Annual Report of Activities
October 1, 2012, to September 30, 2013

Delta Operations for Salmonids and Sturgeon (DOSS)

Technical Working Group

October 2013

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Acronyms and Abbreviations

BDCP	Bay-Delta Conservation Plan
BiOp	Biological Opinion
CDEC	California Data Exchange Center
CNFH	Coleman National Fish Hatchery
CPUE	catch per unit effort
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWT	coded wire tag
DAT	Data Assessment Team
DCC	Delta Cross Channel
DCT	Delta Conditions Team
DFW	California Department of Fish & Wildlife
DPM	Delta Passage Model
DPS	distinct population segment
DSM2	Delta Simulation Model
DSC	Delta Stewardship Council
DSP	Delta Science Program
DWR	California Department of Water Resources
EFH	essential fish habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FWS	U.S. Fish & Wildlife Service
I:E	inflow-to-export ratio
IEP	Interagency Ecological Program
IRP	independent review panel
JPE	juvenile production estimate
KLCI	Knights Landing Catch Index
LSNFH	Livingston Stone National Fish Hatchery
MAF	million acre-feet
NGO	non-governmental organization
NMFS	National Marine Fisheries Service
OCAP	Operations, Criteria and Plan for the Central Valley Project and State Water Project
OMR	net tidal flow measurement in Old and Middle Rivers combined
PTM	particle tracking model
PWA	public water agencies
RBDD	Red Bluff Diversion Dam
Reclamation	U.S. Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
RST	rotary screw trap
SAR	smolt to adult return rate
SCI	Sacramento Catch Index
SWG	Smelt Working Group

SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management program
WOMT	Water Operations Management Team
WY	water year

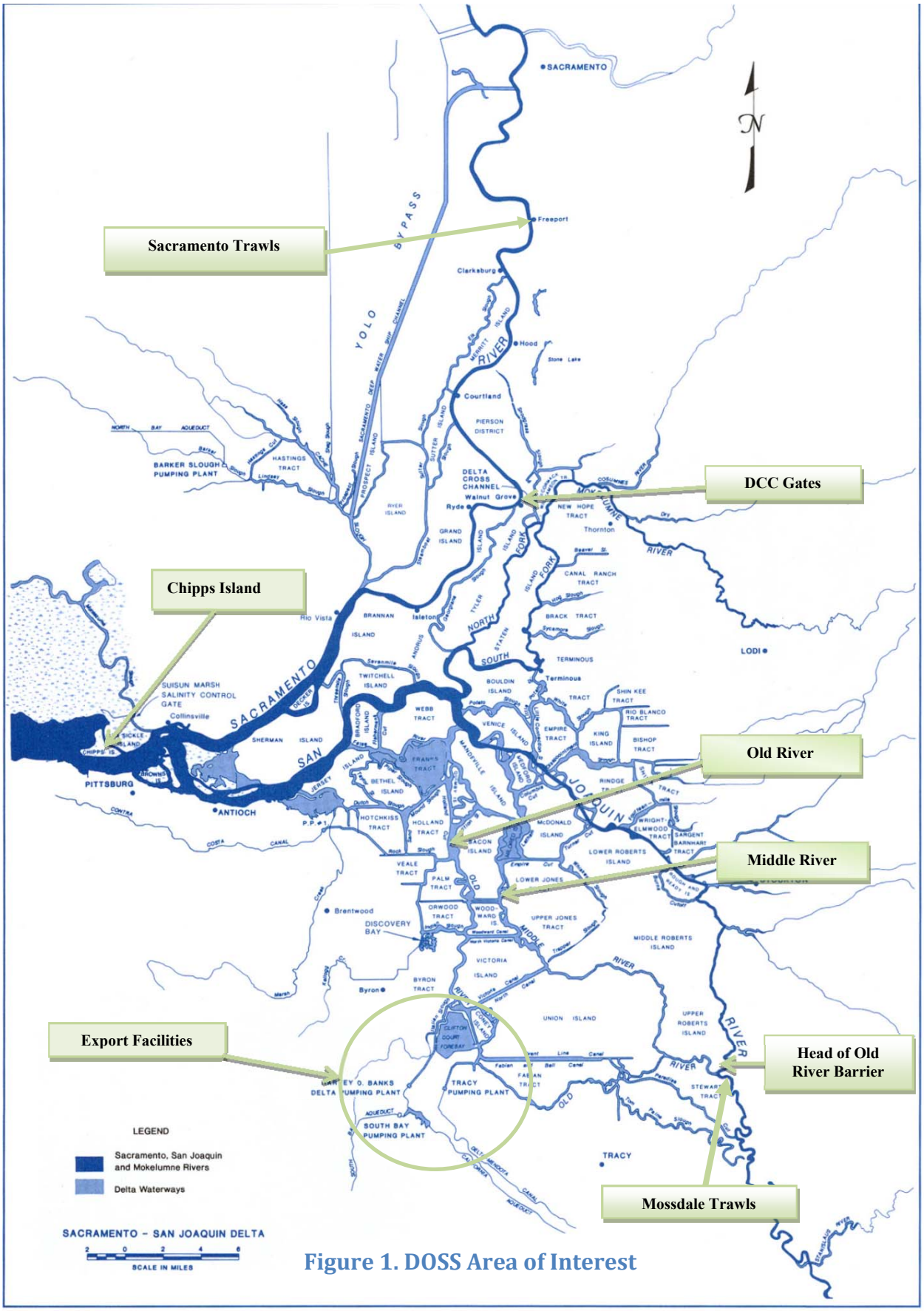

Figure 1. DOSS Area of Interest

Sacramento–San Joaquin Delta Atlas *Department of Water Resources*

Chapter 1 – Background

1.1 Background

On June 4, 2009, NOAA's National Marine Fisheries Service (NMFS) issued its Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project (CVP) and State Water Project (SWP, NMFS BiOp). NMFS BiOp reasonable and prudent alternative (RPA) Action IV.5 called for the formation of the Delta Operations for Salmonids and Sturgeon (DOSS) Technical Working Group. DOSS is a technical team that comprises biologists, hydrologists, and operators with relevant expertise from the U.S. Bureau of Reclamation (Reclamation), California Department of Water Resources (DWR), California Department of Fish and Wildlife (DFW), the Delta Stewardship Council (DSC), U.S. Fish and Wildlife Service (FWS), State Water Resources Control Board (SWRCB), U.S. Geological Survey (USGS), U.S. Environmental Protection Agency (EPA), and NMFS that provides advice to NMFS and to the Water Operations Management Team (WOMT) on issues related to fisheries and water resources in the Delta and recommendations on measures to reduce adverse effects of Delta operations of the CVP/SWP export facilities to salmonids and green sturgeon.

The purposes of DOSS are to:

1) provide recommendations for real-time management of operations to WOMT and NMFS, consistent with implementation procedures provided in the RPA;

2) review annually project operations in the Delta and the collected data from the different ongoing monitoring programs;

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

4) evaluate the effectiveness of RPA 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 6-year acoustic tag experiment for San Joaquin fish provided for in RPA Action IV.2.2;

6) coordinate with the Smelt Working Group (SWG) to maximize benefits to all listed species; and

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

1.2 Participants

DOSS consisted of the following representatives in 2012–2013:

U. S. Bureau of Reclamation (Reclamation)
Rachel Johnson
Paul Fujitani
John Hannon
Josh Israel*
Elizabeth Kiteck
Tom Morstein-Marx
Russ Yaworsky*

U. S. Fish and Wildlife Service (FWS)
Craig Anderson*
Leigh Bartoo*
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Barb Byrne*
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Jeff Stuart
Brycen Swart
Garwin Yip

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Anke Mueller-Solger (IEP)

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Dan Yamanaka
Edmund Yu

State Water Resources Control Board (SWRCB)
Kari Daniska
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Larry Lindsay

U. S. Environmental Protection Agency (EPA)
Erin Foresman*

U.S. Geological Survey (USGS) (Non-participant in 2013)
Jon Burau*

*Designated representative of the agency

1.3 Summary of Key Delta RPA Actions

Key RPA actions relating to Delta operations (topics) on which advice was provided to NMFS and WOMT are summarized below:

1. **Delta Cross Channel (DCC) gate operations (IV.1.1–IV.1.2)**

   - **Action IV.1.1**: Monitor and provide alerts to trigger changes in DCC operations to provide timely information for DCC gate operations that will reduce loss of emigrating winter-run Chinook, spring-run Chinook, steelhead, and green sturgeon.

   - **Action IV.1.2**: Modify DCC gate operations to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon from October through June.

2. **Old and Middle River (OMR) flow management (Action IV.2.3):**

   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 River or Sacramento River into the southern or central Delta.

3. **San Joaquin Inflow-to-Export (I:E) Ratio (Action IV.2.1):**

   Increase the inflow-to-export ratio to reduce the vulnerability of emigrating California Central Valley steelhead within the lower San Joaquin River to entrainment into the channels of the south Delta and at the pumps from diversion of water by the CVP/SWP 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.

4. 6-Year Acoustic Tag Experiment (Action IV.2.2)

DOSS will conduct annual reviews of the experiment results. At the end of the 6-year period, a status review of Action IV.2.1 shall be prepared by DOSS and 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, DOSS will make recommendations to NMFS, Reclamation, DFW, DWR, and FWS 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.

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

Reduce losses of winter-run and spring-run Chinook salmon, Central Valley steelhead, and 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 facilities in the following weeks.

Chapter 2 — Summary of Discussions and Advice/Recommendations

2.1 Weekly Discussion Topics

- CVP/SWP operations
- Delta fish monitoring, salvage, loss, and loss densities
- DCC gate closures
- OMR flow management
- Coordination with other technical teams

2.3 Summary of RPA Actions

2.3.1 Topic 1. DCC Gate Operations (Action IV.1.2)

RPA Action IV.1.2 modifies DCC gate operations to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon. Relative to previous DCC operations requirements, the operating criteria in Action IV.1.2 (Table 2.1) provide for longer periods of gate closures during the emigration season to reduce direct and indirect mortality of yearling spring run, winter run, and Central Valley (CV) steelhead. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures specified in Action IV.1.2 (Table 2.1).

Table 2.1. DCC operations

Date	Action Triggers	Action Responses
October 1–November 30	Water quality criteria per D-1641 are met and either the KLCI or the SCI are > 3 fish per day ≤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 >5 fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is < 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.

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
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.
February 1–May 15	D-1641 mandatory gate closure.	Gates closed, per WQCP criteria
May 16–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.

KLCI = Knights Landing Catch Index; SCI = Sacramento River Catch Index; DCC = Delta Cross Channel; NMFS = National Marine Fisheries Service; WOMT = Water Operations Management Team; DWR = California Department of Water Resources; WQCP = Water Quality Control Plan

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 to entrainment into the DCC at night than during the day because

of their higher position in the water column and the depth of the lip to the DCC 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) because of 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 increases the survival of salmonid emigrants through the Delta, and early closure reduces 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 the 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.

2.3.1.1 Implementation procedures: Monitoring data related to triggers in the decision tree were reported on DAT calls and evaluated by DOSS. DOSS provided advice to NMFS, and the action was vetted through WOMT standard operating procedures.

During the first DOSS meeting on 10/23/12 for water year (WY) 2013, DOSS discussed the proposal (from East Bay Municipal Utility District and partners) to close the DCC gates during the Mokelumne River fall pulse flow to reduce straying of returning fall-run Chinook salmon adults into the Sacramento River through the DCC. It was reported that, because of water quality issues in the Delta associated with low flows, the DCC gates would not be closed during the Mokelumne pulse flows in October 2012. In 2012, 12.091 adult Chinook salmon escaped to the Mokelumne River. The impact of not closing the DCC gates on potential fall-run Chinook salmon straying will not be known until coded wire tag (CWT) recoveries from other hatcheries in 2012 are processed.

On 11/23/12, NMFS sent an official notification to Reclamation that the catch trigger of >5.0 fish/day had been met and that the DCC gates were to be closed. The gates were closed on 11/27/12 at 10:00 a.m., and remained closed until spring 2013. Effective 12/1/12, RPA Action IV.1.2 called for the gates to be closed with a potential exception allowed when water quality conditions were not being met; the exception was not needed during the 2013 water year.

Table 2.2. Preliminary catch indices reported on the 11/27/12 DOSS call

Sacramento Catch Index (trawl data)	Sacramento Catch Index (seine data)	Knights Landing Catch Index
11/23: 9.0 11/26: 42.0	11/26: 16.0	11/23: 5.4 11/24: 98.5 11/25: 130.7 11/26: 20.1

2.3.2 Topic 2. Old and Middle River Flow management (Action IV.2.3)

The objective of this action is to reduce the vulnerability of emigrating juvenile winter run, yearling spring run, and CV steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the south Delta and at the pumps due to the diversion of water by the export facilities in the south Delta. From January 1 through June 7 (the action ended before mid-June because conditions for the temperature offramp were met; see details in Section 2.5.3), the flows in Old and Middle rivers (OMR flows) were managed to no more negative than from -2,500 to -5,000 cfs, depending on the loss density of salmonids at the export facilities. The reverse flow was managed within this range to reduce flows toward the pumps during periods of increased salmonid presence.

OMR restrictions for the protection of delta smelt per the FWS biological opinion or requirements in SWRCB's Decision 1641 controlled operations through March 21 and the Vernalis inflow-to-export (I:E) ratio or Delta outflow controlled operations during April, May, and early June. Although OMR requirements per the NMFS BiOp were in effect during those periods, the controlling regulatory requirements provided OMR conditions as or less negative than the OMR requirement per the NMFS BiOp. The NMFS OMR requirement did control operations during WY 2013 between March 22 and March 31. Details regarding OMR limits in effect are provided in the operations table in Appendix F (preliminary data subject to change); daily loss densities for steelhead and Chinook salmon are provided in Appendices D and E, respectively.

2.3.3 Topic 3. San Joaquin River Inflow-to-Export (I:E) Ratio (Action IV.2.1)

The yeartype for the San Joaquin Basin during implementation of the I:E ratio in April and May 2013 was designated as "Critical", which required implementation of a 1:1 I:E ratio. When Vernalis flows were below 1,500 cfs, the projects were allowed to operate to the health and safety exception to Action IV.2.1 and export a minimum combined 1,500 cfs.

2.3.4 Topic 4. 6-Year Acoustic Tag Experiment (Action IV.2.2)

The 6-Year Acoustic Tag Experiment was undertaken for the third of the 6 years as required by the NMFS BiOp. Three releases of between 468 and 480 tagged Mokelumne River Hatchery steelhead were made over multiday periods from Durham Ferry (Table 2.3). The experiment was undertaken by FWS, USGS, Reclamation, and the University of Washington. FWS was responsible for tagging steelhead at the Mokelumne River hatchery, transporting these fish to Durham Ferry, releasing approximately 24 fish every 4 hours at a site downstream of the holding location, and testing fish health as part of each release. The FWS

California–Nevada Fish Health Center performed a fish pathology test and screened for disease. Two battery-life tests were completed using tags randomly selected from all three release groups and completed at the Reclamation's Tracy Aquaculture Facility. Operational conditions varied somewhat during the three 30-day periods following the steelhead releases, and the flow-related information and additional environmental monitoring data will be used for evaluating factors influencing survival and route entrainment of steelhead.

Table 2.3. Tagging and release dates and average hydrologic and operation conditions during 2013 steelhead releases for the six-year study.

			14-Day Average				
Year	Tagging Dates	Release Dates	Vernalis (cfs)	Combined Exports (cfs)	I:E	Old River @ Head (cfs)	OMR (cfs)
2013	March 5–7	March 6–9	1,632	4,591	0.3	1,397	-3,645
2013	April 2–4	April 3–5	1,445	1,467	1.0	1,083	-283
2013	May 7–9	May 8–11	2,459	1,714	1.5	1,701	-859

USGS maintained more than 100 VR2W receivers, 10 VR2C receivers, and 4 HR receivers between upstream of Durham Ferry and Chipps Island. Dual arrays were operated at many sites, including Chipps Island, Jersey Point, Clifton Court Radial Gates, and Head of Old River. Additional receivers deployed at the Tracy Fish Collection Facility (TFCF) were useful for characterizing survival and efficiency through the facility for the three releases. Receivers remained deployed until early August. Receiver data will be converted into the individual tag's detection histories for use at University of Washington's Columbia Basin Research Laboratory to estimate route entrainment and survival along the San Joaquin River and south-Delta migration corridors. Results from the 2013 investigation, anticipated in late 2014, will be characterized with and without a predator-fish filter, which was developed for the 2011 study.

2.3.5 Topic 5. Reduce Likelihood of Entrainment or Salvage at Export Facilities (Action IV.3)

The objective of RPA Action IV.3 is to reduce the loss of winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon by reducing CVP/SWP exports when large numbers of juvenile Chinook salmon are migrating into the upper Delta region and are at risk of entrainment into the south and central Delta. Exports are reduced based on established loss or loss-density triggers for Chinook salmon in the RPA action. From 11/1/12 to 12/31/12, DOSS tracked the daily loss and loss density of non-ad-clipped older juvenile Chinook salmon and the cumulative percent loss for selected hatchery Chinook salmon release groups at the Delta fish facilities to determine whether the CVP/SWP triggered an action response for export reductions. As an early alert, DOSS used the Knights Landing Catch Index (KLCI) and Sacramento Catch Index (SCI) of non-ad-clipped older juvenile Chinook salmon to indicate that CVP/SWP exports might need to be reduced.

The third alert threshold of >10 fish/day based on the KLCI or SCI was first met on 11/24/12, when the KLCI was at 98.51. FWS did not conduct the Sacramento beach seine or trawl surveys on 11/24/12; therefore, no SCI could be calculated for the day. However, the SCI for the Sacramento trawl and the Sacramento area beach seines was also >10 fish/day when sampling was done on 11/26/12. Catch indices which exceed the third alert threshold of >10 fish/day provided an alert that a large number of older juvenile Chinook salmon were migrating into the upper Delta region and indicate that the loss or loss-density triggers that would require an export reduction might be triggered in the near future..

After meeting the third alert threshold, RPA Action IV.3 was triggered for the first time on 12/4/12, when the daily older juvenile Chinook salmon loss exceeded the first-stage trigger of 95 fish/day (see Appendix A). Pursuant to RPA Action IV.3, combined exports had to be reduced to no more than 6,000 cfs for 3 days. This was the first time that an action response was triggered under this RPA action since the 2009 NMFS BiOp has been in effect, and there was some uncertainty about how operations should be transitioned for export reductions or for increasing exports after the 3-day period. The transition criteria for operations were not explicitly stated in the RPA action; therefore, DOSS worked with NMFS to provide clarification for the RPA action (see Section 2.5.1).

Despite the uncertainties on implementation, the CVP/SWP reduced combined exports from 12/8/12 to 12/10/12 to no more than 6,000 cfs and there was no loss of older juvenile Chinook during the duration of the action response. After satisfying the action response on 12/10/12, RPA Action IV.3 was triggered again on 12/18/12 when the daily older juvenile Chinook salmon loss exceeded the second-stage trigger of 120 fish/day (see Appendix A). This required combined exports to be reduced to 4,000 cfs for 3 days; however, a change in operations was not necessary because the OMR criteria for delta smelt was more controlling, and combined exports were already at or below 4,000 cfs. Therefore, day one of the action response began on 12/19/12 (the following day) and the action response lasted until 12/21/12. The daily loss during the duration of the action response ranged from 0 to 65.96 fish for an average of 21.99 fish/day.

Summary:
DOSS was able to use daily fish monitoring data to track the implementation of the RPA action and provide clarification on the implementation of the action response for exceeding a trigger (see Section 2.5.1). In summary, the CVP/SWP triggered Action IV.3 twice from 11/1/12 to 12/31/12 and the appropriate action responses were taken in near real-time (i.e., 3 days); however, there were some limitations when making decisions in near real-time based on the preliminary data. Oftentimes, revisions to the data have to be made and, by that time, it might be too late to take an appropriate action response or the wrong action response might have already been taken.

As an example, DFW had to change the daily older juvenile Chinook salmon loss on 12/18/12 because a non-ad-clipped (i.e., the adipose fin was not clipped as a designated mark) older juvenile Chinook, misidentified as ad-clipped, was accidentally collected for CWT processing at the SWP and not included in the original loss calculation. This revision was reported to DOSS on 1/8/13, which changed the daily non-ad-clipped older juvenile Chinook salmon loss from 123.02 as reported on 12/19/12 to 141.43. Subsequently, DFW did a preliminary

adjustment to the daily older juvenile loss on 12/18/12 by increasing the loss by one because the non-ad-clipped Chinook salmon was collected for CWT processing and not released back into the Delta. This preliminary adjustment increased the daily loss from 141.43 to 142.43 using preliminary protocols. Nevertheless, these revisions did not lead to a different action response because the daily loss on 12/18/12 was already above the second-stage trigger of 120 fish/day. Even so, DOSS acknowledges that actions must often be made based on the data that are available at the time and that the data are subject to change.

2.4 Other Topics

2.4.1 Smelt Working Group

SWG participants who also participated in the DOSS calls provided updates each week on Smelt Working Group (SWG) advice and the status of any existing or pending determinations from FWS (for delta smelt) and DFW (for longfin smelt). Summaries of SWG advice and related determinations can be found at: http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm.

2.4.2 Juvenile Production Estimate for Winter-run Chinook salmon

The preliminary and final juvenile production estimates (JPE) for winter-run Chinook salmon for brood year 2012 (juvenile outmigration year 2012–2013), the loss-density triggers used in the implementation of Action IV.2.3, and the incidental take limit at the fish facilities, were as follows:

	Preliminary	**Final (per JPE letter issued 1/31/13)**
JPE	535,325	532,809
Incidental take allowed at the CVP/SWP fish collection facilities (2% of the JPE)	10,706	10,656
Wild older juvenile Chinook loss-density triggers in Action IV.2.3		
First-stage trigger (2% of the JPE/2000)	5.35	5.33
Second-stage trigger (2% of the JPE/1000)	10.71	10.66

2.4.3 Spring-Run Surrogate Releases

Coleman National Fish Hatchery (CNFH) juvenile late-fall-run Chinook salmon are used as surrogates to mimic the natural yearling spring-run emigration pattern from Deer, Mill, and Antelope creeks. These fish are ad-clipped and marked with a unique CWT code before being released. The CNFH late-fall-run Chinook salmon are considered appropriate surrogates for spring-run Chinook salmon because they are reared to a size similar to that of natural spring-run yearlings and released in the upper Sacramento River based on turbidity and flow events that mimic natural storm events in spring-run Chinook salmon natal streams.

In WY 2013, CNFH released three groups of late-fall Chinook salmon uniquely marked as spring-run Chinook salmon surrogates into Battle Creek: 1) 72,974 on 12/18/12, 2) 70,287on

1/8/13, and 3) 80,191on 1/25/13. In addition to these surrogate releases, CNFH released 807,967late-fall-run Chinook salmon into Battle Creek on 11/29/12 as part of its production release[1]. Before these releases, DOSS provided input to CNFH on the release schedule of the spring-run Chinook salmon surrogates. A summary of the input provided from DOSS to CNFH is described in Table 2.4.

Table 2.4. Summary of DOSS input to Coleman National Fish Hatchery (CNFH) on spring-run surrogate releases.

Release Type	DOSS Input
First Surrogate Release	DOSS wanted a 2-week separation period from the 11/29/12 late-fall-run Chinook salmon production release before the first spring-run Chinook salmon surrogate release so that the Chinook salmon from both release groups do not comingle with each other. CNFH released the first spring-run surrogate group on 12/18/12 and the release was consistent with DOSS input because the spring-run surrogates were released approximately 19 days after the late-fall-run Chinook salmon production release.
Second Surrogate Release	CNFH originally scheduled the second spring-run Chinook salmon surrogate group to be released on 1/17/13; however, DOSS was interested in moving up the release date to coincide with high flows and low exports expected in late December and early January. CNFH agreed with the request and released the second spring-run Chinook salmon surrogate group on 1/8/13.
Third Surrogate Release	CNFH originally scheduled the third spring-run Chinook salmon surrogate group to be released on 2/7/13; however, CNFH was running out of space in mid-January and needed to make room for the fall-run Chinook salmon fry; therefore, CNFH needed to release the final surrogate group no later than the week of 1/28/13 and sought input from DOSS. Despite the dry forecast at the time, DOSS had no objections with an earlier release schedule as long as there was a 2-week separation period since the second spring-run Chinook salmon surrogate release. For these reasons, CNFH released the third spring-run Chinook salmon surrogate group on 1/25/13.

After each release, DOSS tracked the cumulative loss of each spring-run Chinook salmon surrogate group at the Delta fish facilities to ensure that the cumulative percent loss did not exceed the surrogate incidental take limit of 1.0% for each individual release group. Cumulative loss exceeding 0.5% of each individual release group would trigger an action response for export reductions in RPA Action IV.3 or for less negative OMR flow in RPA Action IV.2.3. In WY 2013, the cumulative percent loss for each individual spring-run Chinook salmon surrogate group was well below 0.5% (see Table 2.5, below, or Table 2 in Appendix A); therefore, no RPA action response was necessary for export reductions or OMR flow management in WY 2013 on the basis of loss of spring-run Chinook salmon surrogates.

[1] The estimates of release group size provided in the 2013 DOSS Annual Report are the most current available; DOSS notes will reflect the preliminary release group size estimates available at the time.

Table 2.5. Summary of 2013 spring-run surrogate releases.

Release date	CWT race	Release Type	Preliminary number released	Percent loss of number released
12/18/2012	Late-fall run	Spring surrogate	72,974	0.103
1/8/2013	Late-fall run	Spring surrogate	70,287	0.198
1/25/2013	Late-fall run	Spring surrogate	80,191	0.030

CWT = coded wire tag

2.4.4 Progress on alternate form of the loss equation per Term and Condition 2(a)

Term and Condition 2(a) of the 2009 NMFS BiOp requires Reclamation to "seek to develop an alternative technique to quantify incidental take of listed anadromous salmonid species at the federal and state export facilities." With funding from NMFS, Dr. Andy Jahn of Kier Associates was contracted to develop an alternative technique to quantify the incidental take of Endangered Species Act (ESA)-listed species at the Delta export facilities and a final report was issued in July 2011. Jahn (2011) simplified the current loss equation for Chinook salmon by incorporating the louver efficiency term and pre-screen survival rate into a single pre-transport survival term and by dropping the holding and transport survival term. The alternative loss equation from Jahn (2011) is applicable for both Chinook salmon and steelhead using placeholder values on the pre-transport survival term for each species at each facility based on scientific assumptions. In addition, the alternative method in Jahn (2011) allowed for the calculation of lower and upper confidence limits of the point estimate; however, Reclamation and DWR were not ready to adopt the alternative loss equation in Jahn (2011) and requested a 2-year study in December 2011 to evaluate the equation before providing a recommendation for quantifying incidental take that will be provided to the Independent Review Panel (IRP) in 2013 as part of the annual review. The 2-year study comprised the following:

(1) 2-year loss comparison study of the current and alternative loss equations for quantifying incidental take at the Delta export facilities in the 2011/2012 and 2012/2013 annual incidental take reports prepared for NMFS,

(2) sensitivity analysis to help understand which terms are most important in the alternative loss equation, and

(3) uncertainty analysis to determine the relative contribution of each term of the alternative loss equation to the variance of the estimate.

In January 2012, NMFS agreed with the timeline of the 2-year study. The loss comparison between the current and alternative loss equations was completed in the 2011/2012 and 2012/2013 annual incidental take reports (see Appendix A) and a sensitivity and uncertainty analysis of the alternative loss equation for older juvenile Chinook salmon and steelhead was completed in 2013 (Cramer Fish Sciences 2013). This sensitivity and uncertainty analysis involved a series of workshops to characterize the variation in the terms observed at the CVP and SWP fish facilities, and a global sensitivity analysis and an uncertainty analysis of these terms using salvage data. The sensitivity analysis proceeded with a modified equation from Jahn (2011) that included a classification accuracy term for genetic identification of older juvenile Chinook salmon. Subsequent technical meetings with DOSS participants discussed the benefits and risks of various terms in the current and alternative loss equations and resulted in the development of technical approaches for increasing accuracy and identifying sources of uncertainty in the estimations of facility loss for Chinook salmon, steelhead, and green sturgeon. These technical approaches were provided to the Interagency Management Team during summer to inform a recommended approach for estimating loss of these species and Reclamation will be providing a recommendation for quantifying incidental take to the IRP in November 2013 as part of the annual review.

2.4.5 Tracy Fish Facility Study

In 2013, Tracy Fish Collection Facility (TFCF) and Reclamation Technical Service Center biologists initiated a multiple-year study of whole-facility survival to evaluate sources of mortality and facility loss occurring in the TFCF. In the 2013 study, 21 hydrophones were set up throughout the TFCF, and predators, Chinook smolts, and steelhead were tagged with HTI acoustic tags and released to assess survival from outside the facility through the holding tank under different operating conditions (low, medium, and high pumping rates). Two groups of control fish were processed and held for 7 days.

The primary operating conditions of interest were the primary louver velocities, which directly influence the efficiency and rate of bypassing fish into the holding tanks. Water velocity in the primary louvers is controlled by the number of pumps removing water from the Delta–Mendota Canal. TFCF hydraulic data were recorded at least hourly throughout the entire 3-day study period. Originally, 48-hour periods were requested under each flow condition and the plan was to release fish every 2 hours for 24 hours, followed by a 24-hour recovery period. During the two experimental periods, biologists were able to take advantage of short windows (~24 hours) of different pumping conditions to test the influence of velocities on survival to accommodate a restricted pumping schedule. In future years, biologists would like operational periods to be extended to at least 48 hours so that sample sizes can be increased without creating experimentally high densities of fish in TFCF.

2.4.6 Monitoring Activities

The 2009 BiOp specifies monitoring requirements that are necessary to inform potential interactions between fish and project operations and are either directly related to management of releases (e.g., temperature and flow), or are a necessary component of the Salmon Decision Process used to manage Delta operations (e.g., DCC gates and export pumping). Reclamation and DWR are jointly funding these monitoring locations through 2030 to ensure compliance with the RPA and assess the performance of the RPA actions.

Reclamation and DWR participated in the design, implementation, and funding of the comprehensive CV steelhead monitoring program, under development through the Interagency Ecological Program Steelhead Project Workteam, that includes adult direct counts and escapement estimates on CVP- and SWP-controlled streams. This program will provide information important in evaluating population trends in CV steelhead.

In the Delta, the following monitoring stations are part of the Interagency Ecological Program (IEP): Chipps Island Trawl, Sacramento Trawl, Knights Landings rotary screw traps, and the beach seining program. For detailed information on these monitoring sites and monitoring data, please refer to Chapter 4.

2.5 RPA Clarifications Discussed

2.5.1 Action IV.3: Language Clarification

Although Action IV.3 has been in effect since issuance of the BiOp in June 2009, the action responses were triggered for the first time in fall 2012 (see summary in 2.3.5). Based on experience gained in fall 2012, DOSS provided advice on clarifications to the text of Action IV.3 to guide future implementation. The DOSS advice was approved by NMFS, but these clarifications do NOT represent a formal amendment to the RPA, as was done in 2011, although the format of the clarifications is similar to that effort. The clarifications are provided in Appendix B and were memorialized in the March 19, 2013, DOSS notes[2].

2.5.2 Action IV.2.3: Rounding in Implementation of Steelhead Loss-Density Trigger

For the past few years, DOSS has monitored the daily steelhead loss density to nearest hundredths place for the purpose of implementing the steelhead triggers of 8 fish/TAF or 12 fish/TAF in RPA Action IV.2.3 (see Section 2.3.2); however, there were DOSS discussions this past year on the use of significant digits in the loss-density calculation used to implement the RPA action. The issue originated from the daily non-ad-clipped steelhead loss-density calculations on 4/5/13 and 4/6/13, when the daily steelhead loss density was 11.98 fish/TAF on both days. This led to a question from DOSS on 4/9/13 about whether the calculations could be rounded up to 12.0 fish/TAF.

In general, DOSS agreed that rounding to the nearest tenths place from a number that was calculated to the nearest hundredths place would be adequate (e.g., from 11.98 fish/TAF to 12.0 fish/TAF). Either way, this would not result in exceeding the second-stage trigger on 4/5/13 or 4/6/13 because the daily loss density must be >12 fish/TAF and not equal to it; however, there was not a consensus from DOSS on expressing the steelhead daily loss-density trigger to the nearest tenths place because 8 fish/TAF and 12 fish/TAF are expressed as an integer in the 2009 RPA with 2011 amendments[3]. Therefore there were concerns that there should be a strong biological rationale for expressing the trigger to the nearest tenths place since it could have implications for water supply loss. For example, a daily loss density of

[2] http://swr.nmfs.noaa.gov/ocap/doss/Final_DOSS_031913_with_attachments.pdf
[3] http://swr.nmfs.noaa.gov/ocap/040711_OCAP_opinion_2011_amendments.pdf

12.4 fish/TAF would exceed the 12.0 fish/TAF trigger if the trigger was expressed to nearest tenths place, but would not exceed the trigger if the loss density was rounded to the nearest integer to 12 fish/TAF (i.e., 12.4 fish/TAF rounded down to 12 fish/TAF).

On the other hand, other DOSS members were concerned about whether rounding down to the nearest integer would be consistent with the intent of the RPA action to protect salmonids. To resolve this issue, DOSS advised WOMT and NMFS to express the steelhead trigger in terms of daily loss rather than loss density. NMFS had based the steelhead trigger on daily steelhead loss in the 2009 RPA with 2011 amendments by multiplying combined exports in TAF on a given day by either 8 fish/TAF or 12 fish/TAF. With this approach, the daily loss trigger would change each day based on the export volume and would resolve any rounding issues because there would be consistent rounding to both the loss and trigger calculations.

For the purposes of calculating the daily steelhead loss trigger, the daily combined exports in TAF will be calculated by the sum of the mean daily pumping at the Harvey O. Banks Pumping Plant (SWP) and the C.W. Jones Pumping Plant (CVP). Afterward, the daily combined exports would be multiplied by either 8 fish/TAF or 12 fish/TAF, which will produce the daily steelhead loss triggers. Any rounding that occurs in the daily loss trigger calculation would be done at the end of the calculation and rounded up because the daily loss should not be expressed as a fraction of a fish.

Typically, expressing the trigger as a daily loss density or as a daily loss should produce the same result regarding whether the CVP/SWP exceeded the steelhead trigger. DOSS chose to track daily loss density rather than daily loss for ease of reporting because the loss-density trigger would be static, while the daily loss trigger would change each day based on the export volume. Based on a preliminary NMFS analysis, expressing the loss-density trigger to the nearest tenths place would produce the same implementation result as intended by the daily loss trigger in the RPA action, while expressing the loss-density trigger to the nearest integer would not (see Table 2 for an example).

Rounding for Older Juvenile Chinook Salmon Triggers: The clarification on rounding from DOSS for the implementation of Action IV.2.3 was primarily related to the steelhead trigger; however, the clarification would also likely apply to the older juvenile Chinook salmon triggers. There are two criteria for exceeding a first- or second-stage trigger for older juvenile Chinook salmon in Action IV.2.3. One criterion is based on the loss density of 2% of the JPE/2000 or 2% of the JPE/1000, and the other is based on daily loss of the daily export volume in TAF and multiplied by 8 fish/TAF or 12 fish/TAF. Rounding for the daily older juvenile Chinook salmon loss trigger should be the same as the steelhead loss trigger since the triggers are equivalent.

By comparison, the precision of the daily older juvenile Chinook salmon loss density should be characterized by how NMFS rounded the JPE-based loss-density triggers. In 2013, NMFS rounded the older juvenile Chinook salmon loss-density triggers to the nearest hundredths and the triggers were set at 5.33 fish/TAF (first-stage trigger) and 10.66 fish/TAF (second-stage trigger). As a result, the daily older juvenile Chinook salmon loss density should be rounded to the nearest hundredths for implementing the RPA action. Any clarifications on rounding for the implementation of the NMFS RPA actions should be included in any modifications or

amendments to the 2009 RPA with 2011 amendments.

Table 2.6. Comparison using daily loss density and daily loss to implement the steelhead trigger in RPA Action IV.2.3.

	Loss-Density Trigger Expressed to Nearest Tenths	Loss-Density Trigger Expressed to Nearest Integer	Daily Loss Trigger Based on Export Volume as Intended by the 2009 NMFS BiOp
Steelhead loss *(rounded to nearest hundredths)*	91.56 fish	91.56 fish	91.56 fish
Combined exports *(converted from AF with no rounding)*	7.36 TAF	7.36 TAF	7.36 TAF
Steelhead loss density *(rounded to nearest hundredths)*	12.44 fish/TAF	12.44 fish/TAF	12.44 fish/TAF
Rounding for RPA implementation if applicable?	12.4 fish/TAF	12 fish/TAF	N/A
Action trigger	Loss density >12.0 fish/TAF	Loss density >12 fish/TAF	Daily loss > 89 fish (12 fish/TAF multiplied by 7.36 TAF=88.32 and rounded up)
Exceed trigger?	Yes	No	Yes
How?	Loss density of 12.4 fish/TAF > trigger of 12.0 fish/TAF	Loss density of 12 fish/TAF is not > trigger of 12 fish/TAF	Daily loss of 92 fish (rounded up from 91.56 fish) > trigger of 89 fish

2.5.3 Action IV.2.3: Temperature Offramp

Implementation of Action IV.2.3 continues "until June 15th or until average daily water temperature at Mossdale is greater than 72°F (22°C) for 7 consecutive days (1 week), whichever is earlier" (p. 77 of the 2009 RPA with 2011 Amendments).. NMFS notified WOMT that implementation of Action IV.2.3 ended effective 6/7/13, based on 7 consecutive days (5/31/13–6/6/13) of water temperatures at Mossdale (a location on the San Joaquin River just as it enters the Delta; gage data available on the California Data Exchange Center [CDEC] website) of >72°F; however, based on Figure 11-4 on p. 59 of the 2009 RPA with 2011 amendments, DOSS noted and NMFS confirmed that per Figure 11-4, "temperature

exceedance" days counted toward the temperature-based end of implementation ("temperature offramp") must occur June 1st or later.

NMFS based the original notification to WOMT on the decision tree on page 77 of the 2009 RPA with 2011 amendments that did not specify whether the temperature exceedance days had to be after 6/1 and the notification was only premature by 1 day because the mean daily temperature at Mossdale on 6/7/13 was also >72°F. Because OMR was not controlling at the time of the NMFS notification, and thus operations were not changed in response to the notification, the inclusion of the 5/31/13 temperature exceedance day did not affect water supply or salmonid protection.

In reviewing the text regarding the temperature offramp on implementation of Action IV.2.3, DOSS also noted that the following clarifications would be helpful for future implementation:

(1) The temperature criterion is listed both as ">" and "≥" 72°F within the text of Action Suite IV; text should be edited for consistency.

(2) Both Fahrenheit and Celsius temperature thresholds are listed, rounded to the ones place; additional implementation guidelines should be added to clarify which temperature scale, from which data source, and to what precision will be used to assess whether the temperature offramp of Action IV.2.3 has been met. In 2013, NMFS reviewed the Fahrenheit water temperature data at Mossdale to the nearest tenth to assess the temperature offramp and any day with a mean water temperature of 72.1°F or higher was considered to count toward the 7-day temperature offramp.

2.5.4 Action IV.2.1: Calculation of 14-day I:E ratio with Pumping at Minimum Health Safety Levels

Action IV.2.1 restricts combined exports to some fraction of Delta inflow measured at Vernalis on the San Joaquin River, with the specific I:E ratio dependent on year type (based on the San Joaquin Valley "60-20-20" Hydrologic Classification). Compliance with the I:E ratio is measured on a 14-day average. By April 2013, the San Joaquin year type was "Critical" and the required I:E ratio was 1:1 (that is, combined exports were not to exceed 100% of the flow at Vernalis): however, Action IV.2.1 includes a "health and safety exception" that allows the projects to deviate from the required I:E ratio if meeting it would require combined exports to drop below the level needed to maintain health and safety demands (1,500 cfs). Because flows at Vernalis were below 1,500 cfs for parts of April and May 2013, the health and safety exception was in effect for parts of those months, and DWR asked for guidance on how to calculate the 14-day I:E average under these circumstances.

The guidance provided by NMFS on 4/1/13 directed that the running 14-day average I:E ratio be calculated using the average of each day's actual I:E ratio (if the health and safety exception is not in effect) or the required I:E ratio (if the health and safety exception is in effect). The full NMFS guidance and sample worksheet are provided in Appendix C.

Chapter 3— Operations Summary

3.1 Water Year 2013

Despite some winter storms in the early winter, by May of WY 2013, the hydrologic year types in the Sacramento and San Joaquin river basins were classified as Dry and Critical, respectively. A summary of WY 2013 operations and controlling factors is provided in Appendix F; a summary chart of OMR operations is provided below in Figure 3.1.

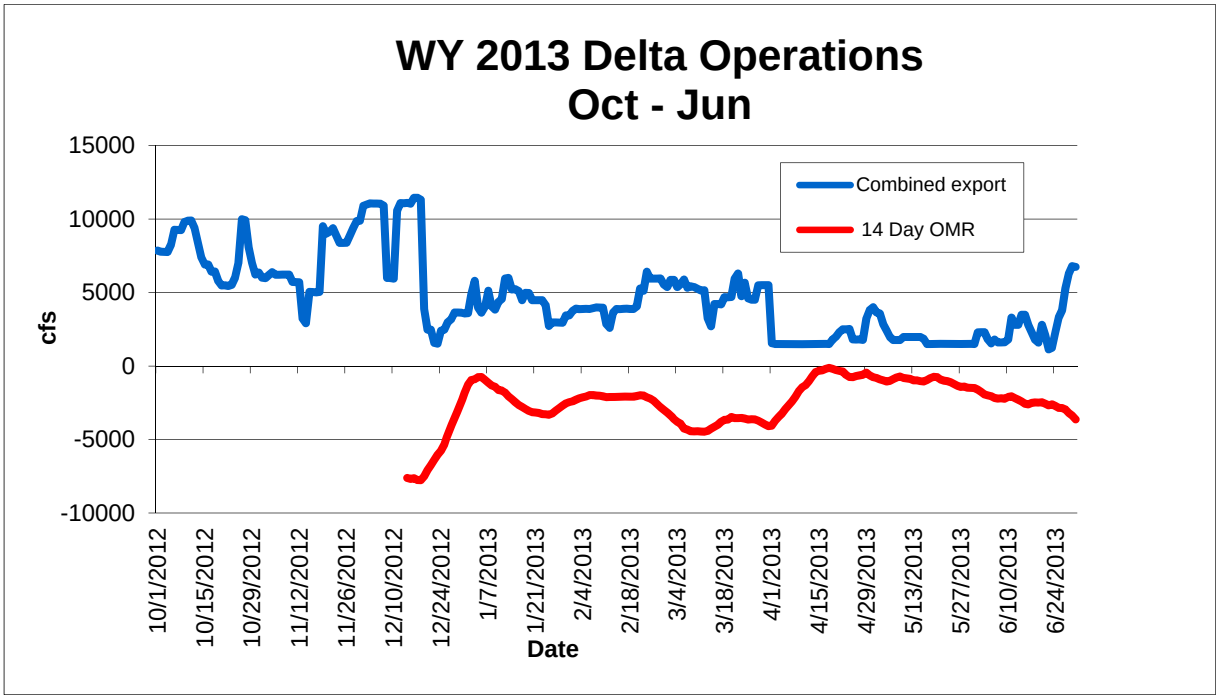

Figure 3.1. Export and OMR operations through June 2013.

Chapter 4 — Monitoring Activities

4.1 Salvage Monitoring (see Appendix A)

The Annual Incidental Take Report, included as Appendix A, is a document prepared by DWR and Reclamation.

Chapter 5 — References Cited

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Appendix A: Incidental Take Report with Comparison of Loss Estimate

The content of Appendix A, the 2013 Incidental Take Report, is paginated independently from the rest of the 2013 DOSS Annual Report.

2012/2013
SALMONID AND GREEN STURGEON
INCIDENTAL TAKE AND MONITORING REPORT

September 27, 2013

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2012/2013 SALMONID AND GREEN STURGEON INCIDENTAL TAKE AND MONITORING REPORT

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2012/2013 SALMONID AND GREEN STURGEON INCIDENTAL TAKE AND MONITORING REPORT

This annual report is required under the terms and conditions of the 2009 National Marine Fisheries Service (NMFS) Biological Opinion and Conference Opinion on the Proposed Long-Term Operations of the Central Valley Project and State Water Project (2009 NMFS Biological Opinion). This report summarizes the incidental take of winter-run Chinook salmon (*Oncorhynchus tshawytscha*), spring-run Chinook salmon (*O. tshawytscha*) surrogates, Central Valley steelhead (*O. mykiss*), and green sturgeon (*Acipenser medirostris*) at the State Water Project's (SWP) John E. Skinner Delta Fish Protective Facility and the Central Valley Project's (CVP) Tracy Fish Collection Facility (Delta fish facilities) for 2012/2013. Furthermore, this report includes data from the salmonid monitoring program for the lower Sacramento River and the Delta, and summarizes the hydrologic conditions in the Delta. The geographic range of the data used in this report is presented in Figure 1 on page 21.

For this report, the California Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation) quantified incidental take for the listed species to the nearest whole fish using the current methods that are described in the 2009 NMFS Biological Opinion. However, there is a high degree of uncertainty associated with the current methods used to quantify incidental take. As a result, Dr. Andy Jahn of Kier Associates developed and proposed a new loss equation in 2011 to quantify incidental take at the Delta fish facilities (Jahn 2011). The proposed loss equation from Jahn (2011) was done in accordance with Term and Condition 2a of the 2009 NMFS Biological Opinion that requires an independent contractor to determine the best technique to quantify incidental take.

To evaluate the proposed loss equation, DWR and Reclamation have conducted a two-year study that was intended to refine and adapt the proposed loss equation suggested in Jahn (2011) that could be used to quantify incidental take at the Delta fish facilities. One component of the two-year study includes a comparison of loss using the proposed and current loss calculations. A comparison of the different loss equations for 2011/2012 was presented in last year's incidental take and monitoring report (see DWR and Reclamation 2012) and a comparison of the different loss equations for 2012/2013 is presented in this year's annual incidental take and monitoring report.

DWR and Reclamation acquired data from the California Department of Fish and Wildlife (DFW), the United States Fish and Wildlife Service (USFWS), and other internal DWR and Reclamation divisions. At the time of the data acquisition, many of the agencies were still in the process of finalizing their data. Because of this, these data presented in this report are preliminary and subject to revision. DWR and Reclamation will add an addendum to this report if the finalized data leads to substantial changes to the results.

In addition to this annual report, DWR and Reclamation also prepared preliminary weekly data reports for the Data Assessment Team (DAT) and the Delta Operations for Salmonids and Sturgeon technical working group (DOSS) during the 2012/2013 incidental take season. Preliminary analysis of the weekly data reports can be found in the weekly meeting notes that are posted on the DAT and DOSS websites:

DAT: http://www.water.ca.gov/swp/operationscontrol/calfed/calfeddat.cfm
DOSS: http://www.swr.noaa.gov/ocap/doss.htm

Observed Chinook Salmon Salvage

In 2012/2013, older juvenile Chinook salmon were observed in salvage at the Delta fish facilities beginning in early December (Figure 2, page 22). Based on recent clarifications found in DOSS (2013), DWR and Reclamation defined naturally produced older juvenile Chinook salmon as all non-adipose fin clipped (non-clipped) Chinook salmon greater than or equal to the minimum winter-run length-at-date criteria using the Delta Model and less than the maximum length-at-date criteria considered in the Delta Model. In other words, Chinook salmon that cannot be classified using the Delta Model are not classified as older juvenile Chinook salmon even if the salmon are above the minimum winter-run length-at-date criteria. In November 2012, two Chinook salmon were observed at the CVP that could not be classified using the Delta model and are thus not reported in Figure 2.

In 2012/2013, the majority of the observed older juvenile Chinook salmon salvage occurred in December 2012 or March 2013 (Figure 2). The initial pulse of older juvenile Chinook salmon in December coincided with an increase in observed salvage of hatchery late fall-run and hatchery fall-run Chinook salmon, and coincided with increased Sacramento and San Joaquin River flows.

Young-of-the-year (YOY) Chinook salmon were observed at the Delta fish facilities starting in February and nearly all of the observed YOY Chinook salmon salvage occurred between mid-March and the end of May. During the spring salvage period, combined mainstem flows were low when compared to December (Figure 2). During this time, hatchery fall-run and hatchery spring-run Chinook salmon were observed between the end of April and early May. Interestingly, nearly all of the hatchery fall-run Chinook salmon originated from the Sacramento Basin for the brood year 2012 releases (Figure 2). Only one hatchery fall-run Chinook salmon was observed from the San Joaquin Basin for the brood year 2012 releases. This differed from 2011/2012 where the majority of the hatchery fall-run Chinook salmon salvaged originated from the San Joaquin Basin for the brood year 2011 releases. Overall, observed hatchery fall-run Chinook salmon salvage was low for 2012/2013 when compared to 2011/2012.

Observed Chinook Salmon Genetic Run Assignment

Juvenile Chinook salmon were collected at the Delta fish facilities in 2012/2013 between the period of August 1, 2012, and July 31, 2013 (Figure 3, page 23). For the SWP, all collected tissues sampled through May 23, 2013, were analyzed for genetic run assignment. For the CVP, only tissue samples classified as older juvenile Chinook salmon by the Delta Model length-at-date criteria underwent genetic analysis.

At the SWP, 624 non-clipped juvenile Chinook salmon were observed and 620 samples were collected for genetic analysis. Of the 620 samples collected, 581 samples were provided for analysis and 552 provided usable DNA (Table 1, page 39). Of these 552 samples, 36 were classified as winter-run Chinook salmon by the Delta Model. Of these 36 samples, 10 were assigned to winter-run Chinook salmon by the Delta Model. In other words, about 28% of the samples identified as winter-run Chinook salmon by the Delta Model were actually winter run by genotype. The percentage of viable samples that were assigned to winter run was about 2% of the total samples. The remaining 39 samples, most likely fall-run Chinook salmon, were collected after the period of analysis and will be analyzed with the first set of samples from 2013/2014. Once these samples have been analyzed, DWR will be able to determine the percentage of winter-run Chinook salmon accurately identified through genetics in relation to the total observed Chinook salmon salvage for 2012/2013 at the SWP and not just in terms of the accuracy of the winter-run size criteria in the Delta model.

For the CVP, 1,989 non-clipped juvenile Chinook salmon were observed in 2012/2013 (Table 1). Of these samples, 42 samples were designated as winter-run Chinook salmon by the Delta Model (Table 1). Samples were obtained from 40 of these and all were provided by the DFW Central Valley Tissue Archive (CVTA) to Cramer Fish Sciences (CFS) for analysis. Of these 40 samples for which run assignments were ascertained, 17 were assigned to winter run. In other words, viable samples were actually winter run by genotype for about 43% of those provided to CVTA. The percentage of viable samples that were assigned to winter run in relation to the total observed Chinook salmon salvage would be determined once samples outside of the older juvenile Chinook salmon category are analyzed.

In comparison, a percentage of the 2011/2012 samples identified as being winter-run Chinook salmon, as defined by the Delta Model, were correct approximately 42% of the time at the SWP and 23% of the time at the CVP. While all samples that fell within the older juvenile size classification were analyzed, only a subset of samples that fell outside of the older juvenile size classification in 2011/2012 were analyzed due to budgetary constraints, and this representative sub-sample was analyzed and reported in 2011/2012. The representative sample was determined by estimating the cumulative percent loss for each “stat week” and the weekly CVTA “Tissue Count” necessary to match proportionally observed loss. “Stat week” was defined as the week within which a sampling event occurred, starting the first week of December. Some deviations did

occur for several of the “stat weeks” due to a lack of tissue samples being available. For systematically sampled tissues from the SWP in 2011/2012, the percentage of winter-run Chinook salmon was identified to be 20% in terms of all the Chinook salmon for which a run assignment could be made. For systematically sampled tissues from the CVP in 2011/2012, the percentage of winter-run Chinook salmon was identified to be approximately 9%.

In 2013, additional funds were dedicated to processing the majority of the remaining samples not analyzed at the SWP due to the sub-sampling matrix for 2011/2012. An additional 136 samples were processed and assigned for 2011/2012. Previously, 147 samples were analyzed, 144 of which provided usable DNA. With this additional set of samples, the percentage of correctly identified winter-run Chinook salmon observed in 2012/2013 was reduced from about 20% to 9%. The remaining CVP samples have not been analyzed to date due to delays in contracting. The magnitude of the change reported for the SWP underlies the need to analyze as many of the fish as possible.

Accidental Mortality

In 2012/2013, DWR reported one Chinook salmon mortality on December 18, 2012, during a salvage count when a non-clipped late fall-run Chinook salmon was accidentally sacrificed for coded wire tag (CWT) processing. Accordingly, DWR took a tissue sample for genetic analysis, but the tissue sample could not be analyzed. Subsequently, DFW did a preliminary adjustment to the loss for this Chinook salmon by increasing the loss by one to account for this fish mortality (DFW 2013). However, the majority of the late fall-run Chinook salmon classified using the Delta Model during the December period at the SWP did not turn out to be winter-run Chinook salmon based on genetic results (Figure 3).

Special studies at the CVP are typically done to gain further insight on the CVP fish facility. As an example, Reclamation is currently conducting a multiple year whole facility survival study for Chinook salmon and steelhead to evaluate sources of mortality and facility loss occurring at the CVP fish facility. In 2012/2013, about 1,088 Chinook salmon were observed at the CVP from all the special studies conducted. From this total, 182 Chinook salmon died incidentally, which means Reclamation staff did not intend to sacrifice these Chinook salmon. However, the fish counts from the CVP special studies are preliminary and subject to change since the count information has not yet been finalized. Even so, salmon observed in special studies are not reported in salvage or loss.

Winter-Run Chinook Salmon

Winter-Run Chinook Salmon Incidental Take

In 2012, DFW estimated a total adult escapement of 2,674 winter-run spawners to the

upper Sacramento River and this estimate is about 3 times higher than the adult escapement of 824 spawners in 2011. However, the methodology used in 2012 to calculate the annual winter-run escapement was modified from using the Jolly-Seber Model to using the Cormack-Jolly-Seber Model and incorporated an estimate of uncertainty. Nevertheless, DFW considers the estimates using the Cormack-Jolly-Seber Model to be comparable to the Jolly-Seber Model that was used for the escapement estimates from 2003 to 2011.

Based on 2012 escapement, NMFS estimated that 532,809 juvenile winter-run Chinook salmon would enter the Delta. Based on this juvenile production estimate (JPE), the incidental take level from October 1, 2012, through June 30, 2013, for the Delta fish facilities was 10,656 non-clipped winter-run Chinook salmon, equal to 2% of the natural winter-run production entering the Delta. For tracking incidental take, winter-run Chinook salmon are classified by length according to the Delta Model length-at-date criteria and the measurement of winter-run Chinook salmon incidental take is based on loss using the current loss equation from DFW (2013).

Loss of winter-run Chinook salmon loss, based on the Delta Model, occurred at both Delta fish facilities for an expanded loss of approximately 633 at the SWP and approximately 98 at the CVP. The majority of the winter-run Chinook salmon loss occurred during December or March and the highest daily loss of older juvenile Chinook salmon occurred during December (Figure 4, page 24). However, the majority of the older juvenile Chinook salmon loss that occurred in December was not winter-run Chinook salmon based on the Delta Model. Nonetheless, the daily older juvenile Chinook loss exceeded both the first stage action trigger of 95 fish per day and the second stage action trigger of 120 fish per day in the NMFS Reasonable and Prudent Alternative (RPA) Action IV.3 during December. Exceeding the trigger required reduced SWP and CVP pumping (Figure 4). Outside of December, the older juvenile Chinook salmon loss were all comprised of winter-run Chinook salmon based on the Delta Model. The combined older juvenile Chinook salmon loss density was greater than the daily trigger of 5.33 fish per thousand acre-feet (TAF) in NMFS RPA Action IV.2.3 on 2 days in March and April, which restricted Old and Middle River flows toward the SWP and CVP pumps. To quantify the benefits from the RPA actions, please refer to the appendix at the end of the report.

The combined expanded loss of winter-run Chinook salmon was 731 for the season; about 7% of the incidental take permitted. Overall, the annual winter-run Chinook salmon loss was the lowest on record when compared to the past nine water years. Interestingly, the annual loss substantially decreased from 2010/2011 and 2011/2012 where the incidental take level exceeded the 1% level of concern (i.e., exceeding 50% of the take limit) for naturally produced winter-run Chinook salmon (Figure 5, page 25).

Hatchery Winter-Run Chinook Salmon Incidental Take

On February 7, 2013, an estimated 181,778 winter-run smolts from Livingston Stone National Fish Hatchery (LSNFH) were released in the Sacramento River at Caldwell Park near Redding, California. Of the total released, 169,967 were adipose-fin clipped with a coded wire tag (CWT). NMFS estimated that 96,525 hatchery fish would enter the Delta. NMFS set the incidental take level at 1% of the total hatchery production entering the Delta, or 965 hatchery winter-run Chinook salmon from October 1, 2012, through June 30, 2013. One hatchery winter-run Chinook salmon was identified at the Delta fish facilities at the end of March for an expanded loss of nine when using the current loss equation from DFW (2013). This estimated confirmed loss is about 0.009% of the total number of hatchery winter-run Chinook salmon entering the Delta and is well below the 1% incidental take level (see Table 2, page 39).

CWT data for several hatchery fish (n=6) were unavailable from a salvage count or predator removal due to missing, lost, or damaged tags for an expanded unknown loss of approximately 59 Chinook salmon (Table 3, page 40). Of this expanded unknown loss total, about 50 (n=5) were above the minimum winter-run length using the Delta Model length-at-date criteria. However, it is not likely that these unconfirmed CWT fish were from the hatchery winter-run Chinook salmon release based on the date and size of loss. For instance, 3 of the unknown CWT Chinook salmon were observed prior to the release of the hatchery winter-run Chinook salmon and the remaining 2 unknown CWT Chinook salmon that were observed in March ranged in fork length from 212 to 249 mm. The fork lengths of these unknown Chinook salmon are much larger than the confirmed 136 mm hatchery winter-run Chinook salmon that was also observed in March.

Spring-Run Chinook Salmon

Under the 2009 NMFS Biological Opinion, NMFS uses hatchery reared subyearling late fall-run Chinook salmon as surrogates for yearling spring-run Chinook salmon emigrating from the upper Sacramento River and tributaries into the Delta. Late fall-run Chinook salmon are used as a surrogate because spring-run Chinook salmon cannot be easily distinguished from the other races of salmon based upon their size in the lower Sacramento River and Delta. The Coleman National Fish Hatchery (CNFH) releases a percentage of the total CNFH late fall-run Chinook salmon production into surrogate release groups. CNFH made the first release in mid-December, while the second and third releases were made in January. CNFH released all of the surrogate groups into the Sacramento River at Battle Creek. For this report, the number released reported for each surrogate group only refers to the number released that were adipose fin clipped with a CWT.

Releases are typically associated with storm events as attempts are made for the releases to coincide with an increase in yearling juvenile Chinook salmon in the spring-

run tributaries, such as Mill and Deer creeks. In the past, DWR and Reclamation used the rotary screw trap data from Mill and Deer creeks to evaluate the timing of each surrogate release group in this annual report. However, DFW did not operate the rotary screw traps on Mill and Deer creeks for the last two years due to concerns regarding incidental mortality, trapping difficulties, and a desire to conduct a review of this monitoring requirement (DOSS 2012).

In 2013, DFW completed a review of this monitoring requirement and recommended using a flow criteria rather than rotary screw trap data from Mill and Deer creeks to indicate that yearling spring-run Chinook salmon emigration from the tributaries has started or is occurring (Johnson and Merrick 2013). The flow criteria are based either on the mean daily flow being greater than 110 cfs or on a mean daily flow increase by more than 50% in Mill or Deer Creek. DWR and Reclamation plans to start using the flow criteria as recommended in Johnson and Merrick (2013) for the next water year, while DFW continues to refine its analysis and recommendation on rotary screw trapping at Mill and Deer creeks.

Measuring Incidental Take

The incidental take level for the combined operation of the Delta pumping plants is equal to 1% of any individual CNFH late-fall Chinook salmon surrogate release group. Measurement of incidental take for each surrogate release group is based on loss using the current loss equation from DFW (2013). However, there are occasions when the hatchery of origin for the CWT Chinook salmon could not be confirmed due to lost, missing, or damaged tags. For this reason, the actual loss could be higher than what is confirmed in Table 2. Six CWT Chinook salmon from a salvage count or predator removal could not be determined for hatchery of origin this water year due to lost, missing, or damaged tags. The expanded unknown loss of these 6 CWT Chinook salmon was approximately 59 fish (Table 3).

To account for this unknown surrogate loss, DWR and Reclamation assigned a race to the unconfirmed Chinook salmon. The assigned race was based on Chinook salmon that were greater than the minimum winter-run length using the Delta Model by comparing the length-at-date of salvage data to the data for confirmed fish from the CNFH late fall-run Chinook salmon release and the Mokelumne yearling fall-run Chinook salmon release. Following this method, an unknown loss of 50 fish out of a total of 59 fish could either be a CNFH late fall-run Chinook salmon or Mokelumne yearling fall-run Chinook salmon. Mokelumne yearling fall-run Chinook salmon had to be incorporated into the adjusted loss calculations due to temporal and size overlap with the late fall-run Chinook salmon from the CNFH (Figure 2). Based on these assigned identities, an adjusted loss for the CNFH late fall-run Chinook salmon groups and the Mokelumne yearling fall-run Chinook salmon group were calculated based on the proportion of actual loss from these release groups (see Table 4, page 40).

Furthermore, two CWTs found at the SWP could not be assigned to a salvage record with certainty in 2012/2013. First, these CWTs were lost and then found. Second, the tag codes from these two CWTs match a set of tag codes that were used both for an actual CNFH production release of hatchery late fall-run Chinook salmon in January 2012 and for training personnel at the SWP. However, no lost tags were reported in 2011/2012 at the SWP and the size of the fish for the lost tag record in 2012/2013 does not match with the size of a fish being released in January 2012.

First Surrogate Release Group and Incidental Take

The first spring-run Chinook salmon surrogate hatchery group of approximately 72,974 CNFH late fall-run Chinook salmon was released on December 18, 2012. Nine surrogates, four at the SWP and five at the CVP, were observed at the Delta fish facilities in January (Figure 8, page 28). The expanded loss for the season was approximately 75 or 0.103% of the total hatchery release, which is well below the 1% incidental take level (Table 2; Figure 8). Including unconfirmed hatchery Chinook salmon, the adjusted loss for the first surrogate release group was 76 or 0.104% of the total hatchery release (Table 4). The surrogate loss occurred around the time when older juvenile Chinook salmon were also lost at the Delta fish facilities (Figure 8).

Second Surrogate Release Group and Incidental Take

On January 8, 2013, CNFH released the second spring-run Chinook salmon surrogate hatchery group of approximately 70,287 late fall-run Chinook salmon into Battle Creek. Twenty surrogates, eleven at the SWP and nine at the CVP, were observed at the Delta fish facilities between mid-January and the end of March. The expanded loss for the season was approximately 139 or 0.198% of the total hatchery release, which is well below the 1% incidental take level (Table 2; Figure 8). Including unconfirmed hatchery Chinook salmon, the adjusted loss for the second surrogate release group was 140 or 0.199% of the total hatchery release (Table 4). The surrogate loss usually occurred around the time when older juvenile Chinook salmon loss was also observed at the Delta fish facilities in January and March (Figure 8). However, there were days during this period where surrogate loss was observed, but no older juvenile Chinook salmon loss was observed.

Third Surrogate Release Group and Incidental Take

On January 25, 2013, CNFH released the third spring-run Chinook salmon surrogate hatchery group of approximately 80,191 late fall-run Chinook salmon into Battle Creek. Six surrogates, one at the SWP and five at the CVP, were observed at the Delta fish facilities between early February and late March. The expanded loss for the season was approximately 24 or 0.030% of the total hatchery release (Table 2; Figure 8). Including unconfirmed hatchery Chinook salmon, the adjusted loss for the third surrogate release group was 25 or about 0.031% of the total hatchery release (Table 4). The majority of

the surrogate loss occurred in early to mid-February when the daily older juvenile Chinook salmon loss was low or not observed at the Delta fish facilities (Figure 8). However, the surrogate loss in March occurred around the time when older juvenile Chinook salmon loss was also observed at the Delta fish facilities (Figure 8).

Fry/Smolt Chinook Salmon Loss

The combined expanded loss of fry/smolt Chinook salmon salvaged between October 2012 and July 2013 was 11,147 (Figure 6, page 26). Using the Delta Model length-at-date criteria, DWR and Reclamation defined fry/smolts as all non-clipped Chinook salmon smaller than the minimum winter-run length-at-date criteria. Most of the fry/smolt Chinook loss occurred between April and May, with the greatest monthly loss in May. The annual loss was still notably low when compared to the last nine water years (Figure 7, page 27), particularly to 2010/2011, where the annual loss was at 86,781. However, the annual loss increased from 2011/2012 when the loss was 4,733.

Chinook Salmon Monitoring in the Sacramento River and the Delta

The Delta Juvenile Fish Monitoring Program (DJFMP) conducted by USFWS operates under the auspices of the Interagency Ecological Program (IEP). The DJFMP has been conducting juvenile salmon monitoring in the Delta since the early 1970s with the goals of gaining information on potential management actions that could improve the survival of juvenile salmon rearing and migrating through the Delta and to document non-salmonid temporal and spatial distribution. For the USFWS Sacramento River and Delta surveys, DWR and Reclamation separated non-clipped older juvenile Chinook salmon from fry/smolts using the Frank Fisher Model.

To facilitate data summarization of the beach seine data, DWR and Reclamation divided the beach seine monitoring program into different regions: 1) lower Sacramento River, 2) north Delta, 3) central Delta, and 4) south Delta (Figure 1). For comparison purposes across different years, DWR and Reclamation only used the beach seine sites that have been active since August 2003.

Spring-Run Chinook Salmon Surrogate Monitoring

The USFWS conducted a midwater and Kodiak trawl survey on the Sacramento River at Sherwood Harbor to gauge the relative abundance and timing of juvenile Chinook salmon entering the Delta. USFWS recovered no surrogates from the first and second surrogate release, but recovered one surrogate from the third surrogate release in late January after the peak of older juvenile Chinook salmon catch that occurred at the Sacramento River trawl (Figure 8).

Additionally, USFWS recovered four surrogates from the first surrogate release from the north Delta seines: two at Garcia Bend and two at Clarksburg from late December to

late January. In comparison, USFWS also recovered two surrogates from the second surrogate release from the lower Sacramento River seines at Elkhorn in late January. No surrogates were recovered from the third surrogate release group in the beach seines.

Lastly, a midwater trawl survey was conducted at Chipps Island, which is the most downstream trawl survey location of the legal Delta. USFWS recovered surrogates at Chipps Island for an expanded catch of nine surrogates for the first surrogate release from late December to March, eight surrogates for the second surrogate release from January to March, and twelve surrogates for the third surrogate release from February to March (Figure 8). The timing of recoveries at Chipps Island for all three surrogate releases was usually consistent with the timing of older juvenile Chinook salmon catch at Chipps Island except from late January to February when USFWS recovered no older juvenile Chinook salmon.

Hatchery Winter-Run Chinook Salmon Monitoring

Recoveries of hatchery winter-run Chinook salmon from LSNFH in the Delta monitoring trawls and seines were very low. In April, the USFWS recovered one hatchery winter-run Chinook salmon from LSNFH in the Sacramento trawl and one hatchery winter-run Chinook salmon from LSNFH in the Chipps Island midwater trawl (Figure 9, page 29). No older juvenile Chinook salmon were recovered from the Sacramento trawl when hatchery winter-run Chinook salmon were recovered. However, a hatchery winter-run Chinook salmon was recovered at Chipps Island when older juvenile Chinook salmon were observed at this monitoring site.

In comparison, the USFWS recovered seven hatchery winter-run Chinook salmon in the lower Sacramento River beach seines at Wards Landing in late February, which coincided with winter-run older juvenile Chinook salmon collected at this location.

Non-Clipped Chinook Salmon Monitoring

Between August 2012 and July 2013, the total number of older juvenile and fry/smolt Chinook salmon caught in the beach seines was highest in the lower Sacramento River and north Delta when compared to the central and south Delta (Figure 10 and 11, page 30). The total number of non-clipped older juvenile Chinook salmon recoveries in the lower Sacramento River and the north Delta was substantially higher than in 2011/2012 and slightly higher than in 2010/2011.

In the Sacramento River trawl, the number of older juvenile Chinook salmon caught increased substantially to a level not observed since 2007/2008 (Figure 12, page 31). During 2012/2013, 88 older juvenile Chinook salmon were caught compared to 29 in 2011/2012. Interestingly, the number of fry/smolt Chinook salmon caught in the Sacramento River trawl for 2012/2013 remains in a similar range as 2011/2012 (Figure

13).

In the Chipps Island trawl, 89 older juvenile Chinook salmon were caught in 2012/2013 (Figure 12). The number of older juvenile Chinook salmon caught in the Chipps Island trawl increased slightly when compared to 2011/2012. However, in comparison to the last nine water years, older juvenile Chinook salmon catch at Chipps Island was still low (Figure 12). Similarly, the number of fry/smolt Chinook salmon increased slightly in the Chipps Island trawl from 2011/2012, but was still relatively low when compared to the other years since 2003/2004 (Figure 13, page 31).

Central Valley Steelhead

Steelhead Incidental Take

From October 2012 to July 2013, greater than 50% of the non-clipped steelhead salvage occurred at the SWP. For non-clipped steelhead, the CVP salvaged a total of 326 and the SWP salvaged a total of 472, with the most salvage occurring in March and April at the SWP and in March and May at the CVP (Figure 14, page 32). Between late March and early May, the daily non-clipped steelhead loss was greater than the loss triggers in NMFS RPA Action IV.2.3 on 18 days. Outside of this period, the daily steelhead loss triggers were not exceeded. The daily steelhead loss triggers were calculated by multiplying combined exports in TAF on a given day by either 8 fish/TAF or 12 fish/TAF. Exceeding the daily loss triggers restricted the Old and Middle River flows toward the SWP and CVP pumps (Figure 18, page 34). To quantify the benefits from the RPA actions, please refer to the appendix at the end of the report.

The SWP and CVP total expanded salvage of non-clipped steelhead was approximately 798 and remained below the incidental take limit of 3,000 fish for the water year (Figure 14). The annual salvage of non-clipped steelhead increased from 2011/2012 and was very similar to 2010/2011, which had a total salvage of 738 during the October to July reporting period (Figure 16, page 33).

Salvage of hatchery (adipose fin clipped) steelhead peaked in March. From October 2012 to July 2013, the CVP salvaged a total of 320 and the SWP salvaged a total of 389 for a combined total annual salvage of 709 steelhead (Figure 15, page 32). The total salvage of hatchery steelhead was higher than in 2011/2012, but the overall seasonal salvage for hatchery steelhead was still low compared to the data from the past nine water years (Figure 17, page 33).

Steelhead Monitoring

From October 2012 to July 2013, the catch of steelhead from the USFWS DJFMP was predominantly hatchery origin fish (Figure 19, page 35). Unlike in 2011/2012, the Sacramento River trawl had the lowest steelhead catch in 2012/2013 with a total of 3

non-clipped steelhead and 8 hatchery steelhead. In contrast, a greater number of recoveries occurred in the Chipps Island trawl with a total of 7 non-clipped steelhead and 49 hatchery steelhead (Figure 19).

Like in 2011/2012, the majority of the hatchery steelhead recovered at the Mossdale trawl had sutures, which implied that these steelhead were acoustically tagged. In 2012/2013, the majority of the non-clipped steelhead catch occurred in April and May, which was in a similar time frame of the non-clipped steelhead catch at the Sacramento Trawl. However, the non-clipped steelhead catch was higher at the Mossdale Trawl than at the Sacramento Trawl.

Green Sturgeon Incidental Take

The incidental take level for green sturgeon is set at 74 fish for the water year and is based on historical salvage. Similar to 2011/2012, no green sturgeon were salvaged at the Delta fish facilities between October and July in 2012/2013. This differs from 2010/2011 when the green sturgeon salvage was 14 (Figure 20, page 36).

Delta Hydrology

Water year 2013 was mostly drier than the last water year in both the Sacramento and San Joaquin basins (Figure 21, page 37). The combined January through May precipitation total for water year 2013 was the lowest in about 90 years. However, the average monthly Sacramento River flows in 2012/2013 were higher from December to February when compared to 2011/2012. The average monthly San Joaquin River flows were also higher in 2012/2013 in December and February when compared to 2011/2012. For water year 2013, the Sacramento Valley was classified as a “dry” water year type and the San Joaquin Valley was classified as a “critical” water year type. Table 5 on page 41 is a monthly average summary of SWP and CVP exports, Sacramento and San Joaquin River flows, Delta outflow, and western Delta flows.

In addition, modeled volumetric water fingerprints derived from the Delta Simulation Model 2 (DSM2) at Clifton Court Forebay (SWP) and at the Jones Pumping Plant are presented in Figure 22 and 23 on page 38. Overall, these fingerprints show that the majority of the water from the SWP typically came from the Sacramento River. In contrast, the majority of the water at the CVP was more evenly split between the Sacramento River and the San Joaquin River throughout the year. Interestingly, a stronger influence of San Joaquin River water at the SWP and CVP during the month of May did not lead to any salvage of Merced River hatchery fish as seen in previous years (e.g., DWR and Reclamation 2012).

Comparison of Loss Estimation between Current and Proposed Loss Equation

DWR and Reclamation did not exceed the annual take limits that were permitted for 2012/2013 when using the current methods to quantify incidental take for winter-run Chinook salmon, spring-run Chinook salmon surrogates, Central Valley steelhead, and green sturgeon. At present, there is currently a high degree of uncertainty and a lack of documentation associated with the current methods used to quantify incidental take. As an example, incidental take of steelhead and green sturgeon are currently based on historical salvage and not loss since there are no known population estimates for these species that could be used to quantify an appropriate level of incidental take. Moreover, there is still uncertainty with calculating loss even when a population estimate is known, such as with Chinook salmon. For instance, the current loss equation (i.e., DFW 2013) used to quantify incidental take includes an expansion for salvage, and accounts for louver efficiency, pre-screen loss and survival during transport. However, the current loss equation is specific to Chinook salmon and currently does not include error terms that are needed to calculate confidence limits for the loss estimate.

In comparison, the proposed method (i.e., Jahn 2011) reduces some of the uncertainty by accounting for overall facility survival and can provide a point estimate with a lower and upper confidence limit for various listed salmonids. However, the proposed loss equation essentially drops the survival rate in transport that is used in the current loss equation since the term is so close to 100%. As a result, the survival rate in transport term could get lost in the uncertainty with the salvage and facility survival terms that are in the proposed loss equation.

The proposed loss equation is intended to be used for steelhead and Chinook salmon under different survival rates to account for species and facility differences. However, there is a high level of uncertainty on the most appropriate facility survival rate for each species since there is no clear definition on the entrainment zone (i.e., the start and end of entrainment) and a need for additional facility studies. To account for the uncertainty, Jahn (2011) provides a range of survival rates that could be used in the proposed loss equation for steelhead and Chinook salmon based on past facility studies and scientific assumptions. However, Jahn (2011) does not provide a recommendation on which survival rate to use. Similarly, the proposed loss equation could also be applied to green sturgeon, but there are currently no parameter estimates that could be used for such an equation.

To help determine the appropriate survival rate assumptions for Chinook salmon and steelhead, a two-year loss comparison study began in 2011/2012 to compare the current and proposed loss equations. Results from 2011/2012 showed that the use of the proposed loss equation to monitor take of Chinook salmon or steelhead may result in higher levels of loss under the low or medium survival rates and lower levels of loss

under the high survival rate when compared to the amount of loss estimated using the current methods (DWR and Reclamation 2012). As a result, DWR and Reclamation would have exceeded the winter-run incidental take limit in 2011/2012 if the low survival rate were used to implement the proposed loss equation. If taking the upper confidence limit into account, DWR and Reclamation may have also exceeded the incidental take limit for winter-run Chinook salmon if the medium survival rate was used.

Furthermore, results in 2011/2012 showed that there was a potential for negative lower confidence limits when the sample size is small, such as with the hatchery release groups. In addition, there were concerns on whether the proposed loss equation could be applied on a daily scale since Jahn (2011) only applied the proposed loss equation on an annual scale. Based on these concerns, DWR and Reclamation sought the guidance of Dr. Andy Jahn of Kier Associates in October 2012 to help refine the proposed methodology in Jahn (2011).

The issue of negative lower confidence limits was based on the method for computing confidence intervals in Jahn (2011), which assumed a normal distribution of the data. Jahn (2011) did not consider the possibility of a small sample size when computing the confidence intervals on an annual scale. To resolve the issue, Dr. Jahn recommended computing confidence limits using a formula found in Jahn and Smith (1986) that assumes a log-normal distribution rather than a normal distribution. The log-normal distribution formula should produce a similar result as the normal distribution formula if the central-limit theorem applies. Tables 6 to 12[1] provide a comparison of the confidence limits in 2011/2012 that were calculated using different assumptions based on this new information from Dr. Jahn. Using the confidence interval formula that assumed a log-normal distribution resolved the issue of negative lower confidence limits for the hatchery release groups in 2011/2012 and overall produced higher lower and upper confidence limits when compared to normal distribution formula.

During the October 2012 meeting, Dr. Jahn also confirmed that the proposed loss equation could also be applied on a daily scale, but did not recommend calculating confidence limits on a daily scale due to uncertainty in the daily values. This observation was validated in the sensitivity and uncertainty analysis found in CFS (2013) that showed that there are many uncertainties on whether a daily action trigger actually occurs. Therefore, DWR and Reclamation will not be reporting daily confidence limits on daily loss estimates in this annual report.

The results from the second year of the loss comparison study using the proposed loss equation from Jahn (2011) for winter-run Chinook salmon, spring-run Chinook salmon surrogates, and steelhead for 2012/2013 are documented in the sub-sections below.

[1] The results in these tables were also presented in the 2011/2012 annual incidental take and monitoring report with the exception of the confidence limits using a log-normal distribution formula (see DWR and Reclamation 2012). However, results may have changed from the previous year due to revised data sets.

Like in 2011/2012, DWR and Reclamation assumed that each fish facility entrained fish independently. For this reason, our sampling domain excluded any days that did not produce a count of the species at a given facility.

Winter-Run Chinook Salmon Proposed Loss Calculation Estimates

Between October 2012 and June 2013, the estimated loss using the current equation for non-clipped winter-run Chinook salmon was about 633 fish at the SWP and about 98 fish at the CVP for a combined loss of 731 fish or 7% of the incidental take limit (Table 13). If the proposed loss equation were used, then the combined estimated loss with 95% confidence limits would have been 2,422 fish $\pm$ 2,027 for the low survival rate, 1,101 fish $\pm$ 632 for the medium survival rate, and 535 fish $\pm$ 188 for the high survival rate based on a normal distribution confidence limit formula (Table 14, page 44). Based on these results, the proposed loss equation using the low and medium survival rates produced higher levels of loss when compared to the current loss equation.

Despite the higher levels of loss, the point estimate and the upper confidence limit for the low and medium survival rates would still be below the incidental take limit of 10,656 fish (i.e., 2% of the JPE) and the concern level of 5,328 fish (i.e., 1% of the JPE) for 2012/2013. However, the results changed when DWR and Reclamation calculated 95% confidence limits based on a log-normal distribution (Table 14). In this scenario, the upper confidence limit for the low survival rate would have been 5,402 fish, which would be slightly above the concern level of 5,328 fish.

The higher level of loss using the low and medium survival rates in the proposed loss equation would also lead to higher exceedance of the daily loss and loss density triggers of older juvenile Chinook salmon that are used to manage SWP/CVP operations in NMFS RPA Action IV.3 during November to December (Table 15 and 16, page 44) and in NMFS RPA Action IV.2.3 during January to June (Table 17, page 45). As an example, the daily older juvenile Chinook salmon loss was only above the daily loss triggers of 95 fish or 120 fish per day on two days during the November to December 2012 period when using the current equation (Table 15). In comparison, the proposed loss equation would have led the daily older juvenile Chinook loss to be above the daily loss trigger in NMFS RPA Action IV.3 on 8 days if the low survival rate were used or on 4 days if the medium survival rate were used.

Hatchery Winter-Run Chinook Salmon Proposed Loss Calculation Estimates

Hatchery winter-run Chinook salmon from LSNFH were only recovered at the SWP fish facility. The estimated loss was 9 fish when using the current loss equation or about 0.009% of the hatchery winter-run Chinook salmon entering the Delta (Table 2). If the proposed loss equation were used, then the loss estimate with the 95% confidence limits would have been 23 fish $\pm$ 41 (0.024% loss) for the low survival rate, 13 fish $\pm$ 23

(0.013% loss) for the medium survival rate, and 6 fish ± 10 (0.006% loss) for the high survival rate based on a normal distribution confidence limit formula (Table 18, page 45).

Like in 2011/2012, the lower confidence limit for the hatchery winter-run Chinook salmon group was negative under all survival rates when calculating the confidence limits using the formula that assumes a normal distribution. If the 95% confidence limits were calculated based on a log-normal distribution formula, then the lower and upper confidence limits would increase and the lower confidence limits would not be below zero. Using a log-normal distribution formula, the low survival rate confidence interval would range from 5 (0.005% loss) to 106 fish (0.110% loss), the medium survival rate confidence interval would range from 3 (0.003% loss) to 58 fish (0.060% loss), and the high survival rate confidence interval would range from 1 (0.001% loss) to 25 fish (0.026% loss) (Table 18).

Overall, the loss estimated from the proposed equation using the low and medium survival rates was higher than the estimated loss from the current equation. However, the loss using the high survival rate was lower than what was estimated from the current equation. Nevertheless, DWR and Reclamation would not have exceeded the 1% incidental take limit that NMFS permitted for 2012/2013 even if the proposed loss equation were used.

Spring-Run Chinook Salmon Surrogate Proposed Loss Calculation Estimates

For the first spring-run Chinook salmon surrogate release group, the estimated loss using the current loss equation was about 62 fish at the SWP and 13 fish at the CVP for a combined loss of 75 fish or about 0.103% of the total number released for the group (Table 2). If the proposed loss equation were used, then the estimated loss with 95% confidence limits would have been 256 fish ± 298 (0.351% loss) for the low survival rate, 112 fish ± 109 (0.153% loss) of the release group for the medium survival rate, and 55 fish ± 49 (0.075% loss) for the high survival rate based on a normal distribution confidence limit formula (Table 19, page 45). Based on these results, DWR and Reclamation would not have exceeded the 1% incidental take level permitted for the first surrogate release group when looking at the point estimates using the proposed loss equation. However, the upper confidence limit for the low survival rate is at 554 fish or 0.759% of the hatchery release group, which is above the 0.5% concern level for the first surrogate release group. On the other hand, the lower confidence limit for the low survival rate is below zero and thus provides inconclusive results about the accuracy of the point estimate.

A lower confidence limit below zero implies that a confidence limit formula based on a normal distribution assumption should not be used. Using a log-normal distribution formula, the low survival rate confidence interval would range from 87 (0.119% loss) to

753 fish (1.03% loss) (Table 19). These results show that there is a possibility that the incidental take limit for the first surrogate group could have been exceeded when calculating loss using the low survival rate.

For the second surrogate release group, the estimated loss using the current loss equation was about 113 fish at the SWP and 26 fish at the CVP for a combined loss of 139 fish or about 0.198% of the total number released for the group (Table 2). If the proposed loss equation were used, then the combined estimated loss with 95% confidence limits would have been 477 fish $\pm$ 448 (0.679% loss) for the low survival rate, 203 fish $\pm$ 146 (0.289% loss) for the medium survival rate, and 101 fish $\pm$ 57 (0.143% loss) for the high survival rate based on a normal distribution confidence limit formula (Table 20, page 46). Based on the point estimates and confidence limits, the loss calculated using the proposed loss equation for the medium and high survival rate was below the 0.5% concern level and thus the1% incidental take limit permitted for the second surrogate release group. However, the confidence interval using a log-normal confidence limit formula for the medium survival rate would range from 101 (0.143% loss) to 407 fish (0.579% loss) (Table 20). Therefore, there is a possibility that the loss estimate using the medium survival rate could be above the 0.5% concern level based on the upper confidence limit if the log-normal confidence limit formula were used.

In comparison, the point estimate of 477 fish (0.679% loss) calculated using the low survival rate was above the 0.5% concern level for the second surrogate group (Table 20). The confidence interval based on a normal distribution ranges from 29 (0.041% loss) to 925 fish (1.32% loss), while the confidence interval based on a log-normal distribution ranges from 195 (0.277 % loss) to 1,162 fish (1.65% loss). Therefore, there is a possibility that the point estimate could be above the incidental take limit of 1% or below the concern level of 0.5% for the second surrogate release group.

For the third surrogate release group, the estimated loss using the current loss equation was about 9 fish at the SWP and 15 fish at the CVP for a combined loss of 24 fish or about 0.030% of the number of fish released for the group (Table 2). If the proposed loss equation were used, then the combined estimated loss with 95% confidence limits would have been 146 fish $\pm$ 168 (0.182% loss) for the low survival rate, 36 fish $\pm$ 41 (0.045% loss) for the medium survival rate, and 23 fish $\pm$ 23 (0.029% loss) for the high survival rate based on a normal distribution confidence limit formula (Table 21, page 46). Based on the point estimates and confidence limits, the loss calculated using the proposed loss equation for all survival rates was below the 0.5% concern level and thus the 1% incidental take limit permitted for the third surrogate release group.

However, some of the lower confidence limits using the normal distribution formula were at or below zero for some of the loss estimates for the third surrogate group. Using a log-normal distribution formula, the low survival rate confidence interval would range from 52 (0.064% loss) to 430 fish (0.536% loss), the medium survival rate confidence interval would range from 14 (0.017% loss) to 108 fish (0.134% loss), and the high

survival rate confidence interval would range from 9 (0.011% loss) to 61 fish (0.076% loss) (Table 21). Therefore, the loss estimate using the low survival rate could have been above the 0.5% concern level since the upper confidence limit is at 430 fish (0.536% loss) when using the log-normal confidence limit formula. However, the margin of error was high and the lower confidence limit was at 52 fish (0.064% loss) and below the 0.5% concern level.

Steelhead Proposed Loss Calculation Estimates

The current incidental take level of 3,000 for non-clipped steelhead is based on historical salvage since a distinct population segment-wide estimate of Central Valley steelhead abundance is currently not available. Therefore, DWR and Reclamation could not compare the estimated loss from the proposed loss equation with the incidental take limit based on historical salvage. In the future, it will be necessary to adjust the incidental take limit for steelhead if the proposed loss equation is implemented to track annual take. As an alternative, DWR and Reclamation made a comparison of steelhead loss between the proposed loss equation and the interim DOSS loss equation described in DOSS (2011) that calculated steelhead loss using loss multipliers based on Chinook salmon loss estimates.

From October 2012 to July 2013, the estimated loss for non-clipped steelhead using the interim DOSS loss equation was 2,042 fish at the SWP and 221 fish at the CVP for a combined loss of 2,263 fish (Table 22, page 46). If the proposed loss equation were used, then the combined estimated loss with 95% confidence limits would have been 4,639 fish $\pm$ 1,351 for the low survival rate, 2,414 fish $\pm$ 689 for the medium survival rate, and 1,132 fish $\pm$ 257 for the high survival rate based on a normal distribution confidence limit formula (Table 23, page 47). In general, the combined loss estimated from the proposed loss equation using the low and medium survival rates was higher than the estimated loss from the interim DOSS loss equation. However, the combined estimated loss using the medium survival rate was only slightly higher than what was estimated using the interim DOSS equation. In contrast, the loss using the high survival rate was lower than what was estimated from the interim DOSS equation.

The higher level of loss calculated using the low and medium survival rates in the proposed loss equation would lead to higher daily loss of non-clipped steelhead when compared to the interim DOSS loss equation. Daily loss of non-clipped steelhead is used to manage SWP/CVP operations in NMFS RPA Action IV.2.3 during January to June (Table 25, page 47). From January to June 2013, the daily steelhead loss was above the trigger threshold in NMFS RPA Action IV.2.3 on 18 days using the interim DOSS loss equation. Similarly, the proposed method using the medium survival rate would have resulted in daily loss being above the trigger threshold on 19 days. However, the use of the medium survival rate would have resulted in greater exceedance of the 12 fish/TAF threshold when compared to the interim DOSS loss equation (Table 25). In comparison, the proposed method using the low survival rate

would have resulted in daily loss being above the trigger threshold on 41 days. Based on these results, the use of the proposed loss equation using the low or medium survival rates may have resulted in greater restrictions in terms of SWP/CVP operations.

The data set from the SWP for non-clipped steelhead met the definition of a time series from March 18 to April 13, 2013. However, the results presented in Table 23 were not corrected for autocorrelation. For comparison purposes, a correction for autocorrelation was applied to this data set and the results are presented in Table 24 on page 47. Overall, the correction for autocorrelation slightly lowered the lower confidence limit and slightly raised the upper confidence limit for all survival rates. Like in 2011/2012, the correction for autocorrelation did not make a considerable difference to the adjustment of the standard error that was used to calculate the confidence limits of the loss estimate.

Summary

In summary, it appears that the use of the proposed loss equation to monitor take of Chinook salmon or steelhead may result in higher levels of calculated loss under the low or medium survival rates when compared to the amount of loss estimated using the current methods in both 2011/2012 and 2012/2013. However, steelhead loss calculated using the interim DOSS loss equation was in a closer range to the steelhead loss calculated using the medium survival rate in the proposed loss equation than compared to the low or high survival rate. In contrast, Chinook salmon loss calculated using the current loss equation was in a closer range to the Chinook salmon loss calculated using the medium or high survival rate than compared to the low survival rate.

The ability to have confidence limits surrounding the loss estimate provided some additional insight on the reliability of the loss estimate used to determine incidental take for the year. However, it appears difficult on how to incorporate confidence limits in decision making if the margin of error is high. In this study, there were multiple scenarios where the upper confidence limit is above a take limit or concern level and the lower confidence limit is below a take limit or concern level.

Furthermore, confidence limits calculated using the formula found in Jahn (2011) often resulted in negative lower confidence limits for the loss estimates of some of the hatchery release groups that are of a smaller sample size. If DWR and Reclamation are to move forward with calculating confidence limits for the loss estimates, then the confidence limit formula based on a log-normal distribution should be used. Using the confidence limit formula based on a log-normal distribution resolved the issue of negative lower confidence limits for the hatchery release groups in both years of the loss comparison study.

In addition, results from this two year loss comparison study showed that a correction

for autocorrelation did not make a considerable difference to the adjustment of the standard error used to calculate confidence limits. Based on these results, there does not appear to be a need to incorporate a correction for autocorrelation, especially since there are uncertainties related to salvage at the facilities.

In the end, results from this two-year loss comparison study will help Reclamation and DWR provide a recommendation on the best equations used to quantify incidental take at the facilities for listed anadromous species.

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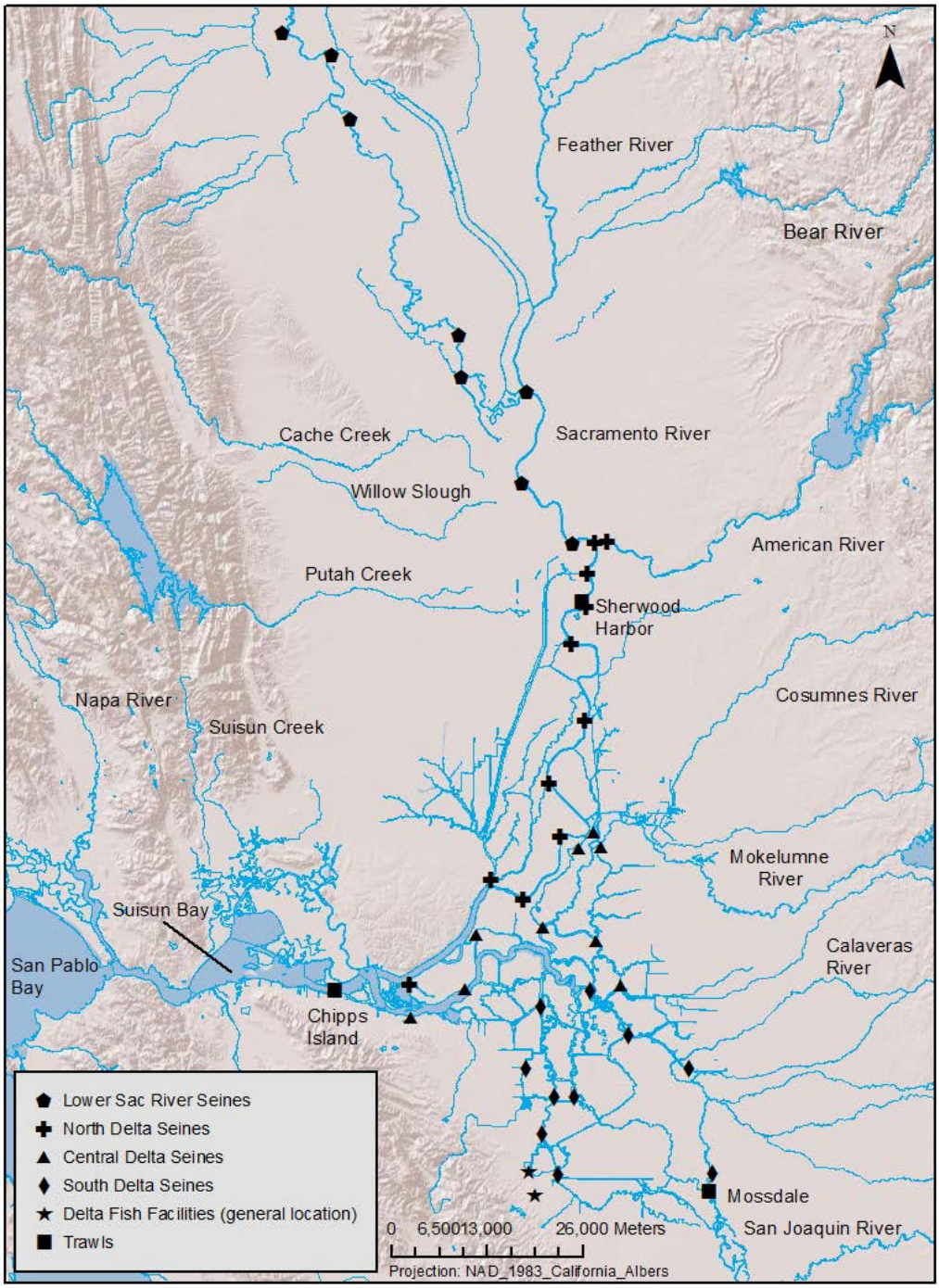
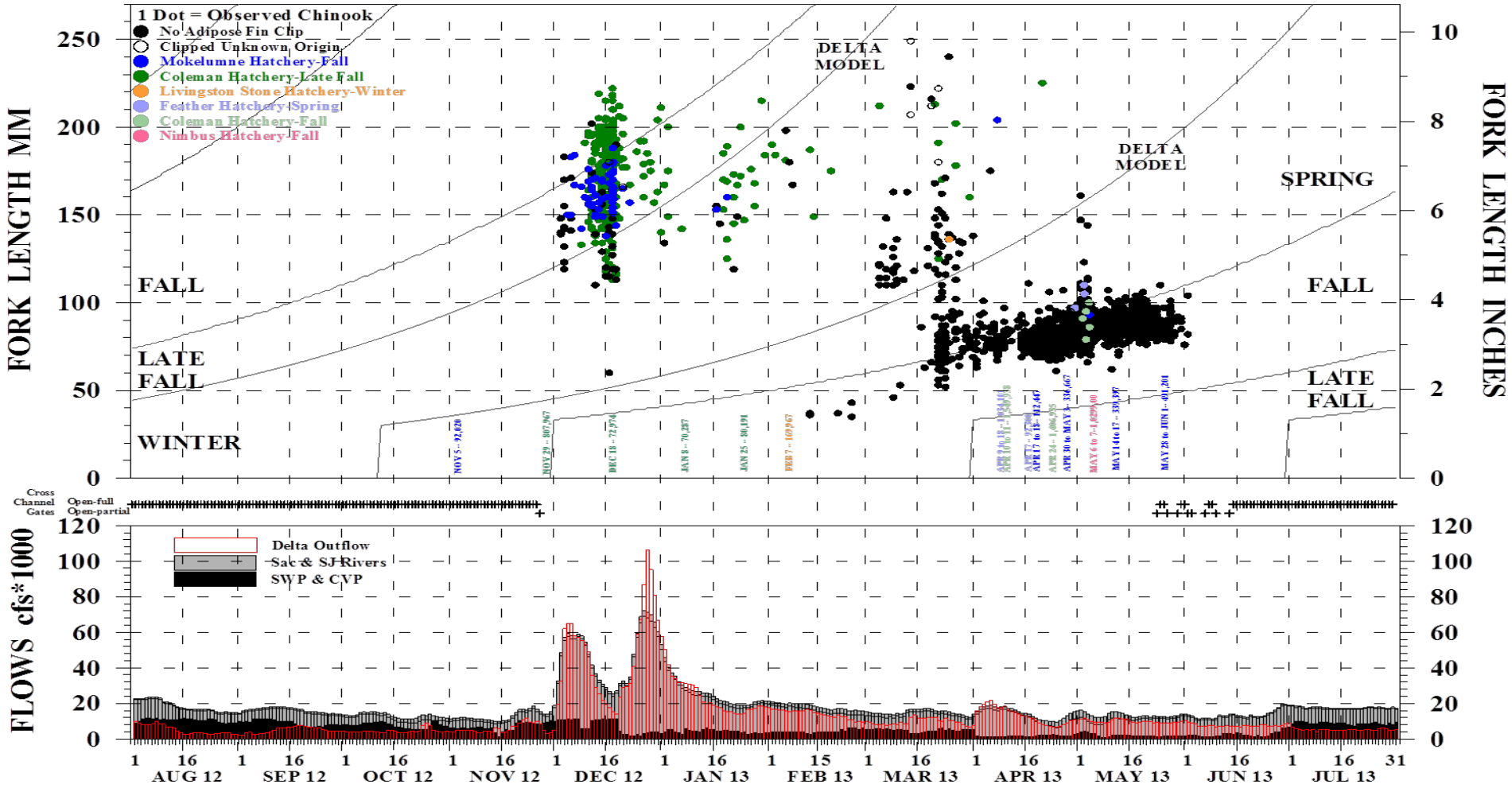
LIST OF FIGURES

Figure 1. Map of monitoring sites used in this report.



Base map from ESRI and GPS coordinates provided by USFWS. Only seine sites that have been active since August 2003 are presented.

Figure 2. Observed Chinook salvage at the Delta fish facilities with Delta hydrology based on Delta model and CWT race designations, August 1, 2012, through July 31, 2013.



Chinook salmon not measured for fork length or outside of the length-at-date criteria are not reported.

Figure 3. Observed non-clipped Chinook salvage at the SWP Delta fish facility with Delta hydrology based on Delta model and genetic race designations, August 1, 2012, through July 31, 2013.

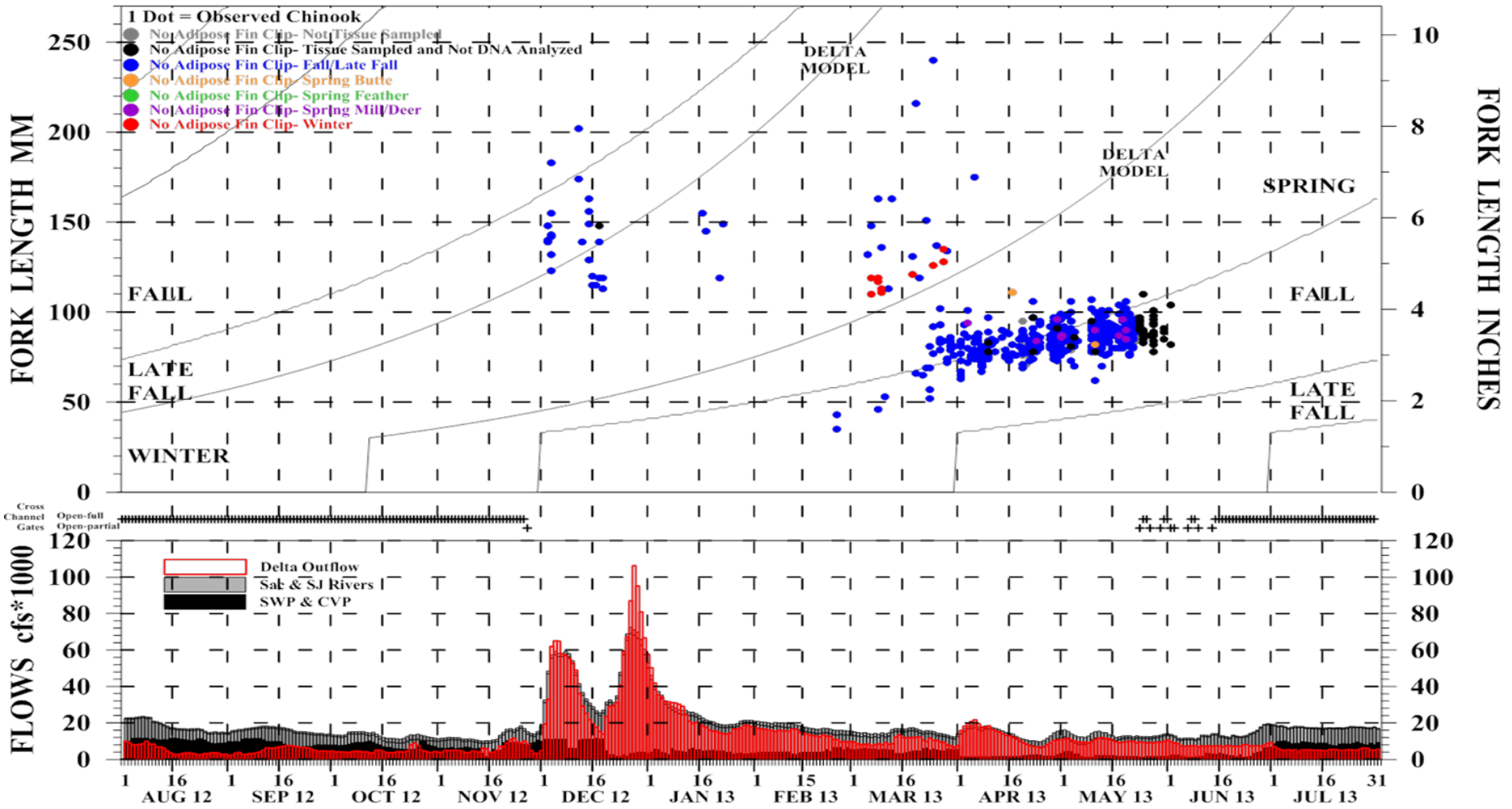


Figure 4. Daily loss and loss density of non-clipped winter-run length and older juvenile Chinook salmon at the Delta fish facilities using the current loss equation (DFW 2013), October 1, 2012, through June 30, 2013.

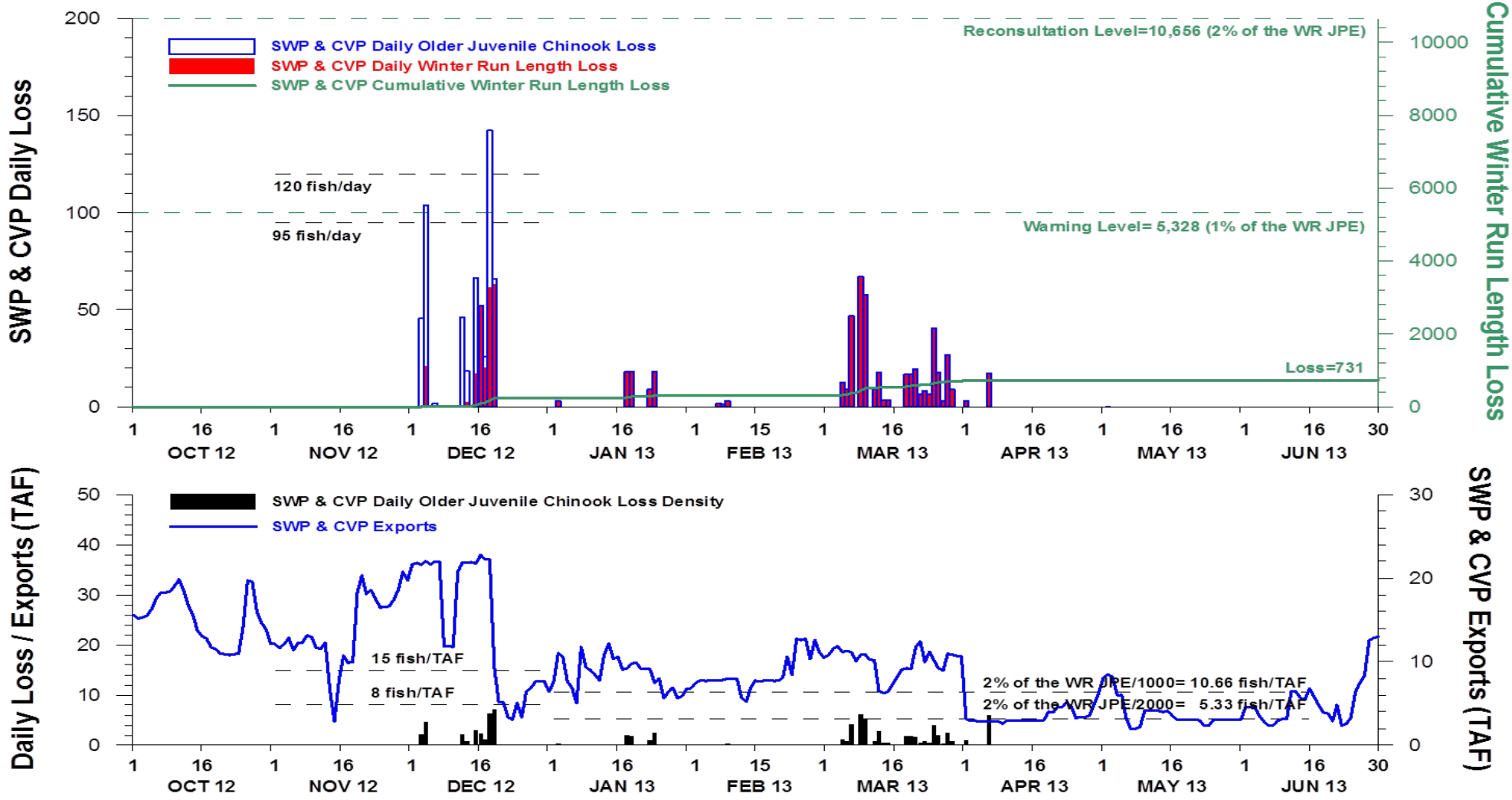


Figure 5. Non-clipped winter-run length Chinook salmon loss at the Delta fish facilities from October to June using the current loss equation (DFW 2013), water years 2004 through 2013.

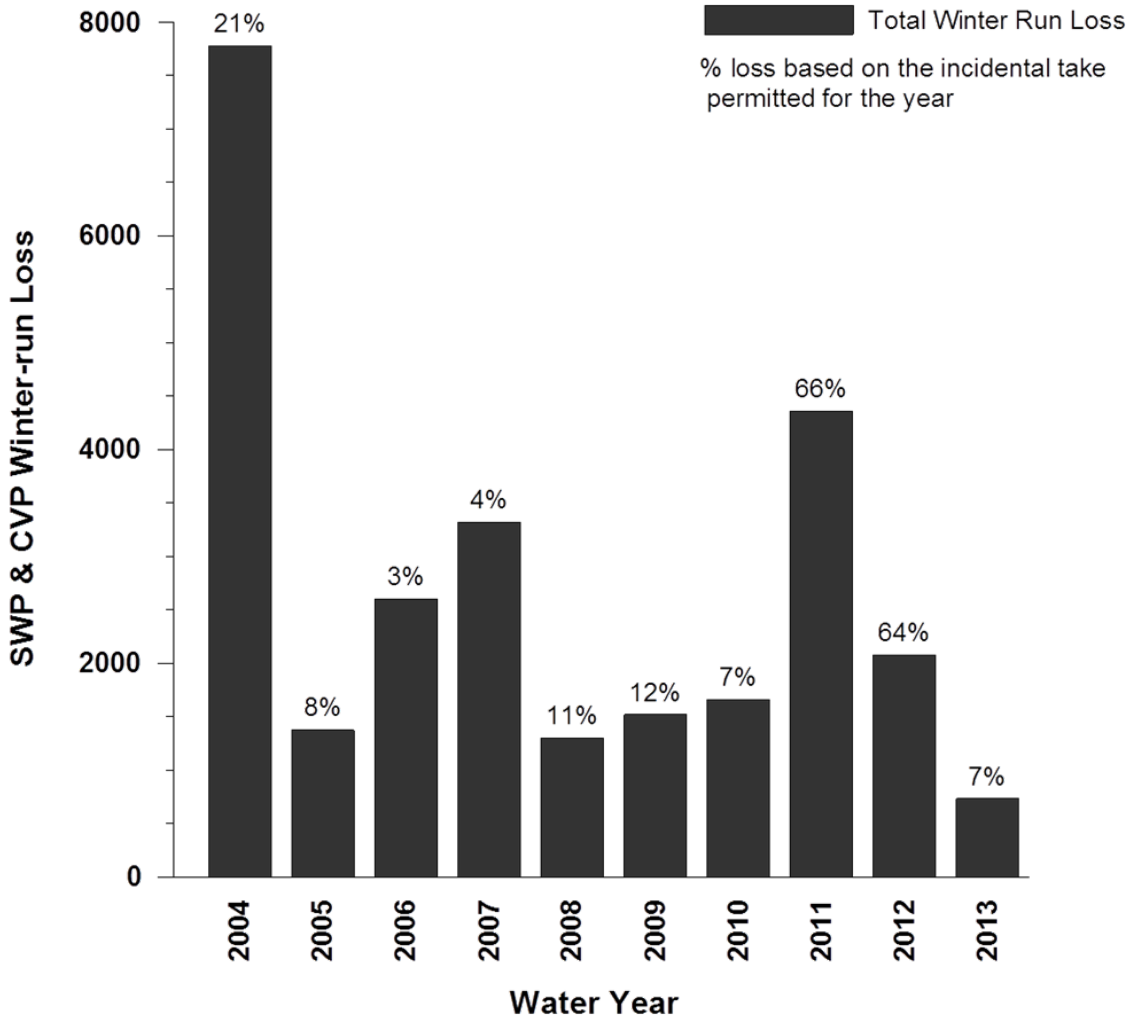


Figure 6. Daily loss and loss density of non-clipped fry/smolt Chinook salmon at the Delta fish facilities using the current loss equation (DFW 2013), October 1, 2012, through July 31, 2013.

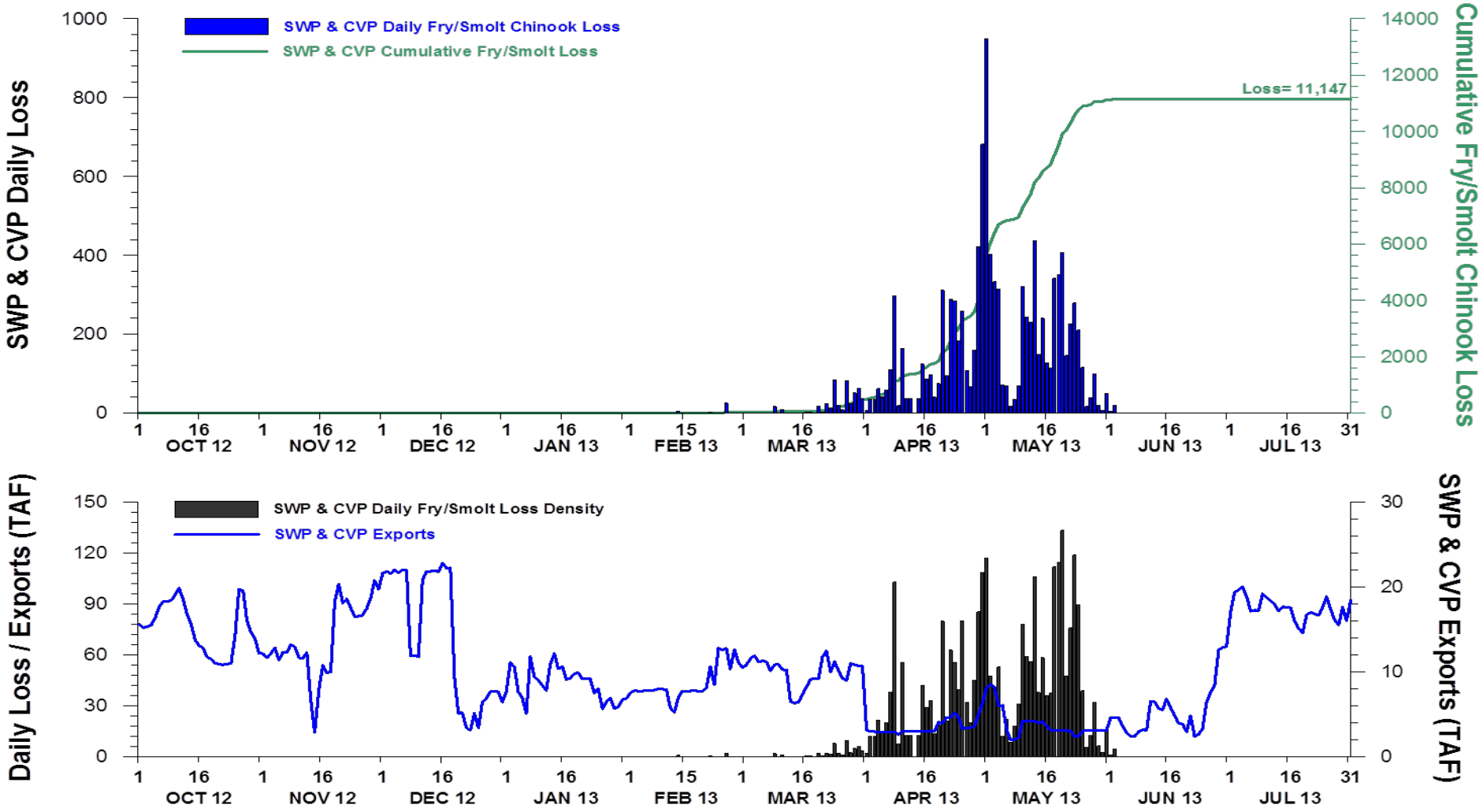


Figure 7. Non-clipped fry/smolt Chinook salmon loss at the Delta fish facilities from October to July using the current loss equation (DFW 2013), water years 2004 through 2013.

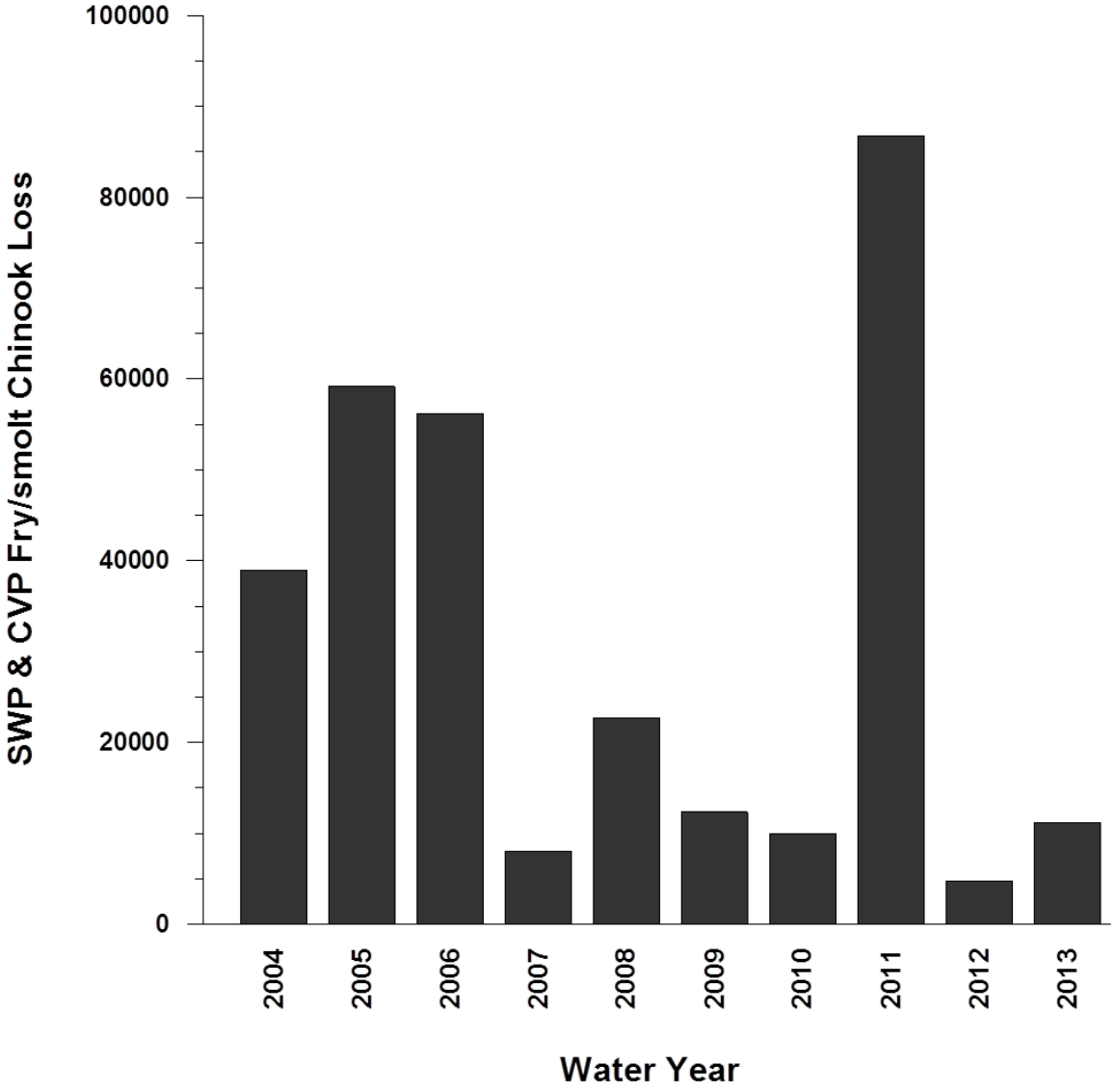


Figure 8. Older juvenile Chinook salmon and CNFH late-fall Chinook salmon (spring-run surrogate) recoveries from the Delta monitoring program and loss at the Delta fish facilities, October 1, 2012, through June 30, 2013.

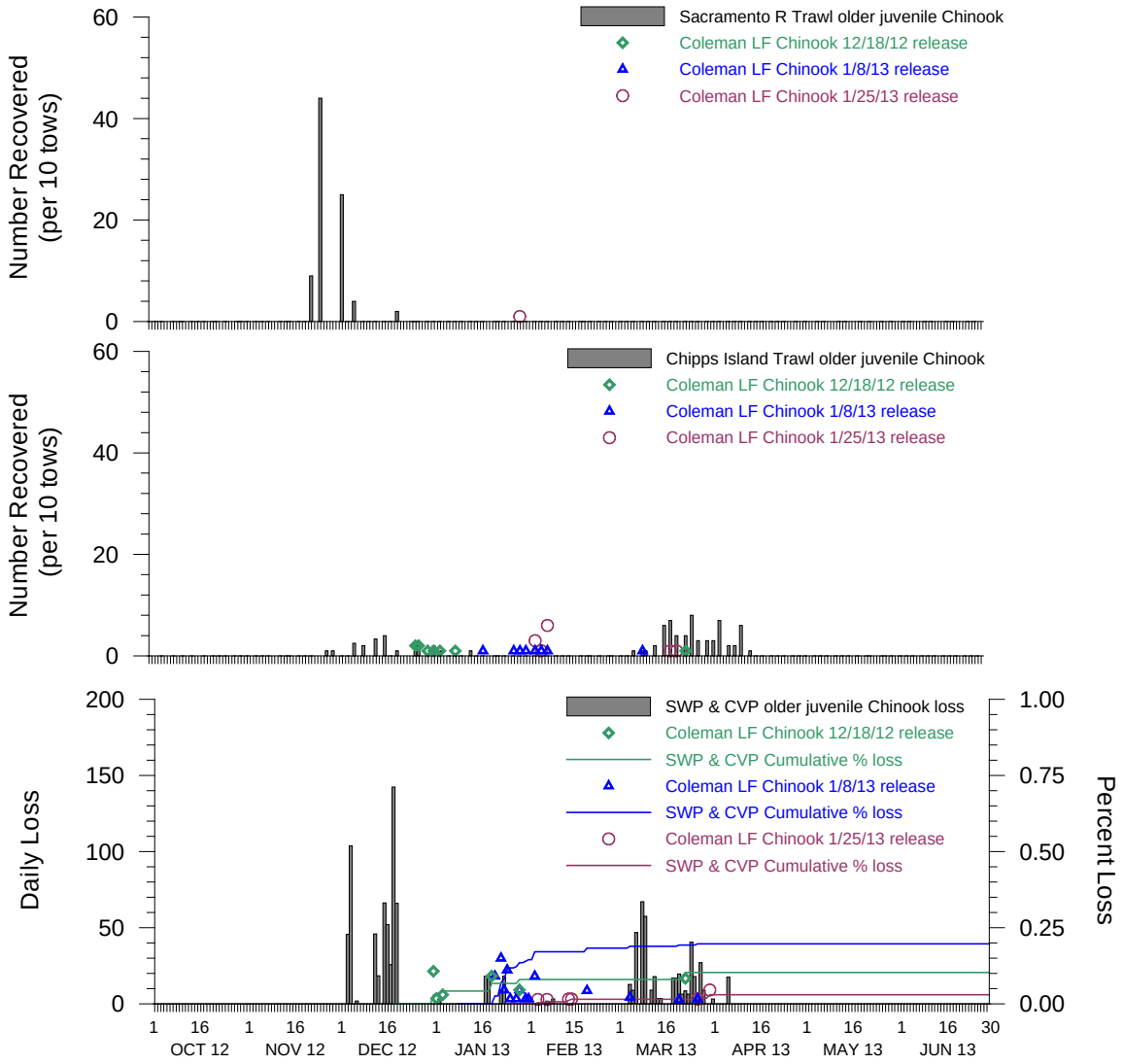


Figure 9. Older juvenile Chinook salmon and LSNFH winter-run Chinook salmon recoveries from the Delta monitoring program and loss at the Delta fish facilities, October 1, 2012, through June 30, 2013.

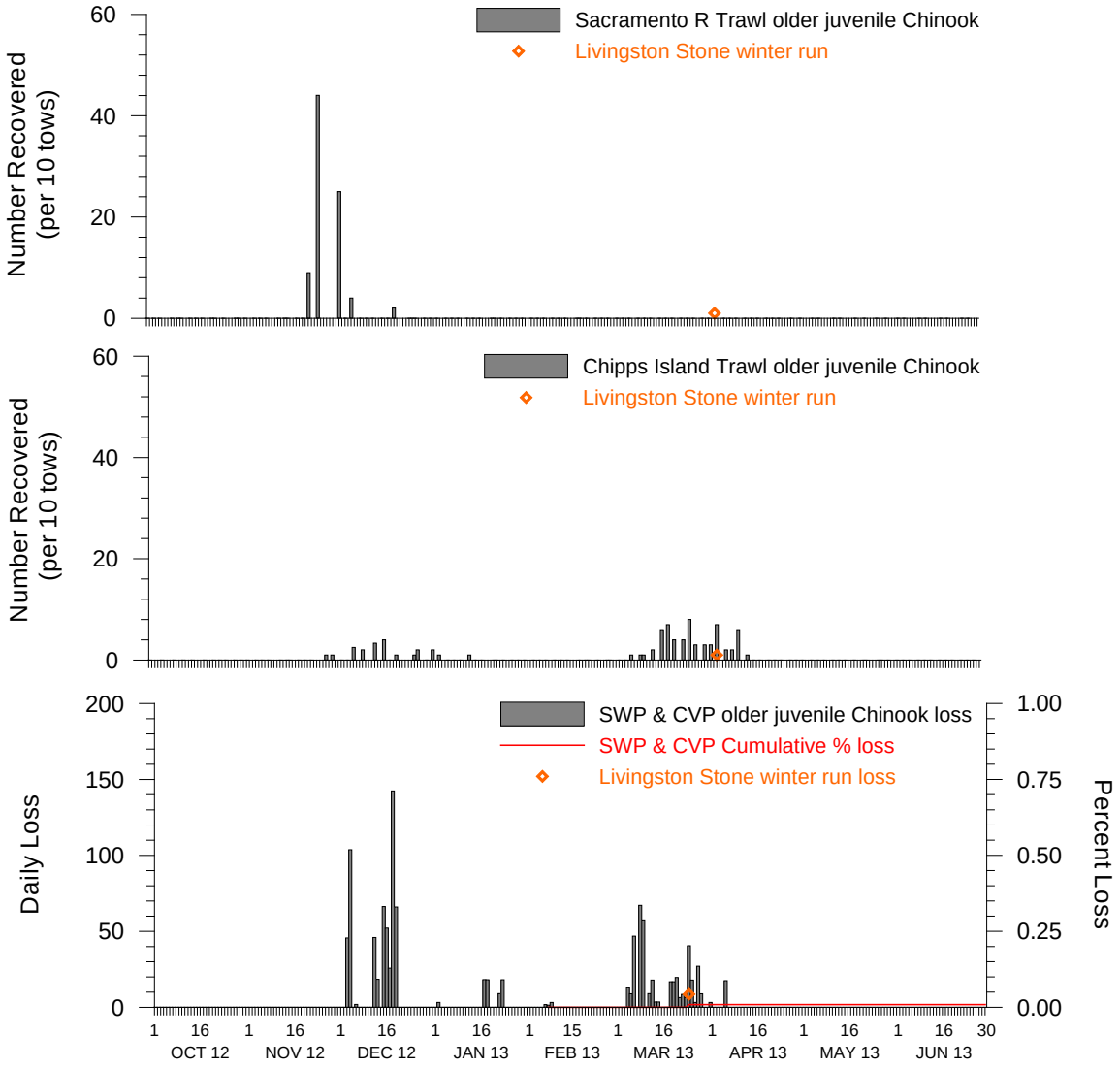


Figure 10. Number of non-clipped older juvenile Chinook salmon caught in the lower Sacramento River and the Delta beach seines from August 1 through July 31, 2003/2004 to 2012/2013.

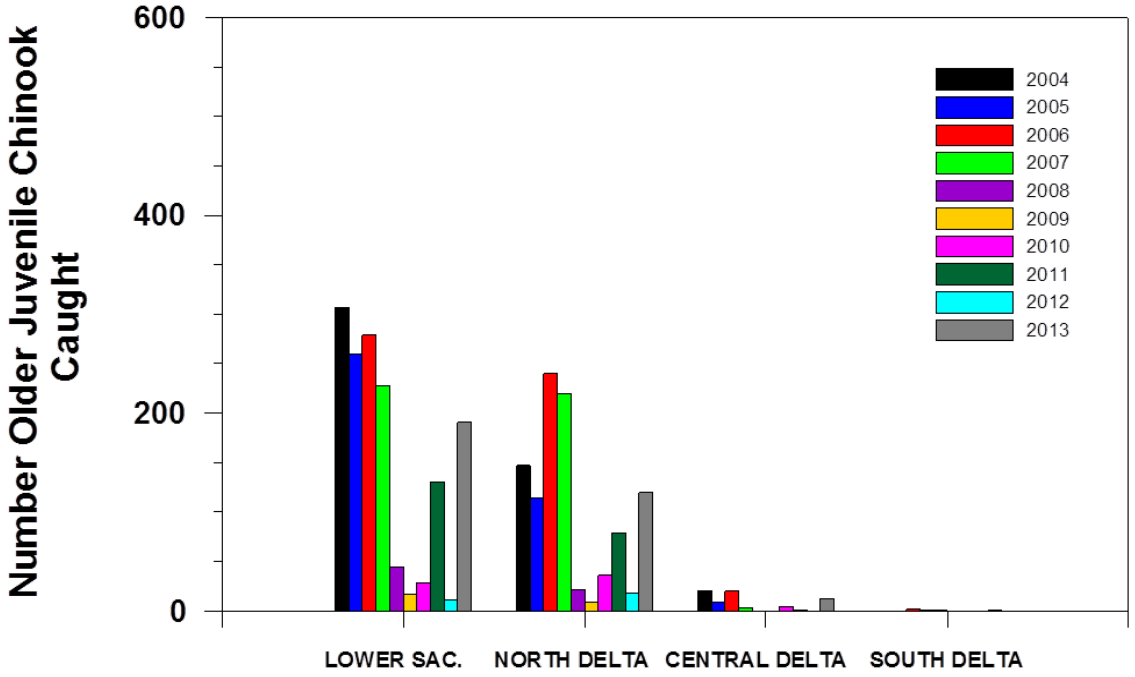


Figure 11. Number of non-clipped fry/smolt Chinook salmon caught in the lower Sacramento River and the Delta beach seines from August 1 through July 31, 2003/2004 to 2012/2013.

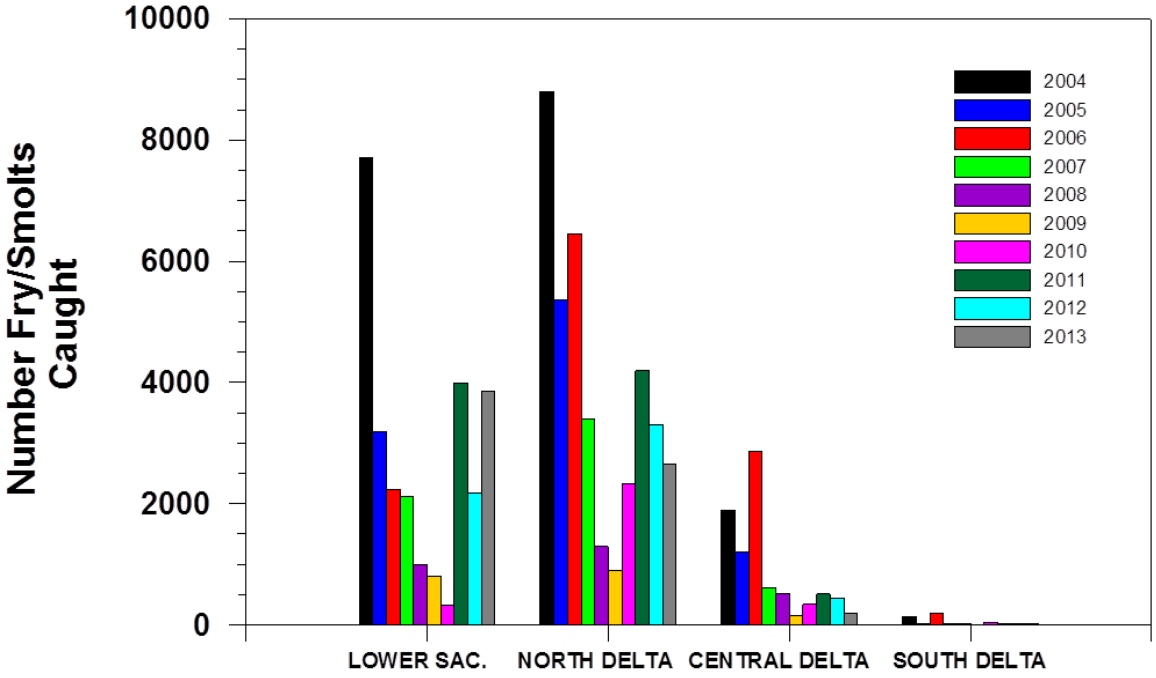


Figure 12. Number of non-clipped older juvenile Chinook salmon caught in the Sacramento River and Chipps Island trawls from August 1 through July 31, 2003/2004 to 2012/2013.

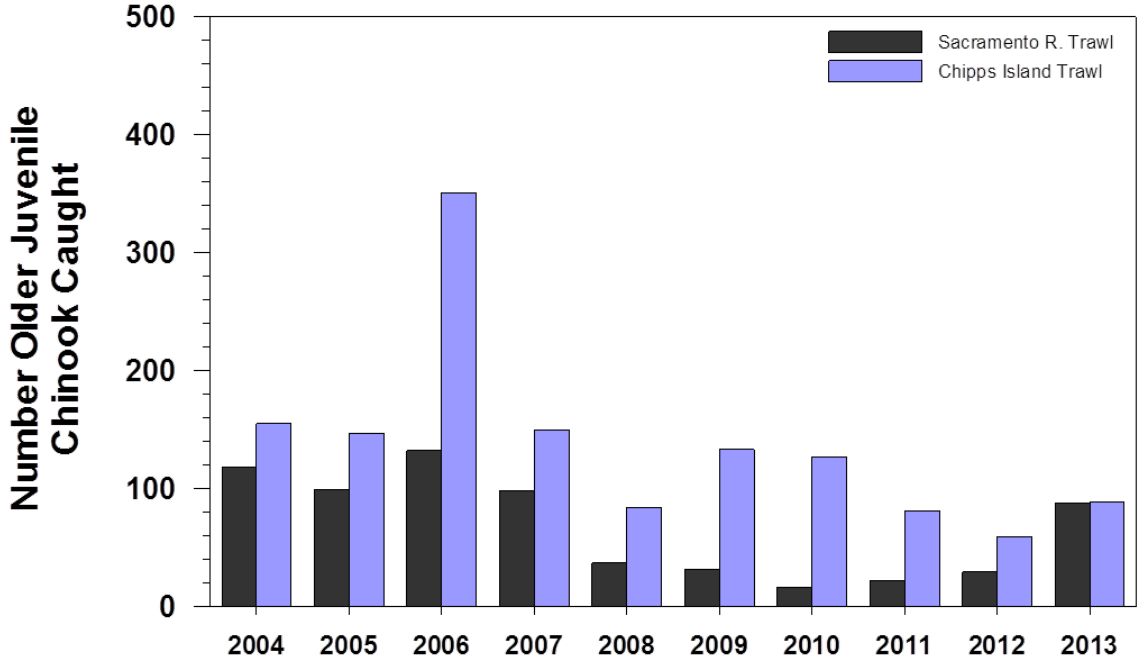


Figure 13. Number of non-clipped fry/smolt Chinook salmon caught in the Sacramento River and Chipps Island trawls from August 1 through July 31, 2003/2004 to 2012/2013.

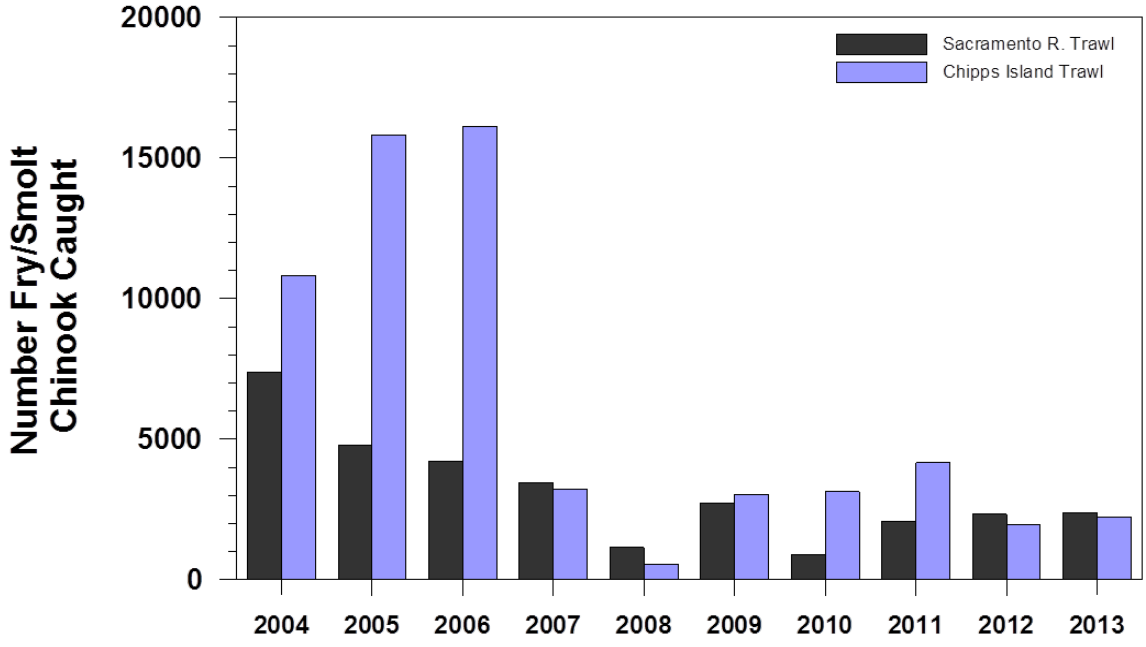


Figure 14. Non-clipped steelhead salvage at the Delta fish facilities, October 2012 through July 2013.

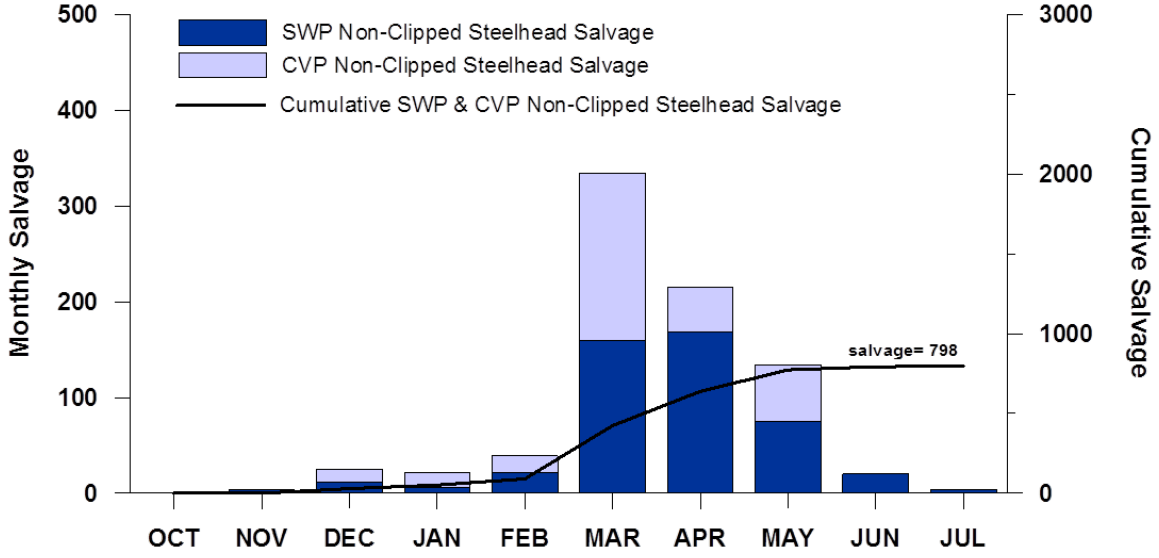


Figure 15. Hatchery (adipose fin clipped) steelhead salvage at the Delta fish facilities, October 2012 through July 2013.

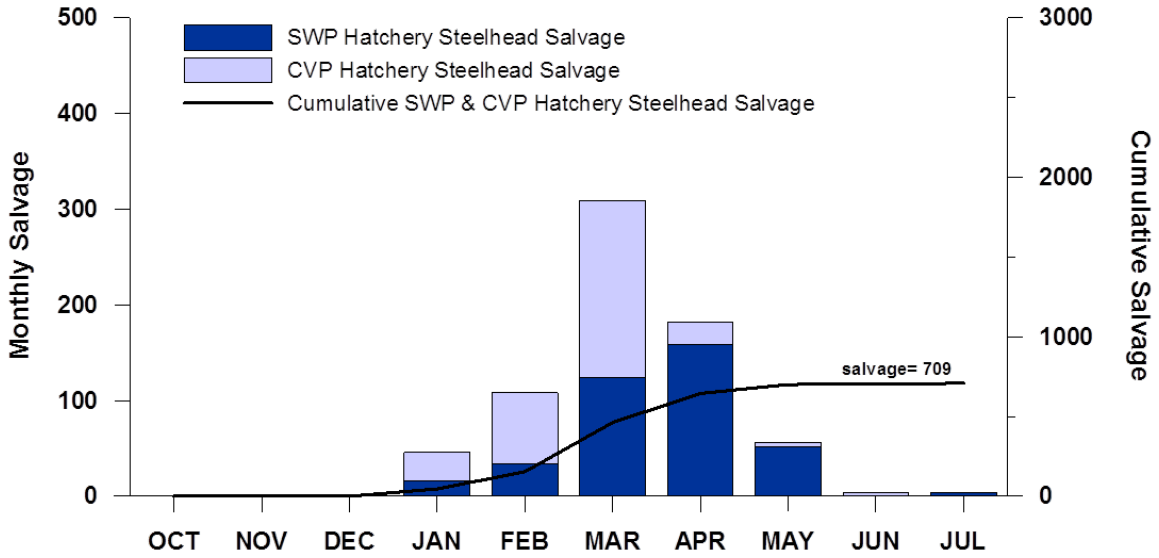


Figure 16. Non-clipped steelhead salvage at the Delta fish facilities from October to July, water years 2004 through 2013.

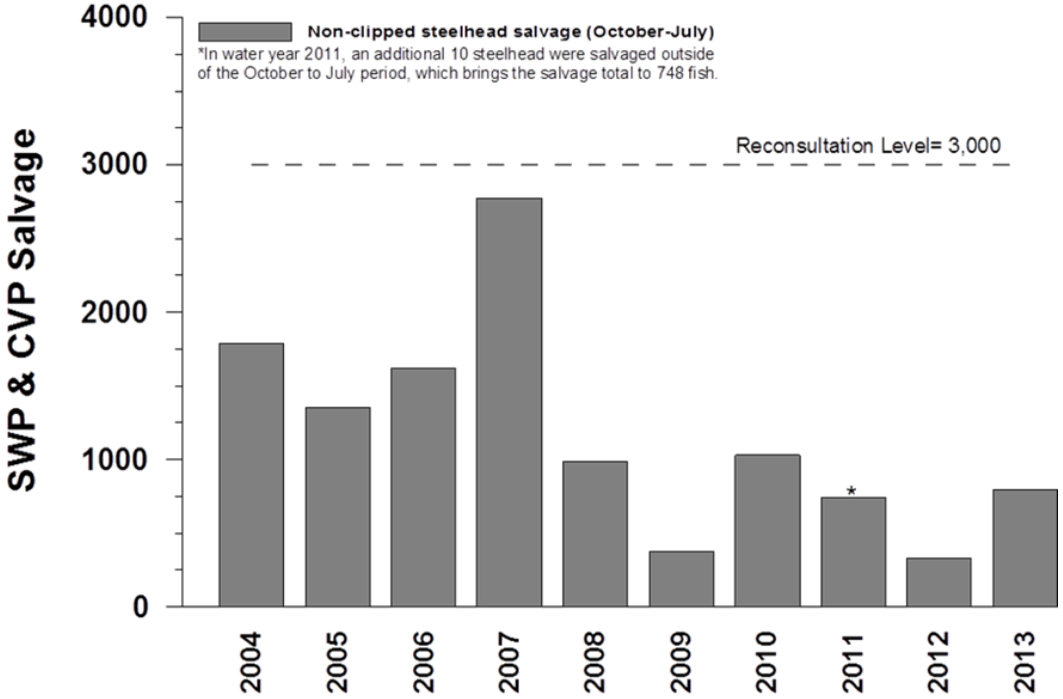


Figure 17. Hatchery (adipose fin clipped) steelhead salvage at the Delta fish facilities from October to July, water years 2004 through 2013.

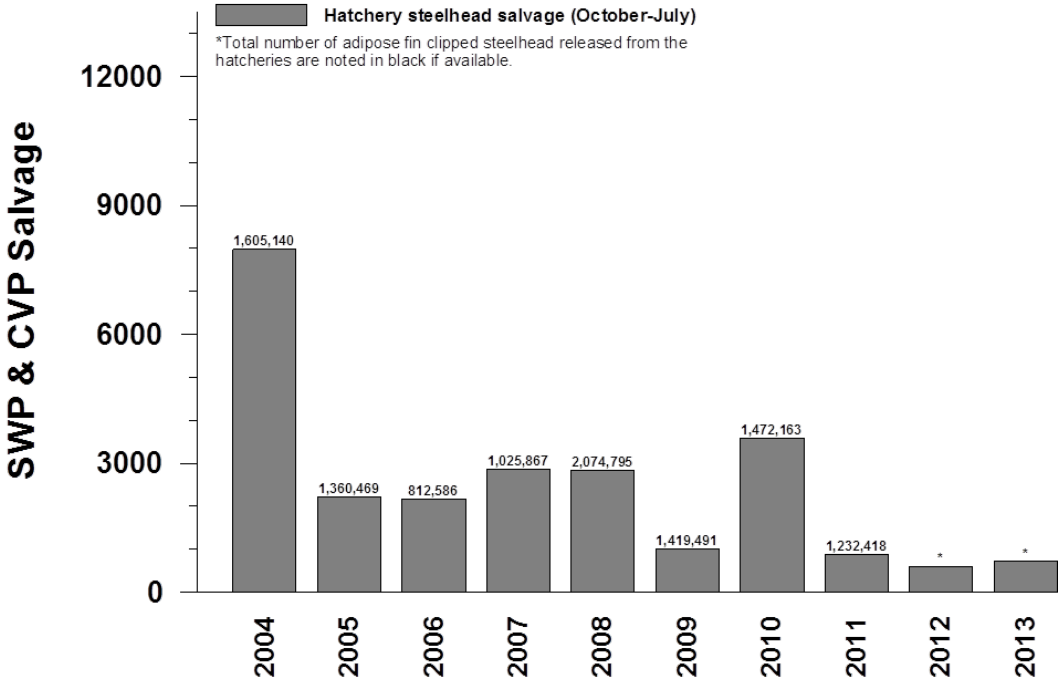
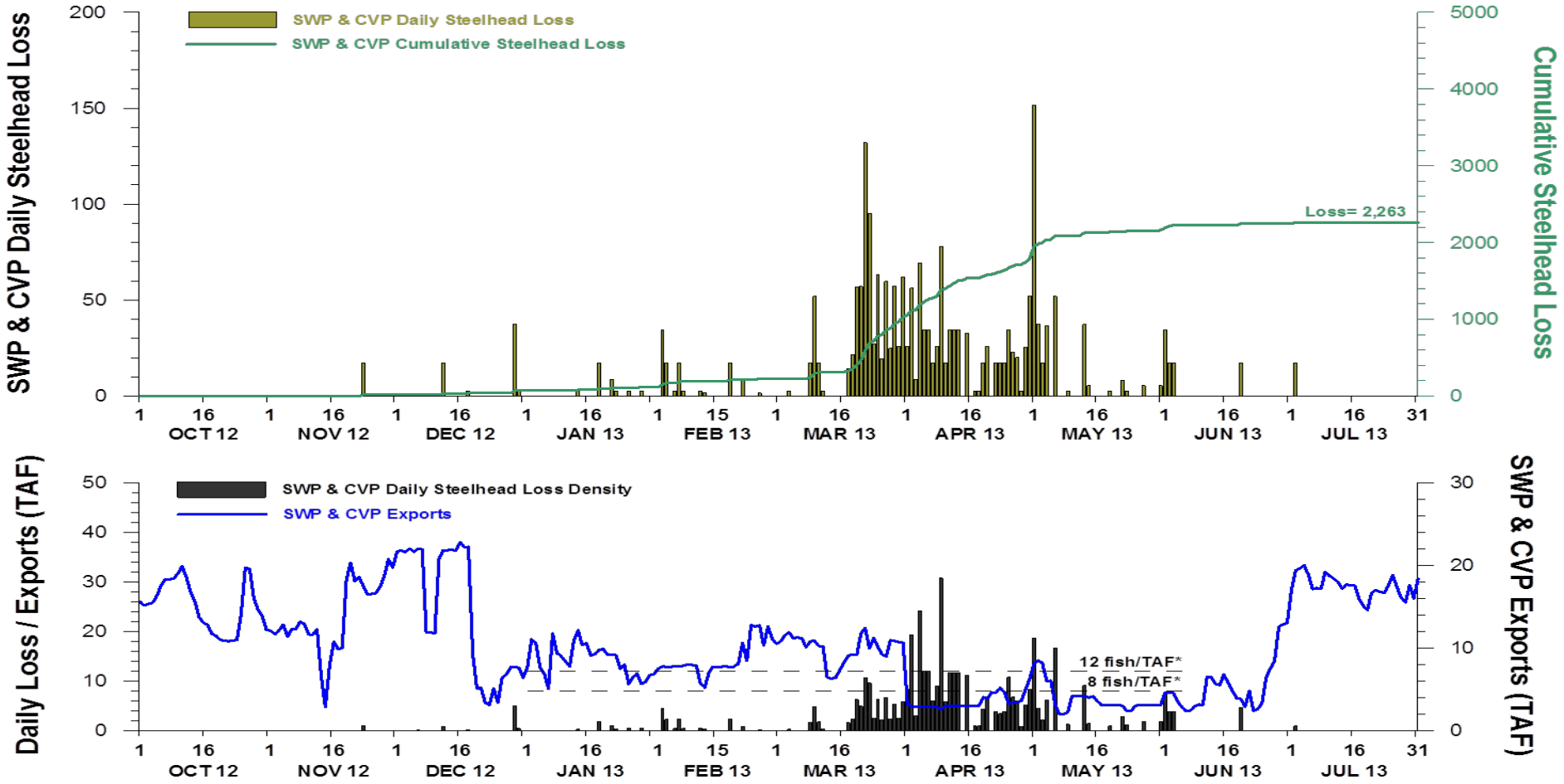


Figure 18. Daily loss and loss density of non-clipped steelhead at the Delta fish facilities using the interim loss equation (DOSS 2011), October 1, 2012, through July 31, 2013.



*Used to roughly estimate whether the daily loss is greater than 8 fish/TAF multiplied by the volume exported in TAF or 12 fish/TAF multiplied by the volume exported in TAF.

Figure 19. Number of steelhead recovered in the Delta monitoring program, October 2012 through July 2013.

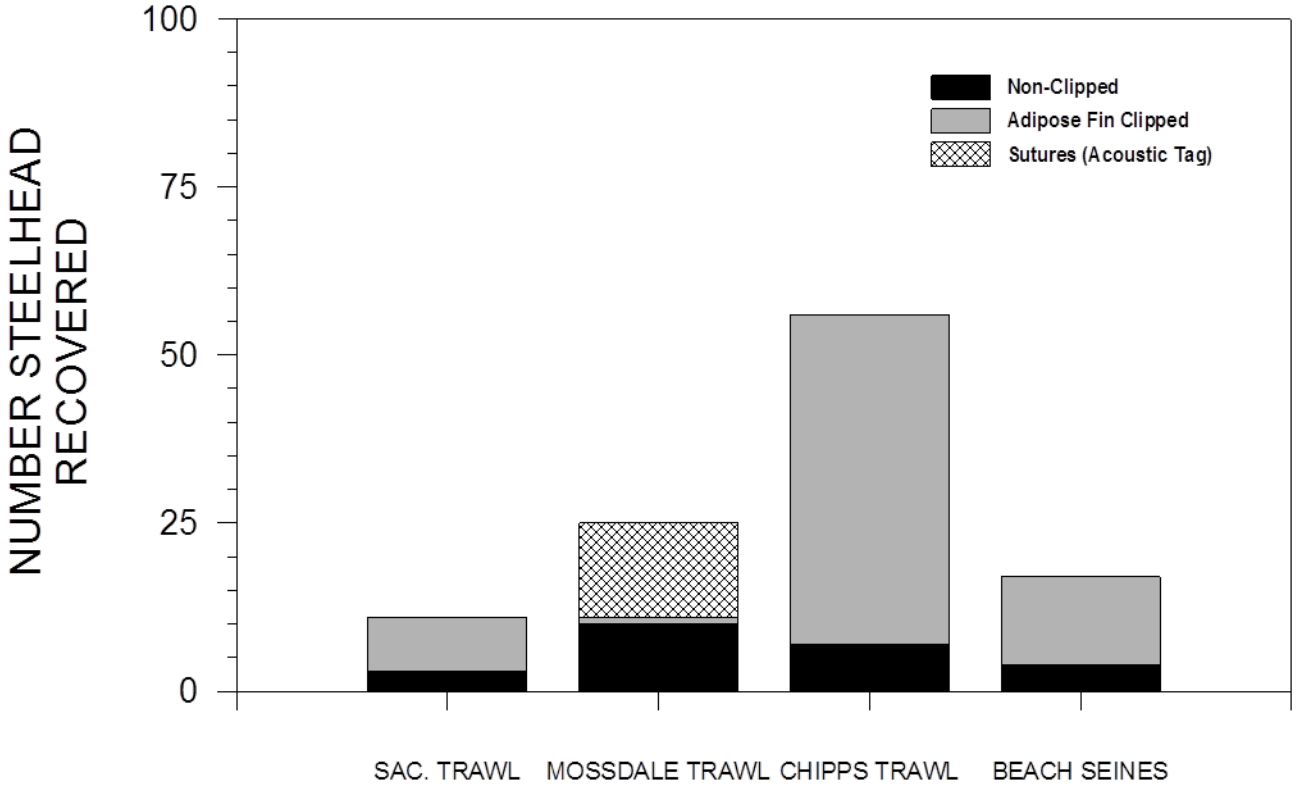


Figure 20. Green sturgeon salvage at the Delta fish facilities from October to July, water years 2004 through 2013.

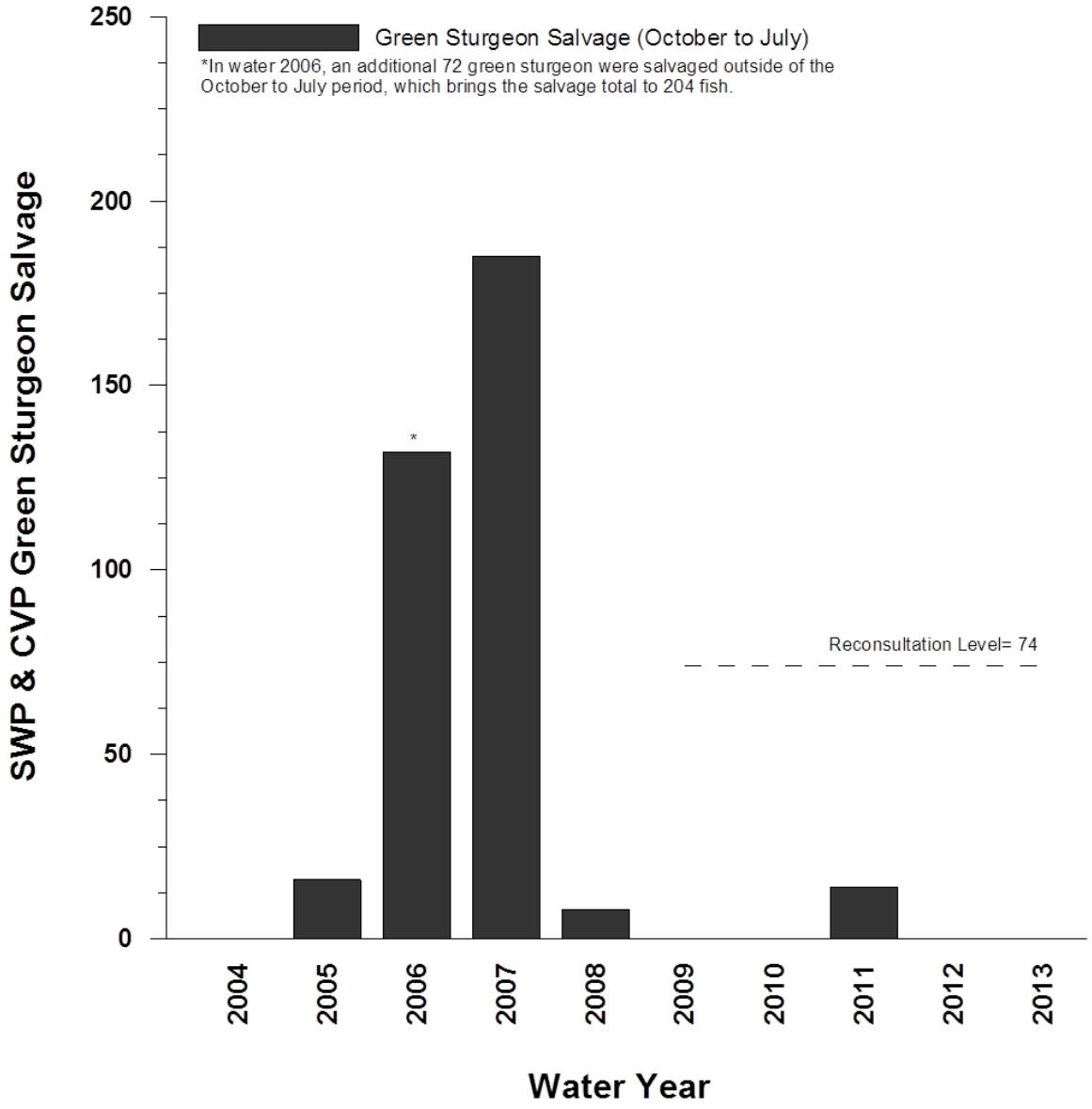


Figure 21. Monthly averages of Delta hydrology, water years 2004 through 2013.

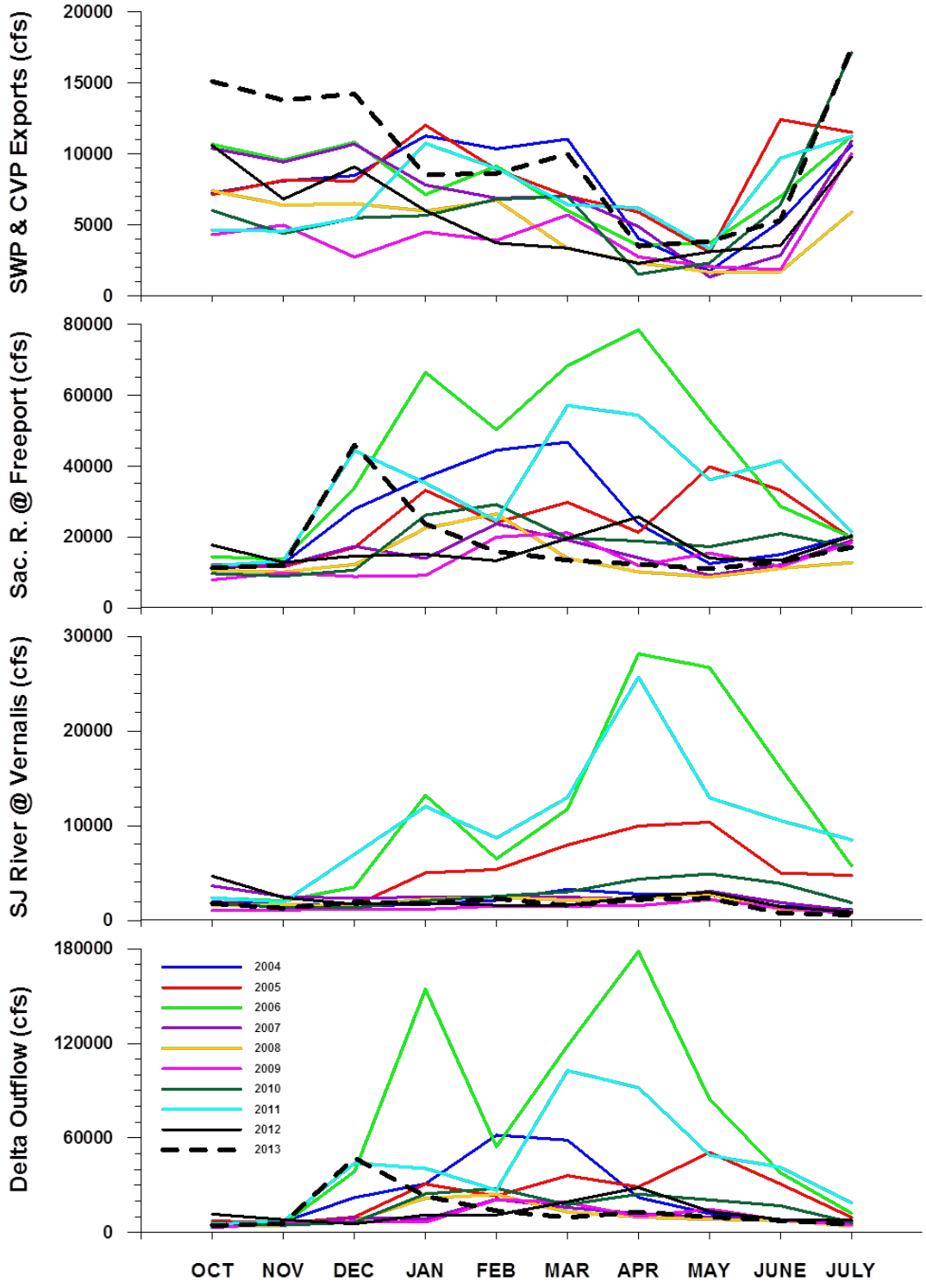


Figure 22. Modeled volumetric water fingerprint for the Clifton Court Forebay (SWP) as derived from DSM2, October 2012 through July 2013.

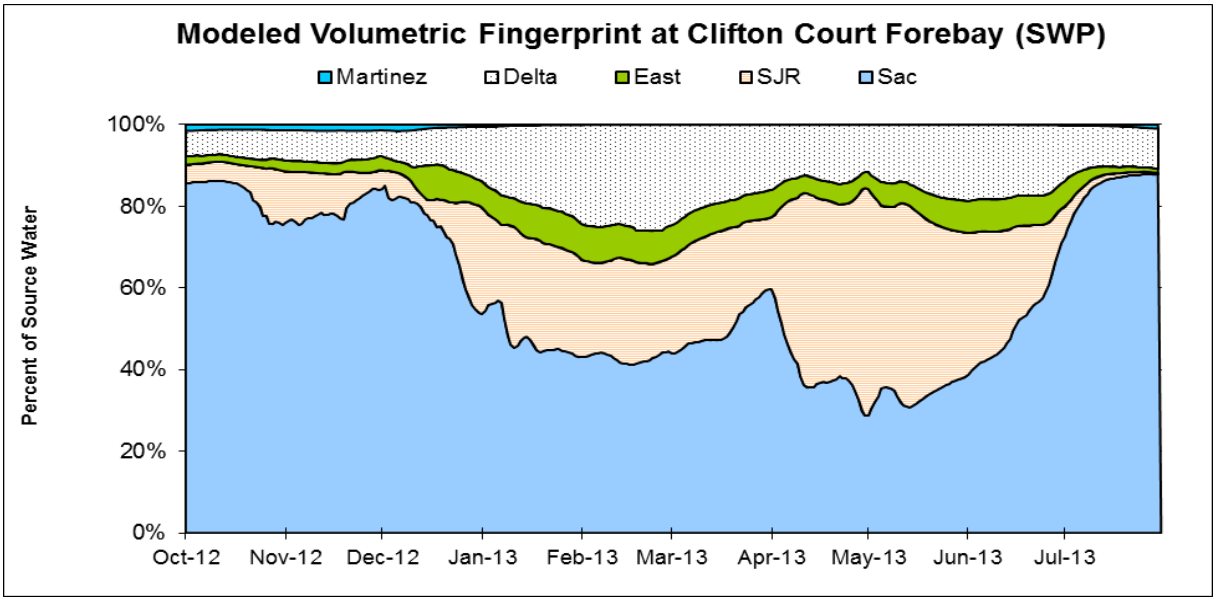
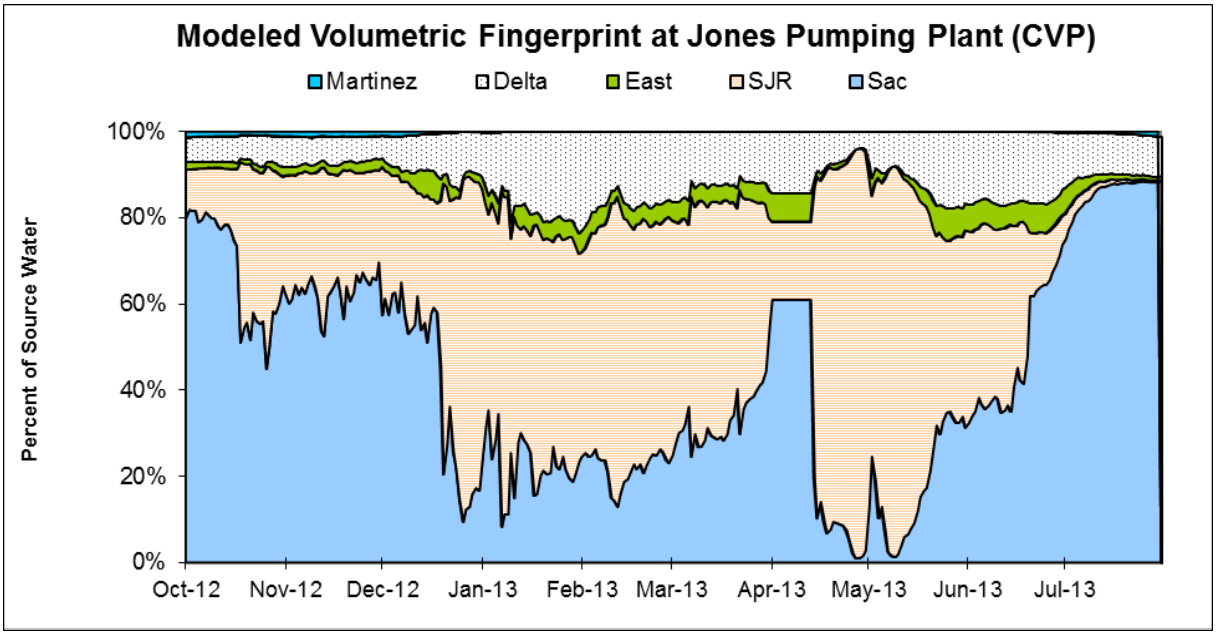


Figure 23. Modeled volumetric water fingerprint for the Jones Pumping Plant (CVP) as derived from DSM2, October 2012 through July 2013.



Delta fingerprint figures from DWR-Operations Control Office.

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Table 1. 2012/2013 non-clipped Chinook salmon genetic analysis results.

	SWP 2013	CVP 2013
No. Juvenile Chinook Observed	**624**	**1,989**
No. Juvenile Chinook DNA Sampled	**620**	**NA**
No. of DNA Samples Supplied by DFW CVTA	**581**	**42**
No. of Samples that Properly Amplified	**552**	**42**
No. of Length at Date Winter Run	**36**	**42**
No. of Length at Date Winter-Run Samples Supplied by DFW CVTA	**36**	**40**
No. of DNA Based Winter Run	**10**	**17**

Table 2. Hatchery (adipose fin clipped) Chinook salmon loss at the Delta fish facilities using the current loss equation (DFW 2013), October 2012 through June 2013.

Release Date	CWT Race	Hatchery	Release Site	Release Type	Confirmed Loss	Number Released[1]	Total Entering Delta	% Loss of Number Released[2]	% Loss of Total Entering Delta[3]	First Concern Level	Second Concern Level	Date of First Loss[4]	Date of Last Loss[4]
11/5/2012	F	Mokelumne River Hatchery	Mokelumne River	Production	599	92,020	n/a	0.651	n/a	n/a	n/a	12/5/2012	4/8/2013
11/29/2012	LF	Coleman NFH	Battle Creek	Production	4100	807,967	n/a	0.507	n/a	n/a	n/a	12/9/2012	4/21/2013
12/18/2012	LF	Coleman NFH	Battle Creek	Spring Surrogate	75	72,974	n/a	0.103	n/a	0.5%	1.0%	12/31/2012	3/23/2013
1/8/2013	LF	Coleman NFH	Battle Creek	Spring Surrogate	139	70,287	n/a	0.198	n/a	0.5%	1.0%	1/20/2013	3/27/2013
1/25/2013	LF	Coleman NFH	Battle Creek	Spring Surrogate	24	80,191	n/a	0.030	n/a	0.5%	1.0%	2/3/2013	3/31/2013
2/7/2013	W	Livingston Stone NFH	Caldwell Park	Production	9	169,967	96,525	0.005	0.009	0.5%	1.0%	3/25/2013	3/25/2013
4/9 to 4/18/2013	S	Feather River Hatchery	Boyd's Pump	Production	4	1,034,101	n/a	0.0004	n/a	n/a	n/a	4/30/2013	5/3/2013
4/10 to 4/11/2013	F	Coleman NFH	Battle Creek	Production	2	1,549,938	n/a	0.0001	n/a	n/a	n/a	5/2/2013	5/4/2013
4/17 to 4/18/2013	F	Mokelumne River Hatchery	Sherman Island Rd	Production	0	112,447	n/a	0.000	n/a	n/a	n/a	5/4/2013	5/4/2013

[1]Number released with the adipose fin clipped and a CWT.
[2]% Loss of Number Released = (Confirmed Loss/Number Released)*100.
[3]% Loss of Total Entering Delta= (Confirmed Loss/Total Entering Delta)*100.
[4]Date of first and last loss accounts for all CWT loss even those from special studies where salvage and loss=0.

Table 3. Unknown hatchery (adipose fin clipped) Chinook salmon loss at the Delta fish facilities using the current loss equation (DFW 2013), October 2012 through June 2013.

Facility	Unknown CWT Loss[1]	Acoustic Tag Loss[2]	Number of Unassigned CWTs[3]
SWP	54	18	2
CVP	5	0	0
TOTAL	**59**	**18**	**2**

[1]Adipose fin clipped Chinook was observed during fish count, but tag code could not be determined (e.g., damaged tag, lost tag, no tag, or Chinook accidentally released).
[2]Adipose fin clipped Chinook released due to presence of sutures.
[3]CWT cannot currently be assigned to a salvage record with certainty since the CWT was lost and then found. CWT may be assigned to a salvage record if new information is available.

Table 4. Adjusted cumulative percent loss of hatchery (adipose fin clipped) Chinook salmon loss at the Delta fish facilities to account for processing errors, October 2012 through June 2013.

Release Date	CWT Race	Release Type	Confirmed Loss	Proportion Confirmed F/LF Loss[1]	NON Confirmed Loss	New Total Loss[2]	Number Released[3]	Total Entering Delta	Adjusted % Loss of Number Released[4]	Adjusted % Loss of Total Entering Delta[5]
11/5/2012	F	Production	599.45	0.121	6.11	606	92,020	n/a	0.659	n/a
11/29/2012	LF	Production	4100.48	0.830	41.82	4142	807,967	n/a	0.513	n/a
12/18/2012	LF	Spring Surrogate	74.95	0.015	0.76	76	72,974	n/a	0.104	n/a
1/8/2013	LF	Spring Surrogate	138.7	0.028	1.41	140	70,287	n/a	0.199	n/a
1/25/2013	LF	Spring Surrogate	24.4	0.005	0.25	25	80,191	n/a	0.031	n/a
2/7/2013	W	Production	8.59	n/a	0.00	9	169,967	96,525	0.005	0.009

[1]Assigned a proportion of the unknown Chinook loss greater than the minimum winter-run length-date criteria using the Delta Model to a fall (F)/late-fall (LF) or winter-run Chinook salmon race category by comparing length-at-date of salvage for non-confirmed adipose fin clipped fish to data for confirmed (read tag) fish.
[2] The sum of the confirmed loss and the non-confirmed loss.
[3]Number released with the adipose fin clipped and a CWT.
[4]% Adjusted Loss of Number Released = (New Total Loss/Number Released)*100.
[5]% Adjusted Loss of Total Entering Delta= (New Total Loss/Total Entering Delta)*100.

Table 5. Monthly averages of hydrologic parameters in the Sacramento-San Joaquin River Delta, October 2012 through July 2013.

Month	SWP Average Exports cfs	CVP Average Exports cfs	Sacramento R. Average Flow cfs	San Joaquin R. Average Flow cfs	Delta Outflow Average Flow cfs	Q West Average Flow cfs
October	3,682	3,922	11,335	1,769	4,546	-1,151
November	3,007	3,930	11,912	1,275	5,882	-504
December	4,233	2,927	45,907	1,925	47,351	4,622
January	2,642	1,643	23,655	1,749	23,025	1,961
February	1,738	2,601	15,866	2,306	13,837	719
March	2,567	2,459	13,420	1,575	9,648	-1,214
April	1,300	455	12,329	2,193	13,048	2,936
May	891	1,037	11,015	2,324	9,977	1,852
June	1,897	782	12,983	753	7,666	877
July	5,134	3,658	17,096	577	5,271	-3,912

Table 6. Loss estimates with 95% confidence limits for non-clipped winter-run Chinook salmon under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011) and not corrected for autocorrelation, October 2011 through June 2012.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	4,462	2,597	1,164	2,780	531	385
lcl (normal)	843	1,196	928	639	350	259
ucl (normal)	8,081	3,998	1,400	4,921	712	511
lcl (log-normal)	2,047	1,529	951	1,323	379	278
ucl (log-normal)	9,727	4,410	1,425	5,842	745	532

Table 7. Loss estimates with 95% confidence limits for non-clipped winter-run Chinook salmon under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011) and corrected for autocorrelation, October 2011 through June 2012.

	CVP-w/autocorrelation		
Survival Rate	**Low**	**Medium**	**High**
S	0.14	0.46	0.54
SE(S)	0.047	0.043	0.043
Loss	2,780	531	385
lcl (normal)	615	338	250
ucl (normal)	4,945	724	520
lcl (log-normal)	1,312	370	272
ucl (log-normal)	5,888	762	545

Table 8. Loss estimates with 95% confidence limits for LSNFH winter-run Chinook salmon under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2011 through June 2012.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	46	27	12	*	*	*
lcl (normal)	-38	-19	-8	*	*	*
ucl (normal)	130	73	32	*	*	*
lcl (log-normal)	10	6	3	*	*	*
ucl (log-normal)	217	119	51	*	*	*

Table 9. Loss estimates with 95% confidence limits for the first spring-run Chinook salmon surrogate release group under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2011 through June 2012.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	*	*	*	22	4	3
lcl (normal)	*	*	*	-8	-1	-1
ucl (normal)	*	*	*	52	9	7
lcl (log-normal)	*	*	*	7	1	1
ucl (log-normal)	*	*	*	74	12	9

Table 10. Loss estimates with 95% confidence limits for the second spring-run Chinook salmon surrogate release group under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2011 through June 2012.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	115	67	30	68	13	9
lcl (normal)	-28	-6	1	-7	2	1
ucl (normal)	185	103	44	143	24	17
lcl (log-normal)	37	24	12	24	6	4
ucl (log-normal)	361	186	76	189	30	21

Table 11. Loss estimates with 95% confidence limits for the third spring-run Chinook salmon surrogate release group under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2011 through June 2012.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	242	141	63	55	11	8
lcl (normal)	-10	21	19	-15	0	0
ucl (normal)	494	261	107	125	22	16
lcl (log-normal)	91	62	32	17	4	3
ucl (log-normal)	643	319	124	177	29	21

Table 12. Loss estimates with 95% confidence limits for non-clipped steelhead under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2011 through July 2012.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.13	0.18	0.33	0.18	0.55	0.65
SE(S)	0.013	0.017	0.013	0.017	0.035	0.035
Loss	1,626	1,107	493	403	72	48
lcl (normal)	1,082	740	357	252	45	31
ucl (normal)	2,170	1,474	629	554	99	65
lcl (log-normal)	1,166	797	375	278	50	34
ucl (log-normal)	2,267	1,538	649	585	104	69

Table 13. Loss of non-clipped winter-run Chinook salmon using the current loss equation (DFW 2013), water years 2012 and 2013.

Facility	Total Loss, Water Year 2012	Total Loss, Water Year 2013
SWP	1,702	633
CVP	377	98
Combined	2,079	731

Table 14. Loss estimates with 95% confidence limits for non-clipped winter-run Chinook salmon under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2012 through June 2013.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	1,633	950	426	789	151	109
lcl (normal)	251	386	286	144	83	61
ucl (normal)	3,015	1,514	566	1,434	219	157
lcl (log-normal)	726	532	308	360	97	71
ucl (log-normal)	3,673	1,698	590	1,729	235	168

Table 15. Number of days where the combined daily older juvenile Chinook salmon loss was above the NMFS RPA Action IV.3 trigger threshold, November 2012 through December 2012.

Method	# of days daily loss above 95 fish and below 120 fish	# of days daily loss above 120 fish	Total
DFW	1	1	2
Jahn Low Survival	3	5	8
Jahn Medium Survival	2	2	4
Jahn High Survival	1	0	1

Table 16. Number of days where the combined daily older juvenile Chinook salmon loss density was above the NMFS RPA Action IV.3 trigger threshold, November 2012 through December 2012.

Method	# of days daily loss density above 8 fish/TAF and below 15 fish/TAF	# of days daily loss density above 15 fish/TAF	Total
DFW	0	0	0
Jahn Low Survival	1	2	3
Jahn Medium Survival	1	0	1
Jahn High Survival	0	0	0

Table 17. Number of days where the combined daily older juvenile Chinook salmon loss density was above the NMFS RPA Action IV.2.3 trigger threshold, January 2013 through June 2013.

Method	# of days daily loss density above 5.33 fish/TAF and below 10.66 fish/TAF	# of days daily loss density above 10.66 fish/TAF	Total
DFW	2	0	2
Jahn Low Survival	6	5	11
Jahn Medium Survival	5	0	5
Jahn High Survival	0	0	0

Table 18. Loss estimates with 95% confidence limits for LSNFH winter-run Chinook salmon under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2012 through June 2013.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	23	13	6	*	*	*
lcl (normal)	-18	-10	-4	*	*	*
ucl (normal)	64	36	16	*	*	*
lcl (log-normal)	5	3	1	*	*	*
ucl (log-normal)	106	58	25	*	*	*

Table 19. Loss estimates with 95% confidence limits for the first spring-run Chinook salmon surrogate release group under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2012 through June 2013.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	161	94	42	95	18	13
lcl (normal)	-20	4	7	-22	-1	-1
ucl (normal)	342	184	77	212	37	27
lcl (log-normal)	56	38	19	31	7	5
ucl (log-normal)	459	232	92	294	48	35

Table 20. Loss estimates with 95% confidence limits for the second spring-run Chinook salmon surrogate release group under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2012 through June 2013.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	288	167	75	189	36	26
lcl (normal)	15	44	34	14	13	10
ucl (normal)	561	290	116	364	59	42
lcl (log-normal)	117	82	44	78	19	14
ucl (log-normal)	707	340	128	455	67	48

Table 21. Loss estimates with 95% confidence limits for the third spring-run Chinook salmon surrogate release group under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011), October 2012 through June 2013.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.08	0.13	0.25	0.14	0.46	0.54
SE(S)	0.03	0.03	0	0.047	0.043	0.043
Loss	23	13	6	123	23	17
lcl (normal)	-19	-10	-4	-3	5	4
ucl (normal)	65	36	16	249	41	30
lcl (log-normal)	5	3	1	47	11	8
ucl (log-normal)	108	59	25	322	49	36

Table 22. Loss of non-clipped steelhead using the current loss equation (DFW 2013), water years 2012 and 2013.

Facility	Total Loss, Water Year 2012	Total Loss, Water Year 2013
SWP	1,052	2,042
CVP	611	221
Combined	1,113	2,263

Table 23. Loss estimates with 95% confidence limits for non-clipped steelhead under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011) and not corrected for autocorrelation, October 2012 through June 2013.

	SWP			CVP		
Survival Rate	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
S	0.13	0.18	0.33	0.18	0.55	0.65
SE(S)	0.013	0.017	0.013	0.017	0.035	0.035
Loss	3,155	2,148	957	1,484	266	175
lcl (normal)	2,245	1,536	750	1,043	189	125
ucl (normal)	4,065	2,760	1,164	1,925	343	225
lcl (log-normal)	2,368	1,618	771	1,104	200	132
ucl (log-normal)	4,203	2,851	1,188	1,995	355	232

Table 24. Loss estimates with 95% confidence limits for non-clipped steelhead under a range of loss parameter (S) estimates using the proposed loss equation (Jahn 2011) and corrected for autocorrelation, October 2012 through June 2013.

	SWP- w/autocorrelation		
Survival Rate	**Low**	**Medium**	**High**
S	0.13	0.18	0.33
SE(S)	0.013	0.017	0.013
Loss	3,155	2,148	957
lcl (normal)	2,211	1,513	736
ucl (normal)	4,099	2,783	1,178
lcl (log-normal)	2,343	1,601	760
ucl (log-normal)	4,248	2,882	1,205

Table 25. Number of days where the combined daily non-clipped steelhead loss was above the NMFS RPA Action IV.2.3 trigger threshold, January 2013 through June 2013.

Method	# of days daily loss above 8 fish/TAF threshold and below 12 fish/TAF threshold	# of days daily loss above 12 fish/TAF threshold	Total
DOSS	13	5	18
Jahn Low Survival	16	25	41
Jahn Medium Survival	8	11	19
Jahn High Survival	3	1	4

APPENDIX

Quantification of Fish Benefits from the Delta Division Reasonable and Prudent Alternative Actions during 2012/2013

September 27, 2013

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Quantification of Fish Benefits from the Delta Division Reasonable and Prudent Alternative Actions during 2012/2013

The Delta division reasonable and prudent alternative (RPA) actions found in the 2011 amendments of the 2009 NMFS Biological Opinion are intended to reduce the likelihood of diversion of winter-run Chinook salmon, spring-run Chinook salmon, Central Valley steelhead, and green sturgeon into the south and central Delta (NMFS 2011). Diversion into the south and central Delta could lead to a lower chance of survival due to higher risks in the region, such as predation and water diversion entrainment. In 2012/2013, the California Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation) took various actions to protect these species as required by the RPA actions. Some of these RPA actions include the following:

1) NMFS RPA Action IV.1.2: Manage Delta Cross Channel (DCC) gate operations to reduce mortality of juvenile salmonids and green sturgeon from October to June.
2) NMFS RPA Action IV.3: Manage exports at the State Water Project and Central Valley Project from November to December to protect juvenile salmonids and green sturgeon. This is done by curtailing exports when a large number of older juvenile Chinook salmon are migrating into the upper Delta region.
3) NMFS RPA Action IV.2.3: Manage Old and Middle River (OMR) flow in a more positive direction from January to June to reduce the likelihood of juvenile salmonids being diverted from the Sacramento River or San Joaquin River into the south and central Delta.

To quantify benefits from DCC gate closures, DWR and Reclamation looked at the proportion of the cumulative Knights Landing Catch Index and the Sacramento Catch Index during periods when DCC gates were closed (Table 1). In contrast, DWR and Reclamation compared weekly loss or loss density trends at the Delta fish facilities during the period when a trigger and action response occurred. This was done in an attempt to quantify benefits of export curtailments (Table 2) and OMR flow management (Table 3).

For the data analysis, DWR and Reclamation acquired data from the California Department of Fish and Wildlife (DFW), the United States Fish and Wildlife Service (USFWS), and other internal DWR and Reclamation divisions. At the time of the analysis, many of the agencies were still in the process of finalizing their data. Because of this, these results are subject to revision if the data used in the analysis changes.

Overall, the fish benefits that are quantified in Table 1 to 3 are not conclusive for various reasons. First off, it was difficult to quantify the benefits of export curtailments or from OMR flow management without looking at other environmental variables that could have influenced salvage. In the future, DWR and Reclamation should incorporate other ways to measure the impact of the RPA actions to strengthen the analysis. Lastly, DWR and Reclamation did not look at benefits in terms of the fish lost that might have occurred without the action response that was in place at the time. Nonetheless, the analysis presented in Table 1 to 3 provides a framework on how benefits could be quantified from DCC gate closures or export curtailment/OMR flow management.

References

[NMFS] National Marine Fisheries Service. 2011. RPA Amendments to the 2009 Biological Opinion and Conference Opinion on the Proposed Long-Term Operations of the Central Valley Project and State Water Project. Long Beach, California. Retrieved at http://swr.nmfs.noaa.gov/ocap/040711_OCAP_opinion_2011_amendments.pdf

Table 1. Potential Benefits to Fish Protection from DCC Gate Closures.

RPA Action	Action Trigger	Action Response	Potential Benefits to Fish Protection
IV.1.2	Exceedance of the Knights Landing Catch Index and the Sacramento Catch Index trigger of 5 fish/day on November 23, 2012.	Gate closure of DCC on November 27, 2012.	The proportion of the older juvenile Chinook salmon contributing to the October 2012 to June 2013 cumulative catch index from November 27 to November 30 was 1.24% for the Knights Landing Catch Index and 8.80% for the Sacramento Catch Index (beach seines). These Chinook salmon likely benefited from the DCC gate closure before the Action IV.1.2 calendar based closure on December 1, 2012. No trawl sampling occurred at Sherwood Harbor on the Sacramento River from November 27 to November 30, 2012. NOTE: Sacramento Catch Index (beach seines) trigger of 3 fish/day was exceeded on November 21, 2012, but the data were not received in time for decision-making.
IV.1.2	Calendar based.	Gate closure of DCC from December 1, 2012, to January 31, 2013.	The proportion of the older juvenile Chinook salmon contributing to the October 2012 to June 2013 cumulative catch index from December 1, 2012, to January 31, 2013, was 72.22% for the Knights Landing Catch Index, 81.45% for the Sacramento Catch Index (beach seines), and 36.90% for the Sacramento Catch Index (trawl). These Chinook salmon likely benefited from the DCC gate closure before the D-1641 calendar based closure on February 1, 2013. However, the benefits to fish protection cannot be fully evaluated since the Knights Landing rotary screw trap was only in operation from December 1 to December 15 during this action response period.

Table 2. Potential Benefits to Fish Protection from Export Curtailment.

RPA Action	Action Trigger	Action Response	Potential Benefits to Fish Protection**
IV.3	The first stage daily older juvenile Chinook salmon loss trigger of 95 fish/day exceeded on December 4, 2012.	Reduction to 6,000 cfs combined exports from December 8 to December 10, 2012.	The average daily older juvenile Chinook salmon loss during the week prior to exceeding the trigger was 0 fish/day (November 25 to December 1). The average daily loss during the week of exceeding the trigger was 22 fish/day (December 2 to 8). The average daily loss during the 3-day action response was 0 fish/day. Prior to the action response, the average daily loss was 27 fish/day from December 5 to December 7. This decrease in the daily average loss suggests the export reduction did reduce salvage risk. Non-salvage, indirect benefits of reduced exports are not quantifiable.
IV.3	The second stage daily older juvenile Chinook salmon loss trigger of 120 fish/day exceeded on December 18, 2012.	Due to more restrictive protections for delta smelt, the RPA Action IV.3 response of combined export reduction to 4,000 cfs was not implemented. NMFS credited the 3-day action response from December 19 to December 21, 2012.	The average daily older juvenile Chinook salmon loss during the week prior to exceeding the trigger was 19 fish/day (December 9 to 15). The average daily loss during the week of exceeding the trigger was 41 fish/day (December 16 to 22), which included the credited 3-day action response. The average daily loss during the credited 3-day action response was 22 fish/day. This decrease in the daily average loss suggests the export reduction did reduce salvage risk. Non-salvage, indirect benefits of reduced exports are not quantifiable.

**Average daily fish loss reported as a whole fish by rounding up.

Table 3. Potential Benefits to Fish Protection from OMR Flow Management.

RPA Action	Action Trigger	Action Response	Potential Benefits to Fish Protection**
IV.2.3	The first stage older juvenile Chinook salmon loss density trigger of 5.33 fish/TAF exceeded on March 9, 2013.	Exports already being operated within the first-stage action response where the 5-day average OMR flow was no more negative than 25% more negative than -3,500 cfs. Thus, no change in operations and the action response lasted from March 10 to March 15, 2013.	The average daily older juvenile Chinook salmon loss density during the week prior to exceeding the trigger was 0 fish/TAF (February 24 to March 2). The average daily loss during the week of exceeding the trigger was 1.76 fish/TAF (March 3 to 9), which does not include the action response. The average daily loss density during the 5-day action response was 1.68 fish/TAF. The slight decrease in average daily loss density suggests the export restriction provided some fish protection via salvage reduction. Non-salvage, indirect benefits of reduced exports are not quantifiable.
IV.2.3	The first stage steelhead loss trigger (8 fish/TAF * combined daily volume exported) exceeded on March 22, 2013.	Exports operated to the first-stage action response where the 5-day running average OMR flow was no more negative than 25% more negative than -3,500 cfs from March 23 to March 27, 2013. .	The average daily steelhead loss during the week prior to exceeding the trigger was 11 fish/day (March 10 to 16). The average daily loss during the week of exceeding the trigger was 54 fish/day (March 17 to 23), which included 1 day of the 5-day action response. The average daily loss during the 5-day action response was 54 fish/day. There was essentially no change in the average daily loss during the action response when compared to the average daily loss during the week of exceeding the trigger. This suggests the action response did not benefit fish protection via salvage reduction. Non-salvage, indirect benefits of reduced exports are not quantifiable.

**Average daily fish loss reported as a whole fish by rounding up.

RPA Action	Action Trigger	Action Response	Potential Benefits to Fish Protection**
IV.2.3	The first stage steelhead loss trigger (8 fish/TAF * combined daily volume exported) exceeded on April 1, 2013, and the second stage steelhead loss trigger (12 fish/TAF * combined daily volume exported) exceeded on April 2, 2013.	Exports were already operating to the 5-day running average OMR flow requirement of no more negative than 25% more negative than -3,500 cfs. Day 1 of the action response began on April 2, 2013. However, the second stage trigger was exceeded on April 2. Even so, exports were already operating to the 5-day running average OMR flow requirement of no more negative than 25% more negative than -2,500 cfs. The second stage action response lasted from April 3 to April 7, 2013. During this action response period, the daily older juvenile Chinook salmon loss density exceeded the first stage trigger of 5.33 fish/TAF on April 6. DWR and Reclamation continued to be restricted to the -3,500 cfs OMR flow requirement after April 7 since the first stage action response was not satisfied.	The average daily steelhead loss during the week prior to exceeding the trigger was 40 fish/day (March 24 to 30), which included four days of the action response for exceeding the first stage steelhead loss trigger on March 22, 2013. The average daily loss during the week of exceeding the trigger was 42 fish/day (March 31 to April 6), which included 4 days of the 5-day second stage action response. The average daily loss during the 5-day second stage action response was 33 fish/day. There was essentially no change in the average daily loss during the week of exceedance when compared to the average daily loss during the week prior to exceedance. However, the average loss during the 5-day action response was lower than the average daily loss during the week of exceedance. This suggests the action response did benefit fish protection via salvage reduction.
IV.2.3	The second stage steelhead loss trigger (12 fish/TAF * combined daily volume exported) exceeded on April 9, 2013.	Exports were already operating to the 5-day running average OMR flow requirement of no more negative than 25% more negative than -2,500 cfs. Thus, no change in operations and the second stage action response lasted from April 10 to April 14, 2013. After April 14, DWR and Reclamation continued to be restricted to the -3,500 OMR flow requirement until April 18, 2013, since the daily non-clipped steelhead loss was not below the first stage trigger for the last 3 consecutive days on April 14.	The average daily steelhead loss during the week prior to exceeding the trigger was 42 fish/day (March 31 to April 6), which included four days of the action response for exceeding the second stage steelhead loss trigger on April 2, 2013. The average daily loss during the week of exceeding the trigger was 35 fish/day (April 7 to 13), which included 4 days of the 5-day second stage action response. The average daily loss during the 5-day second stage action response was 25 fish/day, while the average daily loss during the 4-day first stage action response was 10 fish/day. The average daily loss during the 5-day second stage action response was lower than the average daily loss during the week of exceedance. This suggests the action response did benefit fish protection via salvage reduction.

**Average daily fish loss reported as a whole fish by rounding up.

RPA Action	Action Trigger	Action Response	Potential Benefits to Fish Protection**
IV.2.3	The first stage steelhead loss trigger (8 fish/TAF * combined daily volume exported) exceeded on April 25, 2013.	Exports were already operating to the 5-day running average OMR flow requirement of no more negative than 25% more negative than -3,500 cfs. Day 1 of the action response began on April 26, 2013, and lasted until April 30. On May 1, the second stage trigger was exceeded.	The average daily steelhead loss during the week prior to exceeding the trigger was 12 fish/day (April 14 to 20). On 5 of the 7 days from April 14 to 20, OMR flow restrictions that were more positive than -5,000 cfs were in place via RPA Action IV.2.3. The average daily loss during the week of exceeding the trigger was 19 fish/day (April 21 to 27), which included 2 days of the first stage action response. The average daily loss during the first stage action response that occurred from April 25 to April 30 was 25 fish/day. The higher average daily loss that occurred during the first stage action response when compared to the average daily loss during the week of exceedance suggests the action response may not have benefitted fish protection via salvage reduction.
IV.2.3	The second stage steelhead loss trigger (12 fish/TAF * combined daily volume exported) exceeded on May 1, 2013.	Exports were already operating to the 5-day running average OMR flow requirement of no more negative than 25% more negative than -2,500 cfs. Day 1 of the action response began on May 2 and lasted until May 9, 2013.	The average daily steelhead loss during the week prior to exceeding the trigger was 19 fish/day (April 21 to 27). The prior week included two days of the first stage action response for exceeding the steelhead loss trigger on April 25. The average daily loss during the week of exceeding the trigger was 47 fish/day (April 28 to May 4). OMR flow restrictions that were more positive than -5,000 cfs were in place via RPA Action IV.2.3 for all 7 days during the week. The average daily loss during the second stage action response that occurred from May 2 to May 9 was 19 fish/day. The average daily loss during the second stage action response was lower than the average daily loss during the week of exceedance. This suggests the action response did benefit fish protection via salvage reduction.
IV.2.3	The first stage steelhead loss trigger (8 fish/TAF * combined daily volume exported) exceeded on May 13, 2013.	Exports were already operating to the 5-day running average OMR flow requirement of no more negative than 25% more negative than -3,500 cfs. Day 1 of the action response began on May 14 and lasted until May 19, 2013.	The average daily steelhead loss during the week prior to exceeding the trigger was 8 fish/day (May 5 to 11). On 5 of the 7 days from May 5 to 11, OMR flow restrictions that were more positive than -5,000 cfs were in place via RPA Action IV.2.3. The average daily loss during the week of exceeding the trigger was 7 fish/day (May 12 to 18). OMR flow restrictions that were more positive than -5,000 cfs were in place via RPA Action IV.2.3 for 5 of the 7 days during the week of exceedance. The average daily loss during the first stage action response that occurred from May 14 to May 19 was 2 fish/day. The average daily loss during the first stage action response was lower than the average daily loss during the week of exceedance. This suggests the action response did benefit fish protection via salvage reduction.

**Average daily fish loss reported as a whole fish by rounding up.

Appendix B: Action IV.3 Text

Attachment 1

Clean Version of the Action IV.3 Text from the 2011 Amendments to the Reasonable and Prudent Alternative Revised to Include Clarifications.

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 because of 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: Either the Knights Landing Catch Index[1] or Sacramento Catch Index[2], based on catch of older juvenile Chinook[3], is greater than 10 fish per day from November 1 to February 28, or greater than 15 fish per day from March 1 to April 30.

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

[1]The Knights Landing Catch Index is based on reported catch of older juveniles at the Knights Landing rotary screw trapping location and is calculated as the total catch of older juveniles divided by the number of "trap days" (adjusted, as necessary, for downtime resulting from, for example, debris removal) since the last sampling event.

[2]Both the Sacramento trawl and Sacramento seine data are used to generate a Sacramento Catch Index (one for the seine data; one for the trawl data). The seine version of the catch index is standardized to eight hauls; therefore, the index is calculated as: (total number of older juveniles captured/# hauls)*8. The trawl version of the catch index is standardized to 10 tows; therefore, the index is calculated as: (total number of older juveniles captured/# tows)*10.

[3]Juvenile Chinook salmon at or above the minimum winter-run size based on the length-at-date model used at a particular sampling location, and below the maximum size considered by the length-at-date model, on a given sampling date, are considered "older juveniles".

Date	Action Triggers	Action Responses[4]
November 1 – December 31 First-Stage Trigger	(1) Daily SWP/CVP older juvenile Chinook salmon loss density is greater than 8 fish/thousand acre feet (TAF), or (2) daily losses of older juvenile Chinook salmon are greater than 95 fish per day, or (3) cumulative loss of Coleman National Fish Hatchery coded wire tagged late fall-run Chinook salmon (CNFH CWT LFR) spring-run Chinook salmon surrogates is greater than 0.5% for each individual release group[5], or (4) cumulative loss of Livingston Stone National Fish Hatchery CWT'd winter-run (LSNFH CWT WNT) is greater than 0.5% for the release group[5].	Reduce combined exports to no more than 6,000 cfs for 3 consecutive days. Export reductions are required when any one of the four criteria is met.
November 1 – December 31 Second-Stage Trigger (increasing level of concern)	(1) Daily SWP/CVP older juvenile Chinook salmon loss density is greater than 15 fish/TAF, or (2) daily loss is greater than 120 fish per day.	Reduce combined exports to no more than 4,000 cfs for 3 consecutive days. Export reductions are required when either of the two criteria is met.

Implementation procedures: A new action response is not required if the same or a less-restrictive trigger is exceeded on the first or second day of an action response, or during the allowed period between the trigger exceedance and the initiation of the action response. A new action response is required if a more-restrictive trigger is exceeded on the first or second day of an action response, or during the allowed period between the trigger exceedance and the initiation of the action response. If the daily SWP/CVP older juvenile loss density or daily loss exceeds any of the action triggers on the third day of an action response, a new action is triggered, and a new 3-day action response is required.

[4]The Projects may continue to operate to the old limit for a maximum of 2 additional days upon data verification from CDFW and a concurrence notification from NMFS to allow for power scheduling changes.

[5] The cumulative loss for each CNFH CWT LFR spring-run Chinook salmon surrogate or LSNFH CWT WNT release group can trigger an action only once (*i.e.* there is only one action response per release group exceedance).

From November 1 through December 31, these actions will be taken in coordination with the USFWS RPA for delta smelt and state-listed longfin smelt 2081 incidental take permit, and the most conservative operation for the protection of listed fish species shall be implemented.

From January 1 through April 30, implement Action IV.2.3, which includes restrictions on OMR flows rather than sets levels of combined export pumping. Alert triggers will remain in effect to notify 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 the real-time operation of the export facilities because the collection and dissemination of field data to the resource agencies and coordination of response actions might take several days. This action is designed to work in concert with the OMR action in IV.2.3.

Attachment 2

Track Changes Version of the Action IV.3 Text from the 2011 Amendments to the Reasonable and Prudent Alternative Revised to Include Clarifications.

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~~because of 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: Either t~~T~~he Knights Landing ~~c~~Catch I~~i~~ndex[1] or Sacramento Catch Index[2], based on catch of older juvenile Chinook[3], 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~~ loss numbers reach the action triggers, exports shall be reduced as follows:

[1]The Knights Landing Catch Index is based on reported catch of older juveniles at the Knights Landing rotary screw trapping location and is calculated as the total catch of older juveniles divided by the number of "trap days" (adjusted, as necessary, for downtime resulting from, for example, debris removal) since the last sampling event.

[2]Both the Sacramento trawl and Sacramento seine data are used to generate a Sacramento Catch Index (one for the seine data; one for the trawl data). The seine version of the catch index is standardized to eight hauls; therefore, the index is calculated as: (total number of older juveniles captured/# hauls)*8. The trawl version of the catch index is standardized to 10 tows; therefore, the index is calculated as: (total number of older juveniles captured/# tows)*10.

[3]Juvenile Chinook salmon at or above the minimum winter-run size based on the length-at-date model used at a particular sampling location, and below the maximum size considered by the length-at-date model, on a given sampling date, are considered "older juveniles".

Date	Action Triggers	Action Responses[4]
November 1 – December 31 First-Stage Trigger	(1) Daily SWP/CVP older juvenile Chinook salmon loss density is greater than 8 fish/thousand acre feet (TAF~~taf~~), or (2) daily losses of older juvenile Chinook salmon are ~~is~~ greater than 95 fish per day, or (3) cumulative loss of Coleman National Fish Hatchery coded wire tagged late fall-run Chinook salmon (CNFH CWT LFR) spring-run Chinook salmon surrogates is greater than 0.5% for each individual release group[5], or (4) cumulative loss of Livingston Stone National Fish Hatchery ~~coded wire tagge~~CWT'd winter-run (LSNFH CWT WNT) ~~cumulative loss~~ is greater than 0.5% for the release group[5].	Reduce combined exports to no more than~~a combined~~ 6,000 cfs for 3 consecutive 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.
November 1 – December 31 Second-Stage Trigger (increasing level of concern)	(1) Daily SWP/CVP older juvenile Chinook salmon loss density is greater than 15 fish/~~taf~~TAF, or (2) daily loss is greater than 120 fish per day. ~~or CNFH CWT LFR or LSNFH CWT WNT cumulative loss greater than 0.5%.~~	Reduce combined exports to ~~a combined~~no more than 4,000 cfs for 3 consecutive days. ~~or until CVP/SWP daily density is less than 8 fish/taf.~~ Export reductions are required when ~~any one~~either of the two~~four~~ criteria is met.

Implementation procedures: A new action response is not required if the same or a less-restrictive trigger is exceeded on the first or second day of an action response, or during the allowed period between the trigger exceedance and the initiation of the action response. A new action response is required if a more-restrictive trigger is exceeded on the first or second day of an action response, or during the allowed period between the trigger exceedance and the initiation of the action response. If the daily SWP/CVP older juvenile loss density or daily loss exceeds any of the action triggers on the third day of an action response, a new action is triggered, and a new 3-day action response is required.

[4] The Projects may continue to operate to the old limit for a maximum of 2 additional days upon data verification from CDFW and a concurrence notification from NMFS to allow for power scheduling changes.

[5] The cumulative loss for each CNFH CWT LFR spring-run Chinook salmon surrogate or LSNFH CWT WNT release group can trigger an action only once (*i.e.* there is only one action response per release group exceedance).

From November 1 through December 31, these actions will be taken in coordination with the USFWS RPA for delta smelt and state-listed longfin smelt 2081 incidental take permit, and the most conservative operation for the protection of listed fish species shall be implemented.

From January 1 through April 30, implement Action IV.2.3, which includes restrictions on OMR flows rather than sets 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 r~~R~~ivers 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 the 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~~ might take several days. This action is designed to work in concert with the OMR action in IV.2.3.

Appendix C: I:E Ratio 14-Day Running Average

Barbara Byrne - NOAA Federal <barbara.byrne@noaa.gov>

Calculation of the 14-day running average of the I:E ratio with instances of minimum combined exports of 1,500 cfs
1 message

Garwin Yip - NOAA Federal <garwin.yip@noaa.gov> Mon, Apr 1, 2013 at 4:07 PM
To: "Milligan, Ronald E" <RMilligan@usbr.gov>, "Leahigh, John@DWR" <John.Leahigh@water.ca.gov>
Cc: "Maria.rea@noaa.gov" <Maria.rea@noaa.gov>, womt@water.ca.gov

Ron and John,

I understand that DWR asked NMFS for clarification on how the 14-day running average of the San Joaquin Inflow:Export (I:E) ratio (under Action IV.2.1) should be implemented when, within the 14 days, Vernalis inflow is so low that the projects can't meet the required I:E ratio without going below the minimum combined "health & safety" export level of 1,500 cfs.

The minimum combined export level of 1,500 cfs is intended to allow the projects to meet the minimum demand for health and safety needs at all times (page 71 of the 2009 RPA with 2011 amendments). When calculating the 14-day running average of the I:E ratio, operating to the minimum combined export level of 1,500 cfs on a daily basis will be considered equivalent to operating to the target I:E ratio required under Action IV.2.1. The attached excel file shows a scenario similar to what we might observe this month (assuming implementation of a 1:1 I:E ratio) and may be useful in understanding the averaging process.

Page 31 of the 2011 DOSS annual report (http://swr.nmfs.noaa.gov/ocap/doss/DOSS_annual_report_2011.pdf) provides the formula for calculating the 14-day I:E average and also describes an appropriate format (as modeled in the attached Excel file) for reporting I:E during April and May.

-Garwin-

Garwin Yip
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NOAA FISHERIES

Action IV.2.1 reporting worksheet_H&S example.xlsx
12K

Date	Day of Implementation	Daily Vernalis flow (cfs)	SWP export (cfs)	CVP exports (cfs)	SWP + CVP exports (cfs)	Pumping at Health & Safety minimum?	Daily I:E ratio (actual)	Daily I:E ratio (operational equivalent)	Progressive daily (in gray) or 14-day (in red) I:E ratio	
1-Apr	1	1000	1500	0	1500	Y	1:1.5, or 0.7	1:1, or 1.0	1:1, or 1.0	
2-Apr	2	1000	1500	0	1500	Y	1:1.5, or 0.7	1:1, or 1.0	1:1, or 1.0	
3-Apr	3	1000	1500	0	1500	Y	1:1.5, or 0.7	1:1, or 1.0	1:1, or 1.0	
4-Apr	4	1000	1500	0	1500	Y	1:1.5, or 0.7	1:1, or 1.0	1:1, or 1.0	
5-Apr	5	1000	1500	0	1500	Y	1:1.5, or 0.7	1:1, or 1.0	1:1, or 1.0	
6-Apr	6	1000	1500	0	1500	Y	1:1.5, or 0.7	1:1, or 1.0	1:1, or 1.0	
7-Apr	7	1000	1500	0	1500	Y	1:1.5, or 0.7	1:1, or 1.0	1:1, or 1.0	
8-Apr	8	2000	2000	0	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
9-Apr	9	2000	2000	0	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
10-Apr	10	2000	2000	0	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
11-Apr	11	2000	2000	0	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
12-Apr	12	2000	2000	0	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
13-Apr	13	2000	2000	0	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
14-Apr	14	2000	2000	0	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
15-Apr	15	2000	1000	1000	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
16-Apr	16	2000	1000	1000	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
17-Apr	17	2000	1000	1000	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
18-Apr	18	2000	1000	1000	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
19-Apr	19	2000	1000	1000	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
20-Apr	20	2000	1000	1000	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	
21-Apr	21	2000	1000	1000	2000	N	1:1, or 1.0	1:1, or 1.0	1:1, or 1.0	

Appendix D: Steelhead Loss-Density Table

Steelhead - Daily Summary Table

California Department of Fish and Game - Results Subject to Revision

Prepared by Geir Aasen *Report Date:* 6/4/2013 *Report Time:* 12:47 PM

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT							
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED				
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	LENGTH (FL mm)	LOSS DENSITY
11/23/12	1	4	17.32										301	0.99
12/6/12							1	1	0.68				236	0.03
12/12/12	1	4	17.32										218	0.79
12/18/12							1	4	2.72				243	0.12
12/29/12	2	8	34.64				1	4	2.72				199 - 225	4.88
12/30/12							1	4	2.72				220	0.36
1/13/13							1	4	2.72				308	0.22
1/19/13	1	4	17.32										250	1.76
1/21/13	1	2	8.66										234	0.95
1/22/13							1	4	2.72				213	0.30
1/25/13							1	4	2.72				226	0.48
1/26/13				3	12	51.96							243 - 297	
1/27/13										3	10	6.8	217 - 235	
1/28/13							1	4	2.72				196	0.48
1/29/13				1	4	17.32				2	8	5.44	217 - 245	
1/30/13										2	8	5.44	230 - 259	
1/31/13										1	4	2.72	250	
2/2/13	2	8	34.64							1	3	2.04	145 - 222	4.47
2/3/13	1	4	17.32							3	12	8.16	236 - 270	2.39
2/4/13				1	4	17.32				1	2.5	1.70	214 - 235	
2/5/13							1	4	2.72	1	2	1.36	235 - 268	0.35
2/6/13	1	4	17.32										251	2.24
2/7/13							1	4	2.72	3	12	8.16	215 - 252	0.35
2/11/13							1	4	2.72				239	0.48
2/12/13							1	2.5	1.70				235	0.33
2/18/13	1	4	17.32										227	2.25
2/19/13				1	4	17.32							242	
2/20/13				2	8	34.64				1	4	2.72	241 - 265	
2/21/13	1	2	8.66	1	4	17.32							208 - 231	0.82
2/22/13				1	4	17.32							231	
2/24/13				2	6	25.98				2	8	5.44	221 - 230	
2/25/13				1	2	8.66	1	2.5	1.7	1	4	2.72	252 - 272	0.13
2/26/13				2	2	8.66							215 - 217	
2/27/13										4	16	10.88	188 - 246	
2/28/13										3	10.5	7.14	233 - 240	
3/1/13										1	4	2.72	242	
3/2/13				1	4	17.32							208	
3/3/13										3	12	8.16	200 - 247	
3/4/13				2	4	17.32	1	4	2.72				214 - 255	0.23
3/5/13				3	5	21.65				3	12	8.16	224 - 260	
3/6/13				2	4	17.32				1	4	2.72	208 - 229	
3/7/13				4	16	69.28				2	8	5.44	203 - 252	
3/8/13				1	2	8.66				1	4	2.72	201 - 219	
3/9/13	1	4	17.32	1	4	17.32							204 - 251	1.60
3/10/13	3	12	51.96										183 - 256	4.79
3/11/13	1	4	17.32	1	2	8.66				1	4	2.72	201 - 283	1.69
3/12/13							1	4	2.72				239	0.27
3/16/13				1	4	17.32							249	
3/17/13				2	6	25.98							291 - 301	
3/18/13	1	2	8.66	3	12	51.96	2	8	5.44	3	12	8.16	197 - 287	1.56
3/19/13	4	5	21.65	4	7	30.31							196 - 272	2.35
3/20/13	2	12.5	54.13	4	8	34.64	1	4	2.72	2	8	5.44	249 - 315	6.22
3/21/13	2	8	34.64				9	33	22.44				193 - 274	4.87
3/22/13	8	28	121.24	6	22	95.26	4	16	10.88	5	20	13.60	185 - 293	10.64
3/23/13	11	22	95.26	2	4	17.32				1	4	2.72	160 - 303	9.57

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT							
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED				
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	LENGTH (FL mm)	LOSS DENSITY
3/24/13	2	4	17.32				4	15	9.97	5	18	12.24	210 - 272	2.44
3/25/13	5	14	60.62	2	4	17.32	1	4	2.72	1	4	2.72	211 - 261	6.27
3/26/13	2	2	8.66	1	4	17.32	4	16	10.88	9	33	22.44	212 - 255	2.12
3/27/13	2	8	34.64	2	4	17.32	10	37	25.16	1	4	2.72	206 - 310	6.68
3/28/13	1	4	17.32	1	2	8.66	3	11	7.48	2	8	5.44	189 - 250	2.27
3/29/13	4	12	51.96				2	8	5.44	2	8	5.44	240 - 305	5.30
3/30/13	2	6	25.98	2	6	25.98							141 - 358	2.43
3/31/13	5	12	51.96				4	15	10.20	5	18	12.24	189 - 294	5.85
4/1/13	3	6	25.98							2	8	5.44	201 - 257	8.30
4/2/13	4	13	56.29	5	8	34.64			NS			NS	201 - 286	19.33
4/3/13	1	2	8.66	4	12	51.96			NS			NS	242 - 267	2.97
4/4/13	5	16	69.28	8	20	86.6			NS			NS	222 - 294	24.09
4/5/13	2	8	34.64	2	6	25.98			NS			NS	222 - 239	11.98
4/6/13	2	8	34.64	1	4	17.32			NS			NS	237 - 282	11.98
4/7/13	1	4	17.32	4	10	43.30			NS			NS	227 - 291	5.99
4/8/13	2	6	25.98						NS			NS	204 - 220	8.99
4/9/13	3	18	77.94	6	54	233.82			NS			NS	193 - 283	30.73
4/10/13	1	4	17.32	7	28	121.24			NS			NS	200 - 423	5.80
4/11/13	2	8	34.64						NS			NS	232 - 235	11.61
4/12/13	2	8	34.64	1	4	17.32			NS			NS	232 - 260	11.61
4/13/13	2	8	34.64						NS			NS	242 - 271	11.61
4/15/13	2	6	25.98				3	10	6.80				201 - 447	11.11
4/16/13				1	4	17.32							238	
4/17/13				1	4	17.32	1	4	2.72	1	3	2.04	219 - 241	0.92
4/18/13							1	4	2.72	1	4	2.72	240 - 245	0.91
4/19/13	1	4	17.32							1	4	2.72	277 - 330	4.30
4/20/13	2	6	25.98										236 - 291	6.66
4/22/13	1	4	17.32	1	4	17.32							221 - 232	3.77
4/23/13	4	4	17.32	1	1	4.33							211 - 370	3.37
4/24/13	1	4	17.32							1	4	2.72	203 - 216	3.75
4/25/13	2	8	34.64										230 - 257	10.73
4/26/13	1	4	17.32				2	8	5.44				190 - 272	6.71
4/27/13	1	4	17.32				1	4	2.72				271 - 300	5.94
4/28/13							1	4	2.72				192	0.76
4/29/13	2	4	17.32				3	12	8.16				121 - 403	5.14
4/30/13	6	12	51.96										210 - 271	8.28
5/1/13	6	35	151.55	3	20	86.60							220 - 349	18.67
5/2/13	2	8	34.64	1	4	17.32	1	4	2.72				223 - 425	4.40
5/3/13	1	4	17.32										270	2.12
5/4/13	3	8	34.64	3	12	51.96	1	3	2.04				228 - 386	6.15
5/6/13	3	12	51.96										243 - 395	16.60
5/9/13							1	4	2.72				382	1.23
5/13/13	2	8	34.64				1	4	2.72				236 - 332	9.05
5/14/13							2	8	5.44	1	4	2.72	192 - 262	1.37
5/19/13				2	8	34.64	1	4	2.72				191 - 223	0.89
5/20/13				2	8	34.64							226 - 525	
5/22/13							3	12	8.16				198 - 235	2.73
5/23/13							1	4	2.72				219	1.16
5/27/13							2	8	5.44				229 - 338	1.76
5/31/13							2	8	5.44				211 - 241	1.77
6/1/13	2	8	34.64										346 - 398	7.64
6/2/13	1	4	17.32										213	3.81
6/3/13	1	4	17.32										276	3.81
6/17/13										1	4	2.72	296	
6/19/13	1	4	17.32										279	4.57
7/2/13	1	4	17.32										281	0.89
7/4/13				1	4	17.32							247	

Non-clipped = adipose fin present; Clipped = adipose fin removed

State Water Project loss = salvage x 4.33; Central Valley Project loss = salvage x 0.68

Steelhead Loss Density = daily combined (SWP+CVP) losses of non adipose clipped steelhead /1000AF (SWP+CVP exports)

NS: CVP ceased water exports and salvage operations at 0600 on 4/1/2013 due to a scheduled installation of a new hoist trolley beam in the fish holding tank building. CVP will resume exports and salvage at 0800 on 4/15/2013.

Appendix E: Salmon Loss-Density Table

Chinook Salmon - Daily Summary Table

California Department of Fish and Wildlife - Results Subject to Revision

Prepared by Geir Aasen *Report Date:* 6/3/2013 *Report Time:* 1:41 PM

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT									
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED			LENGTH	RACE*		OLDER JUV LOSS
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	(FL mm)	SIZE	CWT	DENSITY
11/8/12							1	4	2.60				311	U		
11/29/12							1	4	2.60				325	U		
12/3/12	3	10	45.63										139 - 148	LF		2.11
12/4/12	6	21	95.92				3	12	7.80				119 - 183	W,F,LF		4.71
12/5/12										1	4	2.60	150	LF	F	
12/6/12							3	3	1.95	2	5	3.25	141 - 183	F,LF	F	0.09
12/7/12				2	8	36.40							167 - 184	F,LF	F***	
12/9/12				3	10	45.84							133 - 166	LF	F,LF	
12/10/12				2	6	27.35							160 - 191	F,LF	F,LF	
12/11/12				4	6	26.62				4	16	10.99	146 - 197	F,LF	F,LF	
12/12/12	2	10	45.92	16	73	330.21				2	8	5.21	142 - 202	F,LF	F,LF	2.10
12/13/12	1	3	13.18	14	47	208.73	2	8	5.20	5	20	13.00	110 - 196	W,LF	F,LF	0.84
12/14/12				11	54	240.25				6	19	12.36	147 - 219	F,LF	F,LF	
12/15/12	4	15	66.30	25	91	401.03				2	7	4.55	129 - 200	W,F,LF	F,LF	3.05
12/16/12	2	12	52.11	35	182	809.88				4	14	9.11	115 - 215	W,F,LF	F,LF	2.29
12/17/12	1	4	18.19	20	136	623.28	3	12	7.53	10	30	19.50	60 - 192	W,F,LF	F,LF	1.16
12/18/12	3****	28	129.55	28	220	1007.58	6	18	12.88	69	82	53.30	113 - 222	W,LF	F,LF	6.36
12/19/12	2	14	63.36	9	88	400.42	1	4	2.60	7	16	10.64	113 - 193	W,LF,F	F,LF	7.11
12/20/12				5	16	72.39				1	4	3.88	148 - 212	F,LF	LF	
12/21/12				6	16	77.88							165 - 205	F,LF	F,LF	
12/22/12										1	4	3.88	177	LF	LF	
12/23/12										2	8	7.76	157 - 167	LF	F,LF	
12/25/12										1	4	3.88	186	LF	LF	
12/26/12										1	3	2.59	192	LF	LF	
12/27/12				4	10	44.90							160 - 192	LF	LF	
12/28/12				1	4	18.01							185	LF	LF	
12/29/12				1	4	17.93				1	4	3.52	175 - 180	LF	LF	
12/30/12				1	4	17.91							157	LF	LF	
12/31/12				1	4	17.88				1	4	3.52	163 - 204	LF,F	LF	
1/1/13										2	8	7.04	140 - 211	F,W	LF	

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT									OLDER JUV LOSS
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED			LENGTH	RACE*		
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	(FL mm)	SIZE	CWT	DENSITY
1/2/13							1	4	3.19	1	2	1.59	134 - 167	LF,W	LF	0.29
1/3/13										3	7.5	5.97	149 - 200	LF,W	LF	
1/7/13										1	4	3.19	142	W	LF	
1/17/13	1	4	18.19	1	4	18.21							153 - 155	W	F	1.97
1/18/13	1	4	18.14										145	W		1.86
1/19/13				3	12	54.73							153 - 185	LF,W	LF	
1/20/13				5	14	63.63							125 - 189	LF,W	F,LF	
1/22/13	1	2	9.05	2	6	27.30				1	2.8	2.75	119 - 173	W	LF	0.99
1/23/13	1	4	18.07	1	2	9.07							149 - 167	W	LF	2.42
1/24/13				1	4	18.35				1	4	3.88	172 - 200	W,LF	LF	
1/25/13										1	4	3.29	147	W	LF	
1/27/13										1	4	3.29	176	W	LF	
1/28/13				2	4	18.11							155 - 168	W	LF	
1/30/13										1	4	3.29	215	LF	LF	
1/31/13										1	4	3.29	184	W	LF	
2/2/13				1	4	18.18							190	W	LF	
2/3/13										1	4	2.88	184	W	LF	
2/6/13							1	2.5	1.80	1	4	2.88	181 - 198	W	LF	0.23
2/7/13							1	2	1.44				180	W		0.18
2/8/13							1	4	3.19				167	W		0.40
2/13/13							2	7	4.84	1	4	3.19	36 - 187	F,W	LF	
2/14/13										1	4	3.19	149	W	LF	
2/19/13				2	2	8.66							175*****	W	LF	
2/21/13							1	2.5	1.73				37	F		
2/25/13	2	6	24 .82										35 - 43	F		
3/5/13				1	1	4.33	4	16	12.75				110 - 212	W	LF	1.14
3/6/13	1	2	8.88										132	W		0.79
3/7/13	3	10	43.64				1	4.0	3.19				110 - 148	W		4.20
3/9/13	3	12	54.39				4	16	12.75				46 - 163	F,W		6.21
3/10/13	3	12	54.34				1	4	3.19				111 - 136	W		5.30
3/11/13	1	2	8.52										53	F		
3/12/13	1	2	9.05										113	W		0.89
3/13/13	1	4	17.93										163	W		2.78
3/14/13				2	8	35.87	1	4	3.52				207 - 249	W	******	0.56
3/15/13							1	4	3.52				118	W		0.55
3/17/13							1	4	3.01				86	S		
3/18/13							1	4	3.01				63	F		
3/19/13	2	4	16.77										121 - 132	W		1.82
3/20/13	2	8	32.79	1	4	18.20							66 - 216	F,W	***	1.84
3/21/13	1	2	9.21				6	20	12.74	1	4	2.60	92 - 213	S,W	LF	1.67

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT									OLDER JUV LOSS
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED			LENGTH	RACE*		
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	(FL mm)	SIZE	CWT	DENSITY
3/22/13	1	4	16.29				5	20	14.66				53 - 222	F,S,W		0.51
3/23/13	2	4	16.48	1	4	16.75	2	8	5.95				61 - 170	F,S,W	LF	0.85
3/24/13	4	16	65.15				8	32	22.95				52 - 171	F,S,W		0.57
3/25/13	4	12	50.46	1	2	8.59	4	12	9.14				67 - 240	F,S,W	W	4.01
3/26/13	1	4	17.93				3	11	7.6				68 - 113	F,S,W		1.95
3/27/13	7	18	76.61				5	12	9.14	2	8	6.37	72 - 202	S,W	LF	0.36
3/28/13	3	10	43.97				5	10	6.909				64 - 135	F,S,W		2.47
3/29/13	4	14	59.53										72 - 134	S,W		0.82
3/30/13	5	14	59.45				1	4	2.76				74 - 86	S		
3/31/13	2	8	34.01	1	2	9.07	1	4	2.76				76 - 160	S,W	LF	
4/1/13							5	12	8.71				69 - 138	F,S.W		1.02
4/2/13	8	8	34.66						NS			NS	63 - 84	F,S		
4/3/13	2	8	33.92						NS			NS	88 - 93	S		
4/4/13	5	14	61.78						NS			NS	72 - 101	F,S		
4/5/13	3	10	41.52						NS			NS	75 - 79	S		
4/6/13	5	18	75.45						NS			NS	74 - 175	F,S,W		6.04
4/7/13	8	26	109.24						NS			NS	75 - 88	F,S		
4/8/13	21	72	296.92	1	2	8.77			NS			NS	67 - 204	F,S,W	F	
4/9/13	2	4	18.29						NS			NS	75 - 81	F,S		
4/10/13	9	36	164.66						NS			NS	74 - 97	F,S		
4/11/13	2	8	36.61						NS			NS	82 - 85	S		
4/12/13	2	8	36.57						NS			NS	78 - 84	F,S		
4/14/13	2	8	36.56						NS			NS	86 - 90	S		
4/15/13	5	20	84.72				12	48	39.22				69 - 93	F,S		
4/16/13	4	7	29.94				17	68	55.56				71 - 88	F,S		
4/17/13	3	12	51.77				16	56	45.75				72 - 111	F,S		
4/18/13	1	4	16.92				9	28	23.17				71 - 84	F,S		
4/19/13	2	8	35.177				14	48	39.22				69 - 86	F,S		
4/20/13	19	68	288.45				9	28	22.88				69 - 95	F,S		
4/21/13	2	8	36.53	1	4	19.72	20	72	58.82				69 - 225	F,S,W	LF	
4/22/13	7	28	128.05				51	196	160.13				69 - 90	F,S		
4/23/13	14	29	124.77				51	196	160.13				67 - 106	F,S		
4/24/13	8	32	146.01				13	44	35.95				72 - 87	F,S		
4/25/13	7	28	127.8				40	160	130.7				61 - 95	F,S		
4/26/13							35	132	107.8				68 - 94	F,S		
4/27/13							21	80	65.98				73 - 107	F,S		
4/28/13	7	20	84.65				25	92	75.16				71 - 92	F,S		
4/29/13	24	88	369.94	1	2	8.42	18	64	52.29				70 - 97	F,S	S	
4/30/13	71	157	668.59	1	1	4.33	6	16	13.07				73 - 97	F,S	S	
5/1/13	39	224	937.93				6	14	11.44				76 - 99	F,S		

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT									OLDER JUV LOSS DENSITY
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED			LENGTH	RACE*		
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	(FL mm)	SIZE	CWT	
5/2/13	39	224	937.93				132	490	295.40	1	4	2.33	71 - 147	F,S	F	
5/3/13	6	20	95.81				97	354	236.68				72 - 103	F,S		
5/4/13	20	60	252.57				23	84	61.57				73 - 106	F,S		
5/5/13	5	12	50.85				77	24	19.61				70 - 99	F,S		
5/6/13	1	4	16.72				18	64	52.29				78 - 96	F,S		
5/7/13							7	20	16.34				80 - 93	F,S		
5/8/13							13	43	34.86				82 - 95	F,S		
5/9/13							0	0	0.00				76 - 96	F,S		
5/10/13	17	68	292.78				11	34	27.78				75 - 107	F,S		
5/11/13	14	56	239.31				1	4	3.27				62 - 100	F,S		
5/12/13	11	44	187.67				15	52	42.49				76 - 98	F,S		
5/13/13	24	94	401.90				11	44	35.95				70 - 101	F,S		
5/14/13	10	28	119.11				11	36	29.41				76 - 121	F,S		
5/15/13	11	44	203.35				13	44	36.56				77 - 103	F,S		
5/16/13	1	1	4.33				0	0	0.00				78 - 93	F		
5/17/13	6	12	57.82				19	68	56.17				80 - 101	F,S		
5/18/13	11	44	213.81				41	156	127.45				80 - 104	F,S		
5/19/13	17	56	271.62				26	96	78.43				77 - 103	F,S		
5/20/13	21	78	381.23				10	32	26.14				83 - 106	F,S		
5/21/13	13	18	82.82				21	76	62.71				76 - 101	F		
5/22/13	14	42	204.82				9	26	21.24				80 - 96	F		
5/23/13	13	52	256.38				9	28	22.88				80 - 97	F		
5/24/13	8	32	158.05				18	64	52.29				84 - 97	F		
5/25/13	7	20	99.11				7	20	16.34				80 - 110	F,S		
5/26/13							7	20	16.34				79 - 97	F		
5/27/13	1	4	19.77				8	23	18.79				80 - 90	F		
5/28/13	11	19	88.61				5	12	9.80				78 - 101	F		
5/29/13							8	23	18.79				81 - 90	F		
5/30/13							4	8	6.54				91 - 92	F		
5/31/13	3	10	49.04										85 - 91	F		
6/1/13							1	4	3.27				76	F		
6/2/13	2	4	19.34										82 - 104	F		

Non-clipped = adipose fin present; Clipped = adipose fin removed; Race: S = spring run, F = fall run,LF = late fall run, W = winter run

U = Unknown race; fish was larger than any established race by length of the fish at date criteria (> 300 mm).

**Race of clipped (hatchery) salmon reported in this report is determined by length of the fish at date criteria on date of salvage. Actual race determination will be determined from the coded wire tag data once the tag has been read (if available).*

SIZE = race determined by fish length at date of salvage criteria; CWT = hatchery fish race from coded wired tag information

Older Juvenile Loss Density = daily combined (SWP+CVP) losses of older non-clipped juveniles /1000AF (SWP+CVP exports)

**One or more CWT tags has been read and code is currently being researched for hatchery and race

Appendix F: Operations Summary Tables

Data and controlling factors summarized in this table are preliminary and subject to change.

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
10/1/2012	B	4,356	3,494	O				D-1641 Delta Outflow (4,000 cfs)
10/2/2012	B	4,286	3,495	O				
10/3/2012	B	4,285	3,488	O				
10/4/2012	B	4,267	3,491	O				
10/5/2012	B	4,276	3,993	O				
10/6/2012	B	4,272	4,996	O				
10/7/2012	B	4,267	4,994	O				
10/8/2012	B	4,260	4,990	O				
10/9/2012	B	4,309	5,499	O				
10/10/2012	B	4,404	5,489	O				
10/11/2012	B	4,412	5,492	O				
10/12/2012	B	4,402	4,994	O				
10/13/2012	B	4,398	3,990	O				
10/14/2012	B	4,404	2,997	O				
10/15/2012	B	4,409	2,498	O				
10/16/2012	B	4,422	2,483	O				
10/17/2012	B	4,426	1,996	O				
10/18/2012	B	4,425	1,999	O				
10/19/2012	B	3,794	1,995	O				
10/20/2012	B	3,486	1,994	O				
10/21/2012	B	3,501	1,993	O				
10/22/2012	B	3,454	1,996	O				
10/23/2012	B	3,529	1,993	O				
10/24/2012	B	3,519	2,499	O				
10/25/2012	B	3,519	3,499	O				
10/26/2012	B	3,508	6,486	O				
10/27/2012	B	3,254	6,674	O				
10/28/2012	B	1,419	6,673	O				
10/29/2012	B	3,431	3,590	O				
10/30/2012	B	3,505	2,717	O				
10/31/2012	B	3,381	2,988	O				

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
11/1/2012	B	3,532	2,480	O				
11/2/2012	B	3,983	1,996	O				D-1641 Delta Outflow (4,500 cfs)
11/3/2012	B	4,197	1,997	O				
11/4/2012	B	4,392	1,997	O				
11/5/2012	B	4,217	1,993	O				
11/6/2012	B	4,218	1,991	O				
11/7/2012	B	4,229	1,992	O				
11/8/2012	B	4,229	1,992	O				
11/9/2012	B	4,229	1,989	O				
11/10/2012	B	4,224	1,499	O				
11/11/2012	B	4,212	1,493	O				
11/12/2012	B	4,205	1,496	O				
11/13/2012	B	1,752	1,481	O				
11/14/2012	B	1,423	1,493	O				
11/15/2012	B	3,554	1,492	O				
11/16/2012	B	3,548	1,490	O				
11/17/2012	B	3,527	1,491	O				
11/18/2012	B	3,546	1,499	O				
11/19/2012	B	3,521	5,996	O				
11/20/2012	B	3,519	5,997	O				D-1641 E/I Ratio
11/21/2012	B	4,146	4,997	O				
11/22/2012	B	4,383	4,997	O				
11/23/2012	B	4,379	4,491	O				
11/24/2012	B	4,378	3,995	O				
11/25/2012	B	4,385	3,998	O				
11/26/2012	B	4,393	3,992	O				
11/27/2012	B	4,398	4,492	C				DCC Gate Closure Action IV.1.2
11/28/2012	B	4,413	4,986	C				
11/29/2012	B	4,371	5,488	C				
11/30/2012	B	4,393	5,495	C				

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
12/1/2012	E	4,411	6,490	C				Excess Conditions Declared
12/2/2012	E	4,319	6,677	C				
12/3/2012	E	4,399	6,668	C				
12/4/2012	E	4,377	6,676	C				
12/5/2012	E	4,383	6,676	C				
12/6/2012	E	4,375	6,670	C				
12/7/2012	E	4,369	6,551	C				
12/8/2012	E	3,302	2,695	C				NMFS BO Action IV.3
12/9/2012	E	2,802	3,196	C				
12/10/2012	E	2,758	3,194	C				
12/11/2012	E	3,904	6,673	C				No Controlling ESA constraints
12/12/2012	E	4,417	6,671	C				
12/13/2012	E	4,413	6,671	C				
12/14/2012	E	4,421	6,680	C				
12/15/2012	E	4,368	6,676	C				
12/16/2012	E	4,361	7,090	C				
12/17/2012	E	4,357	7,091	C				
12/18/2012	E	4,231	7,093	C				
12/19/2012	E	2,388	1,488	C				Smelt BO OMR -2,000 cfs
12/20/2012	E	983	1,498	C				
12/21/2012	E	985	1,493	C				
12/22/2012	E	871	698	C				
12/23/2012	E	817	697	C	-2480			
12/24/2012	E	911	1,492	C	-1592			
12/25/2012	E	986	1,490	C	-1253			
12/26/2012	E	991	1,990	C	-873			
12/27/2012	E	1,307	1,878	C	-308			
12/28/2012	E	1,644	1,996	C	-515			
12/29/2012	E	1,656	1,986	C	-642			
12/30/2012	E	1,635	1,996	C	-726			
12/31/2012	E	1,586	1,992	C	-566			

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
1/1/2013	E	1,603	1,998	C	-755	-1271	-2044	
1/2/2013	E	2,479	2,410	C	-677	-956	-2082	
1/3/2013	E	2,803	2,992	C	-701	-903	-2278	
1/4/2013	E	1,984	1,997	C	-767	-752	-2358	
1/5/2013	E	1,637	1,996	C	-1111	-749	-2478	**Smelt BO OMR -3,500 cfs**
1/6/2013	E	2,475	1,554	C	-1562	-943	-2627	
1/7/2013	E	2,812	2,315	C	-2101	-1138	-2793	
1/8/2013	E	698	3,358	C	-2435	-1325	-2892	
1/9/2013	E	0	3,837	C	-2721	-1412	-2979	
1/10/2013	E	0	4,368	C	-2766	-1626	-3105	
1/11/2013	E	480	4,079	C	-2552	-1671	-3193	
1/12/2013	E	1,957	3,991	C	-2519	-1809	-3386	
1/13/2013	E	2,502	3,494	C	-2777	-2057	-3587	
1/14/2013	E	2,712	2,499	C	-2910	-2249	-3735	
1/15/2013	E	2,743	2,490	C	-3069	-2453	-3857	
1/16/2013	E	2,101	2,999	C	-3424	-2652	-3879	
1/17/2013	E	983	3,494	C	-3435	-2785	-3795	
1/18/2013	E	982	3,997	C	-3188	-2922	-3861	
1/19/2013	E	983	3,990	C	-3357	-3052	-3948	
1/20/2013	E	986	3,499	C	-3498	-3144	-3978	
1/21/2013	E	986	3,497	C	-3531	-3163	-3937	
1/22/2013	E	987	3,497	C	-3587	-3197	-3971	
1/23/2013	E	989	3,491	C	-3713	-3276	-4027	
1/24/2013	E	1,664	2,491	C	-3405	-3280	-4029	
1/25/2013	E	1,730	993	C	-3026	-3313	-3923	**Smelt BO OMR -2,500 cfs**
1/26/2013	E	1,969	996	C	-2705	-3229	-3741	
1/27/2013	E	1,973	990	C	-2307	-3029	-3551	
1/28/2013	E	1,966	993	C	-1780	-2872	-3409	
1/29/2013	E	1,956	990	C	-1440	-2698	-3272	
1/30/2013	E	1,947	1,496	C	-1268	-2544	-3173	
1/31/2013	E	1,946	1,499	C	-1273	-2457	-3113	

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
2/1/2013	E	2,263	1,489	C	-1422	-2399	-3037	
2/2/2013	E	2,401	1,497	C	-1734	-2293	-2960	
2/3/2013	E	2,384	1,489	C	-2070	-2188	-2909	
2/4/2013	E	2,386	1,493	C	-2359	-2125	-2857	
2/5/2013	E	2,396	1,493	C	-2503	-2070	-2804	
2/6/2013	E	2,392	1,488	C	-2534	-1977	-2751	
2/7/2013	E	2,445	1,489	C	-2512	-1974	-2723	
2/8/2013	E	2,494	1,492	C	-2530	-2011	-2788	
2/9/2013	E	2,484	1,490	C	-2394	-2014	-2829	
2/10/2013	E	2,474	1,490	C	-2277	-2059	-2865	
2/11/2013	E	1,858	988	C	-2160	-2113	-2829	**Smelt BO OMR -1,250 cfs**
2/12/2013	E	1,609	986	C	-1824	-2111	-2776	
2/13/2013	E	2,155	1,489	C	-1513	-2099	-2758	**Smelt BO OMR -2,000 cfs**
2/14/2013	E	2,387	1,490	C	-1542	-2110	-2746	
2/15/2013	E	2,370	1,497	C	-1529	-2097	-2715	**Smelt BO OMR -2,500 cfs**
2/16/2013	E	2,388	1,500	C	-1621	-2073	-2687	
2/17/2013	E	2,401	1,499	C	-2009	-2089	-2663	
2/18/2013	E	2,383	1,495	C	-2309	-2081	-2636	
2/19/2013	E	2,387	1,493	C	-2442	-2088	-2609	
2/20/2013	E	2,562	1,492	C	-2374	-2040	-2596	**Smelt BO OMR -3,500 cfs**
2/21/2013	E	2,788	2,488	C	-2260	-1983	-2658	
2/22/2013	E	3,065	2,055	C	-2288	-2003	-2709	
2/23/2013	E	3,458	2,956	C	-2513	-2123	-2853	
2/24/2013	E	3,458	2,494	C	-2635	-2216	-2968	
2/25/2013	E	3,453	2,498	C	-3050	-2358	-3156	
2/26/2013	E	3,456	2,498	C	-3508	-2584	-3360	
2/27/2013	E	3,464	2,494	C	-3755	-2803	-3500	
2/28/2013	E	3,056	2,491	C	-3945	-2981	-3609	**D-1641 E/I Ratio**

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
3/1/2013	E	2,872	2,497	C	-4176	-3161	-3721	
3/2/2013	E	2,867	2,998	C	-4449	-3368	-3872	
3/3/2013	E	2,873	2,992	C	-4883	-3611	-4028	
3/4/2013	E	2,877	2,491	C	-5078	-3792	-4156	
3/5/2013	E	2,882	2,696	C	-5078	-3923	-4298	
3/6/2013	E	2,899	2,989	C	-5424	-4250	-4452	
3/7/2013	E	2,633	2,696	C	-4946	-4327	-4485	**D-1641 E/I Ratio**
3/8/2013	E	2,529	2,897	C	-4598	-4436	-4542	
3/9/2013	E	2,684	2,691	C	-4332	-4442	-4514	
3/10/2013	E	2,562	2,692	C	-4055	-4430	-4509	
3/11/2013	E	2,648	2,498	C	-3637	-4460	-4498	
3/12/2013	E	2,661	2,491	C	-3914	-4472	-4488	
3/13/2013	B	1,762	1,489	C	-3701	-4416	-4360	**Balanced Conditions Declared**
3/14/2013	B	1,703	999	C	-3440	-4262	-4224	**D-1641 Delta Outflow (11,400 cfs)**
3/15/2013	B	1,728	2,493	C	-3330	-4128	-4175	
3/16/2013	B	1,719	2,496	C	-3170	-4003	-4085	
3/17/2013	B	1,702	2,492	C	-2983	-3794	-3989	
3/18/2013	B	1,693	2,997	C	-2978	-3666	-3956	
3/19/2013	B	1,698	2,979	C	-3352	-3645	-3908	
3/20/2013	B	1,699	3,004	C	-3562	-3463	-3843	
3/21/2013	E	3,446	2,499	C	-3646	-3539	-3898	**Excess Conditions Declared**
3/22/2013	E	3,299	2,996	C	-3880	-3537	-3963	**NMFS BO OMR -5,000 cfs**
3/23/2013	E	1,560	3,189	C	-3941	-3527	-3926	**NMFS BO OMR -3,500 cfs**
3/24/2013	E	2,180	3,493	C	-3864	-3577	-3957	
3/25/2013	E	2,609	1,993	C	-4143	-3643	-3928	
3/26/2013	E	2,517	1,998	C	-4127	-3614	-3894	
3/27/2013	E	2,515	1,994	C	-3961	-3630	-3977	
3/28/2013	E	2,695	2,794	C	-3970	-3716	-4163	**NMFS BO OMR -5,000 cfs**
3/29/2013	E	2,911	2,592	C	-4074	-3843	-4259	
3/30/2013	E	2,904	2,597	C	-4107	-3978	-4357	
3/31/2013	E	2,906	2,593	C	-4317	-4091	-4456	

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
4/1/2013	E	866	691	C	-4153	-4050	-4257	NMFS BO IV.2.1; Vernalis 1:1
4/2/2013	E	0	1,493	C	-3389	-3729	-4044	
4/3/2013	B	0	1,496	C	-2508	-3466	-3825	Balanced Conditions Declared
4/4/2013	B	0	1,489	C	-1581	-3240	-3531	
4/5/2013	B	0	1,494	C	-640	-2934	-3213	
4/6/2013	B	0	1,490	C	-77	-2670	-2995	
4/7/2013	B	0	1,493	C	-169	-2410	-2718	
4/8/2013	B	0	1,491	C	-295	-2092	-2510	
4/9/2013	B	0	1,498	C	173	-1705	-2308	
4/10/2013	B	0	1,490	C	216	-1442	-2104	
4/11/2013	B	0	1,499	C	-121	-1295	-1832	
4/12/2013	B	0	1,498	C	-194	-1024	-1560	
4/13/2013	B	0	1,494	C	-207	-699	-1289	
4/14/2013	B	0	1,493	C	-694	-411	-1022	
4/15/2013	B	586	895	C	-1002	-316	-1021	
4/16/2013	B	811	692	C	-565	-287	-1032	
4/17/2013	E	809	696	C	-161	-186	-1042	Excess Conditions Declared
4/18/2013	E	808	692	C	12	-130	-1040	
4/19/2013	E	807	992	C	-27	-192	-1053	
4/20/2013	E	807	1,193	C	38	-275	-1076	
4/21/2013	E	810	1,494	C	-288	-329	-1105	
4/22/2013	E	810	1,694	C	-834	-378	-1138	
4/23/2013	E	813	1,690	C	-1166	-608	-1165	
4/24/2013	E	821	1,695	C	-1343	-749	-1184	
4/25/2013	B	817	996	C	-1473	-758	-1140	Balanced Conditions Declared
4/26/2013	B	815	991	C	-1184	-683	-1088	D-1641 Delta Outflow (7,100 cfs)
4/27/2013	B	814	995	C	-933	-637	-1033	
4/28/2013	B	815	963	C	-649	-592	-969	
4/29/2013	B	815	2,421	C	-157	-447	-997	NMFS BO IV.2.1; Vernalis 1:1
4/30/2013	B	817	2,998	C	-223	-636	-1055	

2013 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
5/1/2013	B	814	3,193	C	-361	-754	-1138	
5/2/2013	B	3,155	494	C	-463	-807	-1211	
5/3/2013	B	3,082	494	C	-899	-904	-1267	D-1641 Delta Outflow/WQ
5/4/2013	B	1,353	1,492	C	-1452	-979	-1271	
5/5/2013	B	937	1,490	C	-1456	-1053	-1234	
5/6/2013	B	982	993	C	-1547	-1009	-1165	
5/7/2013	B	980	793	C	-1399	-890	-1092	
5/8/2013	B	979	792	C	-997	-780	-1031	
5/9/2013	B	978	793	C	-722	-711	-1038	
5/10/2013	B	978	999	C	-504	-810	-1069	
5/11/2013	B	983	993	C	-457	-839	-1104	
5/12/2013	B	982	993	C	-615	-878	-1145	
5/13/2013	B	980	993	C	-713	-979	-1099	
5/14/2013	B	980	993	C	-949	-970	-1025	
5/15/2013	B	979	992	C	-958	-1023	-945	
5/16/2013	B	863	993	C	-1058	-1052	-900	
5/17/2013	B	811	688	C	-1095	-948	-845	
5/18/2013	B	808	689	C	-1018	-824	-845	
5/19/2013	B	808	699	C	-786	-731	-881	
5/20/2013	B	809	694	C	-795	-755	-950	
5/21/2013	B	811	693	C	-1019	-916	-1027	
5/22/2013	B	811	698	C	-1127	-995	-1104	
5/23/2013	B	810	696	C	-1298	-1029	-1181	
5/24/2013	B	810	691	O	-1554	-1107	-1242	DCC Gate Operations per D-1641
5/25/2013	B	811	696	O	-1766	-1222	-1304	
5/26/2013	B	813	699	O	-1803	-1340	-1363	
5/27/2013	B	813	685	O	-1896	-1417	-1419	
5/28/2013	B	811	694	C	-1996	-1403	-1473	
5/29/2013	B	811	690	C	-1992	-1476	-1511	
5/30/2013	B	810	699	C	-1802	-1487	-1537	
5/31/2013	B	807	695	O	-1532	-1497	-1574	

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Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	Mean 5-Day OMR (cfs)	Mean 14-Day OMR (cfs)	Mean 14-Day OMR Equation Calculation (cfs)	Controlling
6/1/2013	B	806	1,491	O	-1558	-1610	-1665	D-1641 Delta Outflow (7,100 cfs)
6/2/2013	B	809	1,492	O	-1789	-1762	-1753	
6/3/2013	B	813	1,492	C	-2080	-1935	-1838	
6/4/2013	B	816	998	C	-2431	-1992	-1890	
6/5/2013	B	815	723	C	-2671	-2048	-1923	
6/6/2013	B	813	992	C	-2876	-2174	-1984	
6/7/2013	B	813	789	O	-2815	-2212	-2027	OMR restrictions lifted
6/8/2013	B	814	790	O	-2478	-2189	-2061	Act IV.2.3 (temperature off-ramp)
6/9/2013	B	822	792	O	-2457	-2225	-2097	
6/10/2013	B	816	991	C	-2061	-2107	-2153	
6/11/2013	B	810	2,490	C	-1669	-2057	-2313	
6/12/2013	B	810	1,994	C	-1911	-2183	-2441	
6/13/2013	B	807	1,999	C	-2072	-2286	-2567	
6/14/2013	B	803	2,689	O	-2058	-2413	-2740	
6/15/2013	B	804	2,684	O	-2836	-2563	-2855	
6/16/2013	B	804	1,992	O	-3337	-2610	-2921	
6/17/2013	B	804	1,490	O	-2995	-2510	-2953	
6/18/2013	B	804	993	O	-2952	-2472	-2984	
6/19/2013	B	804	789	O	-2886	-2490	-3020	
6/20/2013	B	805	1,993	O	-2588	-2460	-3106	
6/21/2013	B	807	1,283	O	-2698	-2568	-3159	
6/22/2013	B	347	795	O	-2922	-2668	-3147	
6/23/2013	B	465	782	O	-2837	-2607	-3141	
6/24/2013	B	812	1,493	O	-2693	-2715	-3192	
6/25/2013	B	808	2,493	O	-2753	-2847	-3206	
6/26/2013	B	808	2,989	O	-2707	-2852	-3284	
6/27/2013	B	805	4,499	O	-2882	-2957	-3464	
6/28/2013	B	801	5,488	O	-3694	-3192	-3660	
6/29/2013	B	801	5,998	O	-4677	-3373	-3886	
6/30/2013	B	801	5,950	O	-5532	-3631	-4154	