Annual Report of Activities
October 1, 2013, to
September 30, 2014

Delta Operations for
Salmonids and Sturgeon (DOSS)
Technical Working Group

October 2014

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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
LOBO	Long-term Operations of the CVP and SWP Biological Opinions
LSNFH	Livingston Stone National Fish Hatchery
MAF	million acre-feet
NGO	non-governmental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
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

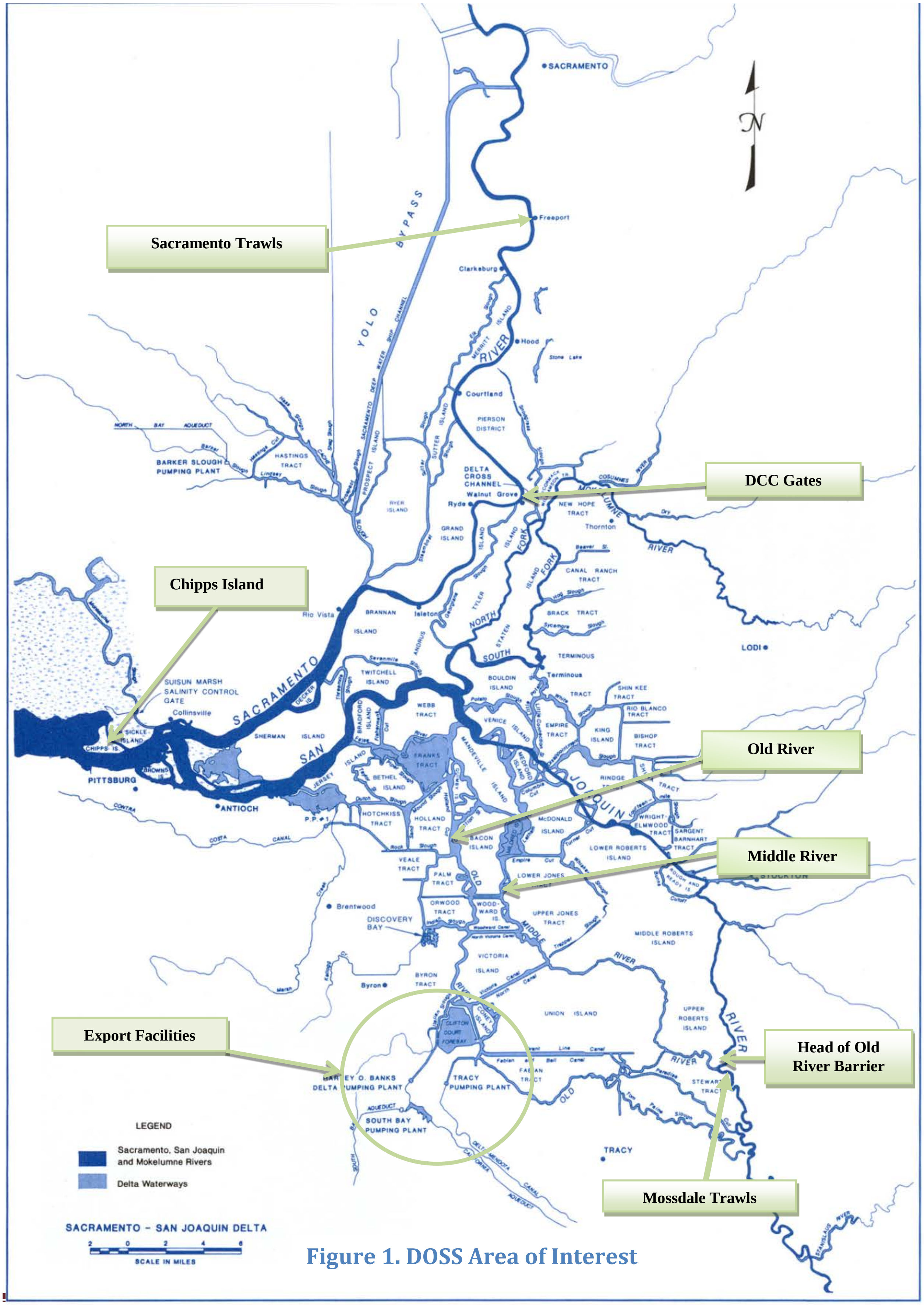

Figure 1. DOSS Area of Interest

Chapter 1 – Background

1.1 Background

On June 4, 2009, the National Oceanic and Atmospheric Association's (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). The NMFS BiOp's 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), 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 to WOMT and NMFS for real-time management of operations 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 2013–2014. Names listed were on the DOSS e-mail distribution list; not all individuals participated actively in the weekly DOSS calls.

U. S. Bureau of Reclamation (Reclamation)
Paul Fujitani
John Hannon
Josh Israel*
Elizabeth Kiteck
Tom Morstein-Marx
Michele Palmer
David van Rijn
Russ Yaworsky*

U. S. Fish and Wildlife Service (FWS)
Craig Anderson*
Leigh Bartoo*
Pat Brandes
Roger Guinee*

National Marine Fisheries Service (NMFS)
Barb Byrne*
Lauren Ledesma
Jeff Stuart
Brycen Swart
Garwin Yip

California Department of Fish and Wildlife (DFW)
Krystal Acierto*
Russ Bellmer
Chad Dibble
Bob Fujimura*
Chris McKibbin
Colin Purdy

Delta Stewardship Council
Anke Mueller-Solger (IEP)

Department of Water Resources (DWR)
Andy Chu*
Mike Ford
James Gleim
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Aaron Miller*
Rhiannon Mulligan
Tracy Pettit
Kevin Reece
Dan Yamanaka
Edmund Yu

State Water Resources Control Board (SWRCB)
Scott Ligare*
Larry Lindsay

U. S. Environmental Protection Agency (EPA)
Valentina Cabrera-Stagno
Erin Foresman*

U.S. Geological Survey (USGS) (Non-participant in 2014)
Jon Burau*

*Designated representative(s) 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 San Joaquin River for emigrating fish, including greater net downstream flows.

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

Conduct annual reviews of the experiment results. Prepare a status review of the action at the end of the 6-year period 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, 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, California 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 –Annual Review Panel Feedback on Actions Relevant to DOSS

2.1 2013 Annual Review Feedback: Loss Equations per Term and Condition 2a

Term and Condition 2a 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." As part of the process, many members of DOSS joined an interagency Term and Condition 2a Technical Work Team (technical team) during summer 2013. At the time, the purpose of the technical team was to develop narratives on the proposed modifications to the current methods used to estimate loss (i.e., incidental take) of Chinook salmon, steelhead, and green sturgeon for feedback from the independent review panel (hereafter, IRP) during the 2013 Annual Review on implementation of the long-term operations of the CVP and SWP Biological Opinions (LOBO review;(see Anonymous 2013 for the narratives). Feedback on the proposed modifications from IRP would help inform a recommendation to NMFS on the best technique for estimating loss at the Delta export facilities.

For the 2013 LOBO review, the IRP (see Anderson et al. 2013) expressed concerns with how Reclamation and DWR are estimating loss based on the assumptions and statistical approaches found in Anonymous (2013). These concerns ranged from using fixed survival parameters for estimating loss to characterizing uncertainty using an error propagation method that would underestimate the true variability (Anderson et al. 2013). Due to these concerns, the IRP recommended different approaches to reduce the bias of and better quantify the loss and uncertainty estimates. One recommended approach would incorporate essential terms as random variables for estimating loss and its uncertainty via a Monte Carlo simulation.

After the issuance of Anderson et al. (2013), the technical team continued meeting throughout WY14 to discuss how to address the IRP comments. The IRP comments on questions related to Term and Condition 2a from the LOBO review and the technical team's response to the comments are documented below. For WY 2015, the technical team will continue its work on incorporating the IRP recommendations.

1) Are the technical work team's proposed equations for estimating loss supported by current science?

IRP Response:

Mostly. However, the direct application of the equations to annual salvage creates a bias. Overlooking the losses associated with inserted zeros creates additional bias in the loss estimates.

Additional modeling research may be needed to devise the most accurate (least biased) loss estimates.

Technical Team Response to IRP:

IRP provided many different approaches to increase the accuracy of the loss estimates. To move forward with some of these approaches, the technical team agreed to continue evaluating multiple equations for loss and include these estimates in DWR and Reclamation's annual incidental take report, which is included as an appendix to the DOSS annual report. Specifically, changes that the agencies are interested in evaluating during future WYs should be coordinated through the technical team and other appropriate work teams, such as DOSS, the Tracy Technical Advisory Team, and the Central Valley Fish Facility Review Team, for integration into alternate calculation methods that will be described and calculated in the annual incidental take report. Since the actual loss quantity is not known, comparing methods to understand where uncertainty exists and what influences the estimate can assist biologists in determining the most accurate loss estimate. As DWR and Reclamation continues to develop new models and refine previous equations, efforts to incorporate possible losses associated with inserted zeroes will be advanced and reviewed by DOSS and other aforementioned teams.

2) Are the technical work team's proposed equations for estimating annual loss confidence intervals scientifically appropriate?

IRP Response:

No. Uncertainty has been modeled in terms of standard errors (SE) of fixed parameters. This approach greatly understates the true uncertainty. Also, an error propagation method was used to estimate the SE of loss from the SEs of survival and salvage. Two of Jahn's (2011) equations (8 and 9) for this propagation are incorrect. The IRP proposes modeling salvage, survival, entrainment and loss as random variables, and estimating the mean and standard deviation of daily and annual losses via Monte Carlo simulation instead of closed-form error propagation.

Technical Team Response to IRP:

The technical team is considering the IRP's suggestion to develop a different framework for calculating loss by modeling various parameters as random variables and estimating its uncertainty via a Monte Carlo simulation. However, this different framework would require further model development and could benefit from additional fish facility research before it is implementable. Additional research or sampling that would inform the desired parameterization of variables might include measurements of whole facility survival and prescreen mortality, and genetic identification of salvaged salmonids to race.

As a result, the technical team would have to move forward with the error propagation method for developing confidence intervals in the near term using the modifications suggested by the IRP:

(1) replacing incorrect equation 8 and 9 from Jahn (2011)[1] with equation 2 and 4 of Appendix 2 from Anderson et al. (2013), or

[1] Dr. Jahn submitted corrected equations in a subsequent e-mail; see discussion on p. A-10 of Appendix A

(2) replacing equation 7 and 8 of Jahn (2011) with equation 3 of Appendix 2 from Anderson et al. (2013) and replacing incorrect equation 9 of Jahn (2011) with equation 4 of Appendix 2 from Anderson et al. (2013).

In its annual incidental take report, DWR and Reclamation will evaluate these alternative methods for estimating the standard error of loss before moving forward with a standard error of loss equation for estimating confidence intervals (see Appendix A for 2013/2014 results). In the meantime, DWR and Reclamation, with guidance from the technical team, are working with biostatisticians to ensure the accuracy and correct implementation of any interim equations that DWR and Reclamation will use for the error propagation method.

If a NMFS approved confidence interval methodology is eventually used to estimate uncertainty in the loss estimates, then NMFS may need to consider whether the confidence interval should be used in decision-making. In Anonymous (2013), the technical team only recommended estimating confidence limits of the loss estimates on an annual scale and not on a daily scale due to uncertainties in the daily loss estimates. For example, there could be situations where the upper confidence limit is above a trigger, but the lower confidence limit is below a trigger. Regardless, in WY2015, the technical team recommended changes in the steelhead daily and annual loss calculation equation to use the best available information from recent species-specific studies.

The IRP suggested two possible strategies for making a sensible trigger-exceedance decision given the high uncertainty in the daily loss estimates: (1) using a 7-day moving average of daily loss, or (2) using a one-sided (rather than a two-sided) confidence interval and relaxing the confidence level. At past meetings, the technical team members have expressed interest in evaluating these strategies, but this would involve the development of new triggers using these strategies since the current triggers are based on daily point estimates. Moreover, these strategies differ from the technical team's method of only looking at the confidence interval on an annual scale. For WY 2015, the technical team will continue to evaluate these new strategies for decision making, as DWR and Reclamation refine methods for measuring uncertainty of the loss estimates.

3) Which, if any, of the proposed terms in the technical work team's equations introduce the greatest uncertainty? How might these formulations be improved in the future?

IRP Response:

The greatest uncertainty is due to the survival proportion, and to the lack of direct measures of entrainment. The IRP suggests additional research to better characterize whole-facility survival, as a function of season, flow, temperature and other relevant factors. Appendix 2 of the present review report includes a Bayesian model for loss estimation which has the ability to incorporate independent knowledge about entrainment, if and when such knowledge becomes available.

Technical Team Response to IRP:

The technical team is aware of the technical and fiscal challenges of obtaining these survival and entrainment measurements. Without additional regulatory mandates and funding, attention has been focused on obtaining supplemental information from current field or facility studies. In WY14, the regional acoustic telemetry studies for San Joaquin River Chinook salmon and steelhead, both of which used Mokelumne River hatchery stocks, is expected to estimate survival from the facility to Chipps Island. Additionally, PIT tag whole facility efficiency tests are continuing at the State Water Project fish protection facility. Directly measuring entrainment during any of these studies would require an additional array downstream of the fish protection facility. To the extent that results of these studies related to whole facility efficiency are available, those results as a function of season, flow, temperature, and other relevant factors should be included in these studies' annual reports. The development of an equation that can be informed by such drivers and incorporated via a Bayesian method is likely to continue and may be presented as an alternative methodology for estimating loss in the future.

4) Which, if any, data inputs in the technical work team's equations are likely to reduce accuracy in their estimates?

IRP Response:

The current assumptions about zero data values for salvage leads to a negative bias in daily and annual loss estimation. Appendix 2 suggests a correction for this bias. The unrealistic assumption of a single, fixed value for survival creates an additional negative bias for annual loss.

Technical Team Response to IRP:

The technical team continues to consider the issue of zero data values. In particular, the technical team wants greater detail and assurance regarding the methodology in Appendix 2 of Anderson et al. (2013), and will have additional review of this recommendation to ensure it is correctly incorporated into potential alternative methods for estimating daily loss.

In WY14, the technical team has considered the recommendation of not using a single, fixed value for survival when estimating annual loss. This recommendation would require modeling survival as a random variable, which would require further research and development before it is implementable. In the near term, equations with alternative fixed values representing low, medium, and high survival could be used to estimate a range of potential annual losses if there is interest from the agencies.

5) Are ongoing studies sufficient to gather data needed to calibrate coefficients and terms in the loss equations? What changes to ongoing studies or recommendations for future studies are needed to gather data to measure coefficients and values in the equations' terms?

IRP Response:

The concept of coefficients that can be calibrated, and of model parameters with standard errors, is not a realistic framework for modeling survival rate, entrainment, and loss. Realistically, these quantities vary widely and unpredictably over time. The IRP suggests viewing these quantities as random variables and modeling their distributions, as is done by Cramer Fish Sciences (2013). A careful synthesis of previous mark recapture experiments that estimate whole-facility survival (e.g., Clark et al. 2009), along with additional novel experiments, may be the most effective path to estimate survival distributions and to model the effects of factors that control survival. In addition, research aimed at directly measuring entrainment is encouraged. Even if resulting measurements are crude, they can increase the accuracy of loss estimates via the Bayesian model described in Appendix 2.

Technical Team Response to IRP:

The technical team agrees that the IRP framework of incorporating random variables will be useful. The development of an equation that uses random variables, including seasonality, flow, and other drivers, into the daily and annual loss estimation procedure will continue and may be presented as an alternative methodology for estimating loss in the future. The technical team hopes to identify important drivers to consider by developing an agreeable conceptual model that reflects the contents of multiple conceptual models presented by technical team members from CDFW, DWR, NMFS, and Reclamation. Additional novel studies investigating this is outside the objective of the work team, but may advance through other ecological and management research identification processes, such as the Biological Opinion's Collaborative Science and Adaptive Management Program and the Delta Science Program's Science Action Plan.

6) Given the importance of the hypothesized relationship between water velocity and facility efficiency for salmonid salvage, what scientific study designs and methods might be appropriate to investigate how this relationship could be incorporated into whole facility survival estimates?

IRP Response:

Given the limited potential to manipulate exports for the purposes of conducting controlled experiments aimed at establishing a relationship between water velocity and whole facility survival rates, controlled flume studies may provide a portion of the answer. However, it will be difficult to simulate realistic conditions that capture all of the variables that determine whole facility survival. For example, the effects of predator fields associated with the facilities would be particularly difficult to simulate. In order to accurately determine whole facility survival rates, it is important to determine whether or not there is even a relationship between salmonid salvage and entrainment survival (mortality). Perhaps this could be addressed with carefully designed mark-recapture experiments conducted over multiple but relatively short-term periods of controlled water export pumping that would not interfere with total exports. For example, low and high water velocity runs could be alternated in experimental runs such that average weekly (or monthly) exports were unaffected while monitoring the recapture (in salvage and escapement, i.e., *sensu*, fish overcoming the influence of entrainment flows and migrating out of the area) of marked fish released at the point where they would be initially entrained into the pumping facilities.

Technical Team Response to IRP:

The technical team is considering the question posed by the IRP regarding a relationship between salvage and entrainment. Results from over a decade of facility efficiency tests and regional salmonid survival studies in the south Delta suggest numerous factors influence salvage other than facility entrainment. These studies suggest drivers suggested by the IRP and other biological and water operations processes, such as predation and facility operations, likely influence salvage efficiency and entrainment losses at a measurable level. The technical team hopes to identify important drivers to consider and how to mediate the biological and operational processes occurring within and in the vicinity of the facilities in an agreeable conceptual model. Additional novel studies investigating these drivers are outside the objective of the technical team, but may advance through other ecological and management research identification processes, such as the

Biological Opinion's Collaborative Science and Adaptive Management Program and the Delta Science Program's Science Action Plan.

7) What additional studies should be seasonally, annually, or semiannually completed to increase the accuracy of estimates of loss for green sturgeon?

IRP Response:

So little is known about the life-history of the green sturgeon that any studies shedding light on this species' responses to physical habitat variables (velocity, depth, substrate, cover, and complex hydraulics), particularly during its early life stages are likely to be useful.

Technical Team Response to IRP:

DWR is currently in the process of working with UC Davis to conduct laboratory experiments that will look into the guidance efficiency and behavior of juvenile green sturgeon in a model louver array, and will examine the risk of predation to green sturgeon from Delta predators. These experiments could help inform parameters for a green sturgeon loss equation. In particular, data collected from these studies could be used to analyze how green sturgeon respond to various physical habitat variables like velocity and depth, as suggested by the IRP. These laboratory experiments are focused on juvenile green sturgeon (currently targeting 6 to 34 cm long fish) since that is the life stage most prevalent in Delta salvage operations; any parameters derived from these experiments for a green sturgeon loss equation may thus be applicable only to juvenile green sturgeon, not to larvae or adults.

For information on earlier life stages of green sturgeon, the technical team is aware of a planned FWS study that will assess when and where green sturgeon larvae migrate out of the upper Sacramento River. When this study is complete, the technical team would have some additional information about green sturgeon habitat use and migration timing to the lower Sacramento River.

8) How well is the genetic information used in the technical work team's equation for estimating loss of winter run Chinook?

IRP Response:

With the information provided, it is difficult to determine the effectiveness of the genetic information.

Technical Team Response to IRP:

The winter-run classification accuracy approach suggested by the technical team for the 2013 LOBO review was meant to serve as a starting point for incorporating genetics-based run classification into the management paradigm on an annual scale. Therefore, the information provided to the IRP may not have been as comprehensive as needed for IRP input. For WY 2015, DWR and Reclamation with guidance from the technical team will continue to refine the classification accuracy term and document uncertainties. These refinements might include how to account for the probabilities of a false positive or false negative genetic race assignment, how to deal with tissue samples that could not be amplified, and how to account for missed samples.

Furthermore, the technical team will need to evaluate how to implement a classification accuracy rate that varies seasonally versus using a single rate throughout the entire season, which is the current approach described in Anonymous (2013). The technical team agrees with the IRP's concern of using set survival parameters, which would also apply to the classification accuracy term. For instance, the probability assignment for winter-run Chinook salmon depends on a Bayesian approach, which uses the proportion of genetic winter-run Chinook salmon detected in the sample as prior information in an iterative process to arrive at a final probability assignment. Waiting until the end of the year would lead to a larger sample size, but could lead to issues since genetic winter-run proportions in the winter-run size range could change through the season. To address this issue, a new QA/QC procedure has been developed and is currently being evaluated by DWR staff.

9) What sampling design provides the most accurate approach for characterizing the presence of genetic winter run Chinook salmon occurring inside and outside the Delta model winter-run size category?

IRP Response:

IRP was not provided with alternative approaches to consider and is reluctant to suggest novel sampling designs at this time. However, the ability to separate cohorts associated with different salmon runs from overlapping size distributions seems to be at the core of this issue. There are algorithms and software packages that may assist in separating these cohorts with an assignable probability of goodness of fit (e.g., legacy software MIX Program v. 3.1, and the more current mixdist; for details see http://ms.mcmaster.ca/peter/mix/mix31.html and http://cran.rproject.org/web/packages/mixdist/mixdist.pdf). In practice, fitting mixed distributions can be more of an art than a science, but the more information that one has at the start, the better the chances of successfully distinguishing cohorts among mixed size distributions. In this regard, the genetic information available on winter-run Chinook salmon could be applied in retrospective analyses to test the accuracy of this approach.

Technical Team Response to IRP:

In WY14, the technical team did discuss the possibility of using the algorithms and software packages suggested by the IRP to separate out the different Chinook salmon cohorts with an assigned probability goodness of fit. However, Harvey and Stroble (2013) (not provided to the technical team for the 2013 LOBO review) describes the annual and biweekly timing of juvenile Chinook salmon fork length distributions observed in salvage based on genetic race assignments. This report is being closely examined by the technical team to determine whether the retrospective analyses suggested by the IRP would provide any additional information.

Chapter 3 — Summary of DOSS Discussions and Advice/Recommendations

3.1 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 (e.g., Delta Smelt Working Group)
- Drought and drought contingency plan (focus on DCC trigger table) for March 2014

3.2 Other Discussion Topics

- Special report on winter-run stranding and rescue (related materials provided to DOSS by e-mail on 9/30)
- Monitoring of juveniles at Red Bluff Diversion Dam
- Spring-run surrogate releases
- Temporary Urgency Change Petition (TUCP), SWRCB response, and NMFS
- OMR Index Demonstration Project on using an OMR index rather than measured gage data for compliance on the 14-day average. (NMFS letter available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/nmfs_response_to_reclamation_s_omr_index_demonstration_project_-_february_27__2014.pdf)

3.3 Summary of WY 2014 RPA Action Implementation

3.3.1 DCC Gate Operations (Action IV.1.2)

RPA Action IV.1.2 modifies the DCC gate operations to reduce the 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 23.1) 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 3.1).

Table 3.1. DCC operations

Date	Action Triggers	Action Responses
October 1–November 30	Water quality criteria per D-1641 are met and either KLCI or SCI are >3 fish per day but ≤5 fish per day.	Within 24 hours of trigger, DCC gates are closed and kept closed for 3 days.
	Water quality criteria per D-1641 are met and either KLCI or SCI is >5 fish per day.	Within 24 hours, DCC gates are closed and kept closed until both KLCI and SCI <3 fish per day.
	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.
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 KLCI and SCI are <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 KLCI or SCI is >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 experiments may request gate opening for up to 5 days; NMFS will determine whether opening is consistent with ESA obligations.
	One-time event between December 15 and 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 1 hour after sunrise to 1 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 (*e.g.* 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 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.

3.3.1.1 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 10/22/13 for water year (WY) 2014, DOSS discussed that since 10/1, none of the criteria for DCC gate closure had been met. D-1641 water quality standards were of concern including Contra Costa chloride levels, Rio Vista flow, and Delta outflow during fall. It was noted that Rio Vista flow and Delta outflow could be increased by closing the DCC gates and that export reductions could help boost Delta outflow. Fall pulse flows from the San Joaquin tributaries, particularly the Stanislaus River, might have also helped to improve water quality conditions. No Sacramento Catch Index (SCI) was available until 10/18 because of the partial federal government shutdown. During several DOSS meetings, concerns were discussed about meeting water quality (WQ) standards in December once Action IV.1.2 entered a phase (in effect 12/1–12/14) that called for DCC gate closure as the default action; however, it was agreed that Action IV.1.2 includes two exceptions to avoid WQ issues:

1. When WQ standards are not being met and the SCI and Knights Landing Catch Index (KLCI) are <3 fish/day, the DCC may be opened.

2. When WQ standards are not being met and the SCI and KLCI are >3 fish/day, DOSS reviews monitoring data and makes a recommendation to WOMT.

Over various meetings, DOSS discussed the many factors (not necessarily related to the RPA) that might be considered when managing water quality and DCC gate operations:

- Rio Vista flow standard in D-1641 (a closed DCC helps meet this standard)
- Contra Costa chloride standard in D-1641 (an open DCC helps meet this standard)
- WQ standards in the North Delta Water Agency contract
- Other operational "knobs" available in addition to/instead of the DCC to meet different standards of concern
- Tidal conditions expected in December
- Typical fish migration timing past DCC
- Boater use of DCC

DOSS suggested that a WOMT meeting be convened to discuss the concerns about meeting WQ standards in December and the request for additional flexibility in DCC gate operations, because a request for expanded RPA flexibility was beyond the scope of DOSS. DOSS also discussed information relevant for assessing how DCC operations would affect risks to outmigrating salmon.

The 250 mg/L chloride standard at the Contra Costa Canal location was identified as the interior Delta WQ standard most likely to be of concern in early to mid-December; opening the DCC gates would have been one way to help meet this standard; however, it was agreed that WQ conditions can be quickly, and unpredictably, affected by tides, barometric pressure, and wind in addition to flows and exports. WQ upstream could have been regulated by reservoir releases and export reductions, but the additional upstream releases were also a concern given the desire to conserve storage, and exports were already near minimum levels. DCC gate operations were the only remaining "knob" to control WQ in the interior Delta; however, WQ modeling is would have been very uncertain.

The following indicators were identified as relevant to assessing the potential risk of DCC operations to outmigrating salmon, with some discussion points highlighted.

- KLCI—Most likely the most useful for detecting migration of winter-run Chinook because spring-run yearling Chinook are strong swimmers and are less likely to be captured in the RSTs used for sampling at KL. Although the index is measured in fish/day, it was noted that any quantitative inference drawn from the index should be tempered by the expectation that the RSTs used to sample at this location have a low and variable efficiency.

- SCI—Most likely the most useful for detecting migration of winter-run Chinook because spring-run yearling Chinook are strong swimmers and are less likely to be captured by the trawling and seining methods used to sample the locations used to calculate this index.
- First Alert in Action IV.1.1, Either Component—Mean daily flow >110 cfs or an increase in mean daily flow of 50% is an indicator that spring-run yearlings might be moving out of the tributaries into the mainstem Sacramento River.
- Second Alert in Action IV.1.1—The second alert is an indicator that flow and temperature conditions in the Wilkins Slough/KL area have reached thresholds that have been associated with the migration of salmonids in the Sacramento River. It was suggested that forecasted flows and temperature trends could be used to predict whether the second alert might be tripped in the near future.

DOSS generally agreed that KLCI, SCI, and the combination of the first and second alerts were relevant indicators that winter-run Chinook and/or spring-run Chinook yearlings might be migrating past DCC, and thus potentially be routed into the interior Delta through an open DCC; however, there was no consensus about how those indicators might be used to predict what fraction of a population might be at risk and there was a difference of opinion about whether triggering of the first alert but not the second alert indicated any risk to spring-run yearlings to entrainment through an open DCC.

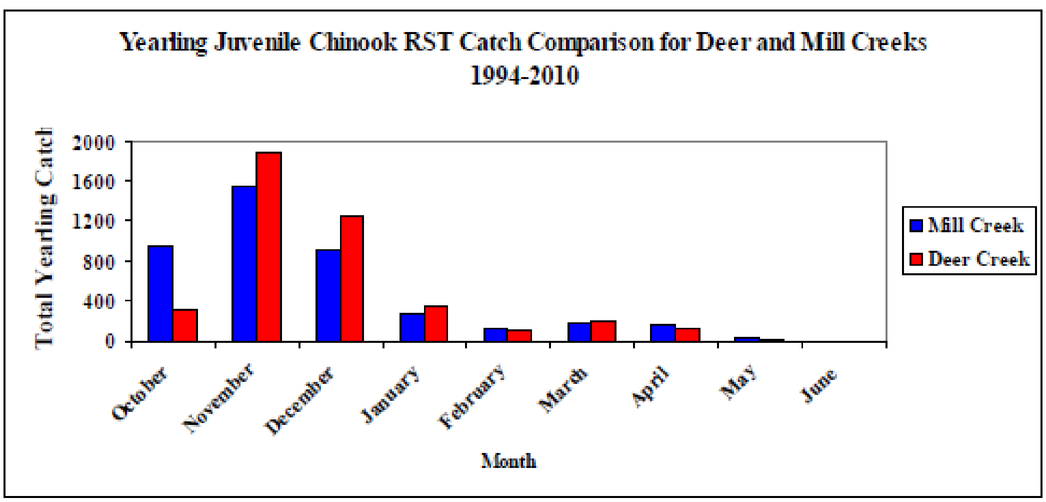

Figure 3.— A comparison of yearling juvenile Chinook out-migration timing and catch statistics based on the 1994-2010 Deer and Mill Creek rotary screw trap data.

On January 14, 2014, a request was sent to NMFS from Reclamation to open the DCC gates from January 17th through the 31st to address concerns about rapidly deteriorating delta water quality. NMFS did not have sufficient supporting information (modeling of water quality to demonstrate the water quality benefits in consideration of the potential risk that listed species might be entrained into the interior delta through the DCC) to evaluate the request in late January and the DCC remained closed through January. The various drought contingency plans (see Chapter 4) effective from February through mid-November did, under certain conditions, allow for DCC opening. Under the drought contingency plans, the DCC was opened on February 1 and was closed the morning of February 11.

3.3.2 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 2014 was designated as "Critical", which required implementation of a 1:1 ratio of Vernalis inflow to combined CVP/SWP exports (I:E ratio), though implementation of this RPA action was modified under the Drought Operations Plan (see Chapter 4). While the Drought Operations Plan allowed for modification of I:E implementation during the first half of April and the second half of May, because of other conditions, the I:E implementation was modified only during the first half of April in that the I:E ratio of 1:1 did *not* limit exports during that early April period.

3.3.3 6-Year Acoustic Tag Experiment (Action IV.2.2)

Table 3.2. Tagging and release dates and average hydrologic and operation conditions during 2014 steelhead releases for the six-year study.

				14-Day average					
2014 Tagging Dates	**2014 Release Dates**	**Release Group size**	**Head of Old River Barrier**	**River Temp @ release**	**Vernalis (cfs)**	**Total Exports**	**I:E**	**Old River @ Head (CFS)**	**OMR (cfs)**
March 25-27	March 26-29	478	Closed April 8	16.6°C	734	3640	0.2	607	-2735
April 23-26	April 24-27	480	Closed prior to releases. Removal started on May 28. Weir breached on June 9	15.6°C	2645	2354	1.1	738	-2230
May 20-23	May 21-24	478		19.0°C	615	1012	0.6	240	-1250

Steelhead release dates and environmental conditions for the 2014 field season of the 6-year acoustic tag experiment are summarized in Table 3.3, above. 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 2014 investigation, anticipated in late 2015, will be characterized with and without a predator-fish filter, which was developed for the 2011 study.

3.3.4 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 because of the diversion of water by the export facilities in the south Delta. The action is in effect from January 1 through June 15, or until the average daily water temperature at Mossdale is >72°F for 7 consecutive days in June, whichever is earlier. In WY 2014, temperatures at Mossdale ("MSD" station data reported on CDEC exceeded 72°F for the first seven days of June. Effective 6/8/14, the Old River and Middle River (OMR) flow restrictions were lifted.

None of the loss density triggers were exceeded in WY 2014. Therefore, with the exception of modifications allowed during March 2014 (see Chapter 4 and Appendix D), Action IV.2.3 limited OMR flows to be no more negative than -5,000 cfs on a 14-day average.

In WY 2014, NMFS approved[2], with some conditions, a trial implementation of the "OMR Index Demonstration Project", during which OMR compliance would be measured using the OMR index (an estimate of OMR flow based on an equation that includes Vernalis flow and exports) rather than the tidally-averaged daily OMR based on USGS gauge data. The operations figures in Chapter 5 and the operations tables in Appendix D report both the gauge and index data.

3.3.5 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 11/1/13 to 12/31/13, 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 KLCI and SCI of non-ad-clipped older juvenile Chinook salmon to indicate that CVP/SWP exports might need to be reduced. These indices provide alerts that a large number of older juvenile Chinook salmon are migrating into the upper Delta region. An alert threshold >10 fish/day, for example, indicates that the loss or loss-density triggers that would require an export reduction might be tripped in the near future.

During WY 2014, no triggers were tripped that required action under RPA IV.3.

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[2] NMFS' 2/27/14 letter approving the OMR Index Demonstration Project is available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/nmfs_response_to_reclamation_s_omr_index_demonstration_project_-_february_27__2014.pdf

3.4 Other Topics

3.4.1 Juvenile Production Estimate for Winter-run Chinook Salmon

NMFS issued the juvenile production estimate for brood-year 2013 winter-run Chinook salmon (JPE) on 2/21/14[3]. The JPE for juvenile winter-run outmigrating in 2013/2014 (juveniles from brood year 2013) was 1,196,387; the incidental take limit at the CVP/SWP pumps was 23,928 (2%). Action IV.2.3 (OMR management) includes a loss-density trigger based on the JPE. The two levels of the JPE-based OMR trigger for WY 2014 RPA implementation were 11.96 fish/TAF and 23.93 fish/TAF.

The term in the JPE calculation for survival from Red Bluff to the Delta is traditionally based on CWT data; however, the survival term in the JPE calculation for WY 2014 RPA implementation was based on recent survival studies on winter-run and late-fall-run Chinook using acoustic tag technology. Specifically, estimates for WY 2014 RPA implementation were based on a weighted average of a single survival estimate from hatchery winter-run releases in 2013 and from the average of four survival estimates from 4 out of 5 years of recent late-fall-run releases. Because 2011 was a wet year, late-fall-run survival from that year was excluded as not being representative of this year's conditions.

3.4.2 Spring-Run Surrogate Releases

Coleman National Fish Hatchery (CNFH) juvenile late fall-run Chinook salmon are used as surrogates for natural yearling spring-run emigrating from Deer, Mill, and Antelope creeks. These fish are marked with a clipped adipose fin and 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 similar size to that of wild 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 water year 2014, CNFH released three groups of late fall-run Chinook salmon uniquely marked as spring-run Chinook salmon surrogates into Battle Creek: 1) 68,516 on 1/07/14, 2) 81,962 on 1/13/14, and 3) 72,857 on 1/23/14. In addition to these surrogate releases, CNFH also released 267,301 late fall-run Chinook salmon into Battle Creek on 12/10/13 and 452,526 late fall-run Chinook salmon into Battle Creek on 1/13/14 to 1/14/14 as part of its production release. Prior to these releases, DOSS provided input to the CNFH on the release schedule of the spring-run Chinook salmon surrogates based on the information that the production release would occur during the first significant rainfall event in December. After reviewing the migration timing pattern of yearling spring-run Chinook in Mill and Deer creeks from 1994 through 2010, showing sparse RST catches February onward and due to the surrogate fish beginning to smolt, DOSS recommended that all surrogate groups be released by the end of January, 2014. A summary of more specific inputs provided from DOSS to CNFH is described in Table 3.3.

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3 http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/nmfs__winter-run_broodyear_2013_jpe_letter_-_february_21__2014.pdf

Table 3.3. Summary of DOSS input to CNFH on spring-run surrogate releases.

Release Type	DOSS Input
First Surrogate Release	DOSS originally recommended the first release should take place in mid-December, ideally at least a week after the production release and coincident with a rainfall event. Some members expressed concerned that predation could be higher in the surrogate group in the absence of a large production group release to "swamp" predators. DOSS also recommended that the release be completed no later than December 31. However, due to dry conditions, low river flows and clear water, the CNFH did not release its entire production group or any spring-run surrogate groups in December. The first surrogate group was released on 1/07/14.
Second Surrogate Release	DOSS recommended the second release to take place 2-3 weeks after the first release, ideally coincident with a rainfall event. DOSS also preferred the release to be done by mid-January, no later than January 21. However, the 2-3 weeks separation between releases was not possible because the first group was released at a later date than anticipated due to dry conditions. The second group was released a week later than first group on 1/13/14.
Third Surrogate Release	DOSS originally recommended the third release should take place 2-3 weeks after the second release, ideally coincident with a rainfall event but no later than January 31, unless delaying (to no later than February 10) would allow the release to coincide with a rainfall event. However, the third release was completed on 1/13/14, one week later than the second release. Even though DOSS recommended waiting until 2/10/14 to coincide the release with rainfall, CNFH staff recommended that all spring-run Chinook salmon surrogates be released in January because the surrogates were in smolting condition and there were concerns that they would pass through these conditions and would not be inclined to migrate if released past January.

After each release, DOSS tracked the cumulative loss of each spring-run Chinook salmon surrogate group at the Delta fish facilities to ensure the cumulative percent loss did not exceed the 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 of export reductions as specified in RPA Action IV.3 or more positive OMR flow as specified in RPA Action IV.2.3. In WY 2014, there was no loss observed for any of the spring-run Chinook salmon surrogate group (see Table 1 in Appendix A). Therefore, the SWP/CVP did not exceed the take limit for the spring-run Chinook salmon surrogates and no action response was taken in the RPA actions for export reductions or OMR flow management in water year 2014.

3.4.3 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.

Chapter 4 — Drought Operations

Because of extremely dry conditions, SWP and CVP project operations during WY 2014 were managed under a series of drought contingency plans and associated orders issued by the State Water Resources Control Board (SWRCB) beginning 2/1/14. The fish agencies (NMFS, USFWS and CDFW) and the project agencies (Reclamation and DWR) worked collaboratively to allow the CVP and SWP to export the water supplies needed to meet essential human health and safety needs throughout the CVP and SWP service areas while providing needed protections for and minimizing adverse effects to listed fish species. Table 4.1 provides a brief overview of the Delta actions in the NMFS BiOp that were implemented in modified fashion during 2014.

Table 4.1 Delta RPA actions that were implemented in modified fashion during 2014 per the drought contingency plans. Except for the 3/31/14 NMFS e-mail (available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/2014_03_31_bor_request_and_nmfs_concurrence_on_april_1_operations.pdf), links to all documents referenced in the "2014 implementation" column are available in the chronological summary on the SWRCB's website: http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp.shtml.

RPA Action	Usual Implementation	2014 Implementation
IV.1.2 (DCC operations)	Mandatory gate closure from February 1 to May 20	DCC gate opening was conditionally allowed per the guidelines in the "DCC Trigger Table", which was developed by an interagency technical team and evolved with each drought contingency plan. The DCC gates were opened on 2/1/14 and closed the morning of 2/10/14. *See (a) Enclosure 2 of 1/31/14 NMFS letter, (b) Enclosure 1 of the 2/28/14 NMFS letter, and (c) Attachment G of the 4/8/14 Drought Operations Plan.*
IV.2.1 (I:E ratio)	In a critical year, the projects shall operate to an I:E ratio (inflow at Vernalis: combined CVP/SWP exports) of not less than 1:1 from April 1 to May 31.	Before and after the spring pulse flow at Vernalis, the projects were not required to operate to the I:E ratio of 1:1 if there was natural flow in the Delta. Because storm events did cause natural flow in the Delta before the pulse period, but not after the pulse period, the projects operated to the 1:1 I:E ratio from 4/18/14-5/31/14.

		See (a) 3/31/14 NMFS e-mail regarding operations beginning April 1, 2014, and (b) p 18-19 of the 4/8/14 Drought Operations Plan.
IV.2.3 (OMR flow management)	The 14-day average of the OMR index shall not be more negative than -5,000 cfs anytime between January 1 and June 15. If the temperature offramp condition is met, this action may end sooner than June 15.	The 14-day average of the OMR index was allowed to be more negative than -5,000 cfs for up to 7 days in mid-March; CVP and SWP exports were limited to the minimum health and safety levels of 1500 cfs in late March to provide more positive OMR flows as an offset. *See the 3/14/14 NMFS letter (and associated 3/19/14 letter regarding the corrected enclosure).*

The SWRCB has compiled a comprehensive chronological summary[4] of the drought actions and associated documentation during WY 2014; readers are referred to that summary for full details on drought actions. The listing below includes just the drought contingency plan proposals and NMFS responses, since those documents are most relevant to the NMFS BiOp RPA actions tracked by DOSS.

- January 31, 2014 - Letter from U.S. Bureau of Reclamation to National Marine Fisheries Service with enclosures, dated 1/31/14
    - Enclosure 1- Temporary Urgency Change Petition, dated 1/29/14
    - Enclosure 2 - Salmonid and Green Sturgeon Supporting Information for Endangered Species Act Compliance for Temporary Urgency Change Petition Regarding Delta Water Quality, dated 1/31/14
- January 31, 2014 - Letter from National Marine Fisheries Service to U.S. Bureau of Reclamation and Department of Water Resources with enclosures
    - Enclosure 1 - January 2014 forecast at 90% hydrology
    - Enclosure 2 - Matrix of Delta Cross Channel Gates Operational Criteria
    - Enclosure 3 - Additional Monitoring Relative to Delta Cross Channel Operations, dated 1/31/14
- February 27, 2014 - Petitioners' Request to Modify Order Approving Temporary Urgency Change for the State and Federal Water Project
- February 28, 2014 - Letter from National Marine Fisheries Service
- March 14, 2014 - Letter from U.S Bureau of Reclamation to National Marine Fisheries Service regarding interim contingency plan for March (2009 Biological Opinion)
- March 14, 2014 - National Marine Fisheries Service letter to U.S. Bureau of Reclamation and Department of Water Resources regarding interim contingency plan for March

[4] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp.shtml

- March 17, 2014 - Letter from U.S Bureau of Reclamation to National Marine Fisheries Service regarding interim contingency plan for March (2009 Biological Opinion) - Corrected page 8 of Enclosure
- March 19, 2014 - National Marine Fisheries Service letter to U.S. Bureau of Reclamation and Department of Water Resources regarding correction of typographical errors in interim contingency plan for March.
- March 31, 2014 – National Marine Fisheries Service e-mail concurrence on operations beginning April 1, 2014 *(not posted on the SWRCB website; available at: http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/2014_03_31_bor_request_and_nmfs_concurrence_on_april_1_operations.pdf)*
- April 8, 2014 - Reclamation consultation with National Marine Fisheries Service (NMFS) regarding Drought Operations Plan
- April 8, 2014 - Central Valley Project and State Water Project Drought Operations Plan and Operational Forecast April 1, 2014 through November 15, 2014
- April 8, 2014 - NMFS response to Reclamation and DWR regarding Drought Operations Plan
- April 18, 2014 - Petitioners' request for a modification to the April 11, 2014 Revised Order Approving Temporary Urgency Change for the State Water Project and Central Valley Project
- April 18, 2014 - National Marine Fisheries Service Concurrence email

Chapter 5 — Operations Summary

5.1 Water Year 2014

The hydrologic yeartype in both the Sacramento and San Joaquin river basins were classified as Critical. A summary of WY 2014 operations and controlling factors is provided in Appendix D; a summary of Old and Middle River flows is provided in Appendix E; some summary operations charts are provided below in Figures 5.1, 5.2, 5.3, and 5.4.

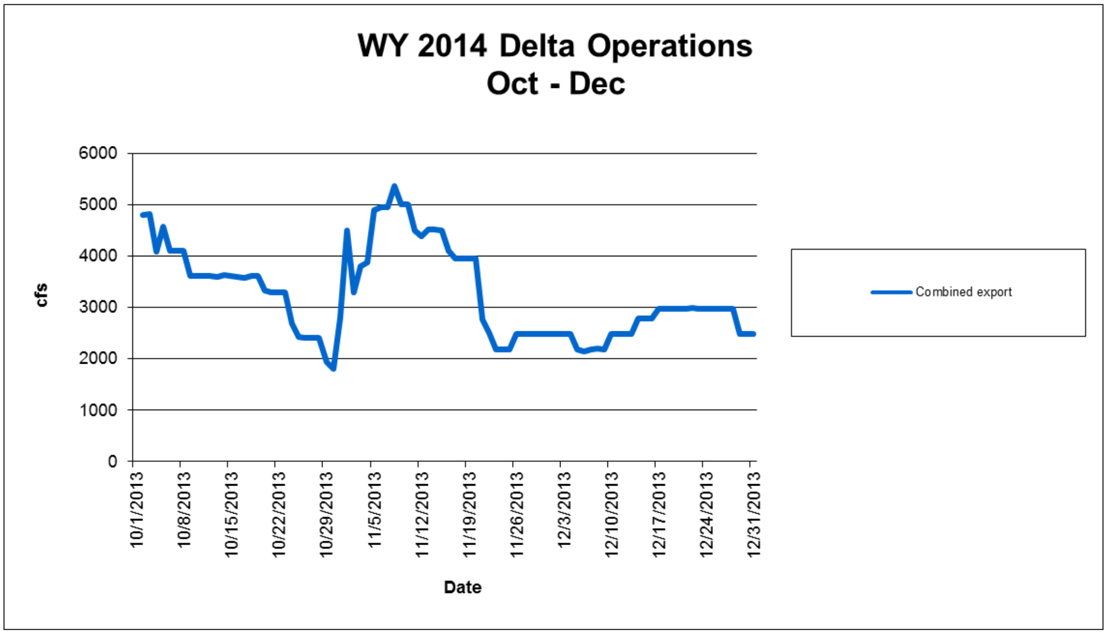


Figure 5.1 Combined exports at the CVP and SWP (in cubic feet per second) from October through December 2013.

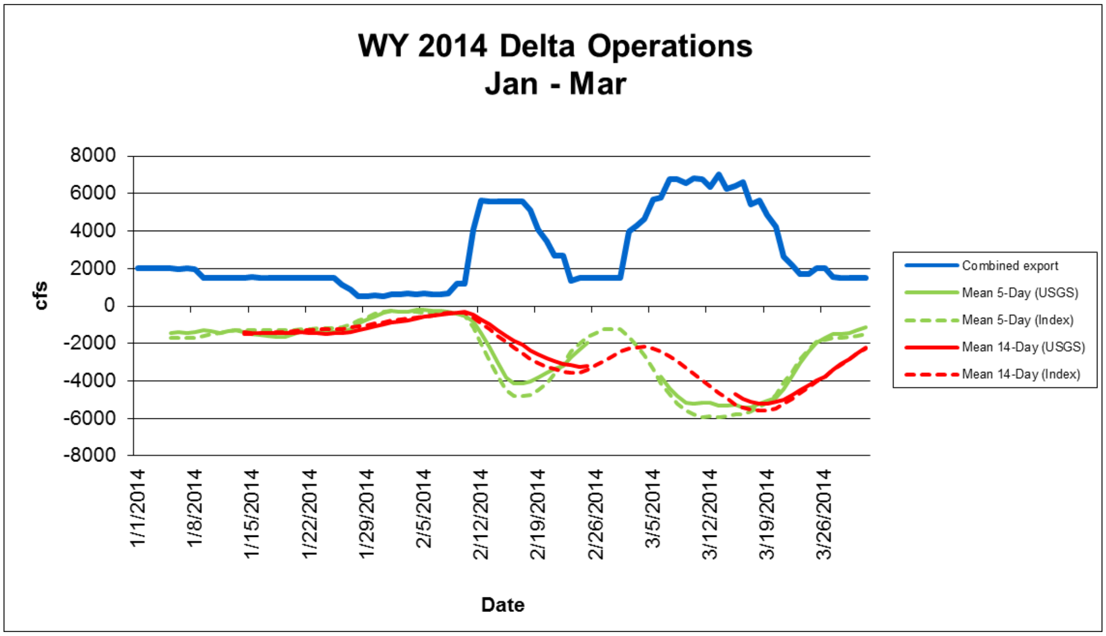


Figure 5.2 Combined exports at the CVP and SWP (blue, in cubic feet per second) and Old and Middle river flows (red and green, in cubic feet per second) from January through March 2014.

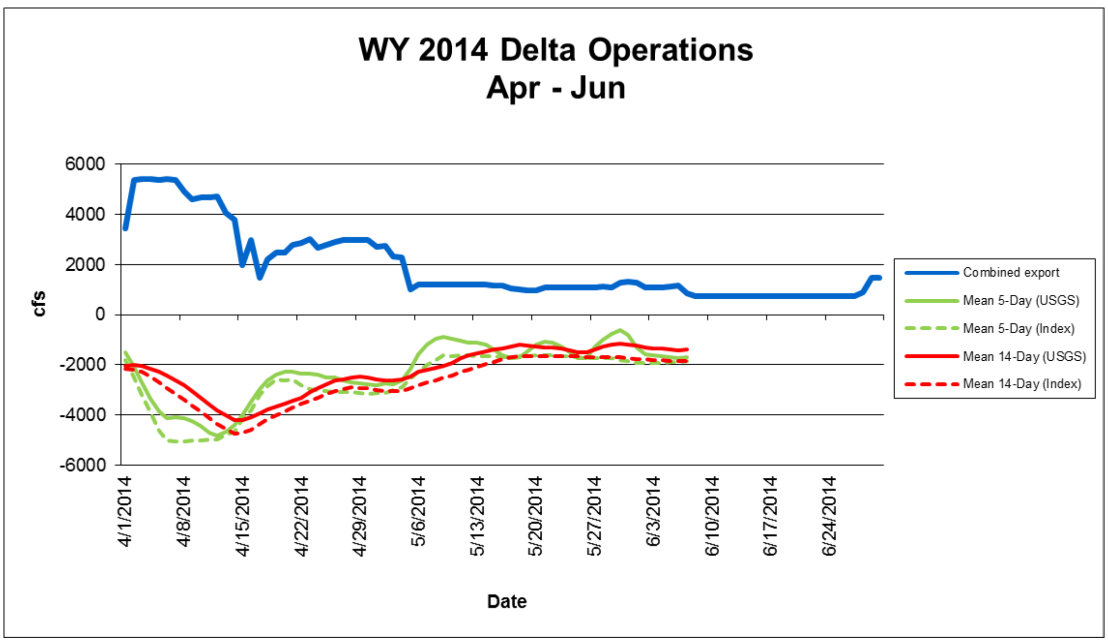


Figure 5.3 Combined exports at the CVP and SWP (blue, in cubic feet per second) and Old and Middle river flows (red and green, in cubic feet per second) from April through June 2014.

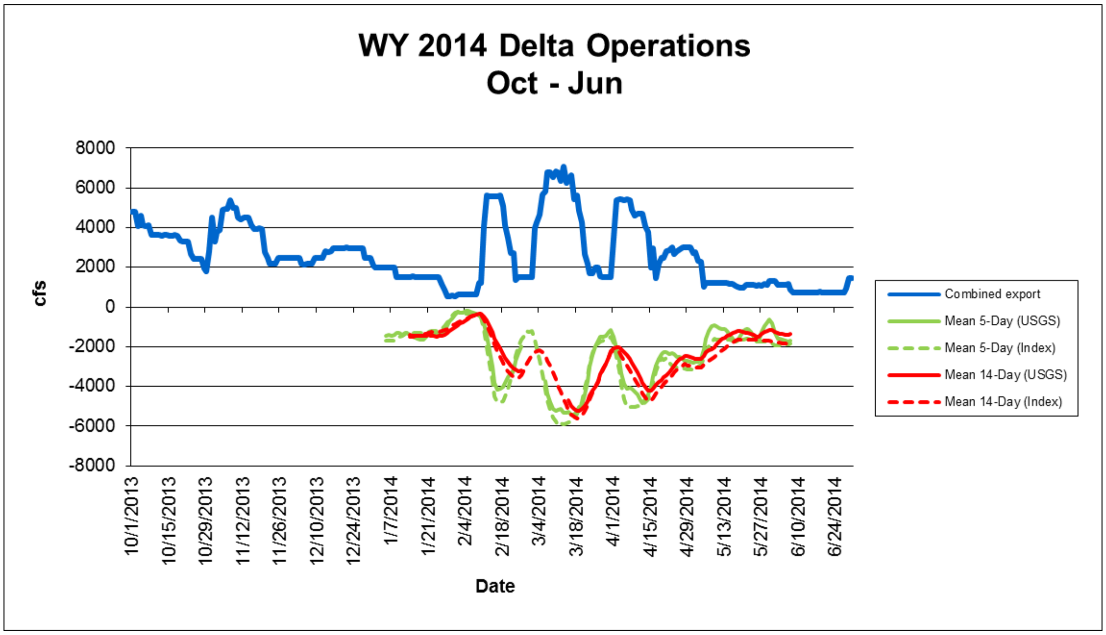


Figure 5.4 Combined exports at the CVP and SWP (blue, in cubic feet per second) and Old and Middle river flows (red and green, in cubic feet per second) from October 2013 through June 2014.

Chapter 6— Monitoring Activities

6.1 WY 2014 Monitoring summary (see also Appendix A)

The Annual Incidental Take Report, included as Appendix A, is a document prepared by DWR and Reclamation that provides a detailed summary of WY 2014 monitoring activities. However, during WY 2014, DOSS started to estimate fish distribution in the Delta based on the available catch and hydrological data. Starting in early March, 2014, members reviewed the weekly fish monitoring data and other related data (hydrology, weather forecast, hatchery release) to estimate the distribution of ESA-listed Chinook salmon. Separate estimates were made for young-of-year (YOY) winter-run, yearling spring-run, and YOY spring-run Chinook salmon. This estimation was initially started to give the Real Time Drought Operations Team an overview of the fisheries condition for consideration in drought-related operations. The assessment of Chinook salmon distribution was categorized in three following geographic "bins" that add up to 100%: *Yet to enter Delta, In the Delta, and Exited the Delta past Chipps Island.* DOSS members thought that many of the YOY spring-run-sized Chinook salmon in the monitoring data could be from the millions of fall-run hatchery fish that were released at Rio Vista and in Battle Creek, and DOSS considered this "spillover" when estimating YOY spring-run Chinook distribution. However, DOSS was unable to adjust the estimation with any precision because the ranges for the YOY spring-run distribution were rather wide. As the water year progressed, members discussed the various factors influencing fish migration and reviewed monitoring data to estimate the percentage for each category. The estimation was intended to provide an overview for the distribution of fish which might be hard to get from individual catch information.

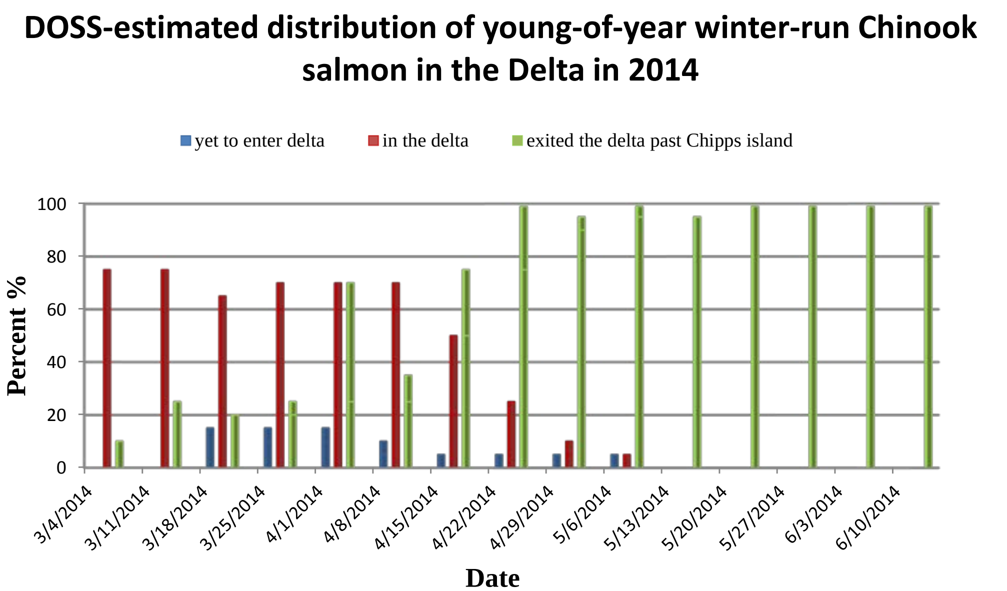
Figures 6.1 and 6.2 summarize the DOSS estimates for the proportion of the YOY winter run-Chinook salmon and YOY spring run Chinook salmon in each of the three geographic bins, as the year progressed. DOSS began to estimate the fish distribution in mid-March, around the same time period as the group felt the majority of yearling spring-run Chinook salmon were exiting the Delta and as such their distribution information is not conveyed in a graph.

While for some periods there appears to be little change in the DOSS estimate for winter-run Chinook distribution (Figure 3) from week to week, the pattern shifted dramatically with the large flow pulse in April when DOSS concluded that any remaining winter-run sized Chinook in the Delta would likely have exited the Delta past Chipps Island.

The trend for YOY spring-run Chinook salmon (Figure 3) shows that by early May, DOSS estimated that most of them were in the Delta, and that by early June DOSS estimated that most or all had exited the Delta. A significant number were estimated to have moved into the Delta with the storm that occurred in early April. DOSS members thought that the release of millions of hatchery fall-run in Battle Creek, a tributary of the Sacramento River, might have caused a "Pied Piper" effect and that YOY spring run might have moved out with the hatchery fish.

A comparison in trends between years is not possible for this year's report as this is the first year DOSS started reviewing the fish monitoring and hydrology data to estimate fish distribution throughout the Delta. DOSS is planning to continue these estimates of the proportion of the population in different areas of the Central Valley for next year, with some possible restructuring.

After multiple consecutive years, it may be possible to undertake a comparative analysis of the trends in estimated distribution.



Data Source: Weekly Meeting Notes for Delta Operations for Salmonids and Sturgeon (DOSS) group provided by NMFS.

Figure 6.1. Seasonal distribution of young-of-year winter-run Chinook salmon in the Delta in 2014

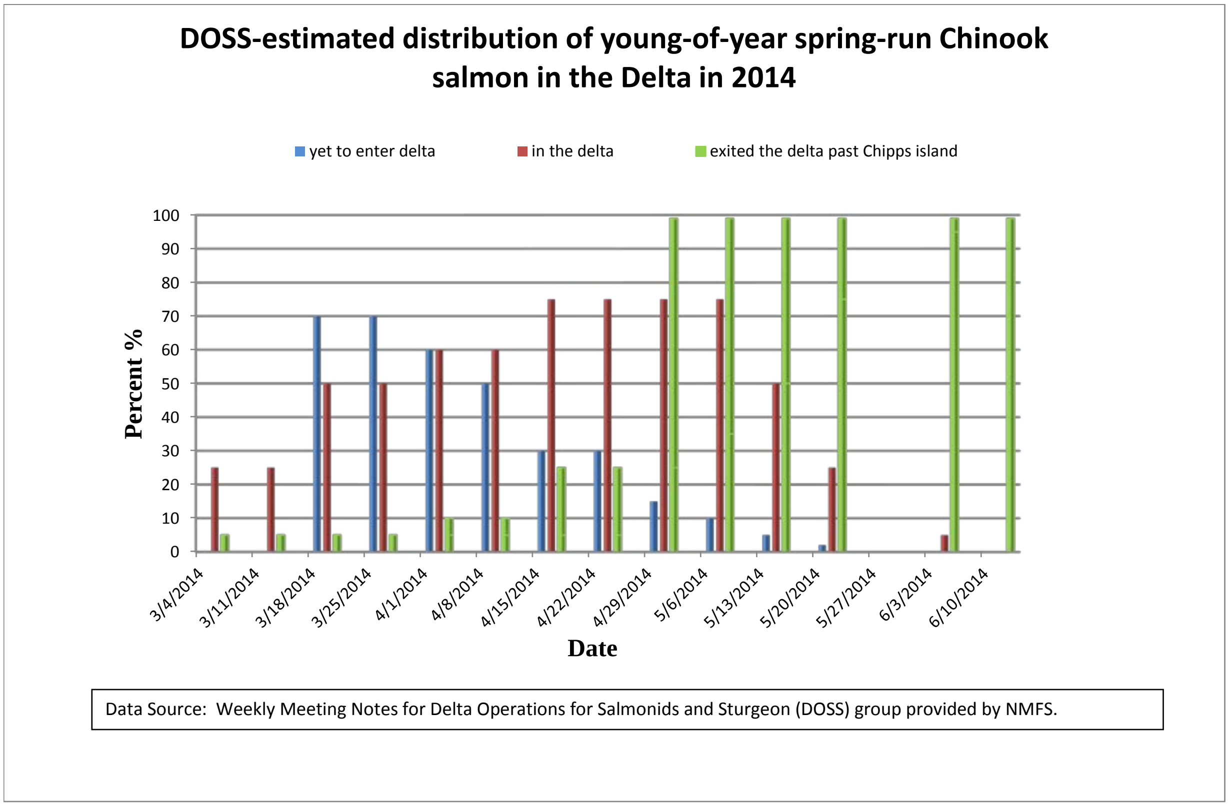


Figure 6.2. Seasonal distribution of young-of-year spring-run Chinook salmon in the Delta in 2014

6.2 Monitoring gaps due to partial government shutdown in October 2013

6.2.1 Red Bluff Diversion Dam gap increased uncertainty in estimate of juvenile production index for winter-run Chinook salmon.

The Red Bluff RSTs did not sample from 10/1 to 10/17 during the partial federal government shutdown. Unfortunately, per FWS staff in Red Bluff, the estimated peak of winter-run Chinook passage (predicted based on spawning timing and temperature-dependent fry development rates) was expected to have occurred during the gap in sampling. The sampling supported this because catch was on the rise when the RSTs were pulled and catch was steadily decreasing when the RSTs were sampling again.

Daily passage for the non-sampled period of 10/1 to 10/17 was interpolated using a monthly mean daily passage estimated calculated from data collected between 10/18 and 10/31.

NMFS management was aware of the gap in juvenile winter-run monitoring data and the possibility of not being able to compare the NMFS-calculated JPE (based on carcass surveys and other information) to the JPI (that uses the Red Bluff RST counts) in its annual JPE letter. This was acknowledged in the JPE letter.

6.2.2 Delta Juvenile Fish Monitoring Program gap limited implementation of Delta Cross Channel triggers in Action IV.1.2

From October 1 through November 30, depending on water quality conditions, a Knights Landing Catch Index or Sacramento Catch Index of greater than 3 fish per day could trigger DCC gate closure. However, the usual Delta Juvenile Fish Monitoring Program sampling, including the beach seines and Sacramento trawls used to calculate the Sacramento Catch Index, did not occur from 10/1 to 10/17 during the partial federal government shutdown because USFWS field staff were furloughed. Because the Knights Landing rotary screw traps are staffed by a state agency, CDFW, sampling at Knights Landing was not disrupted by the partial federal government shutdown. So, while staff of the state agencies were monitoring data for BiOp implementation during the partial federal government shutdown, only the Knights Landing Catch Index was available for use in evaluating the DCC triggers.

6.3 Mill and Deer Creek monitoring and modification to first alert in Action IV.1.1 for Oct and November of 2013.

RPA Action IV.1.1 describes two alerts that are signals that juvenile Chinook salmon may be migrating down the Sacramento River and indicate that Delta Cross Channel gate operations may need to be altered in the near future per the triggers in Action IV.1.2. In the 2009 BiOp, the first component of the first alert was triggered when there was capture of yearling-sized (>70 mm) spring-run Chinook salmon at the rotary screw traps (RSTs) in Mill Creek or Deer Creek. Because rotary screw trapping operations no longer occur on Mill Creek and Deer Creek, NMFS approved a request from Reclamation and DWR that the first component of the first alert be replaced by a hydrologic criterion which triggers when flows are greater than 110 cfs in Deer or Mill creeks.

6.4 Protocol shifts and sampling at Tisdale and Knights Landing

Background from WY 2013

In WY 2013, concerns about take at the Tisdale and Knights Landing rotary screw trapping (RST) locations resulted in the shutdown of those monitoring sites on 12/15/12. While Tisdale sampling was resumed on 3/4/13 under a modified protocol, sampling at Knights Landing did not resume during the 2013 juvenile salmonid outmigration season. Without data from the Knights Landing rotary screw traps, no Knights Landing Catch Index could be calculated after 12/15/12.

The Knights Landing Catch Index (KLCI) is the basis of an action trigger in Action IV.1.2 (DCC gate operation) from October 1 through December 14 of each year, so the shutdown of sampling at Knights Landing didn't affect implementation of Action IV.1.2 in WY 2013. The KLCI is also the basis of one component of a third alert for Action IV.3 (Reduce entrainment at the export facilities) from November 1-December 31 of each year. For the second half of December 2012, just the Sacramento Catch Index component of the third alert was implemented. Because none of the action triggers for Action IV.3 (which, if triggered, would limit combined exports to 6,000 cfs or 4,000 cfs) are based on the KLCI, the shutdown of sampling at Knights Landing didn't substantively affect implementation of Action IV.3 in WY 2013.

WY 2014

To reduce the likelihood of take concerns and potential sampling gaps in WY 2014, both the Tisdale and Knights Landing rotary screw trapping locations are being sampled according to a modified protocol which, among other provisions, effectively limits nighttime sampling once ESA-listed species are observed in the trap's catch.

Specifically, the *Daily Rotary Screw Trap Operations Protocol* includes the following actions:

I. Traps will be checked twice daily during periods when there is a high potential for listed species to be emigrating (October-early May). During other times of the year when salmonid catch is negligible trap checks may occur at longer intervals depending upon conditions observed. Two checks daily will be used as a baseline to identify the presence of listed species passing through the middle river. Catch of listed species will be seen as an indicator of the potential that greater numbers of listed species could be emigrating.
   A. When low numbers (1-5) of ESA-listed species are observed in the traps, the traps will be monitored continuously as described above. All debris will be constantly removed from cones and live wells. No fishing will occur during dark hours. This will be continued until observations of listed species cease for two days, flow forecasts are stable, no debris is observed upstream of traps, and then normal fishing operations will resume.

The data from Knights Landing and Tisdale show that, at least during pulses in fish passage, the catch per unit effort is higher at night than during the day. This might be due to greater fish movement at night, greater trap efficiency at night (when fish are less able to see and avoid the trap), or both. DOSS had several discussions about how to interpret trends in RST catch at Tisdale and Knights Landing when both total sampling effort and CPUE may be reduced during pulses of juvenile salmonid outmigration – a time at which the KLCI is particularly important for management of Delta Cross Channel (DCC) gate operations.

In WY 2014, as mentioned in Chapter 4, the drought contingency plans included modifications to DCC operations that included triggers based on the KLCI. Because of the potential impacts of sampling protocol on the sensitivity of the KLCI, technical and management staff developed a series of triggers and actions necessary to allow for flexibility in water operations. One such modification to current operations included the Delta Cross Channel (DCC) gate operations—continuous monitoring of juvenile salmonid emigration at Knights Landing during the period of modified DCC operations was necessary to keep management informed for making decisions on a more real-time basis in order to protect ESA-listed salmonids to the extent possible, while also allowing for increased water savings. Because of the potential impacts of sampling protocol on the sensitivity of the KLCI,, the protocol at Knights Landing was changed as follows:

I. Traps will be checked twice daily during periods when there is a high potential for listed species to be emigrating (October-early May). During other times of the year when salmonid catch is negligible trap checks may occur at longer intervals depending upon conditions observed. Two checks daily will be used as a baseline to identify the presence of listed species passing through the middle river. Catch of listed species will be seen as an indicator of the potential that greater numbers of listed species could be emigrating.
   A. When low numbers (5 or more) of ESA-listed species are observed in the traps, the traps will be monitoring continuously as described above. The appropriate agency contacts (NMFS, CDFW, and CDWR) will be informed immediately to allow for discussion as to whether continued sampling is warranted given total catch numbers and environmental conditions. Continuous sampling at this site

was expected to enable the implementation of adaptive management practices and aid in the recovery and protection of the Sacramento River's anadromous fish populations. The temporary change was to remain in place until NMFS and CDFW determined that continuous sampling for the purpose of informing management decisions was no longer warranted.

6.5 Summary of sampling gaps at the export facilities in WY 2014

Routine, experimental, and maintenance-related changes to the operations of the Delta fish salvage facilities affect the performance of these facilities to salvage entrained fish. One major factor influencing the salvage efficiency of the Central Valley Project Tracy Fish Collection Facility is the occurrence of routine outages scheduled to clean the primary and secondary channels' louvers of accumulated debris. Debris loads have always been high in the south Delta and the Tracy Fish Collection Facility purposely selected salvage equipment that could handle large amounts of debris (floating deflector boom, trash rack, and louvers). However, debris conditions have rapidly increased in recent years following the introduction of *Egeria densa* and the installation of the three agriculture barriers during the spring and summer months. Surges of debris routinely enters the fish facility after storms that cause high water events, rapid changes in the amount of water exported, freezing temperatures that kill water hyacinth and allows mats to float downstream, and the removal of South Delta temporary barriers. The South Delta temporary barriers provide a lake environment for water hyacinth, which has been in the Delta for 100 years, and the more recently introduced *E. densa*. Starting in fall these barriers are removed and plant material growing behind the barriers is delivered to the fish facilities to such an extent that it overwhelms operations (October to February). Cleaning louvers is necessary to maintain and target operational standards related to bypass ratios and channel velocities. However, from October to February of each year these target values cannot be attained for long periods after cleaning due to the quantity of debris entering the system. During these cleaning periods (Figure 6.3), louvers are removed and fish are not sampled since they can enter the canal instead of bypasses. Between October 1 2013 and June 30 2014, primary louvers were removed on 50% (156 days) of the days for between zero and 855 minutes (Figure 6.4, median= 90 minutes). During this period, secondary louvers were cleaned on 25% (64 days) of the days for between zero and 275 minutes (Figure 6.5, median= 36 minutes). The SWP Skinner Fish Facility can independently clean its primary and secondary louvers without affecting salvage performance.

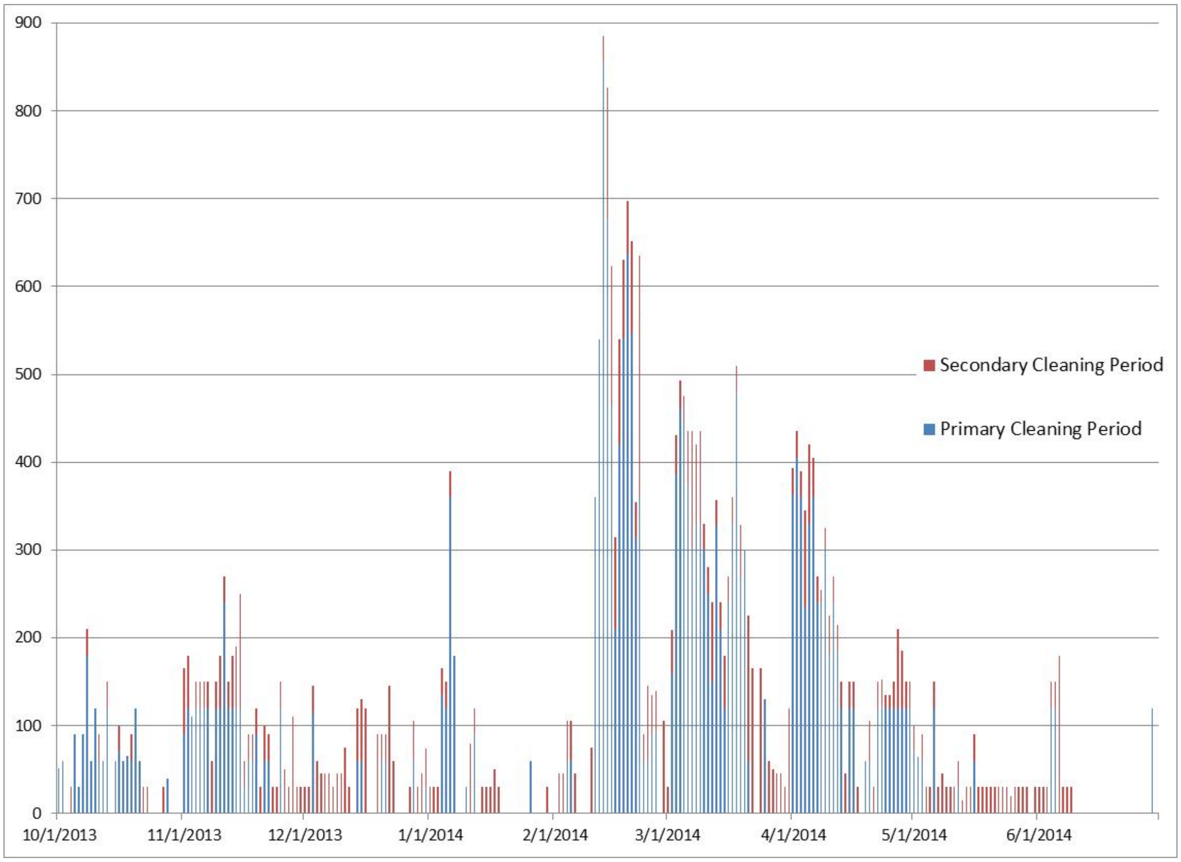


Figure 6.3. Daily cumulative cleaning periods for primary and secondary cleaning between October 1 2013 and June 30 2014 at the Tracy Fish Collection Facility.

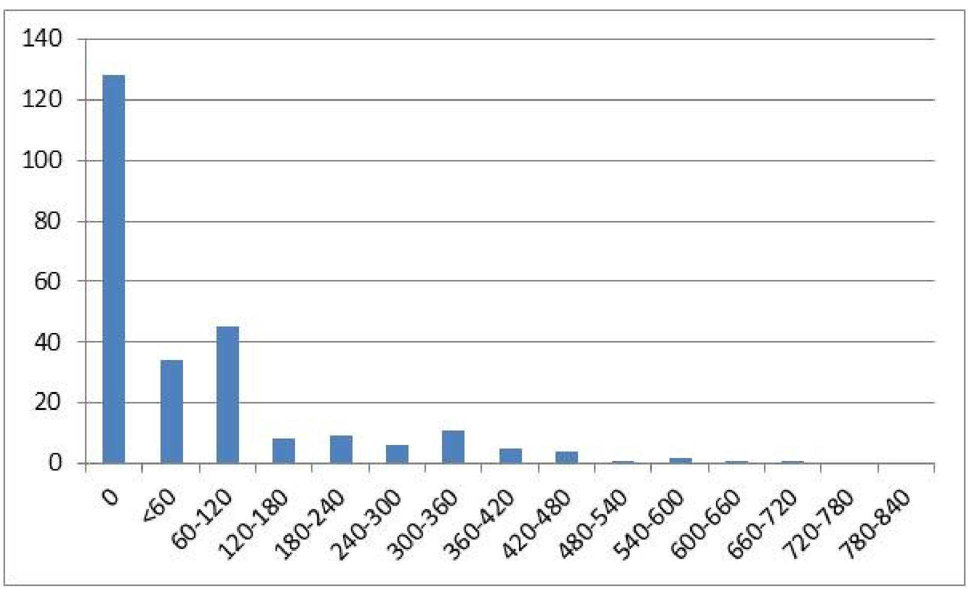


Figure 6.4. Frequency of cleaning period duration for primary channel cleaning between October 1 2013 and June 30 2014 at the Tracy Fish Collection Facility.

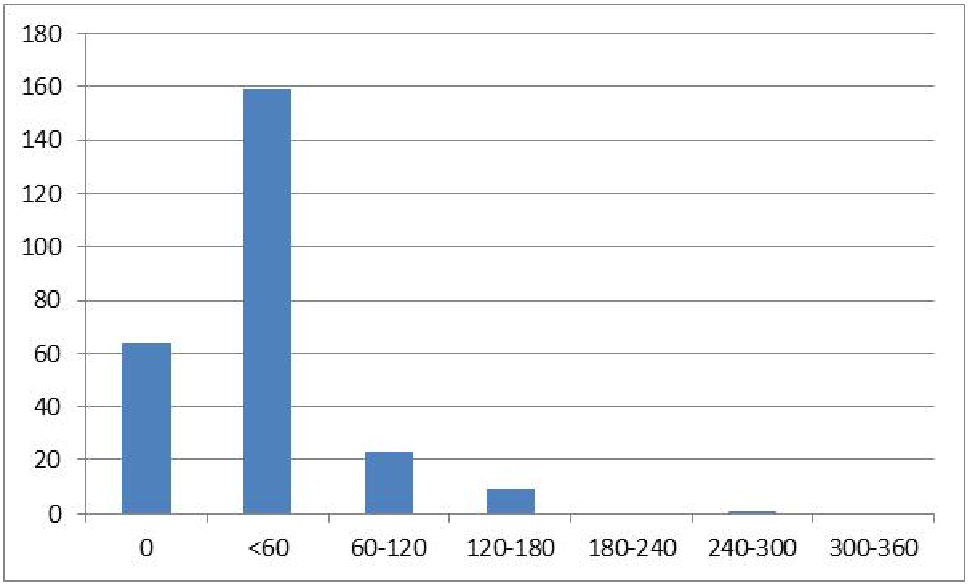


Figure 6.5 Frequency of cleaning period duration for secondary channel cleaning between October 1 2013 and June 30 2014 at the Tracy Fish Collection Facility.

Fish facility outages not accompanied with concurrent shutdowns of the export pumping plant can bias entrainment related losses or cause challenges to estimating these losses. During the pre- or post-construction installation of the Hydrolox screen project, the Tracy Fish Collection Facility experienced 11 facility outages when the Jones Pumping Plant continued export operations (Table 6.1). Duration of these outages ranged from 1.2 to 3.0 hours and resulted in 8 missed routine salvage counts. An interim loss calculation was used to estimate salmonid loss on 2 of the 8 missed counts (3/12/14 and 3/18/14). Three other repair or maintenance related shutdowns were also reported.

Table 6.1. Facility outages or major operational variances that occurred at the Tracy Fish Collection Facility during the period of October 1, 2013 to July 2, 2014.

DATE	DURATION	DESCRIPTION
11/12/13	1.3 h	Secondary channel de-watered for contractor inspection
12/11/13	1.2 h	Same as above
12/19/13	2.5 h	Same as above; one scheduled count missed
1/3-13/14	10 days	Primary bypass #4 closed due gate failure
1/9/14	3.75 h	Facility shutdown due to "oil" leak
2/6/14	10 h	Primary bypass #4 closed due electrical problems

2/9/14	5 days	Same as above
2/19/14	3.5 h	Removed old secondary screen water screen
3/4/14	16 h	Primary bypass #4 closed and gate broken
3/12/14	2.0 h	Secondary channel de-watered for contractor work; one scheduled count missed and interim loss calculation used
3/13/14	2.0 h	Secondary channel de-watered for contractor work; one scheduled count missed
3/18/14	2.0 h	Secondary channel de-watered for contractor work; one scheduled count missed and interim loss calculation used
3/19/14	2.0 h	Secondary channel de-watered for contractor work; one scheduled count missed
3/20/14	2.0 h	Secondary channel de-watered for contractor work; one scheduled count missed
4/25/14	35 min	Facility shutdown due to installation of a low pressure pump
4/29/14	15 min	Facility shutdown due to electrical work
6/3/14	3 hours	Power outage associated with Hydrolox screen project; one scheduled count missed
7/2/14	95 min	Facility shutdown due to contractor work; one count missed

The closure of primary louver bypasses is believed to affect the salvage efficiency due to the loss of available fish entrances to the remainder of the fish salvage facility. In 2013-2014 the Tracy Fish Collection Facility (TFCF) experienced higher proportion of time where one or more of the four primary bypasses closed compared to recent years (Table 6.2). The first quarter of 2014 had 374 counts where one or more bypasses closed and represented roughly 748 hours of salvage operation. The 374 counts in 2014 were a 2.4-fold increase compared to bypass closures in 2013 (159 counts) and was only second to closures in 1993 (389 counts). Failure of the Number 4 bypass gate system, secondary louver cleaning, and closure of bypasses for debris management purposes were the most common reasons given for these events. Closure of the Number 4 bypass was of major concern because of the relatively long duration of the closures (up to 10 days), and due to past observations suggesting that more salvaged fish used this bypass.

Table 6.2. Summary of primary louver bypass closures for 1993-2014. Number of fish counts when 1 or more of the primary bypasses were closed. One fish count at the TFCF typically represents 120 minutes of salvage operation. Totals do not include count times when all 4 primary bypasses were closed.

		Number of events when 1 or more bypasses were closed					
Year	**Fish Counts**	**0 - 2 h**	**3 - 12 h**	**13 - 24 h**	**25 - 48 h**	**49 - 96 h**	**> 96 h**
1993	389	60	1	1			1 (630 h)
1994	66	64	1				
1995	14	14					
1996	275	13	2	2	2	1	2
1997	61	13	3	4			
1998	264	5	3	1	1		2
1999	5	5					
2000	1	1					
2001	42		1			1	
2002	1	1					
2003	0						
2004	11		2				
2005	15	1	3				
2006	17	6	4				
2007	2	1					
2008	2		1				
2009	7	3	1				
2010	4	4					
2011	28	1				1	

2012	34	1		1	1		
2013	159	6	1				1
2014*	374		13	1	2		3

*Fish count total through March 5, 2014

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Appendix A: Incidental Take Report With Comparison of Loss Estimate

2013/2014
SALMONID AND GREEN STURGEON
INCIDENTAL TAKE AND MONITORING REPORT

October 1, 2014

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2013/2014 SALMONID AND GREEN STURGEON INCIDENTAL TAKE AND MONITORING REPORT

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2013/2014 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 2013/2014. This report also includes data from a wide geographic area including the salmonid monitoring program for the lower Sacramento River and the Delta (Figure 1), and the hydrologic conditions in the Delta.

In addition to this annual report, the California Department of Water Resources (DWR) and the United States Bureau of Reclamation (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 2013/2014 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.westcoast.fisheries.noaa.gov/central_valley/water_operations/doss.html

Data Acquisition

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, therefore, the data presented in this report are preliminary and subject to revision. DWR and Reclamation will add an addendum to this report if analysis of the finalized data leads to substantial changes to the results.

Methods for Measuring Incidental Take

Current Method

For this report, DWR and Reclamation quantified incidental take for the listed species to the nearest whole fish at each facility using the current methods that are described in the 2009 NMFS Biological Opinion. DWR and Reclamation estimated the incidental take of steelhead and green sturgeon based on salvage, and estimated the incidental take of Chinook salmon based on loss using the procedures in DFW (2013). For implementation of NMFS Reasonable and Prudent Alternative (RPA) Action IV.2.3, DWR and Reclamation also estimated daily steelhead loss using the interim DOSS (2011) method, which expands for steelhead loss from salvage using Chinook salmon expansion factors.

However, there was some uncertainty associated with the salvage and loss estimates in 2013/2014, for several reasons. First, Reclamation replaced two existing rows of the secondary louvers at the CVP fish facility during the summer of 2014 with a single line of traveling screens that are self-cleaning. Installation of these traveling screens meant that Reclamation would no longer need to dewater the secondary channel for screen cleaning, which prevented Reclamation from salvaging fish. Before construction, secondary channel inspections required periodic shutdowns of salvage operations at the CVP fish facility and continued pumping at the Jones Pumping Plant. To account for potential loss from these shutdowns, Reclamation proposed an interim fill-in method to NMFS based on the following criteria:

a) One Fish Count Missed: Add salvage and loss from the fish count after the missed fish count to estimate potential loss.
b) Two or More Fish Counts Missed: Use averaged sum of salvage and loss from the fish count before and after the missed fish counts to estimate potential loss.

NMFS approved the interim method for 2013/2014 and DFW applied the interim method for tracking incidental take of listed NMFS species and for implementation of NMFS RPA Action IV.2.3. In total, DFW applied the fill in method on March 12 and March 18, 2014, at the 1200 hour outages to estimate potential winter-run Chinook salmon loss. However, the application of the fill-in method is preliminary since NMFS could still revise the application of the method.

In addition, not all of the primary bypasses were open during salvage operations at the CVP facility on certain days due to technical issues, which could lead to bias in the salvage estimates. This is especially important when primary bypass #4 is closed since this bypass normally collects a greater proportion of the louvered fish from the primary intake channel when compared to the other upstream bypasses. Reclamation and DWR discussed potential ways to account for this bias in the salvage estimates with DFW, but no interim method was officially used to account for potential salvage from the primary bypass issues in 2013/2014.

During discussions about the primary bypass issues, Reclamation and DWR noted that DFW could be incorrectly estimating the loss of Chinook salmon at the CVP fish facility.

It appeared that DFW was adjusting the primary channel width based on the number of bypasses that are open for the screen efficiency estimation of the DFW (2013) loss calculation. However, the primary width should be set at 84 feet, regardless of how many primary bypasses that are open. The water velocity in the primary channel is not influenced by how many bypasses that is open in the primary channel. If the width is made narrower in the calculation, then it will artificially boost the primary channel velocity and give the wrong reading using the regression formulas for estimating screen efficiency. As of September 2014, DFW is still working with DWR and Reclamation to investigate the extent of the incorrect application of the DFW (2013) loss equation. For 2013/2014, no Chinook salmon were observed during normal salvage operations when Reclamation closed a primary bypass. Thus, this issue did not have any impact on the loss estimates in 2013/2014. If the incorrect application of the loss equation has an impact on the loss estimates in other years, then DWR and Reclamation will add an addendum to past incidental take reports when the DFW investigation is complete.

Alternative Methods

At present, there is a high degree of uncertainty and poor documentation associated with the current methods used to estimate loss or incidental take of Chinook salmon, steelhead, and green sturgeon. Reclamation is required to improve the quantification of loss by developing an alternative technique to quantify incidental take of listed anadromous species at the Delta fish facilities in compliance with Term and Condition 2a of the 2009 NMFS Biological Opinion. In the summer of 2013, Reclamation and DWR, with guidance from the interagency Term and Condition 2a Technical Work Team (technical team), drafted Anonymous (2013) to describe the proposed modifications to the current methods for estimating loss. Anonymous (2013) was drafted for independent review and consideration at the 2013 Long-Term Operations Biological Opinions (LOBO) Annual Review, and was based on various documents drafted for the Term and Condition 2a process. These documents include:

1) Jahn (2011), which describes an alternative technique for estimating point and confidence interval estimates of loss;
2) CFS (2013), which describes the most important terms in the modified Jahn (2011) loss equation for estimating loss and the contribution each term makes to the overall variance of loss; and
3) a two year comparison of the Jahn (2011) method with the current methods for estimating incidental take, which is documented in the 2011/2012 and 2012/2013 incidental take and monitoring reports (see DWR and Reclamation 2012; DWR and Reclamation 2013).

However, the Independent Review Panel (IRP) for the 2013 LOBO review expressed concerns in their final report on the Jahn (2011) model for calculating point and confidence interval estimates of loss, which would also apply to the Anonymous (2013) approach and to the current methods (see Anderson et al. 2013 for concerns). The

IRP's concerns include using fixed survival values in the equation, not accounting for probable losses from zero salvage, and using the error propagation method for characterizing uncertainty (Anderson et al. 2013). To address these concerns, the IRP provided recommendations on how to improve the loss and uncertainty estimates, including using a Bayesian method to account for probable losses from zero salvage and using a Monte Carlo simulation for estimating loss and its uncertainty (see Anderson et al. 2013 for recommendations).

To move forward with some of these approaches from the IRP, DWR and Reclamation will be working to develop alternative equations based on IRP input and evaluating these alternative equations in the annual incidental take and monitoring report. A comparison of multiple methods for estimating loss will help determine the most accurate estimate of loss, and Reclamation will eventually be able to move forward with a recommendation on the "best" technique for quantifying incidental take in compliance with Term and Condition 2a.

For 2013/2014, DWR and Reclamation will be evaluating the Anonymous (2013) approach for estimating loss of all listed NMFS species to the nearest whole fish at each facility. For the Anonymous (2013) approach, DWR and Reclamation also applied the fill-in method to estimate potential loss from salvage shutdowns when pumping continued at the CVP.

To quantify uncertainty in the loss estimates, DWR and Reclamation estimated confidence interval estimates of loss for Chinook salmon and steelhead to the nearest whole fish. However, DWR and Reclamation replaced the normal distribution formula for estimating confidence limits in Anonymous (2013) with a log-normal distribution formula:

$$\mathrm{CL} = \mathrm{K} * \exp\left\{\pm t_{0.05df}\sqrt{[\ln(1 + \mathrm{SE}(\mathrm{K})^2/\mathrm{K}^2)]}\right\} \quad \text{(Equation 1)}$$

Where CL= Confidence Limit, K= Loss, df=Degrees of Freedom, SE=Standard Error

Anonymous (2013) took the normal distribution formula from Jahn (2011), which led to negative lower confidence limits when loss was low, which typically occurred when quantifying incidental take of the hatchery Chinook salmon groups (see DWR and Reclamation 2012; DWR and Reclamation 2013). To address the issue of negative confidence limits, Dr. Andrew Jahn suggested using a log-normal distribution formula from Jahn and Smith (1987) during a meeting in October 2012. Therefore, DWR and Reclamation decided to evaluate Anonymous (2013) with a log-normal distribution formula in 2013/2014 since we are not making any assumptions about the distribution of the data. For reporting purposes, DWR and Reclamation will refer to the Anonymous (2013) approach with a log-normal distribution formula as the Anonymous (2013) approach.

However, the IRP does not recommend using a closed-form error propagation method for quantifying uncertainty. Instead, the IRP recommends treating entrainment and loss as random variables and estimating uncertainty via a Monte Carlo simulation (Anderson et al. 2013). Reclamation and DWR with guidance from the technical team are looking into this approach, but it would require further research and development before it is implementable. Nonetheless, the IRP did provide some suggestions to improve the closed-form error propagation method, which will also be evaluated in this report.

First, the IRP noted incorrect formulas in Jahn (2011) for the standard error of loss at each facility (equation 8) and for the standard error of loss at the combined SWP/CVP facilities (equation 9). The standard error of loss at the combined SWP/CVP facilities is used to estimate the confidence interval. To address the issue, the IRP provided the correct equations in Appendix 2 of Anderson et al. (2013), which are below:

$$SE(K) = \sqrt{(SE(G))^2 + \left(SE(H)\right)^2 - 2COV\,(G,H)} \quad \text{(Equation 2)}$$

Where SE= Standard Error, K= Loss at SWP or CVP, G= Entrainment, H=Salvage, COV= Covariance

$$SE(K_{Total}) = \sqrt{(SE(K_1))^2 + \left(SE(K_2)\right)^2 + 2COV\,(K_1, K_2)} \quad \text{(Equation 3)}$$

Where SE= Standard Error, K_1= SWP Loss, K_2= CVP Loss, COV= Covariance

For this report, DWR and Reclamation will refer to the use of these equations for estimating the confidence interval as the corrected Anonymous (2013) approach. In August 2014, Dr. Jahn confirmed that equation 7 and 8 were inaccurate in Jahn (2011) and confirmed the accuracy of equation 2 and 3 of this report. However, DWR and Reclamation do not have an estimate on the covariance of salvage and entrainment or the covariance of loss at each facility. For this reason, the covariance parameter is set at zero for both equations 2 and 3 of this report. Even so, it may not be reasonable to set the covariance of salvage and entrainment to zero because entrainment is likely to have a positive covariance with salvage because the Jahn (2011) model estimates entrainment from dividing salvage by survival (Anderson et al. 2013). In contrast, it may be reasonable to assume that the covariance between the CVP and SWP facility is zero, which implies that the facilities are mutually independent (Anderson et al. 2013).

In addition to the corrected Anonymous (2013) approach, the IRP also suggested replacing the standard error of entrainment formula (equation 7) and equation 8 of Jahn (2011) by applying the error propagation method to the entire loss expression using the equation:

$$SE(K) \approx \sqrt{\frac{(1-S)^2}{S^2}\left(SE(H)\right)^2 + \frac{H^2}{S^4}(SE(S))^2 - 2\frac{H(1-S)^2}{S^3}COV(H,S)} \quad \text{(Equation 4)}$$

Where SE= Standard Error, K= Loss at SWP or CVP, H=Salvage, S=Survival, COV= Covariance

Afterwards, DWR and Reclamation would estimate the combined SWP/CVP standard error of loss using equation 3 of this report. The IRP recommends this approach over the corrected Anonymous (2013) approach since it allows for DWR and Reclamation to make some reasonable assumptions about the covariance of salvage and survival. Therefore, DWR and Reclamation will refer to the use of equation 4 and 3 for estimating the confidence interval as the preferred Anonymous (2013) approach. This approach differs from the corrected Anonymous (2013) approach that requires information on the covariance of entrainment and survival in the standard error of loss equation for each facility, which is not known. However, DWR and Reclamation did not make any assumptions about the covariance of salvage and survival this year in equation 4, and assumed the covariance to be zero.

Observed Chinook Salmon Salvage

Figure 2 on page 23 describes the observed Chinook salmon salvage at the Delta fish facilities in 2013/2014 from normal salvage counts, special studies, and secondary flushes. However, Figure 2 does not depict any Chinook salmon that cannot be classified using the Delta model length-at-date criteria. This includes Chinook salmon that are larger than the length-at-date criteria considered in the model, and any Chinook salmon that were not measured for length. In 2013/2014, there were no Chinook salmon that fell outside of the length-at-criteria, but there was one observed Chinook salmon that was not measured for fork length at the CVP on May 12, 2014. The length-at-date race of this fish is not known. Moreover, estimated fish loss will be underestimated in 2013/2014 since loss cannot be expanded using the current methods without a fork length. Nevertheless, the date of salvage for this Chinook salmon is outside the period of when older juvenile Chinook salmon were salvaged at the Delta fish facilities.

Based on recent clarifications 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. The Delta Model categorizes two different brood years of winter-run Chinook salmon in July. For this month, DWR and Reclamation used the minimum winter-run length-at-date criteria for the older brood year.

In 2013/2014, all of the non-clipped observed older juvenile Chinook salmon salvage occurred in March and April 2014 (Figure 2). The initial pulse of older juvenile Chinook salmon in mid-March and early April coincided with increased Sacramento and San Joaquin River flows. In comparison, young-of-the-year (YOY) Chinook salmon were first observed at the Delta fish facilities around mid-March and were salvaged until the end of May.

Overall, the number of observed hatchery Chinook salmon at the Delta fish facilities was substantially lower in 2013/2014 than in 2012/2013. No specific hatchery group dominated salvage, but the Mokelumne fall-run brood year 2012 releases had the highest salvage out of all the hatchery fish observed in salvage.

Observed Chinook Salmon Genetic Run Assignment

Juvenile Chinook salmon were collected at the Delta fish facilities in 2013/2014 between the period of August 1, 2013, and July 31, 2014 (Figure 3). Tissue samples were taken from each juvenile Chinook salmon collected at the SWP and CVP and were submitted for genetic analysis.

At the SWP, 23 non-clipped juvenile Chinook salmon were observed and 23 samples were collected for DNA analysis in 2013/2014. All of these samples yielded usable DNA and were provided for analysis (Table 1). Eighteen of these 23 sampled fish were classified as winter-run Chinook salmon by the Delta Model, but only 1 of these 18 was classified as winter-run Chinook salmon on the basis of genetic analysis. In other words, only 5.6% of fish identified as winter-run Chinook salmon by the Delta Model were actually genotypically winter-run.

For the CVP, 302 non-clipped juvenile Chinook salmon were observed and 295 were collected in 2013/2014 (Table 1). Of these samples, 42 were classified as winter-run Chinook salmon by the Delta Model (Table 1). Samples were obtained from 41 of these and all were provided by the DFW Central Valley Tissue Archive (CVTA) for analysis. Of the 40 samples from winter-run sized juvenile Chinook salmon that were successfully processed, 11 were assigned to winter-run. For viable samples, 27.5% classified as winter-run were actually winter-run by genotype. Only one sample that was a true winter-run was not identified as such, a 93 mm Chinook collected at the CVP on March 17, 2014.

While the current loss calculation does not incorporate the genetic assignment data, efforts are being made to include them and one potential approach can be found in this report in the “Comparison of Alternative and Current Methods for Quantifying Incidental Take” section.

Winter-Run Chinook Salmon

Winter-Run Chinook Salmon Incidental Take

In 2013, DFW estimated a total adult escapement of 6,075 winter-run spawners to the upper Sacramento River, which is 227% higher than the estimated adult escapement of 2,674 spawners in 2012. The methodology (Cormack-Jolly-Seber Model) used in 2013 to calculate the annual winter-run escapement was the same as in 2012. This Cormack-Jolly-Seber model allowed for an estimation of the 90% confidence interval, which ranged from 5,275 to 6,667 fish. Based on the point estimate of escapement, NMFS calculated the juvenile production estimate (JPE) of natural (non-clipped) winter-run Chinook salmon entering the Delta in 2013/2014. However, NMFS made various changes to the survival terms used in the JPE calculation. First, the egg-to-fry survival term was changed from 0.25 to 0.27 based on two additional years of data at the Red Bluff Diversion Dam. Second, NMFS made changes to the smolts to Delta survival term based on recommendations from the Winter-Run Project Work Team (WRPWT).

In 2013/2014, the WRPWT met to review the JPE calculation method as the data from most recent acoustic tag studies became available. The use of acoustic tag studies would allow for direct comparison of in-river reach survival. This differs from the use of coded-wire tag (CWT) ocean recoveries of paired late-fall run Chinook salmon between Battle Creek and the Delta for estimating the smolts to Delta survival term. After reviewing the data, the WRPWT suggested two different proposals on how to change the smolts to Delta survival term in the JPE calculation method. The proposals were either to modify the value from 0.53625 either to 0.16 or to 0.39.

The 0.16 value was determined from in-river survival of rearing smolt winter-run Chinook salmon in water year 2013,a dry year, based on data from the Hassrick and Hayes (unpublished) study that estimated the juvenile acoustic tagged hatchery winter-run Chinook salmon survival between Red Bluff (Salt Creek) and Tower Bridge. In contrast, the 0.39 value was an average of in-river survival of rearing winter-run Chinook salmon in water year 2013 from Hassrick and Hayes (unpublished), and five years (2007-2011) of in-river survival data of migrating late-fall run Chinook salmon from Michel et al. (unpublished). However, due to uncertainties among the WRPWT members regarding the benefits and risks of proceeding with either proposal, there was no consensus on which proposal should be recommended for NMFS consideration. Therefore, the WRPWT submitted both proposals to NMFS.

Based on these two proposals by the WRPWT, NMFS decided to apply a weighted average to the acoustically-tagged winter-run and late fall-run data for the smolts to Delta survival term, which comes out to 0.27(Rea 2014). This value only included data from years with similar hydrological conditions, so it excluded the data from 2011 due to wet conditions. Using the acoustic tag data for the smolts to Delta term led to reach overlap with the fry to smolts survival term of 0.59 in the middle Sacramento River. Therefore, NMFS dropped the 0.59 value and combined the fry to smolts survival term in the middle Sacramento River and the smolts to Delta survival term into a single fry to smolts survival term.

Using the modified survival terms and based on the best available information, NMFS estimated that 1,196,387 natural origin juvenile winter-run Chinook salmon would enter the Delta. Based on this JPE, the incidental take level from October 1, 2013, through June 30, 2014, for the Delta fish facilities was 23,928 non-clipped winter-run Chinook salmon, which is 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, based on the Delta Model, occurred at both Delta fish facilities for an expanded loss of approximately 220 at the SWP and approximately 116 at the CVP. The combined expanded loss of winter-run Chinook salmon was 336 for the season; about 1.4% of the incidental take permitted. Overall, the combined annual winter-run Chinook salmon loss was lower than the previous water year and the lowest on record when compared to the past nine water years (Figure 5). However, there is some uncertainty with the loss estimates at the CVP in 2013/2014 due to the shutdown of salvage operations that occurred and continued pumping at the Jones Pumping Plant. In addition, there was one Chinook salmon that could not be categorized using the Delta model on May 12, 2014, since the fish jumped into the holding tank prior to processing and thus no fork length or genetic sample was taken. This fish was outside of the detection period for the length-at-date winter-run Chinook salmon loss at the Delta fish facilities, which occurred from March to April with a peak in March (Figure 4). Nevertheless, there is still uncertainty about the race, but DWR and Reclamation were well below the incidental take limit in 2013/2014.

In 2013/2014, there was no need for export reductions or for more restrictive Old and Middle River flow levels for the protection of non-clipped winter-run Chinook salmon. There were no older juvenile Chinook salmon triggers exceeded from November to December for export reductions in NMFS RPA IV.3. Similarly, there were no older juvenile Chinook salmon triggers exceeded from January to June for more restrictive OMR flow (Figure 4).

Hatchery Winter-Run Chinook Salmon Incidental Take

On February 10, 2014, an estimated 193,115 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, 190,905 were adipose fin clipped with a CWT. Based on preliminary release information and an updated survival term, NMFS estimated that 30,880 hatchery fish would enter the Delta. NMFS set the incidental take level at 1% of the total hatchery production entering the Delta, or 309 hatchery winter-run Chinook salmon from October 1, 2013, through June 30, 2014. There was no confirmed loss estimated of hatchery winter-run Chinook salmon at the Delta fish facilities (Table 2). Therefore, DWR and Reclamation were below the incidental take level.

One hatchery (adipose fin clipped) Chinook salmon was caught on April 8, 2014, at the CVP fish facility, but was released because the wand did not detect a CWT was present (i.e., there was no beep). Therefore, no CWT data could be retrieved from that fish (Table 3). The fork length of this Chinook salmon was recorded as 87 mm, which is below the minimum winter-run length on April 8 using the Delta Model length-at-date criteria. It is not likely that this unknown hatchery fish was from the hatchery winter-run Chinook salmon release based on the date and size of loss.

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.

In water year 2014, CNFH released three groups of late fall-run Chinook salmon uniquely marked as spring-run Chinook salmon surrogates into Battle Creek: 1) 68,516 on 1/07/14, 2) 81,962 on 1/13/14, and 3) 72,857 on 1/23/14. In addition to these surrogate releases, CNFH also released 267,301 late fall-run Chinook salmon into Battle Creek on 12/10/13 and 452,526 late fall-run Chinook salmon into Battle Creek on 1/13/14 to 1/14/14 as part of its production release. Prior to these releases, DOSS provided input to the CNFH on the release schedule of the spring-run Chinook salmon surrogates based on the information that the production release would occur during the first significant rainfall event in December. After reviewing the migration timing pattern of yearling spring-run Chinook in Mill and Deer creeks from 1994 through 2010, showing sparse RST catches February onward and due to the surrogate fish beginning to smolt, DOSS recommended that all surrogate groups be released by the end of January, 2014. A summary of more specific inputs provided from DOSS to CNFH is described in DOSS (2014).

Additionally in 2014, the San Joaquin River Restoration Program released an experimental group of approximately 60,114 Spring-run Chinook salmon into the San Joaquin River on April 17th and 18th. The released fish were raised at the Feather River Fish Hatchery, then transferred to net-pens below Friant Dam on the San Joaquin River, and finally transported to the release site on the San Joaquin River just above the Confluence with the Merced River. NMFS provided more details on the purpose, plan, and method of this experiment in the 2014 Technical memo which "*calculates and documents the proportionate contribution of Central Valley (CV) spring-run Chinook salmon originating from the reintroduction to the San Joaquin River and deducts or otherwise adjusts for this share of CV spring-run Chinook salmon take when applying the operational triggers and incidental take statements associated with the NMFS 2009 Biological Opinion...*"
All of the released fish were marked with an adipose fin-clip and CWT tag, and therefore will have no impact on the incidental take estimate. Coordination was reasonable, and

the tag number was known for comparison with salvaged CWT salmonid at the Delta export facilities in 2014. The technical memo acknowledges the challenge of identifying naturally produced spring-run Chinook salmon emigrating from the San Joaquin Basin, which is expected when returning fish enter the SJRRP to spawn in three years. NMFS is working with a technical team comprised of subject matter experts from various agencies to discuss possible issues and how to account for them.

More detailed Information (including the 2014 Technical Memorandum) related to the spring-run experimental population is available at:

http://www.westcoast.fisheries.noaa.gov/central_valley/san_joaquin/san_joaquin_reint.html

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, or due to released fish. For this reason, the actual loss could be higher than what is confirmed in Table 2. However, one adipose fin clipped Chinook salmon from a salvage count on April 8, 2014, at the CVP could not be determined for hatchery of origin since it was released. The expanded unknown loss of that CWT Chinook salmon was approximately 3 fish (Table 3). Even so, this loss is not likely from the spring-run surrogate groups since the fish was below the winter-run length criteria on the given date.

First Surrogate Release Group and Incidental Take

The first spring-run Chinook salmon surrogate hatchery group of approximately 68,516 CNFH late fall-run Chinook salmon was released on January 7, 2014. There was no spring surrogates salvaged this year from this group.

Second Surrogate Release Group and Incidental Take

On January 13, 2014, CNFH released the second spring-run Chinook salmon surrogate hatchery group of approximately 81,962 late fall-run Chinook salmon into Battle Creek. There was no spring surrogates salvaged this year from this group.

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Third Surrogate Release Group and Incidental Take

On January 23, 2014, CNFH released the third spring-run Chinook salmon surrogate hatchery group of approximately 73,600 late fall-run Chinook salmon into Battle Creek. There was no spring surrogates salvaged this year from this group.

Fry/Smolt Chinook Salmon Loss

The combined expanded loss of fry/smolt Chinook salmon salvaged between October 2013 and July 2014 was about 750 (Figure 6). 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. The Delta Model categorizes two different brood years of winter-run Chinook salmon in July. For this month, DWR and Reclamation used the minimum winter-run length-at-date criteria for the older brood year.

Similar to 2012/2013, most of the fry/smolt Chinook loss occurred between April and May. However, the majority of the monthly loss in 2013/2014 occurred in late April rather than in May. The annual loss in 2013/2014 was still notably low when compared to the last nine water years (Figure 7), particularly to 2010/2011, where the annual loss was at 86,781 from October to July. Interestingly, the annual loss increased during 2012/2013 from 2011/2012, but substantially decreased in 2013/2014 from 2012/2013 when the loss was about 11,147.

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. The Frank Fisher Model categorizes two different brood years of winter-run Chinook salmon in July and August. DWR and Reclamation used the minimum length of the dominant brood year of a reporting period for categorizing older juveniles and fry/smolts.

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 used the beach seine sites that have been active since August 2004.

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 0 surrogates from the first surrogate release, 3 surrogates from the second release group, and 2 surrogates from the third release group. The number of recovered surrogates was higher than the previous year (Figure 9). All surrogate catch occurred between early February and mid-March of 2014, which usually coincided with the catch of older juvenile Chinook salmon at the Sacramento trawl.

Additionally, USFWS recovered one surrogate from the first surrogate release and one surrogate from the second surrogate release from the north Delta seine region during mid-February of 2014. 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 a catch of 2 surrogates for the first surrogate release from late February to March 1 surrogate for the second surrogate release in February, and 3 surrogates for the third surrogate release in February that occurred on the same day. 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. The number of recovered surrogates was lower at Chipps Island than the previous year.

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 13 hatchery winter-run Chinook salmon from LSNFH in the Sacramento trawl and 17 hatchery winter-run Chinook salmon from LSNFH in the Chipps Island midwater trawl (Figure 8).
The USFWS recovered one hatchery winter run Chinook salmon in the north Delta beach seine region. This differed from the previous year where USFWS caught seven-hatchery winter-run Chinook salmon in the lower Sacramento River beach seine region, which coincided with older juvenile Chinook salmon collected at that location.

Non-Clipped Chinook Salmon Monitoring

In 2014, the frequency of sampling was increased during the fish migration period as part of the Drought Operations Plan (DOSS 2014). To standardize the data across years, DWR and Reclamation calculated the mean annual catch per unit effort (CPUE) of non-clipped older juvenile and fry/smolt Chinook salmon for each seine or tow using the following formula: (catch/volume) * 10,000. For this report, DWR and Reclamation calculated the mean annual CPUE for each sampling year (August to July) from 2004/2005 to 2013/2014. The mean annual CPUE is based on the mean monthly CPUE, which is based on the mean weekly CPUE for a given month. To estimate the mean weekly CPUE, DWR and Reclamation took the sum of the daily mean CPUE for each sample week and divided it by the number of sampling days in a given week. DWR and Reclamation defined the sample week as Sunday to Saturday. If the sample week occurred in more than one month, then DWR and Reclamation assigned a sample week to the month that contained the start of the sample week. Additional details on estimating the mean annual CPUE is found in Dekar et al. (2013).

Between August 2013 and July 2014, the annual mean CPUE of older juvenile and fry/smolt Chinook salmon 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). Overall, the annual mean CPUE was substantially lower in 2013/2014 than in 2012/2013 for older juveniles and noticeably higher for fry/smolts at the beach seines.

In the Sacramento River trawl, the annual mean CPUE for older juvenile Chinook salmon was noticeably lower in 2013/2014 when compared to 2012/2013, but noticeably higher for fry/smolt Chinook salmon (Figure 12 and 13). In the Chipps Island trawl, the annual mean CPUE remains in a similar range as 2012/2013 for older juveniles and fry/smolts (Figure 12 and 13). However, in comparison to the last nine water years, the annual mean CPUE of older juvenile Chinook salmon at Chipps Island in 2013/2014 was slightly higher than in 2012/2013 though the annual mean CPUE was still relatively low when compared to the other years since 2003/2004 (Figure 13).

Central Valley Steelhead

Steelhead Incidental Take

Between October 2013 and July 2014, greater than 79% of the non-clipped steelhead salvage occurred at the CVP. This differs from 2012/2013 where greater than 50% of the non-clipped steelhead salvage occurred at the SWP. For non-clipped steelhead, the CVP salvaged a total of 148 and the SWP salvaged a total of 37, with the most salvage occurring in April at the CVP and in March at the SWP (Figure 14). However, DWR and Reclamation did not exceed any steelhead loss triggers from January to June 2014 for more restrictive Old and Middle River flow limits (Figure 18). 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.

The SWP and CVP total expanded salvage of non-clipped steelhead was approximately 185 and remained well below the incidental take level of 3,000 fish for the water year (Figure 14). The annual salvage of non-clipped steelhead for 2013/2014 decreased by more than 50% from 2013/2014, which was 798(Figure 16,).

Salvage of hatchery (adipose fin clipped) steelhead peaked in March. From October 2013 to July 2014, the CVP salvaged a total of 183 and the SWP salvaged a total of 47 for a combined total annual salvage of 230 steelhead (Figure 15). Salvage of hatchery steelhead was much lower than the 2012/2013 total of 709 steelhead. The overall seasonal salvage for hatchery steelhead was extremely low compared to the data from the past nine water years (Figure 17).

Steelhead Monitoring

As mentioned in the “Non-Clipped Chinook Salmon Monitoring” sub-section, there was an increase in the frequency of sampling for the Drought Operations Plan (DOSS 2014). For consistency, DWR and Reclamation also estimated the mean annual CPUE for steelhead. From October 2013 to July 2014, the catch of steelhead from the USFWS DJFMP was predominantly hatchery origin fish (Figure 19), which is similar to 2012/2013. The mean annual CPUE at the Sacramento trawl remained in a similar range for non-clipped steelhead, but was higher for hatchery fish when compared to 2012/2013.

During 2013/2014, 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. The mean annual CPUE distribution among 4 regions shows the highest number at lower Sacramento seine region and none at south Delta region (Figure 20).

Accidental Mortality

In 2013/14, there was a onetime occurrence of steelhead accidental mortality reported at CVP. On April 5, 2014, an adipose fin clipped steelhead caught at the CVP was initially misidentified as adipose fin clipped Chinook salmon and therefore sacrificed.

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 2012/2013, no green sturgeon was salvaged at the Delta fish facilities between October and July in 2013/2014. The last salvage of green sturgeon was observed in 2010/2011 (Figure 21).

Delta Hydrology

Water year 2014 was even drier than water year 2013, which was already drier than the previous water year in both the Sacramento and San Joaquin basins (Figure 22). It was one of the driest water years in decades throughout the state. Regardless of the minor rainfall events in February and March, the combined rainfall has been well below normal during this year. A combination of very low rainfall, andsnow fall followed by two consecutive dry water years resulted in an urgent water crisis for the state. In response to the critical situation, the governor proclaimed a State of Emergency on January 17, 2014 and directed state officials to take all essential steps to reduce water consumption in order to make more water available.

More information on drought can be found on http://ca.gov/drought/.

The average monthly Sacramento River flows in 2013/2014 were significantly lower from December to February when compared to 2012/2013. The average monthly San Joaquin River flows were also lower in 2013/2014 throughout the water year. For water year 2014, the Sacramento Valley was classified as a "critical" water year type and the San Joaquin Valley was classified as a "critical" water year type. Table 4 on page 43 is a monthly average summary of SWP and CVP exports, Sacramento and San Joaquin River flows, and Delta outflow.

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 23 and 24. 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.

Comparison of Alternative and Current Methods for Quantifying Incidental Take

DWR and Reclamation did not exceed the annual take limits permitted by NMFS in 2013/2014 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. However, there is a high degree of uncertainty related to the current methods used to estimate incidental take, which the IRP highlighted during the 2013 LOBO review (see Anderson et al. 2013). For this reason, DWR and Reclamation compared the point and confidence interval estimates of loss using variations of the Anonymous (2013) approach with the current methods for quantifying incidental take. The results for 2013/2014 using these alternative methods for winter-run Chinook salmon, spring-run Chinook salmon surrogates, steelhead, and green sturgeon are documented below for comparative purposes.

Non-Clipped Winter-Run Chinook Salmon

DWR and Reclamation made a comparison of non-clipped winter-run Chinook salmon loss using the alternative Anonymous (2013) method and the current DFW (2013) method. The Anonymous (2013) is essentially the same as DFW (2013), but with a few refinements. Unlike DFW (2013), Anonymous (2013) applies a classification accuracy adjustment to winter-run sized Chinook salmon, applies a primary/secondary louver cleaning adjustment at the CVP fish facility, and accounts for any sacrificing of non-clipped winter-run Chinook salmon. For 2013/2014, DWR and Reclamation used a length-at-date classification accuracy of 5.6% at the SWP and 27.5%[1] at the CVP for winter-run sized Chinook salmon. However, one genetic winter-run Chinook salmon was not included in the classification accuracy at the CVP since it was outside of the winter-run length-at-date criteria.

From October 2013 to June 2014, the estimated loss using the DFW (2013) method for non-clipped winter-run Chinook salmon was about 220 fish at the SWP and 116 fish at the CVP for a combined loss of 336 fish (Table 5). This is about 1.4% of the annual incidental take level of 23,928 fish. In contrast, the estimated loss of non-clipped winter-run Chinook salmon using the Anonymous (2013) loss method is 12 fish at the SWP and 57 fish at the CVP for a combined loss of 69 fish (Table 5). This is about 0.29% of the annual incidental take level of 23,928 fish. However, NMFS based the current incidental take level on 2% of the JPE, which already accounts for misclassification of winter-run Chinook salmon using the length-at-date criteria. If genetics were incorporated into the management paradigm, then 1% of JPE would be a more appropriate incidental take level, which comes out to 11,964 fish in 2013/2014. If DWR and Reclamation used 1% of the JPE, then we would have reached 0.58% of the incidental take level using the Anonymous (2013) method.

The 95% confidence interval of the Anonymous (2013) point estimate ranges from 11 to 433 fish using Anonymous (2013), 11 to 454 fish using corrected Anonymous (2013), and 16 to 296 using preferred Anonymous (2013) (Table 5). Out of all the approaches, the preferred Anonymous (2013) approach led to the narrowest confidence interval. Moreover, the corrected Anonymous (2013) approach led to a slightly wider confidence interval than the Anonymous (2013) approach. In the end, the 95% upper confidence limit for all approaches was below 1% of the JPE.

In summary, the Anonymous (2013) loss method would lead to lower SWP and CVP

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[1]DWR and Reclamation also included special study fish for the CVP classification accuracy. In 2013/2014, we used the number of winter-run sized Chinook salmon that were successfully processed and the number of genetic winter-run Chinook salmon that were within the winter-run size category.

annual loss than the DFW (2013) loss method, which is due to the classification accuracy term. Interestingly, the annual combined CVP loss ended up being higher than the SWP loss with the Anonymous (2013) method, which differs from the estimates using the DFW (2013) method. This difference is likely due to a combination of the cleaning adjustment and lower classification accuracy rate at the SWP. Without the cleaning adjustment, the CVP loss using the Anonymous (2013) method would be lower than the CVP loss using DFW (2013) method. In 2013/2014, daily cleaning survival on days where the CVP fish facility salvaged non-clipped winter-run Chinook salmon ranged from approximately 67% to 98% for an average of 75%. This average survival is lower than the set cleaning survival of 88% in Jahn (2011).

As described in Anonymous (2013), the classification accuracy term would only apply to the annual loss estimate since genetic information will not be available in near real-time for implementation of NMFS RPA Action IV.3 from November to December and NMFS RPA Action IV.2.3 from January to June. Without the classification accuracy, the SWP loss using Anonymous (2013) should be the same as DFW (2013) unless there is an unintended sacrifice of the non-clipped fish. For CVP loss, the Anonymous (2013) should produce slightly higher levels of loss than DFW (2013) when not accounting for the classification accuracy if cleaning occurred at the facility.

There is potential for higher levels of loss using Anonymous (2013) for implementation of the RPA that could lead to more restrictive SWP/CVP operations. From November to December 2013, the Delta fish facilities did not salvage any older juvenile Chinook salmon. Therefore, there is no change in implementation for NMFS RPA Action IV.3. Similarly, DWR and Reclamation did not exceed any older juvenile Chinook salmon triggers when using current or alternative methods for implementation of NMFS RPA Action IV.2.3 from January to June 2014 (Figure 4 and 24). The difference of the daily combined non-clipped older juvenile Chinook salmon loss density between alternative and current methods ranged from 0.00 fish/TAF to 1.45 fish/TAF for an average of about 0.38 fish/TAF. This only accounts for days when the Delta fish facilities salvaged non-clipped older juvenile Chinook salmon. A difference of 0.00 fish/TAF indicates the days where salvage only occurred at the SWP fish facility.

Hatchery Winter-Run Chinook salmon and Spring-Run Chinook Salmon Surrogates

The Delta fish facilities did not salvage hatchery winter-run Chinook salmon from LSNFH or spring-run Chinook salmon surrogates from October 2013 to June 2014. Therefore, the loss is zero using the current DFW (2013) method and the alternative Anonymous (2013) method. The Anonymous (2013) method for quantifying loss of these hatchery fish is essentially the same as the current DFW (2013) method, but it also accounts for cleaning loss at the CVP fish facility and accounts for the intentional sacrifice of hatchery fish from CWT extraction.

Non-Clipped Steelhead

DWR and Reclamation made a comparison of steelhead loss using the alternative Anonymous (2013) method and the current interim DOSS (2011) method. The current interim DOSS (2011) method for estimating steelhead loss is based on Chinook salmon expansion factors. In comparison, the Anonymous (2013) method is modeled after the Jahn (2011) loss method using the medium survival rate, but incorporates variation in cleaning survival at the CVP fish facility. Unlike the DOSS (2011) method, the Anonymous (2013) method uses steelhead information for its parameters when available. Surrogate information has to be used at the CVP fish facility where the whole facility survival for steelhead is not yet known.

From October 2013 to July 2014, the estimated loss of non-clipped steelhead using the DOSS (2011) method was 160 fish at the SWP and 100 fish at the CVP for a combined loss of 260 fish (Table 6). In contrast, the estimated loss of non-clipped steelhead using the Anonymous (2013) method was 168 fish at the SWP and 183 fish at the CVP for a combined loss of 351 fish (Table 6). However, these results cannot be compared to the annual take limit for steelhead since the take limit is based on salvage.

The 95% confidence interval of the Anonymous (2013) point estimate ranges from 226 to 548 fish using Anonymous (2013), 221 to 559 fish using corrected Anonymous (2013), and 252 to 491 using preferred Anonymous (2013) (Table 6). Out of all the approaches, the preferred Anonymous (2013) approach led to the narrowest confidence interval. In addition, the corrected Anonymous (2013) approach led to a slightly wider confidence interval than the Anonymous (2013) approach.

In summary, the Anonymous (2013) loss method would lead to higher SWP and CVP annual loss than the DOSS (2011) method. Like with non-clipped winter-run Chinook salmon, the annual combined CVP loss ended up being higher than the SWP loss with the Anonymous (2013) method, which differs from the estimates using the DOSS (2011) method. This difference is due to the cleaning adjustment. Without the cleaning adjustment, the CVP loss using the Anonymous (2013) method would be lower than the CVP loss using DOSS (2011) method. In 2013/2014, daily cleaning survival on days where the CVP fish facility salvaged non-clipped steelhead ranged from approximately 38% to 98% for an average of 77%. This average survival is lower than the set cleaning survival of 88% in Jahn (2011).

A higher level of loss calculated using the Anonymous (2013) method could potentially lead to more restrictive SWP/CVP operations under NMFS RPA Action IV.2.3, which is in place from January to June 2014. During this period, DWR and Reclamation did not exceed any steelhead triggers when using current or alternative methods (Figure 18 and 26). The difference of the daily combined non-clipped steelhead loss density between alternative and current methods ranged from -0.09 fish/TAF to 3.39 fish/TAF for an average of about 0.38 fish/TAF. These differences only account for days when the Delta fish facilities salvaged non-clipped steelhead. Negative differences indicate that the alternative method could result in lower estimates of loss when compared to the current method if there was no SWP loss on a given day and CVP cleaning survival is high on a given day.

Green Sturgeon

There is currently no official method for estimating loss of green sturgeon, so DWR and Reclamation uses salvage to track incidental take at the Delta fish facilities. To improve upon this method, the Anonymous (2013) approach for green sturgeon describes a framework for estimating loss of green sturgeon. However, actual loss cannot be accurately calculated since there is no estimate of pre-screen loss. In the near future, DWR will be working with UC Davis to examine guidance efficiency and behavior of green sturgeon in a model louver array, and will examine predation risk to juvenile green sturgeon. Data from this study may help inform parameters for the framework described in Anonymous (2013). Until then, Anonymous (2013) recommends estimating loss by adjusting salvage for CVP cleaning and the number of green sturgeon released back to the Delta.

From October 2013 to July 2014, DWR and Reclamation did not salvage any green sturgeon at the Delta fish facilities. However, the salvage estimates using the current methodology could differ from the Anonymous (2013) approach. The salvage estimates from Anonymous (2013) would account for rescued adult green sturgeon that were impinged on the trash rack at the Delta fish facilities. Currently, impingement of adult green sturgeon on the trash racks is a rare occurrence at the Delta fish facilities. In 2013/2014, the Delta fish facilities did not report any impinged green sturgeon on the trash racks. Therefore, there is no difference in the salvage estimates between the current and Anonymous (2013) approach.

Summary

DWR and Reclamation did not exceed the incidental take level for winter-run Chinook salmon when using both the DFW (2013) and Anonymous (2013) methods. Steelhead loss using both methods cannot be contextualized in terms of the incidental take level that is based on salvage. When applied on a daily scale, the loss estimated using Anonymous (2013) for non-clipped winter-run sized Chinook salmon and steelhead would not have led to more restrictive SWP/CVP operations. Over the next year, DWR and Reclamation with guidance from the technical team will continue to address the recommendations from the IRP on improving the accuracy of loss, such as the need to consider the issue of zero data values and not using fixed survival values. Full details on how DWR and Reclamation plans to address IRP recommendations is found in DOSS (2014).

Out of all the confidence interval approaches evaluated in 2013/2014, the preferred Anonymous (2013) approach led to the narrowest confidence interval. However, this was only the IRP's preferred approach when using a closed-form error propagation method. The IRP actually recommended measuring uncertainty via a Monte Carlo simulation, which would require modeling various parameters as random variables. At this time, DWR and Reclamation with guidance from the technical team are considering this possibility, but it would require further research and development before it is implementable. If there is interest to move forward with measuring uncertainty using a closed-form error propagation method, then DWR and Reclamation will need to decide which approach to use when estimating confidence intervals and to ensure the accuracy of any equations used to estimate confidence intervals.

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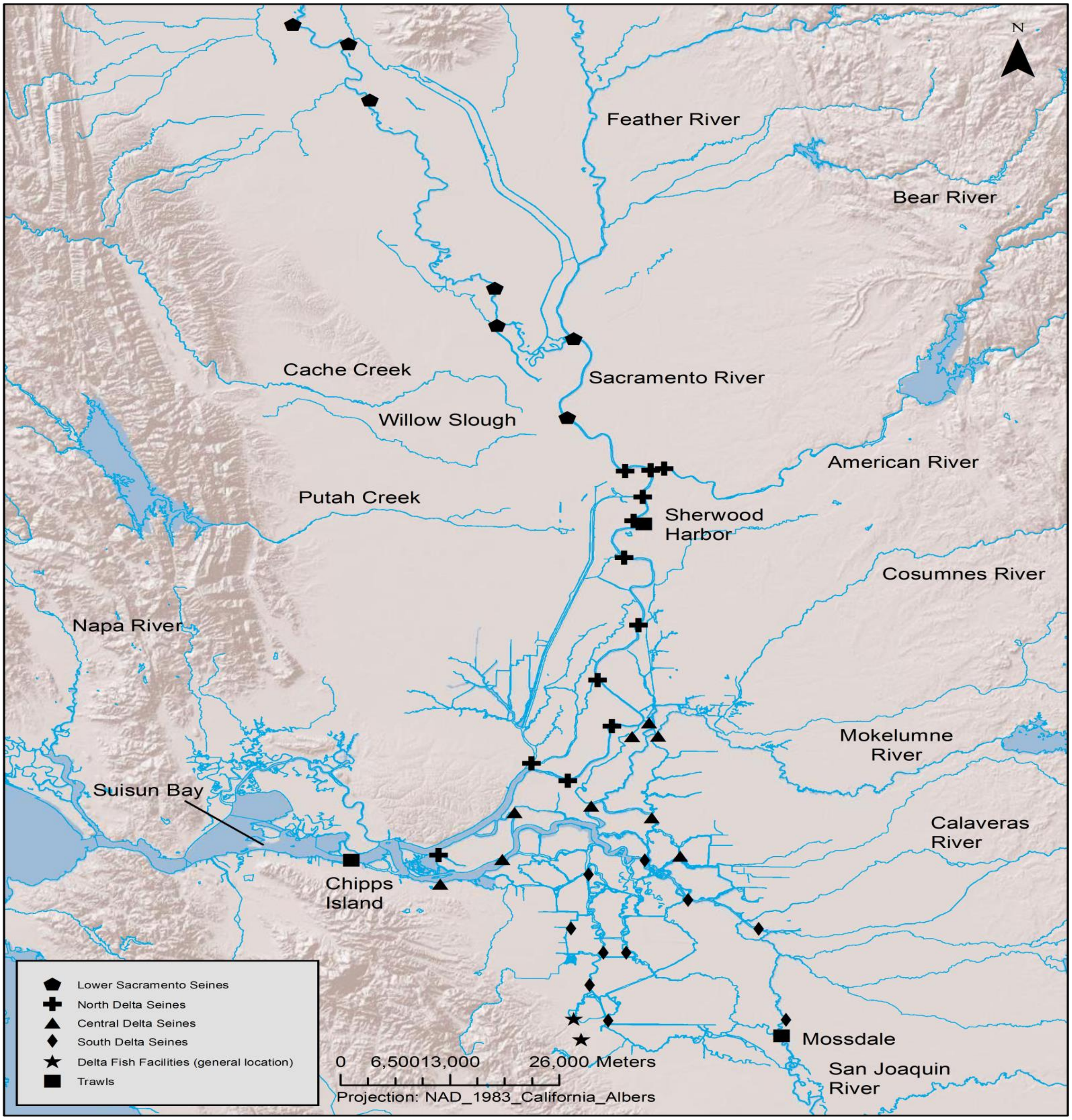
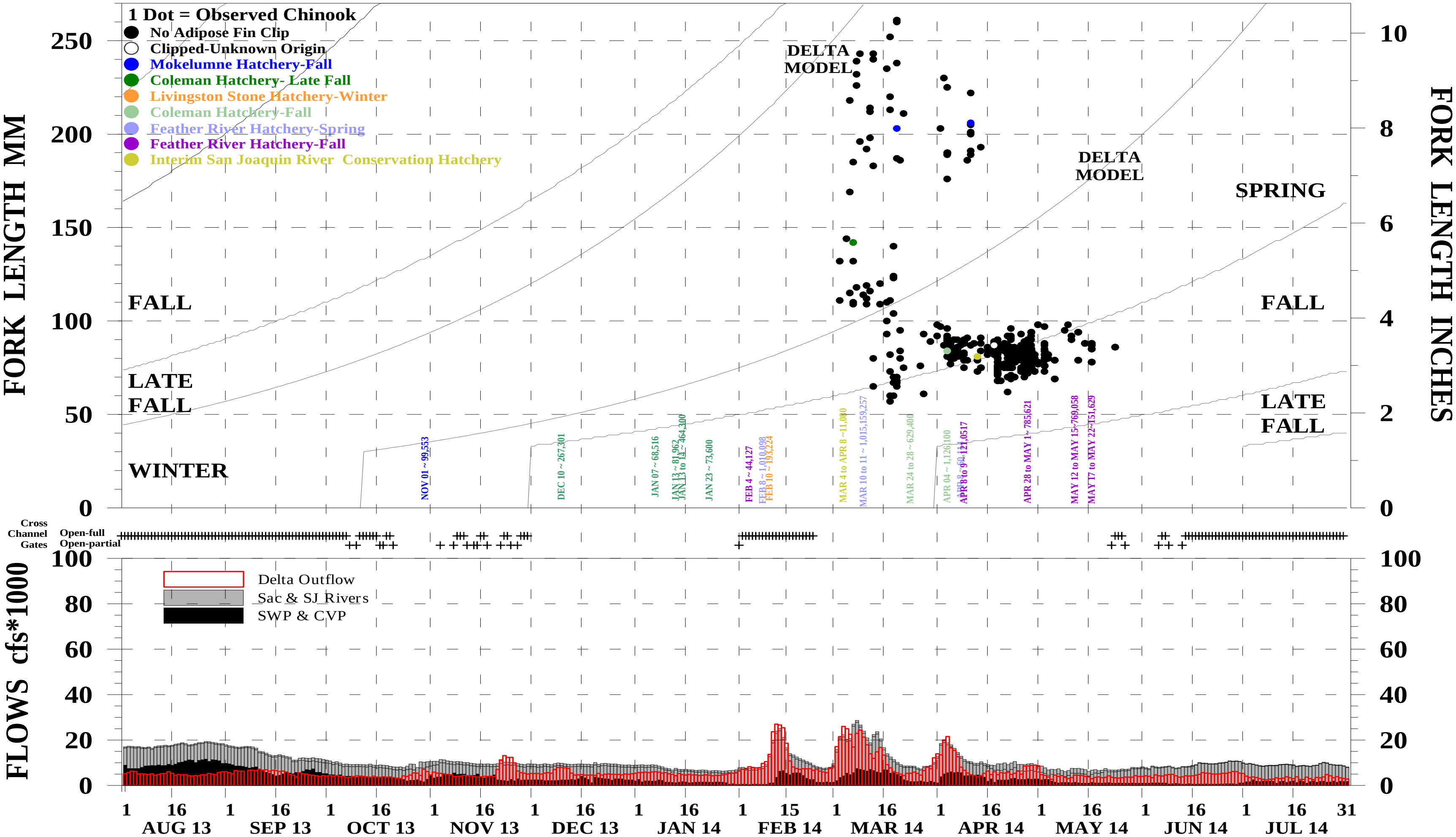
Figure 1. Map of monitoring sites used in this report.



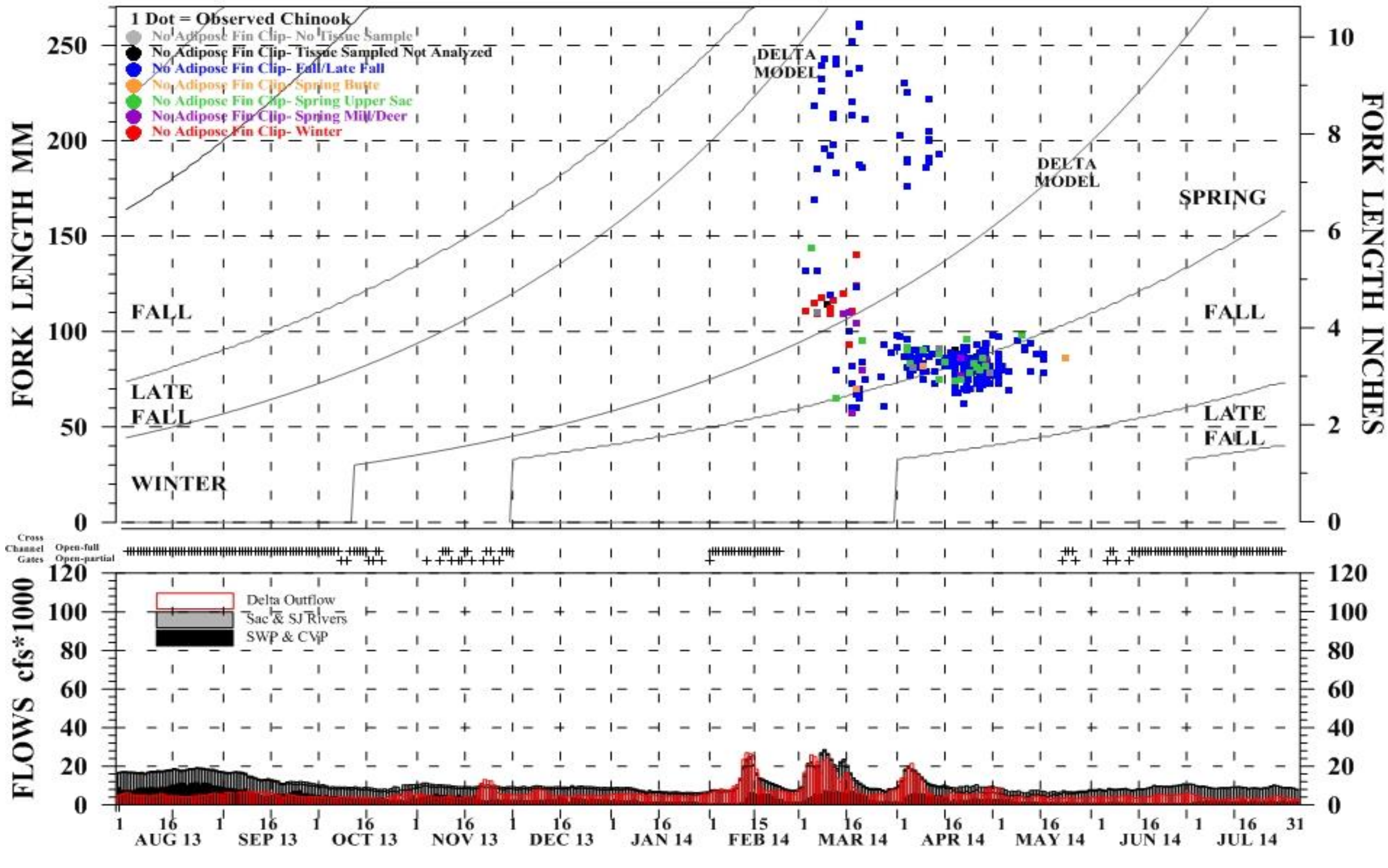
Base map from ESRI and GPS coordinates provided by USFWS. Only seine sites that have been active since August 2004 are presented.

Figure 2. Observed Chinook salvage at the Delta fish facilities, with Delta hydrology August 1, 2013, through July 31, 2014. Race designation based on Delta model and CWT's



Note: Chinook not measured for length and Chinook outside of the length-at-date criteria (Delta Model) 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, 2013, through July 31, 2014.



Note: Chinook not measured for length and Chinook outside of the length-at-date criteria (Delta Model) are not reported.

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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, 2013, through June 30, 2014.

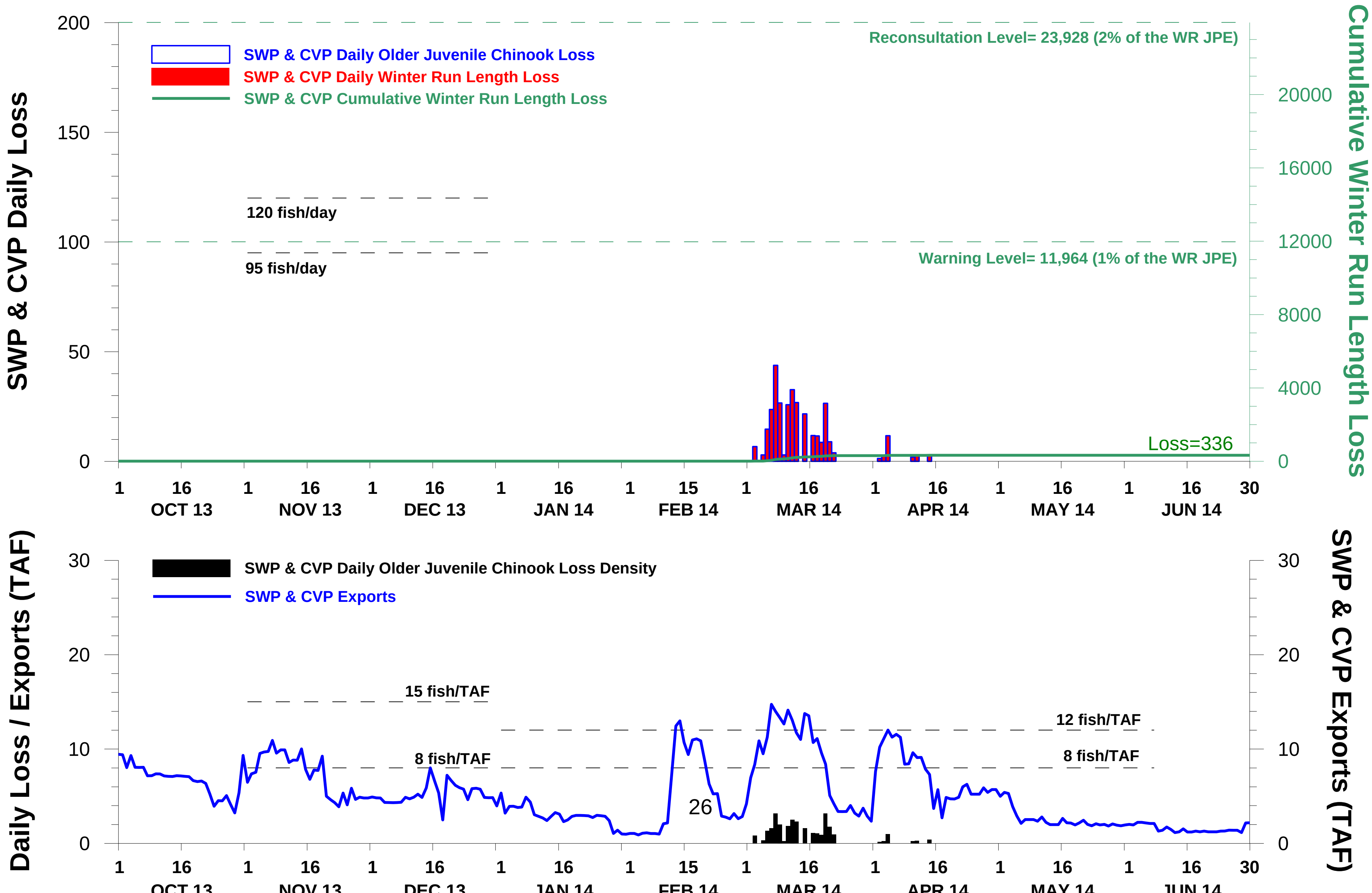

Figure 5. Non-clipped winter-run length Chinook salmon loss at the Delta fish facilities from October to June using the current loss equation (DFW 2013), water years 2005 through 2014.

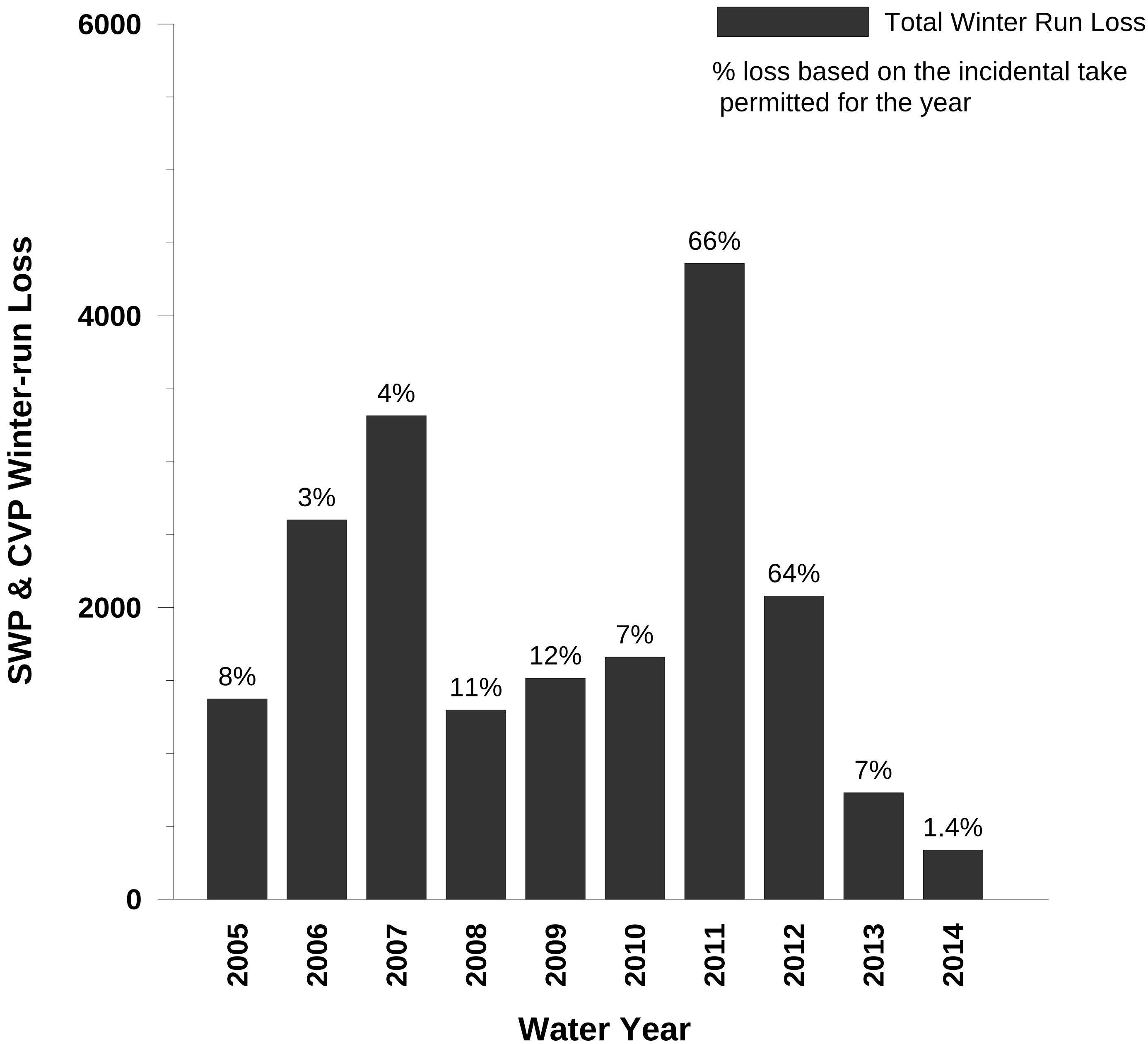

Figure 6. Daily loss and loss density of non-clipped fry/smolt Chinook salmon at the Delta fish facilities using the current loss equation (DFW 2013), October 1, 2013, through July 31, 2014.

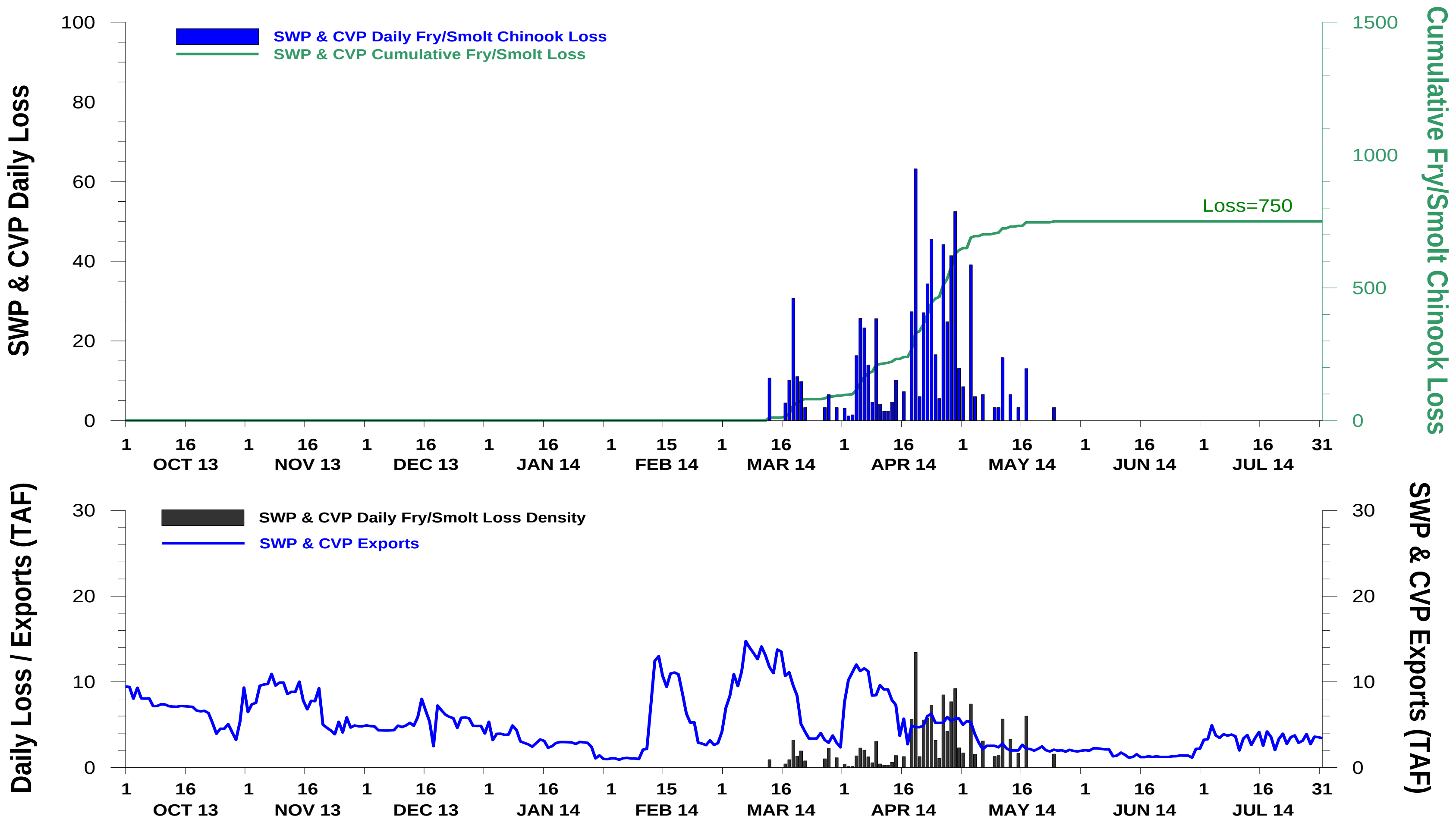

Figure 7. Non-clipped fry/smolt Chinook salmon loss at the Delta fish facilities from October to July using the current loss equation (DFW 2013), water years 2005 through 2014.

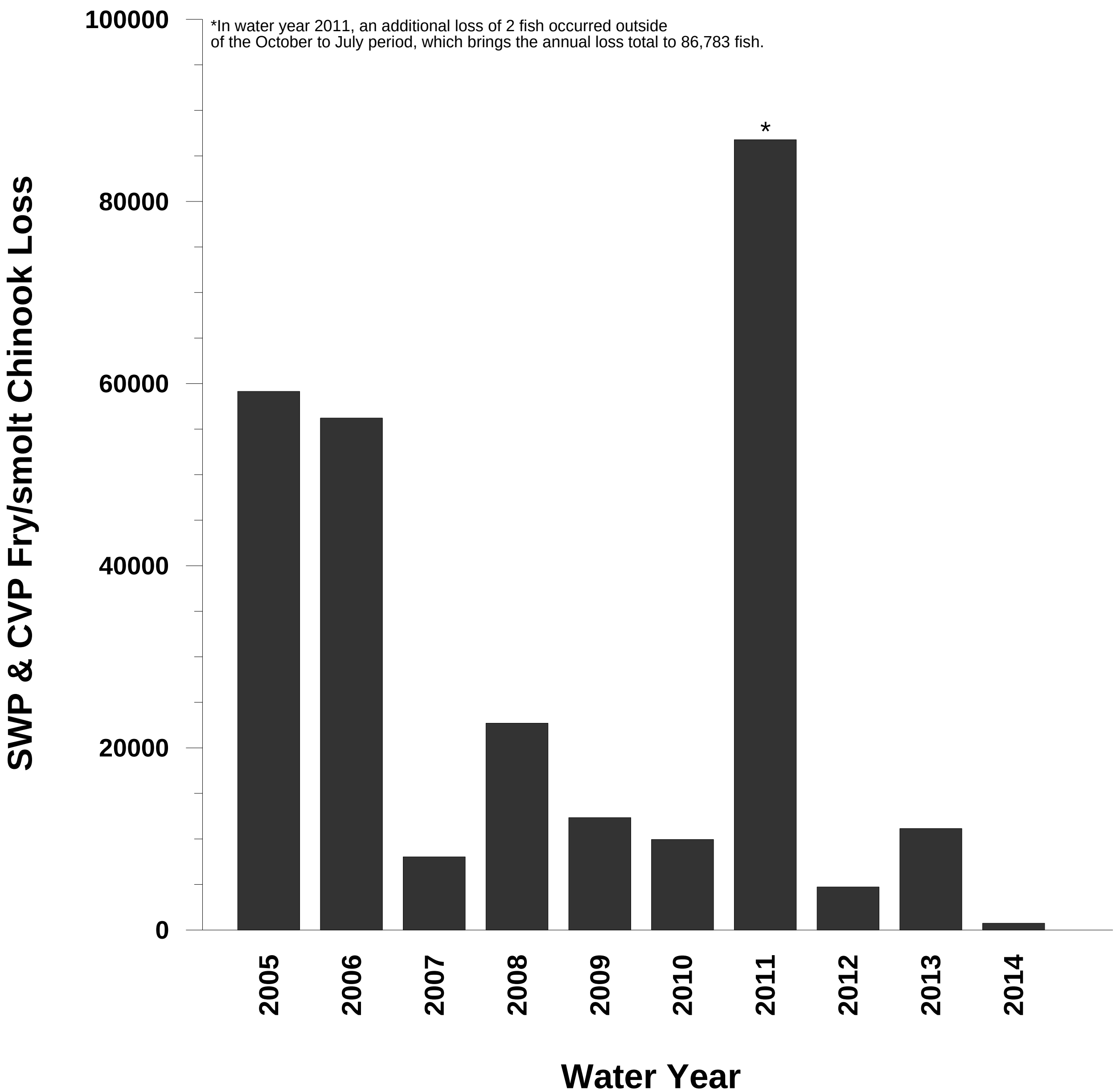

Figure 8. Older juvenile Chinook salmon and LSNFH winter-run Chinook salmon recoveries from the Delta monitoring program and loss at the Delta fish facilities, October 1, 2013, through June 30, 2014.

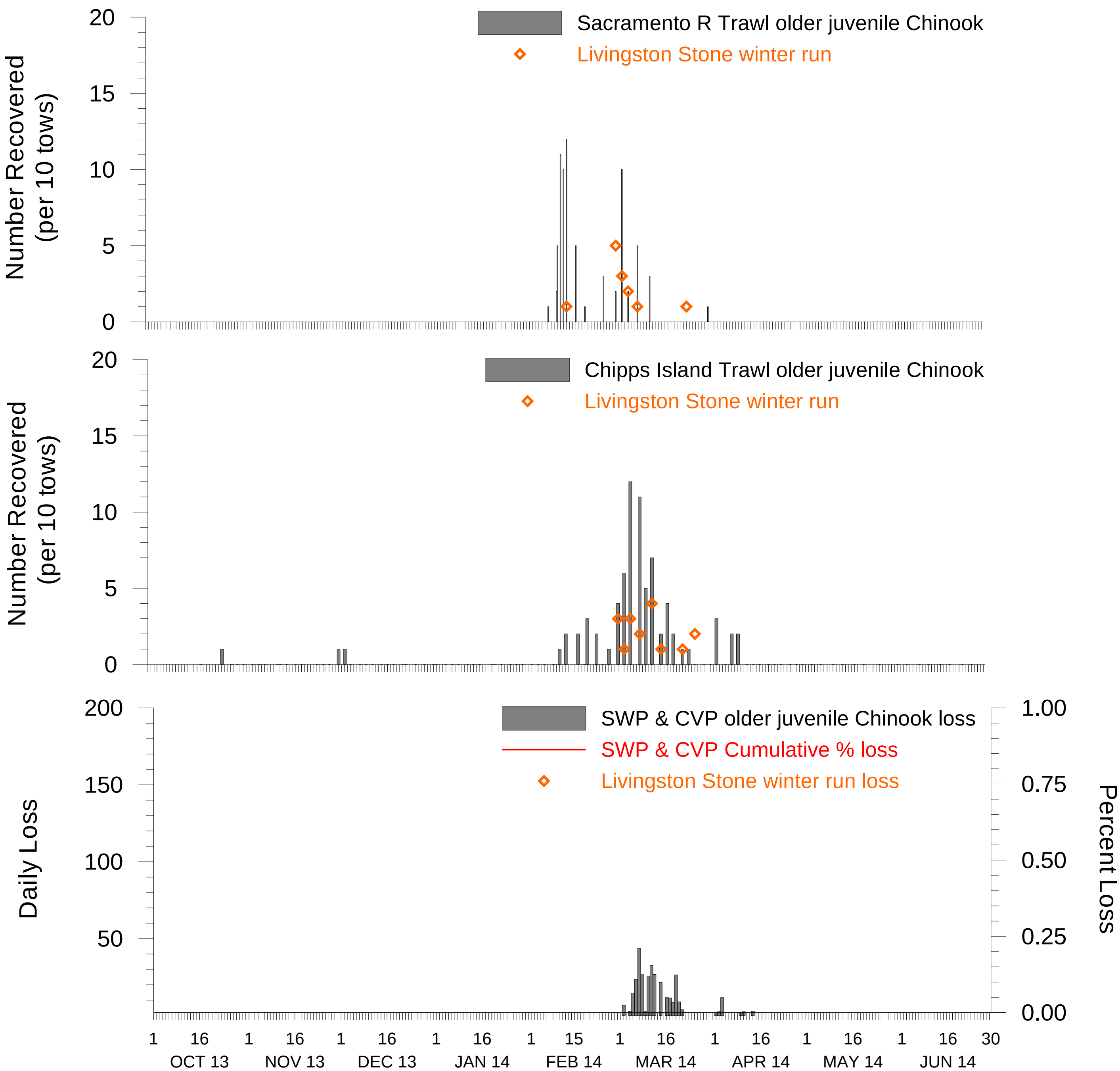

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Figure 9. Older juvenile Chinook salmon and CNFH late-fall Chinook salmon (spring-run surrogate) recoveries from the Delta monitoring program and loss at the Delta fish facilities, October 1, 2013, through June 30, 2014.

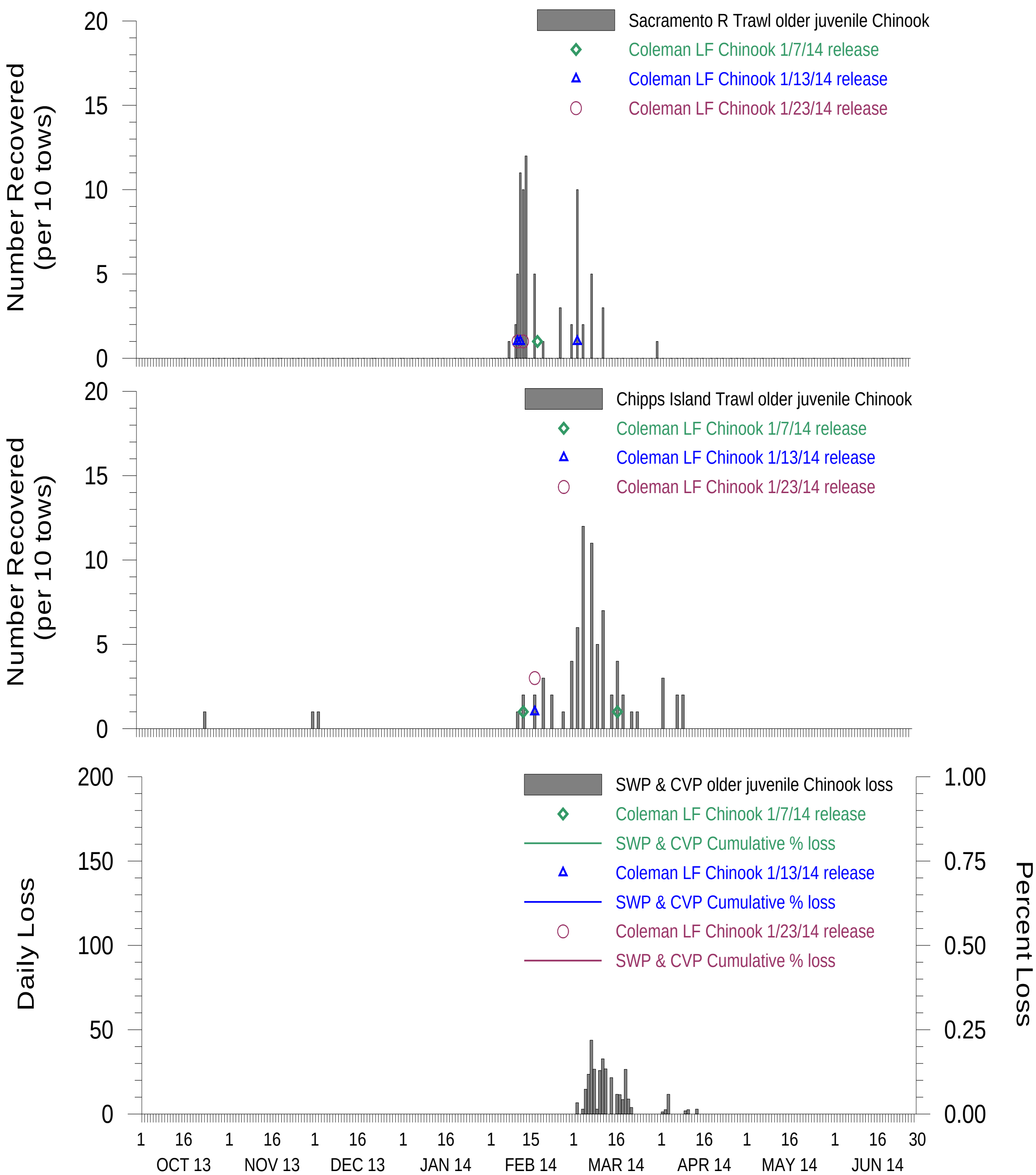

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Figure 10. Mean annual CPUE of non-clipped older juvenile Chinook salmon caught in the lower Sacramento River and the Delta beach seines from August 1 through July 31, 2004/2005 to 2013/2014.

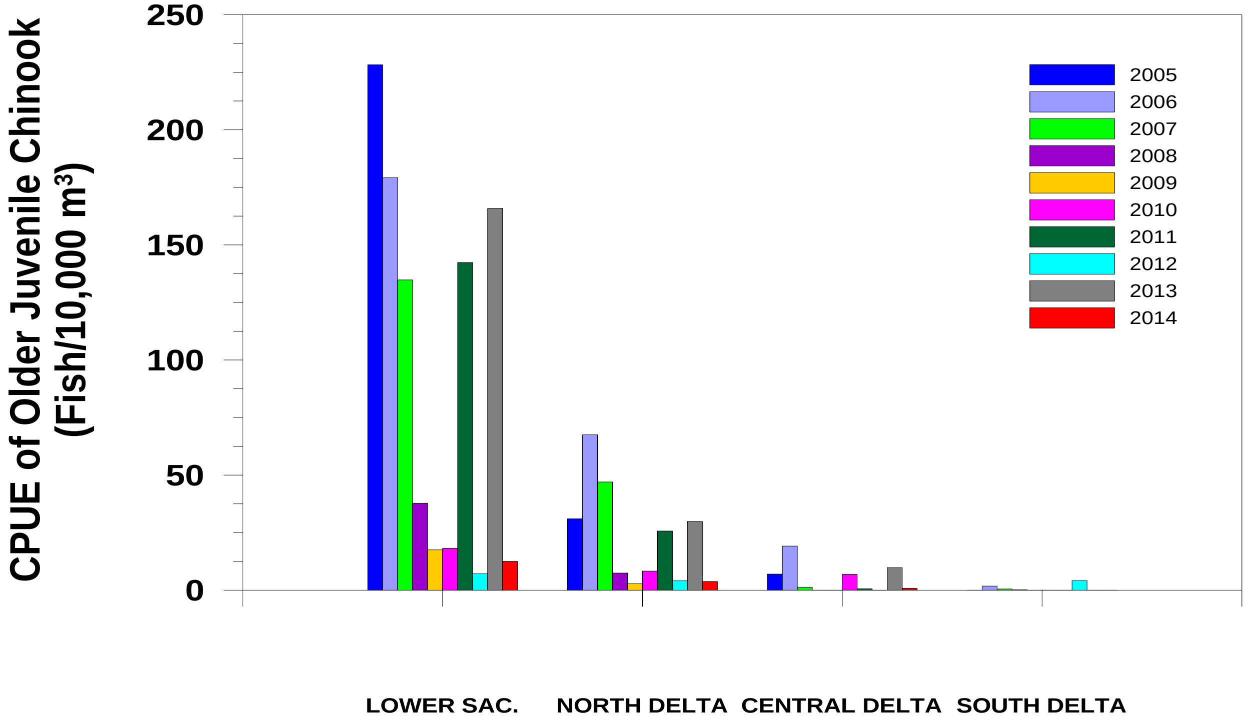


Figure 11. Mean annual CPUE of non-clipped fry/smolt Chinook salmon caught in the lower Sacramento River and the Delta beach seines from August 1 through July 31, 2004/2005 to 2013/2014.

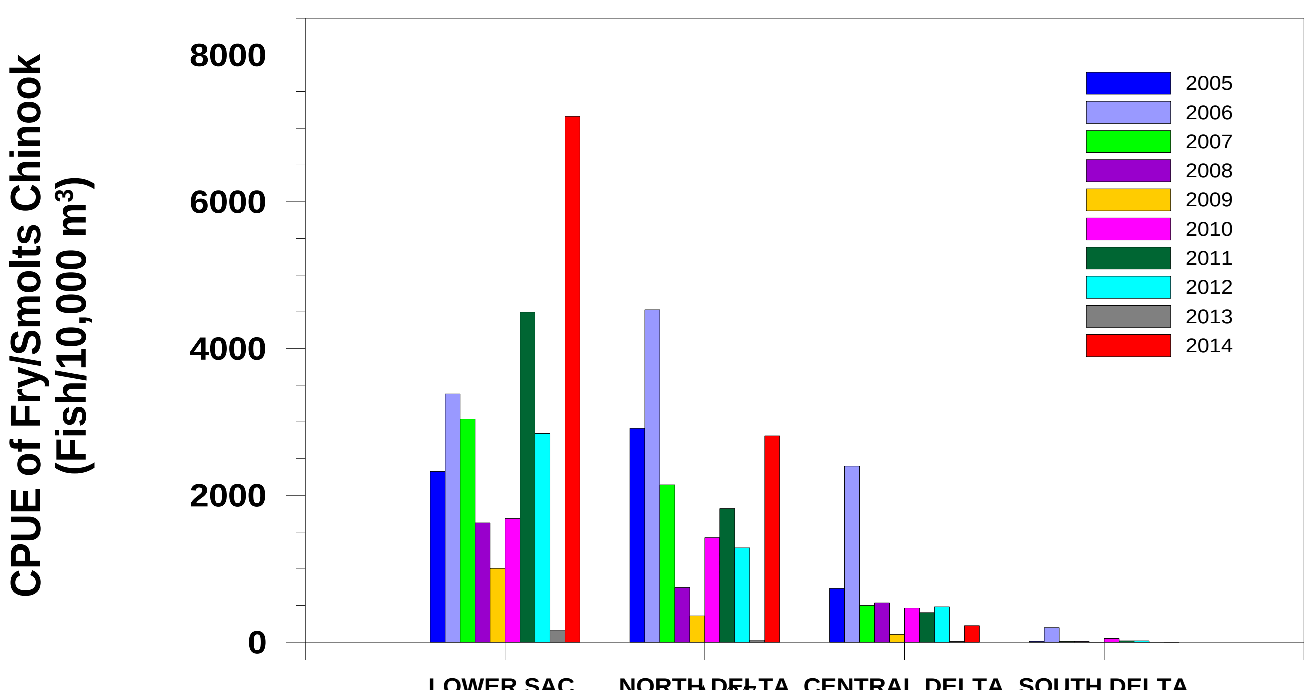


Figure 12. Mean annual CPUE of non-clipped older juvenile Chinook salmon caught in the Sacramento River and Chipps Island trawls from August 1 through July 31, 2004/2005 to 2013/2014.

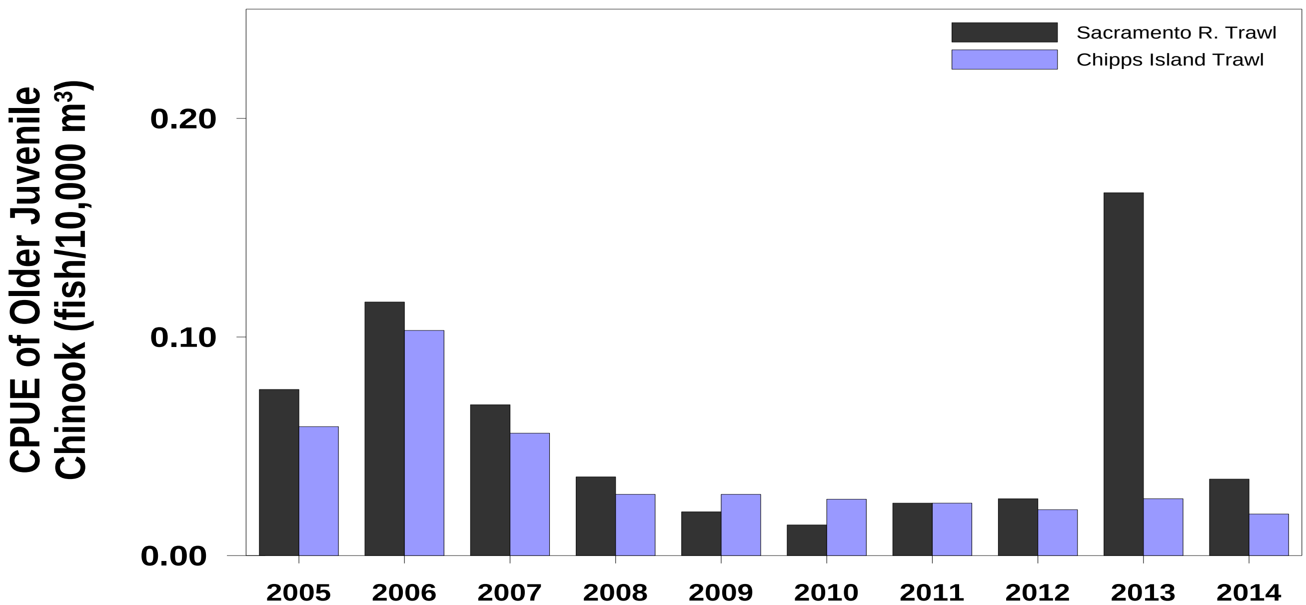


Figure 13. Mean annual CPUE of non-clipped fry/smolt Chinook salmon caught in the Sacramento River and Chipps Island trawls from August 1 through July 31, 2004/2005 to 2013/2014.

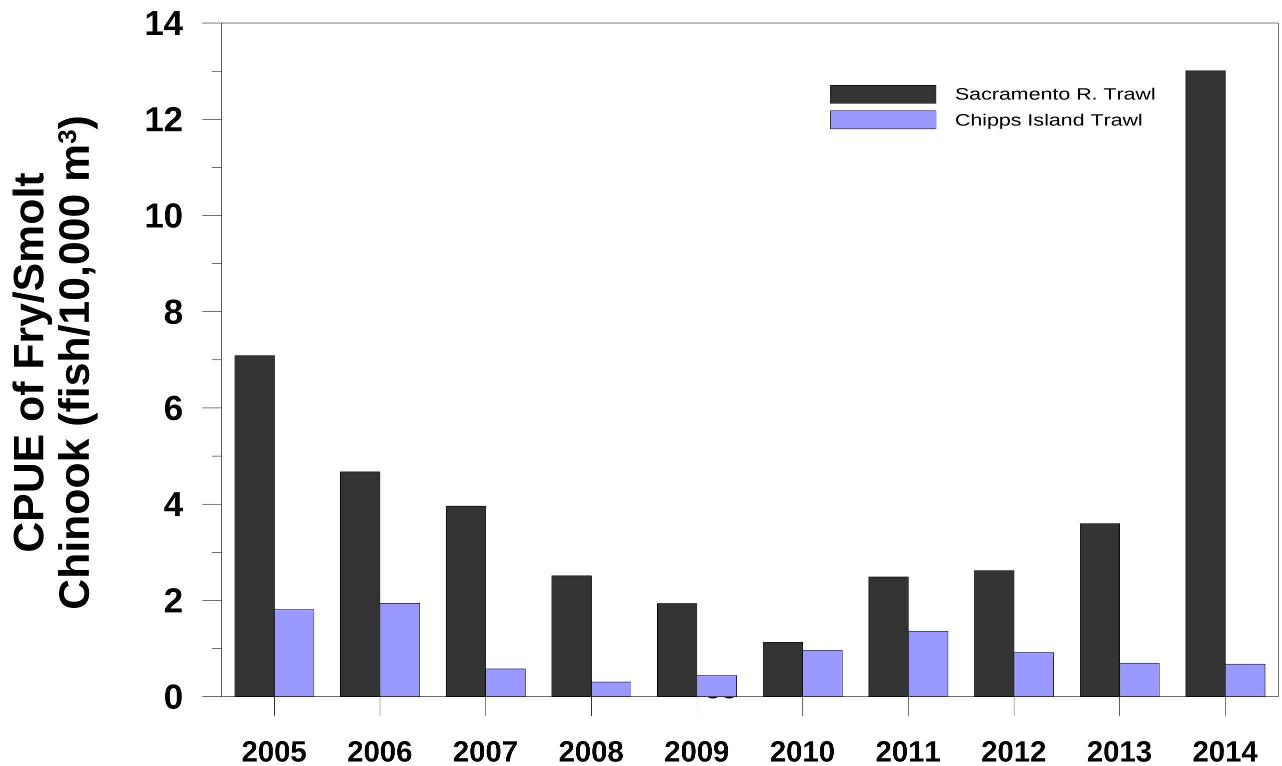


Figure 14. Non-clipped steelhead salvage at the Delta fish facilities, October 2013 through July 2014.

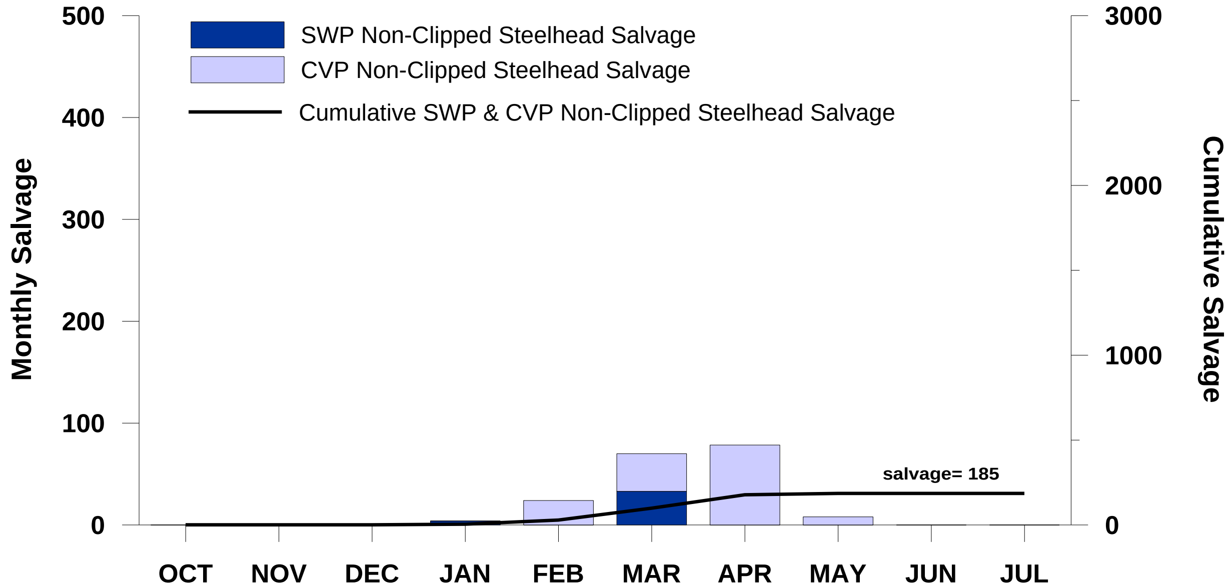


Figure 15. Hatchery (adipose fin clipped) steelhead salvage at the Delta fish facilities, October 2013 through July 2014.

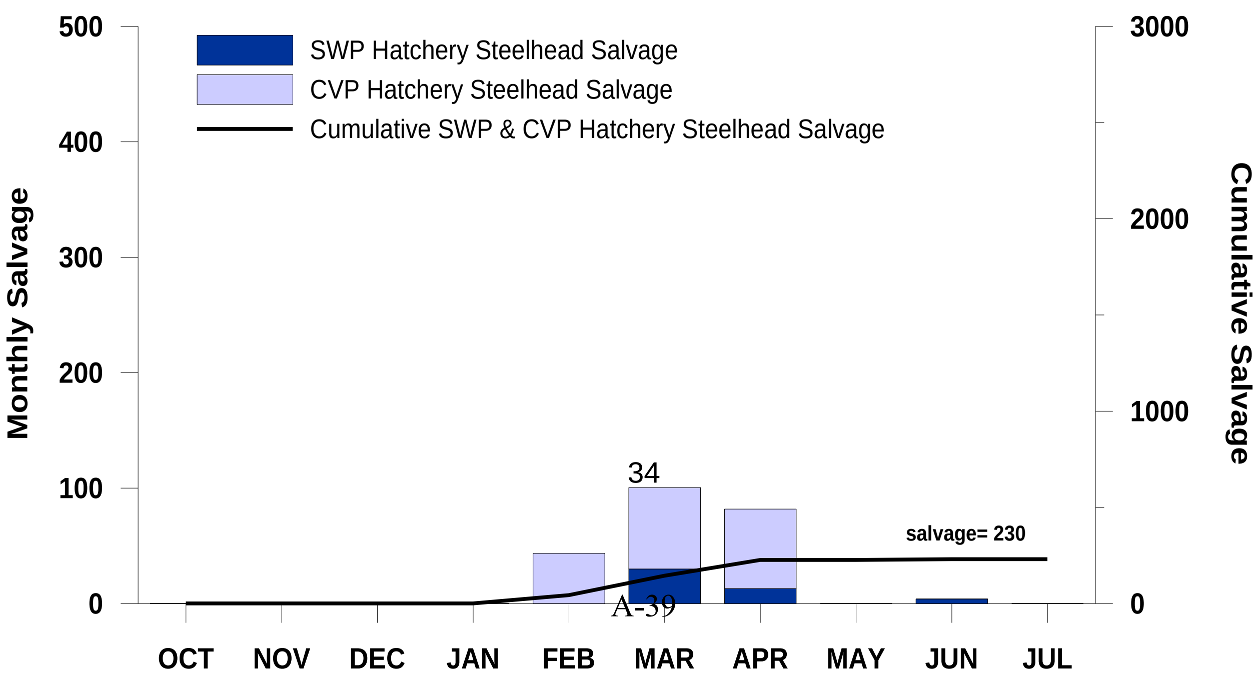


Figure 16. Non-clipped steelhead salvage at the Delta fish facilities from October to July, water years 2005 through 2014.

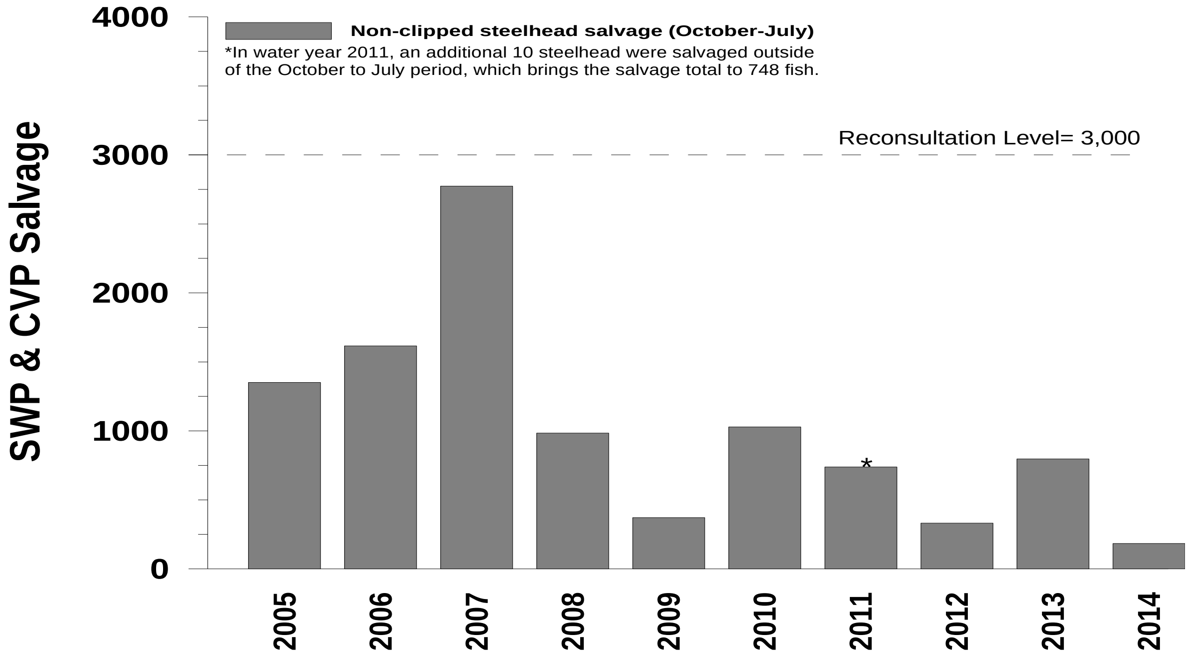


Figure 17. Hatchery (adipose fin clipped) steelhead salvage at the Delta fish facilities from October to July, water years 2005 through 2014.

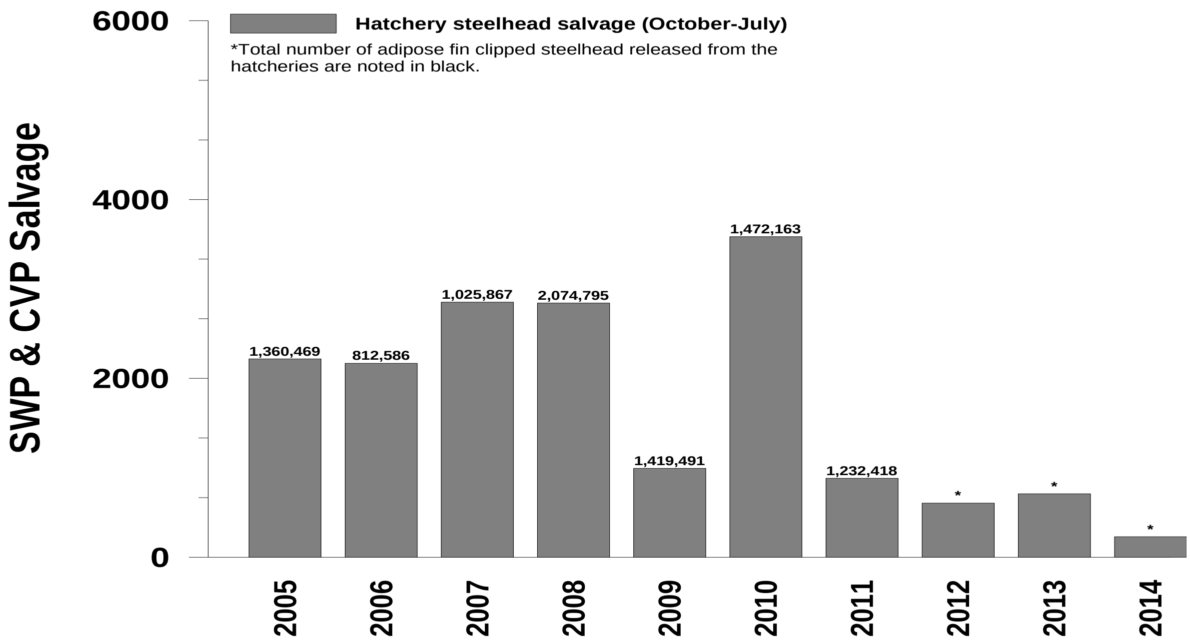
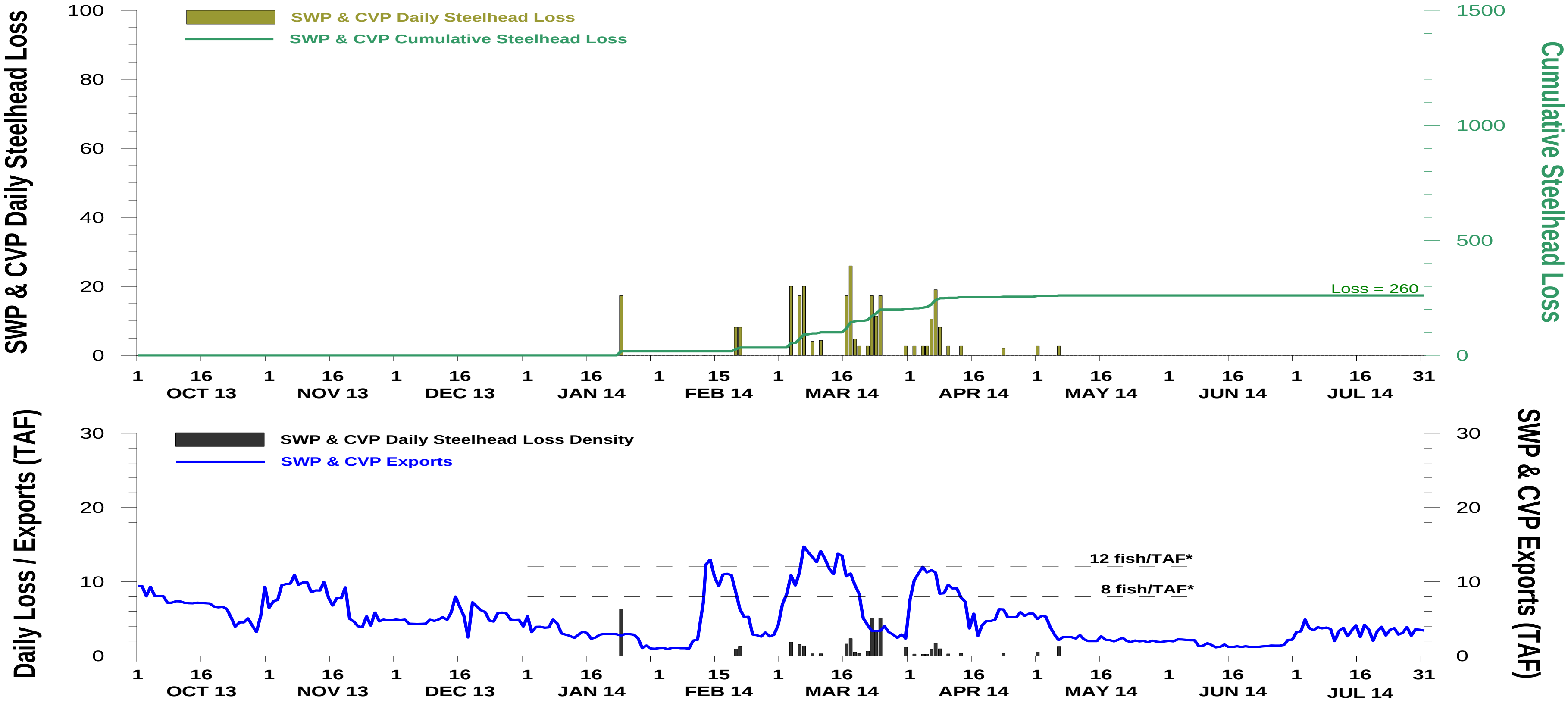


Figure 18. Daily loss and loss density of non-clipped steelhead at the Delta fish facilities using the interim loss equation (DOSS 2011), October 1, 2013, through July 31, 2014.



*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 2013 through July 2014.

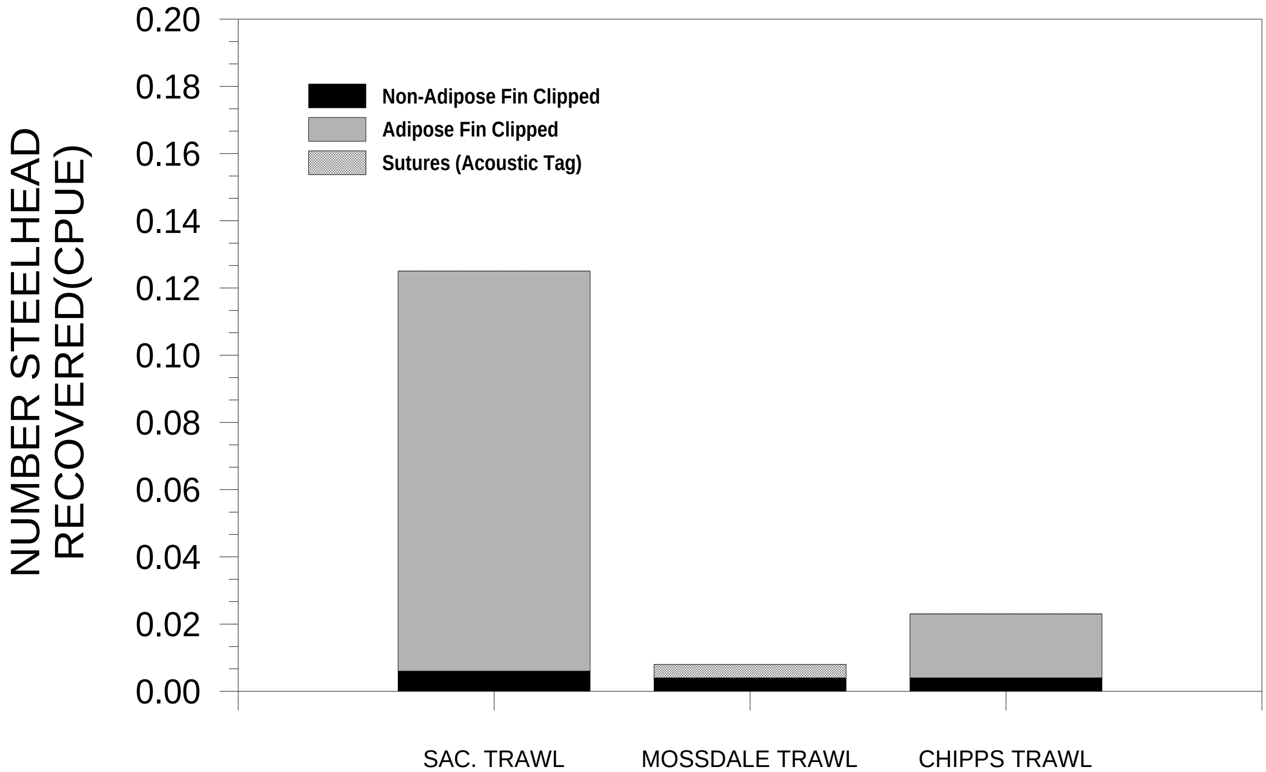


Figure 20. Number of steelhead recovered in the Delta monitoring program, October 2013 through July 2014 at Beach Seines.

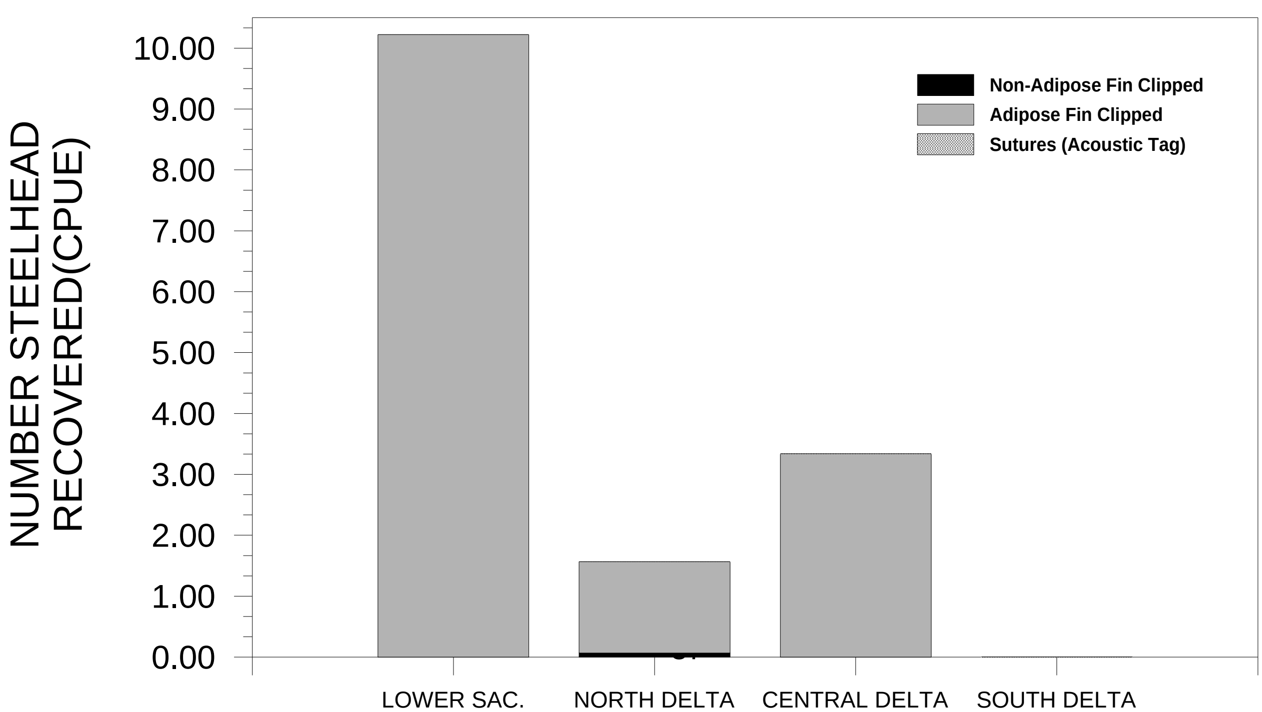


Figure 21. Green sturgeon salvage at the Delta fish facilities from October to July, water years 2005 through 2014.

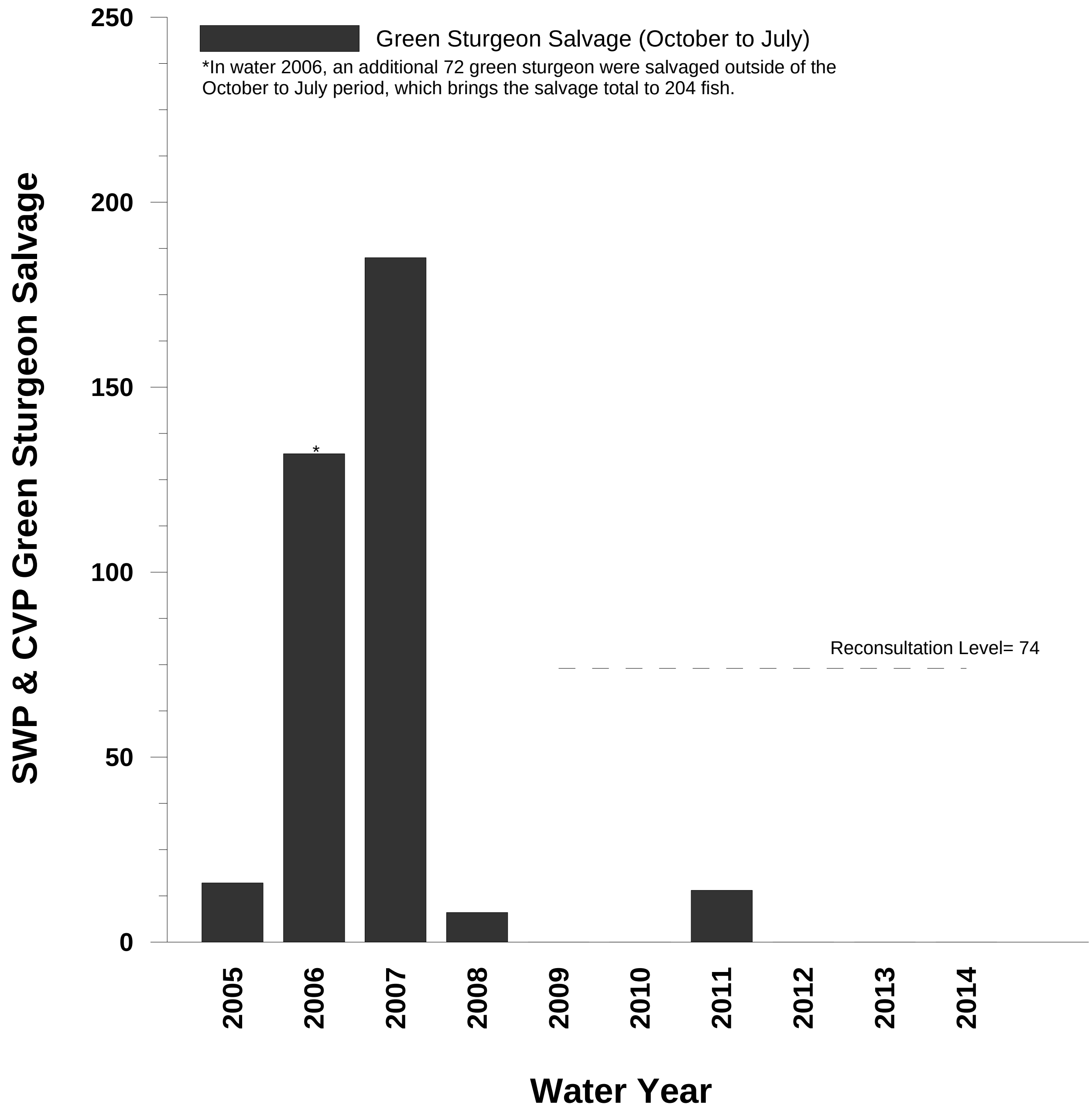


Figure 22. Monthly averages of Delta hydrology from October to July, water years 2005 through 2014.

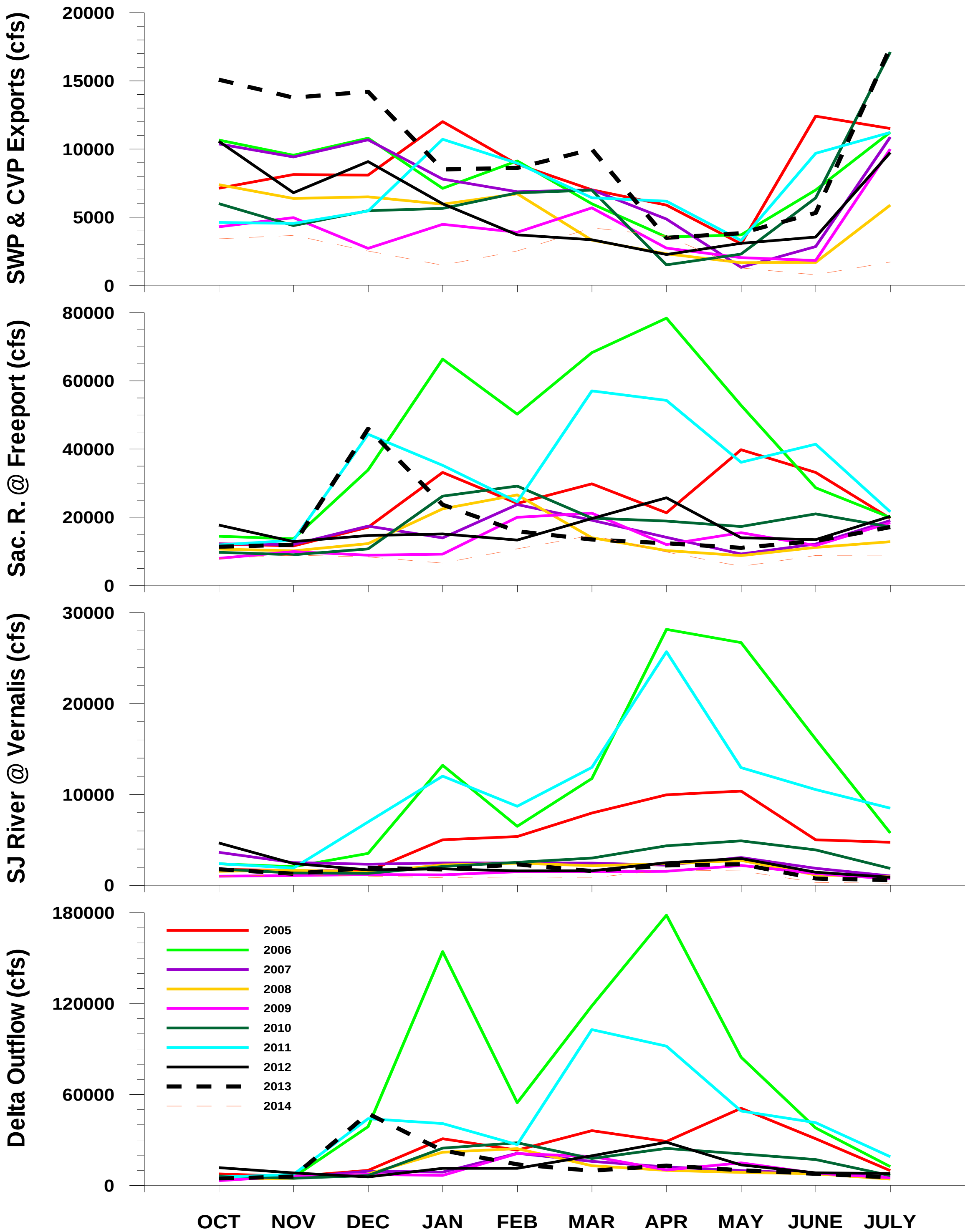


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Figure 23. Modeled volumetric water fingerprint for the Clifton Court Forebay (SWP) as derived from DSM2, October 2013 through July 2014.

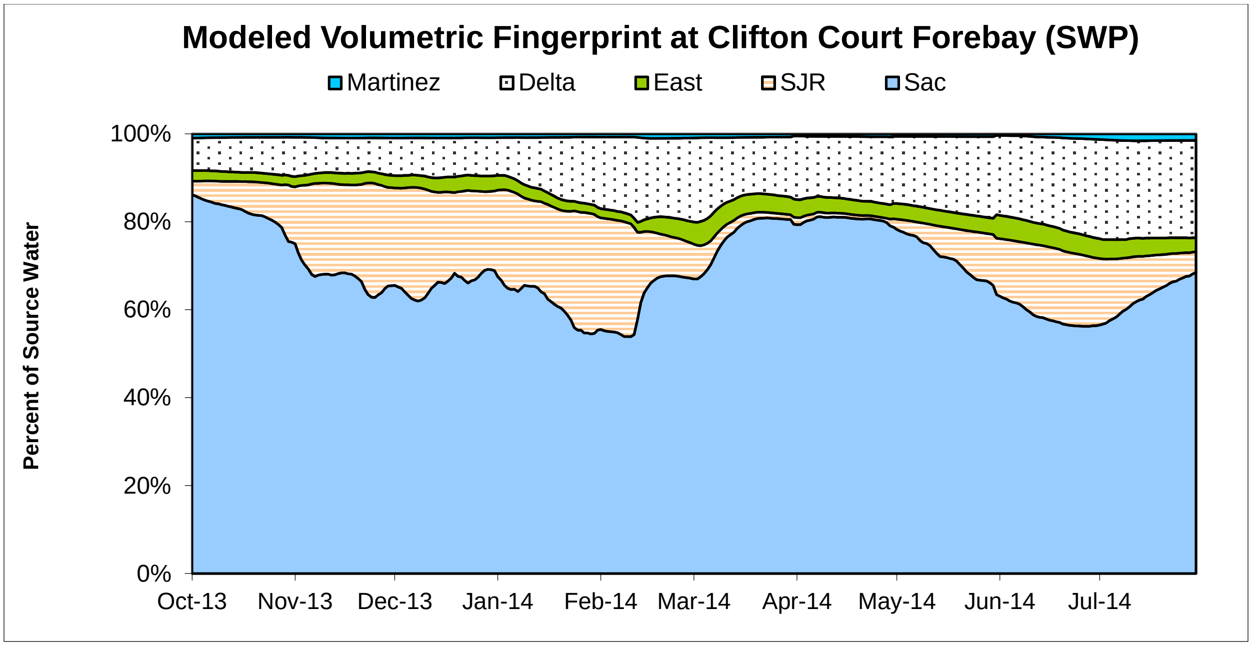
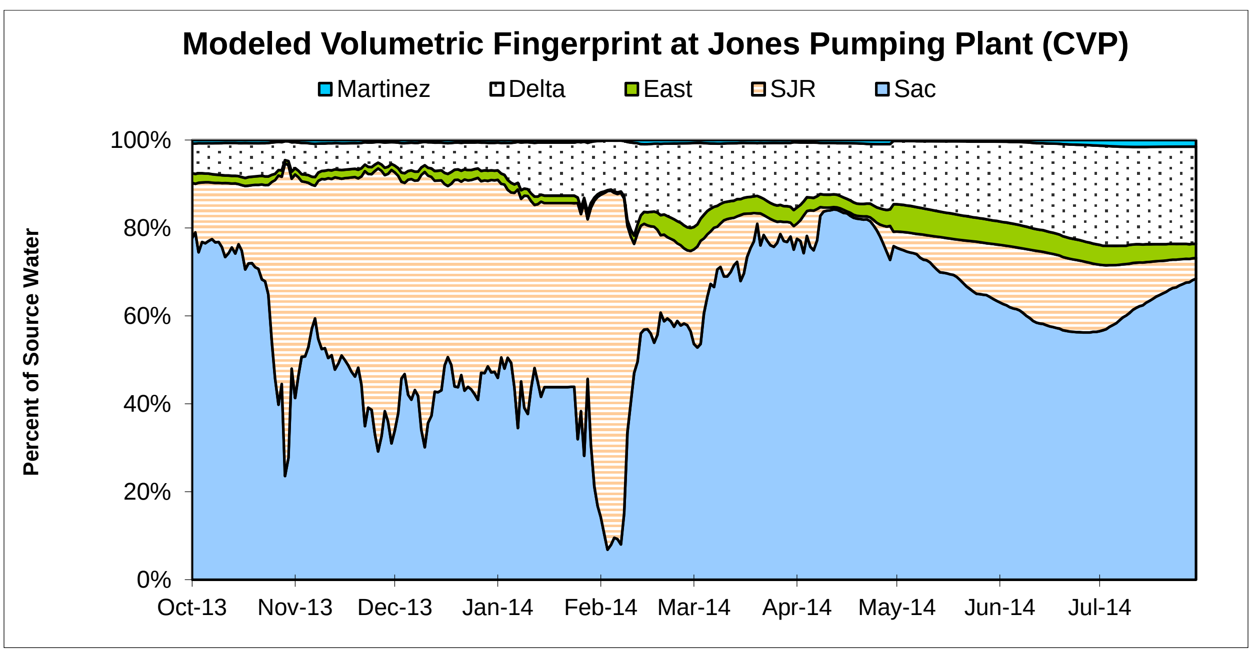


Figure 24. Modeled volumetric water fingerprint for the Jones Pumping Plant (CVP) as derived from DSM2, October 2013 through July 2014.



Delta fingerprint figures from DWR-Operations Control Office.

Figure 25 Alternate loss density estimates of non-clipped older juvenile Chinook salmon using Anonymous (2013), October 1, 2013, to June 30, 2014

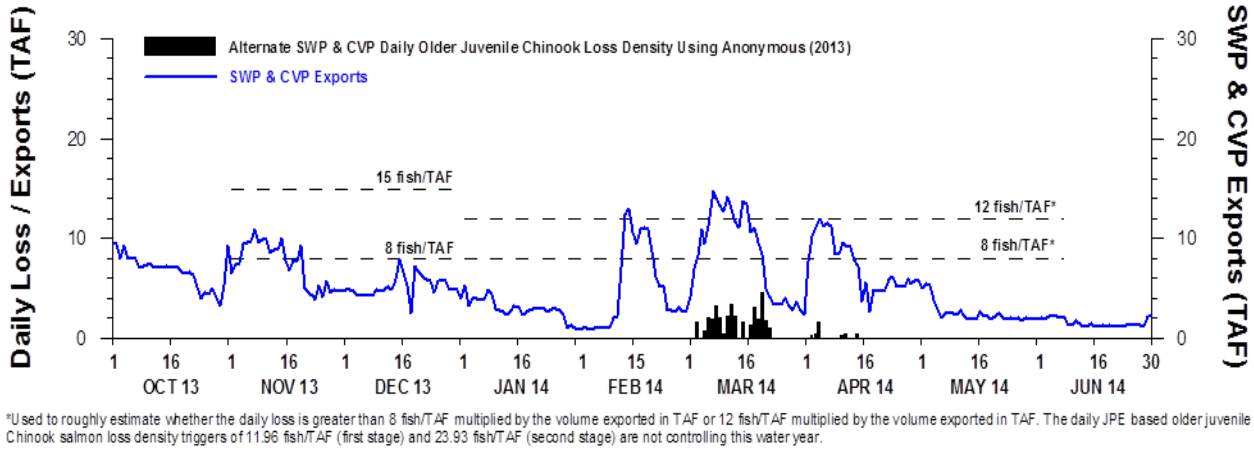


Figure 26 Alternate loss density estimates of non-clipped steelhead using Anonymous (2013), October 1, 2013, to July 31, 2014

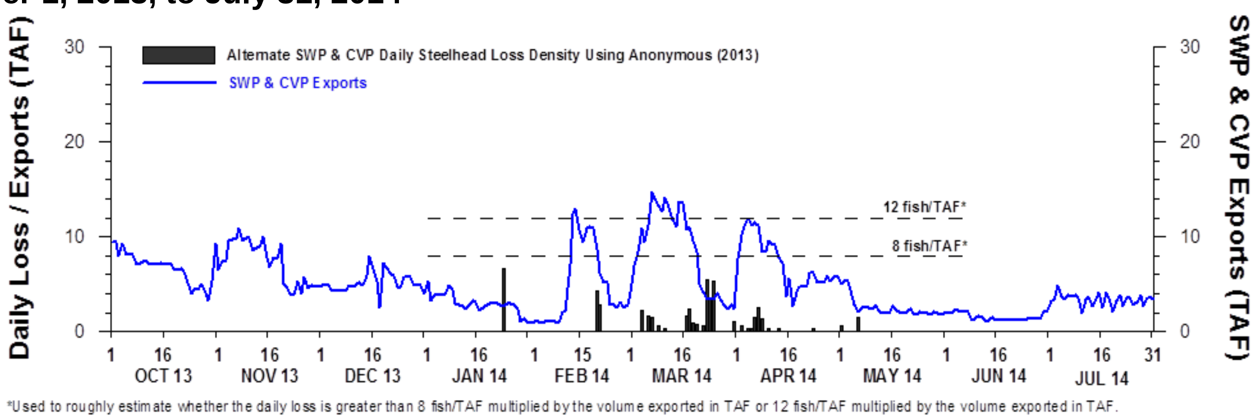


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Table 1. 2013/2014 non-clipped Chinook salmon genetic analysis results.

	SWP 2014	CVP 2014
No. Unclipped Juvenile Chinook Observed	23	302
No. Unclipped Juvenile Chinook DNA sampled	23	291
No. of DNA samples supplied by DFW CVTA	23	290
No. of samples that properly amplified	23	287
No. of Length at Date WR	18	42
No. of Length at Date WR samples supplied by DFW CVTA	18	41
No. of DNA based WR	1	11

Table 2. Hatchery (adipose fin clipped) Chinook salmon loss at the Delta fish facilities using the current loss equation (DFW 2014), October 2013 through June 2014.

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]
11/1/2013	F	Mokelumne River Hatchery	Mokelumne River Hatchery	Production	9	99,553	n/a	0.009	n/a	n/a	n/a	3/20/2014	4/11/2014
12/10/2013	LF	Coleman NFH	Battle Creek	Production	0	267,301	n/a	0.000	n/a	n/a	n/a	*	*
1/7/2014	LF	Coleman NFH	Battle Creek	Spring Surrogate	0	68,516	n/a	0.000	n/a	0.5%	1.0%	*	*
1/13/2014	LF	Coleman NFH	Battle Creek	Spring Surrogate	0	81,962	n/a	0.000	n/a	0.5%	1.0%	*	*
1/13 to 1/14/2014	LF	Coleman NFH	Battle Creek	Production	3	452,526	n/a	0.001	n/a	n/a	n/a	3/7/2014	3/7/2014
1/23/2014	LF	Coleman NFH	Battle Creek	Spring Surrogate	0	72,857	n/a	0.000	n/a	0.5%	1.0%	*	*
2/10/2014	W	Livingston Stone NFH	Caldwell Park	Production	0	193,224	30,880	0.000	0.000	0.5%	1.0%	*	*
3/24 to 3/28/2014	F	Coleman NFH	Rio Vista net pens	Production	2	629,400	n/a	0.0003	n/a	n/a	n/a	4/4/2014	4/4/2014
3/7 to 5/8/2014	F	Interim San Joaquin River Conservation Hatchery	Hills Ferry Barrier/Fremont Ford Bridge	Experimental/SJRRP	2	38,240	n/a	0.0052	n/a	n/a	n/a	4/13/2014	4/13/2014
4/17 to 4/18/2014	S	Feather River Hatchery	Hills Ferry Barrier	Experimental/SJRRP	0	60,114	n/a	0.0000	n/a	n/a	n/a	*	*

[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 2014), October 2013 through June 2014.

Facility	Unknown CWT Loss[5]	Unread CWT Loss[6]	Unknown Hatchery Loss[7]	Acoustic Tag Loss[8]	Number of Unassigned CWTs[9]
SWP	0	0	0	0	0
CVP	3	0	0	0	0
TOTAL	**3**	**0**	**0**	**0**	**0**

[5]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 released).
[6]Adipose-fin clipped Chinook was collected during fish count and has not been processed yet.
[7]CWT has been read, but hatchery release information not yet available.
[8]Adipose-fin clipped Chinook released due to presence of sutures.
[9]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 Monthly averages of hydrologic parameters in the Sacramento-San Joaquin River Delta, October 2013 through July 2014.

Month	SWP Average Exports af	SWP Average Exports cfs	CVP Average Exports af	CVP Average Exports cfs	Sacramento R. Average Flow cfs	San Joaquin R. Average Flow cfs	Delta Outflow Average Flow cfs
October	71	1150	140	2273	987	7912	4156
November	115	1928	104	1740	1169	8884	5893
December	101	1638	60	883	1018	8366	5360
January	64	1046	27	435	860	6544	5063
February	69	1235	72	1292	824	10747	10826
March	124	2017	136	2206	845	14707	12893
April	35	594	180	3031	1701	9799	8179
May	16	261	62	1015	1603	5587	3770
June	32	538	14	244	330	8786	4780
July	68	1109	37	608	253	8913	3289

Table 5. Loss estimates of non-clipped winter-run Chinook salmon using the current loss equation (DFW 2013) and Anonymous (2013) with 95% confidence limits (CL), October 2013 to June 2014.

Method	SWP Loss	CVP Loss	Combined SWP/CVP Loss	LCL	UCL
DFW (2013)	220	116	336	n/a	n/a
Anonymous (2013)	12	57	69	11	433
Corrected Anonymous (2013)	12	57	69	11	454
Preferred Anonymous (2013)	12	57	69	16	296

Table 6. Loss estimates of non-clipped steelhead using the current loss equation (DFW 2013) and Anonymous (2013) with 95% confidence limits (CL), October 2013 to July 2014

Method	SWP Loss	CVP Loss	Combined SWP/CVP Loss	LCL	UCL
DFW (2013)	160	100	260	n/a	n/a
Anonymous (2013)	168	183	351	226	548
Corrected Anonymous (2013)	168	183	351	221	559
Preferred Anonymous (2013)	168	183	351	252	491

Appendix B: Steelhead Loss-Density Table

Steelhead - Daily Summary Table

This report has ended due to the lack of Chinook Salmon salvage.
It will resume if any Chinook Salmon are salvaged

California Department of Fish and Wildlife - Results Subject to Revision

Prepared by Geir Aasen *Report Date:* 6/30/2014 *Report Time:* 12:00 PM

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT							
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED			LENGTH	LOSS
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	(FL mm)	DENSITY
1/23/2014	1	4	17.32				NS			NS			281	6.33
2/18/2014										2	24	16.32	232-249	
2/19/2014							1	12	8.16	1	9.5	6.46	208-268	0.94
2/20/2014							1	12	8.16				192	1.30
2/21/2014										1	10	6.80	259	
3/4/2014	1	4	17.32				1	4	2.72				217-238	1.85
3/5/2014										1	4	2.72	235	
3/6/2014	1	4	17.32	1	4	17.32				1	4	2.72	238-266	1.54
3/7/2014	1	4	17.32				1	4	2.72	1	4	2.72	210-442	1.36
3/8/2014				2	8	34.64				1	4	2.72	255-297	
3/9/2014							2	6	4.08	1	4	2.72	220-270	0.31
3/10/2014										3	12	8.16	215-272	
3/11/2014	1	1	4.33										314	0.31
3/12/2014				1	2	8.66				2	8	5.44	221-251	
3/13/2014				1	4	17.32							232	
3/16/2014				1	4	17.32							257	
3/17/2014	1	4	17.32	3	6	25.98							240-253	1.62
3/18/2014	2	6	25.98							1	2.5	1.70	248-281	2.34
3/19/2014				1	2	8.66	2	7	4.76				220-244	0.50
3/20/2014							1	4	2.72	1	4	2.72	219-272	0.32
3/21/2014										1	4	2.72	267	
3/22/2014							1	4	2.72	3	12	8.16	226-256	0.65
3/23/2014	1	4	17.32										233	5.12
3/24/2014	1	2	8.66				1	4	2.72				165-259	3.39
3/25/2014	1	4	17.32										281	5.14
3/27/2014										1	4	2.72	257	
3/31/2014							1	4	2.72	1	4	2.72	230-268	1.16
4/1/2014										3	12	8.16	246-305	
4/2/2014				1	4	17.32	1	4	2.72	1	2	1.36	275-435	0.27
4/4/2014				1	2	8.66	1	4	2.72	2	8	5.44	223-254	0.23
4/5/2014							1	4	2.72	2	8	5.44	237-298	0.24
4/6/2014				1	4	17.32	4	15.5	10.54	1	4	2.72	211-411	0.91
4/7/2014				1	2	8.66	7	28	19.04				185-310	1.69
4/8/2014	NS			NS			3	12	8.16	1	4	2.72	190-269	0.97
4/9/2014										2	8	5.44	235-275	
4/10/2014							1	4	2.72	1	4	2.72	236-237	0.28
4/13/2014							1	4	2.72				261	0.35
4/15/2014										1	4	2.72	172	
4/17/2014										1	4	2.72	227	
4/22/2014				1	1	4.33							458	
4/23/2014							1	3	2.04				299	0.33
4/24/2014										1	4	2.72	267	
4/25/2014										2	6.83	4.65	257-260	
5/1/2014							1	4	2.72				255	0.55
5/6/2014							1	4	2.72				256	1.29
6/17/2014				1	4	17.32							426	

The table will only be updated with catch, salvage, loss, length, and loss density on dates when steelhead were salvaged, although the report and "report date" will be updated each week day to indicate that the information is current.

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 on 1/15/2014 to support Western Area Power Administration (WAPA) switchyard work at the O'Neill Substation. CVP will resume exports and salvage on 1/26/2014. Meanwhile, SWP increased pumping to account for exports to the Delta Mendota Canal.

NS: no salvage due to facility shutdown

Appendix C: Salmon Loss-Density Table

Chinook Salmon - Daily Summary Table

This report has ended due to the lack of Chinook Salmon salvage.
It will resume if any Chinook Salmon are salvaged

California Department of Fish and Wildlife - Results Subject to Revision

Prepared by Geir Aasen | *Report Date:* 6/27/2014 | *Report Time:* 12:00 PM

	STATE WATER PROJECT						CENTRAL VALLEY PROJECT									OLDER
	NON-CLIPPED			CLIPPED			NON-CLIPPED			CLIPPED			LENGTH	RACE*		JUV LOSS
DATE	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	CATCH	SALVAGE	LOSS	(FL mm)	SIZE	CWT	DENSITY
3/3/14							2	8	6.71				111-132	W		0.80
3/5/14							1	4	2.88				144	W		0.30
3/6/14	1	2	8.90				2	8	5.76				115-218	W		1.31
3/7/14	2	4	17.87				2	8	5.76	1	4	2.88	109-185	W	LF	1.60
3/8/14	3	10	41.59				1	3	2.16				118-239	W		3.13
3/9/14	2	6	26.62										196-243	W		2.00
3/10/14							1	4	2.88				114	W		0.23
3/11/14	1	4	17.52				3	11.5	8.29				109-192	W		1.83
3/12/14	2	6	26.90				2	8	12.64**				116-214	W		3.03**
3/13/14	4	8	34.93				1	4	2.54				65-243	W,S		2.28
3/15/14	1	4	18.45				1	4	3.19				109-120	W		1.57
3/17/14	1	2	8.87				3	11	7.32				93-235	W,S		1.10
3/18/14							8	32	28.56**				57-252	W,S,F		1.66**
3/19/14	2	6	25.28				5	20	14.07				60-140	W,S,F		0.90
3/20/14	1	4	17.82	1	2	8.90	7	28	19.70				65-261	W,S,F	F	3.16
3/21/14	1	2	8.91				3	12	9.80				80-186	W,S		1.76
3/22/14							2	8	7.15				75-211	W,S		0.93
3/27/14							1	4	3.27				76	S		
3/28/14							2	8	6.54				61-93	S,F		
3/30/14							1	4	3.27				89	S		
4/1/14							2	5.3	3.10				92-98	S		
4/2/14							2	4	2.46				97-203	W,S		0.13
4/3/14							2	6.5	4.06				87-230	W,S		0.23
4/4/14							12	46	27.99	1	4	2.33	81-225	W,S	F	0.97
4/5/14							11	44	25.58				77-88	S		
4/6/14							10	40	23.26				81-90	S		
4/7/14							6	24	13.95				81-90	S		
4/8/14	NS			NS			2	8	4.65				81-87	S		
4/9/14							11	44	25.58				75-90	S,F		
4/10/14							3	10	6.02				79-186	S,W		0.20
4/11/14							2	8	4.93***				87-205	W,S		0.29***
4/12/14							1	4	2.33				88	S		
4/13/14							2	8	4.65	1	4	2.33	73-81	F,S	F	
4/14/14							6	20	13.03				75-193	W,S,F		0.40
4/16/14							3	10.5	7.25				82-86	S		
4/18/14							9	36	27.32	1	4	3.01	82-89	S	*	
4/19/14							21	84	63.14				68-90	S,F		
4/20/14							2	8	6.01				68-85	S,F		
4/21/14							9	36	27.06				75-88	S,F		
4/22/14							12	48	34.38				70-92	S,F		
4/23/14							17	66	45.60				69-96	S,F		
4/24/14							8	24	16.58				70-86	S,F		
4/25/14							2	8	5.53				83	F		
4/26/14							16	64	44.22				73-93	S,F		
4/27/14							9	36	24.87				70-89	S,F		
4/28/14							15	60	41.46				72-90	S,F		
4/29/14							19	76	52.51				75-94	S,F		
4/30/14							5	19	13.13				73-82	S,F		
5/1/14							3	12	8.534				77-98	S,F		
5/3/14							13	52	39.09				73-97	S,F		
5/4/14							2	8	6.01				80-82	F		
5/6/14							2	8	6.54				69-79	F		
5/9/14							1	4	3.27				95	S		
5/10/14							1	4	3.27				98	S		
5/11/14	2	4	15.80										90-92	F		
5/12/14							1	4	****				****	****		
5/13/14							2	8	6.54				79-94	F		
5/15/14							1	4	3.27				88	F		
5/17/14							4	16	13.07				78-88	F		
5/24/14							1	4	3.27				86	F		

The table will only be updated with catch, salvage, loss, length, race, and loss density on dates when salmon were salvaged,
although the report and "report date" will be updated each week day to indicate that the information is current.

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)
**Values include the latest interpretation of a NMFS/USBR interim procedure to estimate loss due to secondary channel construction outage
**Calculations used in the loss estimates for 3/12/14 and 3/18/14 at the 1200 outages at the TFCF has not been validated/accepted by NMFS or USBR
NS: no salvage due to facility shutdown
***Please note that the 1000 AM count on 4/11/2014 at CVP was changed from study code 0000 to 8888 as per discussion with NMFS and USBR.
****No length was taken for the Chinook Salmon and consequently race cannot be determined by length at date criteria

Appendix D: Operations Summary Tables

2014 CVP & SWP Operations & Delta Conditions									
Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	USGS Tidally Filtered Mean 5-Day OMR (cfs)	USGS Tidally Filtered Mean 14-Day OMR (cfs)	Mean 5-Day OMR Index Calculation (cfs)	Mean 14-Day OMR Index Calculation (cfs)	Controlling
10/1/2013	B	3306	1488	O					Delta Outflow (4,000 cfs)
10/2/2013	B	2815	1997	O					
10/3/2013	B	2593	1492	O					
10/4/2013	B	2585	1993	O					
10/5/2013	B	2607	1488	O					
10/6/2013	B	2602	1490	O					
10/7/2013	B	2612	1488	O					
10/8/2013	B	2616	996	C					
10/9/2013	B	2616	994	C					
10/10/2013	B	2619	995	C					
10/11/2013	B	2620	991	O					
10/12/2013	B	2592	989	O					
10/13/2013	B	2627	992	O					
10/14/2013	B	2622	992	O					
10/15/2013	B	2596	991	O					
10/16/2013	B	2593	969	O					
10/17/2013	B	2624	994	C					
10/18/2013	B	2610	992	C					
10/19/2013	B	2534	794	O					
10/20/2013	B	2491	798	O					
10/21/2013	B	2494	792	C					
10/22/2013	B	2491	799	C					
10/23/2013	B	1889	789	C					
10/24/2013	B	1623	798	C					
10/25/2013	B	1616	796	C					
10/26/2013	B	1612	793	C					
10/27/2013	B	1614	798	C					
10/28/2013	B	1129	798	C					
10/29/2013	B	818	990	C					
10/30/2013	B	809	1990	C					
10/31/2013	B	1499	2988	O					

*The “Delta WQ” controlling factor generally refers to seasonal salinity management rather than a specific water quality compliance location.
**Italicized items in controlling factor column are for informative purposes and not related to export control.

2014 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	USGS Tidally Filtered Mean 5-Day OMR (cfs)	USGS Tidally Filtered Mean 14-Day OMR (cfs)	Mean 5-Day OMR Index Calculation (cfs)	Mean 14-Day OMR Index Calculation (cfs)	Controlling
11/1/2013	B	1789	1492	O					**Delta Outflow (4,500 cfs)**
11/2/2013	B	1807	1989	O					
11/3/2013	B	1881	1993	O					
11/4/2013	B	1897	2988	C					
11/5/2013	B	1958	2994	C					
11/6/2013	B	1957	2990	C					
11/7/2013	B	2364	2995	C					
11/8/2013	B	2513	2488	O					
11/9/2013	B	2509	2493	O					
11/10/2013	B	2512	1989	O					
11/11/2013	B	2401	1989	O					
11/12/2013	B	2528	1988	C					
11/13/2013	B	2510	1996	C					
11/14/2013	B	2494	1994	C					
11/15/2013	B	2115	1993	O					
11/16/2013	B	1951	1994	O					
11/17/2013	B	1951	1988	O					
11/18/2013	B	1951	1997	C					
11/19/2013	B	1951	1996	C					
11/20/2013	B	1278	1489	C					
11/21/2013	B	994	1496	C					
11/22/2013	B	991	1193	O					**Delta WQ**
11/23/2013	B	988	1198	O					
11/24/2013	B	986	1198	O					
11/25/2013	B	983	1496	C					
11/26/2013	B	984	1490	C					
11/27/2013	B	986	1487	O					
11/28/2013	B	989	1493	O					
11/29/2013	B	990	1495	O					
11/30/2013	B	990	1494	O					
12/1/2013	B	990	1498	C					*DCC Gate Closure Action IV.1.2*
12/2/2013	B	990	1492	C					**Delta Outflow (4,500 cfs) / WQ**
12/3/2013	B	996	1490	C					
12/4/2013	B	992	1195	C					
12/5/2013	B	988	1159	C					
12/6/2013	B	992	1191	C					
12/7/2013	B	995	1196	C					
12/8/2013	B	992	1191	C					
12/9/2013	B	987	1491	C					
12/10/2013	B	986	1489	C					
12/11/2013	B	987	1494	C					
12/12/2013	B	994	1493	C					
12/13/2013	B	993	1796	C					
12/14/2013	B	993	1791	C					
12/15/2013	B	992	1794	C					
12/16/2013	B	987	1986	C					
12/17/2013	B	984	1990	C					
12/18/2013	B	985	1987	C					
12/19/2013	B	989	1989	C					
12/20/2013	B	984	1993	C					
12/21/2013	B	984	1998	C					
12/22/2013	B	982	1988	C					
12/23/2013	B	980	1988	C					
12/24/2013	B	980	1990	C					
12/25/2013	B	980	1993	C					
12/26/2013	B	980	1995	C					
12/27/2013	B	982	1995	C					
12/28/2013	B	984	1498	C					
12/29/2013	B	985	1494	C					
12/30/2013	B	986	1496	C					
12/31/2013	B	861	1234	C					

*The "Delta WQ" controlling factor generally refers to seasonal salinity management rather than a specific water quality compliance location.
**Italicized items in controlling factor column are for informative purposes and not related to export control.

2014 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	USGS Tidally Filtered Mean 5-Day OMR (cfs)	USGS Tidally Filtered Mean 14-Day OMR (cfs)	Mean 5-Day OMR Index Calculation (cfs)	Mean 14-Day OMR Index Calculation (cfs)	Controlling
1/1/2014	B	801	1198	C					**Delta Outflow (4,500 cfs) / WQ**
1/2/2014	B	801	1190	C					
1/3/2014	B	799	1195	C					
1/4/2014	B	801	1189	C					
1/5/2014	B	799	1196	C	-1450		-1710		
1/6/2014	B	797	1190	C	-1400		-1700		
1/7/2014	B	797	1195	C	-1460		-1700		
1/8/2014	B	797	1191	C	-1390		-1700		
1/9/2014	B	797	694	C	-1300		-1610		
1/10/2014	B	794	688	C	-1330		-1520		
1/11/2014	B	797	690	C	-1420		-1440		
1/12/2014	B	799	689	C	-1330		-1360		
1/13/2014	B	796	694	C	-1290		-1270		
1/14/2014	B	805	692	C	-1390	-1400	-1280	-1520	
1/15/2014	B	72	1496	C	-1520	-1430	-1300	-1500	*O'Neill Pumping Plant Outage*
1/16/2014	B	0	1489	C	-1560	-1460	-1310	-1470	
1/17/2014	B	0	1491	C	-1590	-1440	-1310	-1440	
1/18/2014	B	0	1491	C	-1650	-1440	-1310	-1410	
1/19/2014	B	0	1494	C	-1630	-1470	-1300	-1370	
1/20/2014	B	0	1492	C	-1490	-1470	-1270	-1340	
1/21/2014	B	0	1487	C	-1330	-1410	-1240	-1300	
1/22/2014	B	0	1496	C	-1360	-1430	-1220	-1270	
1/23/2014	B	0	1488	C	-1400	-1470	-1210	-1260	
1/24/2014	B	4	1488	C	-1370	-1480	-1190	-1260	
1/25/2014	B	0	1490	C	-1370	-1450	-1180	-1250	
1/26/2014	B	758	393	C	-1410	-1440	-1110	-1220	*(End O'Neill Outage)*
1/27/2014	B	476	395	C	-1220	-1400	-980	-1160	**Delta WQ**
1/28/2014	B	246	290	C	-920	-1300	-790	-1090	
1/29/2014	B	248	290	C	-730	-1200	-610	-1010	
1/30/2014	B	264	297	C	-590	-1100	-420	-930	
1/31/2014	B	251	289	C	-370	-1000	-300	-860	
2/1/2014	B	248	393	O	-250	-900	-260	-790	**Delta WQ**
2/2/2014	B	251	390	O	-310	-830	-290	-730	
2/3/2014	B	257	397	O	-300	-770	-310	-670	
2/4/2014	B	252	391	O	-190	-690	-330	-610	
2/5/2014	B	252	395	O	-180	-580	-350	-550	
2/6/2014	B	247	389	O	-250	-490	-350	-490	
2/7/2014	B	242	391	O	-270	-440	-340	-420	
2/8/2014	B	254	398	O	-320	-400	-340	-370	
2/9/2014	B	809	397	O	-420	-340	-430	-360	
2/10/2014	E	804	393	C	-490	-320	-520	-380	
2/11/2014	E	1604	2488	C	-840	-460	-1130	-610	**NMFS Action IV.2.3**
2/12/2014	E	2269	3342	C	-1460	-700	-2030	-930	**Mean 14-Day OMR -5,000 cfs**
2/13/2014	E	2591	2995	C	-2220	-980	-2920	-1260	
2/14/2014	E	2588	2995	C	-3010	-1280	-3710	-1580	
2/15/2014	E	2592	2988	C	-3830	-1600	-4510	-1900	
2/16/2014	E	2596	2990	C	-4150	-1840	-4800	-2220	
2/17/2014	E	2608	2993	C	-4120	-2060	-4810	-2540	
2/18/2014	B	2601	2493	C	-4010	-2350	-4730	-2830	**Delta Outflow (7,100 cfs)**
2/19/2014	B	2605	1496	C	-3830	-2590	-4480	-3050	
2/20/2014	B	1975	1494	C	-3550	-2770	-4110	-3240	
2/21/2014	B	1714	990	C	-3360	-2940	-3610	-3380	
2/22/2014	B	1715	989	C	-3180	-3090	-3100	-3530	
2/23/2014	B	1074	288	C	-2720	-3170	-2450	-3550	
2/24/2014	B	798	696	C	-2300	-3230	-1990	-3580	
2/25/2014	B	801	693	C	-1970	-3180	-1650	-3430	
2/26/2014	B	800	698	C	#N/A	#N/A	-1440	-3170	
2/27/2014	B	805	692	C	#N/A	#N/A	-1230	-2920	
2/28/2014	B	827	691	C	#N/A	#N/A	-1250	-2670	

*The "Delta WQ" controlling factor generally refers to seasonal salinity management rather than a specific water quality compliance location.
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2014 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	USGS Tidally Filtered Mean 5-Day OMR (cfs)	USGS Tidally Filtered Mean 14-Day OMR (cfs)	Mean 5-Day OMR Index Calculation (cfs)	Mean 14-Day OMR Index Calculation (cfs)	Controlling
3/1/2014	B	811	694	C	#N/A	#N/A	-1230	-2410	
3/2/2014	E	1458	2493	C	#N/A	#N/A	-1630	-2290	
3/3/2014	E	2085	2196	C	#N/A	#N/A	-2100	-2210	14-Day E/I
3/4/2014	E	2447	2193	C	#N/A	#N/A	-2640	-2170	
3/5/2014	E	2871	2789	C	#N/A	#N/A	-3380	-2280	3-Day E/I
3/6/2014	E	3312	2491	C	-3750	#N/A	-4150	-2420	OMR -6,000 cfs Mean Daily Index
3/7/2014	E	3297	3485	C	-4370	#N/A	-4700	-2690	
3/8/2014	E	3301	3484	C	-4790	#N/A	-5190	-2950	
3/9/2014	E	3195	3348	C	-5140	#N/A	-5550	-3280	
3/10/2014	E	3326	3493	C	-5210	#N/A	-5770	-3620	
3/11/2014	E	3273	3496	C	-5160	#N/A	-5950	-3960	
3/12/2014	E	3361	2991	C	-5150	#N/A	-5880	-4270	
3/13/2014	E	3356	3691	C	-5340	#N/A	-5920	-4630	
3/14/2014	E	2736	3489	C	-5340	#N/A	-5870	-4930	
3/15/2014	E	2891	3495	C	-5280	-4720	-5800	-5250	
3/16/2014	E	3338	3285	C	-5410	-4970	-5780	-5440	
3/17/2014	E	3345	2088	C	-5440	-5130	-5630	-5530	3-Day E/I
3/18/2014	B	3350	2281	C	-5230	-5230	-5380	-5600	Delta Outflow; 14-Day E/I
3/19/2014	B	3346	1487	C	-5060	-5210	-5140	-5560	
3/20/2014	B	2753	1485	C	-4920	-5130	-4770	-5470	Delta Outflow Target~5-6,000 cfs
3/21/2014	B	1448	1193	C	-4420	-4990	-4080	-5220	
3/22/2014	B	1001	1190	C	-3730	-4750	-3520	-4940	
3/23/2014	B	1000	704	C	-3020	-4470	-2840	-4640	
3/24/2014	B	998	689	C	-2420	-4210	-2300	-4320	
3/25/2014	B	1004	997	C	-1980	-4000	-1920	-4030	
3/26/2014	B	1004	992	C	-1690	-3750	-1820	-3770	
3/27/2014	B	866	694	C	-1520	-3390	-1720	-3430	NMFS OMR Modifications
3/28/2014	B	801	698	C	-1490	-3090	-1700	-3150	
3/29/2014	B	804	691	C	-1470	-2850	-1670	-2850	
3/30/2014	B	805	693	C	-1270	-2520	-1590	-2530	
3/31/2014	B	804	691	C	-1160	-2220	-1490	-2290	
4/1/2014	E	2746	689	C	-1510	-2060	-1810	-2160	NMFS OMR Modifications
4/2/2014	E	4205	1190	C	-2070	-2020	-2500	-2210	OMR -5,000 cfs
4/3/2014	E	4241	1188	C	-2700	-2050	-3200	-2290	
4/4/2014	E	4218	1188	C	-3360	-2140	-3910	-2480	
4/5/2014	E	4199	1194	C	-3860	-2270	-4640	-2690	
4/6/2014	E	4216	1188	C	-4110	-2440	-5020	-2940	
4/7/2014	E	4193	1195	C	-4090	-2620	-5040	-3180	
4/8/2014	E	4225	688	C	-4110	-2820	-5060	-3410	3-Day E/I
4/9/2014	E	4206	395	C	-4250	-3050	-5020	-3620	14-Day E/I
4/10/2014	E	4180	494	C	-4430	-3310	-5000	-3860	OMR -5,000 cfs
4/11/2014	E	4205	490	C	-4700	-3590	-4980	-4110	
4/12/2014	E	4217	494	C	-4840	-3830	-4960	-4360	
4/13/2014	B	3586	494	C	-4660	-4030	-4800	-4560	Delta Outflow/WQ
4/14/2014	B	3300	497	C	-4390	-4200	-4660	-4750	
4/15/2014	B	1479	493	C	-4030	-4210	-4160	-4700	
4/16/2014	B	2489	486	C	-3490	-4100	-3830	-4580	
4/17/2014	B	987	488	C	-2960	-3920	-3220	-4360	
4/18/2014	B	1703	489	C	-2630	-3770	-2860	-4180	Act IV.2.1; Vernalis 1:1
4/19/2014	B	1996	485	C	-2380	-3670	-2580	-4020	
4/20/2014	B	1993	494	C	-2270	-3550	-2640	-3850	
4/21/2014	B	1994	797	C	-2280	-3450	-2580	-3710	
4/22/2014	B	2364	494	C	-2360	-3300	-2820	-3560	
4/23/2014	B	2500	503	C	-2340	-3090	-2960	-3450	
4/24/2014	B	2496	189	C	-2390	-2940	-3000	-3310	
4/25/2014	B	2498	291	C	-2520	-2770	-3060	-3170	
4/26/2014	B	2502	394	C	-2510	-2620	-3070	-3030	
4/27/2014	B	2500	482	C	-2620	-2570	-3090	-2950	
4/28/2014	B	2499	483	C	-2710	-2490	-3080	-2880	
4/29/2014	B	2496	489	C	-2720	-2480	-3130	-2940	
4/30/2014	B	2496	494	C	-2770	-2520	-3170	-2930	

*The “Delta WQ” controlling factor generally refers to seasonal salinity management rather than a specific water quality compliance location.

**Italicized items in controlling factor column are for informative purposes and not related to export control.

2014 CVP & SWP Operations & Delta Conditions

Date	Balance Excess	Jones PP (cfs)	Clifton Court Export (cfs)	DCC Gate Status	USGS Tidally Filtered Mean 5-Day OMR (cfs)	USGS Tidally Filtered Mean 14-Day OMR (cfs)	Mean 5-Day OMR Index Calculation (cfs)	Mean 14-Day OMR Index Calculation (cfs)	Controlling
5/1/2014	B	2138	587	C	-2820	-2570	-3140	-3010	**Act IV.2.1; Vernalis 1:1**
5/2/2014	B	1987	782	C	-2750	-2610	-3120	-3040	
5/3/2014	B	1826	490	C	-2770	-2630	-3010	-3040	
5/4/2014	B	1234	1042	C	-2620	-2600	-2900	-3030	
5/5/2014	B	1028	0	C	-2150	-2470	-2550	-2920	**Delta Outflow/WQ**
5/6/2014	B	1003	192	C	-1590	-2290	-2280	-2810	
5/7/2014	B	1001	196	C	-1200	-2200	-2000	-2700	
5/8/2014	B	996	194	C	-970	-2120	-1800	-2610	
5/9/2014	B	999	190	C	-900	-2030	-1610	-2510	
5/10/2014	B	999	194	C	-950	-1910	-1640	-2410	
5/11/2014	B	999	194	C	-1050	-1730	-1630	-2290	
5/12/2014	B	999	195	C	-1100	-1620	-1630	-2180	
5/13/2014	B	998	194	C	-1100	-1540	-1640	-2080	
5/14/2014	B	1000	187	C	-1190	-1460	-1650	-1970	
5/15/2014	B	1002	174	C	-1380	-1390	-1660	-1880	
5/16/2014	B	1003	180	C	-1620	-1330	-1700	-1780	
5/17/2014	B	870	186	C	-1740	-1250	-1690	-1710	**Delta Outflow/WQ**
5/18/2014	B	813	203	C	-1680	-1210	-1670	-1640	**(End Vernalis 1:1)**
5/19/2014	B	812	181	C	-1460	-1220	-1660	-1650	
5/20/2014	B	810	178	C	-1210	-1260	-1630	-1650	
5/21/2014	B	807	289	C	-1090	-1290	-1620	-1650	
5/22/2014	B	808	297	C	-1120	-1310	-1620	-1650	
5/23/2014	B	809	291	O	-1270	-1340	-1640	-1650	*DCC Gate Operations per D-1641*
5/24/2014	B	810	294	O	-1490	-1410	-1670	-1660	
5/25/2014	B	810	276	O	-1750	-1510	-1700	-1670	
5/26/2014	B	811	286	O	-1720	-1510	-1720	-1680	
5/27/2014	B	810	275	C	-1280	-1370	-1730	-1680	
5/28/2014	B	850	292	C	-980	-1260	-1740	-1690	
5/29/2014	B	810	294	C	-770	-1190	-1750	-1690	
5/30/2014	B	810	487	C	-630	-1160	-1810	-1710	
5/31/2014	B	810	493	C	-820	-1180	-1860	-1740	
6/1/2014	B	809	485	C	-1320	-1240	-1920	-1770	**D-1641 Delta Outflow (4,000 cfs)**
6/2/2014	B	811	291	C	-1580	-1310	-1930	-1780	**Delta WQ**
6/3/2014	B	809	284	C	-1610	-1340	-1940	-1800	
6/4/2014	B	807	287	C	-1670	-1360	-1910	-1820	
6/5/2014	B	836	292	C	-1710	-1390	-1890	-1830	
6/6/2014	B	883	289	O	-1730	-1410	-1880	-1850	*DCC Gate Operations per D-1641*
6/7/2014	B	592	283	O	-1680	-1370	-1850	-1850	**OMR restrictions lifted**
6/8/2014	B	0	739	O	#N/A	#N/A	#N/A	#N/A	*Jones outage - TFCF louver work*
6/9/2014	B	0	745	C	#N/A	#N/A	#N/A	#N/A	
6/10/2014	B	0	740	C	#N/A	#N/A	#N/A	#N/A	
6/11/2014	B	0	734	C	#N/A	#N/A	#N/A	#N/A	
6/12/2014	B	0	735	C	#N/A	#N/A	#N/A	#N/A	
6/13/2014	B	0	739	O	#N/A	#N/A	#N/A	#N/A	*DCC Gate Operations per D-1641*
6/14/2014	B	0	737	O	#N/A	#N/A	#N/A	#N/A	
6/15/2014	B	0	744	O	#N/A	#N/A	#N/A	#N/A	
6/16/2014	B	0	744	O	#N/A	#N/A	#N/A	#N/A	
6/17/2014	B	0	739	O	#N/A	#N/A	#N/A	#N/A	
6/18/2014	B	5	746	O	#N/A	#N/A	#N/A	#N/A	
6/19/2014	B	0	741	O	#N/A	#N/A	#N/A	#N/A	
6/20/2014	B	0	742	O	#N/A	#N/A	#N/A	#N/A	
6/21/2014	B	0	743	O	#N/A	#N/A	#N/A	#N/A	
6/22/2014	B	0	747	O	#N/A	#N/A	#N/A	#N/A	
6/23/2014	B	6	742	O	#N/A	#N/A	#N/A	#N/A	
6/24/2014	B	0	728	O	#N/A	#N/A	#N/A	#N/A	
6/25/2014	B	0	743	O	#N/A	#N/A	#N/A	#N/A	
6/26/2014	B	0	742	O	#N/A	#N/A	#N/A	#N/A	
6/27/2014	B	0	737	O	#N/A	#N/A	#N/A	#N/A	
6/28/2014	B	172	734	O	#N/A	#N/A	#N/A	#N/A	*TFCF louver work completed*
6/29/2014	B	873	589	O	#N/A	#N/A	#N/A	#N/A	
6/30/2014	B	876	584	O	#N/A	#N/A	#N/A	#N/A	

*The “Delta WQ” controlling factor generally refers to seasonal salinity management rather than a specific water quality compliance location.
**Italicized items in controlling factor column are for informative purposes and not related to export control.

Appendix E: Old and Middle River Flow Summary Tables

Old and Middle River Flow (OMR)

Preliminary Data - Subject to Change

February-June 2014

(*** Computed from available USGS Tidally Filtered Data)

Date	USGS Tidally Filtered OMR*** (cfs)		OMR Index Calculation (cfs)		
	Mean 5-Day	Mean 14-Day	Mean Daily	Mean 5-Day	Mean 14-Day
1/1/2014			-1730		
1/2/2014			-1720		
1/3/2014			-1710		
1/4/2014			-1690		
1/5/2014	-1450		-1700	-1710	
1/6/2014	-1400		-1690	-1700	
1/7/2014	-1460		-1690	-1700	
1/8/2014	-1390		-1720	-1700	
1/9/2014	-1300		-1250	-1610	
1/10/2014	-1330		-1260	-1520	
1/11/2014	-1420		-1280	-1440	
1/12/2014	-1330		-1280	-1360	
1/13/2014	-1290		-1290	-1270	
1/14/2014	-1390	-1400	-1290	-1280	-1520
1/15/2014	-1520	-1430	-1380	-1300	-1500
1/16/2014	-1560	-1460	-1300	-1310	-1470
1/17/2014	-1590	-1440	-1290	-1310	-1440
1/18/2014	-1650	-1440	-1270	-1310	-1410
1/19/2014	-1630	-1470	-1250	-1300	-1370
1/20/2014	-1490	-1470	-1220	-1270	-1340
1/21/2014	-1330	-1410	-1190	-1240	-1300
1/22/2014	-1360	-1430	-1190	-1220	-1270
1/23/2014	-1400	-1470	-1180	-1210	-1260
1/24/2014	-1370	-1480	-1180	-1190	-1260
1/25/2014	-1370	-1450	-1160	-1180	-1250
1/26/2014	-1410	-1440	-830	-1110	-1220
1/27/2014	-1220	-1400	-550	-980	-1160
1/28/2014	-920	-1300	-250	-790	-1090
1/29/2014	-730	-1200	-250	-610	-1010
1/30/2014	-590	-1100	-240	-420	-930
1/31/2014	-370	-1000	-230	-300	-860

Old and Middle River Flow (OMR)

Preliminary Data - Subject to Change

February-June 2014

(*** Computed from available USGS Tidally Filtered Data)

Date	USGS Tidally Filtered OMR*** (cfs)		OMR Index Calculation (cfs)		
	Mean 5-Day	Mean 14-Day	Mean Daily	Mean 5-Day	Mean 14-Day
2/1/2014	-250	-900	-330	-260	-790
2/2/2014	-310	-830	-380	-290	-730
2/3/2014	-300	-770	-360	-310	-670
2/4/2014	-190	-690	-340	-330	-610
2/5/2014	-180	-580	-340	-350	-550
2/6/2014	-250	-490	-340	-350	-490
2/7/2014	-270	-440	-330	-340	-420
2/8/2014	-320	-400	-330	-340	-370
2/9/2014	-420	-340	-810	-430	-360
2/10/2014	-490	-320	-780	-520	-380
2/11/2014	-840	-460	-3410	-1130	-610
2/12/2014	-1460	-700	-4790	-2030	-930
2/13/2014	-2220	-980	-4780	-2920	-1260
2/14/2014	-3010	-1280	-4790	-3710	-1580
2/15/2014	-3830	-1600	-4800	-4510	-1900
2/16/2014	-4150	-1840	-4830	-4800	-2220
2/17/2014	-4120	-2060	-4850	-4810	-2540
2/18/2014	-4010	-2350	-4400	-4730	-2830
2/19/2014	-3830	-2590	-3510	-4480	-3050
2/20/2014	-3550	-2770	-2960	-4110	-3240
2/21/2014	-3360	-2940	-2310	-3610	-3380
2/22/2014	-3180	-3090	-2330	-3100	-3530
2/23/2014	-2720	-3170	-1120	-2450	-3550
2/24/2014	-2300	-3230	-1250	-1990	-3580
2/25/2014	-1970	-3180	-1260	-1650	-3430
2/26/2014			-1250	-1440	-3170
2/27/2014			-1250	-1230	-2920
2/28/2014			-1250	-1250	-2670

Old and Middle River Flow (OMR)

Preliminary Data - Subject to Change

February-June 2014

(*** Computed from available USGS Tidally Filtered Data)

Date	USGS Tidally Filtered OMR*** (cfs)		OMR Index Calculation (cfs)		
	Mean 5-Day	Mean 14-Day	Mean Daily	Mean 5-Day	Mean 14-Day
3/1/2014			-1150	-1230	-2410
3/2/2014			-3240	-1630	-2290
3/3/2014			-3590	-2100	-2210
3/4/2014			-3970	-2640	-2170
3/5/2014			-4920	-3380	-2280
3/6/2014	-3750		-5050	-4150	-2420
3/7/2014	-4370		-5980	-4700	-2690
3/8/2014	-4790		-6020	-5190	-2950
3/9/2014	-5140		-5790	-5550	-3280
3/10/2014	-5210		-6020	-5770	-3620
3/11/2014	-5160		-5960	-5950	-3960
3/12/2014	-5150		-5600	-5880	-4270
3/13/2014	-5340		-6250	-5920	-4630
3/14/2014	-5340		-5520	-5870	-4930
3/15/2014	-5280	-4720	-5660	-5800	-5250
3/16/2014	-5410	-4970	-5900	-5780	-5440
3/17/2014	-5440	-5130	-4810	-5630	-5530
3/18/2014	-5230	-5230	-5000	-5380	-5600
3/19/2014	-5060	-5210	-4320	-5140	-5560
3/20/2014	-4920	-5130	-3830	-4770	-5470
3/21/2014	-4420	-4990	-2420	-4080	-5220
3/22/2014	-3730	-4750	-2030	-3520	-4940
3/23/2014	-3020	-4470	-1610	-2840	-4640
3/24/2014	-2420	-4210	-1620	-2300	-4320
3/25/2014	-1980	-4000	-1890	-1920	-4030
3/26/2014	-1690	-3750	-1920	-1820	-3770
3/27/2014	-1520	-3390	-1550	-1720	-3430
3/28/2014	-1490	-3090	-1500	-1700	-3150
3/29/2014	-1470	-2850	-1480	-1670	-2850
3/30/2014	-1270	-2520	-1480	-1590	-2530
3/31/2014	-1160	-2220	-1430	-1490	-2290

Old and Middle River Flow (OMR)

Preliminary Data - Subject to Change

February-June 2014

(*** Computed from available USGS Tidally Filtered Data)

Date	USGS Tidally Filtered OMR*** (cfs)		OMR Index Calculation (cfs)		
	Mean 5-Day	Mean 14-Day	Mean Daily	Mean 5-Day	Mean 14-Day
4/1/2014	-1510	-2060	-3150	-1810	-2160
4/2/2014	-2070	-2020	-4960	-2500	-2210
4/3/2014	-2700	-2050	-5000	-3200	-2290
4/4/2014	-3360	-2140	-5020	-3910	-2480
4/5/2014	-3860	-2270	-5050	-4640	-2690
4/6/2014	-4110	-2440	-5060	-5020	-2940
4/7/2014	-4090	-2620	-5050	-5040	-3180
4/8/2014	-4110	-2820	-5130	-5060	-3410
4/9/2014	-4250	-3050	-4810	-5020	-3620
4/10/2014	-4430	-3310	-4940	-5000	-3860
4/11/2014	-4700	-3590	-4960	-4980	-4110
4/12/2014	-4840	-3830	-4950	-4960	-4360
4/13/2014	-4660	-4030	-4360	-4800	-4560
4/14/2014	-4390	-4200	-4110	-4660	-4750
4/15/2014	-4030	-4210	-2400	-4160	-4700
4/16/2014	-3490	-4100	-3350	-3830	-4580
4/17/2014	-2960	-3920	-1890	-3220	-4360
4/18/2014	-2630	-3770	-2530	-2860	-4180
4/19/2014	-2380	-3670	-2730	-2580	-4020
4/20/2014	-2270	-3550	-2720	-2640	-3850
4/21/2014	-2280	-3450	-3020	-2580	-3710
4/22/2014	-2360	-3300	-3080	-2820	-3560
4/23/2014	-2340	-3090	-3220	-2960	-3450
4/24/2014	-2390	-2940	-2940	-3000	-3310
4/25/2014	-2520	-2770	-3020	-3060	-3170
4/26/2014	-2510	-2620	-3100	-3070	-3030
4/27/2014	-2620	-2570	-3170	-3090	-2950
4/28/2014	-2710	-2490	-3190	-3080	-2880
4/29/2014	-2720	-2480	-3190	-3130	-2940
4/30/2014	-2770	-2520	-3210	-3170	-2930

Old and Middle River Flow (OMR)

Preliminary Data - Subject to Change

February-June 2014

(*** Computed from available USGS Tidally Filtered Data)

Date	USGS Tidally Filtered OMR*** (cfs)		OMR Index Calculation (cfs)		
	Mean 5-Day	Mean 14-Day	Mean Daily	Mean 5-Day	Mean 14-Day
5/1/2014	-2820	-2570	-2970	-3140	-3010
5/2/2014	-2750	-2610	-3030	-3120	-3040
5/3/2014	-2770	-2630	-2650	-3010	-3040
5/4/2014	-2620	-2600	-2630	-2900	-3030
5/5/2014	-2150	-2470	-1460	-2550	-2920
5/6/2014	-1590	-2290	-1630	-2280	-2810
5/7/2014	-1200	-2200	-1650	-2000	-2700
5/8/2014	-970	-2120	-1640	-1800	-2610
5/9/2014	-900	-2030	-1650	-1610	-2510
5/10/2014	-950	-1910	-1650	-1640	-2410
5/11/2014	-1050	-1730	-1540	-1630	-2290
5/12/2014	-1100	-1620	-1670	-1630	-2180
5/13/2014	-1100	-1540	-1700	-1640	-2080
5/14/2014	-1190	-1460	-1690	-1650	-1970
5/15/2014	-1380	-1390	-1700	-1660	-1880
5/16/2014	-1620	-1330	-1730	-1700	-1780
5/17/2014	-1740	-1250	-1640	-1690	-1710
5/18/2014	-1680	-1210	-1620	-1670	-1640
5/19/2014	-1460	-1220	-1600	-1660	-1650
5/20/2014	-1210	-1260	-1560	-1630	-1650
5/21/2014	-1090	-1290	-1660	-1620	-1650
5/22/2014	-1120	-1310	-1670	-1620	-1650
5/23/2014	-1270	-1340	-1710	-1640	-1650
5/24/2014	-1490	-1410	-1740	-1670	-1660
5/25/2014	-1750	-1510	-1730	-1700	-1670
5/26/2014	-1720	-1510	-1730	-1720	-1680
5/27/2014	-1280	-1370	-1720	-1730	-1680
5/28/2014	-980	-1260	-1800	-1740	-1690
5/29/2014	-770	-1190	-1780	-1750	-1690
5/30/2014	-630	-1160	-1990	-1810	-1710
5/31/2014	-820	-1180	-2000	-1860	-1740

Old and Middle River Flow (OMR)

Preliminary Data - Subject to Change

February-June 2014

(*** Computed from available USGS Tidally Filtered Data)

Date	USGS Tidally Filtered OMR*** (cfs)		OMR Index Calculation (cfs)		
	Mean 5-Day	Mean 14-Day	Mean Daily	Mean 5-Day	Mean 14-Day
6/1/2014	-1320	-1240	-2010	-1920	-1770
6/2/2014	-1580	-1310	-1840	-1930	-1780
6/3/2014	-1610	-1340	-1860	-1940	-1800
6/4/2014	-1670	-1360	-1840	-1910	-1820
6/5/2014	-1710	-1390	-1900	-1890	-1830
6/6/2014	-1730	-1410	-1950	-1880	-1850
6/7/2014	-1680	-1370	-1690	-1850	-1850
6/8/2014					
6/9/2014					
6/10/2014					
6/11/2014					
6/12/2014					
6/13/2014					
6/14/2014					
6/15/2014					