State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

Chinook Salmon Populations for the Upper Sacramento River Basin In 2006

By
Douglas Killam
Northern California-North Coast Region
Sacramento River Salmon and Steelhead Assessment Project

SRSSAP Technical Report No. 07-2
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1/ This report is funded by the Federal Aid in Sport Fish Restoration Grant F-51-R-19 Project 60. Some activities described in this report were through a cooperative investigation with the U.S. Fish and Wildlife Service, Red Bluff Fish and Wildlife Office and were supported by various funding sources including a CALFED ERP Grant as part of a cooperative agreement with the California Department of Fish and Game pursuant to the California Bay-Delta Environmental Enhancement and Water Security Act (PL. 104-333).

Cover photo: Adult male accompanied by precocious male juvenile. Photo by author

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SUMMARY

Population sizes were estimated for Chinook salmon passing upstream of Princeton Ferry in the Upper Sacramento River Basin (Figure 1). Annual population estimates for the Basin are determined through a number of methodologies including: carcass surveys, hatchery counts, aerial and in-stream redd surveys, snorkel counts, angler interviews, video counts and ladder counts at hatcheries and the Red Bluff Diversion Dam (RBDD). This report does not include salmon information from tributaries that enter into the Sacramento River downstream of Princeton Ferry (Butte Creek, and the Feather and American River(s)) or from Big Chico Creek near Chico. These and other waterways are detailed in reports from other projects. A summary of the entire California Central Valley salmon stocks is available annually in reports titled "Annual Report: Chinook Salmon Spawning Stocks in California's Central Valley"

An estimated **207,733** Chinook salmon (salmon) were in the Upper Sacramento River Basin (USRB) upstream of Princeton Ferry in 2006. This includes an estimate of 18,023 late-fall-run, 17,304 winter-run, 3,822 spring-run, (SRCS) and 168,584 fall-run Chinook salmon, (FRCS) (Table 1). The majority of these salmon passed above RBDD (84%) to spawn in the tributaries or main-stem of the Sacramento River upstream of Red Bluff.

Readers interested in conducting further analysis of the data provided in this report should be aware that the summaries of data herein may be generalized to fit the limited scope of the report. For analytical data needs, readers should directly contact the author or other Project staff for specific requirements or limitations to the data. The author may be reached via e-mail at (dkillam@dfg.ca.gov).

This program received financial assistance through the **Federal Aid in Sport Fish Restoration Program**. The U.S. Department of the Interior prohibits discrimination on the basis of race, color, national origin, age, sex, or disability. If you believe you have been discriminated against in any program, activity, or facility, or if you desire further information, please write to:

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Arlington, CA 22203

INTRODUCTION

The Upper Sacramento River Basin (USRB) of California's Central Valley is unique in that it has four separate runs of Chinook salmon (*Oncorhynchus tshawytscha*) each year. Each run of Chinook salmon, hereafter referred to as salmon or run, (i.e. winter-run) has adopted a different life history (spawning locations, and seasonal timing) that allows it to survive the many different environmental conditions found over the course of a year in the USRB (the anadromous portions of the Sacramento River watershed upstream of Princeton CA) (Figure 1).

Management of salmon stocks for both sport and commercial fisheries was the primary purpose for monitoring salmon stocks in the USRB for earlier years. (Note: the USRB has no spawning populations of other Pacific salmon species (Chum, Coho, Sockeye, Pink) other than Chinook and steelhead (O. *mykiss*)). In recent years the focus of monitoring has been augmented to provide feedback for restoration activities (including protection of listed stocks) in the Central Valley as well as the traditional role of managing stocks for sport and commercial fisheries.

This report provides a summary of some the monitoring activities for salmon populations that occurred in 2006 in the USRB. Details of other monitoring efforts in the basin can be found in the reports and literature listed in the Reference section of this report. The data found here is a compilation of the many different sources and methodologies used to produce population estimates within the USRB. Annual reports providing data on the USRB salmon populations are available going back to the early 1950's. In these early years, data is often lacking for particular streams due to lack of funding and personnel. Fish ladders and hatchery counts were the primary methods of data collection until 1967.

From 1967 until 1986 the Red Bluff Diversion Dam (RBDD) provided a method of monitoring the four salmon runs as well as steelhead. During this period the RBDD was typically operated throughout the year allowing for complete accounting of escapement. Beginning in 1987, operation of the RBDD was restricted to facilitate improved passage of winter-run salmon which were at critically low and declining population levels and had been previously petitioned for listing (October 1985) under state and federal Endangered Species Act (ESA). From 1995 to present day, the RBDD has been operated from approximately 15 May through 15 September. The data produced at the RBDD has largely been replaced by carcass survey data but the RBDD is still utilized to provide some data for the USRB.

Carcass surveys using mark and recapture methodologies were re-initiated in 1996 on the main-stem Sacramento River above RBDD. The year-round main-stem carcass surveys now provide the only source of natural spawning late fall-run escapement in the USRB, as well as report the fall and winter-run escapements used by the Department of Fish and Game (Department) as official estimates.

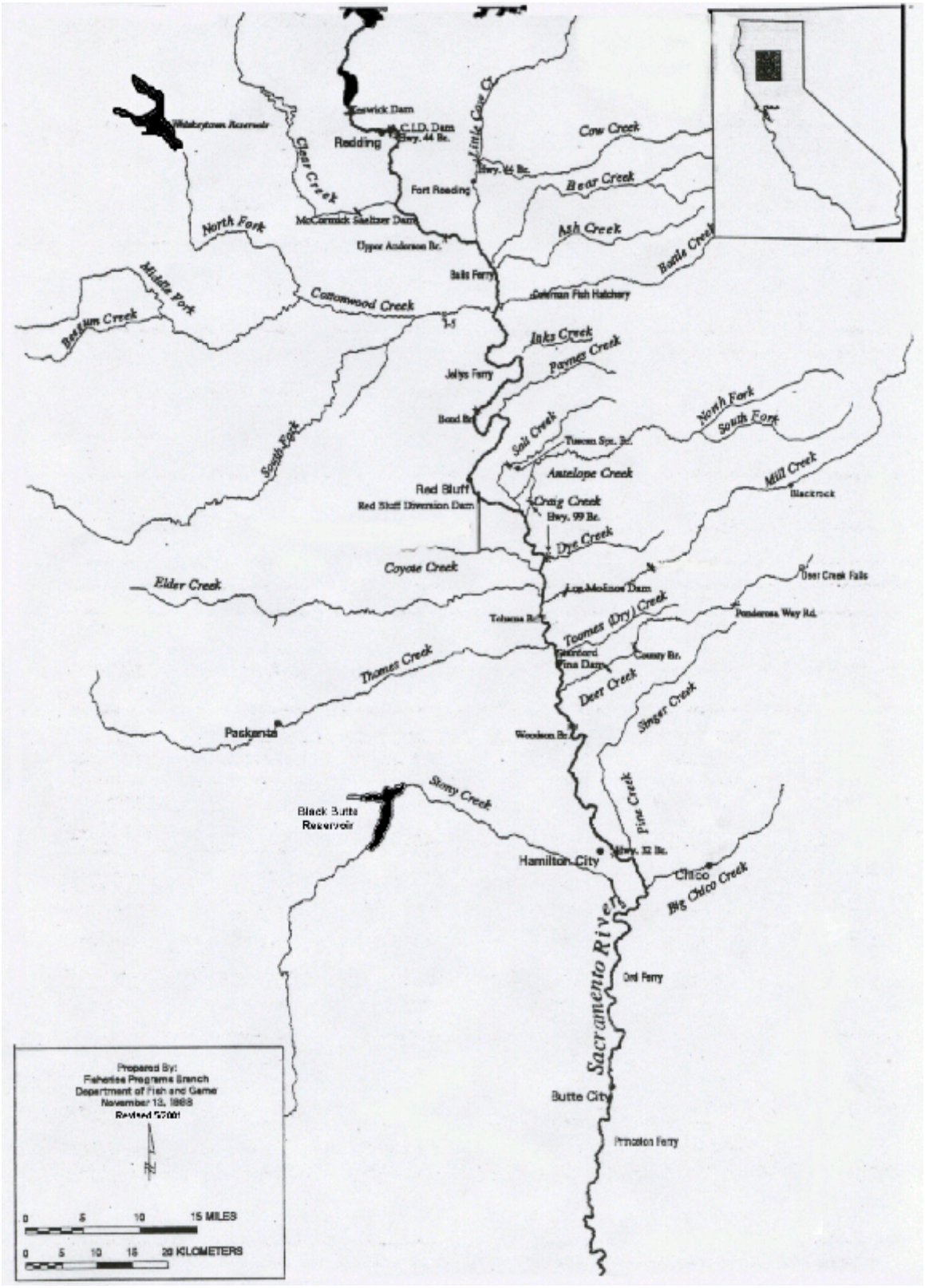

Figure 1. The Upper Sacramento River Basin (from Keswick Dam to Princeton Ferry).

Table 1. Summary of Chinook salmon population estimates in 2006 for the USRB, (Sacramento River and tributaries from Keswick Dam downstream to Princeton Ferry).

LOCATION	Late-Fall-Run	Winter-run*	Spring-Run	Fall-Run
Red Bluff up to Keswick Dam				
Sacramento River Main-Stem	7,684	17,157	0	46,568
Livingston Stone Hatchery	0	93		
Battle Creek Coleman Hatchery	5,111	5		58,017
Battle Creek Above hatchery	n/a^	1	154	n/a
Battle Creek Below Hatchery	n/a			19,493
Clear Creek	n/a		77	8,422
Cow Creek	n/a			4,130
Cottonwood Creek	n/a		55	n/a
Angler Harvest (avg-1998-2002) vs run size	1,373	0	0	7,128
SUB-TOTAL UPSTREAM OF RBDD	***14,168***	***17,256***	***286***	***143,758***
Red Bluff down to Princeton				
Sacramento River Main-Stem	2,487	48	0	8,900
Mill Creek	n/a		1,002	1,403
Deer Creek	n/a		2,432	1,905
Antelope Creek	n/a		102	n/a
Angler Harvest (avg-1998-2002) vs run size	1,368	0	0	12,618
SUB-TOTAL DOWNSTREAM OF RBDD	***3,855***	***48***	***3,536***	***24,826***
SYSTEM GRAND TOTAL	**18,023**	**17,304**	**3,822**	**168,584**
(Keswick Dam to Princeton)$				
2006 TOTAL SALMON ALL RUNS COMBINED:			**207,733**	

NOTE: These values represent minimum numbers, unsurveyed waters have additional smaller salmon populations
* Carcass survey results vs RBDD of 7,415.
^ n/a: Is not available, represents salmon present but no estimate available.
$ Numerous tributaries not surveyed, Big Chico creek survey results are available from other DFG project

The CALFED-funded Sacramento River Winter-run Chinook carcass survey has provided the official escapement estimate for this federally and state-listed endangered species since 2001 (Killam, 06-4, 2006). This species currently spawns only in the main-stem Sacramento River and is the focus of many restoration activities throughout the Central Valley. The winter-run estimate forms the scientific basis for establishing allowable juvenile winter-run "take" limits at the pumping facilities in the Delta.

Fall-run salmon inventories have been routinely conducted since 1953 on USRB tributary streams. Prior to 1988, Peterson mark/recapture methodologies, ladder counts and aerial redd surveys were used with varying sampling intensity and reliability of estimates. Since 1988, mark/recapture surveys have been standardized into weekly surveys for the duration of the spawning run on each tributary. The mark/recapture estimator used on each creek (seasonal Peterson, Schaefer or Jolly-Seber), is based on the total carcasses encountered and weekly percent recovery of tags. In Battle Creek and Cow Creek (first year) video counting stations were operated to obtain fall-run escapement estimates.

Spring-run salmon inventories have been sporadically conducted since the 1940's on USRB tributary streams. Methodologies from the 1940's through the 1980's were

incomplete, inconsistent and not reproducible at best. In many years surveys were not conducted. Spawning escapement estimates were derived from incomplete spawning ground surveys, carcass surveys with unknown expansion factors, and partial ladder and weir counts. Since the early 1990's, in a effort to standardize sampling efforts and develop an annual index of abundance, a single escapement estimator has been selected for each spring run tributary, recognizing the sampling limitations in each watershed. Unlike fall-run carcasses surveys, too few spring run carcasses are encountered to obtain a percent recovery for a tag/recapture escapement estimator. In Deer, Antelope and Beegum Creek(s) a snorkel survey of the known holding habitat is conducted to obtain an annual count of holding salmon. In Mill Creek water clarity prohibits reliable underwater observation, consequently an annual redd survey is conducted and expanded into a population estimate.

Details of specific fall and spring run surveys conducted for Clear, Antelope, Mill and Deer Creeks are available in a separate report for the 2006 year, (Harvey Arrison-2007). In past SSRAP annual reports these creeks were included within a single report, however this year it was decided to split the reports by individual project biologists/authors to allow greater detail in reporting than previously possible. This report contains limited summary information on these creeks.

Late-fall-run salmon carcass surveys are difficult to conduct on USBR tributaries due to high flow conditions, making consistent weekly mark-recapture surveys not practical. Late-fall-run salmon are known to spawn in most fall-run tributaries and opportunities for alternative monitoring opportunities exist but at present only Clear Creek (United States Fish and Wildlife Service-USFWS-carcass count) and Battle Creek (hatchery count-USFWS) provide salmon data (counts). The late-fall-run escapement on the Sacramento River is monitored through a boat mark-recapture carcass survey and aerial redd counts.

METHODS and RESULTS

Since 1969 the RBDD estimates were used to generate estimates for all runs of salmonids in the Sacramento River (steelhead, four runs of Chinook salmon). In 2006 only the RBDD data from spring-run salmon were used to provide an estimate. To provide continued RBDD data trends, estimates using the RBDD data are still generated but the Department has used carcass surveying as the means for generating official estimates since 2001.

Carcass Mark and Recapture Surveys:

Carcass mark and recapture surveys (carcass surveys) have been used by the Department for many years to estimate salmon populations on rivers throughout the state. Since all Chinook salmon die after spawning a population can be counted by estimating how many carcasses were present each year. Because of the current "gates out" schedule at the RBDD (September- May) the carcass surveys have been chosen as the "official" alternative to the RBDD count for the Upper Sacramento River main-stem. Carcass

surveys are conducted by boat or walking on foot along a river or stream examining carcasses. Carcasses are tagged with a colored plastic or some other type tag to enable personnel to recognize them on subsequent surveys. Carcasses that were tagged in previous periods and recaptured in new periods form the basic proportion of "carcasses tagged" to "carcasses recaptured" that create a population estimate. Data is often collected on sex, length, hatchery origin salmon (see Appendix B), location, and other categories of interest. There are different methods or population models employed to create an estimate.

The Population models were created for live populations of organisms and each model has a list of sampling assumptions that must be met in order for the model to reflect an accurate portrayal of the population size. The three models used by the Department in the USRB are the Peterson, the Schaefer, and the Jolly-Seber. Each has been modified from the original intent of studying live organisms and applied to carcasses. Carcass surveys do not meet the underlying assumptions of any single model so it is often left up to the biologist analyzing the data as to which model best fits the data for a particular survey.

Each model has numerous advantages and disadvantages. The Peterson model is the simplest and is useful in developing an estimate when disruptions to the sampling schedule occur. The Peterson takes the entire schedule and treats it as two periods, a tagging period and a recapture period. This is the least "accurate" model but is in some surveys the only one that can be used due to low numbers of recaptures, or floods, etc. The Schaefer and the Jolly-Seber models are more complicated and depend on repetitive survey periods and recaptured carcasses throughout the survey. Of the two the Jolly-Seber is the more complicated to analyze but recent software programs have been developed to allow simpler calculation of this method. The Jolly-Seber differs from the Schaefer in that it attempts to account for survival of carcasses between survey periods. Historically, the Schaefer is utilized for the fall-run on tributaries on Battle and Clear Creeks. In 2001 the Jolly-Seber method was chosen as the method to be utilized whenever possible for the main-stem Sacramento River (winter, fall, and late-fall runs).

Red Bluff Diversion Dam (RBDD):

Estimates from the RBDD during 2006 were based on daily ladder counts made by the USFWS-Red Bluff Fish and Wildlife Office and by the fish-trap sampling conducted by the Department at the dam (late-fall-run excluded). Ladder counts were obtained through closed-circuit television monitoring of salmon passing through the RBDD fish ladders.

Total counts of salmon passing each week were adjusted for those periods when the fish ladders remained open but no counts were possible, such as when river turbidity was high, during flood conditions when the dam gates were temporarily opened, and when no observations were made at night. Adjustments to lapses in daytime counts were made by interpolation. Night passage numbers were calculated by multiplying the 14-hour day ladder count by a "night-factor" which was generated from a twice-a-week night count. The adjusted weekly number of fish was apportioned among the winter-, spring-, and

fall-runs based on their relative proportions seen that week in random samples of salmon taken from the dam's east-bank trapping facility. At the trap each salmon observed was assigned to a run based on phenotypical characteristics including: color, scale condition, and relative degree of sexual maturation (an indication of when it was believed that it would spawn).

Estimated numbers of salmon for those periods when the fish ladders were not operated (September-May) were calculated based on historical data. This historical data is presented as weekly averages for each run's migration past RBDD, and is provided in Appendix Table A1. The values presented in Appendix Table A1 are based on years when the RBDD gates were down throughout the year and the trap and fish ladders were operated continuously. Concern for declining populations of winter-run salmon resulted in the gates being raised for portions of each year. The data that was used to develop historic run timing is different for winter-run than the other runs. Spring-, late-fall- and fall-run weekly migration patterns are based on data from 1970 to 1988 (1986 for late-fall). For the winter-run, 1982-1986 was chosen to be the historical average framework due to the reduced numbers of winter-run seen at RBDD during these years as more closely mirroring the current winter-run populations.

The majority (average approx. 85%, 76%) of winter and fall-run migration occurs outside the season of the RBDD operation. The accuracy of spawner estimates based on the RBDD fish ladder counts are, therefore, highly suspect, and often result in estimates of negative numbers of fall-run salmon in the main-stem Sacramento River after known tributary estimates are subtracted from the RBDD estimate.

The total for the 2006 salmon population estimates passing RBDD was calculated as follows:

1) For each Julian week, (Sunday-Saturday), determine estimate of actual salmon counted for period when gates were down (actual fish seen passing ladders + night and other adjustments = Estimate). (Other adjustments may include missing day counts, ad-clipped fish, and individual ladder closures.)
2) Determine from the RBDD trap data the percent of that week's passage to be assigned to a particular run (i.e., 75% winter-, 15% spring-, and 10% fall-run).
3) Determine the total number of salmon for each run during each week that actual counts were made. (Example: estimate multiplied by percentage in #2 for each run.)
4) Sum all of the weekly numbers of salmon counted for each run when counts were made and sum all of the corresponding percentages for those same weeks in Appendix Table A1. This provides the starting point to back calculate for period when the gates were up.
5) Calculate a total estimate for each run for the entire year using the proportion determined in step 4. (Example: winter-run 2006 total fish counted = 1,144, sum of historical percent during weeks of actual counts =

15.42%, thus total winter-run estimate is 1,144 * 100% /15.42% = 7,415 fish).

6) The RBDD data for 2006 is presented in Appendix Table A2. If desired, any week or months passage may be estimated by determining total historical passage for that period multiplied by the total in #5 for a given run of salmonids.

7) It is important to note that data from the RBDD does not account for downstream populations. These are determined through aerial redd counts.

The data collected at the RBDD does not determine distribution and numbers into the tributaries and main-stem upstream of RBDD. Instead, the Department (with seasonal assistance from the USFWS) now conducts combinations of mark and recapture carcass surveys, aerial and in-stream redd surveys, hatchery counts, angler harvest surveys, video counts, weir counts, and snorkel surveys of the main-stem Sacramento River and the major salmon tributaries to determine adult salmon escapements for specific runs and streams.

Sacramento River Main-Stem Aerial Flight Redd Distribution:

In 2006, a Department airplane was used to conduct monthly surveys for the late-fall, spring and fall-run redd distributions. During the winter-run migration period a number of helicopter surveys were conducted to enable detailed inspection of winter-run spawning areas.

Aerial redd maps are created (digital versions available) to document the location of spawning distributions in the main-stem and are used to supplement other counting methods to determine the overall population estimate for each run of salmon. Table 2 presents the data from the aerial redd surveys conducted by the Department. These surveys provide a historical database on redd distribution in the main-stem Sacramento River from Princeton (river mile (RM) 164) to Keswick Dam (RM 302) (1969-2006), Appendix Table A3. The surveys are also used to estimate spawning escapement in the main-stem downstream of RBDD or the carcass survey areas. Aerial flights are used to determine estimates downstream of carcass surveys or the RBDD for salmon spawning in the main-stem. A simple proportion is used to calculate this estimate. The proportion is constructed as follows: Number of salmon downstream = (salmon upstream after harvest in main-stem / redds upstream) * redds downstream.

The Department conducted 15 aerial redd flights for the 2006 escapement surveys. **Two late-fall**-run surveys were conducted between 15 December 2005 and 24 February. A fourth late-fall flight was conducted on 20 December but those results are associated with the 2007 late-fall estimate. The majority of late-fall-run redds were from the Anderson Cottonwood Irrigation District Dam (ACID) upstream to Keswick Dam (35%). **Seven winter-run** flights using a helicopter from 1 June through 18 July were flown. Winter-run redds were observed from Keswick Dam to just downstream of Red Bluff Diversion Dam (RM 243). The majority of these redds (84%) were located between Keswick Dam

and the Highway 44 Bridge in Redding. **Two spring-run** flights were conducted on 5 September and 14 September. A total of 31 redds were observed from Keswick Dam to just below the RBDD**. Four fall-run** flights between 6 October and 30 November reported fall-run redds from the Ord Ferry Bridge upstream to Keswick Dam. The fall-run redds were fairly evenly distributed from Keswick Dam downstream to the Tehama Bridge below the RBDD.

In summary, during 2006 there were 3,280 new redds observed in the main-stem from Keswick Dam to Princeton Ferry (RM 164) over a total of 15 flights. The majority of these redds (86.5%) were upstream of Red Bluff Diversion Dam. Appendix Table A3 presents a summary of historical aerial redd information for years 1969-2006.

Table 2. Summary of redd data collected from aerial flights for year 2006.

2006 Summary of Aerial Redd Survey Data**										
Winter	% Dist.	Spring	% Dist.	Fall	% Dist	Late-Fall~	% Dist	ALL	% Dist.	RIVER SECTIONS
250	35%	0	0%	302	14%	146	35%	698	21%	Keswick to A.C.I.D. Dam.
350	49%	18	58%	133	6%	5	1%	506	15%	A.C.I.D. Dam to Highway 44 Bridge
115	16%	8	26%	215	10%	6	1%	344	10%	Highway 44 Br. to Airport Rd. Br.
0	0%	1	3%	331	16%	88	21%	420	13%	Airport Rd. Br. to Balls Ferry Br.
0	0%	0	0%	226	11%	44	11%	270	8%	Balls Ferry Br. to Battle Creek.
0	0%	1	3%	233	11%	13	3%	247	8%	Battle Creek to Jellys Ferry Br.
0	0%	3	10%	178	8%	5	1%	186	6%	Jellys Ferry Br. to Bend Bridge
0	0%	0	0%	161	8%	5	1%	166	5%	Bend Bridge to Red Bluff Diversion Dam
2	0%	0	0%	269	13%	53	13%	324	10%	Red Bluff Diversion Dam to Tehama Br.
0	0%	0	0%	27	1%	15	4%	42	1%	Tehama Br. To Woodson Bridge
0	0%	0	0%	23	1%	15	4%	38	1%	Woodson Bridge to Hamilton City Br.
0	0%	0	0%	21	1%	18	4%	39	1%	Hamilton City Bridge to Ord Ferry Br.
0	0%	0	0%	0	0%	0	0%	0	0%	Ord Ferry Br. To Princeton Ferry.
717	**100%**	**31**	**100%**	**2,119**	**100%**	**413**	**100%**	**3,280**	**100%**	

**** Summary of 7 winter-run, 2 spring-run, 4 fall-run and 2 late-fall run flights**
~ Late-fall run redd counts do not include survey on 20-Dec-2006

The 2006 Salmon Runs in the Upper Sacramento River Basin

Late-fall-run No estimates were made for the late-fall-run at the RBDD. Although some late-fall salmon use tributaries to the upper Sacramento River (e.g., Clear, Cow and Battle creeks) no spawner population estimates were made in those streams for late-fall salmon. The USFWS conducted a survey to tally carcasses, live fish and redds on Clear Creek late-fall-run salmon, but no population estimate was generated. Of special note on late-fall salmon is that they spawn over the calendar year change. For the purposes of reporting late-fall numbers it is customary to report estimates based on when the juveniles emerge. Late-fall salmon spawning in November and December are classified as belonging to the following year, (i.e., December of 2005 spawners are put into 2006 estimate and December of 2006 spawners will be part of the 2007 estimate).

A main-stem carcass survey was conducted from 20 December 2005 through 3 May 2006. These surveys covered a 13.2 mile (21 km) section of the Sacramento River between Keswick Dam, (RM 302), and the power lines just downstream of the mouth of Clear Creek (RM 288.8). In the winter and spring of 2006 the USRB had large amounts of rainfall (40% greater than normal). The rain resulted in large water releases from Shasta and Keswick Dams during the late-fall-run carcass survey. Flows ranged from 5

to 50 thousand cfs with spikes in early January, early February, early March and most of April. Although no survey periods were skipped, the high flows reduced the ability of crews to observe fish from early January on. As a result the estimate for the 2006 late fall-run was calculated through a combination of data from the 2005 late-fall estimate and population data from late December 2005 when flows were low enough to observe large numbers of carcasses. The mark recapture estimate of spawning adult females in 2005 was used in combination with the population characteristic data collected in 2006 to generate an estimate of **10,171** late-fall-run spawners in the mainstem Sacramento River in 2006.

Appendix Table A4 provides a data summary on the 2006 late-fall-run mainstem population. Crews observed a total of 869 carcasses. Crews tagged 402 of these and recaptured 41 for a recapture rate of 10.2% which is very low for a mainstem carcass survey. Crews measured 191 fresh fish and a grilse (2 year old) percentage of 1.0% was estimated based on a length cut-off of 610 millimeters. Males represented 43.5% of the population. Females were checked for egg retention following spawning. Only 7 of 127 fresh females (5.5%) had not completely spawned. All fish examined were checked for adipose fin clips representing hatchery origin from the Coleman National Fish Hatchery (CNFH) on Battle Creek. Eight salmon of a total 197 examined had an adipose (or unknown adipose) fin clip in 2006. Coded wire tags (CWT) were recovered from 5 of these and represented late-fall, fall (n = 3) and winter-run salmon (n = 2) from CNFH and Livingston Stone National Fish Hatcheries (LSNFH) (Appendix table B4).

The late-fall-run are subject to sport fishing in the main-stem river below Deschutes Road Bridge (RM 280.9) The Department's Angler Harvest Survey was discontinued in July of 2003 so an average estimated harvest of late-fall salmon above Knights Landing in late 2005 and early 2006 was calculated to be **2,741** fish, (1,373 upstream RBDD). This estimate includes half of November's 2005 harvest (other half is considered fall-run) and all of December 2005 and of January 2006 and is developed by using the historical Angler Survey data. This total is not indexed to the spawning escapement size due to lack of data and would not include those late-fall fish harvested in November-December of 2006 as those fish are classified as year 2007 fish for the purposes of this report.

The CNFH spawned and excessed late-fall salmon from December 2005 through March 2006. The hatchery total was **5,111** late-falls spawned and excessed, (includes 4 fish removed at Keswick trap), (Robert Null, USFWS, personal communication).

Based on the carcass survey, angler survey, CNFH, and aerial redd data it is estimated that **at least 18,023 late-fall-run** salmon were present above Knights Landing in late 2005 and early 2006 (Table 1). This estimate does not include other in-stream tributary estimates that were not conducted due to limited staffing and typically poor weather and turbidity conditions during late autumn and winter.

Winter-run

Carcass Survey: Since 1996 an annual report dedicated to the winter-run mainstem Sacramento River carcass survey was produced in addition to this report. Beginning in

2006, the results of the winter-run carcass survey will be integrated into this report and a separate report will no longer be developed.

The mark-and-recapture carcass survey for winter-run salmon was conducted on the Upper Sacramento River from 1 May through 25 August 2006 (Appendix Table A5). Based on a sample size of 2,939 tagged adult female carcasses and the subsequent recapture of 1,630 (recovery rate of 55.5%) of these carcasses, a population estimate of **17,298** winter-run salmon was obtained using the Jolly-Seber model. The carcass survey results were based upon large (>609 mm) female carcasses. The total number of spawning females in the mainstem Sacramento River was (including the females retained at Livingston Stone National Fish Hatchery (n = 53) and the mainstem grilse (n = 51) and) was 8,915.

For the 2006 winter-run carcass survey the addition of data from skeletons observed on the survey was refined to better develop the mark-recapture estimate. Previous to this survey all skeletons observed were assumed to be natural origin fish, (a carcass "skeleton" does not have flesh on it to allow adipose fin identification). In this survey, (and subsequent surveys, i.e. fall-run-2006, late-fall-run-2007, etc.) the numbers of skeletons observed on the carcass surveys was determined to be natural or hatchery origin based on the ratios of these categories found in the fresh fish sample. Overall, this produces a slight lowering of the number of chopped mark-recapture fish and a subsequent small reduction in the population estimate compared to previous methods used for skeletons.

Run size estimates at the RBDD have been made since 1967. The National Marine Fisheries Service (NMFS, 1996) developed draft winter-run population recovery goals of 10,000 spawning females over 13 consecutive years. This recovery goal was set using the RBDD winter-run population estimates. *Beginning in 2001, the Department has chosen for regulatory purposes that the population estimates from the carcass survey will be used in reporting the winter-run salmon estimate.* Data are still presented for the RBDD to continue trend data that has been available over the past 34 years.

Red Bluff Diversion Dam: The RBDD estimate for the 2006 winter-run was **7,436**. This included and estimated 6,952 natural-origin salmon (all hatchery winter-run have adipose fin-clipped off) and 484 hatchery-origin winter-run. Winter-run fish migrate past RBDD from December through August. Winter-run passing RBDD in December of 2005 were part of the 2006 estimate based on traditional run timing (Appendix Table A1). Most of these fish were thought to have spawned in the main-stem of the Sacramento River above Red Bluff. The Livingston Stone National Fish Hatchery (LSNFH) collected **93** winter-run for the LSNFH brood stock program).

Other Winter-run Data: Seven helicopter surveys were conducted to determine winter-run spawning distributions in the main-stem Sacramento River from Woodson Bridge (RM 218) to Keswick Dam (RM 302). This data is presented in Table 2. The proportion of redds above and below RBDD and the total estimate of winter-run passing RBDD are used to calculate the winter-run estimate for downstream of RBDD. In 2006, two winter-

run redds were observed downstream of RBDD during aerial flights. Therefore, the winter-run population estimate downstream of RBDD is 20 using the RBDD estimate and 48 (Table 1) winter-run using the "official" carcass survey methods.

There was no estimated angler harvest of winter-run above or below RBDD due to a zero salmon possession limit from 15 January through 16 July 2005 although some angling activities in late December and January in Delta probably catch winter-run. Also poaching and possibly hooking mortality associated with trout angling probably occurs.

In 2006 during the USFWS monitoring of the CNFH Barrier Weir reported the capture of 5 hatchery origin winter-run salmon based on coded-wire-tag codes. The Barrier Weir fish ladder in Battle Creek at the CNFH is monitored each spring from March through August to count the number of natural and hatchery origin fish migrating upstream in the Battle Creek fish ladder. During the periods when average water temperatures are under 60 degrees Fahrenheit in the fish ladder, hatchery origin (adipose fin clipped) salmon are trapped and sacrificed for CWT analysis. Typically most (to all) of the hatchery origin fish are late-fall-run fish returning to the CNFH. The 5 hatchery origin winter-run were the first reported winter-run salmon in Battle Creek since winter-run salmon hatchery operations were moved to the mainstem at the LSNFH (1998). Natural origin salmon are allowed to pass upstream of the fish ladder. Genetic tissue sample analysis on these natural-origin salmon passing upstream reported that only **one** of the 138 tested was a winter-run, (USFWS: Kevin Niemela personal communication).

In summary, the "official" carcass survey reported 17,298 winter-run salmon while an additional 6 winter-run were estimated to have entered into Battle Creek, for a total of **17,304** (Table 1). The "historical" RBDD winter-run estimate was 7,436 winter-run salmon in the Sacramento River in 2006, (this includes the Battle Creek fish).

Spring-run Spawning of natural spring-run in the Upper Sacramento River is considered by the Department to have largely been eliminated through competition plus hybridization with fall-run salmon (Department, 1998). Historically spring-run salmon migrated upstream in the late spring or early summer and held over the summer in higher elevations with cooler water temperatures. These fish were then spatially separated from the later arriving fall-run by low flows and warmer temperatures in the lower sections of the waterways. Presently, dams on the Sacramento River, Clear, and Battle creek(s) prevent the spring-run from being spatially isolated from the fall-run. Since fall and spring-run salmon are spawning around the same time each year (late September-October) in the same stream section they may encounter each other during spawning and not be genetically isolated.

Attempts to prevent this spatial overlap of spawning areas for fall and spring runs through the use of a temporary picket weir occurred on Clear Creek in 2006 and previous years (USFWS: Jim Early personal comm.). In addition the possibility of utilizing the ACID dam on the mainstem Sacramento River to create a spring-run "sanctuary" has recently been discussed. The Department does not support this idea as the overlap between the winter, spring and fall runs in this river section during the summer months and the current

lack of a reliable means of genetically identifying spring-run from fall-run likely would prevent success of isolating spring-run above ACID. Currently the Department cannot make reliable carcass survey estimates of spring-run upstream of RBDD in the main-stem river because of this overlap between the two runs and the lack of a suitable means of distinguishing them.

The difficulties in determining a spring-run estimate on the river include the spring/fall-run mixing and also the occurrence of spring-run from the Feather River Hatchery which commonly stray into the USRB. Using the data from the traditional methodology indicates a mainstem estimate of zero, (Table 1). There is considerable uncertainty and disagreements amongst biologists as to the exact nature of the spring-run population in the main-stem Sacramento River. Until further research is conducted this uncertainty will continue.

Similar to winter-run fish, in-river angler harvest of spring-run is considered to be zero due to fishing closures during migration periods and in primary spawning areas, although some poaching and hook mortality associated with trout angling probably occurs.

An estimated 198 salmon showing spring-run characteristics passed RBDD in 2006 (Appendix Table A2). This number is less than the 286 spring-run cumulatively counted in Beegum Creek (55) (author), and in Clear Creek (77) and Battle Creek (154) (Jess Newton, USFWS, pers. comm.). Of these fish, only the Beegum Creek salmon were spatially isolated from the fall-run by natural means. A picket weir on Clear Creek was again set-up to isolate the spring-run in the upper reaches of Clear Creek.

Two spring-run flights were conducted in September and 31 redds were observed. None of these were downstream of RBDD before the gates were raised in mid September. Historically the flights in early September were titled “Spring-run” although it is likely that they are from a mix of fall and spring-run salmon as previously mentioned.

In summary, the above RBDD estimate is **286** spring-run salmon. Data for below RBDD includes the tributaries (see below): Antelope (102), Mill (1,002) and Deer Creek(s) (2,432) (Harvey-Arrison) for a downstream (RBDD to Princeton) spring-run total of 3,536. The total 2006 escapement to the Upper Sacramento River Basin was at least **3,822** (Table 1). Note that Butte (4,579) and Big Chico Creek(s) (299) spring-run results are presented in a separate report (Tracy McReynolds, Department, personal communication).

Fall-run

Carcass Survey: A fall-run carcass survey was conducted to estimate the fall-run spawner population on the main-stem Sacramento River. An estimated **55,468** salmon spawned in the river from Princeton to Keswick Dam based upon expansion of the fall-run carcass survey data, (Appendix Table A6). The carcass survey was conducted from the Clear Creek Power lines (RM 288.8) upstream to the Keswick Dam in Redding (RM 302) The Jolly-Seber method was used to calculate an estimate of 8,920 natural adult females for this section. This number is expanded to account for redds located outside of

the carcass survey reach. Based on aerial redd flight data showing that 69.4% of the main-stem redds were downstream of the carcass area and further expansions for hatchery fish, grilse, and adult males a final estimate of 55,468 for the entire main-stem was developed.

Red Bluff Diversion Dam: An estimated 42,466 fall-run salmon passed the RBDD in 2006 (Appendix Table A2). A recurring problem was encountered with the RBDD fall-run estimate in 2006. Results of the hatchery counts for just Battle Creek alone were larger than the total RBDD estimate. For the sixth consecutive year the RBDD estimate resulted in a negative number for the main-stem Sacramento River. The main-stem fall-run RBDD estimate is calculated by using the RBDD total and subtracting the tributaries, harvest, and hatchery estimates (pre carcass survey-1967-2001). The remaining fish were then "assigned" to the main-stem and unsurveyed tributaries.

It is not known why this large underestimation has occurred for the past six years. A number of possibilities exist including:
1. The fall-run was late arriving to RBDD in 2006.
2. With the temperature control device on Shasta Dam the river water during summer months (when fall-run begin upstream migration) is now colder to ensure winter-run spawning success. The colder water temperature in the river may be allowing fall-run fish arriving in the summer to hold further downstream (beneath RBDD) than was possible before the temperature control began (1998). This may result in reduced fall-run passage at RBDD during the "gates-in" period of 15 May through 15 September thus impacting the ability to use historical patterns to describe current populations. As a result of these and/or other possibilities it is unlikely that the fall-run data from the RBDD has much value in producing a population estimate.

No estimate of angler harvest was made in 2006 due to the lack of funding for the Department's Angler Harvest Project as a result of the State's fiscal crisis. Instead an average harvest percentage for the years 1998-2002 (11.7% of the entire run) was applied to the carcass survey estimate, resulting in an estimated 19,746 salmon being taken by anglers, (7,128 above RBDD and 12,618 from RBDD downstream to the Feather River).

An estimated 77,510 salmon entered Battle (19,493 in stream and 58,017 CNFH) and Clear creeks (8,422). For the first time since 1984 a fall-run estimate was made for Cow Creek (4,130) using the video station technology that has been used on Battle Creek since 2003. The overall fall-run estimate upstream of RBDD was 143,758 (Table 1) but this number did not include salmon that used other tributaries to the upper main-stem that were not surveyed (Cottonwood, Paynes, Inks, Bear, and Ash Creek(s) etc.). These systems were traditionally accounted for in the RBDD estimate but this was not the case in 2006 since the main-stem carcass survey is used. Additionally an estimate of 3,308 was made for fall-run escapement to Mill Creek (1,403) and Deer Creek (1,905), (Harvey-Arrison).

In summary, total fall-run escapement to the Upper Sacramento River Basin above Princeton is estimated to be at least 168,584 salmon plus an additional number of salmon in unsurveyed areas (Table 1).

Appendix Table A7 contains a summary of historical run information from all runs from 1986 to present. Readers should use caution in interpreting these data to meet specific needs. There are numerous categories (total populations, spawner populations, etc) to these data and readers should contact the authors of this report and other reports directly to ensure that the data required is available. For this report the data is available electronically and can be sent directly to interested readers with appropriate categories and data limitations explained.

Sacramento River Tributary Specific Estimates

Clear Creek

Late-Fall-run No escapement estimates were conducted for this run in 2006.

Spring-run The U.S. Fish and Wildlife Service (USFWS), Northern Central Valley Fisheries Resource Office (NCVFRO) conducts snorkel surveys in August as an annual index of spring-run Chinook salmon (SRCS) abundance. Seventy seven (**77**) spring-run were counted in August 2006. A temporary picket weir was installed to spatially separate spring-run from fall-run spawners.

Fall-run Ten weekly fall-run spawner surveys of lower Clear Creek were made during 2006 in the 6.7 km (4.2 mi) reach downstream of the former McCormick-Saeltzer Dam site. An estimated population of **8,422** fall-run salmon resulted. (Harvey-Arrison).

Nine coded-wire-tags (CWT's) were recovered in Clear Creek. Of these, only two tags were found one of which was from the Feather River Hatchery and the other was from the Merced River Fish Facility (Appendix Table B4).

Cow Creek

Late-Fall run No surveys for this run in this tributary were made in 2006.

Fall run A video monitoring station located in lower Cow creek reported **4,130** fall-run salmon. The station was set-up less than a mile from the mouth the creek. Specific details of the station and data are available in a separate report, (Killam, 07-1, 2007). The station recorded fish passage 24/7 using an overhead camera from 11 September to 17 November 2006. This was the first time since 1984 that an estimate was available for Cow Creek.

Cottonwood Creek

Late-fall run No surveys for this run in this tributary were made in 2006.

Spring run **Fifty-five** spring-run Chinook were estimated in Beegum Creek a tributary to the Middle Fork of Cottonwood Creek in 2006. Water temperatures during the holding period in Beegum Creek were very hot this year. Average weekly water temperatures in the spatial range of spring-run holding habitat reached 67-71 (upstream to downstream) degrees Fahrenheit (19.4-21.7 Celsius) in late July (Julian week 30). Concern for the reproductive viability of the salmon holding in these high temperatures was alleviated during snorkel surveys in the spring of 2007 when plentiful schools of young of the year juveniles were observed in Beegum Creek.

Fall run No escapement estimates were made for Cottonwood Creek 2006 fall-run. A kayak survey from the Interstate Five Bridge to the mouth reported the presence of 75 redds and 125 live salmon. This confirms the use of Cottonwood Creek by fall-run but this number should not be used as an estimate but rather a footnote on the presence of fall-run in the creek. A video station similar to Battle and Cow creeks is planned in 2007.

Battle Creek

Late-fall run No in-river surveys were made for naturally spawning late-fall-run in Battle Creek in 2006. The CNFH reported that 5,111 fish entered the facility.

Spring run The USFWS NCVFRO in Red Bluff monitors fish passage in Battle Creek using the CNFH barrier weir. The salmon passing the weir are sampled for genetic analysis and the test results are not final at this time. An estimated 154 Spring-run were counted in Battle Creek in 2006. (USFWS: Jess Newton, personal com.).

Fall run The traditional fall-run carcass survey that has been previously used on Battle Creek was not conducted this year. Instead the data from the Battle Creek Video Station was used to estimate the in-creek population. An estimated **77,510** fall-run were recorded in Battle Creek in 2006 by the video station. The CNFH reported that **58,017** (Table 1) of these entered into the hatchery leaving a remainder of **19,493** estimated for the in-creek spawning population.

To maintain a database of the biological characteristics of the spawning population a short stream survey was made weekly to observe fresh carcasses. This survey observed 1,012 fresh carcasses from 02 October to 29 November. In the survey 76% of the carcasses were adult females, 26% adult males, and 2% jack grilse. In contrast, the CNFH reported 56% adult females, 48% adult males and 2% jack grilse. These sex-ratio differences among adult spawners are typical of in-stream carcass surveys in the USRB and are the reason why expansions are made to the mainstem spawner populations (Tables A4, A5, and A6) to account for adult males observed to exit the system prior to their deaths. In addition to these findings the survey also reported that 0.5% (n = 5) of

the observed carcasses were adipose fin clipped; (in 2003 the CNFH ceased tagging large numbers of production fall-run). Another finding of the survey was that 15% of the females observed were unspawned, (died before spawning). This number, although large for most USRB waters, is again typical for Battle Creek.

In year 2000 and 2001, approximately 15% of the Fall-run hatchery production from all of the Central Valley salmon hatcheries was tagged with CWT's. In 2002 thru 2004, these mass-marked fish were recovered during in-river spawning escapement surveys. Following the pilot mass-marking program, tagging rates for hatchery Fall-run returned to low or nonexistent levels; as a result, recovery rates of tagged fish also declined. In 2006 survey crews encountered relatively few CWT's when compared with returns in 2002 thru 2004. This doesn't mean that fewer hatchery fish are straying into non-natal areas, but rather (due to the low mark rate after 2001), hatchery origin fish aren't identifiable.

Antelope Creek

Spring run On July 25, 2006 Antelope Creek, Tehama County, was snorkel-surveyed to count holding adult Spring-run. One hundred and two (**102**) adult salmon were observed. (Harvey Arrison).

Fall run No surveys for this run in this tributary were made in 2006, although fall-run are typically observed in Antelope Creek during October and November in an area near Highway 99 East (Cone Grove Park).

Mill Creek

Spring run An estimated **1,002** spring-run Chinook spawned in Mill Creek in 2006. This was based on redd surveys of 41 miles of the creek made between 6 and 13 October 2006, (Harvey-Arrison).

Fall run Six weekly spawner surveys were made between 26 November and 7 December covering the 8 mile reach between the canyon mouth and the confluence with the Sacramento River. An estimated minimum of **1,402** fall-run Chinook were present Mill Creek in 2006, (Harvey-Arrison)

Deer Creek

Spring run On 8 August, 2006, Deer Creek, Tehama County, was snorkel surveyed to count holding adult spring-run. There were **2,432** spring run observed**.** Twenty-four miles of stream was surveyed, (Harvey-Arrison)

Fall run Seven weekly spawner surveys were made between 20 October and 8 December covering the reach between the USGS stream flow gauge and the Highway 99 East Bridge. An estimated minimum of **1,905** fall-run Chinook were present Deer Creek in 2006, (Harvey-Arrison)

ACKNOWLEDGEMENTS

The author wishes to thank everyone who assisted with the collection of the information and administration of activities in this report. Many individuals participated in the data collection efforts associated with the escapement estimates listed in this report. Individual thanks are given to the following: From the **Department:** Randy Benthin, Alice Low, Brett Rohrer, Andy Holland, Brian Kreb, Matt Johnson, Jeremy Notch, Colleen Harvey-Arrison, Ed Martin, Amber Leininger, Rich Anthes, Shannon Stewart, Becky Mitchell, Allen Grover, Jim Chakarun, and James Lyons. From the **USFWS:** Jim Smith, Kevin Niemala, Matt Brown, Sarah Giovannetti, Shea Gaither, Jim Early, Naseem Alston, Bob Null, Kevin Offill, Bill McKinney, Mike Ricketts, Josh Gruber, Laura Mahoney, Curtis Brownfield, Rob Emge, Scott Hammelberg, Sharon Grover, Paula Wittner, Vicky Van Gundy, and Debbie Anderson. Thanks also to the staffs and organizations that assisted us in completion of the work described in this report. These include: Redding Air Services, U.S. Forest Service, NOAA Fisheries, U.S. Bureau of Reclamation, and the Department of Water Resources.

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APPENDIX A (Data Tables)

Appendix Table A1. Average migration timing for the various salmonid runs passing the Red Bluff Diversion Dam 1970-1988.

Percentage and cumulative percentages

		Based on years--82-86		1970-1988		1970-1988		1970-1986		1970-1988	
		Winter Run		**Spring Run**		**Fall Run**		**Late-Fall**		**Steelhead**	
	Week	%	cum.%	%	cum.%	%	cum.%	%	cum.%	%	cum.%
JAN	1	1.70	3.45					6.50	55.39	0.97	91.84
	2	1.78	5.23					6.32	61.71	0.80	92.64
	3	0.35	5.57					3.07	64.77	0.61	93.25
	4	1.28	6.85					2.91	67.69	0.50	93.75
FEB	5	2.38	9.23					3.58	71.26	0.29	94.05
	6	3.12	12.35					4.08	75.34	0.45	94.50
	7	3.08	15.44					4.19	79.54	0.56	95.06
	8	0.97	16.41					4.38	83.91	0.53	95.59
MAR	9	6.35	22.76					3.29	87.20	0.49	96.09
	10	7.72	30.48					2.14	89.34	0.46	96.54
	11	9.23	39.70	start				1.74	91.08	0.38	96.92
	12	7.79	47.49	0.10	0.10			3.39	94.47	0.30	97.22
	13	4.91	52.40	0.25	0.35			2.08	96.55	0.28	97.50
APR	14	7.64	60.04	0.59	0.93			1.82	98.37	0.35	97.85
	15	8.26	68.29	0.96	1.89			1.39	99.76	0.28	98.12
	16	9.19	77.48	1.38	3.27			0.24	100.00	0.19	98.31
	17	3.47	80.95	1.63	4.90			end		0.17	98.48
MAY	18	2.02	82.98	1.60	6.50					0.16	98.63
	19	1.60	84.58	1.71	8.21					0.17	98.80
	20	2.17	86.75	2.16	10.37					0.23	99.03
	21	3.09	89.84	2.63	13.00	start				0.18	99.20
JUN	22	2.03	91.87	2.86	15.86	0.01	0.01			0.20	99.40
	23	1.63	93.50	2.61	18.47	0.00	0.02			0.13	99.54
	24	1.84	95.34	2.93	21.40	0.01	0.03			0.14	99.68
	25	0.51	95.85	3.50	24.89	0.03	0.06			0.15	99.82
	26	0.76	96.61	3.10	27.99	0.08	0.14			0.18	100.00
JUL	27	1.60	98.20	3.67	31.66	0.10	0.24			0.13	0.13
	28	0.31	98.52	6.02	37.68	0.29	0.53			0.18	0.31
	29	1.04	99.55	4.75	42.44	0.49	1.02			0.18	0.49
	30	0.44	99.99	3.21	45.65	0.70	1.72			0.22	0.72
AUG	31	0.01	100.00	4.12	49.77	0.96	2.68			0.26	0.98
	32	end		6.97	56.74	1.68	4.36			0.39	1.36
	33			6.07	62.81	2.95	7.31			0.68	2.04
	34			6.75	69.55	3.53	10.84			1.12	3.16
	35			5.74	75.29	3.91	14.75			2.36	5.52
SEP	36			7.22	82.51	4.54	19.29			3.82	9.34
	37			6.68	89.19	5.59	24.88			5.80	15.14
	38			5.23	94.42	8.58	33.46			7.54	22.67
	39			3.70	98.12	9.24	42.70			8.95	31.63
OCT	40			1.19	99.31	10.49	53.19	start		11.75	43.37
	41			0.69	100.00	10.59	63.78	0.26	0.26	11.27	54.65
	42			end		8.97	72.75	2.06	2.32	9.79	64.44
	43					6.99	79.74	2.33	4.65	6.51	70.95
NOV	44					6.70	86.44	3.27	7.92	5.17	76.12
	45					4.68	91.12	4.24	12.16	4.04	80.17
	46					2.71	93.83	3.42	15.58	2.44	82.61
	47					2.23	96.06	3.65	19.23	2.21	84.82
DEC	48	start				1.68	97.74	5.37	24.60	2.05	86.87
	49	0.17	0.17			0.90	98.64	5.27	29.87	1.44	88.31
	50	0.38	0.55			0.66	99.30	5.27	35.14	1.04	89.35
	51	0.49	1.04			0.51	99.81	6.94	42.08	0.69	90.04
	52	0.71	1.75			0.19	100.00	6.81	48.89	0.83	90.87

Appendix Table A2. Summary of 2006 Red Bluff Diversion Dam fish passage information. *Readers note: to better access this and following data tables use the zoom function of your software.*

DATA Collected During 2006 RBDD Operations																
Trapped at Dam				Percentages by Race			Adjusted	Calculated Number of Fish			Historical Percentages of Runs				Steelhead
Week	F	S	W	%F	%S	%W	Counts	# F	#S	#W	F	S	W	Steelhead	Counts
20	0	11	43	0.0%	20.4%	79.6%	241	0	49	192	0.00%	2.16%	2.17%	0.23%	0
21	0	2	9	0.0%	18.2%	81.8%	120	0	22	98	0.00%	2.63%	3.09%	0.18%	0
22	0	1	7	0.0%	12.5%	87.5%	127	0	16	112	0.01%	2.86%	2.03%	0.20%	0
23	0	2	39	0.0%	4.9%	95.1%	313	0	15	298	0.00%	2.61%	1.63%	0.13%	0
24	0	1	8	0.0%	11.1%	88.9%	237	0	26	211	0.01%	2.93%	1.84%	0.14%	0
25	3	3	12	16.7%	16.7%	66.7%	161	27	27	108	0.03%	3.50%	0.51%	0.15%	0
26	14	1	10	56.0%	4.0%	40.0%	117	65	5	47	0.08%	3.10%	0.76%	0.18%	0
27	13	0	2	86.7%	0.0%	13.3%	101	88	0	13	0.10%	3.67%	1.60%	0.13%	0
28	26	0	6	81.3%	0.0%	18.8%	124	100	0	23	0.29%	6.02%	0.31%	0.18%	0
29	63	0	10	86.3%	0.0%	13.7%	233	201	0	32	0.49%	4.75%	1.04%	0.18%	0
30	8	0	0	100.0%	0.0%	0.0%	85	85	0	0	0.70%	3.21%	0.44%	0.22%	0
31	11	0	0	100.0%	0.0%	0.0%	268	268	0	0	0.96%	4.12%	0.01%	0.26%	0
32	28	0	1	96.6%	0.0%	3.4%	299	289	0	10	1.68%	6.97%	0.00%	0.39%	0
33	0	0	0	100.0%	0.0%	0.0%	544	544	0	0	2.95%	6.07%	0.00%	0.68%	4
34	38	0	0	100.0%	0.0%	0.0%	416	416	0	0	3.53%	6.75%	0.00%	1.12%	4
35	93	0	0	100.0%	0.0%	0.0%	1904	1904	0	0	3.91%	5.74%	0.00%	2.36%	17
36	123	0	0	100.0%	0.0%	0.0%	2751	2751	0	0	4.54%	7.22%	0.00%	3.82%	27
37	120	0	0	100.0%	0.0%	0.0%	3825	3825	0	0	5.59%	6.68%	0.00%	5.80%	22
Totals	540	21	147				11,868	10,564	160	1,144	24.88%	80.98%	15.42%	16.34%	74
Note: F = Fall, S= Spring, and W = Winter-run							Total 2006	42,466	198	7,415					

Expanded Red Bluff Diversion Dam Trap and Upstream of RBDD System Information-2006

RBDD Actual Trap				Estimate for System above RBDD				
F	S	W	Total	Fall	Spring	Winter	Total	SUMMARY OF MAJOR CATEGORIES
540	21	147	708	42,466	198	7,415	50,080	**ALL SALMON (both Ad-clipped and Natural).**
528	21	137	686	40,431	198	6,933	47,562	**NATURAL (non-ad-clipped) fish.**
98%	100%	93%	97%	95%	100%	93%	95%	**% Natural Fish.**
12	0	10	22	2,035	0	482	2,517	**AD-CLIPPED fish.**
2%	0%	7%	3%	5%	0%	7%	5%	**% Ad-Clipped Fish**
529	20	95	644	41,601	188	4,792	46,582	**ADULTS (all fish greater than 609 mm).**
98%	95%	65%	91%	98%	95%	65%	93%	**% Adults.**
11	1	52	64	865	9	2,623	3,498	**GRILSE (all fish less than 610mm).**
2%	5%	35%	9%	2%	5%	35%	7%	**% Grilse.**
248	1	101	350	19,830	49	5,095	24,974	**MALES (all fish). *Note River estimate #'s for unknowns added here.**
46%	5%	69%	49%	47%	25%	69%	50%	**% Males (of all fish).**
283	3	46	332	22,629	148	2,320	25,097	**FEMALES (all fish). *Note River estimate #'s for unknowns added here**
52%	14%	31%	47%	53%	75%	31%	50%	**% Females (of all fish).**
9	17	0	26	708	160	0	868	**UNKNOWN SEX (all fish). These fish already added to above categories.**
2%	81%	0%	4%	2%	81%	0%	2%	**% Unknown (of all fish). Unknowns proportioned by ratio of known male:female**
F	S	W	Total	Fall	Spring	Winter	Total	SUMMARY OF MISCELLANEOUS CATEGORIES
517	20	88	625	39,589	188	4,453	44,231	**Natural Adults**
11	1	49	61	842	9	2,480	3,331	**Natural Grilse**
12	0	7	19	2,035	0	338	2,373	**Ad-Clipped Adults**
0	0	3	3	0	0	145	145	**Ad-Clipped Grilse**
243	1	95	339	18,930	49	4,808	23,787	**male natural**
276	3	42	321	21,501	148	2,125	23,775	**female natural**
9	17	0	26	689	160	0	849	**unknown sex natural**
5	0	6	11	848	0	289	1,137	**male ad-clipped**
7	0	4	11	1,187	0	193	1,380	**female ad-clipped**
0	0	0	0	0	0	0	0	**unknown ad-clipped**
238	0	49	287	19,004	0	2,472	21,476	**male adults**
283	3	46	332	22,597	188	2,320	25,106	**female adults**
8	17	0	25	629	160	0	789	**unknown adults**
10	1	52	63	865	9	2,623	3,498	**male grilse**
0	0	0	0	0	0	0	0	**female grilse**
1	0	0	1	79	0	0	79	**unknown grilse**
233	0	46	279	18,122	0	2,328	20,450	**male natural adults**
276	3	42	321	21,467	188	2,125	23,780	**female natural adults**
8	17	0	25	613	160	0	773	**unknown natural adults**
10	1	49	60	842	9	2,480	3,331	**male natural grilse**
0	0	0	0	0	0	0	0	**female natural grilse**
1	0	0	1	77	0	0	77	**unknown natural grilse**
5	0	3	8	848	0	145	993	**male ad-clipped adults**
7	0	4	11	1,187	0	193	1,380	**female ad-clipped adults**
0	0	0	0	0	0	0	0	**unknown ad-clipped adults**
0	0	3	3	0	0	145	145	**male ad-clipped grilse**
0	0	0	0	0	0	0	0	**female ad-clipped grilse**
0	0	0	0	0	0	0	0	**unknown ad-clipped grilse**

Note-Unknown fish for the System estimate have been added proportionally into the male and female categories

Note: Values shown in this table are rounded to whole numbers; calculations are made using unrounded numbers this may cause the slight discrepancies between group totals.

Appendix Table A3. Summary of aerial redd counts for Sacramento River System from Keswick Dam downstream to Princeton Ferry from 1969-2006.

Percentages of redds in main-stem Sacramento from aerial flights (up and downstream of RBDD)										
YEAR	Winter-Run		Spring-Run		Fall-Run		Late-Fall		ALL COMBINED	
	% Up	% Down	% Up	% Down	% Up	% Down	% Up	% Down	% Up	% Down
1969	n/a	n/a	n/a	n/a	74.4%	25.6%	n/a	n/a	74.4%	25.6%
1970	n/a	n/a	n/a	n/a	85.6%	14.4%	n/a	n/a	85.6%	14.4%
1971	n/a	n/a	n/a	n/a	68.5%	31.5%	n/a	n/a	68.5%	31.5%
1972	n/a	n/a	n/a	n/a	63.5%	36.5%	67.2%	32.8%	64.8%	35.2%
1973	n/a	n/a	n/a	n/a	69.9%	30.1%	75.9%	24.1%	74.7%	25.3%
1974	n/a	n/a	n/a	n/a	60.9%	39.1%	n/a	n/a	60.9%	39.1%
1975	n/a	n/a	n/a	n/a	56.4%	43.6%	n/a	n/a	56.4%	43.6%
1976	n/a	n/a	n/a	n/a	72.9%	27.1%	64.7%	35.3%	71.9%	28.1%
1977	n/a	n/a	n/a	n/a	45.1%	54.9%	n/a	n/a	45.1%	54.9%
1978	n/a	n/a	n/a	n/a	46.0%	54.0%	25.6%	74.4%	43.2%	56.8%
1979	n/a	n/a	n/a	n/a	53.9%	46.1%	42.7%	57.3%	52.0%	48.0%
1980	n/a	n/a	n/a	n/a	48.7%	51.3%	n/a	n/a	48.7%	51.3%
1981	87.8%	12.2%	n/a	n/a	63.0%	37.0%	63.5%	36.5%	63.5%	36.5%
1982	97.0%	3.0%	n/a	n/a	67.1%	32.9%	n/a	n/a	67.5%	32.5%
1983	n/a	n/a	81.1%	18.9%	47.6%	52.4%	71.2%	28.8%	59.3%	40.7%
1984	n/a	n/a	93.3%	6.7%	66.6%	33.4%	78.9%	21.1%	67.2%	32.8%
1985	71.8%	28.2%	78.6%	21.4%	55.5%	44.5%	81.5%	18.5%	56.3%	43.7%
1986	n/a	n/a	100.0%	0.0%	64.5%	35.5%	72.8%	27.2%	64.9%	35.1%
1987	95.5%	4.5%	n/a	n/a	71.4%	28.6%	64.1%	35.9%	71.0%	29.0%
1988	74.5%	25.5%	97.4%	2.6%	77.9%	22.1%	98.9%	1.1%	78.3%	21.7%
1989	97.9%	2.1%	100.0%	0.0%	83.3%	16.7%	41.9%	56.4%	82.6%	17.4%
1990	93.3%	6.7%	100.0%	0.0%	66.8%	33.2%	87.4%	12.6%	67.8%	32.2%
1991	100.0%	0.0%	100.0%	0.0%	66.9%	33.1%	81.6%	18.4%	67.8%	32.2%
1992	96.4%	3.6%	100.0%	0.0%	73.8%	26.2%	85.8%	14.2%	75.1%	24.9%
1993	97.7%	2.3%	100.0%	0.0%	72.5%	27.5%	100.0%	0.0%	72.7%	27.3%
1994	100.0%	0.0%	85.1%	14.9%	77.8%	22.2%	77.0%	23.0%	77.8%	22.2%
1995	99.4%	0.6%	90.9%	9.1%	83.5%	16.5%	61.9%	38.1%	83.5%	16.5%
1996	100.0%	0.0%	100.0%	0.0%	85.5%	14.5%	n/a	n/a	86.0%	14.0%
1997	100.0%	0.0%	99.0%	1.0%	82.8%	17.2%	n/a	n/a	83.6%	16.4%
1998	97.5%	2.5%	100.0%	0.0%	90.5%	9.5%	97.2%	2.8%	92.4%	7.6%
1999	100.0%	0.0%	100.0%	0.0%	78.8%	21.2%	n/a	n/a	99.0%	1.0%
2000	100.0%	0.0%	100.0%	0.0%	90.8%	9.2%	98.6%	1.4%	94.7%	5.3%
2001	99.6%	0.4%	96.6%	3.4%	85.4%	14.6%	95.2%	4.8%	93.1%	6.9%
2002	99.8%	0.2%	100.0%	0.0%	69.3%	30.7%	100.0%	0.0%	80.5%	19.5%
2003	99.7%	0.3%	100.0%	0.0%	74.5%	25.5%	97.3%	2.7%	79.8%	20.2%
2004	100.0%	0.0%	100.0%	0.0%	78.1%	21.9%	100.0%	0.0%	87.1%	12.9%
2005	100.0%	0.0%	84.8%	15.2%	78.8%	21.2%	90.2%	9.8%	90.9%	9.1%
2006	99.7%	0.3%	100.0%	0.0%	84.0%	16.0%	75.5%	24.5%	86.5%	13.5%
AVERAGE	**96%**	**4%**	**96%**	**4%**	**71%**	**29%**	**78%**	**22%**	**73%**	**27%**

n/a = not available

Appendix Table A4. Summary of the 2006 Late-fall-run Chinook carcass survey results for the main-stem Sacramento River.

2006 Mainstem Sacramento River Late-Fall-Run Chinook Salmon

Survey conducted from 20 Dec 2005 through 3 May 2006. Total of 20 weekly survey periods

Category	Fresh Large Female	Fresh Large Male	Non-Fresh Large Female	Non-Fresh Large Male	Fresh Small Female	Fresh Small Male	Non-Fresh Small Female	Non-Fresh Small Male	TOTAL
Tagged	122	61	148	68	1	1	1	0	**402**
Chopped	32	24	256	144	0	0	1	2	**459**
Hatchery	1	2	3	2	0	0	0	0	**8**
TOTAL	**155**	**87**	**407**	**214**	**1**	**1**	**2**	**2**	**869**
Recaptured	14	5	16	6	0	0	0	0	**41**

Note: On mainstem carcass survey a large fish is greater than 609 mm in forklength; a fresh fish is clear eyed.

Notes: High flows hindered collections of large numbers of carcasses during the 2006 mainstem survey. As a result the mark-recapture data resulted in a low number. As a result the female spawner from 2005 was used as a starting point in the 2006 estimate below.

POPULATION ESTIMATE CALCULATIONS: Late-Fall-Run 2006 Mainstem

POPULATION ESTIMATE CATEGORIES	ESTIMATE	Adjustments	
Calculation for Female Adults (From 2005 survey)	**2,108**	2,108	This number is the 2005 Jolly-Seber used in 2006 as a substitute for 2006 carcass estimate
Adult Female Ad-Clipped Fish In-River Adjustment	**2,125**	1.0080	* Based on measured Large Female Fresh Carcasses with Ad-clips (1) of 126 total /125 natural
Number of All Adult Females-Downstream Redd Factor	**5,590**	2.6306	256 redds below carcass survey location. (A total of 413 redds were observed during LFR surveys)
Number of All Adult Males Adjustment Factor	**4,457**	0.7974	^ Based on the ratio of male adults to female adults at CNFH: (2172 male to 2724 female)
Number of All Female Grilse Adjustment Factor	**44**	0.0079	Based on female grilse (<610mm) to female adults from fresh fish sample (127 total: 1 jills to 126 adults).
Number of All Male Grilse Adjustment Factor	**71**	0.0159	Based on male grilse (<610mm) to male adults from the fresh fish sample (64 total: 1 jacks to 63 adults)
Number of Fish Removed from Population by LSNFH	**8**	8	USFWS Data from Keswick Collections 2006. Four additional to CNFH
Final Estimate is	**10,171**	This number is spawners in Sacramento River Mainstem: CNFH had additional 5,111, and anglers estimated at 2,741	

* Adipose clipped carcasses are not part of the Jolly Seber Estimate since they are dissected to remove coded wire tags.

^ The carcass survey sex ratio of fresh fish was 67% female, to account for males leaving the system while alive, the CNFH Late-fall data is instead used.

Appendix Table A5. Summary of the 2006 Winter-run Chinook carcass survey results for the main-stem Sacramento River.

2006 Mainstem Sacramento River Winter-Run Chinook Salmon

Survey conducted from 1 May 2006 through 25 August 2006. Total of 39 survey periods

Category	Fresh Large Female	Fresh Large Male	Non-Fresh Large Female	Non-Fresh Large Male	Fresh Small Female	Fresh Small Male	Non-Fresh Small Female	Non-Fresh Small Male	TOTAL
Tagged	1885	708	1054	414	14	24	5	17	**4,121**
Chopped+	55	62	1668	838	1	1	5	26	**2,656**
Hatchery	333	102	351	127	4	1	0	3	**921**
TOTAL	**2,273**	**872**	**3,073**	**1,379**	**19**	**26**	**10**	**46**	**7,698**
Recaptured	1093	358	537	203	4	8	0	3	**2,206**

Notes: The 2006 winter-run carcass survey resulted in the largest population estimate since 1981. Water visibility was not good due to spring run-off. Spawning activity was low in late-July and early August compared to other years and the survey was terminated due to lack of carcasses in late August as compared to other years which typically go into early September.

Note: On mainstem carcass survey a large fish is greater than 609 mm in forklength; a fresh fish is clear eyed.

+ Note chopped category includes skeleton chops that were tallied as unknown sex and large or small size

POPULATION ESTIMATE CALCULATIONS: Winter-Run 2006 Mainstem

Jolly-Seber Calculation for large Female	**7497.6**	**Adjustments**	
Large Female Ad-Clipped Fish In-River Adjustment	**8,759**	1.1682	*Based on large female fresh:(>609mm) with Ad-clips (final) (320 of 2222) = 14.4% (2222/1902)
Number of All Large Females (>609 mm) Downstream Redds	**8,783**	1.0028	Two redds below carcass survey location: 717 new redds were observed during WR surveys,
Number Large Males (> 609 mm) from Keswick Trap Data	**8,074**	0.9193	^ Based on large males (>609) (n = 148) to large females (>609) (n = 161) at Keswick Trap
Total Females	**8,863**	1.0090	Based on total females to large females (>609mm) from fresh fish (2242 total fresh: 20 small).
Total Males	**8,342**	1.0332	Based on total males to large males (>609mm) from fresh fish (841 total fresh: 27 small)
Number of Fish Removed from Population by LSNFH	**93**	93	USFWS Data from LSNFH Collections 2005.
Final Estimate is	**17,298**	This number includes all Winter run in the Sacramento River: 6 additional estimated to have entered Battle Creek	

In-River age composition				
Adult Females >2 yrs	8,811	Jills	51	Adults and Jills based on 590 mm cut-off (13 females <590mm vs 2229 >589mm) of 2,242 total females)
Adult Males >2 yrs	8,015	Jacks	327	Adults and Jacks based on 660 mm cut-off (33 males <660mm vs 808 >659mm) of 841 total males)

Carcass Population Component Breakdowns:						HATCHERY FISH			NATURAL FISH			OVERALL		
#'s From top	**% of totals clipped**	**Total clipped**	**@ LSNFH %unclipped**	**CATEGORY**		**In -River**	**In-LSNFH**	**Total**	**In - River**	**In-LSNFH**	**Total**	**Total**	**%**	
8,811	0.1445	1273	0.00032	Number of Adult Females (>589mm)		1,276	2	1,278	7,535	51	7,586	**8,864**	**51.2%**	Number of Adult Females
8,015	0.1238	992	0.00032	Number of Adult Males (>659mm)		994	0	994	7,021	40	7,061	**8,055**	**46.6%**	Number of Adult Males
51	0.1538	8	0.00588	Number of Grilse Females (Jills)		8	0	8	43	0	43	**51**	**0.3%**	Number of Grilse Females (Jills)
327	0.0606	20	0.00588	Number of Grilse Males (Jacks)		22	0	22	306	0	306	**327**	**1.9%**	Number of Grilse Males (Jacks)
17,205	Total in-river				TOTALS	2,300	2	2,302	14,905	91	14,996	**17,298**	**100.0%**	
93	Total in hatchery													

* Adipose clipped carcasses are not part of the Jolly Seber Estimate since they are dissected to remove coded wire tags.

^ The carcass survey sex ratio of fresh fish was 73% female, to account for males leaving the system while alive, the Keswick Dam Trap data is instead used.

@ This is the number of LSNFH hatchery juvenile fish which accidentally did not receive ad-clips for the year 2003(.032%) for 3 year olds, and in 2004 (.588%) for 2 year olds.

@ 4 year old clips were not averaged in for 2006 since none showed up in the CWT data base.

Appendix Table A6. Summary of the 2006 Fall-run Chinook carcass survey results for the main-stem Sacramento River.

2006 Mainstem Sacramento River Fall-Run Chinook Salmon

Survey conducted from 1 September 2006 through 18 January 2007. Total of 19 survey periods

Category	Fresh Large Female	Fresh Large Male	Non-Fresh Large Female	Non-Fresh Large Male	Fresh Small Female	Fresh Small Male	Non-Fresh Small Female	Non-Fresh Small Male	TOTAL
Tagged	952	410	1148	453	1	22	6	7	**2,999**
Chopped	59	68	1963	1130	0	2	6	21	**3,249**
Hatchery	6	1	12	9	1	0	1	1	**31**
TOTAL	**1,017**	**479**	**3,123**	**1,592**	**2**	**24**	**13**	**29**	**6,279**
Recaptured	387	153	477	151	0	0	1	0	**1,169**

Note: On mainstem carcass survey a large fish is greater than 609 mm in forklength; a fresh fish is clear eyed.

Notes: The Fall-run survey this year went well. Visibility was good and no significant problems were encountered. The run seemed to be late this year so the survey was extended until mid-Jan to account for the later spawning fall run from December. It was difficult to clearly distinguish the fall from late-fall timing. A cut-off for fresh carcasses of Dec 21 was chosen, after that date a fresh carcass was assigned as a late-fall fish.

POPULATION ESTIMATE CALCULATIONS: Fall-Run 2006 Mainstem

Jolly-Seber Calculation for large females	**8,920**	**Adjustments**	
Large Female Ad-Clipped Fish In-River Adjustment	**8,975**	1.0062	* Based on Large Female Fresh Carcasses with Ad-clips (6 of 970)
Number of All Large Females (>609 mm) Downstream Redds	**29,350**	3.2701	Redds below survey (A total of 2119 redds, 648 were within carcass survey boundaries: 30.6%)
Number Large Males (> 609 mm) from RBDD Trap Data	**24,683**	0.8410	^ Based on large males (>610) to large females at RBDD Trap: (521 total: 238-male to 283-female)
Total Females	**29,441**	1.0031	Based on total females to large females (>609mm) from fresh fish (973 total: 3 small to 970 large).
Total Males	**26,027**	1.0545	Based on total males to large males (>609mm) from fresh fish (426 total: 22 small to 404 large).
Final Estimate is	**55,468**		

In-River age composition				
Adult Females >2 yrs	29,410	Jills	30	Adults and Jills based on 590 mm (1 females <590mm vs 972 >589mm) of 973 total females)
Adult Males >2 yrs	24,133	Jacks	1,894	Adults and Jacks based on 680 mm (31males <680mm vs 395 >679mm) of 426 total males)

* Adipose clipped carcasses are not part of the Jolly Seber Estimate since they are dissected to remove coded wire tags.

^ The carcass survey sex ratio of fresh fish was 71% female, to account for males leaving the system while alive the Red Bluff Diversion Dam Trap sex ratio data is instead used.

Appendix Table A7. Summary of the Chinook salmon population estimates by run in the Upper Sacramento River Basin, upstream of Princeton (RM 164) for the years 1986-2006.

YEAR **	Salmon Totals for Sacramento System above Princeton ^				
	Fall	Spring	Winter	Late-Fall	TOTALS
1986	144,377	17,657	2,596	11,398	176,029
1987	134,686	11,435	2,186	26,438	174,746
1988	159,448	11,003	2,886	12,937	186,273
1989	96,271	5,895	696	31,261	134,123
1990	71,799	5,305	430	8,150	85,683
1991	56,277	1,607	211	8,591	66,686
1992	51,588	876	1,240	11,944	65,649
1993	71,314	716	387	n/a	72,416
1994	112,923	2,221	186	n/a	115,330
1995	169,556	2,082	1,297	n/a	172,935
1996	172,058	1,520	1,337	n/a	174,915
1997	249,118	793	880	n/a	250,791
1998	119,114	4,096	3,002	46,454*	172,666
1999	308,745	2,660	3,288	32,368*	347,061
2000	184,987	1,442	1,352	16,015*	203,796
2001	232,601*	3,715	5,523 / **8,100***	25,725*	270,141
2002	571,169*	4,445	9,172 / **7,441***	40,101*	623,156
2003	287,876*	4,423	9,757 / **8,218***	9,485*	310,002
2004	162,596*	2,380	7192 / **7,869***	16,663*	189,426
2005	272,229*	3,697	5,299 / **15,839***	19,776*	311,683
2006	168,584*	3,822	7,415 / **17,304***	18,023*	311,684
AVERAGE	180,825	4,371	4,131	20,958	139,631

^ Data from RBDD counts + aerial redd flights + tributary surveys beneath RBDD

** Totals reflect available data, many streams not surveyed have populations of salmon

* These estimates calculated using carcass survey results, hatchery counts, video counts, angler and redd surveys

Note: Winter run average is calculated using RBDD numbers from 1986 till 2000 and carcass numbers after 2000

APPENDIX B (Coded-Wire-Tag Results Tables)

Appendix Table B1. Summary of the Coded-wire-tag (CWT) results, **by brood year,** for adipose-fin clipped (hatchery) Chinook salmon in the Upper Sacramento River Basin in 2006 collected during Sacramento River Salmon and Steelhead Assessment Project escapement surveys.

Brood Year	Clear	Deer	Mill	Sac. Riv.	Totals	Age	Percent
2005	0	0	0	1	1	2 year old	0.1%
2004	0	0	0	1	1	3 year old	0.1%
2003	2	1	2	739	744	4 year old	94.1%
2002	0	0	0	45	45	5 year old	5.7%
No tag data	7	0	1	135	143	unknown	
Totals	9	1	3	921	934		100.0%

Appendix Table B2. Summary of the 2006 CWT results, **by run,** for adipose-fin clipped (hatchery) Chinook salmon in the Upper Sacramento River Basin collected during Sacramento River Salmon and Steelhead Assessment Project escapement surveys.

Location	Spring ^	Fall	Winter	Late-Fall	Totals
Clear Creek	1	1	0	0	2
Deer Creek	0	1	0	0	1
Mill Creek	0	2	0	0	2
Sacramento	9	9	764	4	786
Totals	10	13	764	4	791

^ Spring-run CWT data are salmon from the Feather River Hatchery (n = 8) and from the rotary screw trap tagging of juvenile natural origin Butte Creek spring-run, (n = 2).

Appendix Table B3. Summary of the 2006 CWT results, **by hatchery,** for adipose-fin clipped (hatchery) Chinook salmon in the Upper Sacramento River Basin collected during Sacramento River Salmon and Steelhead Assessment Project escapement surveys.

HATCHERY SOURCE	Total	Percentage
Butte Creek Screw Trap	2	0.3%
Coleman National Fish Hatchery	5	0.6%
Feather River Hatchery	17	2.1%
Livingston Stone Hatchery	764	96.6%
Merced River Fish Facility	3	0.4%
CWT's with good reads: Total	791	100.0%
TAG NOT DETECTED (100000)	117	
TAG LOST (200000)	12	1.5%
HEAD NOT RECOVERED (300000)	11	
TAG ILLEGIBLE (400000)	3	0.4%
Total Problem CWT's	143	% of total found cwt's
Overall CWT (found) Totals	806	

Appendix Table B4. Summary of the 2006 CWT results, **by tag code,** for adipose-fin clipped (hatchery) Chinook salmon in the Upper Sacramento River Basin collected during Sacramento River Salmon and Steelhead Assessment Project escapement surveys.

CWT Code	Hatchery*	Release Location	Brood Year	Run	Clear	Deer	Mill	Sac Riv.
51166	CNFH	PORT CHICAGO	2002	Late-Fall				1
51276	LSNFH	LAKE REDDING	2002	Winter				2
51277	LSNFH	LAKE REDDING	2002	Winter				1
51279	LSNFH	LAKE REDDING	2002	Winter				1
51280	LSNFH	LAKE REDDING	2002	Winter				1
51282	LSNFH	LAKE REDDING	2002	Winter				1
51285	LSNFH	LAKE REDDING	2002	Winter				1
51287	LSNFH	LAKE REDDING	2002	Winter				1
51291	LSNFH	LAKE REDDING	2002	Winter				1
51293	LSNFH	LAKE REDDING	2002	Winter				2
51294	LSNFH	LAKE REDDING	2002	Winter				2
51296	LSNFH	LAKE REDDING	2002	Winter				1
51297	LSNFH	LAKE REDDING	2002	Winter				2
51298	LSNFH	LAKE REDDING	2002	Winter				7
51364	LSNFH	LAKE REDDING	2002	Winter				1
51366	LSNFH	LAKE REDDING	2002	Winter				2
51370	LSNFH	LAKE REDDING	2002	Winter				1
51371	LSNFH	LAKE REDDING	2002	Winter				5
51372	LSNFH	LAKE REDDING	2002	Winter				1

CWT Code	Hatchery*	Release Location	Brood Year	Run	Clear	Deer	Mill	Sac Riv.
51679	LSNFH	LAKE REDDING	2003	Winter				17
51696	LSNFH	LAKE REDDING	2004	Winter				1
51774	CNFH	WEST SAC	2003	Late-Fall				1
51777	CNFH	COLEMAN NFH	2003	Late-Fall				1
51964	LSNFH	LAKE REDDING	2003	Winter				11
51965	LSNFH	LAKE REDDING	2003	Winter				19
51966	LSNFH	LAKE REDDING	2003	Winter				22
51967	LSNFH	LAKE REDDING	2003	Winter				19
51968	LSNFH	LAKE REDDING	2003	Winter				24
51969	LSNFH	LAKE REDDING	2003	Winter				17
51970	LSNFH	LAKE REDDING	2003	Winter				17
51971	LSNFH	LAKE REDDING	2003	Winter				19
51972	LSNFH	LAKE REDDING	2003	Winter				33
51973	LSNFH	LAKE REDDING	2003	Winter				20
51974	LSNFH	LAKE REDDING	2003	Winter				21
51975	LSNFH	LAKE REDDING	2003	Winter				23
51976	LSNFH	LAKE REDDING	2003	Winter				20
51977	LSNFH	LAKE REDDING	2003	Winter				15
51978	LSNFH	LAKE REDDING	2003	Winter				16
51979	LSNFH	LAKE REDDING	2003	Winter				15
51980	LSNFH	LAKE REDDING	2003	Winter				10
51981	LSNFH	LAKE REDDING	2003	Winter				11
51982	LSNFH	LAKE REDDING	2003	Winter				15
51983	LSNFH	LAKE REDDING	2003	Winter				16
51984	LSNFH	LAKE REDDING	2003	Winter				23
51985	LSNFH	LAKE REDDING	2003	Winter				7
51986	LSNFH	LAKE REDDING	2003	Winter				6
51987	LSNFH	LAKE REDDING	2003	Winter				18
51988	LSNFH	LAKE REDDING	2003	Winter				18
51989	LSNFH	LAKE REDDING	2003	Winter				12
51990	LSNFH	LAKE REDDING	2003	Winter				9
51991	LSNFH	LAKE REDDING	2003	Winter				21
51992	LSNFH	LAKE REDDING	2003	Winter				9
51993	LSNFH	LAKE REDDING	2003	Winter				41
51994	LSNFH	LAKE REDDING	2003	Winter				38
51995	LSNFH	LAKE REDDING	2003	Winter				52
51996	LSNFH	LAKE REDDING	2003	Winter				47
51997	LSNFH	LAKE REDDING	2003	Winter				49
52065	FRH	PORT CHICAGO	2003	Fall				1
52869	CNFH	COLEMAN NFH	2005	Late-Fall				1
62401	FRH	SAN PABLO BAY	2003	Spring				1
62402	FRH	SAN PABLO BAY	2003	Spring	1			
62408	FRH	SAN PABLO BAY	2003	Fall				2
62409	FRH	SAN PABLO BAY	2003	Fall				1
62756	FRH	BENICIA	2002	Spring				2
62758	FRH	BENICIA	2002	Spring				2

CWT Code	Hatchery*	Release Location	Brood Year	Run	Clear	Deer	Mill	Sac Riv.
62760	FRH	BENICIA	2002	Spring				1
62766	FRH	LIVE OAK	2002	Fall				1
62770	FRH	CROCKETT	2002	Fall				1
62772	FRH	CROCKETT	2002	Fall				1
62787	FRH	BENICIA	2002	Spring				1
62794	FRH	SAN PABLO BAY	2003	Fall		1		
64580	MRFF	JERSEY PT, SJR	2003	Fall	1		1	1
501021514	CNFH	BELOW RBDD	2003	Fall			1	
601000401	BUTTE trap	BALDWIN YARD	2002	Spring				1
601000402	BUTTE trap	BALDWIN YARD	2002	Spring				1
601010102	FRH	YOLO BYPASS	2003	Fall				1
100000	No Tag	No tag detected		Fall	6	0	1	9
100000	No Tag	No tag detected		Late-Fall	0	0	0	2
100000	No Tag	No tag detected		Winter	0	0	0	99
200000	Tag Lost	Tag Lost		Fall	1	0	0	0
200000	Tag Lost	Tag Lost		Winter	0	0	0	11
300000	Head lost	No tag available		Late-Fall	0	0	0	1
300001	Head lost	No tag available		Winter	0	0	0	10
400000	Illegible	Tag Scratched		Late-Fall				3
TOTALS					**9**	**1**	**3**	**921**
Carcasses examined for ad-clips: These numbers are for general categories; for specific analysis purposes please contact Project biologists					4,923	1,275	748	15,437
Chinook Population estimates (tributaries fall-run only)					8,422	1,905	1,403	82,844

* Hatchery Abbreviations as follows:
CNFH = Coleman National Fish Hatchery
LSNFH = Livingston Stone National Fish Hatchery
FRH = Feather River Hatchery
MRFF = Merced River Fish Facility