Juvenile Production Estimate (JPE) Calculation and Use/Application of Survival Data from Acoustically-tagged Chinook Salmon Releases

Report prepared by Bruce Oppenheim, NMFS, West Coast Region, Sacramento, California for the 2014 Annual Science Panel Review Workshop, November 6-7.

Introduction

Each year, NOAA's National Marine Fisheries Service (NMFS) estimates the number of juvenile winter-run Chinook salmon expected to enter the Delta. NMFS' June 4, 2009, biological and conference opinion on the long-term operation of the Central Valley Project and State Water Project provides an incidental take limit on natural juvenile winter-run based on the juvenile production estimate (JPE, attachment 1).

Description of the Process to Calculate the Winter-run Chinook Salmon Juvenile Production Estimate (JPE)

The JPE is a simple Excel spreadsheet model that starts with the official winter-run spawning escapement estimate from the California Department of Fish and Wildlife (CDFW), and subtracts a number of factors from the number of eggs produced (see enclosure 2 in Attachment 1). It contains 2 other models within it, along with the following 8 variable factors.

1. **Escapement:** Adult spawners are estimated from annual carcass counts using mark-recapture data conducted in the upper Sacramento River from the end of May to the beginning of September. Typically, peak spawning occurs in July. The official estimate of escapement is prepared by CDFW (see enclosure 1 in Attachment 1). The estimate is based on the application of the Cormack Jolly-Seber (CJS) model with the addition of 90 percent confidence intervals. It estimates the total number of naturally spawning in-river winter-run Chinook salmon, including hatchery returns, and those taken in for broodstock at the Livingston Stone National Fish Hatchery (LSNFH). Beginning in 2009, LSNFH stopped taking hatchery-origin spawners for its broodstock to reduce genetic drift, and now uses only natural fish (non-clipped) for its broodstock collection. The sex ratio in the CJS model is based on winter-run captured in the trap at the base of Keswick Dam for LSNFH broodstock. From the CDFW official estimate of escapement, NMFS obtains the estimated number of naturally-spawning females to use in the JPE.

2. **Pre-spawn mortality:** This is the number of females that die before spawning. It is estimated from observations made during the carcass counts. Typically, this number represents 1-2 percent of the total number of females.

3. **Temperature impacts**: The impact of high water temperatures is factored in to total production by calculating the percent redds observed below the temperature compliance point for that year and applying it to the number of eggs produced. For the JPE, NMFS assumes 100 percent mortality for any redds constructed downstream of the temperature

compliance point. In reality, mortality would vary depending on the degree of exposure. Egg loss due to high water temperatures (greater than daily average of 56 ºF) is typically less than 0.5% of the total eggs produced in most years (~1-2 redds below the temperature compliance point).

4. **Fecundity:** This is the number of eggs per female spawner. Prior to 2000, NMFS used values for fecundity derived from the literature or female length regressions (*e.g.*, 3,800 eggs/female). More recently, the value is obtained from an average of eggs per females spawned at LSNFH (typically, n <50). The number of eggs depends on female size, but ranges from 4,000–5,800 eggs/female. The average over the last 5 years (2009–2013) has been 4,925 eggs/female (Rueth 2013).

5. **Survival (egg-to-fry):** This is the first of 3 survival terms used to describe different juvenile life stages. It covers the time from when the eggs are laid to when fry leave the spawning gravel and begin migrating downstream past Red Bluff Diversion Dam (RBDD). In the past, this term was included in a larger term characterizing egg-to-smolt survival (S = 0.1475) derived from fall-run. However, starting in 2012, this survival term was split into egg-to-fry and fry-to-smolt survival, where egg-to-fry survival was S = 0.25 due to direct measurements of winter-run production (Table 1, Figure 1). In comparison, for the U.S. Fish and Wildlife Service's (USFWS) juvenile production index (JPI), egg-to-fry survival was calculated based on annual data, comparing the number of juveniles estimated passing RBDD (based on expansion from rotary screw trap sampling) to the number of females estimated in the carcass surveys to determine average survival to the fry stage (Table 1).

6. **Survival (fry-to-smolt):** The second survival term describes fry-to-smolt survival (S=0.59), which includes parr and pre-smolt life stages. Pre-smolts are used in calculating the number of fry equivalents passing RBDD (Poytress and Carrillo 2012), since not all winter-run are the same size when they begin migrating downstream. In 2012, this survival term was added after review by the Winter-run Project Work Team to describe juvenile growth and emigration for the 3-6 months spent holding in the upper Sacramento River (*i.e*., Red Bluff to Colusa). Previously, S=0.1475 was used as a combined egg-to-smolt survival term in the JPE to describe egg-to-smolt survival (*i.e.*, 0.25 x 0.59 = 0.1475) based on the average fall-run Chinook survival rates obtained from the Tehama-Colusa Spawning Channel 1971–1984 (Table 2).

7. **Survival (smolt-to-Delta):** The third survival term describes survival from the smolt stage to the Delta (S = 0.53). Although the exact location in the Sacramento River that winter-run become smolts is unknown, for the JPE, this term describes downstream emigration from approximately Colusa to the time they enter the Delta (defined as Sacramento, or start of the legal Delta). This term was based on the difference in survival rates between paired coded wire tag (CWT) releases, using late fall-run Chinook as surrogates, between Battle Creek in the upper Sacramento River above RBDD, and Ryde located in the Delta (USFWS 2005, Table 3). Using ocean recoveries of the CWTs, the difference in survival between the two locations gave an approximate survival rate for in-river life-stages. These data were then updated as subsequent years became available and

represents an average of 8 years, from 1994–2001. Data from 2002–2004 were not included because tag returns were not available. After 2004, the USFWS stopped making paired releases using CWTs due to funding restraints, concern about straying impacts, and the rising use of acoustic tags.[1]

8. **Confidence Intervals (CIs):** The need to recognize uncertainty in the JPE was a key component of early reviews (Brown and Kimmerer 2002). The application of confidence intervals to the JPE began in 2009 when NMFS contracted Cramer Fish Sciences (CFS) to develop a model that would incorporate CIs based on the best data available. The CFS model (CFS 2010) uses a GoldSim dashboard application with the following input data: (1) number of winter-run carcasses per day, (2) number of females, (3) daily average water temperatures, and (4) daily flow data from CDEC at Freeport. The CFS model fits a standard Ricker stock-recruitment curve to determine the number of fry produced using both carcass and RBDD data. Daily carcass data were used to determine egg deposition in time. A generalized additive model was used to fit non-linear temperature and survival data (CFS 2010). The default survival to the Delta was based on late fall-un CWT releases (S= 0.53) used in the winter-run JPE. The data for each year can be changed (*e.g.*, temperature, survival, water year type, river flows, *etc*.).

A. Recent Data from Acoustically-tagged Releases

From November 2013 through January 2014, the Winter-run Project Work Team (WRPWT), under the Interagency Ecological Program, began a review of the JPE to assess the use of acoustic tag data on juvenile Chinook salmon releases in the upper Sacramento River. At the time most of these data were unpublished. A subteam of the WRPWT was formed to analyze the available acoustic data and compare them to the existing survival rates based on CWT data (attachments 2-4). Individual researchers were contacted for data (Figures 2-4). Reach survival from Red Bluff to Sacramento was compared between releases.

In all, there were 6 years in which acoustic tag releases were made; 5 years using late fall-run, and 1 year using winter-run. The acoustic tag data showed significant differences in run timing and survival rates between the late fall-run releases and the winter-run release (attachment 2). In 2013, juvenile winter-run spent considerable time (from 30-50 days) holding in the upper Sacramento River as compared to the late fall-run releases that left the upper river immediately (Figure 2). In addition, when compared to average late fall-run survival (S=0.43), winter-run survival (S=0.15) was much lower between Red Bluff and Sacramento (see below).

1. **Late fall-run Chinook salmon:** The average survival rate from Salt Creek (located at RM 240, approximately 2.5 river miles downstream of RBDD) to Sacramento (measured at the I-80/Hwy 50 bridge) for the five releases from 2007– 2011 was S=0.437 (Table 4). In comparison, the JPE uses S= 0.53 based on CWT data from late fall-run ocean recoveries. The 2007–2011 water years were all classified as dry, except for 2011, which was classified as a wet year with subsequently higher survival in that year (Figures 3-4).

[1] For more information on these studies, see USFWS, Anadromous Fisheries Restoration Program/Delta Action 8, http://www.fws.gov/stockton/jfmp.

2. **Winter-run Chinook salmon:** 2013 was the first year direct measurements of winter-run survival became available using acoustic tag data. 148 hatchery winter-run were tagged and released in February near Caldwell Park (RM 299) in Redding. A later release of 48 control fish was made in March. The survival rate for the February release was S=0.156 (95% LCI=0.104, UCI=0.228) from Salt Creek to the Tower Bridge in Sacramento (Hassrick and Hayes 2013). Survival to the Delta was considerably lower than the 5 years of late fall-run acoustic tag releases, and lower than the previously-used survival rates in the JPE based on CWT data.

The subteam performed a number of analyses to determine survival rates to the Delta. It reviewed the current JPE methodology using Chipps Island ocean recoveries (CWTs) data up to 2011 (USFWS 2013). It reviewed the latest winter-run and late fall-run acoustic tag releases (Tables 4 and 5). Then it reviewed the latest trawl data from Chipps Island based on genetic identification (Pyper *et al.* 2013). The subteam back-calculated the different survival rates from acoustic tag and CWT data from RBDD to Chipps Island, minus through Delta survival (*i.e.,* Sacramento to Chipps Island), to determine juvenile production estimates that were close to estimates based on observed genetic identification. The subteam recommended the following changes to the survival terms, along with pros and cons (attachment 4).

1. use of the 2013 winter-run acoustic tag survival (16%);
2. or, combine the 5-year average of late fall-run (2007-2011) and 2013 winter-run acoustic data (39%);
3. apply 2 significant figures to survival terms; and
4. change egg-to-fry survival from 25% to 27% based on added 2 years of additional data.

The WRPWT provided a memorandum back to the subteam (attachment 5). Although the WRPWT could not reach consensus on which survival rate to use, it did agree that the use of data from acoustic tags rather than surrogate releases (*i.e.*, CWT'ed late fall-run) provided direct information on the unique behaviors and life histories of the winter-run population instead of requiring additional inferences.

B. Application of Acoustic tag data

After reviewing the WRPWT subteam analysis and options for consideration to estimate winter-run survival, NMFS conferred with its Southwest Fisheries Science Center on the appropriate data to use for the JPE. NMFS concluded that there was enough information to modify the JPE methodology using acoustic tag data (enclosure 3 in Attachment 1). The following changes were applied by NMFS to the winter-run JPE for broodyear 2013:

1. Egg-to-fry survival changed from 0.25 to 0.27 based on 2 years additional data from RBDD.
2. The previous fry-to-smolt and smolt-to-Delta survival terms were combined together using a combination of acoustic tag data from winter-run and late fall-run releases (Michel *et. al*. unpublished). This term would a more direct measure of survival and eliminate overlap between survival terms.
3. A 50 percent weighting factor was applied to the late fall-run and winter-run acoustic tag survival data to account for the one year of data from winter-run.

C. Results

Incorporating new survival terms based on combination of winter-run and late fall-run acoustic data had only a minor impact on the JPE results compared to the previous methodology which used only CWT data from late fall-run Chinook ocean recoveries. One of the possible reasons for this was the elimination of the fry-to-smolt survival rate (S=0.59) and reduction in smolt survival (S=0.27), which effectively reduced overall survival, as shown in the table, below.

JPE Survival Terms

	2011	2012	2013
egg to smolt	0.1475		
egg to fry		0.25	0.27
fry to smolt		0.59	
smolt to Delta	0.53	0.53	0.27
total survival	0.078	0.078	0.073

Reducing survival terms from 3 to 2 terms prevented temporal and spatial overlap between the terms and provided a more direct measure, but also left a small gap in life-stage survival (*i.e.*, 3-4 months of rearing in the upper Sacramento River before the smolt stage is reached).

Using the same data from 2013 to compare results between the two methods of calculation (*i.e.,* 2012 methodology compared to the 2013 methodology) resulted in a slightly lower JPE (1,247,260 in 2012 vs 1,119,387 in 2013, respectively). This is a difference of 50,873 winter-run reaching the Delta. Using the new methodology resulted in a 4 percent lower JPE compared to the old method. At the 95 percent CI this would not be considered significant, since it is less than a 5 percent difference.

D. Summary

The changes made to the JPE calculation improved the accuracy of the estimate by providing more direct survival data through acoustic tagging studies (on both late fall-run and winter-run), rather than indirect survival estimates through comparisons of paired CWT releases of late fall-run and ocean recoveries. Instead of waiting 3 years to obtain data on CWT ocean recoveries, survival could be measured on an annual basis. . Although the JPE still uses late fall-run acoustic tag data, these data are considered by NMFS and the WRPWT to be more indicative of the real-time conditions faced by winter-run juveniles as they migrate through the Sacramento River. Data and survival estimates using the paired CWT releases were replaced with the acoustic tag data that allow for survival rates to be calculated between various reaches (*e.g*., reaches of the Sacramento River, to the Delta, to San Francisco Bay), allowing more accuracy and the use of CIs. Survival rates can be determined for various water year types and flow rates. In-river survival has been found to be positively related to flow (Kjelson & Brandes 1989, del Rosario *et. al*. 2013, and CFS 2014). The changes made to the JPE methodology in 2013 are consistent with improvements that have been made in the past (*e.g.*, change to carcass surveys in 2000, change to CIs in 2004) as a result of WRPWT review and analysis.

E. Questions for Review Panel

1. How important is it to eliminate overlap in survival terms, vs. potentially not including the survival rate of the fry life history stage?

2. How should the missing life-stages (*i.e.*, fry-to-smolt) and the gap in juvenile rearing from RBDD to Salt Creek be accounted for in the current JPE methodology?

3. Hatchery origin juvenile winter-run have shown a unique life-history strategy not seen in other runs, in that they hold upstream in dry years for 30-50 days. How should this behavior be incorporated into the JPE?

4. The weighting for the JPE in 2013 was 50% for the 5 years of late fall-run acoustic tag data, and 50% for the one year of winter-run acoustic tag data.

    a. The late fall-run acoustic tag data included data from various water year types, and the year of winter-run acoustic tag survival was conducted in a dry water year. How should water year type be considered and factored into the weighting in any given water year?
    b. What should the weighting be between late fall-run and winter-run acoustic tag data with each additional year of winter-run acoustic tag data? At what point (how many years of winter-run acoustic tag data) should we not consider the late fall-run acoustic tag data to develop the winter-run JPE?

5. What additional studies or methods would you recommend to improve the accuracy of the JPE in the future?

6. Given that approximately 4.43 million fry were estimated to pass RBDD from the JPE calculator, but only 1.78 million fry were estimated to pass RBDD based on U.S. Fish and Wildlife Service's rotary screw trapping, how should these conflicting data be interpreted?

F. References

Brown, R. and W. Kimmerer. 2002. Chinook Salmon and the Environmental Water Account: A Summary of the 2002 Salmonid Workshop. Prepared for the CALFED Science Program, October 2002, Sacramento, CA. 47 pg.

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del Rosario, R. B, Y. J. Redler, K. Newman, P. L. Brandes, T. Sommer, K. Reece, and R. Vincik. 2013. Migration Patterns of Juvenile Winter-Run-Sized Chinook Salmon (*Oncorhynchus tshawytscha*) through the Sacramento–San Joaquin Delta. San Francisco Estuary & Watershed Science 11(1): 1-22.

Hassrick, J. and S. Hayes. 2013. Survival of Migratory Patterns of Juvenile Winter-run Chinook salmon in the Sacramento River, Delta, and S.F. Bay. Unpublished results of first year acoustic tag study. NOAA, UCD, CFS, DWR, and USFWS.

Kjelson, M.A. and P.L. Brandes. 1989. The use of smolt estimates to quantify the effects if habitat changes on salmonid stocks in the Sacramento-San Joaquin Rivers, California. Pages 100-115 *in* C.D. Levings, L.B. Holtby, and M.A. Henderson (editors), Proceedings of the National Workshop on Effects of Habitat Alteration on Salmonid Stocks. Canadian Special Publications of Fisheries and Aquatic Sciences 105.

Poytress, W. R. and F. D. Carrillo. 2012. Brood-Year 2010 Winter Chinook Juvenile Production Indices with Comparisions to Juvenile Production Estimates Derived from Adult Escapement. Report of U.S. Fish and Wildlife Service to California Department of Fish and Game and U.S. Bureau of Reclamation. U.S. Fish and Wildlife Service, 42 pp.

Tables and Figures

Table 1. Percent egg-to-fry survival based on Red Bluff Diversion Dam data 1996-2012 (USFWS 2014), unpublished data.

Year	Eggs/ Female	FE JPI LCI	FE JPI HCI	FE JPI	Total JPI	JPE
1996	3859	0.174	0.371	0.213	0.112	0.250
1997	3859	0.338	0.641	0.398	0.359	0.250
1998	3859	0.247	0.351	0.267	0.239	0.250
1999	3859	0.168	0.423	0.218	0.171	0.237
2002	4923	0.076	0.471	0.274	0.255	0.250
2003	4854	0.139	0.321	0.230	0.208	0.246
2004	5515	0.121	0.298	0.209	0.196	0.159
2005	5500	0.095	0.274	0.185	0.173	0.250
2006	5484	0.088	0.221	0.154	0.141	0.250
2007	5112	0.136	0.286	0.211	0.186	0.240
2008	5424	0.110	0.241	0.175	0.159	0.249
2009	5519	0.187	0.480	0.333	0.295	0.250
2010	5161	0.230	0.520	0.375	0.306	0.250
2011	4832	0.328	0.645	0.486	0.414	0.250
2012	4518	0.172	0.359	0.266	0.200	0.250
min.	3859	0.076	0.221	**0.154**	0.112	0.159
Ave.	4819	0.174	0.394	**0.266**	0.228	0.242
max.	5519	0.338	0.645	**0.486**	0.414	0.250
StDev.	668	0.081	0.134	**0.093**	0.084	0.023

FE = fry equivalent, JPI = juvenile production index expanded from rotary screw trap data, JPE = NMFS calculated juvenile production estimate, CI = 90% Confidence Interval, StDev = Standard Deviation.

Table 2. Fall-run Chinook salmon spawning data collected from USFWS annual reports on theTehama Colusa Fish Facilities for brood years 1971–1984, summarized for the IEP Winter-run Project Workteam.

Table 1.—Tehama Colusa Fish Facilities fall Chinook salmon cultural operations and juvenile outmigrant survival estimates 1971-1984. Results include fiscal year of report, fall Chinook brood-year, the spawning channel data was obtained from (single purpose channel (SPC) or dual purpose channel (DPC)), estimated number of female spawners, estimated pre-spawn mortality, estimated eggs per female, estimated number of eggs deposited, juvenile count estimates, the number of pounds of fish released, and the estimated egg to outmigrant survival rate (estimated survival rate),. All data derived from Tehama Colusa Fish Facilities Annual Reports for fiscal years 1972-1985; data in italics was calculated based on information contained in the reports.

Fiscal year	Brood-year	Spawning channel used	Female spawners	Estimated pre-spawn mortality (%)	Estimated eggs per female	Estimated number of eggs deposited	Juvenile count	Pounds of salmon released	Estimated survival rate (%)
1972	1971	SPC	1,089	39.6	6,995	7,247,818	1,093,662	5,097	15.1
1973	1972	SPC	774	14.4	6,410	4,789,000	1,088,000	4,288	22.8
1974	1973	SPC	1,242	6.5	5,344	6,571,000	418,000	1,871	6.3
1975	1974	SPC	1,220	9.4	6,140	7,418,000	4,448,000	5,461	60.0
1976	1975	SPC	1,410	5.1	6,083	8,474,000	1,122,175	4,731	13.2
1977	1976	SPC	1,448	15.8	*4,547*	6,585,000	498,000	2,437	11.2
1978	1977	SPC	1,681	9.4	*5,442*	9,148,000	1,308,697	3,097	14.3
1979	1978	SPC	1,912	13.7	*4,917*	9,402,000	469,000	2,174	5.0
1980	1979	SPC	977	9.0	*5,412*	5,288,000	1,016,000	1,694	19.2
1981	1980	SPC	714	2.8	*4,601*	3,284,820	840,670	2,242	25.6
1982	1981	SPC	468	23.3	3,912	1,830,900	241,465	256	13.1
1983	1982	DPC	-	-	-	*4,125,815*	647,753	602	15.7
1984[a]	1983	East SPC	-	-	-	380,920	*95,230*	232	25.0[b]
1985[a]	1984	West SPC	-	-	-	1,687,896	421,974	2,854	25.0[b]

[a] Data for this year indicated that only one channel of the two channel single purpose channels were used for salmon propagation; due to gravel cleaning operations of adjacent channel.

[b] General value of estimated survival applied to this brood-year.

↑

$\bar{X}_{71-82}$ = 18.458 %

$\bar{X}_{75-80}$ = 14.75

Table 3. Late fall-run Chinook salmon coded wire tag data showing differential ocean recovery rate, which is the difference between the survival of releases at Battle Creek compared to locations in the Delta (*i.e.*, Ryde, Isleton, Courtland, Vorden). source: Chipps Island Table 2 (USFWS 2005) unpublished data.

Year	**Reach**	**Differential Ocean Recovery Rate[1,2]**	
			Revised in 2004
1994	Battle Cr to Ryde	0.41	0.40
1995	Battle Cr to Isleton	0.67	0.62
1996	Battle Cr to Courtland	0.90	0.50
1997	Battle Cr to Miller Park, Sacramento	0.46	0.72
1998	Battle Cr to Ryde	0.59	0.70
1999	Battle Cr to Ryde	0.34	0.60
2000	Battle Cr to Isleton		0.48
2001	Battle Cr to Vorden		0.27
2002	Battle Cr to Vorden and Ryde		
2003	Battle Cr to West Sacramento		
2004	Battle Cr to Vorden		
	6 year average in 2001	0.56	
	8 year average in 2004[3]		0.53

[1]Several CWT releases were made each year in November, December, and January. The rationale for selecting survival rates was based on the greatest number recovered corresponding to the first storm events. Survival rates > 1.0 were excluded.

[2] Revised survival rates when ocean recovery data became available (3 years after release)

[3] Includes 2000 and 2001 recovery rates

Table 4. Late fall-run cumulative survival rates from Red Bluff to Sacramento using acoustically tagged hatchery releases 2007–2011. (Michel *et.al*. 2013, unpublished data)

Year	**WY**	**S**	**SE**	**CI**	**UCI**	**LCI**	**River Segment[1]**
2007	D	0.213	0.060	0.118	0.331	0.095	RB to I-80/50 bridge in Sacramento
2008	C	0.378	0.059	0.116	0.494	0.262	RB to I-80/50 bridge in Sacramento
2009	D	0.501	0.058	0.114	0.615	0.387	RB to I-80/50 bridge in Sacramento
2010	BN	0.419	0.053	0.104	0.523	0.315	RB to I-80/50 bridge in Sacramento
2011	W	0.672	0.039	0.076	0.748	0.596	Jelly's Ferry to I-80/50 bridge in Sacramento[2]
average		0.437					

[1] Release site located at Salt Creek ~4 rkm below Red Bluff Diversion Dam.

[2] Survival in 2011 from RBDD down was not available due to poor detection efficiency.

[3] WY = Water Year Type based on unimpaired runoff (CDEC WSIHIST), S = cumulative survival between reaches, SE = Standard Error, CI = Confidence Interval, UCI = Upper CI, LCI = Lower CI, D = Dry, C = Critical, BN = Below Normal, W = Wet, and rkm = river kilometer

Table 5. Comparison of late fall-run (2007–2011) and winter-run (2013) acoustic tag releases. Source: Hassrick and Michel *et al*., unpublished data.

Run	Fork Length (mm)	Number tagged	Date of Release	Location of Release
Late-fall run	152-168	200-300	December – January	Battle Cr, Jelly's Ferry, Chico, Butte City
Winter-run	90	148	February	Caldwell Park, Redding

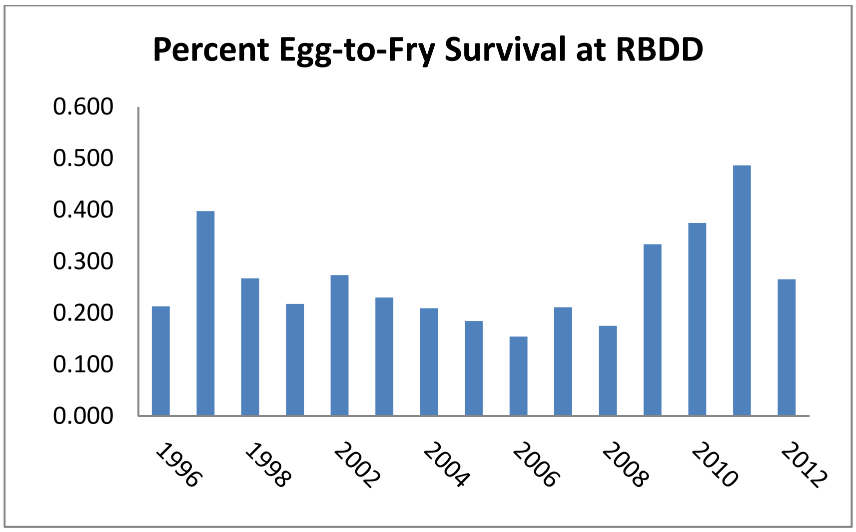


Figure 1. Egg-to-fry survival based on above RBDD data 1996–2012.

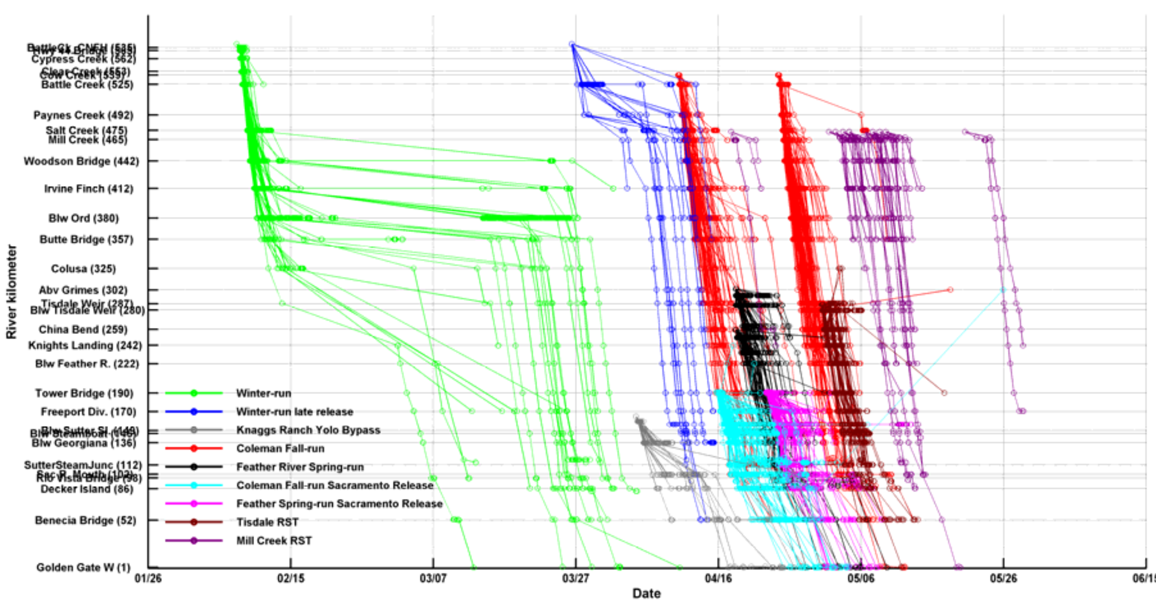


Figure 2. Comparison of acoustic tags releases by location in the upper Sacramento River, winter-run (green), winter-run control (blue), late fall-run (red), fall-run (turquoise), spring-run (black, purple & brown), source: (Hassrick and Hayes 2013, unpublished).

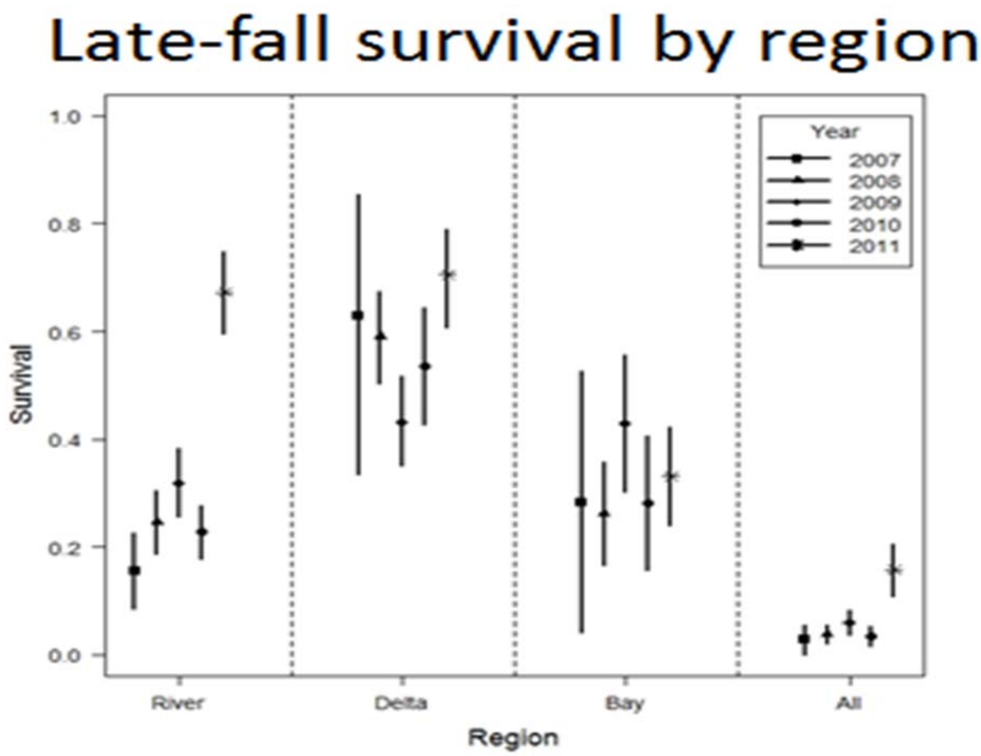


Figure 3. Late fall-run acoustic tag survival by region 2007–2011, source: Michel *et al*, unpublished.

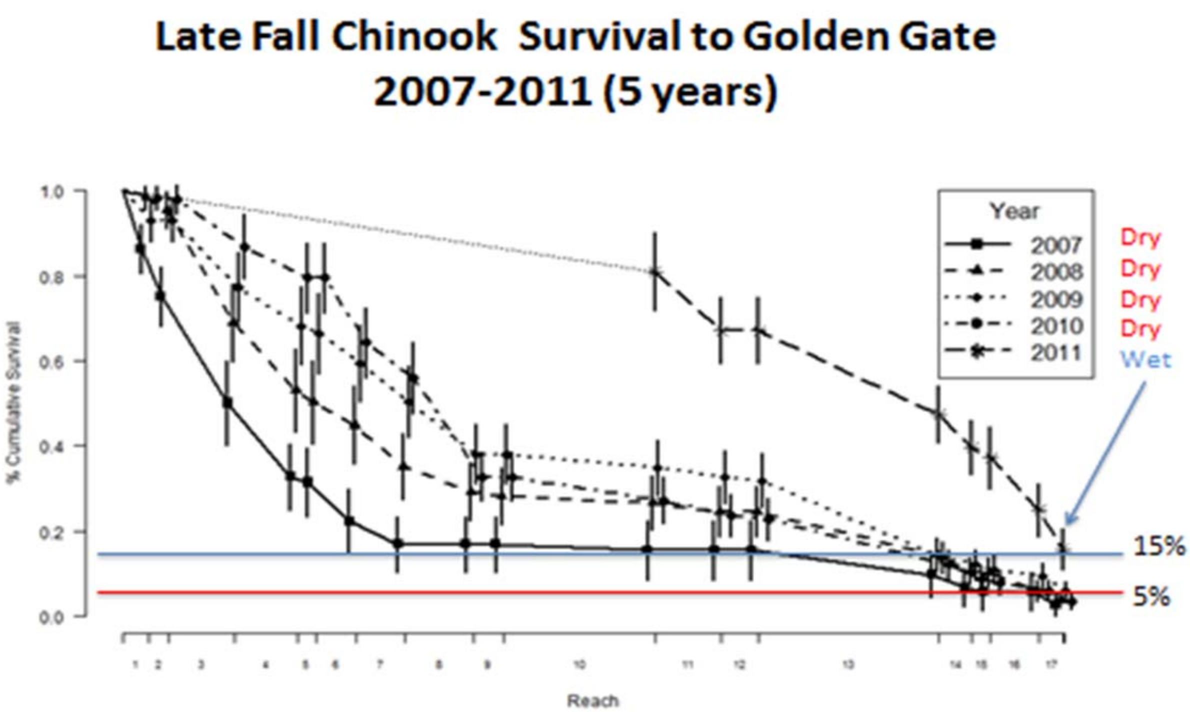


Figure 4. Cumulative late fall-run survival rate by reach 2007–2011, source: Michel *et al*. unpublished.

Attachments:

1. **February 21, 2014, letter from NMFS to Reclamation transmitting the JPE**
2. **WRPWT subteam notes: November 26, 2013**
3. **WRPWT subteam notes: December 6, 2013**
4. **WRPWT subteam notes: December 19, 2013**
5. **Memorandum from the Winter-run Project Work Team to its subteam concerning the subteam summary report of the Juvenile Production Estimate. Interagency Ecological Program, Winter-run Project Work Team. January 31, 2014. 2 pg.**

Attachment 1

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

FEB 21 2014

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 2014. In order to provide incidental take for the combined operation of the Central Valley Project (CVP) and the State Water Project (SWP), NOAA's National Marine Fisheries Service (NMFS) calculates a juvenile production estimate (JPE), pursuant to the June 4, 2009, biological opinion on the long-term operations of the CVP and SWP (CVP/SWP Opinion). This estimate is used to determine the authorized level of incidental take, under section 7 of the Endangered Species Act (ESA), for winter-run while operating the CVP/SWP Delta pumping facilities in water year 2014.

The winter-run adult escapement estimate for 2013 was derived from carcass surveys conducted in the upper Sacramento River by the California Department of Fish and Wildlife (CDFW). This information was provided to NMFS via a letter dated January 7, 2014 (enclosure 1). The CDFW estimate of total winter- run escapement in 2013 was **6,075** spawners, which includes 117 collected for hatchery broodstock at the Keswick trap. The estimate is 227 percent higher than, or more than double, the estimated 2,674 adults that returned in 2012 and a change to a positive cohort replacement rate for the first time in 7 years (figures 1 and 2). The 2010 adult escapement that this year's return originated from was 1,596, resulted in a 3.81 increase in the population growth rate. The methodology (*i.e.*, Cormack-Jolly-Seber Model) used by CDFW to calculate winter-run escapement in 2013 was the same as in 2012. This method allows the calculation of confidence intervals. The 90 percent confidence interval for total estimate (6,075) is from 5,275 to 6,677 fish.

This year the Interagency Ecological Program's winter-run Project Work Team (WRPWT) conducted a technical review of the survival terms used to calculate the JPE based on the most recent acoustic tag studies in the Sacramento River. The WRPWT review found that the current JPE overestimates the number of juveniles entering the Delta on average by 400 percent (Table 1) based on four years of genetic studies at Chipps Island (Pyper *et al.* 2013). The positive identification of juvenile winter-run captured at Chipps Island allowed for comparisons between abundance estimates using actual observed data from 2008–2011instead of modeled data.

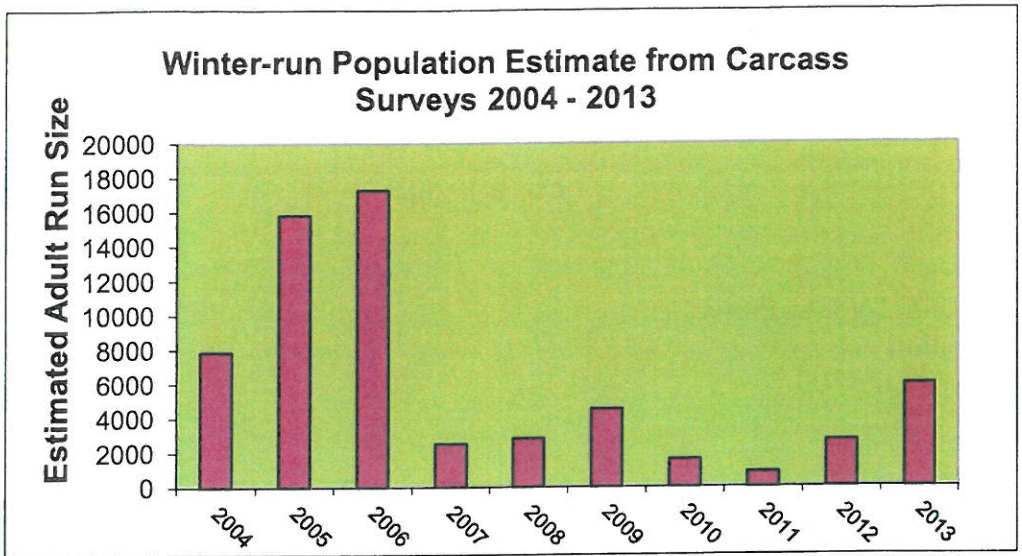


Figure 1. Adult winter-run Chinook escapement in the Sacramento River from 2004-2013.

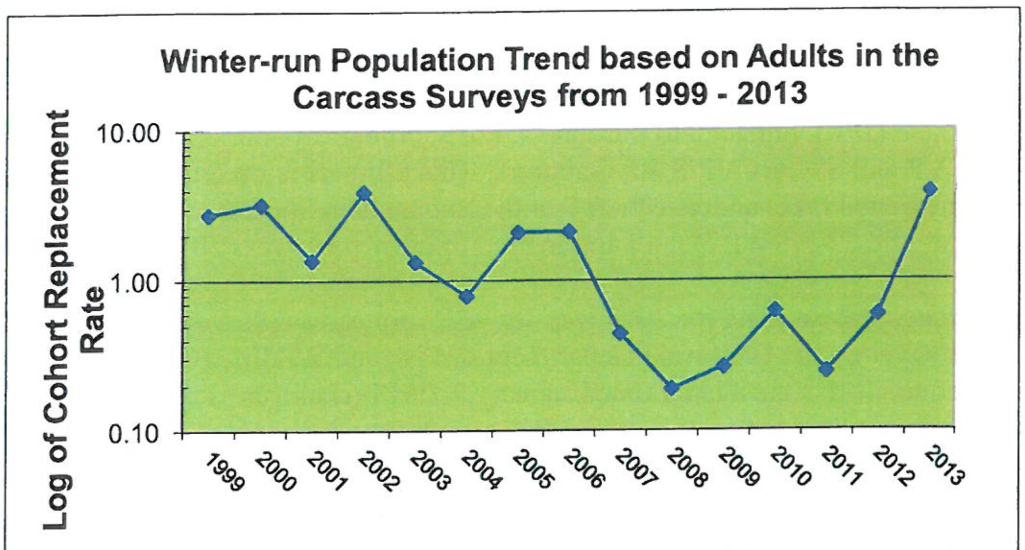


Figure 2. Cohort replacement rate for winter-run Chinook salmon from 1999-2013.

Table 1. Winter-run JPE comparison to Chipps Island Trawl data accounting for in Delta survival from Sacramento to Chipps Island.

	Year			
	2008	**2009**	**2010**	**2011**
JPE to Sacramento (NMFS)	589,911	617,783	1,179,633	332,012
JPE to Chipps w/ Delta survival added[1]	195,260	204,486	390,458	109,895
JPE to Chipps w/DNA (Pyper *et al.* 2013)	44,943	51,228	63,442	60,051
% overestimated at Chipps	400	400	600	180

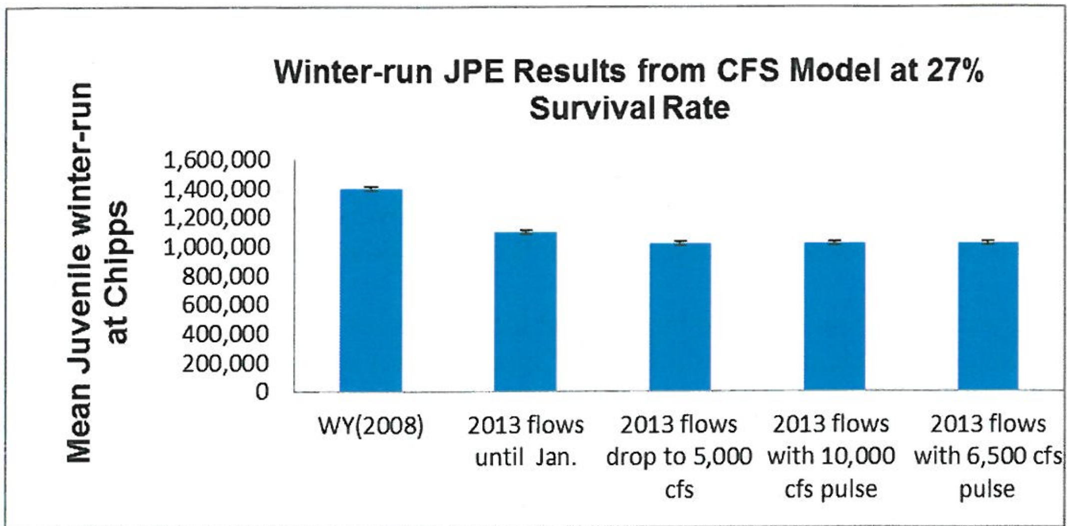
[1] JPE through Delta uses 33% survival for all years based on Perry *et al.* (2012).

In addition, 2013 was the first year that in-river survival was directly estimated for hatchery-released juvenile winter-run (using acoustic JSAT tags). This allowed for the comparison of survival rates from the 2013 data to those previously used in the calculation of the JPE. Direct estimates of survival are considered the best method of estimating natural juvenile winter-run survival and abundance between reaches on the Sacramento River. Previously, NMFS used survival rates indirectly by comparing the differences in ocean recovery rates of hatchery CWT coded wire tagged (CWT) late-fall run releases made at Battle Creek and in the Delta.

For the 2013 broodyear, NMFS has revised the survival terms in the JPE calculator based on the latest acoustic tag studies and abundance estimates at Chipps Island (Table 1). Smolt survival in from Red Bluff to the Delta was changed based on: (1) 2013 survival of acoustically-tagged hatchery winter-run (hydrologic conditions at release were similar to water year 2014); and (2) the average survival of 4 years (2007–2010) of acoustically-tagged late fall-run hatchery releases (excluding 2011 releases because it was a wet year with high survival). In 2013, the habitat and environmental conditions were considered to be similar to the dry year survival estimates from the acoustic tag data. Survival from Red Bluff to the Delta was derived by equally weighting the survival of both the winter-run and the average of the late fall-run releases (see enclosure 3). Various survival terms in the JPE calculator may be revised for the 2014 broodyear based on additional data from the 2014 release of acoustically-tagged winter-run.

Details of this year's calculation of the JPE are described in the NMFS JPE Estimator Program (enclosure 2). In most years, NMFS compares its modeled estimate to the U.S. Fish and Wildlife Service (USFWS) juvenile production index (JPI) at Red Bluff. The JPI is an independently-developed estimate based on real-time rotary screw trap catch data of juvenile winter-run passage at Red Bluff Diversion Dam (RBDD). However, due to the partial government shutdown, 17 days of catch data were missed from October 1–17 period, during the peak of winter-run juvenile outmigration from the upper Sacramento River. Although data were extrapolated to fill in the gap of missed catch days, NMFS does not consider the JPI as a good comparison for the JPE from the 2013 spawning season.

NMFS uses a model developed by Cramer Fish Sciences (CFS) in 2011 to estimate uncertainty in the JPE. Although, the end point for juveniles in the CFS model is Chipps Island in the Delta, and not the entrance into the Delta, it is still useful for purposes of estimating uncertainty. For the JPE from the 2013 spawning season, NMFS has defined entrance into the Delta as the Tower Bridge at Sacramento for purposes of comparing in-reach survival; consistent with how the JPE is defined in the CVP/SWP Opinion. Using the CFS model default critical water year hydrology (WY 2008) resulted in an estimate of 1,395,200 winter-run to Chipps Island, with a confidence interval of 14,776 (5 (Figure 3). Additional modeling, using a 10,000 cfs pulse flow in February, and 6,500 cfs March, only increasing the JPE by 2,640 fish (or <0.5%), compared to more significant increases found in del Rosario *et al.* (2013).



[1] Current low flows at Freeport in January are lower than the default (WY 2008) flows in model.

[2] Pulse flows 10,000 cfs in February and 6,500 cfs in March as cues for migration (Rosario *et al.* 2013).

Figure 3. Cramer Fish Sciences model summary of mean winter-run juvenile production under various critical water year scenarios.

Using the JPE as defined in the CVP/SWP Opinion (*i.e.*, survival to the Delta but not through the Delta), and based upon the best available information, NMFS estimates that 1,196,387 natural origin juvenile winter-run will enter the Delta during water year 2014 (enclosure 2). The NMFS JPE was within 100,000 of the CFS model results for the 2013 water year. The outmigration period for winter-run into the Delta typically runs from November through April, based upon CDFW historical monitoring data at Knights Landing rotary screw traps.

An additional 193,000 hatchery-reared juvenile winter-run propagated at Livingston Stone National Fish Hatchery (LSNFH) were released into the upper Sacramento River near Redding on February 10, 2014. All hatchery-produced winter-run are CWTed and marked with an adipose fin clip, so that they can be identified from other hatchery fish. NMFS has determined that the survival of these hatchery fish would be similar to the acoustic tag release in 2013 since they were released at the same time, location, and size. NMFS estimates that approximately 30,880 hatchery winter-run will survive to enter the Delta during water year 2014 (enclosure 2).

The authorized incidental take limit for the combined CVP/SWP Delta pumping facilities includes both the natural (wild) and hatchery-produced juvenile Sacramento River winter-run Chinook salmon, as both are considered necessary components of the population for survival and recovery of the species. The authorized incidental take for naturally-produced Sacramento River winter-run Chinook salmon has been established as 2 percent of the JPE [The incidental take limit is actually 1 percent of the JPE based on genetically determined winter-run, however, a 50 percent allowance is provided due to the uncertainties in the length-at-date criteria and difficulty in identifying juveniles of other races (*i.e.*, fall-run, late-fall run, and spring-run Chinook salmon)]. The incidental take for hatchery winter-run is set at one percent of the LSNFH release because the race is known and all are marked with CWTs. Therefore, the authorized level of incidental take (*i.e.*, reported as loss) under the ESA for the combined CVP/SWP Delta pumping facilities from October 1, 2013, through June 30, 2014, is set at **23,928 natural (non-clipped or wild)**, and **309 hatchery-produced** Sacramento River winter-run Chinook salmon. If the incidental take exceeds 1 percent of the natural production entering the Delta (*i.e.*, 11,964) or 0.5 percent of the hatchery production (*i.e.*, 154), Reclamation and the California Department of Water Resources (DWR) must immediately convene the Water Operations Management Team (WOMT) to consider actions to minimize incidental take, pursuant to the CVP/SWP Opinion.

The initial identification of naturally-produced (non-clipped) winter-run Chinook salmon at the CVP/SWP Delta fish facilities shall be based on the length-at-date criteria for the Delta developed by the USFWS in cooperation with CDFW and DWR. As additional information becomes available through genetic analysis of tissue samples and other fisheries monitoring programs (*e.g.*, acoustical tag studies) in the Central Valley region, 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 salvage and loss, and loss densities of Sacramento River winter-run Chinook salmon and other ESA-listed species at the Delta fish salvage facilities through participation in the Delta Operations for Salmonids and Sturgeon (DOSS) Technical Team and the WOMT. We appreciate the opportunity to provide Reclamation and DWR with information related to the juvenile production of Sacramento River winter-run Chinook salmon.

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 provide direct calculation of survival, and greatly improve 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 request that Reclamation provide funding to continue these studies. In addition, the calculation of the JPE, and specifically the use and application of data from the acoustically-tagged Chinook salmon releases, will be included as a topic in the 2014 annual review, as required in section 11.2.1.2 of the CVP/SWP Opinion (page 9 of the 2009 RPA with 2011 amendments, http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/040711_ocap_opinion_2011_amendments.pdf).

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 Area Office

References cited:

Michel, C. J., A. J. Ammann, S. T. Lindley, P. T. Sandstrom, E. D. Chapman, H. E. Fish, M. J. Thomas, G. P. Singer, P. Klimley, and B. MacFarlane. unpublished draft. Chinook Salmon (*Oncorhynchus Tshawytscha*) Outmigration Survival between Wet and Dry Years in California's Sacramento River.42.

Perry, R. W., P. L. Brandes, J. R. Burau, A. P. Klimley, B. MacFarlane, C. Michel, and J. R. Skalski. 2012. Sensitivity of Survival to Migration Routes Used by Juvenile Chinook Salmon to Negotiate the Sacramento-San Joaquin River Delta. Environmental Biology of Fishes 96(2-3):381-392.

Pyper, B., T. Garrison, S. Cramer, P. L. Brandes, D. P. Jacobson, and M. A. Banks. 2013. Absolute Abundance Estimates of Juvenile Spring-Run and Winter-Run Chinook Salmon at Chipps Island. Page 89. Delta Science of Delta Stewardship Council, Sacramento-San Joaquin Delta.

del Rosario, R. B. d., Y. J. Redler, K. Newman, P. L. Brandes, T. Sommer, K. Reece, and R. Vincik. 2013. Migration Patterns of Juvenile Winter-Run-Sized Chinook Salmon (*Oncorhynchus tshawytscha*) through the Sacramento–San Joaquin Delta. San Francisco Estuary & Watershed Science 11(1).

Enclosures:
1. CDFW letter to NMFS, dated January 7, 2014
2. NMFS winter-run juvenile production estimate from the 2013 spawning escapement
3. Supporting memorandum modifying survival.

cc: Copy to file: ARN 151422SWR2006SA00268
Sue Fry, Reclamation, Bay-Delta Office, 801 I St., Suite 140, Sacramento, CA 95814
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Bill Poytress, FWS, 10950 Tyler Rd., Red Bluff, CA 96080
Doug Killam, CDFW, 2440 Main St., Rm. 41, Red Bluff, CA 96080
Michael Lacey, Colin Purdy, CDFW, 830 S St., Sacramento, CA 95811
Edmund Yu, DWR, 3500 Industrial Blvd, Sacramento, CA 95691
Andy Chu, DWR, 3310 El Camino Ave, Sacramento, CA 95821-9000

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
http://www.dfg.ca.gov
Fisheries Branch
830 S Street
Sacramento, CA 95811
(916) 327-8840

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

Attachment 1

January 7, 2013

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 2013

The California Department of Fish and Wildlife (Department) has developed Sacramento River winter-run Chinook salmon escapement estimates for 2013. 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 upper Sacramento River winter-run carcass survey data for 2013 are shown below:

Estimated Total In-river Escapement (hatchery and natural origin)	**5,958**
Estimated In-river Escapement (hatchery origin)	**397**
Estimated Number of In-river Adult Females (hatchery and natural origin)	**3,613**

These estimates include naturally spawning winter-run Chinook in the upper Sacramento River. In addition, 117 winter-run Chinook 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 Chinook. The total winter-run spawning escapement estimate in 2013, including in-river spawners and fish collected for normal hatchery broodstock, is **6,075** fish. The 90% confidence interval on this total estimate is from **5,275 to 6,677** fish.

This year, the escapement estimate was again calculated from the carcass survey data using a different statistical model than used in some previous years. From 2003-2011, the escapement estimate had been based on application of the Jolly-Seber model. Based on the recommendations of the *Central Valley Chinook Salmon In-River Escapement Monitoring Plan* (DFG 2012), starting in 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.

In the spring of 2013 the Department observed a number of Chinook salmon had strayed into the Colusa Basin Drain area and were trapped by irrigation diversions. Many of these fish were winter-run Chinook and were released back into the Sacramento River. These released fish are included in the in-river totals listed above because they were assumed to have reached the spawning grounds. Other salmon (spring-run and winter-run) were observed to have died in the Colusa Basin Drain and are not included in the above totals. In addition, another 47 known winter-run Chinook were rescued and taken into LSNFH on an emergency basis and are not included in any of the totals above.

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. Michael Lacy, Michael.Lacy@wildlife.ca.gov or at the address and phone number above.

Sincerely,

Stafford Lehr, Chief
Fisheries Branch

cc: See next page.

Attachment 1

cc: Ms. Maria Rea, Sacramento Area Supervisor
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Mr. Doug Killam
Department of Fish and Wildlife
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Redding, California 96001

NMFS - Southwest Region | Enclosure 2

WINTER RUN JPE ESTIMATOR PROGRAM

DATA ENTRY HERE		Version 5		2/10/2014
Year Pair	Broodyear	WINTER RUN CHINOOK SALMON Juvenile Production Estimate	Factors	Carcass Survey Estimate
2013/2014	2010			
actually observed				
3,309		Total In-river Escapement - 1/		5958
Females unspawned				
1.00%	3/	Adult Female Estimate - 2/	0.61	3613
CDFG Carcass Survey		Prespawn mortality - 3/	0.01	3577
6,075	1/			
Female Percent		Average Fecundity - 4/	4596	16439295
60.64%	2/	Egg Loss Due To Temperature - 5/	0.0017	27947
LSNFH		Total Viable Eggs		16411348
Hatchery Release				
193,000	9/	Estimated Survival - egg to fry (at RBDD) -6/	0.27	4431064
Release Date				
02/01/14				
		Estimated Survival - fry-to-smolt - 7/ (RBDD to Tower Bridge at Sacramento)	0.27	1196387
		Total Natural Production Entering Delta		1196387
		Hatchery Release - 8/		193000
		Total Hatchery Production Entering Delta - 9/	0.16	30880
		Level of Concern for wild fish (1%)		11964
		Level of Concern for hatchery fish (0.5%)		154
		Incidental Take Level for Natural Production (2%)		23928
		Incidental Take level for Hatchery Production (1%)		309

Footnotes -

1/ Total in-river escapement from Cormack-Jolly-Seber (CJS) model (90% CI), includes natural and hatchery origin, but not 117 collected at Keswick trap for LSNFH (CDFW letter 1/7/14).

2/ The number of 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 final estimate 12/15/13).

4/ Average # eggs/female, from 2013 returns to LSNFH (n=50), John Rueth, USFWS, email 12/13/13.

5/ 1 of 569 redds (569/1) observed below Airport Rd temperature compliance point (CDFW redd data).

6/ Egg-to-fry survival based on 15 year average at RBDD using JPI/female spawners in carcass survey, and fecundity data. Increased from 25% in 2013 (Bill Poytress, USFWS, subteam notes 12/6/13)

7/ Weighted average (50/50) of winter-run (2013) and late-fall run (2007-2010) acoustic tag data.

8/ LSNFH estimated 2014 release numbers from USFWS pre-release, 2/3/14 (100% tagged & clipped).

9/ Hatchery survival estimated from 2013 acoustic tag study (Hassrick, unpublished)

MEMORANDUM TO: File AR151422SWR2006SA00268 Enclosure 3

FROM: Bruce Oppenheim
Fishery Biologist, California Central Valley Area Office
West Coast Region, National Marine Fisheries Service

SUBJECT: 2013 Winter-run Juvenile Production Estimate

PROJECT BACKGROUND

Project Name: Biological Opinion on the Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP)
Date: January 27, 2014

In order to provide the incidental take for the CVP/SWP operations at the export facilities in the south Delta, NMFS calculates the number of juvenile winter-run that will enter the Sacramento-San Joaquin Delta annually based on adult escapement. The California Department of Fish and Wildlife (CDFW) typically provides an official adult escapement estimate in late December, or early January (official letter to NMFS). The number of adults is determined from carcass surveys conducted during the summer (May–September) in the upper Sacramento River (upstream of above Red Bluff Diversion Dam). A simple spreadsheet model calculates the juvenile production estimate (JPE) to the Delta based on these data, and survival terms based on life history stages and river reaches. Each year, the Winter-run Project Work Team (WRPWT) part of the Interagency Ecological Program, reviews the data that feed into the calculations of the JPE. For the 2013 winter-run spawning escapement, the WRPWT, of which NMFS is a member, reviewed the latest studies using acoustic tags and recommended making changes to the survival terms used in the JPE.

This memorandum describes the modifications to the winter-run JPE for brood-year 2013. NMFS staff from the California Central Valley Area Office and the Southwest Fisheries Science Center participated in the review of the latest studies (both published and unpublished). This was the first year that direct measurements of juvenile winter-run survival were available using acoustic tags. Also, 4 years of absolute abundance estimates (2008–2011) using genetic identification of winter-run at Chipps Island (Pyper *et al.* 2013) were compared to the JPE to determine in-river survival. Acoustic tag data from other runs including late-fall run Chinook salmon (Table 2) were used to compare the cumulative survival rates from the upper Sacramento River spawning grounds (above Red Bluff Diversion Dam) to Sacramento (Tower Bridge). The changes made to the JPE for the 2013 spawning escapement reflect a more accurate abundance estimate that reduces uncertainty associated with assumptions used in previous indirect methods that were considered best available at the time. The survival estimates were revised based on both acoustically-tagged winter-run and late-fall run hatchery releases, rather than solely inferring survival from surrogates (*e.g.*, CWT fall-run and late-fall run hatchery releases). Table 1 summarizes the changes made to the survival terms in the JPE.

Table 1. Summary of Modifications to Survival Terms in the JPE

Survival Term (life-stage)	Old Term	Basis	New Term	Basis
Egg-to-Fry	.25	RBDD data (direct)	.27	Added 2 years data (direct)
Fry-to-Smolt	.59	Fall-run spawning, 1985 Tehama-Colusa Canal (indirect)	N/A	Deleted, overlaps with the following survival term
Smolt (Salt Creek to Delta)	.54	Difference in CWT ocean recoveries of paired late-fall between Battle Creek and Delta 1994–2004 (indirect)	.27	Weighted average of late-fall run (2007–2010) and winter-run (2013) acoustic tag data (direct)

RBDD = Red Bluff Diversion Dam, CWT = Coded Wire Tag, N/A = not applicable

A technical subteam of the WRPWT made two proposals to modify the survival (S) to the Delta term (S= .54) currently used in the JPE, based on the latest studies. These were to either use: (1) one year of winter-run 2013 acoustic data (S = .16; Hassrick and Hayes, unpublished data), or (2) combine the winter-run 2013 acoustic data with the average survival of five years (2007–2011) of late-fall run acoustic data (S = .39), from Michel *et al.* (unpublished draft). After reviewing both the pros and cons of each proposal, the WRPWT could not reach agreement on which proposal to from the JPE subteam to support (CDFW 2014).

To calculate the JPE for the 2013 spawning escapement, NMFS applied a weighted average to the acoustically-tagged winter-run and late fall-run data (Lindley 2014). To reflect this year's critically dry habitat conditions, data representing dry years was chosen: the 2013 winter-run data and the average of 4 dry years of late fall-run acoustic data (2007–2010[1], Table 2). The survival rates of the 2013 winter-run data and the average of the late fall-run data were then weighted equally (50/50) and added together, in consideration of using a single year of winter-run data from 2013, and multiple years of acoustic tag data from late fall-run that likely have different life history and habitat needs and migration patterns.

NMFS methodology to calculate the JPE for the 2013 winter-run spawning escapement:

(1) Average of late-fall run (dry year) survival (2007-2010) = .38 * .50 (weighting) =.19
(2) 2013 (dry year) winter-run survival = .16 * .50 (weighting) = .08
(3) Sum of weighted survivals = (.19 + .08) = .27

In the future, if and when more data on winter-run juvenile survival becomes available, this weighting method can change to reflect the variability in multiple years and differences in hydrologic conditions (*i.e.*, environmental/habitat conditions).

[1] 2011 was a wet year, therefore, acoustic data from that year were not included.

Table 2. Late fall-run cumulative survival rates from RBDD to Sacramento using acoustically-tagged hatchery releases (Michel *et al.* unpublished draft).

Year	WY	S	SE	CI	UCI	LCI	River Segment
2007	D	0.213	0.060	0.118	0.331	0.095	RBDD to I-80/50 bridge in Sacramento
2008	C	0.378	0.059	0.116	0.494	0.262	RBDD to I-80/50 bridge in Sacramento
2009	D	0.501	0.058	0.114	0.615	0.387	RBDD to I-80/50 bridge in Sacramento
2010	BN	0.419	0.053	0.104	0.523	0.315	RBDD to I-80/50 bridge in Sacramento
2011	W	0.672	0.039	0.076	0.748	0.596	Jelly's Ferry to I-80/50 bridge in Sacramento (survival from RBDD down was not available due to poor detection efficiency)

S = survival, SE = Standard Error, CI = Confidence Interval, UCI = upper confidence interval, LCI= lower confidence interval. WY=Water Year Type, based on unimpaired runoff (CDEC WSIHIST) where D=Dry, C=Critical, BN=Below Normal, W=Wet.

References:

Lindley, S. 2014. Electronic mail summarizing a conference call with Steve Lindley, Maria Rea, and Garwin Yip concerning winter-run survival estimates. January 22, 2014.

CDFW. 2014. Memorandum from the winter-run Project Work Team to the JPE sub-team concerning modifications to the 2013 winter-run juvenile production estimate. Interagency Ecological Program. February 4.

Hassrick, J. and Sean Hayes. Unpublished. Survival of Migratory Patterns of Juvenile Winter-run Chinook salmon in the Sacramento River, Delta, and San Francisco Bay. Results of first year acoustic tag study. Contributing agencies include the National Marine Fisheries Service, University of California at Davis, Cramer Fish Sciences, California Department of Water Resources, and the U.S. Fish and Wildlife Service.

Michel, C. J., A. J. Ammann, S. T. Lindley, P. T. Sandstrom, E. D. Chapman, H. E. Fish, M. J. Thomas, G. P. Singer, P. Klimley, and B. MacFarlane. unpublished draft. Chinook Salmon (*Oncorhynchus Tshawytscha*) Outmigration Survival between Wet and Dry Years in California's Sacramento River.42.

Pyper, B., T. Garrison, S. Cramer, P. L. Brandes, D. P. Jacobson, and M. A. Banks. 2013. Absolute Abundance Estimates of Juvenile Spring-Run and Winter-Run Chinook Salmon at Chipps Island. Page 89. Delta Science of Delta Stewardship Council, Sacramento-San Joaquin Delta.

Winter-run PWT subteam notes: (conference call) 11/26/13

Participants: Jim Smith, FWS, Pat Brandes, FWS, Bruce Oppenheim, NMFS, Jason Hassrick, NMFS SWFSC, Edmund Yu, DWR, Kevin Reece, DWR, and Josh Israel, Reclamation

Background: The subteam was formed at the request of the large Winter-run PWT mtg on 11/20/13. See discussion item IV from the PWT meeting. "Revising survival estimates in the JPE based on recent genetic studies (Are we overestimating survival to the Delta?). The larger PWT group concluded that recent absolute abundance estimates to Chipps Is based on genetics (Pyper et al 2013) indicated the NMFS JPE was overestimating juvenile abundance. A subteam was created to review the latest acoustic tag data and consider revisions to the survival factors.

Task: review latest data and advise larger PWT on survival.

The subteam considered what recent data was available; (1) the abundance estimates based paper that Pat co-authored on Chipps Is trawl data (Pyper et al 2013), (2) winter-run acoustic tag results (Hassrick unpublished data, see poster), (3) recent acoustic tag data from other runs (Cyril Michel, 2012 unpublished data), (4) 2 more years of egg to fry survival data from RBDD rotary screw traps, and (5) late-fall run data from ocean recoveries (Chipps Is Table revised November 2011).

Pat's genetic study: 4 years of data (2008, 2009, 2010, and 2011) with absolute juvenile abundance estimates to Chipps Is showed lower abundance than the NMFS JPE.

Jason Hassrick's acoustic tag study: Acoustic tag data from 2013 winter-run released at Caldwell Park shows much lower survival to the Delta than what is used in NMFS JPE. Hassrick 2013 tag data (survival estimates from release): Tower Bridge (Sacramento) 14%, Freeport 10%, Steamboat 9%, Rio Vista 6% (note: still being QC'd). Hassrick pointed out the data showed obvious differences between juvenile winter-run survival and that of other runs. Juvenile winter-run are holding longer (30 – 40 days) in the upper Sacramento River than late-fall run (*i.e*., what JPE uses). Therefore, juvenile winter-run experience greater mortality than late-falls before entering the Delta. It was noted that 2013 was the driest year on record in January and February when the winter-run were released. Hassrick used hatchery winter-run (n=150) that average 90 mm, compared to the late-fall run releases that average 120 – 140 mm. This is the first time hatchery winter-run have been acoustically tagged and tracked downstream. The subteam chose the reach 1 mile below RBDD (*i.e*., Salt Creek) as the upstream end to compare survival to other runs. By multiplying the reach specific survival terms, the survival of winter-run from Salt Creek to Tower Bridge in Sacramento (entrance to Delta) was 14%.

Cyril Michel has acoustic tag data from late-fall run (140 mm) released in similar reaches for comparison. This data covers both wet and dry year hydrology (2007 – 2011). Michel's data includes one year with a survival estimate similar to the winter run Chinook survival Hassrick estimated (*i.e.,* 2007 late-fall run suvival=0. 213 (SE= ±0.06) from RBDD to I-80/50 bridge). Differences in survival through these reaches vary by approximately 45% depending on the year, over the 5 years studied. It is unclear what the major factor is driving this significant difference. The subteam discussed possible factors like water year type, flows, and size at release. Overall survival of the late-fall releases was 7% to the Golden Gate Bridge and 16% in 2011 (a wet year). Jason will try to get this data and 2013 spring-run acoustic tag data from Battle Creek so that the subteam can estimate survival for both wet and dry years.

Discussed how late-fall run ocean recoveries are used for survival in the JPE. The subteam reviewed the 3 survival terms in the JPE; (1) egg to fry survival, 25%, (2) fry to smolt survival, 59%, and (3) smolt survival to the Delta, 53%. The focus of the subteam was on reviewing the smolt survival term, but will also look for any data on the other terms, as well. The current JPE uses the difference in ocean recoveries of late-fall run released between Battle Creek and Delta locations from 1994 – 2001, last updated in 2005. We have more recent data for late-fall releases from the Chipps Is Trawl, however, the studies stopped using a downstream control point (Sacramento release site) in 2008.

Jason also acoustically tagged juvenile fall-run Chinook in 2013 released at Battle Creek. We could compare similar reach survival to winter-run (Salt Creek to Tower Bridge). Tower Bridge was chosen as the furthest point downstream that represents entry into the Delta. Note; the JPE does not define Delta entry point, just "to the Delta", which is assumed to mean Sacramento (legal definition of northern extent of Delta).

Josh mentioned that survival for juvenile Chinook salmon has generally been declining over time (cited San Joaquin River VAMP experiments), therefore, we need to define what needs to be measured and describe our approach. The subteam agreed to compare the most recent acoustic tag and CWT data from 2001–2013, between runs and between years.

Assignments for next mtg:

Jason- review & send out latest data on winter-run, fall-run, late-fall, and spring-run acoustic tags

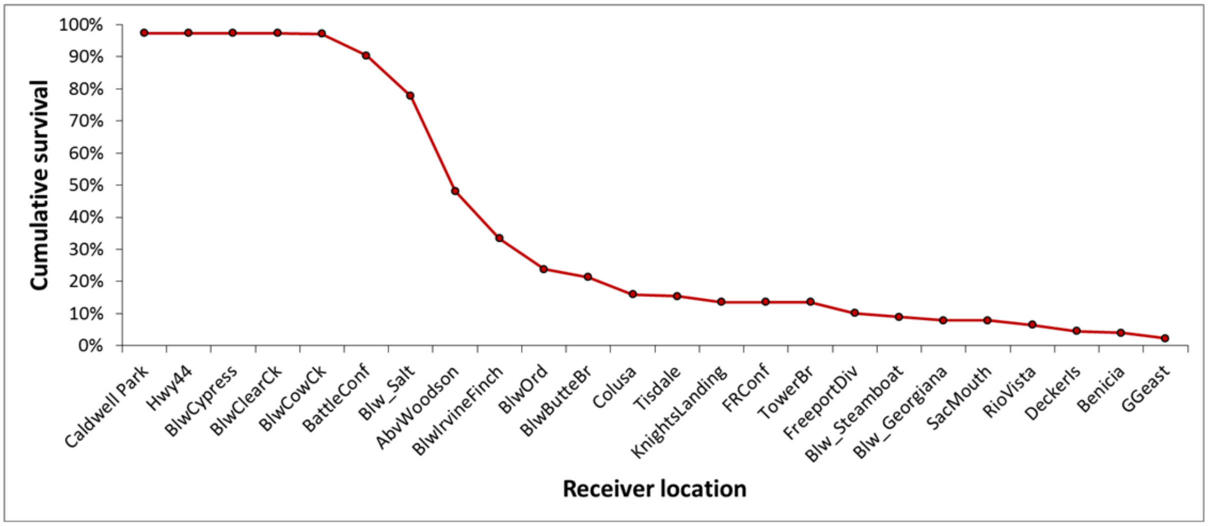
Bill – review & send out data from RBDD last 2 years on egg-fry survival

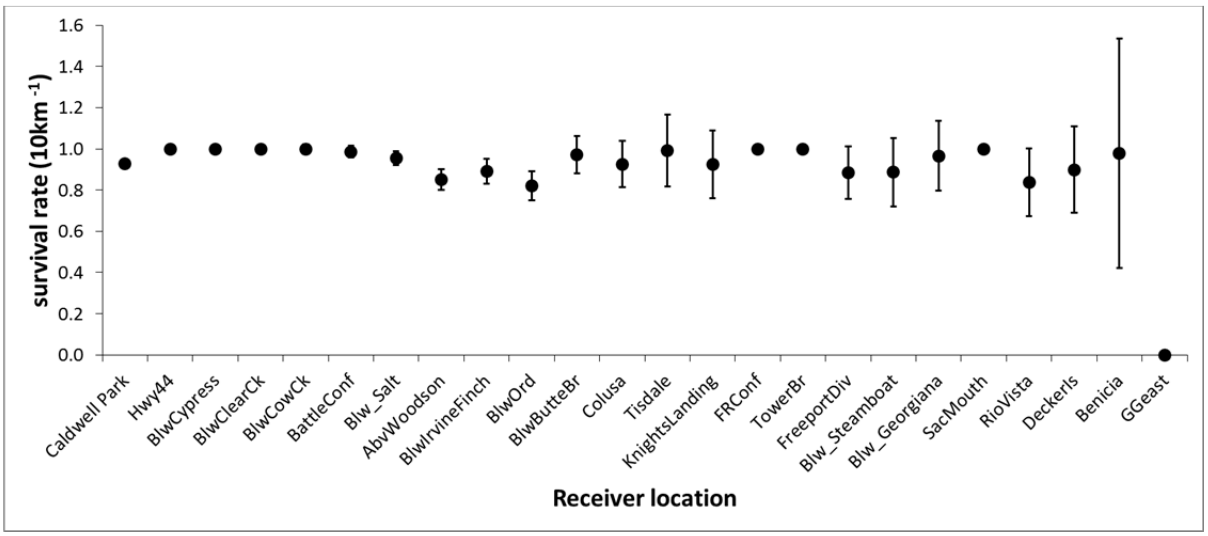
Pat – review & update CWT data from late-fall run releases

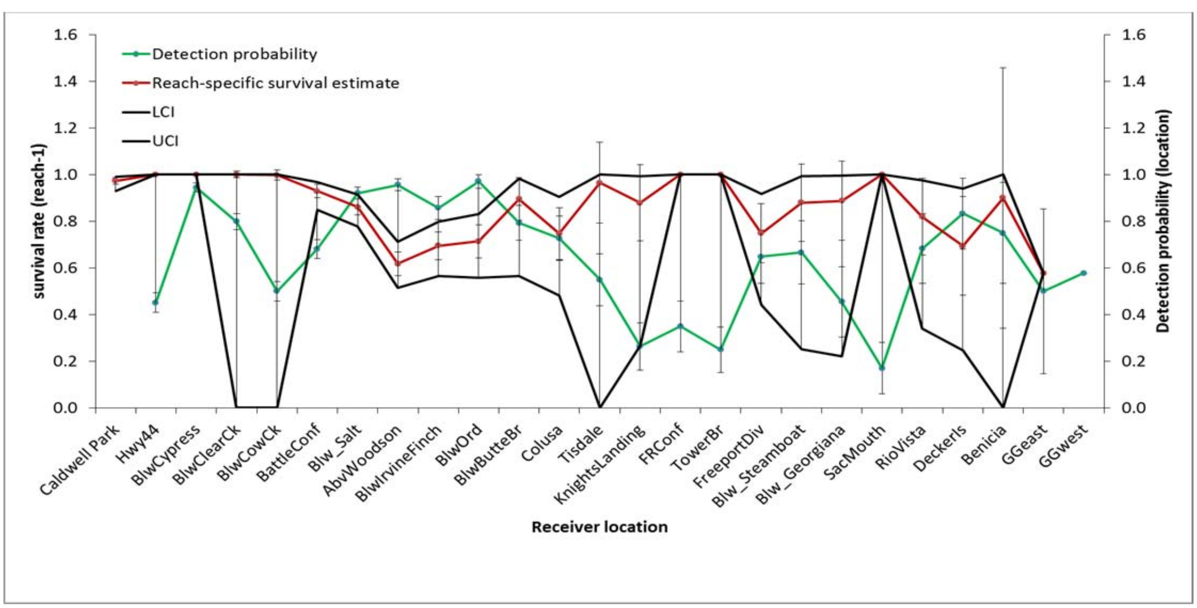
Bruce- send out most recent Chipps Is Mega-Table (1993 –2011) revised 11/2011

Next mtg (in person) on 12/6/13 at NMFS Office in Sacramento

Preliminary results of winter-run acoustic tag study in 2013 sent by Jason after PWT mtg 11/20/13


Cumulative survival
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Caldwell Park
Hwy44
BlwCypress
BlwClearCk
BlwCowCk
BattleConf
Blw_Salt
AbvWoodson
BlwIrvineFinch
BlwOrd
BlwButteBr
Colusa
Tisdale
KnightsLanding
FRConf
TowerBr
FreeportDiv
Blw_Steamboat
Blw_Georgiana
SacMouth
RioVista
DeckerIs
Benicia
GGeast
Receiver location


survival rate (10km -1)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Caldwell Park
Hwy44
BlwCypress
BlwClearCk
BlwCowCk
BattleConf
Blw_Salt
AbvWoodson
BlwIrvineFinch
BlwOrd
BlwButteBr
Colusa
Tisdale
KnightsLanding
FRConf
TowerBr
FreeportDiv
Blw_Steamboat
Blw_Georgiana
SacMouth
RioVista
DeckerIs
Benicia
GGeast
Receiver location


Detection probability
Reach-specific survival estimate
LCI
UCI
survival rate (reach-1)
Detection probability (location)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Caldwell Park
Hwy44
BlwCypress
BlwClearCk
BlwCowCk
BattleConf
Blw_Salt
AbvWoodson
BlwIrvineFinch
BlwOrd
BlwButteBr
Colusa
Tisdale
KnightsLanding
FRConf
TowerBr
FreeportDiv
Blw_Steamboat
Blw_Georgiana
SacMouth
RioVista
DeckerIs
Benicia
GGeast
GGwest
Receiver location

Winter-run Subteam Mtg (in person, NMFS Office Sacramento) **12/6/13**

Participants: Bruce Oppenheim, NMFS, Jason Hassrick, NMFS, Pat Brandes, FWS, Jim Smith, FWS, Bill Poytress, FWS, Josh Israel, Reclamation, Edmund Yu, DWR, Kevin Reece, DWR.

Agenda: A) Review recent CWT and acoustic data on winter-run

B) Review and revise survival terms in JPE based on recent data

Started with the review of the Chipps Is ocean recoveries (CWTs) data up to 2011 (see Chipps Is Table 1993-2011) because that is what is currently used in the NMFS JPE. Pat presented her analysis of data on survival based on paired hatchery late-fall run releases from Battle Creek and an associated Delta location (*e.g.*, Courtland, Sac, Ryde, Isleton) up to 2008. The data suffers from high variability, uncertainty in recapture efforts, and only yields an indirect measurement of survival. In some years, values are used as averages of releases, in other years a single value is used based on timing of release with storms or flow increases. In other years, biologists decided not to use any results since values > 1.0, suggesting the assumptions regarding recapture rates are not statistically valid. No data for 2012 and 2013 late-fall releases yet, because they have not shown up in ocean harvest. This limits use of most recent data for comparison, always 3 years behind. However, FWS has not been conducting paired late-fall run Chinook salmon releases since about 2008. The subteam consensus was not to use this data due to the problems inherit in sampling, it results in an indirect measure of what we are attempting to capture in the term, and because of perceived differences in behavior between late-fall and winter-run emigration. The subteam felt that there were better data available now in the more recent acoustic tag studies.

Then reviewed the Hassrick 2013 winter-run acoustic data (n=148). Two releases were made, one in February with the normal hatchery release, and one later in March. Jason presented the unpublished results of his study. Livingston Stone National Fish Hatchery does one release a year (unlike Coleman), so the tagged 148 fish (shown in green) were released on February 7 with that group from Caldwell Park. An additional 25 smolts (shown in blue) were retained to assess tag effects and released on March 24th. This is notable because even the later released fish held in the upper river before migrating downstream. No other runs showed this behavior for this year. This data included reach survival from Caldwell Park (Redding to the Golden Gate).

One concern is that the results only represent one year, and it was the driest year on record. Another concern was the limited sample size and detection probabilities used to estimate survival to Tower (n=19 being observed downstream of Tower, 5 being observed at Tower). Recent work on winter-run emigration patterns, Rosario et al (2013), showed a different pattern between wet years and dry years. In dry years winter-run hold in the upper river for 30–40 days, and this pattern is captured in the migration timing of the 2013 acoustically tagged winter run which spent approximately 30-50 days in the between Red Bluff and Colusa. In wet years, winter-run move downstream quickly and rear in the Delta for 30–40 days. The JPE only considers in-river survival and not the Delta survival, so should we consider averaging wet and dry year survival?

Josh suggested we need to change the fry to smolt survival term (.59) because it was based on outdated fall-run data from 1972–1981 at the Tehama-Colusa Spawning Channel. The fry to smolt survival term represents approximately 2 months in river (check old reports). It should really represent 4 months from October – January. We may need a daily mortality model for 120 days to incorporate variable rearing strategies in river. Ken Newman, FWS statistician, developed such a daily mortality model for the Rosario et al (2013) paper. Pat explained the Newman model by referring to Figure 8 in the Rosario et al (2013). The subteam looked at Jason's graph of winter-run compared to other runs (spring, fall, late-fall) and concluded that winter-run hold above Colusa for a considerable time compared to other runs which emigrated right out at release. The winter-run acoustic tag data also had a low detection probability (.40) between Knights Landing and Tower Bridge, but this could be due to the number of tags declining as they move downstream. The standard error also increases as you move downstream. Jason will look into methodology for estimating standard error.

1st Approach:

The subteam tried to develop a formula to account for daily mortality that could be incorporated into the JPE. In particular, the subteam was interested in looking at daily mortality from Salt Creek to Colusa to better incorporate winter-run rearing strategies in that reach based on a graph presented by Hassrick. The subteam came up with the following formula below:

S/RKM x RKM/days = S/days

For S/RKM, the subteam used 0.991 S/RKM, which is based on the average survival rate per km from Salt Creek to Colusa. For RKM/days, the subteam originally planned to use 150 RKM/40 days. Forty days was based on the period of 2/15 to 3/27 when winter-run were in the Salt Creek to Colusa region (see Hassrick graph), while the 150 RKM represents the distance from Salt Creek to Colusa. This led to the following:

(0.991 S/RKM) * (150 RKM/40 days).

However, the above equation would give survival per 40 days and the subteam was interested in survival per day. To accomplish this, the subteam raised 0.991 to the 4th power and the results are below to capture the period of 160 days:

(0.991^4)/4   0.991 to 4th Power = 0.964483 for 160 days

S = 0.00238 for 4 months

160 days represented the time period for fry to change to smolts

S = 0.2%, In the end, the survival calculated using this approach was too low for even the Hassrick data. However, participants from the meeting felt this is something that would still be worth looking into as new ideas arise on how to determine survival per day.

2nd Approach:

Josh proposed back-calculating 2008–2012 data from JPI at RBDD to Chipps Is abundance estimates using different survival estimates (*e.g*., using winter-run, spring-run , and late-fall acoustic data) and compare to the absolute estimates made using genetics (Pyper, et al 2013). The subteam went through this exercise by calculating the number entering the Delta at Sacramento based on winter-run RBDD data using different survival estimates. Afterwards, the subteam compared the estimates of survival through the Delta, calculated by dividing the genetic estimate of winter run Chinook at Chipps by the number entering the Delta, to the estimated through-delta survival reported by Perry using late-fall Chinook (2007–2009 overall average survival 0.359, PWT notes). We were able to compare results from 4 years (2008, 2009, 2010, and 2011).

When the estimated survival to Chipps using WRC telemetry data was compared to the Perry estimates, the average survival estimated was very similar to the Perry estimates (Table 1). A second modification using four observed years of survival from LFC releases resulted in estimated survival to Chipps that was an order of magnitude smaller than estimated during these years to results in the genetic estimates of WRC (Table 2). An average of all acoustic releases (4 LFC +1WRC) was used for all 4 years, and resulted in estimated survival to Chipps that was less than half was was observed as the average Delta survival by Perry (Table 3). The comparison that seemed to match estimated survival to through the Delta the best used the 16% survival of tagged winter-run Chinook from Salt Creek to Tower Bridge.

The subteam did not reach a consensus on the best value to use, but proposed two estimates of rearing smolt to Delta survival; one based on the winter-run data from 2013 (*i.e.,* Salt Cr to Tower Bridge S =.156 95% LCI=0.104, UCI=0.228), and the other based on late-fall data from 2007–2011 and winter-run data in 2013 (S=.39). The subteam felt there were benefits and risks to using either survival estimate, but both were likely more accurate than late-fall ocean recoveries of CWTs. Also, some of the subteam felt better documentation, similar to that recently developed for the equation estimating loss at the facilities, should be developed with an additional section on recommendations for completing survival studies necessary to derive accurate estimates for calculating the JPE. There was also some discussion of whether the JPE calculator should continue to focus on using point estimates for survival or recommend completing studies documenting the relationships between survival and environmental covariates of interest to use in estimating JPEs.

Arguments for and against using the WY13 winter run estimate:

1) The winter-run (.16) survival estimate was based on only one year of tag data in 2013 and that year was the driest on record. This data should be updated every year that in-river survival estimates are measured using winter run Chinook. Regardless, benefits from using this estimate include that it captures survival of actual winter-run Chinook and not surrogates as in the past. Also, this value provides Delta survival estimates more similar to the overall average Delta survival based on existing genetic estimates for WRC juvenile abundance at Chipps Island (Pyper, et al 2013). The back-calculated survival estimate was similar in 3 out of 4 years (2008–2011).
2) The late-fall estimate (.43) survival value represents an average of both wet and dry year hydrology over the last 5 years (2007–2011) and includes approximately 45% variation in survival that may be attributed to environmental and/or experimental effects. However, it is

not representative of winter-run behavior. This estimate leaves out mortality in the upper river due to 30–40 day known delay/rearing in winter-run emigration and did not fit as well when back calculated with estimates from Chipps Is (2008–2011).

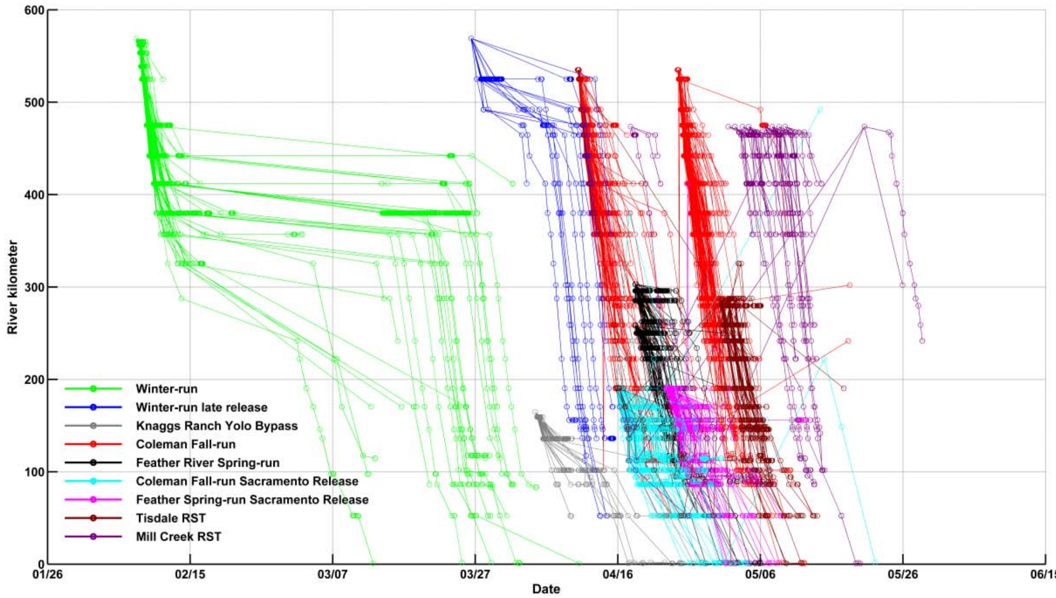
3) A combination of late fall and winter run Chinook (0.39; 2007–2011 and 2013, respectively) value is inclusive of multiple species, multiple release timings, and captures low and high values of survival, which are anticipated to exist under different water year types and environmental conditions. This value is not exclusive to winter run Chinook, which is a desirable and should be recommended until a certain number of water year types, total release years, or some other measure of variation/repeatability is achieved. This value is not exclusive to releases including rearing smolt behavior, and there were multiple opinions about how to capture rearing survival in the survival values in the JPE calculator. Rearing smolt survival is incorporate currently in the JPE calculator in 1 term – "fry to smolt survival." Once modified with this value or just the survival value using the 2013 winter run result, this term will incorporate data where rearing survival is incorporates into the "rearing smolt to Sacramento" survival term as well.
4) Both estimates are based on the latest acoustic tag data, however, these data are unpublished at this time and may change after QC review.

The subteam did reach agreement on keeping the fry to smolt survival (.59) the same based on no new data for that term, and changing the egg to fry survival from .25 to .26, or .27 (if rounded up) based on two more years of JPI data at RBDD rotary screw trap (see Bill's table).

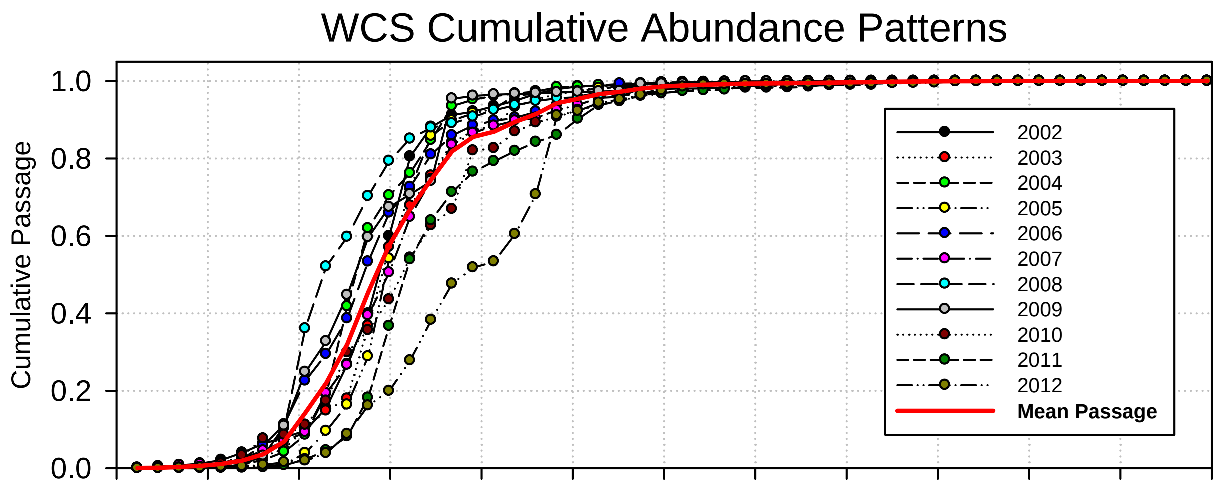
Future Work:

a) Subteam send notes to the larger PWT by 1/26/14 mtg
b) Develop trawl efficiencies at Chipps Is from the Pyper (2013) report and expand the Winter-run Hatchery Survival Index contained in the Chipps Is data table.
c) NMFS should decide on significant figures in survival terms in JPE.
d) Develop documentation (greater than footnotes) detailing term value data sources, certainty/comfort in term, and recommendations for how we will get results we would like for measuring point estimates and variation to achieve more accurate JPE.
e) Potentially seek guidance on the JPE at the next annual review on long-term operations of the State Water Project and Central Valley Project.
f) Check in with other staff working on the winter-run life cycle model to see what in-river survival is currently being used for the model.

Enclosures: a) Winter-run 2013 acoustic tag results compared to other runs, b) RBDD data, and c) Winter-run vs Late-fall run out-migration patterns.



		RBDD RST	**Egg To Fry Survival (ETF)**				
Year	**Egg/Female**	**FE JPI Lo 90 CI**	**FE JPI Hi 90 CI**	**FE JPI**	**Tot JPI**	**JPE**	
96	3859	17.4%	37.1%	21.3%	11.2%	25.0%	T Test P value
97	3859	33.8%	64.1%	39.8%	35.9%	25.0%	0.322663
98	3859	24.7%	35.1%	26.7%	23.9%	25.0%	
99	3859	16.8%	42.3%	21.8%	17.1%	23.7%	
2	4923	7.6%	47.1%	27.4%	25.5%	25.0%	
3	4854	13.9%	32.1%	23.0%	20.8%	24.6%	
4	5515	12.1%	29.8%	20.9%	19.6%	15.9%	
5	5500	9.5%	27.4%	18.5%	17.3%	25.0%	
6	5484	8.8%	22.1%	15.4%	14.1%	25.0%	
7	5112	13.6%	28.6%	21.1%	18.6%	24.0%	
8	5424	11.0%	24.1%	17.5%	15.9%	24.9%	
9	5519	18.7%	48.0%	33.3%	29.5%	25.0%	
10	5161	23.0%	52.0%	37.5%	30.6%	25.0%	
11	4832	32.8%	64.5%	48.6%	41.4%	25.0%	
12	4518	17.2%	35.9%	26.6%	20.0%	25.0%	
min	3859	7.6%	22.1%	**15.4%**	11.2%	15.9%	
Ave	4819	17.4%	39.4%	**26.6%**	22.8%	24.2%	
max	5519	33.8%	64.5%	**48.6%**	41.4%	25.0%	
StDev	668	8.1%	13.4%	**9.3%**	8.4%	2.3%	


WCS Cumulative Abundance Patterns
Cumulative Passage
1.0
0.8
0.6
0.4
0.2
0.0
2002
2003
2004
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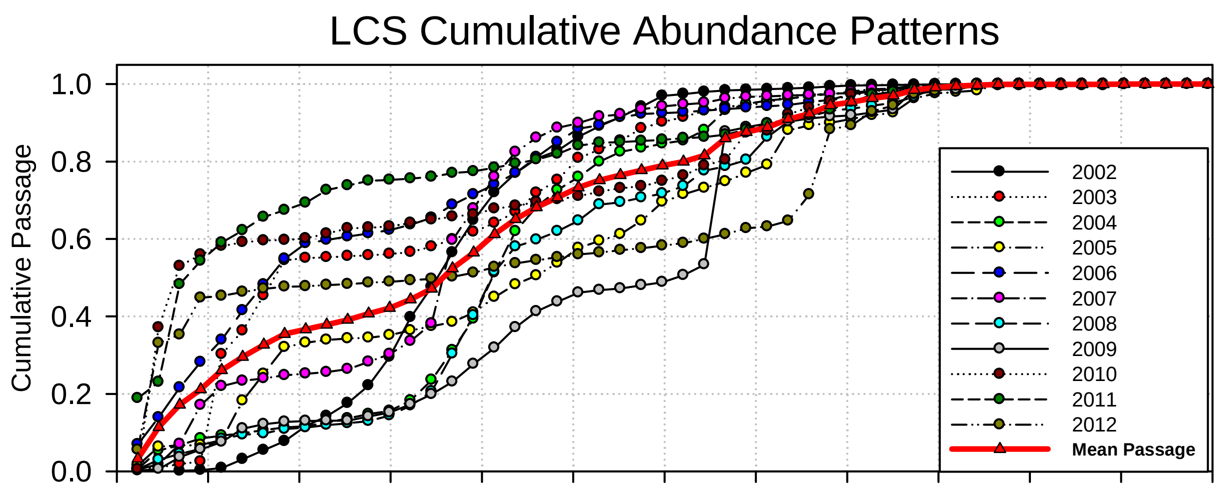
2009
2010
2011
2012
Mean Passage


LCS Cumulative Abundance Patterns
Cumulative Passage
1.0
0.8
0.6
0.4
0.2
0.0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Mean Passage

Winter-run Subteam Final Call: **12-19-13**

Participants: Bruce Oppenheim, NMFS, Kevin Reece,DWR, Jim Smith, USFWS, Edmund Yu, DWR, Pat Brandes, USFWS, Colin Purdy, CDFW, Jason Hassrick, NMFS

Agenda:

1) Determine recommendation for revising the winter-run survival term (survival to the Delta):

a) average of five years of acoustic data from late-fall run releases (44%)

b) 2013 acoustic data from winter-run release (16%)

c) average combination of late-fall and winter-run data (39%)

The Subteam decided against using (a) the average survival of late-fall run releases for the five year period (2007–2011), because late-fall run behave differently than winter-run and are released at a larger size (see arguments for and against using in 12/6/13 notes). Also, the late-fall releases did not come close to comparisons of estimated survival using abundance data at Chipps Is trawl (Pyper et al 2013). The Subteam was split on whether to recommend using (b) the 2013 winter-run survival estimate (15%) since it is only one year of data, or c) combining the 5 years (2007–2011) of late-fall run releases with the 1 year of winter-data. Combining the late-fall and winter-run data represents both wet and dry hydrologic conditions in the Sacramento River, but is skewed heavily towards use of a surrogate (late-fall) which behaves completely differently (*i.e*. spends less time in the upper river) and is twice as large at release (*i.e*., the larger the size at release the greater the survival rate). The Subteam agreed to recommend both (b) and (c) to the larger Winter-run Project Work Team, since they are both an improvement over the currently used indirect approach of estimating survival based on ocean recoveries of CWT late-fall run releases. See 12/6/13 notes, current method has sampling problems, is always 3 years behind, and uses a different species (late-fall) as a surrogate.

2) Determine recommendation for significant figures used in the survival term

The subteam agreed to recommend using two significant figures (hundredths) for rounding in survival estimates. Each year would be rounded to two figures before averaging years.

3) Determine recommendations for future modifications to the JPE (for example):

a) Update annually based on continuing with acoustic tagging of winter-run juveniles

b) Continue to combine data (Late-fall as surrogates + winter-run)

c) Average all years, or use representative water year types

The subteam agreed to recommend updating annually survival terms in the JPE based on continued winter-run acoustic tagging. If possible, allow tagging of natural winter-run in the future. As more data on winter-run survival becomes available apply survival terms to water year types. Although the JPE is calculated typically in December, before the water year is known, it may be helpful for adjusting the JPE later in the year. Since the most recent acoustic tag data allows survival estimates by reach, the group requested that NMFS define the reaches used for entrance into the Delta. As for the other survival terms used in the JPE, the Subteam agreed to keeping the fry-to-smolt survival at 59% since there was no new data, and increase the egg-to-fry survival from 25 to 27% based on the addition of two more years of data at Red Bluff (see 12/6/13 notes). In the future, consideration should be given to whether the 3 survival terms used in the JPE overlap and whether the fry-to-smolt survival (59%), which is based on fall-run data from the Tehama-Colusa spawning channel, could be eliminated.

Attachment 5

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch
830 "S" Street
Sacramento, CA 95811
(916) 327-8840
www.wildlife.ca.gov

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

MEMORANDUM

DATE: January 31, 2014

TO: Mr. Bruce Oppenheim, NMFS, Sacramento Office, and Chair of Winter-run Sub Team

FROM: Mr. Michael Lacy and Dr. Russell Bellmer, CDFW, Fisheries Branch, and Chairs of IEP Winter-run Satellite PWT

SUBJECT: Report titled, "Winter-run Sub team Summary" of the Winter-run Sub Team dated January 22, 2014 (Attached)

A Winter-run sub team was formed at the IEP Winter-run Satellite Project Work Team (WRPWT) meeting on 11/20/13 with the purpose of reviewing and revising survival terms used in the NMFS juvenile production estimate (JPE) in light of recent acoustic tag studies. The sub team met three (3) times to review the most recent data/information and current survival terms. After reviewing the current methodology which is based on the difference in survival rates between late-fall run Chinook coded wire tag (CWT) releases at Battle Creek and in the Delta, the sub team found that the current method has many sampling errors and likely over-estimates the number of natural origin winter-run Chinook entering the Delta. The sub team found that the use of acoustic tag data provided greater accuracy, had fewer sampling errors, and provided confidence intervals not available with the current JPE method; therefore it was considered to be the best available science. The use of acoustic data allowed comparisons of in-river reach survival between specific locations, which was not possible before. The sub team compared survival rates using acoustic tag data between Red Bluff Diversion Dam and Sacramento (Tower Bridge).

The sub team presented four (4) recommendations to the WRPWT:

1) Use of the 2013 winter-run acoustic tag survival (16%) in the JPE calculations
2) or combine the 5 year average of late-fall run (2007-2011) and 2013 winter-run acoustic data (39%) in the JPE calculations.
3) Apply 2 significant figures to survival terms; and
4) change egg-to-fry survival from 25% to 27% based on added 2 years of additional data

The WRPWT members reviewed all documents provided by the sub team and it was the consensus of the group that the sub team did an excellent review, sound analysis of available information, and excellent presentation of the pros and cons of the recommendations.

The WRPWT members agreed that using study fish from the specific population of management importance (i.e., winter-run Chinook salmon), rather than from a surrogate population (late-fall run Chinook salmon) provides direct information on the influence of unique behaviors and life histories of the winter-run population on survival instead of requiring additional inference regarding surrogacy. However, with very limited (one year) acoustic winter-run data, the WRPWT could also not find consensus supporting a recommendation that NMFS shift to this metric this year. None of the alternatives provided by the sub team was clearly best; each present with strengths and weaknesses of different kinds. Although the WRPWT could not come to consensus about the best alternative to use this year, we are very supportive of undertaking the necessary acoustic studies to allow for a future shift in the JPE to the direct measurement of reach specific survival rate using winter-run Chinook. We feel that the best approach for the long-term is to create a time series of direct annual survival estimates representing different water-year, flow, and outmigrant population size to determine the annual survival coefficients for the JPE.

As to the other three (3) recommendations from the sub team, the WRPWT did not reach consensus on the approach for this year.