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State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

Chinook Salmon Populations for the Upper Sacramento River Basin In 2007

By
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Northern California-North Coast Region
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and
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SRSSAP Technical Report No. 08-4
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Cover photo: Spring-run Chinook salmon. Photo by D. Killam

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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 were 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 the town of Princeton (Butte Creek, Feather and American River(s) and Big Chico Creek). 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"

In 2007, there were an estimated **79,126** Chinook salmon in the Upper Sacramento River Basin (USRB), upstream of Princeton Ferry. This includes an estimate of 21,701 late-fall-run, 2,541 winter-run, 2,357 spring-run, and 52,527 fall-run Chinook salmon (Table 1). The majority of these salmon migrated above RBDD (88%) 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 authors or other project staff for specific requirements or limitations to the data. The authors may be reached via e-mail at (dkillam@dfg.ca.gov) or (briankreb@yahoo.com). This report and others from this project can be found on the Calfish.Org website. Interested readers should go to the Calfish.org website and select "Independent Datasets", then CDFG Red Bluff. Next, select a category to view databases, reports, presentations, etc. If interested, readers may request specific tables in spreadsheet formats allowing further analysis based on their individual requirements.

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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INTRODUCTION

The Upper Sacramento River Basin (USRB) of California's Central Valley is unique because it has four separate runs of Chinook salmon (*Oncorhynchus tshawytscha*) each year. The USRB for purposes of this report refers to the anadromous portions of the Sacramento River watershed upstream of Princeton CA (RM 165). Each run of Chinook, 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 many different environmental conditions found over the course of a year in the USRB (Figure 1).

The historical migration timing of the four adult Chinook salmon runs into the USRB is provided in Appendix Table 1. The naming of the runs can be confusing (e.g. winter-run spawn in mid-June). The run names originate from the time salmon canneries operated in the lower river (i.e. 1860's). The name of each run described when the peak of the run was passing through the San Francisco Bay.

During earlier years the primary purpose for monitoring salmon was to manage for commercial and sport salmon harvest. (Note: the USRB has Chinook and steelhead (O. *mykiss*), but no spawning populations of the other Pacific salmon species (i.e. chum/dog, coho/silver, humpback/pink, and sockeye/red). 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 harvest.

This report provides a summary of the 2007 USRB salmon monitoring activities conducted by staff from the California Department of Fish and Game's (CDFG), Sacramento River Salmon and Steelhead Assessment Project (SRSSAP). Funding for the SRSSAP staff in 2007 was provided by the Sport Fish Restoration Program (SFR), and by a CALFED Ecosystem Restoration Program (ERP) grant. The SFR staff included two CDFG Associate Biologists and a Fish and Wildlife Technician. The ERP grant provided funding for six Pacific States Marine Fisheries Commission (PSMFC) field survey crew members.

In 2007 the SRSSAP staff conducted both stand-alone surveys and cooperative surveys with the staff from several organizations: the United States Fish and Wildlife Service: Red Bluff Fish and Wildlife Office (USFWS), the Coleman National Fish Hatchery (CNFH), the Western Shasta Resource Conservation District (WSRCD) and other watershed groups. Details of other specific monitoring surveys in the USRB can be found on the websites of these groups. 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, walking surveys, and hatchery counts were the primary methods of data collection until 1967.

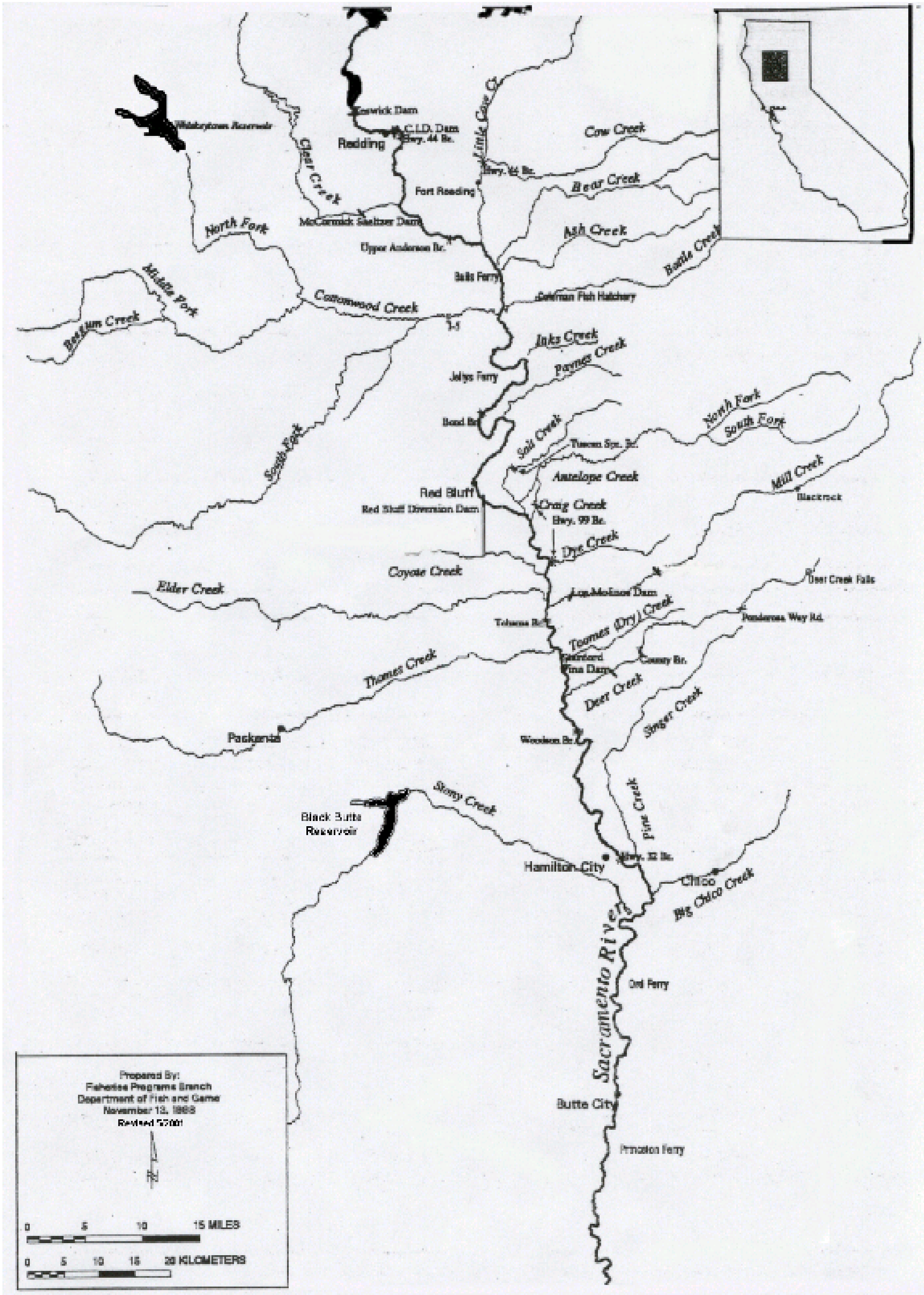

Figure 1. The Upper Sacramento River Basin (from Keswick Dam to Princeton Ferry).

Table 1. Summary of the 2007 Chinook salmon population estimates 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	13,864	2,487	248	14,097
Livingston Stone Hatchery	66	54		
Battle Creek Coleman Hatchery	3,319			11,778
Battle Creek Above hatchery	234		291	
Battle Creek Below Hatchery	n/a ^			9,904
Bear Creek	n/a			140
Clear Creek	n/a		194	4,129
Cow Creek	n/a			2,044
Cottonwood Creek	n/a		34	1,250
Angler Harvest	1,373	0	0	1,676
SUB-TOTAL UPSTREAM OF RBDD	*18,856*	*2,541*	*767*	*45,017*
Red Bluff down to Princeton				
Sacramento River Main-Stem	1,477	0	0	2,964
Mill Creek	n/a		920	796
Deer Creek	n/a		644	508
Antelope Creek	n/a		26	n/a
Angler Harvest	1,368	0	0	3,242
SUB-TOTAL DOWNSTREAM OF RBDD	*2,845*	*0*	*1,590*	*7,510*
SYSTEM GRAND TOTAL	**21,701**	**2,541**	**2,357**	**52,527**
(Keswick Dam to Princeton)$				
2007 TOTAL SALMON ALL COMBINED:			**79,126**	

NOTE: These values represent minimum numbers, unsurveyed waters have additional smaller salmon populations
* Carcass survey results vs RBDD of 6,144.
^ 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

From 1967 until 1986, the Red Bluff Diversion Dam (RBDD) provided a method of monitoring all four salmon runs, as well as steelhead trout. During this period, the RBDD was typically operated throughout the year. This allowed for complete accounting of salmon and steelhead escapement. The RBDD is operated by lowering 11 large steel gates (15 feet tall) into the Sacramento River at Red Bluff. The resulting pool forms Lake Red Bluff and provides gravity flow water "free" (no pumping necessary) into agricultural diversions. During RBDD operation, adult salmon migrating into the USRB, must find and use one of three fish ladders at the dam. The delay in finding these ladders at the RBDD was thought to be a major reason for the decline of the winter-run populations (NMFS 1996). Beginning in 1987, the time period of operation of the RBDD was limited for portions of each year to facilitate improved passage of winter-run salmon. When not in operation, the RBDD gates are raised completely out of the water. This returns the river to natural flow conditions and eliminates any passage delay. This action was deemed necessary for 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 limited data (e.g. spring-run on the main-stem) 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. In addition, the carcass surveys are used to report the fall and winter-run escapements used by the CDFG as official estimates.

The late-fall-run escapement on the main-stem Sacramento River is monitored through a boat mark and recapture carcass survey and aerial redd counts (December-April). Late-fall-run carcass surveys are difficult to conduct on USBR tributaries due to typically high flow (or flood) conditions, making consistent weekly mark and recapture surveys not practical. Late-fall-run are known to spawn in most fall-run tributaries and opportunities for future alternative monitoring opportunities exist. Presently, only Clear Creek (USFWS-carcass count) and Battle Creek (CNFH-hatchery count) provide tributary data on late-fall-run salmon.

A main-stem winter-run carcass survey (May-August) has been conducted since 1996. Since 2001, the CALFED-ERP funded survey has provided the “official” annual escapement estimate (replacing the RBDD estimate) for this federally and state-listed endangered species. 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 the allowable juvenile winter-run “take” limits at the pumping facilities in the Sacramento-San Joaquin Delta.

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 replicable 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, there has been an effort to standardize sampling methods and to 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, there are not enough spring-run carcasses encountered to conduct mark and recapture surveys in the USRB.

Details of specific fall and spring-run surveys conducted for Clear, Antelope, Mill and Deer Creeks are available in a separate report for the 2007 year (Harvey Arrison-in prep, 2008). In past SRSSAP annual reports, these creeks were included within a single report. Beginning in 2006, the reports were conducted by the individual project biologists/authors. This allowed for greater detail in reporting than previously possible. This report contains limited summary information on these creeks.

Since 1953, fall-run salmon inventories have been routinely conducted since 1953 on USRB tributary streams. Prior to 1988, Peterson mark and recapture methodologies, ladder counts and aerial redd surveys were used with varying sampling intensity and reliability of estimates. Since 1988, mark and recapture surveys have been standardized into weekly surveys for the duration of the spawning run on each tributary. The mark and 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. To obtain fall-run escapement estimates in Battle, Cow, Cottonwood and Bear Creek(s) video counting stations were operated.

METHODS and RESULTS

Since 1969, the RBDD estimates were used to generate estimates for all runs of salmonids in the main-stem Sacramento River (steelhead, four runs of Chinook salmon). Only the RBDD data for spring-run salmon was used to provide an estimate in 2007. Data trends and estimates from RBDD were still generated in 2007, but the CDFG has used main-stem carcass survey data and tributary specific results as the official estimates since 2001, (1998 for late-fall-run).

Carcass Mark and Recapture Surveys:

Carcass mark and recapture surveys (carcass surveys) have been used by the CDFG 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 a few different methods and/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 CDFG 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 treats the entire schedule as two periods, a tagging period and a recapture period. This is the most simplistic 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 because they 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. The Schaefer is utilized for the fall-run on tributaries on Deer, Mill and Clear Creek(s). Beginning in 2001, the Jolly-Seber method was selected by CDFG statisticians and managers 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):

During 2007, the estimates from the RBDD were based on daily ladder counts made by the USFWS and by the fish-trap sampling conducted by the CDFG at the dam (late-fall-run excluded). Ladder counts were obtained through a combination of closed-circuit television monitoring and digital video recording 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 or when the dam gates were temporarily opened. Adjustments to lapses in daytime counts were made by interpolation. The adjusted (if necessary) 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).   In 2007, a fin tissue sample from selected trapped salmon was taken for a separate genetic analysis study being conducted by the USFWS.

Estimated numbers of salmon for the periods when the fish ladders were not operated (September to 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 the years prior to 1988, when the RBDD was operated throughout the year. During this time 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 salmon 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, the years 1982 to 1986 were selected to be used as the historical average framework due to the reduced numbers of winter-run seen at RBDD during these years. It was reasoned that this selected period of time more closely mirrors the current low numbers in winter-run populations.

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

The total for the 2007 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 + any 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., 53% fall, 30% spring, and 17% winter) (see Appendix table A-2 week 25 for this RBDD data).
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 2007 total fish counted = 948, sum of historical percent during weeks of actual counts = 15.42%, thus total 2007 winter-run estimate is 948 * 100% /15.42% = 6,144 fish), (**note**: actual numbers not rounded until final estimate)
6) The RBDD data for 2007 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 CDFG and the USFWS now conduct 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 2007, a CDFG airplane was used to conduct monthly surveys for the late-fall, spring, and fall-run redd distributions. During the winter-run spawning period, 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 areas and 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 CDFG. 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) (1969-2007), Appendix Table A3. The aerial redd data is also used to estimate spawning escapement in the Sacramento main-stem downstream of both the RBDD and carcass survey areas. The ratio of redds upstream to redds downstream is used in conjunction with the upstream escapement estimate of either the carcass surveys or the RBDD. A simple proportion is used to calculate the downstream estimate. The proportion is constructed as follows: Number of salmon downstream = (salmon upstream after harvest in main-stem / redds upstream) * redds downstream.

Table 2. Summary of redd data collected from aerial flights for year 2007.

2007 Summary of Aerial Redd Survey Data**

Late-Fall~	% Dist	Winter	% Dist.	Spring	% Dist.	Fall	% Dist	ALL	% Dist.	RIVER SECTIONS
565	57%	149	52%	6	20%	221	20%	941	39%	Keswick to A.C.I.D. Dam.
25	3%	90	31%	7	23%	57	5%	179	7%	A.C.I.D. Dam to Highway 44 Bridge
21	2%	32	11%	6	20%	129	12%	188	8%	Highway 44 Br. to Airport Rd. Br.
122	12%	6	2%	4	13%	152	14%	284	12%	Airport Rd. Br. to Balls Ferry Br.
69	7%	5	2%	0	0%	116	10%	190	8%	Balls Ferry Br. to Battle Creek.
56	6%	4	1%	2	7%	124	11%	186	8%	Battle Creek to Jellys Ferry Br.
15	2%	2	1%	3	10%	77	7%	97	4%	Jellys Ferry Br. to Bend Bridge
19	2%	0	0%	2	7%	42	4%	63	3%	Bend Bridge to Red Bluff Diversion Dam
68	7%	0	0%	0	0%	132	12%	200	8%	Red Bluff Diversion Dam to Tehama Br.
6	1%	0	0%	0	0%	34	3%	40	2%	Tehama Br. To Woodson Bridge
21	2%	0	0%	0	0%	13	1%	34	1%	Woodson Bridge to Hamilton City Br.
0	0%	0	0%	0	0%	12	1%	12	0%	Hamilton City Bridge to Ord Ferry Br.
0	0%	0	0%	0	0%	2	0%	2	0%	Ord Ferry Br. To Princeton Ferry.
987	**100%**	**288**	**100%**	**30**	**100%**	**1,111**	**100%**	**2,416**	**100%**	

** Summary of 4 late-fall run, 9 winter-run, 1 spring-run, and 3 fall-run flights.
~ Late-fall run redd counts include survey on 20-Dec-2006.

Aerial redd surveys do not provide complete counts of new redds. Variability in turbidity, river depth, riparian vegetation, weather and wind all effect the ability of the observer to count new redds. Analysis of redd data should be done with caution. The staff of the SRSSAP recommend using aerial redd data only for comparisons of redd distributions by river sections or for specific needs such as use of a specific area as a spawning location.

The SRSSAP conducted 17 aerial redd flights for the 2007 escapement surveys (Table 2). **Four late-fall**-run surveys were conducted between 20 December 2006 and 06 April 2007. The majority of late-fall-run redds were from the Anderson Cottonwood Irrigation District Dam (ACID) upstream to Keswick Dam (57%). **Nine winter-run** flights using a helicopter from 10 May through 05 July were conducted. Winter-run redds were observed from Keswick Dam to just upstream of the Bend Bridge (RM 258). The majority of these redds (83%) were located between Keswick Dam and the Highway 44 Bridge in Redding (Turtle Bay area). **One spring-run** flight was conducted on 20 September. A total of 30 redds were observed from Keswick Dam to just above the RBDD**. Three fall-run** flights between 23 October and 30 November reported fall-run redds from the Princeton upstream to Keswick Dam. The fall-run redds were fairly evenly distributed from Keswick Dam downstream to the Tehama Bridge, that is located below the RBDD.

In summary, during 2007 there were 2,416 new redds observed in the main-stem from Keswick Dam to Princeton Ferry (RM 164) over a total of 17 flights. The majority of these redds (88%) were upstream of Red Bluff Diversion Dam. Appendix Table A3 presents a summary of historical aerial redd information for years 1969-2007.

The 2007 Salmon Runs in the Upper Sacramento River

Late-fall-run No estimates were made for the late-fall-run at the RBDD. Although some late-fall salmon use tributaries to the USRB (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. One should note that late-fall salmon 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 2006 spawners are put into 2007 estimate and December of 2007 spawners will be part of the 2008 estimate).

A main-stem carcass survey was conducted from 26 December 2006 through 09 May 2007. 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 2007 the USRB experienced few rain runoff/flood events. As a result survey conditions were ideal for tagging and recapturing carcasses. The spawner population estimate for the 2007 main-stem late-fall-run was 15,341 including spawners outside the survey area (using aerial redd proportions).

Appendix Table A4 provides a data summary of the 2007 late-fall-run main-stem population. Crews observed a total of 4,791 carcasses. Crews tagged 2,327 of these and recaptured 1,323 for a recapture rate of 56.9%; which is a typical rate for a main-stem carcass survey under good conditions. Crews measured 926 fresh fish, and a grilse (2 year old) percentage of 0.8% was estimated based on a length cut-off of 610-female and 650-male (millimeters). Males represented 40% of the population. Females were checked for egg retention following spawning. Only 9 of 661 fresh females (1.4%) had not completely spawned. All fish examined were checked for adipose fin clips representing hatchery origin from the CNFH on Battle Creek. Seventy-two salmon of the total 4,791 examined had an adipose (or unknown adipose) fin clip in 2007. Coded wire tags (CWT) were recovered from 63 of these carcasses. Three of these were winter-run salmon from Livingston Stone National Fish Hatchery (LSNFH) and the remaining 60 were late-fall-run from the Coleman National Fish Hatchery (CNFH), (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 CDFG's Angler Harvest Survey was discontinued in July of 2003, which caused biologists to use an average estimated harvest of late-fall salmon above Knights Landing in late 2006 and early 2007. This average catch was calculated to be **2,741** fish, (1,373 upstream RBDD). This estimate was developed using historical average Angler Harvest Survey data and includes half of November's 2006 harvest (other half is considered fall-run), all of December 2006, and January 2007. 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 2007 as those fish are classified as year 2008 fish for the purposes of this report.

The CNFH spawned and excessed late-fall salmon from December 2006 through February 2007. The hatchery total was **3,385** late-falls spawned and excessed, (includes 66 fish removed at Keswick trap), (Robert Null, USFWS, personal communication). In addition, 234 natural origin (non-adipose fin clipped) late-fall-run salmon were allowed to pass upstream of the barrier weir at CNFH. The staff at the CNFH allows natural origin salmon to pass upstream as these fish may be natural origin late-fall, spring or winter-run salmon.

Based on the carcass survey, angler harvest estimate, CNFH data, and aerial redd data it is estimated that **at least 21,701 late-fall-run** salmon were present above Knights Landing in late 2006 and early 2007 (Table 1), (Note the SRSSAP monitoring begins at Princeton; Angler Survey data above Knights Landing is used since fish caught above Knights Landing were likely destined to spawn in the USRB). 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.

<u>Winter-run</u>

Carcass Survey: From 1996 to 2005, an annual CDFG report dedicated to the winter-run main-stem 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. Appendix C-1 provides readers with an extensive summary table of the winter-run data collected in 2007 and previous years. This table, and all other data found in this report is available upon request in spreadsheet format. Requests can be directed to authors listed in the Summary section of this report.

The mark and recapture carcass survey for winter-run salmon was conducted on the Upper Sacramento River from 1 May through 24 August 2007 (Appendix Table A5). Based on a sample size of 811 tagged large female carcasses and the subsequent recapture of 565 (recovery rate of 70%) of these carcasses, a population estimate of **2,541** winter-run salmon was obtained using the Jolly-Seber model and subsequent adjustments. The carcass survey results were based upon large (>609 mm) female carcasses. The total number of spawning females in the main-stem Sacramento River was 1,578 (including the females retained at Livingston Stone National Fish Hatchery (LSNFH)(n = 28) and the main-stem grilse (n = 8)), (Appendix Table A5).

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 CDFG has chosen for regulatory purposes that the population estimates from the carcass survey will be used in reporting the winter-run salmon estimate.* Data is still presented for the RBDD in order to continue trend data that has been available over the past 35 years.

Red Bluff Diversion Dam: The RBDD estimate for the 2007 winter-run was **6,144**. This included and estimated 5,238 natural-origin salmon (all hatchery winter-run have adipose fin-clipped off) and 906 hatchery-origin winter-run. Winter-run fish migrate past the RBDD from December through August. Winter-run passing the RBDD in December of 2006 were part of the 2007 estimate based on traditional run timing (Appendix Table A1). All of these fish were thought to have spawned in the main-stem Sacramento River above Red Bluff. (The LSNFH collected **54** winter-run for the brood stock program).

Other Winter-run Data: Nine 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 the RBDD, and the total estimate of winter-run passing the RBDD, are used to calculate the winter-run estimate for downstream of the RBDD. In 2007, no winter-run redds were observed downstream of the RBDD during aerial flights. Therefore, the winter-run population estimates downstream of the RBDD is zero using the RBDD methodology, and also zero using the “official” carcass survey methods in Table 1.

There was no estimated angler harvest of winter-run above or below the RBDD due to a zero salmon possession limit from 15 January through 16 July 2007 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 summary for 2007, the official carcass survey reported an escapement of 2,541 winter-run salmon, (Table 1). In contrast, the historical RBDD winter-run estimate was 6,144 winter-run salmon (Table A2). The reason for the large decline in winter-run numbers between 2006 (17,304) and 2007 (2,541) is not known. One common hypothesis (among biologists) for the decline was that poor upwelling conditions occurred in the ocean during the years 2004-2006. This may have led to limited food availability for the juveniles from the 2004 year class (or the 2007 adults). There has been much focus on determining the cause of the decline, since both winter and fall-run salmon populations were reduced. At present it is felt that in-river conditions (temperature, flow, delays, pollution, etc) did not primarily cause the decline as conditions have remained relatively constant over the past years and populations of winter-run were increasing during the past few year classes (positive cohort replacement rates). Whatever the cause, the low 2007 escapement of winter-run was a setback for the recovery of this endangered species.

<u>Spring-run</u> Spawning of natural origin spring-run natal to the main-stem Sacramento River is considered by the CDFG to have largely been eliminated through competition plus hybridization with fall-run salmon (CDFG, 1998). Historically spring-run salmon migrated upstream in the spring and 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 not be genetically isolated.

In 2007 and previous years, attempts to prevent the spatial overlap of spawning fall and spring-run through the use of a temporary picket weir occurred on Clear Creek (USFWS: Jim Early personal comm.). In Battle Creek a fish ladder is operated in a manner to allow spring-run passage upstream of CNFH early in the year. The ladder is closed later in the summer to prevent early arriving fall-run from getting above the CNFH (USFWS: Jess Newton, personal comm.).

The possibility of utilizing the ACID dam on the main-stem Sacramento River to create a spring-run "sanctuary" has been recently discussed. The CDFG does not support this idea because of the temporal overlap between the winter, spring and fall-run populations in this river section during the summer months. In addition, there is a current lack of a reliable means to genetically identify individual spring-run from fall-run that would likely prevent success of isolating spring-run above ACID. Currently, the CDFG cannot make reliable carcass survey estimates of spring-run upstream of RBDD in the main-stem river. This is because of the overlap between the two runs and the lack of a suitable means of distinguishing them.

There is no main-stem Sacramento River spring-run carcass survey, instead results from the RBDD, aerial redd surveys, and the combined totals of Beegum, Battle, and Clear Creek(s) (snorkel surveys of holding areas) are used to provide an index of main-stem spring-run. An estimated 767 salmon showing spring-run characteristics passed RBDD in 2007 (Appendix Table A2). This number is more than the 519 total spring-run cumulatively counted in Beegum Creek (34) (authors), and in Clear Creek (194) and

Battle Creek (291) (Jess Newton, USFWS, pers. comm.). Using this traditional RBDD methodology the remainder of these fish (767-519) or 248 was “assigned” to the main-stem Sacramento River. Of these fish, only the Beegum Creek salmon were spatially isolated from the fall-run by natural means.

The difficulties encountered in determining a spring-run estimate on the Sacramento River include the spring and fall-run mixing, and also the occurrence of spring-run from the Feather River Hatchery (FRH), that commonly stray into the USRB. Using the data from the traditional methodology indicates a main-stem estimate of 248, (Table 1). There is considerable uncertainty and disagreement 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 the ESA listed “threatened” 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.

One spring-run flight was conducted on 20 September 2007 in which 30 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, **767** spring-run salmon were estimated above RBDD. Data for below RBDD includes the tributaries: Mill (920) (redd survey), Antelope (26), and Deer Creek(s) (644) snorkel surveys (Harvey-Arrison) for a downstream (RBDD to Princeton) spring-run total of 1,590. In Mill Creek, water clarity prohibits reliable underwater snorkel survey observations, consequently an annual walking redd survey is conducted and expanded into a population estimate.

The total 2007 spring-run escapement to the USRB was at least **2,357** (Table 1). Note that Butte (4,943) and Big Chico Creek(s) (0) spring-run results are presented in a separate report, since both creeks enter the Sacramento River below Princeton CA, (Tracy McReynolds, CDFG, 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 **17,060** salmon spawned in the main-stem Sacramento 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 2,851 non adipose fin clipped adult females for this section. This number is expanded to account for the 65.3% of redds (aerial redd data) located outside of the carcass survey reach. Further expansions for hatchery fish, small grilse, and adult males result in a final estimate of 17,060 for the entire main-stem.

Red Bluff Diversion Dam: An estimated 20,710 fall-run salmon passed the RBDD in 2007 (Appendix Table A2). A recurring problem was encountered with the RBDD fall-run estimate in 2007. Results of the hatchery counts for Battle Creek alone were larger than the total RBDD estimate. For the seventh consecutive year, the RBDD estimate for the main-stem Sacramento River resulted in a negative number. 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 7 years. A number of possibilities exist including:
1. The fall-run was late arriving to RBDD in 2007.
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.**

The CDFG re-initiated an angler survey project in 2007 with CALFED-ERP funding. The overall results of this angler survey are available in a separate report. For summary purposes the salmon caught in the Sacramento River upstream of Knights Landing (i.e. above the mouth of the Feather River and a Angler Survey section break) are assumed to have been destined for the USRB and are included in Table 1 for purposes of estimating the **total** Chinook salmon escapement to the USRB as compared to an estimate of **spawner** escapement.

The angler survey does not currently attempt to distinguish between fall and late-fall-run harvest. For summary purposes the fall-run is assumed to be all salmon caught above Knights Landing from July though October and one-half of the November catch. Late-fall-run salmon are assumed to be all salmon caught above Knights Landing during December and January and one half of the November catches. In 2007, the fall-run estimate using this method for the USRB was 4,918 (Table 1), including 3,242 downstream of RBDD and 1,676 upstream of RBDD. The harvest in November and December of 2007 will be included in the 2008 late-fall-run harvest.

In previous years, with no angler survey available, an average harvest percentage for the survey years 1998-2002 (11.7% of the entire run) was applied to the spawning escapement estimate to determine the angler harvest. It is of interest to note that if this method were applied in 2007 an estimated 5,688 salmon would have been taken by anglers, a difference of only 770 salmon higher than the actual survey estimate.

An estimated 29,244 salmon entered tributaries above Red Bluff. These included estimates for: Battle (9,904 in-stream and 11,778 CNFH) and Clear creeks (4,129), also for the second consecutive year a fall-run estimate was made for Cow Creek (2,044) using the video station technology that has been used on Battle Creek since 2003. In addition, new video stations on Cottonwood and Bear Creek(s) were utilized and resulted in estimates of 1,250 for Cottonwood and 140 for Bear Creek(s) The overall fall-run estimate upstream of RBDD was 45,017 (Table 1) but this number did not include salmon that used other tributaries to the upper main-stem that were not surveyed (Paynes, Inks, Sulphur and Ash Creek(s) etc.). These systems were traditionally accounted for in the RBDD estimate, but this has not been the case since 2001, when the main-stem carcass survey was used. Additionally, a combined estimate of 1,304 was made for fall-run escapement to Mill Creek (796) and Deer Creek (508) (Harvey-Arrison).

In summary, total fall-run escapement to the Upper Sacramento River Basin above Princeton is estimated to be at least **52,527** 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 this data to meet specific needs. There are numerous categories (total populations, spawner populations, etc) included in this data, and readers should contact the authors of this report (and other reports) directly to ensure that the data required is available. The data for this report is available electronically and can be sent directly to interested readers with appropriate categories and data limitations explained.

Sacramento River Tributaries: Specific Estimates

Clear Creek

Late-Fall-run No escapement estimates were conducted for this run in 2007.

Spring-run The USFWS conducts snorkel surveys in August as an annual index of spring-run abundance. In 2007, during the August survey 194 spring-run were counted. A temporary picket weir was again installed to spatially separate spring-run from fall-run spawners in this creek.

Fall-run Ten weekly fall-run spawner surveys of lower Clear Creek were made during 2007 in the 6.7 km (4.2 mi) reach downstream of the former McCormick-Saeltzer Dam site. An estimated population of **4,129** fall-run salmon resulted (Harvey-Arrison).

Fourteen coded-wire-tags (CWT's) were recovered in Clear Creek. Three of these were labeled as spring-run from the Feather River Hatchery. Another one was from the Merced River fish facility and the remaining 10 were from CNFH, (Appendix Table B4).

Cow Creek

Late-Fall-run   No surveys for this run in this tributary were made in 2007.

Fall-run   A video monitoring station located in lower Cow creek reported **2,044** 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, 08-2, 2008). The station recorded fish passage 24/7 using an overhead camera from 20 September to 06 December 2007. This was the second time since 1984 that an estimate was available for Cow Creek.

Bear Creek

Fall-run   A video monitoring station located in lower Bear Creek reported **140** fall-run salmon. The station was set-up about 1.5 miles from the confluence of Bear Creek and the Sacramento River. Specific details of the station and data are available in a separate report, (Chichester, 2008). The station recorded fish passage 24/7 using an overhead camera from 20 September to 17 December 2007. This was the first time a video station was used to produce an estimate and provide a complete count of fall-run salmon in Bear Creek. In previous years, selected sections of the creek were walked, and population counts made were based on live fish and redd counts.

Cottonwood Creek

Late-fall-run   No surveys for this run in this tributary were made in 2007.

Spring-run   **Thirty-four** spring-run Chinook were estimated in Beegum Creek a tributary to the Middle Fork of Cottonwood Creek in 2007.

Fall-run   A video monitoring station located in lower Cottonwood Creek reported **1,250** 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, 08-3, 2008). The station recorded fish passage 24/7 using an overhead camera from 17 September to 06 December 2007. This was the first time a video station was used to produce an estimate in Cottonwood Creek, and the first time since 1992 that an estimate was made for Cottonwood Creek.

Battle Creek

Late-fall-run   No in-river surveys were made for naturally spawning late-fall-run in Battle Creek in 2007. The CNFH reported that 3,319 fish entered the facility.

Spring-run   The USFWS monitors spring-run passage in Battle Creek using the CNFH fish ladder. If water temperatures are below 60 degrees (Fahrenheit) salmon may be trapped for adipose fin clip observations and for genetic sample collection. Trapped salmon with an adipose fin clip representing hatchery origin are taken into the hatchery. Salmon with no clip are allowed to pass upstream. If water temperature is above 60 degrees (F) a video monitoring system is installed in the ladder and salmon are counted as they pass. An estimated 291 Spring-run were counted in Battle Creek in 2007. (USFWS: Jess Newton, personal com.).

Fall-run   The data from the Battle Creek Video Station was used to estimate the in-creek population. In 2007, an estimated **21,682** total fall-run passed the video station. The CNFH reported that **11,778** (Table 1) of these entered into the hatchery leaving a remainder of **9,904** for an in-creek spawning population estimate.

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 341 fresh carcasses from 11 October to 16 November. In the survey 58% of the carcasses were adult females, 41% adult males, and 0.6% jack grilse. In contrast, the CNFH reported 56% adult females, 42% adult males and 2% jack grilse. In addition to these findings, it was observed that 0.9% (n = 3) 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 13% of the females observed were unspawned, (died before spawning). This number, although large for most USRB waters, is typical for Battle Creek.

In years 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 2007, 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.

Beginning in 2006, the CALFED ERP funded a mass marking program with a goal of adipose fin clipping and implanting CWT's in 25 percent of the California's Central Valley hatchery fall-run production. This was the second year that the program was in operation. Salmon from the 2006 tagging effort are expected to begin appearing in the USRB spawner surveys during the fall of 2008, as 2-year old grilse.

Antelope Creek

Spring-run   On July 10, 2007 Antelope Creek, Tehama County, was snorkel-surveyed to count holding adult Spring-run. Twenty six (**26**) adult salmon were observed. (Harvey Arrison).

Fall-run No surveys for this run in this tributary were made in 2007, 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 **920** spring-run Chinook spawned in Mill Creek in 2007. This was based on redd surveys of 41 miles of the creek made between 2 and 12 October 2007, (Harvey-Arrison).

In 2007, a video station was used for the first time to count incoming and outgoing steelhead and spring-run Chinook salmon on lower Mill Creek. Results of the study are detailed in Killam and Johnson, 2008. The station was located about 1.8 miles from the mouth of Mill Creek. It was operated from 06 March to 18 June 2007. During this period an estimated 67 upstream moving steelhead and 145 downstream or “kelt” steelhead were observed. In addition 1,060 spring-run salmon were counted. The peak of spring-run passage was 03 May with passage occurring from 08 March through 07 June. The station’s success on the notoriously turbid Mill Creek proved that species other than fall-run salmon can be successfully counted using the video station techniques developed by the SRSSAP office.

Fall-run Six weekly spawner surveys were made between 31 October and 6 December covering the 8 mile creek section between the canyon mouth and the confluence with the Sacramento River. In 2007, an estimated minimum of **796** fall-run Chinook were present in Mill Creek in (Harvey-Arrison).

Deer Creek

Spring-run On 24 July, 2007, Deer Creek, Tehama County, was snorkel surveyed to count holding adult spring-run. There were **644** spring-run observed**.** Twenty-four miles of stream was surveyed, (Harvey-Arrison).

Fall-run Six weekly spawner surveys were made between 26 October and 30 November covering the reach between the USGS stream flow gauge and the Highway 99 East Bridge. In 2007, an estimated minimum of **508** fall-run Chinook were present Deer Creek (Harvey-Arrison).

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REFERENCES

California Department of Fish and Game. 1998. A status review of the spring-run Chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River drainage, Candidate Species Status Report 98-01, June 1998.

Chichester, J. 2008. Results of the 2007 Bear Creek video station fall-run Chinook salmon escapement. Western Shasta Resources Conservation District, Project Report 35-31. 2008.

Harvey-Arrison, C. 2008, Chinook salmon Monitoring in Clear, Antelope, Mill, and Deer Creeks for 2007.SRSSAP Sport Fish Restoration Annual Progress Report (in prep)

National Marine Fisheries Service. 1996. Recommendations for the recovery of the Sacramento River winter-run Chinook salmon. Nat. Marine Fish. Serv.

Southwest Region. Long Beach, CA

Killam, D. S. 2008. Results of the 2007 Cow Creek video station fall-run Chinook salmon escapement. SRSSAP. Tech. Report No. 08-2, 2008.

Killam, D. S. 2008. Results of the 2007 Cottonwood Creek video station fall-run Chinook salmon escapement. SRSSAP. Tech. Report No. 08-3, 2008.

Killam, D. S. and M. Johnson 2008. The 2007 Mill Creek video station steelhead and spring-run Chinook salmon counts. SRSSAP. Tech. Report No. 08-1, 2008.

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 Winter Run		1970-1988 Spring Run		1970-1988 Fall Run		1970-1986 Late-Fall		1970-1988 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	0.26	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 2007 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 2007 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	8	7	0%	53%	47%	374	0	199	175	0.00%	2.16%	2.17%	0.23%	0
21	0	1	2	0%	33%	67%	269	0	90	179	0.00%	2.63%	3.09%	0.18%	0
22	0	2	3	0%	40%	60%	323	0	129	194	0.01%	2.86%	2.03%	0.20%	0
23	1	2	8	9%	18%	73%	217	20	39	158	0.00%	2.61%	1.63%	0.13%	0
24	6	0	3	67%	0%	33%	320	213	0	107	0.01%	2.93%	1.84%	0.14%	0
25	16	9	5	53%	30%	17%	294	157	88	49	0.03%	3.50%	0.51%	0.15%	0
26	25	4	3	78%	13%	9%	147	115	18	14	0.08%	3.10%	0.76%	0.18%	0
27	16	0	0	100%	0%	0%	105	105	0	0	0.10%	3.67%	1.60%	0.13%	0
28	46	0	2	96%	0%	4%	195	187	0	8	0.29%	6.02%	0.31%	0.18%	0
29	47	1	4	90%	2%	8%	303	274	6	23	0.49%	4.75%	1.04%	0.18%	0
30	55	0	0	100%	0%	0%	312	312	0	0	0.70%	3.21%	0.44%	0.22%	0
31	9	0	0	100%	0%	0%	142	142	0	0	0.96%	4.12%	0.01%	0.26%	0
32	13	0	2	87%	0%	13%	144	125	0	19	1.68%	6.97%	0.00%	0.39%	0
33	5	0	1	83%	0%	17%	132	110	0	22	2.95%	6.07%	0.00%	0.68%	1
34	7	0	0	100%	0%	0%	372	372	0	0	3.53%	6.75%	0.00%	1.12%	6
35	58	0	0	100%	0%	0%	583	583	0	0	3.91%	5.74%	0.00%	2.36%	4
36	148	0	0	100%	0%	0%	1,280	1280	0	0	4.54%	7.22%	0.00%	3.82%	24
Totals	452	27	40				5,512	3,994	570	948	19.29%	74.30%	15.42%	10.54%	35
Note: F = Fall, S= Spring, and W = Winter-run							Total 2007	20,710	767	6,144					

Expanded Red Bluff Diversion Dam Trap and Upstream of RBDD System Information-2007

RBDD Actual Trap				Estimate for System above RBDD				
F	S	W	Total	Fall	Spring	Winter	Total	SUMMARY OF MAJOR CATEGORIES
573	27	45	645	20,710	767	6,144	27,621	**ALL SALMON (both Ad-clipped and Natural).**
530	26	38	594	19,020	754	5,238	25,012	NATURAL (non-ad-clipped) fish.
92%	96%	84%	92%	92%	98%	85%	91%	% Natural Fish.
43	1	7	51	1,690	13	906	2,609	AD-CLIPPED fish.
8%	4%	16%	8%	8%	2%	15%	9%	% Ad-Clipped Fish
549	17	22	588	19,842	483	3,004	23,329	ADULTS (all fish greater than 609 mm).
96%	63%	49%	91%	96%	63%	49%	84%	% Adults.
24	10	23	57	867	284	3,140	4,292	GRILSE (all fish less than 610mm).
4%	37%	51%	9%	4%	37%	51%	16%	% Grilse.
269	17	32	318	10,056	483	4,369	14,908	MALES (all fish). *Note River estimate #'s for unknowns added here.
47%	63%	71%	49%	49%	63%	71%	54%	% Males (of all fish).
285	10	13	308	10,654	284	1,775	12,713	FEMALES (all fish). *Note River estimate #'s for unknowns added here
50%	37%	29%	48%	51%	37%	29%	46%	% Females (of all fish).
19	0	0	19	687	0	0	687	UNKNOWN SEX (all fish). These fish already added to above categories.
3%	0%	0%	3%	3%	0%	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
507	16	16	539	18,194	464	2,205	20,864	Natural Adults
23	10	22	55	825	290	3,032	4,148	Natural Grilse
42	1	6	49	1,650	13	777	2,440	Ad-Clipped Adults
1	0	1	2	39	0	129	169	Ad-Clipped Grilse
253	17	30	300	9,362	493	4,135	13,990	male natural
261	9	8	278	9,658	261	1,103	11,022	female natural
16	0	0	16	574	0	0	574	unknown sex natural
16	0	2	18	676	0	259	935	male ad-clipped
24	1	5	30	1,014	13	647	1,674	female ad-clipped
3	0	0	3	118	0	0	118	unknown ad-clipped
246	7	9	262	9,192	199	1,229	10,620	male adults
285	10	13	308	10,650	284	1,775	12,709	female adults
18	0	0	18	651	0	0	651	unknown adults
23	10	23	56	867	284	3,140	4,292	male grilse
0	0	0	0	0	0	0	0	female grilse
1	0	0	1	36	0	0	36	unknown grilse
231	7	8	246	8,542	203	1,103	9,848	male natural adults
261	9	8	278	9,652	261	1,103	11,016	female natural adults
15	0	0	15	538	0	0	538	unknown natural adults
22	10	22	54	825	290	3,032	4,148	male natural grilse
0	0	0	0	0	0	0	0	female natural grilse
1	0	0	1	36	0	0	36	unknown natural grilse
15	0	1	16	635	0	129	764	male ad-clipped adults
24	1	5	30	1,016	13	647	1,676	female ad-clipped adults
3	0	0	3	118	0	0	118	unknown ad-clipped adults
1	0	1	2	39	0	129	169	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 1969-2007.

Percentages of redds in main-stem Sacramento from aerial flights (up and downstream of RBDD)

YEAR	Late-Fall		Winter-Run		Spring-Run		Fall-Run		ALL COMBINED	
	% Up	% Down	% Up	% Down	% Up	% Down	% Up	% Down	% Up	% Down
1969	n/a	n/a	n/a	n/a	n/a	n/a	74.4%	25.6%	74.4%	25.6%
1970	n/a	n/a	n/a	n/a	n/a	n/a	85.6%	14.4%	85.6%	14.4%
1971	n/a	n/a	n/a	n/a	n/a	n/a	68.5%	31.5%	68.5%	31.5%
1972	67.2%	32.8%	n/a	n/a	n/a	n/a	63.5%	36.5%	64.8%	35.2%
1973	75.9%	24.1%	n/a	n/a	n/a	n/a	69.9%	30.1%	74.7%	25.3%
1974	n/a	n/a	n/a	n/a	n/a	n/a	60.9%	39.1%	60.9%	39.1%
1975	n/a	n/a	n/a	n/a	n/a	n/a	56.4%	43.6%	56.4%	43.6%
1976	64.7%	35.3%	n/a	n/a	n/a	n/a	72.9%	27.1%	71.9%	28.1%
1977	n/a	n/a	n/a	n/a	n/a	n/a	45.1%	54.9%	45.1%	54.9%
1978	25.6%	74.4%	n/a	n/a	n/a	n/a	46.0%	54.0%	43.2%	56.8%
1979	42.7%	57.3%	n/a	n/a	n/a	n/a	53.9%	46.1%	52.0%	48.0%
1980	n/a	n/a	n/a	n/a	n/a	n/a	48.7%	51.3%	48.7%	51.3%
1981	63.5%	36.5%	87.8%	12.2%	n/a	n/a	63.0%	37.0%	63.5%	36.5%
1982	n/a	n/a	97.0%	3.0%	n/a	n/a	67.1%	32.9%	67.5%	32.5%
1983	71.2%	28.8%	n/a	n/a	81.1%	18.9%	47.6%	52.4%	59.3%	40.7%
1984	78.9%	21.1%	n/a	n/a	93.3%	6.7%	66.6%	33.4%	67.2%	32.8%
1985	81.5%	18.5%	71.8%	28.2%	78.6%	21.4%	55.5%	44.5%	56.3%	43.7%
1986	72.8%	27.2%	n/a	n/a	100.0%	0.0%	64.5%	35.5%	64.9%	35.1%
1987	64.1%	35.9%	95.5%	4.5%	n/a	n/a	71.4%	28.6%	71.0%	29.0%
1988	98.9%	1.1%	74.5%	25.5%	97.4%	2.6%	77.9%	22.1%	78.3%	21.7%
1989	41.9%	56.4%	97.9%	2.1%	100.0%	0.0%	83.3%	16.7%	82.6%	17.4%
1990	87.4%	12.6%	93.3%	6.7%	100.0%	0.0%	66.8%	33.2%	67.8%	32.2%
1991	81.6%	18.4%	100.0%	0.0%	100.0%	0.0%	66.9%	33.1%	67.8%	32.2%
1992	85.8%	14.2%	96.4%	3.6%	100.0%	0.0%	73.8%	26.2%	75.1%	24.9%
1993	100.0%	0.0%	97.7%	2.3%	100.0%	0.0%	72.5%	27.5%	72.7%	27.3%
1994	77.0%	23.0%	100.0%	0.0%	85.1%	14.9%	77.8%	22.2%	77.8%	22.2%
1995	61.9%	38.1%	99.4%	0.6%	90.9%	9.1%	83.5%	16.5%	83.5%	16.5%
1996	n/a	n/a	100.0%	0.0%	100.0%	0.0%	85.5%	14.5%	86.0%	14.0%
1997	n/a	n/a	100.0%	0.0%	99.0%	1.0%	82.8%	17.2%	83.6%	16.4%
1998	97.2%	2.8%	97.9%	2.1%	100.0%	0.0%	90.6%	9.4%	92.5%	7.5%
1999	n/a	n/a	100.0%	0.0%	100.0%	0.0%	78.8%	21.2%	99.0%	1.0%
2000	98.6%	1.4%	100.0%	0.0%	100.0%	0.0%	90.8%	9.2%	94.7%	5.3%
2001	95.2%	4.8%	99.6%	0.4%	96.6%	3.4%	76.9%	23.1%	86.2%	13.8%
2002	100.0%	0.0%	99.8%	0.2%	100.0%	0.0%	69.3%	30.7%	80.5%	19.5%
2003	97.3%	2.7%	99.7%	0.3%	100.0%	0.0%	74.5%	25.5%	79.8%	20.2%
2004	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	78.1%	21.9%	87.1%	12.9%
2005	90.2%	9.8%	100.0%	0.0%	84.8%	15.2%	78.8%	21.2%	90.9%	9.1%
2006	75.5%	24.5%	99.7%	0.3%	100.0%	0.0%	84.0%	16.0%	86.5%	13.5%
2007	90.4%	9.6%	100.0%	0.0%	100.0%	0.0%	82.6%	17.4%	88.1%	11.9%
AVERAGE	**78%**	**22%**	**96%**	**4%**	**96%**	**4%**	**71%**	**29%**	**73%**	**27%**

n/a = not available

Appendix Table A4. Summary of the 2007 Late-fall-run Chinook carcass survey results for the main-stem Sacramento River.

2007 Mainstem Sacramento River Late-Fall-Run Chinook Salmon

Survey conducted from 26 Dec 2006 through 9 May 2007. 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	643	254	1,071	349	1	5	2	2	**2,327**
Chopped+	57	49	1,543	731	0	0	2	10	**2,392**
Hatchery	19	8	30	12	0	0	0	3	**72**
TOTAL	**719**	**311**	**2,644**	**1,092**	**1**	**5**	**4**	**15**	**4,791**
Recaptured	352	144	661	165	0	0	0	1	**1,323**

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

Notes: Weather, and flow conditions combined with full staffing resulted in the 2007 Late-Fall survey being conducted under ideal conditions

POPULATION ESTIMATE CALCULATIONS: Late-Fall-Run 2007 Mainstem

POPULATION ESTIMATE CATEGORIES	ESTIMATE	Adjustments	
Calculation for large female (Jolly Seber)	**5,504**	5,504	Jolly Seber mark-recapture calculation result
Large Female Ad-Clipped Fish In-River Adjustment	**5,667**	1.0296	* Based on Large Female Fresh Carcasses with final Ad-clips (19 of 660).
Number of All Large Females Downstream Redd Factor	**9,199**	1.6234	Redds below carcass survey location (379) total of 987 redds
Number Large Males (> 649 mm) from CNFH Data	**5,970**	0.6489	^ Based on the ratio of male large (>649) to female large at the CNFH: 1,061-male to 1635-female
Total Females	**9,213**	1.0015	Based on total females to large females from carcass survey fresh fish sample 1 small to 660 large
Total Males	**6,061**	1.0153	Based on total males to large males from carcass survey fresh fish sample 4 small to 261 large
	66	66	Number of LF fish transferred to CNFH from Keswick for Spawning
Final Estimate is **15,341** =	**15,341**		

In-River age composition				
Adult Females >2 yrs	9,199	Jills	14	Adults and Jills based on 610 mm cut-off (1 female <610mm vs 660 >609mm) of 661 total females) from length frequency analysis
Adult Males >2 yrs	5,947	Jacks	114	Adults and Jacks based on 655 mm cut-off (5 males <655mm vs 260 >654mm) of 265 total males) from length frequency analysis

* Adipose clipped carcasses are not part of the Jolly Seber Estimate since they are dissected to remove coded wire tags.
+ Note: Chopped non-fresh carcass categories include skeleton chops that were unknown ad-clip status, and some of these had unknown sex.
^ The carcass survey sex ratio of large fresh fish was 72% female, to account for males leaving the system while alive, the CNFH Late-fall data is instead used (61%).

Appendix Table A5. Summary of the 2007 Winter-run Chinook carcass survey results for the main-stem Sacramento River.

2007 Mainstem Sacramento River Winter-Run Chinook Salmon

Survey conducted from 1 May 2007 through 24 August 2007 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	501	150	310	71	3	20	2	6	1,063
Chopped+	30	26	224	128	0	1	3	15	427
Hatchery	42	4	36	6	0	2	0	1	91
TOTAL	573	180	570	205	3	23	5	22	1,581
Recaptured	339	92	226	46	1	7	1	4	716

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

Notes: The 2007 winter-run carcass survey resulted in the smallest population estimate since 1997. Water visibility was fair and the low number was not related to changing survey conditions. Many biologists focused on ocean conditions as the primary reason for the decline. The fall run salmon also declined in 2007 leading to hypothesis that poor ocean food supply for juvenile salmon caused the population crash.

POPULATION ESTIMATE CALCULATIONS: Winter-Run 2007 Mainstem

Jolly-Seber Calculation for large Female	1383.3	Adjustments	
Large Female Ad-Clipped Fish In-River Adjustment	1,483	1.0718	*Based on large female fresh:(>609mm) with Ad-clips (final) (37 of 552) = 6.7%
Number of All Large Females (>609 mm) Downstream Redds	1,542	1.0397	Eleven redds below carcass survey location: 288 new redds were observed during WR surveys,
Number Large Males (> 609 mm) from Keswick Trap Data	823	0.5340	^ Based on large males (>609) (n = 55) to large females (>609) (n = 103) at Keswick Trap
Total Females	1,550	1.0054	Based on total females to large females (>609mm) from fresh fish (555 total fresh: 3 small).
Total Males	937	1.1386	Based on total males to large males (>609mm) from fresh fish (189 total fresh: 23 small)
Number of Fish Removed from Population by LSNFH	54	54	USFWS Data from LSNFH Collections 2007.
Final Estimate is	**2,541**	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	1,542	Jills	8	Adults and Jills based on 600 mm cut-off (3 females <600 mm vs 552 >599mm) of 555 total females)
Adult Males >2 yrs	808	Jacks	129	Adults and Jacks based on 670 mm cut-off (26 males <670mm vs 162 >669mm) of 189 total males)

Carcass Population Component Breakdowns:

#'s From top	% of totals clipped	Total clipped	@ LSNFH %unclipped	CATEGORY	HATCHERY FISH In -River	HATCHERY FISH In-LSNFH	HATCHERY FISH Total	NATURAL FISH In - River	NATURAL FISH In-LSNFH	NATURAL FISH Total	OVERALL Total	OVERALL %	
1,542	0.0670	103	0.00310	Number of Adult Females (>599mm)	108	6	114	1,433	22	1,455	1,570	61.8%	Number of Adult Females
808	0.0245	20	0.00310	Number of Adult Males (>669mm)	22	2	24	786	22	808	832	32.8%	Number of Adult Males
8	0.0000	0	0.00057	Number of Grilse Females (Jills)	0	0	0	8	0	8	8	0.3%	Number of Grilse Females (Jills)
129	0.0385	5	0.00057	Number of Grilse Males (Jacks)	5	1	6	124	1	125	131	5.2%	Number of Grilse Males (Jacks)
2,487	Total in-river			TOTALS	135	9	144	2,352	45	2,397	2,541	100.0%	
54	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 75% female, to account for males leaving the system while alive, the Keswick Dam Trap data is instead used.

+ Note: Chopped non-fresh carcass categories include skeleton chops that were unknown ad-clip status, and some of these had unknown sex.

@ This is the number of LSNFH hatchery juvenile fish which accidentally did not receive ad-clips for the year: 2003 (.032%) for 4 year olds, 2004(.588%) for 3 year olds, and 2005 (.057%) for 2 year ol

@ 4 year old clips and 3 year old clips (adults) were averaged in for 2007 since both showed up in the CWT data base (.00032 + .00588) / 2 =.0031

Appendix Table A6. Summary of the 2007 Fall-run Chinook carcass survey results for the main-stem Sacramento River.

2007 Mainstem Sacramento River Fall-Run Chinook Salmon

Survey conducted from 24 Sept 2007 through 3 Jan 2008. Total of 15 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	290	103	489	149	0	9	1	7	**1,048**
Chopped+	25	22	766	366	0	1	3	14	**1,197**
Hatchery	22	3	15	5	0	0	1	0	**46**
TOTAL	**337**	**128**	**1,270**	**520**	**0**	**10**	**5**	**21**	**2,291**
Recaptured	121	33	192	59	0	0	0	0	**405**

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

Notes: Fall run 2007 went well. Low flows due to continued dry water conditions. Problems were encountered in accessing section 1 above ACID due to boat ramp renovations and low flows on the far shore. Conditions for carcassing were good, but there were not a lot of salmon to be surveyed.

POPULATION ESTIMATE CALCULATIONS: Fall-Run 2007 Mainstem

POPULATION ESTIMATE CATEGORIES	ESTIMATE	Adjustments	
Calculation for large female (Jolly Seber)	2,851	2,851	Jolly Seber mark-recapture calculation result
Large Female Ad-Clipped Fish In-River Adjustment	3,067	1.0756	* Based on Large Female Fresh Carcasses with final Ad-clips (22 of 313).
Number of All Large Females Downstream Redd Factor	8,827	2.8782	Redds within carcass survey location (386) of total of 1,111 redds
Number Large Males (> 609 mm) from RBDD Data	7,589	0.8596	^ Based on the ratio of male large (>609) to female large at theRBDD: 245-male to 285-female
Total Females	8,827	1.0000	Based on total females to large females from carcass survey fresh fish sample 0 small to 313 large
Total Males	8,233	1.0849	Based on total males to large males from carcass survey fresh fish sample 9 small to 106 large
Final Estimate is 17,060 =	**17,060**		

In-River age composition

Adult Females >2 yrs	8,827	Jills	0	Adults and Jills based on 610 mm cut-off (0 female <610mm vs 313 >609mm) of 661 total females) from length frequency analysis
Adult Males >2 yrs	7,374	Jacks	859	Adults and Jacks based on 675 mm cut-off (12 males <675mm vs 103 >674mm) of 115 total males) from length frequency analysis

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

+ Note: Chopped non-fresh carcass categories include skeleton chops that were unknown ad-clip status, and some of these had unknown sex.

^ The carcass survey sex ratio of large fresh fish was 75% female, to account for males leaving the system while alive, the RBDD fall data is instead used (54%).

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 1986-2007.

YEAR **	**Salmon Totals for Sacramento System above Princeton ^**				
	Late-Fall	**Winter**	**Spring**	**Fall**	**TOTALS**
1986	11,398	2,596	17,657	144,377	176,029
1987	26,438	2,186	11,435	134,686	174,746
1988	12,937	2,886	11,003	159,448	186,273
1989	31,261	696	5,895	96,271	134,123
1990	8,150	430	5,305	71,799	85,683
1991	8,591	211	1,607	56,277	66,686
1992	11,944	1,240	876	51,588	65,649
1993	n/a	387	716	71,314	72,416
1994	n/a	186	2,221	112,923	115,330
1995	n/a	1,297	2,082	169,556	172,935
1996	n/a	1,337	1,520	172,058	174,915
1997	n/a	880	793	249,118	250,791
1998	46,454*	3,002	4,096	119,114	172,666
1999	32,368*	3,288	2,660	308,745	347,061
2000	16,015*	1,352	1,442	184,987	203,796
2001	25,725*	5,523 / **8,100***	3,715	232,601*	270,141
2002	40,101*	9,172 / **7,441***	4,445	571,169*	623,156
2003	9,485*	9,757 / **8,218***	4,423	287,876*	310,002
2004	16,663*	7192 / **7,869***	2,380	162,596*	189,508
2005	19,776*	5,299 / **15,839***	3,697	272,229*	311,541
2006	18,023*	7,415 / **17,304***	3,822	168,584*	207,733
2007	21,701*	6,144/ **2,541***	2,357	52,527*	79,126
AVERAGE	21,002	4,058	4,279	174,993	199,559

^ 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 2007 collected during Sacramento River Salmon and Steelhead Assessment Project escapement surveys.

Brood Year	Clear	Sac. Riv.	Totals	Age	Percent
2005	0	4	4	2 year old	2.2%
2004	5	74	79	3 year old	43.4%
2003	9	89	98	4 year old	53.8%
2002	0	1	1	5 year old	0.5%
No tag data	0	29	29	unknown	
Totals	14	197	211		100.0%

Appendix Table B2. Summary of the 2007 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	3	11	0	0	14
Sacramento	27	14	68	59	168
Totals	30	25	68	59	182

^ Spring-run CWT data are salmon from the Feather River Hatchery (Clear Creek n = 3), (Sacramento main-stem n = 26) and from the rotary screw trap tagging of juvenile natural origin Butte Creek spring-run, (Sacramento River n = 1).

Appendix Table B3. Summary of the 2007 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	1	0.5%
Coleman National Fish Hatchery	68	37.4%
Feather River Hatchery	43	23.6%
Livingston Stone Hatchery	68	37.4%
Merced River Fish Facility	2	1.1%
CWT's with good reads: Total	182	100.0%
TAG NOT DETECTED (100000)	29	
Total Problem CWT's	29	13.7%
Overall CWT (found) Totals	182	percent Tag not detected
Total heads found to be hatchery	**211**	

Appendix Table B4. Summary of the 2007 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	Survey	**Clear**	**Sac Riv.**
51095	CNFH	CNFH	2002	late-fall	late-fall		1
51681	LSNFH	LAKE REDDING	2004	winter	winter		2
51683	LSNFH	LAKE REDDING	2004	winter	winter		5
51684	LSNFH	LAKE REDDING	2004	winter	winter		1
51685	LSNFH	LAKE REDDING	2004	winter	winter		2
51686	LSNFH	LAKE REDDING	2004	winter	winter		3
51687	LSNFH	LAKE REDDING	2004	winter	winter		5
51688	LSNFH	LAKE REDDING	2004	winter	winter		2
51689	LSNFH	LAKE REDDING	2004	winter	winter		2
51690	LSNFH	LAKE REDDING	2004	winter	winter		2
51691	LSNFH	LAKE REDDING	2004	winter	winter		3
51692	LSNFH	LAKE REDDING	2004	winter	winter		3
51693	LSNFH	LAKE REDDING	2004	winter	winter		2
51694	LSNFH	LAKE REDDING	2004	winter	winter		2
51695	LSNFH	LAKE REDDING	2004	winter	winter		3
51696	LSNFH	LAKE REDDING	2004	winter	winter		2
51699	CNFH	CNFH	2003	late-fall	late-fall		4
51764	CNFH	CNFH	2003	late-fall	late-fall		3
51765	CNFH	CNFH	2003	late-fall	late-fall		4
51766	CNFH	CNFH	2003	late-fall	late-fall		9
51768	CNFH	CNFH	2003	late-fall	late-fall		3

CWT Code	Hatchery*	Release Location	Brood Year	Run	Survey	**Clear**	**Sac Riv.**
51769	CNFH	CNFH	2003	late-fall	late-fall		1
51770	CNFH	CNFH	2003	late-fall	late-fall		2
51773	CNFH	WEST SAC	2003	late-fall	late-fall		2
51774	CNFH	WEST SAC	2003	late-fall	late-fall		1
51775	CNFH	CNFH	2003	late-fall	late-fall		7
51776	CNFH	CNFH	2003	late-fall	late-fall		2
51778	CNFH	VORDEN	2003	late-fall	late-fall		1
51780	CNFH	BENICIA	2003	late-fall	late-fall		2
51781	CNFH	RYDE-KOKET	2003	late-fall	late-fall		1
51782	CNFH	RYDE-KOKET	2003	late-fall	late-fall		2
51783	CNFH	SHERMAN ISL	2003	late-fall	late-fall		4
51964	LSNFH	LAKE REDDING	2003	winter	winter		2
51966	LSNFH	LAKE REDDING	2003	winter	late-fall		1
51966	LSNFH	LAKE REDDING	2003	winter	winter		1
51967	LSNFH	LAKE REDDING	2003	winter	winter		1
51969	LSNFH	LAKE REDDING	2003	winter	winter		1
51973	LSNFH	LAKE REDDING	2003	winter	winter		1
51976	LSNFH	LAKE REDDING	2003	winter	winter		1
51979	LSNFH	LAKE REDDING	2003	winter	late-fall		1
51980	LSNFH	LAKE REDDING	2003	winter	winter		2
51982	LSNFH	LAKE REDDING	2003	winter	winter		1
51985	LSNFH	LAKE REDDING	2003	winter	winter		1
51988	LSNFH	LAKE REDDING	2003	winter	winter		1
51990	LSNFH	LAKE REDDING	2003	winter	winter		4
51993	LSNFH	LAKE REDDING	2003	winter	late-fall		1
51993	LSNFH	LAKE REDDING	2003	winter	winter		1
51994	LSNFH	LAKE REDDING	2003	winter	winter		1
51996	LSNFH	LAKE REDDING	2003	winter	winter		2
51998	FRH	WEST SAC	2003	fall	fall		1
52064	FRH	PORT CHICAGO	2003	fall	fall		2
52273	CNFH	CNFH	2004	late-fall	late-fall		2
52274	CNFH	CNFH	2004	late-fall	late-fall		1
52279	CNFH	CNFH	2004	late-fall	late-fall		1
52286	CNFH	CNFH	2004	late-fall	late-fall		1
52293	CNFH	GEORGIANNA	2004	late-fall	late-fall		1
52294	CNFH	CNFH	2004	late-fall	late-fall		1
52476	LSNFH	LAKE REDDING	2004	winter	winter		2
52477	LSNFH	LAKE REDDING	2004	winter	winter		3
52481	LSNFH	LAKE REDDING	2005	winter	winter		1
52866	CNFH	COLEMAN NFH	2005	late-fall	late-fall		1
52867	CNFH	COLEMAN NFH	2005	late-fall	late-fall		1
52870	CNFH	COLEMAN NFH	2005	late-fall	late-fall		1
62400	FRH	SAN PABLO BAY	2003	spring	fall		3
62401	FRH	SAN PABLO BAY	2003	spring	fall		1
62403	FRH	SAN PABLO BAY	2003	spring	fall		3
62410	FRH	WICKLAND OIL	2004	spring	fall		2

CWT Code	Hatchery*	Release Location	Brood Year	Run	Survey	**Clear**	**Sac Riv.**
62411	FRH	WICKLAND OIL	2004	spring	fall		3
62411	FRH	WICKLAND OIL	2004	spring	winter		1
62412	FRH	WICKLAND OIL	2004	fall	fall		1
62415	FRH	WICKLAND OIL	2004	fall	fall		1
62420	FRH	WICKLAND OIL	2004	spring	fall		1
62428	FRH	WEST SAC	2004	fall	fall		1
62443	FRH	WICKLAND OIL	2004	spring	fall		2
62444	FRH	WICKLAND OIL	2004	spring	fall		2
62445	FRH	WICKLAND OIL	2004	spring	fall	1	
62446	FRH	WICKLAND OIL	2004	spring	fall		1
62447	FRH	WICKLAND OIL	2004	spring	fall	1	4
62794	FRH	SAN PABLO	2003	fall	fall	1	2
62799	FRH	WICKLAND OIL	2004	spring	fall	1	3
64580	MRFF	JERSEY PT	2003	fall	fall		1
64687	MRFF	HATFIELD ST.	2004	fall	fall	1	
501020108	CNFH	RBDD	2004	fall	fall		1
501021514	CNFH	RBDD	2003	fall	fall	1	2
501030104	CNFH	RBDD	2003	fall	fall	4	
501040109	CNFH	BATTLE CREEK	2003	fall	fall	1	
501040407	FRH	WEST SAC	2003	fall	fall	1	
601000405	BUTTE	BALDWIN CON.	2003	spring	fall		1
601010005	FRH	YOLO BYPASS	2003	fall	fall	1	
601010102	FRH	YOLO BYPASS	2003	fall	fall		1
601010104	FRH	YOLO BYPASS	2003	fall	fall		1
601010308	FRH	YOLO BYPASS	2004	fall	fall	1	
				total		14	168
100000	No Tag	No tag detected			fall	0	6
100000	No Tag	No tag detected			late-fall	0	6
100000	No Tag	No tag detected			winter	0	17
				total		0	29
				2007 TOTALS		14	197
Carcasses examined for ad-clips: These numbers are for general categories; for specific analysis purposes please contact Project biologists						2,613	8,663
Chinook Popualtion estimates (tributaries fall-run only)						4,129	34,942

* Hatchery Abbreviations as follows:
CNFH = Coleman National Fish Hatchery
LSNFH = Livingston Stone National Fish Hatchery
FRH = Feather River Hatchery
MRFF = Merced River Fish Facility
BUTTE = Butte Creek Rotary Screw Trap Wild stock tagging study.

APPENDIX C: Winter-run Carcass Survey Summary Table)

WINTER-Run Carcass Survey Summary		YEAR											
Category	**Note**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Official total System estimate	1	**1337**	**880**	**2992**	**3288**	**1352**	**8,224**	**7,464**	**8,218**	**7,869**	**15,839**	**17,304**	**2,541**
In-river spawner estimate	2	1,012	836	2,893	3,264	1,263	8,120	7,360	8,133	7,784	15,730	17,205	2,487
Into Hatchery (CNFH or LSNFH)	3a	325	44	99	24	89	104	104	85	85	109	93	54
Winter-run surveyed in Battle Creek	3b	237	226	0	0	0	0	0	0	0	0	6	0
Peterson Standardized estimate	4	**273**	**564**	**2,162**	**1,136**	**4,290**	6,760	6,106	6,602	6,205	13,549	13,924	2,161
Reported Peterson estimate	5	820	2,053	5,501	2,262	6,670	11,502	10,541	n/a	n/a	n/a	n/a	n/a
Jolly-Seber in-river + expansions	6	n/a	n/a	n/a	n/a	6,023	**8,120**	**7,360**	**8,133**	**7,784**	**15,730**	**17,205**	**2,487**
RBDD estimate	7	1,337	880	2,992	3,288	1,352	5,523	9,169	9,757	7,192	5,299	7,436	6,144
Estimated Adult Females in-river-survey	8	193	395	1908	817	3,483	5,262	5,682	**5,179**	**3,252**	**9,005**	**8,811**	**1,542**
Carcasses Encountered on survey	9a	118	239	785	475	2,482	5,145	4,959	4,549	3,280	8,771	7,698	1,581
Date of peak carcasses encountered	9b	15-July	11-July	01-July	22-June	02-July	08-July	15-July	20-July	13-July	15-July	14-July	14-July
Carcasses Tagged (all)	10	86	191	575	313	1,954	4,364	3,770	3,457	2,072	4,758	4,121	1,063
Carcasses Chopped (all)	11	32	48	208	162	482	781	1,189	882	958	2,448	2,656	427
Carcasses Recaptured (all)	12	13	22	75	57	829	2,200	2,159	2,175	1,128	3,001	2,206	716
Carcasses with fin clip (CWT / Hatchery)	13	0	5	4	4	4	155	208	179	250	1,565	885	83
Number of CWT's found	14	0	5 (0)	2 (0)	2 (1)	1 (1)	124 (0)	148 (8)	134 (0)	168 (1)	1269 (1)	776 (0)	66 (1)
Percent Hatchery Fish in Population	15	0	2.1%	0.5%	0.8%	0.2%	5.2%	5.3%	5.3%	10.2%	20.0%	13.3%	5.7%
Number of Hatchery Fish in Population	16	0	12	11	10	7	428	396	434	804	3,165	2,307	144
Percent Recapture of Tagged (all)	17	15%	12%	13%	18%	42%	50%	57%	63%	54%	63%	54%	67%

WINTER-Run Carcass Survey Summary		YEAR											
Category	**Note**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Percent males in carcass survey	**18**	29%	25%	12%	25%	18%	35%	22%	36%	58%	43%	48%	38%
Percent adult males to all adults: survey	**19**	13%	24%	10%	11%	17%	29%	18%	32%	43%	38%	48%	35%
Percent adult males to all fish: survey	**20**	11%	22%	10%	9%	16%	26.20%	17%	30%	32%	35%	47%	33%
Percent jacks to all fish: survey	**21**	18%	4%	2%	17%	2%	9%	5%	6.1%	25.9%	7.3%	1.9%	5.2%
Number of Jacks: survey: in-river	**22**	50	21	40	189	90	738	360	504	2041	1156	327	131
Percent jacks to all fish: RBDD	**23**	42%	37%	18%	58%	46%	65%	13%	34%	64%	30%	35%	51%
Number of jacks from RBDD-system	**24**	564	328	522	1,907	620	3,566	1,152	3,282	4,570	1,604	2,630	3,140
Fork length cutoff for jacks (mm): survey	**25**	< 645	< 645	< 595	< 635	< 605	< 665	< 685	< 610	< 710	< 670	< 660	< 670
Fork length cutoff for jacks (mm): RBDD	**26**	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610
Percent females in carcass survey	**27**	71%	75%	88%	75%	82%	65%	78%	64%	42%	57%	52%	62%
Percent adult females to all adults: survey	**28**	87%	76%	90%	89%	83%	71%	82%	68%	57%	62%	52%	65%
Percent adult females to all fish: survey	**29**	71%	70%	88%	72%	81%	64.30%	77%	64%	42%	57%	51%	62%
Percent jills to all fish: survey	**30**	0%	4.7%	0%	2.9%	0.6%	0.4%	0.7%	0.5%	0.5%	0.3%	0.3%	0.3%
Number of Jills: survey: in-river	**31**	0	27	0	32	25	33	51	39	41	42	51	8
Fork length cutoff for jills (mm): survey	**32**	< 645	< 645	none	< 595	< 585	< 605	< 545	< 610	< 610	< 600	< 590	< 600
Percent Adults vs Percent Grilse- survey	**33**	82%-18%	92%-8%	98%-2%	80%-20%	97%-3%	90%-10%	94%-6%	93%-7%	74%-26%	93%-7%	98%- 2%	95%-5%
Number Adults vs Number Grilse (survey)	**34**	223 - 50	516 - 48	2122 - 40	915 - 221	4175-115	7349-771	6949-411	7675-543	5786-2083	14683-1156	16926-378	2402-139
Percent female spawn success	**35**	95%	96%	95%	97%	100%	99%	99%	99%	99%	98%	98%	98%
Percent of redds within survey	**36**	100%	100%	94%	92.5%	72.1%	89.5%	95.9%	99.3%	100%	100%	99.7%	96.2%
Total number of winter redds observed	**37**	70	30	141	1,144	588	1,396	610	878	621	1,968	717	288

WINTER-Run Carcass Survey Summary		YEAR											
Category	**Note**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Survey Date Start	**38**	4-Apr	30-Apr	5-May	5-May	3-May	2-May	1-May	30-Apr	30-Apr	28-Apr	1-May	1-May
Survey Date End	**39**	5-Sep	29-Aug	28-Aug	27-Aug	29-Aug	29-Aug	27-Aug	4-Sep	3-Sep	2-Sep	25-Aug	24-Aug
Number of Survey Periods	**40**	19	41	39	38	40	40	40	41	43	43	39	39
Survey River Mile Range	**41**	271 - 301	288 -301	288 -301	288 -301	288 - 301	288 -301	288 - 301	286.5 - 301	273.5-301	273.5-301	276 -301	276 - 301
Flow range (cfs x 1000)	**42**	7 - 16	8 - 15	10 - 23	9 - 13	8 - 16	8 - 15	7 - 15	8 - 29	8 - 16	4 - 37	6 - 15	8 - 15
Water temp (^{o}F) range	**43**	52 - 59	49 - 52	50 - 54	50 - 54	51 - 54	50 - 55	50 - 56	50 - 54	50 - 57	51 - 59	50 - 56	50 - 58
Visibility range (ft)	**44**	n/a	3 - 10	4.5 - 11	6 - 11	9 - 21	14 - 21	17 - 22	8 - 15+	8.5 - 16	2 - 16+	5 - 13	2.5 - 20+

Winter Run Carcass Survey Summary Table Notes

1 - Official total System estimate: This is the official number used by the CDFG and other agencies when reporting winter-run spawning populations (both hatchery and in-river). This data is also available in the Department's "GrandTab", an electronic summary of Central Valley salmon escapements. This number may include winter-run observed in Battle Creek (i.e. the six seen in Battle Creek in 2006). The RBDD number was used from 1996 to 2000. From 2001 to present, the Jolly-Seber estimate from the carcass survey was used. It is important to note that this number includes some winter-run that were estimated to have entered Battle Creek (1996 = 325, 1997 = 44, 2006 = 6).

2 – In river spawner estimate: This number is the number of winter-run salmon thought to have spawned naturally in the Sacramento River. It includes both natural origin and hatchery fish which spawned in the river. It also includes adults and grilse as well as fish assumed to have spawned downstream determined by aerial redds.

3a – Removed for hatchery use: This number is the number of fish removed for hatchery brood stock including fish which died before being spawned. It includes mostly natural origin fish as well as some hatchery origin fish used for brood stock or sacrificed to determine hatchery origin. In 1996 and 1997, this number represents the number of fish that were observed in Battle Creek at Coleman National Fish Hatchery. In 2006, five coded-wire-tagged winter-run were sacrificed at the Coleman Barrier Weir to determine hatchery origin. These five fish (along with a one natural winter-run) are not listed here, but are included in the total system estimate row above.

3b - In years 96, 97 and 06 winter-run salmon were surveyed in Battle Creek based on timing and passage dates. In 2006, five of the six were sacrificed at CNFH, and the other was passed upstream.

4 – Peterson Standardized estimate: This number represents an expanded and corrected Peterson estimate from earlier carcass surveys that allows for comparison of estimates for all years using identical data parameters. In this estimate both fresh and non-fresh adult carcasses are used in calculations. In addition, grilse numbers and salmon spawning outside of carcass survey area (determined by aerial redd counts) are included. A correction to the Peterson estimate was applied to the 1996-2002 survey results. The correction eliminated the inclusion of tagged fish in the "examined fish" variable of the Peterson formula. A discussion of the details surrounding this correction is available in the 2004 CDFG Winter-run carcass survey report: Appendix 6.

5 - Reported Peterson estimate: This number represents the Peterson estimate reported in the CDFG reports from 1996-2002. In years 1998-2000 it does not include spawners outside of the carcass area (in 1996-1997 this number was zero, and in 2001-2002 aerial redd data was included). It also includes (except 1996-1997) the data from only fresh adult carcasses. Estimates produced using only fresh carcasses must account for the non-fresh tagged carcasses as fish examined or the Peterson estimate will be incorrect (Killam, 2004: Appendix 6). This problem is corrected for by using both fresh and non-fresh data in the Peterson Standardized estimate in the row above.

6 – Jolly-Seber in-river + expansions: This number represents the number of in-river spawners estimated through the use of the Jolly-Seber model and other expansions (including hatchery in-river spawners, downstream spawners, adult males, and grilse). The Jolly-Seber number has been the official CDFG estimate since 2001. Due to insufficient recaptures in earlier years the Jolly-Seber model was unable to be used, because during the calculations in the Jolly-Seber model if recaptures are zero for any recovery period an error is generated as a result of dividing by zero. This problem was prevalent in earlier years when populations were low and sometimes currently in the beginning and end of the survey when carcass numbers are low.

7 – RBDD estimate: This number results from calculations at the Red Bluff Diversion Dam fish trap and fish ladders. The RBDD numbers go back to 1967 and represent a long term database for winter-run populations. Since 1986 the RBDD number has been calculated using an average number which recently has resulted in significantly different numbers from the carcass survey. Beginning in 2001 the CDFG recognized that the carcass survey provided an improved method of counting winter-run salmon. The RBDD number is still developed to provide a continuation of data trends since 1967 but is no longer recognized as the most accurate number, however, it's use continues to provide some information to determine trends and to different groups analyzing data.

8 – Estimated adult females in-river: This number (from carcass survey) provides an estimate of the number of adult females that can be useful in comparing the number of juveniles produced by the winter-run spawners. The calculation of this number has been "standardized" for the survey years. The numbers in Table 1 years 1996-2000 are based on the standardized Peterson estimates for those years, but these numbers are not the official ones (RBDD was official). From 2001 to 2006 the number is based on the Jolly-Seber estimates (official). The adult female numbers for years 1996 to 2000 from the RBDD "official" reporting are as follows: 1996 = 421, 1997 = 308, 1998 = 1,183, 1999 = 427, and 2000 = 394. This number is useful in calculating a JPE (Juvenile Production Estimate) number used by NMFS to determine the number of juveniles produced each year and the subsequent expectations of "take" numbers to be set for the state and federal pumping facilities in the south Delta area.

9a – Total carcasses encountered: This number is the total number of individual carcasses encountered during the survey. It does not include the fish recaptured after they were initially tagged. It can be compared to the total population to determine what proportion of the population was sampled.

9b- Date of peak carcasses encountered: This is the date, during each yearly survey, that the most carcasses were found. It does not include recaptured carcasses. It includes all sizes, sexes, hatchery and natural origin fish. This date can be used to estimate the timing of peak spawning activity. It can be assumed that the peak carcass date precedes peak spawning by a two-week (14 day) period. Thus if peak carcasses occurs on 15 July, then peak spawning likely occurred on 01 July. Caution in interpreting this data should be used, as often there are two or more peaks, or many days of similar but slightly lower counts either earlier or later in survey.

10 – Carcasses tagged (all): This number is the total of all carcasses tagged during the surveys. It includes males and females, hatchery fish and grilse. In all surveys the grilse and adults were recorded as separate categories. Starting in 2003, identifiable hatchery fish were not tagged for mark and recapture purposes because their heads were removed for CWT extraction. Therefore they were not part of the tagged numbers. Population estimates were based on adult (large fish (defined as greater than 609mm for years 2003-present, similar-years 96-2002) and expanded for grilse after a large (adult) estimate was made. Subsequent expansions utilize other data to calculate the final population estimate.

11 – Carcasses chopped (all): In Table 1 this number includes the carcasses (including grilse) that were not tagged and did not have a survey jaw tag in them (recaptures). A chopped carcass is typically non-fresh; meaning it is not suitable for tagging or collecting biological data from. They are checked for survey tags placed in prior periods and then chopped in half to avoid re-counting. In some cases, fresh carcasses were chopped if they had been partially eaten by scavengers. It is also important to note that a recaptured previously tagged carcass is also chopped after the tag color and location is recorded, but these are not labeled as "chopped" in the database. For purposes of the Peterson estimate calculation the category labeled "Examined" includes both recaptured and chopped carcasses, but not tagged fish.

12 – Carcasses recaptured (all): This number represents the number of previously tagged carcasses (including grilse) that are recaptured during subsequent survey periods. It does not include hatchery tags or other types of tags applied when the fish were alive. The survey protocols specify that all recaptures be chopped upon recapture. This was done to ensure that the surveys were conducted as "sampling without replacement" surveys. Starting in 2004, individually numbered "disc" tags were also applied to fresh carcasses to determine carcass decay times and movements over time. These carcasses were not chopped upon recapture but their first recapture date was used as if they were chopped for purposes of the population estimate protocols, (all subsequent recaptures were ignored for mark and recapture purposes). This type of sampling was still "sampling without replacement" but the data on these disc tagged fish can be used in the future as "sampling with replacement" if desired.

13 – Carcasses with a fin-clip (CWT / Hatchery): This number represents the number of adipose fin clipped (i.e. coded-wire-tagged (CWT) hatchery fish that were collected during the surveys. A carcass is identified as a hatchery fish by the absence of the adipose fin that is clipped off during hatchery coded-wire-tagging when the fish was a juvenile. In some cases the carcass is too decayed (or eaten) to tell if the fin has rotted off or was clipped off. In these "unknown clipped" cases the carcass head was removed and dissected for a CWT. The fish was subsequently classified as a hatchery fish if a tag was found or as a natural fish if no tag was found. Because some adipose fin clip fish shed their CWT there are often fish that are obviously clipped, but when dissected have no tag detected. If crews were positive that it was an adipose fin clip, the fish (with no tag detected) was labeled as a hatchery fish even if no CWT was found. Not all hatchery fish found on the surveys were winter-run as some late-fall-run and spring-run fish were encountered. In recent years, 2001-present, the vast majority of hatchery fish were winter-run salmon raised at the Livingston Stone National Fish Hatchery. More specific details of hatchery evaluation are located in the USFWS Annual winter-run carcass survey reports.

14 – Number of CWT's found: This number represents the total number of coded-wire-tags actually recovered by crews dissecting heads. The tag codes 200000 (lost) and 400000 (illegible) are included here because these were actual tags present in the fish. The number given is the total number of CWT's. The number in the parentheses is the number of CWT's (included in the total) that were from other runs (i.e. CNFH late-fall, or Feather River spring-run).

15 – Percent hatchery fish in population: This value is the percentage of hatchery fish present in the overall total population. It is calculated with survey data and is the fresh fish ratios of clipped to natural origin carcasses. The value given here is based upon the database used by the CDFG in generating the population estimate. Values in the USFWS final reports are different but generally similar. The differences occur in the methodologies used by the two agencies. From 2003 to present the value given is based on the "final ad-clip" status in the CDFG database. The final ad-clip data attempts to account for all fish sampled in the survey. Fish are listed as natural if they had no fin clip or had an unknown fin clip that no CWT was detected. Fish that were listed as ad-fin clipped by crews receive a hatchery label. Unknown and partial clipped fish are listed according to the dissection results. Unknowns with CWT's are hatchery, those without are natural, this is similar for partials. Another category during dissection is "head lost" or 300000 tag code. In the rare cases of unknown clip and head lost carcasses the final database status is proportioned to the ratio of the rest of the population. In short all sampled carcasses are assigned one origin or the other (natural or hatchery).

16 – Number of hatchery fish in population: This number is the percent of hatchery fish multiplied by the overall population. It is useful in a general sense in comparing year to year numbers. Although generally similar, this number may differ from the numbers calculated by the USFWS in their annual reports, (differences due to methodology and category values). For in-depth analysis of hatchery fish populations refer to the USFWS reports that provide a more detailed evaluation of hatchery-origin fish.

17 – Percent recapture of tagged (all): This number is the total recaptured divided by the total tagged. It is a useful way to see if there was consistency over the yearly surveys. A high percent recapture indicates that many of the tagged fish released are recovered in future survey periods. A high recapture rate generally means that the survey periods were spaced close in time and that a lot of effort by crews was applied to the survey. Water visibility and number of fish both can lead to varying recapture rates. Turbid water makes the decaying tagged fish harder to see and lowers recapture percentages. Fewer fish makes finding any fish difficult and increases the likelihood of scavengers eating the released tagged fish (often observed at the start and end of the surveys). Recapture rates can vary widely throughout the winter-run survey (more common in fall and late-fall surveys) due to flooding and muddy water. This can have a large effect on the final population estimate, especially if such an episode occurs in the busy part of the survey. A flood immediately following the tagging of many new fish will make recapture of these fish difficult and effectively increase the overall population artificially by making it seem as if many fish were tagged but few recaptured. This is one of many possible biases of carcass surveys, but rarely occurs during the winter-run survey.

18- Percent males in carcass survey: This value is the percent of jacks, adults, and hatchery fish calculated from the fresh fish ratios determined by the survey for years 96-02. Beginning in year 2003, and continuing to the present, this percentage is calculated using the number of males determined in the population methodology. This methodology attempts to correct for a known bias that some proportion of male fish leave the carcass survey area after spawning and are not available to crews sampling fresh carcasses. This is "corrected" for by using the ratios of winter-run male adults to female adults observed (alive) at the Keswick Dam Fish Trap (Keswick). This ratio is incorporated into the methodology and generates a large male (>609mm) population estimate. This large male number is used to generate a small male number (<610mm) based on the ratio of these categories in the fresh carcasses sampled database of the survey. Additionally, all fresh male carcasses are plotted by length and frequency to visually determine a fork length cut-off (see #25 category below for this value each year). After plotting, a cut-off length is selected and the jacks vs. adult male numbers are generated. The percent of males from years 2003 to 2007 includes all fish, including those taken into LSNFH. Years 1996 to 2002 include estimates for in-river fish only.

19 - Percent adult males to all adults in survey: This number compares male to female adults (greater than 2 year old fish). It incorporates fresh fish survey data for years 96-02 and for years 03-present is based on data from Keswick and survey results.

20 - Percent adult males to all fish in survey: This number is similar to above only it compares the percentage of the adult male category to all the other categories (jacks, jills and adult females). It is useful in comparing year to year trends and gives some indication of the proportions of other categories.

21 – Percent jacks to all fish in survey: This number compares 2-year old males (jacks) (based on length frequency analysis) to all other fish in the survey (includes adult males and adult females and jills).

22 – Number of jacks from survey that were in-river: This number is the estimated number of jacks present in the river during the year. It is from carcass survey results. It does not include fish taken into the hatchery.

23 – Percent jacks to all fish from RBDD: This number compares the number of jacks (based on fork length cut-off of <610 mm) to all other winter-run encountered at annually at the RBDD.

24 – Number of jacks from the RBDD expanded for the entire system: This number is the estimated number of jacks present in the river for each year based on RBDD data. It would include jacks entering into LSNFH. It does not include the few jacks downstream of RBDD winter-run fish.

25 – Fork length cut-off for jacks (mm) from survey: This number is the fork length cut-off determined by biologists after viewing a length frequency graph of male fish lengths. For years 96-02 it was chosen post-survey but may have conflicted with the mark and recapture efforts since mark and recapture requires a pre-season cut-off to determine adult size during data collection efforts. For years 03 to present a 610 mm cut-off is used to collect mark and recapture data on **small** and **large** carcasses. This eliminates the conflict between mark and recapture data and biological grilse vs. adult data, because the mark and recapture method generates an estimate, and the number of jacks is derived from within the confines of this estimate after it is complete. Afterwards, the length frequency histogram of all males is observed by biologists and a fork length cut-off is chosen. This fork length cut-off is specific to biological data of fresh carcasses and is independent of mark and recapture data.

26 – Fork length cut-off for jacks from RBDD data: The traditional cut-off for jacks and jills has been 610 mm. Of note is that Coleman National Fish Hatchery (CNFH) uses 650 as their cut-off for jacks. These two numbers may not be that different since fish at RBDD are not typically mature. As the male reaches maturity the upper snout lengthens and fork lengths may increase on some jacks to be comparable with either site's cut-off.

27 – Percent females in carcass survey: Similar to footnote 18- for females. Exception is that females are calculated for years 03 to present by the mark and recapture estimate. The assumption made is that large females are truly represented by the mark and recapture survey alone and that no bias is associated with this data. (Unlike males which use Keswick fish trap data).

28 – Percent adult females to all adults from survey: Similar to footnote 19 except for females.

29 - Percent adult females to all fish from survey: Similar to footnote 20 except for females.

30 – Percent jills to all fish from survey: Similar to footnote 21 except for females.

31 -Number of jills from survey that were in-river: Similar to footnote 22 except for females.

32– Fork length cut-off for jills from survey: Similar to footnote 25 except for females.

33 – Percent adults vs. percent grilse from survey: This number summarizes the proportion of adults and grilse for all winter-run from each year. It includes all adults vs. all grilse (jack and jills). For years 96 to 00, it is based on the standardized Peterson estimate (footnote 4), for 01-02, it was based on Jolly-Seber in-river estimate (footnote 6). For years 03 to present, it is based on all fish, including LSNFH fish.

34 – Number of adults vs. number of grilse from survey: These numbers added together equal the standardized Peterson (footnote 4) for years 96-00. For years 01-02, this number equal the Jolly-Seber estimate in-river estimate (footnote 6), and for years 2003-to-present the number equals the overall official estimate, including the LSNFH fish.

35 – Percent female spawn success: This number is the ratio of completely spawned to unspawned fresh female fish, primarily based on crew's judgment of carcass appearance, (e.g. shrunken abdomen, worn tail). Unsuccessful spawners are those with without tail damage or those with more than a small (handful) of eggs remaining in their body cavity. Unspawned winter-run female fish are uncommon. Otters and incidental hooking by trout anglers are thought to be primary causes. In recent years, habitat and/or water quality limitations have not affected winter-run pre-spawning mortality.

36 - Percent of redds within the survey area: This number represents the percentage of new redds observed within the boundaries of the carcass survey by the CDFG's aerial redd flights. These flights are to count new redds and determine the spawning distributions of all salmon runs on the main-stem Sacramento River. The winter-run flights are typically done in helicopters (planes if no helicopter available) and begin downstream of RBDD in Corning, California. If winter-run redds are observed outside of the survey area the population estimate is expanded by the percent of redds noted outside the boundaries.

37 – Total number of winter-run redds observed: This is the total number of new redds counted by an observer on helicopter or fixed wing plane. Typically the flights are flown from mid-April to late-August. Only new redds are counted during each flight. Counting typically begins at either Woodson Bridge in Corning CA or Tehama Bridge near Tehama CA and ends near Keswick Dam.

38 – Survey start date: The date in which new fresh fish are tallied as winter-run salmon. Typically carcass surveys are ongoing year round on the Sacramento River. After the winter-run survey commences any older recaptures from the late-fall survey (few) are removed from winter-run databases. After two weeks from the start date all fish (decayed, skeletons, etc) encountered are tallied as winter-run.

39 – Survey end date: The end of the intensive seven days per week sampling for winter-run carcasses.

40 – Number of survey periods: This is the number of survey periods typically characterized by a single pass through the entire survey area marking fish with a single color tag. A new period starts the next day (2003 to present; periods are 3 days long). A survey period starts at the downstream end of the river distance being surveyed and continues until the crews reach the Keswick Dam.

41 – Survey river mile range: This category lists the range of river miles surveyed by crews from 1996 to present. Surveys have been shortened or lengthened based on opinions of biologists to ensure that the majority of winter-run spawning is encompassed by the carcass survey.

42 – Flow range in cfs: This number is determined post season by analysis of Keswick outflow data on the CDEC website.

43 – Water temperature: This number is determined by crews taking a single water temperature using a low-cost thermometer at the end of each day in the section just completed. It should not be used for rigorous in depth analysis of temperature relationships for winter-run.

44 - Visibility range: This number is the visibility in feet observed by the crews after finishing a section each day. It is usually taken at the same time of the water temperature measurement (footnote 43). Due to the large variability in techniques and crews over the years it should not be used for in-depth analysis of data. It is designed to provide a general sense of the daily visibility conditions (e.g. wind, glare, turbidity) that crews encounter on the river. For years 96-02, a Secchi disc was lowered on a flexible measuring tape into a deep hole on the river. The depth at which it was no longer visible was then recorded. For years 03 to present, a Secchi disc was attached to a rigid measuring pole, and the depth at which the disc was no longer visible was recorded. A (+) after a number in this category represents that the Secchi was visible past the depth available for crews to reach (i.e. either to the river bottom or the length of the pole).