



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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JUL 1 2015

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Mr. Mark Cowin
Director
California Department of Water Resources
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Re: Contingency Plan for Water Year 2015 Pursuant to Reasonable and Prudent Alternative Action I.2.3.C of the 2009 Coordinated Long-term Operation of the Central Valley Project and State Water Project Biological Opinion, Including a Revised Sacramento River Water Temperature Management Plan

Dear Mr. Murillo and Mr. Cowin:

This letter responds to the U.S. Bureau of Reclamation's (Reclamation) May 18, and June 25, 2015, letters and enclosures: (1) *Updated Project Description for July - November 2015 Drought Response Actions to Support Endangered Species Act Consultations* (Project Description), (2) *Biological Review for Endangered Species Act Compliance of the WY 2015 Updated Drought Contingency Plan for July - November Project Description* (Biological Review), (3) *Revised Sacramento River Water Temperature Management Plan June 2015 Temperature Management Plan*, and (4) *Updated Biological Information for June 2015 Temperature Management Plan*; wherein Reclamation proposes modifications to the Interim Contingency Plan for April through September 2015¹. On March 27, 2015, NOAA's National Marine Fisheries Service (NMFS) concurred² that Reclamation and the California Department of Water Resources' (DWR) Interim Contingency Plan was consistent with reasonable and prudent alternative (RPA) Action I.2.3.C in NMFS' June 4, 2009, biological and conference opinion on the long-term operation of the Central Valley Project (CVP) and State Water Project (SWP; CVP/SWP Opinion). However, in response to continuing severe drought conditions, Reclamation and DWR have proposed that the updated Project Description, and the supporting

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http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/bureau_of_reclamation_s_march_24_2015_request_for_nmfs_concurrence_on_contingency_plan_for_april_through_september_2015.pdf

http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/nmfs_determination_on_contingency_plan_and_tuc_petition_-_march_27_2015.pdf



Biological Review, should serve as the Contingency Plan July through November 2015. Reclamation seeks NMFS concurrence that the operations described in the previously submitted Updated Project Description dated May 14, 2015, and supplemented by the revised Sacramento River Temperature Management Plan and Updated Biological Information enclosed in its June 25, 2015, letter, are within the limits of the Incidental Take Statement of the CVP/SWP Opinion and serves as the Contingency Plan through November 2015.

Background

The proposed Project Description and Temperature Management Plan are being considered in the context of continuing and severe drought conditions. Water year 2015 is the State's fourth straight year of below-average rainfall and very low snowmelt runoff. Water year 2014 was the fourth driest year in recorded history for California (after 1924, 1931, and 1977 based on the Sacramento Valley water year index), resulting in the low initial storage at the beginning of water year 2015. Although surface water storage levels are currently greater than they were at this point last year, the electronic reading of the State's snowpack water content stood at 1.4 inches, or 5 percent of the April 1st average, the driest reading in California's written record. On April 1, 2015, the Governor of California, through executive order B-29-15³, reaffirmed his January 17, 2014, and April 25, 2014, Emergency Proclamation regarding California's drought noting that "severe drought conditions continue to present urgent challenges including: drinking water shortages in communities across the state, diminished water for agricultural production, degraded habitat for many fish and wildlife species, increased wildfire risk, and the threat of saltwater contamination to fresh water supplies in the Sacramento-San Joaquin Bay Delta." Since the initial proclamation, NMFS has acted to provide the assistance needed to manage through drought conditions in California. NMFS continues to work quickly and collaboratively with the other fish agencies and the operators of the CVP and SWP to protect health and safety while providing needed protections for and minimizing adverse effects to listed anadromous fish species under the Endangered Species Act (ESA), as demonstrated in the exchange of letters⁴ in 2014 and 2015 regarding requested changes in specific operating parameters.

Consultation History and Project Description

On February 27, 2015, and in response to Reclamation's February 2015 forecast of deliverable water⁵, NMFS acknowledged that the end of September 2015 storage in Shasta Reservoir would be less than 1.9 million acre-feet based on the 90 percent hydrology. Subsequently, on March 24, 2015, Reclamation issued its *Project Description for April- September 2015 Drought Response Actions To Support Endangered Species Act Consultations* and renewed its commitment to take necessary actions within its discretion to meet the multiple water needs, including actions that preserve cold water at Shasta Reservoir for the protection of winter-run. A number of those actions have been carried over into the May 18, 2015, updated Project

³ http://gov.ca.gov/docs/4.1.15_Executive_Order.pdf

⁴ All NMFS letters regarding 2014 and 2015 drought operations are posted online under "Biological Opinion Actions" at: http://www.westcoast.fisheries.noaa.gov/central_valley/water_operations/

⁵ http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/2015-02-27_nmfs_response_to_bor_s_february_forecast.pdf

Description, which includes the following modifications to CVP/SWP operations being proposed under RPA Action I.2.3.C:

1. Modification of Net Delta Outflow Index (D-1641)
2. Modification of Rio Vista Flow Requirement (D-1641)
3. Modification of Emmaton Salinity Compliance Point (D-1641)
4. Modification of Ripon Dissolved Oxygen Compliance Point (D-1422)
5. Modification of the Water Transfer Window (CVP/SWP biological assessment)

In addition to these specific modifications, the Project Description described a suite of proposed upstream tributary operations, including an operation and release schedule for Keswick Dam, developed by Reclamation, in coordination with NMFS, DWR, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and the State Water Resources Control Board (State Water Board), and intended to manage the cold water storage within Shasta Reservoir to provide winter-run habitat throughout the temperature management season. RPA Action I.2.4 requires Reclamation to manage operations to a final Temperature Management Plan that will achieve daily average water temperatures not in excess of 56°F at Sacramento River compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for winter-run Chinook salmon, and whenever possible, October 1 through October 31 for mainstem spring-run Chinook salmon. However, the updated May forecast described diminished quantity and quality of the cold water pool available in 2015, and the subsequent temperature modeling indicated that a daily average water temperatures of 56°F at the Clear Creek temperature compliance point (CDEC ID: CCR) could not be met for the duration of the temperature management season through October 31, 2015. The final Sacramento River Temperature Management Plan, enclosed in Reclamation's June 25, letter and developed in the context of the drought contingency plan per Action I.2.3.C, sets a compliance point upstream of Balls Ferry this year, targeting an average water temperature of 57°F at CCR, and not to exceed 58°F (unless going above is needed to conserve cold water pool, and based on real-time temperature management team guidance), with an added commitment to monitor operations in real-time.

Biological Reviews of the Submittals

The Biological Review submitted with Reclamation's May 18 letter refers to the species status updates provided in DWR's Emergency Drought Barrier Aquatic Biological Assessment to describe the abundance and distribution in water year 2015 of ESA-listed salmonids and sturgeon covered by the CVP/SWP Opinion. The Biological Review summarized the generalized effects of the proposed drought flexibilities on the listed anadromous salmonid and green sturgeon species, describing the form and trend of expected effects, and assigning a qualitative level of certainty to each effect. Quantifying the specific effects of any particular contingency plan element, or of the full suite of proposed actions, is difficult as a result of combined uncertainties relating to, for example:

- specific migration timing of listed species and presence in the "footprint" of any particular component of the modified action;
- uncertainty in the quantitative relationship between any underlying factor (*e.g.*, outflow) and the response variable of interest (*e.g.*, survival); and

- specific timing, magnitude, and duration of any particular component of the modified action (for example, it is not known when or how much water will be transferred outside of the transfer window).

The Biological Review also included an assessment of the potential effects of Reclamation's proposed Shasta Operations/Keswick release schedule and associated operational actions in the July through November period. However, on May 29, 2015, and as a result of recent Shasta Reservoir temperature profiles, Reclamation indicated that the cold water pool was 1°F warmer, and a smaller volume, than in April 2015. Over the following 3 weeks, representatives from Reclamation, DWR, CDFW, USFWS, State Water Board, and NMFS developed multiple Shasta operations and Keswick release schedules, and water temperature modeling, in order to come up with the scenario that would provide the most opportunity for temperature management throughout the winter-run spawning, incubation, and fry rearing season.

While NMFS agrees with Reclamation's overall analysis presented in the Biological Review, the Sacramento River temperature modelling results of the Shasta operations and Keswick release schedule presented as part of the May 18, 2015, letter lacked certainty with regard to how accurately they predict the ability to meet temperature compliance below Keswick Dam. This concern is predicated on the loss of temperature control in 2014, even though modeled water operations had been forecasted to maintain temperature compliance until October below Keswick Dam. Reclamation's assessment, *Initial Hindcast of Temperature Performance Sacramento River 2014*⁶, submitted to the State Board on March 17, 2015, acknowledged that the temperature model did a poor job of characterizing the Temperature Control Device (TCD) performance once the full side gates were used to access the remaining cold water in Shasta Reservoir, resulting in river temperatures much higher than expected. In addition, low Shasta storage levels have precluded use of the TCD's upper gates, which can in turn cause the model to underestimate temperatures.

It is now very clear through evaluating operations in both 2014 and 2015 that the volume of cold water available for real-time management in June through October is highly dependent on Keswick releases in April through early June. In 2016, should drought conditions persist, these releases in April through early June will need to be held to minimal levels to achieve adequate temperatures only. Reclamation, through coordination with NMFS, has taken a number of steps intended to avoid temperature control failure in 2015. For example:

- Reclamation has developed a Shasta Temperature Management Plan⁷ (enclosed), where one of its key goals is to "Avoid the severe winter-run Chinook mortalities of last year -- develop temperature management criteria and related operations that reduce the risk of a second year-class failure by carefully expending very limited cold water pool resources over the course of the season (June through late October). The overall strategy is to manage for warmer temperatures earlier in the season in order to reduce risk of running out of cold water and catastrophic losses later in the season."

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http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/sac_river_hindcast_usbr_2014.pdf

⁷ <http://www.usbr.gov/mp/drought/docs/shasta-temp-mgmt-plan-key-components-06-18-15.pdf>

- From April 13 through May 26, 2015, Reclamation implemented a warm-water bypass at Shasta Dam, which has conserved ~102 TAF of cold water pool for use later in the season.
- NMFS and Reclamation have made a commitment to co-chair a technical team to improve Reclamation's ability to accurately forecast water temperatures in the upper Sacramento River. Reclamation and NMFS have developed an initial strategy for this team to review the existing model and develop new or revised accurate and transparent temperature forecasting tools to be used in the February through April spring forecast period (prior to real-time summer operations) in order to support operational decisions, and associated ESA consultations. In addition, Reclamation and NMFS-Southwest Fisheries Science Center (SWFSC) are working on a multiyear effort to develop a Temperature Decision Support Tool that includes a reservoir temperature model coupled with the existing River Assessment for Forecasting Temperature (RAFT) model that successfully forecasts downstream river temperatures using real-time meteorological conditions. This model may have some applicability for forecasting water temperatures resulting from differing operational plans, and will incorporate peer reviews and iterative technical workshops to inform its development and implementation in the future.

In anticipation of potential high water temperatures in 2014, NMFS developed the winter-run drought contingency plan for 2014 that was included as part of the April 8, 2014, Drought Operations Plan⁸. A key contingency measure in the winter-run drought contingency plan was an effort to increase capacity for collecting and rearing winter-run at the Livingston Stone National Fish Hatchery (LSNFH) so as to bolster the 2014 brood year. Recognizing the considerable contribution of the increased production at LSNFH to the 2014 brood year, and the expected poor in-river conditions, broodstock collection in 2015 has again been increased.

NMFS' Summaries and Expectations Based on Reclamation's Proposed Contingency Plan for July through November

NMFS supports the May 18, 2015, Project Description (with the exception of the Shasta Operations/Keswick Release Schedule, which was superseded by the June 2015 Revised Sacramento River Water Temperature Management Plan. See next section.), incorporated by reference in Reclamation's June 25, 2015, letter, as the contingency plan pursuant to RPA Action 1.2.3.C., with the following provisions:

- This response approves extending the water transfer window to November 15, 2015, contingent upon:
 - the continued implementation of RPA Actions IV.1.2 and IV.3;
 - November 15, 2015, applying to the date that transfer water is last exported, and not the last date of release from the reservoirs; and
 - reporting on a weekly basis, at a minimum, on the specific timing, magnitude, and duration of transfers outside of the transfer window, during Delta Operations for Salmonids and Sturgeon technical working group and Water Operations Management Team meetings. If those groups are not meeting on any given week, Reclamation shall provide e-mail updates to both groups.

⁸ see Attachment D in <http://www.water.ca.gov/waterconditions/docs/2014-Operations-Plan.pdf>

- NMFS acknowledges that the ESA section 7 consultation on the construction of the Emergency Drought Barrier at West False River is conducted through emergency consultation procedures separate from this effort.
- NMFS expects that all actions within the anadromous fish section of the WY2015 Biological Monitoring Plan will (continue to) be implemented. Due to the generally poor status of winter-run Chinook salmon, as affected by multiple years of drought, we expect Reclamation and DWR to work closely with NMFS, USFWS, and CDFW to track and assess the real-time distribution of both wild and hatchery juvenile winter-run Chinook salmon and continually assess whether additional measures may be implemented to minimize adverse effects of operations to this critically-imperiled species.
- Reclamation shall coordinate with DWR regarding increasing releases out of Oroville Reservoir during the summer months to meet Delta requirements, in order to preserve the cold water pool in Folsom Reservoir. In the late summer and fall, releases out of Folsom Reservoir shall increase to meet Delta requirements in order to compensate for the earlier releases out of Oroville Reservoir.
- Reclamation shall deploy a new Oak Bottom temperature curtain within Whiskeytown Reservoir by April, 2016.
- This response does not provide concurrence on any of the potential modifications identified in the “Possible Future Conditions Warranting Additional Modifications” section of the Project Description. In the event that any of those actions are deemed necessary, NMFS expects Reclamation and DWR to seek concurrence prior to implementation.

NMFS concurs with the Sacramento River temperature management plan, as proposed in Reclamation’s June 25, 2015, letter, with key conditions, as follows:

- Biological objectives:
 - Target 57°F at CCR, not to exceed 58°F unless going above is needed to conserve cold water pool based on real-time temperature management team guidance.
 - Delay last TCD side gate operation until mid-October (target October 15th). Minimize the potential for fall-run Chinook redd dewatering in October and November.
- Base Operations:
 - Establish 7,250 cubic feet per second (cfs) as a base flow from Keswick Dam in June and July.
 - Keswick releases in August through October shall be as modelled (August: 7,250 cfs; September: 6,500 cfs; and October: 5,000 cfs). These releases are subject to adjustment by the real-time monitoring and decision making group based on performance of the plan in June and July.
- Real-Time Management:
 - Actual operations will be decided using a real-time monitoring and decision making process that includes representatives from the relevant Federal and State agencies. This decision making process may yield adjustments to base operations depending on real-time conditions on the ground (e.g., real-time water temperatures and resulting cold water pool volume).
 - Reclamation shall convene a real-time monitoring and decision making group at least weekly, and more frequently if necessary, that carefully tracks river temperatures, air

temperatures, and biological metrics to ensure that water releases are made for the sole purpose of optimizing limited cold water pool resources throughout the season; and to inform decisions about temperature operations. The agencies also acknowledge the expertise of water districts and irrigation districts to operate their systems in partnership with the agencies to optimize results and minimize impacts. The agencies expect to work closely during real-time operations with such districts. Decisions on real-time adjustments to base operations will be made using the following principles:

- Attaining temperatures close to 57°F as possible at CCR, while monitoring in real-time temperatures near the Highway 44 Bridge to assess what temperatures the majority of redds are actually exposed to (assuming spawning will be at or upstream of the Highway 44 Bridge).
- Based on projected temperatures, and if it appears that they will exceed 58°F at CCR, Reclamation will call a meeting to determine what actions are most advisable given salmon life-stage and projected ability to withstand additional adverse effects of temperatures. Actions which could be implemented include: TCD gate changes, bypassing power and other operational adjustments, allowing short-term exceedances above 58°F at CCR as long as night-time temperatures are low, and possibly increasing Keswick releases above 7,250 cfs. Releases above the base flow have a negative cumulative effect on thermal mass, cold water and possible timing of side gate operations, and therefore require careful consideration.
- Because overall seasonal temperature management, and most importantly the timing of future side gate operations, appears very sensitive to managing through heat waves, additional consideration will be given to optimal procedures for longer heat spells which are most likely to occur in July.
- If air temperatures are cooler, and 57°F is attainable at CCR, real-time adjustments may be made to reduce Keswick releases below 7,250 cfs in order to conserve thermal mass and cold water for later in the season, as long as 58°F at CCR is not exceeded.
- CDFW will monitor observed redd locations, particularly the most downstream redd and redds at risk of being dewatered and report results on a weekly basis. While this is not a comprehensive survey due to redds that are in deep water above Highway 44, it will provide a general distribution of redds. It will also provide a way of tracking the duration and peak of spawning which will inform temperature management decisions.
- NMFS will track temperature exposures and report on cumulative estimated mortalities on at least a bi-weekly basis. NMFS is also in the process of deploying new automated temperature fiber optic cables behind Shasta Dam and within Keswick Reservoir.
- Additional Monitoring Commitments:
 - Reclamation and NMFS will deploy new automated temperature fiber optic cables behind Shasta Dam and within Keswick Reservoir and use the data and information collected to make adjustment decisions.
 - Reclamation will monitor temperatures near the Highway 44 Bridge to assess what temperatures the majority of winter-run redds are actually exposed to (New CDEC station: SAC).

- The agencies will monitor weather conditions and forecasts and adjust releases and TCD gate operations accordingly. For example:
 - The River Assessment for Forecasting Temperature (RAFT) model will be used to better anticipate the need for management actions and help predict effectiveness of different real-time operations options.
 - Seasonal temperature management appears to be very sensitive to heat-storms, so the agencies will devise optimal procedures for longer heat spells (most likely to occur in July).
 - If air temperatures from June through August are substantially below what was forecast, there may be additional opportunities to increase releases in September and October for other purposes, while still meeting temperature objectives.
- CDFW will monitor observed redd locations throughout the temperature management season, particularly the downstream distribution of redds and those redds at potential risk of being dewatered as flows are ramped down in the fall.
- The agencies will meet as often as needed to share and review information, and/or make real-time decisions or adjustments, but no less than weekly.
- Commitment to Advance New Peer-Reviewed Temperature Model Review
 - NMFS and Reclamation will co-chair a new model review technical working group that will identify the shortcomings with the existing modeling tools and will make recommendation about short-term fixes to the current tool or defer changes to a new model.
 - In addition, Reclamation and NMFS-Southwest Fisheries Science Center are working on a multiyear effort to develop a Temperature Decision Support Tool that includes a reservoir temperature model coupled with the existing *RAFT model*⁹ that forecasts downstream river temperatures using real-time meteorological conditions. This model may have some applicability for forecasting water temperatures resulting from differing operational plans, and will incorporate peer reviews and iterative technical workshops to inform its development and implementation in the future.
 - Future efforts will use NOAA Climate Prediction Center forecasts, NOAA National Weather Service assistance, and more conservative meteorology as input to future model runs, rather than the median projections used in 2014 and prior years.
 - The agencies will develop a plan for independent peer review of these models and tools.
 - Through all of these steps, the agencies can and will improve on temperature management from here forward to more accurately project TCD operations and downstream river temperatures to manage potential effects on listed and special status species.
- Non-Operational Measures for Winter-Run Chinook Protection
 - Livingston Stone National Fish Hatchery is a small conservation hatchery for this species. FWS has increased capacity at Livingston Stone National Fish Hatchery production for winter-run from the typical 120 adults broodstock to accommodate up to 400 adults.
 - Other non-operational decisions (including for recreational and commercial fishing) are being made in this time frame for benefit of winter-run Chinook salmon.

⁹ <http://oceanview.pfeg.noaa.gov/RAFT/stream.html>

- The agencies will continue to actively investigate other project elements that make sense, including:
 - applying reflective paint or other shading on the penstocks into Whiskeytown Reservoir and
 - accelerating acquisitions related to the installation of the Oak Bottom Temperature Curtain in Whiskeytown Reservoir, decreasing the exposure of cold water from Trinity to sunlight as it travels through the powerhouse and exposed pipes that to help ensure this cold water remains cold.
 - The agencies will continue to seek input from stakeholders to develop other non-flow actions that may help minimize overall impacts (*e.g.*, predation control strategies and/or restoration, hatchery, *etc.*).

Conclusions

In conclusion, NMFS concurs that Reclamation's May 18, 2015, Project Description (with the exception of the Shasta Operations/Keswick Release Schedule, which was superseded with the June 25 Sacramento River temperature management plan), is consistent with RPA Action I.2.3.C and meets the specified criteria for a contingency plan. We are making this finding based on the information contained in the Biological Review. It is our conclusion that the potential effects of the types of operations proposed in the contingency plan were considered in the underlying analysis of the CVP/SWP Opinion. The analysis in the CVP/SWP Opinion considered that droughts would occur and concluded that implementation of the RPA, including Action I.2.3.C, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, the Southern Distinct Population Segment of North American green sturgeon, and the Southern Resident killer whales, and will not result in the destruction or adverse modification of their designated critical habitats.

In addition, NMFS concurs with the Sacramento River temperature management plan, as proposed for the CVP in Reclamation's June 25, 2015, letter, and its associated Updated Biological Information. NMFS acknowledges that storage in Shasta Reservoir at the beginning of the temperature management season in June, and the quantity and quality of the cold water pool, will not provide for suitable winter-run habitat needs throughout their egg and alevin incubation and fry rearing periods. The base operations plan, including the Keswick release schedule, delayed use of full side gates, and real-time monitoring and decision-making based on winter-run run timing, location of redds, air and surface water temperature modeling, and projected versus actual cold water storage conditions and downstream water temperatures, represents the best that can be done with a really bad set of conditions. We note that these conditions could have been largely prevented through upgrades in monitoring and modeling, and reduced Keswick releases in April and May. Based on extensive analyses of alternative scenarios (6,000 to 8,000 cfs Keswick releases), the plan provides a reasonable possibility that there will be some juvenile winter-run survival this year.

We look forward to continued close coordination with you and your staff throughout this extremely challenging water year.

If you have any questions regarding this letter, please contact me at will.stelle@noaa.gov, or (206) 526-6150, or contact Maria Rea at (916) 930-3600, maria.rea@noaa.gov.

Sincerely,



William W. Stelle, Jr.
Regional Administrator

Enclosure

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Shasta Temperature Management Plan – Key Components

The Bureau of Reclamation, in coordination with NOAA's National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (USFWS), the California Department of Water Resources (DWR), the California Department of Fish and Wildlife (CDFW), and the State Water Resources Control Board (State Water Board), has developed a new Shasta Temperature Management Plan. This document summarizes key components of that plan. Additional details of the final plan are being prepared, and the plan will be submitted to NMFS, USFWS, CDFW, and the State Water Board for review and concurrence within the next week.

Current circumstances:

- 1. Cold water storage in Shasta Reservoir is critically low.** The lack of snowpack translated into a much smaller volume of cold water in Shasta Reservoir (called the “cold water pool”) than occurred last year. The cold water pool is both about 30% smaller than what was anticipated in early May 2015, and is not as cold as it was at this time last year. The size of the projected cold water pool is a key variable in any seasonal temperature management plan, hence the need to revise the 2015 plan to reflect these new and significantly lower projections (see Supplemental Graphics document, Figure 1).
- 2. Summer is likely to bring record-breaking high temperatures.** Scientists have been tracking a ‘warm blob’ of Pacific Ocean surface water since fall of 2013. The warmest ocean temperatures in the blob now are around 5°F above average. Researchers have linked these ocean temperatures to record high temperatures on land, which are likely to continue. Air temperatures in Redding over the last 3 months have tracked an average of almost 7°F (3.82°C) higher than normal (Supplemental Graphics, Figure 2).
- 3. Most streams and rivers are already running warm.** For example, water temperatures coming from Whiskeytown Dam into Clear Creek have been about 2°F warmer than last year and 3°F warmer than average (Supplemental graphics, Figure 3). Further, temperature profiles in Shasta Reservoir showed significantly warmer water than expected, making it very unlikely to meet the NMFS Biological Opinion and Water Rights Order 90-5 requirements of 56°F maximum temperature at any compliance point in the river throughout the temperature-control season (through October).
- 4. Models used to predict Shasta cold water pool temperatures are uncertain.** A hindcast report issued in March 2015¹ found that the Sacramento River temperature model represented well the pre-side gate performance progression of the Shasta Temperature Control Device (TCD), but did a poor job at characterizing the TCD performance once the TCD side gate operation went into real-time effect 2014. These

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http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/sac_river_hindcast_usbr_2014.pdf

model errors led to an excess expenditure of Shasta cold water pool last summer, resulting in early depletion of cold water reserves and loss of temperature control in the river in September 2014.

5. **The population of winter run Chinook salmon is at extreme risk.** NMFS recently named Sacramento River winter-run Chinook as one of the eight species most at-risk of extinction in the near future. Last year, due to lack of ability to regulate water temperatures in the Sacramento River in September and October, water temperature rose to greater than 60°F. This reduced early lifestage survival (eggs and fry) from Keswick to Red Bluff from a recent average of approximately 27% (egg-to-fry survival estimates averaged 26.4% for winter-run Chinook salmon in 2002-2012) down to 5% in 2014. Consequently, 95% of the year class of wild winter-run Chinook was lost last year.
6. **Winter-run Chinook egg and hatchings (alevin in the gravel) are extremely sensitive to high temperatures.** Winter-run experience increased levels of mortality during egg and alevin development when water temperatures rise above 56°F, coupled with other potential stressors, including water quality, disease, predation, competition, habitat availability, contaminants and food availability.

Poor results of Temperature Management in 2014:

Despite projections and modeling efforts in 2014, Shasta Reservoir ran out of sufficiently cold water in September 2014. After this point, there was insufficient cold water available for release to the Sacramento River to manage temperatures. This lack of ability to regulate temperature was a primary factor contributing to the loss of 95% of last year's year class of wild Sacramento River winter-run Chinook.

All of the agencies that worked to develop this plan are committed to taking all steps within their collective responsibility and authority to minimize the risk of a second year-class failure to this endangered species of salmon. Losing two out of three year classes would be devastating to the viability of this species.

The hindcast report of last year's operations highlighted how the TCD side gates factored into elevated river temperatures last year, along with the significant role of ambient meteorological conditions on seasonal temperature management. To address these limitations, this plan builds additional conservatism into the modeling assumptions, including utilizing a 10% meteorological conditions outlook (*i.e.* using the warmest 10% temperature projections) over the next 90 days to predict seasonal temperatures. These changes are expected to better predict actual cold water pool management this year. But there is still a high level of risk and uncertainty, given the very poor inflows, low reservoir levels and warm air temperatures being projected for the season.

New information compelled revisions to the May 2015 temperature plan:

The six agencies worked with the Sacramento River Settlement Contractors in early May to come up with a strategy for water releases in the Sacramento River for the remainder of the year. At that time, based on cold water pool projections, the agencies projected that there was a reasonable likelihood that 56°F could be attained throughout the season.

In late May, Reclamation notified NMFS and the State Water Board that the updated Shasta Reservoir temperature profile was noticeably warmer than the data used in the April temperature

plan, and that the change was beyond the typical reservoir warming experienced in past years in April and May. Current temperature modeling indicates that a temperature objective of 56°F downstream to the temperature compliance point at Bonnyview Bridge, Redding, California (Sacramento River above Clear Creek, CDEC ID: CCR) would be very difficult this year and that a modified temperature plan was warranted. Reclamation has examined the April temperature data and has concluded that much of the shift in temperature readings was due to an instrument calibration error (causing earlier temperature readings to read cooler than actual). In addition, unusually warm air temperatures and a lack of snowmelt runoff contributed to warmer than expected inflows into Shasta Reservoir this spring.

Subsequent temperature profiles in Shasta Reservoir, when input into the temperature model, forecasted significantly warmer water temperatures than previously expected. The model results indicated a lack of ability to meet the NMFS Biological Opinion and Water Rights Decision 90-5 requirement of a maximum daily average water temperature of 56°F at any compliance point in the river throughout the temperature-control season (through October). Reclamation modeled various Keswick release scenarios, including June through August releases at 7,000 cfs and 7,500 cfs (Supplemental Graphics, Figures 4 and 5, respectively).

Plan Components:

A. 2015 Shasta Temperature Management Plan Goals

Considering the information developed to date, the six agencies developed the following overarching goals for a new plan:

- Maintain access to essential water supplies for California communities throughout the Central Valley Project (CVP)/State Water Project (SWP) system.
- Avoid the severe winter-run Chinook mortalities of last year— develop temperature management criteria and related operations that reduce the risk of a second year-class failure by carefully expending very limited cold water pool resources over the course of the season (June though late October). The overall strategy is to manage for warmer temperatures earlier in the season in order to reduce risk of running out of cold water and catastrophic losses later in the season.
- Recognize the major uncertainties associated with predicting how 2015 will transpire given the extreme conditions and uncertain weather and prepare to manage around well-informed “real time” operations based upon ever-changing current conditions.
- Retain integrated system operations and flexibility for end users/water districts to devise local solutions to assist in plan implementation as the season progresses.
- Maintain Delta outflows, consistent with the current Temporary Urgency Change Petition (TUCP).

B. Shasta Temperature Management Plan Objectives

These overarching goals led to the following plan objectives:

- Biological objectives:
 - Target 57°F at CCR, not to exceed 58°F unless going above is needed to conserve cold water pool based on real-time temperature management team guidance.
 - Develop a base operation that meets this temperature objective and delays last TCD side gate operation until mid-October (target October 15th).

- Develop a rigorous real-time management process (see below) that carefully tracks river temperatures, air temperatures, and biological metrics to ensure that water releases are made for the sole purpose of optimizing limited cold water pool resources throughout the season.
 - Minimize the potential for fall-run Chinook redd dewatering in October and November.
 - Retain wildlife refuge water supply planning objectives to the maximum extent feasible, consistent with previous considerations.
- Water Supply Objectives:
- Maintain access to essential water supplies for California communities.
 - Specify minimum end of September storage of 120 thousand acre-feet in Folsom Lake.
 - Specify minimum end of October storage of 900 thousand acre-feet in Lake Oroville.
 - Provide some level of south Delta exports to address health and safety concerns for City of Tracy and South Bay Aqueduct municipal supplies, which rely on diversions directly from the Delta.
 - Facilitate water transfers to the extent possible as part of overall water operations plans.
- Retain integrated system operations and flexibility for local solutions:
- Retain commitment to meet Delta objectives (outflow and salinity) in the TUCP.
 - Work to manage south of Delta exports to achieve San Joaquin Valley refuge management objectives based on allocations.
 - Commit to working with Sacramento River Settlement contractors and others in real-time to minimize water supply impacts.
 - Minimize impact on/affects to non-CVP water users (*e.g.*, Feather River service area, SWP, other system operators).
 - Release a volume of transfer water from Shasta Reservoir in October through November 15 whenever ambient air temperatures drop and river temperatures are suitable.
 - Reshape project releases in November/December (consistent with fall-run Chinook needs) in order to meet critical needs South of Delta.
 - Flexibly implement the Coordinated Operations Agreement in order to achieve overall system goals.

C. Shasta Temperature Management Plan Base Operations

- Establish 7,250 cubic feet per second (cfs) as a base flow from Keswick Dam in June and July.
- Modeled Keswick releases in other months that achieve the above objectives are: August: 7,250 cfs; September: 6,500 cfs; October: 5,000 cfs. These are subject to adjustment by the real-time monitoring and decision making group based on performance of the plan in June and July.

D. Shasta Temperature Management Plan Real-time Management

The above guidelines in section “C” are for base operations—actual operations will be decided using a real-time monitoring and decision making process that includes representatives from the relevant Federal and State agencies. This decision making process may yield adjustments to base operations depending on real-time conditions on the ground (*e.g.*, real-time water temperatures and resulting cold water pool volume).

Reclamation will convene the real-time monitoring and decision making group at least weekly, and more frequently if necessary to inform decisions about temperature operations. The agencies also acknowledge the expertise of water districts and irrigation districts to operate their systems in partnership with the agencies to optimize results and minimize impacts. The agencies expect to work closely during real-time operations with such districts.

Decisions on real-time adjustments to base operations will be made using the following principles:

- Attaining temperatures close to 57°F as possible at CCR, while monitoring in real-time temperatures near the Highway 44 Bridge to assess what temperatures the majority of redds are actually exposed to (assuming spawning will be at or upstream of the Highway 44 Bridge).
- Based on projected temperatures, and if it appears that they will exceed 58°F at CCR, Reclamation will call a meeting to determine what actions are most advisable given salmon life-stage and projected ability to withstand additional adverse effects of temperatures. Actions which could be implemented include: TCD gate changes, bypassing power and other operational adjustments, allowing short-term exceedances above 58°F at CCR as long as night-time temperatures are low, and possibly increasing Keswick releases above 7,250 cfs. Releases above the base flow have a negative cumulative effect on thermal mass, cold water and possible timing of side gate operations, and therefore require careful consideration.
- Because overall seasonal temperature management, and most importantly the timing of future side gate operations, appears very sensitive to managing through heat waves, additional consideration will be given to optimal procedures for longer heat spells which are most likely to occur in July.
- If air temperatures are cooler, and 57°F is attainable at CCR, real-time adjustments may be made to reduce Keswick releases below 7,250 cfs in order to conserve thermal mass and cold water for later in the season, as long as 58°F at CCR is not exceeded.
- CDFW will monitor observed redd locations, particularly the most downstream redd and redds at risk of being dewatered and report results on a weekly basis. While this is not a comprehensive survey due to redds that are in deep water above Highway 44, it will provide a general distribution of redds. It will also provide a way of tracking the duration and peak of spawning which will inform temperature management decisions.
- NMFS will track temperature exposures and report on cumulative estimated mortalities on at least a bi-weekly basis. NMFS is also in the process of deploying

new automated temperature fiber optic cables behind Shasta Dam and within Keswick Reservoir.

E. Additional Monitoring Commitments:

- Reclamation and NMFS will deploy new automated temperature fiber optic cables behind Shasta Dam and within Keswick Reservoir and use the data and information collected to make adjustment decisions.
- Reclamation will monitor temperatures near the Highway 44 Bridge to assess what temperatures the majority of winter-run redds are actually exposed to. (New CDEC station: SAC)
- The agencies will monitor weather conditions and forecasts, and adjust releases and TCD gate operations accordingly. For example:
 - The River Assessment for Forecasting Temperature (RAFT) model will be used to better anticipate the need for management actions and help predict effectiveness of different real-time operations options.
 - Seasonal temperature management appears to be very sensitive to heat-storms, so the agencies will devise optimal procedures for longer heat spells (most likely to occur in July).
 - If air temperatures from June through August are substantially below what was forecast, there may be additional opportunities to increase releases in September and October for other purposes, while still meeting temperature objectives.
- CDFW will monitor observed redd locations, particularly the downstream distribution of redds, throughout the temperature management season. They will also monitor those redds at potential risk of being dewatered as flows are ramped down in the fall.
- The agencies will meet as often as needed to share and review information, and/or make real-time decisions or adjustments, but no less than weekly.

F. Commitment to advance new peer reviewed temperature model review

Changing climatic conditions are not easily reconciled in the current temperature model used by Reclamation, and model outputs defining projected TCD side gate operations and river temperatures can be inaccurate, creating circumstances contributing to increased egg and alevin to fry mortality of winter-run Chinook salmon. To address these limitations:

- NMFS and Reclamation will co-chair a new model review technical working group that will identify the shortcomings with the existing modeling tools and will make recommendation about short-term fixes to the current tool or defer changes to a new model.
- In addition, Reclamation and NMFS-Southwest Fisheries Science Center are working on a multiyear effort to develop a Temperature Decision Support Tool that includes a reservoir temperature model coupled with the existing RAFT model² that forecasts downstream river temperatures using real-time meteorological conditions. This model may have some applicability for forecasting water temperatures resulting from differing operational plans, and will incorporate peer reviews and iterative technical workshops to inform its development and implementation in the future.

² <http://oceanview.pfeg.noaa.gov/RAFT/stream.html>

- Future efforts will use NOAA Climate Prediction Center forecasts, NOAA National Weather Service assistance, and more conservative meteorology as input to future model runs, rather than the median projections used in 2014 and prior years.
- The agencies will develop a plan for independent peer review of these models and tools.
- Through all of these steps, the agencies can and will improve on temperature management from here forward to more accurately project TCD operations and downstream river temperatures to manage potential effects on listed and special status species.

G. Non-operational measures for winter-run Chinook protection

- Livingston Stone National Fish Hatchery is a small conservation hatchery for this species. FWS has increased capacity at Livingston Stone National Fish Hatchery production for winter-run from the typical 120 adults broodstock to accommodate up to 400 adults.
- Other non-operational decisions are being made in the same time frame as this decision for benefit of winter-run Chinook salmon, including decisions on recreational and commercial fishing.
- The agencies will continue to actively investigate other project elements that make sense, including:
 - applying reflective paint or other shading on the penstocks into Whiskeytown Reservoir, and
 - accelerating acquisitions related to the installation of the Oak Bottom Temperature Curtain in Whiskeytown Reservoir, decreasing the exposure of cold water from Trinity to sunlight as it travels through the powerhouse and exposed pipes that to help ensure this cold water remains cold.
- The agencies will continue to seek input from stakeholders to develop other non-flow actions that may help minimize overall impacts (*e.g.*, predation control strategies and/or restoration, hatchery, *etc.*).

Summary

Given the very limited cold water resource, not all needs can be met with higher summer flows from Shasta Reservoir. The agencies have addressed several of the most critical areas of concern, and believe that the elements of the new plan described here allow flexibility for the agencies to continue working with other water entities and partners to find local solutions to the remaining needs.

Based on the temperature model predictions and RAFT model predictions at the 10% meteorological forecast (Supplemental Graphics, Figure 6), habitat conditions are predicted to be substantially better than last year, because temperature control will not be lost in the September timeframe. Actual performance of the plan will depend heavily on real-time management and actual air temperatures observed.