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

February 13, 2019

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

Dear Mr. Rieker:

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*) from brood year (BY) 2018 expected to enter the Sacramento-San Joaquin Delta (Delta) during water year (WY) 2019. 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). The JPE is calculated annually and 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 (NMFS 2009). As a result of the partial Federal government shutdown from December 22, 2018, through January 25, 2019, NMFS is providing this year's JPE letter later than usual.

The winter-run JPE for BY 2018 is **433,176 natural-origin juvenile winter-run entering the Delta during WY 2019**. This JPE calculation is described in detail below, and is developed as a function of the estimated number of adult spawners (and estimated number of viable eggs) combined with estimated egg-to-fry and fry-to-smolt survival rates. There was a considerable increase in the adult escapement, from 1,155 in 2017 to 2,458 in 2018. Despite a decrease in estimated winter-run egg-to-fry survival to Red Bluff Diversion Dam (RBDD, from 44 percent in 2017 to 26 percent in 2018), there was an increase in JPE for BY 2018 as compared to the JPE for BY 2017 (201,409).[1]

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 length-at-date (LAD) criteria to determine Chinook salmon race (i.e., differentiating from fall-run, late-fall run, and spring-run Chinook salmon). In WY 2019, as in WY 2018, genetic race identification will be used. The use of genetic data to determine race of juvenile Chinook salmon observed at the CVP/SWP Delta fish facilities eliminates the uncertainty that was included in previous (2015 and earlier) annual incidental take limits for winter-run. Therefore, the authorized level of incidental take (i.e., reported as loss at the Delta

[1]Found by exact address https://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water Operations/Delta Operations for Salmonids and Sturgeon/DOSS WY 2018/winter-run_juvenile_production_estimate__jpe__for_brood_year_2017_-_january_29__2018__1_.pdf

fish facilities) under the ESA for the combined CVP/SWP Delta pumping facilities from October 1, 2018, through June 30, 2019, is set at 1 percent of the JPE, or **4,332 natural-origin (non-clipped)** winter-run.

The incidental take for hatchery-origin winter-run is set at 1 percent of each release (i.e., Sacramento River and Battle Creek release groups). Therefore, the incidental take limit for juveniles released from Livingston Stone National Fish Hatchery (LSNFH) into the Sacramento River is **867 hatchery-produced (adipose fin clipped)** winter-run for WY 2019. The incidental take limit of juveniles released from LSNFH into Battle Creek is **824 hatchery produced (adipose fin clipped and left ventral fin clipped)** winter-run**.**

Status of Winter-run Chinook Salmon, BY 2014-2018

Despite significant partnership and commitment from all partners involved, execution of drought contingency plans were more successful in some drought years than in others. The temperature dependent egg-to-fry mortality was highest in BY 2015 at 85 percent compared to 2 percent in BY 2016. Temperature-dependent mortality estimates in 2016 were a noteworthy success, and resulted from substantial partnership from all parties to ensure successful execution of the 2016 temperature management plan. In 2015, NMFS selected winter-run as one of eight species highlighted in our "Species in the Spotlight" initiative[2]; an effort designed to focus attention and resources to manage our eight most critically endangered species.

Juvenile winter-run experienced very low survival in 2014 and 2015 during the recent California drought due to unfavorable temperature conditions on the spawning grounds. The California Department of Fish and Wildlife (CDFW), NMFS and the U.S. Fish and Wildlife Service (USFWS) responded to this crisis in part by reinstating the winter-run Chinook salmon Captive Broodstock Program at LSNFH. The primary purpose of the Captive Broodstock Program is to maintain a refugial population of winter-run in a safe and secure environment to be available for use as hatchery broodstock in the event of a catastrophic decline in abundance. A secondary purpose of the program is to provide fish, when possible, to fulfill multi-agency efforts to reintroduce winter-run Chinook salmon into the restored habitats of Battle Creek and above Shasta Dam. Approximately 1,000 juvenile winter-run propagated at LSNFH have been retained annually for the Captive Broodstock Program since it was reinstated beginning with BY 2014 (with the exception of BY 2016, when approximately 534 juveniles were retained).

BY 2018 was largely comprised of winter-run that spawned in 2015, and whose fry were subjected to high temperature conditions during their outmigration. Little rainfall was received in WY 2018 until the month of March, when precipitation events increased and reservoir refill helped recover temperature management expectations. California had the warmest July on record in 2018, followed by severe fires, which likely increased water temperatures downstream of Keswick Dam during the summer months. In May, Reclamation submitted a Temperature Management Plan to NMFS that included a temperature compliance point at Balls Ferry with a target of 56°F daily average temperature (DAT) from May 15 through October 31. As in 2017, NMFS requested from Reclamation additional thermal protections for winter-run by targeting 53.5°F DAT at the Clear Creek gage station (approximately 13 miles downstream of Keswick

[2] found at exact address http://www.nmfs.noaa.gov/stories/2015/09/spotlight_chinook_salmon.html

Dam) as a surrogate for a temperature metric of 55.0°F 7-day average of the daily maximum temperatures to the most downstream winter-run redd. Reclamation successfully implemented 56.0 °F DAT at Balls Ferry, and for 68.4 percent of the period at 53.0 °F DAT at the Clear Creek station.

Redd dewatering surveys are conducted below Keswick Dam to identify winter-run redds susceptible to flow decreases, determine emergence timing, and to estimate flows at which dewatering may occur. Reclamation projected a monthly average Keswick release of 6,000 cfs in October 2018, however, it did not include consideration of flows necessary to minimize winter-run Chinook salmon redd dewatering. Throughout the egg and alevin incubation period, 3 winter-run redds were dewatered[3].

The BY 2017 winter-run Chinook salmon return was near the record low due to extreme drought conditions in 2014 and 2015. The BY 2018 return showed improved adult returns compared to BY 2017, and emigration at RBDD also improved. Increased winter-run hatchery production in 2015 (release of approximately 400,000 juvenile winter-run, compared to the standard release of approximately 200,000 juveniles) helped increase 2018 returns.

JPE Development Process

The process for developing the JPE was the similar to what was done for BY 2017. A technical team from the Interagency Ecological Program (IEP), the Winter-run Project Work Team (WRPWT), met at the beginning of 2019 and provided recommendations to NMFS (Enclosure 2). The method used to calculate the 2018 JPE is derived from the number of juveniles passing RBDD, as estimated by USFWS. This estimate is known as the Juvenile Production Index, or JPI, and it is based on fry-equivalents at RBDD.

The CVP/SWP operations Opinion defines the JPE as the estimated number of juvenile winter-run to enter the Delta (*i.e.,* Tower Bridge in Sacramento), but not through the Delta. The calculation of the winter-run JPE for BY 2018 begins with estimates of winter-run adult escapement for 2018, which are derived from carcass surveys conducted in the upper Sacramento River by CDFW. Escapement information was provided to NMFS via a February 1, 2019, letter (Enclosure 1). The CDFW estimate for total winter-run escapement in 2018 was **2,458 spawners**[4]. Of this total number of spawners, 1,088 were estimated to be females.

The number of adult spawners in 2018 (2,458) increased approximately 213 percent from 2017 (1,155), and was lower than the 10-year average (*i.e.,* 2,802) for 2008–2017 (Figure 1). The cohort replacement rate (CRR), which is a measure of the population's growth rate, was negative (0.71, meaning the population is not replacing itself) in 2018, negative for the 9th time over a 12-year period (2007-2018, Figure 2), but the trend is increasing towards a positive growth rate. With more adults returning in 2018, the estimated number of juvenile winter-run emigrating past

[3] Dewatering is defined here as any part of the redd exposed to air. CDFW field staff moved tail spill rocks from 2 of the redds to offer the best possible opportunity for fry to emerge.
[4] The methodology used by CDFW (*i.e.*, Cormack-Jolly-Seber Model) to estimate escapement is the same model that has been used since 2012.

RBDD is higher than in previous years, and estimates of the JPI which incorporate the additional number of winter-run due to misclassification of spring-run using the river LAD criteria (as described above) are likely to be more accurate.

Similar to BY 2017, genetic analyses were conducted on some LAD juvenile spring-run sampled from the RBDD RSTs, and the estimate of juvenile winter-run emigration past RBDD were adjusted to include the LAD spring-run that were determined to be genetic winter-run.

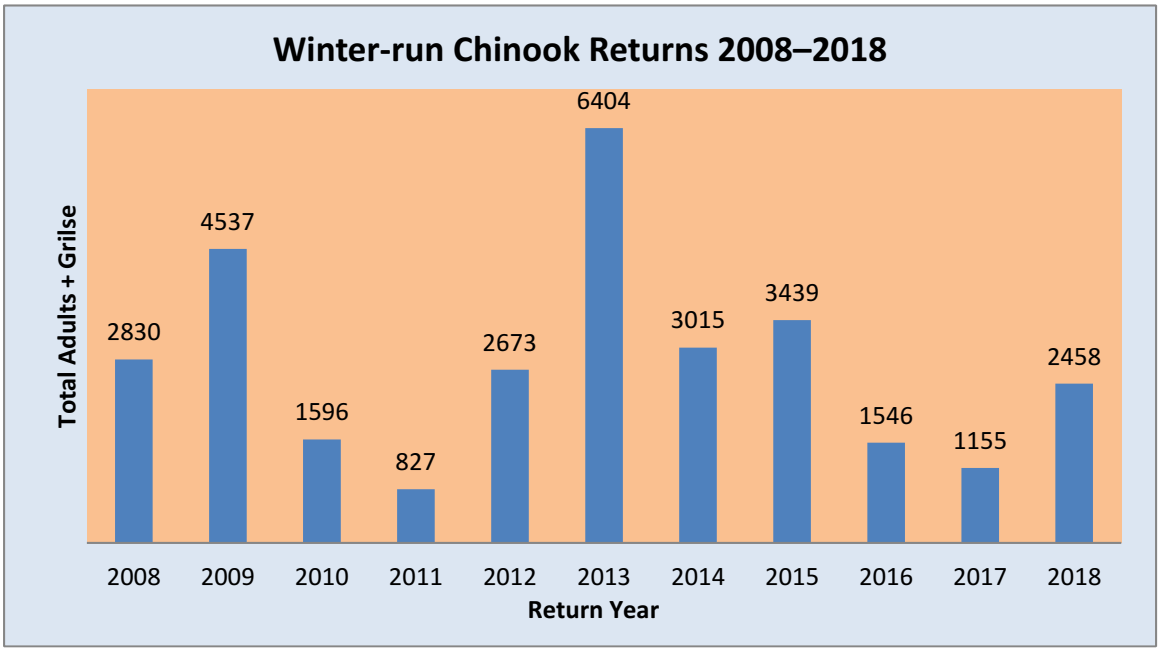

Figure 1. Winter-run Spawning Escapement 2008-2018 (CDFW 2017 and Enclosure 1).

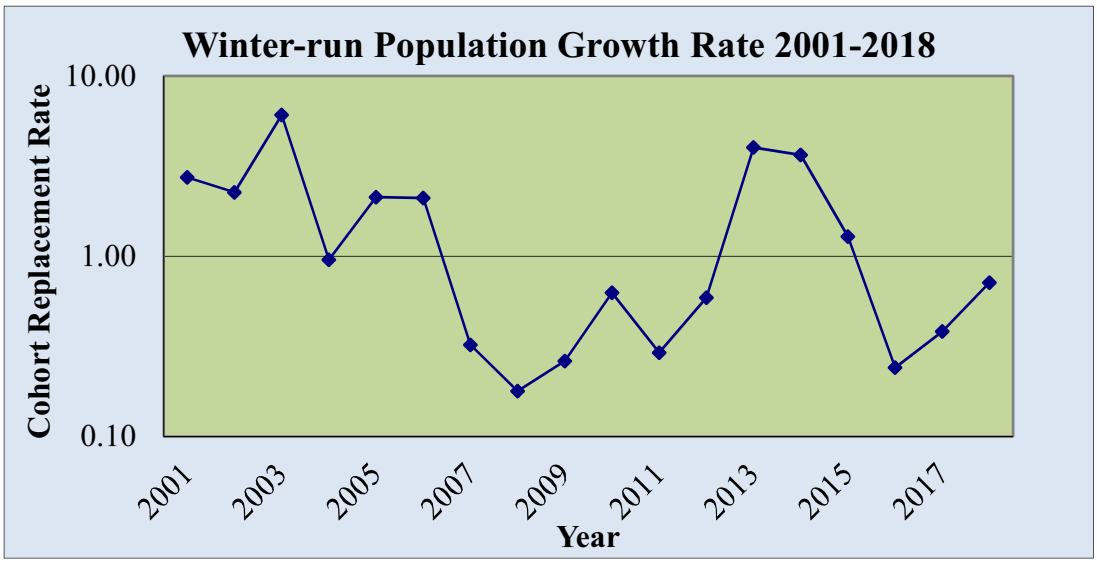

Figure 2. Cohort replacement rate for winter-run Chinook salmon 2008–2018 (CDFW 2018).

The JPE for BY 2018 incorporates the recommendations from the WRPWT (Enclosure 2). The WRPWT identified four factors in calculating the JPE, similar to last year, that they would advise continuing for BY 2018:

1. Estimated number of fry passing the RBDD
2. Survival rate of natural-origin fry to smolts
3. Survival rate of smolts from RBDD to Delta entry (defined as Sacramento at the I-80/I-50 Bridge)
4. Estimated survival rate of winter-run hatchery fish to be released in February of 2019

Estimates of egg-to-fry survival rate are based on the JPI estimate at RBDD. The JPI method is considered a more accurate estimate of egg-to-fry survival rate because it is an annual estimate which better represents the response of fish to the environmental conditions at the time of spawning (see recommendations from the WRPWT in Enclosure 2). The egg-to-fry survival has ranged from 4 percent to 49 percent from BY 2002 to BY 2018, with an average of 24 percent (see Figure 3).

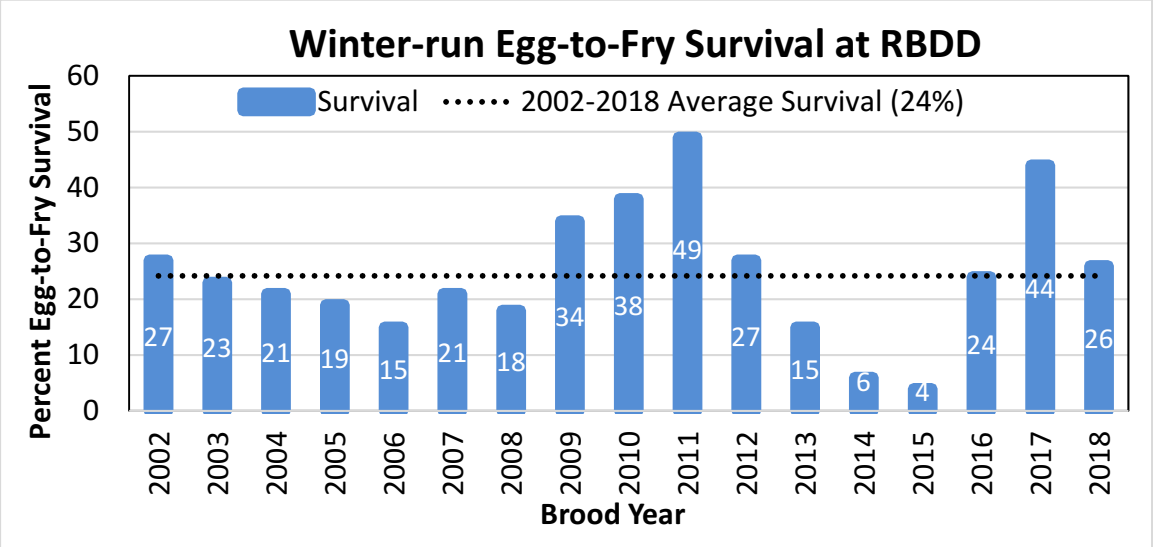

Figure 3. Winter-run egg-to-fry survival estimated at Red Bluff Diversion Dam 2002-2018 (Poytress *et al.* 2014, Poytress 2016, and Enclosure 2)

A fry-to-smolt survival rate of 0.59, based on fall-run Chinook salmon, has been used since 1993 as a surrogate for winter-run fry-to-smolt survival. This value is based on previous studies by Hallock (undated), and confirmed through a literature review in 1995 (B. Poytress, USFWS, personal communication). Without this factor, survival from fry to smolts is assumed to be 100 percent, which is unrealistic. The WRPWT has expressed reservations about the accuracy of the 0.59 term, and thus have interest in considering alternative approaches.

The survival of juvenile winter-run to the Delta is based on assumed environmental conditions (*e.g.,* temperature, flows, and turbidity) in the Sacramento River. However, actual environmental conditions, which may occur after the JPE is calculated, may be different than those assumed in the calculation of the JPE. Based on recommendations from the WRPWT, smolt survival to the

Delta was calculated based on a weighted average of acoustically tagged hatchery winter-run releases from RBDD to the Tower Bridge (at Sacramento). NMFS considers the Tower Bridge as the point of Delta entry.

Using the JPI, and based upon the WRPWT recommendation, NMFS estimates a JPE of **433,176 natural-origin juvenile winter-run entering the Delta during WY 2019** (Table 1 in Enclosure 2). Winter-run juveniles are expected to emigrate into the Delta from November 2018 through April 2019, based upon CDFW historical monitoring data at Knights Landing rotary screw traps.

In early 2019, approximately 225,017 winter-run juveniles propagated at LSNFH will be released into the upper Sacramento River near Redding (Caldwell Park). A portion of the juvenile winter-run from LSNFH will be acoustically-tagged (JSAT) to monitor their survival and movement downstream, some of which may be released up to 30 days prior to the production release. The objective of the early tag release is to use this information to parameterize the JPE equation of survival versus holding time upstream in the river. All hatchery-produced winter-run will be coded-wire tagged and marked (100 percent) 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.

Based on the WRPWT advice (Enclosure 2), NMFS used a weighted average survival rate (*i.e.,* 0.3853) of the hatchery acoustic tag releases between Caldwell Park in Redding and the Tower Bridge in Sacramento to estimate how many hatchery fish released in the Sacramento River would enter the Delta. The survival rate for hatchery-origin fish is different than the natural-origin fish because it is measured over a longer distance (Caldwell Park vs RBDD). NMFS estimates that approximately **86,699 (225,017 x 0.3853 = 86,699) juvenile winter-run from BY 2018 released into the Sacramento River from LSNFH will survive to enter the Delta during WY 2019**.

In 2017, the first group of winter-run captive broodstock withheld and maintained at LSNFH reached maturity and became ready to spawn. Given the precarious status of winter-run resulting from numerous years of drought, CDFW, NMFS, and USFWS determined that the progeny from captive broodstock could be used to "jump start" the Battle Creek Winter-Run Chinook Salmon Reintroduction Plan. The reintroduction of winter-run Chinook salmon to Battle Creek is an extremely important step in the conservation of this endangered species, highlighted by the fact that only a single population exists today. The progeny of the captive broodstock proposed for release into Battle Creek will be the second year juvenile winter-run to experience portions of Battle Creek that were recently restored, providing a unique opportunity to learn vital information about release strategies, marking and tagging regimes, habitat utilization, survival, *etc*.

Although data are lacking on survival rates from juvenile Chinook salmon released in Battle Creek, the size at release and the distance traveled to the Delta is comparable to the releases occurring in the Sacramento River. Therefore, for 2019, the weighted average survival rate described above (*i.e.*, 0.3853) has been used to estimate how many hatchery winter-run released into Battle Creek would enter the Delta. A subset of the winter-run released in Battle Creek during 2019 will receive acoustic tags, allowing for the estimation of survival rates specific to

releases occurring in Battle Creek. As releases of acoustically-tagged winter-run continue in Battle Creek during subsequent years, the data collected will allow for the refinement of the survival rates specific to Battle Creek and better estimates of the number of winter-run released in Battle Creek that survive to the Delta. NMFS estimates that approximately **82,366 juvenile winter-run from BY 2018 released into Battle Creek will survive to enter the Delta during WY 2019**.

Incidental Take Limits for Natural and Hatchery Juvenile Winter-Run Chinook Salmon

The authorized incidental take limit for the combined CVP/SWP Delta pumping facilities includes both the natural-origin (wild) and hatchery-produced juvenile winter-run, as both are 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 LAD criteria to determine Chinook salmon race (*i.e.*, differentiating from fall-run, late-fall run, and spring-run Chinook salmon). In WY 2019, as in WY 2018, genetic race identification will be used. The use of genetic data to determine race of juvenile Chinook salmon observed at the CVP/SWP Delta fish 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, 2018, through June 30, 2019, is set at 1 percent of the JPE, or **4,332 natural-origin (non-clipped)** winter-run. In addition, the incidental take for hatchery-origin winter-run is set at 1 percent of each release (*i.e.*, Sacramento River and Battle Creek release groups). Therefore the incidental take for juveniles released from LSNFH into the Sacramento River is **867 hatchery-produced (adipose fin clipped)** winter-run, and the incidental take of juveniles released into Battle Creek is **824 hatchery produced (adipose fin clipped and left ventral fin clipped)** winter-run.

The JPE is low enough that the older juvenile Chinook salmon loss density based triggers used for Old and Middle River flow management Reasonable and Prudent Alternative Action IV.2.3 would be below the minimums established in the CVP/SWP operations Opinion. NMFS allows for flexibility in water operations by establishing minimum loss densities [i.e., **2.5 older juvenile Chinook salmon per thousand acre-feet (TAF) of water exported for the first stage trigger and 5.0 older juvenile Chinook salmon per TAF of water exported for the second stage trigger]** rather than lower triggers based on the JPE. If the first and second stage triggers were calculated based on the BY 2018 JPE, the first stage trigger would be 2.17 [(4,332 x 1 percent)/ 2,000 = 2.17] fish per TAF and the second stage trigger 4.33 [(4,332 x 1 percent)/1,000] fish per TAF. The minimum loss densities of 2.5 and 5.0 will allow for more water to be exported before a loss density trigger is exceeded in WY 2019.

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 Delta Operations for Salmonids and Sturgeon technical team, WOMT, 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, thereby greatly improving the accuracy of the JPE. We recommend that funding be continued for acoustic tag studies on winter-run for BYs 2019 and beyond to provide data on survival rates over a range of hydrologic conditions.

In closing, we look forward to continuing to work with Reclamation and the other State and Federal agencies to manage water resources in WY 2019 in a way that supports both water supply and fish and wildlife resources. If you have any questions regarding this correspondence, or if NMFS can provide further assistance, please contact Mr. Garwin Yip at (916) 930-3611, or via email at Garwin.Yip@noaa.gov.

Sincerely,

Maria Rea
Assistant Regional Administrator
California Central Valley Office

Enclosures:

1. CDFW letter with winter-run escapement estimate for BY 2018, dated December 13, 2018
2. Winter-Run Project Work Team letter to NMFS, dated February 1, 2019

cc: Copy to file: ARN 151422SWR2006SA00268

Electronic copy only:
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California Department of Fish and Wildlife (CDFW). 2017. Unpublished data, GrandTab Spreadsheet of Adult Chinook Escapement in the Central Valley, revised 4/07/17. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=141570&inline=1

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Poytress, W. R. 2016. Brood-year 2014 winter Chinook juvenile production indices with comparisons to juvenile production estimates derived from adult escapement. Report of U.S. Fish and Wildlife Service to U.S. Bureau of Reclamation, Sacramento, CA.

U.S. Fish and Wildlife Service (USFWS). 2016. Hatchery and Genetic Management Plan for the Livingston Stone National Fish Hatchery – Winter Chinook Integrated-Recovery Supplementation Program. Red Bluff Fish and Wildlife Office.

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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

December 13, 2018

Mr. Barry Thom
Regional Administrator
West Coast Region
NOAA Fisheries
7600 Sand Point Way Northeast
Seattle, WA 98115

Dear Mr. Thom:

Winter-run Chinook Salmon Escapement Estimates for 2018

The California Department of Fish and Wildlife (Department) has developed Sacramento River winter-run Chinook Salmon escapement estimates for 2018. 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 2018 are shown below:

Estimated Total In-river Escapement (hatchery and natural origin)	**2,458**
Estimated In-river Escapement (hatchery origin)	**2,023**
Estimated Number of In-river Spawning Females (hatchery and natural origin)	**1,088**

These estimates include naturally spawning winter-run Chinook Salmon (winter-run) in the upper Sacramento River. In addition, **180** 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 2018, including in-river spawners and fish collected for hatchery broodstock, is **2,638** fish. The 90% confidence interval on this total estimate is from **2,235 to 3,029** 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 2012 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 from 2012- 2018 to be directly comparable for trend analysis with escapement estimates from 2003 through 2011. 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 modeled 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. Figure 1 below shows the winter-run spawner escapements from 2003 to present. The most up to date modeled 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).

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,

Kevin Shaffer, Branch Chief

cc: Ms. Maria Rea, Sacramento Area Supervisor
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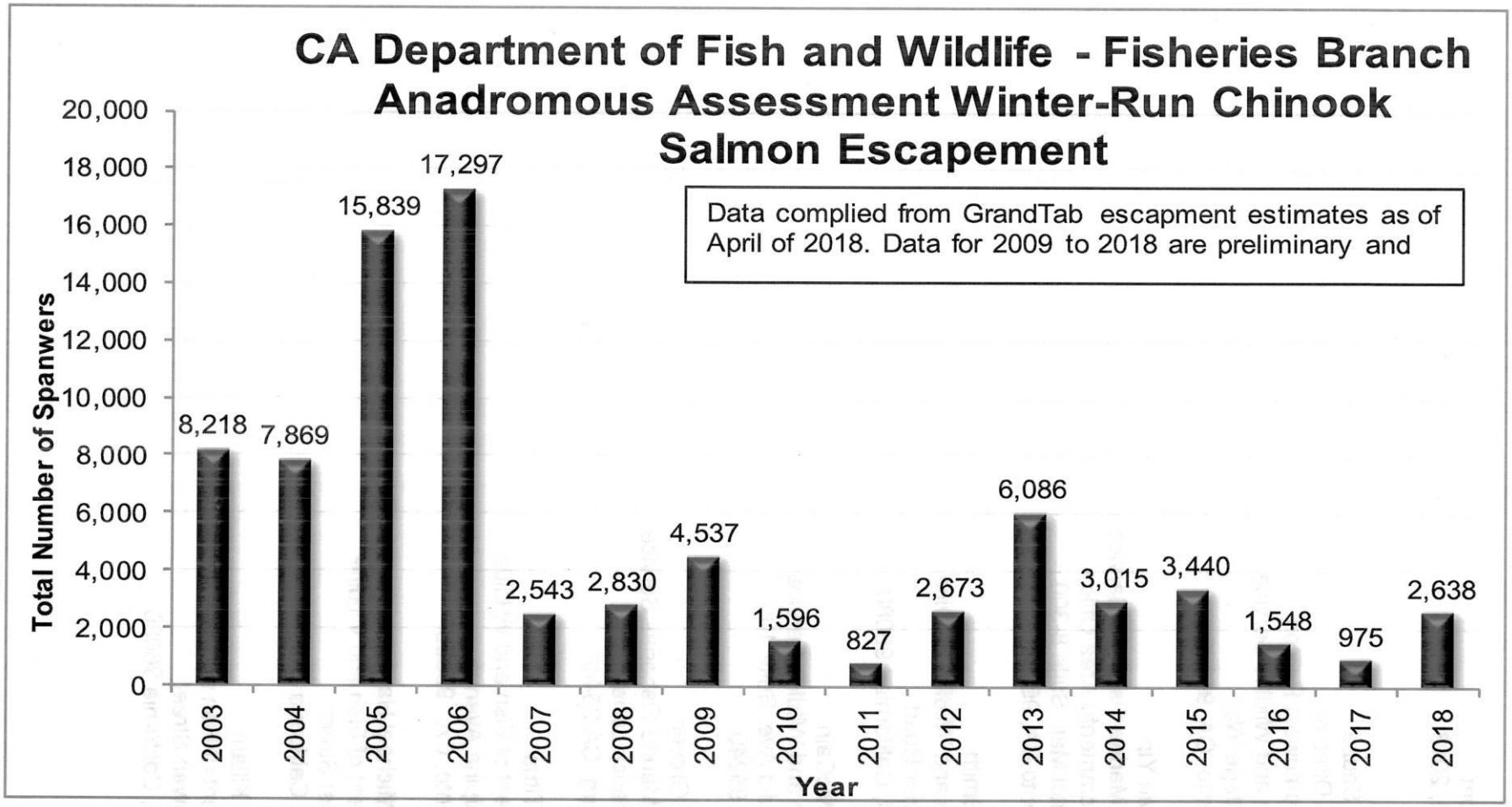

Figure 1. Winter-run Chinook Salmon spawner escapements to Upper Sacramento River Basin for years 2003-2018

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch
830 S Street
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GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

February 1, 2019

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

Dear Mr. Yip:

Five years ago, the Interagency Ecological Program's (IEP) Winter-Run Project Work Team (Winter-Run PWT) recommended that the National Marine Fisheries Service (NMFS) Juvenile Production Estimate (JPE), which is used to calculate the incidental take limit of winter-run Chinook Salmon in the Delta at the State Water Project and Central Valley Project export facilities, be revisited annually and updated as needed with any new or improved information. A subgroup of the Winter-Run PWT met in early 2019 to review the factors used to calculate the brood year (BY) 2018 JPE.

In past years, this subgroup has evaluated several methods for calculating JPE and reviewed and recommended monitoring and research that would improve future JPE estimates and provide better information for managing water project operations. However, the subgroup convened later than usual this year due to the partial Federal Government shutdown between December 22, 2018 and January 25, 2019 and to the loss of key subgroup members to retirement. For this reason, the BY 2018 JPE recommendations are abbreviated as compared to past recommendations.

JPE Recommendations

The Winter-Run PWT identified four factors in calculating the JPE, similar to last year, that we advise continuing or updating for BY 2018. These factors include:

1) Estimated number of fry passing Red Bluff Diversion Dam (RBDD)
2) Survival rate of natural origin fry to smolts
3) Survival rate of smolts from RBDD to Delta entry (defined as Sacramento at the I-80/I-50 Bridge)
4) Estimated survival rate of winter-run hatchery fish to be released in February of 2019

The California Department of Fish and Wildlife (CDFW) estimated 2,638 winter-run adults returned to the upper river in 2018, and of these, 2,458 were estimated as in-river escapement in the JPE (Table 1). Of those, 44.2 percent were female, for a total in-river adult female escapement estimate of 1,088 (Table 1). Pre-spawning adult mortality was estimated at 0.7 percent, resulting in 1,080 adult female winter-run estimated to have spawned (Table 1). We estimated total egg deposition of natural spawning winter

Chinook Salmon in 2018 based on the average fecundity (5,141 eggs/female) of 49 brood fish spawned at the Livingston Stone National Fish Hatchery (LSNFH) and the estimated number of natural spawning female winter Chinook Salmon. The estimated fecundity of 5,141 eggs per natural spawning female winter Chinook Salmon (n=1,080) yields an estimate of 5,552,280 eggs (Table 1).

For the BY 2018 JPE, the Winter-Run PWT recommends using the Juvenile Production Index (JPI), which is based on fry-equivalents at RBDD (Figure 1). The JPI has been used in the calculation since 2014 and better represents the response of fish to annual environmental conditions during spawning, egg incubation, and outmigration, as compared to the long-term average egg-to-fry survival rate used in the JPE prior to 2014. The JPI seasonal estimate as of January 14, 2019 (week 2) was 1,429,551 (B. Poytress, USFWS, personal communication). The value through January 14 accounts for approximately 97.9 percent of annual winter-run passage at RBDD based on data collected from 2002 to 2017 and, including an interpolation of the remaining 2.1 percent for the remainder of BY 2018, would equate to a total BY 2018 estimate of 1,460,216 (Table 1). This value accounts for in-season winter-run genetic and trap efficiency corrections, which had a modest effect on the estimate. With this estimate of fry production at RBDD, the estimated egg-to-fry survival is calculated to be 26.3 percent (Table 1).

The second recommendation of the Winter Run PWT is the continued inclusion of a fry-to-smolt survival factor based on the peak of fry catch at RBDD (generally in October) and the smolt life-stage at RBDD for naturally produced winter-run. This is necessary because the available survival estimates between RBDD and the Delta are based on releases of acoustically telemetered smolts, which have a higher survival rate than fry due to their larger size and faster migration rates. A fry-to-smolt survival rate of 59 percent, based on fall-run Chinook salmon, has been used as a surrogate for winter-run fry-to-smolt survival since 1993. This value is based on previous studies by Hallock (undated) and confirmed through a literature review in 1995 (B. Poytress, USFWS, personal communication). Without this factor, survival from fry to smolts is assumed to be 100 percent, which is unrealistic.

We have had reservations about the accuracy of the 59 percent term and thus have interest in considering alternative approaches. A fry-to-smolt survival rate forecasting method developed by O'Farrell et al. (2018[1]) may be used in the future, if feasible. Due to the Federal Government shutdown, this work which is completed by NMFS scientists is unavailable for inclusion at this time.

The third recommendation of the Winter-Run PWT is related to the smolt survival term for estimating survival of natural origin winter-run smolts from RBDD (*i.e.*, Salt Creek) to the Delta (*i.e.*, Sacramento at the I-80/I-50 Bridge). For this term, we recommend using

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[1] O'Farrell M.R., W.H. Satterthwaite, A.N. Hendrix, and M.S. Mohr. Alternative Juvenile Production Estimate (JPE) Forecast Approaches for Sacramento River Winter-Run Chinook Salmon. San Francisco Estuary & Watershed Science. Volume 16, Issue 4 | Article 4. https://doi.org/10.15447/sfews.2018v16iss4art4

averaged survival estimates from acoustically tagged LSNFH smolts released in 2013-2018. There were two release groups each year in 2015 and 2016; based on recommendations from Ken Newman (recommendations made while a statistician at the U.S. Fish and Wildlife Service, Lodi Office; Dr. Newman is now at the University of Edinburgh), we pooled individual estimates separately for 2015 and 2016 prior to calculating the weighted average annual survival from RBDD to the Delta of 50.28 percent (M. O'Farrell, NMFS, personal communication). The 2013-2018 average survival rate of acoustically tagged juveniles is used to estimate survival of naturally produced winter-run smolts in 2018-2019.

The fourth recommendation from the Winter-Run PWT is to update the term used to estimate survival of hatchery winter-run to the Delta (Table 1 and Figure 1). This term is the weighted average survival of BYs 2013-2018 acoustically tagged hatchery smolts. Again, the estimates in each year in 2015 and 2016 were pooled prior to averaging them to calculate a weighted average annual survival of 38.53 percent. This survival rate is the full migration survival for acoustically tagged hatchery fish from the release point (approximately 60 miles upstream of the RBDD) to the Delta and is therefore lower than the one used for naturally produced smolts at RBDD.

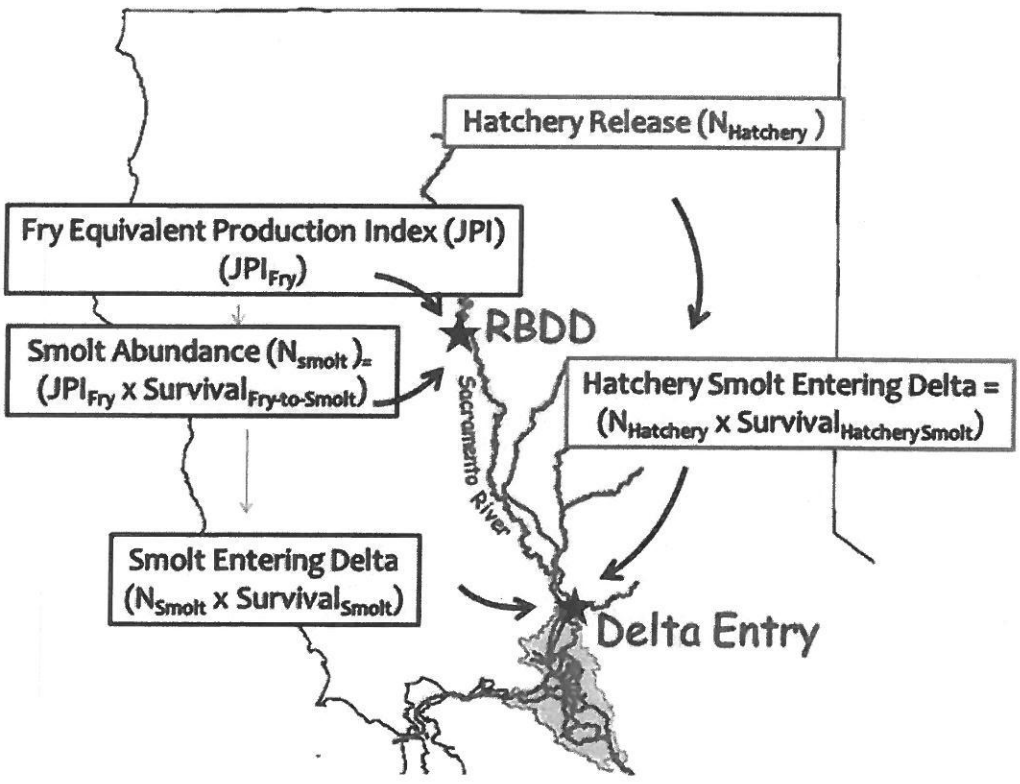

Figure 1 - Location and formulas recommended for use in the JPE for the wild (black boxes) and hatchery (red boxes) components of the winter-run population estimated for 2018-2019

The Winter Run PWT recommends that the following methods be used for estimating the BY 2018 natural-origin (Equation 1) and hatchery-origin (Equation 2) JPE:

Equation 1: JPE (natural origin) = 1,460,216 (JPI) x 0.59 (fry-to-smolt survival) x 0.5028 (smolt survival of acoustic tag hatchery winter run from RBDD to the Delta) = 433,176

Equation 2: JPE (hatchery origin) = 223,817 (LSNFH release) x 0.3853 (smolt survival of acoustic tag hatchery winter-run from release location to Delta) = 86,237

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 currently available from which to derive a JPE. In summary, we hope this analysis and technical advice from the Winter-Run PWT will help improve the JPE and the accuracy of the incidental take limit for water year 2018-2019 at the Central Valley Project and State Water Project export facilities.

Sincerely,

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Winter-Run Project Work Team

Table 1: Factors in the Juvenile Production Estimate and the resulting estimates for 2018-2019, using the Winter-Run PWT approach. Hatchery produced winter-run Chinook data is shown in the column denoted as hatchery.

Component	Natural	Hatchery
Total in-river escapement [1]	2,458	
Adult female estimate (AFE) [2]	1,088	
AFE minus pre-spawn mortality [3] (0.7%)	1,080	
Average Fecundity [4]	5,141	
Total Viable Eggs	5,552,280	
Estimated egg to fry survival based on JPI at RBDD/Total Viable eggs[5]	0.263	
Fry equivalents of juvenile production @ RBDD (JPI) [6]	1,460,216	
Fry-to-smolt survival estimates from October (peak) to February at RBDD[7]	0.59	
Number of smolts at RBDD	861,527	
Estimated smolt survival term – RBDD to Delta[8]	0.5028	
Total natural production entering the Delta	433,176	
LSNFH Hatchery release [9]		223,817
Total hatchery production entering the Delta [10] (based on survival rate from release to Sacramento of 0.3853).		86,237

Footnotes:

1/ Total in-river escapement from CDFW Cormack-Jolly Seber (CJS) model includes natural and hatchery origin, but not hatchery fish retained for brood stock at LSNFH

2/ The number of adult females is derived from carcass surveys, and 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/ Preliminary (subject to change) average number of eggs/female from 49 fish spawned at LSNFH

5/ Back calculated estimated survival between eggs laid in-river and fry production estimates at RBDD based on numbers of fry equivalents (JPI) using traditional (59%) fry-to-smolt survival estimates

6/ Preliminary number of fry-equivalents estimated on January 14, 2019 plus 2.1% interpolation at RBDD using traditional (59%) fry to smolt survival estimates (Bill Poytress, USFWS, personal communication)

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

8/ Average weighted survival of acoustically tagged winter-run in 2013, 2014, 2015 (2 values), 2016 (2 values), 2017, and 2018 between RBDD and I80 Tower Bridge in Sacramento. Survival is estimated from the Salt Creek receiver site, located 3 miles downstream of RBDD, to estimate survival from RBDD for acoustic tag studies (M. O'Farrell, NMFS, personal communication)

9/ Estimated LSNFH production release as of 1/31/19 (100% tagged and adipose clipped). Up to 1,200 additional juveniles may be retained as broodstock or to conduct fish health assessments

10/ Weighted average of acoustically tagged winter-run survival in 2013, 2014, 2015 (2 values), 2016 (2 values), 2017, and 2018 between release location and I80/I50 Bridge in Sacramento