UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Mr. David Murillo
Regional Director
Bureau of Reclamation
2800 Cottage Way
Sacramento, California 95825

Mr. Mark Cowin
Director
California Department of Water Resources
1416 Ninth Street
Sacramento, California 95814

Re: Drought Operations Plan for the Central Valley Project and State Water Project from April 1 through November 15, 2014

Dear Mr. Murillo and Mr. Cowin:

This letter is in response to the U.S. Bureau of Reclamation's (Reclamation) April 8, 2014, letter, wherein Reclamation and the California Department of Water Resources (DWR) propose operations described in the Central Valley Project (CVP) and State Water Project (SWP) Drought Operations Plan (Plan) for April 1 through November 15, 2014. The Plan was developed in coordination with Reclamation, DWR, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, State Water Resources Control Board (State Water Board), and NOAA's National Marine Fisheries Service (NMFS, collectively "six agencies") and outlines a likely range of coordinated operations for the CVP and SWP through November 15, 2014, including modifications, as deemed prudent under the current low storage conditions, to several reasonable and prudent alternative[1] actions from NMFS' June 4, 2009, biological and conference opinion on the long-term operation of the CVP and SWP (NMFS BiOp). Reclamation has requested concurrence that the operations described in the Plan serve as the Contingency Plan for the remainder of Water Year 2014 in accordance with Reasonable and Prudent Alternative (RPA) Action 1.2.3.C and that the biological effects of implementing the Plan will be within the limits of the existing Incidental Take Statement. Additionally, 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.

[1] On April 7, 2011, NMFS issued an amended RPA (http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/040711_ocap_opinion_2011_amendments.pdf).

NMFS understands that California is continuing to experience unprecedented drought conditions, and is currently in its third straight year of below-average rainfall and very low snowpack. Calendar year 2013 was the driest year in recorded history for many parts of California, resulting in the low initial storage at the beginning of water year 2014. On January 17, 2014, the Governor of California announced an Emergency Proclamation, finding that "conditions of extreme peril to the safety of persons and property exist in California due to water shortage and drought conditions." Since that declaration, NMFS has acted to provide the assistance needed to manage through drought conditions in California. NMFS has continued 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 letters[2] in January, February and March regarding requested changes in specific operating parameters.

Over the last two weeks, the six agencies have been engaged in intense and extensive discussions towards the development of a comprehensive Plan that will chart out operations, given the current hydrology and modeling, through November 15, 2014. We have had extensive discussions about the predicted effects on ESA-listed fish resulting from the drought, including limited cold-water pools and carryover storage in the major CVP and SWP reservoirs that limit the ability to provide for adequate water quality throughout the life cycle of the anadromous fish in freshwater habitat. In light of real-time physical and biological data, both on hydrology and fish distribution, NMFS has examined all the required RPA actions, and endeavored to balance water needs while not deepening the harm to listed species. In order to augment storage south of the Delta in San Luis Reservoir for future critical needs, the operators of the CVP and SWP have requested flexibility to export water above health and safety levels during rain pulses, and then to taper off quickly to minimum combined 1,500 cfs exports. NMFS has engaged Reclamation and DWR on this flexibility while also clearly identifying the highest risks to species this year, including the possible loss of an entire year class of endangered winter-run Chinook salmon on the Sacramento River due to poor storage conditions in Shasta Reservoir.

It has been advantageous to look at real-time conditions and the operation of the CVP and SWP as a whole. Throughout these six agency discussions, we have focused on the highest priority opportunities and needs to minimize adverse effects of operations within the framework of the NMFS BiOp. As a result of these discussions, we have reached agreement on the following key improvements for fish that would not have otherwise occurred.

1. Winter-run Chinook salmon viability and Sacramento Settlement Contractor deliveries: 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

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

operations and increased availability of water to these senior water rights holders in this critically-dry year. This deferral of irrigation would allow implementation closer to the lower range of the Keswick release schedule for April and May, as identified in Section V of the DOP. During April and May, estimates of water volume differences if the revised (lower) maximum, rather than the original maximum, releases are implemented could translate to gains of up to 151-174 thousand acre-feet (TAF) in Shasta storage. From April through September, implementing the revised minimum, rather than the revised maximum, releases represents a water volume difference that could translate to gains of up to 544-556 TAF in Shasta Reservoir. These calculations, summarized in the enclosure, are estimates of the *maximum* potential storage gain – more modest storage gains are expected to be actually realized. Given this large range, NMFS intends to work closely with Reclamation and the affected water districts to achieve April and May Keswick releases towards the lower end of the range, if at all possible. As forecasts are updated, NMFS also intends to work closely with Reclamation and the Sacramento River Temperature Task Group to optimize June – September releases within the identified range for temperature management for winter-run, while also being mindful of effects on end of September storage.

In addition, 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. This measure will benefit winter-run, spring-run and fall-run Chinook salmon by preserving storage and, perhaps, helping to avoid large flow fluctuations during spawning and egg incubation seasons.

2. Listed species needs and timing of emergency drought barriers: DWR has agreed to defer the start of in-water construction of the drought barriers at Sutter and Steamboat sloughs to no earlier than May 22, which is largely outside of the emigration window for listed anadromous fish species into the Delta (see Table 6-34 on page 402 in the NMFS BiOp[3]; end of mandatory DCC gate closure in RPA Action IV.1.2). They have also agreed to remove the Sutter and Steamboat drought barriers by October 31, 2014, which again is largely outside of the range of impacts to this year's juvenile listed species emigration into the Delta. These drought barriers may not be necessary at all, given the recent rains, and their necessity will continue to be evaluated by DWR.

3. San Joaquin River steelhead offset measures: Reclamation and DWR have agreed to offset the desired flexibility in implementing the San Joaquin inflow-to-export ratio Action IV.2.1 with two additional measures not included in the RPA, as written, and that were not previously analyzed. These measures provide benefits to San Joaquin River origin steelhead (the Southern Sierra Nevada Diversity group of the California Central Valley steelhead distinct population segment):
   a. 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

[3]http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/nmfs_biological_and_conference_opinion_on_the_long-term_operations_of_the_cvp_and_swp.pdf

April/May 2014 period available in a future year to provide for a larger pulse flow, for the fishery agencies to shape, in the next "dry" or better water year type[4] for the San Joaquin River Basin. For example, if there is a 60 TAF gain in exports above the 1:1 I:E ratio (or minimum health and safety diversion of 1,500 cfs, whichever is greater), 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.

b. Shift exports to Jones Pumping Plant (CVP) for all of April and May up to the federal capacity (either pumping or canal capacity); remainder of exports to be pumped at the Banks Pumping Plant (SWP) up to the operable constraint (likely the OMR limit before the pulse period; I:E ratio (or minimum 1,500 cfs) after the pulse period unless wet). 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.

4. Other key points of the Plan for species protection include:
   a. Conserving storage in Shasta Reservoir by limiting releases from Keswick Dam 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. In addition, Keswick releases will not be increased to directly support CVP Delta diversions;
   b. Minimum human health and safety pumping (as defined in the NMFS Biop as 1,500 cfs) throughout the April 1 to May 31 timeframe when there is no natural or abandoned flow in the Delta;
   c. Utilizing power bypasses at Trinity Dam and Shasta Dam to access colder water, as necessary;
   d. A commitment to implement the two pulse flows in Clear Creek to attract adult spring-run Chinook salmon, as provided in RPA Action I.1.1, and per advice from the Clear Creek Technical Team; and
   e. Consideration of increasing flows into the American River as hydrology improves to improve in-river conditions this spring, summer, and fall for salmonids; and decrease the reliance on Shasta Reservoir for meeting Delta legal requirements. Temperature model runs are forthcoming to help us better manage and balance the trade-offs between providing improved in-river conditions now and maintaining a limited cold water pool in Folsom Reservoir for management this summer.

Although recent storms in February and March have relieved some of the most urgent water needs, NMFS recognizes that if the drought conditions continue beyond water year 2014, the CVP and SWP must continue minimum operations, as needed, in water year 2015, to provide for minimum human health and safety, and also minimum protections for ESA-listed anadromous fish species.

[4] Year type according to the San Joaquin Basin Hydrologic Index, based on the 75% forecast.

Flexible drought provisions were built in to the NMFS BiOp and RPA, which anticipated these types of conditions. RPA Action I.2.3.C (pages 26-27 of the 2009 RPA with 2011 amendments) provides drought exception procedures and requires that Reclamation develop and submit to NMFS a drought contingency plan if the February forecast, based on 90 percent hydrology, shows that the Clear Creek temperature compliance point or 1.9 million acre feet end of September storage at Shasta Reservoir is not achievable. The rationale for this action explicitly recognizes that in drought conditions, there is potential for conflict between the need to maintain storage at Shasta Reservoir and other legal and ecological requirements in the Delta, including outflow and salinity standards. Our ESA review of the proposed 8-month Plan is a continuation of the interim contingency plans that were provided for February and March 2014, with specific linkages to the underlying NMFS BiOp, as follows:

1. RPA Action I.2.3.C: Based on the most recent assessments of Shasta, Trinity, Whiskeytown, and Folsom Reservoirs, and Delta operations under this provision, as supported by Reclamation's biological review for salmonids and green sturgeon provided as Appendix G of the Plan (Biological Review), NMFS finds that these proposed operations are consistent with Action 1.2.3.C of the NMFS BiOp and meets the specified criteria for a drought contingency plan.

2. RPA Action IV.2.1: The RPA provides for flexibility in modifying operational elements, as provided in section 11.2.1.1 (pages 8-9 in the 2009 RPA with 2011 amendments). In addition, the proposed modification to RPA Action IV.2.1 (specifically, to increase export pumping to capture abandoned or natural flows in the Delta for a duration of 10-30 days during April 1-May 31) was vetted through the Real-Time Drought Operations Management Team, which was convened as a result of the State Water Board's first Order on January 31, 2014. NMFS has reviewed the proposed operational modification and evaluated differences as compared to the RPA language in IV.2.1, including the biological rationale, action statement, implementation procedures, and related components of the Incidental Take Statement. NMFS also evaluated the two proposed offsetting measures described above, and which are not included in the RPA. Our analysis reviewed whether the modified action and the two proposed offsetting measures provided roughly equivalent protection to that of Action IV.2.1. These two additional measures provide benefits to San Joaquin River origin steelhead [the Southern Sierra Nevada Diversity group of the California Central Valley (CCV) steelhead distinct population segment (DPS)], and meet the objectives of Action IV.2.1[5], as follows:
    a. Additional flows in the San Joaquin River: One of the objectives of Action IV.2.1 is to provide greater net downstream flows. This measure is intended to partially offset reductions in flow during this critically dry year with increases in flow in a future year. The Biological Review (page 27) states that, "Part of the action includes a measure to provide an additional Spring pulse of water down the San Joaquin River in

[5] The objectives of Action IV.2.1 are, "To reduce the vulnerability of emigrating CV steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

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."

b. Shift exports to Jones Pumping Plant: The Biological Review (pages 36-37) states that, "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 4200 CVP) may increase overall survival from 42% to 59% (an approximately 40% increase in survival). There is a low level of uncertainty in this conclusion."

Based on the above, NMFS concludes that the additional steelhead conservation measures will ensure that the operation of Action IV.2.1, modified from the way the RPA was written in 2009, will have roughly equivalent effects as what was previously analyzed in the NMFS BiOp and will result in a level of take that is within the incidental take authorized by the NMFS BiOp. As noted above, the additional flows in the San Joaquin River will not provide protection to those juvenile steelhead emigrating this year, but will provide extra protection to those emigrating in a future year, thereby providing protections to the Southern Sierra Nevada diversity group as a whole.

The Biological Review includes status updates on the abundance and distribution in water year 2014 of ESA-listed salmonids and sturgeon covered by the NMFS BiOp, and summarizes the generalized effects of project operations, including most of the proposed modifications, on those species. Inherent in the Plan is the objective to meet multiple needs with limited water resources. Most of the adverse effects to species identified in the Biological Review (*e.g.*, the potential for reduced survival of outmigrating salmonids from the Sacramento Basin due to modifications to outflow criteria in D-1641) are the consequences of actions intended to result in conditions (*e.g.*, greater Shasta Reservoir storage and a greater cold water pool) that will pre-empt more severe adverse effects to species (*e.g.*, potentially running out of cold water in Shasta Reservoir to meet the needs of winter-run and spring-run egg incubation throughout the temperature management season). Some adverse effects to species identified in the Biological Review (*e.g.*, the potential for reduced survival of outmigrating steelhead from the San Joaquin Basin due to modifications to the I:E ratio implementation period) are the consequences of actions intended to result in conditions (*e.g.*, greater south-of-delta storage) that will pre-empt adverse effects to non-fish-and-wildlife beneficial uses of CVP and SWP project water (*e.g.*, municipal and agricultural

purposes). The latter trade-offs are offset by some of the "additional" actions described above in 2a and 2b.

The Biological Review describes the direction of effect expected and assigns a qualitative level of certainty to each effect conclusion. Quantifying the specific effects of any particular Plan element, or of the full suite of proposed actions, is difficult as a result of combined uncertainties relating to:

- specific timing and duration of any particular component of the modified action (for example, it is not known when or if the DCC might open, though the opening is provided for under certain conditions; hydrology will play an important role in whether or not the modification to the I:E ratio will be in effect in late May).
- specific migration timing of listed species and presence in the "footprint" of any particular component of the modified action (for example, if temperatures in the lower San Joaquin and delta are unsuitable for salmonid migration in late May, few listed salmonids may be exposed to the effects of implementing a modified I:E action).
- uncertainty in the quantitative relationship between any underlying factor (*e.g.*, outflow) and the response variable of interest (*e.g.*, survival).

NMFS supports the general conclusions in the Biological Review, though notes that the effects are, for the most part, considered singly rather than in concert. As we have noted above, it is difficult to assess the cumulative effect of the Plan because of the uncertainties described. While the Biological Review does not draw a conclusion about the balancing embedded in the Plan, NMFS supports the implementation of the Plan as a reasonable approach to minimize adverse effects to species given the constraints this water year. NMFS is particularly concerned about winter-run Chinook salmon temperature management and has developed a winter-run Chinook salmon contingency plan if the actions to preserve Shasta storage are not sufficient to protect some extent of spawning habitat through fry emergence. Specifically, the state and federal agencies have developed a winter-run Chinook salmon contingency plan that includes: (1) infrastructure needs at Livingston Stone National Fish Hatchery, (2) increased monitoring of redds and temperature impacts, and (3) rescue and relocation to more suitable habitats including Battle Creek. This contingency plan will protect winter-run Chinook salmon from an entire year class failure.

In conclusion, Reclamation and DWR have proposed a drought operations plan for April 1 through November 15, 2014, that includes adjustments in the implementation of several operating criteria in the NMFS BiOp and RPA to address changing conditions associated with the drought. Reclamation has characterized the effects of the drought operations plan as follows:

> "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."

Based on the proposed drought operations plan and summary of effects provided above, and described in detail in the Biological Review, NMFS has determined that the anticipated incidental take associated with the drought operations plan falls within the incidental take

statement issued as part of the NMFS BiOp. In addition, NMFS evaluated the drought operations plan, and specifically Reclamation's proposed adjustments in the implementation of one or two RPA actions, for a limited duration in 2014, due to existing circumstances of the drought.

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, (206) 526-6150, or contact Maria Rea at (916) 930-3600, maria.rea@noaa.gov.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

Enclosure:
1. Estimates of Potential Storage Gains in Shasta Reservoir under Drought Operations Plan

cc: Copy to file 151422SWR2006SA00268

Pablo Arroyave
Deputy Regional Director
Bureau of Reclamation
2800 Cottage Way
Sacramento, California 95825

Sue Fry
Bureau of Reclamation
801 I Street, Suite 140
Sacramento, California 95814

Ron Milligan
Operations Manager
Bureau of Reclamation
3310 El Camino Avenue, Room 300
Sacramento, California 95821

John Leahigh
California Department of Water Resources
3310 El Camino Avenue
Sacramento, California 95821

Chuck Bonham
Director
California Department of Fish & Wildlife
1416 Ninth Street
Sacramento, California 95814

Carl Wilcox
California Department of Fish & Wildlife
1416 Ninth Street
Sacramento, California 95814

Laura King-Moon
California Department of Water Resources
P.O. Box 942836
Room 115-2
Sacramento, California 94236

Dean Messer
Chief, Environmental Services
California Department of Water Resources
P.O. Box 942836
Sacramento, California 94236

Ren Lohoefener
Regional Director
US Fish & Wildlife Service
2800 Cottage Way, W-2606
Sacramento, California 95825

Dan Castleberry
Field Supervisor
US Fish & Wildlife Service
2800 Cottage Way
Sacramento, California 95825

Michael Chotkowski
Field Supervisor
US Fish & Wildlife Service
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

Felicia Marcus
State Water Resource Control Board
P.O. Box 100
Sacramento, California 95812

Tom Howard
State Water Resource Control Board
P.O. Box 100
Sacramento, California 95812

Enclosure

Estimates of Potential Storage Gains in Shasta Reservoir under Drought Operations Plan

Comparison #1 – Potential Storage Gains in Shasta Reservoir during April and May Due to Revision of the Forecasted Release Range.

Recent revisions in the proposed operations, summarized in Table 1, lower the high end of the forecasted release range in recognition of the ongoing discussions with settlement contractors to postpone at least some diversions of water for irrigation of rice fields. In the 50% exceedance scenario for April, the low end of the forecasted release range is also lowered.

Table 1. Revised range of Keswick Reservoir releases (in cubic feet per second), with the unrevised forecasted release range in parentheses.

	90% Exceedance With Salinity Barriers	90% Exceedance Without Salinity Barriers	50% Exceedance Without Salinity Barriers
April	4000-6500 *(4000-7800)*	4000-6500 *(4000-7900)*	3800-6500 *(4000-7750)*
May	4500-7000 *(4500-8300)*	4500-7200 *(4500-8300)*	4500-7000 *(4500-8615)*

These revised ranges of releases result in the potential for increased storage in Shasta Reservoir. A range of potential storage gains can be estimated by comparing the water volume necessary to support the maximum release as originally proposed to the water volume necessary to support both the low and high end of the revised release ranges. Those comparisons result in a range of estimated potential storage gains, for April and May combined, summarized in Tables 2 and 3.

Table 2. Estimates of water volume differences that could translate to gains (of up to 460-488 TAF) in Shasta storage if the revised minimum, rather than the original maximum, releases are implemented during all of April and May. These calculations are estimates of the *maximum* potential storage gain – more modest storage gains are expected to be realized.

	Original Maximum vs. Revised Minimum Daily Keswick Reservoir Releases (cubic feet per second)							
	90% Exceedence				50% Exceedence			
	With Salinity Barriers		Without Salinity Barriers		With Salinity Barriers		Without Salinity Barriers	
Month	Minimum release (revised)	Maximum release (original)	Minimum release (revised)	Maximum release (original)	Minimum release (revised)	Maximum release (original)	Minimum release (revised)	Maximum release (original)
April	4,000	7,800	4,000	7,900	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary		3,800	7,750
May	4,500	8,300	4,500	8,300			4,500	8,615

	Original Maximum vs. Revised Minimum Daily Keswick Reservoir Releases (thousand acre-feet*)							
	90% Exceedence				50% Exceedence			
	With Salinity Barriers		Without Salinity Barriers		With Salinity Barriers		Without Salinity Barriers	
Month	Minimum release (revised)	Maximum release (original)	Minimum release (revised)	Maximum release (original)	Minimum release (revised)	Maximum release (original)	Minimum release (revised)	Maximum release (original)
April	8	15	8	16	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary		8	15
May	9	16	9	16			9	17

* Daily thousand acre-feet (TAF) of release calculated as:

Daily average release in cfs*Number of seconds per day*conversion factor in TAF per cfs, which is equivalent to:

Daily average release in cfs*(60 secs/min*60 mins/hr*24 hrs/day)*(1 TAF per 43,560,000 cfs)

	Potential Storage Gain in Shasta Reservoir -- Original Maximum vs. Revised Minimum (thousand acre-feet)**			
	90% Exceedence		50% Exceedence	
	With Salinity Barriers	Without Salinity Barriers	With Salinity Barriers	Without Salinity Barriers
Month	If revised minimum, rather than original maximum, releases implemented	If revised minimum, rather than original maximum, releases implemented	If revised minimum, rather than original maximum, releases implemented	If revised minimum, rather than original maximum, releases implemented
April	226	232	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary	235
May	234	234		253
Total	**460**	**466**		**488**

** For each month and scenario, the Potential Storage Gain is calculated as:

(Original maximum daily release, in TAF - Revised minimum daily release, in TAF) * Number of days in month

Table 3. Estimates of water volume differences that could translate to gains (of up to 151-174 TAF) in Shasta storage if the revised maximum, rather than the original maximum, releases are implemented during all of April and May. These calculations are estimates of the *maximum* potential storage gain – more modest storage gains are expected to be realized.

	Original Maximum vs. Revised Maximum Daily Keswick Reservoir Releases (cubic feet per second)							
	90% Exceedence				50% Exceedence			
	With Salinity Barriers		Without Salinity Barriers		With Salinity Barriers		Without Salinity Barriers	
Month	Maximum release (revised)	Maximum release (original)	Maximum release (revised)	Maximum release (original)	Maximum release (revised)	Maximum release (original)	Maximum release (revised)	Maximum release (original)
April	6,500	7,800	6,500	7,900	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary		6,500	7,750
May	7,000	8,300	7,200	8,300			7,000	8,615

	Original Maximum vs. Revised Maximum Daily Keswick Reservoir Releases (thousand acre-feet*)							
	90% Exceedence				50% Exceedence			
	With Salinity Barriers		Without Salinity Barriers		With Salinity Barriers		Without Salinity Barriers	
Month	Maximum release (revised)	Maximum release (original)	Maximum release (revised)	Maximum release (original)	Maximum release (revised)	Maximum release (original)	Maximum release (revised)	Maximum release (original)
April	13	15	13	16	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary		13	15
May	14	16	14	16			14	17

* Daily thousand acre-feet (TAF) of release calculated as:

Daily average release in cfs*Number of seconds per day*conversion factor in TAF per cfs, which is equivalent to

Daily average release in cfs*(60 secs/min*60 mins/hr*24 hrs/day)*(1 TAF per 43,560,000 cfs)

	Potential Storage Gain in Shasta Reservoir -- Original Maximum vs. Revised Maximum (thousand acre-feet)**			
	90% Exceedence		50% Exceedence	
	With Salinity Barriers	Without Salinity Barriers	With Salinity Barriers	Without Salinity Barriers
Month	If revised maximum, rather than original maximum, releases implemented	If revised maximum, rather than original maximum, releases implemented	If revised maximum, rather than original maximum, releases implemented	If revised maximum, rather than original maximum, releases implemented
April	77	83	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary	74
May	80	68		99
Total	**157**	**151**		**174**

** For each month and scenario, the Potential Storage Gain is calculated as:

(Original maximum daily release, in TAF - Revised maximum daily release, in TAF) * Number of days in month

Since there is considerable overlap in the original and revised ranges, it is possible that no storage gains will be achieved. However, it is expected that the recent discussions with rice growers about rescheduling deliveries will allow for reduced releases during April and May relative to the releases that would otherwise have been implemented, which will result in improved storage and cold water pool conditions in Shasta Reservoir. The estimated gains provided above are high-end estimates to indicate the maximum potential storage gain if the extremes of the operating range were implemented – a gain in between 0 TAF and these maximum estimates is what is expected to be realized.

Comparison #2 –Potential Storage Gains in Shasta Reservoir Through End of September due to Implementation of the Minimum, Rather than the Maximum, Release Within the Proposed Operating Range

The full range of proposed operations through September, including the revised release ranges in April and May, demonstrates important storage and flow tradeoffs, with an overall maximum potential gain in Shasta storage of approximately 550 TAF (Table 4, bottom panel) by the end of September. Because it is expected that the actual releases will likely not be at either extreme of the release range for an extended period, NMFS emphasizes that the calculations in Table 4 (as in Tables 2 and 3) are estimates of the *maximum* potential storage gain – more modest storage gains are expected to be realized.

Table 4. Estimates of water volume differences that could translate to gains (of up to 544-556 TAF) in Shasta storage if the revised minimum, rather than the revised maximum, releases are implemented through September. These calculations are estimates of the *maximum* potential storage gain – more modest storage gains are expected to be realized.

	Range of Proposed Daily Keswick Reservoir Releases (cubic feet per second)							
	90% Exceedence				50% Exceedence			
	With Salinity Barriers		Without Salinity Barriers		With Salinity Barriers		Without Salinity Barriers	
Month	Minimum release	Maximum release	Minimum release	Maximum release	Minimum release	Maximum release	Minimum release	Maximum release
April	4,000	6,500	4,000	6,500	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary		3,800	6,500
May	4,500	7,000	4,500	7,200			4,500	7,000
June	9,000	10,000	10,000	11,000			9,000	10,000
July	9,000	10,000	10,000	11,000			9,000	10,000
August	7,000	8,000	7,000	8,000			8,000	9,000
September	4,000	5,000	4,000	5,000			5,000	6,000

	Range of Proposed Daily Keswick Reservoir Releases (thousand acre-feet*)							
	90% Exceedence				50% Exceedence			
	With Salinity Barriers		Without Salinity Barriers		With Salinity Barriers		Without Salinity Barriers	
Month	Minimum release	Maximum release	Minimum release	Maximum release	Minimum release	Maximum release	Minimum release	Maximum release
April	8	13	8	13	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary		8	13
May	9	14	9	14			9	14
June	18	20	20	22			18	20
July	18	20	20	22			18	20
August	14	16	14	16			16	18
September	8	10	8	10			10	12

* Daily thousand acre-feet (TAF) of release calculated as:

Daily average release in cfs*Number of seconds per day*conversion factor in TAF per cfs, which is equivalent to

Daily average release in cfs*(60 secs/min*60 mins/hr*24 hrs/day)*(1 TAF per 43,560,000 cfs)

	Maximum Potential Storage Gain in Shasta Reservoir (Intermediate Effect expected) (thousand acre-feet)**			
	90% Exceedence		50% Exceedence	
	With Salinity Barriers	Without Salinity Barriers	With Salinity Barriers	Without Salinity Barriers
Month	If minimum, rather than maximum, releases implemented	If minimum, rather than maximum, releases implemented	If minimum, rather than maximum, releases implemented	If minimum, rather than maximum, releases implemented
April	149	149	NA -- under 50% hydrology, it is expected that no salinity barriers will be necessary	161
May	154	166		154
June	60	60		60
July	61	61		61
August	61	61		61
September	60	60		60
Total	**544**	**557**		**556**

** For each month and scenario, the Maximum Potential Storage Gain is calculated as:

(Maximum daily release, in TAF - Minimum daily release, in TAF) * Number of days in month