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

JAN 28 2016

Mr. Ron Milligan
Operations Manager, Central Valley Project
U.S. Bureau of Reclamation
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

Dear Mr. Milligan:

This letter provides the U.S. Bureau of Reclamation (Reclamation) with the estimated number of juvenile Sacramento River winter-run Chinook salmon (winter-run, *Oncorhynchus tshawytscha*) expected to enter the Sacramento-San Joaquin Delta (Delta) during water year 2016. This juvenile production estimate, or JPE, is calculated by NOAA's National Marine Fisheries Service (NMFS) pursuant to the June 4, 2009, biological opinion on the long-term operations of the Central Valley Project (CVP) and the State Water Project (SWP, CVP/SWP operations Opinion) in order to provide incidental take for the combined operation of the CVP and SWP. The JPE is used to determine the authorized level of incidental take for winter-run, under section 7 of the Endangered Species Act (ESA), while operating the CVP/SWP Delta pumping facilities in a given water year.

Due to the imperiled state of winter-run, NMFS recently announced its inclusion as one of eight species highlighted in our agency's "Species in the Spotlight" initiative. This initiative is an effort to focus attention and resources to managing NMFS' eight most critically endangered species with the goal of reversing their trajectories towards extinction.

One of the most significant impacts to winter-run in recent time is California's current extended drought. Due to temperature management challenges in 2014, Shasta Reservoir ran out of cold water in August, and in-river temperatures in the Sacramento River rose quickly to lethal levels in September and October – ultimately resulting in a failure of winter-run in brood year 2014.

Despite our best coordinated efforts in 2015 to plan for Sacramento River temperature management, the reduced size and quality of the cold water pool in Shasta Reservoir and the competing demands for limited water reserves collectively forced us to make compromises to ensure we had enough cold water to last through the temperature control season (October).

We recognize and appreciate Reclamation's efforts throughout the summer of 2015 to implement the agreed-upon Shasta River temperature management plan. With a few exceptions, and through a lot of good coordination, operations were able to match the plan. However, the information below illustrates that despite our best efforts, winter-run in brood year 2015 also

suffered very high mortality. As such, the winter-run JPE for brood year 2015 reflects a smaller level of authorized take, relative to years when the strength of the wild winter-run year class was more robust.

Examination of 2015 Data; JPE Model Investigation

The CVP/SWP operations Opinion defines the JPE as juvenile survival to the beginning of the Delta (*i.e.,* Tower Bridge in Sacramento, California), but not through the Delta. The calculation of the winter-run JPE for brood year 2015 begins with estimates of winter-run adult escapement for 2015, which are derived from carcass surveys conducted in the upper Sacramento River by the California Department of Fish and Wildlife (CDFW). This escapement information was provided to NMFS via a letter received on December 29, 2015 (enclosure 1). The CDFW estimate for total winter-run escapement in 2015 was **3,439 spawners** (90% confidence interval: 3,042 - 3,836). Of these, 257 broodstock were collected at the Keswick trap for Livingston Stone National Fish Hatchery (LSNFH), leaving an estimated 3,182 in-river spawners. The methodology used by CDFW (*i.e.*, Cormack-Jolly-Seber Model) to establish this 2015 estimate is the same as was used in 2014. Adult escapement in 2015 increased slightly from the previous year (3,015 adults in 2014) but was lower than the 10-year average (*i.e.,* 4,484) for 2006-2015 (figure 1). The cohort replacement rate (CRR), which is a measure of the population's growth rate, was positive (> 1.0) in 2015, similar to the rate observed in the previous 2 years (figure 2). Over the last 10 years, the CRR has been negative for 6 out of 10 years, indicating wide fluctuations in the status of the population.

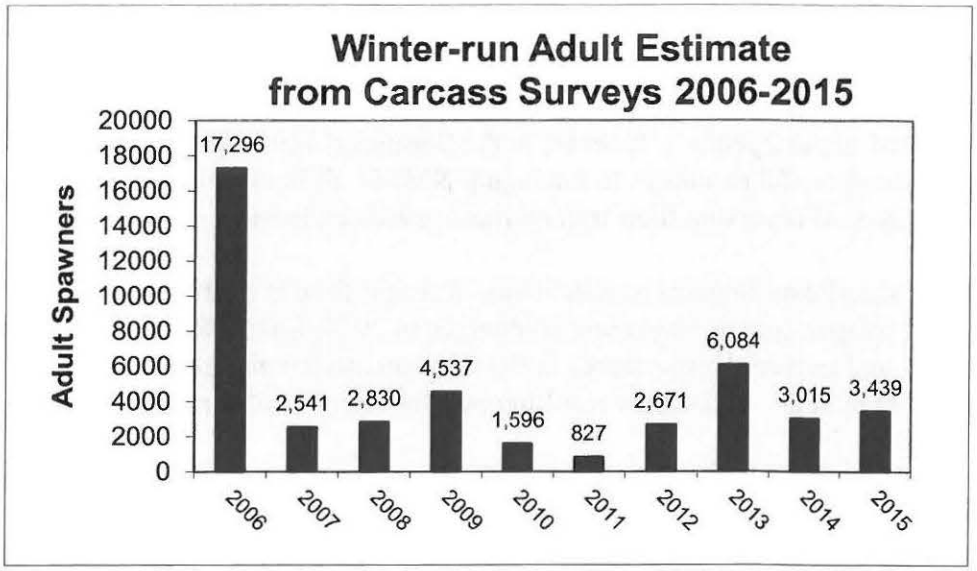

Figure 1. Winter-run spawning escapement in the Sacramento River 2006-2015 (CDFW GrandTab 2015).

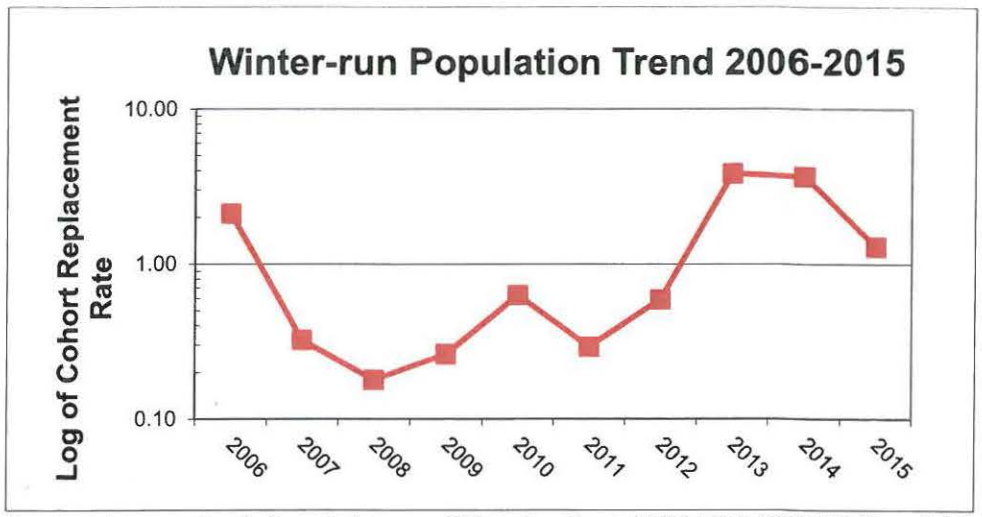

Figure 2. Cohort replacement rate for winter-run Chinook salmon 2006-2015 (CDFW GrandTab 2015).

The JPE calculated for the winter-run 2015 brood year incorporates the November 2014 recommendations of the Independent Review Panel (IRP) [Delta Science Program (DSP) 2014] and the advice of the Winter-Run Project Work Team (WRPWT) from their 2015 technical review (enclosure 2). Based on these recommendations (and similar to last year), NMFS is providing three methods of calculating the JPE in 2015.[1]

Methods used for 2015 JPE calculation (Table 1):

1. NMFS (JPE) spreadsheet method
2. Cramer Fish Sciences (CFS) model: a systems dynamics computer simulation model that includes Monte Carlo stochastic simulations (CFS 2010)
3. Juvenile Production Index (JPI) method: real-time passage estimates at Red Bluff Diversion Dam (RBDD)

Table 1. Winter-run JPE using three available methods. Adult escapement from CDFW 2015 letter. Juvenile passage at RBDD from U.S. Fish and Wildlife Service (USFWS) passage estimated through December 16, 2015.

Method	Adult Escapement	Viable Eggs Estimated	Survival to RBDD (S1)	Juveniles passing RBDD	Survival to Delta (S2)	Juveniles to Delta (JPE)
NMFS[1]	3,439	9,744,018	0.27	2,630,547	0.42	650,476
CFS model[2]	3,439	9,744,018	0.20	n/a	0.42	278,569
JPI method[3]	3,439	9,744,018	0.042	410,475	0.42	101,716

[1] NMFS spreadsheet model same as methodology in 2014, S1 is based on 15-year average

[2] Cramer Fish Science (CFS) winter-run production model at the 95% confidence interval (CI) level, using 2014 critical year flows and temperature data at Bend Bridge. S1 is an approximate value, varies daily depending on exponential relationship with observed water temperatures (CFS 2010).

[1] Per recommendations of the IRP in the November 2014 report, NMFS is conducting additional statistical analyses of historical data. These additional analyses have not been completed at this time.

[3] Juvenile Production Index = the number of fry equivalents based on passage at RBDD and actual environmental conditions in 2015 at the 90% CI level.
n/a = not available

Each of the methods begins with the same adult escapement estimate from CDFW, which is further refined using data from carcass surveys to estimate the number of adult female spawners. Using average fecundity (eggs/female) collected from females surveyed at LSNFH, NMFS calculated that 9,744,018 viable eggs were produced in brood year 2015[2] -- this estimate is again the same for each of the three methods in Table 1.

Estimates of egg-to-fry survival rate (S1) vary among the above three methods. Historically, the S1 survival rate has been based on an average over the last 15 years (*i.e.*, 0.27) calculated from adult escapement and juvenile passage estimates at RBDD. However, this tends to overestimate juveniles in poor production years. Based in part on advice from the WRPWT 2015 technical review, the JPI method calculated early life-stage survival at 0.042 (*i.e.*, 4.2% survival) based on the number of fry equivalents[3] that passed RBDD as of December 16, 2015 (enclosure 2).

The survival of juvenile winter-run in the Sacramento River varies depending on environmental conditions (*e.g.*, flows, turbidity, and temperature) which are not known until after the JPE is calculated. This year, based on recommendations from the IRP report (DSP 2014) and the WRPWT, smolt survival (S2) to the Delta was calculated from the average of acoustically-tagged winter-run Chinook salmon releases in 2013, 2014, and 2015 (two releases) from Salt Creek (3 miles downstream of RBDD) to the Tower Bridge (at Sacramento, Table 1). The Tower Bridge is considered the point of Delta entry.

Smolt survival to the Delta (S2, from acoustic tag releases):

2013 = 0.16
2014 = 0.42
2015 = 0.45
2015 = 0.63
Average = 0.42

Method Selection and 2015 JPE Calculation

After reviewing the recommendations from the WRPWT technical team (enclosure 2), NMFS chose the JPI method to calculate the winter-run JPE from broodyear 2015, since it more closely represented the actual hydrologic conditions experienced by winter-run egg and fry in 2015 and because the loss of juveniles due to high temperatures is not accurately represented in either the NMFS or CFS models. Using the JPI method, and based upon the best available information,

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[2] This estimate corrects an error in enclosure 2. Specifically, in table 1, the number of viable eggs should be 9,744,018 (2,022 adult females multiplied by 4,819 average fecundity) rather than the stated 9,742,765 eggs.
[3] Through December 16, 2015, estimated passage past Red Bluff Diversion Dam was 312,038 juvenile winter-run (http://www.fws.gov/redbluff/RBDD%20JSM%20Biweekly/2015/BiWeekly20151217-20151231.pdf). This resulted in an estimated 3.2% survival, or conversely, 96.8% mortality of eggs and fry. Juvenile winter-run production was standardized by estimating a fry-equivalent JPI for among-year comparisons. The number of presmolts/smolts (≥ 46 mm FL) is multiplied by 1.7 to determine the fry-equivalents. See http://www.fws.gov/redbluff/MSJM%20Reports/RST/Brood%20Year%202013%20Juvenile%20Chinook%20Indices.pdf for further discussion.

NMFS estimates a JPE of **101,716 natural-origin juvenile winter-run entering the Delta during water year 2016** (enclosure 3). Based upon CDFW historical monitoring data at Knights Landing rotary screw traps, winter-run juveniles are expected to emigrate into the Delta from November 2015 to April 2016.

In early February 2016, approximately 420,000 winter-run juveniles propagated at LSNFH will also be released into the upper Sacramento River near Redding. As you are aware, hatchery production at LSNFH was increased in both 2014 and 2015 above standard propagation levels to compensate for expected losses in natural production due to drought conditions (*i.e.*, low cold water pool volume at Shasta Reservoir, resulting in high water temperatures in the Sacramento River). As in 2014, an additional 1,000 juvenile winter-run from broodyear 2015 will be held at LSNFH for the re-instituted captive broodstock program. All hatchery-produced winter-run will be coded-wire tagged and marked with an adipose fin clip before release so that they can be identified from other hatchery fish. Since the hatchery winter-run have not been released yet, their survival rate is unknown. NMFS used the average survival rate (*i.e.,* 0.37) of the winter-run acoustic tag releases in 2013, 2014, and 2015 between Redding (Caldwell Park) and the Tower Bridge in Sacramento to predict how many hatchery fish would enter the Delta (enclosure 2). NMFS estimates that approximately 148,000 juveniles from LSNFH will survive to enter the Delta during water year 2016 (enclosure 3).

The authorized incidental take limit for the combined CVP/SWP Delta pumping facilities includes both the natural (wild) and hatchery-produced juvenile winter-run, as both are considered necessary components of the population for survival and recovery of the species. The authorized incidental take for naturally-produced winter-run has been established in the CVP/SWP operations Opinion as 2 percent of the JPE to allow for errors in fish identification due to use of the length-at-date criteria to determine salmon race (*i.e.*, differentiating from fall-run, late-fall run, and spring-run Chinook salmon). This year, a new program to genetically identify juvenile salmon races was initiated by the California Department of Water Resources (DWR) in December 2015. The use of genetic data to determine race of juvenile Chinook salmon observed at the CVP/SWP Delta pumping facilities eliminates the uncertainty that was included in previous annual incidental take limits for winter-run. Therefore, the authorized level of incidental take (*i.e.*, reported as loss at the Delta fish facilities) under the ESA for the combined CVP/SWP Delta pumping facilities from October 1, 2015, through June 30, 2016, is set at 1 percent or **1,017 natural (non-clipped or wild)** winter-run. The incidental take for hatchery winter-run is set at 1 percent of the LSNFH release, or **1,554 hatchery-produced** winter-run. If the incidental take for natural production exceeds 0.5 percent of the JPE entering the Delta (*i.e.*, 508), or 0.5 percent of the hatchery production (*i.e.*, 777), Reclamation and DWR must immediately convene the Water Operations Management Team (WOMT) to consider actions to minimize incidental take, pursuant to the CVP/SWP Opinion.

As was the case in 2014, the JPE in 2015 is low enough that the triggers used for certain Reasonable and Prudent Alternative actions like Old and Middle River flow management Action IV.2.3 are below the minimums established in the CVP/SWP Opinion. NMFS allows for flexibility in water operations by using the minimum (*i.e.,* loss density of 2.5 older juvenile Chinook salmon per thousand acre-feet of water exported) for the first stage trigger rather than

the lower trigger based on the 2015 JPE. This minimum loss density will allow for more water to be exported before a loss density trigger is exceeded in 2016.

The initial identification of naturally-produced (non-clipped) winter-run at the CVP/SWP Delta fish facilities shall be based on the length-at-date criteria for the Delta. As additional information becomes available through genetic analysis of tissue samples and other fisheries monitoring programs (*e.g.*, continued acoustical tag studies) in the Central Valley, estimates of the incidental take at the Delta fish facilities may be adjusted, if deemed scientifically sound by NMFS. NMFS will continue to monitor daily fish salvage and loss, and loss densities of winter-run and other ESA-listed species at the Delta fish salvage facilities, through participation in the DOSS technical team, WOMT, Drought Contingency Planning, California Water meetings, and Fish Agency Coordination.

NMFS acknowledges that additional research using acoustically-tagged winter-run (both hatchery and wild) is necessary to provide a more robust estimate of in-reach survival of winter-run in the Sacramento River and would also provide direct calculation of survival; greatly improving the accuracy of the JPE. We support the continuation of acoustic tag studies on winter-run to provide data on survival rates over a range of hydrologic conditions, and are encouraged that Reclamation has provided funding to continue these studies.

With the loss of two out of three cohorts of endangered wild winter-run, it is also critical that we develop cold water pool resources this winter and spring to support temperature management needed later in the year for this third wild winter run year class. We look forward to continuing to work with Reclamation and the other State and Federal agencies to manage limited 2016 water resources in a way that supports fish and wildlife resources.

If you have any questions regarding this correspondence, or if NMFS can provide further assistance, please contact Mr. Bruce Oppenheim at (916) 930-3603, or via email at bruce.oppenheim@noaa.gov.

Sincerely,

Maria Rea

Maria Rea
Assistant Regional Administrator
California Central Valley Office

cc: Copy to file: ARN 151422SWR2006SA00268

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Farida Islam, DWR, 3500 Industrial Blvd, Sacramento, CA 95691
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References cited:

California Department of Fish and Wildlife (CDFW). 2015. Unpublished data, GrandTab Spreadsheet of Adult Chinook Escapement in the Central Valley, revised 4/15/15. http://www.calfish.org/tabid/104/Default.aspx.

Cramer Fish Sciences (CFS) 2010. A revised Sacramento River Winter Chinook Juvenile Production Model. Prepared for NOAA, Auburn, CA. 30 pages.

Delta Science Program (DSP). 2014. Letter transmitting Independent Review Panel (IRP) Report for the 2014 Long-term Operations Biological Opinions (LOBO) Annual Science Review. A report to the Delta Science Program of the Delta Stewardship Council. December 2014. 47 pages.

NMFS 2009. Biological and conference opinion on the long-term operations of the Central Valley Project and State Water Project. Long Beach, California. June 4. 844 pg. Plus appendices.

Enclosures:

1. CDFW letter to NMFS, dated December 15, 2015
2. Winter-Run Project Work Team letter to NMFS, dated January 5, 2016
3. NMFS winter-run JPE based on the 2015 spawning escapement

G/Enclosure 1

State of California – Natural Resources Agency
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

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Nat'l Marine Fisheries Svs.
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December 15, 2015

Mr. Will Stelle
Regional Administrator, West Coast Region
National Marine Fisheries Service
7600 Sand Point Way Northeast
Seattle, WA 98115

Dear Mr. Stelle:

Winter-run Chinook Salmon Escapement Estimates for 2015

The California Department of Fish and Wildlife (Department) has developed Sacramento River winter-run Chinook salmon escapement estimates for 2015. These estimates were developed from data collected in the Upper Sacramento River Winter-run Chinook Salmon Escapement Survey (carcass survey) by Department and U.S. Fish and Wildlife Service (USFWS) personnel.

Escapement estimates based on the application of the Cormack-Jolly-Seber (CJS) mark-recapture population model to the carcass survey data for 2015 are shown below:

Estimated Total In-river Escapement (hatchery and natural origin)	**3,182**
Estimated In-river Escapement (hatchery origin)	**639**
Estimated Number of In-river Adult Females (hatchery and natural origin)	**2,063**

These estimates include naturally spawning winter-run Chinook salmon (winter-run) in the upper Sacramento River. In addition, 257 winter-run were collected at the Keswick trap site upstream from RBDD for spawning at Livingston Stone National Fish Hatchery (LSNFH). These fish are not included in the above estimate of naturally spawning winter-run. The total winter-run spawning escapement estimate in 2015, including in-river spawners and fish collected for hatchery broodstock, is **3,439** fish. The 90% confidence interval on this total estimate is from **3,042 to 3,836** fish.

This year, the escapement estimate was again calculated from the carcass survey data using a CJS model. The CJS model has been used from 2013 to present. From 2003-2011, the escapement estimate had been based on application of the Jolly-Seber model. In 2012, based on the recommendations of the *Central Valley Chinook Salmon In-River Escapement Monitoring Plan* (DFG 2012), the winter-run carcass survey used field and analysis methods consistent with application of the CJS model. In simulation studies performed in the development of the Monitoring Plan, the CJS model was shown to more accurately estimate escapement based on mark-recapture data than any other available model. Due to its similarity to the Jolly-Seber model previously used to estimate winter-run escapement, we consider the data for 2013 to be directly comparable for trend analysis with escapement estimates from 2003 through 2012. The CJS model allows the calculation of confidence intervals; we began reporting confidence intervals on our total estimate for the first time in 2012 and continue doing so this year. The total escapement number above is the winter-run total estimate modelled to date and is a final number subject to revision. This estimate is subject to revision if additional data becomes available after the date of this letter. The additional data would then be used in the CJS model to recalculate the final escapement number. The most up to date modelled estimate calculation can be found in the GrandTab spreadsheet which is updated periodically after this letter is sent in the event that new information is received (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=84381&inline=1).

In the spring of 2015 the Department and the other fisheries agencies again recognized the continuing severity of the drought in California. To maximize survival of adult winter-run given the uncertainty of sufficiently cold water in the upper Sacramento River later in the year, the LSNFH was permitted to take additional winter-run brood stock. In prior years LSNFH was permitted to take 120 adults for hatchery brood stock, but given the emergency drought conditions, the LSNFH staff removed 257 fish in 2015 including 146 natural-origin and 111 hatchery-origin fish.

We look forward to further discussion and collaboration with NOAA Fisheries staff regarding the application of this information. Inquiries regarding the methodology and development of the estimates in this letter should be directed to Mr. Douglas Killam, Doug.Killam@wildlife.ca.gov or Mr. Daniel Kratville, Daniel.Kratville@wildlife.ca.gov and at the address and phone number above.

Sincerely,

Stafford Lehr, Chief

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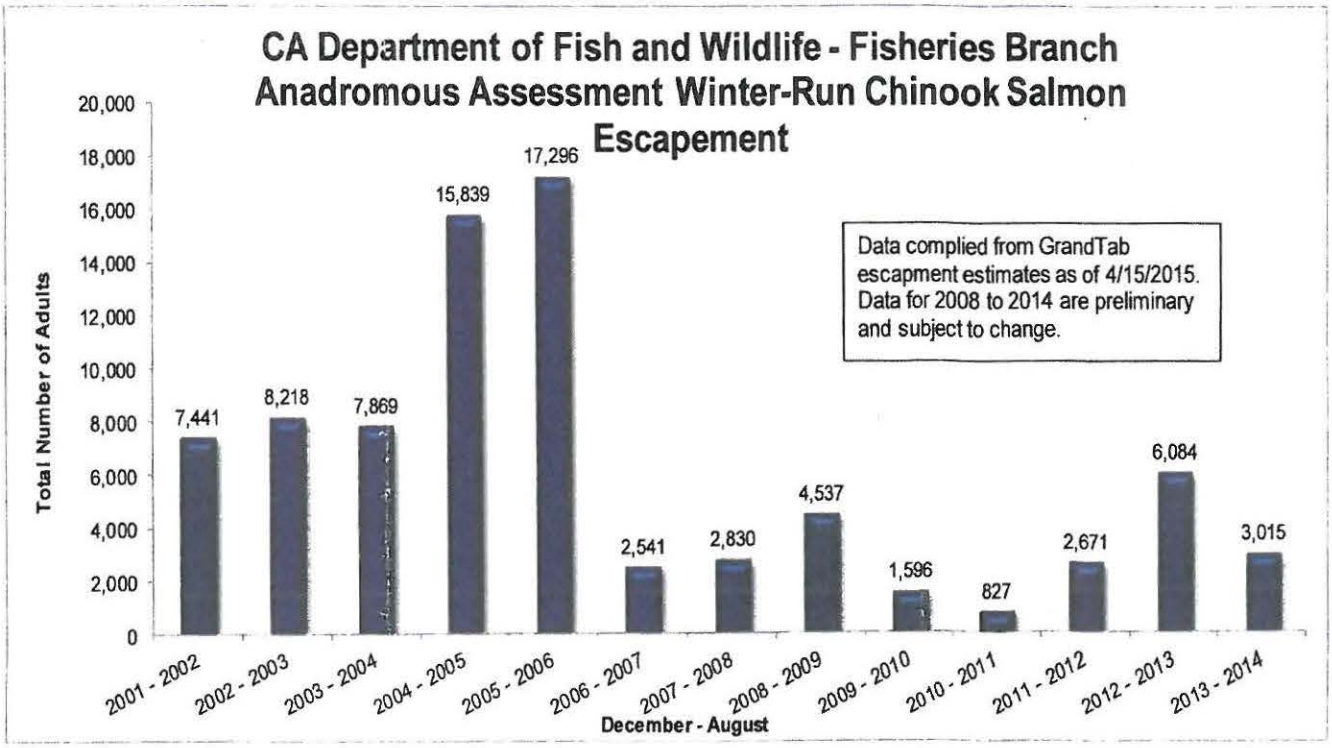
CA Department of Fish and Wildlife - Fisheries Branch
Anadromous Assessment Winter-Run Chinook Salmon
Escapement
Total Number of Adults
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
7,441
8,218
7,869
15,839
17,296
2,541
2,830
4,537
1,596
827
2,671
6,084
3,015
2001 - 2002
2002 - 2003
2003 - 2004
2004 - 2005
2005 - 2006
2006 - 2007
2007 - 2008
2008 - 2009
2009 - 2010
2010 - 2011
2011 - 2012
2012 - 2013
2013 - 2014
December - August
Data complied from GrandTab escapment estimates as of 4/15/2015. Data for 2008 to 2014 are preliminary and subject to change.

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

January 5, 2016

Mr. Garwin Yip
National Marine Fisheries Service
650 Capital Mall, Suite 5-100
Sacramento, CA 95814

Dear Mr. Yip:

Two years ago, the Interagency Ecological Program (IEP)'s Winter-Run Project Work Team (WRPWT) recommended that the NOAA Fisheries Juvenile Production Estimate (JPE) be revisited annually and updated as needed with any new or improved information. A sub-team of the WRPWT met in February, June, September and October of 2015 to review the factors used to calculate the JPE. The JPE is used for estimating the incidental take limit of winter-run Chinook salmon in the Delta at the State Water Project (SWP) and Central Valley Project (CVP). The sub-team also discussed priority monitoring and research that would improve future JPE estimates and provide better information for managing water project operations.

JPE Recommendations:

The sub-team identified four factors in the JPE that they would advise updating for the 2015 broodyear or Water Year 2016:

1) estimated number of fry passing Red Bluff Diversion Dam (RBDD)

2) survival rate of fry to smolts

3) survival rate of smolts from RBDD to Delta entry (defined as Sacramento)

4) estimated survival rate of the winter-run hatchery fish to be released in January or February of 2016

In 2015, a preliminary estimate of 3,439[1] winter-run returned to the upper river, and of these, 3,182 were counted as in-river escapement in the JPE (Table 1). Of those, 64.8 percent were female, for a total adult female escapement estimate of 2,063 (Table 1). Pre-spawning adult mortality was estimated at 2.0 percent resulting in 2,022 adult female winter- run estimated to have spawned (Table 1). The average fecundity in 2015 was measured at 4,819 eggs per

[1] This estimate may change as the official number from CDFW has not been issued yet.

female (from Livingston-Stone National Fish Hatchery broodstock) resulting in an estimate of 9,744,018 total eggs laid in 2015 (Table 1).

Eggs and alevins experienced another year of extremely low survival potentially due to the effects of the drought and state and federal water operations. The egg loss due to water temperature is not accurately represented in the JPE methodology. No redds were observed downstream of the temperature compliance point in 2015; however water temperatures were above 56oF during periods of incubation, hatching, and rearing. Without an accurate method to estimate impacts to egg and alevin survival from high water temperatures and other stressors, the sub-team's first recommendation is to use the Juvenile Production Index (JPI) in the JPE for 2015-2016 which is based on fry equivalents at RBDD, as it was in 2014-2015 (Figure 1). The JPI seasonal estimate as of December 16, 2015 was 410,475 (B. Poytress, USFWS, personal communication; Table 1). The value through week 50 (December 16) accounts for 96.3% of annual winter Chinook passage at RBDD based on data collected from 2002 to 2014 and includes an interpolation of the remaining 3.7% (395,287 / 0.963 = 410,475). With this estimate of fry production at RBDD, the estimated mortality due to water temperatures and other stressors can be best represented.

The second recommendation of the sub-team is the continued inclusion of a factor to account for survival between the fry and smolt lifestage for the naturally produced winter-run. This is necessary because the available survival estimates between RBDD and Delta entry are based on releases of acoustically telemetered (AT) smolts, which have a higher survival rate than fry due to their larger size and faster migration rate. The AT smolt survival rate is then used to determine survival between RBDD and Delta entry (discussed in more detail below). A survival rate of 0.59, based on fall-run salmon survival from fry to smolt has been used for winter-run fry to smolt survival since 1993. This value is based on previous studies (Hallock, undated), and confirmed through a literature review in 1995 (B. Poytress, USFWS, personal communication). Without this survival factor, survival from fry to smolts is assumed to be 100%, which is unrealistic While we have reservations about the accuracy of this term (0.59; Table 1 and Figure 1), we believe it should continue to be used, until a better estimate of fry to smolt survival is available. To address this critical uncertainty we are suggesting that additional studies be conducted in the future to better estimate fry to smolt survival (see monitoring recommendations below).

The third recommendation of the sub-team is related to the smolt survival term for survival from RBDD to the Delta (*i.e.*, Sacramento; at the I-80 Bridge) for naturally produced winter-run. We recommend using results from acoustic tagging of hatchery winter-run from Livingston Stone National Fish Hatchery (LSNFH) in 2013, 2014 and 2015 for this term. There were two release groups in 2015 with survival estimated from RBDD to the Delta of 0.16 in 2013, 0.42 in 2014, and 0.45 and 0.63 in 2015 (A. Ammann, NMFS, personal communication). All hatchery releases were made at Caldwell Park. The survival estimate used for naturally produced winter run, was from RBDD to the Delta and obtained from the detections of the acoustic tag fish on acoustic receivers near RBDD and Sacramento. Although there was not complete agreement in the sub-team, the majority of members recommended that the average survival

estimate from RBDD to Sacramento of all four acoustic tag release groups (*i.e.*, average = 0.42) be used to estimate smolt survival from RBDD to the Delta for naturally produced winter-run in the JPE for 2015-2016 (Table 1 and Figure 1).

The fourth recommendation from the sub-team is updating the term for estimating survival of hatchery winter-run to the Delta (Table 1 and Figure 1). Last year, this term was the average of the 2013 and 2014 estimates of winter-run survival to the Delta (0.29). This year the sub-team recommends that the average survival value of 0.37 (Table 1) be used which is the average of the four available estimates (0.15, 0.38, 0.42, 0.52) from the upper Sacramento River (Caldwell Park) to Sacramento at the I80 Bridge. The reason these survival rates are different than those used for the wild winter-run (used in the previous paragraph) is because the hatchery fish were released from Caldwell Park, whereas we are trying to get an estimate for wild winter-run that is from RBDD to I80 Bridge to apply to the JPI fry equivalents at RBDD.

Monitoring Recommendations:

One of the models we have been developing to support the JPE is associated with the holding time of winter-run acoustic tagged hatchery fish upstream of the Delta and their survival to the Delta. In using the last three years of data (four data points) from the acoustic tag releases of hatchery fish we have found that survival to the Delta appears to be related to holding time, with the lowest survival in 2013, when the holding time was the greatest at 40 days and the highest survival was for the second release in 2015 when the holding time was only 10 days. To apply this model to smaller-sized winter-run, we are recommending that hatchery winter-run be acoustically tagged and released at a smaller size (possible now due to smaller tag sizes), earlier in the season (*e.g.*, December, or early January), to inform our model for future application to smaller winter-run observed at RBDD. The peak of winter-run at RBDD is usually observed in late-September or early October. We are unable to acoustically tag winter-run fish in late-September or early October due to their small size, even with the smallest acoustic tags available.

This recommendation of acoustic tagging a small proportion of the hatchery winter-run and releasing them earlier in the season was supported by the sub-team as a way to estimate a portion of the fry to smolt survival from RBDD to the Delta for the JPE. Other high priority monitoring identified by our sub-team to improve estimates of survival of winter-run, but not explicitly tied to the JPE were;

1) expand tissue samples already collected and processed from the Sacramento Trawl between 2009 and 2011 to estimate the genetic winter-run population entering the Delta and to compare it the JPE and loss at the salvage facilities in those years

2) use parentage methods (genotypes) to link carcass and juvenile outmigrant monitoring to estimate the number of successful breeders and the factors that contribute to successful recruitment, and

3) evaluate disease impacts on winter-run juvenile Chinook salmon survival in the Upper Sacramento River.

While most members of the team thought that continuing to acoustically tag a portion of the hatchery winter-run over the next 10 years was important, there was even more support to develop a wild winter-run tagging proposal. In addition, expanding the genetic samples collected in both the Sacramento and Chipps Island trawls in 2016 for estimating the population size of genetic winter-run at those locations for comparison to the JPE was also a high priority. The improvement of the efficiency estimates at Sacramento and Chipps Island trawls was considered a high priority for all salmon runs to reduce uncertainty in abundance estimates, although one member of the team questioned whether poor and variable efficiency of these trawls could ever provide reliable expansions of total abundance.

Monitoring or research that was discussed by the sub-team, but needs more development or understanding of present work include (not in prioritized order):

1) development of a higher efficiency, continuous trapping gear for juvenile salmonids approaching the Delta (*e.g.* a motorized screw trap at Sacramento with guidance mechanism)

2) placement of additional acoustic receivers in the south Delta to understand movement of tagged winter-run in the central and south Delta

3) placement of additional real time monitoring receivers to provide accurate proportions of acoustic tagged hatchery winter-run at various locations as they move into and through the Delta

4) PIT tagging or dyeing smaller wild winter-run at RBDD to learn more about their growth and timing of entry into the Delta,

5) updating the Cramer Fish Sciences winter-run juvenile production simulation model to estimate juveniles entering the Delta

6) doing additional winter-run otolith work to learn where the survivors reared and how long they spend in different habitats as juveniles and

7) increasing effort at Sacramento and Chipps Island trawls to better estimate winter-run abundance.

We will continue to assess these potential projects and proposals for possible recommendation in 2017.

While we acknowledge that there will still be uncertainty in the JPE estimate even if these recommendations are incorporated, we believe it to be the best information available from which to derive a JPE. To reduce the uncertainty in the JPE in future years, we have suggested additional monitoring or analyses in 2016.

To better manage exports for improving juvenile winter-run survival in the Delta, a suggestion was made, during sub-team discussions, to estimate patterns of entrainment loss using genetic and coded-wire tag information for exporting water at the SWP and CVP in ways that entrainment losses could be targeted to be below required limits. Such an analytical method would provide statistical confidence intervals associated with proposed operations. For example, a proposed export level for a specific river inflow regime could be estimated (with available data) not to exceed a 1% level of incidental take with 95% confidence. Entrainment losses could continue to be monitored to provide a backstop to identify atypical events and to adjust operations accordingly. Further discussion of this topic by the team will be done during 2016.

In summary, we hope these additional analyses and technical advice from the sub-team of the Interagency Ecological Program's WRPWT will help improve the JPE and the incidental take limits for 2015-2016. Continued drought conditions have likely resulted in significant mortality to the winter-run population in the last two years and improvements to the JPE would increase the accuracy of the take limits for the SWP and CVP in water year 2016, for managing the incidental take of winter run at the CVP/SWP water projects.

Sincerely,

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Winter-Run PWT (email list)

Table 1: Factors in the Juvenile Production Estimate and the resulting estimates for 2014-2015, using the Winter-Run PWT approach. Hatchery components in red text.

	Factors	2015-2016 Result using suggested methodology
Total in-river escapement [1]		3,182
Adult female estimate [2]		2,063
Pre-spawn mortality [3]		2.0% (2,022)
Average Fecundity [4]		4,819
Egg loss due to temperature [5] (below compliance point)		No redds below CCR
Total Viable Eggs		9,742,765
In redd loss and fry loss upstream of RBDD due to temperature and other factors[6]	0.958	
Estimated survival: egg to fry (at RBDD) [7]	0.042	
Estimate of fry production at RBDD [8]		410,475
fry survival from October (peak at RBDD in most years) to smolt at RBDD [9]	0.59	242,180
Estimated smolt survival – RBDD to Delta [10]	0.42	101,716
Total natural production entering the Delta		101,716
hatchery release [11]		400,000
Total hatchery production entering the Delta [12]	0.37	148,000
Level of concern for naturally produced fish (1%)		1,017
Level of concern for hatchery fish (0.5%)		740
Incidental Take limit for Natural Production (2%)		2,034
Incidental Take limit for hatchery production (1%)		1,480

Footnotes:

1/ Total in-river escapement from Cormack-Jolly Seber (CJS) model includes natural and hatchery origin, but not hatchery fish retained for brood stock at Livingston Stone National Fish Hatchery.

2/ The number of adult (age 3 or older) females is derived from carcass survey and then the number of males is derived using sex ratio at Keswick trap

3/ Pre-Spawn mortality was estimated from carcass surveys of females (CDFW)

4/ Average # eggs/female from 175 females (including females less than 3 years old) collected from the 2015 returns to Livingston Stone National Fish Hatchery.

5/ No redds observed downstream of Airport Rd, temperature compliance point, but temperatures were not in compliance during periods of the season in 2015

6/ Estimated loss between egg and fry upstream of Red Bluff based on numbers of fry equivalents at RBDD divided by total number of eggs laid

7/ Egg to fry survival based on 1 minus the estimated loss on previous line

8/ Number of fry equivalents at RBDD – JPI – Bill Poytress, (USFWS), personal communication

9/ Estimate of fry to smolt survival based on fall run at Tehama Colusa Spawning Channel (Hallock undated)

10/ Average survival of acoustically tagged winter run in 2013, 2014 and 2015 (2 values in 2015) between RBDD and I80 Tower Bridge in Sacramento – A. Ammann, NMFS, personal communication. Survival is estimated from the Salt Creek receiver site, located 3 miles downstream of RBDD, to estimate survival from RBDD for acoustic tag studies.

11/ LSNFH estimated release as of 12/10/15 (100% tagged and adipose clipped). Production was increased due to the drought.

12/ Average of acoustically tagged winter run survival in 2013, 2014 and 2015 (2 values in 2015) between Caldwell Park and I80 Tower Bridge in Sacramento, (A. Ammann, NMFS, personal comm).

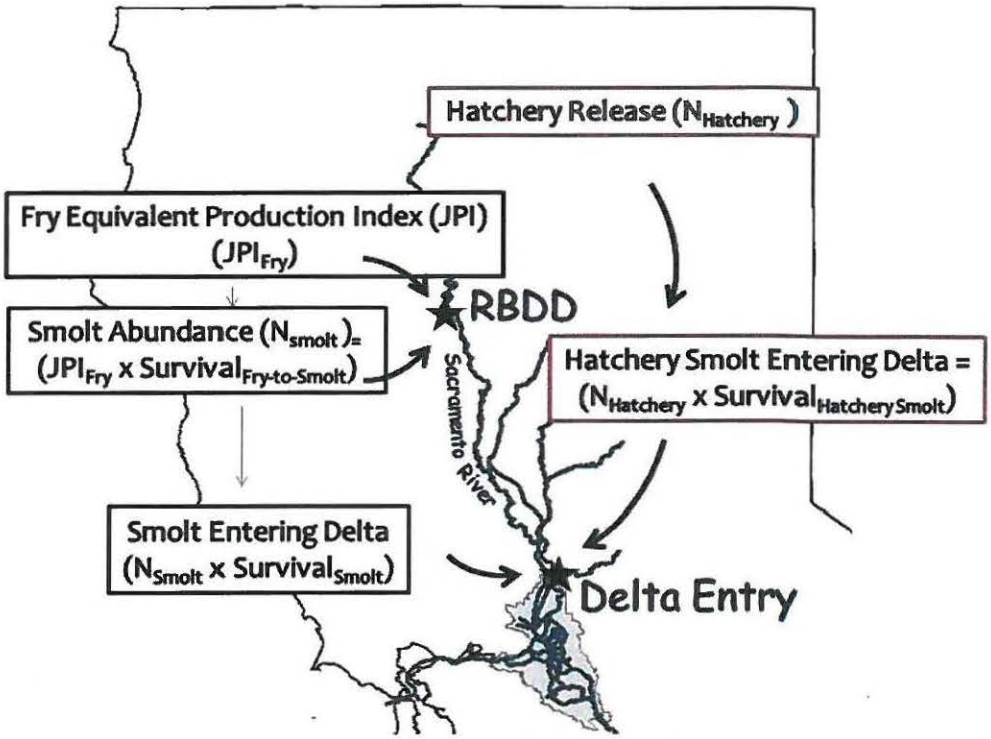

Figure 1: Location and formula's recommended for use in the JPE for the wild (black boxes) and hatchery (red boxes) components of the winter run population estimated in 2015-2016.

NMFS - Southwest Region
WINTER RUN JPE ESTIMATOR PROGRAM

Enclosure 3

DATA ENTRY HERE	
Year Pair	*Broodyear*
2015/2016	2012
Carcasses observed	
1,193	
Females unspawned	
2.00%	3/
CDFG Carcass Survey	
1,193	1/
Female Percent	
64.83%	2/
LSNFH *Hatchery Release*	
420,000	
Release Date	
02/05/16	

Version 3 — 1/25/2016

WINTER RUN CHINOOK SALMON Juvenile Production Estimate	Factors	Carcass Survey Estimate
Total in-river escapement - 1/		3,182
In-river adult females - 2/	0.65	2,063
Prespawn mortality - 3/	0.02	2,022
Average fecundity - 4/	4,819	9,744,018
Egg loss due to temperature (old method)- 5/	n/a	
Total viable eggs		9,744,018
Egg to fry survival from JPI estimate at RBDD (S1) -6/	0.042126	410,475
Fry to pre-smolt survival (Oct-Mar) - 7/	0.59	242,180
Survival to Delta (S2) - 8/ (RBDD to Tower Bridge at Sacramento)	0.42	101,716
Total Natural Production Entering Delta		101,716
Hatchery Release - 9/		420,000
Hatchery Production Entering Delta - 10/	0.37	155,400
Level of Concern for wild fish (0.5%)		509
Level of Concern for hatchery fish (0.5%)		777
Incidental Take Level for wild fish (1%)		1,017
Incidental Take level for Hatchery Production (1%)		1,554

Footnotes -

1/ Total in-river escapement, CDFW letter 12/15/15. Not including 257 kept for broodstock at Keswick Trap.
2/ In-river females derrived from carcass survey. Males derived using sex ratio at Keswick trap.
3/ Pre-spawn mortality from 2015 carcass survey data (CDFW Table 1 Summary).
4/ Average # eggs/female from LSNFH (n = 104), John Rueth, USFWS, pers. comm. 10/30/15.
5/ No redds observed below the temperature compliance point at Clear Creek.
6/ RBDD passage estimate in fry equivalents as of 12/16/15, Bill Poytress, USFWS, pers. comm. 12/23/15.
7/ Pre-smolt survival from fall-run Chinook studies at Tehama-Colusa spawning channel (USFWS 1975-1980)
8/ Average of 4 acoustic tag releases (2013-2015) RBDD to Sacramento. A. Ammann, NMFS, pers. comm.
9/ LSNFH estimate, John Rueth, USFWS, as of 1/13/16, increased due to drought (100% tagged & clipped).
10/ Hatchery survival from average of acoustic tag studies (2013-2015) Redding to Sacramento.