UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

April 7, 2011

Mr. Donald Glaser
Regional Director
Mid-Pacific Region
U.S. Bureau of Reclamation
2800 Cottage Way, MP-3700
Sacramento, California 95825-1898

Dear Mr. Glaser:

On June 4, 2009, NOAA's National Marine Fisheries Service issued a biological and conference opinion on the long-term operations of the Central Valley Project (CVP) and State Water Project (SWP)(NMFS Opinion). The NMFS Opinion concluded that the CVP/SWP operations were likely to jeopardize the continued existence of several federally listed species under NMFS' jurisdiction, and to destroy or adversely modify designated critical habitat. Consequently, NMFS provided a reasonable and prudent alternative (RPA) that met the criteria of 50 CFR 402.02. The purposes of this letter are to: (1) transmit amendments to the 2009 RPA, in response to an Independent Review Panel (IRP) report, and based on the adaptive management provision in section 11.2.1.2 of the NMFS Opinion; (2) acknowledge and highlight efforts to improve some real-time operations; (3) highlight how current studies will be used for real time management; and (4) highlight the need for the U.S. Bureau of Reclamation (Reclamation) to explore options to avoid non-compliance with the RPA.

Section 11.2.1.2 of the RPA in NMFS Opinion provides:

> Not later than November 30 of every year, in conjunction with the CALFED Science Program or other Science Peer Review process, Reclamation and NMFS shall host a workshop to review the prior water years' operations and to determine whether any measures prescribed in this RPA should be altered in light of information learned from prior years' operations or research.

Over a three-month timeframe, NMFS and the Reclamation have worked diligently together to fulfill this component of the RPA. On November 8 and 9, 2010, the Delta Science Program (DSP) hosted a public workshop to provide an IRP a forum for presentations and discussion of previously submitted technical reports. Following the workshop, the IRP produced a report (Anderson *et al.* 2010) that included recommendations for adjustments to the RPA, based on

information presented in the review process. NMFS and Reclamation staff reviewed the report carefully and worked together to develop this amendment to the RPA.

Through this letter, NMFS is amending the RPA, consistent with IRP recommendations that relate to the actions and implementation procedures. For example, consistent with NMFS' proposal to the IRP, and supported by the IRP, NMFS is providing more flexibility to the Stanislaus Operations Group to adjust the timing and shape of various pulse flows within the Stanislaus River. NMFS is also providing a second trigger for Old and Middle River (OMR) Flow Management, Action IV.2.3, and clarifying the language for the other triggers and the action response. In addition, NMFS has taken this opportunity to correct errors in the 2009 RPA and provide useful clarification. Enclosure 1 provides a "track changes" version of the pages of the RPA where changes to the actions or implementation procedures were made. In all cases, NMFS has provided the rationale for the 2011 amendments. Enclosure 2 provides a clean version of the amended RPA in its entirety. Enclosure 2 supersedes the 2009 RPA.

With no exception, the objectives for each of the actions to which changes were made will be met. The RPA, as a whole, still "can be implemented in a manner consistent with the intended purpose of the action, . . . consistent with the scope of the Federal agency's legal authority and jurisdiction, . . . is economically and technologically feasible, and . . . would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat" (50 CFR 402.02). Further, NMFS does not believe the 2011 amendments meet any of the criteria for reinitiation of consultation listed in 50 CFR 402.16. Consequently, NMFS has not advised Reclamation to reinitiate consultation. Rather, as you know, the amendments have been developed using the collaborative process established in the 2009 Opinion.

NMFS has also used the annual review process as an opportunity to suggest improvements in real time operations that do not require amending the RPA, determine priorities for further research, and review compliance with the RPA as written in 2009. The remaining sections of this letter address those topics.

Improvements in Real Time Operations

Efforts need to be made to improve real time operations that do not warrant changes to any of the RPA actions, but would help better implement the RPA and improve protection for listed fish species. These include the following:

1. A subgroup of the Delta Operations for Salmonids and Sturgeon (DOSS) group will convene to brainstorm viable options to expedite the coded wire tagged (CWT) data extraction and reporting. The surrogate releases of CWT Chinook salmon, which are the basis for the third trigger of RPA Action IV.2.3 (OMR Flow Management), appear at the Federal and State fish facilities along with tagged fish from other releases (for example, late fall-run Chinook salmon production release). Differentiation between release groups cannot be made until CWT data have been extracted. These data are necessary for accurate determinations for action triggers under RPA Action IV.2.3. For CWTs that have not been extracted and read, the California Department of Water Resources (DWR) currently provides "tag fraction projections" to the

DOSS group to implement the third trigger. However, projections should not be substituted for timely and accurate data reporting for implementation of Action IV.2.3.

2. DWR should report salvage and expanded loss data to NMFS on a daily basis. Real-time operations within the Delta are dependent on timely data reporting. Currently, reporting of salvage and loss of fish at the State fish facilities is reported to NMFS and the DOSS once weekly. An OMR action could be triggered only after fish salvage and loss is reported to NMFS and DOSS. This could result in delays of a week or more before an RPA action is taken, thereby losing critical time for listed species to be protected from further influence of the Federal and State pumping facilities.

Studies

At the November 8, 2010, IRP workshop, NMFS' Southwest Fisheries Science Center (SWFSC) presented a NOAA/National Atmospheric and Space Administration (NASA) model that could improve temperature predictions on the mainstem Sacramento River. The IRP supports the use of this tool. NMFS also supports the use of this tool, and will coordinate with the SWFSC and the Sacramento River Temperature Task Group (SRTTG) to begin use of the NOAA/NASA model to improve real time operations on the Sacramento River.

NMFS acknowledges the complexities and environmental variables that feed into OMR flow using tidally-filtered values reported by the U.S. Geological Survey. The IRP supports the use of an equation that defines exports or diversions in order to provide flexibility and to operate OMR closer to the OMR limit, and it suggested that the Metropolitan Water District (MWD) equation (Hutton 2008) is the most accurate equation at this time. However, the IRP also warned that the actual OMR flow would need to be monitored in order to confirm that the predicted and actual OMR flows track closely. The Water Operations Management Team (WOMT) convened a subgroup to develop a proposal for using the MWD equation to predict OMR flow during a trial period. The current draft proposal includes a trial period through water year 2011, when Reclamation and the California Department of Water Resources continue to utilize actual OMR, but also calculate OMR using the MWD equation to see how it tracks. At the end of water year 2011, if the WOMT subgroup determines that the calculated OMR flow using the MWD equation tracks closely with the actual OMR flow, it may recommend to the WOMT and NMFS to consider using the MWD equation to predict OMR flow.

Non-compliance with RPA

RPA Action I.1.5 of the NMFS Opinion requires Reclamation to manage Whiskeytown Dam releases to meet specific water temperatures, including 56°F at the Igo gage from September 15 to October 31. For much of that time, from September 15 through October 21, 2010, that temperature criterion was exceeded[1], at times by up to 2°F. NMFS recognizes that the SRTTG met several times to discuss the Clear Creek temperature exceedences, and Reclamation implemented changes in operations that included raising the flows released at Whiskeytown Dam

[1] http://www.usbr.gov/mp/cvo/vungvari/sactemprpt_0910.pdf
http://www.usbr.gov/mp/cvo/vungvari/sactemprpt_1010.pdf

to 200 cfs, and increasing the diversion of water from Trinity Reservoir through Whiskeytown Reservoir to provide colder water. However, as shown in the temperature reports, changes to water temperatures followed over a month of exceedences. NMFS strongly encourages Reclamation to fully explore actions that could be taken earlier in the year to avoid potential exceedences in the future, and to proactively manage and coordinate operations within the Shasta Division to ensure timely temperature compliance on Clear Creek.

I look forward to another productive year collaborating with Reclamation on implementation of the RPA. If you have any questions regarding this letter, please contact Garwin Yip, of my staff, at (916) 930-3611, or via e-mail at garwin.yip@noaa.gov.

Sincerely,

for Rodney R. McInnis
Regional Administrator

Enclosures:

1. Track Changes Version of the 2009 Reasonable and Prudent Alternative that Includes Only the Pages that have 2011 Amendments
2. Clean Version of the 2009 Reasonable and Prudent Alternative Revised to Include the 2011 Amendments

Reference Cited

Anderson, J.J., R.T. Kneib, S.A. Luthy, and P.E. Smith. 2010. Report of the 2010 Independent Review Panel (IRP) on the Reasonable and Prudent Alternative (RPA) Actions Affecting the Operations Criteria And Plan (OCAP) for State/Federal Water Operations. Prepared for: Delta Stewardship Council, Delta Science Program. December 9. 39 pages. (http://www.deltacouncil.ca.gov/delta_science_program/events/workshop_OCAP_2010.html)

Hutton, P. 2008. A model to estimate combined Old & Middle River flows: Report for the Metropolitan Water District of Southern California. April. 90 pages.

cc: ARN: 151422SWR2006SA00268
FWS – Ren Lohoefener, Jennifer Norris
DWR – Mark Cowan, Kathy Kelly
CDFG – John McCammon, Scott Cantrell

Enclosure 1

Track Changes Version of the 2009 Reasonable and Prudent Alternative that Includes Only the Pages that have 2011 Amendments

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2011 Amendment: In the Fall of 2010, the Delta Stewardship Council convened an Independent Review Panel (IRP) to assist in the annual review required in this action[2]. On November 8-9, 2010, the Delta Science Program held a workshop to provide the IRP a forum for presentations and discussion of previously submitted technical reports. Following the workshop, the IRP produced a report that included recommendations for adjustments to the RPA, based on information presented in the review process. The IRP Report was finalized on December 9, 2010 (Anderson *et al*. 2010; http://www.deltacouncil.ca.gov/delta_science_program/events/workshop_OCAP_2010.html). NMFS has amended the RPA consistent with the IRP recommendations and this Opinion's underlying analysis and conclusions[3]. This amended RPA supersedes the 2009 RPA.

NMFS and Reclamation will establish a research program in coordination with the CALFED Science Program and other agencies to address key research and management questions arising from this Opinion. Prior to the beginning of a new calendar year, Reclamation shall submit to NMFS a research plan for the following year, developed in coordination with the above programs and agencies. Reclamation also shall provide NMFS access to all draft and final reports associated with this research. Specific research projects that have been identified as important to begin in the first year and complete as soon as possible are:

1) Cooperative development of a salmonid lifecycle model acceptable to NMFS, Reclamation, CDFG, and DWR

2) Temperature monitoring and modeling identified in RPA Action I.5

3) Green sturgeon research described in the RBDD actions

4) Rearing habitat evaluation metrics to guide rearing habitat Action 1.6

5) A 6-year acoustic-tagged study of juvenile salmonids out-migration in the San Joaquin River and through the southern Delta identified in Action IV.2.2.

11.2.1.3. Monitoring and Reporting

1) Reclamation and DWR shall participate in the design, implementation, and funding of the comprehensive CV steelhead monitoring program, under development through ERP, that includes adult and juvenile direct counts, redd surveys, and escapement estimates on CVP- and SWP-controlled streams. This program is necessary to develop better juvenile production estimates that form the basis of incidental take limits and will also provide necessary information to calculate triggers for operational actions.

[2] Under direction from the Secretaries of Commerce and Interior, the NMFS review was expanded to include a review of the implementation of the FWS' 2008 OCAP Opinion. The integrated review provided an opportunity to assure that the NMFS and FWS RPAs worked together in an ecosystem context.

[3] In addition, NMFS has taken this opportunity to correct some errors in the 2009 RPA. All changes are noted and explained in the "Rationale for 2011 amendment" sections accompanying the amendments.

temperature and flow), or are a necessary component the Salmon Decision Process used to manage Delta operations (*e.g.*, DCC gates and export pumping). Reclamation and DWR shall jointly fund these monitoring locations for the duration of the Opinion (through 2030) to ensure compliance with the RPA and assess the performance of the RPA actions. Most of these monitoring stations already exist and are currently being funded through a variety of sources (*i.e.*, CDFG, USFWS, Reclamation, DWR, CALFED, and Interagency Ecological Program), however, CALFED funding for monitoring ends in 2009 and CDFG funding has been reduced due to budget cuts.

a) Upstream: Adult escapement and juvenile monitoring for spring-run, winter-run, and steelhead on the Sacramento River, American River, Feather River, Clear Creek, Mill Creek, Deer Creek and Battle Creek. These may be performed through carcass surveys, redd surveys, weir counts, and rotary screw trapping. Unless prevented by circumstances beyond the control of Reclamation, aerial redd counts shall be conducted annually on the mainstem Sacramento River from Keswick Dam downstream to at least Tehama Bridge, from at least April through September. These surveys are necessary to determine the temporal and spatial distribution of winter-run and spring-run Chinook salmon. Exceptions to the annual aerial redd counts are allowed only when requested in writing (including the specific circumstance that may preclude the aerial redd surveys) and upon written concurrence by NMFS.

   Rationale for 2011 amendment: Aerial redd counts have been conducted annually at least since 2001. However, in water year 2010, they were conducted later in the winter-run Chinook salmon spawning season, and the SRTTG did not have the benefit of the temporal and spatial distribution data to inform its recommendation of a temperature compliance point. The IRP noted the confusion in the final establishment of the temperature compliance point: "It is not known why the compliance point was established downstream (Jelly's Ferry) when aerial redd surveys in 2010 indicated redds were upstream of Airport Road Bridge." (Anderson *et al*. 2010, page 12, note E).

b) RBDD: Adult counts using the three current fish ladders until the new pumping plant is operational. Rotary screw trapping to determine juvenile Chinook salmon passage or abundance year-round before and after pumping plant is operational. Green sturgeon monitoring, to include adult and juvenile estimates of passage, relative abundance, and run timing, in order to determine habitat use and population size with respect to management of Shasta Reservoir resources.
c) Sacramento River new juvenile monitoring station: The exact location to be determined, between RBDD and Knights Landing, in order to give early warning of fish movement and determine survival of listed fish species leaving spawning habitat in the upper Sacramento River.
d) Delta: Continuation of the following monitoring stations that are part of the IEP: Chipps Island Trawl, Sacramento Trawl, Knights Landings RST, and beach seining

Rationale for Actions I.6.2 to I.6.4: These actions have been fully vetted by CDFG and found to be necessary initial steps in improving rearing habitat for listed species in the lower Sacramento River basin. These improvements are necessary to off-set ongoing adverse effects of project operations, primary due to flood control operations. Additional descriptions of these actions are contained in the draft amendment to the Delta Fish Agreement (CVP/SWP operations BA appendix Y).

Action I.7. Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass

Objective: Reduce migratory delays and loss of adult and juvenile winter-run, spring-run, CV steelhead and Southern DPS of green sturgeon at Fremont Weir and other structures in the Yolo Bypass.

Description of Action: By December 31, 2011, as part of the plan described in Action I.6.1, Reclamation and/or DWR shall submit a plan to NMFS to provide for high quality, reliable migratory passage for Sacramento Basin adult and juvenile anadromous fishes through the Yolo Bypass. By June 30, 2012, Reclamation and/or DWR shall obtain NMFS concurrence and, to the maximum extent of their authorities, and in cooperation with other agencies and funding sources, begin implementation of the plan, including any physical modifications. By September 30, 2009, Reclamation shall request in writing that the Corps take necessary steps to alter Fremont Weir and/or any other facilities or operations requirements of the Sacramento River Flood Control Project or Yolo Bypass facility in order to provide fish passage and shall offer to enter into a Memorandum of Understanding, interagency agreement, or other similar mechanism, to provide technical assistance and funding for the necessary work. By June 30, 2010, Reclamation shall provide a written report to NMFS on the status of its efforts to complete this action, in cooperation with the Corps, including milestones and timelines to complete passage improvements.

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Reclamation and/or DWR shall assess the performance of improved passage and flows through the bypass, to include an adult component for salmonids and sturgeon (*i.e.*, at a minimum, acoustic receivers placed at the head and tail of the bypass to detect use by adults).

Rationale: The Yolo Bypass and Fremont Weir has been a documented source of migratory delay to, and loss of, adult winter-run, spring-run, CV steelhead and Southern DPS of green sturgeon. The existing fish passage structure is inadequate to allow normal passage at most operational levels of the Sacramento River. The project agencies must work with the Corps, which owns and operates Fremont Weir, to achieve improvements for fish. Other structures within the Yolo Bypass, such as the toe drain, Lisbon Weir, and irrigation dams in the northern end of the Tule Canal, also can impede migration of adult anadromous fish. Additionally, stranding of juvenile salmonids and sturgeon has been reported in the Yolo Bypass in scoured areas behind the weir and in other areas. This action offsets unavoidable

project effects on adult migration and minimizes the direct losses from flood management activities associated with operations.

Rationale for 2011 amendment: The date "June 30, 2011" in the 2009 RPA was a typographical error, and corrected to "June 30, 2012." The action refers back to Action I.6.1, which has a requirement for a plan to be submitted to NMFS by December 31, 2011. NMFS concurrence on the plan cannot precede the date that the plan is due.

II. AMERICAN RIVER DIVISION

Introduction to American River Actions: The CV steelhead DPS is the only species addressed in this Opinion with a spawning population in the American River. The DPS includes naturally spawned steelhead in the American River (and other Central Valley stocks) and excludes steelhead spawned and reared at Nimbus Fish Hatchery. The in-river population is small, with observations of a few hundred adults returning to spawn in the American River each year. Limited observations made in 2003, 2004, 2005, and 2007 of whether in-river spawners were adipose fin-clipped or not indicate that some in-river spawners are of wild origin (Hannon and Deason 2008). This suggests that the listed stock has some ability to survive habitat conditions in the American River, Delta, and Ocean, even in their degraded state as described in preceding sections of this Opinion.

The in-river population is likely entirely made up of Nimbus Fish Hatchery steelhead or their descendents. Early Nimbus Fish Hatchery broodstock included naturally produced fish from the American River and stocks from the Washougal (Washington), Siletz (Oregon), Mad, Eel, Sacramento and Russian rivers, with the Eel River stock being the most heavily used (Staley 1976, McEwan and Jackson 1996).

Even though the American River steelhead population is small and is entirely influenced by hatchery fish with out-of-basin genetics, NMFS views the population as being important to the survival and recovery of the species. CV TRT shares this view by recommending that, "*every extant population be viewed as necessary for the recovery of the ESU*" (Lindley *et al*. 2007). In addition, the steelhead population has presumably become somewhat locally adapted to the American River, and it has potential to substantially contribute to the viability of the DPS if water, habitat, and hatchery management efforts are coordinated and directed at achieving such a goal.

Key proposed project-related stressors include: (1) the provision of water temperatures warmer than steelhead life stage-specific requirements; (2) flow fluctuations that dewater redds, strand fry, and isolate fry and juveniles in off-channel pools where they are vulnerable to both predation and exposure to lethal and sub-lethal water temperatures; and (3) low flows limiting the availability of quality rearing habitat including predator refuge habitat.

The most influential baseline stressor to steelhead within the American River Division is the presence of Nimbus and Folsom dams, which block steelhead from all of their historic spawning

Action III.1.3. Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam, Characterized in Figure 11-1, and as Specified in Appendix 2-E

Objective: To maintain minimum base flows to optimize CV steelhead habitat for all life history stages and to incorporate habitat maintaining geomorphic flows in a flow pattern that will provide migratory cues to smolts and facilitate out-migrant smolt movement on declining limb of pulse.

Action: Reclamation shall operate releases from the East Side Division reservoirs to achieve a minimum flow schedule as described in Appendix 2-E and Figure 11-1, below. This flow schedule specifies minimum flows and does not preclude Reclamation from making higher releases for fishery benefits or other operational criteria. When operating at higher flows than specified, Reclamation shall implement ramping rates for flow changes that will avoid stranding and other adverse effects on CV steelhead. In particular, flows that exceed 800 cfs will inundate known side channels that provide habitat, but that also pose stranding risks. When spring pulses greater than 800 cfs are identified in Figure 11-1, the declining limb is not reduced below 800 cfs until after the last pulse.

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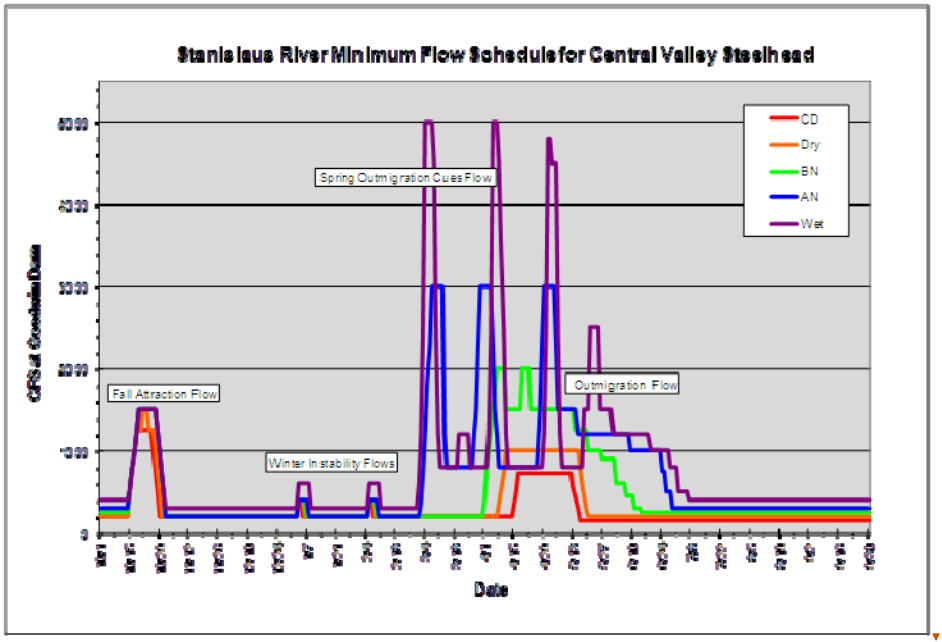

Figure 11-1. Minimum Stanislaus River in-stream flow schedule for CV steelhead as measured at Goodwin Dam

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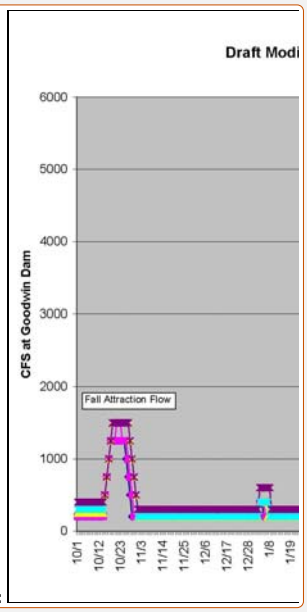

Implementation procedures: Reclamation shall convene the SOG to adaptively manage flows according to this schedule. The timing, magnitude, and duration of the flows in Appendix 2-E are intended to provide certain hydrologic features at certain times of year to benefit CV steelhead, as explained in the Rationale. Based upon the advice of SOG and the concurrence by NMFS[6], the flows may be implemented with minor modifications to the timing, magnitude, and/or duration, as long as NMFS concurs that the rationale for the shift in timing, magnitude, and/or duration is deemed by NMFS to be consistent with the intent of the action. For example, Reclamation may execute shorter duration pulses more frequently (*e.g.*, 2 - 4 times) during the longer pulse period. Implementation of this action should be coordinated with allocation of water resources dedicated for fish, such as the 98.3 TAF to CDFG and b(2) or b(3), if applied. The SOG shall follow standard operating procedures resolving any conflict through the WOMT process. The team shall also advise Reclamation on operations needed to minimize the adverse effects of flow fluctuations associated with New Melones Reservoir and Goodwin Dam operations on CV steelhead spawning, egg incubation, and fry and juvenile rearing within the Stanislaus River. If new information is developed, such as an update of Stanislaus River CV steelhead in-stream flow needs, more specific geomorphic analyses regarding channel forming flows, or real-time recommendations from the SOG, Reclamation may submit to NMFS a revised annual minimum flow schedule that may be implemented if NMFS concurs that it is consistent with ESA obligations. These revisions may trigger re-initiation and re-consultation.

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Rationale: This flow schedule includes the following components:

1) Minimum base flows based on IFIM (Aceituno 1993) to optimize available CV steelhead habitat for adult migration, spawning, and juvenile rearing. These base flows are scaled to water year type as defined by the New Melones water supply parameter[7], with lowest flows in critically dry years and highest flows in wet years.

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2) Fall pulse flow to improve in-stream conditions sufficiently to attract CV steelhead to the Stanislaus River.

3) Winter instability flows to simulate natural variability in the winter hydrograph and to enhance access to varied rearing habitats.

4) Channel forming and maintenance flows in the 3,000 to 5,000 cfs range in above normal and wet years to maintain spawning and rearing habitat quality. These flows are scheduled to occur after March 1 to protect incubating eggs and are intended to work synergistically with providing outmigration flow cues and late spring flows, described next. These flows are high intensity, but limited duration to avoid potential seepage issues that have been alleged under extended periods of flow greater than 1,500 cfs.

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[6] Concurrence by NMFS is necessary only for pulse flows that are timed or shaped differently than the pulse descriptions I Appendix 2-E.

[7] The New Melones water supply parameter is calculated as the sum of end of February New Melones Reservoir storage and cumulative inflow to New Melones Reservoir from March through September.

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flow is to provide flow cues downstream for incoming adults, as well as providing some remedial effect on the low dissolved oxygen conditions that develop in the Stockton Deep Water Ship Channel. In addition to steelhead, this action also produces ancillary benefits to fall-run EFH.

Modeling conducted in the preparation of this action indicate that the temperature criteria of Action III.1.2 can generally be met under this alternative minimum flow schedule and are often improved, but that exceedances may occur in certain months (*e.g.*, May and early fall) during dry year types. Based on SALMOD analyses, temperature related mortality may be about 2 percent higher in critically dry years, but is reduced by about 1 percent in all other year types under the proposed alternative (Figure 11-3).

Salmon Mortality:

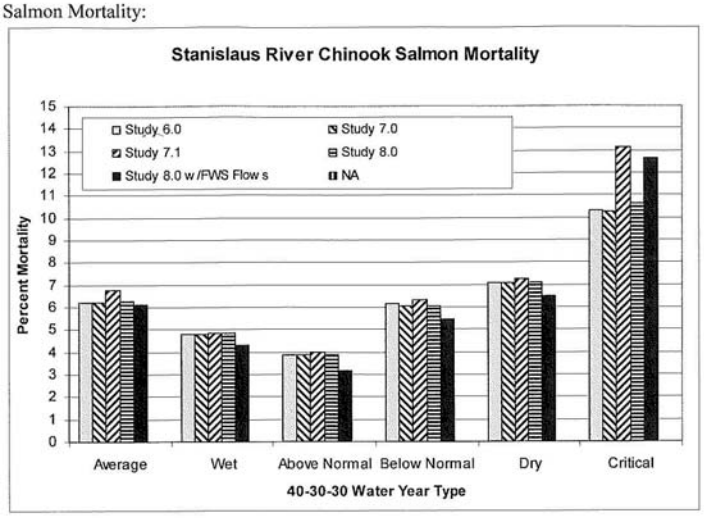

Figure 11-3. Modeled temperature effects of alternative Stanislaus River flows, draft provided by Reclamation on May 5, 2009.

Rationale for 2011 amendments:

1) Figure 11-1: Figure 11-1, as provided in the 2009 RPA, showed draft flows that varied slightly from the final flow schedule in Appendix 2-E. Figure 11-1 is now fully consistent with the flow schedule in Appendix 2-E.
2) Flexibility in implementing flow schedules: The minimum flow schedules provided in Appendix 2-E remain the same. The amendments to Action III.1.3 and its implementation procedures are intended to provide the SOG with more flexibility to adjust the timing, magnitude, and duration of the pulse flows (*not* the minimum flows in between pulses) described in Figure 11-1 and Appendix 2-E based on considerations such as:

a) optimizing intended benefits to CV steelhead (*e.g.*, based on observed fish distribution or run timing and observed flow and temperature conditions and the intent of the pulse flow as described in the "Rationale," above);
b) coordinating Stanislaus River flows for CV steelhead with flows on other San Joaquin River tributaries (*e.g.*, during the fall attraction flow or during the VAMP period); or
c) coordinating operational objectives to use Goodwin Dam releases to achieve multiple benefits (*e.g.*, during April and May when Stanislaus River flows may be contributing to multiple regulatory requirements at the same time).

Any change in the timing, magnitude, and/or duration of the pulse flows must provide protection to CV steelhead and critical habitat that is equal to or greater than the protection provided by the pulse flows as described in Appendix 2-E. This clarified flexibility can also result in improved water supply when multiple operational objectives can be satisfied with a single strategic release. These amendments were supported by the ISP.

Action Suite III.2. Stanislaus River CV Steelhead Habitat Restoration

Overall objective: Dam operations have and will continue to suppress channel-forming flows that replenish spawning beds. The physical presence of the dams impedes normal sediment transportation processes. This action is necessary to partially alleviate adverse modification of steelhead critical habitat from operations.

Action III.2.1. Increase and Improve Quality of Spawning Habitat with Addition of 50,000 Cubic Yards of Gravel by 2014 and with a Minimum Addition of 8,000 Cubic Yards per Year for the Duration of the Project Actions

Action: Reclamation shall minimize effects of their operations through improving spawning habitat with addition of 50,000 cubic yards of gravel by 2014. Reclamation shall submit a plan, including monitoring, and schedule to NMFS for gravel augmentation by June 2010. Reclamation shall begin gravel augmentations no later than summer 2011. Reclamation shall submit to NMFS a report on implementation and effectiveness of action by 2015. Spawning gravel replenishment sites shall be monitored for geomorphic processes, material movement, and salmonid spawning use for a minimum of three years following each addition of sediment at any given site.

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Rationale: Kondolf (*et al.*,) 2001 identified levels of sediment depletion at 20,000 cubic yards per year owing to a variety of factors including mining and geomorphic processes associated with dam operations, past and ongoing. Kondolf (*et al.*,) 2001 and other reports cited in that work, identify a loss of over 60 percent of spawning area for salmonids since 1966. This level of replenishment will restore adversely affected spawning habitat to relieve adverse habitat conditions and provide sediment to partially offset ongoing loss rates. Sediment addition may also be conducted in a manner to remediate sediment related loss of geomorphic function, such as channel incision, to and allow for inundation of floodplain rearing habitat.

Rationale for 2011 Amendment: Use of "tons" in the 2009 RPA was a typographical error. The change from "tons" to "cubic yards" was made to be consistent with the intent of the action. This change does not result in any change in implementation.

Action III.2.2. Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on One- to Three-Year Schedule.

Action: Reclamation shall seek advice from SOG to develop an operational strategy to achieve floodplain inundation flows that inundate CV steelhead juvenile rearing habitat on a one- to three-year return schedule. Reclamation shall submit a proposed plan of operations to achieve this flow regime by June 2011. This plan shall include the minimum flow schedule identified in Action III.1.2, or shall provide justification for any proposed modification of the minimum flow schedule. NMFS will review and, if satisfactory, approve the operational strategy. Reclamation will implement strategy starting in 2012.

Rationale: Kondolf *et al*., (2001) identified that floodplain terraces and point bars inundated before operation of New Melones Dan have become fossilized with fine material and thick riparian vegetation that is never rejuvenated by scouring. Channel forming flows in the 8,000 cfs range have occurred only twice since New Melones Dam began operation 28 years ago. Lack of channel forming flows and lack of sediment input blocked by the dams has resulted in channel incision of one to three feet over 13 years. Floodplain juvenile rearing habitat and connectivity will continue to be degraded by New Melones operations, as proposed.

Action III.2.3. Restore Freshwater Migratory Habitat for Juvenile Steelhead by Implementing Projects to Increase Floodplain Connectivity and to Reduce Predation Risk During Migration

Objective: This action is necessary to compensate for continued operational effects on rearing and freshwater migratory habitat due to flood control operations. The goal of this action is to improve habitat quality of freshwater migratory habitat for juvenile steelhead.

Action: By June 2010, in cooperation with the SOG, Reclamation shall develop a list of projects to improve the habitat values of freshwater migratory habitat in the Stanislaus River, and associated monitoring, for implementation and submit the list to NMFS for review. Reclamation shall begin implementation of NMFS-approved projects by June 2011. Reclamation shall submit a report of project implementation and effectiveness by June 2016.

These projects may include actions that reduce exposure to predation directly, or projects that may offset predation effects by improving rearing habitat values to allow juveniles to grow larger before outmigration. These projects may include both flow- and non-flow-related actions. Flow-related actions shall be coordinated with operational flows as defined in Action III.2.2 and Action III.1.2. These projects may also include, but shall not be limited to,

	Action IV. 1.2 - Operation of DCC to enhance protection of emigrating salmonids/green sturgeon	**Action IV. 2.1** - Maintain San Joaquin River Inflow/Export ratio		**Action IV. 2.2** - Acoustic Tag Experiment	**Action IV. 2.3** - Reduced exports to limit negative flows in OMR depending on presence of salmonids
		2009 - 2011 Interim Operations	**2012 + Long term Operations**		
Oct.	**Oct. 1 - Nov. 30** - Gates closed if fish are present				
Nov.					
Dec.	**Dec. 1 - 14** - Gates closed except for experiments/water quality				
Jan.	**Dec. 15 - Jan. 31** Gates Closed				**Jan 1 - June 15** - OMR (-5000 to -2500 cfs) until after June 1 water temperature at Mossdale ≥72° F for 7 days
Feb.	**Feb. 1 - May 20 - Gates Closed per D1641**				
Mar.				**March 1 - June 15**	
Apr.		**April 1 - May 31** - Maintain Vernalis Inflow/Export ratio dependingon IOP water supply parameters	**April 1 - May 31** - Maintain Vernalis Inflow/Export Ratios depending on water year type		
May	**May 21 - June 15** - up to 14 days closed per D-1641				
Jun.					

Figure 11-4. A summary of Actions IV.1 and IV.2 and their timeframes.

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Action IV.1.2 DCC Gate Operation

Objective: Modify DCC gate operation to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January.

Action: During the period between November 1 and June 15, DCC gate operations will be modified from the proposed action to reduce loss of emigrating salmonids and green sturgeon. The operating criteria provide for longer periods of gate closures during the emigration season to reduce direct and indirect mortality of yearling spring-run, winter-run, and CV steelhead. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree (below).

Implementation procedures: Monitoring data related to triggers in the decision tree will be reported on DAT calls and evaluated by DOSS (for formation of DOSS – see Action IV.5). Reclamation/DWR shall take actions within 24 hours of a triggered condition occurring. If the decision tree requires an evaluation of data or provides options, then DOSS shall convene within one day of the trigger being met. DOSS shall provide advice to NMFS, and the action shall be vetted through WOMT standard operating procedures.

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Rationale for 2011 amendment: "KK" was a typographical error in the 2009 RPA, intended to be a placeholder until the number for action that describes the formation of DOSS was identified.

October 1-November 30:

Date	VI. Action Triggers	Action Responses
October 1-November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index (KLCI) or the Sacramento Catch Index (SCI) are greater than 3 fish per day but less than or equal to 5 fish per day.	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than 5 fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is less than 3 fish per day at both the Knights Landing and Sacramento monitoring sites.
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.

February 1 – June 15:

Date	Action Trigger	Action Response
February 1 – May 20	D-1641 mandatory gate closure.[9]	Gates closed, per WQCP criteria

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Date	Action Trigger	Action Response
May 21 – June 15	D-1641 gate operations criteria	DCC gates closed for 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.

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Overall Rationale for Action IV.1.2: Emigrating salmonids are vulnerable to diversion into the DCC when the gates are open. Fish traveling downstream in the Sacramento River move past the mouth of the DCC on the outside bend of the river. A series of studies conducted by Reclamation and USGS (Horn and Blake 2004) used acoustic tracking of released juvenile Chinook salmon to follow their movements in the vicinity of the DCC under different flows and tidal conditions. The study results indicate that the behavior of the Chinook salmon juveniles increased their exposure to entrainment through both the DCC and Georgiana Slough. Horizontal positioning along the east bank of the river during both the flood and ebb tidal conditions enhanced the probability of entrainment into the two channels. Upstream movement of fish with the flood tide demonstrated that fish could pass the channel mouths on an ebb tide and still be entrained on the subsequent flood tide cycle. In addition, diel movement of fish vertically in the water column exposed more fish at night to entrainment into the DCC than during the day, due to their higher position in the water column and the depth of the lip to the DCC channel mouth (-2.4 meters). Additional studies have shown that the mortality rate of the fish diverted into the DCC and subsequently into the Mokelumne river system is quite high (Perry and Skalski 2008; Vogel 2004, 2008). Closure of the DCC gates during periods of salmon emigration eliminates the potential for entrainment into the DCC and the Mokelumne River system with its high loss rates. In addition, closure of the gates appears to redirect the migratory paths of emigrating fish into channels with relatively less mortality (*e.g.*, Sutter and Steamboat Sloughs), due to a redistribution of river flows among the channels. The overall effect is an increase in the apparent survival rate of these salmon populations as they move through the Delta.

The closure of the DCC gates will increase the survival of salmonid emigrants through the Delta, and the early closures reduce loss of fish with unique and valuable life history strategies in the spring-run and CV steelhead populations. Spring-run emigrating through the Delta during November and December are yearling fish. These fish are larger and have a higher rate of success in surviving their entrance into the ocean environment. In addition, variation in the timing of ocean entry distributes the risk of survival over a broader temporal period. This alternative life history strategy reduces the probability that poor ocean conditions in spring and summer will affect the entire population of spring-run. Since

yearling fish enter the marine environment in late fall and winter, they avoid the conditions that young-of-the-year fish encounter in spring and summer, thus increasing the likelihood that at least a portion of the population will benefit from suitable ocean conditions during their recruitment to the ocean phase of their life cycle. For the same reasons, CV steelhead benefit from having their ocean entry spread out over several months.

Rationale for 2011 amendments:

1) **Change in dates**: The change in dates from "February 1 – May 15" to "February 1 – May 20" and from "May 16 – June 15" to "May 21 – June 15" are minor amendments to be consistent and in compliance with State law (Water Rights Decision D-1641, December 29, 1999, page 184, http://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1600_d1649/wrd1641.pdf).
2) **Change in action response**: The change in action response for May 21-June 15 from "DCC gates may be closed for up to 14 days during this period" to "DCC gates closed for 14 days during this period," is an amendment to be consistent and in compliance with State law (Water Quality Control Plan, December 13, 2006, page 17, footnote 24, http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/2006wqcp/docs/2006_plan_final.pdf).

Action IV.1.3 Consider Engineering Solutions to Further Reduce Diversion of Emigrating Juvenile Salmonids to the Interior and Southern Delta, and Reduce Exposure to CVP and SWP Export Facilities

Objectives: Prevent emigrating salmonids from entering the Georgiana Slough channel from the Sacramento River during their downstream migration through the Delta. Prevent emigrating salmonids from entering channels in the south Delta (*e.g.*, Old River, Turner Cut) that increase entrainment risk to CV steelhead migrating from the San Joaquin River through the Delta.

Action: Reclamation and/or DWR shall convene a working group to consider engineering solutions to further reduce diversion of emigrating juvenile salmonids to the interior Delta and consequent exposure to CVP and SWP export facilities. The working group, comprised of representatives from Reclamation, DWR, NMFS, USFWS, and CDFG, shall develop and evaluate proposed designs for their effectiveness. in reducing adverse impacts on listed fish and their critical habitat. Reclamation or DWR shall subject any proposed engineering solutions to external independent peer review and report the initial findings to NMFS by March 30, 2012. Reclamation or DWR shall provide a final report on recommended approaches by March 30, 2015. If NMFS approves an approach in the report, Reclamation or DWR shall implement it. To avoid duplication of efforts or conflicting solutions, this action should be coordinated with USFWS' Delta smelt biological opinion and BDCP's consideration of conveyance alternatives..

Rationale: One of the recommendations from the CALFED Science Panel peer review was to study engineering solutions to "separate water from fish." This action is intended to

January 1 – June 15 First Stage Trigger (increasing level of concern)	(1) Daily SWP/CVP older juvenile Chinook salmon[14] loss density (fish per taf) is greater than incidental take limit divided by 2000 (2 percent WR JPE ÷ 2000), with a minimum value of 2.5 fish per taf, or (2) daily SWP/CVP older juvenile Chinook salmon loss is greater than 8 fish/taf multiplied by volume exported (in taf) or (3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5% for each surrogate release group, or (4) daily loss of wild steelhead (intact adipose fin) is greater than 8 fish/taf multiplied by volume exported (in taf)[15]	Reduce exports to achieve an average net OMR flow of (minus) -3,500 cfs for a minimum of 5 consecutive days. The five day running average OMR flows shall be no more than 25 percent more negative than the targeted flow level at any time during the 5-day running average period (*e.g.*, -4,375 cfs average over five days). Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction[16]. Reductions are required when any one criterion is met.
January 1 - June 15 Second Stage Trigger (analogous to high concern level)	(1) Daily SWP/CVP older juvenile Chinook salmon loss density (fish per taf) is greater than incidental take limit (2 percent of WR JPE) divided by 1000 (2 percent of WR JPE ÷ 1000), with a minimum value of 2.5 fish per taf, or (2) daily SWP/CVP older juvenile Chinook salmon loss is greater than 12 fish/taf multiplied by volume exported (in taf), or (3) daily loss of wild steelhead (intact adipose fin) is greater than 12 fish/taf multiplied by volume exported (in taf)	Reduce exports to achieve an average net OMR flow of (minus) -2,500 cfs for a minimum 5 consecutive days. Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction. Reductions are required when any one criterion is met.

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

[15] NMFS assumes that the loss of winter-run Chinook salmon and steelhead are similar in nature based on annual loss estimates. As an initial trigger, the density of steelhead, which includes smolts and adults, will be used in the same equation as the older juvenile salmon trigger to change OMR flows. This will be reviewed by the DOSS group annually and recommendations to the trigger criteria made based on an assessment of the results.

[16] Three consecutive days in which the loss numbers are below the action triggers are required before the OMR flow reductions can be relaxed to -5,000 cfs. A minimum of 5 consecutive days of export reduction are required for the protection of listed salmonids under the action. Starting on day three of the export curtailment, the level of fish loss must be below the action triggers for the remainder of the 5-day export reduction to relax the OMR requirements on day 6. Any exceedance of a more conservative trigger restarts the 5-day OMR action response with the three consecutive days of loss monitoring criteria.

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End of Triggers	Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72°F (22°C) for 7 consecutive days (1 week), whichever is earlier.	If trigger for end of OMR regulation is met, then the restrictions on OMR are lifted.

Implementation procedures: Combined exports will be managed to provide for an OMR flow of -5,000 cfs, tidally filtered over 14-days during the period between January 1 and June 15. The 5-day running average shall be no more than 25 percent more negative than the targeted flow requirement. Further reductions in exports will occur in a tiered fashion depending on the magnitude of Chinook salmon and steelhead salvage at the CVP and SWP fish salvage facilities. There are two export reductions triggered by increases in fish salvage rates at the fish collection. The first reduction decreases exports to achieve a net average OMR flow of -3,500 cfs over a minimum of 5 consecutive days. The second reduction, based on higher salvage numbers, further reduces exports to achieve a net average OMR flow of -2,500 cfs over a minimum of 5 days.

Alternatively, to provide flexibility in operations, once an action trigger is met, combined exports could be reduced immediately to a floor of 1,500 cfs (*i.e.*, the project operators would not be required to reduce combined exports to less than 1,500 cfs) until the required OMR limit is met.

These actions will be taken in coordination with USFWS RPA for Delta smelt and State-listed longfin smelt 2081 incidental take permit. During the January 1 through June 15 period, the most restrictive export reduction shall be implemented. If the USFWS Delta smelt RPA requires greater reductions in exports than those required by NMFS for salmonids, to achieve a more positive OMR flow, then the smelt action will be implemented, since it also will increase survival of listed salmonids. Likewise, if the NMFS RPA criteria are more restrictive than those called for under the Delta smelt RPA, then NMFS RPA criteria will prevail and will increase survival of Delta smelt as well as salmonids.

Rationale: Juvenile listed salmonids emigrate downstream in the main channel of the San Joaquin River during the winter and spring period. Juvenile listed steelhead from the San Joaquin River basin, the Calaveras River basin, and the Mokelumne River basin also utilize the lower reaches of the San Joaquin River as a migration corridor to the ocean. The river reach between the Port of Stockton and Jersey Point has many side channels leading south toward the export facilities. High export levels draw water through these channels toward the pumps, as these channels are the conduits that supply water to the pumps from the north. Outputs from PTM simulations, as well as data from acoustic tagging studies (Vogel 2004, SJRGA 2006, 2007), show that migrating fish are vulnerable to diversion into these channels and respond to flow within the channels, including the net migration speed downstream (SJRGA 2008).

The acoustic tagging studies also indicate that fish behavior is complex, with fish exhibiting behavior that is not captured by the "tidal surfing' model utilized as one of the options in the PTM simulations. Fish made their way downstream in a way that was more complicated than simply riding the tide, and no discernable phase of the tide had greater net downstream movement than another. Furthermore, tagged fish chose channels leading south more frequently when exports were elevated, than when exports were lower (Vogel 2004). Fish that moved into channels leading south may eventually find their way back to the main channel of the San Joaquin, but this roundabout migratory path exposes fish to higher predation risks as well as the potential to become lost within the Delta interior, increasing migration route length and duration of the outmigration. Increased time in the channels of the Central and South Delta exposes fish to unscreened agricultural diversions, discharges of agricultural irrigation return water to the Delta, increased water temperature later in the season, and the risk of predation from pelagic predators such as striped bass and localized ambush predators such as largemouth bass. In order to increase the likelihood of survival, emigrating steelhead from the San Joaquin Basin and the east-side tributaries should remain in the mainstem of the San Joaquin River to the greatest extent possible and reduce their exposure to the adverse effects that are present in the channels leading south toward the export facilities.

Reducing the risk of diversion into the central and southern Delta waterways also will increase survival of listed salmonids and green sturgeon entering the San Joaquin River via Georgiana Slough and the lower Mokelumne River. As described in the effects section of the Opinion, these fish also are vulnerable to entrainment by the far-field effects of the exports. The data output for the PTM simulation of particles injected at the confluence of the Mokelumne River and the San Joaquin River (Station 815) indicate that as net OMR flow increases southwards from -2,500 to -3,500 cfs, the risk of particle entrainment nearly doubles from 10 percent to 20 percent, and quadruples to 40 percent at -5,000 cfs. At flows more negative than -5,000 cfs, the risk of entrainment increases at an even greater rate, reaching approximately 90 percent at -7,000 cfs. Even if salmonids do not behave exactly as neutrally buoyant particles, the risk of entrainment escalates considerably with increasing exports, as represented by the net OMR flows. The logical conclusion is that as OMR reverse flows increase, risk of entrainment into the channels of the South Delta is increased. Conversely, the risk of entrainment into the channels of the South delta is reduced when exports are lower and the net flow in the OMR channels is more positive -- that is, in the direction of the natural flow toward the ocean.

Rationale for 2011 amendments:

1) First OMR trigger: This was clarified to identify the loss as pertaining to older juvenile Chinook salmon.
2) Second OMR trigger: The second trigger, as described in the 2009 RPA, was not workable as drafted[17]. During 2010, DOSS convened a subgroup to revise the second trigger (both the first and second stages), based on discussions that led to the development of the salmon decision tree.

[17] See Attachment 1 for discussions regarding how the second trigger was not workable.

3) Third OMR trigger:
   a) First stage trigger: This was clarified to reflect that the trigger applies to each surrogate release group.
   b) Second stage trigger: The first and second stage triggers for surrogate release groups are exactly the same. Therefore, the second stage trigger for surrogate releases was deleted to avoid confusion in implementation of the action response.
4) Fourth OMR trigger: The fourth OMR trigger was the same as the second OMR trigger, but applied to steelhead. As with the second OMR trigger (applied to Chinook salmon), it was not workable as drafted. The fourth OMR trigger was corrected.
5) Action response: In the 2009 RPA, the action response read as if the 3 days of average daily fish density less than the trigger density had to occur after the 5 days of export reductions. The language for both the first and second stage triggers was clarified in the 2011 amendment so that the average daily fish density is less than the trigger density for the last 3 consecutive days of export reductions.
6) Footnote 16: The last sentence was clarified to say that a new action response applies only if a more conservative (*i.e.*, less negative) OMR flow trigger is met.

Rationale for 2011 amendment to implementation procedure: What the fish need is a rapid response to redirect their migration from the south Delta and pumps. OMR flows are influenced by tidal and other physical forces that are beyond the control of the project operators, and therefore, may prevent strict adherence to the specific OMR flow limits. As a result, combined exports quickly reduced to 1,500 cfs will be deemed compliance if OMR flows do not actually meet the required action responses specified in the table, above. There may be more flexibility in the OMR, and therefore, exports, later in the averaging period. This amendment was supported by the ISP.

Action IV.3 Reduce Likelihood of Entrainment or Salvage at the Export Facilities

Objective: Reduce losses of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon by reducing exports when large numbers of juvenile Chinook salmon are migrating into the upper Delta region, at risk of entrainment into the central and south Delta and then to the export pumps in the following weeks.

Action: From November 1 through April 30, operations of the Tracy and Skinner Fish Collection Facilities shall be modified according to monitoring data from upstream of the Delta. In conjunction with the two alerts for closure of the DCC (Action IV.1.1), the Third Alert shall be used to signal that export operations may need to be altered in the near future due to large numbers of juvenile Chinook salmon migrating into the upper Delta region, increasing their risk of entrainment into the central and south Delta and then to the export pumps.

Third Alert: The catch index is greater than 10 fish captured per day from November 1 to February 28, or greater than 15 fish captured per day from March 1 to April 30, from either the Knights Landing catch index or the Sacramento catch index.

operation of the SWP. Because of commitments expressed in the COA and the Congressional mandate to Reclamation to operate the CVP in conjunction with the SWP, the operations of the two projects are linked . . . ." (CVP/SWP operations BA, p. 1-10) DWR stated in a recent letter to Ren Lohoefener, Regional Director of the USFWS, "For purposes of consultations under the . . . ESA, the operations of the SWP and CVP are intentionally and inextricably connected . . . . . ESA protection of Delta species under the BO is impossible without the participation and cooperation of the Department." (DWR 2009a). Consequently, DWR asserted its standing to request reinitiation of consultation, regardless of whether Reclamation did so.

Moreover, state law gives DWR authority to provide for needs of fish and wildlife independent of the connection of the two water projects. According to the BA, DWR

> "is required to plan for recreational and fish and wildlife uses of water in connection with State-constructed water projects and can acquire land for such uses (Wat. Code Sec. 233, 345,346, 12582). The Davis-Dolwig Act (Wat. Code Sec. 11900-11925) establishes the policy that preservation of fish and wildlife is part of State costs to be paid by water supply contractors, and recreation and enhancement of fish and wildlife are to be provided by appropriations from the General Fund."

(CVP/SWP operations BA, page 1-4) DWR, like Reclamation, has broad authority to preserve and enhance fish and wildlife.

The Preamble to the ESA consultation regulations states that "a Federal agency's responsibility under section 7(a)(2) permeates the full range of discretionary authority held by that agency," and that the Services can prescribe a RPA "that involves the maximum exercise of Federal agency authority when to do so is necessary, in the opinion of the Service, to avoid jeopardy." 51 Fed. Reg. 19925, 19937 (June 3, 1986). The independent review panel concluded that despite Congressional authorization and direction more than 16 years ago to restore anadromous fish populations in Central Valley rivers and streams, Reclamation continues to take an unduly narrow view of its authorities in carrying out Congress' mandate. The legal foundation of this RPA is a broader view of Reclamation's authorities, one that is consistent with the CVPIA, the ESA, and the independent review panel's recommendations.

JEOPARDY ANALYSIS AND CONCLUSION

The "Rationale for 2011 amendments" sections for those actions to which changes were made explain the reasons for the changes. With no exception, the objectives for each of the actions where changes were made will be met. With the changes in the actions or implementation procedures, the RPA, as a whole, still "can be implemented in a manner consistent with the intended purpose of the action, . . . consistent with the scope of the Federal agency's legal authority and jurisdiction, . . . is economically and technologically feasible, and . . . would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat" (50 CFR 402.02).

NMFS does not believe the 2011 amendments meet any of the criteria for reinitiation of consultation listed in 50 CFR 402.16. Consequently, NMFS has not advised the action agency to reinitiate consultation. Rather, the amendments have been developed using the collaborative process established in the 2009 Opinion.

LITERATURE CITED

Anderson, J.J., R.T. Kneib, S.A. Luthy, and P.E. Smith. 2010. Report of the 2010 Independent Review Panel (IRP) on the Reasonable and Prudent Alternative (RPA) Actions Affecting the Operations Criteria And Plan (OCAP) for State/Federal Water Operations. Prepared for: Delta Stewardship Council, Delta Science Program. December 9. 39 pages.

Enclosure 2

Clean Version of the 2009 Reasonable and Prudent Alternative Revised to Include the 2011 Amendments

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11.0 REASONABLE AND PRUDENT ALTERNATIVE

11.1 OVERVIEW

11.1.1 Approach to the RPA

If NMFS finds that a proposed action is likely to jeopardize a listed species or adversely modify its critical habitat, the ESA requires NMFS to suggest those reasonable and prudent alternatives that it believes would enable the project to go forward in compliance with the ESA. By regulation, a RPA is defined as "alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that is economically and technologically feasible, and that the [NMFS] Director believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat" (50 CFR 402.02).

Regulations also require that NMFS discuss its findings and any RPAs with the action agency and utilize the action agency's expertise in formulating the RPA, if requested (50 CFR 402.14(g)(5)). This RPA was developed through a thoughtful and reasoned analysis of the key causes of the jeopardy and adverse modification findings, and a consideration of alternative actions within the legal authority of Reclamation and DWR to alleviate those stressors. NMFS has worked closely with Reclamation and DWR staff and greatly appreciates the expertise contributed by these agencies.

Because this complex action takes place in a highly altered landscape subject to many environmental stresses, it has been difficult to formulate an RPA that is likely to avoid jeopardy to all listed species and meets all regulatory requirements. As detailed in this Opinion, the current status of the affected species is precarious, and future activities and conditions not within the control of Reclamation or DWR are likely to place substantial stress on the species. NMFS initially attempted to devise an RPA for each species and its critical habitat solely by modifying project operations (*e.g.*, timing/magnitude of releases from dams, closure of operable gates and barriers, and reductions in negative flows). In some cases, however, simply altering project operations was not sufficient to ensure that the projects were likely to avoid jeopardizing the species or adversely modifying critical habitat.

Consequently, NMFS developed focused actions designed to compensate for a particular stressor, considering the full range of authorities that Reclamation and DWR may use to implement these actions. These authorities are substantial. The CVPIA, in particular, provides Reclamation with ample authority to provide benefits for fish and wildlife through measures such as purchasing water to augment in-stream flow, implementing habitat restoration projects, and taking other beneficial actions (Cummins *et al.*, 2008). Some RPA actions, therefore, call for restoring habitat or providing fish passage above dams, even though the water projects are not directly responsible for the impaired habitat or the blocked passage.

NMFS concentrated on actions that have the highest likelihood of alleviating the stressors with the most significant effects on the species, rather than attempting to address every project stressor for each species or every PCE for critical habitat. For example, water temperatures lethal to incubating eggs often occur when the air is warm and flows are low. Fish cannot reach spawning habitat with colder water at higher elevations if it is above currently impassable dams. Accordingly, NMFS' near-term measures provide suitable water temperatures below dams in a higher percentage of years, and long-term measures provide passage to cooler habitat above dams as soon as practicable. Reducing egg mortality from high water temperatures is a critical step in slowing or halting the decline of Central Valley salmonids.

The effects analysis in this Opinion explains that the adverse effects of the proposed action on listed anadromous fish and their critical habitats are both direct and indirect. The USFWS stated in its biological opinion on effects of the projects on Delta smelt that in addition to direct adverse effects such as entrainment at the pumps, the water projects have affected smelt "by creating an altered environment in the Delta that has fostered both the establishment of non-indigenous species and habitat conditions that exacerbate their adverse influence on delta smelt population dynamics." (USFWS 2008a, p. 189) Similarly, NMFS concludes that the water projects have both directly altered the hydrodynamics of the Sacramento-San Joaquin River basins and have interacted with other activities affecting the Delta to create an altered environment that adversely influences salmonid and green sturgeon population dynamics. The altered environment includes changes in habitat formation, species composition, and water quality, among others. Consequently, NMFS must take a broad view of the ways in which the project agencies can improve the ecosystem to ameliorate the effects of their actions.

There are several ways in which water operations adversely affect listed species that are addressed in this RPA. We summarize the most significant here:

1) Water operations result in elevated water temperatures that have lethal and sub-lethal effects on egg incubation and juvenile rearing in the upper Sacramento River. The immediate operational cause is lack of sufficient cold water in storage to allow for cold water releases to reduce downstream temperatures at critical times and meet other project demands. This elevated temperature effect is particularly pronounced in the Upper Sacramento for winter-run and mainstem spring-run, and in the American River for steelhead. The RPA includes a new year-round storage and temperature management program for Shasta Reservoir and the Upper Sacramento River, as well as long-term passage prescriptions at Shasta Dam and re-introduction of winter-run into its native habitat in the McCloud and/or Upper Sacramento rivers.

2) In Clear Creek, recent project operations have led to increased abundance of Clear Creek spring-run, which is an essential population for the short-term and long-term survival of the species. Nonetheless, in the proposed action, continuation of these operations is uncertain. The RPA ensures that essential flows and temperatures for holding, egg incubation and juvenile survival will be maintained.

3) Red Bluff Diversion Dam (RBDD) on the Sacramento River impedes both upstream migration of adult fish to spawning habitat and downstream migration of juveniles. Effects are significant for winter-run and spring-run, but are particularly pronounced for green sturgeon and its proposed critical habitat in that a significant portion of the population is blocked from its spawning and holding habitat. The RPA mandates gate openings at critical times in the short term while an alternative pumping plant is built, and, by 2012, opening of the gates all year.

4) Both project and non-project effects have led to a significant reduction in necessary juvenile rearing habitat in the Sacramento River Basin and Delta. The project's flood control operations result in adverse effects through reduced frequency and magnitude of inundation of rearing habitat. To minimize these effects, the RPA contains both short-term and long-term actions for improving juvenile rearing habitat in the Lower Sacramento River and northern Delta.

5) Another major effect of water operations is diversion of out-migrating juveniles from the north Delta tributaries into the interior Delta through the open DCC gates. Instead of migrating directly to the outer estuary and then to sea, these juveniles are caught in the interior Delta and subjected to pollution, predators, and altered food webs that cause either direct mortality or impaired growth. The RPA mandates additional gate closures to minimize these adverse effects to winter-run, spring-run, and steelhead.

6) Similarly, water pumping causes reverse flows, leading to loss of juveniles migrating out from the Sacramento River system in the interior Delta and more juveniles being exposed to the State and Federal pumps, where they are salvaged at the facilities. The RPA prescribes Old and Middle River flow levels to reduce the number of juveniles exposed to the export facilities and prescribes additional measures at the facilities themselves to increase survival of fish.

7) The effects analysis shows that juvenile steelhead migrating out from the San Joaquin River Basin have a particularly high rate of loss due to both project and non-project related stressors. The RPA mandates additional measures to improve survival of San Joaquin steelhead smolts, including both increased San Joaquin River flows and export curtailments. Given the uncertainty of the relationship between flow and exports, the RPA also prescribes a significant new study of acoustic tagged fish in the San Joaquin Basin to evaluate the effectiveness of the RPA and refine it over the lifetime of the project.

8) On the American River, project-related effects on steelhead are pronounced due to the inability to consistently provide suitable temperatures for various life stages and flow-related effects caused by operations. The RPA prescribes a flow management standard, a temperature management plan, additional technological fixes to temperature control structures, and, in the long term, a passage at Nimbus and Folsom Dams to restore steelhead to native habitat.

9) On the Stanislaus River, project operations have led to significant degradation of floodplain and rearing habitat for steelhead. Low flows also distort cues associated with out-migration. The RPA proposes a year-round flow regime necessary to minimize project effects to each life-stage of steelhead, including new spring flows that will support rearing habitat formation and inundation, and will create pulses that cue out-migration.

10) Nimbus Fish Hatchery steelhead program contribute to both loss of genetic diversity and mixing of wild and hatchery stocks of steelhead, which reduces the viability of wild stocks. The Nimbus and Trinity River Hatchery programs for non-listed fall-run also contribute to a loss of genetic diversity, and therefore, viability, for fall-run. The RPA requires development of Hatchery Genetics Management Plans to improve genetic diversity of both steelhead and fall-run, an essential prey base of Southern Resident.

This RPA is composed of numerous elements for each of the various project divisions and associated stressors and must be implemented in its entirety in order to avoid jeopardy and adverse modification. There are several actions that allow the project agencies options for alleviating a particular stressor. Reclamation and DWR may select the option they deem most practical — NMFS cares only that the stressor be sufficiently reduced. There are several actions in which NMFS expressly solicits additional research and suggestions from the project agencies for alternative actions to achieve needed results.

NMFS recognizes that the RPA must be an alternative that is likely to avoid jeopardizing listed species or adversely modifying their critical habitats, rather than a plan that will achieve recovery. Both the jeopardy and adverse modification standards, however, include consideration of effects on an action on listed species' chances of recovery. NMFS believes that the RPA does not reduce the likelihood of recovery for any of the listed species. The RPA cannot and does not, however, include all steps that would be necessary to achieve recovery. NMFS is mindful of potential social and economic consequences of reducing water deliveries and has carefully avoided prescribing measures that are not necessary to meet section 7 requirements.

An RPA must avoid jeopardy to listed species in the short term, as well as the long term. Essential short-term actions are presented for each division and are summarized for each species to ensure that the likelihood of survival and recovery is not appreciably reduced in the short term (*i.e.*, one to five years). In addition, because the proposed action is operation of the CVP/SWP until 2030, this consultation also includes long-term actions that are necessary to address project-related adverse effects on the likelihood of survival and recovery of the species over the next two decades.

Some of these long-term actions will require evaluation, planning, permitting, and funding. These include:

1) Providing fish passage at Shasta, Nimbus, and Folsom Dams, which ultimately is the only means of counteracting the loss of habitat needed for egg incubation and emergence, and steelhead over-summering habitat at lower elevations. This habitat loss has already occurred and will be exacerbated by climate change and increased water demands.

2) Providing adequate rearing habitat on the lower Sacramento River and Yolo Bypass through alteration of operations, weirs, and restoration projects.

3) Engineering projects to further reduce hydrologic effects and indirect loss of juveniles in the interior Delta.

4) Technological modifications to improve temperature management in Folsom Reservoir.

NMFS considered economic and technological feasibility in several ways when developing initial actions in this RPA. The RPA also allows for tailored implementation of many actions in consideration of economic and technological feasibility without compromising the RPA's effectiveness in avoiding jeopardy and adverse modification of critical habitat. Examples include:

1) Providing reasonable time to develop technologically feasible alternatives where none are "ready to go" – *e.g.*, the Delta engineering action (Action IV.1.3), and lower Sacramento River rearing habitat action (Action I.6.1).

2) Calling for a stepped approach to fish passage at dams, including studies and pilot projects, prior to a significant commitment of resources to build a ladder or invest in a permanent trap and haul program.

3) Providing a health and safety exception for export curtailments.

4) Using monitoring for species presence to initiate actions when most needed.

NMFS examined water supply costs of the RPA as one aspect of considering economic feasibility. While only costs to the action agency are considered in determining whether a RPA meets the regulatory requirement of economic feasibility, NMFS is mindful of potential social and economic costs to the people and communities that historically have depended on the Delta for their water supply. Any water supply impact is undesirable. NMFS made many attempts through the iterative consultation process to avoid developing RPA actions that would result in high water costs, while still providing for the survival and recovery of listed species.

NMFS estimates the water costs associated with the RPA to be 5-7% of average annual combined exports: 5% for CVP, or 130 TAF/year, and 7% for SWP, or 200 TAF/year[1]. The combined estimated annual average export curtailment is 330 TAF/year. These estimates are over and above export curtailments associated with the USFWS smelt Opinion. The OMR restrictions inn both Opinions tend to result in export curtailments of similar quantities at similar times of year. Therefore, in general, these 330 TAF export curtailments are associated with the NMFS San Joaquin River Ratio actions in the RPA. These water costs can be offset by application of b(2) water resources, water conservation, groundwater use, water recycling and toher processes currently underway.

The RPA includes collaborative research to enhance scientific understanding of the species and ecosystems, and to adapt actions to new scientific knowledge. This adaptive structure is important, given the long-term nature of the consultation and the scientific uncertainty inherent in a highly variable system. Monitoring and adaptive management are both built into many of the individual actions and are the subject of an annual program review. NMFS views both the CALFED Science Program and the NMFS Southwest Fisheries Science Center as essential partners in ensuring that the best scientific experts are brought together to assess the implementation and effectiveness of actions in this RPA. We will continue to pursue many of the long-term recommendations for improving science as recommended by the CALFED and CIE peer reviews, and we will seek to incorporate this new science as it becomes available through the adaptive management processes embedded in the RPA.

Finally, we note that the project agencies are currently developing and evaluating a plan to construct a diversion on the Sacramento River and a canal around the Delta, in the BDCP planning effort. Such a reconfiguration of the water conveyance system would take careful planning to avoid jeopardizing Sacramento River and north Delta species, as well as several years of environmental review and permitting, and would trigger a re-initiation of this Opinion. We expect that the collaborative research that is part of this RPA will inform this planning effort as it proceeds.

11.1.2 Organization of the RPA

The specific actions in the RPA are detailed in Section 11.2. That section begins with overarching actions that apply to operations in all geographic divisions of the project, including procedures for orderly functioning of the many technical teams that assist with decision making, research and adaptive management, and monitoring. These are followed by actions specific to each geographic division of the proposed action: Sacramento River, American River, East Side (Stanislaus River), and the Delta. There is a suite of actions for each geographic area. Section 11.2 concludes with subsections regarding fish passage at dams and modification of hatchery practices.

[1] The proportion share between the CVP and SWP is attributable to CalLite programming and may not represent the true share of export reductions that would be allocated to each facility under actual conditions.

Section 11.3 is a species-by-species explanation of: (1) how each measure contributes to avoiding jeopardy or adverse modification for that species; and (2) the basis for NMFS' conclusion that the RPA measures as a whole are likely to avoid jeopardizing the species or adversely modifying its critical habitat. The information is presented in both narrative and table form. The narrative provides an overview, while the tables add detail. This section also address the other regulatory criteria necessary for a Reasonable and Prudent Criteria.

11.2 Reasonable and Prudent Alternative – Specific Actions

11.2.1. Decision-Making Procedures, Monitoring and Adaptive Management Protocols

11.2.1.1 Responsibilities and Procedures of Technical Teams

There are currently four Fisheries and Operations Technical Teams whose function is to make recommendations for adjusting operations to meet contractual obligations for water delivery and minimize adverse effects on listed anadromous fish species:

- Sacramento River Temperature Task Group (SRTTG)
- Clear Creek Technical Working Group (CCTWG)
- American River Group (ARG)
- San Joaquin River Technical Committee (SJRTC)

This RPA requires the creation of three additional technical teams:

- Delta Operations for Salmon and Sturgeon (DOSS) Group
- Stanislaus Operations Group (SOG)
- Interagency Fish Passage Steering Committee

Each group has responsibility to gather and analyze information, and make recommendations, regarding adjustments to water operations within the range of flexibility prescribed in the implementation procedures for a specific action in their particular geographic area. Under previous operations plans, recommendations for adjustments were made to the Water Operations Management Team (WOMT), a management-level group of representatives of Reclamation, DWR, CDFG, NMFS, and USFWS. The WOMT then made recommendations to state and regional directors for final action.

The Project Description for the proposed action (Appendix 1 to this Opinion), as revised by this RPA, establishes the responsibilities of each technical team. The RPA establishes the operations parameters that are necessary to avoid jeopardizing listed species or adversely modifying their critical habitat. Within those parameters, there is flexibility to adjust actions within a specified range based on current conditions. The allowed range of flexibility is prescribed in the "implementation procedures" portion of the RPA action. The technical teams and the WOMT will work within those implementation procedures to meet discretionary water contract obligations to the greatest extent consistent with survival and recovery of listed species. The

teams also may recommend changes to the measures in this RPA, as detailed in the Research and Adaptive Management section of the RPA. Recommended changes outside the range of flexibility specified in the implementation procedures must receive written review and concurrence by NMFS and may trigger re-initiation.

This action prescribes standard operating procedures for decision-making that will apply to all teams.

1) Within 90 days of issuance of this Opinion, Reclamation shall send to the WOMT members a list of current members of each technical team. The WOMT representatives shall review the membership and make changes, if necessary. All groups shall include members with expertise in fish biology and hydrology. Each group shall designate a group leader to convene meetings and assure that necessary administrative steps are taken, such as recording and distributing meeting notes and recommendations.

2) Each group shall establish a regular meeting schedule at the beginning of each year, based on the anticipated need for adjustments to operations, and distribute the schedule to the members of the group. The group leader may reschedule a meeting, or call a special meeting, with three days notice at his or her discretion, or on request of NMFS or any two or more group members.

3) Brief notes of each meeting shall be recorded, including issues considered, recommendations made, and key information on which recommendations were based. Meeting notes shall be distributed to members within two days of the meeting.

4) Within one day after a technical team advises that an operational action should be initiated, changed, suspended, or terminated, consistent with the implementation procedures specified for actions in this RPA, the group leader shall provide to NMFS and Reclamation written advice and a biological rationale. The technical teams shall use the process described in the applicable RPA implementation procedures to provide a framework for their analysis. NMFS shall determine whether the proposed action is consistent with the implementation procedures in this RPA. If NMFS determines that the proposed action is consistent with the implementation procedures, then it avoids jeopardy to listed species or adverse modification of critical habitat. Both the technical team's advice and NMFS' recommendation shall be presented to the WOMT for discussion and concurrence. In the event that there is not consensus at the workgroup level, the workgroup leader shall convey the options and summary of the technical discussion to NMFS for consideration. NMFS will make a recommendation for action within the procedural guidelines of this RPA. NMFS will present its recommendations to the WOMT for discussion and concurrence (see #6 below).

5) If the recommended action will affect species within the jurisdiction of USFWS as well as NMFS, the technical team making the recommendation shall, to the extent that time allows, first coordinate with the Smelt Working Group (SWG). The technical team and

the SWG, to the extent feasible, shall jointly make a recommendation to USFWS and NMFS (the Services), who will jointly determine whether the recommended action is consistent with the actions and implementation procedures of this RPA and is, therefore, necessary to avoid jeopardy to listed species and adverse modification of critical habitat. The Services shall then present their findings and recommendations to the WOMT.

6) The WOMT shall either concur with NMFS' (or the Services', as appropriate) recommendation or provide a written alternative to the recommendation, with biological justification, to NMFS (or the Services) within one calendar day. NMFS (or the Services) shall then make a determination as to whether the action proposed by the WOMT is consistent with this Opinion and ESA obligations.

7) Once NMFS (or the Services) makes a final determination that a proposed operational action is consistent with ESA obligations, Reclamation and DWR shall implement the operational action within two calendar days. Reclamation and DWR shall submit to NMFS (or the Services) data demonstrating the implementation of the action on a weekly basis, or post their operations on their website.

8) The action shall remain in effect until NMFS (or the Services), with advice from the appropriate technical team(s), determines that it should be modified or terminated as inconsistent with the implementation procedures for the RPA. The action shall be modified or terminated within two calendar days of such a determination.

9) These procedures may be modified for a particular team or working group by mutual agreement of NMFS and Reclamation. Modifications to the procedures shall be in writing, dated, and promptly distributed to all members of the group.

11.2.1.2. Research and Adaptive Management

Not later than November 30 of every year, in conjunction with the CALFED Science Program or other Science Peer Review process, Reclamation and NMFS shall host a workshop to review the prior water years' operations and to determine whether any measures prescribed in this RPA should be altered in light of information learned from prior years' operations or research. After completion of the annual review, NMFS may initiate a process to amend specific measures in this RPA to reflect new information, provided that the amendment is consistent with the Opinion's underlying analysis and conclusions and does not limit the effectiveness of the RPA in avoiding jeopardy to listed species or adverse modification of critical habitat. NMFS will ask the appropriate informational and technical teams to assess the need for a particular amendment and make recommendations to NMFS, according to the group processes for decision-making set forth in this RPA in action 11.2.1.1 above.

2011 Amendment: In the Fall of 2010, the Delta Stewardship Council convened an Independent Review Panel (IRP) to assist in the annual review required in this action[2]. On November 8-9, 2010, the Delta Science Program held a workshop to provide the IRP a forum for presentations and discussion of previously submitted technical reports. Following the workshop, the IRP produced a report that included recommendations for adjustments to the RPA, based on information presented in the review process. The IRP Report was finalized on December 9, 2010 (Anderson *et al*. 2010; http://www.deltacouncil.ca.gov/delta_science_program/events/workshop_OCAP_2010.html). NMFS has amended the RPA consistent with the IRP recommendations and this Opinion's underlying analysis and conclusions[3]. This amended RPA supersedes the 2009 RPA.

NMFS and Reclamation will establish a research program in coordination with the CALFED Science Program and other agencies to address key research and management questions arising from this Opinion. Prior to the beginning of a new calendar year, Reclamation shall submit to NMFS a research plan for the following year, developed in coordination with the above programs and agencies. Reclamation also shall provide NMFS access to all draft and final reports associated with this research. Specific research projects that have been identified as important to begin in the first year and complete as soon as possible are:

1) Cooperative development of a salmonid lifecycle model acceptable to NMFS, Reclamation, CDFG, and DWR

2) Temperature monitoring and modeling identified in RPA Action I.5

3) Green sturgeon research described in the RBDD actions

4) Rearing habitat evaluation metrics to guide rearing habitat Action 1.6

5) A 6-year acoustic-tagged study of juvenile salmonids out-migration in the San Joaquin River and through the southern Delta identified in Action IV.2.2.

11.2.1.3. Monitoring and Reporting

1) Reclamation and DWR shall participate in the design, implementation, and funding of the comprehensive CV steelhead monitoring program, under development through ERP, that includes adult and juvenile direct counts, redd surveys, and escapement estimates on CVP- and SWP-controlled streams. This program is necessary to develop better juvenile production estimates that form the basis of incidental take limits and will also provide necessary information to calculate triggers for operational actions.

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[2] Under direction from the Secretaries of Commerce and Interior, the NMFS review was expanded to include a review of the implementation of the FWS' 2008 OCAP Opinion. The integrated review provided an opportunity to assure that the NMFS and FWS RPAs worked together in an ecosystem context.

[3] In addition, NMFS has taken this opportunity to correct some errors in the 2009 RPA. All changes are noted and explained in the "Rationale for 2011 amendment" sections accompanying the amendments.

2) Reclamation and DWR shall ensure that all monitoring programs regarding the effects of CVP and SWP operations and which result in the direct take of winter-run, spring-run, CV steelhead, or Southern DPS of green sturgeon, are conducted by a person or entity that has been authorized by NMFS. Reclamation and DWR shall establish a contact person to coordinate these activities with NMFS.

3) Reclamation and DWR shall submit weekly reports to the interagency Data Assessment Team (DAT) regarding the results of monitoring and incidental take of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon associated with operations of project facilities.

4) Reclamation and DWR shall provide an annual written report to NMFS no later than October 1, following the salvage season of approximately October to May. This report shall provide the data gathered and summarize the results of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon monitoring and incidental take associated with the operation of the Delta pumping plants (including the Rock Slough Pumping Plant). All juvenile mortality must be minimized and reported, including those from special studies conducted during salvage operations. This report should be sent to NMFS (Southwest Region, Protected Resources Division, Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814-4706).

5) Reclamation and DWR shall continue the real-time monitoring of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the lower Sacramento River, the lower San Joaquin River, and the Delta to establish presence and timing to serve as a basis for the management of DCC gate operations and CVP and SWP Delta pumping operations consistent with actions in this RPA. Reclamation and DWR shall conduct continuous real-time monitoring between October 1 and June 30 of each year, commencing in 2009.

6) Reclamation and DWR shall submit weekly DAT reports and an annual written report to NMFS describing the results of real-time monitoring of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon associated with operations of the DCC and CVP and SWP Delta pumping facilities, and other Division level operations authorized through this RPA.

7) Reclamation shall coordinate with NMFS, the USFWS, and CDFG to continue implementation and funding of fisheries monitoring of spring-run and CV steelhead (including adult snorkel surveys, population estimates for steelhead, and rotary screw trapping) in Clear Creek to aide in determining the benefits and effects of flow and temperature management.

8) Monitoring Requirements: The following (A-E) are necessary to adaptively manage project operations and are either directly related to management of releases (*e.g.*,

temperature and flow), or are a necessary component the Salmon Decision Process used to manage Delta operations (*e.g.*, DCC gates and export pumping). Reclamation and DWR shall jointly fund these monitoring locations for the duration of the Opinion (through 2030) to ensure compliance with the RPA and assess the performance of the RPA actions. Most of these monitoring stations already exist and are currently being funded through a variety of sources (*i.e.*, CDFG, USFWS, Reclamation, DWR, CALFED, and Interagency Ecological Program), however, CALFED funding for monitoring ends in 2009 and CDFG funding has been reduced due to budget cuts.

a) Upstream: Adult escapement and juvenile monitoring for spring-run, winter-run, and steelhead on the Sacramento River, American River, Feather River, Clear Creek, Mill Creek, Deer Creek and Battle Creek. These may be performed through carcass surveys, redd surveys, weir counts, and rotary screw trapping. Unless prevented by circumstances beyond the control of Reclamation, aerial redd counts shall be conducted annually on the mainstem Sacramento River from Keswick Dam downstream to at least Tehama Bridge, from at least April through September. These surveys are necessary to determine the temporal and spatial distribution of winter-run and spring-run Chinook salmon. Exceptions to the annual aerial redd counts are allowed only when requested in writing (including the specific circumstance that may preclude the aerial redd surveys) and upon written concurrence by NMFS.

   Rationale for 2011 amendment: Aerial redd counts have been conducted annually at least since 2001. However, in water year 2010, they were conducted later in the winter-run Chinook salmon spawning season, and the SRTTG did not have the benefit of the temporal and spatial distribution data to inform its recommendation of a temperature compliance point. The IRP noted the confusion in the final establishment of the temperature compliance point: "It is not known why the compliance point was established downstream (Jelly's Ferry) when aerial redd surveys in 2010 indicated redds were upstream of Airport Road Bridge." (Anderson *et al*. 2010, page 12, note E).

b) RBDD: Adult counts using the three current fish ladders until the new pumping plant is operational. Rotary screw trapping to determine juvenile Chinook salmon passage or abundance year-round before and after pumping plant is operational. Green sturgeon monitoring, to include adult and juvenile estimates of passage, relative abundance, and run timing, in order to determine habitat use and population size with respect to management of Shasta Reservoir resources.
c) Sacramento River new juvenile monitoring station: The exact location to be determined, between RBDD and Knights Landing, in order to give early warning of fish movement and determine survival of listed fish species leaving spawning habitat in the upper Sacramento River.
d) Delta: Continuation of the following monitoring stations that are part of the IEP: Chipps Island Trawl, Sacramento Trawl, Knights Landings RST, and beach seining

program. Additionally, assist in funding new studies to determine green sturgeon relative abundance and habitat use in the Delta.

e) San Joaquin River monitoring shall include: Adult escapement and juvenile monitoring for steelhead on the Stanislaus River; Mossdale Kodiak Trawling to determine steelhead smolt passage; steelhead survival studies associated with VAMP; monitoring at HORB to determine steelhead movement in and around the barrier; predation studies in front of HORB and at the three agricultural barriers in the South Delta; and new studies to include the use of non-lethal fish guidance devices (*e.g.*, sound, light, or air bubbles) instead of rock barriers to keep juveniles out of the area influenced by export pumping.

11.2.2 Actions Listed by Division

I. SACRAMENTO RIVER DIVISION

Introduction to the Sacramento River Division: Project operations of the Sacramento River Division affect winter-run, spring-run, CV steelhead, the Southern DPS of green sturgeon. In addition, project operations affect fall-run, which are not listed. Fall-run salmon are considered in developing the actions as a prey base for Southern Residents. This Division section of the RPA includes actions related to minimizing adverse effects to spring-run and steelhead spawning and rearing in Clear Creek and all species in the main stem Sacramento River. Actions include those necessary to reduce the risk to temperature effects to egg incubation in the upper river, especially to winter-run and spring-run spawning below Shasta Dam. Also, the RPA contains actions for operation of RBDD – a major impediment to salmonid and green sturgeon migration. In addition, the RPA includes an action related to adjusting the antiquated Wilkins Slough navigation requirement, mandates the continuation of the fish screening program, and calls for restoration of essential rearing habitat in the lower river/northern Delta.

Operations of the Sacramento River Division are interconnected with those of the Trinity River Division. NMFS is in the process of conducting a separate consultation on the effects of the Trinity River Division operations on listed coho salmon in the Trinity River. NMFS is committed to ensuring appropriate coordination between the analysis and results of this Opinion and the forthcoming coho opinion. The Sacramento River Division RPA will be analyzed in that Opinion, and may be adjusted as necessary to avoid jeopardy to coho salmon and adverse modification of critical habitat.

Action Suite I.1. Clear Creek

Suite Objective: The proposed action includes a static flow regime (no greater than 200 cfs all year) and uncertainty as to the availability of b(2) water in the future pose significant risk to these species. The RPA actions described below were developed based on a careful review of past flow studies, current operations, and future climate change scenarios. Although not all of

the flow studies have been completed, NMFS believes these actions are necessary to address adverse project effects on flow and water temperature that reduce the viability of spring-run and CV steelhead in Clear Creek.

Action I.1.1. Spring Attraction Flows

Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.

Action: Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem. This may be done in conjunction with channel-maintenance flows (Action I.1.2).

Rationale: In order to prevent spring-run from hybridizing with fall-run in the Sacramento River, it is important to attract early spring-run adults as far upstream in Clear Creek as possible, where cooler water temperatures can be maintained over the summer holding period through releases from Whiskeytown Dam. This action will also prevent spring-run adults from spawning in the lower reaches of Clear Creek, where water temperatures are inadequate to support eggs and pre-emergent fry during September and October.

Action I.1.2. Channel Maintenance Flows

Objective: Minimize project effects by enhancing and maintain previously degraded spawning habitat for spring-run and CV steelhead

Action: Reclamation shall re-operate Whiskeytown Glory Hole spills during the winter and spring to produce channel maintenance flows of a minimum of 3,250 cfs mean daily spill from Whiskeytown for one day, to occur seven times in a ten-year period, unless flood control operations provide similar releases. Re-operation of Whiskeytown Dam should be implemented with other project facilities as described in the EWP Pilot Program (Reclamation 2008d).

Rationale: Channel maintenance flows are a necessary element of critical habitat (see PCEs) in order to restore proper functioning rivers. This modified operation allows higher flows necessary to move spawning gravels downstream from injection sites, which will increase the amount of spawning habitat available to spring-run and steelhead. Previous studies (McBain and Trush 1999) have shown that Clear Creek lacks sufficient gravel for spawning habitat. Both spring-run and steelhead need higher flows to provide the spawning and rearing habitat elements essential for survival and recovery.

Action I.1.3. Spawning Gravel Augmentation

Objective: Enhance and maintain previously degraded spawning habitat for spring-run and CV steelhead.

Action: Reclamation, in coordination with the Clear Creek Technical team, shall continue spawning gravel augmentation efforts. By December 31 each year, Reclamation shall provide a report to NMFS on implementation and effectiveness of the gravel augmentation program.

Rationale: Similar to above for Action I.1.2. Recent studies (USFWS 2007, 2008) have shown steelhead and spring-run utilize gravel injection sites for spawning. Gravel augmentation has increased the steelhead spawning habitat available in the lower reaches of Clear Creek and directly relates to higher abundance in recent years. The gravel augmentation program also benefits fall-run and late fall-run spawning. Including the gravel augmentation program in the RPA ensures that it is reasonably certain to occur in the future.

Action I.1.4. Spring Creek Temperature Control Curtain *(Note: This action benefits Sacramento River conditions, but is part of Clear Creek operations)*

Objective: Reduce adverse impacts of project operations on water temperature for listed salmonids in the Sacramento River.

Action: Reclamation shall replace the Spring Creek Temperature Control Curtain in Whiskeytown Lake by June 2011 .

Rationale: The Spring Creek Tunnel releases provide cold water to Keswick Reservoir, which improves the ability to lower water temperatures during the summer for winter-run spawning and incubation. Recent underwater surveys concluded that the Whiskeytown Curtain is in poor condition and needs a major overhaul (Reclamation 2008b). Six rips in the fabric run the full depth of the curtain to 55 feet.

Action I.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.

Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of:

1) 60°F at the Igo gage from June 1 through September 15; and

2) 56°F at the Igo gage from September 15 to October 31.

Reclamation, in coordination with NMFS, will assess improvements to modeling water temperatures in Clear Creek and identify a schedule for making improvements.

Rationale: The water temperature criteria address the critical need for colder water that historically was available to salmonids above Whiskeytown Dam. If the criteria are not met, juvenile steelhead rearing habitat is limited, predation is higher, and disease is more prevalent. Spring-run adults need colder water to hold over during the summer until September. If water temperature is too warm, spring-run experience pre-spawn mortality and reduced production. The lower water temperature in September is necessary to reduce mortality of spring-run eggs and pre-emergent fry.

Action I.1.6. Adaptively Manage to Habitat Suitability/IFIM Study Results

Objective: Decrease risk to Clear Creek spring-run and CV steelhead population through improved flow management designed to implement state-of-the-art scientific analysis on habitat suitability.

Action: Reclamation shall operate Whiskeytown Reservoir as described in the Project Description with the modifications described in Action I.1 until September 30, 2012, or until 6 months after current Clear Creek salmonids habitat suitability (*e.g.*, IFIM) studies are completed, whichever occurs later.

When the salmonid habitat suitability studies are completed, Reclamation will, in conjunction with the CCTWG, assess whether Clear Creek flows shall be further adapted to reduce adverse impacts on spring-run and CV steelhead, and report their findings and proposed operational flows to NMFS within 6 months of completion of the studies. NMFS will review this report and determine whether the proposed operational flows are sufficient to avoid jeopardizing spring-run and CV steelhead or adversely modifying their critical habitat.

Reclamation shall implement the flows on receipt of NMFS' written concurrence. If NMFS does not concur, NMFS will provide notice of the insufficiencies and alternative flow recommendations. Within 30 days of receipt of non-concurrence by NMFS, Reclamation shall convene the CCTWG to address NMFS' concerns. Reclamation shall implement flows deemed sufficient by NMFS in the next calendar year.

Rationale: Past project operations have reduced spring-run and CV steelhead abundance in Clear Creek by creating passage barriers, raising water temperature, and reducing spawning gravels in key areas of critical habitat. Abundance has increased in recent years as a result of passage improvements, habitat restoration, and operational changes to improve temperature control. Persistence of the population and maintenance of its critical habitat will require continuation of flows adequate for migration and maintenance of spawning gravels and suitable water temperatures.

Action Suite I.2. Shasta Operations

Introduction to Shasta Operations: Maintaining suitable temperatures for egg incubation, fry emergence, and juvenile rearing in the Sacramento River is critically important for survival and recovery of the winter-run ESU. The winter-run ESU has been reduced to a single population, which has been blocked from its historical range above Shasta Dam. Consequently, suitable temperatures and habitat for this population must be maintained downstream of Shasta Dam through management of the cold water pool behind the dam in the summer. Maintaining optimum conditions for this species below Shasta is crucial until additional populations are established in other habitats or this population is restored to its historical range. Spring-run are also affected by temperature management actions from Shasta Reservoir.

The effects analysis in this Opinion highlights the very challenging nature of maintaining an adequate cold water pool in critically dry years, extended dry periods, and under future conditions, which will be affected by increased downstream water demands and climate change. This suite of actions is designed to ensure that Reclamation uses maximum discretion to reduce adverse impacts of the projects to winter-run and spring-run in the Sacramento River by maintaining sufficient carryover storage and optimizing use of the cold water pool. In most years, reservoir releases through the use of the TCD are a necessity in order to maintain the bare minimum population levels necessary for survival (Yates *et al.* 2008, Angilletta *et al.* 2008).

The effects analysis in this Opinion, and supplemental information provided by Reclamation, make it clear that despite Reclamation's best efforts, severe temperature-related effects cannot be avoided in some years. The RPA includes exception procedures to deal with this reality. Due to these unavoidable adverse effects, the RPA also specifies other actions that Reclamation must take, within its existing authority and discretion, to compensate for these periods of unavoidably high temperatures. These actions include restoration of habitat at Battle Creek that may be support a second population of winter-run, and a fish passage program at Keswick and Shasta dams to partially restore winter-run to their historical cold water habitat.

Objectives: The following objectives must be achieved to address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:

1) Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.

2) Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to

naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents.

3) Establish a second population of winter-run in Battle Creek as soon as possible, to partially compensate for unavoidable project-related effects on the one remaining population.

4) Restore passage at Shasta Reservoir with experimental reintroductions of winter-run to the upper Sacramento and/or McCloud rivers, to partially compensate for unavoidable project-related effects on the remaining population.

Action 1.2.1 Performance Measures.

Objective: To establish and operate to a set of performance measures for temperature compliance points and End-of-September (EOS) carryover storage, enabling Reclamation and NMFS to assess the effectiveness of this suite of actions over time. Performance measures will help to ensure that the beneficial variability of the system from changes in hydrology will be measured and maintained.

Action: The following long-term performance measures shall be attained. Reclamation shall track performance and report to NMFS at least every 5 years. If there is significant deviation from these performance measures over a 10-year period, measured as a running average, which is not explained by hydrological cycle factors (*e.g.*, extended drought), then Reclamation shall reinitiate consultation with NMFS.

Performance measures for EOS carryover storage at Shasta Reservoir:

- 87 percent of years: Minimum EOS storage of 2.2 MAF
- 82 percent of years: Minimum EOS storage of 2.2 MAF and end-of-April storage of 3.8 MAF in following year (to maintain potential to meet Balls Ferry compliance point)
- 40 percent of years: Minimum EOS storage 3.2 MAF (to maintain potential to meet Jelly's Ferry compliance point in following year)

Measured as a 10-year running average, performance measures for temperature compliance points during summer season shall be:

- Meet Clear Creek Compliance point 95 percent of time
- Meet Balls Ferry Compliance point 85 percent of time
- Meet Jelly's Ferry Compliance point 40 percent of time
- Meet Bend Bridge Compliance point 15 percent of time

Rationale: Evaluating long-term operations against a set of performance measures is the only way to determine the effectiveness of operations in preserving key aspects of life history

and run time diversity. For example, maintaining suitable spawning temperatures down to Bend Bridge in years when this is feasible will help to preserve the part of winter-run distribution and run timing that relies on this habitat and spawning strategy. This will help to ensure that diversity is preserved when feasible. The percentages are taken from those presented in the CVP/SWP operations BA, effects analysis in the Opinion, and NMFS technical memo on historic Shasta operations.

Action I.2.2. November through February Keswick Release Schedule (Fall Actions)

Objective: Minimize impacts to listed species and naturally spawning non-listed fall-run from high water temperatures by implementing standard procedures for release of cold water from Shasta Reservoir.

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as detailed below.

Action I.2.2.A Implementation Procedures for EOS Storage at 2.4 MAF and Above

If the EOS storage is at 2.4 MAF or above, by October 15, Reclamation shall convene a group including NMFS, USFWS, and CDFG, through B2IT or other comparable process, to consider a range of fall actions. A written monthly average Keswick release schedule shall be developed and submitted to NMFS by November 1 of each year, based on the criteria below. The monthly release schedule shall be tracked through the work group. If there is any disagreement in the group, including NMFS technical staff, the issue/action shall be elevated to the WOMT for resolution per standard procedures.

The workgroup shall consider and the following criteria in developing a Keswick release schedule:

1) Need for flood control space: A maximum 3.25 MAF end-of-November storage is necessary to maintain space in Shasta Reservoir for flood control.

2) Need for stable Sacramento River level/stage to increase habitat for optimal spring-run and fall-run redds/egg incubation and minimization of redd dewatering and juvenile stranding.

3) Need/recommendation to implement USFWS' Delta smelt Fall X2 action as determined by the Habitat Study Group formed in accordance with the 2008 Delta smelt Opinion. NMFS will continue to participate in the Habitat Study Group (HSG) chartered through the 2008 Delta smelt biological opinion. If, through the HSG, a fall flow action is recommended that draws down fall storage significantly from historical patterns, then NMFS and USFWS will confer and recommend to Reclamation an optimal storage and fall flow pattern to address multiple species' needs.

If there is a disagreement at the workgroup level, actions may be elevated to NMFS Sacramento Area Office Supervisor and resolved through the WOMT's standard operating procedures.

Rationale: 2.2 MAF EOS storage is linked to the potential to provide sufficient cold water to meet the minimum Balls Ferry Compliance point in the following year, and it is achievable approximately 85 percent of the time. Based on historical patterns, EOS storage will be above 2.4 MAF 70 percent of the time. The 2.4 MAF storage value provides a reasonable margin above the 2.2 level to increase the likelihood that the Balls Ferry Compliance Point will be reached while also implementing fall releases to benefit other species and life stages. Therefore, in these circumstances, actions should target the fall life history stages of the species covered by this Opinion *(i.e.*, spring-run spawning, winter-run emigration). The development of a Keswick release schedule is a direct method for controlling storage maintained in Shasta Reservoir. It allows Reclamation to operate in a predictable way, while meeting the biological requirements of the species. The B2IT workgroup has been used in the past to target actions to benefit fall-run during this time of year using b(2) resources, and, because of its expertise, may also be used by Reclamation to develop this flow schedule. In the past, the B2IT group has used the CVPIA AFRP guidelines to target reservoir releases. Over time, it may be possible to develop a generic release schedule for these months, based on the experience of the work group.

Action I.2.2.B Implementation Procedures for EOS Storage Above 1.9 MAF and Below 2.4 MAF

If EOS storage is between 1.9 and 2.4 MAF, then Reclamation shall convene a group including NMFS, USFWS, and CDFG, through B2IT or other comparable workgroup, to consider a range of fall actions. Reclamation shall provide NMFS and the work group with storage projections based on 50 percent, 70 percent, and 90 percent hydrology through February, and develop a monthly average Keswick release schedule based on the criteria below. The monthly release schedule shall be submitted to NMFS by November 1.

Criteria for the release schedule shall include:

1) Maintain Keswick releases between 7000 cfs and 3250 cfs to reduce adverse effects on mainstem spring-run and conserve storage for next year's cold water pool.

2) Consider fall-run needs per CVPIA AFRP guidelines, through January, including stabilizing flows to keep redds from de-watering.

3) Be more conservative in Keswick releases throughout fall and early winter if hydrology is dry, and release more water for other purposes if hydrology becomes wet. For example, release no more than 4,000 cfs if hydrology remains dry.

The Keswick release schedule shall follow this or a similar format, to be refined by the workgroup:

	October forecast based on EOS storage	50% hydrology		70% hydrology		90% hydrology	
		Projected storage MAF	Planned release CFS	Projected storage MAF	Planned release CFS	Projected storage MAF	Planned release CFS
Monthly average Keswick release	November						
	December						
	January						
	February						

Reclamation, in coordination with the work group, shall review updated hydrology and choose a monthly average release for every month (November, December, January, February), based on the release schedule. In the event that the updated hydrology indicates a very dry pattern and consequent likely reduction in storage, the work group may advise Reclamation to take additional actions, including export curtailments, if necessary to conserve storage

If there is a disagreement at the work group level, actions may be elevated to NMFS and resolved through the WOMT's standard operating procedures.

Rationale: It is necessary to be reasonably conservative with fall releases to increase the likelihood of adequate storage in the following year to provide cold water releases for winter-run. This action is intended to reduce adverse effects on each species without compromising the ability to reduce adverse effects on another species. A work group with biologists from multiple agencies will refine the flow schedule, providing operational certainty while allowing for real-time operational changes based on updated hydrology. Over time, it may be possible to develop a generic release schedule for these months, based on the experience of the work group.

Action I.2.2.C. Implementation and Exception Procedures for EOS Storage of 1.9 MAF or Below

If the EOS storage is at or below 1.9 MAF, then Reclamation shall:

1) In early October, reduce Keswick releases to 3,250 cfs as soon as possible, unless higher releases are necessary to meet temperature compliance points (see action I.2.3).

2) Starting in early October, if cool weather prevails and temperature control does not mandate higher flows, curtail discretionary water deliveries (including, but not limited to agricultural rice decomposition deliveries) to the extent that these do not coincide with temperature management for the species. It is important to maintain suitable

temperatures targeted to each life stage. Depending on air and water temperatures, delivery of water for rice decomposition, and any other discretionary purposes at this time of year, may coincide with the temperature management regime for spring-run and fall-run. This action shall be closely coordinated with NMFS, USFWS, and CDFG.

3) By November 1, submit to NMFS storage projections based on 50 percent, 70 percent, and 90 percent hydrology through February. In coordination with NMFS, Reclamation shall: (1) develop a monthly average Keswick release schedule similar in format to that in Action I.2.2.B, based on the criteria below and including actions specified below; and (2) review updated hydrology and choose a monthly average release for every month, based on the release schedule. November releases shall be based on a 90 percent hydrology estimate.

Criteria and actions:

1) Keswick releases shall be managed to improve storage and maintained at 3,250 cfs unless hydrology improves.

2) November monthly releases will be based on 90 percent hydrology.

3) Consider fall-run needs through January as per CVPIA AFRP guidelines, including stabilizing flows to keep redds from dewatering.

4) Continue to curtail discretionary agricultural rice decomposition deliveries to the extent that these do not coincide with temperature management for the species, or impact other ESA-listed species. It is important to maintain suitable temperatures targeted to each life stage. Depending on air and water temperatures, delivery of water for rice decomposition may coincide with the temperature management regime for spring-run and fall-run. This action shall be closely coordinated with NMFS. USFWS, and CDFG.

5) If operational changes are necessary to meet Delta outflow, X2, or other legal requirements during this time, then:

    a) CVP/SWP Delta combined exports shall be curtailed to 2,000 cfs if necessary to meet legal requirements while maintaining a 3,250 cfs Keswick release (or other planned release based on biological needs of species); and
    b) if it is necessary to curtail combined exports to values more restrictive than 2000 cfs in order to meet Delta outflow, X2, or other legal requirements, then Reclamation and DWR shall, as an overall strategy, first, increase releases from Oroville or Folsom; and
    c) in general, Reclamation shall increase releases from Keswick as a last resort.
    d) Based on updated monthly hydrology, this restriction may be relaxed, with NMFS' concurrence.

6) If the hydrology and storage have not improved by January, additional restrictions apply – see Action I.2.4.

Rationale: Per actions I.2.3 and I.2.4 below, Reclamation is required to meet 1.9 MAF EOS. The BA's CALSIM modeling shows that during a severe or extended drought, 1.9 EOS storage may not be achievable. In this circumstance, Reclamation should take additional steps in the fall and winter months to conserve Shasta storage to the maximum extent possible, in order to increase the probability of maintaining cold water supplies necessary for egg incubation for the following summer's cohort of winter-run.

Assessment of the hydrologic record and CALSIM modeling shows that operational actions taken during the first year of a drought sequence are very important to providing adequate storage and operations in subsequent drought years. The biological effects of an extended drought are particularly severe for winter-run. Extended drought conditions are predicted to increase in the future in response to climate change. While it is not possible to predict the onset of a drought sequence, in order to ensure that project operations avoid jeopardizing listed species, Reclamation should operate in any year in which storage falls below 1.9 MAF EOS as potentially the first year of a drought sequence. The CVP storage system is likely to recover more quickly in the winter and spring months if additional storage conservation measures are taken in the fall and winter.

The curtailments to discretionary rice decomposition deliveries and combined export curtailment of 2,000 cfs are necessary to conserve storage when EOS storage is low. These actions were developed through an exchange of information and expertise with Reclamation operators.

This action is consistent with comments from the Calfed Science Peer Review panel. That panel recommended that Shasta be operated on a two-year (as opposed to single year) hydrologic planning cycle and that Reclamation take additional steps to incorporate planning for potential drought and extended drought into its operations.

Action I.2.3. February Forecast; March – May 14 Keswick Release Schedule (Spring Actions)

Objective: To conserve water in Shasta Reservoir in the spring in order to provide sufficient water to reduce adverse effects of high water temperature in the summer months for winter-run, without sacrificing carryover storage in the fall.

Actions:

1) Reclamation shall make its February 15 forecast of deliverable water based on an estimate of precipitation and runoff within the Sacramento River basin at least as conservative as the 90 percent probability of exceedence. Subsequent updates of water

delivery commitments must be based on monthly forecasts at least as conservative as the 90 percent probability of exceedence.

a) Reclamation shall provide the draft February forecast, and a projection of temperature management operations for the summer months, to NMFS no later than seven business days after receipt of the official DWR runoff forecast.
b) NMFS shall be provided at 3 three business days to review the draft forecast.
c) NMFS shall review the draft February forecast to determine whether the predicted delivery schedule is likely to leave sufficient water for temperature management to meet ESA requirements.
d) NMFS shall provide a written evaluation to Reclamation prior to Reclamation making the first allocation announcements and for each subsequent month for discretionary contract deliveries.
e) Reclamation shall manage releases from Keswick consistent with the February forecast and subsequent monthly hydrology updates.

2) Reclamation shall make releases to maintain a temperature compliance point not in excess of 56 degrees between Balls Ferry and Bend Bridge from April 15 through May 15.

Action I.2.3.A Implementation Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that Balls Ferry Temperature Compliance Point and 2.2 MAF EOS are Both Achievable

NMFS will review the draft February forecast to determine whether both a temperature compliance point at Balls Ferry during the temperature control season (May – October), and EOS storage of at least 2.2 MAF, is likely to be achieved. If both are likely, then Reclamation shall announce allocations and operate Keswick releases in March, April, and May consistent with its standard plan of operation. Preparation of a separate Keswick release schedule is not necessary in these circumstances.

Rationale: The 90 percent forecast is a conservative approach for assessing the potential to meet both the Balls Ferry TCP and 2.2 MAF EOS performance goals. If both of these performance goals are projected to be met at the time of the February forecast, then no restrictions on allocations due to this suite of actions are necessary.

Action I.2.3.B Implementation Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that Only Balls Ferry Compliance or 2.2 MAF EOS, but Not Both, Is Achievable

1) On or before February 15, Reclamation shall reduce Keswick releases to 3,250 cfs, unless NMFS concurs on an alternative release schedule. This reduction shall be maintained until a flow schedule is developed per procedures below.

2) In coordination with NMFS, by March 1, Reclamation shall develop an initial monthly Keswick release schedule, based on varying hydrology of 50 percent, 70 percent, and 90 percent (similar in format to the fall and winter action implementation procedures – see table above). These schedules shall be used as guidance for monthly updates and consultations.

3) Based on this guidance, Reclamation shall consult with NMFS monthly on Keswick releases. Reclamation shall submit a projected forecast, including monthly average release schedules and temperature compliance point to NMFS every month, within 7 business days of receiving the DWR runoff projections for that month. Within 3 business days of receiving this information from Reclamation, NMFS will review the draft schedule for consistency with the criteria below and provide written recommendations to Reclamation.

4) The initial monthly Keswick release schedule, and subsequent monthly updates, shall be developed based on the following criteria and including the following actions:

   a) Maintain minimum monthly average flows necessary to meet nondiscretionary delivery obligations and legal requirements.
   b) Provide for flow-related biological needs of spring life stages of all species covered by this Opinion in the Sacramento River and Delta, to the greatest extent possible.
   c) If operational changes are necessary to meet Delta outflow, X2, or other legal requirements during this time, then:

      - CVP/SWP Delta combined exports shall be curtailed to 2,000 cfs if necessary to meet legal requirements while maintaining a 3,250 cfs Keswick Dam release (or other planned release based on biological needs of species); and
      - if it is necessary to curtail combined exports to values more restrictive than 2000 cfs in order to meet Delta outflow, X2, or other legal requirements, then Reclamation and DWR shall, as an overall strategy, first, increase releases from Oroville or Folsom Dam; and
      - in general, Reclamation shall increase releases from Keswick Dam as a last resort.
      - Based on improvements in updated monthly hydrology, this restriction may be relaxed, with NMFS' concurrence.

Rationale: It is necessary to manage storage for potential dry years, to reduce adverse effects on winter-run egg incubation in summer months, and on spring-run in fall months. According to information provided by Reclamation, the hydrology is too variable this time of year to provide for a meaningful 3-month release schedule. Instead, monthly consultations between NMFS and Reclamation are needed to ensure that operations are based on biological criteria.

Action I. 2.3. C. Drought Exception Procedures if February Forecast, Based on 90 Percent Hydrology, Shows that Clear Creek Temperature Compliance Point or 1.9 MAF EOS Storage is Not Achievable

Reclamation shall follow all procedures immediately above (Action I.2.3.B) and, in addition, shall:

1) By March 1, provide a contingency plan with a written justification that all actions within Reclamation's authorities and discretion are being taken to preserve cold water at Shasta Reservoir for the protection of winter-run.

2) The contingency plan shall also, at a minimum, include the following assessments and actions:

   a) Relaxation of Wilkins Slough navigation criteria to at most 4,000 cfs.
   b) An assessment of any additional technological or operational measures that may be feasible and may increase the ability to manage the cold water pool.
   c) Notification to State Water Resources Control Board that meeting the biological needs of winter-run and the needs of resident species in the Delta, delivery of water to nondiscretionary Sacramento Settlement Contractors, and Delta outflow requirements per D-1641, may be in conflict in the coming season and requesting the Board's assistance in determining appropriate contingency measures, and exercising their authorities to put these measures in place.

3) If, during the temperature control season, a Clear Creek TCP on the Sacramento River cannot be achieved, then Reclamation shall bypass power at Shasta Dam if NMFS determines a bypass is necessary for preserving the cold water pool. This power by-pass may be necessary to maintain temperature controls for winter-run, or later in the temperature season, for spring-run.

Rationale: In these circumstances, there is a one-in-ten likelihood that minimal requirements for winter-run egg survival will not be achieved due to depletion of the cold water pool, resulting in temperature-related mortality of winter-run and, in addition, most likely contributing to temperature-related mortality of spring-run spawning in the fall. This is a conservative forecast, since there is a 90 percent probability that conditions will improve. However, the effects analysis in this Opinion concludes that these poor conditions could be catastrophic to the species, potentially leading to a significant reduction in the viability of winter-run. Delta objectives (salinity, X2, E/I ratio, OMR flow restrictions for both smelt and salmon) are also controlling at this time of year. There is potential for conflict between the need to maintain storage at Shasta and other legal and ecological requirements. Consequently, it is necessary to immediately limit releases from Shasta and develop a contingency plan.

Notification to the State Water Resources Control Board (SWRCB) is essential. Sacramento Settlement Contract withdrawal volumes from the Sacramento River can be quite substantial during these months. The court has recently concluded that Reclamation does not have discretion to curtail the Sacramento Settlement contractors to meet Federal ESA requirements. Therefore, NMFS is limited in developing an RPA that minimizes take to acceptable levels in these circumstances. Consequently, other actions are necessary to avoid jeopardy to the species, including fish passage at Shasta Dam in the long term.

Separate from this consultation, NMFS will work with the SWRCB to determine whether contingency plans within the Board's authority are warranted, and to assist in developing such plans that will allow Reclamation to meet ESA requirements. The incidental take statement for this Opinion also provides limitations of ESA incidental take coverage for Settlement Contractors under the terms of this Opinion.

Action 1.2.4 May 15 Through October Keswick Release Schedule (Summer Action)

Objective: To manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts. To the extent feasible, manage for suitable temperatures for naturally spawning fall-run.

Action: Reclamation shall develop and implement an annual Temperature Management Plan by May 15 to manage the cold water supply within Shasta Reservoir and make cold water releases from Shasta Reservoir and Spring Creek to provide suitable temperatures for listed species, and, when feasible, fall-run.

Reclamation shall manage operations to achieve daily average water temperatures in the Sacramento River between Keswick Dam and Bend Bridge as follows:

1) Not in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of winter-run, and not in excess of 56°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31 for protection of mainstem spring run, whenever possible.

2) Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

3) As part of the adaptive management process, and in coordination with NMFS, by March 2010, Reclamation shall fund an independent modeler to review these procedures and the recommendations of the Calfed Science Panel report on temperature management and recommend specific refinements to these procedures to achieve optimal temperature management, with due consideration of the Calfed Science panel's recommendations

(Deas *et al*., 2009) regarding temperature management. Upon written concurrence of NMFS, refinements to the implementation procedures for this action suite, based on the independent contractor's report, may be adopted and implemented.

Implementation Procedures: Reclamation shall take the following steps to develop an annual Temperature Management plan:

1) By April 15, Reclamation shall develop and submit to NMFS both 50 percent and 90 percent forecasts, consistent with its draft plan of summer operations. Reclamation shall model two complete runs for each forecast, one with an upstream TCP and one with a downstream TCP. Together, Reclamation will present four risk-management options to NMFS for review. EOS Storage will be projected for each of the four runs. If it is very wet or very dry, there will be fewer options to present to NMFS.
2) NMFS will provide comments within five business days to Reclamation, recommending that Reclamation either: (1) operate to one of the options; or (2) develop an alternative operations plan necessary to meet reasonably attainable preferred TCP and EOS storage.
3) Within five business days of receiving NMFS' recommendations, and based on NMFS' comments, Reclamation will develop an operations plan with specific monthly average Keswick releases to attain both TCP from May 15 through the EOS and EOS storage, and submit the plan to NMFS for concurrence.
4) By May 15, Reclamation and NMFS shall jointly submit a final Temperature Management Plan to meet the SWRCB 90-5 requirements using the SRTTG. From May 15 through October 31, the SRTTG shall track implementation of this plan, and shall refine it based real-time information, including run timing, location of redds, air and surface water temperature modeling, and projected versus actual extent of the cold water pool. Any disagreement at the work group level regarding how to implement or modify the plan will be elevated to NMFS and resolved through WOMT standard operating procedures.

Rationale: Depending on hydrology and air temperature, from May through October, it is necessary to use the cold water pool in Shasta Reservoir to provide cold water releases to maintain suitable water temperatures for listed anadromous fish below Shasta. Without access to the cold water pool, suitable temperatures for egg incubation are not attainable. Preparation of an annual Temperature Management Plan allows Reclamation, in consultation with NMFS, to achieve optimal cold water management in a given year. Temperature management requires tradeoffs between extending the range of suitable habitat by moving the compliance point downstream from Balls Ferry, and conserving EOS storage. The storage level at the EOS is important to manage the risk of unsuitably warm water temperatures for winter-run in the following summer. Maintaining suitable temperatures in September and October is also important to minimize adverse effects of project operations to main stem Sacramento River spring-run. Fall-run, a non-listed species that is important as a prey base for Southern Resident Killer Whale, also benefits from suitable temperatures in the Fall.

Development of 2 to 4 options for temperature management, prior to finalizing a plan allows for meaningful discussion of appropriate risk management strategies in a given year, based on timely hydrologic and biological considerations. Important factors differ from year to year, and need to be considered in operations planning. They include the projected size of the winter-run year class (and thus the extent of habitat needed); timing and location of spawning and redds based on aerial surveys; the extent of the cold water pool, given air temperatures; and operation of the Temperature Control Device to provide optimal use of the cold water pool. Preparation of a draft plan also allows for iterative planning and feedback. Operations can be tailored each year to achieve the optimal approach to temperature management to maintain viable populations of anadromous fish, based on the best available information.

The Calfed Science Program peer review report on temperature management emphasized the importance of refining temperature management practices in the long term and included recommendations for doing so. The requirement to hire an independent contractor to recommend specific refinements to the procedures in this RPA responds to these recommendations.

Action I.2.5. Winter-Run Passage and Re-Introduction Program at Shasta Dam

See Fish Passage Program, Action V

Action I.2.6. Restore Battle Creek for Winter-Run, Spring-Run, and CV Steelhead

Objective: To partially compensate for unavoidable adverse effects of project operations by restoring winter-run and spring-run to the Battle Creek watershed. A second population of winter-run would reduce the risk of extinction of the species from lost resiliency and increased vulnerability to catastrophic events.

Description of Action: Reclamation shall direct discretionary funds to implement the Battle Creek Salmon and Steelhead Restoration Project. Phase 1A funding is currently allocated through various partners and scheduled to commence in Summer 2009 (Reclamation 2008c). DWR shall direct discretionary funds for Phase 1B and Phase 2, consistent with the proposed amended Delta Fish Agreement by December 31 of each year, Reclamation and DWR will submit a written report to NMFS on the status of the project, including phases completed, funds expended, effectiveness of project actions, additional actions planned (including a schedule for further actions), and additional funds needed. The Battle Creek Salmon and Steelhead Restoration Project shall be completed no later than 2019.

Rationale: Modeling projections in the BA show that adverse effects of ongoing project operations cannot be fully minimized. Severe temperature-related effects due to project operations will occur in some years. This RPA includes an exception procedure in anticipation of these occurrences (see Action I.2.2). Establishing additional populations of winter-run is critical to stabilize the high risk of extinction resulting from the proposed action

on the only existing population of this species. $26 million has been identified for this project in the American Recovery and Reinvestment Act of 2009.

Action Suite I.3. Red Bluff Diversion Dam (RBDD) Operations

Objectives: Reduce mortality and delay of adult and juvenile migration of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon caused by the presence of the diversion dam and the configuration of the operable gates. Reduce adverse modification of the passage element of critical habitat for these species. Provide unimpeded upstream and downstream fish passage in the long term by raising the gates year-round, and minimize adverse effects of continuing dam operations, while pumps are constructed replace the loss of the diversion structure.

Action I.3.1. Operations after May 14, 2012: Operate RBDD with Gates Out

Action: No later than May 15, 2012, Reclamation shall operate RBDD with gates out all year to allow unimpeded passage for listed anadromous fish. If the Red Bluff Alternative Intake Structure is not anticipated to be operational by May 15, 2012, Reclamation may submit a request to NMFS, no later than January 31, 2012, to close the gates from June 15 to September 1, 2012. This request must document that all milestones for construction of the alternative pumping plant have been met and that all other conservation measures (see below) have been implemented.

Rationale: RBDD impedes and delays upstream migration of adult winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon. It also impedes and delays downstream passage of juveniles of the same species. It adversely modifies critical habitat for these species by impairing important mainstem passage. Pumps can be used to deliver water currently made available by placing gates in the river, and $109 million has been identified in the recent American Recovery and Reinvestment Act of 2009 for the Red Bluff Pumping Plant.

Action I.3.2. Interim Operations

Action: Until May 14, 2012, Reclamation shall operate RBDD according to the following schedule:

- September 1 - June 14: Gates open. No emergency closures of gates are allowed.
- June 15 - August 31: Gates may be closed at Reclamation's discretion, if necessary to deliver water to TCCA.

Rationale: Having gates out until June 15 is necessary for winter-run, spring-run and green sturgeon adult passage to spawning habitat. TCCA can withdraw 465 cfs without the gates in the river. Their water demand typically reaches 800 cfs by June 15, therefore, TCCA will need supplemental pumping capacity to meet water demand until June 15. NMFS has

consulted with Reclamation separately on the effects of an interim pumping operation. Implementation of these improvements to passage conditions at RBDD, in conjunction with several other conservation and research measures proposed by TCCA (Appendix 2-B), is expected to reduce the effects of continuing (for the next three years) the (modified) operations of RBDD to a level that will not reduce the likelihood of survival and recovery of these ESUs and DPSs.

Action I.3.3. Interim Operation for Green Sturgeon

Objective: Allow passage of green sturgeon during interim operations.

Action: When gates are in, Reclamation shall retain a minimum 18-inch opening under the gates that are open, to allow safe downstream passage of adult green sturgeon. The 18-inch opening may be modified to 12 inches by the RBDD technical team if necessary to maintain the structural integrity of the dam and/or adequate attraction flows for salmonids at the fish ladders, or in consideration of other real-time fish migratory issues.

Rationale: Twelve to 18 inches is the estimated minimum gate opening that would allow adult green sturgeon to pass downstream underneath the RBDD gates uninjured.

Action I.3.4: Measures to Compensate for Adverse Effects of Interim Operations on Green Sturgeon

Objective: Offset short-term effects to green sturgeon due to interim gate operations by investing in geographically specific research needed to determine green sturgeon life history and recovery needs.

Action: Reclamation shall continue ongoing funded research to characterize green sturgeon populations in the upper Sacramento River Basin, their movements, and habitat usage, as planned through fiscal year 2009. In addition, Reclamation (or TCCA) shall convene a technical team, including representatives from NMFS, CDFG, USFWS, Corps, the University of California at Davis (UCD), and other cooperators, to review studies and results and coordinate research needs for green sturgeon. Reclamation and/or TCCA shall provide the necessary funding to insure that research will continue to be conducted in a coordinated and cooperative manner with the express intent of fully implementing the research projects described in the UCD proposal in Appendix 2-B to this Opinion.

Rationale: The exact timing of spawning migration for green sturgeon is not known, and during interim operations the potential remains for late arriving green sturgeon to be blocked by the dam after June 14. There is also a potential for post-spawn adult migrants and post-hatch juvenile migrants to be adversely affected, since they must pass downstream through the narrow clearance and high turbulence caused by the closed dam gates between June 14 and August 31.

Although the proposed studies will not directly benefit the green sturgeon that will be impacted by the dam during the interim period before the gates are permanently lifted, these studies will greatly benefit the Southern DPS of green sturgeon as a whole by revealing important information that will improve their likelihood of survival and recovery over the long term. The studies will provide vital information on the life history and biological requirements of green sturgeon, which will allow NMFS to develop and implement a comprehensive and effective recovery plan for the DPS. By combining these long-term benefits to the survival and recovery of the Southern DPS of green sturgeon with the other significant improvements to habitat conditions required within this RPA (reduced gates-in periods, increased minimum gate openings, improved water temperature conditions for spawning and rearing, improved migration and rearing conditions in the lower river and Delta), the full implementation of this RPA is expected to offset the effects of continuing (for the next three years) the (modified) operations of RBDD to a level that will not reduce the likelihood of survival and recovery of the green sturgeon DPSs.

Action I.3.5. Measures to Compensate for Adverse Effects of Interim Operations on Spring-Run

Objective: Offset unavoidable short-term effects to spring-run from passage impediments of RBDD by restoring spring-run passage elsewhere in the Sacramento River system.

Action: Reclamation shall provide $500,000 for implementation of spring- run passage improvement projects in the Sacramento River. Appendix 2-B describes specific projects that may be implemented. By December 15, 2009, Reclamation shall provide NMFS with a prioritized list of projects from Appendix 2-B and an implementation schedule. Reclamation shall provide an annual report to NMFS on implementation and effectiveness of projects. Reclamation shall monitor and maintain these projects for five years.

Rationale: During interim operations, late arriving spring-run may be adversely affected by the dam after June 14. Construction and maintenance of the interim pumping facility also may have short-term adverse effects on spring-run.

The proposed passage restoration projects are likely to benefit the spring-run ESU as a whole by improving access to spawning habitat for some of the key populations within the ESU. Although the proposed improvements will not provide passage benefits to the small dependent populations that spawn upstream of RBDD, they will benefit the large independent populations that spawn in downstream tributaries. Passage improvements for the large independent population, in turn, will benefit the smaller populations throughout the Central Valley that depend on these larger populations to supplement their numbers and genetic diversity.

Action I.4. Wilkins Slough Operations

Objective: Enhance the ability to manage temperatures for anadromous fish below Shasta Dam by operating Wilkins Slough in the manner that best conserves the dam's cold water pool for summer releases.

Action: Reclamation shall convene the SRTTG to review past operational data, hydrology, and fisheries needs for Wilkins Slough. The SRTTG shall recommend Wilkins Slough minimum flows for anadromous fish in critically dry years, in lieu of the current 5,000 cfs navigation criterion. Recommendations shall be made to NMFS by December 1, 2009. The recommendations will be implemented upon NMFS' concurrence.

In years other than critically dry years**,** the need for a variance from the 5,000 cfs navigation criterion will be considered during the process of developing the Keswick release schedules (Action I.2.2-4).

Rationale: In some circumstances, maintaining the Wilkins Slough navigation channel at 5,000 cfs may be a significant draw on Shasta reservoir levels and affect the summer cold water pool necessary to maintain suitable temperatures for winter-run egg incubation and emergence. Reclamation has stated that it is no longer necessary to maintain 5,000 cfs for navigation (CVP/SWP operations BA, page 2-39). Operating to a minimal flow level based on fish needs, rather than on outdated navigational requirements, will enhance the ability to use cold-water releases to maintain cooler summer temperatures in the Sacramento River.

Action I.5. Funding for CVPIA Anadromous Fish Screen Program (AFSP)

Objective: To reduce entrainment of juvenile anadromous fish from unscreened diversions.

Action: Reclamation shall screen priority diversions as identified in the CVPIA AFSP, consistent with previous funding levels for this program. In addition, Reclamation/CVPIA Program shall evaluate the potential to develop alternative screened intakes that allow diverters to withdraw water below surface levels required by the antiquated Wilkins Slough navigation requirement criterion of 5,000 cfs.

Rationale: Approximately ten percent of 129 CVP diversions listed in Appendix D-1 of the CVP/SWP operations BA are currently screened. Of these, most of the largest diversions (greater than 250 cfs) have already been screened; however, a large number of smaller diversions (less than 250 cfs) remain unscreened or do not meet NMFS fish screening criteria (NMFS 1997; *e.g.*, CVP and SWP Delta diversions, Rock Slough diversion). The AFSP has identified priorities for screening that is consistent with the needs of listed fish species. Screening will reduce the loss of listed fish in water diversion channels. In addition, if new fish screens can be extended to allow diversions below 5,000 cfs at Wilkins Slough, then cold water can be conserved during critically dry years at Shasta Reservoir for winter-run and spring-run life history needs.

Action Suite I.6: Sacramento River Basin Salmonid Rearing Habitat Improvements

Objective: To restore floodplain rearing habitat for juvenile winter-run, spring-run, and CV steelhead in the lower Sacramento River basin, to compensate for unavoidable adverse effects of project operations. This objective may be achieved at the Yolo Bypass, and/or through actions in other suitable areas of the lower Sacramento River.

The suite of actions includes near term and long-term actions. The near-term action (Action I.6.2) is ready to be implemented and can provide rearing benefits within two years of issuing this Opinion. The long-term actions (Actions I.6.1, I.6.3, and I.6.4) require additional planning and coordination over a five- to ten-year time frame.

These actions are consistent with Reclamation's broad authorities in CVPIA to develop and implement these types of restoration projects. When necessary to achieve the overall objectives of this action, Reclamation and DWR, in cooperation with other agencies and funding sources, including the Delta Fish Agreement and any amendments, shall: (1) apply for necessary permits; (2) seek to purchase land, easements, and/or water rights from willing sellers; (3) seek additional authority and/or funding from Congress or the California State Legislature, respectively; and (4) pursue a Memorandum of Agreement with the Corps.

Similar actions addressing rearing and fish passage are under consideration in the BDCP development process and may ultimately satisfy the requirements in Actions I.6 and I.7. BDCP is scheduled to be completed by December 31, 2010.

Action I.6.1. Restoration of Floodplain Rearing Habitat

Objective: To restore floodplain rearing habitat for juvenile winter-run, spring-run, and CV steelhead in the lower Sacramento River basin. This objective may be achieved at the Yolo Bypass, and/or through actions in other suitable areas of the lower Sacramento River.

Action: In cooperation with CDFG, USFWS, NMFS, and the Corps, Reclamation and DWR shall, to the maximum extent of their authorities (excluding condemnation authority), provide significantly increased acreage of seasonal floodplain rearing habitat, with biologically appropriate durations and magnitudes, from December through April, in the lower Sacramento River basin, on a return rate of approximately one to three years, depending on water year type. In the event that this action conflicts with Shasta Operations Actions I.2.1 to I.2.3, the Shasta Operations Actions shall prevail.

Implementation procedures: By December 31, 2011, Reclamation and DWR shall submit to NMFS a plan to implement this action. This plan should include an evaluation of options to: (1) restore juvenile rearing areas that provide seasonal inundation at appropriate intervals, such as areas identified in Appendix 2-C or by using the Sacramento River Ecological Flow Tool (ESSA/The Nature Conservancy 2009) or other habitat modeling tools; (2) increase inundation of publicly and privately owned suitable acreage within the Yolo Bypass; (3)

modify operations of the Sacramento Weir (which is owned and operated by the Department of Water Resources) or Fremont Weir to increase rearing habitat; and (4) achieve the restoration objective through other operational or engineering solutions. An initial performance measure shall be 17,000-20,000 acres (excluding tidally-influenced areas), with appropriate frequency and duration. This measure is based on the work by Sommer *et al*. (2001, 2004) at Yolo Bypass and on recent analyses conducted for the BDCP process of inundation levels at various river stages. (BDCP Integration Team 2009).[4] The plan may include a proposal to modify this performance measure, based on best available science or on a scientifically based adaptive management process patterned after Walters (1997).

This plan also shall include: (1) specific biological objectives, restoration actions, and locations; (2) specific operational criteria; (3) a timeline with key milestones, including restoration of significant acreage by December 31, 2013; (4) performance goals and associated monitoring, including habitat attributes, juvenile and adult metrics, and inundation depth and duration criteria; (5) specific actions to minimize stranding or migration barriers for juvenile salmon; and (6) identification of regulatory and legal constraints that may delay implementation, and a strategy to address those constraints. Reclamation and DWR shall, to the maximum extent of their authorities and in cooperation with other agencies and funding sources, implement the plan upon completion, and shall provide annual progress reports to NMFS. In the event that less than one half of the total acreage identified in the plan's performance goal is implemented by 2016, then Reclamation and DWR shall re-initiate consultation.

The USFWS' Delta smelt biological opinion includes an action to restore 8,000 acres of tidal habitat for the benefit of Delta smelt. If these 8,000 acres also provide suitable rearing habitat for salmonids, they may be used in partial satisfaction of the objective of this action.

This action is not intended to conflict with or replace habitat restoration planning in the BDCP process.

Rationale: Rearing and migration habitats for all anadromous fish species in the Sacramento basin are in short supply. Project operations limit the availability of such habitats by reducing the frequency and duration of seasonal over-bank flows as a result of flood management and storage operational criteria. Recent evaluations on the Yolo Bypass and Cosumnes River have shown that juvenile Chinook salmon grow faster when seasonal floodplain habitats are available (Sommer *et al*. 2001, 2005; Jeffres *et al.* 2008). Sommer *et al.* (2005) suggest these floodplain benefits are reflected in adult return rates. This action is intended to offset unavoidable adverse effects to rearing habitat and juvenile productivity of winter-run, spring-run, and CV steelhead in the Sacramento River basin, by increasing available habitat that is inundated with the frequency and duration of suitable floodplain rearing habitats during December through April.

[4] The analyses assumed a notch in the Fremont Weir.

In high flow years (*e.g.*, similar to 1998), this action can be achieved solely by inundation of the Yolo Bypass. In other years, this action may be accomplished by a combination of actions such as increasing the year-to-year inundation frequency of existing floodplains such as portions of the Yolo Bypass, by restoring rearing habitat attributes to suitable areas, through restoration or enhancement of intertidal areas such as Liberty Island, creation or re-establishment of side channels, and re-created floodplain terrace areas.

Action I.6.2. Near-Term Actions at Liberty Island/Lower Cache Slough and Lower Yolo Bypass

Description of Action: By September 30, 2010, Reclamation and/or DWR shall take all necessary steps to ensure that an enhancement plan is completed and implemented for Liberty Island/Lower Cache Slough, as described in Appendix 2-C. This action shall be monitored for the subsequent five years, at a minimum, to evaluate the use of the area by juvenile salmonids and to measure changes in growth rates. Interim monitoring reports shall be submitted to NMFS annually, by September 30 each year, and a final monitoring report shall be submitted on September 30, 2015, or in the fifth year following implementation of enhancement actions. NMFS will determine at that time whether modification of the action or additional monitoring is necessary to achieve or confirm the desired results. This action shall be designed to avoid stranding or migration barriers for juvenile salmon.

Action I.6.3. Lower Putah Creek Enhancements

Description of Action: By December 31, 2015, Reclamation and/or DWR shall develop and implement Lower Putah Creek enhancements as described in Appendix 2-C, including stream realignment and floodplain restoration for fish passage improvement and multi-species habitat development on existing public lands. By September 1 of each year, Reclamation and/or DWR shall submit to NMFS a progress report towards the successful implementation of this action. This action shall not result in stranding or migration barriers for juvenile salmon.

Action I.6.4. Improvements to Lisbon Weir

Action: By December 31, 2015, Reclamation and/or DWR shall, to the maximum extent of their authorities, assure that improvements to the Lisbon Weir are made that are likely to achieve the fish and wildlife benefits described in Appendix 2-C. Improvements will include modification or replacement of Lisbon Weir, if necessary to achieve the desired benefits for fish. If neither Reclamation nor DWR has authority to make structural or operational modifications to the weir, they shall work with the owners and operators of the weir to make the desired improvements, including providing funding and technical assistance. By September 1 of each year, Reclamation and/or DWR shall submit to NMFS a report on progress toward the successful implementation of this action. Reclamation and DWR must assure that this action does not result in migration barriers or stranding of juvenile salmon.

Rationale for Actions I.6.2 to I.6.4: These actions have been fully vetted by CDFG and found to be necessary initial steps in improving rearing habitat for listed species in the lower Sacramento River basin. These improvements are necessary to off-set ongoing adverse effects of project operations, primary due to flood control operations. Additional descriptions of these actions are contained in the draft amendment to the Delta Fish Agreement (CVP/SWP operations BA appendix Y).

Action I.7. Reduce Migratory Delays and Loss of Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the Yolo Bypass

Objective: Reduce migratory delays and loss of adult and juvenile winter-run, spring-run, CV steelhead and Southern DPS of green sturgeon at Fremont Weir and other structures in the Yolo Bypass.

Description of Action: By December 31, 2011, as part of the plan described in Action I.6.1, Reclamation and/or DWR shall submit a plan to NMFS to provide for high quality, reliable migratory passage for Sacramento Basin adult and juvenile anadromous fishes through the Yolo Bypass. By June 30, 2012, Reclamation and/or DWR shall obtain NMFS concurrence and, to the maximum extent of their authorities, and in cooperation with other agencies and funding sources, begin implementation of the plan, including any physical modifications. By September 30, 2009, Reclamation shall request in writing that the Corps take necessary steps to alter Fremont Weir and/or any other facilities or operations requirements of the Sacramento River Flood Control Project or Yolo Bypass facility in order to provide fish passage and shall offer to enter into a Memorandum of Understanding, interagency agreement, or other similar mechanism, to provide technical assistance and funding for the necessary work. By June 30, 2010, Reclamation shall provide a written report to NMFS on the status of its efforts to complete this action, in cooperation with the Corps, including milestones and timelines to complete passage improvements.

Reclamation and/or DWR shall assess the performance of improved passage and flows through the bypass, to include an adult component for salmonids and sturgeon (*i.e.*, at a minimum, acoustic receivers placed at the head and tail of the bypass to detect use by adults).

Rationale: The Yolo Bypass and Fremont Weir has been a documented source of migratory delay to, and loss of, adult winter-run, spring-run, CV steelhead and Southern DPS of green sturgeon. The existing fish passage structure is inadequate to allow normal passage at most operational levels of the Sacramento River. The project agencies must work with the Corps, which owns and operates Fremont Weir, to achieve improvements for fish. Other structures within the Yolo Bypass, such as the toe drain, Lisbon Weir, and irrigation dams in the northern end of the Tule Canal, also can impede migration of adult anadromous fish. Additionally, stranding of juvenile salmonids and sturgeon has been reported in the Yolo Bypass in scoured areas behind the weir and in other areas. This action offsets unavoidable

project effects on adult migration and minimizes the direct losses from flood management activities associated with operations.

Rationale for 2011 amendment: The date "June 30, 2011" in the 2009 RPA was a typographical error, and corrected to "June 30, 2012." The action refers back to Action I.6.1, which has a requirement for a plan to be submitted to NMFS by December 31, 2011. NMFS concurrence on the plan cannot precede the date that the plan is due.

II. AMERICAN RIVER DIVISION

Introduction to American River Actions: The CV steelhead DPS is the only species addressed in this Opinion with a spawning population in the American River. The DPS includes naturally spawned steelhead in the American River (and other Central Valley stocks) and excludes steelhead spawned and reared at Nimbus Fish Hatchery. The in-river population is small, with observations of a few hundred adults returning to spawn in the American River each year. Limited observations made in 2003, 2004, 2005, and 2007 of whether in-river spawners were adipose fin-clipped or not indicate that some in-river spawners are of wild origin (Hannon and Deason 2008). This suggests that the listed stock has some ability to survive habitat conditions in the American River, Delta, and Ocean, even in their degraded state as described in preceding sections of this Opinion.

The in-river population is likely entirely made up of Nimbus Fish Hatchery steelhead or their descendents. Early Nimbus Fish Hatchery broodstock included naturally produced fish from the American River and stocks from the Washougal (Washington), Siletz (Oregon), Mad, Eel, Sacramento and Russian rivers, with the Eel River stock being the most heavily used (Staley 1976, McEwan and Jackson 1996).

Even though the American River steelhead population is small and is entirely influenced by hatchery fish with out-of-basin genetics, NMFS views the population as being important to the survival and recovery of the species. CV TRT shares this view by recommending that, "*every extant population be viewed as necessary for the recovery of the ESU"* (Lindley *et al.* 2007). In addition, the steelhead population has presumably become somewhat locally adapted to the American River, and it has potential to substantially contribute to the viability of the DPS if water, habitat, and hatchery management efforts are coordinated and directed at achieving such a goal.

Key proposed project-related stressors include: (1) the provision of water temperatures warmer than steelhead life stage-specific requirements; (2) flow fluctuations that dewater redds, strand fry, and isolate fry and juveniles in off-channel pools where they are vulnerable to both predation and exposure to lethal and sub-lethal water temperatures; and (3) low flows limiting the availability of quality rearing habitat including predator refuge habitat.

The most influential baseline stressor to steelhead within the American River Division is the presence of Nimbus and Folsom dams, which block steelhead from all of their historic spawning

and rearing habitat. This Opinion concludes that both increased water demands and effects of climate change will lead to further deterioration of suitable habitat conditions, including increased temperatures and decreased flows. Therefore, a passage program to expand the range of the American River steelhead population above Folsom Dam is necessary. If feasible, American River steelhead should be provided access to their full historic range. Given the long-term duration associated with the fish passage actions (see Fish Passage Program below, in Action V), it is necessary to plan and implement actions targeted at improving steelhead habitat below Nimbus Dam. NMFS concludes that coordinated management in four realms - water operations and associated structures, American River habitat, Nimbus Fish Hatchery operations, and in-river harvest – will substantially lower the extinction risk of American River steelhead

Action II.1. Lower American River Flow Management

Objective: To provide minimum flows for all steelhead life stages.

Action: Implement the flow schedule specified in the Water Forum's[5] Flow Management Standard (FMS), which is summarized in Appendix 2-D of this Opinion. The FMS flow schedule has been developed by the Water Forum, Reclamation, USFWS, NMFS, and CDFG in order to establish required minimum flows for anadromous salmonids in the lower American River. The flow schedule specifies minimum flows and does not preclude Reclamation from making higher releases at Nimbus Dam.

Reclamation shall ensure that flow, water temperature, steelhead spawning, and steelhead rearing monitoring is conducted annually in order to help inform the ARG process and to evaluate take associated with flow fluctuations and warm water temperatures. Steelhead monitoring surveys should follow the objectives and protocols specified in the FMS Monitoring and Evaluation Program relating to steelhead spawning and rearing.

Implementation procedures: Reclamation shall convene the American River Group (ARG), comprised of representatives from Reclamation, NMFS, USFWS, CDFG and the Water Forum, to make recommendations for management within the constraints of the FMS. If there is a lack of consensus, ARG shall advise NMFS, and NMFS will make a recommendation to the WOMT for a decision.

Rationale: Reclamation operates Folsom Dam and Reservoir to provide water for irrigation, municipal and industrial uses, hydroelectric power, recreation, water quality, flood control, and fish protection. Reclamation operates Folsom Dam and Reservoir under a state water right permit and fish protection requirements that were adopted in 1958 as SWRCB Decision 893 (D-893). This decision allows flows at the mouth of the American River to fall as low as 250 cfs from January through mid-September, with a minimum of 500 cfs required between September 15 and December 31.

[5] In September 1993, the Water Forum, a diverse group of business and agricultural leaders, citizens groups, environmentalists, water managers, and local governments in the Sacramento Region, was formed to evaluate water resources and future water supply needs of the Sacramento metropolitan region.

Biological, socioeconomic, legal, and institutional conditions have changed substantially since the SWRCB adopted D-893 in 1958. For example, D-893 does not address requirements of the CVPIA, the 1995 Bay Delta Plan, or previous Opinions to protect Central Valley anadromous salmonids. The SWRCB, Reclamation and many diverse stakeholders (*e.g.*, Water Forum) involved in various American River actions have agreed that the conditions specified in D-893 are not sufficiently protective of the fishery resources within the lower American River.

The flow schedule specified in Appendix 2-D was developed to require more protective minimum flows in the lower American River in consideration of the river's aquatic resources, particularly steelhead and fall-run.

The monitoring called for in this RPA action including flow, water temperature, steelhead spawning, and steelhead rearing monitoring is necessary for the ARG to responsibly carry out this mission. In addition, this monitoring is necessary to evaluate take associated with American River Division operations.

Action II.2. Lower American River Temperature Management

Objective: Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River.

Action: Each year, Reclamation shall prepare a draft Operations Forecast and Temperature Management Plan based on forecasted conditions and submit the draft Plan to NMFS for review by May 1 of each year. The information provided in the Operations Forecast will be used in the development of the Temperature Plan. The draft plan shall contain: (1) forecasts of hydrology and storage; (2) a modeling run or runs, using these forecasts, demonstrating that the temperature compliance point can be attained (see Coldwater Management Pool Model approach in Appendix 2-D); (3) a plan of operation based on this modeling run that demonstrates that all other non-discretionary requirements are met; and (4) allocations for discretionary deliveries that conform to the plan of operation. Reclamation shall use an iterative approach, varying proposed operations, with the objective to attain the temperature compliance point at Watt Avenue Bridge. Within ten calendar days of receiving the draft Temperature Plan, NMFS will provide a written review of this plan for the purpose of determining whether requirements in this Opinion are likely to be met. Reclamation shall produce a final plan prior to May 15 deliveries and implement the plan upon finalization. Reclamation may update the plan every month based on hydrology and must seek NMFS' concurrence on proposed deviations from the plan that may reduce the likelihood that the temperature objective will be met.

Temperature Requirement: Reclamation shall manage the Folsom/Nimbus Dam complex and the water temperature control shutters at Folsom Dam to maintain a daily average water temperature of 65°F or lower at Watt Avenue Bridge from May 15 through October 31, to

provide suitable conditions for juvenile steelhead rearing in the lower American River. If this temperature is exceeded for three consecutive days, or is exceeded by more than 3°F for a single day, Reclamation shall notify NMFS in writing and will convene the ARG to make recommendations regarding potential cold water management alternatives to improve water temperature conditions for fish, including potential power bypasses. If there is a lack of consensus on actions to be taken, the ARG shall advise NMFS and be elevated through the WOMT standard operating procedures.

Exception: When preparing the Operations Forecast and Temperature Management Plan, Reclamation may submit to NMFS a written determination that, after taking all actions within its authorities, it is unlikely to meet the above temperature requirement. This determination must be supported by specific iterative modeling techniques that vary allocations and delivery schedules such as application of the Coldwater Management Pool model (see Appendix 2-D). In the event that Reclamation determines that other nondiscretionary requirements (*e.g.*, D-1641 or requirements of the USFWS' Delta smelt biological opinion) conflict with attainment of the temperature requirement, Reclamation will convene the ARG to obtain recommendations. If consensus cannot be achieved within the ARG, the ARG shall advise NMFS, and NMFS will make a recommendation to the WOMT, per standard operating procedures.

During the May 15 to October 31 period, when the 65°F temperature requirement cannot be met because of limited cold water availability in Folsom Reservoir, then the target daily average water temperature at Watt Avenue may be increased incrementally (*i.e.*, no more than one degree Fahrenheit every 12 hours) to as high as 68°F.

The priority for use of the lowest water temperature control shutters at Folsom Dam shall be to achieve the water temperature requirement for steelhead, and thereafter may also be used to provide cold water for fall-run spawning.

Rationale: As demonstrated in section 6.4 of this Opinion, steelhead are frequently exposed to water temperatures warmer than required for juvenile rearing, resulting in reduced fitness as is evident through the expression of visible thermal stress symptoms (*i.e.*, bacterial inflammations). This thermal stress decreases steelhead immune system function and increases steelhead vulnerability to other sources of sub-lethal and lethal effects such as disease and predation. Monitoring of juvenile steelhead conducted by CDFG showed that bacterial inflammation was prevalent in steelhead throughout the river and the frequency of its occurrence increased as the duration of exposure to water temperatures over 65°F increased. The 65°F or lower daily average water temperature target was identified based on CDFG's monitoring as well as published scientific literature. Based on past convention of the ARG, the temperature compliance point is maintained at Watt Avenue Bridge, even though suitable rearing habitat is between Watt Avenue and Nimbus Dam.

Action II.3. Structural Improvements

Objective: Improve the ability to manage the cold water pool to provide suitable temperatures for listed fish through physical and structural improvements at the dams.

Action: Reclamation shall evaluate physical and structural modifications that may improve temperature management capability, as detailed below. Upon completion of the evaluation, Reclamation shall select the most promising projects and shall submit, by June 30th 2010, a proposed plan to NMFS to implement selected projects. Reclamation shall seek NMFS' concurrence that the proposed projects are likely to be effective in reducing adverse effects of warm water temperatures on listed fish. With NMFS' concurrence, Reclamation shall implement selected projects by December 15, 2012.

Modifying the following structures may substantially improve the ability to manage temperature in the Lower American River to reduce adverse effects of unsuitably warm water on listed species. The comparative benefits and costs of alternative modifications that will achieve objectives have not been fully analyzed. Reclamation shall analyze alternatives for each of the objectives listed below and shall implement the most effective alternative(s) for each objective:

1) **Folsom Dam temperature control device.** The objective of this action is to improve access to and management of Folsom Reservoir's cold water pool. Alternatives include enhancement of the existing shutters, replacement of the shutter system, and construction of a device to access cold water below the penstocks. If neither Reclamation nor DWR has authority to make structural or operational modifications to the control device, they shall seek to enter into an MOU with the Army Corps of Engineers to utilize their existing authorities.

2) **Cold water transport through Lake Natoma.** The objective of this action is to transfer cold water from Folsom Dam to Nimbus Dam with minimal increase in temperature. Alternatives include dredging, construction of temperature curtains or pipelines, and changes in Lake Natoma water surface elevation.

3) **El Dorado Irrigation District Temperature Control Device (EID TCD).** The objective of this action is to conserve cold water in Folsom Lake. Alternative intake structures have been analyzed by EID. The most effective device for conserving cold water should be constructed. If neither Reclamation nor DWR has authority to make structural or operational modifications to the EID TCD, they shall work with the owners and operators of the TCD to make the desired improvements, including providing funding and technical assistance

4) **Temperature Management Decision-Support Tools.** The objective of this action is to provide effective tools to make transparent temperature management decisions.

Alternatives include decision impact analyses, regular analysis of a broad array of operational scenarios, improved operations group processes, and monitoring.

Rationale: Maintaining suitable water temperatures for all life history stages of steelhead in the American River is a chronic issue because of operational (*e.g.*, Folsom Reservoir operations to meet Delta water quality objectives and demands and deliveries to M&I users in Sacramento County) and structural (*e.g.*, limited reservoir water storage and coldwater pool) factors. Increased water demand and climate change will lead to further deterioration of suitable habitat conditions, including increased temperatures. Action II.2 provides for a temperature management plan to minimize operational effects to steelhead using current technology. However, the current technology is out-dated resulting in less than optimal ability to access and fully utilize cold water in any given hydrology or ambient temperature regime. Alternative technologies have been studied previously, but not funded or implemented. Because of the significant temperature related effects that will persist despite implementation of Action II.2, all feasible technological options should be pursued. These technological actions will increase the likelihood that temperate control points will be attained, as prescribed in Action II-2, and therefore American River water temperatures will be suitable for steelhead more frequently.

Action II.4. Minimize Flow Fluctuation Effects

Objective: Reduce stranding and isolation of juvenile steelhead through ramping protocols.

Action: The following flow fluctuation objectives shall be followed:

1) From January 1 through May 30, at flow levels <5,000 cfs, flow reductions shall not exceed more than 500 cfs/day and not more than 100 cfs per hour.

2) From January 1 through May 30, Reclamation shall coordinate with NMFS, CDFG, and USFWS to fund and implement monitoring in order to estimate the incidental take of salmonids associated with reductions in Nimbus Dam releases.

3) Minimize the occurrence of flows exceeding 4,000 cfs throughout the year, except as may be necessary for flood control or in response to natural high precipitation events.

Rationale: Flow fluctuations in the lower American River have been documented to result in steelhead redd dewatering and isolation (Hannon *et al.*, 2003, Hannon and Deason 2008), fry stranding, and fry and juvenile isolation (Water Forum 2005a). By limiting the rate of flow reductions, the risk of stranding and isolating steelhead is reduced. Two lower American River habitat evaluations indicate that releases above 4,000 cfs inundate several pools along the river that are isolated at flows below this threshold (CDFG 2001, Hall and Healey 2006). Thus, by maintaining releases below 4,000 cfs the risk of isolating juvenile steelhead is reduced.

Action II.5. Fish Passage at Nimbus and Folsom Dams

Objective: Provide access for steelhead to historic cold water habitat above Nimbus and Folsom dams.

Action: See Fish Passage Program, Action V.

Rationale: The effects analysis in this Opinion leads to the conclusion that steelhead will continue to be vulnerable to serious effects of elevated temperatures in most years and particularly in dry and critically dry years, even if actions are taken to improve temperature management. The frequency of these occurrences is expected to increase with climate change and increased water demands. Therefore, it is essential to evaluate options for providing steelhead to access their historic cold water habitat above Nimbus and Folsom dams and to provide access if feasible.

Action Suite II.6. Implement the Following Actions to Reduce Genetic Effects of Nimbus and Trinity River Fish Hatchery Operations

Objective of Actions II.6.1-3: The following actions are identified to offset project effects related to Nimbus Fish Hatchery by reducing introgression of out-of-basin hatchery stock with wild steelhead populations in the Central Valley, including the American River population and other populations in the Sacramento River system (Garza and Pearse 2008). In addition, actions are necessary at both Nimbus and Trinity River fish hatcheries to increase diversity of fall-run production, in order to increase the likelihood of prey availability for Southern Residents and reduce adverse effects of hatchery fall-run straying on genetic diversity of natural fall-run and spring-run.

Action II.6.1. Preparation of Hatchery Genetic Management Plan (HGMP) for Steelhead

Action: Reclamation shall fund CDFG to prepare a complete draft HGMP for steelhead production at Nimbus Fish Hatchery, in accordance with current NMFS guidelines, and submit that draft for NMFS review by June 2011. Specific actions shall include:

1) Reclamation shall fund genetic screening at Nimbus Fish Hatchery for steelhead to determine most appropriate brood stock source. This action shall be completed by March 31, 2012.

2) Reclamation shall fund a study examining the potential to replace the Nimbus Fish Hatchery steelhead broodstock, with genetically more appropriate sources. This action shall be completed by March 31, 2012.

Action II.6.2. Interim Actions Prior to Submittal of Draft HGMP for Steelhead

Action: Reclamation shall use its authorities to ensure that, prior to completion of the draft HGMP, the hatchery is operated according to the following protocols:

1) Release all hatchery-produced steelhead juveniles in the American River at Nimbus Fish Hatchery or at a location in the American River as close to Nimbus Fish Hatchery as is feasible to reduce straying. This action shall be implemented within 30 days of issuance of this Opinion.

2) Release all unclipped steelhead adults returning to Nimbus Fish Hatchery back into the lower American River so they can spawn naturally. This action shall be implemented within 30 days of issuance of this Opinion.

3) Stop inter-basin transfers of steelhead eggs or juveniles to other hatcheries, except upon specific written concurrence of NMFS. This action shall be implemented within 30 days of issuance of this Opinion.

Action II.6.3: **Develop and Implement Fall-run Chinook Salmon Hatchery Management Plans for Nimbus and Trinity River Fish Hatcheries**

Action: By June 2014, develop and begin implementation of Hatchery Management Plans for fall-run production at Nimbus Fish Hatchery and spring-run and fall-run at Trinity River Fish Hatchery. Reclamation shall fund CDFG to develop and submit draft plans for NMFS review by June 2013. The goal of the plans shall be to reduce impacts of hatchery Chinook salmon on natural fall-run and spring-run, and increase the genetic diversity and diversity of run-timing for these stocks.

Rationale for actions II.6.1-3: Hatcheries have been established on CVP and SWP rivers to offset effects of dams and project operations. Since these hatcheries were initially put into operation, additional knowledge has been developed that has advanced NMFS understanding of how hatchery operations can affect listed and non-listed salmonids. The operations of Nimbus Fish Hatchery and the spring- and fall-run operations of Trinity River Fish Hatchery are inter-related and interdependent to the proposed action.

Nimbus Fish Hatchery steelhead broodstock is predominantly Eel River stock. Maintaining this genetic broodstock has adverse effects on listed steelhead in the CV steelhead DPS (Garza and Pearse 2008). Based on genetics information presented in Garza and Pearse (2008), *O. mykiss* from the American River above Folsom Dam retain ancestral CV steelhead genetics and potentially could provide a broodstock source to replace the current Nimbus Fish Hatchery steelhead broodstock. This would eliminate the spread of Eel River genetics to CV steelhead. An HGMP is necessary to minimize effects of ongoing steelhead hatchery program on steelhead contained within the DPS.

Southern Residents depend on Chinook salmon as prey. Preparation of hatchery management plans for fall-run at Nimbus Fish Hatchery and spring-run and fall-run at Trinity River Fish Hatchery is necessary to reduce operational effects on Southern Residents prey over the long term. Improving the genetic diversity and diversity of run timing of Central Valley fall-run will decrease the potential for localized prey depletions and increase the likelihood that fall-run can withstand stochastic events, such as poor ocean conditions (Lindley *et al.*, 2009), and thereby provide a consistent food source in years with overall poor productivity. .

III. EAST SIDE DIVISION

Introduction to Stanislaus River/Eastside Division Actions: The steelhead population on the Stanislaus River is precariously small and limited to habitat areas below the dams that historically were unsuitable owing to high summer temperatures. All of the four steelhead populations in the Southern Sierra Nevada Diversity Group of the CV steelhead DPS are in similar condition and are not presently considered viable. Using the framework in this Opinion for jeopardy analysis, the DPS is not viable if one of the Diversity Groups is not viable. The overall poor status of the Diversity Group increases the importance of minimizing the effects of project operations on the Stanislaus River population.

Modeled operations suggest that it is possible to operate dams of the Eastside Division in a manner that avoids jeopardy to steelhead; however, if future climate conditions are warmer, drier, or both, summertime temperatures will restrict the extent of suitable habitat for steelhead.

The fundamental operational criteria are sufficiently ill-defined in the CVP/SWP operations BA as to provide limited guidance to the Action Agency on how to operate. This suite of actions provides sufficiently specific operational criteria so that operations will avoid jeopardizing steelhead and will not adversely modify their critical habitat. Operational actions to remove adverse modification of critical habitat include a new flow schedule to minimize effects of flood control operations on functionality of geomorphic flows and access of juvenile steelhead to important rearing areas.

Overall Objectives: (1) Provide sufficient definition of operational criteria for Eastside Division to ensure viability of the steelhead population on the Stanislaus River, including freshwater migration routes to and from the Delta; and (2) halt or reverse adverse modification of steelhead critical habitat.

Overall Rationale: Sufficient uncertainty exists as to whether VAMP pulse flows and b(2) allocations are reasonably likely to occur in the future. VAMP, as defined by the SJRA, is due to expire in 2011. The BA commits to subsequent flows similar to VAMP ("Vamp-like flows"), but this is a very vague commitment. The project description does not define the particular contribution, timing, duration, or magnitude of these flows from the tributaries that contribute to VAMP, including the Stanislaus River. In addition, the BA specifies the amount of water designated to offset VAMP export curtailments as 48 TAF; but the need, based on past

performance, has varied from approximately 45 to 150 TAF. Additional demands for smelt protection and future drainage settlement terms are being placed on b(2) water, and it is uncertain that b(2) water will be available consistently in each year in the quantity, duration, and timing needed for CV steelhead in the Stanislaus River. The annual water contract allocation process from New Melones is inadequately defined in the project description to assure the proposed action will not prevent the establishment of a viable population of steelhead.

Action III.1.1. Establish Stanislaus Operations Group for Real-Time Operational Decision-Making as Described in These Actions and Implementation Procedures

Action: Reclamation shall create a SOG to provide a forum for real-time operational flexibility implementation of the alternative actions defined in this RPA and for clarification of decision-making processes regarding other allocations of the NMTP. This group shall include Reclamation, NMFS, USFWS, DWR, CDFG, SWRCB, and outside expertise at the discretion of NMFS and Reclamation. This group shall provide direction and oversight to ensure that the East Side Division actions are implemented, monitored for effectiveness and evaluated. Reclamation, in coordination with SOG, shall submit an annual summary of the status of these actions. See introduction to RPA for further information on group procedures.

Action III.1.2. Provide Cold Water Releases to Maintain Suitable Steelhead Temperatures

Action: Reclamation shall manage the cold water supply within New Melones Reservoir and make cold water releases from New Melones Reservoir to provide suitable temperatures for CV steelhead rearing, spawning, egg incubation smoltification, and adult migration in the Stanislaus River downstream of Goodwin Dam in order to maintain the following temperature compliance schedule:

Criterion and Temperature Compliance Location	Duration	Steelhead Life Stage Benefit
Temperature below 56°F at Orange Blossom Bridge (OBB)	Oct 1*-Dec 31	Adult migration
Temperature below 52 °F at Knights Ferry and 57°F at OBB	Jan 1-May 31	Smoltification
Temperature Below 55°F at OBB	Jan 1-May 31	Spawning and incubation
Temperature below 65°F at OBB	June 1-Sept 30	Juvenile rearing

***This criterion shall apply as of October 1 or as of initiation date of fall pulse flow as agreed to by NMFS**.

Temperature compliance shall be measured based on a seven-day average daily maximum temperature.

Exception: If any of these criteria is or is expected to be exceeded based on a three-day average daily maximum temperature, Reclamation shall immediately notify NMFS of this condition and shall submit to NMFS a written determination that, after taking all actions within its authorities, it is unlikely to meet the above temperature requirement and the extent

and duration of the expected exceedance. This determination must be supported by specific iterative modeling techniques that vary allocations and delivery schedules. In the event that Reclamation determines that other nondiscretionary requirements (*e.g.*, D-1641 or requirements of the USFWS' Delta smelt biological opinion) conflict with attainment of the temperature requirement, Reclamation will convene SOG to obtain recommendations. If consensus cannot be achieved within SOG, then SOG shall advise NMFS, and NMFS will make a recommendation to WOMT per standard operating procedures.

Rationale: CV steelhead are dependent on East Side Division operations to maintain suitable in-stream temperatures. Operational criteria are not clearly described in the CVP/SWP Operations BA to ensure that appropriate temperatures are met for CV steelhead adult migration, spawning, egg incubation, juvenile rearing, and smoltification. The temperature compliance schedule above provides an operational framework to minimize temperature-related effects of proposed operations in the reaches of the river most used by CV steelhead on a year-round basis. Temperature criteria for adult CV steelhead migration in the lower Stanislaus River are included, as we expect that fall attraction flows will improve downstream temperature conditions for adult migration.

Observations at the fish counting weir on the Stanislaus River indicate that apparent CV steelhead enter the river in October, usually coincident with the release of fall attraction flows that provide cooler water and flow cues for fall-run.

The literature regarding appropriate criteria for smoltification suggests optimal temperatures of less than 52°F (Adams *et al*., 1975, Myrick and Cech 2001) or 57°F (EPA 2001). In order to provide optimal temperatures for smoltification within a feasible operational scenario, the smoltification temperature criteria are lower for Knights Ferry at 52°F and 57°F for Orange Blossom Bridge.

No steelhead spawning surveys have been conducted on the Stanislaus River, but fall-run surveys indicate that spawning may occur from Goodwin Dam (RM 59) almost to the City of Oakdale (RM 40), with the highest use occurring above Knights Ferry (RM 55). Based on observations of trout fry, most spawning occurs upstream of OBB (Kennedy and Cannon 2002). Consequently, specific temperature criteria of 55ºF or less at Riverbank should be met from December through May to ensure that temperatures are suitable for all available spawning habitat, however, modeled results and CDEC data (figure 6-35) indicates that temperatures at Riverbank are likely to exceed this level. Based on observations of trout fry, most spawning occurs upstream of OBB (Kennedy and Cannon 2002). Suitable spawning temperatures are likely to be met at OBB, except in May in critically dry years, and exception procedures will be implemented.

Action III.1.3. Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam, Characterized in Figure 11-1, and as Specified in Appendix 2-E

Objective: To maintain minimum base flows to optimize CV steelhead habitat for all life history stages and to incorporate habitat maintaining geomorphic flows in a flow pattern that will provide migratory cues to smolts and facilitate out-migrant smolt movement on declining limb of pulse.

Action: Reclamation shall operate releases from the East Side Division reservoirs to achieve a minimum flow schedule as described in Appendix 2-E and Figure 11-1, below. This flow schedule specifies minimum flows and does not preclude Reclamation from making higher releases for fishery benefits or other operational criteria. When operating at higher flows than specified, Reclamation shall implement ramping rates for flow changes that will avoid stranding and other adverse effects on CV steelhead. In particular, flows that exceed 800 cfs will inundate known side channels that provide habitat, but that also pose stranding risks. When spring pulses greater than 800 cfs are identified in Figure 11-1, the declining limb is not reduced below 800 cfs until after the last pulse.

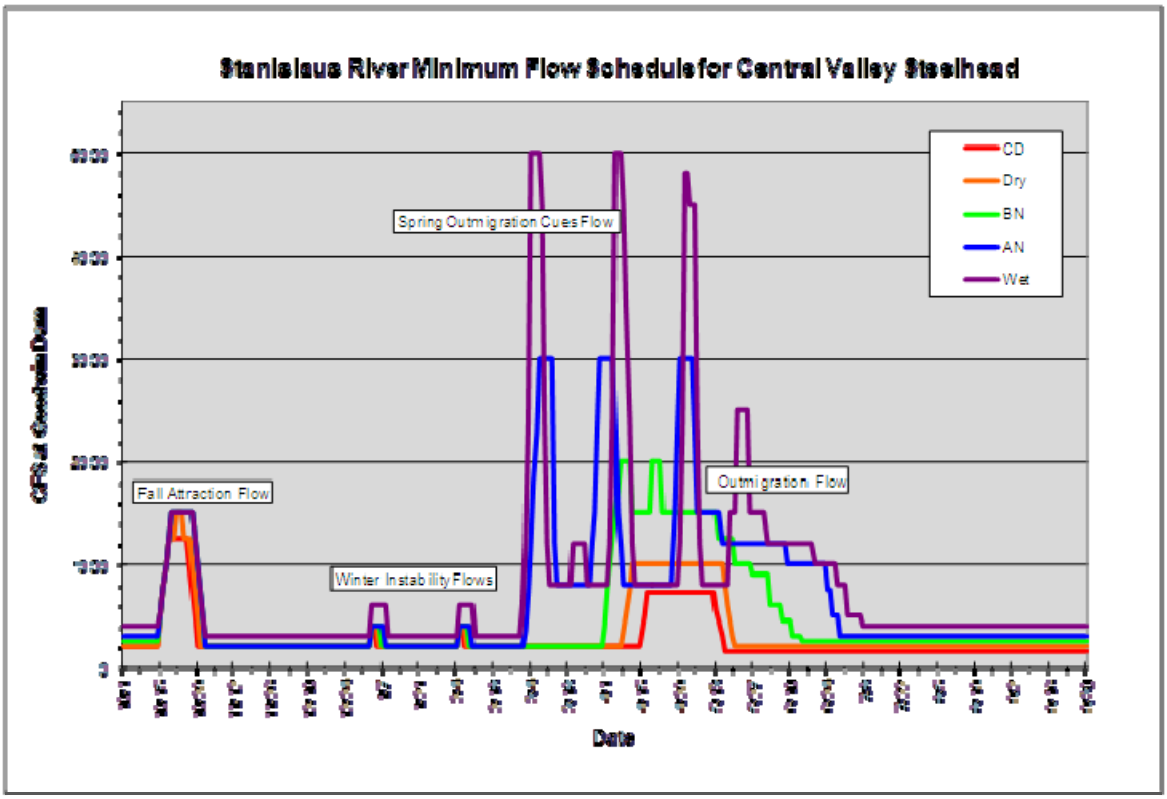

Figure 11-1. Minimum Stanislaus River in-stream flow schedule for CV steelhead as measured at Goodwin Dam

Implementation procedures: Reclamation shall convene the SOG to adaptively manage flows according to this schedule. The timing, magnitude, and duration of the flows in Appendix 2-E are intended to provide certain hydrologic features at certain times of year to benefit CV steelhead, as explained in the Rationale. Based upon the advice of SOG and the concurrence by NMFS[6], the flows may be implemented with minor modifications to the timing, magnitude, and/or duration, as long as NMFS concurs that the rationale for the shift in timing, magnitude, and/or duration is deemed by NMFS to be consistent with the intent of the action. For example, Reclamation may execute shorter duration pulses more frequently (*e.g.*, 2 - 4 times) during the longer pulse period. Implementation of this action should be coordinated with allocation of water resources dedicated for fish, such as the 98.3 TAF to CDFG and b(2) or b(3), if applied. The SOG shall follow standard operating procedures resolving any conflict through the WOMT process. The team shall also advise Reclamation on operations needed to minimize the adverse effects of flow fluctuations associated with New Melones Reservoir and Goodwin Dam operations on CV steelhead spawning, egg incubation, and fry and juvenile rearing within the Stanislaus River. If new information is developed, such as an update of Stanislaus River CV steelhead in-stream flow needs, more specific geomorphic analyses regarding channel forming flows, or real-time recommendations from the SOG, Reclamation may submit to NMFS a revised annual minimum flow schedule that may be implemented if NMFS concurs that it is consistent with ESA obligations. These revisions may trigger re-initiation and re-consultation.

Rationale: This flow schedule includes the following components:

1) Minimum base flows based on IFIM (Aceituno 1993) to optimize available CV steelhead habitat for adult migration, spawning, and juvenile rearing. These base flows are scaled to water year type as defined by the New Melones water supply parameter[7], with lowest flows in critically dry years and highest flows in wet years.

2) Fall pulse flow to improve in-stream conditions sufficiently to attract CV steelhead to the Stanislaus River.

3) Winter instability flows to simulate natural variability in the winter hydrograph and to enhance access to varied rearing habitats.

4) Channel forming and maintenance flows in the 3,000 to 5,000 cfs range in above normal and wet years to maintain spawning and rearing habitat quality. These flows are scheduled to occur after March 1 to protect incubating eggs and are intended to work synergistically with providing outmigration flow cues and late spring flows, described next. These flows are high intensity, but limited duration to avoid potential seepage issues that have been alleged under extended periods of flow greater than 1,500 cfs.

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[6] Concurrence by NMFS is necessary only for pulse flows that are timed or shaped differently than the pulse descriptions I Appendix 2-E.

[7] The New Melones water supply parameter is calculated as the sum of end of February New Melones Reservoir storage and cumulative inflow to New Melones Reservoir from March through September.

5) Outmigration flow cues to enhance likelihood of anadromy.

6) Late spring flows for conveyance and maintenance of downstream migratory habitat quality in the lowest reaches and into the Delta.

An analysis of Stanislaus River rotary screw trap captures of smolted CV steelhead conducted by Reclamation in April 2009 (Hannon 2009b) identified that the median date for smolt CV steelhead out migration is March 1 (Figure RR- Julian Day 60), ranging from January through June. Juveniles are generally captured in trawls at Mossdale in smolted condition in late May (Julian Day 151 and Figure 4-4). CV steelhead are larger than fall-run smolts and may be less dependent on pulse flows to convey them out of the Stanislaus River, but the variability of pulses provides migratory cues to smolted CV steelhead. Capture information suggests that it is important to maintain suitable migratory conditions from the Stanislaus River to the Delta into the month of June. This action will allow more smolted fish to migrate out of system by extending the declining limb of the outmigration pulse and increasing migratory cues.

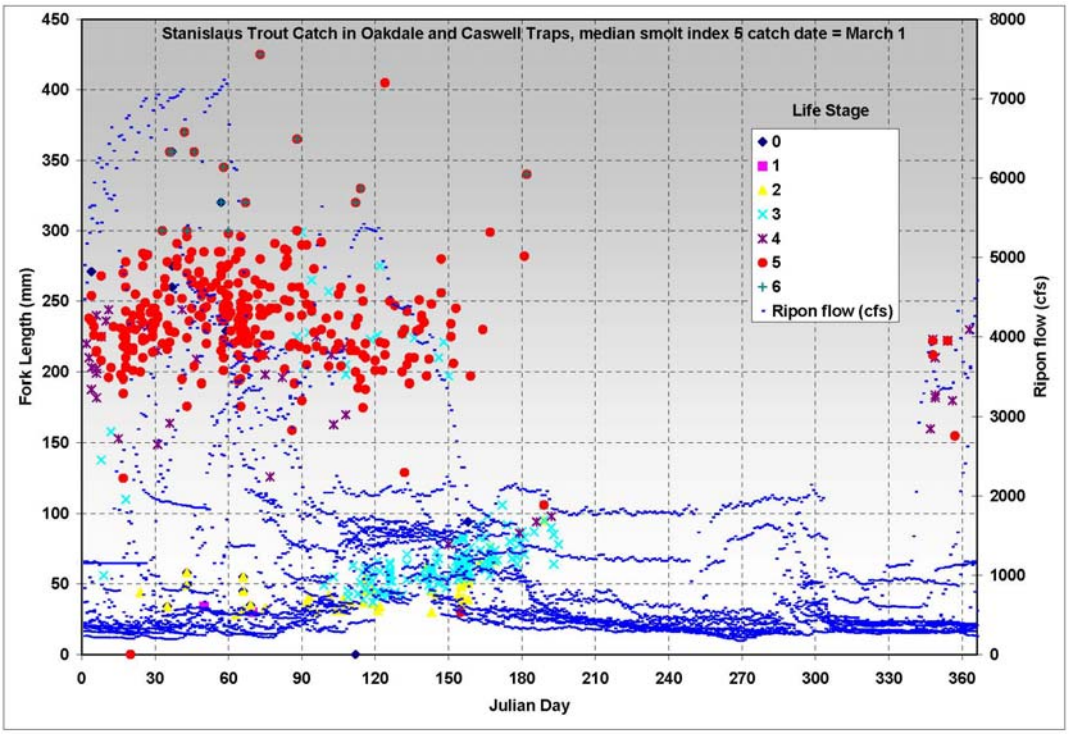

Figure 11-2. Smolt stage *O.mykiss* captured in Stanislaus River Rotary Screw Traps

The fall pulse flow was originally instituted to provide attraction flows for fall-run. Monitoring of adult salmonids at the Stanislaus River counting weir indicates that the fall pulse flow attracts both fall-run and CV steelhead into the Stanislaus River, making freshwater riverine habitat available. These riverine conditions have better temperature and water quality than conditions in the Delta during this period. The purpose of the fall pulse

flow is to provide flow cues downstream for incoming adults, as well as providing some remedial effect on the low dissolved oxygen conditions that develop in the Stockton Deep Water Ship Channel. In addition to steelhead, this action also produces ancillary benefits to fall-run EFH.

Modeling conducted in the preparation of this action indicate that the temperature criteria of Action III.1.2 can generally be met under this alternative minimum flow schedule and are often improved, but that exceedances may occur in certain months (*e.g.*, May and early fall) during dry year types. Based on SALMOD analyses, temperature related mortality may be about 2 percent higher in critically dry years, but is reduced by about 1 percent in all other year types under the proposed alternative (Figure 11-3).

Salmon Mortality:

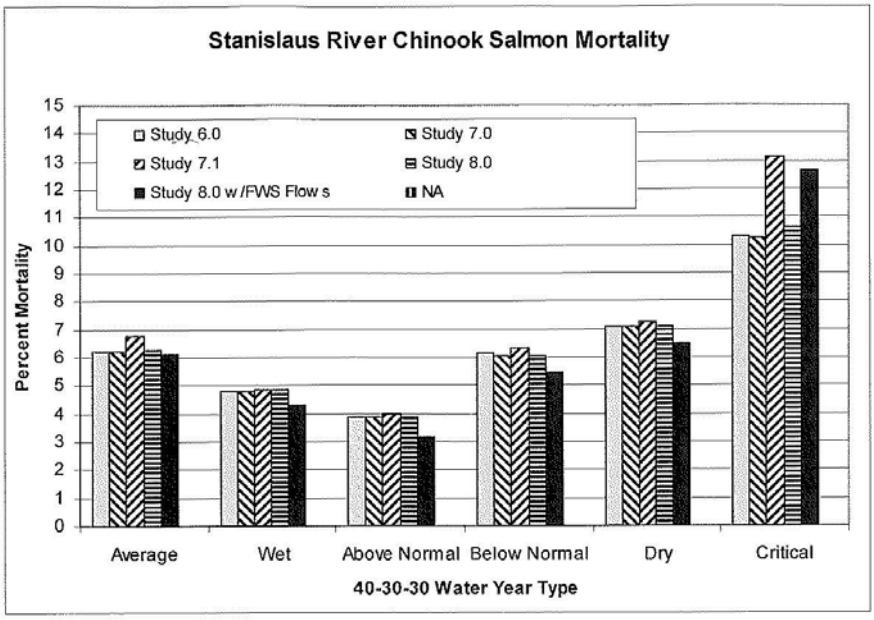

Figure 11-3. Modeled temperature effects of alternative Stanislaus River flows, draft provided by Reclamation on May 5, 2009.

Rationale for 2011 amendments:

1) Figure 11-1: Figure 11-1, as provided in the 2009 RPA, showed draft flows that varied slightly from the final flow schedule in Appendix 2-E. Figure 11-1 is now fully consistent with the flow schedule in Appendix 2-E.
2) Flexibility in implementing flow schedules: The minimum flow schedules provided in Appendix 2-E remain the same. The amendments to Action III.1.3 and its implementation procedures are intended to provide the SOG with more flexibility to adjust the timing, magnitude, and duration of the pulse flows (*not* the minimum flows in between pulses) described in Figure 11-1 and Appendix 2-E based on considerations such as:

a) optimizing intended benefits to CV steelhead (*e.g.*, based on observed fish distribution or run timing and observed flow and temperature conditions and the intent of the pulse flow as described in the "Rationale," above);
b) coordinating Stanislaus River flows for CV steelhead with flows on other San Joaquin River tributaries (*e.g.*, during the fall attraction flow or during the VAMP period); or
c) coordinating operational objectives to use Goodwin Dam releases to achieve multiple benefits (*e.g.*, during April and May when Stanislaus River flows may be contributing to multiple regulatory requirements at the same time).

Any change in the timing, magnitude, and/or duration of the pulse flows must provide protection to CV steelhead and critical habitat that is equal to or greater than the protection provided by the pulse flows as described in Appendix 2-E. This clarified flexibility can also result in improved water supply when multiple operational objectives can be satisfied with a single strategic release. These amendments were supported by the ISP.

Action Suite III.2. Stanislaus River CV Steelhead Habitat Restoration

Overall objective: Dam operations have and will continue to suppress channel-forming flows that replenish spawning beds. The physical presence of the dams impedes normal sediment transportation processes. This action is necessary to partially alleviate adverse modification of steelhead critical habitat from operations.

Action III.2.1. Increase and Improve Quality of Spawning Habitat with Addition of 50,000 Cubic Yards of Gravel by 2014 and with a Minimum Addition of 8,000 Cubic Yards per Year for the Duration of the Project Actions

Action: Reclamation shall minimize effects of their operations through improving spawning habitat with addition of 50,000 cubic yards of gravel by 2014. Reclamation shall submit a plan, including monitoring, and schedule to NMFS for gravel augmentation by June 2010. Reclamation shall begin gravel augmentations no later than summer 2011. Reclamation shall submit to NMFS a report on implementation and effectiveness of action by 2015. Spawning gravel replenishment sites shall be monitored for geomorphic processes, material movement, and salmonid spawning use for a minimum of three years following each addition of sediment at any given site.

Rationale: Kondolf (*et al.*,) 2001 identified levels of sediment depletion at 20,000 cubic yards per year owing to a variety of factors including mining and geomorphic processes associated with dam operations, past and ongoing. Kondolf (*et al*.,) 2001 and other reports cited in that work, identify a loss of over 60 percent of spawning area for salmonids since 1966. This level of replenishment will restore adversely affected spawning habitat to relieve adverse habitat conditions and provide sediment to partially offset ongoing loss rates. Sediment addition may also be conducted in a manner to remediate sediment related loss of geomorphic function, such as channel incision, to and allow for inundation of floodplain rearing habitat.

Rationale for 2011 Amendment: Use of "tons" in the 2009 RPA was a typographical error. The change from "tons" to "cubic yards" was made to be consistent with the intent of the action. This change does not result in any change in implementation.

Action III.2.2. Conduct Floodplain Restoration and Inundation Flows in Winter or Spring to Inundate Steelhead Juvenile Rearing Habitat on One- to Three-Year Schedule.

Action: Reclamation shall seek advice from SOG to develop an operational strategy to achieve floodplain inundation flows that inundate CV steelhead juvenile rearing habitat on a one- to three-year return schedule. Reclamation shall submit a proposed plan of operations to achieve this flow regime by June 2011. This plan shall include the minimum flow schedule identified in Action III.1.2, or shall provide justification for any proposed modification of the minimum flow schedule. NMFS will review and, if satisfactory, approve the operational strategy. Reclamation will implement strategy starting in 2012.

Rationale: Kondolf *et al*., (2001) identified that floodplain terraces and point bars inundated before operation of New Melones Dan have become fossilized with fine material and thick riparian vegetation that is never rejuvenated by scouring. Channel forming flows in the 8,000 cfs range have occurred only twice since New Melones Dam began operation 28 years ago. Lack of channel forming flows and lack of sediment input blocked by the dams has resulted in channel incision of one to three feet over 13 years. Floodplain juvenile rearing habitat and connectivity will continue to be degraded by New Melones operations, as proposed.

Action III.2.3. Restore Freshwater Migratory Habitat for Juvenile Steelhead by Implementing Projects to Increase Floodplain Connectivity and to Reduce Predation Risk During Migration

Objective: This action is necessary to compensate for continued operational effects on rearing and freshwater migratory habitat due to flood control operations. The goal of this action is to improve habitat quality of freshwater migratory habitat for juvenile steelhead.

Action: By June 2010, in cooperation with the SOG, Reclamation shall develop a list of projects to improve the habitat values of freshwater migratory habitat in the Stanislaus River, and associated monitoring, for implementation and submit the list to NMFS for review. Reclamation shall begin implementation of NMFS-approved projects by June 2011. Reclamation shall submit a report of project implementation and effectiveness by June 2016.

These projects may include actions that reduce exposure to predation directly, or projects that may offset predation effects by improving rearing habitat values to allow juveniles to grow larger before outmigration. These projects may include both flow- and non-flow-related actions. Flow-related actions shall be coordinated with operational flows as defined in Action III.2.2 and Action III.1.2. These projects may also include, but shall not be limited to,

evaluations to identify locations or sources of higher juvenile mortality in order to identify and implement projects with the highest likelihood to prevent CV steelhead mortality.

Rationale: Predation studies on the Tuolumne River have shown losses of up to 60 percent of outmigrating salmon smolts in run-of-river gravel mining ponds and dredged areas. Losses on the Stanislaus River have not been similarly quantified, but predation on fall run smolts and *O. mykiss* by striped bass and large mouth bass have been documented. These run-of-river ponds also reduce flow velocities as compared to incoming river channels, requiring outmigrating salmonids to expend more energy to traverse these sections. Operational releases provide flows lower than typical unimpaired flows, which exacerbates the effect of this stressor on outmigrating juveniles and degrades the habitat value of necessary freshwater migratory corridors. Additional flows or flow pulses could alleviate this added energy demand and improve survival through these problem areas. Channel modifications in these problem areas can improve migration success. Improvements in floodplain habitat quality can improve juvenile growth and larger juveniles are more likely to avoid predation mortality.

Action III.2.4. Evaluate Fish Passage at New Melones, Tulloch, and Goodwin Dams

Objective: Evaluate access for steelhead to historic cold water habitat above New Melones, Tulloch, and Goodwin dams.

Action: See Fish Passage Program, Action V.

Rationale: The effects analysis in this Opinion leads to the conclusion that steelhead will continue to be vulnerable to serious effects of elevated temperatures in dry and critically dry years, even if actions are taken to improve temperature management. The frequency of these occurrences is expected to increase with climate change and increased water demands. Therefore, it is essential to evaluate options for providing steelhead to access their historic cold water habitat above New Melones, Tulloch, and Goodwin dams and to provide access if feasible..

IV. DELTA DIVISION

Introduction: An important life history phase for all anadromous fish is their movement through an estuary as adults moving upstream to spawning grounds, and as juveniles moving downstream to the ocean. For some fish, the estuary also serves as a staging area and, for some juveniles, a rearing area prior to their entering the ocean. Within the Central Valley, all anadromous fish, including listed winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon, depend on the Sacramento-San Joaquin Delta environment during these life phases. This dependence was an important factor in designation of critical habitat in the Delta for these species. A properly functioning Delta is critical to migration pathways and rearing habitat, both of which are primary constituent elements of critical habitat for these fish.

Currently, the fish are exposed to a multitude of stressors in the Delta during passage and rearing. The Delta has been severely degraded over the past 150 years, primarily due to anthropogenic actions within its boundaries and in its surrounding watersheds. Nearly 90 percent of its fringing marshes have been lost and replaced with raised levees armored with rock riprap. The channelization of the Delta waterways through the construction of raised levees for flood control has isolated the Delta from its surrounding floodplains. These seasonally inundated floodplains served as important rearing habitats for many of the native fish species occurring in the Delta, including salmonids, and juvenile green sturgeon.

The structure of the Delta, particularly in the central and southern Delta, has been significantly altered by construction of manmade channels and dredging, for shipping traffic and water conveyance. Intentional and unintentional introductions of non-native plant and animal species have greatly altered the Delta ecosystem. Large predatory fish such as striped bass and largemouth bass have increased the vulnerability of emigrating juveniles and smolts to predation, while infestations of aquatic weeds such as *Egeria densa* have diminished the useable near-shore, shallow water habitat needed by emigrating salmonids for rearing.

The use of Delta islands for intensive agriculture has increased demand for irrigation water from the Delta, as well as increased the discharge of agricultural runoff into Delta waterways surrounding these farmed islands. These discharges carry chemicals such as fertilizers, pesticides, herbicides, and excessive nutrients, leading to degradation of water quality parameters such as DO content and suspended sediment, and increasing exposure to toxic compounds. Likewise, increasing urbanization in the areas surrounding the Delta increases the load of contaminants associated with stormwater runoff, discharges from wastewater sanitation plants, and industrial activities. Overall, conditions in the Delta make emigrating anadromous fish highly vulnerable to any added stressors and substantially reduce their chances for survival.

The proposed actions for the CVP and SWP include continued diversion of water from the Delta at the project's export facilities, with increased export levels. These actions will increase the level of stressors in the Delta beyond those previously described and exacerbate many of those already present. NMFS has identified several factors associated with operation of the CVP and SWP that affect the long-term viability and resiliency of winter-run, spring-run, CV steelhead, and the Southern DPS of green sturgeon in the Central Valley. In addition to these specific factors, the operations of the CVP and SWP alter Delta hydrodynamics and interact with other stressors to enhance the vulnerability of listed fish to morbidity and mortality during their time in the Delta.

The adverse effects of the proposed action identified in this Opinion include:

1) Diversion from the North Delta into the Delta interior of early emigrating winter-run juveniles, yearling spring-run, and CV steelhead, through the operation of the DCC gates in late fall and early winter.

2) Enhanced vulnerability of juvenile salmonids to entrainment and indirect mortality, through alteration of the hydrodynamics of the interior and south Delta waterways, due to the influence of export pumping actions in winter and spring.

3) Enhanced vulnerability of CV steelhead from the San Joaquin River basin to exports and export-related changes in hydrodynamics.

4) Direct mortality from entrainment of juvenile salmonids and green sturgeon at the CVP and SWP export facilities.

The actions prescribed below will minimize or avoid the proposed action's adverse effects on hydraulic patterns in the Delta that affect listed salmonids and green sturgeon. They will modify the interactions that listed fish have with other stressors in the Delta and thereby avoid appreciably reducing the likelihood of survival and recovery of listed fish.

The current metric for monitoring direct take and mortality of listed fish by the CVP and SWP actions is the level of salvage and calculated loss at fish collection facilities. This metric is a reflection of export levels and the diversion of large volumes of water through the facilities. Counting fish at the salvage facilities alone, however, does not account for fish that have been lost prior to the point of collection, and thus is an inaccurate measure of adverse export influence. It does not account for fish that have been drawn into the waters of the central Delta through the DCC gates or Georgiana Slough and lost to predation, toxics, or other factors before reaching the south Delta, nor does it account for fish that make it to the south Delta, where they are further influenced by the reverse flows moving toward the pumps and are delayed in their migration; which increases their vulnerability to predation, toxics, or other forms of loss, such as stranding in agricultural diversions.

Overall Objectives: The juveniles of all four listed species migrating downstream in the Sacramento River have a much greater chance of survival when they migrate directly to the estuary within the Sacramento River than when they are diverted by water operations into the southern or central Delta, where they are exposed to increased risks of predation, exposure to toxic pollutants, and entrainment into water diversions. The Delta Division measures will reduce the likelihood of diversion of emigrating juveniles into the southern or central Delta, and will reduce mortality of emigrating juveniles that have been entrained at the fish collection facilities and entered the salvage process.

There are six actions to be taken in the Delta:

- Action IV.1: Modify DCC gate operations and evaluate methods to control access to Georgiana Slough and the Interior Delta to reduce diversion of listed fish from the Sacramento River into the southern or central Delta.
- Action IV.2: Control the net negative flows toward the export pumps in Old and Middle rivers to reduce the likelihood that fish will be diverted from the San Joaquin or Sacramento River into the southern or central Delta.

- Action IV.3: Curtail exports when protected fish are observed near the export facilities to reduce mortality from entrainment and salvage.
- Action IV.4: Improve fish screening and salvage operations to reduce mortality from entrainment and salvage.
- Action IV.5: Establish a technical group to assist in determining real-time operational measures, evaluating the effectiveness of the actions, and modifying them if necessary.
- Action IV.6: Do not implement the South Delta Barriers Improvement Program.

A summary of Actions IV.1 and IV.2 and their timeframes is provided below in Figure 11-4.

Action Suite IV.1 Delta Cross Channel (DCC) Gate Operation, and Engineering Studies of Methods to Reduce Loss of Salmonids in Georgiana Slough and Interior Delta

Objective: Reduce the proportion of emigrating listed salmonids and green sturgeon that enter the interior delta through either the open DCC gates or Georgiana Slough.

Rationale: Salmon migration studies show losses of approximately 65 percent of groups of outmigrating fish that are diverted from the mainstem Sacramento River into the waterways of the central and southern Delta (Brandes and McLain 2001; Vogel 2004, 2008; Perry and Skalski 2008). Diversion into the internal Delta also increases the likelihood of entrainment and mortality associated with the pumping facilities. These effects are inferred from both particle tracking models, which derive the fate of particles over time, and direct study of acoustically tagged and CWT salmonids (Vogel 2004, SJRGA 2007).

On average, up to 25 percent of Sacramento River flows are diverted into the channels of the DCC when the gates are open, with a maximum of 35 to 40 percent. Approximately 20 percent, on average, of the Sacramento River flow is diverted into Georgiana Slough. During November and December, approximately 25 percent of the Sacramento River flow is diverted into the interior Delta through these two channels. Recent studies by Perry and Skalski (2008) indicate that by closing the DCC gates when fish are present, total through-Delta survival of marked fish to Chipps Island increases by nearly 50 percent for fish moving downstream in the Sacramento River system. Closing the DCC gates appears to redirect the migratory path of emigrating fish into Sutter and Steamboat Sloughs and away from Georgiana Slough, resulting in higher survival rates. Similar benefits have been described in previous studies (Newman 2008, Brandes and McLain 2001) with CWT fish.

Based on data from monitoring studies in the lower Sacramento River, approximately 45 percent of the annual winter-run emigration from the Sacramento River enters the Delta between November and January. During the same period, about eight percent of the annual CV steelhead emigration from the Sacramento River Basin occurs. Yearling spring-run pass into the Delta in January, but these fish account for only three percent of the total annual population of spring-run emigrants entering the Delta.

<table>
<tr><td rowspan="2"></td><td>Action IV. 1.2 - Operation of DCC to enhance protection of emigrating salmonids/green sturgeon</td><td colspan="2">Action IV. 2.1 - Maintain San Joaquin River Inflow/Export ratio</td><td>Action IV. 2.2 - Acoustic Tag Experiment</td><td>Action IV. 2.3 - Reduced exports to limit negative flows in OMR depending on presence of salmonids</td></tr>
<tr><td></td><td>2009 - 2011 Interim Operations</td><td>2012 + Long term Operations</td><td></td><td></td></tr>
<tr><td>Oct.</td><td rowspan="2">Oct. 1 - Nov. 30 - Gates closed if fish are present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Nov.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Dec.</td><td>Dec. 1 - 14 - Gates closed except for experiments/water quality</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Jan.</td><td>Dec. 15 - Jan. 31 Gates Closed</td><td></td><td></td><td></td><td rowspan="6">Jan 1 - June 15 - OMR (-5000 to -2500 cfs) until after June 1 water temperature at Mossdale ≥72° F for 7 days</td></tr>
<tr><td>Feb.</td><td rowspan="4">Feb. 1 - May 20 - Gates Closed per D1641</td><td></td><td></td><td></td></tr>
<tr><td>Mar.</td><td></td><td></td><td rowspan="4">March 1 - June 15</td></tr>
<tr><td>Apr.</td><td rowspan="3">April 1 - May 31 - Maintain Vernalis Inflow/Export ratio dependingon IOP water supply parameters</td><td rowspan="3">April 1 - May 31 - Maintain Vernalis Inflow/Export Ratios depending on water year type</td></tr>
<tr><td>May</td><td rowspan="2">May 21 - June 15 - up to 14 days closed per D-1641</td></tr>
<tr><td>Jun.</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Figure 11-4. A summary of Actions IV.1 and IV.2 and their timeframes.

Actions taken during the early emigration period (November through January) to reduce diversion of listed salmonids can affect a significant proportion of the populations of listed fish. As discussed earlier in the effects section, these early migrants represent life history strategies that spread the risk of mortality over a greater temporal span, increasing diversity and resiliency of the populations.

Percent of Juvenile Chinook salmon and steelhead production entering the Delta from the Sacramento River by month.

Month	Sacramento River Total[1,2]	Fall-Run[3]	Spring-Run[3]	Winter-Run[3]	Sacramento Steelhead[4]
January	12	14	3	17	5
February	9	13	0	19	32
March	26	23	53	37	60
April	9	6	43	1	0
May	12	26	1	0	0
June	0	0	0	0	0
July	0	0	0	0	0
August	4	1	0	0	0
September	4	0	0	0	1
October	6	9	0	0	0
November	9	8	0	03	1
December	11	0	0	24	1
Total	100	100	100	100	100

Notes:
[1]Mid Water trawl data
[2]All runs combined
[3]Runs from Sacramento River basin only
[4]Rotary screw trap data from Knights Landing
Source: SDIP Draft EIR/EIS 2005 Tables J-23 and J-24, Appendix J.

Action IV.1.1 Monitoring and Alerts to Trigger Changes in DCC Operations

Objective: To provide timely information for DCC gate operation that will reduce loss of emigrating winter-run, spring-run, CV steelhead, and green sturgeon.

Action: Monitoring of Chinook salmon migration in the Sacramento River Basin and the Delta currently occurs at the RBDD, in spring-run tributaries to the Sacramento River, on the Sacramento River at Knights Landing and Sacramento, and sites within the Delta. Reclamation and DWR shall continue to fund these ongoing monitoring programs, as well as the monitoring of salvage and loss of Chinook salmon juveniles at the Delta fish collection facilities operated by the CVP and SWP. Funding shall continue for the duration of the proposed action (2030). Reclamation and DWR may use their own fishery biologists to conduct these monitoring programs, or they may provide funds to other agencies to do the required monitoring.

Monitoring protocols shall follow established procedures utilized by the USFWS, CDFG, Reclamation, and DWR. Information collected from the monitoring programs will be used to make real-time decisions regarding DCC gate operation and export pumping.

The DOSS group (Action IV.5) and WOMT will use information from monitoring to make decisions regarding DCC closures consistent with procedures below.

The DCC gate operations in the fall are initiated through a series of alerts. These alerts are signals that gate operations may need to be altered in the near future to avoid diversion of juvenile Chinook salmon migrating down the Sacramento River.

There are two initial alerts to warn of salmon presence in the system:

First Alert: There are two components to the first alert. Either condition, when met or identified, can trigger the alert. Capture of yearling-sized (> 70 mm) spring-run at the mouths of natal tributaries between October and April indicates that emigration from the tributaries has started or is occurring. As an environmental surrogate to the capture of the yearling-sized spring-run, which are difficult to capture in the rotary screw traps at the mouths of the natal tributary creeks, tributary flow increases are used to signal conditions conducive to emigration. Starting in October, an increase in tributary flow of more than 50 percent over levels immediately preceding the flow spike is used to indicate the appropriate cues for the initiation of salmon emigration[8].

Second Alert: The second alert is based on two physical hydrologic criteria. When both criteria are met the second alert is triggered. The monitoring station used for these environmental measurements is Wilkins Slough, located near Knights Landing approximately 35 miles upstream of the Delta. When flows are greater than 7,500 cfs as measured at Wilkins Slough, and water temperatures are less than 13.5^{o}C (56.3^{o}F) as measured at Knights Landing, the second alert is triggered. Recoveries of emigrating Chinook salmon at the Knights Landing monitoring location have been associated with these two hydrologic conditions.

Rationale: Monitoring programs are necessary to track the movement of salmon within the Central Valley watersheds so that timely changes can be made when project actions are in conflict with the needs of listed fish. Evidence of initiation of juvenile Chinook salmon migration in the upper tributaries, or environmental conditions that would trigger such migration, is the basis for the alerts. The alerts are important to effective gate operation because the collection and dissemination of field data to the resource agencies, and coordination of responsive actions, may take several days to occur. The first two alerts warn NMFS and Reclamation that changes in DCC gate operations are likely to be necessary within a short time period.

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[8] The first significant flow in October is associated with the beginning of spring-run yearling emigration from natal tributaries - an indication that those fish are on their seaward migration and will soon be entering the Delta where they are susceptible to mortality factors associated with the Delta Cross Channel (DCC) and SWP/CVP export operations. This first tributary flow event, or "First Alert", is the early warning criteria for closing the DCC.

Action IV.1.2 DCC Gate Operation

Objective: Modify DCC gate operation to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January.

Action: During the period between November 1 and June 15, DCC gate operations will be modified from the proposed action to reduce loss of emigrating salmonids and green sturgeon. The operating criteria provide for longer periods of gate closures during the emigration season to reduce direct and indirect mortality of yearling spring-run, winter-run, and CV steelhead. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree (below).

Implementation procedures: Monitoring data related to triggers in the decision tree will be reported on DAT calls and evaluated by DOSS (for formation of DOSS – see Action IV.5). Reclamation/DWR shall take actions within 24 hours of a triggered condition occurring. If the decision tree requires an evaluation of data or provides options, then DOSS shall convene within one day of the trigger being met. DOSS shall provide advice to NMFS, and the action shall be vetted through WOMT standard operating procedures.

Rationale for 2011 amendment: "KK" was a typographical error in the 2009 RPA, intended to be a placeholder until the number for action that describes the formation of DOSS was identified.

October 1-November 30:

Date	**VI. Action Triggers**	Action Responses
October 1-November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index (KLCI) or the Sacramento Catch Index (SCI) are greater than 3 fish per day but less than or equal to 5 fish per day.	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than 5 fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is less than 3 fish per day at both the Knights Landing and Sacramento monitoring sites.
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.

Rationale: Depending on the catch magnitude, there are several options for closing the DCC gates, ranging from not closing them and monitoring catch at Knights Landing and the Sacramento monitoring sites, to closing the DCC gates until the catch index decreases to fewer than three fish per day at the Knights Landing and Sacramento monitoring sites. Fish and water quality needs (*i.e.*, salinity levels) are frequently mutually exclusive, with respect to the DCC position, from November through January.

December 1-14:

Date	Action Triggers	Action Responses
December 1 - December 14	Water quality criteria are met per D-1641.	DCC gates are closed. If Chinook salmon migration experiments are conducted during this time period (*e.g.*, Delta Action 8 or similar studies), the DCC gates may be opened according to the experimental design, with NMFS' prior approval of the study.
	Water quality criteria are not met but both the KLCI and SCI are less than 3 fish per day.	DCC gates may be opened until the water quality criteria are met. Once water quality criteria are met, the DCC gates will be closed within 24 hours of compliance.
	Water quality criteria are not met but either of the KLCI or SCI is greater than 3 fish per day.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5

Rationale: The Spring-run Protection Plan (1998 *op. cit*. CVP/SWP operations BA Appendix B) provides that Reclamation will close the DCC gates on December 1 for the protection of spring-run yearlings unless there is a water quality issue. The DOSS can recommend opening the DCC gates for water quality purposes during this period. In addition, CDFG analysis indicates that there is a significant relationship between DCC gate operations and subsequent loss of winter-run at the Delta Fish Facilities. Closing the DCC gates between December 15 and January 15 reduces the total loss of winter-run at the Delta Fish Facilities. The report is posted at: http://www.science.calwater.ca.gov/pdf/ewa/EWA_delta_cross_channel_closures_06_111406.pdf.

The USFWS conducts a juvenile Chinook salmon Delta survival experiment each year in December and January. This is usually conducted in the first two weeks of December and may include experimental openings of the DCC gates.

http://www.delta.dfg.ca.gov/jfmp/PatFiles/Delta_Action_8_Workshop.doc. These studies may be implemented if NMFS concurs that the study plan has been adapted to sufficiently reduce loss of salmonids.

December 15 – January 31:

Date	Action Triggers	Action Responses
December 15 – January 31	December 15-January 31	DCC Gates Closed.
	NMFS-approved experiments are being conducted.	Agency sponsoring the experiment may request gate opening for up to five days; NMFS will determine whether opening is consistent with ESA obligations.
	One-time event between December 15 to January 5, when necessary to maintain Delta water quality in response to the astronomical high tide, coupled with low inflow conditions.	Upon concurrence of NMFS, DCC Gates may be opened one hour after sunrise to one hour before sunset, for up to 3 days, then return to full closure. Reclamation and DWR will also reduce Delta exports down to a health and safety level during the period of this action.

Rationale: CDFG analysis indicates that there is a significant relationship between DCC gate operations and subsequent loss of winter-run at the Delta Fish Facilities. Closing the DCC gates between December 15 and January 15 reduces the total loss of winter-run at the Delta Fish Facilities. The report is posted at: http://www.science.calwater.ca.gov/pdf/ewa/EWA_delta_cross_channel_closures_06_111406.pdf

If the KLCI or SCI is less than three, and the water temperature and flow criteria are indicative of low risk to listed salmonids, then experiments on fall- and late-fall-run may be permissible; however, in a low production year, trap efficiencies and detection rates may result in under-representation of the number of fish passing these locations. Under such conditions the DOSS group shall act conservatively in this decision process even when no fish have been detected at Knights Landing or Sacramento rotary screw traps. If conditions change, indicating that risks to listed salmonids are elevated, experiments will be suspended and the DCC gates closed if NMFS determines that closure is necessary to reduce the risk to emigrating salmonids.

February 1 – June 15:

Date	Action Trigger	Action Response
February 1 – May 20	D-1641 mandatory gate closure.[9]	Gates closed, per WQCP criteria

Date	Action Trigger	Action Response
May 21 – June 15	D-1641 gate operations criteria	DCC gates closed for 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.

Overall Rationale for Action IV.1.2: Emigrating salmonids are vulnerable to diversion into the DCC when the gates are open. Fish traveling downstream in the Sacramento River move past the mouth of the DCC on the outside bend of the river. A series of studies conducted by Reclamation and USGS (Horn and Blake 2004) used acoustic tracking of released juvenile Chinook salmon to follow their movements in the vicinity of the DCC under different flows and tidal conditions. The study results indicate that the behavior of the Chinook salmon juveniles increased their exposure to entrainment through both the DCC and Georgiana Slough. Horizontal positioning along the east bank of the river during both the flood and ebb tidal conditions enhanced the probability of entrainment into the two channels. Upstream movement of fish with the flood tide demonstrated that fish could pass the channel mouths on an ebb tide and still be entrained on the subsequent flood tide cycle. In addition, diel movement of fish vertically in the water column exposed more fish at night to entrainment into the DCC than during the day, due to their higher position in the water column and the depth of the lip to the DCC channel mouth (-2.4 meters). Additional studies have shown that the mortality rate of the fish diverted into the DCC and subsequently into the Mokelumne river system is quite high (Perry and Skalski 2008; Vogel 2004, 2008). Closure of the DCC gates during periods of salmon emigration eliminates the potential for entrainment into the DCC and the Mokelumne River system with its high loss rates. In addition, closure of the gates appears to redirect the migratory paths of emigrating fish into channels with relatively less mortality (*e.g.*, Sutter and Steamboat Sloughs), due to a redistribution of river flows among the channels. The overall effect is an increase in the apparent survival rate of these salmon populations as they move through the Delta.

The closure of the DCC gates will increase the survival of salmonid emigrants through the Delta, and the early closures reduce loss of fish with unique and valuable life history strategies in the spring-run and CV steelhead populations. Spring-run emigrating through the Delta during November and December are yearling fish. These fish are larger and have a higher rate of success in surviving their entrance into the ocean environment. In addition, variation in the timing of ocean entry distributes the risk of survival over a broader temporal period. This alternative life history strategy reduces the probability that poor ocean conditions in spring and summer will affect the entire population of spring-run. Since

yearling fish enter the marine environment in late fall and winter, they avoid the conditions that young-of-the-year fish encounter in spring and summer, thus increasing the likelihood that at least a portion of the population will benefit from suitable ocean conditions during their recruitment to the ocean phase of their life cycle. For the same reasons, CV steelhead benefit from having their ocean entry spread out over several months.

Rationale for 2011 amendments:

1) **Change in dates**: The change in dates from "February 1 – May 15" to "February 1 – May 20" and from "May 16 – June 15" to "May 21 – June 15" are minor amendments to be consistent and in compliance with State law (Water Rights Decision D-1641, December 29, 1999, page 184, http://www.waterboards.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1600_d1649/wrd1641.pdf).
2) **Change in action response**: The change in action response for May 21-June 15 from "DCC gates may be closed for up to 14 days during this period" to "DCC gates closed for 14 days during this period," is an amendment to be consistent and in compliance with State law (Water Quality Control Plan, December 13, 2006, page 17, footnote 24, http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/2006wqcp/docs/2006_plan_final.pdf).

Action IV.1.3 Consider Engineering Solutions to Further Reduce Diversion of Emigrating Juvenile Salmonids to the Interior and Southern Delta, and Reduce Exposure to CVP and SWP Export Facilities

Objectives: Prevent emigrating salmonids from entering the Georgiana Slough channel from the Sacramento River during their downstream migration through the Delta. Prevent emigrating salmonids from entering channels in the south Delta (*e.g.*, Old River, Turner Cut) that increase entrainment risk to CV steelhead migrating from the San Joaquin River through the Delta.

Action: Reclamation and/or DWR shall convene a working group to consider engineering solutions to further reduce diversion of emigrating juvenile salmonids to the interior Delta and consequent exposure to CVP and SWP export facilities. The working group, comprised of representatives from Reclamation, DWR, NMFS, USFWS, and CDFG, shall develop and evaluate proposed designs for their effectiveness. in reducing adverse impacts on listed fish and their critical habitat. Reclamation or DWR shall subject any proposed engineering solutions to external independent peer review and report the initial findings to NMFS by March 30, 2012. Reclamation or DWR shall provide a final report on recommended approaches by March 30, 2015. If NMFS approves an approach in the report, Reclamation or DWR shall implement it. To avoid duplication of efforts or conflicting solutions, this action should be coordinated with USFWS' Delta smelt biological opinion and BDCP's consideration of conveyance alternatives..

Rationale: One of the recommendations from the CALFED Science Panel peer review was to study engineering solutions to "separate water from fish." This action is intended to

address that recommendation. Years of studies have shown that the loss of migrating salmonids within Georgiana Slough and the Delta interior is approximately twice that of fish remaining in the Sacramento River main stem (Kjelson and Brandes 1989; Brandes and McLain 2001; Vogel 2004, 2008; and Newman 2008). Based on the estimated survival rate of 35 percent in Georgiana Slough (Perry and Skalski 2008), the fraction of emigrating salmonids that would be lost to the population is 6 to 15 percent of the number entering the Delta from the Sacramento River basin. Keeping emigrating fish in the Sacramento River would increase their survival rate. This action is also intended to allow for engineering experiments and possible solutions to be explored on the San Joaquin river/Southern Delta corridor to benefit out-migrating steelhead. For example, non-physical barrier (i.e., "bubble curtain") technology can be further vetted through this action.

Action Suite IV.2 Delta Flow Management

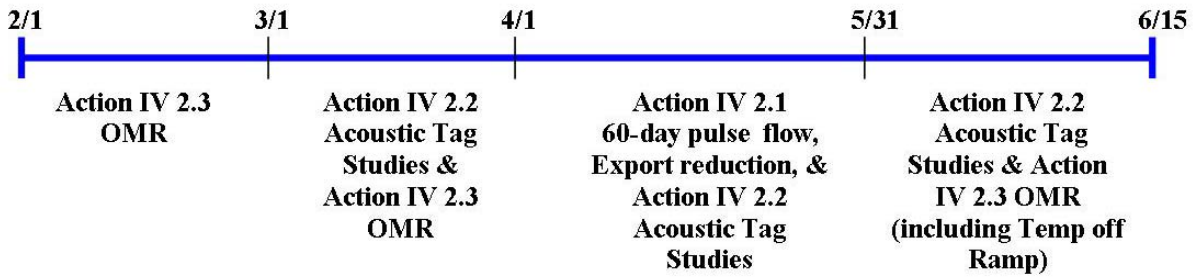
Objective: Maintain adequate flows in both the Sacramento River and San Joaquin River basins to increase survival of steelhead emigrating to the estuary from the San Joaquin River, and of winter-run, spring-run, CV steelhead, and green sturgeon emigrating from the Sacramento River through the Delta to Chipps Island.

Rationale for the Suite of Actions: Numerous studies have found positive associations between increased river flows and increased survival of salmon smolts through the Delta and the adult escapement of that cohort several years later when they return to spawn. Increased flows and greater smolt survival have been positively associated in other river systems as well Increased flows reduce the travel time of smolts moving through the river and Delta system, thus reducing the duration of their exposure to adverse effects from predators, water diversions, and exposure to contaminants.

Action IV.2.1 San Joaquin River Inflow to Export Ratio

Objectives: 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.

Action: The following timeline indicates the annual schedule for implementing related San Joaquin actions that will occur concurrent with this action.



Phase I: Interim Operations in 2010-2011.

From April 1 through May 31:

1. Flows at Vernalis (7-day running average shall not be less than 7 percent of the target requirement) shall be based on the New Melones Index[9]. In addition to the Goodwin flow schedule for the Stanislaus River prescribed in Action III.1.3 and Appendix 2-E, Reclamation shall increase its releases at Goodwin Reservoir, if necessary, in order to meet the flows required at Vernalis, as provided in the following table. NMFS expects that tributary contributions of water from the Tuolumne and Merced rivers, through the SJRA, will continue through 2011 and that the installation of a fish barrier at the Head of Old River will continue to occur during this period as permitted.

New Melones Index (TAF)	Minimum flow required at Vernalis (cfs)
0-999	No new requirements
1000-1399	D1641 requirements or 1500, whichever is greater
1400-1999	D1641 requirements or 3000, whichever is greater
2000-2499	4500
2500 or greater	6000

[9] The New Melones Index is a summation of end of February New Melones Reservoir storage and forecasted inflow using 50% exceedance from March through September.

2. Combined CVP and SWP exports shall be restricted through the following:

Flows at Vernalis (cfs)	Combined CVP and SWP Export
0-6,000	1,500 cfs
6,000-21,750[10]	4:1 (Vernalis flow:export ratio)
21,750 or greater	Unrestricted until flood recedes below 21,750

In addition:

1) Reclamation/DWR shall seek supplemental agreement with the SJRGA as soon as possible to achieve minimum long term flows at Vernalis (see following table) through all existing authorities.

San Joaquin River Index (60-20-20)	Minimum long-term flow at Vernalis (cfs)
Critically dry	1,500
Dry	3,000
Below normal	4,500
Above normal	6,000
Wet	6,000

Rationale:

1) Flows at Vernalis: Reclamation has limited discretion to require additional flows from the Tuolumne and Merced rivers that are necessary in the long run to meet the needs of outmigrating juvenile steelhead. Modeling for our analysis of the East Side Division show that relying on New Melones Reservoir to provide the flows at Vernalis cannot be sustained, and attempting to do so would likely have additional adverse effects on CV steelhead. Reclamation and DWR have obtained additional flows in the Tuolumne and Merced rivers through CVPIA authorities, including options to purchase water from willing sellers, and entered into the SJRA which expires on December 31, 2009. Reclamation is in negotiations to extend the current agreement to 2011. The flows required in Phase I at Vernalis were developed through iterative modeling and will provide an important increment of additional flow to provide for outmigration of steelhead smolts, while not unduly depleting New Melones Reservoir storage. Using CVPIA authorities, it is important that Reclamation seek to immediately change the terms of the existing SJRA to achieve the long-term flows.

[10] Flood warning stage at Vernalis is 24.5 feet, flow is 21,750 cfs at this point. Flood stage is 29 feet with a corresponding flow of 34,500 cfs. Data from CDEC looking at April 8-9, 2006 period. As such, recognizing that the flows associated with these stages do vary, the trigger allowing unrestricted exports will be a Vernalis stage of 24.5 feet.

2) The rationale for the export curtailments is provided in the rationale for Phase II.

3) The SWRCB has initiated proceedings to establish minimum flows in the San Joaquin River basin. The proceedings are scheduled to conclude in 2011. Flow requirements for fish will be provided by this action in the interim.

Phase II: Beginning in 2012:

From April 1 through May 31:

1. Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action III.1.3 and Appendix 2-E.

2. Reclamation and DWR shall implement the Vernalis flow-to-combined export ratios in the following table, based on a 14-day running average.

San Joaquin Valley Classification	Vernalis flow (cfs):CVP/SWP combined export ratio[11]
Critically dry	1:1[12]
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1
Vernalis flow equal to or greater than 21,750 cfs	Unrestricted exports until flood recedes below 21,750.

Exception procedure for multiple dry years: If the previous 2 years plus current year of San Joaquin Valley "60-20-20" Water Year Hydrologic Classification and Indicator as defined in D-1641 and provided in following table, is 6 or less, AND the New Melones Index is less than 1 MAF, exports shall be limited to a 1:1 ratio with San Joaquin River inflow, as measured at Vernalis.

San Joaquin Valley Classification	Indicator
Critically dry	1
Dry	2
Below normal	3
Above normal	4
Wet	5

[11] Exception to the ratio is provided for floods, where exports are not restricted until the flood recedes. See footnote 2 above.
[12] Minimum combined CVP and SWP exports is for health and safety.

Exception procedure for Health and Safety: If, by February 28 of a given year, Reclamation and DWR predict that they will not be able to achieve these ratios and make deliveries required for human health and safety, even after pursuing all options to augment inflow while preserving the ability to meet fish flow needs in all seasons, the agencies may submit a plan to NMFS to maximize anadromous fish benefits while meeting health and safety needs. The project agencies' current estimate of health and safety needs is a combined CVP/SWP export rate of 1,500 cfs. The plan must demonstrate that all opportunities for purchasing water in the San Joaquin Basin have been or will be exhausted, using b(3) or other water purchasing authority.

Meeting the long-term biological requirements of listed species and providing adequate water deliveries for these needs under the current system configuration may not be compatible, particularly considering anticipated hydrologic patterns associated with climate change. For this reason, Reclamation and DWR may propose a reconfiguration of the water conveyance system to allow diversion from the Sacramento River. Such an alteration of the conveyance system is being considered in the BDCP planning process. The operation of a conveyance structure that diverts water directly from the Sacramento River carries additional risk for listed species that migrate, spawn, or rear in the Sacramento River or North Delta. As detailed in this Opinion, the status of those species is precarious. Any new conveyance will be subject to section 7 consultation, and issues of injury or mortality of juvenile fish associated with all diversion facilities, reduction of flow variability for fish life history functions, reduction of Shasta Reservoir storage necessary for mainstem temperature control, and other potential adverse effects must be adequately addressed in any conveyance proposal.

Rationale: VAMP studies of CWT Chinook salmon smolts indicate that in general, fish released downstream of the zone of entrainment created by the export pumps (*e.g.*, Jersey Point) have higher survival indices to Chipps Island than fish released higher up in the system (*e.g.*, Durham Ferry, Mossdale, or Dos Reis). Studies identify increased flows as a factor that increases survival of tagged Chinook salmon smolts. To date, most VAMP experiments have utilized San Joaquin River flows to export pumping ratios of approximately 2:1. Survival to Chipps Island of smolts released upstream has been relatively low under these conditions. (Kjelson *et al*. 1981, Kjelson and Brandes 1989, SJRGA 2007). Historical data indicates that high San Joaquin River flows in the spring result in higher survival of outmigrating Chinook salmon smolts and greater adult returns 2.5 years later (Kjelson *et al.* 1981, Kjelson and Brandes 1989, USFWS 1995) and that when the ratio between spring flows and exports increase, Chinook salmon production increases (CDFG 2005, SJRGA 2007). NMFS, therefore, concludes that San Joaquin River Basin and Calaveras River steelhead would likewise benefit under higher spring flows in the San Joaquin River in much the same way as fall-run do. For a full explanation of data and analysis supporting this action, see appendix 5.

Increased flows within the San Joaquin River portion of the Delta will also enhance the survival of Sacramento River salmonids. Those fish from the Sacramento River which have been diverted through the interior Delta to the San Joaquin River will benefit by the increased net flow towards the ocean caused by the higher flows in the San Joaquin River from upstream and the reduced influence of the export pumps. Such flows will reduce the proportion of Sacramento River fish that continue southwards toward the pumps and increase the percentage that move

westwards toward Chipps Island and the ocean. Although the real environment is much more complex than this generality, in theory, increasing the speed of migration through a particular reach of river, or shortening the length of the migratory route decrease the extent of exposure to factors causing loss (Anderson *et al.* 2005)

Action IV.2.2 Six-Year Acoustic Tag Experiment

Objective: To confirm proportional causes of mortality due to flows, exports and other project and non-project adverse effects on steelhead smolts out-migrating from the San Joaquin basin and through the southern Delta.

Action: Reclamation and DWR shall fund a 6-year research-oriented action concurrent with Action IV.2.1.

The research shall be composed of studies utilizing acoustically-tagged salmonids, and will be implemented to assess the behavior and movement of the outmigrating fish in the lower San Joaquin River. The studies will include three releases of acoustic tagged fish, timed to coincide with different periods and operations: March 1 through March 31, April 1 through May 31, and June 1 through June 15. NMFS anticipates that studies will utilize clipped hatchery steelhead and hatchery fall-run as test fish.

During the period from March 1 through March 30, the exports will be operated in accordance with the requirements dictated by action IV.2.3. During the 60-day period between April 1 and May 30, exports will be dictated by the requirements of action IV.2.1. Reclamation shall operate to a minimum 1:1 inflow to export ratio during the period between June 1 and June 15, allowing exports to vary in relation to inflows from the San Joaquin to test varying flow to export ratios during this period. If daily water temperatures at Mossdale exceed 72°F for seven consecutive days during the period between June 1 and June 15, then the inflow to export ratio may be relaxed. NMFS anticipates that warm water conditions in the lower San Joaquin River will not be suitable for steelhead under these conditions.

Implementation procedures:

1) By September 1, 2009, Reclamation/DWR shall convene DOSS for the purpose of refining the study design for this experiment. The experiments shall be developed to ensure that results are statistically robust and uncertainties due to experimental design have been minimized to the fullest extent possible. Additional expertise may be included in the workgroup, at the discretion of the agencies.

2) Issues relevant to listed anadromous fish species that shall be addressed include, but are not limited to:
   a) Increasing survival of emigrating smolts from the tributaries into the main stem of the San Joaquin River.
   b) Increasing survival of emigrating smolts through the main stem of the San Joaquin River downstream into the Delta.

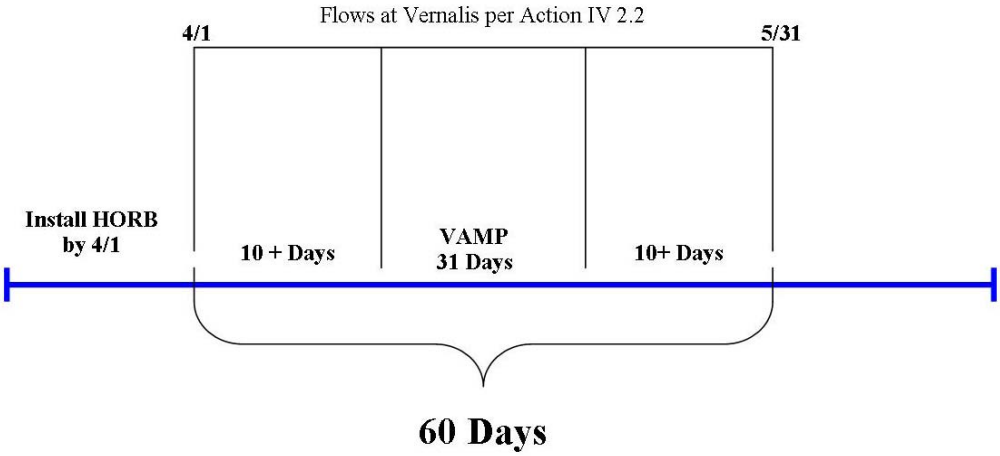
c) Increasing survival of emigrating smolts through the Delta to Chipps Island.
d) The role and influence of flow and exports on survival in these migratory reaches.
e) Selection of routes under the influence of flows and exports.
f) Identifying reach-specific mortality and or loss.
g) The effectiveness of experimental technologies, if any, *e.g.*, non-physical barrier ("bubble curtain**.")**

3) Annual reviews of the study results shall be conducted by the DOSS group. At the end of the 6-year period, a status review of Action IV.2.1 shall be prepared by the DOSS group. The status review shall be used to assess the success of Action IV.2.1 in increasing survival through the Delta for San Joaquin River basin salmonids, but in particular, steelhead. Based on the findings of the status review, the DOSS group will make recommendations to NMFS, Reclamation, CDFG, DWR, and USFWS on future actions to be undertaken in the San Joaquin River basin as part of an adaptive management approach to the basin's salmonid stocks.

4) Complementary studies to achieve performance goals**:** At its discretion, Reclamation and DWR also may develop and propose complementary studies to examine alternative actions that would accomplish the targeted survival performance goals. A primary effort of these studies will be to establish an appropriate survival goal for out-migrating steelhead smolts from Vernalis to Chipps Island in all water year types. Reclamation and DWR may propose studies which test actions that incorporate non-flow or non-export related actions. The studies shall contain specific actions within the authority and discretion of Reclamation and/or DWR, an evaluation of the projected benefits of each action with respect to increasing survival to the performance goal, evidence used to support this evaluation including literature citations, particle tracking modeling and other predictive tools, to demonstrate that the survival will be achieved, and a demonstration that the actions are reasonably certain to occur within the term of the study period. Any complementary study proposal shall be peer reviewed by the Calfed Science Program (or other comparable science group) and by the DOSS workgroup prior to being submitted to NMFS.

Upon receipt of the complementary study proposal, NMFS will review the draft proposal for sufficiency of information, experimental design, and likelihood to meet performance goals and provide comments back to Reclamation and DWR within 30 days of receipt. If NMFS concurs with the complementary study proposal, and finds the studies do not conflict with the actions implemented under the RPA, then the study may be conducted concurrently with the actions set forth above (Action IV.2.1 and IV.2.2). Throughout the six years of study, all new data will be annually evaluated by the proposed DOSS group, which will then provide recommendations through a written report to the management of NMFS and Reclamation for continuing actions in the San Joaquin River basin in support of CV steelhead.

Exception: If, despite Reclamation and DWR's best efforts, the new experiment is not ready for implementation in 2010, then VAMP study design may continue for 1 year, upon written concurrence of NMFS. A generalized representation of the design is provided, as follows:



Rationale: This experiment will provide important information about the response of fish migration to flows, exports, and other stressors in the San Joaquin River corridor. Flows and exports will be varied according to time period. From March 1 through March 31, the studies will assess the relationship of the Vernalis flow-to-export ratio under the OMR flow restriction (see Action IV.2.3) to route selection at channel bifurcations in the South Delta and mainstem San Joaquin River, survival in the different channels reaches of the South Delta, and ultimately through the Delta to Chipps Island as a whole.

From April 1 through May 30, the studies will assess the effectiveness of varying ratios by water year type (see Action IV.2.1) by comparing channel selection, route survival, and overall through-Delta survival during this period of stabilized conditions to the other two periods.

From June 1 to June 15, the studies will focus on the relative importance of exports, as compared to flows, by deliberately varying exports under similar flow conditions. Acoustic tagging studies have the potential to provide this level of resolution. Results from these studies may be able to indicate, at a fine temporal and spatial scale, how exports and flow influence route selection of migrating fish and their survival probabilities in the different channel reaches. Knowledge of these factors should aid in the management decision process and reduce project impacts to listed salmonids based on findings with strong scientific foundations.

<u>Action IV.2.3</u> Old and Middle River Flow Management

Objective: Reduce the vulnerability of emigrating juvenile winter-run, yearling spring-run, and CV steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta. Enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the mainstem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: From January 1 through June 15, reduce exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids. The reverse flow will be managed within this range to reduce flows toward the pumps during periods of increased salmonid presence. The negative flow objective within the range shall be determine based on the following decision tree:

Date	Action Triggers	Action Responses
January 1 – June 15	January 1 – June 15	Exports are managed to a level that produces a 14-day running average of the tidally filtered flow of (minus) -5,000 cfs in Old and Middle River (OMR). A five-day running average flow shall be calculated from the daily tidally filtered values and be no more than 25 percent more negative than the targeted requirement flow for the 14-day average flow.[13]

[13] Daily OMR flows used to compute the 14-day and 5-day averages shall be tidally filtered values reported by the USGS for the Old River at Bacon Island and Middle River at Middle River monitoring stations. The 14-day running average shall be no more negative than the targeted flow requirement. The 5-day running average shall be no more than 25 percent more negative than the targeted flow requirement. (Transition explanations below are based on personal communication Ryan Olah, USFWS, to ensure consistency of OMR measurements and averaging periods with implementation of OMR in Smelt Biological Opinion).

Transition to more restrictive (less negative) OMR limit

When a more restrictive Old and Middle River flow (OMR) limit is decided upon, the water projects may continue to operate to the old limit for up to two additional days, with both 5-day and 14-day averaging periods in effect. On the third day, the moving daily OMR will be no more negative than the new limit, and no moving averages will apply. New moving averages will be calculated from the third day forward. On the fourth day, OMR can be no more than 25% more negative than the daily OMR on the third day; On the fifth day, OMR can be no more than 25% more negative than the midpoint between the daily OMRs on the third day and the fourth day; on the sixth day, OMR can be no more than 25% more negative than the average of the OMRs on the third, fourth, and fifth day; and so on. From the 8th day forward, if OMR restrictions due to triggers are still be implemented, a full 5-day moving average will exist, and daily OMR on any day cannot be more than 25% more negative than the 5-day moving average. On the 17th day, a 14-day moving average will be available. Consequently, from the 17th day forward, the 14-day moving average cannot be more negative than the OMR limit.

Transition to less restrictive (more negative) OMR limit

When a less restrictive OMR limit is decided upon, the water projects may begin to operate to that limit on the same day. The 5-day and 14-day averaging periods will continue to be computed through the transition. However, the 5-day averaging period will not provide 25% flexibility from the day the new OMR is imposed through the 7th day after the new limit is adopted. Through the 7th day after imposition, daily OMR may not be more negative than the new limit.

January 1 – June 15 First Stage Trigger (increasing level of concern)	(1) Daily SWP/CVP older juvenile Chinook salmon[14] loss density (fish per taf) is greater than incidental take limit divided by 2000 (2 percent WR JPE ÷ 2000), with a minimum value of 2.5 fish per taf, or (2) daily SWP/CVP older juvenile Chinook salmon loss is greater than 8 fish/taf multiplied by volume exported (in taf) or (3) CNFH CWT LFR or LSNFH CWT WR cumulative loss greater than 0.5% for each surrogate release group, or (4) daily loss of wild steelhead (intact adipose fin) is greater than 8 fish/taf multiplied by volume exported (in taf)[15]	Reduce exports to achieve an average net OMR flow of (minus) -3,500 cfs for a minimum of 5 consecutive days. The five day running average OMR flows shall be no more than 25 percent more negative than the targeted flow level at any time during the 5-day running average period (*e.g.*, -4,375 cfs average over five days). Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction[16]. Reductions are required when any one criterion is met.
January 1 - June 15 Second Stage Trigger (analogous to high concern level)	(1) Daily SWP/CVP older juvenile Chinook salmon loss density (fish per taf) is greater than incidental take limit (2 percent of WR JPE) divided by 1000 (2 percent of WR JPE ÷ 1000), with a minimum value of 2.5 fish per taf, or (2) daily SWP/CVP older juvenile Chinook salmon loss is greater than 12 fish/taf multiplied by volume exported (in taf), or (3) daily loss of wild steelhead (intact adipose fin) is greater than 12 fish/taf multiplied by volume exported (in taf)	Reduce exports to achieve an average net OMR flow of (minus) -2,500 cfs for a minimum 5 consecutive days. Resumption of (minus) -5,000 cfs flows is allowed when average daily fish density is less than trigger density for the last 3 days of export reduction. Reductions are required when any one criterion is met.

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

[15] NMFS assumes that the loss of winter-run Chinook salmon and steelhead are similar in nature based on annual loss estimates. As an initial trigger, the density of steelhead, which includes smolts and adults, will be used in the same equation as the older juvenile salmon trigger to change OMR flows. This will be reviewed by the DOSS group annually and recommendations to the trigger criteria made based on an assessment of the results.

[16] Three consecutive days in which the loss numbers are below the action triggers are required before the OMR flow reductions can be relaxed to -5,000 cfs. A minimum of 5 consecutive days of export reduction are required for the protection of listed salmonids under the action. Starting on day three of the export curtailment, the level of fish loss must be below the action triggers for the remainder of the 5-day export reduction to relax the OMR requirements on day 6. Any exceedance of a more conservative trigger restarts the 5-day OMR action response with the three consecutive days of loss monitoring criteria.

End of Triggers	Continue action until June 15 or until average daily water temperature at Mossdale is greater than 72°F (22°C) for 7 consecutive days (1 week), whichever is earlier.	If trigger for end of OMR regulation is met, then the restrictions on OMR are lifted.

Implementation procedures: Combined exports will be managed to provide for an OMR flow of -5,000 cfs, tidally filtered over 14-days during the period between January 1 and June 15. The 5-day running average shall be no more than 25 percent more negative than the targeted flow requirement. Further reductions in exports will occur in a tiered fashion depending on the magnitude of Chinook salmon and steelhead salvage at the CVP and SWP fish salvage facilities. There are two export reductions triggered by increases in fish salvage rates at the fish collection. The first reduction decreases exports to achieve a net average OMR flow of -3,500 cfs over a minimum of 5 consecutive days. The second reduction, based on higher salvage numbers, further reduces exports to achieve a net average OMR flow of -2,500 cfs over a minimum of 5 days.

Alternatively, to provide flexibility in operations, once an action trigger is met, combined exports could be reduced immediately to a floor of 1,500 cfs (*i.e.*, the project operators would not be required to reduce combined exports to less than 1,500 cfs) until the required OMR limit is met.

These actions will be taken in coordination with USFWS RPA for Delta smelt and State-listed longfin smelt 2081 incidental take permit. During the January 1 through June 15 period, the most restrictive export reduction shall be implemented. If the USFWS Delta smelt RPA requires greater reductions in exports than those required by NMFS for salmonids, to achieve a more positive OMR flow, then the smelt action will be implemented, since it also will increase survival of listed salmonids. Likewise, if the NMFS RPA criteria are more restrictive than those called for under the Delta smelt RPA, then NMFS RPA criteria will prevail and will increase survival of Delta smelt as well as salmonids.

Rationale: Juvenile listed salmonids emigrate downstream in the main channel of the San Joaquin River during the winter and spring period. Juvenile listed steelhead from the San Joaquin River basin, the Calaveras River basin, and the Mokelumne River basin also utilize the lower reaches of the San Joaquin River as a migration corridor to the ocean. The river reach between the Port of Stockton and Jersey Point has many side channels leading south toward the export facilities. High export levels draw water through these channels toward the pumps, as these channels are the conduits that supply water to the pumps from the north. Outputs from PTM simulations, as well as data from acoustic tagging studies (Vogel 2004, SJRGA 2006, 2007), show that migrating fish are vulnerable to diversion into these channels and respond to flow within the channels, including the net migration speed downstream (SJRGA 2008).

The acoustic tagging studies also indicate that fish behavior is complex, with fish exhibiting behavior that is not captured by the "tidal surfing' model utilized as one of the options in the PTM simulations. Fish made their way downstream in a way that was more complicated than simply riding the tide, and no discernable phase of the tide had greater net downstream movement than another. Furthermore, tagged fish chose channels leading south more frequently when exports were elevated, than when exports were lower (Vogel 2004). Fish that moved into channels leading south may eventually find their way back to the main channel of the San Joaquin, but this roundabout migratory path exposes fish to higher predation risks as well as the potential to become lost within the Delta interior, increasing migration route length and duration of the outmigration. Increased time in the channels of the Central and South Delta exposes fish to unscreened agricultural diversions, discharges of agricultural irrigation return water to the Delta, increased water temperature later in the season, and the risk of predation from pelagic predators such as striped bass and localized ambush predators such as largemouth bass. In order to increase the likelihood of survival, emigrating steelhead from the San Joaquin Basin and the east-side tributaries should remain in the mainstem of the San Joaquin River to the greatest extent possible and reduce their exposure to the adverse effects that are present in the channels leading south toward the export facilities.

Reducing the risk of diversion into the central and southern Delta waterways also will increase survival of listed salmonids and green sturgeon entering the San Joaquin River via Georgiana Slough and the lower Mokelumne River. As described in the effects section of the Opinion, these fish also are vulnerable to entrainment by the far-field effects of the exports. The data output for the PTM simulation of particles injected at the confluence of the Mokelumne River and the San Joaquin River (Station 815) indicate that as net OMR flow increases southwards from -2,500 to -3,500 cfs, the risk of particle entrainment nearly doubles from 10 percent to 20 percent, and quadruples to 40 percent at -5,000 cfs. At flows more negative than -5,000 cfs, the risk of entrainment increases at an even greater rate, reaching approximately 90 percent at -7,000 cfs. Even if salmonids do not behave exactly as neutrally buoyant particles, the risk of entrainment escalates considerably with increasing exports, as represented by the net OMR flows. The logical conclusion is that as OMR reverse flows increase, risk of entrainment into the channels of the South Delta is increased. Conversely, the risk of entrainment into the channels of the South delta is reduced when exports are lower and the net flow in the OMR channels is more positive -- that is, in the direction of the natural flow toward the ocean.

Rationale for 2011 amendments:

1) First OMR trigger: This was clarified to identify the loss as pertaining to older juvenile Chinook salmon.
2) Second OMR trigger: The second trigger, as described in the 2009 RPA, was not workable as drafted[17]. During 2010, DOSS convened a subgroup to revise the second trigger (both the first and second stages), based on discussions that led to the development of the salmon decision tree.

[17] See Attachment 1 for discussions regarding how the second trigger was not workable.

3) Third OMR trigger:
   a) First stage trigger: This was clarified to reflect that the trigger applies to each surrogate release group.
   b) Second stage trigger: The first and second stage triggers for surrogate release groups are exactly the same. Therefore, the second stage trigger for surrogate releases was deleted to avoid confusion in implementation of the action response.
4) Fourth OMR trigger: The fourth OMR trigger was the same as the second OMR trigger, but applied to steelhead. As with the second OMR trigger (applied to Chinook salmon), it was not workable as drafted. The fourth OMR trigger was corrected.
5) Action response: In the 2009 RPA, the action response read as if the 3 days of average daily fish density less than the trigger density had to occur after the 5 days of export reductions. The language for both the first and second stage triggers was clarified in the 2011 amendment so that the average daily fish density is less than the trigger density for the last 3 consecutive days of export reductions.
6) Footnote 16: The last sentence was clarified to say that a new action response applies only if a more conservative (*i.e.*, less negative) OMR flow trigger is met.

Rationale for 2011 amendment to implementation procedure: What the fish need is a rapid response to redirect their migration from the south Delta and pumps. OMR flows are influenced by tidal and other physical forces that are beyond the control of the project operators, and therefore, may prevent strict adherence to the specific OMR flow limits. As a result, combined exports quickly reduced to 1,500 cfs will be deemed compliance if OMR flows do not actually meet the required action responses specified in the table, above. There may be more flexibility in the OMR, and therefore, exports, later in the averaging period. This amendment was supported by the ISP.

Action IV.3 Reduce Likelihood of Entrainment or Salvage at the Export Facilities

Objective: Reduce losses of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon by reducing exports when large numbers of juvenile Chinook salmon are migrating into the upper Delta region, at risk of entrainment into the central and south Delta and then to the export pumps in the following weeks.

Action: From November 1 through April 30, operations of the Tracy and Skinner Fish Collection Facilities shall be modified according to monitoring data from upstream of the Delta. In conjunction with the two alerts for closure of the DCC (Action IV.1.1), the Third Alert shall be used to signal that export operations may need to be altered in the near future due to large numbers of juvenile Chinook salmon migrating into the upper Delta region, increasing their risk of entrainment into the central and south Delta and then to the export pumps.

Third Alert: The catch index is greater than 10 fish captured per day from November 1 to February 28, or greater than 15 fish captured per day from March 1 to April 30, from either the Knights Landing catch index or the Sacramento catch index.

Response: From November 1 through December 31, when salvage numbers reach the action triggers, exports shall be reduced as follows:

Date	Action Triggers	**Action Responses**
November 1 – December 31	Daily SWP/CVP older juvenile loss density greater than 8 fish/thousand acre feet (taf), or daily loss is greater than 95 fish per day, or Coleman National Fish Hatchery coded wire tagged late fall-run Chinook salmon (CNFH CWT LFR) or Livingston Stone National Fish Hatchery coded wire tagged winter-run (LSNFH CWT WNT) cumulative loss is greater than 0.5%.	Reduce exports to a combined 6,000 cfs for 3 days or until CVP/SWP daily density is less than 8 fish/taf. Export reductions are required when any one of the four criteria is met.
	Daily SWP/CVP older juvenile loss density greater than 15 fish/taf, or daily loss is greater 120 fish per day, or CNFH CWT LFR or LSNFH CWT WNT cumulative loss greater than 0.5%.	Reduce exports to a combined 4,000 cfs for 3 days or until CVP/SWP daily density is less than 8 fish/taf. Export reductions are required when any one of the four criteria is met.

From January 1 through April 30, implement Action IV.2.3 which include restrictions on OMR flows rather than set levels of combined export pumping. Alert triggers will remain in effect to notify the operators of the CVP and SWP that large numbers of juvenile Chinook salmon are entering the Delta system.

Rationale: As explained previously, juvenile salmonids and green sturgeon have a lower chance of survival to the ocean if they are diverted from their migratory routes on the main Sacramento and San Joaquin Rivers into the central and south Delta. Export pumping changes flow patterns and increases residence time of these diverted fish in the central Delta, which increases the risk of mortality from predation, water diversions, poor water quality, and contaminant exposure, as well as the likelihood of entrainment at the pumps. When more fish are present, more fish are at risk of diversion and losses will be higher. The Third Alert is important for real-time operation of the export facilities because the collection and dissemination of field data to the resource agencies and coordination of response actions may take several days. This action is designed to work in concert with the OMR action in IV.2.3.

Action Suite IV.4 Modifications of the Operations and Infrastructure of the CVP and SWP Fish Collection Facilities

Objective: Achieve 75 percent performance goal for whole facility salvage at both state and Federal facilities. Increase the efficiency of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage survival of winter-run, spring-run, CV steelhead, and green sturgeon.

Action: Reclamation and DWR shall each achieve a whole facility salvage efficiency of 75 percent at their respective fish collection facilities. Reclamation and DWR shall implement the following actions to reduce losses associated with the salvage process, including: (1) conduct studies to evaluate current operations and salvage criteria to reduce take associated with salvage, (2) develop new procedures and modifications to improve the current operations, and (3) implement changes to the physical infrastructure of the facilities where information indicates such changes need to be made. Reclamation shall continue to fund and implement the CVPIA Tracy Fish Facility Program. In addition, Reclamation and DWR shall fund quality control and quality assurance programs, genetic analysis, louver cleaning loss studies, release site studies and predation studies. Funding shall also include new studies to estimate green sturgeon screening efficiency at both facilities and survival through the trucking and handling process.

By January 31 of each year, Reclamation and DWR shall submit to NMFS an annual progress report summarizing progress of the studies, recommendations made and/or implemented, and whole facility salvage efficiency. These reports shall be considered in the Annual Program Review.

Action IV.4.1 Tracy Fish Collection Facility (TFCF) Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency

Objective: Implement specific measures to reduce pre-screen loss and improve screening efficiency at Federal facilities**.**

Action: Reclamation shall undertake the following actions at the TFCF to reduce pre-screen loss and improve screening efficiency:

1) By December 31, 2012, improve the whole facility efficiency for the salvage of Chinook salmon, CV steelhead, and Southern DPS of green sturgeon so that overall survival is greater than 75 percent for each species.

    a) By December 31, 2011, Reclamation shall complete studies to determine methods for removal of predators in the primary channel, using physical and non-physical removal methods (*e.g.*, electricity, sound, light, CO_2), leading to the primary louver screens with the goal of reducing predation loss to ten percent or less. Findings shall be reported to NMFS within 90 days of study completion. By December 31, 2012, Reclamation shall implement measures to reduce pre-screen predation in the primary channel to less than ten percent of exposed salmonids.
    b) By March 31, 2011, Reclamation shall complete studies for the re-design of the secondary channel to enhance the efficiency of screening, fish survival, and reduction of predation within the secondary channel structure and report study findings to NMFS. NMFS shall review study findings and if changes are deemed feasible, Reclamation shall initiate the implementation of the study findings by January 31, 2012.
    c) No later than June 2, 2010, Reclamation shall submit to NMFS, one or more potential solutions to the loss of Chinook salmon and green sturgeon associated with the

cleaning and maintenance of the primary louver and secondary louver systems at the TFCF. In the event that a solution acceptable to NMFS is not in place by June 2, 2011, pumping at the Tracy Pumping Plant shall cease during louver cleaning and maintenance operations to avoid loss of fish during these actions.

2) By December 31, 2011, Reclamation shall implement operational procedures to optimize the simultaneous salvage of juvenile salmonids and Delta smelt at the facility.

3) Immediately upon issuance of this biological opinion, Reclamation shall begin removing predators in the secondary channel at least once per week. By June 2, 2010, Reclamation shall install equipment to monitor for the presence of predators in secondary channel during operations. This could include an infrared or low light charged coupled device camera or acoustic beam camera mounted within the secondary channel.

4) Reclamation shall operate the facility to meet design criteria for louver bypasses and channel flows at least 75 percent efficiency.

5) Reclamation shall maintain a head differential at the trash rack of less than 1.5 ft. between the ambient Old River water surface elevation and the primary intake channel at all times.

6) By January 2, 2010, Reclamation shall install and maintain flow meters in the primary and secondary channels to continuously monitor and record the flow rates in the channel. Deviations from design flow criteria shall initiate immediate corrective measures to remedy deficiencies and return channel flows to design flow specifications.

7) Reclamation shall change its operations of the TFCF to meet salvage criteria, while emphasizing the following actions: (a) Primary Bypass Ratio; (b) Secondary Bypass Ratio; (c) Primary Average Channel Velocity; and (d) Secondary Average Channel Velocity.

8) Records of all operating actions shall be kept and made available to NMFS engineers upon request. NMFS shall be notified of any major or long-term deviations from normal operating design criteria within 24 hours of occurrence.

Action IV.4.2 Skinner Fish Collection Facility Improvements to Reduce Pre-Screen Loss and Improve Screening Efficiency

Objective: Implement specific measures to reduce pre-screen loss and improve screening efficiency at state facilities**.**

Action: DWR shall undertake the following actions at the Skinner Fish Collection Facility:

1) By December 31, 2012, operate the whole Skinner Fish Protection Facility to achieve a minimum 75 percent salvage efficiency for CV salmon, steelhead, and Southern DPS of green sturgeon after fish enter the primary channels in front of the louvers.

2) Immediately commence studies to develop predator control methods for Clifton Court Forebay that will reduce salmon and steelhead pre-screen loss in Clifton Court Forebay to no more than 40 percent.

    a) On or before March 31, 2011, improved predator control methods. Full compliance shall be achieved by March 31, 2014. Failure to meet this timeline shall result in the cessation of incidental take exemption at SWP facilities unless NMFS agrees to an extended timeline.
    b) DWR may petition the Fish and Game Commission to increase bag limits on striped bass caught in Clifton Court Forebay.

3) Remove predators in the secondary channel at least once per week.

Action IV.4.3 Tracy Fish Collection Facility and the Skinner Fish Collection Facility Actions to Improve Salvage Monitoring, Reporting and Release Survival Rates

Objective: To improve overall survival of listed species at facilities through accurate, rapid salvage reporting and state-of-the-art salvage release procedures. This reporting is also necessary to provide information needed to trigger OMR actions.

Action: Reclamation and DWR shall undertake the following actions at the TFCF and the Skinner Fish Collection Facility, respectively. Actions shall commence by October 1, 2009, unless stated otherwise.

1) Sampling rates at the facilities for fish salvage counts shall be no less than 30 minutes every 2 hours (25 percent of operational time) year-round to increase the accuracy of salvage estimates used in the determination of trigger levels. Exceptions to the 30-minute count may occur with NMFS' concurrence under unusual situations, such as high fish densities or excessive debris loading.

2) By October 1, 2010, websites shall be created or improved to make salvage count data publicly available within 2 days of observations of the counts. Information available on the website shall include at a minimum:

    a) duration of count in minutes;
    b) species of fish salvaged;
    c) number of fish salvaged including raw counts and expanded counts;
    d) volume of water in acre-feet, and average daily flow in cfs;
    e) daily average channel velocity and bypass ratio in each channel, primary and secondary;
    f) average daily water temperature and electrical conductivity data for each facility; and

g) periods of non-operation due to cleaning, power outages, or repairs.

3) Release Site Studies shall be conducted to develop methods to reduce predation at the "end of the pipe" following release of salvaged fish. Studies shall examine but are not limited to:

   a) potential use of barges to release the fish in different locations within the western Delta, with slow dispersion of fish from barge holding tanks to Delta waters;
   b) multiple release points (up to six) in western Delta with randomized release schedule; and
   c) conducting a benefit to cost analysis to maximize this ratio while reducing predation at release site to 50 percent of the current rate.

4) By June 15, 2011, predation reduction methods shall be implemented according to analysis in 3. By June 15, 2014, achieve a predation rate that has been reduced 50 percent from current rate.

5) Add salt to water within the tanker trucks hauling fish to reduce stress of transport. Assess use of other means to reduce stress, protect mucous slime coat on fish, and prevent infections from abrasions (*i.e.*, commercially available products for this purpose).

6) All personnel conducting fish counts must be trained in juvenile fish identification and have working knowledge of fish physiology and biology.

7) Tanker truck runs to release salmonids should be scheduled at least every 12 hours, or more frequently if required by the "Bates Table" calculations (made at each count and recorded on the monthly report).

8) Reclamation and DWR shall use the Bates Table to maintain suitable environmental conditions for fish in hauling trucks. Trucks should never be overcrowded so that the carrying capacity of the tanker truck is exceeded.

Rationale: The process for salvaging listed salmonids and green sturgeon that are drawn into the pumping facilities is not efficient. For salmonids, at the Skinner Fish Protection Facility, loss rates can be as high as five fish lost for every fish salvaged. Most of this loss occurs in the forebay before the fish even encounter the fish screen louvers and the screening process. Conversely, at the Federal TFCF, most loss occurs because of poor screening efficiency in the louver array, although predation also occurs in front of the trash racks and in the primary channel leading to the primary louver array. Louver array cleaning protocols also lead to high loss rates because louvers are removed during cleaning, but pumping continues and fish are drawn directly into the facilities. The efficiency of the salvage process for green sturgeon is unknown, and this is a significant gap in the operational protocol for the facilities. The 2004 CVP/SWP operations Opinion identified terms and conditions to be implemented regarding salvage improvements, including evaluations for operational

improvements. Some of those terms and conditions have been implemented but many have not.

Action IV.5 Formation of Delta Operations for Salmon and Sturgeon (DOSS) Technical Working Group

Objective: Create a technical advisory team .that will provide recommendations to WOMT and NMFS on measures to reduce adverse effects of Delta operations of the CVP and SWP to salmonids and green sturgeon and will coordinate the work of the other technical teams.

Action: The DOSS group will be comprised of biologists, hydrologists, and other staff with relevant expertise from Reclamation, DWR, CDFG, USFWS, and NMFS. Invitations to EPA, USGS, and Regional Water Quality Board biologists will be extended to provide expertise on issues pertinent to Delta water quality, hydrology and environmental parameters. By October 1, 2009, Reclamation shall, jointly with NMFS, convene the DOSS working group. The working group will have biweekly phone conferences, or more frequently if necessary for real-time operations, and meet at least quarterly to discuss and review information related to project operations and fisheries issues. Either Reclamation or NMFS may call for a special meeting of the DOSS group if they deem it necessary.

The team will:

1) provide recommendations for real-time management of operations to WOMT and NMFS, consistent with implementation procedures provided in this RPA;
2) review annually project operations in the Delta and the collected data from the different ongoing monitoring programs;

3) track the implementation of Actions IV.1 through IV.4;

4) evaluate the effectiveness of Actions IV.1 through IV.4 in reducing mortality or impairment of essential behaviors of listed species in the Delta;

5) oversee implementation of the acoustic tag experiment for San Joaquin fish provided for in Action IV.2.2;

6) coordinate with the SWG to maximize benefits to all listed species; and

7) coordinate with the other technical teams identified in this RPA to ensure consistent implementation of the RPA.

The DOSS team shall provide annual written reports to Reclamation, DWR, and NMFS, including a summary of major actions taken during the year to implement Action Suite IV of this RPA, an evaluation of their effectiveness, and recommendations for future actions. At the technical staff level, the working group will coordinate with the DAT, the SWG, and other workgroups to ensure coherent and consistent implementation of actions in the Delta.

Every five years, the DOSS working group will produce a summary report of the previous five years of operations, actions taken, and the effectiveness of those actions in achieving the objectives of the Delta actions in this RPA. Included in this report will be recommendations for adaptive management changes consistent with the objectives of this RPA. The report will be provided to NMFS, Reclamation, DWR, CDFG and USFWS.

The DOSS group shall also provide a coordinating function for the other technical working groups, to assure that relevant information from all technical groups is considered in actions to implement this RPA.

Rationale: This RPA contains a series of measures to minimize adverse effects of project operations in the Delta. An interagency technical team is necessary to track implementation of these measures, recommend actions within the boundaries of the implementation procedures in this document, and to build expertise over time to recommend changes to Delta operations. Any significant changes to Operations will trigger re-initiation of this opinion.

Action IV.6 South Delta Improvement Program—Phase I (Permanent Operable Gates)

Action: DWR shall not implement the South Delta Improvement Program, which is a proposal to replace temporary barriers with permanent operable gates.

Rationale: In a separate formal consultation (2009/01239), NMFS issued a 2008 biological opinion on the installation and operation of temporary barriers through 2010 (NMFS 2008). That biological opinion concluded that the temporary barriers would not jeopardize the continued existence of listed species or adversely modify critical habitat. This CVP/SWP operations Opinion concludes that on the basis of the best information available, the proposed replacement of these temporary barriers with permanent operable gates will adversely modify critical habitat. NMFS has not identified an alternative to the proposed permanent gates that meets ESA obligations.

After analyses of the operations of the temporary barriers are completed, as specified in the 2008 biological opinion, DWR may request that Reclamation reinitiate consultation with NMFS on the South Delta Improvement Program or may pursue permitting under ESA section 10. Additionally, DWR may apply information developed from Action IV.1.2 to modify the barrier design.

V. Fish Passage Program

Introduction: The duration of the proposed action is more than two decades. The long time horizon of the consultation requires NMFS to anticipate long-term future events, including increased water demand and climate change. The effects analysis in this Opinion highlights the difficulty of managing cold water aquatic species below impassible barriers, depending entirely on a fluctuating and often inadequate cold water reservoir pool. The analysis shows that even after all discretionary actions are taken to operate Shasta and Folsom reservoirs to reduce adverse effects of water operations on listed anadromous fish, the risk of temperature-related mortality of

fish and eggs persists, especially in critically dry years. This mortality can be significant at the population level. The analysis also leads us to conclude that due to climate change, the frequency of these years will increase.

Therefore, NMFS believes it is necessary for Reclamation, in cooperation with NMFS, other fisheries agencies, and DWR, to undertake a program to provide fish passage above currently impassable artificial barriers for Sacramento River winter-run, spring-run, and CV steelhead, and to reintroduce these fish to historical habitats above Shasta and Folsom Dams. Substantial areas of high quality habitat exist above these dams: there are approximately 60 mainstem miles above Lake Shasta and 50 mainstem miles above Lake Folsom. These high-elevation areas of suitable habitat will provide a refuge for cold water fish in the face of climate change.

An RPA requiring a fish passage program has recently been issued by the Northwest Region of NMFS, as part of the Willamette Projects Biological Opinion (NMFS 2008). This jeopardy biological opinion resulted from the operation of a series of Federal projects in Oregon. That RPA represents the state-of-the-art program to address passage concerns such as residualism (failure to complete the downstream migration) and predation. The following suite of actions is similar, but not identical, to those in the Willamette projects Opinion. There are several designs available for passage, and some are likely to be more effective in some locations than others. Consequently, while NMFS suggests that Reclamation learn from the Willamette experience, the actions allow Reclamation to follow different critical paths, particularly with respect to the construction of a downstream passage prototype.

The Fish Passage Program includes a fish passage assessment for evaluating steelhead passage above Goodwin, Tulloch, and New Melones Dams on the Stanislaus River. The assessment will develop information necessary for consideration and development of fish passage options for the Southern Sierra Diversity Group of CV steelhead. Although pilot testing of passage in the Stanislaus is encouraged, it is not specifically required.

The Fish Passage Program Action includes several elements that are intended to proceed in phases. The near-term goal is to increase the geographic distribution and abundance of listed species. The long-term goal is to increase abundance, productivity, and spatial distribution, and to improve the life history and genetic diversity of the target species. Several actions are included in this program, as indicated in the following outline of the program:

Near-Term Fish Passage Actions:

- NF 1. Formation of Interagency Fish Passage Steering Committee
- NF 2. Evaluation of Habitat Above Dams
- NF 3. Development of Fish Passage Pilot Plan
- NF 4. Implementation of Pilot Reintroduction Program
  - NF 4.1. Adult Fish Collection and Handling Facilities
  - NF 4.2. Adult Fish Release Sites above Dams, and Juvenile Fish Sites Below Dams
  - NF 4.3. Capture, Trapping, and Relocation of Adults
  - NF 4.4. Interim Downstream Fish Passage through Reservoirs and Dams
  - NF 4.5. Juvenile Fish Collection Prototype

NF 4.6. Pilot Program Effectiveness Monitoring and Evaluation
NF 4.7. Stanislaus River Fish Passage Assessment
NF 5. Comprehensive Fish Passage Report

Long-Term Fish Passage Actions:
LF 1. Long-term Funding and Support for the Interagency Fish Passage Steering Committee.
LF 2. Long-term Fish Passage Program
LF 2.1. Construction and Maintenance of Adult and Juvenile Fish Passage Facilities
LF 2.2. Development of Supplementation and Management Plan
LF 2.3. Construction and Maintenance of Long-term Adult and Juvenile Release Locations and Facilities.
LF 2.4. Development of Fish Passage Monitoring and Evaluation Plan

NEAR-TERM FISH PASSAGE ACTIONS

NF 1. Formation of Interagency Fish Passage Steering Committee

Objective: To charter, and support through funding agreements, an interagency steering committee to provide oversight and technical, management, and policy direction for the Fish Passage Program.

Action: By December 2009, Reclamation shall establish, chair and staff the Interagency Fish Passage Steering Committee. The Committee shall be established in consultation with and the approval of NMFS and shall include senior biologists and engineers with experience and expertise in fish passage design and operation, from Reclamation, NMFS, DWR, CDFG, and USFWS. The Steering Committee also shall include academic support by including at least one academic member from a California University with and established fishery program. The committee shall be limited to agency membership unless otherwise approved by Reclamation and NMFS. Steering committee membership shall include on lead member and one alternate.

Rationale: Interagency coordination and oversight is critical to ensuring the success of the fish passage program.

NF 2. Evaluation of Salmonid Spawning and Rearing Habitat Above Dams

Objective: To quantify and characterize the location, amount, suitability, and functionality of existing and/or potential spawning and rearing habitat for listed species above dams operated by Reclamation.

Action: Beginning in January 2010 and continuing through January 2012, Reclamation, shall conduct habitat evaluations to quantify and characterize the location, amount, suitability, and functionality of existing and/or potential spawning and rearing habitat for

listed species above the project reservoirs. Reclamation shall obtain the Steering Committee's assistance in designing and implementing the habitat evaluations. Evaluations shall be conducted using established field survey protocols such as the USFS Region 5 Stream Condition Inventory, Field Intensive and Field Extensive protocols; and habitat models including the Salmon Habitat Integrated Resource Analysis (Shiraz) in combination with the Distributed Hydrology Soil Vegetated Model (DHSVM) or RIPPLE. Shiraz is a life-cycle model that incorporates stream flow and temperature inputs from DHSVM to develop future projections of salmon population sizes. Ripple uses digital terrain information with aquatic habitat and biological data to identify habitat limitations that affect salmon production. Both modeling approaches have been applied in the Washington and Oregon assess the value of providing passage to salmonids to historically available habitat.

Rationale: The condition and suitability of historical habitats located above impassable barriers is likely to have changed considerably since last occupied by anadromous fish. The location, quantity, and condition of habitat must be inventoried and assessed in order to evaluate the current carrying capacity and restoration potential. This information is essential to determine where passage and reintroduction, if feasible, are most likely to improve reproductive success for listed fish.

NF 3. Development of Fish Passage Pilot Plan

Action: From January 2010 through January, 2011, Reclamation, with assistance from the Steering Committee, shall complete a 3-year plan for the Fish Passage Pilot program. The plan shall include: (1) a schedule for implementing a 3-year Pilot Passage program on the American River above Nimbus and Folsom dams, and on the Sacramento River above Keswick and Shasta dams; and (2) a plan for funding the passage program. This plan and its annual revisions shall be implemented upon concurrence by NMFS that it is in compliance with ESA requirements. The plan shall include, but not be limited to, the following:

1) Identify any operational requirements needed for the passage and re-introduction program.

2) Identify protocols for optimal handling, sorting, and release conditions for ESA-listed fish collected at Reclamation or partner agency-funded fish collection facilities when they are constructed.

3) Identify the number, origin, and species of fish to be released into habitat upstream of Reclamation dams, incorporated into the hatchery broodstock, or taken to other destinations.

4) Identify fish collection and transportation requirements (*e.g.*, four wheel-drive vehicles, smooth-walled annular tanks, large vertical slide gates, provisions for tagging/marking, *etc*.) for moving fish from below project dams to habitats above reservoirs, avoiding the use of facilities or equipment dedicated for other purposes (*e.g.*, existing transport trucks).

5) Identify optimal release locations for fish, based on access, habitat suitability, disease concerns, and other factors (*e.g.*, those which would minimize disease concerns, recreational fishery impacts, interbreeding with non-native *O. mykiss* strains, regulatory impacts, special authorities for studies/construction, complications from upstream dams, *etc*.).

6) Identify and evaluate options for providing tailored ESA regulatory assurances for non-Federal landowners above the dams where species could be re-introduced.

7) Identify interim downstream fish passage options through reservoirs and dams with the objective of identifying volitional downstream passage scenarios and alternatives for juvenile salmon and steelhead migrating through or around project reservoirs and dams. If these options are not considered feasible, identify interim non-volitional alternatives. Near-term operating alternatives that are determined to be technically and economically feasible and biologically justified shall be identified by Reclamation and the steering committee agencies.

8) Describe scheduled and representative types of unscheduled, maintenance of existing infrastructure (dams, transmission lines, fish facilities, *etc*.) that could adversely impact listed fish, and describe measures to minimize these impacts.

9) Describe procedures for coordinating with Federal and state resource agencies in the event of scheduled and unscheduled maintenance.

10) Describe protocols for emergency events and deviations.

Reclamation and partner agencies shall annually revise and update the Fish Passage Pilot Plan. The revisions and updates shall be based on results of Fish Passage Pilot Plan activities, construction of new facilities, recovery planning guidance, predicted annual run size, and changes in hatchery management. By January 15 of each year, Reclamation shall submit a revised draft plan to NMFS. By February 15, NMFS shall advise Reclamation and partner agencies whether it concurs that the revised Fish Passage Plan is likely to meet ESA requirements. Reclamation and partner agencies shall release a final updated Fish Passage Pilot Plan by March 14 of each year.

Rationale: The Fish Passage Pilot Plan is a critical link between measures in the Proposed Action and this RPA and the long-term fish passage program. The plan will provide a blueprint for obtaining critical information about the chances of successful reintroduction of fish to historical habitats and increasing the spatial distribution of the affected populations. By including emergency operations within the Plan, field staff will have a single manual to rely on for all fish-related protocols, including steps that should be taken in emergency situations to minimize adverse effects to fish.

NF 4. Implementation of Pilot Reintroduction Program

Objective: To implement short-term fish passage actions that will inform the planning for long-term passage actions.

Actions: From January 2012 through 2015, Reclamation shall begin to implement the Pilot Reintroduction Program (see specific actions below). The Pilot Program will, in a phased approach, provide for pilot reintroduction of winter-run and spring-run to habitat above Shasta Dam in the Sacramento River, and CV steelhead above Folsom Dam in the American River. This interim program will be scalable depending on source population abundance, and will not impede the future installation of permanent facilities, which require less oversight and could be more beneficial to fish. This program is not intended to achieve passage of all anadromous fish that arrive at collection points, but rather to phase in passage as experience with the passage facilities and their benefits is gained.

Rationale: The extent to which habitats above Central Valley dams can be successfully utilized for the survival and production of anadromous fish is currently unknown. A pilot reintroduction program will allow fishery managers to incrementally evaluate adult reintroduction locations, techniques, survival, distribution, spawning, and production, and juvenile rearing, migration. The pilot program also will test juvenile collection facilities.

This action requires facility improvements or replacements, as needed, and establishes dates to complete work and begin operation. In some cases, work could be initiated sooner than listed above, and NMFS expects Reclamation and partner agencies to make these improvements as soon as possible.

Because these facilities will be used in lieu of volitional fish passage to provide access to historical habitat above the dams, this measure is an essential first step toward addressing low population numbers caused by decreased spatial distribution, which is a key limiting factor for Chinook salmon and CV steelhead.

Upstream fish passage is the initial step toward restoring productivity of listed fish by using large reaches of good quality habitat above project dams. Restriction to degraded habitat below the dams has significantly impaired reproductive success and caused steep declines in abundance.

NF 4.1. Adult Fish Collection and Handling Facilities

Beginning in 2012, Reclamation, with assistance from the Steering Committee, shall design, construct, install, operate and maintain new or rebuilt adult fish collection, handling and transport facilities at the sites listed below. The objective is to provide interim facilities to pass fish above project facilities and reservoirs.

Reclamation and partner agencies shall incorporate NMFS' Fish Screening Criteria for Anadromous Salmonids (NMFS 1997a) and the best available technology. During the design

phase, Reclamation and partner agencies shall coordinate with NMFS to determine if the design should accommodate possible later connection to improved facilities, if necessary in years beyond 2015.

Reclamation and partner agencies shall complete all interim steps in a timely fashion to allow them to meet the following deadlines for completing construction and beginning operation of the facilities listed below. These steps may include completing plans and specifications. Reclamation and partner agencies shall give NMFS periodic updates on their progress. The order in which these facilities are completed may be modified with NMFS' concurrence, based on interim analyses and biological priorities.

1) Sacramento River Fish Facility – Collection facility shall be operational no later than March 2012.

2) American River Fish Facility – Collection facility shall be operational no later than March 2012.

NF 4.2. Adult Fish Release Sites above Dams and Juvenile Fish Sites Below Dams

Reclamation shall provide for the safe, effective, and timely release of adult fish above dams and juvenile fish below dams. The Fish Passage Plan must identify and release sites. Fish transport and release locations and methods shall follow existing State and Federal protocols. With assistance from the Steering Committee, and in coordination with applicable landowners and stakeholders, Reclamation shall complete construction of all selected sites by March 2012.

NF 4.3. Capture, Trapping, and Relocation of Adults

By March 2012, Reclamation shall implement upstream fish passage for adults via "trap and transport" facilities while it conducts studies to develop and assess long-term upstream and downstream volitional fish passage alternatives. At least one fish facility must be in place at terminal upstream passage points for each river that is subject to this measure. Facilities to capture adults currently exist at or below Keswick and Nimbus Dams, though these may need to be upgraded. The Pilot Program is a first step in providing anadromous fish passage to historical habitat above Project dams but will not be sufficient by itself.

The number of fish that shall be relocated is expected to vary depending on the source population, source population size, and the results of fish habitat evaluations and modeling of carrying and production capacity. The Steering Committee will work in consultation with the NMFS Southwest Fishery Science Center to develop adult relocation source populations and abundance targets. The Steering Committee shall evaluate the use of wild and hatchery sources and develop strategies that minimize risk to existing wild populations.

NMFS considers volitional passage via a fish ladder or other fishway to be the preferable alternative in most circumstances. In the short term, upstream passage can be provided with

fish trap and transport mechanisms, while Reclamation evaluates program effectiveness and passage alternatives.

NF 4.4. Interim Downstream Fish Passage through Reservoirs and Dams

Beginning in 2012, following the emergence of the first year class of reintroduced fish, and until permanent downstream passage facilities are constructed or operations are established at Project dams, Reclamation shall carry out interim operational measures to pass downstream migrants as safely and efficiently as possible through or around Project reservoirs and dams under current dam configurations and physical and operational constraints, consistent with authorized Project purposes.

Near-term operating alternatives shall be identified, evaluated, and implemented if determined to be technically and economically feasible and biologically justified by Reclamation and partner agencies, within the framework of the Annual Operating Plan updates and revisions, and in coordination with the Fish Passage Plan Steering Committee. Interim devices shall be constructed to collect emigrating juvenile salmonids and emigrating post-spawn adult steelhead from tributaries, main stems above project reservoirs, or heads of reservoirs. Fish shall be safely transported through or around reservoirs as necessary and released below currently impassible dams.

Reclamation and partner agencies shall evaluate potential interim measures that require detailed environmental review, permits, or Congressional authorization as part of the Fish Passage Plan. Reclamation shall complete this component of the Plan by April 30, 2011, including seeking authorization (if necessary) and completing design or operational implementation plans for the selected operations. Measures to be evaluated include, but are not limited to, partial or full reservoir drawdown during juvenile outmigration period, modification of reservoir refill rates, and using outlets, sluiceways, and spillways that typically are not opened to pass outflow.

NF 4.5. Juvenile Fish Collection Prototype

Objective: To determine whether the concept of a head-of-reservoir juvenile collection facility is feasible, and if so, to use head-of-reservoir facilities in Project reservoirs to increase downstream fish survival. Safe and timely downstream passage of juvenile Chinook salmon and juvenile and adult post-spawn steelhead is a critical component to the success of the Fish Passage Program.

Beginning in January, 2010, with input from the CVP/SWP operations Fish Passage Steering Committee, Reclamation shall plan, design, build, and evaluate a prototype head-of-reservoir juvenile collection facility above Shasta Dam. Construction shall be complete by September 2013.

Because the head-of-reservoir fish collection concept is virtually untested, it would be imprudent to require such facilities without prior field studies, design, and prototype testing

to validate the concept. For this measure, NMFS defines "prototype" to refer to temporary facilities intended for concept evaluation, not long-term operations. Further, "prototype" does not necessarily refer to a single concept; multiple concepts may be tested simultaneously. Possible options include, among others: (1) floating collectors in the reservoir near the mouths of tributaries, (2) use of curtained or hardened structures near mouths of tributaries, that block surface passage into reservoirs, (3) fish collection facilities on tributaries above the reservoir pools, and (4) a combination of the above to maximize collection in high flow and low flow conditions.

By the end of 2010, Reclamation, with assistance from the Fish Passage Steering Committee and concurrence by NMFS, shall identify a preferred location(s) and design(s) for construction of the prototype(s). Construction of the prototype facility(s) must be completed in time to conduct two years of biological and physical evaluations of the head-of-reservoir prototype collection facilities by the end of 2016. The Fish Passage Steering Committee shall have opportunity to comment on study proposals and a draft report on the effectiveness of the facilities, including recommendations for installing full-scale head-of-reservoir facilities at this and other reservoirs. By December 31, 2016, after receiving concurrence from NMFS and USFWS on the draft report, Reclamation and partner agencies shall make necessary revisions to the draft report and issue a final report. The report shall recommend technically and biologically feasible head-of-reservoir facilities, capable of safely collecting downstream migrating fish, and capable of increasing the overall productivity of the upper basins, then Reclamation and partner agencies shall include such facilities in the design alternatives that they consider in the Fish Passage Plan studies.

NF 4.6. Pilot Program Effectiveness Monitoring and Evaluation

From 2012 to 2015, Reclamation shall study, and provide annual reports on, the elements of the pilot program, including adult reintroduction locations, techniques, survival, distribution, spawning, and production; and juvenile rearing, migration, recollection, and survival. The objective is to gather sufficient biological and technical information to assess the relative effectiveness of the program elements and determine the feasibility of long-term passage alternatives. A final summary report of the 5-year pilot effort shall be completed by December 31, 2015.

NF 4.7. Stanislaus River Fish Passage Assessment

Objective: To develop information needed in order to evaluate options for achieving fish passage on the Stanislaus River above Goodwin, Tulloch, and New Melones Dams.

Action: By March 31, 2011, Reclamation shall develop a plan to obtain information needed to evaluate options for fish passage on the Stanislaus River above Goodwin, Tulloch and New Melones Dams and shall submit this plan to NMFS for review. This plan shall identify reconnaissance level assessments that are needed to support a technical evaluation of the potential benefits to CV steelhead that could be achieved with passage above the dams, a general assessment of logistical and engineering information needed, and a schedule for

completing those assessments by December 31, 2016. Reclamation is encouraged to use information developed for the American and Sacramento Rivers in Action NF 3 above, when also applicable for the Stanislaus River.

By December 31, 2016, Reclamation shall submit a report, including the results of the assessments and proposed options for further consideration, to NMFS. By December 31, 2018, Reclamation shall include recommendations for fish passage on the Stanislaus River in the Comprehensive Feasibility Report (Action NF 6.) The report will outline the costs of potential projects, their biological benefits and technical feasibility, potential alternatives, and steps necessary to comply with all applicable statutes and regulations.

Rationale: This assessment process will develop foundational information necessary for consideration and development of fish passage options above New Melones Reservoir to relieve unavoidable effects of project operations on the Southern Sierra Diversity Group of CV steelhead and on adverse modification of critical habitat.

NF 5. Comprehensive Fish Passage Report

Objective: To evaluate the effectiveness of fish passage alternatives and make recommendations for the development and implementation of long-term passage alternatives and a long-term fish passage program.

Action: By December 31, 2016, Reclamation shall prepare a Comprehensive Fish Passage Report. The Report shall include preliminary determinations by Reclamation and partner agencies regarding the feasibility of fish passage and other related structural and operational alternatives. The report should include specific recommendations for improvements to highest priority sub-basins and/or features and to include recommendations for major operational changes. It will also include identification and evaluation of high priority actions and may suggest modifying the scope or timelines of these high priority actions, based on the predicted outcome of long-term efforts.

Re-initiation trigger: If the downstream fish passage improvements are determined not likely to be technically or biologically feasible at this milestone, then Reclamation and the Steering Committee shall identify other alternatives that would be implemented within the same timelines as those identified in this RPA. Reclamation and partner agencies shall submit specific implementation plans for alternative actions to NMFS, and NMFS shall evaluate whether the actions proposed in the implementation plans are likely to have the biological results that NMFS relied on in this Opinion. The alternatives must be within the same Diversity Group as the affected population, identify high elevation habitats above dams that provide similar habitat characteristics in terms of water temperatures, habitat structure (sufficient pool depths and spawning gravels), ability to withstand long-term effects of climate change, and must demonstrate an ability to support populations that meet the characteristics of a population facing a low risk of extinction according to the population parameters identified in Lindley *et al.* (2007), "Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin

Basin." If Reclamation and partners believe that the proposed passage locations may not be feasible, the Fish Passage Steering Committee should be directed to develop early assessments of alternative actions that meet the performance standards described above in order to maintain the schedule proposed in this action. NMFS shall notify Reclamation and partner agencies as to whether the proposal is consistent with the analysis in this Opinion. If not, Reclamation will request re-initiation of consultation.

LONG-TERM FISH PASSAGE ACTIONS

In the event that the decision is made by 2016 to pursue a comprehensive fish passage program, the following actions will be implemented.

LF 1. Long-term Funding and Support to the Interagency Fish Passage Steering Committee

If the Comprehensive Fish Passage Report indicates that long-term fish passage is feasible and desirable, Reclamation shall continue to convene, fund, and staff the Fish Passage Steering Committee.

LF 2. Action Suite: Long-Term Fish Passage Plan and Program

Objective: Provide structural and operational modifications to allow safe fish passage and access to habitat above and below Project dams in the Central Valley.

Actions: Based on the results of the Comprehensive Fish Passage Report, Reclamation, with assistance from the Steering Committee, shall develop a Long-term Fish Passage Plan and implement a Long-term Fish Passage Program. Reclamation and partner agencies shall submit a plan to NMFS on or before December 31, 2016, which shall describe planned long-term upstream and downstream fish passage facilities and operations, based on the best available information at that time. The plan shall include a schedule for implementing a long-term program for safe, timely, and effective anadromous fish passage by January 31, 2020.

The Long-term Fish Passage Plan and Program shall target the following performance standards: (1) demonstrated ability to withstand long-term effects of climate change, (2) must support populations in the target watersheds that meet the characteristics of a population facing a moderate risk of extinction by year 5 (2025) and a low risk of extinction by year 15 (2030), according to the population parameters identified in Lindley *et al.* (2007), "Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin."

The structural and operational modifications needed to implement the program shall be developed as high priority measures in the plan. The plan shall include an evaluation of a range of structural and operational alternatives for providing fish passage above Reclamation dams in the Sacramento, American, and Stanislaus River watersheds. Reclamation and

partner agencies will evaluate the information gathered through plan development, the NEPA process, ESA recovery planning (including life cycle modeling developed as part of the recovery planning process), university studies, local monitoring efforts public comment, and other relevant sources, to determine which alternative(s), will provide the most cost-effective means to achieve adequate passage benefits to avoid jeopardy to ESA-listed fish from the water projects in the long term. Reclamation and partner agencies shall proceed with the action(s) that sufficiently address the adverse effects of the Project, in the context of future baseline conditions. Reclamation and DWR shall submit specific implementation plans to NMFS, and NMFS shall evaluate whether the actions proposed in the implementation plans meet ESA requirements, consistent with this Opinion. NMFS will notify Reclamation and partner agencies as to whether the proposal is consistent with ESA obligations.

Reclamation and DWR also shall analyze structural and operational modifications to provide downstream fish passage as part of the plan, following the same process as that for providing upstream passage.

The time frame for implementing the long-term passage measures may extend beyond the time frame of this Opinion. However, Reclamation and DWR must begin some actions during the term of this Opinion, including as investigating feasibility, completing plans, requesting necessary authorization, and conducting NEPA analysis

Rationale: This suite of actions ensures that fish passage actions will be taken by specified dates, or that the Project will be re-analyzed based upon new information. As noted in this Opinion, lack of passage is one of the most significant limiting factors for the viability of the affected populations of Chinook salmon and steelhead. As described in the effects analysis of the biological opinion, this also exposes populations to additional and significant stressors from project operations that also limits their viability and ability to survive below dams. Providing fish passage to historical spawning and rearing habitats would effectively mitigate for unavoidable adverse impacts of the projects on listed fish.

NMFS chose the passage in the Sacramento and American rivers based on the best available information at the time of this Opinion. The choice of location of passage facilities, as well as the method of passage, may change based on additional information, including additional assessment of necessity and feasibility of passage in the Stanislaus River. Passage methods may vary based on the specific requirements of each site, as well as fish behavior at a specific location. If information indicates that a different location or passage method is preferable, then Reclamation and DWR must coordinate with the Fish Passage Plan committee and obtain NMFS' concurrence that a proposed change is likely to meet ESA obligations.

Long-term fish passage should significantly increase abundance and spatial distribution of winter-run, spring-run, and CV steelhead because the fish will have access to upstream spawning and rearing habitat, and the juveniles will have access downstream to the ocean for growth to maturity. This action will address the Habitat Access pathway of critical habitat by improving access past physical barriers, thereby improving the status of PCEs for spawning, rearing, and migration of winter-run, spring-run, and CV steelhead populations.

LF 2.1. Long-term Adult and Juvenile Fish Passage Facilities

Based on the results of the Comprehensive Fish Passage Report and the Fish Passage Plan, and with the assistance of the Steering Committee, Reclamation shall construct long-term fish passage facilities necessary to successfully allow upstream and downstream migration of fish around or through project dams and reservoirs on the Sacramento and American Rivers by 2020, and Stanislaus River depending on results of study provided for in Action NF 4.7.

LF 2.2. Supplementation and Management Plan

Based on the results of the Comprehensive Fish Passage Report and the Fish Passage Plan, and with the assistance of the Steering Committee, in consultation with the NMFS Southwest Fishery Science Center, Reclamation shall develop and implement a long-term population supplementation plan for each species and fish passage location identified in V. *Fish Passage Program*, with adult recruitment and collection criteria developed with consideration for source population location, genetic and life history diversity, abundance and production. The purpose is to ensure that long-term abundance and viability criteria are met for all reintroduced populations, with contingencies for supplementing populations with wild and/or conservation hatchery fish if necessary. The plan shall be developed by 2020. The plan shall identify wild and/or hatchery sources for adult reintroductions and long-term supplementation, and the specific NMFS-approved hatchery management practices that qualify a hatchery for conservation purposes. Species-specific conservation hatchery programs may be developed to supplement reintroductions and maintain long-term performance standards for abundance and viability.

LF 2.3. Long-term Fish Passage Monitoring and Evaluation

Reclamation, through the Steering Committee shall develop a Long-term Fish Passage Monitoring and Evaluation Plan by 2020, to monitor all elements of the Long-term Fish Passage Program including adult reintroduction locations, techniques, survival, distribution, spawning, and production; and juvenile rearing, migration, recollection, and survival. The objective is to gather sufficient biological and technical information to assess the relative effectiveness of the program elements and determine the feasibility of long-term passage alternatives. Annual reports shall be submitted to NMFS by September 30 of each year.

11.3 ANALYSIS OF RPA

This section presents NMFS' rationale for concluding that with adoption of this RPA, Reclamation would avoid jeopardizing the listed species and adversely modifying their proposed and designated critical habitats. This rationale is presented for the following species and critical habitats that NMFS concluded would be jeopardized or adversely modified by the proposed action:

- Sacramento River winter-run and its designated critical habitat,

- CV spring-run and its designated critical habitat,
- CV steelhead and its designated critical habitat,
- Southern DPS of green sturgeon and its proposed critical habitat, and
- Southern Resident killer whales.

Each section summarizes the main stressors and the actions within the RPA that alleviate those stressors, both in the short-term and the long-term. This analysis relies heavily on the tables presented for each species. The supporting biological information for each action referenced in the table is contained in the "objective" and "rationale" sections for each action in the preceding section. Each action of the RPA is linked to at least one main stressor for at least one species, identified in the effects analysis and the integration and synthesis sections of this Opinion. Many RPA actions are designed to minimize adverse effects of project operations on multiple species and life stages.

11.3.1 Sacramento River Winter-Run Chinook Salmon and its Designated Critical Habitat

Throughout this Opinion, NMFS has explained that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS has explained the need for the proper functioning of the PCEs that comprise the critical habitat designation. In sections 9.1 and 9.2, NMFS summarized various project-related stressors that reduced the VSP parameters and the conservation value of PCEs.

The winter-run ESU is currently at a high risk of extinction. As described in the Status of the Species section of this Opinion, weaknesses in all four VSP parameters -- spatial structure, population size, population growth rate, and diversity -- contribute to this risk. In particular (1) multiple populations of this ESU have been extirpated; the ESU now is composed of only one population, and this population has been blocked from all of its historical spawning habitat; (2) habitat destruction and modification throughout the mainstem Sacramento River have dramatically altered the ESU's spatial structure and diversity; (3) the ESU is at risk from catastrophic events, considering the remaining population's proximity to Mt. Lassen and its dependency on the cold water management of Shasta Reservoir; (4) the population has a "high" hatchery influence (Lindley *et al*. 2007); and (5) the population experienced an almost seven fold decrease in 2007. In addition, many of the physical and biological features of critical habitat that are essential for the conservation of winter-run are currently impaired and provide limited habitat value.

The proposed action increases the population's extinction risk and continues to degrade the PCEs of critical habitat by adding numerous stressors to the species' baseline stress regime, as is generally depicted in figure 9-4. The RPA specifies many significant actions that will reduce the adverse effects of the proposed action on winter-run and its critical habitat. Many of the RPA actions specifically address key project-related limiting factors or threats facing the ESU and its critical habitat, as described in the "Objectives" and "Rationale" parts of the actions. Some of these factors are lack of passage to historical spawning habitat above Keswick and Shasta Dams, passage impediments (*e.g.*, RBDD), degraded quantity and quality of the remaining habitat

downstream of Keswick and Shasta Dams, and the entrainment influence of the Federal and state export facilities. As shown in table 11-1, there is a need for both short-term and long-term actions, including:

- providing passage to and from historical habitat;
- increasing Shasta reservoir storage to provide for temperature control and improve the quantity and quality of downstream habitat;
- providing interim and long-term modifications to RBDD;
- providing increased rearing habitat;
- modifying operation of the DCC; and
- implementing a revised decision process for Delta operations, including timing and amount of export reduction..

Implementation of some RPA actions will reduce the adverse effects of project operations on winter-run and its critical habitat immediately or in the near term. Other actions will take longer to plan and implement, and will not provide needed results for many years. We discuss the near-term and long-term actions separately.

Near Term

In the near term, adverse effects of project operations to winter-run will be reduced primarily through the following measures:

1) Modifications to Shasta reservoir management will result in more reliable provision of suitable water temperatures for spawning and egg incubation in the summer months. The new year-round Shasta management program is expected to minimize frequency and duration of temperature related egg mortality in dry and critically dry years, thus reducing, though not eliminating, the population level stress of these temperature related mortalities. The new Shasta program will allow for an expanded range of habitat suitable for spawning and egg incubation in wetter year types (i.e. through meeting downstream compliance points more often). Over time, this will help to preserve diversity of run-timing and decrease the risk of a single event in a localized area causing a population level effect. Temperature related effects on winter-run will persist into the future, and cannot be fully off-set through Shasta reservoir storage actions, due to physical and hydrological constraints on the CVP system, and the delivery of water to non-discretionary CVP contractors (e.g. Sacramento River Settlement Contractors). Given a fixed supply of cold water in any given year starting in May, as an overall strategy, the RPA prioritizes temperature management in favor of winter-run due to their endangered status and complete dependence on suitable habitat downstream of Keswick for their continued survival.
2) Interim operations of RBDD (until 2012) will allow for significant increased passage of adult winter-run, a significant reduction in juvenile mortality associated with downstream passage, and elimination of emergency gate closures in early spring.

3) Continuation of installation of fish screens that meet NMFS criteria along the Sacramento River and Delta thereby reducing entrainment of winter run juveniles throughout their migration path down the Sacramento river and through the Delta.;
4) Additional closures of the DCC gates at key times of year triggered to winter-run needs, thereby will keep a greater percentage of winter-run emigrating through the northern Delta out to sea.
5) Old and Middle River reverse flow restrictions on combined exports in January through spring months, will significantly reduce winter-run juveniles that are drawn further into the Interior and Southern Delta, and therefore exposed to risks due to export facilities.
6) Additional measures will reduce entrainment and improve efficiency of salvage operations at both the State and Federal export facilities. Collectively, these measures will ensure that the winter-run that are exposed to the export facilities have a greater likelihood of survival.
7) Overall, the interim RBDD, DCC gate operations, and OMR restrictions are timed to minimize adverse effects to a greater proportion of the entire winter-run life history run-timing. By ensuring the persistence in a greater proportion of run-timing, more diversity is preserved within the ESU. This diversity of run-timing will ensure greater resiliency of the winter-run ESU to environmental changes. For example, ocean conditions and the timing and duration of upwellings may play a significant role in the survival of any given cohort of winter-run. However, modifying operations to allow for the expansion of ocean entry timing for winter-run will increase the probability that at least a portion of each cohort will enter the ocean when prey are readily available, thereby increasing the cohort's survival.

Long Term

In addition to the continuation of near-term actions, long-term actions are necessary to avoid an appreciable reduction in survival and recovery of the species. The long-term effects analysis for winter-run reveals that climate change and growth are likely to increase adverse effects especially associated with temperature related egg mortality on the Upper Sacramento River in the summertime. A prolonged drought could result in extinction of the species by resulting in significant egg mortality for three years in a row. In order to address the underlying issues of inadequate spatial structure and diversity and quality of critical habitat, and therefore, increased risk of extinction over the long-term, a passage program to provide for winter-run to access their historical habitat is necessary in order to avoid jeopardy. Such a program has many unknowns, and therefore cannot be relied upon to produce results in the near-term. In the long-term however, the RPA includes a structured passage program with pilot reintroductions, an interagency work team, and milestones and re-initiation triggers. This structured program, while not guaranteed to be effective, greatly reduces the likelihood of an appreciable reduction to winter-run survival and recovery in the long-term due to on-going project operations by allowing access of a portion of the population to historical cold-water, high elevation habitat. Furthermore, there are some near-term benefits to the passage pilot reintroduction program, including immediate expansion of the geographical rang of the single population.

In addition to upstream passage, the follow actions will minimize project effects in the long-term to the extent that the species is not jeopardized:

1. The RPA specifies long-term RBDD gate configuration is gates out all year. This will greatly reduce the significant losses associated with current and also the more modest losses associated with interim operations.
2. The RPA ensures that the Battle Creek experimental winter-run re-introduction program will proceed in a timely fashion. This Battle Creek program is critical in creating a second population of winter-run. This second population increases the species spatial structure and diversity and should increase growth rate and abundance over time as well.
3. The RPA ensures that in the long-term, Salmonid rearing habitat actions in the lower Sacramento River and Northern Delta will minimize adverse effects of project operations on winter-run critical habitat in the long-term and off-set effects of ongoing flood control operations. These habitat actions will increase the growth rates of individuals that utilize this habitat. These fish are predicted to enter the estuary and ocean with a higher degree of fitness, and therefore, greater resiliency to withstand stochastic events in these later phases of their life history, thereby increasing the viability of the ESU and reducing the likelihood of appreciable reductions in the survival or recovery of the species.

In conclusion, NMFS believes that if all parts of the RPA pertaining to Sacramento River winter-run Chinook salmon are implemented, the RPA is not likely to reduce appreciably the likelihood of survival and recovery of winter-run or adversely modify its critical habitat, in either the near term or the long term.

11.3.2 Central Valley Spring-Run Chinook Salmon and Its Designated Critical Habitat

As previously stated in the Status of the Species section, the spring-run ESU is currently likely to become endangered within the foreseeable future due to multiple factors affecting spatial structure, diversity, productivity and abundance. Specific factors include: (1) the ESU currently has only three independent populations. All three of these independent populations are in one diversity group, the Northern Sierra Nevada Diversity Group. The other diversity groups contain dependent populations; (2) habitat elimination and modification throughout the Central Valley have drastically altered the ESU's spatial structure and diversity; (3) the ESU has a risk associated with catastrophes, especially considering the remaining independent populations' proximity to Mt. Lassen and the probability of a large scale wild fire occurring in those watersheds (Lindley *et al*. 2007), (4) the presence of dams precludes access to historical spawning areas and (5) for some populations, the genetic diversity of spring-run has been compromised by hybridization with fall-run.

Table 11-1. Summary of actions to minimize or alleviate proposed action-related stressors on Sacramento River winter-run Chinook salmon and its designated critical habitat.

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	RBDD gate closures from May 15 - Sept 15 every year until 2019.	~15 % of adults delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity; continues every year until 2019.	High	Action I.3.2: RBDD Interim Operations.	Action I.3.1: RBDD Operations After May 14, 2012.
Adult immigration and holding	RBDD emergency 10 day gate closures prior to May 15	Greater proportion of run blocked or delayed; sub lethal effects on eggs in fish and energy loss. These emergency gate closures have occurred twice in the past 10 years and the frequency of occurrence may increase with climate change.	High	Action I.3.2: RBDD Interim Operations.	Action I.3.1: RBDD Operations After May 14, 2012.

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Spawning	Reduced spawning area from moving TCP upstream in almost every year from April 15 to Sept 30	Introgression or hybridization with spring/fall-run/late fall-run Chinook salmon; loss of genetic integrity and expression of life history	High	Action I.2.1: Maintain suitable water temperatures for winter-run Chinook salmon. Action I.2.2: Maintain minimum Shasta Reservoir storage. Action I.2.3: February forecast and plan of operation for the Sacramento River. Action I.1.4: Improve and maintain effectiveness of the Spring Creek temperature control curtain. Action I.4: Wilkins Slough Operations Action V: Fish Passage Program (Near-term actions)	Continued implementation of Action I.2.1. Continue implementation of Action I.2.2. Continue implementation of Action I.2.3. Continue implementation of Action I.1.4. Continue implementation of Action I.4. Action V: Fish Passage Program (Long-term actions)
		Density dependency - aggressive behavior among spawning fish could cause higher prespawn mortality, increased for suitable spawning sites, adults forced downstream into unsuitable areas	Medium - may increase as abundance increases		
		Redd superimposition - spawning on top of other redds, destroys eggs	Medium - may increase as abundance increases		
Spawning	Water temperatures warmer than life history stage requirements below TCP, every year April 15 -Sept 30)	Prespawn mortality; reduced fecundity	High		

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	Water temperatures warmer than life history stage requirements, every year from April 15 - Sept 30. (No carry-over storage target designed for fish protection is included in the proposed action. Without such a target, the risk of running out of coldwater in Shasta Reservoir increases.)	Egg mortality - 16 % in critically dry years and increases to 65% in critically dry years with climate change. On average, for all water year types, mortality is 5-12% with climate change and 2-3% without. 56F is exceeded at Balls Ferry in 30% of the years in August and 55% of the years in September Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of winter-run to survive during subsequent life stages (Campbell *et al*. 1998). Campbell *et al*. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	High	Action I.2.1: Maintain suitable water temperatures for winter-run Chinook salmon. Action I.2.2: Maintain minimum Shasta Reservoir storage. Action I.2.3: February forecast and plan of operation for the Sacramento River. Action I.1.4: Improve and maintain effectiveness of the Spring Creek temperature control curtain. Action I.4: Wilkins Slough Operations Action V: Fish Passage Program (Near-term actions)	Continued implementation of Action I.2.1. Continue implementation of Action I.2.2. Continue implementation of Action I.2.3. Continue implementation of Action I.1.4. Continue implementation of Action I.4. Action V: Fish Passage Program (Long-term actions)

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing and downstream movement	RBDD passage downstream through dam gates May 15 - Sept 15	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50 %; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 10 % of winter-run would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	High	Action I.3.2: RBDD Interim Operations	Action I.3.1: RBDD Operations After May 14, 2012

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing and downstream movement	Reduced quality of juvenile rearing habitat related to the formation of Lake Red Bluff when the RBDD gates are in.	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	Action I.3.2: RBDD Interim Operations Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Action I.3.1: RBDD Operations After May 14, 2012 Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.
Juvenile rearing and downstream movement	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	Action I.5: Funding for CVPIA anadromous fish screen program	Continue implementation of Action I.5

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	Lack of channel forming flows and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process	Loss of rearing habitat and riparian habitat and natural river function impaired (e.g., formation of side channels, sinuosity); loss of cottonwood recruitment impacting food availability, juveniles spend longer time in areas of poor water quality, greater predation, less growth from less food sources, greater stress reduces response to predators	High	Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics).	During dry and critical years in December and January, modeling estimates of monthly mortality of up to approximately 15 % of the total winter-run population entering the Delta at Freeport is associated with exports (Greene 2008). Of those winter-run entering the *interior* of the Delta (through DCC or Georgiana Slough), mortality is estimated to be approximately 66 % (range of 35-90 % mortality). This equates to approximately 5-20 % of the total population entering the Delta at Freeport. Anticipated delays in migration due to export operations.	High	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations. Action IV.1.2: DCC gate operation. Action IV.1.3: Engineering studies of methods to reduce loss of salmonids in Georgiana Slough and South Delta channels. Action IV.2.1: San Joaquin River inflow to export ratio. Action IV.2.2: Old and Middle River Flow Management. Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities.	Continue implementation of Actions IV.1 through IV.6.

Life Stage/ Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
				Action IV.4.1: Tracy fish collection facility improvements. Action IV.4.2: Skinner fish collection facility improvements. Action IV.4.3: Additional improvements at Tracy and Skinner fish collection facilities. Action IV. 6: Formation of Delta operations for salmon and sturgeon technical working group. Action IV.6: South Delta improvement program – phase I	

The effects of the proposed action and their affect on spring-run are contained in the sections of the Opinion on project effects and integration and synthesis. The effects are presented for the Clear Creek population, the mainstem Sacramento River population and for the other populations that are effected by project operations, by diversity group. Ultimately all spring-run must migrate through the Delta and are affected by Delta operations. The proposed action increases the extinction risk of spring-run and continues to degrade the PCEs of critical habitat by adding numerous stressors to the species' baseline stress regime and reducing the viability of all extant spring-run populations, as is generally depicted in figure 9-4. Throughout this Opinion, NMFS acknowledged that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS acknowledged the need for the proper functioning of the PCEs that comprise the critical habitat designation. In sections 9.3 and 9.4, NMFS summarized the various stressors that reduced the VSP parameters and conservation value of the PCEs.

The RPA specifies actions that, in total, will minimize the adverse effects of the proposed action on spring-run individuals, populations and the ESU and bring about the proper functioning of PCEs of its critical habitat. Many of the RPA actions, as described in their objectives and rationale, specifically address key limiting factors/threats facing the ESU and its critical habitat, for example, lack of passage to historic spawning habitat above Keswick and Shasta Dams, passage impediments (*e.g*., RBDD), degraded water quantity and quality of the habitat, and entrainment influence of the Federal and state export facilities. Table 11-2 provides the linkage between specific project related stressors identified in the Opinion's Integration and Synthesis, and the specific RPA actions necessary to minimize those stressors in both the near-term and the long-term. All actions that address spring-run in the RPA are necessary to minimize project effects to the extent where they do not appreciably reduce the likelihood of survival and recovery of the ESU in the near-term and the long-term, or adversely modify spring-run critical habitat. This written analysis summarizes some of the most significant RPA actions that NMFS relied on in its analysis.

The RPA contains numerous actions that minimize project effects to critical habitat of spring-run in both the near-term and the long-term. The rationales for the actions include specific PCEs addressed. It is not technologically or physically feasible, or necessary, to remove all adverse effects of project operations on critical habitat. These actions reduce adverse effects to the point where they no longer adversely modify critical habitat.

Summary of RPA effects on Central Valley Spring-run Chinook Salmon in the Near-Term

RPA actions that reduce adverse effects of project operations to spring-run and its critical habitat in the near-term include:

1) Clear Creek actions will be implemented immediately and will significantly reduce project effects to spring-run by stabilizing that population and thereby increasing the likelihood of survival of that one population in the near-term. Ensuring adequate flows to meet temperature requirements in most years, implementing new pulse flows to assist with adult migratory cues, and implementing geomorphic flows that will disperse

restored spawning gravel all will minimize project effects to this population. The Clear Creek population is important to the viability of the ESU as a whole because of its geographic location; ie, if it becomes an independent population it could considerably increase the viability of the ESU. The actions in the RPA are not recovery actions per se, but they will ensure that ongoing project operations do not appreciably reduce the likelihood of recovery of this one population.

2) Modifications to Shasta reservoir management will primarily reduce adverse effects on winter-run. Effects of the year-round Shasta management program on spring-run are more difficult to predict and quantify. The Shasta RPA will result in more carryover storage in some years, as compared to current operations, and therefore, increase ability to meet suitable spring-run spawning and egg incubation temperatures in the Fall in some years, depending on ambient weather conditions and the extent of the cold water pool in Shasta reservoir. The new year-round Shasta management program is expected to minimize frequency and duration of temperature related egg mortality in dry and critically dry years, thus reducing, though not eliminating, the population level stress of these temperature related mortalities. Temperature related effects on spring-run in the mainstem Sacramento River will persist into the future, and cannot be fully off-set through Shasta reservoir storage actions, due to physical and hydrological constraints on the CVP system, and the delivery of water to non-discretionary CVP contractors (e.g. Sacramento River Settlement Contractors). Given a fixed supply of cold water in any given year starting in May, as an overall strategy, the RPA prioritizes temperature management in favor of winter-run due to their endangered status and complete dependence on suitable habitat downstream of Keswick for their continued survival. Despite continued significant project related temperature effects on mainstem spring run, the RPA, in total, does not appreciably reduce the likelihood of survival and recovery of spring-run ESU when all populations and diversity groups are considered.

3) Near-term improvements to Battle Creek through actions identified in the RPA are expected to expand the holding, spawning and rearing habitat for spring-run in Battle Creek. It is difficult to predict the exact timing of Battle Creek projects, though funding has been secured and work is projected to start on the first phase in Summer 2009. NMFS finds that the Battle Creek program is reasonably likely to occur and contribute to the spring-run population in the long-run; however, these beneficial effects to the population may or may not occur in the near-term.

4) Interim operations of RBDD (until 2012, or with an extension until 2013) will allow for significant increased passage of adult spring-run, and a significant reduction in juvenile mortality associated with downstream passage. Extending the "gates out" operation from May 15th until June 15th will allow a very large additional portion of spring run to migrate unimpeded by the diversion dam. This improved passage will increase the likelihood that these individuals will reach cold water pools necessary for summer holding life history in the near-term and will reduce effects of delayed passage on energy consumption and fecundity, thus improving the viability of populations above RBDD. Near-term effects of interim gate operations on remaining spring-run that are delayed due to the June 15th

closure of gates will be offset by passage improvement restoration projects implemented over the next few years.. Abundance, growth rate, and spatial structure are expected to increase with the implementation of the passage restoration projects on Mill, Deer, and Antelope creeks.

5) Continuing installation of fish screens through the Anadromous Fish Screen Program along the Sacramento River and Delta will reduce juveniles entrainment of spring run throughout their migration path down the Sacramento river and through the Delta.

6) All populations of spring-run within the ESU must migrate through the Delta. Within the Delta, additional closures of the DCC gates at key times of year triggered to spring-run presence, will ensure that a greater percentage of spring-run emigrate through the northern Delta out to sea. These fish will avoid adverse effects of predation, water quality and hydrology in the Interior and Southern Delta.

7) Old and Middle River reverse flow restrictions on combined exports will significantly reduce project-related adverse effects on spring-run juveniles in January through June 15th. The OMR restrictions, triggered by spring-run (or their surrogates) in the salvage, will reduce the percentage of spring-run juveniles that are drawn further into the Interior and Southern Delta, and exposed to risks due to export facilities.

8) Additional actions at both the State and Federal export facilities will reduce entrainment and improve efficiency of salvage operations. Collectively, these measures will ensure that the spring-run that are exposed to the export facilities have a greater likelihood of survival.

9) Overall, the interim RBDD, DCC gate operations, and OMR restrictions are timed to minimize adverse effects to a greater proportion of the entire spring-run life history run-timing. By ensuring the persistence in a greater proportion of run-timing, more diversity is preserved within the ESU. This diversity of run-timing will ensure greater resiliency of the spring-run ESU to environmental changes. For example,, ocean conditions and the timing and duration of upwellings may play a significant role in the survival of any given cohort of spring-run. However, modifying operations to allow for the expansion of ocean entry timing for spring-run will increase the probability that at least a portion of each cohort will enter the ocean when prey are readily available, thereby increasing the cohort's survival.

Summary of RPA effects on Central Valley Spring-run Chinook Salmon in the Long Term

The analysis in the Opinion demonstrates that long-term actions are needed, especially considering continued effects of climate change and increasing water demands due to growth. In addition to a continuation of near-term actions described above, RPA actions that reduce adverse effects of project operations to spring-run and its critical habitat in the long-term include:

1) Additional actions that will minimize project-related effects to the Clear Creek population in the long-term include: replacing the Whiskytown temperature control curtain and adaptively managing to habitat suitability/IFIM study results.

2) In the long-term, improvements to Battle Creek through actions identified in the RPA are predicted to significantly improve spring-run habitat and off-set project-related effects on the mainstem population by creating a stable population in Battle Creek.

3) Starting in 2013, RBDD will be operated in the "gates out" formation all year. This operation will allow for unimpeded spring-run migration upstream and downstream of the diversion dam.

4) Salmonid rearing habitat actions in the lower Sacramento River and Northern Delta will minimize adverse effects of project operations on spring-run critical habitat in the long-term and off-set effects of ongoing flood control operations. These habitat actions will increase the growth rates of individuals that utilize this habitat. These fish are predicted to enter the estuary and ocean with a higher degree of fitness, and therefore, greater resiliency to withstand stochastic events in these later phases of their life history. Because all populations of spring-run migrate through this area, a portion of all populations will be likely to benefit from these rearing actions, thereby increasing the viability of the ESU and reducing the likelihood of appreciable reductions in the survival or recovery of the species.

5) In the long-run, in consideration of climate change, and in order to improve the likelihood of withstanding adverse effects associated with prolonged drought, the passage program will improve the diversity and spatial structure of the ESU by reintroducing spring-run to their historical habitat above Shasta reservoir. There is uncertainty associated with the likelihood of this action succeeding. This consultation must take a long-term view, given the 21 year time horizon. Within the long-term view, it is likely that advances in technologies and experimental procedures will increase the likelihood of success of this action. In addition, the quality of much of the habitat above Shasta reservoir is in relatively pristine condition, improving the likelihood of success. The RPA includes a reinitiation trigger in the event that passage is deemed to be infeasible. There are also some near-term benefits associated with the pilot reintroduction program, including immediate expansion of the geographic range of the species.

In summary, with full implementation of the RPA, NMFS expects that the RPA will result in minimizing project related effects to the level where these effects do not appreciably reduce the likelihood of survival or recovery of spring-run, or adversely modify its critical habitat.

Table 11-2. Summary of actions to minimize or alleviate proposed action-related stressors on Central Valley spring-run Chinook salmon and its designated critical habitat. The table is organized by life stage then by the number of populations affected by a particular stressor. Acronyms for diversity groups are as follows: NWC – Northwestern California; BPL – Basalt and Porous Lava; NSN – Northern Sierra Nevada.

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	RBDD gate closures from May 15 – Sept. 15 (plus 10 days in April) delaying adult immigration	~70 % of the spring-run that spawn upstream of RBDD are delayed by approximately 20 days on average, more energy consumed, greater pre-spawn mortality, less fecundity	High	Action I.3.2: RBDD Interim Operations	Action I.3.1: RBDD Operations After May 14, 2012
Adult immigration and holding	NWC: Clear	Water temperatures warmer than life history stage requirements during summer holding period	Water temp control to Igo; possibly some pre-spawn mortality in critically dry years when not enough cold water in Whiskeytown Lake	High	Action I.1.5: Clear Creek Thermal Stress Reduction.	Continue implementation of Action I.1.5.
Adult immigration and holding	NWC: Clear	Spring flows with little variability. Low summer flows (50 cfs), when b2 is unavailable	Limited cues for upstream migration resulting from spring flows with little variation. With low summer flows, Adults are impeded from accessing upstream holding areas.	High	Action I.1.1. Spring Attraction Flows	Continue implementation of Action I.1.1
Spawning	NWC: Clear	Loss of spawning gravel below Whiskeytown Dam – limited spawning habitat availability	Reduced spawning areas; spawning success diminishes	High	Action I.1.3: Clear Creek spawning gravel augmentation	Continue implementation of Action I.1.3
Spawning	NWC: Clear	Low summer flows (50 cfs), when b2 is unavailable	Adults spawn further downstream in less suitable conditions (*i.e.*, in areas with relatively warm water temps.)	High	Action I.1.6: Adaptively manage to Clear Creek habitat suitability/IFIM study results.	Continue implementation of Action I.1.6

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	NWC: Clear	Water temperatures warmer than life history stage requirements in September only for fish that spawn below TCP (Igo)	Mortality varies with exceedance rate and number of redds; loss of some portion of those eggs; reduced chance of survival for fry	High	Action I.1.5: Clear Creek Thermal Stress Reduction	Continue implementation of Action I.1.5:

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	BPL: Sacramento	Water temperatures warmer than life history stage requirements, during September and October	Under near-term operations (Study 7.1) mortality is expected to range from approximately 9% in wet years up to approximately 66 % in critically dry years, with an average of approximately 21 % over all water year types; under modeled climate change projections, average egg mortality over all water year types is expected to be 50 % and during the driest 15 % of years is expected to be 95 %. Sub-lethal effects, such as developmental instability and related structural asymmetry have been reported to occur to salmonids incubated at warm water temperatures (Turner *et al*. 2007, Myrick and Cech 2001, Campbell *et al*. 1998). These sub-lethal effects decrease the chance of spring-run to survive during subsequent life stages (Campbell *et al*. 1998). Campbell *et al*. (1998) concluded that chronic thermal stress produced both selectively lethal and sub-lethal effects that increased structural asymmetry and directly decreased salmon fitness.	High	Action Suite I.2: Shasta operations. Action I.1.4: Spring Creek temperature control curtain. Action I.4: Wilkins Slough Operations Action V: Fish Passage Program (Near-term actions)	Continued implementation of Action suite I.2. Continue implementation of Action I.1.4. Continue implementation of Action I.4. Action V: Fish Passage Program (Long-term actions)

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	RBDD passage downstream through dam gates May15 - Sept 15, plus 10 days in April during emergencies	Mortality as juveniles pass through Lake Red Bluff and RBDD reportedly ranges from 5 to 50%; delayed emigration. Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 5 % of the spring-run ESU spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008).	High	Action I.3.2: RBDD Interim Operations	Action I.3.1: RBDD Operations After May 14, 2012

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NWC: Cottonwood/ Beegum, Clear; BPL: Sacramento, Battle	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	Action I.3.2: RBDD Interim Operations Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Action I.3.1: No later than May 2012, Reclamation shall operate RBDD with gates out all year Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.
Juvenile rearing	All diversity groups and populations	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	Action I.5: Funding for CVPIA Anadromous Fish Screen Program	Continue implementation of Action I.5

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	All diversity groups and populations	Lack of channel forming flows in the Sacramento River and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process.	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	Action I.6.1: Restoration of floodplain rearing habitat. Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass. Action I.6.3: Lower Putah Creek enhancements. Action I.6.4: Improvements to Lisbon Weir	Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4.

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	All diversity groups and populations	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Project-related mortality is significant. Of the spring-run entering the *interior* of the Delta (through DCC or Georgiana Slough), mortality is estimated to be approximately 66 % (range of 35-90 % mortality) (Brandes and McClain 2001; Newman 2008; Perry and Skalski 2008).	High	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations. Action IV.1.2: DCC gate operation. Action IV.1.3: Engineering studies of methods to reduce loss of Salmonids in Georgiana Slough and South Delta channels. Action IV.2.1: San Joaquin River inflow to export ratio. Action IV.2.2: Old and Middle River Flow Management. Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities. Action IV.4.1: Tracy fish collection facility improvements.	Continue implementation of Actions IV.1 through IV. 6.

Life Stage/Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
					Action IV.4.2: Skinner fish collection facility improvements. Action IV.4.3: Additional improvements at Tracy and Skinner fish collection facilities. Action IV. 6: Formation of Delta operations for salmon and sturgeon technical working group. Action IV.6: South Delta improvement program – phase I	

11.3.3 Central Valley Steelhead and Its Designated Critical Habitat

The proposed action increases the extinction risk of CV steelhead and continues to degrade the PCEs of critical habitat by adding numerous stressors to the species' baseline stress regime and reducing the viability of all of the extant CV steelhead populations in the CVP-controlled rivers (Clear Creek, Sacramento River, American River, and Stanislaus River) and the Delta. Throughout this Opinion, NMFS acknowledged that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS acknowledged the need for the proper functioning of the PCEs that comprise the critical habitat designation. In sections 9.5 and 9.6, NMFS summarized the various stressors that reduced the VSP parameters and conservation value of the PCEs. In general, warm water temperatures and low flows, loss of natural river function and floodplain connectivity through levee construction, direct loss of floodplain and riparian habitat, loss of tidal wetland habitat, a collapsed pelagic community in the Delta, and poor water quality associated with agricultural, urban, and industrial land use have caused fitness reductions and degraded the PCEs of critical habitat in the past. The proposed action is expected to continue to degrade the VSP parameters and conservation value of the PCEs, and the effects of climate change and increased water demand in the future are expected to exacerbate conditions that reduce the long-term viability of CV steelhead.

The RPA specifies actions that, in total, will minimize the adverse effects of the proposed action on steelhead individuals, populations and the DPS and bring about the proper functioning of PCEs of its critical habitat. Many of the RPA actions, as described in their objectives and rationale, specifically address key limiting factors/threats facing the DPS and its critical habitat, for example, lack of passage to historic spawning habitat above Keswick and Shasta Dams, and Nimbus and Folsom Dams, and New Melones, Dam, passage impediments (*e.g.*, RBDD), degraded water quantity and quality of the habitat, hatchery fish compromising the genetic integrity of natural CV steelhead and entrainment influence of the Federal and state export facilities. Table 11-3 provides the linkage between specific project related stressors identified in the Opinion's Integration and Synthesis, and the specific RPA actions necessary to minimize those stressors in both the near-term and the long-term. All actions that address CV steelhead in the RPA are necessary to minimize project effects to the extent where they do not appreciably reduce the likelihood of survival and recovery of the DPS in the near-term and the long-term, or adversely modify CV steelhead critical habitat. This written analysis summarizes some of the most significant RPA actions that NMFS relied on in its analysis.

As show in table 11-3, the RPA acknowledges the need for both short-term and long-term actions, including:

- providing safe passage to and from historical habitat;
- improving the quantity and quality of habitat in all of the CVP-controlled streams through water releases;
- providing interim and long-term modifications to RBDD;
- providing increased rearing habitat;
- modifying the operation of the DCC; and
- implementing a revised decision process for Delta operations, including reduced exports.

The anticipated improvements to CV steelhead and its critical habitat are expected to begin immediately through implementation of various actions, and continue to increase over the term of this Opinion (through year 2030) with the implementation of the longer-term actions. While implementation of the RPA will occur during the term of this Opinion, its full effects on population metrics (*e.g.*, spatial structure, diversity, abundance, productivity) and the PCEs of critical habitat will occur over a considerable period of time after implementation. Therefore, NMFS expects the project operations, as modified by the RPA, to minimize effects to critical habitat so that it is not adversely modified.

In the near term, the provision of more cold water throughout the species' upstream migration, rearing, holding, and incubation period are expected to increase in-river production. RPA actions that address flow maintenance and stabilization will minimize redd dewatering and scouring, and stranding. Juveniles will be afforded more rearing habitat during their freshwater residency by reducing the inundation duration of Lake Red Bluff, and expanding access to rearing habitat within the Yolo Bypass and other areas within the Sacramento River Basin, in both the near-term and long-term. Modified operations of RBDD will provide unimpeded passage for more of the upstream spawning migration season of the upper Sacramento River and its tributaries populations. More smolts are expected to outmigrate into the Pacific Ocean as operations of the CVP and SWP are modified to reduce entrainment and mortality. Specifically, requirements in Actions Suite IV.2 will significantly increase the survival of CV steelhead smolts outmigrating from the San Joaquin River basin.

Overall, the interim RBDD, DCC gate operations, and OMR restrictions are timed to minimize adverse effects to a greater proportion of the entire steelhead life history run-timing. By ensuring the persistence in a greater proportion of run-timing, more diversity is preserved within the DPS. This diversity of run-timing will ensure greater resiliency of the CV steelhead DPS to environmental changes, for example, changed productivity in the ocean.

In the long-term, in addition to the continuation of the near-term actions, CV steelhead will be afforded the opportunity to spawn and rear in historical habitat upstream of Nimbus and Folsom Dams. Access to this historical habitat will provide steelhead with cold water temperatures necessary for increased spawning, incubation, and rearing success, especially in consideration of the environmental effects of climate change. Such a program has many unknowns, and therefore cannot be expected to immediately abate all up-river stressors in the near-term, although some near term benefits will occur, such as immediate improvements in the geographic distribution of the population to historic habitats, which would reduce jeopardizing risks to the ESU faced by individuals that remain below project dams. In the long-term however, the RPA includes a structured passage program with pilot reintroductions. Additionally, alternatives to the proposed fish passage actions may also be proposed by Reclamation and the Fish Passage Steering Committee, in the event that the proposed actions are determined to not be technically or biologically feasible, and provided they are capable of meeting similar performance standards in terms of population distribution with Diversity Groups, and viability according the parameters described in Lindley *et al.* (2007).

The long-term operation of RBDD will provide unimpeded passage opportunities for adults and juveniles, and reduce competition and predation from other salmonid species.

The genetic diversity of the CV steelhead DPS is compromised through hatchery operations, including those at Nimbus. Through preparation and implementation of a HGMP, in the long-term, genetic diversity of CV steelhead will increase, thereby increasing the viability of the DPS.

An important aspect of the RPA analysis for steelhead concerns the status of the Southern Sierra Diversity Group, which is critical to preserving spatial structure of the DPS. This diversity group, consisting of extant populations in the Calaveras, Stanislaus, Tuolumne, Merced and Mainstem San Joaquin rivers, is very unstable due to the poor status of each population. This status is due to both project-related and non-project related (baseline) stressors. In the near-term, a new flow schedule for the Stanislaus River and interim actions to increase flows at Vernalis and curtail exports will allow greater out-migration cues and survival of smolts past the state and federal export facilities. In the long-term, additional actions through additional flow to export ratios in the southern Delta, and channel forming flows and gravel augmentations in the Stanislaus river will further reduce project-related adverse-effects to this diversity group. Due to uncertainty in the flow to export ratio, the RPA six year acoustic tag experiment, which can be combined with experimental barrier technologies, will significantly enhance our knowledge base for future consultations and refinements of this RPA action. Ultimately, our analysis is clear that the long-term viability of this diversity group will depend not only on implementation of this RPA, but also on actions outside this consultation, most significantly increasing flows in the Tuolumne and Merced rivers. The State Water Resources Control Board has made establishing additional flows in these rivers a priority and intends to take action within the near-term. A future CVP/SWP operations consultation that will be triggered by implementation of San Joaquin Restoration Program flows will also provide further opportunities to update and refine actions critical to this diversity group.

In summary, with full implementation of the RPA, NMFS expects the adverse effects of project operations will be minimized to the point where the likelihood of survival and recovery of the DPS is not appreciably reduced and its designated critical habitat is not adversely modified.

Table 11-3. Summary of actions to minimize or alleviate proposed action-related stressors to Central Valley steelhead and its designated critical habitat. The table is organized by life stage then by the number of populations affected by a particular stressor. Acronyms for diversity groups are as follows: NWC – Northwestern California; BPL – Basalt and Porous Lava; NSN – Northern Sierra Nevada; SSN – Southern Sierra Nevada.

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	NWC: Cottonwood / Beegum, Clear; BPL: Sacramento, Battle	RBDD gate closures from May 15 – Sept. 15 (plus 10 days in April) delaying adult immigration	17 % of those that spawn above RBDD, delayed in spawning, more energy consumed, greater pre-spawn mortality, less fecundity	High	Action I.3.2: RBDD interim Operations	Action I.3.1: RBDD operations after May 14, 2012
Adult immigration and holding	NWC: Clear	Water temperatures warmer than life history stage requirement for migration possible in lower reach near confluence with Sacramento River during August and September	Some adults may not enter mouth of Clear Creek, 1) delayed run timing, 2) seek other tributaries, 3) spawn in mainstem Sacramento R.; reduced in vivo egg viability	Low- except for critically dry years	Action I.1.5: Clear Creek thermal stress reduction	Continue implementation of Action I.1.5:
Adult immigration	SSN: Stanislaus River	Exposure to stressful water temperatures from the Delta to Riverbank during adult immigration	Delayed entry into river (CDFG 2007a); pre-spawn mortality; reduced condition factor	Medium	Action III.1.1: Establish Stanislaus Operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.2

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Spawning	NWC: Clear	Loss of spawning gravel below Whiskeytown Dam – limited spawning habitat availability	Limited areas of suitable spawning sites. Spawning in sub-optimal habitat	Medium - but could be high without continued gravel augmentation	Action I.1.3: Clear Creek spawning gravel augmentation	Continue implementation of Action I.1.3
Spawning	NSN: American River	Folsom/Nimbus releases – flow fluctuations in the American River resulting in redd dewatering	Redd dewatering and isolation prohibiting successful completion of spawning	Medium	Action II.1: Lower American River flow management, particularly management following the ARG process	Continue implementation of Action II..1
Spawning	NSN: American River; BPL: Sacramento; and potentially all other populations within the NWC, NSN, and BPL diversity groups	Nimbus Hatchery *O. mykiss* spawning with natural-origin steelhead in the American River and in other CV streams	Reduced genetic fitness of CV steelhead through the spread of Eel River genes and potentially hatchery rainbow trout genes to many below-barrier sites (Garza and Pearse 2008).	High	Action II.6.1: Preparation of hatchery genetic management plan for steelhead Action II.6.2: Interim actions prior to submittal of draft HGMP for steelhead	Continue implementation of Actions II.6.1 and II.6.2

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Spawning	SSN: Stanislaus River	Unsuitable flows in the Stanislaus River restrict spawnable habitat and dewater redds	Limited spawning habitat availability according to Aceituno (1993). Instream flows typically drop in January from higher December levels when San Joaquin River water quality objectives are met. This increases the risk for redd dewatering and direct egg mortality.	High	Action III.1.1: Establish Stanislaus operations group Action III.1.3: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.3
Spawning	SSN: Stanislaus River	Excessive fines in spawning gravel resulting from lack of overbank flow	Reduced suitable spawning habitat; For individual: increased energy cost to attempt to "clean" excess fine material from spawning site Fine material deposited in gravel beds because of lack of overbank flow to inundate floodplain and deposit fine material on floodplain, instead of in river (Kondolf *et al*. 2001).	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows	Continue implementation of Action III.2.2
Embryo incubation	NSN: American River	Exposure to stressful water temperatures in the American River during embryo incubation	Sub-lethal effects - reduced early life stage viability; direct mortality; restriction of life history diversity (*i.e.*, directional selection against eggs deposited in Mar. and Apr.)	Medium	Action II.3: Make structural improvements to improve cold water management Action V: Fish passage program (Near-term actions)	Continue implementation of Action II.3 Action V: Fish passage program (Long-term actions)
Egg incubation and emergence	SSN: Stanislaus River	Excessive fines in spawning gravel resulting from lack of overbank flow	Egg mortality from lack of interstitial flow; egg mortality from smothering by nest-building activities of other steelhead or fall-run; suppressed growth rates	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows	Continue implementation of Action III.2.2

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Egg incubation and emergence	SSN: Stanislaus River	Exposure to stressful water temperatures in the Stanislaus River during egg incubation and emergence	Egg mortality, especially for eggs spawned in or after March; Embryonic deformities (Deas *et al*. 2008) Temperatures may be operationally managed, depending on year type	Medium	Action III.1.1: Establish Stanislaus operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.2 Action V: Fish passage program (Long-term actions)
Juvenile rearing	BPL: Sacramento River	Provision of higher flows and cooler water temps during the summer than occurred prior to the construction of Shasta Dam	Potential fitness advantage for resident *O.mykiss* over the anadromous form, which would drive an evolutionary (*i.e*., genetic) change if life history strategy is heritable (Lindley *et al*. 2007).	High	Action V: Fish passage program (Near-term actions)	Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NWC: Cottonwood / Beegum, Clear; BPL: Sacramento, Battle	Lake Red Bluff, river impounded May15 - Sept 15, plus 10 days in April during emergencies	Reduction in rearing habitat quality and quantity; delayed juvenile emigration, increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967	High	Action I.3.2: RBDD interim operations Action I.6.1: Restoration of floodplain rearing habitat Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass Action I.6.3: Lower Putah Creek enhancements Action I.6.4: Improvements to Lisbon Weir	Action I.3.1: RBDD operations after May 14, 2012 Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4
Juvenile rearing	All diversity groups and populations	Unscreened CVP diversions between Red Bluff and the Delta	Entrainment	High	Action I.5: Funding for CVPIA Anadromous Fish Screen Program	Continue implementation of Action I.5

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	All diversity groups and populations, excluding the SSN diversity group	Lack of channel forming flows in the Sacramento River and reversed natural flow pattern (high flows in summer, low flows in late fall/winter), modifies critical habitat, including impaired geomorphic process.	Flow regulation (proposed Project stressor) and levee construction and maintenance (baseline stressor) alter ecological processes that generate and maintain the natural, dynamic ecosystem. This loss of natural river function has reduced the quality and quantity of rearing and migratory habitats (Stillwater Sciences 2007), thereby reducing juvenile growth and survival.	High	Action I.6.1: Restoration of floodplain rearing habitat Action I.6.2: Implement near-term actions at Liberty Island/Lower Cache Slough and lower Yolo Bypass Action I.6.3: Lower Putah Creek enhancements Action I.6.4: Improvements to Lisbon Weir	Continue implementation of Actions I.6.1, I.6.2, I.6.3, and I.6.4
Juvenile rearing	NWC: Clear Creek	Exposure to stressful water temperatures in Clear Creek during juvenile rearing	Limited over-summering habitat, reduced growth, increased susceptibility to disease and predation	High	Action I.1.5: Clear Creek thermal stress reduction	Continue implementation of Action I.1.5
Juvenile rearing	NWC: Clear Creek	Limited rearing habitat availability in Clear Creek resulting from low summer flows (< 80 cfs)	Limited rearing habitat availability; less food, reduced growth, increased predation risk	High	Action I.1.6: Adaptively manage to habitat suitability/IFIM study results	Continue implementation of Action I.1.6

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	NSN: American River	Folsom/Nimbus releases resulting in flow fluctuations; low flows	Fry stranding and juvenile isolation - observations of juvenile steelhead isolation in the American River were made in both 2003 and 2004 (Water Forum 2005a). Low flows limiting the availability of quality rearing habitat including predator refuge habitat	High	Action II.4: Minimize lower American River flow fluctuation effects	Continue implementation of Action II.4
Juvenile rearing	NSN: American River	Exposure to stressful water temperatures in the American River during juvenile rearing	Physiological effects - increased susceptibility to disease (e.g., anal vent inflammation) and predation. Visible symptoms of thermal stress in juvenile steelhead are associated with exposure to daily mean water temperatures above 65°F (Water Forum 2005a). With the exception of 2005, from 1999 through 2007, daily mean water temperatures at Watt Avenue from August through September were warmer than 65°F for approximately 81 percent of the days, and during 2001, 2002, 2004, 2006, and 2007, water temperatures were often over 68°F (figure 30a). Under a drier and warmer climate change scenario (Study 9.5), modeled water temperatures at Watt Avenue from June through September under full build out of the proposed Project range from 65°F to 82°F (Reclamation 2009). Even if no regional climate change is assumed (Study 9.1), water temperatures at this location during this time period are expected to range from 63°F to 79°F.	High	Action II.2: Lower American River temperature management Action II.3: Make structural improvements to improve management Action V: Fish passage program (Near-term actions)	Continue implementation of Actions II.2 and II.3 Action V: Fish passage program (Long-term actions)

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	SSN: Stanislaus River	Lack of overbank flow in the Stanislaus River to inundate rearing habitat	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows Action V: Fish passage program (Near-term actions)	Continue implementation of Action III.2.2 Action V: Fish passage program (Long-term actions)
Juvenile rearing	SSN: Stanislaus River	Reduction in rearing habitat complexity in the Stanislaus River due to reduction in channel forming flows	Reduced food supply; suppressed growth rates; starvation; loss to predation; poor energetics; indirect stress effects, smaller size at time of emigration;	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows	Continue implementation of Action III.2.2
Juvenile rearing	SSN: Stanislaus River	Unsuitable flows in the Stanislaus River for maintaining juvenile rearing habitat	Crowding and density dependent effects relating to reduced habitat availability. Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows Action III.1.3: Stanislaus River flow management	Continue implementation of Actions III.2.2 and III.1.3

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing and downstream movement	SSN: Stanislaus River	Predation in the Stanislaus River by non-native fish predators because rearing habitat is lacking	Juvenile mortality; Reduced juvenile production	High	Action III.2.2: Stanislaus River floodplain restoration and inundation flows Action III.1.3: Stanislaus River flow management Action III.2.3: Implement predation reduction projects	Continue implementation of Actions III.2.2, III.1.3, and III.2.3
Juvenile rearing	SSN: Stanislaus River	Exposure to stressful water temperatures in the Stanislaus River at the end of summer affecting rearing habitat	Metabolic stress; starvation; loss to predation; indirect stress effects, poor growth;	High	Action III.1.1: Establish Stanislaus operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Actions III.1.1 and III.1.2
Smolt emigration	SSN: Stanislaus River	Water temperatures warmer than life history stage (Mar - June)	Missing triggers to elect anadromous life history; failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress;	High	Action III.1.1: Establish Stanislaus operations group Action III.1.3: Stanislaus River flow management	Continue implementation of Actions III.1.1 and III.1.3

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	NSN: American River	Exposure to stressful water temperatures in the American River during smolt emigration	Physiological effects – reduced ability to successfully complete the smoltification process, increased susceptibility to predation	Medium	Action II.3: Make structural improvements to improve cold water management Action V: Fish passage program (Near-term actions)	Continue implementation of Action II.3 Action V: Fish passage program (Long-term actions)
Smolt emigration	SSN: Stanislaus River	Water temperatures warmer than life history stage (Mar - June)	Missing triggers to elect anadromous life history; failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress;	High	Action III.1.1: Establish Stanislaus operations group Action III.1.2: Stanislaus River temperature management	Continue implementation of Action III.1.1 and III.1.2
Smolt emigration	SSN: Stanislaus River	Suboptimal flow in the Stanislaus River (March – June)	Failure to escape river before temperatures rise at lower river reaches and in Delta; thermal stress; misdirection through Delta leading to increased residence time and higher risk of predation	High	Action III.1.3: Stanislaus River flow management	Continue implementation of Action III.1.3

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Smolt emigration	All diversity groups and populations	Cumulative direct and indirect loss associated with export operations (DCC operations, loss in Delta interior, loss at export facilities, creation of artificial freshwater system, altered hydrodynamics)	Substantial mortality to steelhead from all diversity groups. Based on VAMP studies of fall-run, mortality ranges from 90 – 99 % from San Joaquin River release points to Chipps Island (SJRGA 2006). Similar results are assumed for steelhead, as shown through the CCF studies showing similar loss rates between steelhead and Chinook salmon (DWR 2008).	High	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations Action IV.1.2: DCC gate operation Action IV.1.3: Engineering studies of methods to reduce loss of Salmonids in Georgiana Slough and South Delta channels Action IV.2.1: San Joaquin River inflow to export ratio Action IV.2.2: Old and Middle River Flow Management Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities	Continue implementation of Actions IV.1 through IV.6

Life Stage/ Habitat Type	Diversity Group(s): Population(s)	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
					Action IV.4.1: Tracy fish collection facility improvements Action IV.4.2: Skinner fish collection facility improvements. Action IV.4.3: Additional improvements at Tracy and Skinner fish collection facilities Action IV. 6: Formation of Delta operations for salmon and sturgeon technical working group Action IV.6: South Delta improvement program – phase I	

11.3.4 Southern DPS of Green Sturgeon and Its Proposed Critical Habitat

The Southern DPS of green sturgeon is at substantial risk to future population declines (Adams *et al*. 2007). The potential threats faced by the green sturgeon include enhanced vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River, habitat elimination and modification in the mainstem Sacramento River and Delta, lack of good empirical population data, vulnerability of long-term cold water supply for egg incubation and larval survival, and loss of juvenile green sturgeon due to entrainment Federal and State export facilities in the South Delta. In addition, many of the physical and biological features of critical habitat that are essential for the conservation of the Southern DPS of green sturgeon are currently impaired, and provide limited conservation value. The proposed action increases the population's extinction risk and continues to degrade the PCEs of their proposed critical habitat by adding numerous stressors to the species' baseline stress regime. Throughout this Opinion, NMFS acknowledged that a species' viability (and conversely extinction risk) is determined by the VSP parameters of spatial structure, diversity, abundance, and productivity. In addition, NMFS acknowledged the need for the proper functioning of the PCEs that comprise the proposed critical habitat. In sections 9.7 and 9.8, NMFS summarized various stressors that reduced the VSP parameters and conservation value of the PCEs.

The RPA specifies many significant actions that will reduce the adverse effects of the proposed action on Southern DPS of green sturgeon and bring about the proper functioning of PCEs of its proposed critical habitat. Many of the RPA actions, as described in their objectives and rationale, specifically address key limiting factors/threats facing the DPS and its proposed critical habitat, for example, passage impediments, degraded water quantity and quality of the remaining habitat downstream of Keswick and Shasta Dams, and entrainment influence of the Federal and state export facilities. Table 11-4 provides the linkage between specific project related stressors identified in the Opinion's Integration and Synthesis, and the specific RPA actions necessary to minimize those stressors in both the near-term and the long-term. All actions that address the Southern DPS of green sturgeon in the RPA are necessary to minimize project effects to the extent where they do not appreciably reduce the likelihood of survival and recovery of the DPS in the near-term and the long-term, or adversely modify proposed critical habitat. This written analysis summarizes some of the most significant RPA actions that NMFS relied on in its analysis.

As show in table 11-4, the RPA acknowledges the need for both short-term and long-term actions, including:

- increasing Shasta reservoir storage to provide for temperature control and improve the quantity and quality of downstream habitat;
- providing interim and long-term modifications to RBDD to providing safe passage to and from spawning habitat;
- implementing studies on Southern DPS of green sturgeon population size, and life history and habitat needs in the short-term to improve management of the species and their habitat in the long-term;
- providing increased rearing habitat;

- modifying the operation of the DCC; and
- implementing a revised decision process for Delta operations, including reduced exports.

Minimization of adverse effects of project operations on the Southern DPS of green sturgeon and its proposed critical habitat are expected to begin immediately through implementation of various actions, and continue to increase over the term of this Opinion (through year 2030) with the implementation of the longer-term actions. While implementation of the RPA will occur during the term of this Opinion, its full effects on population metrics (*e.g*., spatial structure, diversity, abundance, productivity) and the PCEs of critical habitat will occur over a considerable period of time after implementation. In the near term, precluding an emergency gate closure, delaying the gate closure until June 15th, and increasing the height of gate openings at RBDD will immediately minimize a significant portion of the adverse effects of RBDD on green sturgeon. An increase in survival of spawning adults, and the availability of more cold water that will provide more spawning habitat in more favorable spawning and embryo incubation temperature ranges, will likely result in an increased growth rate and diversity of the population in the long run. Also in the near-term, actions within the Delta will reduce the influence of the Federal and State export facilities, increase survival of juveniles by keeping them within the mainstem Sacramento River, and reduce entrainment and mortality.

In the long term, in addition to the continuation of the near-term actions, adverse effects of project operations will be further minimized with unimpeded passage opportunities for adults and juveniles at RBDD, and reduced competition and predation. Results from the near-term studies will aid in the management and recovery of the species and their proposed critical habitat on the long-term.

In summary, with full implementation of the RPA, NMFS expects that on-going project effects on Southern DPS of green sturgeon and its proposed critical habitat will be minimized to the extent the survival and recovery are not appreciably reduced, and critical habitat is not adversely modified.

Table 11-4. Summary of actions to minimize or alleviate proposed action-related stressors to the Southern DPS of green sturgeon and its proposed critical habitat.

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Adult immigration and holding	RBDD gate closures from May 15 - Sept 15 every year and emergency 10-day gate closures delaying adult immigration.	Passage blocked, 55 miles of spawning habitat made inaccessible upstream of RBDD after May 15. Large aggregations (25-30) of mature adults observed below RBDD gates. Estimate 30 % of run blocked based on run timing. Also, mortalities associated with downstream passage under gates post-spawn, or after fish move above gates. Mortality greater on larger, more fecund females that can not fit through 18" opening Greater proportion of run blocked or delayed (40 -50%) based on run timing; Greater mortalities associated with downstream passage under gates post spawn, or after moving above gates, sub lethal effects on eggs in fish and energy loss. Occurred twice in the past 10 years, but the frequency of occurrence may increase with climate change	High	Action I.3.2: RBDD interim operations Action I.3.3. RBDD interim operations for Green Sturgeon Action I.3.4: Measures to compensate for adverse effects of RBDD interim operations on green sturgeon	Action I.3.1: RBDD operations after May, 2012 Continue implementation of Action I.3.4
Spawning	RBDD	Unnatural spawning site created below RBDD, portion of run (only one in CV) spawning in water 2 feet deep, channel aggradation below hydraulics from gates, eggs suffocate, physiological effects, delayed hatch, greater predation on eggs due to accumulation of predators below RBDD.	High	Action I.3.2: RBDD interim operations Action I.3.3. RBDD interim operations for Green Sturgeon Action I.3.4: Measures to compensate for adverse effects of RBDD interim operations on green sturgeon	Action I.3.1: RBDD operations after May, 2012 Continue implementation of Action I.3.4

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Embryo incubation	Water temperatures warmer than life history stage requirements below Hamilton City.	For eggs and fry that are spawned in areas from RBDD to Hamilton City water quality is less suitable than above RBDD where temperatures are controlled for winter-run. Eggs suffocate from less flow, physiological effects, delayed hatch, greater predation on eggs due to presence of non-native introduced warm-water species.	Medium	Action I.2.1: Maintain suitable water temperatures for Southern DPS of green sturgeon. Action I.2.2: Maintain minimum Shasta Reservoir storage. Action I.2.3: February forecast and plan of operation.	Continued implementation of Action I.2.1. Continued implementation of Action I.2.2. Continued implementation of Action I.2.3.

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile rearing	Increased juvenile mortality related to emigration when RBDD Dam gates are in (*i.e.*, May15 - Sept 15, plus 10 days in April during emergencies)	Based on passage estimates of when juveniles are present at RBDD (USFWS 1997-2007), approximately 100 % of the green sturgeon DPS that is spawned above RBDD would be exposed to higher concentrations of predators when the gates are in (TCCA 2008). Approximately 70 % of the entire green sturgeon DPS spawns above RBDD. Mortality of juvenile salmon emigrating past RBDD when the gates are in ranges from 5 -50 % (Vogel *et al*. 1988; Tucker 1998); mortality of juvenile green sturgeon emigrating past RBDD has not been estimated, but is expected to increase when the gates are in.	High	Action I.3.2: RBDD interim operations Action I.3.3. RBDD interim operations for Green Sturgeon Action I.3.4: Measures to compensate for adverse effects of RBDD interim operations on green sturgeon	Action I.3.1: RBDD operations after May, 2012 Continue implementation of Action I.3.4
	Reduced quality of juvenile rearing habitat related to the formation of Lake Red Bluff when the RBDD gates are in.	Reduction in rearing habitat quality and quantity; increased predation; change in riparian habitat, change in river conditions, change in food supply, every year since 1967.	High		
Juvenile rearing	Unscreened CVP diversions	Entrainment	High	Action I.5: Funding for CVPIA Anadromous Fish Screen Program	Continue implementation of Action I.5

Life Stage/Habitat Type	Stressor	Response/Rationale for Magnitude of Effect	Magnitude of Effect	Short-term Action to Minimize/Alleviate Stressor	Long-term Action to Minimize/Alleviate Stressor
Juvenile and subadult	Loss at export facilitiest Impaired movements through South Delta waterways due to temporary barriers or permanent gates	Entrainment of fish at the CVP and SWP in every month of the year. Louvers function well for larger fish but are inefficient for smaller fish. Fish behavior may make them susceptible to the cleaning practices of louvers. In louver studies, fish position themselves in front of the bottom edge of the louver along the channel bottom, where they held position for prolonged periods of time. Presence of green sturgeon juveniles and subadults in the South Delta as confirmed by salvage records. Presence occurs during operational season of barriers (April through November). Closure of waterways by temporary barriers or permanent gates inhibits movement of green sturgeon through these waterways. Fish located upstream of barriers are potentially trapped or delayed in their movements downstream by structures.	Unknown Unknown	Action IV.1.1: Monitoring and alerts to trigger changes in DCC operations Action IV.1.2: DCC gate operation Action IV.1.3: Engineering studies of methods to reduce loss of Salmonids in Georgiana Slough and South Delta channels Action IV.2.2: Old and Middle River flow management Action IV.3: Reduce the likelihood of entrainment or salvage at the export facilities Action IV.4.1: Tracy fish collection facility improvements Action IV.4.2: Skinner fish collection facility improvements. Action IV.4.3: Additional improvements at Tracy and Skinner fish collection facilities Action IV. 6: Formation of Delta operations for salmon and sturgeon technical working group Action IV.6: South Delta improvement program – phase I	Continue implementation of Actions IV.1 through IV.6

11.3.5 Southern Resident Killer Whales

NMFS evaluated effects of the proposed action on Southern Residents by evaluating effects on the availability of their preferred prey, Chinook salmon. NMFS considered effects on both listed and non-listed Chinook salmon. With respect to the listed winter-run and spring-run ESUs, the proposed action is likely to appreciably reduce the survival and recovery of the listed entities and conservation value of their designated critical habitat, which would increase their risk of extinction in the long term. If these stocks were to become extinct, there would be an increased likelihood of localized killer whale prey depletions on the Pacific coast.

As described in sections 11.3.1 and 11.3.2, full implementation of the RPA is expected to reduce adverse effects of project operations on ESA-listed winter-run and spring-run and their designated critical habitats to the point where there is not an appreciable reduction in the likelihood of survival or recovery or an adverse modification of critical habitat. NMFS anticipates that implementation of RPA actions will decrease the risk of extinction of winter-run and spring-run in the long-term, reducing the risk of localized prey depletions and thereby increasing the prey available to Southern Residents.

NMFS also considered effects of the proposed action on non-listed Chinook salmon that are available to Southern Residents (section 6.8.1.2.2). As discussed in section 6.8.1.2, we quantified effects of hatchery production and project operations on non-listed Chinook salmon available to Southern Residents. Hatchery programs included in the proposed action produce more Chinook salmon than are killed in project operations. However, artificial propagation can have harmful effects on the long-term fitness of salmon populations, and the current hatchery practices at Nimbus and Trinity River fish hatcheries are diminishing the long-term viability of these non-listed stocks over the long term. The proposed action did not identify time lines for reforming harmful hatchery practices that affect these stocks.

RPA Action Suite II.6 calls for development of hatchery management plans for fall-run at Nimbus Fish Hatchery and spring-run and fall-run at Trinity River Fish Hatchery, by June 2014. New hatchery management will be subject to future section 7 consultations and/or the 4(d) HGMP process. NMFS anticipates that implementing these RPA actions will provide long-range planning to reduce impacts of hatchery operations on natural fall-run and spring-run, increase the genetic diversity and diversity of run-timing for these stocks, and increase the likelihood that these stocks are retained as prey available to Southern Resident killer whales in the long term. Improving the genetic diversity and diversity of run timing of CV fall-run will decrease the potential for localized prey depletions and increase the likelihood that fall-run can withstand stochastic events, such as poor ocean conditions.

Many RPA actions intended to avoid jeopardy to listed winter-run and spring-run, or adverse modification of their critical habitat, are also expected to reduce adverse effects of the action on the short- and long-term abundance and the long-term viability of non-listed fall-run and late-fall run. The immediate cause of the recent fall-run decline is most likely a result of ocean conditions (Lindley *et al*. 2009). However, freshwater impacts and hatchery programs most likely contributed to the collapse (Lindley *et al.* 2009). The RPA actions address many of the freshwater impacts identified in Lindley *et al.* (2009). NMFS expects that these actions would

reduce adverse impacts of the project in all years, under all hydrologic conditions. The actions include:

1) After 2012, there will be unrestricted up-stream and down-stream passage at RBDD. The interim measure of gates out on September 1 allows an additional 14 days unimpeded passage for adult fall-run.

2) A continued investment in fish screens along the Sacramento River and in the Delta would reduce entrainment of juvenile fall-run/late fall-run in unscreened diversions.

3) Improved rearing habitat in both the short-term and long-term in the Delta and lower Sacramento River (Liberty Island/Cache Slough) will improve juvenile fall-run survival.

4) Increased closures of DCC gates from October through January will reduce the percentage of juvenile outmigrants that enter the Interior Delta and are then subject to both direct and indirect mortality.

5) Additional Old and Middle River flow restrictions from January through June will reduce exposure of fall-run and late fall-run juveniles to export facilities and increase survival for fall-run leaving the San Joaquin River.

6) Improvements in salvage procedures at the Delta fish facilities will lead to higher survival of juveniles that enter the facilities and are subjected to the salvage process.

7) In the long term, implementation of fall-run hatchery management plans at Nimbus and Trinity River Hatcheries will increase genetic diversity of fall-run.

8) Increased gravel augmentation on Clear Creek and the Stanislaus River will increase spawning and rearing habitat for listed and non-listed salmonids.

9) Improved flows on Clear Creek, Stanislaus River, and the American River will enhance fall-run spawning and maintain spatial diversity between races.

10) Improved water temperature control on the Sacramento River, Clear Creek, American River, and Stanislaus River will provide more suitable habitat for Chinook salmon.

11) Greater storage levels in the fall for temperature control will improve temperatures for fall-run, as well as winter-run and spring-run.

12) Replacement of the Spring Creek temperature control curtain will provide cooler water temperatures to the Sacramento River in the fall.

13) Implementation of spring-run passage improvement projects (*i.e.*, mitigation for RBDD impacts) in the Sacramento River basin will improve fall-run passage and access to greater spawning and rearing habitat.

14) Improvements in San Joaquin River flows at Vernalis will not only improve survival of juvenile steelhead but fall-run as well

15) Export reductions based on fish densities at the fish salvage facilities will improve survival of non-listed salmonids, since they are similar in size at length.

16) Fish passage above project dams, although not intended for non-listed fish species, will benefit EFH by providing spatial and temporal separation between runs, thereby improving the genetic structure and space available for fall-run spawning (reduced competition, and introgression).

17) Restoration of Battle Creek is expected to improve EFH for fall-run as well as listed species.

18) Improvements in fish passage at flood control weirs will reduce stranding of both adult and juvenile non-listed salmonids and sturgeon.

19) Greater monitoring and reporting requirements for listed species will improve management of non-listed species as well.

20) A 6-year acoustical tag study of juvenile salmonids in the San Joaquin River and Delta will improve understanding of fall-run biological requirements.

The following actions in the RPA are expected to decrease the abundance of fall-run and late fall- run to some extent and may reduce viability in the long term:

1) Temperature control management for winter-run during the summer in the upper Sacramento River can reduce or eliminate the cold water available for fall-run spawning and egg incubation in September and October, most likely in dry or critically dry years. The RPA includes a new year-round program for temperature management at Shasta Reservoir, including requirements for carryover storage, and water temperatures until October 31. The new temperature regime will lead to more frequent End of September storage levels that will support cold water releases for spring-run and fall-run in September and October, thereby reducing the adverse effects of temperatures on fall-run and late fall-run as compared to the proposed action.

2) Temperature control management for steelhead on the American River during the summer can reduce the cold water pool available in October and November.

3) Segregation weirs on Clear Creek to reduce introgression with spring-run reduce habitat available for fall-run spawning.

4) Removal of the middle fish ladder at RBDD for green sturgeon to facilitate additional 18 inch gate opening delays passage of fall-run.

5) Wilkins Slough minimum flows in September and October to preserve cold water storage in Shasta Reservoir can delay upstream migration.

Effects numbered 3 through 5 are expected to occur in all years, during all hydrologic conditions; however, the effects, which include delayed arrival at spawning grounds or less available spawning habitat, are not anticipated to be severe enough to cause mortality of adult spawners. Additionally, RBDD will be removed in approximately three years, after which effects numbered 4 will not occur, and the dam removal will reduce adverse effects on fall-run thereafter.

Temperature control effects numbered 1 and 2 are expected to occur only during critically dry years, which represent less than 10 percent of historic years modeled and up to 25 percent of future years, based on a potential climate change scenario of dry, warming conditions (Study 8.0, 2030 Level of Development). These effects are expected to result in prespawn and early life-stage mortalities for fall-run in the mainstem Sacramento River and American River. In up to 25 percent of future years, temperature control effects numbered 1 and 2 could result in a reduction in future production of fall-run. In critically dry years, up to 8 percent of the Sacramento River population and up to 14 percent of the American River population could experience pre-spawn or egg mortality (Oppenheim 2009). A loss of 8 to13 percent future production from natural spawners in the mainstem Sacramento River and American River, respectively, would be a small reduction in the overall number of adult fish available to the whales from this stock, which is dominated by hatchery produced fish. The RPA is designed to conserve storage and will, therefore, improve the likelihood that sufficient cold water will remain in the fall, and the upper estimate of impacts will not be realized. Some impacts from temperature are likely to occur with or without the RPA, because they are linked to hydrologic factors, such as drought and climate variation.

The RPA will generally reduce adverse effects of project operation on naturally- spawning fall-run and late-fall run by improving adult passage and increasing juvenile survival. Implementation of fall-run hatchery management plans at Nimbus and Trinity River fish hatcheries will increase genetic diversity of fall-run. Increased diversity will decrease the potential for localized prey depletions and increase the likelihood that fall-run can withstand stochastic events, such as poor ocean conditions, and thereby provide a consistent food source in years with overall poor productivity. In some years temperature control actions may result in reductions in future production of fall-run in the Sacramento and American rivers; however, the aggregate of the RPA actions will reduce overall adverse effects of project operations to a level that is not likely to imperil this prey source .

In sum, the RPA is not likely to result in an increased extinction risk of winter-run and spring-run, and it is not likely to imperil the long-term viability of fall-run. Consequently, project operations under the RPA are not likely to result in local depletions of killer whale prey that could appreciably reduce the whales' likelihood of survival and recovery. Therefore, NMFS concludes that the RPA will not jeopardize the continued existence of Southern Resident killer whales.

11.3.6 Economic and Technological Feasibility of the RPA

When developing an RPA, NMFS is required by regulation to devise an RPA that is "economically and technologically feasible" in addition to avoiding jeopardy and adverse

modification. These feasibility concerns were discussed and addressed in many ways throughout the period of November 2008 through May 2009, during the course of the consultation. During this period, NMFS developed an initial RPA by December 11, 2009, revised that RPA in response to feedback from the two science panels and DWR, Reclamation, CDFG, and USFWS. NMFS developed a second draft RPA by March 3, 2009, and revised that draft in response to additional feedback from the agencies prior to providing the final action. Some of the more complex RPA actions, including Shasta Storage, Habitat Rearing Actions, Passage Program, Stanislaus Flows and the San Joaquin River Inflow Export Ratio, went through many iterations of review, re-drafting, and refinement, involving interagency staff and management expertise, including biology, ecology, hydrology, and operations, in order to ensure that the actions were based on best available science, would be effective in avoiding jeopardy, and would be feasible to implement. NMFS also secured outside contractual services to provide additional modeling expertise in evaluating draft RPA actions.

Examples of Feasibility Concerns in RPA Actions

As a result of this iterative consultation process, NMFS considered economic and technological feasibility in several ways when developing the CVP/SWP operations RPA. Examples include:

1) Providing reasonable time to develop technologically feasible alternatives where none are "ready to go" – *e.g.*, the Delta engineering action (Action IV.1.3), and lower Sacramento River rearing habitat action (Action I.6.1);

2) Calling for a stepped approach to fish passage at dams, including studies and pilot projects, prior to a significant commitment of resources to build a ladder or invest in a permanent trap and haul program. A reinitiation trigger is built into this action in the event passage is not deemed feasible, prior to construction of permanent infrastructure;

3) Considering limitations of the overall capacity of CVP/SWP systems of reservoirs in determining feasibility of flow actions below reservoirs, and considering the hydrologic record and CALSIM modeling results (Shasta/Sacramento River, Folsom/American River, New Melones/Stanislaus River).

4) Tiering actions to water year type and/or storage in order to conserve storage at reservoirs and not unduly impact water supplies during drought (*e.g.*, see appendix 5);

5) Providing health and safety exceptions for export curtailments;

6) Using monitoring for species presence to initiate actions when biologically supported and most needed, in order to limit the duration of export curtailments;

7) Incorporating scientific uncertainty into the design of the action, when appropriate, in order to refine the action over time (*e.g.*, 6-year acoustic tag study for San Joaquin steelhead).

8) Incorporating performance goals into more complex actions (for example, Shasta storage, rearing habitat and San Joaquin acoustic tag study). A performance goal approach will allow for adaptation of the action over time to incorporate the most up-to-date thinking on cost-effective technologies or operations.

9) Allowing for interim, further constrained, water deliveries to TCCA through modified RBDD operations for 3 years, while an alternative pumping plant is being built.

The RPA includes collaborative research to enhance scientific understanding of the species and ecosystem, and to adapt actions to new scientific knowledge. This adaptive structure is important, given the long-term nature of the consultation and the scientific uncertainty inherent in a highly variable system. Monitoring and adaptive management are both built into many of the individual actions and are the subject of an annual program review. This annual program review will provide for additional opportunities to address any unforeseen concerns about RPA feasibility that may arise.

The rationale statements for individual actions explain more specific reasoning, and the administrative record contains specific hydrology and modeling results in support of the more complex actions (*e.g.*, Shasta and San Joaquin storage/flows).

Water Supply Costs and Projected Impacts

NMFS examined water supply costs of the RPA as one aspect of considering economic feasibility. While only costs to the action agency are considered in determining whether a RPA meets the regulatory requirement of economic feasibility, NMFS is mindful of potential social and economic costs to the people and communities that historically have depended on the Delta for their water supply. Any water supply impact is undesirable. NMFS made many attempts through the iterative consultation process to avoid developing RPA actions that would result in high water costs, while still providing for the survival and recovery of listed species.

NMFS estimates the water costs associated with the RPA to be 5-7% of average annual combined exports: 5% for CVP, or 130 TAF/year, and 7% for SWP, or 200 TAF/year[18]. The combined estimated annual average export curtailment is 330 TAF/year. These estimates are over and above export curtailments associated with the USFWS' Smelt Opinion. The OMR restrictions in both Opinions tend to result in export curtailments of similar quantities at similar times of year. Therefore, in general, these 330 TAF export curtailments are associated with the NMFS San Joaquin River Ratio actions in the RPA.

NMFS also considered that there may be additional localized water costs not associated with South Delta exports. These may include, in some years, localized water shortages necessitating groundwater use, water conservation measures, or other infrastructure improvements in the New Melones service area, and localized impacts in the North of Delta in some years, associated with

[18] The proportional share between the CVP and SWP is attributable to CalLite programming and may not represent the true share of export reductions that would be allocated to each facility under actual conditions.

curtailments of fall deliveries used for rice decomposition. NMFS considered whether it was feasible to model and estimate any water costs associated with the Shasta or American River RPA actions, and discussed this issue with Reclamation. In general, it was decided that modeling tools were not available to assess these costs and/or that costs would be highly variable depending on adaptive management actions, and therefore, not meaningful to model.

To assess the economic feasibility associated with average annual water costs of 330 TAF, NMFS reviewed CVP/SWP project wide and statewide information regarding water availability. NMFS considered the following information as background to economic feasibility. This information is provided by the State Legislative Analyst's Office (California's Water: An LAO Primer, October 2008):

1) "The federal government has developed the most surface storage capacity in the state with over 17 MAF of capacity in ten reservoirs on multiple river systems. These reservoirs generally are part of the federal Central Valley Project (CVP), which serves about 3.1 million people, and provides irrigation water to over 2.6 million acres of land. The largest reservoir in the system is Shasta Lake with 4.6 MAF of capacity. The state, as part of the development of SWP, built Oroville Dam and reservoir on the Feather River system with a capacity of 3.5 MAF. The SWP provides all or part of the drinking water supply for 23 million people and provides irrigation water to about 755,000 acres of land."
2) "The federal government, through the Bureau of Reclamation, holds the most (in volume) water rights in the state with over 112 MAF of water held, mainly for delivery through the federal CVP. Second to this are the water rights held by the Imperial Irrigation District (44 MAF), serving mainly farms in the Colorado River region. Two private gas and electric companies hold rights to over 41 MAF of water collectively, mainly for hydroelectric power. The state, through DWR, holds rights to about 31 MAF of water."

3) "Water dedicated for environmental uses, including instream flows, wild and scenic flows, required Sacramento-San Joaquin River Delta (the Delta) outflow, and managed wetlands use, declines substantially between wet and dry years—a 62 percent reduction. Available water supplied to agricultural and urban users actually increases in dry years. From wet to dry years, urban use increases by 10 percent and agricultural use increases by 20 percent. The main reason for this increase is the need in dry years for more developed water for agricultural irrigation and residential landscaping."

4) "Agricultural use of water is significant. California agriculture uses roughly 30 MAF of water a year on 9.6 million acres. California's vast water infrastructure— including the development of the State Water Project, Central Valley Project, and Colorado River, as well as local and regional groundwater supply projects—was developed to provide water for irrigation (among other purposes), with agriculture using about 80 percent of California's developed water supply." (LAO, 2008)

NMFS also considered information on relative deliveries of water in the state, including Figure 8 from Blue Ribbon Task Force Delta Vision report, and Figure 10 from the same report, showing the relative importance of Delta exports relative to other sources of water supplies (taken from

DWR 2005 California Water Plan Update). To assess the relative impact of export reductions on Southern California urban uses, NMFS reviewed a presentation by Metropolitan Water District, entitled "Metropolitan's Water Supply Planning," January 31, 2009, and reviewed Figure 11 from the Delta Vision report showing the potential range of demand reductions and supply augmentations from different strategies (taken from DWR 2005 Water Plan Update).

NMFS considered the above water cost estimates in the context of the larger set of facts on California's water supply to determine whether the RPA is economically feasible. NMFS believes that a cost of 5-7 percent of the project capacity is not unreasonable for a multi-species ESA consultation, given the factual context of the Delta ecosystem and water delivery system. 330 taf reduction can be compared to 30 MAF for agriculture statewide, according to LAO. In addition, these amounts can be compared to the water rights held by the federal and state governments (112 MAF, and 31 MAF respectively, according to LAO).

Most important, NMFS evaluated the 5-7 percent combined export reduction in the context of future water demand and supply in California. The Delta is only one source of water supply. According to other planning documents (DWR's California Water Plan Update, 2005), water agencies are already planning for and adjusting to reduced supplies from the Delta. Alternative supplies include: water transfers, demand reduction through conservation, conjunctive use/groundwater use during droughts, wastewater reclamation and water recycling, and desalination. For example, urban water use efficiency is estimated by DWR to potentially result in between 1.2 to 3.1 MAF annual water savings, and recycled municipal water is potentially estimated to result in .9 to 1.4 MAF annual water savings. The state of California has had an active Integrated Watershed Management Program for almost 10 years. Projects funded through these local water infrastructure investments are coming on line, and will help offset decreased water supply from the Delta.

Furthermore, NMFS considered RPA water costs in the context of b(2) water assets of 800 taf. As the Opinion explains, for purposes of the effects analysis, NMFS could not be reasonably certain that b(2) water would be available at a specific place and time needed to address adverse effects of the project on a listed species. Therefore, the Opinion analysis and RPA actions developed to avoid jeopardy and adverse modification of critical habitat are independent of the availability of b(2) assets, and are silent about how these assets should be used. The Secretary of the Interior retains discretions over how b(2) assets are dedicated to eligible water actions throughout the water year. It is NMFS understanding that water actions taken by Reclamation to implement the RPA are eligible actions. If the Secretary of the Interior so chooses, dedication of b(2) water assets to the RPA actions could completely or significantly offset the projected water costs of the RPA. In addition, limited EWA assets associated with the Yuba Accord may be available, in part, to offset water costs of the SWP. In the proposed project description, these assets were dedicated to VAMP export curtailments. The VAMP export curtailments will be replaced, in part, by the new San Joaquin River Ratio action.

In evaluating economic feasibility, NMFS examined the direct costs of the modified operations to the Federal action agency, Reclamation. According to the LAO, 85% of Reclamation's costs are reimbursed by water users, and 95% of DWR's SWP costs are reimbursed:

> Irrigation water users pay about 55 percent of CVP reimbursable costs ($1.6 billion), while municipal and industrial water users are responsible for the remaining 45 percent (or about $1.3 billion). These reimbursements are paid through long-term contracts with water agencies. The total capital cost to construct the CVP as of September 30, 2006, is about $3.4 billion. The federal Bureau of Reclamation calculates how much of the capital construction cost is reimbursable from water users. Currently, users pay about 85 percent of total costs. In contrast, more than 95 percent of SWP's costs are reimbursable from water users. The costs assigned to such CVP purposes as flood control, navigation, and fish and wildlife needs are not reimbursable and are paid by the federal government.

(LAO, 2008) Through this arrangement, costs to the action agency itself are minimized.

NMFS also reviewed and evaluated water cost information provided by DWR. In general, the DWR information reinforced the NMFS estimates of water costs. On March 20, 2009, DWR provided estimates of water costs associated with the March 3, 2009, draft of the RPA (letter from Kathy Kelly to Ronald Milligan; Reclamation 2009b). These modeled costs were discussed in several technical team meetings and remain the only modeled projections of water costs of the RPA that NMFS is aware of. DWR estimated that combined CVP/SWP costs, as compared to operations under D1641, are 800 taf to 1.0 MAF (or about 15%-17%). However, because the salmon and smelt are near the export facilities during much of the same time of year (winter to spring), many export curtailments are multi-species in nature. Therefore, DWR estimates that, the average combined water supply impact of the NMFS RPA, layered on top of the USFWS smelt RPA, is an additional 150 taf to 750 taf, (or about 3% to 15%).

The San Joaquin river ratio action changed significantly between the March 3, 2009, draft of the RPA and the final RPA. Specifically, the duration of the period changed from 90 to 60 days, in order to better focus the action on the species' biological requirements, and the ratios were more closely refined to reflect water year type in order to reflect actual available water in the watershed and in acknowledgement that acquiring (or requiring, if the SRCWB acts) additional flows on the Tuolumne and Merced rivers could be difficult or uncertain in the near-term. Both of these refinements would reduce, perhaps substantially, DWR projected water costs, and would most likely make them consistent with NMFS estimates. On April 28, 2009, DWR provided an additional analysis of on the economic impacts of estimated water costs of the March 3, 2009, draft RPA (letter from Kathy Kelly to Ronald Milligan; DWR 2009). DWR estimated that the impact of the RPA would range from $320 million to $390 million per year. The methodology used multipliers estimated indirect and well as direct impacts. Again, these costs were predicated on RPA actions that were modified after March 3rd, and would have reduced water costs.

Project Costs

In addition to water costs, Reclamation and DWR will incur project costs associated with certain RPA actions (*e.g.*, the fish passage program). The State of California has authorized $19.6 billion in water-related general obligation bonds since 2000, and these bonds often contain

provisions for environmental conservation related purposes (LAO, 2008). Over $3 billion has been spent through the Calfed Bay-Delta Program. The CALFED ROD contains a commitment to fund projects through the Ecosystem Restoration Program. Similarly, the CVPIA AFRP funds eligible restoration projects, using federal authorities. Some of the projects in the RPA may qualify for those sources of funds.

Summary

In summary, for all the above reasons, NMFS finds that the costs associated with the RPA, while not insignificant, do not render the RPA economically infeasible. Overall, the RPA is both technologically and economically feasible.

11.3.7 Consistency with the Intended Purpose of the Action and the Action Agencies' Legal Authority and Jurisdiction

As noted in the introduction to this RPA, regulations provide that an RPA must be an alternative that, "can be implemented in a manner consistent with the intended purpose of the action, [and] that can be implemented consistent with the scope of the federal agency's legal authority and jurisdiction." 50 CFR 402.02. This RPA meets both of these criteria.

First, this RPA is consistent with the intended purpose of the action. According to the BA, "[t]he proposed action is the continued operation of the CVP and SWP." (CVP and SWP operations BA, P. 2-1) Specifically, Reclamation and DWR "propose to operate the Central Valley Project (CVP) and State Water Project (SWP) to divert, store, and convey CVP and SWP (Project) water consistent with applicable law and contractual obligations." (CVP and SWP operations BA, p.1-1) Changes in operation of the projects to avoid jeopardizing listed species or adversely modifying their critical habitats require that additional sources of water for the projects be obtained, or that water delivery be made in a different way than in the past (*e.g.*, elimination of RBDD), or that amounts of water that are withdrawn and exported from the Delta during some periods in some years be reduced. These operational changes do not, however, preclude operation of the Projects.

Second, the RPA may be implemented consistent with the scope of the federal agency's legal authority and jurisdiction. The Rivers and Harbors Act of 1937, which established the purposes of the CVP, provided that the dams and reservoirs of the CVP "'shall be used, first, for river regulation, improvement of navigation and flood control; second, for irrigation and domestic uses; and, third, for power.'" (CVP and SWP operations BA, p. 1-2). The CVP was reauthorized in 1992 through the CVPIA, which modified the 1937 Act and added mitigation, protection, and restoration of fish and wildlife as project purposes. The CVPIA provided that the dams and reservoirs of the CVP should be used "'first, for river regulation, improvement of navigation, and flood control; second, for irrigation and domestic uses and fish and wildlife mitigation, protection and restoration purposes; and, third, for power and fish and wildlife enhancement." (CVP and SWP operations BA p. 1-3) One of the stated purposes of the CVPIA is to address impacts of the CVP on fish and wildlife. CVPIA, Sec. 3406(a). The CVPIA gives Reclamation broad authority to mitigate for the adverse effects of the projects on fish and

wildlife, and nothing in the Rivers and Harbors Act of 1937 requires any set amount of water delivery.

In addition to adding protection of fish and wildlife as second tier purposes of the CVP, the CVPIA set a goal of doubling the natural production of anadromous fish in Central Valley rivers and streams on a long-term sustainable basis, by 2002. Sec. 3406(b)(1). This goal has not been met. Instead, as detailed in this Opinion, natural production of anadromous fish has declined precipitously. A 2008 report on the CVPIA anadromous fish program by independent reviewers (Cummins *et al*. 2008), recommended by the Office of Management and Budget and requested by Reclamation and the USFWS, stated that

> "it is far from clear that the agencies have done what is possible and necessary to improve freshwater conditions to help these species weather environmental variability, halt their decline and begin rebuilding in a sustainable way. A number of the most serious impediments to survival and recovery are not being effectively addressed, especially in terms of the overall design and operation of the [CVP] system."

One of the review panel's specific recommendations was that the agencies

> "should develop a more expansive view of the authorities at their disposal to address the problems, especially with regard to water management and project operations. The agencies have followed a more restrictive view of their authorities than appears legally necessary or appropriate to the seriousness of the mission. "

The report notes that the CVPIA contains a "long list of operational changes, actions, tools, and authorities – some quite specific and discrete, some general and on-going – that Interior is to use to help achieve the anadromous fish restoration purposes of the CVPIA . . . ." (Cummins *et al*. 2008 at 5) The report then describes development of a Final Restoration Plan that would utilize these authorities, but concludes that "[t]he agencies implement the CVPIA . . . in a way that bears little resemblance to the integrated, coordinated, holistic vision of the Final Restoration Plan." (Cummins *et al*. 2008 at 9)

Most relevant to this consultation, the review panel observed that

> "[i]t would seem that CVPIA activities and personnel should be central to the OCAP plan, the Section 7 consultation, and the agencies' efforts to satisfy the requirements of the ESA (that is, after all, one of the directives of the CVPIA). The panel received no information or presentations on the involvement of the CVPIA program or personnel in the ESA consultation effort . . . and in the determination of what actions the agencies should be taking to meet the ESA."

(Cummins *et al*. 2008 at 11)

Reclamation and DWR operate their respective projects in close coordination, under a Coordinated Operations Agreement (COA). The COA was authorized by Congress in Public Law 99-546. Consequently, the COA "is the federal nexus for ESA section 7 consultation on

operation of the SWP. Because of commitments expressed in the COA and the Congressional mandate to Reclamation to operate the CVP in conjunction with the SWP, the operations of the two projects are linked . . . ." (CVP/SWP operations BA, p. 1-10) DWR stated in a recent letter to Ren Lohoefener, Regional Director of the USFWS, "For purposes of consultations under the . . . ESA, the operations of the SWP and CVP are intentionally and inextricably connected . . . . . ESA protection of Delta species under the BO is impossible without the participation and cooperation of the Department." (DWR 2009a). Consequently, DWR asserted its standing to request reinitiation of consultation, regardless of whether Reclamation did so.

Moreover, state law gives DWR authority to provide for needs of fish and wildlife independent of the connection of the two water projects. According to the BA, DWR

> "is required to plan for recreational and fish and wildlife uses of water in connection with State-constructed water projects and can acquire land for such uses (Wat. Code Sec. 233, 345,346, 12582). The Davis-Dolwig Act (Wat. Code Sec. 11900-11925) establishes the policy that preservation of fish and wildlife is part of State costs to be paid by water supply contractors, and recreation and enhancement of fish and wildlife are to be provided by appropriations from the General Fund."

(CVP/SWP operations BA, page 1-4) DWR, like Reclamation, has broad authority to preserve and enhance fish and wildlife.

The Preamble to the ESA consultation regulations states that "a Federal agency's responsibility under section 7(a)(2) permeates the full range of discretionary authority held by that agency," and that the Services can prescribe a RPA "that involves the maximum exercise of Federal agency authority when to do so is necessary, in the opinion of the Service, to avoid jeopardy." 51 Fed. Reg. 19925, 19937 (June 3, 1986). The independent review panel concluded that despite Congressional authorization and direction more than 16 years ago to restore anadromous fish populations in Central Valley rivers and streams, Reclamation continues to take an unduly narrow view of its authorities in carrying out Congress' mandate. The legal foundation of this RPA is a broader view of Reclamation's authorities, one that is consistent with the CVPIA, the ESA, and the independent review panel's recommendations.

JEOPARDY ANALYSIS AND CONCLUSION

The "Rationale for 2011 amendments" sections for those actions to which changes were made explain the reasons for the changes. With no exception, the objectives for each of the actions where changes were made will be met. With the changes in the actions or implementation procedures, the RPA, as a whole, still "can be implemented in a manner consistent with the intended purpose of the action, . . . consistent with the scope of the Federal agency's legal authority and jurisdiction, . . . is economically and technologically feasible, and . . . would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat" (50 CFR 402.02).

NMFS does not believe the 2011 amendments meet any of the criteria for reinitiation of consultation listed in 50 CFR 402.16. Consequently, NMFS has not advised the action agency to reinitiate consultation. Rather, the amendments have been developed using the collaborative process established in the 2009 Opinion.

LITERATURE CITED

Anderson, J.J., R.T. Kneib, S.A. Luthy, and P.E. Smith. 2010. Report of the 2010 Independent Review Panel (IRP) on the Reasonable and Prudent Alternative (RPA) Actions Affecting the Operations Criteria And Plan (OCAP) for State/Federal Water Operations. Prepared for: Delta Stewardship Council, Delta Science Program. December 9. 39 pages.

Delta Operations for Salmonids and Sturgeon (DOSS) Group

03/11/10 Thurs conf. call 2:00 pm

Objective: Provide advice to the Water Operations Management Team (WOMT) and National Marine Fisheries Service (NMFS) on measures to reduce adverse effects from Delta operations of the Central Valley Project and the State Water Project to salmonids and green sturgeon. DOSS will coordinate the work of other technical teams. DOSS notes and advice can be found at: http://swr.nmfs.noaa.gov/ocap/actions.htm

Attendees: Mike Ford, Carol Stroble, Sheila Greene, John Leahigh, Andy Chu, Tracy Pettit (DWR); Roger Guinee, Craig Anderson, Nick Hindman (FWS); Bruce Herbold (EPA), Barbara Byrne, Garwin Yip, Jeff Stuart, Bruce Oppenheim (NMFS); Paul Fujitani, Thuy Washburn (USBR); Greg Wilson (SWRCB); Dan Kratville (CDFG)

Agenda: Discuss NMFS' reasonable and prudent alternative (RPA) Action IV.2.3, and determine whether an Old and Middle River (OMR) flow trigger was met on Monday, March 8.

Because not all call participants had attended the DOSS meeting on Tuesday morning, March 9th, or the WOMT meeting on Tuesday afternoon, March 9th, NMFS provided a brief review of the discussions at those meetings.

DOSS meeting summary from March 9th:

The DOSS group discussed the second trigger in the table describing implementation of Action IV.2.3 (NMFS Opinion page 649) and noted that, as written, it advised operations not intended by the RPA. NMFS noted that a more meaningful implementation of the second trigger could be achieved using a modified trigger that would trigger a shift to OMR flows no more negative than -3500 cfs when combined loss density [fish/thousand acre feet (TAF)] exceeded 8 fish/TAF, and a shift to OMR flows no more negative than -2500 cfs when combined loss density exceeded 12 fish/TAF. DOSS supported this proposed trigger.

DOSS then reviewed monitoring data through Sunday (all that was available at the time of the DOSS call) and, using the modified second trigger, concluded that (because no triggers were met) the advice to WOMT was to continue operating so that OMR flows are no more negative than -5000 cfs. Because salvage numbers were observed to be getting higher (combined loss densities greater than 5 fish/TAF were observed on two days), and because March is typically the peak month of winter-run Chinook salmon salvage, DOSS also advised that the daily salvage be monitored closely on a daily basis so that action could be taken in a timely manner, if necessary. In this discussion, it was also noted that the higher salvage numbers were likely linked to the recent storm flows, and that since the flows were going down, it was possible that salvage might also taper off.

WOMT meeting summary:

NMFS reported on the morning's DOSS meeting, providing the advice and noting the points summarized above. WOMT agreed to the following notification procedure if daily combined loss density exceeded a trigger that would advise a change in operations:

1. NMFS sends a formal notification of the trigger being met (and the recommended action) to both the DOSS and WOMT e-mail distribution lists.
2. Project operators, per the transition procedures in the NMFS RPA (page 649), begin operating to the less negative OMR flows within two full days of the formal NMFS notification.
3. DOSS and WOMT, at their discretion, may call a meeting to discuss the triggering data or transition procedure.

New discussion

The group then moved on to a discussion of the second trigger. The second trigger, as written in the RPA (first and second stage triggers are met when loss>measured fish density/12 TAF and when loss>measured fish density/8 TAF, respectively), was modeled after a trigger used in the 2007 Chinook Salmon Decision Tree (same formula, applied to a overlapping, but different time of the year). The Chinook Decision Tree included in the OCAP BA (Appendix B) uses a similar trigger using a slightly different formula (first and second stage triggers are met when loss>measured fish density*12 TAF loss>measured fish density*8 TAF). These triggers will be referred to hereafter as the "division-based second trigger" and the "multiplication-based second trigger".

The group then briefly reviewed the behavior of the triggers and their responsiveness to loss densities at the facilities:

- Divison-based second trigger – This trigger is always exceeded, at both first and second stages, with *any* take at the pumps, which does not provide the sort of tiered protection (increased protection at higher loss densities) intended by this RPA action.
- Multiplication-based second trigger – This trigger is exceeded any time actual total exports (in TAF) exceeds 12 TAF (for the first stage trigger) or 8 TAF (for the second stage trigger), *independent* of loss. This trigger, like the division-based trigger, does not provide the tiered protection intended by this RPA action.

In contrast, a trigger that is met when combined loss density exceeds some "warning level" loss density is able to provide increased protection with increasing loss density and meet the intent of this RPA action. The "modified trigger" discussed would have triggered the first stage action if combined loss density exceeded 8 fish/TAF and the second stage action if combined loss density exceeded 12 fish/TAF.

Because the second trigger, as written in the NMFS RPA, has its basis in the Chinook Decision Tree, much of the call discussed the development of that trigger in the Chinook Decision Tree. It was noted that earlier (pre-2007) Chinook Decision trees did not include any form of the second trigger, and that just two Chinook triggers were used from mid-February onward:

(1) a trigger for winter-run that triggered an action if loss exceeded a criterion based on the current year's winter-run juvenile production estimate (JPE), and
(2) a trigger for spring-run that triggered an action if the percent loss of any spring-run surrogate release exceeded 0.5%.

The Chinook Decision Tree (both in 2007 and earlier) did use triggers very similar to the modified second trigger (*i.e.*, action was triggered if combined loss density exceeded some fixed "warning" loss density), with two differences. First, the Chinook Decision Tree used those types

of triggers during the October 1-February 15 period, and then switched to the triggers described immediately above. Second, the "warning" densities were set at 8 fish/TAF and 15 fish/TAF (compared to the 8 fish/TAF and 12 fish/TAF of the modified trigger).

While the group was able to review the triggers used in past Chinook Decision Trees, we did not have sufficient information to fully reconstruct the development of those triggers. The intent of the OMR actions in the RPA (similar to the export reduction actions in the Chinook Decision Tree) was to provide tiered protection based on the real-time monitoring of salvage at the fish facilities. Further review of materials used in the development of the Chinook Decision Tree (or a new review of relevant materials) would help to ensure that the second trigger is modified in a way that provides the intended protection to listed species, and that it would have associated biological rationale.

After a review and discussion of the various triggers, the group identified three options to move forward and identified the pros and cons of each (provided in the background section of the DOSS advice, below). After discussion of the three options, there was group consensus on the following DOSS advice.

DOSS advice to NMFS and WOMT from the March 11, 2010, DOSS call

Background:
Given the questions regarding the second salmon trigger within NMFS RPA Action IV.2.3 (*i.e.*, daily loss is greater than daily measured fish density divided by 12 taf), DOSS identified 3 options to move forward, along with pros and cons of each:

(1) implement the second trigger as written.
- Pro: Implementing the RPA as written.
- Con: The second trigger, as written, does not meet the intent of the action, which is to be responsive to increasing densities of fish at or near the pumps. As written, any take at either salvage facility would trigger an OMR action.

(2) implement a modified second trigger as discussed during the March 9, 2010, DOSS and WOMT meetings, that is, the first and second stage triggers would be met if combined loss density of older juveniles exceeds 8 fish/thousand acre feet (TAF) and 12 fish/TAF, respectively.
- Pros: A. This modified trigger, as intended, would increase protection as fish density increases at or near the export facilities.
  - B. This modified trigger provides greater protection than the first trigger based on the winter-run juvenile production estimate for 2009-10 (*i.e.*, first and second stage triggers of 11 and 22 fish/TAF, respectively[1]).
- Con: The biological rationale for the modified trigger has not been fully discussed. While the modified trigger is similar to loss density criteria used in the Chinook salmon decision, the exact triggering densities and time of year during which

[1] [1] Based on the official JPE, the first and second stage triggers are 12 and 24 fish/TAF. The trigger levels of 11 and 22 fish/TAF mentioned on the call were based on the preliminary JPE and are no longer current.

those triggers apply differ between the Chinook salmon decision process and the modified trigger.

(3) implement only the first and third triggers while DOSS evaluates the second trigger.

Pros: A. The first and third triggers are well documented and understood, while the second trigger, as written, would require operations not intended by the action.

B. The biological rationale for the modified trigger has not been fully discussed.

Con: Not implementing the second trigger would provide less protection.

Recent loss densities are provided below.

Date	Combined loss (# fish)	Combined exports[2] (TAF)	Combined loss density (fish/TAF)
March 8, 2010	145	16,568	8.75
March 9, 2010	13	16,350	0.80
March 10, 2010	19.72	15,420	1.28
March 11, 2010[3]	17.32	14,951	1.16

DOSS discussed the potential benefits of the JPE-based versus absolute loss density triggers. All acknowledged the value of the first trigger, which is scaled to the current JPE.

- Some felt that this was adequate to protect the juvenile population. The first take concern level this year is 11,796, and the reconsultation level is 23,592. The current combined loss at the facilities is ~1,200. Because the combined loss is low, DWR concluded that protection beyond trigger #1 (*i.e.*, fish density trigger based on winter-run JPE) is not necessary at this time.
- Others felt that an additional fish density trigger not tied to the JPE would provide important protection against sporadic episodes of high salvage events.

<u>DOSS advice</u>:
After discussing the three options, above, and their associated pros and cons, DOSS advises WOMT and NMFS to implement option 3. Because neither the first or third triggers have been met, the DOSS advice to WOMT and NMFS is for the CVP and SWP to operate such that OMR is no more negative than -5,000 cfs.

[2] http://www.usbr.gov/mp/cvo/vungvari/deltaop.pdf

[3] Data for March 11, 2010, were reported after the DOSS call, but DOSS suggested including the data, if available, to inform WOMT