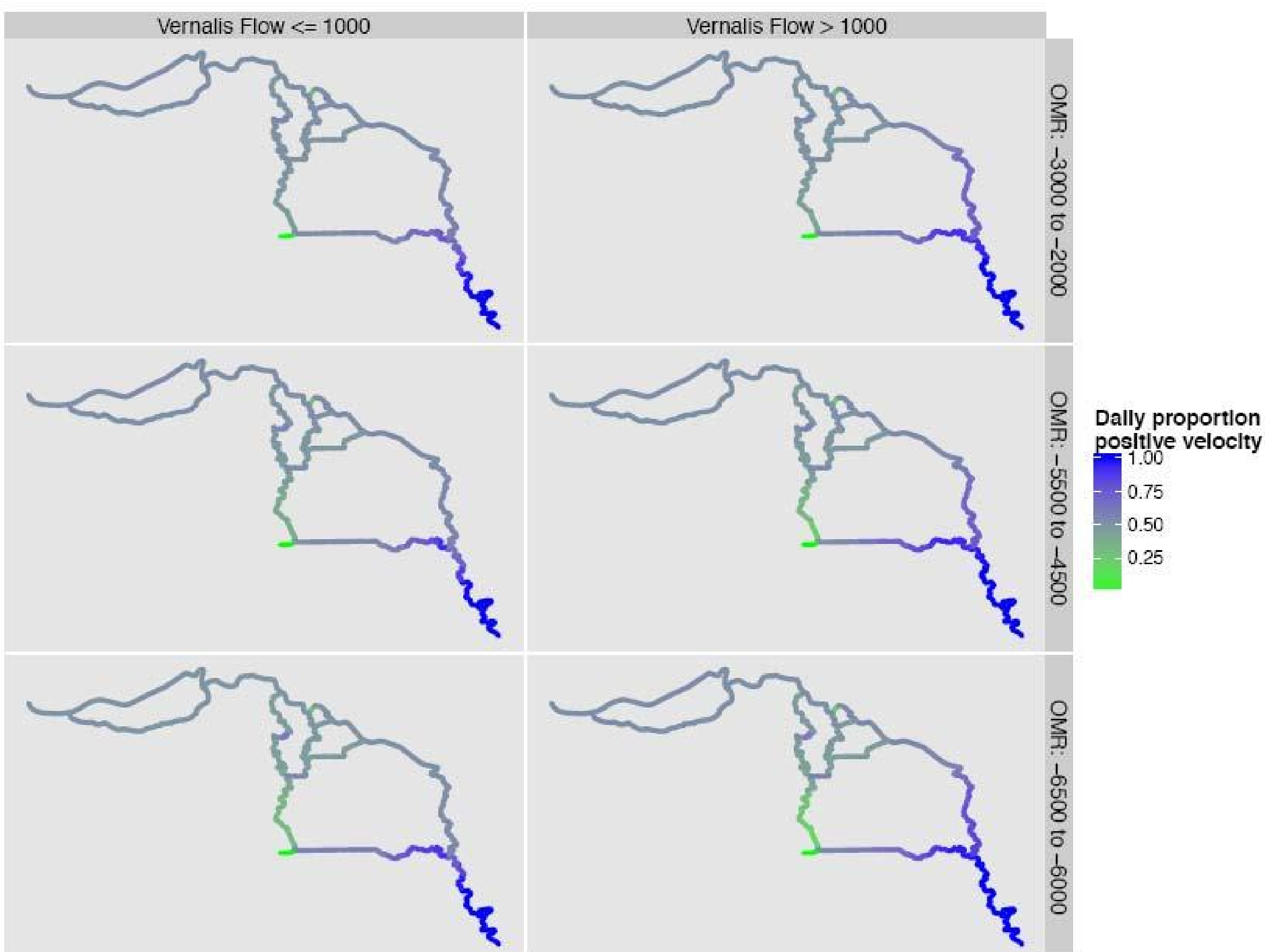

Figure 28. Maps of the San Joaquin River and south and western Delta regions with the channels color coded for daily proportion positive velocity. HORB operation is included in these panels.

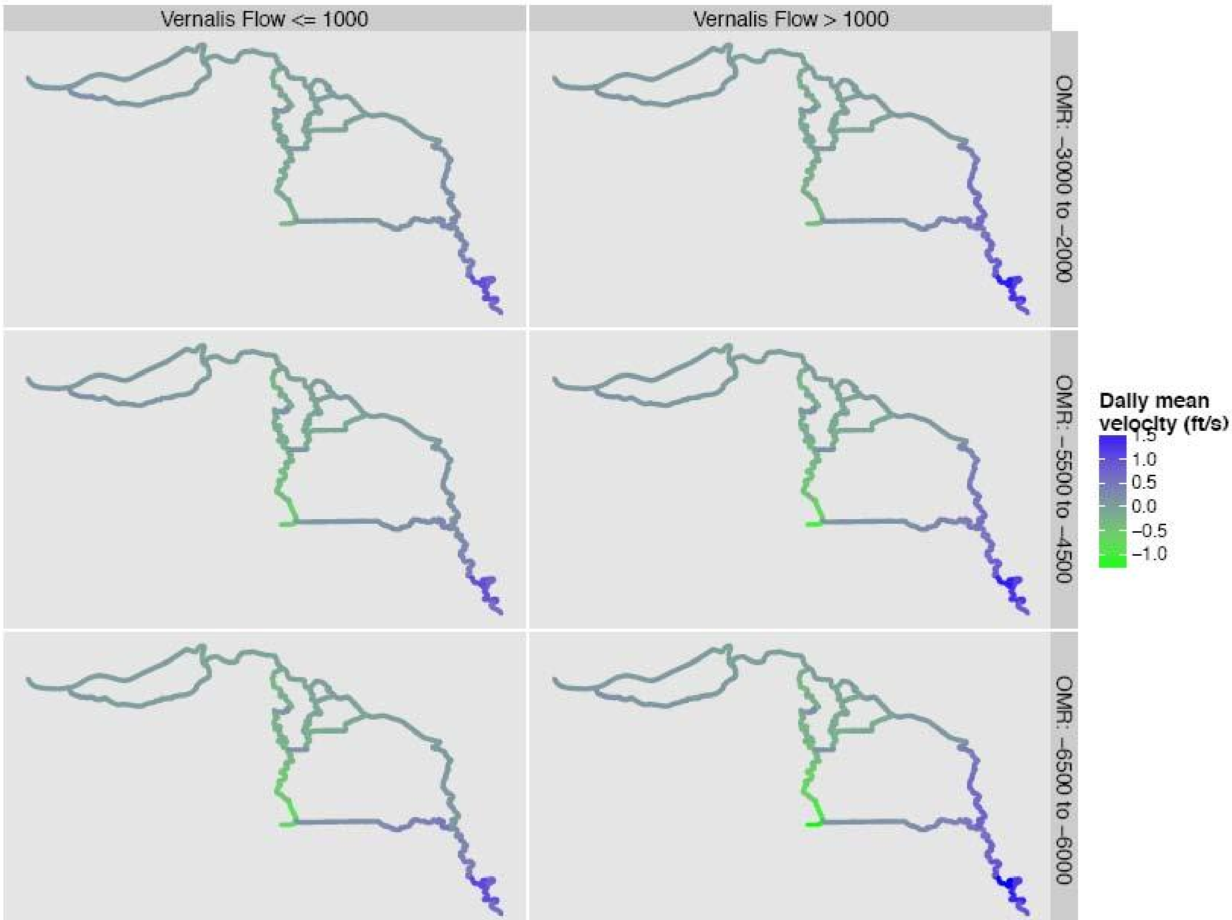

Figure 29. Maps of the San Joaquin River and south and western Delta regions with the channels color coded for daily mean velocity. HORB operation is included in these panels.

The modified I:E ratio, proposed in the drought operation plan causes appreciable differences in hydrodynamics of the Central Delta. This region is a predominantly tidal environment when Vernalis outflows are low and OMR flows are in the -2000 to -3000 cfs range (Figure 29) In these conditions, the daily proportion of positive flows is close to 50% across the lower San Joaquin River migration corridor, although considerably less than 50% close to the fish collection facilities on Old River (Figure 28 and 29). If exports were further limited to reflect an I:E of 1:1, the daily proportion of positive flows would be even greater than observed in Figure 28 in the Central Delta and potentially positively flowing toward the western Delta. Exports greater than Vernalis inflow during April and May will make Old and Middle River flow more negative than under the unmodified RPA Action IV.2.1. At OMR flow values (more negative than -5000 cfs), the daily proportion of positive flows in the Central Delta and at South Delta distributaries entering from the Lower San Joaquin River can be less than half the day even when Vernalis inflow is greater than 1000 cfs (Figure 28). As this entrainment footprint enters the Central Delta, Sacramento origin listed salmonids may have a greater risk to entrainment into the South Delta than under the RPA Action IV.2.1. A minority of the daily flow measurements along the Lower San Joaquin River migration corridor are positive when OMR values range between -6500 and -6000 at Vernalis inflow values examined, suggesting a greater risk of entrainment by San Joaquin River steelhead into the South Delta than under the RPA Action IV.2.1. There is a moderate level of uncertainty in these conclusions.

The changes in daily velocities are small at Turner Cut, in northern Old River, and along the Lower San Joaquin River (Figure 30-32) under the OMR ranges likely to be observed in April and May as part of the proposed drought operation plan. It is hypothesized the likelihood of entrainment of fish into the South Delta is more a function of the time of arrival at these junctions then OMR flows in this range. However, once in the South Delta, daily velocities become substantially more negative, as observed along Grant Line Canal, and thus loss at the CVP/SWP facilities is much greater at OMR flows in the ranges more negative than -4500 cfs compared to the OMR range between -2000 and -3000 cfs (Figure 33). Thus, Old and Middle river flows that are more negative under the proposed modification of Action IV.1.2 than under implementation of RPA IV.2.1 will expose migrating salmonids to greater entrainment risk and lower outmigration survival in the South Delta and potentially Central Delta. There is a moderate level of uncertainty in these conclusions.

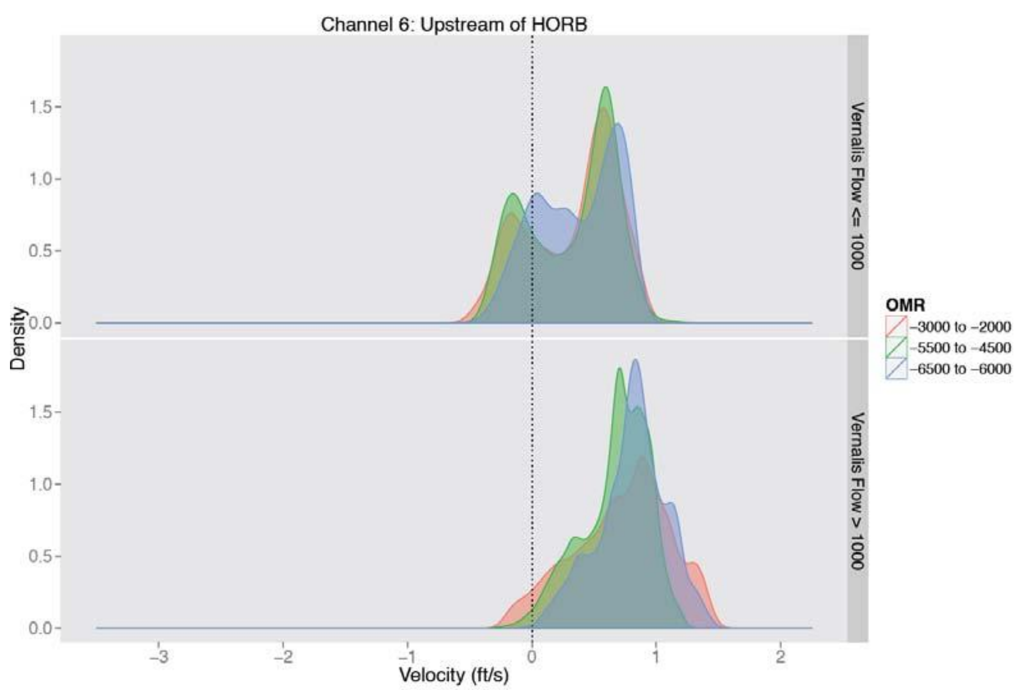

Figure 30. Density plot of velocity (ft/s) observed at DSM2 node 6 for three OMR ranges. HORB operation is included in these panels.

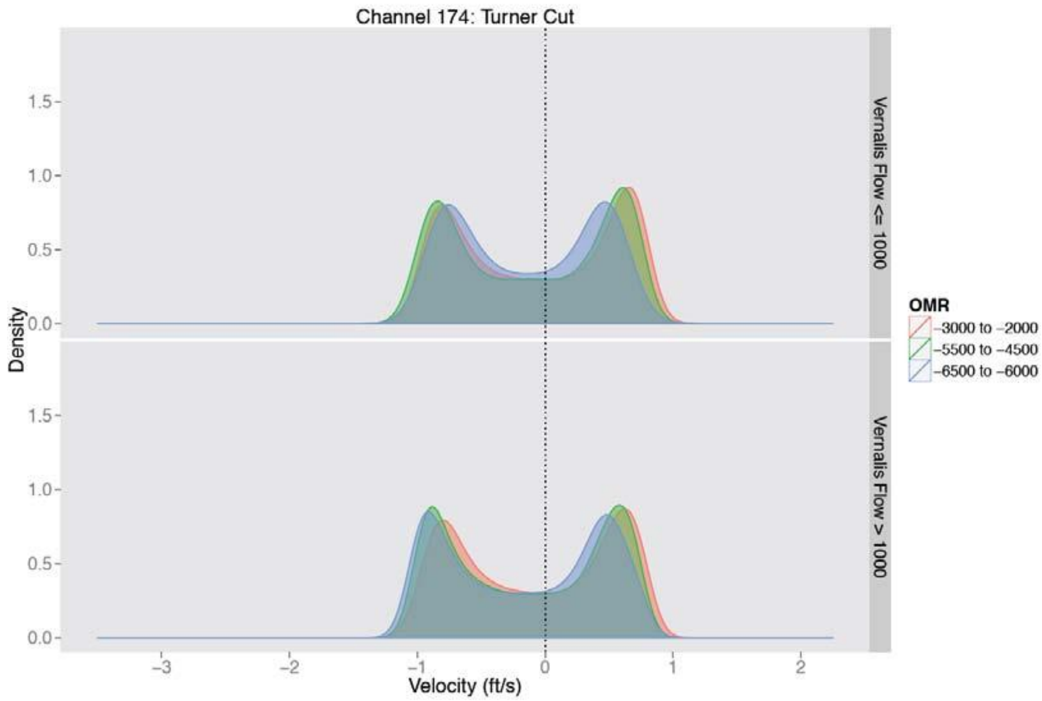

Figure 31. Density plot of velocity (ft/s) observed at DSM2 node 174 for three ranges. HORB operation is included in these panels.

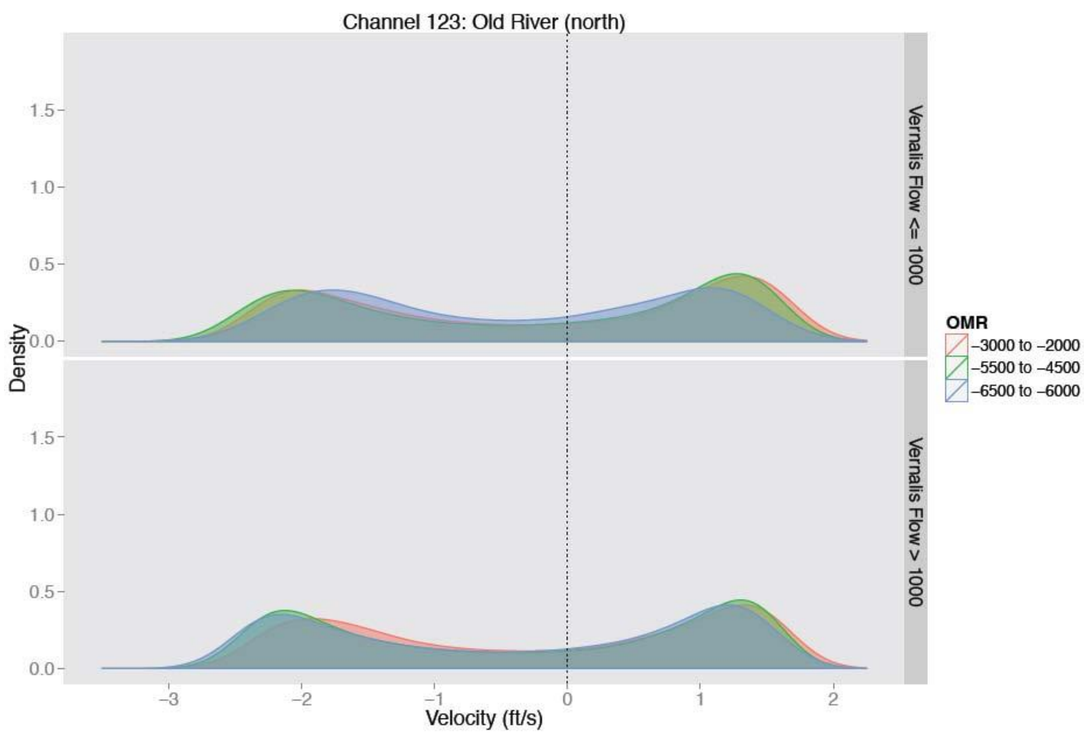

Figure 32. Density plot of velocity (ft/s) observed at DSM2 node 123 for three OMR ranges. HORB operation is included in these panels.

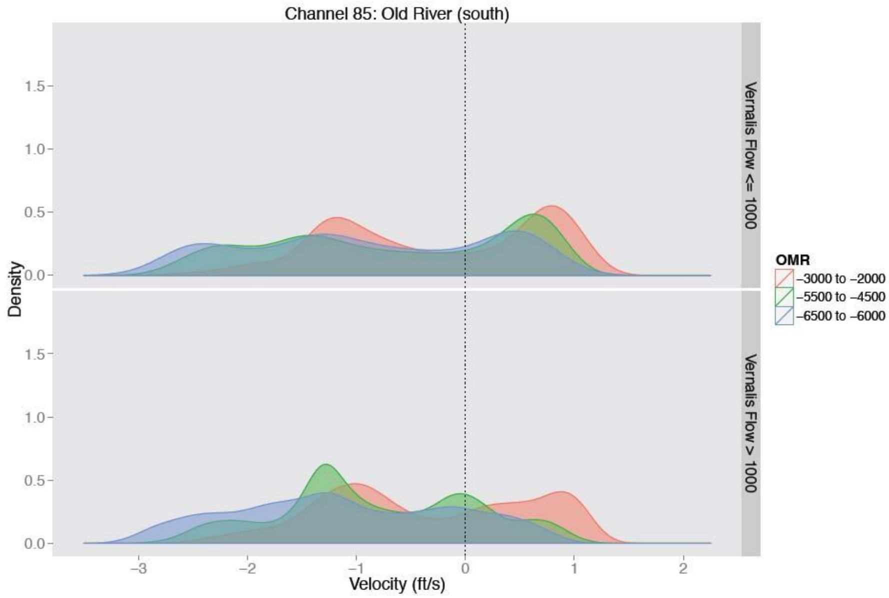

Figure 33. Density plot of velocity (ft/s) observed at DSM2 node 85 for three ranges. HORB operation is included in these panels.

Summary of Proposed Action's Effects

Cumulatively, the continuation of modification to the D-1641 flow and operational criteria and modification of the I:E ratio (Action IV.2.1) may reduce through-Delta survival of juvenile listed salmonids, steelhead and green sturgeon, and may modify their designated critical habitat during April and May. The reductions of juvenile survival on the majority of outmigrating BY13 Winter-run, BY 13 Spring-run Chinook salmon, and outmigrating steelhead would occur primarily in the Sacramento River and North Delta, if outflow levels drop below D-1641 flow and operational criteria due to limited releases of CVP/SWP storage during April and May. Increased exports during April and May, as part of the proposed action, may also reduce survival of these populations by increasing loss at the CVP/SWP collection facilities and from exposure in the interior Delta to degraded habitats and predaceous invasive species. The offsetting action to shift exports from the SWP to the CVP during the spring reduces the risks associated with entrainment loss for the remainder of the WY 2014 salvage season compared to the RPA baseline with normal export operations.

Changes in Sacramento River outflow during April and May may delay adult Winter-run and Spring-run Chinook and green sturgeon migration. Additionally, adult migration of these species may be affected to a lesser extent by operation of three drought barriers in June and July. These drought barriers are unlikely to have an appreciable effect on juvenile outmigration of these species or Central Valley steelhead. Modification to D-1641 Municipal and Industrial and Agricultural water quality standards in the Delta between April and November will not affect Winter-run or Spring-run Chinook, steelhead, or green sturgeon.

Current reservoir storage levels and forecasted operations are likely to impact temperatures in the upper Sacramento River, Trinity River, Clear Creek, American River, and Stanislaus River. While the proposed drought operation plan incorporates numerous operational actions to minimize temperature effects compared to normal CVP/SWP operations, egg mortality of BY14 Winter-run may be substantial in the upper Sacramento River. Even improved temperature conditions may have substantial effects on the Winter-run Chinook salmon population since two brood classes are being impacted by WY 14 operation during winter and summer. Temperature effects on Clear Creek and in the Upper Sacramento may lead to substantial pre-spawn mortality of adult Spring-run Chinook. Temperature effects on the Clear Creek, Stanislaus, American, and Trinity rivers may exceed that expected under RPA actions regarding temperature compliance, but may still be able to provide restricted coolwater refugia for juvenile *O. mykiss*, Spring-run Chinook and Coho salmon. If temperature compliance points are not met on the Trinity River, the amount of habitat available to rearing coho salmon is expected to be lower than it would otherwise, and the probability of mortality of returning adults will increase.

Listed juvenile salmonids still to enter the Delta, particularly young-of-the-year Spring-run Chinook salmon (approximately 50-75%) and San Joaquin origin steelhead (approximately 70%) may have reduced survival due to increased residence times in the interior Delta. The offsetting action to augment flow on the San Joaquin River in the next dry or better year may improve freshwater, and possibly south Delta, survival compared to the RPA baseline without these augmented flow. Hydrodynamic changes in the Delta increasing the risk of entrainment into the Old and Middle River corridors as these flows become more negative may increase loss at the CVP/SWP fish collection facilities, if they enter the South Delta. Similar to the existing biological opinion, exports will conform to existing BiOps when NMFS BiOp Action IV.2.3's fish triggers are exceeded. While the proposed action may increase the likelihood of exceeding these triggers, it does not pose any additional risk to exceeding the annual take limit of Winter- run or Spring-run Chinook salmon or steelhead.

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ATTACHMENT F

BIOLOGICAL REVIEW – DELTA SMELT AND LONGFIN SMELT

BACKGROUND

Temporary Urgency Change Petition and Drought Emergency Contingency Planning

On January 29, 2014, DWR and Reclamation, due to drought-related questions, jointly filed a Temporary Urgency Change Petition (TUCP) that requested the State Water Resources Control Board (SWRCB) allow a temporary modification of their water right permits and licenses. The TUCP requested temporary modification of Delta outflow and Delta Cross Channel (DCC) gate requirements imposed pursuant to State Water Board Decision 1641 (D-1641). On January 31, 2014, the SWRCB Executive Director, acting under delegated authority, issued an Order approving the temporary modification for the next 180 days that allowed the projects to reduce Delta outflow and thus conserve upstream storage for use later. It also allowed the Projects to pump at a minimal level – a combined 1,500 cubic feet per second (cfs) – to supply essential public health and safety needs when Delta outflow was lower than would typically allow such pumping. As part of the order, the State Water Board's executive director also convened a Real Time Drought Operations Management Team (RTDOMT).

Contingency planning by DWR, Reclamation, and NMFS pursuant to Reasonable and Prudent Alternative (RPA) Action I.2.3.C of the NMFS BO on the OCAP for the CVP and SWP has included consideration of a matrix of potential gate operations that would aim to limit the potential for entrainment through the DCC, e.g., by restricting gate operations to periods when listed juvenile salmonids are not abundant in the Sacramento River near the DCC, and by focusing DCC opening to diurnal periods when movement of juvenile salmonids is less likely (NMFS 2014a). Also of relevance is the possibility of installation of a floating fish guidance structure to lessen the probability of juvenile salmonid movement into the DCC.

Old and Middle River Index Demonstration Project

Beginning in March 2014, Reclamation proposed to implement the OMR Index Demonstration Project, which would use an OMR index (instead of tidally filtered daily OMR flow reported by the U.S. Geological Survey) to operate to the required 14-day running average OMR flow from the NMFS 2009 BO's RPA Action IV.2.3. In addition, as part of this project, Reclamation proposed to eliminate the 5-day running average requirement. NMFS determined that this project would have no additional adverse effects to listed anadromous fishes and authorized the OMR Index Demonstration Project for one year, under the condition that operations revert to the RPA, as written, should any unanticipated adverse effects occur (NMFS 2014b). Additionally, USFWS concurred with Reclamations OMR demonstration project, USFWS 2012b).

PROPOSED ACTIONS

For the purpose of this evaluation, the proposed actions and effects review are discussed separately for the April-May period preceding installation of the drought barriers (April1-May 31Period), and the period following installation of the drought barriers through until removal of the barriers (Barrier Period).

April-May Period Proposed Actions

This period describes operational modifications for April 1 through May 31. A suite of proposed modifications to Delta criteria for April and May, including modified DCC gate operations to protect water quality, an export regime designed to take advantage of natural or abandoned flow in those months, and some actions to offset adverse effects to out-migrating San Joaquin River steelhead and salmon. The proposed suite of April/May modifications includes continuation of a number of provisions in the current TUC Order, including compliance specifications for outflow requirements and averaging periods for export/inflow (E/I) ratio requirements. Export limitations during the San Joaquin River pulse flow period would also comport with D-1641 requirements. The Vernalis flow-to-combined export (I:E) ratio of 1:1 associated with San Joaquin River flows for a critically-dry San Joaquin Valley classification (NMFS RPA Action IV.2.1) will be implemented during the April 1 through May 31 period, with the modification noted below under BiOps (1). The D-1641 San Joaquin River flow objectives would also be modified in April and May. In addition, some actions, as described in the Drought Operations Plan, will be implemented to offset adverse effects to out-migrating San Joaquin River steelhead and salmon. Specific elements of the proposal for April and May relative to NMFS BiOp provisions, USFWS BiOp provisions, and D-1641 provisions are defined in the Drought Operations Plan. No modifications to the USFWS BiOp RPA actions are currently proposed under this plan. All OMR flow related actions, including determinations based on advice from the Smelt Working Group (SWG) and the Delta Conditions Team (DCT), remain in place[1]. The OMR Index Demonstration Project as specified in the USFWS concurrence letter continues.

Reclamation and DWR may request further modifications of requirements contained in D-1641. Below is a description of those anticipated requests. These requests would be subject to approval by the State Water Board's Executive Director and potentially the State Water Board members. D-1641 provisions #1 and #2 (below) are intended to be an extension of existing TUC Order provisions 1(a) and 1(b), which terminate on March 31, 2014. D-1641 provisions #3 and #4 are considered within existing D-1641 flexibility and within the process of implementation defined therein. D-1641 provision #5 (below) will be defined through coordination with the BiOps provision #2 (NMFS BiOp Provision #2, Drought Operations Plan).

1. The minimum Delta Outflow levels specified in Table 3 are modified as follows:

The minimum monthly Net Delta Outflow Index (NDOI) described in Figure 3 of D-1641 during the months of April and May shall be no less than 3,000 average (mean) cubic-feet per second (cfs).

2. The maximum Export Limits included in Table 3 of D-1641 are modified as follows:

During April and May when footnote 10 of D-1641 is not being met, or the DCC gates are open during a period inconsistent with footnote 23 of D-1641, the combined maximum SWP and CVP export rate for SWP and CVP contractors at the Harvey O. Banks and C.W. "Bill" Jones pumping plants will be no greater than 1,500 cfs on a 3-day running average. When precipitation and runoff events occur that allow the DCC to be closed and footnote 10 of D-1641 is being met [3-day average Delta Outflow of 7,100 cfs or electrical conductivity of 2.64 millimhos per centimeter on a daily or 14-day running average at the confluence of the Sacramento and the San Joaquin rivers (Collinsville station C2) if applicable[2]], but any additional Delta Outflow requirements contained in Table 4 of D-1641 are not being met, then exports of natural and abandoned flows are permitted up to D-1641 Export Limits contained in Table 3

[1] The CDFW 2081 permit criteria associated with longfin smelt remains in place.

[2] The Standard does not apply in May if the best available estimate of the Sacramento River Index for the water year is less than 8.1 MAF at the 90% exceedence level.

and under the existing Biological Opinions (with implementation modifications or limits, as specified in BiOps section, above).

3. Continue to vary the averaging period of the Delta E/I ratio pursuant to Footnotes 18, 19, and 20 of D-1641 as was approved in the March TUC Order. Operate to a 35 percent E/I ratio with a 3-day averaging period on the rising limb of a Delta inflow hydrograph, and operate to a 14-day averaging period on the falling limb of the Delta inflow hydrograph.

4. Implement combined export limitations as specified in Table 3, Footnotes 17 and 18 of D-1641. The timing and duration of this action is to be coincident with a coordinated pulse flow on the San Joaquin River system as described under BiOps (NMFS BiOp Provision #1, Drought Operations Plan) and (NMFS BiOp Provision #2, Drought Operations Plan) of up to but not to exceed 31 days.

5. D-1641 (5) Vernalis base flow and pulse flow are modified as follows:

   - April 1 to the start of the pulse flow period – maintain Vernalis flow at or above 700 cfs (3-day running average);
   - For the 31-day pulse flow period, create a 16-day pulse averaging 3,300 cfs at Vernalis with flows averaging 1,500 cfs at Vernalis for the remainder of the 31 days. The start date and flow schedule for the overall pulse flow volume of water may be modified (with concurrence with the fishery agencies);
   - From the end of the pulse flow period through May 31– maintain an average flow of 500 cfs for the period.

6. The compliance location for the D-1641 Agricultural Western Delta Salinity Standard at Emmaton (14-day running average of 2.78 millimhos per centimeter through August 15) is moved to Three Mile Slough on the Sacramento River.

The export and hydrodynamic forecasted operations for the Delta hydrodynamics, attached to the Drought Operations Plan, are based on the specific proposed operating criteria outlined above (NMFS BiOp provisions #1 through #4 Drought Operations Plan, and D-1641 provisions #1 through #6). These forecasted values are the current best estimate of resulting exports and flows for the purposes of analysis, but should not be construed as specific proposals.

In early April (prior to the April pulse flow period of April 15 – May 15), the proposed action is expected to allow an elevation of combined exports from 1,500 cfs to as high as 6,500 cfs, and this change will result in projected OMR[3] Index 5-day average flows going from a range of -1,500 cfs to -2,500 cfs, to a more negative range of -5,000 cfs to -6,250 cfs. At the same time, the NDOI and QWEST values will be reduced by an amount similar to the export increase. Operations and resulting flow conditions during this early April period are predicted to be similar to operation and flow conditions observed during the week of March 16 (Figures 1,2). During the expected pulse flow period (approximately April 15 – May 15), OMR negative flows and exports are expected to be the same as without the proposed action. Following the pulse flow period, in the event of wet climatic conditions and

[3] The OMR Index Demonstration Project as specified in the USFWS and NMFS concurrence letters continues.

elevated Sacramento River flows, exports and hydraulic conditions in the Delta are expected to be the same as described above for the proposed action in early April. However, if climatic conditions are dry in May following the pulse flow period, OMR[4] negative flow and exports are expected to be the same as without the proposed action.

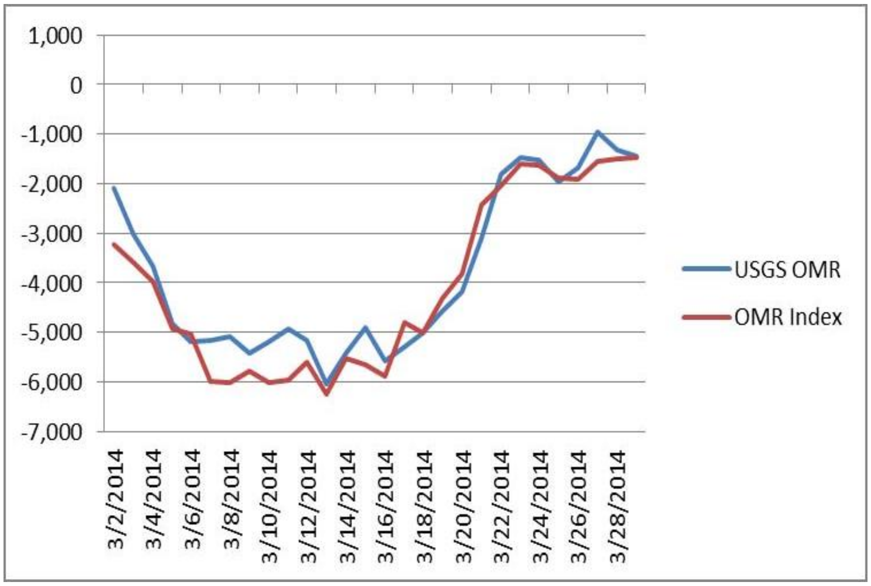

Figure 1: Daily OMR index and USGS gauged OMR values[4]

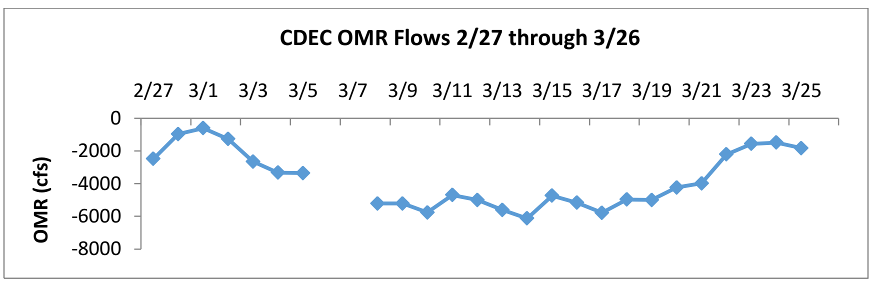

Figure 2: CDEC Tidally Filtered OMR Flows for Past 30 Days[5]

Barrier Period Proposed Actions

This period describes continuing operational modifications following installation of the drought barriers and continuing through November 15, 2014. Under the proposed action during the June to November period with the salinity barriers in place, Delta outflows could range from approximately 2,000 to 2,500 cfs to manage water quality for in-Delta uses and project diversions. Without the installation of the temporary drought barriers, projected outflow would be approximately 3,000 cfs, as X2 would be required to be located further west. Three temporary drought barriers will be installed at the head of Sutter Slough and Steamboat Slough in the North Delta and in False River in the Central Delta (Figure 29). The proposed suite of operational modifications in June through November 15 includes continuation of some provisions in the current TUC Order regarding compliance specifications for outflow

[4] Data Received from Aaron Miller, CDWR, on 4/01/2104
[5] Received from Aaron Miller, CDWR, on 04/01/2014

requirements and averaging periods for export/inflow (E/I) ratio requirements. Specific elements of the proposal for June through November 15 relative to NMFS BiOp provisions, and D-1641 provisions are defined in the Drought Operations Plan. No modifications to the USFWS BiOp RPA actions are currently proposed during June through November 15.

Ninety percent forecasts with and without the proposed barriers show a gain of 149,000 AF in cumulative end of September carryover storage between all reservoirs as a result of implementing the emergency drought barriers.

DELTA SMELT CRITICAL HABITAT

Primary Constituent Elements

Primary Constituent Elements (PCEs) for Delta Smelt include physical habitat, water, river flow, and salinity.

- **Physical** habitat is defined as the structural components of habitat. As Delta Smelt are pelagic fish, spawning substrate, along with depth variation (Bennett et al. 2002) are important structural components of habitat.
- **Water** is defined as water of suitable quality to support various Delta Smelt life stages with the abiotic elements that allow for survival and reproduction. Delta Smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of water temperature, turbidity, and food availability characterize suitable pelagic habitat for Delta Smelt.
- **River flow** is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile Delta Smelt. Inflow, outflow, and Old and Middle River flows (OMR) influence the vulnerability of Delta Smelt larvae, juveniles, and adults to entrainment at the CVP and SWP pumping facilities. River flow interacts with the fourth primary constituent element, salinity, by influencing the extent and location of the highly productive LSZ, the primary rearing area for Delta Smelt.
- **Salinity**, for this critical habitat component of the review, is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water and is defined as 0.5-6.0 practical salinity units (psu) (Kimmerer 2004). The 2 psu isohaline is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby et al. 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu isohaline to the Golden Gate Bridge (X2); X2 serves as an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby et al. 1995; Kimmerer 2002a). The LSZ moves downstream and expands when river flows into the estuary are high. Similarly, it moves upstream and contracts when river flows are low. During the past 40 years, monthly average X2 has varied from as far downstream as San Pablo Bay (45 km) to as far upstream as Rio Vista on the Sacramento River (95 km). At all times of year, the location of X2 influences both the area and quality of habitat available for Delta Smelt to successfully complete their life cycle. In general, Delta Smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish the more frequently and further the LSZ moves upstream, toward the confluence of the Sacramento and San Joaquin rivers as may occur in the summer of 2014.

Status of Critical Habitat within the Action Area

As described in the USFWS Biological Opinion 2008, the existing physical appearance and hydrodynamics of the Action Area have changed substantially from the environment in which native fish species like Delta Smelt evolved. The Action Area once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Action Area from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002b). Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows (Knowles 2002), though Delta outflows have been tightly constrained during late summer-fall for several decades.

Channelization, conversion of Delta islands to agriculture, and water operations have substantially changed the physical appearance, water salinity, water clarity, and hydrology of the Action Area. As a consequence of these changes, most life stages of the Delta Smelt are now distributed across a smaller area than historically (Arthur et al. 1996, Feyrer et al. 2007).

As described in recent BOs such as the USFWS (2014a) BO on the Georgiana Slough Floating Fish Guidance Structure, a number of factors in addition to SWP/CVP have affected Delta Smelt critical habitat in the Action Area, e.g., contaminants and Microcystis, both of which may affect Delta Smelt prey. Introduced species have also impacted the Action Area in several ways including added predation to adult and juvenile Delta Smelt from introduced piscivorous fishes, changes in prey composition due to the introduction of several copepod species, added competition for food resources from introduced filter feeders, and submerged aquatic vegetation (particularly *Egeria densa*) that traps sediment and provides habitat for introduced piscivorous fishes.

EFFECTS REVIEW

Effects of Proposed Action Specific to Delta Smelt Designated Critical Habitat

Physical Habitat and Water Quality Effects

Physical habitat, and water quality, would be affected by the proposed April-May operations. Reduced outflow would result in salinity moving further upstream on the lower Sacramento River, and on the lower San Joaquin River. These changes could slightly alter the quantity of abiotic habitat available for Delta Smelt in the lower Sacramento River and Sacramento-San Joaquin Rivers confluence area, although the changes in conductivity generally are within the range of salinity occupied most by juvenile Delta Smelt in summer/fall. There is a low level of uncertainty in this conclusion.

Food Availability

Prey availability is constrained by habitat use which in turn affects what types of prey are encountered. Larval Delta Smelt are visual feeders. They find and select individual prey organisms and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Thus, Delta Smelt diets are largely comprised of small crustacean that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval Delta Smelt have particularly restricted diets (Nobriga 2002). They do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods: *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding Delta Smelt larvae are largely restricted to the larval stages of these copepods. As the delta grow larger their mouth gape increase, and their swimming ability strengthens, enabling them to target copepods.

In the laboratory, a turbid environment (>25 Nephelometric Turbidity Units [NTU]) was necessary to elicit a first feeding response (Baskerville-Bridges et al. 2000; Baskerville-Bridges 2004). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges et al. 2000; Mager et al. 2004; Baskerville-Bridges et al. 2004). The most common first prey of wild Delta Smelt larvae is the larval stages of several copepod species which occur in the North Delta region. It is hypothesized that the increased residence times of the water in the North Delta may allow for an increase in lower trophic production thereby leading to an increase in potential prey availability. There is moderate-high level of uncertainty in this conclusion.

Effects of Proposed Action during April-May Period

Hydrodynamic Effects (April-May).

DSM2 analysis based on modeled parameters described in the Drought Operations Plan Salmonid and Sturgeon Review, Analytical Framework section.

Since February 1, 2014, Sacramento River outflow effects on Delta hydrodynamics have been greater than what would be realized under the NMFS BiOp (2011) and D-1641 outflow standards for multiple periods of various durations due to drought contingency operations (Appendix A). During these periods, Delta and Longfin smelt have experienced lower outflows than if the D-1641 outflow standard could be met. As these lower outflow conditions persist into April and May greater proportions of these populations could be subject to poorer water quality and increasingly constrained habitat. There is a low level of uncertainty in this conclusion.

The proposed drought operation plan to have greater exports with minimal San Joaquin and Sacramento River outflow than would have been allowed under the 1:1 I:E ratios required in a Critical WY may reduce outmigration survival of larval and juvenile smelt that are currently in the Interior Delta by entraining them into the South Delta, exposing them to loss at the CVP/SWP export facilities, and increasing their travel time and exposure to degraded habitats and predators. There is a moderate level of uncertainty in this conclusion.

An element of the proposed action to offset potentially greater exports during April and May 2014 than allowed under RPA Action IV.2.1 is a facility shift in exports so that minimum pumping will occur at the SWP Banks Pumping Plan and the majority will occur at the CVP Jones Pumping Plant. This export shift will lower predation risks normally associated with the SWP Forebay.

The modified I:E ratio, proposed in the drought operation plan causes appreciable differences in hydrodynamics of the Central Delta. This region is a predominantly tidal environment when Vernalis outflows are low and OMR flows are in the -2,000 to -3,000 cfs range. In these conditions, the daily proportion of positive flows is close to 50% across the lower San Joaquin River migration corridor, although considerably less than 50% close to the fish collection facilities on Old. If exports were further limited to reflect an I:E of 1:1, the daily proportion of positive flows would be even greater in the Central Delta and potentially positively flowing toward the western Delta. Exports greater than Vernalis inflow during April and May will make Old and Middle River flow more negative than under the unmodified RPA Action IV.2.1. At OMR flow values (more negative than -5,000 cfs), the daily proportion of positive flows in the Central Delta and at South Delta distributaries entering from the Lower San Joaquin River can be less than half the day even when Vernalis inflow in greater than 1,000 cfs. As this entrainment footprint enters the Central Delta, Delta Smelt may have a greater risk to entrainment into the South Delta than under the unmodified action. A minority of the daily flow measurements along the Lower San Joaquin River migration corridor are positive when OMR values range between -6,500 and -6,000 at Vernalis inflow values examined, suggesting a greater risk of entrainment of larval and juvenile smelt into the South Delta than under the un modified action. There is a moderate level of uncertainty in these conclusions.

Delta Smelt Effects (April-May 15)

Current Delta Smelt Distribution

The most recent Spring Kodiak Trawl found that the current distribution of adult Delta Smelt within the estuary is primarily in the Sacramento River system, especially the Cache Slough Complex, and Suisun Marsh (Figure 3). The most recent survey caught only one Delta Smelt (1% of total catch) in the San Joaquin system, indicating that the majority of the population is outside of the influence of the export facilities. However, supplemental U.S. Fish and Wildlife Service sampling in the lower San Joaquin River (Jersey Point, Figure 4) shows that Delta Smelt are maintaining a consistent presence in the region.

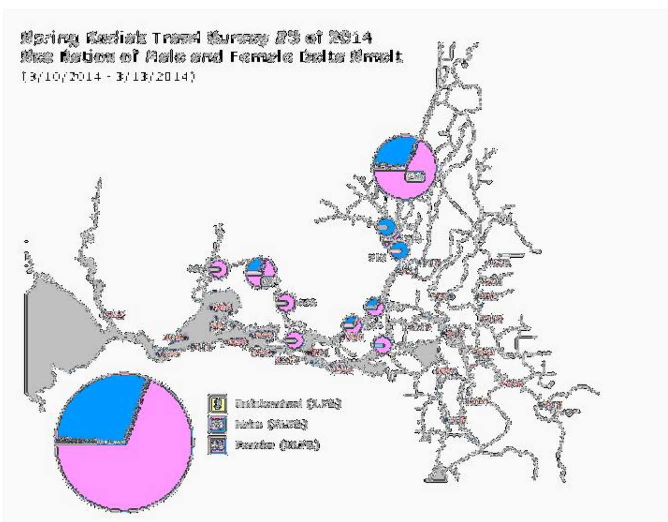

Figure 3, Spring Kodiak Trawl #3 Delta Smelt Catch[6]

[6] Retrieved from http://www.dfg.ca.gov/delta/projects.asp?ProjectID=SKT on 3/26/2014

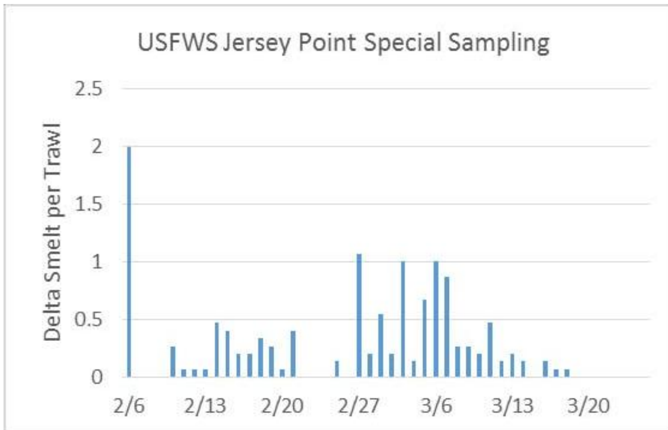

Figure 4, USFWS Jersey Point Special Sampling[7]

A single larval Delta Smelt was salvaged on April 3, 2014. No adult Delta Smelt have been observed in salvage this water year at the South Delta fish facilities. However, pre-screen loss and entrainment effects (e.g. predation) can occur despite zero observed salvage at the facilities, and these effects are difficult to detect and quantify. In addition, salvage operations at the CVP have been sporadically impacted by high levels of debris and outages.

Recent monitoring confirms that Delta Smelt have begun spawning with larvae detected in the Sacramento River system as of March 3. Larvae have been detected in the lower San Joaquin River as of March 17 (Figure 5). In addition, the most recent 20 mm survey, conducted April 2-4, has detected juvenile Delta Smelt in the San Joaquin River upstream of the confluence with the Mokelumne River. The presence of newly hatched larvae and juveniles in the lower San Joaquin River heightens concerns for operations, as these fish are susceptible to the effects of increased South Delta exports. It is likely that hatching will continue to increase over the next few weeks as water temperatures rise. As temperatures rise and more larvae recruit to juvenile size, a more broad distribution in the central Delta may become evident. A temperature off ramp occurs when water temperatures at Clifton Court reach 25°C for three consecutive days (FWS BO 2008). This off ramp typically occurs in late June, if at all (an alternate, calendar based off ramp is June 30), but due to the drought, water temperatures may reach this threshold earlier than normal.

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[7] Data provided to Smelt Working Group on 3/25/2014

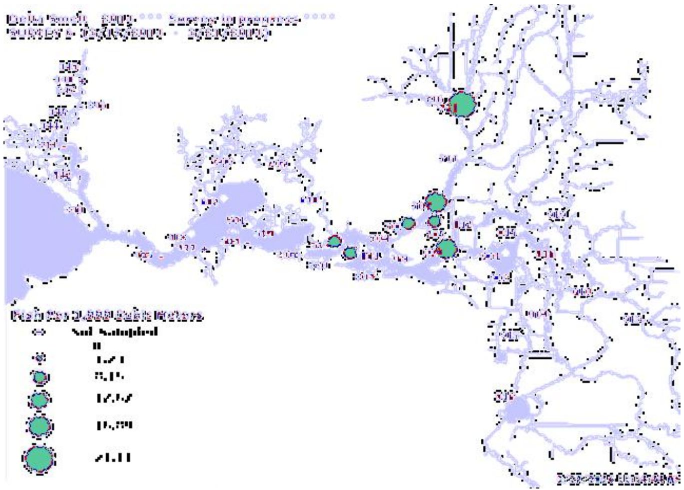

Figure 5, Smelt Larval Survey #6 Delta Smelt catch[8]

Adult Delta Smelt Effects (April-May)

During the April-May 15 period of the proposed action, the primary consideration regarding the Delta Smelt population is for entrainment risk of age-0 fish (larvae and juveniles). If the SKT and USFWS Jersey Point survey results reasonably reflect the current distribution of Delta Smelt, there is a small but persistent population centered in the vicinity of Jersey Point. Entrainment of these adults is unlikely to be a management issue this year. If the SKT and USFWS Jersey Point survey results reasonably reflect the current distribution of Delta Smelt, entrainment of adults is unlikely to be a management issue this year. After the onset of spawning, salvage of adult Delta Smelt typically diminishes, with the regulatory focus shifting from protection of adults to the protection of larvae/juveniles by the end of March (as determined by water temperatures or biological triggers; FWS BO, 2008). The salvage of adult Delta Smelt typically ends by May (Figure 6).

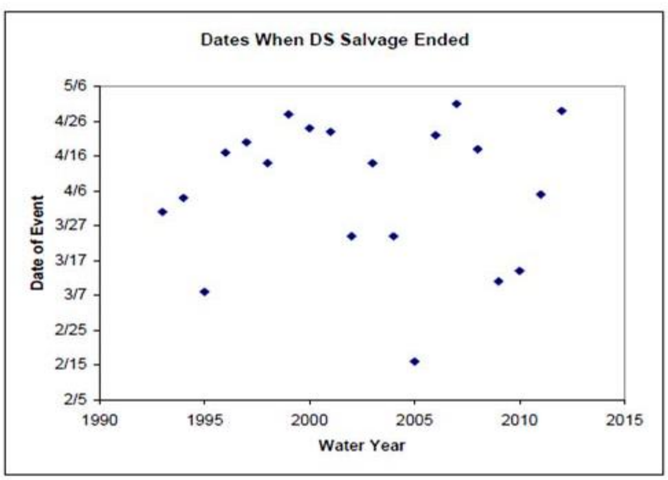

Figure 6: Dates of salvage of last adult Delta Smelt for water year (1993-2012)[9]

[8] Retrieved from http://www.dfg.ca.gov/delta/projects.asp?ProjectID=SLS on 3/26/14

[9] Graph provided by Robert Fujimura, CDFW, on 1/14/2013

Published analyses of a 13-year dataset of salvage records at the CVP/SWP fish collection facilities indicate that increased salvage of adult Delta Smelt at the CVP/SWP occurs when turbidities increase in the South Delta and Old and Middle River flows are highly negative (Grimaldo et al., 2009). Given the present low turbidity in the South Delta (Figure 9), migration of adults into areas of elevated entrainment risk is not expected. However, with increased export levels, there is a greater chance of adult Delta Smelt being drawn into areas of elevated entrainment risk.

The short-term effects of changes in OMR related to the proposed actions are not expected to substantially increase entrainment risk for the population of adult Delta Smelt. Nonetheless, as a result of February and March storms, it is possible that some undetected adult Delta Smelt are located in the South Delta that could be at a higher risk of entrainment. There is a moderate level of uncertainty about this assessment for adult Delta Smelt.

The main smelt-focused surveys (20mm and Smelt Larva Survey) do not sample close to the Sutter Slough and Steamboat Slough barrier locations. However, Delta Smelt adults and early life stages have been collected in the Sacramento River upstream of Georgiana Slough historically in the Sacramento Trawl and Sacramento area beach seines and therefore could be present near the Sutter Slough and Steamboat Slough sites. Indeed, Delta Smelt were collected by trawling at Sherwood Harbor during early March (Figure 7).

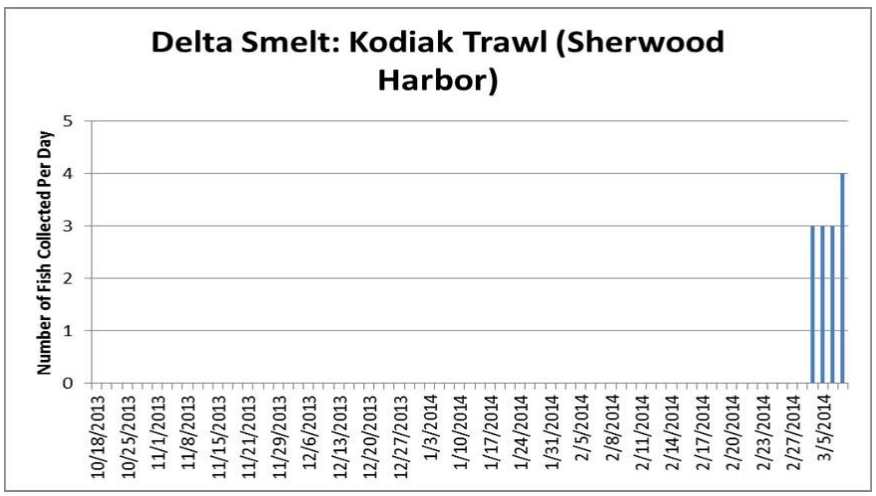

Figure 7, Daily Number of Delta Smelt Collected During Kodiak Trawling at Sherwood Harbor on the Sacramento River, October 18-March 8, 2014.[10]

Larval Delta Smelt Effects (April-May)

The distribution of newly hatched larval Delta Smelt in the lower San Joaquin River is assumed to be similar to the distribution of adults, which are not currently at a high risk of entrainment. Recent larval survey results further support this assumption (see above). However, if undetected adults are present in the south Delta, offspring from these fish may easily be entrained under the proposed action. The entrainment risk of larval Delta Smelt produced in the lower San Joaquin River is expected to

[10] Source: Speegle (pers. comm.). Note that typical daily sampling frequency is ten 20-minute trawls.

be moderated by the maintenance of Index OMR flows at -5,000 cfs on a 14 day running average under the proposed action.

Analyses of salvage patterns at the export facilities indicates that increased larval Delta Smelt salvage is associated with higher levels of turbidity and more negative Old and Middle River flows (Grimaldo et al., 2009). As with adults, the current low turbidity conditions are expected to be maintained during the proposed action for April-May and would be similar to operations that occurred during the week of March 16, which did not result in substantial increases in turbidity in the lower San Joaquin or in the OMR corridor (Figure 8). Thus, the proposed action is unlikely to create turbidity conditions that will cause larval Delta Smelt to move into the South Delta.

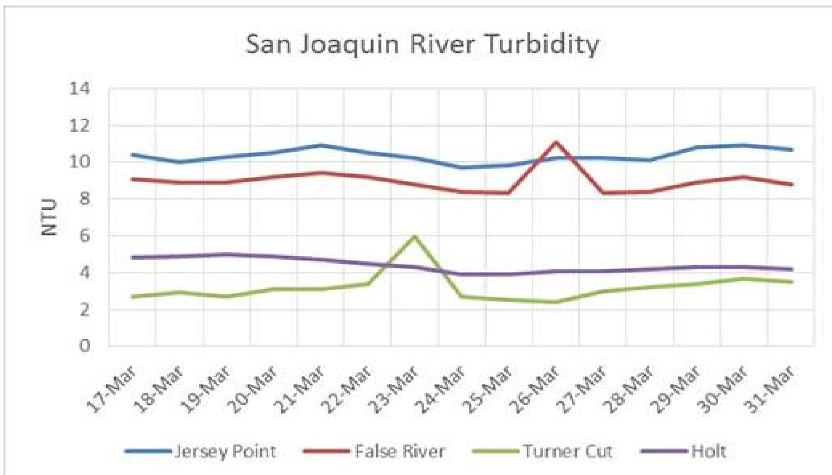

Figure 8, San Joaquin River Turbidities[11]

Recent PTM runs requested by the Smelt Working Group support the conclusion that, given recent distribution data from field surveys, larval Delta Smelt entrainment under the proposed action will be minimal. This modelling was run under conditions similar to the hydrology expected under the proposed actions (from the week of March 16, Table 1), namely OMR flows of -5,000 cfs and moderately negative QWEST flows (around -3,500 cfs). Insertion points for the model were based on the known locations of adult and larval Delta Smelt, primarily throughout the lower San Joaquin River system. Insertion timing of the particles was one week prior to the period of increased pumping during the week of March 16 (Scenario A) and again during this period of increased pumping (Scenario B). The models were run for 30 days. With larval smelt currently present in the lower San Joaquin River, the results from Scenario A are most informative towards predicting the effects of the proposed action (i.e. larval smelt presence exists prior to the implementation of proposed changes in hydrodynamics). Additionally, current surveys indicate that the center of Delta Smelt distribution in the San Joaquin system is near Jersey Point, making station 809 the most relevant insertion point for assessing current risk.

[11] Graph provided to the Smelt Working Group on 4/01/14. Data from CDEC.

Date	Delta Inflows [cfs]								Delta Exports [cfs]			Flow Req'mts				Cons. Use		OMR Flows			Q-West
	Sacram. River	Yolo bypass	Sacto Treat. rel.	DXC Gate ops	San Joaquin River	Cosum River	Mokel. River	Calaver River	Clifton Court intake	Jones pump	Delta precip. [in]	NDOI	% of Inflow Diverted		Precip. Runoff Calcul.	Gross chan'l deplet.	NDOI	Daily Index	5-Day	14-Day	
	Freeport prev.day FPT	Cache &weirs pr.day	estim. week avg pr.day	% of day open current day	Vernalis prior day VNS	Michigan Bar pr. Day	Wood-bridge pr.day	New Hogan pr.day			prev day, inches	Daily	3 Day avg	14 Day avg	5 Day avg cfs	Day-flow table 4	7 or 3 -day avg (cfs)	Value	Avg	Avg	
26-Feb-14	7,138	10	190	0	604	70	112	10	698	800	0.36	5,531	17.7	11.1	0.0	900	5885	-1250	-1441	-3174	487
27-Feb-14	7,392	0	190	0	652	123.54167	113	10	693	805	0	7,724	18.2	12.3	2054.0	900	6374	-1251	-1226	-2921	1952
28-Feb-14	8,706	71	190	0	836	786.54167	240	10.791667	691	827	1.16	8,126	18.1	13.4	2054.0	900	7127	-1250	-1252	-2669	3070
1-Mar-14	14,683	112	190	0	1174	1007.75	164	10.25	694	811	0	17,041	16.3	14.1	8672.3	950	10964	-1150	-1232	-2408	8634
2-Mar-14	20,582	437	190	0	1082	497.16667	101	10	2496	1458	0	21,315	18.8	21.4	8672.3	1000	15494	-3240	-1628	-2295	6265
3-Mar-14	21,367	137	190	0	977	376.33333	110	18.291667	2198	2085	0.16	25,935	19.0	28.3	8672.3	1000	21430	-3594	-2097	-2205	5844
4-Mar-14	19,341	65	190	0	970	657.45833	139	21.375	2195	2447	0.04	24,917	20.3	35.2	7531.2	1000	24056	-3973	-2641	-2175	4757
5-Mar-14	19,682	230	190	0	963	578.95833	134	12	2792	2871	0.16	22,513	21.6	37.8	7759.5	1050	24455	-4919	-3375	-2275	3791
6-Mar-14	26,086	196	190	0	924	1112.125	119	11.791667	2493	3312	0.04	16,878	24.3	39.6	2054.0	1050	21436	-5045	-4154	-2063	1281
7-Mar-14	27,754	110	190	0	913	947.70833	122	15	3488	3297	0	22,913	25.4	41.1	2282.2	1050	20768	-5971	-4700	-2283	485
8-Mar-14	25,724	101	190	0	910	625.04167	128	23.041667	3487	3301	0	24,316	24.1	39.8	2282.2	1100	21369	-6016	-5185	-2506	-162
9-Mar-14	22,948	69	190	0	946	479.70833	125	23	3351	3195	0	21,275	23.3	38.2	1369.3	1100	22835	-5791	-5548	-2723	-988
10-Mar-14	19,937	0	190	0	998	416.25	121	23.041667	3496	3326	0	17,820	24.5	36.0	1141.1	1100	21137	-6020	-5769	-2993	-1823
11-Mar-14	17,817	43	190	0	974	378.375	100	21.916667	3499	3273	0	13,936	27.2	34.2	228.2	1150	17677	-5963	-5952	-3300	-2750
12-Mar-14	21,499	36	190	0	972	302.25	100	21	2994	3361	0	11,916	30.2	32.4	0.0	1150	14557	-5601	-5878	-3617	-2069
13-Mar-14	22,681	0	190	0	979	254.25	120	21	3694	3356	0	14,763	31.3	31.1	0.0	1200	13538	-6249	-5925	-3953	-2664
14-Mar-14	19,541	0	190	0	978	224.125	125	21	3492	2736	0	16,694	29.2	28.8	0.0	1250	14457	-5518	-5870	-4283	-2317
15-Mar-14	15,674	0	190	0	961	200.375	126	21	3498	2891	0	13,344	28.6	28.0	0.0	1250	14933	-5658	-5798	-4609	-3061
16-Mar-14	12,982	0	190	0	961	181.25	124	21.791667	3288	3338	0	9,129	30.7	27.4	0.0	1300	13056	-5896	-5785	-4906	-3712
17-Mar-14	11,617	0	190	0	949	166.79167	123	22.666667	2090	3345	0	7,726	34.7	26.8	0.0	1350	10067	-4809	-5626	-5158	-2591
18-Mar-14	10,449	0	190	0	868	156.625	123	23	2283	3350	0	6,030	39.1	26.4	0.0	1350	7629	-4995	-5376	-5353	-3139
19-Mar-14	9,395	0	190	0	784	146.33333	100	23	1488	3346	0	5,513	39.7	24.4	0.0	1400	6423	-4323	-5136	-5479	-2637
20-Mar-14	8,299	0	190	0	900	200	100	10	1500	2700	0	4,884	40.8	23.5	0.0	1400	5476	-3875	-4780	-5523	-2082
21-Mar-14	7,392	0	190	0	900	200	100	10	1200	1400	0	5,479	35.6	19.9	0.0	1450	5292	-2374	-4075	-5479	-635
22-Mar-14	7,237	0	190	0	900	200	100	10	1200	1000	0	4,922	30.3	16.6	0.0	1500	5095	-2021	-3518	-5360	-288
23-Mar-14	7,113	0	190	0	900	200	100	10	700	1000	0	5,267	23.3	12.9	0.0	1500	5223	-1566	-2832	-5166	195
24-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	5,293	20.1	11.5	0.0	1550	5161	-1395	-2246	-4914	487
25-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	6,230	17.0	10.5	0.0	1550	5597	-1395	-1750	-4614	487
26-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	6,180	15.8	10.6	0.0	1600	5901	-1406	-1557	-4305	455
27-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	6,180	15.2	11.4	0.0	1600	6197	-1406	-1434	-3984	455
28-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	6,130	15.2	12.5	0.0	1650	6163	-1418	-1404	-3665	422
29-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	6,130	15.2	13.4	0.0	1650	6147	-1418	-1408	-3352	422
30-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	6,130	15.2	14.2	0.0	1650	6130	-1418	-1413	-3040	422
31-Mar-14	8,050	0	190	0	900	200	100	10	700	800	0	6,080	15.2	14.7	0.0	1700	6113	-1429	-1418	-2739	390
1-Apr-14	8,050				900	200	100	10	700	800	0	6,030	15.2	15.1	0.0	1750	6080	-1440	-1424	-2457	357
2-Apr-14	8,050				900	200	100	10	700	800	0	6,030	15.2	15.3	0.0	1750	6047	-1440	-1429	-2192	357
3-Apr-14	8,050				1400	200	100	10	700	800	0	6,030	15.2	15.5	0.0	1750	6030	-1440	-1434	-1953	857
4-Apr-14	8,050				1750	200	100	10	700	800	0	6,480	15.0	15.5	0.0	1800	6180	-1216	-1393	-1761	1175
5-Apr-14	8,050				1900	200	100	10	700	800	0	6,830	14.5	15.3	0.0	1800	6447	-1051	-1318	-1604	1325
6-Apr-14	8,050				1800	200	100	10	700	800	0	6,980	14.1	15.1	0.0	1800	6763	-981	-1226	-1490	1225
7-Apr-14	8,050				1700	200	100	10	700	800	0	6,880	13.9	14.9	0.0	1800	6897	-1028	-1143	-1411	1125
8-Apr-14	8,050				1700	200	100	10	700	800	0	6,730	13.9	14.8	0.0	1850	6863	-1086	-1073	-1362	1092
9-Apr-14	8,050				1700	200	100	10	700	800	0	6,730	14.0	14.7	0.0	1850	6780	-1086	-1047	-1326	1092
10-Apr-14	8,050				1700	200	100	10	700	800	0	6,730	14.0	14.6	0.0	1850	6730	-1086	-1054	-1299	1092
11-Apr-14	8,050				1700	200	100	10	700	800	0	6,730	14.0	14.5	0.0	1850	6730	-1086	-1075	-1275	1092
12-Apr-14	8,050				1700	200	100	10	700	800	0	6,730	14.0	14.4	0.0	1850	6730	-1086	-1086	-1252	1092
13-Apr-14	8,050				1700	200	100	10	700	800	0	6,680	14.0	14.4	0.0	1900	6713	-1098	-1089	-1229	1060
14-Apr-14	8,050				1700	200	100	10	700	800	0	6,680	14.0	14.3	0.0	1900	6697	-1098	-1091	-1206	1060
15-Apr-14	8,050				1700	200	100	10	700	800	0	6,680	14.0	14.2	0.0	1900	6680	-1098	-1093	-1182	1060
16-Apr-14	8,050				1700	200	100	10	700	800	0	6,680	14.0	14.1	0.0	1900	6680	-1098	-1095	-1158	1060
17-Apr-14	8,050				1700	200	100	10	700	800	0	6,680	14.0	14.0	0.0	1900	6680	-1098	-1098	-1134	1060
18-Apr-14	8,050				1700	200	100	10	700	800	0	6,680	14.0	14.0	0.0	1900	6680	-1098	-1098	-1113	1060

Table 1, Hydrology Used in PTM Run[12]

PTM results for station 809 in Scenario A found that roughly 8% of particles were entrained south of Holland Tract (Figure 9), 3% were entrained south of Mandeville Island (Figure 10), and 5% were entrained at the projects (Figure 12) by the end of the model period (April 18), while flux past Chipps Island was 35% (Figure 11). These results suggest that the hydrodynamics under the proposed action will likely not result in significantly increased levels of larval Delta Smelt entrainment at the South Delta export facilities.

[12] Model hydrology provided by Dan Yamanaka (DWR) on 3/26/14

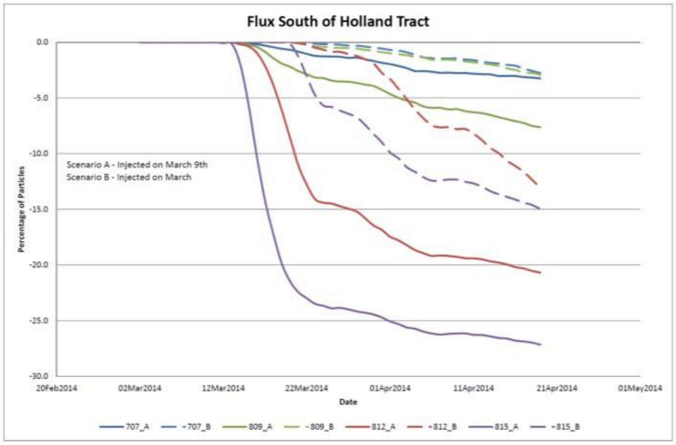

Figure 9, PTM Results for Holland Tract Flux[13]

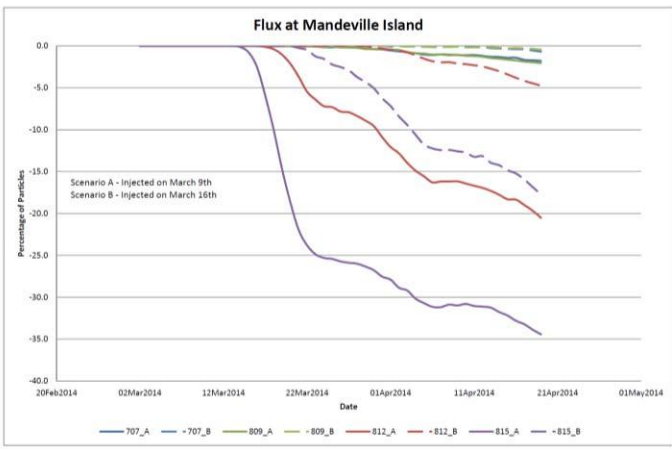

Figure 10, PTM Results for Mandeville Island Flux[14]

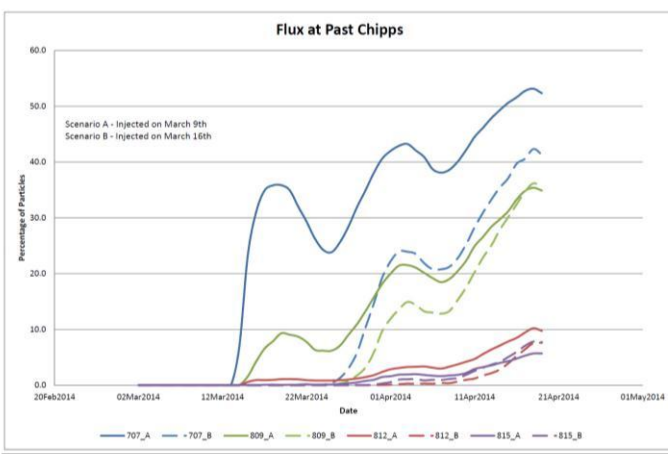

Figure 11, PTM Results for Flux Past Chipps Island[15]

[13] PTM results provided to the Smelt Working Group on 3/21/14 by DWR
[14] PTM results provided to the Smelt Working Group on 3/21/14 by DWR
[15] PTM results provided to the Smelt Working Group on 3/21/14 by DWR

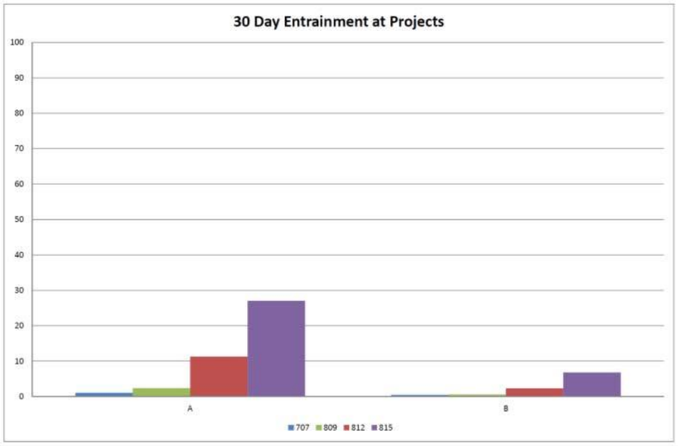

Figure 12, PTM Results for Percent of Particles Entrained at SWP/CVP after 30 Days[16]

Although implementation of the April-May proposed actions are not expected to substantially increase entrainment for larval Delta Smelt located in the lower San Joaquin River. Some increase in entrainment risk is expected compared operations that would occur under an unmodified NMFS IV.2.1. Furthermore, undetected larval Delta Smelt potentially located in the South Delta would also be at a higher risk of entrainment. There is a moderate level of uncertainty about this assessment for larval Delta Smelt.

Longfin Smelt Effects (April-May)

Current Longfin Smelt Distribution

Fish surveys and salvage suggest there was limited Longfin Smelt spawning in the central or south Delta this year, resulting in low densities of larval and juvenile Longfin Smelt in this region. The majority of larval and juvenile Longfin Smelt appear to be distributed in the lower Sacramento and San Joaquin rivers, and the confluence of these rivers, with smaller densities distributed in Suisun Bay, the Cache Slough Complex, and in the South Delta (Figure 5). This water year, no adult Longfin Smelt have been collected in salvage, or in the central or south Delta during Bay Study sampling, December-March, or in the final Fall Midwater Trawl sampling in December, or in the USFWS special study at Jersey Point. Longfin Smelt larvae were detected at 8 of 12 central and south Delta sampling stations during Smelt Larva Survey #3, conducted February 3-5, 2014. However, subsequent Smelt Larva Survey sampling indicated densities of Longfin Smelt larvae in the central and south Delta rapidly diminished in following weeks. The last Smelt Larva Survey of 2014 (SLS #6), conducted March 17-21, detected larvae at only 2 of 12 central and south Delta stations, with moderate densities detected only at station 809 situated at Jersey Point (Figure 13). The first detection of age-0 Longfin Smelt in salvage in 2014 occurred on February 24 (Figure 14). Near daily detection of age-0 Longfin Smelt in salvage continued through the first week in March, followed by detection on only three days between March 5 and April 1. It should be noted that larval sampling at the CVP facility did not begin until March 13 and has proceeded on an intermittent schedule due to facility maintenance.

[16] PTM results provided to the Smelt Working Group on 3/21/14 by DWR

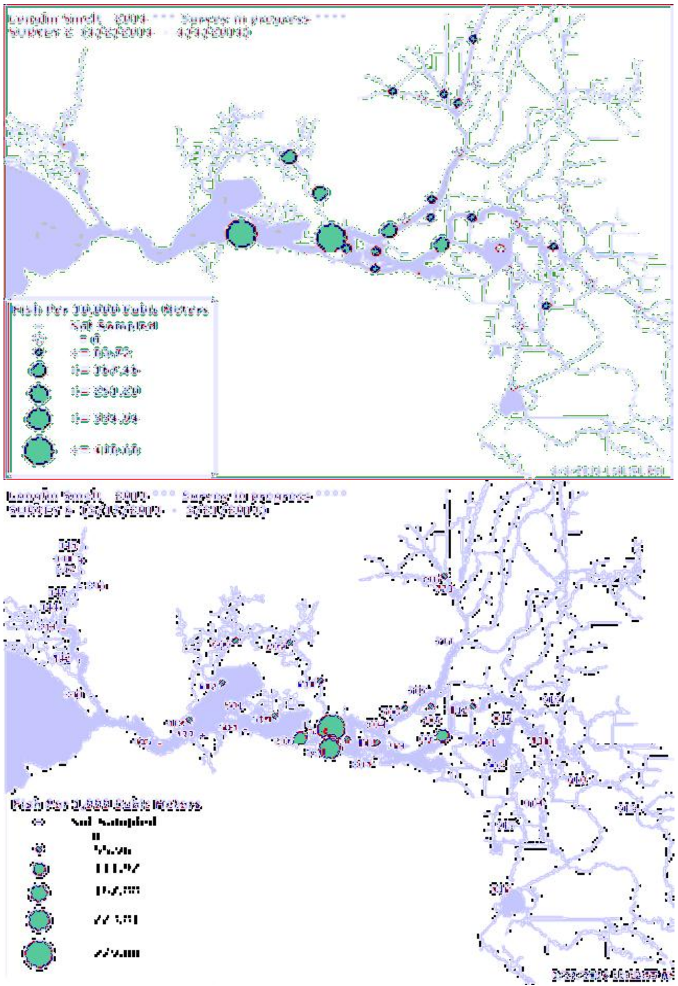

Figure 13, Longfin age-0 distribution from 20 mm survey #1 (top) and Smelt Larval Survey #6 (bottom)[17]

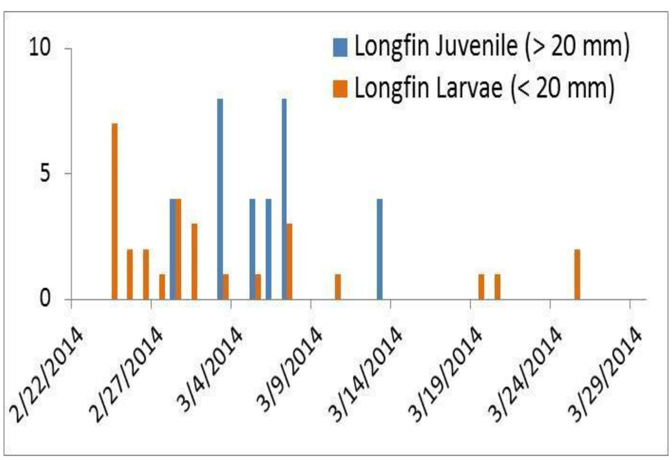

Figure 14, larval detection and expanded juvenile salvage of age-0 Longfin Smelt, water year 2014[18]

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[17] Retrieved from http://www.dfg.ca.gov/delta/data/ on 3/26/14
[18] Retrieved from http://www.dfg.ca.gov/delta/apps/salvage/Default.aspx on 3/26/14

Adult Longfin Smelt Effects (April-May)

Given their current distribution, the proposed actions are not anticipated to affect adult Longfin Smelt in the April-May period.

Larval Longfin Smelt Effects (April-May)

During the majority of the April-May period, the primary consideration regarding the Longfin Smelt population is for entrainment risk of age-0 fish (larvae and juveniles). Daily OMR values, QWEST, and NDOI, under the proposed action, are expected to be more negative in early April prior to the pulse flow period, and in May following the pulse flow period if wet climatic conditions prevail, but would be relatively unchanged during the pulse period and in May following the pulse period under dry conditions. Based on current Longfin Smelt distributions this hydrology would result in an increased level of entrainment of larvae and juveniles distributed in the central and south Delta during the affected periods. However, given the limited distribution of larvae and juveniles in this region, the proposed action will likely not substantially affect the Longfin Smelt population. Additionally, larval Longfin Smelt salvage decreases as water temperatures rise in the spring months, so salvage is likely to continue declining through the action period regardless of operations. Overall, potential increased entrainment effects on Longfin Smelt resulting from the proposed actions will be limited, although a demonstrated positive relationship between Longfin Smelt abundance and winter-spring Delta outflow (Kimmerer 2002; Rosenfeld and Baxter 2007) suggests reduced outflow in April under the proposed action will result in some reduction in overall abundance. There is a low level of uncertainty about this conclusion.

Effects of Proposed Actions during the Barrier Period

Physical Habitat and Water Quality Effects

A reduction in the proportion of Sacramento River flow entering Sutter and Steamboat sloughs, coupled with reduced tidal action upstream of the barriers in these sloughs, may result in poorer water quality in portions of these sloughs that are upstream of the barriers; monitoring of water quality (e.g., dissolved oxygen) would occur and culverts would be opened as necessary in order to improve water quality as necessary.

DSM2 modelling conducted primarily to assess the potential effects of the Emergency Drought Barriers (EDB) on water quality for export and in-Delta use also provides some perspective on potential effects in relation to changes in salinity (electrical conductivity, EC) that could affect Delta Smelt. Note that this preliminary modeling was based on the February forecast for subsequent hydrology and did not account for precipitation in late February/early March; although the maximum salinity patterns are uncertain (dependent on actual outflow), the seasonal increases at the various locations and the changes caused by the EDB are more reliable and indicative of the likely habitat conditions.

In general, the modeling suggests that there would be little difference in conductivity during the operational period of the barriers on the lower San Joaquin River seaward of False River (e.g., at Jersey Point), whereas conductivity would be lower with the barriers in place along the water supply channels (e.g., Old River, Middle River and Rock Slough) that are important for some water users, including in-Delta diversions, south Delta exports, and diversions by Contra Costa Water District. Although the barrier at West False River would prevent most tidal flow from entering False River and therefore tidal flow would tend to move further upstream on the lower San Joaquin River, the modeling suggests that the greater flow coming down the Mokelumne River (via Georgiana Slough and DCC) caused by the Sutter and Steamboat slough barriers would counteract this effect. From this information it is inferred that there would little effect on Delta Smelt from changes in conductivity in the lower San Joaquin River, particularly in light of the relatively low occurrence of Delta Smelt in this area during the summer (Merz et al. 2011)

In contrast to the situation on the lower San Joaquin River, slightly higher conductivity would occur further upstream on the lower Sacramento River because of less freshwater moving down Sutter and Steamboat sloughs and in the Sacramento River at Rio Vista. For example, preliminary DSM2 modeling based on 90% exceedance historical hydrology and forecasted operations through the remainder of 2014 estimated that conductivity at Rio Vista would be between 1,200 and 1,800 micromhos per centimeter (µmhos/cm) during June-August with the EDB operating, whereas without the EDB conductivity would be 700 to 1,400 µmhos/cm (Figure 20). At Emmaton, conductivity also would be slightly higher (Figure 21). Greater conductivity further upstream on the lower Sacramento River could result in the Delta Smelt population that reside in the low salinity zone moving further upstream on the lower Sacramento River than would be the case without the EDB operating. This could result in a slightly smaller area of abiotic habitat, given the general decrease in habitat with movement upstream of the low-salinity zone (Feyrer et al. 2007). As Sommer and Mejia (2013) noted, however, Delta Smelt are not confined to a narrow salinity range and occur from fresh water to relatively high salinity, even though the center of distribution is consistently associated with X2 (Sommer et al. 2011). Nobriga et al. (2008) found that the probability of occurrence of Delta Smelt was highest at low conductivity (1,000-5,000 µmhos/cm), and declines at higher conductivity (Figure 25); conductivity forecasts at Rio Vista with the EDB operating and not operating are within this range during much of the summer (and more so with the EDB operating), whereas at Emmaton conductivity with the EDB operating is greater than 5,000 µmhos/cm during much of the summer/fall and more frequently within the 1,000-5,000 µmhos/cm range with the EDB not operating.

The barrier operation would result in salinity moving further upstream on the lower Sacramento River, whereas salinity on the lower San Joaquin River near or upstream of the West False River barrier would be similar or lower than without the barriers. These changes could slightly alter the quantity of abiotic habitat available for Delta Smelt in the lower Sacramento River and Sacramento-San Joaquin Rivers confluence area, although as noted previously, the changes in conductivity generally are within the range of salinity occupied most by juvenile Delta Smelt in summer/fall.

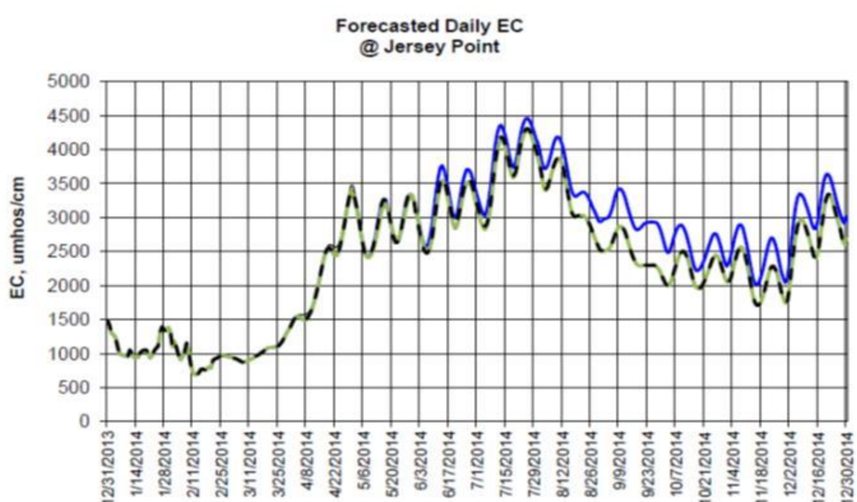


Figure 15, forecasted Daily Electrical Conductivity at Jersey Point, from DSM2 Modelling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.

Hydrodynamic Effects (Barrier Period)

Flow modeling suggests that operation of the drought barriers at Sutter and Steamboat slough in May and June will increase flow from the Sacramento River into the Mokelumne River via the Delta Cross Channel and Georgiana Slough, elevating daily mean flow in the lower San Joaquin River at Jersey Point and Antioch (Figures 16 and 17). Over the spring-neap tidal cycle, the gain in net outflow past Jersey Point and Antioch over the modeled period was mostly due to a dampening of negative daily tidal flows immediately preceding the neap tidal phase. Model scenarios were run with no barriers (base condition), with barriers commencing operation on May 1, and with barriers commencing operation on June 1. All model scenarios had DCC gates open in both May and June, and 90% exceedance historical hydrology and forecasted operations with drought barrier operation commencing on May 1, modeled net outflow at Jersey Point was over 1,800 cfs in May and slightly over 1,700 cfs in June (EDB May 1 in Figure 28), compared to around 990 cfs in May and slightly below 700 cfs in June without the drought barriers (Base in Figure 28). When modeled drought barrier operation commenced on June 1, net outflow at Jersey Point matched the base condition in May, and matched the EDB May 1 condition in June. The accuracy of model-projected flows is uncertain given the uncertainty of future precipitation and corresponding hydrodynamics. However, the relative difference between modeling scenarios provides an indication of the relative change in flow patterns caused by operation of the drought barriers.

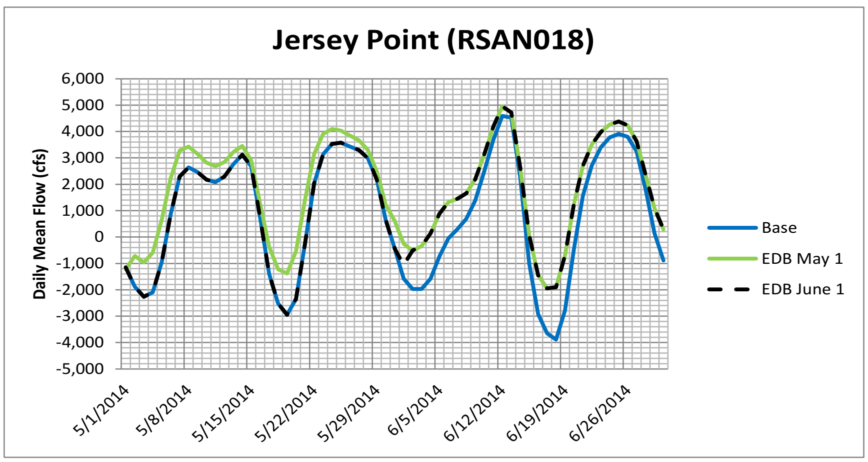


Figure 16, forecasted Mean Daily Flow at Jersey Point in May and June 2014, from DSM2-HYDRO Modeling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.

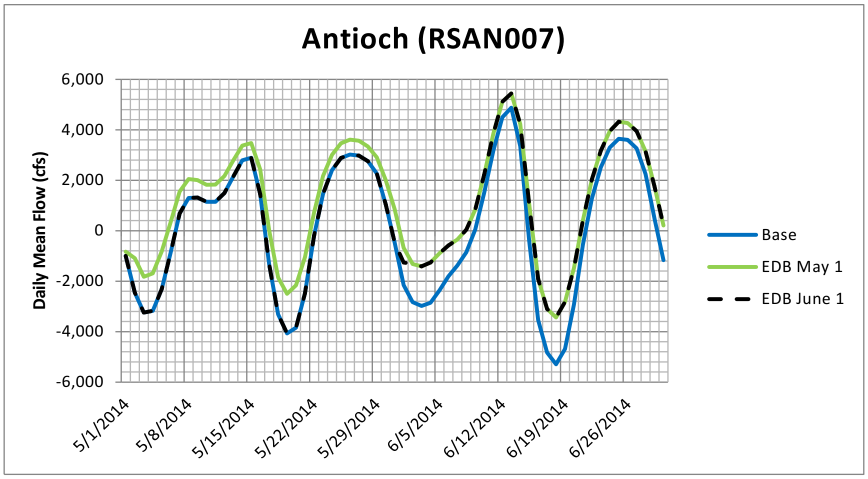


Figure 17, forecasted Mean Daily Flow at Antioch in May and June 2014, from DSM2-HYDRO Modeling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.

While modeling suggests net outflow in San Joaquin River at Jersey Point will be higher with operation of the drought barriers, OMR flows are projected to be slightly more negative (Figure 18). With drought barrier operation commencing on May 1, the mean OMR flow was -1,360 cfs in May and -1,440 cfs in June, compared to -1,290 cfs in May and -1,370 cfs in June without the barriers.

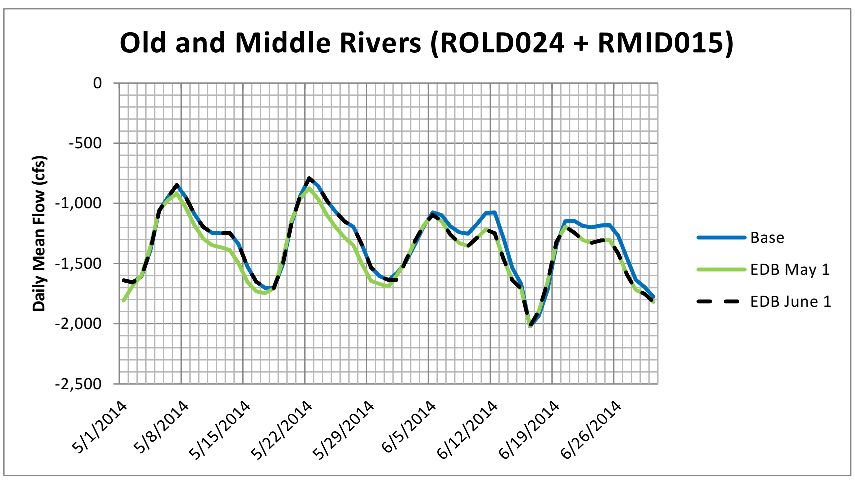
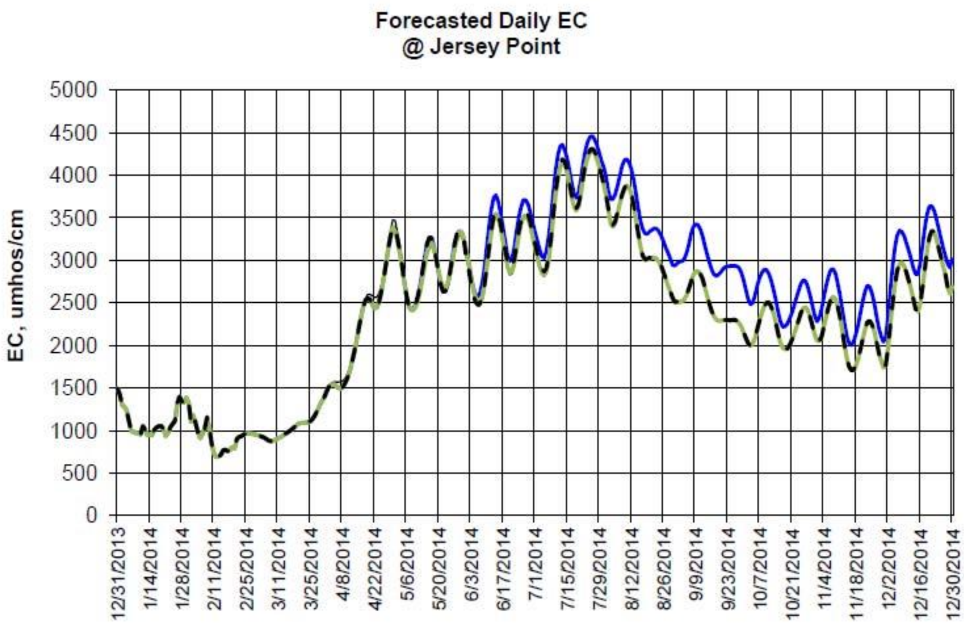


Figure 18, forecasted Mean Daily Flow at Old and Middle Rivers in May and June 2014, from DSM2-HYDRO Modeling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.

Water Quality Effects (Barrier Period)

Preliminary DSM2 modelling conducted primary modelling was also conducted to assess the potential effects of the emergency drought barriers on water quality. The same scenarios were used as described for flow modeling. However, operations and resulting water quality were forecasted through November 15. As with flow modelling, projected salinity patterns should be considered as reflecting the relative influence of barrier operation on salinity patterns, rather than as accurate predictions. In general, the modelling suggests barriers will have little effect on conductivity seaward of Jersey Point on the lower San Joaquin River during the operational period of the barriers (Jersey Point; Figure 19), whereas barriers would cause lower conductivity along south Delta water supply channels (e.g., Old River, Middle River and Rock Slough that are important for some water users, including in-Delta diversions, south Delta exports, and diversions by Contra Costa Water District. Although the barrier at West False River would be expected to force tidal flow further upstream on the main stem San Joaquin River, the modeling suggests this tidal forcing is counteracted by elevated Mokelumne River flow as discussed above under Hydrodynamic Effects.

In contrast to the situation on the lower San Joaquin River, models predict drought barriers will cause conductivity to increase on the lower Sacramento River due to the loss of Sacramento River to the Mokelumne River. For example, preliminary DSM2-QUAL modelling estimated that change in conductivity at Rio Vista would be as much as 500 micromhos per centimeter (µmhos/cm) during June-August with the emergency drought barriers, compared to 700 to 1,400 µmhos/cm without barriers (Figure 20). At Emmaton, conductivity would increase as much as 900 µmhos/cm (Figure 21).

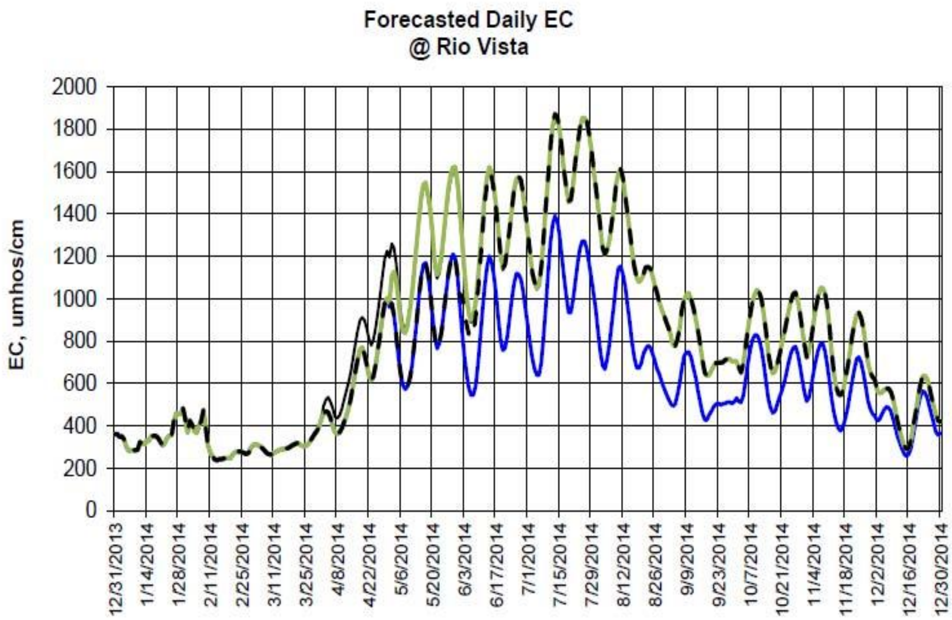


Source: Smith, pers. comm. Legend: Blue line = base case (no barriers); green line = EDB operations commencing May 1; broken black line = EDB operations commencing June 1.

Figure 19, forecasted Daily Electrical Conductivity at Jersey Point, from DSM2-QUAL Modeling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.

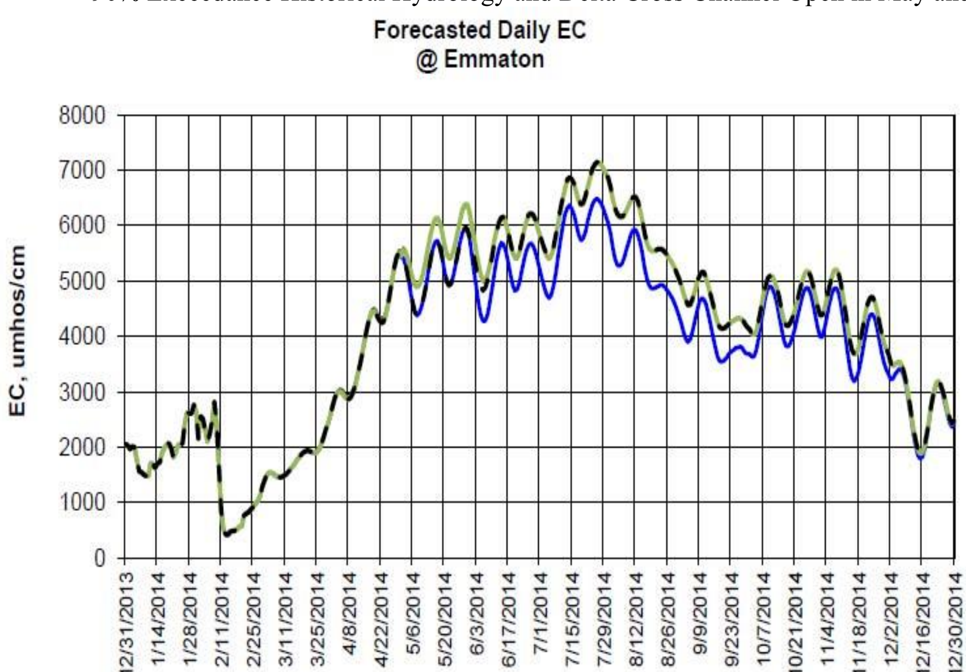
These Sacramento River conductivity values are relatively high compared to historical conditions. Updated forecast modelling may indicate that the Delta outflow can be maintained higher than these modeling scenarios accounted for (3,000 cfs or higher), which would result in lower than estimated conductivity at Emmaton and Rio Vista.

Modelled conductivity at locations downstream of the Sacramento River – San Joaquin River confluence was not affected by their operation (e.g. Collinsville, Figure 22).



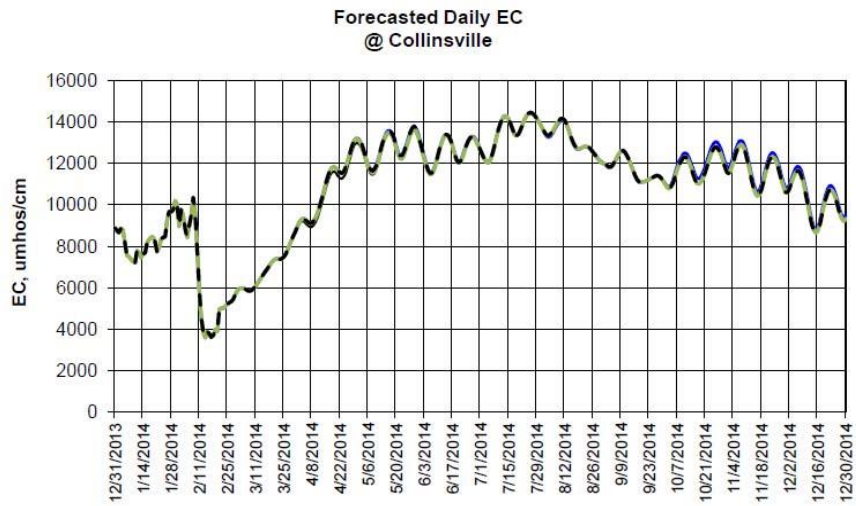
Source: Smith, pers. comm. Legend: Blue line = base case (no barriers); green line = EDB operations commencing May 1; broken black line = EDB operations commencing June 1.

Figure 20, forecasted Daily Electrical Conductivity at Rio Vista, from DSM2-QUAL Modeling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.



Source: Smith, pers. comm. Legend: Blue line = base case (no barriers); green line = EDB operations commencing May 1; broken black line = EDB operations commencing June 1.

Figure 21, forecasted Daily Electrical Conductivity at Emmaton, from DSM2-QUAL Modeling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.



Source: Smith, pers. comm. Legend: Blue line = base case (no barriers); green line = EDB operations commencing May 1; broken black line = EDB operations commencing June 1.

Figure 22, forecasted Daily Electrical Conductivity at Collinsville, from DSM2-QUAL Modeling, Based on 90% Exceedance Historical Hydrology and Delta Cross Channel Open in May and June.

Delta Smelt Effects (Barrier Period)

The main smelt-focused surveys (20mm and Smelt Larva Survey) do not sample close to the Sutter Slough and Steamboat Slough barrier locations. However, Delta Smelt adults and early life stages have been collected in the Sacramento River upstream of Georgiana Slough historically in the Sacramento Trawl and Sacramento area beach seines and therefore could be present at the Sutter Slough and Steamboat Slough sites. Indeed, Delta Smelt were collected by trawling at Sherwood Harbor during early March (Figure 7).

During the Barrier Period, adult Delta Smelt from the previous year have mostly expired. Some two year old fish survive through the summer to spawn the following year, but this is rare (2.3% to 9.3% of population in 2002 and 2003, respectively; Bennett 2005). Although the proportion of fish in this category is typically small, these age 1+ Delta Smelt produce more eggs than age 1 smelt, thus having a disproportionate effect on the population (Bennett 2005). We hypothesize that these age 1+ fish will have a greater ability to move out of areas of poor habitat quality due to their size, and thus will be more likely to survive compared to juvenile Delta Smelt (discussed below). For these reasons the remainder of our discussion regarding Delta Smelt during the Barrier Period will focus on effects on larvae and juveniles.

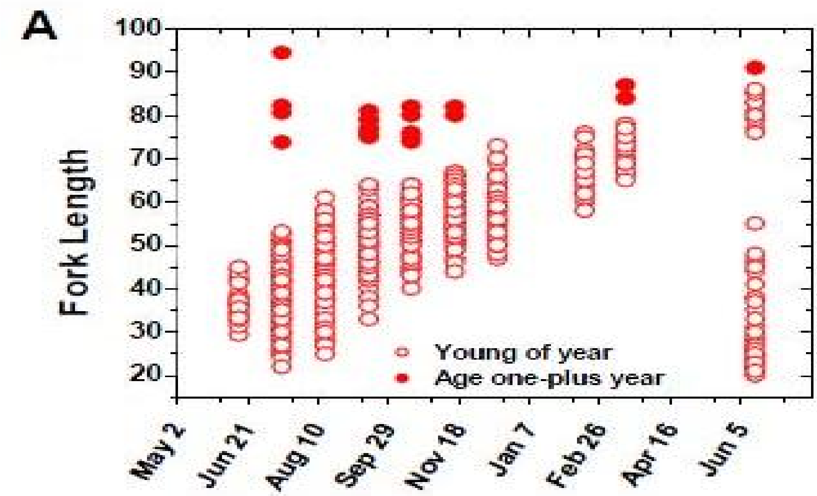


Figure 23, Length of young of year and 1+ adults as determined from Otolith evaluations (n=876) in 1999-2000[19]

Juvenile Delta Smelt during the summer period typically reside in the low salinity zone around X2, with a substantial portion of the population remaining in the North Delta (Sommer and Mejia, 2013). The CDFW Summer Townet Survey (TNS) samples the distribution of Delta Smelt throughout the summer and early fall period, and in the summer of 2013 consistently detected Delta Smelt in both of these areas (Figure 24). It is hypothesized that Delta Smelt in the Cache Slough Complex utilize deep water areas of Cache Slough and the Sacramento Deep Water Ship Channel as thermal refuges during high summer temperatures. Delta Smelt continue to feed and grow through the summer months, and begin to move upstream in early winter during periods of increased outflow and high turbidities, which typically do not commence until December. There is no evidence that any upstream movement occurs prior to this period (Sommer et al. 2011). Between June – November, Delta Smelt will typically remain in their seasonal juvenile rearing habitats.

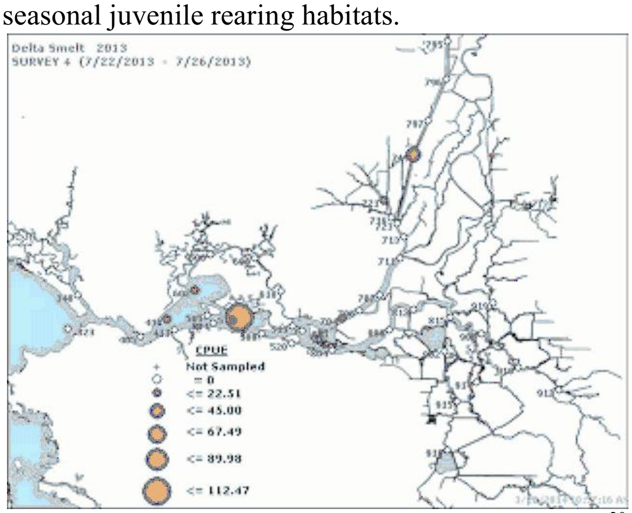


Figure 24, TNS #4 Delta Smelt Distribution in Late July[20]

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[19] Bennett 2005

Salvage of juvenile Delta Smelt during the summer and fall months is virtually non-existent (Table 2, CDFW Salvage data), as Delta Smelt do not use the South Delta as habitat during these months (Sommer et al. 2011).

Facility	2008	2009	2010	2011	2012	2013
CVP	6/20	6/23	5/21	N/A	6/23	6/8
SWP	7/5	6/30	6/8	N/A	6/28	6/17

Table 2, Date of last juvenile Delta Smelt salvaged for water year[21]

Juvenile Delta Smelt have the potential to be substantially affected by the proposed actions. Of the two regions likely to have substantial numbers of Delta Smelt (the Cache Slough Complex and the low salinity zone), it is likely that the Cache Slough Complex fish will be the most heavily impacted. The placement of rock barriers at the heads of Sutter and Steamboat Slough will likely reduce flow into the Cache Slough Complex and increase residence times in the North Delta. This flow reduction is hypothesized to exacerbate less favorable water quality conditions in the North Delta, with more severe effects in Sutter, Minor, and Steamboat Sloughs, though there is typically not a substantial presence of Delta Smelt in these sloughs. The severity of effects on water quality in areas known to be important to Delta Smelt (Liberty Island, Sacramento Deep Water Ship Channel, Lindsey and Cache Sloughs), are less certain because hydrologically, this region is strongly tidally-driven during the months of the proposed action. It is currently unknown what the importance is of flow inputs through Sutter and Steamboat Sloughs to the summer and fall habitat conditions in the rest of the North Delta; therefore, it is difficult to predict what the effects of reduced flows through these sloughs will be. It is possible that with warm conditions in the summer and reduced inflow, that water temperatures will rise, in certain areas of the North Delta, above conditions thought to be tolerable by Delta Smelt (~25C). It is hypothesized that during these periods, deep, cool water refuges may play an even greater role in allowing Delta Smelt to persist in the North Delta.

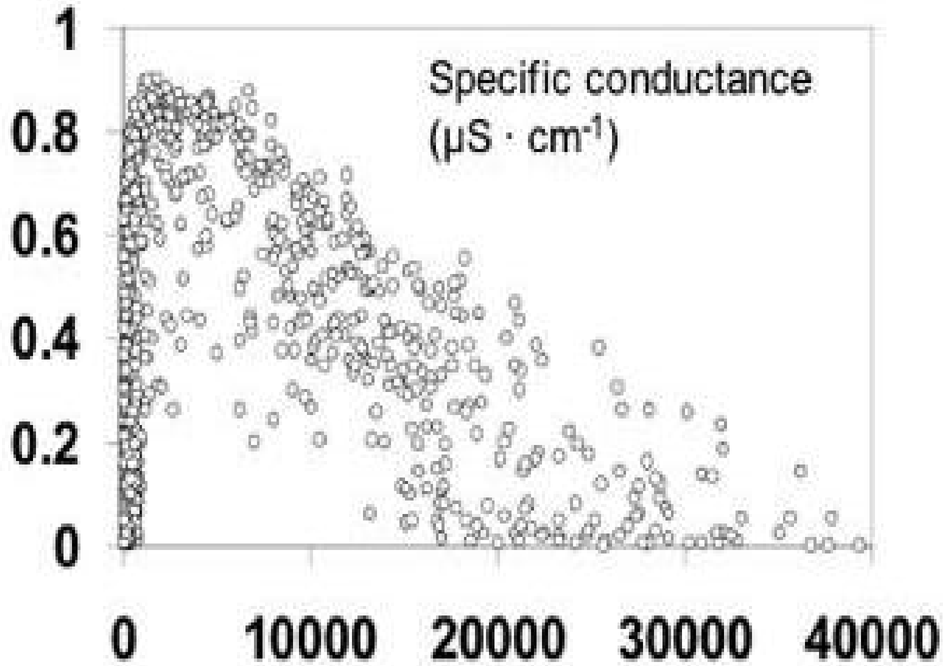
Preliminary DSM2 modelling based on 90% exceedence historical hydrology forecasted operations through the remainder of 2014, as considered at the time of analysis, show a slightly higher conductivity would occur further upstream on the lower Sacramento River but under both scenarios X2 would be downstream of Rio Vista during June-August. Delta Smelt have a strong positive association with the position of X2, with more downstream positions providing higher quality habitat (Feyrer et al. 2011). Under the proposed action, it is likely that summer Delta Smelt distributions will not be in areas optimal for growth and survival (Nobriga et al. 2008). In previous low-flow years, when water quality conditions became less tolerable for Delta Smelt in the Cache Slough Complex, the North Delta population appeared to have the capability to move downstream quickly towards the low salinity zone. It is likely, given the strongly tidal nature of the Cache Slough Complex, that Delta Smelt are able to ride these tidal flows and would be capable of quickly escaping unfavorable habitat conditions in the North Delta should they arise. While the proportion of the total population of Delta Smelt utilizing the North Delta in summer is unquantified, it is potentially significant. However, the potential effects of the proposed action may be mitigated, in part, by Delta Smelt's range of physiological tolerances and ability to find alternate suitable habitat. However, it is unknown the degree to which this induced summer-time

[20] Retrieved from http://www.dfg.ca.gov/delta/projects.asp?ProjectID=TOWNET on 3/28/14
[21] Data from Robert Fujimura, CDFW, on 4/1/2014

movement would increase mortality due to predation or limited food availability. It is possible that increased residence times in Sutter and Steamboat Sloughs may create conditions more favorable to higher phytoplankton growth, but the extent of this and its benefit Delta Smelt is uncertain.

During the early part of the Barrier Period, larvae spawned by the population segment currently situated near Jersey Point are also at risk of movement into the interior Delta, primarily along the False River. Modeling suggests that operation of the drought barriers in May and June 2014, with the DCC gates open, will increase Mokelumne River flows. Increased Mokelumne River flows may reduce the entrainment of Delta Smelt larvae and juveniles in the lower San Joaquin River toward the south Delta export facilities, depending on the extent to which this increased flow is allowed to augment net Delta outflow. Should the DCC gates be open in May and June, this also may result in a lower risk of entrainment for Delta Smelt in the lower San Joaquin River, based on results of particle tracking modeling for particles released in Georgiana Slough (see Figure 13C of Kimmerer and Nobriga 2008). Operation of the West False River barrier could hinder the downstream movement of Delta Smelt that are present upstream of the barrier (e.g., in the Franks Tract area). The fate of Delta Smelt found southeast of the West False River barrier may well be entrainment at the south Delta export facilities regardless of the presence of the barrier, based on simulated fates of neutrally buoyant particles (Kimmerer and Nobriga 2008). Very few Delta Smelt appear to be upstream of the West False River barrier, based on the most recent survey data from February/March 2014 (Figures 3, 5, 7).

From this information it is inferred that changes in conductivity in the lower San Joaquin River would little effect Delta Smelt; greater conductivity further upstream on the lower Sacramento River could result in the Delta Smelt population that reside in the low salinity zone moving further upstream on the lower Sacramento River than would be the case without the EDB operating. This could result in a slightly smaller area of abiotic habitat, given the general decrease in habitat with movement upstream of the low-salinity zone (Feyrer et al. 2007). As Sommer and Mejia (2013: 8) noted, however, Delta Smelt are not confined to a narrow salinity range and occur from fresh water to relatively high salinity, even though the center of distribution is consistently associated with X2 (Sommer et al. 2011). Nobriga et al. (2008) found that the probability of occurrence of Delta Smelt was highest at low conductivity (1,000-5,000 µmhos/cm), and declines at higher conductivity (Figure 25);



Source: Nobriga et al. (2008).
Figure 25, predicted Capture Probability of Delta Smelt Juveniles in 1974-2004 July Summer Townet Surveys From Generalized Additive Modeling In Relation to Specific Conductance, With Scatter Depicting Variation Caused by Secchi Depth and Water Temperature.

Longfin Smelt Effects (Barrier Period)

In recent years, the majority of the Longfin Smelt population vacated the Delta by June. Longfin Smelt were not detected again in the Delta until upstream movement past Chipps Island in preparation for spawning, beginning around early November. For example, in 2013, fish surveys suggest that by June the majority of Longfin Smelt population is distributed in the western Delta and Suisun Bay, and virtually no Longfin Smelt are detected in the north, south or central Delta (Figure 26). By July, the population is distributed primarily west of the confluence of the Sacramento River and San Joaquin River (Figure 26), and by August the population is primarily situated within and westward of Suisun Bay (Figure 27). Since by June, the majority of Longfin Smelt have vacated the region of the Delta most clearly affected by the proposed actions, the actions will likely not substantially affect the Longfin Smelt population through September.

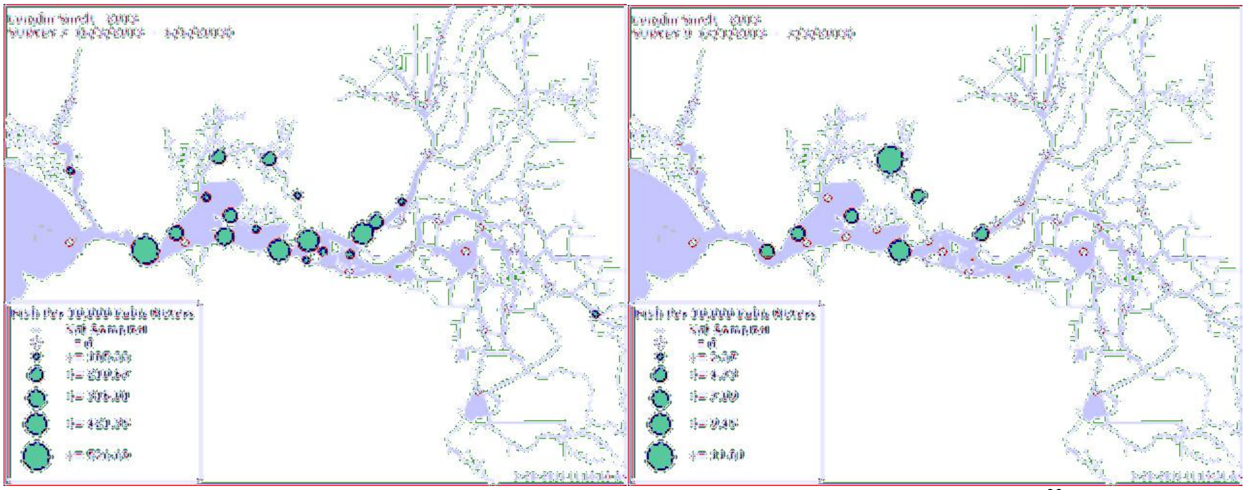


Figure 26, Early June and early July Longfin Smelt distribution in 2013 (20mm Survey #7 and #9[22]

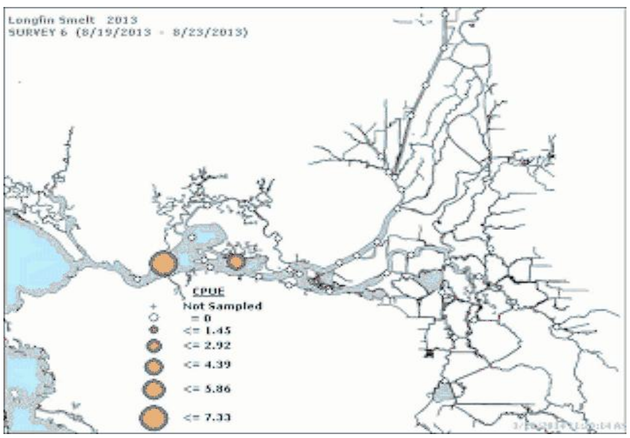


Figure 27, Mid-August Longfin Smelt distribution in 2013 (Summer Townet Survey #6)[23]

If actions continue to modify Delta physical, hydrological, and water quality conditions into November, when Longfin Smelt begin movement into the Delta in preparation for spawning, the proposed actions will likely affect these movements and spawning distributions. Chipps Island Trawl cumulative catch suggests that for years 2006-2012, 0% to 2% (average 0.4%) of adult Longfin Smelt had entered the Delta by November 1st, and 0.7% to 7.1% (average 2.7%) of adult Longfin Smelt had entered the Delta by December 1st (Figure 28). This implies that from a perspective of population percentages, Longfin spawning migrations will not be impacted by barriers in the Fall of 2014 if the barriers are removed by November 1, and may have a small but minor impact on spawning migrations and distributions if the barriers are removed by December 1. However, migrants at the extreme ends of migration timing represent the extremes of life history diversity for this life history trait and therefore may be more valuable to the resilience of the population than is reflected by percentage of population. There is moderate uncertainty surrounding this analysis.

[22] Retrieved from http://www.dfg.ca.gov/delta/projects.asp?ProjectID=20mm on 3/28/14
[23] Retrieved from http://www.dfg.ca.gov/delta/projects.asp?ProjectID=TOWNET on 3/28/14

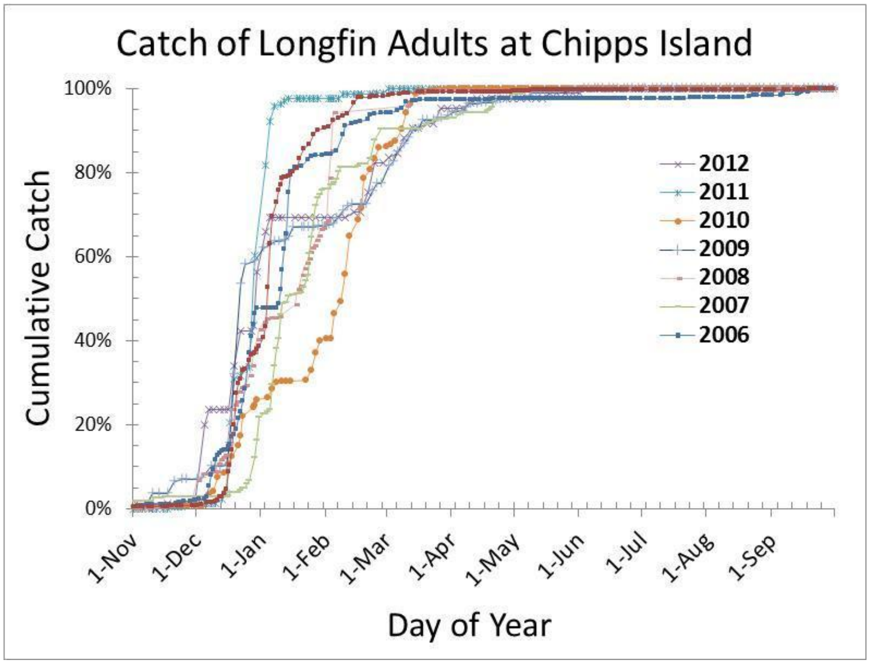


Figure 28.

Summary of Proposed Action's Effects to Delta and Longfin Smelt, Early Period

As the projects would continue to operate within existing OMR[24] flow related actions based on the NMFS and FWS Biological Opinions the proposed actions will have little effect on entrainment of adult Delta Smelt and will have the potential to increase entrainment of larval Delta Smelt at the export facilities. However, current distribution and recent modelling suggests that this increase in entrainment risk for larval Delta Smelt will be relatively minor and constitute a small percentage of the overall Delta Smelt population. It is noteworthy that this year's incidental take limit (FWS BO 2008) is very low (1,007 juvenile Delta Smelt) due to the 2nd lowest FMWT index on record. It is possible that even minor increases in salvage may result in regulatory responses.

The proposed action is unlikely to substantially affect salvage of juvenile or adult Longfin Smelt salvage this water year. However, based on the positive correlation between Longfin Smelt abundance and winter-spring Delta outflow (Kimmerer 2002; Rosenfeld and Baxter 2007), reduced outflow in April under the proposed action may result in some reduction in overall abundance.

Late Period

The proposed actions as described in the Drought Operations Plan and Operational Forecast will have the potential to substantially affect the summertime distribution and survival of Delta Smelt. It is likely that, given the drought conditions, optimal Delta Smelt habitat will be diminished further under the proposed action. Delta Smelt in the North Delta may see decreases in water quality conditions though responses to previous low flow conditions indicates that Delta Smelt will likely be able to escape any unfavorable conditions that arise.

[24] The OMR Index Demonstration Project as specified in the USFWS and NMFS concurrence letters continues.

In general, Delta Smelt would be expected to occur near to the barriers in spring and gradually move further downstream as they grow older (e.g. Dege and Brown 2004); however, the species is distributed according to habitat features such as salinity, water temperature, and water clarity (e.g., Nobriga et al. 2008; Sommer and Mejia 2013).

Longfin Smelt are unlikely to be substantially affected by the proposed actions during the proposed barrier period, due to limited distribution in the Delta east of the confluence. However, there is likely to be an effect on spawning migrations and spawning distributions if the proposed actions continue to substantially modify physical, hydrological, and water quality conditions well into November.

Given the complexity of Delta hydrology and ecology, and our limited understanding of Delta and Longfin Smelt life history, there is high uncertainty surrounding these conclusions.

Proposed Action

The drought barriers will have a number of hydrological and water quality effects. As these pertain to Delta and Longfin Smelt, the most important will be a shift in X2, reduced water quality in Sutter and Steamboat Sloughs, and some change in water quality in the Cache Slough Complex. It is unknown the specifics of any of these potential effects, and there is moderate uncertainty regarding the type and magnitude of any changes compared to conditions without the barriers.

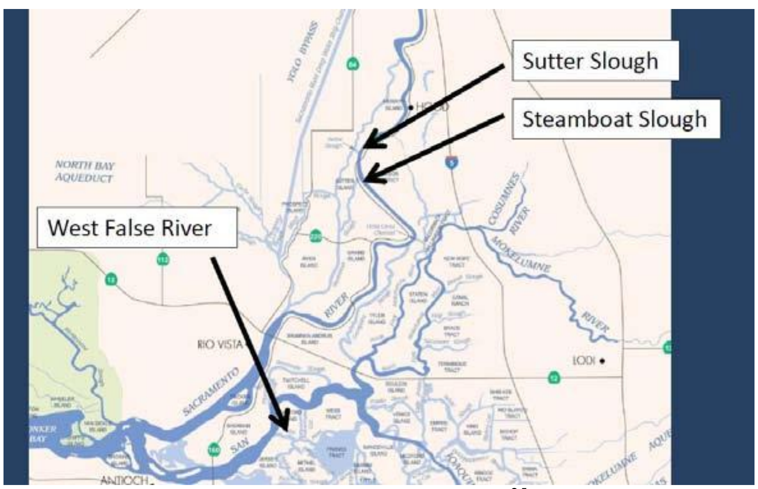


Figure 30, map of Emergency Drought Barriers[25]

Emergency Fisheries Monitoring, Technology Improvement, and Science Plan

The state and federal agencies commit to developing, and implementing as appropriate, a multi-objective emergency fisheries monitoring, technology improvement, and science plan to minimize, and to the extent possible, measure effects to listed species and improve understanding of biological effects associated with water operations during drought conditions. Drought year effects to be studied include, but are not necessarily limited to, effects associated with Delta Cross Channel gate and export facility operations, salinity barrier influence on smelt and associated habitat, and upstream flows and temperature management for anadromous fishes.

A draft of the Plan is currently in development and will be completed in collaboration with FWS, NMFS, DFW, DWR, and Reclamation. It is expected that specific "action plans" for time sensitive items

[25] From Shaun Phillipart, DWR on 3/28/14

will be developed by April 15 so that implementation, as appropriate, can begin. Action plans for longer term actions will be developed by October 1, 2014, through a collaborative process led by NMFS and DFW in coordination with the other agencies. This process will include stakeholder input and scientific-peer review.

Develop a Water Quality Plan to Monitor Water Quality and Operate Barrier Culverts to Improve Water Quality

DWR has developed a water quality plan to assess the effects of the EDB on flow and water quality in the Central and North Delta. DWR will monitor water quality with solar-powered monitoring instruments upstream and downstream of the Sutter and Steamboat slough barriers, in addition to assessing monitoring data from existing stations in the Delta. DWR will open the slide gates of additional culverts to allow greater water flow into Sutter and Steamboat Sloughs, should water quality issues arise.

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ATTACHMENT G

REVISED DCC GATE TRIGGERS MATRIX

Matrix of Triggers for Delta Cross Channel Gate Operations
April 1 through November 15, 2014

The triggers outlined in this matrix provide direction and a method which strives to balance water quality objectives while protecting fisheries resources. This document addresses April 1 through November 15, 2014 Delta Cross Channel (DCC) gate operations while operating under the Drought Operations Plan. There is a reasonable potential that water quality will be affected by a continuation of the drought into early water year (WY) 2015, therefore the Drought Operations Plan proposes modifications to water quality criteria to achieve the aforementioned balance. The triggers are arranged in an upstream to downstream manner, but all triggers are independent of one another and do not need to occur sequentially.

Two to three separate catch indices, specific to species or age-classes, will be calculated at each monitoring location, as specified below. Exceedance of any catch index, at any location, will require implementation of the action specified for trigger exceedance at that monitoring location depending on the date. If multiple trigger thresholds are exceeded, the action most protective for fish shall be implemented.

Trigger calculated based on:	**Knights Landing Catch Index (KLCI)**[f]	**Sacramento Trawl Catch Index (STCI)**[f]	**Sacramento Beach Seine Index (SBCI)**[f]
Winter-run trigger: "Older juveniles" and winter-run-sized hatchery Chinook[a]	Yes	Yes	Yes
Spring-run trigger: Young-of-year spring-run-sized Chinook, both natural-origin and hatchery[b]	Yes	Yes	Yes
Steelhead trigger: Natural origin steelhead[c]	No	Yes	Yes

Water Year 2014 -April 1-May 20

Tisdale Catch Index (TCI) Rotary Screw Trap (RST) Alert

Catch @ RST	Water Quality Concern Levels Exceeded[e]	Action to be Taken at DCC Gates[d]
Any catch of fish	independent of WQ	No Action

Wilkins Slough flow increase Alert

Flow Increase	Water Quality Concern Levels Exceeded[e]	Action to be Taken at DCC Gates[d]
Flow increase over base flow by 45% within a 5-day time period, calculated using daily flow averages.	independent of WQ	No Action

Knights Landing Catch Index (KLCI) RST[f]

Catch @ RST	Water Quality Concern Levels Exceeded[e]	Action to be Taken at DCC Gates[d] Closures to occur within 24 hours of trigger being met and NMFS providing notification or data are disseminated by fisheries agencies.
N/A	N	Closed
< 3 fish per trap day	Y	Open
≥ 3 fish per trap day	Y	Closed until 3 consecutive days of catch < 3 fish per trap day; then open gates

Sacramento Beach Seine Catch Index (SBCI)[f]

Catch per day: standardized beach seines	Water Quality Concern Levels Exceeded[e]	Action to be Taken at DCC Gates[d] Closures to occur within 24 hours of trigger being met and NMFS providing notification or data are disseminated by fisheries agencies.
<1 per day	N	Closed
<1 per day	Y	Open
≥ 1 per day	N	Closed
≥ 1per day	Y	Diurnal Operations[g] until catch <1 fish per day for three consecutive days; then open gates.

Sacramento Trawl Catch Index (STCI) [f]

Catch per day : standardized trawl	Water Quality Concern Levels Exceeded[e]	Action to be Taken at DCC Gates[d] Closures to occur within 24 hours of trigger being met and NMFS providing notification or data are disseminated by fisheries agencies.
<1 per day	Y	Open
<3 per day	N	Closed
1 ≤ X ≤3 per day	Y	Diurnal Operations[g] Diurnal Operations until catch <1 fish per day for three consecutive days; then open gates.
3< X < 5 per day	Y	Closed until 3 consecutive days of daily catch <3 fish per day; then operate diurnally until catch <1 fish per day, then open gates (see above)
≥ 3 per day	N	Closed
≥ 5 per day	N	Closed
≥ 5 per day	Y	Closed until catch per day is < 5 fish

Water Year 2014 - May 21 – June 15

Date	Action Trigger	Action Response
May 16-Jun 15	D-1641 gate operations criteria	DCC gates may be closed for up to 14 days during the period, per 2006 WQCP, if RTDOT determines it is necessary.

WY 2015 - October 1 – November 15

Date	Action Trigger	Action Responses
October 1 – November 15	Water quality concern levels[e] are met and either the KLCI or either of the SCIs are greater than 3 fish per day but less than or equal to 5 fish per day	Within 24 hours of trigger exceedance, DCC gates are closed. Gates will remain closed for 3 days.
	Water quality concern levels[e] are met and either the KLCI or either of the SCIs are greater than 5 fish per day.	Within 24 hours of trigger exceedance, DCC gates are closed and kept closed until catch indices are less than 3 fish per day at both the Knights Landing and Sacramento monitoring sites.
	The KLCI or either of the SCIs triggers are met but water quality concern levels are not met[e]	DOSS review monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.

Footnotes:

a) Catch of older juvenile Chinook salmon and hatchery-produced Winter-run-sized Chinook will be the basis for one trigger criterion. The use of older juveniles is consistent with the triggers used in the Long Term Operations of the State Water Project and Central Valley Project biological opinion (NMFS June 4, 2009), reasonable and prudent alternative Action IV.2.3 Old and Middle River flow management. Older juvenile Chinook salmon are unclipped Chinook that are larger than the minimum Winter-run size criteria of the size at date river model for Chinook salmon. Older juveniles will include Winter-run Chinook salmon and older fish such as yearling Spring-run Chinook salmon and yearling Late Fall/Fall-run Chinook salmon as part of the catch considered for triggers. In addition, the work group decided to include hatchery Winter-run Chinook salmon as part of this trigger criterion. Hatchery-produced Winter-run-sized Chinook salmon will be distinguished by their missing adipose fin and their classification as winter-run based on the size-at-date table. While the CWTs will be verified as soon as possible, clipped fish will be included in the trigger calculation based on size-based, not CWT-confirmed, run assignment. At this time, no releases of hatchery-produced Chinook salmon should overlap with the sizes of the Living Stone National Fish Hatchery (LSNFH) Winter-run production release. Current hatchery produced Late Fall-run Chinook salmon from the Coleman National Fish Hatchery (CNFH) are considerably larger than the Winter-run production fish, thus there should be no mistaking one group of fish for the other. The average fork length at the time of release was 95mm; ad-clipped fish falling within the Winter-run size criteria of the size at date river model for Chinook salmon will be assumed to be hatchery Winter-run.

b) Natural origin (adipose fin present) Spring-run Chinook young-of-year (*not* yearlings) and hatchery origin (adipose fin absent) spring-run Chinook young-of-year identified using the size at date river model will be the basis for another trigger criterion until such time as the first release of hatchery Fall-run occurs (not expected until April 2014), after which time differentiation of natural origin Spring-run from unclipped hatchery Fall-run and hatchery origin spring-run from clipped hatchery-origin Fall-run becomes unreliable due to size overlap of the two runs.

In regards to young of the year Spring-run Chinook salmon, it is difficult to adequately distinguish between wild Spring-run and wild Fall-run Chinook salmon due to the overlap of the sizes of the fish emigrating downstream and the emergence timing of the fish from the spawning areas upstream of the monitoring efforts. Young of the year wild Spring-run are only slightly larger than the wild Fall-run Chinook salmon that are emerging from the gravel just a few weeks behind the wild Spring-run fish in streams and watersheds where they co-occur. For wild fish, this difference in the date of emergence from the gravel should allow for run discrimination based on size at date, assuming that ambient rearing conditions are similar for both groups of fish. However, run discrimination solely by length is further complicated by the large releases (tens of millions) of hatchery produced Fall-run Chinook salmon in river, typically in early April, that overlap with young-of-the-year Spring-run emigration. Seventy-five percent of the Fall-run hatchery release is not adipose fin clipped, and their larger sizes due to hatchery production techniques would overlap and swamp any wild produced Spring-run Chinook salmon production in the river, making the ability to distinguish runs by size at date unreliable. The DCC group believes that triggers using wild Spring-run Chinook salmon within the appropriate length at date size criteria can be implemented if the captures of these fish occur prior to the release of any hatchery produced fall run Chinook salmon. Furthermore, if hatchery production Fall-run Chinook salmon are trucked downstream to the Delta or bays, below the monitoring stations used in the Sacramento region beach seines and trawl, then the integrity of the size at date discrimination should still remain valid. It is not expected that hatchery produced Fall-run Chinook would subsequently ascend the Sacramento River from their downstream release locations and be present in the reaches where the monitoring efforts used in the DCC triggers are being conducted.

Hatchery origin Spring-run will also be included in the trigger criteria prior to any hatchery Fall-run release. For the past few years Feather River Fish Hatchery has released a portion of Spring-run production (all fish are clipped) into the Feather River and upstream of the confluence with the Sacramento River. Similar to hatchery origin Winter-run, these fish are distinguishable by their missing adipose fin and fork lengths and at the time of release are not expected to overlap with other production releases that have occurred to date. An in-river release may not be possible this year if conditions in the river deteriorate due to drought but providing protection for these fish if conditions allow is crucial.

c) Natural origin (adipose fin present) steelhead will also be used as the basis for a trigger criterion but only for the Sacramento Catch Indices (trawl and beach seines). Initially, the group did not come to a consensus regarding the use of steelhead as a potential trigger in the RST catches, beach seines or river trawls. Steelhead are considerably rarer than Chinook in the RST, trawl, or beach seine catches. Although any steelhead (with or without adipose fin) captured in the Tisdale or Knights Landing RSTs are assumed to be part of the California Central Valley steelhead DPS (because natural origin fish and hatchery fish from both hatcheries upstream of those sampling locations, Coleman National Fish Hatchery (CNFH) and the Feather River Fish Hatchery (FRFH), are considered to be part of the protected DPS), clipped steelhead captured below the confluence of the American River cannot be considered wholly fish from the protected DPS due to the potential input of fish from the Nimbus Fish Hatchery (NFH; *not* considered to be part of the protected DPS). All wild fish (intact adipose fin) are considered to be part of the protected DPS, and because all hatchery-produced steelhead are clipped, a trigger based on natural origin, unclipped, steelhead will include only fish that are part of the protected DPS. Given the unpredictability of steelhead downstream emigration, the group decided that only the Sacramento beach seine and trawl monitoring sites near the DCC gate location, and *not* the KLCI, should be used as indicators of steelhead being present in the vicinity of the gates and thus be vulnerable to entrainment into the DCC junction when gates are open. Capture of any wild steelhead in these beach seines or in the Sacramento River trawl will serve as a trigger for gate closures, using the same index thresholds as used for Chinook salmon.

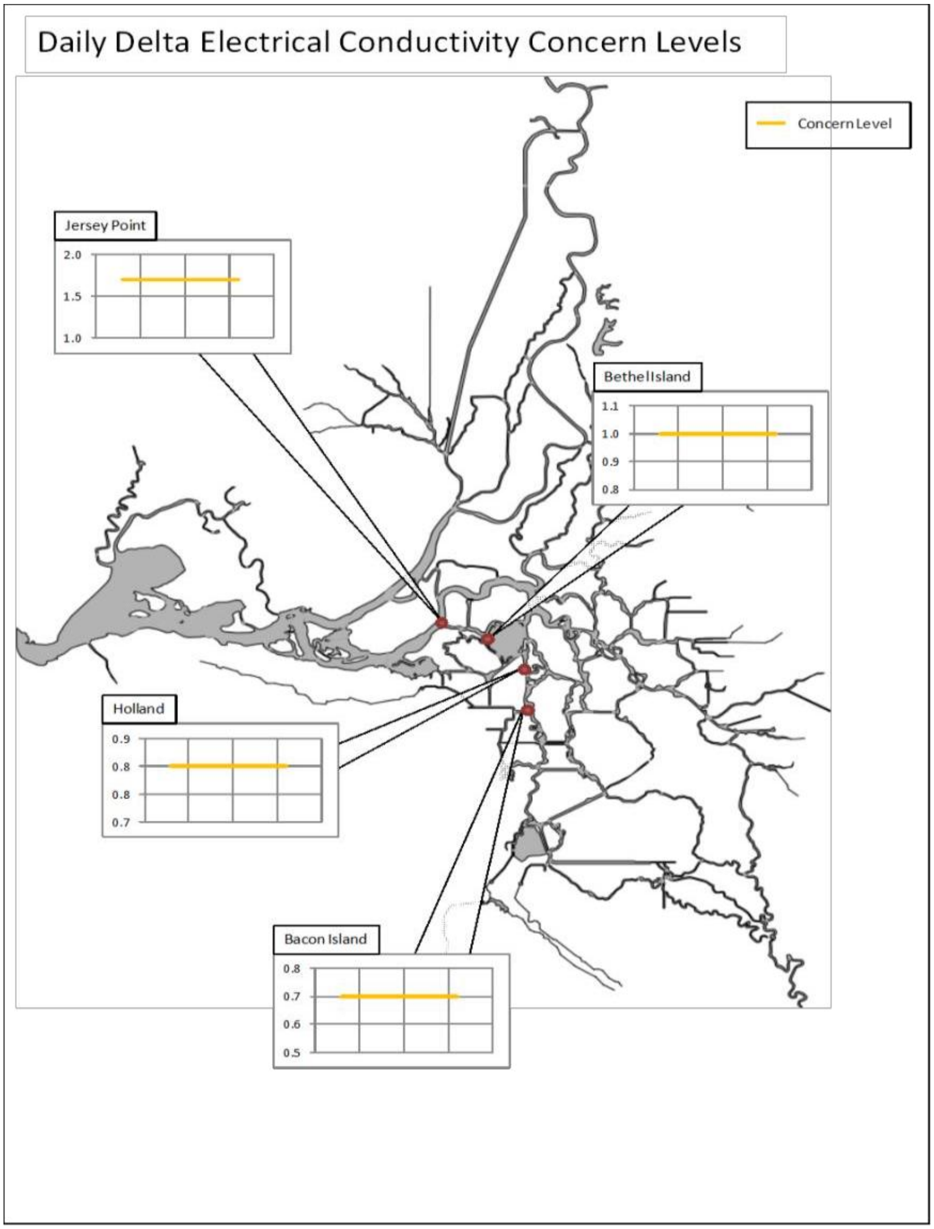
d) The actions pertaining to the different sampling metrics are designed to protect both downstream migrating juvenile Chinook salmon and also those that may be rearing or holding in the Sacramento River near the DCC. With unidirectional river flow, catch data from Tisdale and Knights Landing provides an early warning of emigrating salmonids entering the Delta. Data from both the Sacramento River beach seine and trawl monitoring programs serves to further refine locational information on emigrating salmonids as well as provide information on salmonids rearing in the proximity of the DCC gates. The Tisdale and Knights Landing data provides information from discrete locations within the Sacramento River at the location of the RSTs. In comparison, the Sacramento River Trawl and the Sacramento River Beach Seines provides information from a broader suite of locations within the Sacramento River including mid-channel and river margin habitats that may harbor different life history strategies for juvenile salmonids (rearing versus emigration). In a 2012 NMFS Southwest Fisheries Science Center study using acoustically-tagged Winter-run Chinook hatchery smolts; the approximate travel time from the Knights Landing area to Georgiana Slough, which is downstream of the DCC, was approximately 2.5 days (unpublished data). Data from the aforementioned study and previous acoustic-tagged salmonid studies indicate that movement through the Delta is rapid. As such, the three-day closure period was deemed a reasonable balance between fisheries protection and providing operational flexibility for the operation of the DCC gates to ameliorate water quality issues in the central and southern Delta.

During periods when the DCC gates are closed, consideration should be given to returning the increased Sacramento Trawl and beach seine efforts to baseline levels. Historic baseline efforts are defined as follows. The Sherwood Harbor trawl will continue with sampling occurring 3 days per week through March 31st using a Kodiak trawl, then switching to a mid-water trawl on April 1st. The frequency of trawls will decrease in May and June to twice per a week, resuming to three days per week in July. Kodiak trawls will resume in October. The Lower Sacramento and North Delta beach seine sites will be sampled once per week year round. The special Sacramento region beach seine sites, which includes portions of the Lower Sacramento and North Delta seine routes will be sampled weekly after February 1st, and will continue to include the three additional sites (Sand Cove, Sherwood Harbor, and Miller Park) for the duration of the emergency drought response. Tisdale and Knights Landing RSTs will continue to sample daily with an elevated level of effort until listed species are no longer observed in the monitoring effort. The Projects must notify the Real Time Drought Operations Management Team that water quality concerns levels may be reached within 5-7 days so that monitoring efforts can be increased to daily sampling no less than 72 hours prior to DCC gate opening, depending on fisheries catch indices. Having a complete set of data that maintains the frequency of sampling effort will provide substantial benefits in any retrospective analysis of this data for future operations of the DCC. If sampling effort is allowed to vary across time, then the analysis of fish presence and movement becomes much more difficult as "zero" could mean fish were either not present, or were missed on the off days that sampling did not occur. It should additionally be noted that determining where in the Sacramento River or Delta a majority of Winter-run and Spring-run out-migrating population is will be more difficult if sampling is discontinued.

e) The values for Jersey Point, Bethel Island, and Holland were adapted from the Chinook Salmon Decision Tree. Water Quality Concern Levels are exceeded when the electrical conductivity levels listed below are reached at one or more stations. The Chinook Salmon Decision Tree can be found at:
(https://www.usbr.gov/mp/cvo/OCAP/sep08_docs/Appendix_B.pdf).

Table1

Station	Water Quality Concern Level
Jersey Point	1.8 mmhos/cm
Bethel Island	1.0 mmhos/cm
Holland	0.8 mmhos/cm
Bacon Island	0.7 mmhos/cm



f) The Knights Landing rotary screw trap (RST) data are standardized to the number of older juvenile Chinook salmon (defined as fish larger than the minimum size length for winter-run Chinook salmon at date, *i.e.*, >95mm and hatchery winter-run Chinook) captured in one trap day (24 hours). The number of older juvenile fish captured in each RST is enumerated, and then the cumulative number of fish is divided by the number of hours the two RSTs were operated between sampling days divided by 24. For example, if the two traps are fished for 2 days there is a maximum of 96 hours that the 2 traps could have been fished: (2 days x 24 hours per day x 2 traps = 96 hours total time fished). If 100 fish were caught between both traps, then the catch per trap day is: 100 ÷ (96 hours/ 24 hours per day) = 25 fish per trap day. In a similar fashion the catch from the Sacramento trawl (STCI) and Sacramento area beach seines (SBCI) are standardized to one catch day with 10 tows per sampling day for the trawl data and eight hauls per day for the beach seine data. Data used to calculate the indices will represent the most current day of sampling, data from the Sacramento trawl and the Sacramento area beach seine Catch Indices sites will be reported on the day sampling occurs. Data collected from the Knights Landing RST, representing a 24 hour period, will include the previous daytime trap check (pm) and the current morning trap check (am).

g) Should diurnal operations[1] occur, operations of the gates will follow table 2 (DCC Gate Diurnal Operations):

Table 2: DCC Gate Diurnal Operations

Tidal Phase	Operational window. DCC gates will be closed during crepuscular periods and at night.
	Day is considered to be from sunrise to sunset (approximately 7am-7pm PST). Crepuscular periods are considered to be 1 hour after sunrise and 1 hour before sunset. Gate open window of operations for up to 6 hours within the daylight period.
Ebb Tide[2]	Period of operations for opening the DCC gates will occur during the ebb tidal phase during daylight periods. Periods of gate openings shall avoid the period of slack water surrounding the low tide and high tide changes (± 1 hour; bottom and top of the tides).
Slack[3]	Avoid the period of slack water surrounding the low tide and high tide changes (± 1 hour; bottom and top of the tides).
Flood Tide[4]	If Water Quality concern levels are being exceeded with DCC operations limited to the ebb tidal phase, the Real Time Drought Operations Team can request DCC operations to occur on the flood tide phase.

1 It has not been determined whether or not the necessary water quality benefits can be achieved through diurnal operations of the DCC gates. Additionally the design and wear of the gates may preclude successive openings and closings that may occur through diurnal operations.

2 This phase of the tide has been shown to create hydraulic conditions at junctions that enhance fish entrainment. Best to use period of the ebb tide with the strongest downstream flow. Avoid overlapping this phase of the tide with crepuscular period. Fish migratory movement is elevated during the crepuscular period.

3 Avoid the period of slack water surrounding the low tide and high tide changes (± 1 hour; bottom and top of the tides, as fish may be holding in the vicinity of the DCC and the increased movement by fish (milling behavior) will create conditions for greater exposure to entrainment.

4 This is a less optimal period of DCC gate operations for fish protection since flow convergence will occur with the water moving upstream on the flood tide meeting water still moving downstream at the beginning of the flood tide. This will send more water into an open DCC channel and extend the zone of entrainment across a significant proportion of the Sacramento River channel. If gates are opened 1 to 2 hours after flows change at the bottom of tide, there are likely fewer impacts due to opening during this period. Avoid crepuscular periods.

Biological Justification for Diurnal Delta Cross Channel Gate Operations.

Chapman *et al*. (2013) described a series of experiments conducted on the Sacramento River in which hatchery produced late-fall Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*) were released in the upper Sacramento River and tracked as they migrated downstream through the San Francisco Bay estuary and into the Pacific Ocean through the Golden Gate. From 2007 to 2010, during the months of December and January, a total of 1,110 Late-fall Chinook salmon and 1,100 steelhead trout were released into the upper Sacramento River. In 2007 the release was made in Battle Creek. From 2008 to 2010, releases were made at three different sites: 1) Jellys Ferry; 2) Butte City; and 3) Hamilton City within the upper and middle sections of the Sacramento River. Fish were released just after twilight at each site. Fish were tracked through 420 monitors placed at 186 different locations within the Sacramento and San Joaquin river systems and Delta, the San Francisco estuary, and coastal waters outside the Golden Gate. Receivers were deployed to provide coverage across river channels as single, dual, and multiple arrays to ensure complete coverage of the channel width.

This study found that within the upper river section, late-fall Chinook salmon traveled almost exclusively at night with 90.6 percent of detections recorded at night between sunset and sunrise. As the Chinook salmon smolts moved downstream, the proportion of movement during diurnal periods progressively increased, although movements at night still remained significantly greater than diurnal movements. Within the upper river reaches there were no significant differences in the timing of fish movement during the night, in particular movements were not concentrated within crepuscular periods, but were distributed relatively evenly throughout the nocturnal period. Movement ceased relatively quickly after sunrise and began shortly after sunset (. In contrast, as fish moved downstream into the middle and lower reaches, salmon movement did not stop abruptly at sunrise, but instead detections gradually decreased as light increased.

Tagged hatchery steelhead migrated more uniformly throughout the day in all regions of the river, estuary, and ocean compared to yearling late-fall Chinook salmon smolts. Like the Chinook salmon smolts, the proportion of detected movement at night decreased as fish migrated downstream. In the upper river 63.0 percent of detections occurred at night compared 90.6 percent for salmon smolts in the same reaches. Once these steelhead reached the estuary, the detections of night time movements decreased to 40.9 percent compared to 57.0 percent for late-fall Chinook salmon. In the upper river, there was a significant preference for nighttime movement. In the lower river, where Knights Landing is located, there is no significant difference between night time and day time movement, however in the middle river, Delta, and estuary there were significant preferences for daytime migration.

Chapman *et al.* (2013) found that more than 50 percent of Chinook salmon travelled at night in all of the study reaches, while steelhead were more variable. Chinook salmon also moved more during the day when river flows were increasing, regardless of flow direction (important in the tidal Delta and estuarine environment). In the estuary, incoming flood tides between zero and a flow of approximately -3500 cfs increased daytime detections. Similarly, downstream flows of approximately 12,300 cfs elicited daytime movements of Chinook salmon. Steelhead responded in a more muted manner. Incoming tides did not appear to stimulate more daytime movements in the estuary. In the riverine reaches of the study area, steelhead daytime movement was more likely when flows were 25,000 cfs or greater. Thus, both Chinook salmon and steelhead responded to increases in flow with increased daytime movements. However, Chinook salmon appear to be more sensitive to these higher flows, and also responded to the perceived higher flows of an incoming flood tide in the estuary.

The movement of both Chinook salmon smolts and steelhead were affected by increasing turbidity. In general, increasing turbidity reduced the percentage of nighttime movement, and stimulated daytime movement in fish. However, increasing turbidity is often associated with increasing flow and these two variables typically co-occur.

Plumb reported that in a U.S. Geological Survey (USGS) study the majority of acoustically tagged fish moving downstream past the location of the DCC did so at night. During the winter of 2008-2009 (November through March) 2,983 acoustically tagged Late-Fall Chinook salmon were released upriver from the DCC gate location. The release point was far enough upstream that fish were distributed in the river channel and were believed to be exhibiting normal migratory behavior and movements. Results indicated that 39 percent of the released fish (1,162 fish) were eventually detected in the vicinity of the DCC gates with approximately 5 percent of these detections believed to be fish within predators (154 fish). Of the arriving fish detected (1,008 fish), approximately 83 percent (840 fish) arrived at night, with the remainder (17 percent) arriving during the day (168 fish). Of the fish arriving at the DCC location (day and night), approximately 13 percent (143 fish) arrived when the gate was open. Of the 143 fish arriving at the gates when they were open, 20 percent (20 fish out of 100 fish) were entrained at night and 21 percent were entrained during the day (9 fish out of 43 fish). USGS performed an analysis of the data and calculated the joint probability of arriving at night and being subsequently entrained using different environmental covariates and determined that there was approximately a 19 percent chance of being entrained into the DCC at night. Conversely, the probability of being entrained during the day was approximately 6 percent. During the period of the study (November 2008 through March 2009), 73 percent of negative flood flows occurred during the day, and entrainment was more likely during these periods. Plumb *et al.* (2013 unpublished study) summarized that operation of the DCC gates during the day may allow for water diversion in to the interior Delta while minimizing the risk of entrainment of migrating Chinook salmon into the DCC.

Preliminary results from the 2012 Georgiana Slough non-physical barrier study (DWR 2013 draft) also help to illustrate the behavior of fish moving through this section of the river under different diel and flow conditions. Similar to the Plumb *et al*. 2013 and Chapman *et al.* (2013) studies, the majority of fish detected moving past the junctions of the DCC and Georgiana Slough channels with the main stem Sacramento occurred at night. In addition, data from tagged Late-Fall Chinook salmon passing through the Georgiana Slough junction indicate that greater numbers of fish passed through this study area at night than during the day. Furthermore, the passage of fish was also shown to be strongly influenced by tidal phase. During the night, more fish successfully passed the junction of the Georgiana Slough channel during a strong ebb phase than during the changing of the tide or a flood tide. During the changing of the tide from an outflowing tide to a flood tide, the flow of water increases into Georgiana Slough. It is during this transition that a converging flow situation sets up at the junction and 100 percent of the Sacramento River flow enters Georgiana Slough from both the upstream and downstream directions with little to no flow bypassing the junction. Under this specific scenario, all fish present across the width of the Sacramento River channel are vulnerable to entrainment into the junction. This is particularly true during nocturnal periods when fish are more likely to be moving rather than holding and thus become vulnerable to entrainment as they encounter the junction reach. During the day, more fish are holding, and move less in the region of the junction, thus reducing their vulnerability to entrainment, although not being becoming completely immune to entrainment.).

Summary:
Chapman *et al*. (2013) illustrates how Chinook salmon smolts emigrate primarily at night in the upper reaches of the Sacramento River but progressively increase movements during daytime periods as fish emigrate downstream towards the Delta and San Francisco Bay. Daytime movement is also increased by increasing river flows and stronger flood tidal flows, as well as increased turbidity. Steelhead smolts are more balanced in their use of daytime and night time periods for movements in all river reaches in comparison to Chinook salmon. They are less sensitive to changes in flow and turbidity in comparison to Chinook salmon, but still respond in the same manner: more flow and/or turbidity reduce the proportion of nocturnal movement and increases daytime movement.

The USGS analysis of Chinook salmon at the DCC junction indicates that Chinook salmon predominately arrive at night and are more susceptible to entrainment at night than during the day based on the joint probabilities of arriving at the DCC junction at night and subsequently being entrained into the DCC junction.

The analyses conducted in support of the 2012 Georgiana Slough non-physical barrier (DWR 2013 draft) finds that fish move more at night past the Georgiana Slough junction than during the day based on the number of detections at the non-physical barrier acoustic receiver array and that the behavior of the fish in the junction is strongly dependent on tidal phase and position in the channel cross section at the time of encountering the junction. Fish are more likely to successfully move downstream on a strong ebb tide past the Georgiana Slough junction and avoid entrainment into the Georgiana Slough channel than when downstream flow is weaker and the tides are changing from ebb to flood. The period of time when fish are most vulnerable to entrainment into the Georgiana Slough channel is during the period when flows are reversing and essentially all of the flow in the Sacramento River channel is directed into the channel of Georgiana Slough (converging flows). As negative flows increase and the flood tide strengthens, the vulnerability of entrainment lessens and fish were found to “mill’ in the vicinity of the junction or move back upstream, avoiding the region surrounding the junction.

If the DCC gates are to be operated (*i.e*., opened), then the option which minimizes the entrainment vulnerability to listed salmonids emigrating in the Sacramento River in the vicinity of the DCC gates would involve opening the gates on a diurnal cycle, and closing the gates during the night, thus avoiding the greater nocturnal presence of fish in the vicinity of the gates during fish movements. In addition, further reductions in entrainment vulnerability could be gained by operating the gates with recognition of the tidal phases in which the fish are more vulnerable to entrainment (*i.e*., periods of tidal transition from ebb to flood and when upstream and downstream flows result in converging flow phases entering the DCC channel).

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ATTACHMENT H

APRIL-MAY DELTA EXPORT AND HYDRODYNAMIC FORECASTED OPERATIONS (WITH AND WITHOUT THE PROPOSED MODIFICATIONS)

Forecasted operations *with* *the proposed modifications:*

	Short-Term	Dry Scenario	
Delta Summary (cfs)	Early April	Pulse Flow Period*	Late May**
Combined Exports	**5500**	**1500**	**1500**
OMR Index	**-5000**	**-1500**	**-2000**

	Short-Term	Medium Scenario	
Delta Summary (cfs)	Early April	Pulse Flow Period*	Late May
Combined Exports	**5500**	**2000**	**2800**
OMR Index	**-5000**	**-1500**	**-3000**

	Short-Term	Wet Scenario	
Delta Summary (cfs)	Early April	Pulse Flow Period*	Late May
Combined Exports	**5500**	**2500**	**5000**
OMR Index	**-5000**	**-2000**	**-5000**

Forecasted operations and Delta hydrodynamics *without* *the proposed modifications*

	Short-Term	Dry Scenario	
Delta Summary (cfs)	Early April	Pulse Flow Period*	Late May**
Combined Exports	**1500**	**1500**	**1500**
OMR Index	**-2000**	**-1500**	**-2000**

	Short-Term	Medium Scenario	
Delta Summary (cfs)	Early April	Pulse Flow Period*	Late May
Combined Exports	**1500**	**2000**	**1500**
OMR Index	**-2000**	**-1500**	**-2000**

	Short-Term	Wet Scenario	
Delta Summary (cfs)	Early April	Pulse Flow Period*	Late May
Combined Exports	**1500**	**2500**	**1500**
OMR Index	**-2000**	**-2000**	**-1500**

* Combined Exports during the pulse flow period are assumed to be 100% of the 3-day running average of Vernalis flow or 1500 cfs, whichever is greater.

** Low exports due to low Delta inflow and salinity control operations

ATTACHMENT I

DELTA SMELT MONITORING PLAN

Preliminary Delta Smelt and Longfin Smelt Drought Monitoring and Science Plan

April 8, 2014

The current natural drought has created extremely low Delta flows, and continued low Delta flows are expected through the summer and fall. These conditions likely are changing the physical characteristics of Delta smelt and longfin smelt habitat in the Delta, and may be changing the availability of food resources as well. Drought is a normal feature of the species' natural history. However, the current drought is particularly deep, magnifying these effects. Moreover, the Drought Operations Plan contemplates the possibility of installing physical barriers in certain Delta channels. If installed, the emergency drought barriers would reduce water motion and increase residence time in the affected sloughs in order to increase flow in the Sacramento River and elsewhere. The flow changes are likely to elongate the low salinity zone by moving X2 downstream and creating a larger-than-usual area in the Cache Slough complex that is subject to low flow during the summer and fall months. These effects will need to be carefully investigated via a package of near-term monitoring studies.

An ongoing dialogue among DFW, DWR, Reclamation, and FWS has resulted in general agreement that the sampling techniques and monitoring approaches used to assess delta smelt distribution and abundance need to be carefully reviewed and potentially revised to better support population size estimation and the application of more sophisticated life cycle models that are under development. The Fish and Wildlife Service has taken the lead in developing a package of such studies for implementation and is working with the five agencies to refine and implement them. The long-term items described in Section III below are not part of the Drought Monitoring and Science Plan, but it is important that these long-term studies move forward on a separate, longer track than the near-term monitoring studies described below.

I. Near-Term Drought Questions

The following questions addressing these drought effects were developed by FWS, DWR, and DFW, with input from Reclamation, and are important to understanding the effects of the drought and its implications for future drought operations, particularly if the emergency drought barriers are installed.

1. How do low flow conditions or the combination of low flow conditions and the drought barriers affect the distribution of salinity (i.e., the low-salinity zone)?

2. How do low flow conditions or the combination of low flow conditions and the drought barriers affect water residence time and phytoplankton production in the lower Yolo Bypass, Cache Slough complex, and blocked sloughs (if barriers installed)?

3. What effect do low flows or the combination of low flows and the drought barriers have on turbidity and water temperatures in the lower Yolo Bypass, Cache Slough complex, and blocked sloughs?

4. What effect do the drought barriers have on dissolved oxygen levels in the blocked sloughs?

5. How does the health and condition of delta smelt in the lower Yolo Bypass, Cache Slough complex, and blocked sloughs (if barriers installed) compare to the health and condition of delta smelt in the mainstem Sacramento River and western Delta?

6. How are delta smelt distributed in the Delta in mid-summer with or without the barriers in place?

7. How do summer growth rates (measured in September, from otoliths) of delta smelt in the lower Yolo Bypass, Cache Slough complex, and blocked sloughs (if barriers installed) compare to historical growth rates from the Cache Slough complex?

8. How do low Delta flow conditions or the combination of low flow conditions and the drought barriers affect the abundance and distribution of fishes known to predate delta smelt?

9. How does low flow affect the abundance and density of *Egeria densa* or other non-native aquatic vegetation in the lower Yolo Bypass, Cache Slough complex, and blocked sloughs (if barriers installed)?

The Multi-objective Fisheries Monitoring and Science Plan completed by April 15th will include, as appropriate, study designs addressing the near-term drought questions above and logistics plans for their implementation. In the event the barriers are to be installed, near-term monitoring studies will need to be in place in the field prior to construction. Most of the questions requiring collection of delta smelt can be answered in full or in part using existing monitoring studies, possibly with some temporary adjustment. Answering longer-term questions will require a significant amount of effort beyond what is currently being done, and such studies will require more development and vetting than the near-term .

II. Water Year 2014 Actions to Address Near-Term Questions:

Delta Monitoring:

May-October

i. Monitor Delta flows (Stage, flow, and velocity) and water quality (water temperature, specific conductance, turbidity, and dissolved oxygen); if drought barriers are installed, this includes supplemental water quality monitoring associated with the barriers.
   a. Additional drought barrier sensor locations for temperature, specific conductance, turbidity, dissolved oxygen in blocked sloughs and in the Cache Slough/Sacramento Deepwater Ship Channel complex
   b. Target date for installation of supplementary drought barrier sensors: 1 week before construction begins

ii. Conduct standard IEP fish monitoring and currently proposed supplemental sampling (Liberty Island beach seine, gear efficiency studies, predator sampling by DWR)

iii. Collect fish otoliths and other tissues to assess growth, health, and condition

iv. Monitor submerged aquatic vegetation in the north Delta/Cache Slough complex and phytoplankton assemblage (including *Microcystis*) throughout the upper estuary

Tributary Monitoring:

Not applicable; delta smelt and longfin smelt make very little use of waterways that are not under tidal influence.

Data Analysis:

May-June

a. Analyze and report out results of Jersey Point Early Warning Sampling
b. Work with DWR to provide "Proportional Entrainment Index" (PEI) estimates for all proposed operations scenarios to be considered for implementation through June 30.

    NOTE: The PEI was proposed several years ago by DWR to predict delta smelt entrainment and appears to predict juvenile salvage fairly well. Consequently, its utility for current monitoring efforts should be assessed.

July-October

a. Ongoing analysis of data pertinent to questions 1-4, 6 and 9 above

Longer-term

a. Final analysis and report out of questions 1-4, 6 and 9
b. Initial analysis of data pertinent to questions 5 and 7-8 above

    NOTE: Answers to questions 7 and 8 unlikely prior to WY 2016.

c. Design a long-term experiment to robustly address question 8
d. Studies and analyses associated with longer-term delta smelt gear efficiency and distribution studies

Fish rescues

There are no plans for fish rescues involving the Delta-resident smelt species at this time.

III. Longer-Term Monitoring, Studies, and Actions:

On a longer track, it is critically important that delta smelt monitoring methods be refined to better support population size estimation and the development of more sophisticated life cycle models and viability analyses for the species. Last summer the Service proposed that the five agencies make a strong push to improve understanding of sampling and monitoring methodologies for delta smelt. That proposal was accompanied by a list of specific study concepts. The Stockton FWO will be hosting a multi-agency workshop to further develop these concepts on April 28, 2014. The process the Service has begun will be used to develop and refine longer-term studies to move this effort forward. Actions requiring more time and a larger commitment of resources will be developed by August 31, 2014 via a collaborative process led by the Service, CDFW, Reclamation, DWR, and interested stakeholders. The resulting plan will be subjected to independent peer review and implemented at the appropriate time. The agenda for discussion and development, as appropriate, includes gear selectivity studies, vertical and lateral distribution studies, development of appropriate adjustments to existing long-term monitoring strategies, and quantification of pre-screen direct entrainment losses.

ATTACHMENT J

PRELIMINARY SCIENCE PLAN FOR ANADROMOUS FISH MONITORING AND TECHNOLOGY IMPROVEMENTS

Preliminary Science Plan for Anadromous Fish Monitoring and Technology Improvements

April 7, 2014

As identified in the Bureau of Reclamation (Reclamation) and the California Department of Water Resources' (DWR) Drought Operations Plan for April through October, considerable information and relevant data exists to analyze the potential effects of drought conditions and the actions taken in response to those conditions on threatened and endangered anadromous fishes in the California Central Valley. However, given necessity of rapid management decisions to achieve potential benefits to water storage or the conservation of species, agencies are interested in greater real-time operational decision making, which the current monitoring system does not adequately address. Real-time monitoring requires remote or biologist reported information on a daily (or more frequent basis) to inform the daily decision making desired by agency managers during the drought. To meet these real-time information needs, state and federal agencies are committed to developing, and implementing as appropriate, a multi-objective emergency fisheries monitoring, technology improvement, and science plan to significantly improve the ability to make real-time operational decisions. A second objective of this plan is to undertake monitoring and research to improve understanding of biological effects associated with water operations regardless of hydrologic conditions. Frequently, this information does not require daily reporting, but is needed in a timely fashion to inform the management cycle.

This preliminary plan will be further developed through an interagency team led by NOAA Fisheries and DFW. NOAA Fisheries Central Valley Office and DFW will collaborate with the NOAA South West Fisheries Science Center, and North West Fisheries Science Center, DWR, Reclamation, U.S. Geological Survey, and U.S. Fish and Wildlife Service in developing the plan.

This preliminary plan outlines a number of near-term and long-term actions to address these needs.

I. Water Year 2014 Actions (near-term):

These actions will be developed by **April 15th** and will include:

Delta Monitoring:

1) Expanded use of field crews through the extended drought season to gather and analyze the pertinent trawl and beach seining data for implementation of the Delta Cross Channel operations criteria proposed in the drought operations plan from April 1-November 15.
2) Consider additional monitoring stations (trawl or beach seine) including Georgiana Slough to better quantify the potential risk of entrainment into the Interior Delta.
3) Significant new salmonid and sturgeon monitoring as proposed by DWR and related to drought barrier installation and operations (*e.g.* Didson cameras at barrier culverts; additional measures to be determined and pending implementation).
4) Expanded use of acoustic arrays already proposed or implemented this season. In response to the potential for modified DCC gate operations, acoustic tag receivers have been placed in the Delta Cross Channel in 2014 to capture passage of acoustically tagged fish released for studies associated with the Georgiana Slough Floating Fish Guidance Structure Project installed in 2014.

Tributary Monitoring:

5) Significant new monitoring is needed upstream and on tributaries to document the effects of the drought on sensitive populations. Clear Creek is a particularly interesting tributary for evaluating multiple lifestage, multiple mechanism drought stressors on Spring-run Chinook salmon since temperature effects are likely to influence adults and eggs in WY2014. Steelhead also present numerous interesting monitoring studies since most CVP tributaries contain healthy, stable populations of *O. mykiss*, and the metapopulation dynamics of this species' persistence through drought conditions will be informative to its management. Increased monitoring for winter-run Chinook is included in the Winter-run Chinook Contingency Plan.

Data Analysis

6) Provide technical support for real-time drought water project operations in the Delta. Increase fisheries agencies analytic capacity of operations and scientific support to address in-season immediate requests for flexible operations related to drought (biologists, hydro-modeler, statistician). Support could reside with any of the contributing agencies, or could take the form of an interdisciplinary team from a number of agencies.

Fish Rescues

7) Finalize an emergency fish rescue and re-location program for summer 2014. NOAA Fisheries and CDFW are working to develop emergency rescue and relocation protocols for returning adult winter-run and spring-run Chinook salmon this spring and summer in direct response to the drought crisis.

II. WY 2015 and beyond (long-term):

Actions requiring additional development or a more substantial commitment of resources will be developed by **October 1, 2014**, through a collaborative science process led by NOAA Fisheries and the California Department of Fish and Wildlife (CDFW) in coordination with the other agencies, and stakeholders. This process will identify a series of goals and criteria to be developed and reviewed by an interagency workgroup. The goals and criteria will then be used to evaluate science and monitoring proposals. The process will be designed to incorporate independent review at appropriate steps.

In order to further develop this plan, CDFW and NOAA Fisheries will lead an interagency team that builds on existing efforts. The team will review and prioritize recommendations in the Delta Science Program's Independent Science Review reports regarding long-term operations. The team will also work closely with the South Delta Research Collaborative, the Collaborative Science and Adaptive Management Program and Team, and the Interagency Ecological Program. The plan will be informed by conceptual models and gap analyses using those models being developed through these efforts.

Preliminary components for further development by the team may include, but are not limited to:

1) Significantly augment the “real time” salmon monitoring network in Delta, main-stem Sacramento and tributaries to track fish locations, densities and movement in real-time to improve the ability to manage and measure risks to fisheries resources, and collect information that can be used to assess correlations between water operations and fishery effects associated with those operations, and inform more comprehensive models (e.g. life cycle models).
2) Expand and incorporate the use of existing fish tagging technologies such as active (acoustic) and passive (e.g. PIT tags) fish tagging and tracking technologies in key locations within and upstream of the Delta. These tagging technologies, when used appropriately, will be able to provide greater resolution to fish movement upstream and in the Delta, which can then be incorporated into real-time and future analysis.
3) Expand the use of fish behavioral modeling and other tools that can operate in real time to inform decision making.
4) Expand the analytic capacity of agency scientists and managers to access, analyze and report information on a real-time and annual basis. This includes efforts to synthesize information from existing and new data sets.
5) Develop new approaches to predicting upstream temperature effects based on predicted operations and monitor effects in real-time. Implement recommendations from the Independent Science Review of 2013.
6) Develop and implement targeted studies to address key uncertainties related to water operations and juvenile salmonid behavior and mortality.
7) Develop a program for continued research on other stressors including effects of non-native predation on migrating juvenile salmonids.
8) Expand the ability to document adverse effects that occur on an annual basis.

Some initial proposals that could be evaluated in light of what we expect to arrive at as the developed goals and criteria include:

1) The expanded use of fish tagging technologies through the acquisition, deployment and use of expanded active (acoustic) and passive (e.g. PIT tags) fish tagging and tracking technologies in key locations within and upstream of the Delta, based upon recommendations of National Academy of Science Report, “A Scientific Assessment of Alternatives for Reducing Water management effects on T and E Species in CA’s Bay-Delta.” (consider for WY 2015)
    a) The enhancement of the upstream and Delta monitoring network will likely be a multi-year effort that could begin in earnest with large-scale PIT tagging of hatchery release groups from brood year 2014 (since most of the 2013 brood year hatchery releases have already taken place). NOAA is currently finishing a more detailed proposal that describes some of the opportunities for an expanded PIT tagging network in the Delta.
        i) Special consideration should be given to the applicability of using existing studies to answer questions that the studies were not intended to.
        ii) Further discussion is also needed to identify the regulatory or management applicability of these studies in their relationship to water operations and other stressors. These metrics may influence decision making in a holistic view of fish management (hatchery, harvest, hydro, and habitat).

2) Further development of the pilot Particle Tracking Model (PTM) that incorporates proxy fish behavior, to better quantify potential risk to fish species in the Delta. Current efforts include particle insertion points and values based on key monitoring locations and observed (monitoring) catches. The enhanced PTM results can then be used to make predictions about the fate of fish observed at actual monitoring data. Sensitivity analyses of PTM insertions to assess drivers of fish distribution (i.e. behavior, tides, flows, export management) can be used to consider the relative value of solutions being proposed regarding shifts in fish entrainment and exposure.

3) Salmonid Freshwater Indicators: An interagency collaborative synthesis could be undertaken to develop useful salmonid freshwater indicators to evaluate the condition of juvenile year classes prior to their entering the ocean. These data would be informative to the effect of freshwater conditions during the drought on Central Valley salmonid populations and inform ocean and escapement management of each year class. Considerable monitoring information exists, but some of the above efforts may inform additional indicators demonstrating the influence freshwater conditions have had on the abundance, productivity, diversity, and distribution of salmonids during the drought and looking forward.