

Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002

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Douglas Killam and Colleen Harvey-Arrison
California Department of Fish and Game
Northern California-North Coast Region

SUMMARY

Population sizes were estimated for Chinook salmon passing upstream of Princeton Ferry. Population estimates for the Upper Sacramento River system (Figure 1) are determined through a number of methodologies including: carcass surveys, hatchery counts, aerial surveys, snorkel counts, angler interviews and counts at the Red Bluff Diversion Dam (RBDD). This report does not include salmon information from Butte Creek, Feather and American River(s).

An estimated **623,156** adult salmon were in the Sacramento River System upstream of Princeton Ferry in 2002. This includes an estimate of 40,001 late-fall, 7,441 winter, 4,445 spring and 571,169 fall-run salmon (Appendix Table 1). The majority of these salmon passed above RBDD (80%) to spawn in the tributaries or main-stem of the Sacramento River upstream of Red Bluff.

The Sacramento River has four runs of Chinook salmon: winter, spring, fall, and late-fall. The California Department of Fish and Game (Department) has historically used fish counts at the RBDD to determine spawner population estimates for all four runs when the RBDD gates were down year round. Beginning in 1986, the RBDD was operated to minimize impacts to winter-run migration. Currently the dam and fish ladders are in operation for four months of the year. The Department continues to use RBDD as a source of population estimates for winter, spring and fall runs based on historic timing past RBDD (Table 1). The late-fall run is not estimated using RBDD counts since late-fall fish are not present in the four-month period of operation. Instead, the results of a main-stem escapement carcass survey and other methods are used to estimate the late-fall run.

Since 1996 the Department has conducted a year round carcass survey in the main-stem of the Sacramento River above RBDD to determine the suitability of using this method as an alternative source of spawner population estimates. Beginning in 2001 the Department began using the carcass survey results as a step in the estimation process for the winter and fall runs in addition to the late-fall run. Spring run in 2002 above RBDD continued to be estimated by the RBDD process. The 2002 fall run estimates using RBDD dam counts resulted in a negative number of salmon predicted in the main stem. For this reason the carcass survey estimate was chosen as a starting point for the fall run estimation in 2002.

[illegible]

TABLE 1. Average migration timing for the various salmonid run passing the Red Bluff Diversion Dam 1970-1988.

Percentage and cumulative percentages											
	Week	Based on years--82-88		1970-1988		1970-1988		1970-1988		1970-1988	
		Winter Run		Spring Run		Fall Run		Late-Fall		Steelhead	
		%	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	81.71	0.80	92.64
	3	0.35	5.57					3.07	84.77	0.61	93.25
	4	1.28	6.85					2.91	87.69	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	0.58	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	0.95	1.89			1.39	99.76	0.28	98.12
	16	9.19	77.48	1.38	3.27			0.24	100.00	0.19	98.31
	17	3.47	80.95	1.63	4.90			end		0.17	98.48
MAY	18	2.02	82.98	1.60	6.50					0.16	98.63
	19	1.60	84.58	1.71	8.21					0.17	98.80
	20	2.17	86.75	2.16	10.37					0.23	99.03
	21	3.09	89.84	2.63	13.00	start				0.18	99.20
JUN	22	2.03	91.87	2.86	15.86	0.01	0.01			0.20	99.40
	23	1.63	93.50	2.61	18.47	0.00	0.02			0.13	99.54
	24	1.84	95.34	2.93	21.40	0.01	0.03			0.14	99.68
	25	0.51	95.85	3.50	24.89	0.03	0.06			0.15	99.82
	26	0.76	96.61	3.10	27.99	0.08	0.14			0.18	100.00
JUL	27	1.60	98.20	3.67	31.66	0.10	0.24			0.13	0.13
	28	0.31	98.52	6.02	37.68	0.29	0.53			0.18	0.31
	29	1.04	99.55	4.75	42.44	0.49	1.02			0.18	0.49
	30	0.44	99.99	3.21	45.65	0.70	1.72			0.22	0.72
AUG	31	0.01	100.00	4.12	49.77	0.96	2.68			0.26	0.98
	32	end		6.97	56.74	1.88	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					8.99	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

Red Bluff Diversion Dam Population Estimate Methodology

Since 1969 the RBDD estimates were used to generate estimates for all runs of salmonids in the Sacramento River (steelhead, four runs of Chinook salmon). In 2002 only spring-run salmon were officially estimated by RBDD. To provide continued RBDD data trends, estimates using RBDD data are still generated but the Department has recently used (since 2001) carcass surveying as the means for generating official estimates. The RBDD methods are discussed below. Estimates of the total number of salmon using the Sacramento River system upstream of the RBDD during 2002 were based on daily ladder counts made by the U.S. Fish and Wildlife Service (USFWS) and by trap sampling by the Department at the dam (late-fall run excluded). Ladder counts were obtained through closed-circuit television monitoring of salmon passing through the RBDD fishways.

Total counts of salmon passing each week were adjusted for those periods when the fishways remained open but no counts were possible, such as when river turbidity was high, during flood conditions when the dam gates were temporarily opened, and when no observations were made at night. Adjustments to lapses in daytime counts were made by interpolation. Night passage numbers were calculated by multiplying the 14-h day ladder count by a "night-factor" which was generated from a twice-a-week night count. The adjusted weekly number of fish was apportioned among the winter-, spring-, and fall-runs based on their relative proportions seen that week in random samples of salmon taken from the dam's east-bank trapping facility. At the trap each salmon observed was assigned to a run based on phenotypical characteristics including: color, scale condition, and relative degree of sexual maturation (an indication of when it was believed that it would spawn).

Estimated numbers of salmon for those periods when the fish ladders were not operated 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 Table 1. The values presented in Table 1 are based on years when the RBDD gates were down throughout the year and the trap and fish ladders were operated continuously. Concern for declining populations of winter-run salmon resulted in the gates being raised for portions of each year. The data that was used to develop Table 1 is different for winter run than the other runs. Spring-, late-fall- and fall run weekly migration patterns are based on data from 1970 to 1988 (1986 for late-fall). For the winter run, 1982-1986 was chosen to be the historical average framework due to the reduced numbers of winter run seen at RBDD during these years as more closely mirroring the current winter run populations.

The total for the 2002 salmon population estimates passing RBDD was calculated as follows:

- 1) For each Julian week, (Sunday-Saturday), determine estimate of actual salmon counted for period when gates were down (actual fish seen passing ladders + night and other adjustments = Estimate). (Other adjustments may include missing day counts, ad-clipped fish, and individual ladder closures.)
- 2) Determine from the RBDD trap data the percent of that week's passage to be assigned to a particular run (i.e., 75% winter-, 15% spring-, and 10% fall-run).
- 3) Determine the total number of salmon for each run during each week that actual counts were made. (Example: estimate multiplied by percentage in #2 for each run.)
- 4) Sum all of the weekly numbers of salmon counted for each run when counts were made and sum all of the corresponding percentages for those same weeks in Table 1. 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 2002 total fish counted = 1,413, sum of historical percent ((Table 1)) during weeks of actual counts = 15.43%, thus total winter run estimate is $1,413 * 100\% / 15.43\% = 9,157$ fish).
- 6) The data for 2002 is presented in Table 2. If desired, any week or months passage may be estimated by determining total historical passage (Table 1) for that period multiplied by the total in #5 for a given run of salmonids.
- 7) It is important to note that data from RBDD does not account for downstream populations. These are determined through aerial redd counts.

TABLE 2. Summary of 2002 Red Bluff Diversion Dam fish passage information.

DATA Collected During 2002 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	3	17	0.0%	15.0%	85.0%	496	0	49	98	0.00%	2.16%	2.17%	0.23%	0	
21	0	12	18	0.0%	40.0%	60.0%	283	0	87	100	0.00%	2.63%	3.09%	0.18%	0	
22	0	9	22	0.0%	29.0%	71.0%	117	0	106	62	0.01%	2.86%	2.03%	0.20%	0	
23	0	21	35	0.0%	37.5%	62.5%	187	5	265	156	0.00%	2.61%	1.63%	0.13%	0	
24	70	35	126	30.3%	15.2%	54.5%	586	162	176	103	0.01%	2.93%	1.84%	0.14%	0	
25	109	33	66	52.4%	15.9%	31.7%	349	167	42	92	0.03%	3.50%	0.51%	0.15%	0	
26	74	11	12	76.3%	11.3%	12.4%	303	215	31	61	0.08%	3.10%	0.76%	0.18%	0	
27	47	1	17	72.3%	1.5%	26.2%	192	161	6	72	0.10%	3.67%	1.60%	0.13%	0	
28	40	8	13	65.6%	13.1%	21.3%	147	340	11	57	0.29%	6.02%	0.31%	0.18%	1	
29	161	0	11	93.6%	0.0%	6.4%	524	359	0	22	0.49%	4.75%	1.04%	0.18%	0	
30	281	0	5	98.3%	0.0%	1.7%	2225	272	0	17	0.70%	3.21%	0.44%	0.22%	2	
31	322	0	0	100.0%	0.0%	0.0%	824	485	0	9	0.96%	4.12%	0.01%	0.26%	2	
32	62	0	0	100.0%	0.0%	0.0%	281	1069	0	0	1.68%	6.97%	0.00%	0.39%	9	
33	460	0	0	100.0%	0.0%	0.0%	2487	1027	0	0	2.95%	6.07%	0.00%	0.68%	4	
34	445	0	0	100.0%	0.0%	0.0%	2984	1471	0	0	3.53%	6.75%	0.00%	1.12%	35	
35	216	0	0	100.0%	0.0%	0.0%	3120	1629	0	0	3.91%	5.74%	0.00%	2.36%	70	
36	258	0	0	100.0%	0.0%	0.0%	8797	3195	0	0	4.54%	7.22%	0.00%	3.82%	103	
37	165	0	0	100.0%	0.0%	0.0%	16448	7915	0	0	5.59%	6.68%	0.00%	5.80%	164	
Totals	2710	133	342				40350	38445	492	1413	24.88%	80.99%	15.43%	16.34%	390	
Note: F = Fall, S= Spring, and W = Winter-run							Total 2002	154540	608	9157				Total 02	1745	

Expanded Red Bluff Diversion Dam Trap and Upstream of RBDD System Information																							
RBDD Actual Trap				Estimate for System above RBDD																			
F	S	W	Total	Fall	Spring	Winter	Total	SUMMARY OF MAJOR CATEGORIES															
2710	133	342	3185	154540	608	9157	164305	ALL SALMON (both Ad-clipped and Natural).															
2607	133	302	3042	149270	608	7898	157776	NATURAL (non-ad-clipped) fish.															
96%	100%	88%	96%	97%	100%	86%	96%	% Natural Fish.															
103	0	40	143	5270	0	1259	6529	AD-CLIPPED fish.															
4%	0%	12%	4%	3%	0%	14%	4%	% Ad-Clipped Fish															
2628	119	284	3031	149864	544	7604	158011	ADULTS (all fish greater than 609 mm).															
97%	89%	83%	95%	97%	89%	83%	96%	% Adults.															
82	14	58	154	4676	64	1553	6293	GRILSE (all fish less than 610mm).															
3%	11%	17%	5%	3%	11%	17%	4%	% Grilse.															
1228	51	165	1444	75129	304	4418	79850	MALES (all fish). *Note River estimate #'s for unknowns added here.															
45%	38%	48%	45%	49%	50%	48%	49%	% Males (of all fish).															
1298	51	177	1526	79411	304	4739	84454	FEMALES (all fish). *Note River estimate #'s for unknowns added here															
48%	38%	52%	48%	51%	50%	52%	51%	% Females (of all fish).															
184	31	0	215	10493	142	0	10634	UNKNOWN SEX (all fish). These fish already added to above categories.															
7%	23%	0%	7%	7%	23%	0%	6%	% Unknown (of all fish). Unknowns proportioned by ratio of known male:female															
F	S	W	Total	Fall	Spring	Winter	Total	SUMMARY OF MISCELLANEOUS CATEGORIES															
2538	119	253	2910	145319	544	6616	152479	Natural Adults															
69	14	49	132	3951	64	1281	5296	Natural Grilse															
90	0	31	121	4605	0	976	5580	Ad-Clipped Adults															
13	0	9	22	665	0	283	948	Ad-Clipped Grilse															
1180	51	139	1370	72515	304	3635	76454	male natural															
1249	51	163	1463	76755	304	4263	81322	female natural															
178	31	0	209	10192	142	0	10334	unknown sex natural															
48	0	26	74	2608	0	818	3426	male ad-clipped															
49	0	14	63	2662	0	441	3103	female ad-clipped															
6	0	0	6	307	0	0	307	unknown ad-clipped															
1163	41	122	1326	70966	242	3266	74474	male adults															
1293	51	162	1506	78898	302	4337	83537	female adults															
172	27	0	199	9808	123	0	9932	unknown adults															
65	10	43	118	4342	64	1151	5557	male grilse															
5	0	15	20	334	0	402	736	female grilse															
12	4	0	16	684	18	0	703	unknown grilse															
1126	41	104	1271	69013	242	2720	71975	male natural adults															
1245	51	149	1445	76306	302	3897	80504	female natural adults															
167	27	0	194	9562	123	0	9685	unknown natural adults															
54	10	35	99	3678	64	915	4658	male natural grilse															
4	0	14	18	272	0	366	639	female natural grilse															
11	4	0	15	630	18	0	648	unknown natural grilse															
37	0	18	55	2004	0	567	2571	male ad-clipped adults															
48	0	13	61	2600	0	409	3009	female ad-clipped adults															
5	0	0	5	256	0	0	256	unknown ad-clipped adults															
11	0	8	19	610	0	252	862	male ad-clipped grilse															
1	0	1	2	55	0	31	87	female ad-clipped grilse															
1	0	0	1	51	0	0	51	unknown ad-clipped grilse															

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.

Carcass Survey Methodology

Carcass surveys have been used by the Department for many years to estimate salmon populations on rivers throughout the state. Since all Chinook salmon die after spawning a population can be counted by estimating how many carcasses were present each year. Because of the “gates out” schedule at RBDD carcass surveys have been chosen as an “official” alternative to the RBDD count for the Upper Sacramento River main-stem. Carcass surveys are conducted by boat or walking 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 collected on sex, length, hatchery origin salmon, and other categories of interest. There are different methods or models employed to create an estimate.

Population models were created for live populations of organisms and each model has a list of sampling assumptions that must be met in order for the model to reflect an accurate portrayal of the population size. The three models used by the Department are the Peterson, the Schaefer, and the Jolly-Seber. Each has been modified from the original intent of studying live organisms and applied to carcasses. Carcass surveys do not meet the underlying assumptions of any single model so it is often left up to the biologist analyzing the data as to which model best fits the data for a particular survey. Each model has numerous advantages and disadvantages. The Peterson model is the simplest and is useful in developing an estimate when disruptions to the sampling schedule occur. The Peterson takes the entire schedule and treats it as two periods, a tagging period and a recapture period. This is the least “accurate” model but is in some surveys the only one that can be used due to low numbers of recaptures, or floods, etc. The Schaefer and the Jolly-Seber models are more complicated and depend on repetitive survey periods and recaptured carcasses throughout the survey. Of the two the Jolly-Seber is the more complicated to analyze but recent software programs have been developed to allow calculation of this method. The Jolly-Seber differs from the Schaefer in that it attempts to account for survival of carcasses between survey periods. Historically the Schaefer is utilized for the fall-run on tributaries on Battle and Clear Creeks. The recent winter run main-stem surveys which began in 1996 have presented the results of all three models if possible, but the Jolly-Seber has been chosen as the “official” winter run model in years when the data collected allow it’s calculation.

Sacramento River Main-Stem Aerial Flight Redd Distribution

Table 3 presents the data from the aerial redd surveys conducted by the Department. These surveys provide a historical database on redd distribution in

the main-stem Sacramento River from Princeton ((river mile (RM) 164)) to Keswick Dam (RM 302) (1969-2002). The surveys are also used to estimate spawning escapement in the main-stem downstream of RBDD. Aerial flights are used to determine estimates downstream of carcass surveys or the RBDD for salmon spawning in the main-stem. A simple proportion is used to calculate this estimate. The proportion is constructed as follows: Number of salmon downstream = (salmon upstream after harvest in main-stem / redds upstream) * redds downstream.

The Chinook Salmon Runs in the Sacramento River Main-Stem

Late-fall run. No estimates were made for the late-fall run at the RBDD. Although some late-fall salmon use tributaries to the upper Sacramento River (e.g., Clear and Battle creeks) no spawner population estimates were made in those streams for late-fall salmon. The USFWS conducted a survey to tally carcasses, live fish and redds on Clear Creek late-fall run salmon, but no population estimate was generated. Of special note on late-fall salmon is that they spawn over the calendar year change. For the purposes of reporting late-fall numbers it is customary to report estimates based on when the juveniles emerge. Late-fall adults spawning in November and December are classified as belonging to the following year, (i.e., December of 2001 spawners are put into 2002 estimate, while December of 2002 spawners are reported in 2003).

A main-stem carcass survey was conducted from 17 December 2001 through 5 May 2002. These surveys covered a 26.4 km (16.5 mi) section of the Sacramento River between Anderson-Cottonwood Irrigation District Dam (ACID), (RM 298.5), and Anderson River Park (RM 282.0). The Jolly-Seber mark-recapture model estimated that **24,087** late-fall-run spawned in the Upper Sacramento River in 2002 above Anderson River Park. This was based a total of 7,430 examined carcasses of which 2,737 were tagged and 926 subsequently recovered (33.8%-recovery rate). All fresh fish (828) were measured and a grilse (2 year old) percentage of 1.21 was estimated based on a length of 65 centimeters or less. Males represented 38.8 % and females 61.2 % of the population. Females were checked for egg retention following spawning. It was determined that of 507 females, 482 were completely spawned "out" of eggs (95.1%). The remaining were either partially spawned (3.1%) or not spawned (1.8%) based on egg retention data. All fish examined were checked for adipose fin clips representing hatchery origin from Coleman National Fish Hatchery (CNFH) on Battle Creek. Remarkably **none** of the main-stem salmon examined had an adipose fin clip in 2002.

To calculate an estimate for the entire main-stem, three late-fall run aerial redd surveys were conducted between 1 February and 19 March, (Table 3). Based on these surveys it is estimated that 33.1% of the late-fall spawning occurred outside of the carcass survey area (no redds downstream of RBDD). Accordingly the estimate of 24,087 from the carcass survey is adjusted upwards for an overall late-fall spawning escapement estimate in the **main-stem of 36,004** (24,087/ 66.9%). Other aerial redd surveys were attempted but turbidity of the river during the winter months prevented redd observations.

The Department's Angler Harvest Survey estimated harvest of late-fall salmon above Knights Landing in late 2001 and early 2002 to be **1,428** fish (528 upstream RBDD). This estimate includes half of November's harvest (other half is considered fall run) and all of December 2001 and of January 2002 (angling season ended 14, January 2002). This total did not include those late-fall fish

harvested in November-December of 2002 as those fish were classified as year 2003 fish for the purposes of this report.

The Coleman National Fish Hatchery (CNFH) spawned and excessed late-fall salmon from December 2001 through March 2002. The CNFH total was **2,669** late-fall spawned and excessed. (Kevin Niemela, USFWS, personal communication).

Based on the carcass survey, angler survey, CNFH, and aerial redd data it is estimated that **at least 40,101 late-fall run** salmon were present above Knights Landing in late 2001 and early 2002. This estimate does not include in-river tributary estimates that were not conducted due to staffing and typically poor weather and turbidity conditions during late autumn and winter.

Winter run The RBDD estimate for year 2002 winter run was **9,172** salmon. This included and estimated 7,911 natural-origin salmon (all hatchery winter run have adipose fin-clipped off) and 1,261 hatchery-origin winter-run. Winter-run fish migrate past RBDD from December through August. Winter run passing RBDD in December of 2001 were part of the 2002 estimate based on traditional run timing (Table 1). Most of these fish were thought to have spawned in the main-stem of the Sacramento River above Red Bluff. Livingston Stone National Fish Hatchery (LSNFH) collected **104** winter-run (101 from the Keswick Dam fish trap and 3 fish from the RBDD trapping facility for the LSNFH brood stock program).

Thirteen aerial helicopter surveys were conducted to determine winter-run spawning locations in the main-stem Sacramento River from Woodson Bridge (RM 218) to Keswick Dam (RM 302). This data is presented in Table 3. The proportion of redds above and below RBDD and the total estimate of winter run passing RBDD are used to calculate the winter run estimate for downstream of RBDD. In 2002, one winter run redd was spotted downstream of RBDD during aerial flights. Therefore, the winter run population estimate downstream of RBDD is 15 fish $((9,157 - 104 \text{ into hatchery}) / 99.8\% \times 0.2\%)$.

Data collected at the RBDD trap include length, sex, race, marks, and hook scar information. Historically, salmon at RBDD are classified as grilse (two-year old mature salmon) if their length is less than 61 cm (24 in). The total winter run salmon collected at the trap in 2002 was 342 fish. Of the 302 natural winter-run salmon observed in the trap in 2002, 253 (84%) were adults and 49 (16%) were grilse. Of the 165 males (hatchery included) observed 43 (26%) were grilse and of the 177 females, 15 (8%) were grilse. Forty- (40) hatchery adipose fin-clipped winter-run fish were observed in the trap in 2002 (9 grilse). The trap data was expanded to account for the fish passing the fish ladders and also for the fish estimated to have passed when the gates were up. All of this data is presented in Table 2.

The Department's Stream Evaluation Program (SEP) conducted a carcass survey for winter-run salmon in the Upper Sacramento River from 1 May through 27 August 2002. Based on a sample size of 3,610 tagged carcasses and a recovery rate of 59% of these carcasses, a population estimate of **7,036** winter-run salmon was obtained using the Jolly-Seber model. (Snider, et al. Draft 2002).

Data from the aerial redd flights indicate that 4.1% of the winter run spawning occurred outside of the carcass survey area (0.16% downstream of RBDD). The expanded winter-run carcass survey data is that there were a total of **7,441 winter run** salmon present in the Sacramento River Watershed in 2002, $(7,036) / .951\% \times .041\% + 104 = 7,441$. (Downstream of RBDD = 12).

Run size estimates at RBDD have been made since 1967. The National Marine Fisheries Service (NMFS, 1996) developed draft winter-run population recovery goals of 10,000 spawning females over 13 consecutive years. This recovery goal was set using the RBDD winter-run population estimates. *Beginning in 2001, the Department has chosen for regulatory purposes that the population estimates from the carcass survey will be used in reporting the winter run salmon estimate.* Data are still presented for the RBDD to continue trend data that has been available over the past 33 years.

There was no estimated angler harvest of winter run above or below RBDD due to a 0 salmon possession limit from 15 January through 16 July 2001 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, the RBDD winter run data reports 9,172 salmon in the Sacramento River in 2002 while the carcass survey data reports 7,441 salmon.

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

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

An estimated 608 salmon showing spring run characteristics passed RBDD in 2002 (Table 2). Of these fish, 125 are estimated by the Department to have traveled upstream to Beegum Creek, a tributary of Cottonwood Creek. The remaining fish (483) may have spawned in the main-stem or entered other upstream tributaries such as Clear or Battle creek(s) in areas also accessible to spawning fall-run salmon.

Two spring run flights were conducted and no redds were observed downstream of RBDD. The spring run main-stem spawning estimate downstream of RBDD is zero.

In summary, the above RBDD estimate is 608 spring run salmon. Data for below RBDD includes the tributaries (see below) Thomes (2), Antelope (46), Mill (1,594) and Deer Creek(s) (2,195) for a downstream (RBDD to Princeton) spring run total of 3,837. The total 2002 escapement to the Upper Sacramento River Watershed was at least **4,445**. Note that Butte Creek spring run results are presented in a separate report (Tracy McReynolds, personal communication).

Fall-run. An estimated 154,540 fall-run salmon passed the RBDD in 2002 (Table 2). Based on a sample size of 2,710 live salmon, an estimated 3% were adipose fin-clipped. Unlike winter and late-fall run hatchery fish not all fall-run hatchery fish are fin-clipped so it is **not** assumed that these unmarked 97% are of natural origin.

A large problem was encountered with the fall-run estimate using the RBDD counts in 2002. For the second consecutive year, since complete counts were halted in 1986, the RBDD estimate resulted in a negative number for the main-stem Sacramento River. The main-stem estimate is calculated by using the RBDD total and subtracting the tributaries, harvest, and hatchery estimates. The remaining fish are then “assigned” to the main-stem and unsurveyed tributaries. When this process was applied in 2002 the RBDD counts of 154,540 were lower than combined upstream estimate of 486,516 (413,220 Battle and Clear creek(s) + 7,149 harvest + 66,147 hatchery), resulting in a negative number of -331,976 salmon in the main-stem.

This large underestimation may have resulted from a number of reasons. One possibility is that the run was later arriving to RBDD in 2002. Comments from anglers and ocean fishing communities indicated that fishing was excellent in the ocean later than usual due to an abundance of baitfish in many northern ocean areas. This may have resulted in fall-run salmon staying on the feeding grounds later and subsequently arriving later at RBDD after gates were raised resulting in

a lower count. A second reason may be due to the temperature control of Lake Shasta water released into the Sacramento River for the winter run spawning period from May till August. 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 fish 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.

Some evidence of this was generated by a tagging study done at the RBDD during 2001 and 2002. The tagging study was conducted in conjunction with a flow crowning study done by the U.S. Bureau of Reclamation (USBR). Results from the study indicated that the fish tagged at the RBDD trap traveled in some cases many miles downstream, perhaps seeking deep holes to hold in. One fish even traveled from Red Bluff to the Feather River Hatchery a notable downstream journey. The crowning study itself may have been a problem to fall-run passage. The center-ladder was removed from RBDD, and flow was concentrated in the middle portion of the dam in an attempt to force fish to the sides of the river where they would find the ladders. The removal of the center ladder removed an avenue of passage and the fish did not appear to use the two side ladders with any greater pace than in previous years. In any case the reason for the unusually low RBDD number will likely never be known. Instead the Department relied on the carcass survey conducted on the main-stem to provide an estimate of main-stem population.

The Department’s Stream Evaluation Program (SEP) conducted a fall run carcass survey to estimate fall run spawner populations. In 2002, the SEP draft estimate was 19,707 fall-run salmon spawned from the Anderson Cottonwood Irrigation District Dam (RM 298.5) downstream to just below Deschutes Road Bridge (RM 279.5) in the main-stem Sacramento River (Schaefer formula). Currently this information is in draft form, (Bob Reavis, CDFG, personal communication). This number is expanded to account for redds located outside of the carcass survey reach. Based on flight data 70% of fall run redds were located outside of the carcass survey reach. Accordingly, the 19,707 are expanded to 65,690 fish for the main-stem (**45,523** upstream of RBDD-(69.3%) and 20,167 downstream).

Sport anglers were estimated to have captured 23,501 in the main-stem, split between **7,149** fish upstream of RBDD during the season from 16 July 2002 through 14 January 2003 and 16,352 fish downstream of RBDD (Duane Massa, personal communication). Note that regulation changes in late 2002 altered the fishing season beneath Bend Bridge by shortening the season from 14 January to the current 31 December. Also note that fish harvested from Knights Landing upstream to RBDD are included in the downstream harvest component.

An estimated **479,367** salmon entered Battle (397,149 in-river + 66,147 CNFH) and Clear creeks (16,071). This number did not include salmon that used other tributaries to the upper main-stem that were not surveyed (Cottonwood, Cow, Paynes, Inks, Bear, and Ash Creek(s) etc.), these systems were traditionally accounted for in the RBDD estimate but this was not the case in 2002 since the main-stem carcass survey is used.

Combining all of these surveys resulted in an upstream escapement estimate of at least **532,039** fall run salmon above RBDD.

Cooler water temperatures in the fall provide opportunities for the fall run to spawn further downstream. To account for downstream (of RBDD) spawning activity four fall run flights were made this year. In 2002, an estimated 30.7% of the fall run spawning in the main-stem occurred downstream of RBDD (Table 3). This resulted in a spawner population of 20,167 fall run estimated below the RBDD to Princeton Ferry ($65,690 \times 30.7\%$ downstream). Angler harvests of 16,352 fall run beneath RBDD result in an overall escapement of 36,519 fall run downstream of RBDD for the main-stem river.

Additionally an estimate of 2,611 was made for fall run escapement (see below) to Mill Creek, for a total downstream of RBDD escapement of at least **39,130**.

In summary, total fall-run escapement to the Sacramento River System above Princeton is estimated to be at least 571,169 salmon plus the additional fish in unsurveyed areas.

Please see Appendix Table's 1 - 3 for a summary of current data and historical information.

Summary of Tributaries Above Red Bluff Diversion Dam

Clear Creek.

Late-Fall run. No surveys were conducted for this run in 2002.

Spring run. The U.S. Fish and Wildlife Service (USFWS), Northern Central Valley Fishery Resource Office (NCVFRO) in Red Bluff, surveyed Clear Creek in 2002 for the occurrence of spring-run Chinook salmon. No population estimate has been made.

Fall run. Nine spawner surveys of Clear Creek were made during 7 October 2002 through 2 December 2002 in the 6.7 km (4.2 mi) reach downstream of McCormick-Saeltzer Dam site.

Salmon carcasses were marked by attaching colored tags to the jaw with a hog-ring and placing the fish back into running water for recovery during following

surveys. Using fresh carcass mark-and-recovery data with the Schaefer model, the spawner population in Clear Creek downstream of McCormick-Saeltzer Dam was estimated to be **16,071** fish (Table 4). Based on examination of 6,117 carcasses, the fall-run spawner population in Clear Creek consisted of 47% male

TABLE 4. Chinook salmon carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population for Clear Creek from the McCormick-Saeltzer Dam site to 6.4 km (4.5 mi) downstream, using Schaefer's method.

Week of Recovery (j)	R (ij) by Week of Tagging (i)								Total marked carcasses recovered R(j)	Total carcasses observed C(j)	Population estimate
	1	2	3	4	5	6	7	8			
Oct. 15	5								5	391	1485
Oct. 21	5	47							52	828	2576
Oct. 28	2	17	49						68	1823	3914
Nov. 04		5	11	71					87	1287	3957
Nov. 11			1	32	40				73	1056	2273
Nov. 18				3	9	27			39	538	1388
Nov. 25				3	5	22	6		36	376	361
Dec. 02					2	7	13	8	30	182	117
Recovery R(i)	12	69	61	109	56	56	19	8			16,071
Tagged M(i)	34	147	167	292	179	132	56	23			

adults (fork length [FL] \geq cm [24 in]), 51% female adults, and 2% grilse (FL \leq 61 cm). Pre-spawning mortality of female salmon in Clear Creek this season was 1%.

A total of 42 coded-wire tags (CWT) representing 26 tag codes were recovered during the surveys (Appendix Table 4). Coded-wire tag recoveries were made from the following hatchery releases: Coleman National Fish Hatchery (CNFH), Feather River Hatchery (FRH), Mokelumne River Fish Installation (MRFI), Merced River Fish Facilities (MRFF), and Tiburon Net Pens (Appendix Table 4).

Cow Creek.

Late-Fall run. No surveys for this run in this tributary were made in 2002.

Fall run. No surveys for this run in this tributary were made in 2002.

Cottonwood Creek

Late-Fall run. No surveys for this run in this tributary were made in 2002.

Spring run. A total of 125 adult spring-run chinook were initially counted during snorkel surveys in 2002, although high water temperatures are estimated to have reduced the spawning population to fewer than 50 fish by the time spawning occurred. The known holding and spawning habitat of adult spring-run salmon was surveyed monthly March through November from the North Fork (0.8 km) (0.5 mi) upstream from the North and South Fork confluence, downstream to the HWY-36 Bridge, a distance of approximately (12.1 km) (7.5 mi). Entry of salmon in Beegum Gorge occurred primarily between March and May 2001. Water temperatures in the high 70's may have resulted in significant pre-spawning mortality of holding salmon. Black bear predation may also have contributed to pre-spawning mortality as evidenced by fresh tracks around spawning redds. Spawning surveys confirmed that spring-run Chinook salmon in Beegum Creek remained spatially and temporally isolated from fall-run Chinook salmon in Cottonwood Creek.

Fall run. No surveys for this run in this tributary were made in 2002.

Battle Creek

Late-Fall run. No surveys were made for late-fall-run Chinook salmon in-river escapement in 2002. A total of 2,542 late-fall Chinook entered CNFH in 2002, consisting of 44% male adults, 49% female adults and 7% grilse. In

addition 254 undetermined fall/late-fall origin fish were excessed in November. Half of these (127) were assigned as late-fall run, bringing the CNFH total to 2669.

Spring run. The USFWS, NCVFRO surveyed Battle Creek in 2002 for the occurrence of spring-run Chinook salmon. No population estimate was made.

Fall run. Due to the unusually large number of carcasses in Battle Creek this season, the survey reach was sub-sampled. The resulting population estimate was expanded to an estimate for the entire creek. It was determined from previous year's carcass data that an average 22% of carcasses encountered on Battle Creek occur in the lower 2.6 km (1.6 mi) reach from the Jelly's Ferry Road Bridge crossing to the old hatchery site. Seven carcass surveys were made in this section of Battle Creek during 10 October through 21 November. Salmon carcasses were marked by attaching colored tags to the jaw with a hog-ring and replacing the fish back into running water for recovery during following surveys. Using fresh carcass mark-and-recovery data with the Schaefer model, the spawner population in Battle Creek in the surveyed section was estimated to be 87,373 fish. The total spawner population in Battle Creek downstream from CNFH was estimated to be **397,149** salmon. Combined with an additional 66,147 that entered CNFH, the total Battle Creek fall-run population was **463,296**.

The composition of natural spawning fall-run salmon in Battle Creek was 43% male adults (FL \geq 61cm [24 in]), 55% female adults and 2% grilse (FL \leq 61cm), based on an examination of 18,257 carcasses. In comparison, fall run entering CNFH consisted of 65% male adults, 29% females and 6% grilse. Pre-spawning mortality of natural spawning female salmon in Battle Creek this season averaged 88% and ranged from 33% to 96%.

A total of 489 CWT's representing 62 tag codes were recovered during the surveys (Appendix Table 4). Coded-wire tag recoveries were made from the following hatchery releases: CNFH, FRH and MRFF (Appendix Table 4).

Summary of Tributaries below Red Bluff Diversion Dam

Antelope Creek

Spring run. Antelope Creek was snorkel surveyed to count holding adult spring-run Chinook salmon on 22 July. A total of 23.5 km (14.6 mi) of stream was surveyed including: the North Fork from 0.8 km (0.5 mi) upstream of the Judd Creek confluence to the South Fork confluence, sections of the South Fork from the South Fork Falls to the North Fork confluence, and the main stem from the North and South Fork confluence to Facht Place. The areas surveyed

TABLE 5. Chinook salmon carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population for Battle Creek from Jelly's Ferry Road Bridge to the old hatchery site, using Schaefer's method. The estimate was expanded to include the total spawner population from Coleman National Fish Hatchery to the old hatchery site.

Week of Recovery (j)	1	R(ij) by week of tagging (i)						Total marked carcasses recovered R(j)	Total carcasses observed C(j)	Population estimate
		2	3	4	5	6				
Oct. 17-18	50						50	3921	9303	
Oct. 22-25	8	111					119	5627	13247	
Oct. 30-31	1	4	29				34	4321	29308	
Nov. 05			4	23			27	2101	7243	
Nov. 14				1	4		5	1678	26099	
Nov. 21				3	0	5	8	764	2174	
Recovery R(i)	59	115	33	27	4	5				87,373
Tagged M(i)	124	270	244	82	78	23	22% expansion:			397,149

encompass the known holding habitat of adult spring-run salmon in Antelope Creek. A total of **forty-six (46)** adult salmon was counted and it was concluded that they constituted the entire 2002 spring run in Antelope Creek.

Fall run. No surveys were conducted for this run in Antelope Creek in 2002.

Mill Creek

Spring run. Surveys to count spring-run salmon spawning redds were made between 30 September and 15 October. Mill Creek was surveyed using a combination of ground redd surveys and aerial redd surveys from 3.6 km (2.2 mi) upstream of Hwy-36 Bridge crossing downstream to the steel tower transmission line crossing, a distance of 43.2 km (27 mi). A total of 797 redds was counted. To expand the redd counts to a population estimate, it is assumed each female salmon constructs one redd and that there is a 1:1 sex ratio in the population. Using these assumptions, a total of **1,594** salmon spawned in Mill Creek.

$$797 \text{ redds} \times 1 \text{ female/redd} \times 2 = 1,594 \text{ salmon}$$

Spring-run Chinook had completed spawning activities prior to fall-run Chinook salmon migration into Mill Creek. Fall-run Chinook surveys indicated that the fall run did not migrate upstream into spring run spawning areas. Therefore, both temporal and spatial isolation occurred between these two runs in 2002.

Fall run. Five spawner surveys of Mill Creek were made during 6 November through 4 December between the Upper Diversion Dam and the confluence with the Sacramento River. Salmon carcasses were marked by attaching colored tags to the jaw with a hog-ring and replacing the fish back into running water for recovery during following surveys. No surveys were made upstream of the Upper Dam for spawning fall-run salmon. Using fresh carcass mark-and-recovery data with the Schaefer model, the spawner population in Mill Creek was estimated to be **2,611** fish (Table 6).

The composition of natural spawning fall-run salmon in Mill Creek was 53% male adults (FL \geq 61cm, [24 in], 40% female adults and 7% grilse (FL \geq 61cm), based on an examination of 1671 carcasses. Pre-spawning mortality of female salmon in Mill Creek this season averaged 3%.

A total of 46 CWT's representing 21 tag codes were recovered during the surveys (Appendix Table 4). Coded-wire tag recoveries were made from the following hatchery releases: CNFH, FRH, MRFI and MRFF.

TABLE 6. Chinook salmon mark-and-recovery data used to estimate the 2002 fall-run spawner population for Mill Creek from the Upper diversion dam to the confluence with the Sacramento River, using Schaefer's method.

Week of Recovery (j)	1	R(ij) by week of tagging (i)			Total marked carcasses recovered R(j)	Total carcasses observed C(j)	Population estimate
		2	3	4			
Nov 13	10				10	440	1025
Nov 20	12	34			46	608	861
Nov 26	6	10	21	11	37	350	646
Dec 04	4	7	27		49	345	79
Recovery R(j)	32	51	48	11			2611
Tagged M(i)	48	81	91	13			

Deer Creek.

Spring run. Snorkel counts for adult spring-run Chinook salmon were made on 6 and 12 August from Upper Deer Creek Falls downstream to Dillon Cove, a distance of 53 dm (33.3 mi). A total of **2,195** salmon was counted and it was concluded that this constituted the entire 2002 spring run in Deer Creek. Spring-run spawning surveys in October counted 1022 redds and 290 carcasses. Spring-run Chinook had completed spawning activities prior to fall-run salmon migration into Deer Creek. Fall-run Chinook salmon surveys indicated that fall run did not migrate upstream into spring run spawning areas. Therefore, both temporal and spatial isolation occurred between these two runs in 2002.

Fall run. Two surveys were made between 19 November and 27 November to determine spawning distribution. The survey extended from the Leininger Road Bridge to the Hwy 99 Bridge crossing. A total of 34 carcasses were observed. No salmon were observed upstream of the Stanford Vina Dam. No population estimate will be made from this data. One CWT marked fish was recovered. The CWT was illegible, (Appendix, Table 4).

Thomes Creek.

Spring run. Snorkeling crews surveyed Thomes creek twice in 2002. Two spring run salmon (the same fish each trip) were observed. Surveys were conducted upstream of Paskenta in the Thomes Creek Gorge area on 14 May and 12 June in two separate sections. Other salmon may have been present but water turbidity prevented other observations.

APPENDICES

APPENDIX TABLE 1. Summary of Chinook salmon population estimates for Sacramento River System from Keswick Dam downstream to Princeton Ferry in 2002.

LOCATION	Late-Fall-Run	Winter-run*	Spring-Run	Fall-Run
Red Bluff up to Keswick Dam				
Sacramento River Main-Stem	36,004	7,325	483	45,523
Livingston Stone Hatchery	0	104	0	0
Battle Creek Coleman Hatchery	2,669	0	0	66,147
Battle Creek Above hatchery	n/a^		n/a	n/a
Battle Creek Below Hatchery	n/a			397,149
Clear Creek	n/a		n/a	16,071
Cow Creek	n/a			n/a
Cottonwood Creek	n/a		125	n/a
Angler Harvest total	528	0	0	7,149
SUB-TOTAL UPSTREAM OF RBDD	39,201	7,429	608	532,039
Red Bluff down to Princeton				
Sacramento River Main-Stem	0	12	0	20,167
Mill Creek	n/a		1,594	2,611
Deer Creek	n/a		2,195	n/a
Antelope Creek	n/a		46	n/a
Thomes Creek			2	
Angler Harvest total	900	0	0	16,352
SUB-TOTAL DOWNSTREAM OF RBDD	900	12	3,837	39,130
SYSTEM GRAND TOTAL	40,101	7,441	4,445	571,169
(Keswick Dam to Princeton)				
TOTAL SALMON ALL RUNS COMBINED:			623,156	
Streams not shown did not have surveys conducted in 2002				
* Carcass survey results vs RBDD of 9,172.				
^ n/a: Is not available, represents salmon present but no estimate available.				

APPENDIX TABLE 2. Summary of Chinook salmon population estimates for Sacramento River System upstream of Princeton from 1986-2002.

YEAR **	Salmon Totals for Sacramento System above Princeton ^			
	Fall	Spring	Winter	Late-Fall
1986	144,377	17,657	2,596	11,398
1987	134,686	11,435	2,186	26,438
1988	159,448	11,003	2,886	12,937
1989	96,271	5,895	696	31,261
1990	71,799	5,305	430	8,150
1991	56,277	1,607	211	8,591
1992	51,588	876	1,240	11,944
1993	71,314	716	387	n/a
1994	112,923	2,221	186	n/a
1995	169,556	2,082	1,297	n/a
1996	172,058	1,520	1,337	n/a
1997	249,118	793	880	n/a
1998	119,114	4,096	3,002	46,454*
1999	308,745	2,660	3,288	32,368*
2000	184,987	1,442	1,352	16,015*
2001	232,601*	3,715	5,523 / 8,100*	25,725*
2002	571,169*	4,445	9,172 / 7,441*	40,101*
AVERAGE	171,295	4,557	2,157 ⁺	22,615
^ 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, angler and redd surveys				
⁺ Winter run average is calculated using RBDD numbers				

APPENDIX TABLE 3. Summary of aerial redd counts for Sacramento River System from Keswick Dam downstream to Princeton Ferry from 1969-2002.

Percentage of redds in main-stem Sacramento for aerial flights (up and downstream of RBDD)										
YEAR	Winter-Run		Spring-Run		Fall-Run		Late-Fall		ALL COMBINED	
	% Up	% Down	% Up	% Down	% Up	% Down	% Up	% Down	% Up	% Down
1969	n/a	n/a	n/a	n/a	74.4%	25.6%	n/a	n/a	74.4%	25.6%
1970	n/a	n/a	n/a	n/a	85.6%	14.4%	n/a	n/a	85.6%	14.4%
1971	n/a	n/a	n/a	n/a	68.5%	31.5%	n/a	n/a	68.5%	31.5%
1972	n/a	n/a	n/a	n/a	63.5%	36.5%	67.2%	32.8%	64.8%	35.2%
1973	n/a	n/a	n/a	n/a	69.9%	30.1%	75.9%	24.1%	74.7%	25.3%
1974	n/a	n/a	n/a	n/a	60.9%	39.1%	n/a	n/a	60.9%	39.1%
1975	n/a	n/a	n/a	n/a	56.4%	43.6%	n/a	n/a	56.4%	43.6%
1976	n/a	n/a	n/a	n/a	72.9%	27.1%	64.7%	35.3%	71.9%	28.1%
1977	n/a	n/a	n/a	n/a	45.1%	54.9%	n/a	n/a	45.1%	54.9%
1978	n/a	n/a	n/a	n/a	46.0%	54.0%	25.6%	74.4%	43.2%	56.8%
1979	n/a	n/a	n/a	n/a	53.9%	46.1%	42.7%	57.3%	52.0%	48.0%
1980	n/a	n/a	n/a	n/a	48.7%	51.3%	n/a	n/a	48.7%	51.3%
1981	87.8%	12.2%	n/a	n/a	63.0%	37.0%	63.5%	36.5%	63.5%	36.5%
1982	97.0%	3.0%	n/a	n/a	67.1%	32.9%	n/a	n/a	67.5%	32.5%
1983	n/a	n/a	81.1%	18.9%	47.6%	52.4%	71.2%	28.8%	59.3%	40.7%
1984	n/a	n/a	93.3%	6.7%	66.6%	33.4%	78.9%	21.1%	67.2%	32.8%
1985	71.8%	28.2%	78.6%	21.4%	55.5%	44.5%	81.5%	18.5%	56.3%	43.7%
1986	n/a	n/a	100.0%	0.0%	64.5%	35.5%	72.8%	27.2%	64.9%	35.1%
1987	95.5%	4.5%	n/a	n/a	71.4%	28.6%	64.1%	35.9%	71.0%	29.0%
1988	74.5%	25.5%	97.4%	2.6%	77.9%	22.1%	98.9%	1.1%	78.3%	21.7%
1989	97.9%	2.1%	100.0%	0.0%	83.3%	16.7%	41.9%	56.4%	82.6%	17.4%
1990	93.3%	6.7%	100.0%	0.0%	66.8%	33.2%	87.4%	12.6%	67.8%	32.2%
1991	100.0%	0.0%	100.0%	0.0%	66.9%	33.1%	81.6%	18.4%	67.8%	32.2%
1992	96.4%	3.6%	100.0%	0.0%	73.8%	26.2%	85.8%	14.2%	75.1%	24.9%
1993	97.7%	2.3%	100.0%	0.0%	72.5%	27.5%	100.0%	0.0%	72.7%	27.3%
1994	100.0%	0.0%	85.1%	14.9%	77.8%	22.2%	77.0%	23.0%	77.8%	22.2%
1995	99.4%	0.6%	90.9%	9.1%	83.5%	16.5%	61.9%	38.1%	83.5%	16.5%
1996	100.0%	0.0%	100.0%	0.0%	85.5%	14.5%	n/a	n/a	86.0%	14.0%
1997	100.0%	0.0%	99.0%	1.0%	82.8%	17.2%	n/a	n/a	83.6%	16.4%
1998	97.5%	2.5%	100.0%	0.0%	90.5%	9.5%	97.2%	2.8%	92.4%	7.6%
1999	100.0%	0.0%	100.0%	0.0%	78.8%	21.2%	n/a	n/a	99.0%	1.0%
2000	100.0%	0.0%	100.0%	0.0%	90.8%	9.2%	98.6%	1.4%	94.7%	5.3%
2001	99.6%	0.4%	96.6%	3.4%	85.4%	14.6%	95.2%	4.8%	93.1%	6.9%
2002	99.8%	0.2%	100.0%	0.0%	69.3%	30.7%	100.0%	0.0%	80.5%	19.5%
AVERAGE	95.2%	4.8%	95.9%	4.1%	69.4%	30.6%	75.4%	24.5%	71.3%	28.7%
n/a = not available										

APPENDIX TABLE 4. Summary: 2002 Coded-wire tag (CWT) recoveries in Battle, Mill and Clear Creek(s).

CWT Code	Hatchery Origin	Recapture Location			
		Battle Creek	Clear Creek	Mill Creek	Deer Creek
0501011514	CNFH ^{1/}	2			
0501020101	CNFH	1	3		
0501020408	Sacramento Wild ^{2/}	1			
0501021007	CNFH	1			
0501021012	CNFH	1			
0501021013	CNFH	3			
0501021014	CNFH	2			
0501021101	CNFH	3			
0501021102	CNFH	2			
0501021103	CNFH	2			
0501021104	CNFH	2			
0501021106	CNFH	1			
0501021107	CNFH	1			
0501021108	CNFH	1		1	
0501021109	CNFH	2			
0501021110	CNFH	2			
0501021111	CNFH	1			
0501021112	CNFH	1			
0501021115	CNFH	2		1	
0501021201	CNFH	1			
0501021313	CNFH	1			
0501021314	CNFH	6	1		
0501021315	CNFH	5			
0501021401	CNFH	2	1	1	
0501021402	CNFH	5			
0501021403	CNFH	4			
0501021404	CNFH	5	1		
0501021405	CNFH	3			
0501021406	CNFH	2			
0501021407	CNFH	7	1	1	
0501021408	CNFH	1	2		
0501021409	CNFH	5			
0501021410	CNFH	4			
0501021411	CNFH	6			
0501021412	CNFH	7			
0501021413	CNFH	2			
0501021415	CNFH	1	1		
0501021501	CNFH	3			
0501021502	CNFH	5		1	
0501021503	CNFH	1			
0501021504	CNFH	1	1	1	
0501021506	CNFH	7			
0501021507	CNFH	5		1	
0501021508	CNFH		1		
0501021509	CNFH	2		2	

CWT Code	Hatchery Origin	Recapture Location			
		Battle Creek	Clear Creek	Mill Creek	Deer Creek
0501030501	CNFH	1			
0501030505	CNFH	1			
0501030507	CNFH	1			
0501030508	CNFH	1			
0501030509	CNFH	4			
050497	CNFH		1		
050565	CNFH	1	1		
050566	CNFH	1			
050567	CNFH	1			
050570	CNFH			1	
050571	CNFH	1			
050572	CNFH	1			
0601060702	FRH ^{3/}		1		
0601060902	FRH	1			
0601061002	MRFF ^{4/}	1			
060247	MRFI ^{5/}		1		
060248	MRFI			1	
060250	MRFI		1		
060251	MRFI		1		
060258	MRFI			2	
062637	FRH		1		
062662	MRFI			1	
062664	FRH		6	2	
062665	FRH	1	2	1	
062671	FRH	1			
062674	FRH		1		
062675	FRH			1	
062678	FRH		1		
062940	Tiburon Net Pen ^{6/}		1		
064404	MRFF			1	
064405	MRFF		1		
064441	MRFF			1	
064442	MRFF			1	
064540	MRFF		1		
100000	No CWT found	16	8	7	
200000	CWT lost	3	1		
300000	No head recovered	309		14	
400000	CWT illegible	22	1	4	1
Totals		489	42	46	1

^{1/} CNFH = Coleman National Fish Hatchery

^{2/} Sacramento Wild = Sacramento River Wild Stock

^{3/} FRH = Feather River Hatchery

^{4/} MRFF = Merced River Fish Facility

^{5/} MRFI = Mokelumne River Fish Installation

^{6/} Tiburon Net Pens = FRH stock reared at Tiburon Net Pens

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