Draft 90147

March 23, 1998

CHINOOK SALMON SPAWNING POPULATION FOR THE SACRAMENTO RIVER SYSTEM, 1997

Keswick Dam to Red Bluff Diversion Dam

by

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GENERAL METHODS

During 1997, spawning stock data were collected on some Central Valley streams known to support sizable chinook salmon runs by counting potential spawners passing through fishways, conducting stream surveys where numbers of live fish, carcasses, and redds were enumerated, and making aerial redd counts. In some streams, fresh carcasses were color tagged and released and subsequent recovery rates of tagged carcasses were used in estimating spawning populations. Unless otherwise stated, all counted carcasses were chopped in half or tagged to prevent recounting on subsequent trips.

Weather conditions did not interfere with carcass recovery this season until late in the spawning season. Stream flows were low and carcass recovery conditions good. Results are presented under the individual stream headings.

Estimates were made for three of the four spawning populations in the upper Sacramento River main stem using fish counts at Red Bluff Diversion Dam (RBDD), (Figure 1). In addition, fall-run population estimates were made for Battle Creek using carcass counts and returns to Coleman National Fish Hatchery (CNFH), and for Clear Creek. Spawning surveys were not made on other tributaries due to the inability to gain access

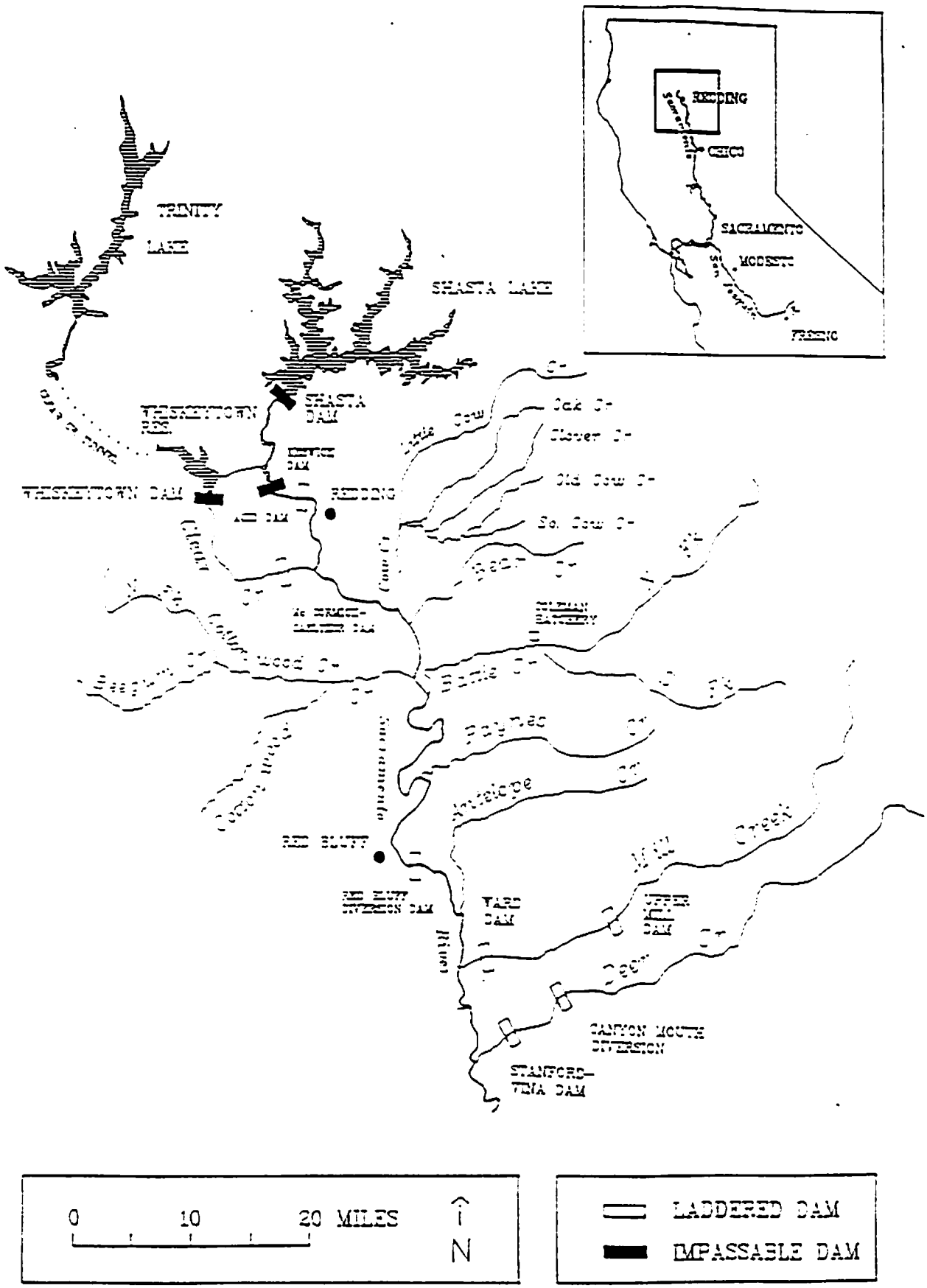

FIGURE 1. Map of the Upper Sacramento Valley depicting the Sacramento River and its tributaries.

permission on private parcels of land. Other tributaries which occasionally have fall-run spawns but were not surveyed in 1997 include: Spring Gulch, China Gulch, Olney, Cow, Paynes, Bear, Ash, Stillwater and Inks creeks. Aerial redd counts were conducted to determine spawning distribution in the Sacramento River main stem and Cottonwood Creek for the various runs.

A total of 206,517 salmon spawned in the Sacramento River system between Keswick Dam and Red Bluff in 1997 including 205,487 fall-, unknown number of late-fall-, 841 winter- and 189 spring-run fish (Table 1). Some tributaries were not routinely surveyed during the spawning season and no population estimates were made. However, the number of redds observed, live fish seen or carcasses counted are noted and are reported as presence or absence of salmon. Any fish that may have spawned in unsurveyed tributaries were assigned to the main stem river. A total of 95,505 fall-, unknown number of late-fall-, 841 winter-run salmon and 189 salmon identified as spring-run salmon spawned in the main stem, and 50,670 fall-run and 4,127 late-fall-run salmon were either trapped at Keswick and trucked to CNFH or voluntarily entered CNFH (Appendix Table 1).

Sacramento River Main Stem

Estimates of the total numbers of salmon utilizing the Sacramento River and its tributaries upstream from RBDD during 1997 were based on daily counts made by the U.S. Fish and Wildlife Service and the Department of Fish and Game at Red Bluff Diversion Dam. The counts were obtained by closed circuit television observations of salmon passing through the fishways (Appendix Table 1).

Weekly counts were adjusted for periods when the fishways remained open, but no counts were made, during weeks which had partial counts, and during night hours when no counts were made. Count adjustments for the daytime lapses were made by interpolation. Adjustment for the nighttime hours was made by multiplying the 14-h day counts by a "night factor" developed from weekly night counts.

TABLE 1. Calculation of Chinook Salmon Runs and Spawning Populations, Sacramento River System above Red Bluff Diversion Dam, 1997.*

Run	Fish Passing Dam in Calendar Year 1996	1997	Potential 19975 Spawners (runs)	Estimated 1996-97 Sport Catch above Dam	Estimated 1997 Spawning Populations
Late-Fall [a/] 1996-1997	No estimate	- - -	- - -	- - -	- - -
Winter [b/] 1996-1997	28	813	841	0	841
Spring [c/] 1997	0	189	189	0	189
Fall 1997	0	223,355	223,355	17,864	205,487
Totals	28	224,357	224,385	17,864	206,517

* Red Bluff Diversion Dam gates raised during January-May 11,1997, and September 13-December 1997.

a/ Could not be counted at RBDD because gates were raised.

b/ Hatchery origin winter run entering Battle Creek (266 fish) are not included as potential winter-run spawners.

c/ Spring-run salmon in the main stem Sacramento River are considered by the Department to have largely been eliminated through competition plus hybridization with fall-run salmon.

The adjusted weekly totals were separated into numbers of winter-, spring-, and fall-run salmon by examining fish entering the trapping facility adjacent to the east bank fishway and estimating, by coloration, scale absorption, secondary sexual characteristics and the degree of ripeness. The portion of each race caught by sportsmen was then estimated and subtracted from the number counted over RBDD (Table 1). The portions caught were estimated by calculating the monthly fraction of each chinook race passing RBDD. These fractions were multiplied by the total chinook catch estimated for that month from a river wide angler survey for that river reach. The estimated catch for winter run is obviously reduced because of the angling closure from 15 January through 31 July to protect the winter run minimizes the catch of this run. No attempt was made to measure any other form of mortality in the upper river prior to spawning. While a

calendar year count includes total annual runs passing the dam for spring- and fall-run salmon, it represents only part of the winter-run salmon since winter run usually begin passing Red Bluff in one calendar year and finish in the next. The same calendar year will usually include most of winter run early in the year and the first small portion of the subsequent winter run at the end of the year.

The counts of fall- and winter-run salmon were discontinued by the raising of the gates at RBDD from 14 September 1996 through 11 May 1997 and 13 September 1997. This is the period when a portion of these races migrate above the dam.

To calculate the seasonal estimates of fall-, spring-, and winter-run salmon, the proportion of these fish that migrated when the dam gates are removed were first estimated. These proportions are averages based upon data collected during the previous 17 years when the gates were usually closed and counts were made year-round (Table 2). The total escapement estimates are calculated by dividing the number of each run counted over RBDD when the dam gates are in place by the estimated proportion of the total run this count represented.

To obtain the Sacramento River main stem spawning population above Red Bluff, the estimated number of fall-run salmon spawning in tributaries and number of salmon counted or trucked to CNFH were subtracted from the respective totals of these races which passed RBDD. Salmon that spawned in all unsurveyed tributaries are included in the main stem estimate.

Late-Fall Run. We are unable to get counts from the annual late fall spawning migration that occurs between October and April because the Red Bluff Diversion Dam gates are raised during this time period. No estimates for late-fall salmon are made.

TABLE 2. Average Migration timing for the various salmonid runs passing Red Bluff Diversion Dam 1970-1988. (Percentage, and cumulative percentage occurrence.)

APPROX MONTH	Week Number	('82-'86) Winter run %	('82-'86) Winter run cum.%	('70-'88) Spring run 1/ %	('70-'88) Spring run 1/ cum.%	('70-'88)* Fall run %	('70-'88)* Fall run cum.%	('70-'86) Late Fall run %	('70-'86) Late Fall run cum.%	('70-'88) Steelhead %	('70-'88) Steelhead cum.%
JAN	1	1.70	3.45								
	2	1.78	5.22					6.50	55.39	0.97	91.84
	3	0.35	5.57					6.32	61.71	0.80	92.64
	4	1.28	6.85					3.07	64.77	0.61	93.25
FEB	5	2.38	9.23					2.91	67.69	0.50	93.75
	6	3.12	12.35					3.58	71.26	0.29	94.05
	7	3.08	15.43					4.08	75.34	0.45	94.50
	8	0.97	16.40					4.19	79.54	0.56	95.06
MAR	9	6.35	22.75					4.38	83.91	0.53	95.59
	10	7.72	30.47					3.29	87.20	0.49	96.09
	11	9.23	39.70					2.14	89.34	0.46	96.54
	12	7.79	47.48	0.10	0.10			1.74	91.08	0.38	96.92
	13	4.91	52.39	0.25	0.35			3.39	94.47	0.30	97.22
APR	14	7.64	60.03	0.59	0.93			2.08	96.55	0.28	97.50
	15	8.26	68.29	0.96	1.89			1.82	98.37	0.35	97.85
	16	9.19	77.48	1.38	3.27			1.39	99.76	0.28	98.12
	17	3.47	80.95	1.63	4.90			0.24	100.00	0.19	98.31
MAY	18	2.02	82.97	1.60	6.50					0.17	98.48
	19	1.60	84.57	1.71	8.21					0.16	98.63
	20	2.17	86.75	2.16	10.37					0.17	98.80
	21	3.09	89.84	2.63	13.00					0.23	99.03
JUN	22	2.03	91.87	2.86	15.86	0.00	0.00			0.18	99.20
	23	1.63	93.50	2.61	18.47	0.00	0.01			0.20	99.40
	24	1.84	95.34	2.93	21.40	0.01	0.01			0.13	99.54
	25	0.51	95.85	3.50	24.89	0.02	0.40			0.14	99.68
	26	0.76	96.60	3.10	27.99	0.05	0.08			0.15	99.82
JUL	27	1.60	98.20	3.67	31.66	0.07	0.15			0.18	100.00
	28	0.31	98.51	6.02	37.68	0.19	0.34			0.13	0.13
	29	1.04	99.55	4.75	42.44	0.39	0.73			0.18	0.31
	30	0.44	99.99	3.21	45.65	0.58	1.31			0.18	0.49
AUG	31	0.01	100.00	4.12	49.77	0.83	2.13			0.22	0.72
	32			6.97	56.74	1.46	3.60			0.26	0.98
	33			6.07	62.81	2.31	5.91			0.39	1.36
	34			6.75	69.55	2.66	8.57			0.68	2.04
	35			5.74	75.29	3.31	11.87			1.12	3.16
SEP	36			7.22	82.51	4.39	16.27			2.36	5.52
	37			6.68	89.19	5.57	21.84			3.82	9.34
	38			5.23	94.42	8.29	30.13			5.80	15.14
	39			3.70	98.12	9.32	39.45			7.54	22.67
OCT	40			1.19	99.31	10.43	49.88			8.95	31.63
	41			0.69	100.00	10.95	60.82			11.75	43.37
	42					9.56	70.39	0.26	0.26	11.27	54.65
	43					7.24	77.63	2.06	2.32	9.79	64.44
NOV	44					7.14	84.76	2.33	4.65	6.51	70.95
	45					5.15	89.91	3.27	7.92	5.17	76.12
	46					2.97	92.89	4.24	12.16	4.04	80.17
	47					2.62	95.50	3.42	15.58	2.44	82.61
DEC	48					1.86	97.36	3.65	19.23	2.21	84.82
	49	0.172	0.172			1.01	98.37	5.37	24.60	2.05	86.87
	50	0.378	0.55			0.81	99.18	5.27	29.87	1.44	88.31
	51	0.493	1.043			0.31	99.79	5.27	35.14	1.04	89.35
	52	0.707	1.75			0.21	100.00	6.94	42.08	0.69	90.04
								6.81	48.89	0.83	90.87

* Revised: fall run to weighted average.

1/ Due to a lick of spatial and temporal isolation during spawning, spring-run salmon may have hybridized with fall-run salmon in the Sacramento River.

Winter Run. An estimated 841 naturally produced winter-run salmon spawned in the Sacramento River above Red Bluff in 1997. In addition, the U.S. Fish and Wildlife Service estimated that 266 hatchery-origin winter-run chinook salmon returned to Battle Creek (CDFG, 1998). For purposes of this report, it is assumed that all hatchery-origin winter-run salmon returned to Battle Creek. The winter-run chinook salmon propagation program at CNFH remained temporarily suspended in 1997 until imprinting and genetic issues can be resolved. During trapping at RBDD 21 of 49 wild fish examined were grilse (42.9%). Only one hatchery-origin winter run was observed at RBDD and it was a grilse.

The Department conducted a carcass survey for winter-run chinook salmon in the Upper Sacramento River from 30 April through 29 August 1997. Based on a sample size of 239 carcasses and a recovery rate of 12% on tagged carcasses, the Peterson model (Ricker, 1975), estimated that 2,053 winter run spawned in the upper Sacramento River in 1997 (Snider et al, 1998). Run size estimates using counts at RBDD have been made since 1967. For regulatory purposes, the population estimates at RBDD will be used in reporting run size.

Spring Run. True spring run in the main stem Sacramento River below Keswick Dam are considered by the Department to have largely been eliminated through competition plus hybridization with fall run. Based on subjective identification at RBDD based on migration timing and external maturation, an estimate of 189 fish identified as spring run migrated past RBDD in 1997. Some spring run salmon spawn in tributaries of the Sacramento River.

Some spring run may have entered Battle Creek in 1997. Although, tissue sample analysis from a subsample of these fish have identified a portion to be winter run and remainder exhibiting significant uncertainty as to race. Therefore, all fish identified as spring run passing RBDD will be assigned to the main stem of the Sacramento River.

No spring-run chinook salmon were observed holding in Cottonwood Creek or Clear Creek. An estimated 189 spring run spawned in the Sacramento River above Red Bluff in 1997.

A total 67 spring run was trapped at RBDD of which 48 were jack size: 71.6% were jack-sized fish.

Fall Run. An estimated 95,505 fall-run salmon spawned in or were assigned to the main stem of the Sacramento River above RBDD during 1997. The main stem total was derived by subtracting 17,868 salmon caught by sportsmen above Red Bluff, 101,413 that entered Battle Creek (including 50,670 that entered CNFH and 50,743 that spawned naturally in the creek), and the 8,569 that spawning in Clear Creek, from the 223,355 total fall run migration over RBDD. The total number of fall run examined at RBDD was 2,571 salmon of which 275 were of jack size; 10.7% were jack-sized fish.

All fall-run salmon that spawned in tributaries above RBDD, other than Battle and Clear creeks, were combined with those that spawned in the main stem of the Sacramento River. No estimates were made for several other tributaries above Red Bluff which usually account for a small portion of the fall-run escapement.

Spawning Distribution

Data collected during 19 airplane flights between 09 May and 03 November 1997 over the main stem of the Sacramento River showed the general salmon redd distribution and indicated the relative number of salmon that spawned on the riffles above Princeton Ferry (Table 3 and Figure 1). Redd counts showed 83.2% of the main stem fall-run chinook salmon spawning occurred upstream from RBDD. Additionally, ratios of redd distribution for fall-, winter- and spring-run salmon were obtained to estimate numbers spawning downstream of RBDD (Appendix Table 1).

TABLE 3. 1997 redd distribution of spawning chinook salmon in the main stem Sacramento River for different salmon runs.

Winter run flights

AREA	FLIGHT 1 May 9, 1997		FLIGHT 2 May 15, 1997		FLIGHT 3 May 27, 1997		FLIGHT 4 June 2, 1997		FLIGHT 5 June 16, 1997		FLIGHT 6 June 23, 1997	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Visibility	TURBID		TURBID		TURBID		TURBID		TURBID		TURBID	
KESWICK DAM TO A.C.I.D. DAM	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%
A.C.I.D. DAM TO HIGHWAY 44	6	100.0%	2	100.0%	1	50.0%	0	0.0%	1	100.0%	2	100.0%
HIGHWAY 44 TO UPPER ANDERSON BR.	0	0.0%	0	0.0%	1	50.0%	1	100.0%	0	0.0%	0	0.0%
UPPER ANDERSON BR. TO BALLS FERRY BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
BALLS FERRY BR. TO JELLY'S FERRY BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
JELLY'S FERRY BR. TO BEND BR.	0	0.0%	0	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%
BEND BR. TO RED BLUFF DIVERSION DAM	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%
RED BLUFF DIVERSION DAM TO TEHAMA BR.	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%
TEHAMA BR. TO WOODSON BR.	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%
TOTALS	6		2		2		1		1		2	

AREA	FLIGHT 7 July 1, 1997		FLIGHT 8 July 8, 1997		FLIGHT 9 July 15, 1997		FLIGHT 10 July 22, 1997		FLIGHT 11 August 5, 1997		FLIGHT 12 August 12, 1997	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Visibility	TUBID		POOR		POOR		POOR		FAIR		FAIR	
KESWICK DAM TO A.C.I.D. DAM	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	0	0.0%	0	0.0%
A.C.I.D. DAM TO HIGHWAY 44	1	100.0%	1	33.3%	4	100.0%	3	100.0%	0	0.0%	4	100.0%
HIGHWAY 44 TO UPPER ANDERSON BR.	0	0.0%	2	66.7%	0	0.0%	0	0.0%	1	100.0%	0	0.0%
UPPER ANDERSON BR. TO BALLS FERRY BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
BALLS FERRY BR. TO JELLY'S FERRY BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
JELLY'S FERRY BR. TO BEND BR.	NS	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
BEND BR. TO RED BLUFF DIVERSION DAM	NS	0.0%	0	0.0%	NS	0.0%	NS	0.0%	0	0.0%	0	0.0%
RED BLUFF DIVERSION DAM TO TEHAMA BR.	NS	0.0%	0	0.0%	NS	0.0%	NS	0.0%	0	0.0%	0	0.0%
TEHAMA BR. TO WOODSON BR.	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	0	0.0%	0	0.0%
TOTALS	1		3		4		3		1		4	

AREA	TOTAL	
	NUMBER	PERCENT
KESWICK DAM TO A.C.I.D. DAM	0	0.0%
A.C.I.D. DAM TO HIGHWAY 44	25	83.3%
HIGHWAY 44 TO UPPER ANDERSON BR.	5	16.7%
UPPER ANDERSON BR. TO BALLS FERRY BR.	0	0.0%
BALLS FERRY BR. TO JELLY'S FERRY BR.	0	0.0%
JELLY'S FERRY BR. TO BEND BR.	0	0.0%
BEND BR. TO RED BLUFF DIVERSION DAM	0	0.0%
RED BLUFF DIVERSION DAM TO TEHAMA BR.	0	0.0%
TEHAMA BR. TO WOODSON BR.	0	0.0%
TOTALS	30	

Spring-run Flights

AREA	FLIGHT 1 August 26, 1997		FLIGHT 2 Sept 2, 1997		FLIGHT 3 Sept 10, 1997		FLIGHT 4 Sept 15, 1997		TOTAL	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
KESWICK DAM TO A.C.I.D. DAM	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	0	0.0%
A.C.I.D. DAM TO HIGHWAY 44	0	0.0%	0	0.0%	3	30.0%	14	87.5%	17	65.4%
HIGHWAY 44 TO UPPER ANDERSON BR.	0	0.0%	0	0.0%	7	70.0%	2	12.5%	9	34.6%
UPPER ANDERSON BR. TO BALLS FERRY BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
BALLS FERRY BR. TO JELLY'S FERRY BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
JELLY'S FERRY BR. TO BEND BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
BEND BR. TO RED BLUFF DIVERSION DAM	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
RED BLUFF DIVERSION DAM TO TEHAMA BR.	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
TEHAMA BR. TO WOODSON BR.	NS	0.0%	NS	0.0%	NS	0.0%	NS	0.0%	0	0.0%
TOTALS	0		0		10		16		26	1

Fall-run Flights

AREA	FLIGHT 1 Sept 23, 1997		FLIGHT 2 Oct 1, 1997		FLIGHT 3 Nov 3, 1997		TOTAL	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
KESWICK DAM TO A.C.I.D. DAM	ns	0.0%						0.0%
A.C.I.D. DAM TO HIGHWAY 44	43	58.1%	60	39.7%	340	15.0%	443	17.7%
HIGHWAY 44 TO UPPER ANDERSON BR.	24	32.4%	60	39.7%	706	31.0%	790	31.6%
UPPER ANDERSON BR. TO BALLS FERRY BR.	6	8.1%	19	12.6%	315	13.9%	340	13.6%
BALLS FERRY BR. TO JELLY'S FERRY BR.	0	0.0%	4	2.6%	229	10.1%	233	9.3%
JELLY'S FERRY BR. TO BEND BR.	0	0.0%	2	1.3%	190	8.4%	192	7.7%
BEND BR. TO RED BLUFF DIVERSION DAM	0	0.0%	2	1.3%	81	3.6%	83	3.3%
RED BLUFF DIVERSION DAM TO TEHAMA BR.	1	1.4%	4	2.6%	182	8.0%	187	7.5%
TEHAMA BR. TO WOODSON BR.	0	0.0%	0	0.0%	68	3.0%	68	2.7%
WOODSON BR. TO HAMILTON CITY	ns		ns		35	1.5%	35	1.4%
HAMILTON CITY TO ORD FERRY	ns		ns		35	1.5%	35	1.4%
ORD FERRY TO PRINCETON FERRY	ns		ns		93	4.1%	93	3.7%
TOTALS	74		151		2274		2499	1

Sockeye Observation

During an aerial redd survey on 25 August, 23 redds were observed near the confluence of Clear Creek and the Sacramento River. An estimated 30-50 salmon were observed to be actively spawning. Subsequent boat observations and diving surveys identified these salmon to be sockeye (Oncorhynchus nerka) salmon. Two fish were reportedly seen by USFWS personnel in Clear Creek below Saeltzer Dam and an additional one was observed in Battle Creek. Five sockeye salmon were trapped and examined at RBDD. Kolanee (Oncorhynchus nerka kennerlyi) are planted in Whiskeytown reservoir. When water storage in Whiskeytown reservoir is at full capacity, excess water spills into Clear Creek. These returning adult sockeye salmon are likely from planted kolanee salmon which escaped into Clear Creek during a high water event.

Clear Creek

Late-Fall Run. Late-fall salmon are known to spawn in Clear Creek. Crews attempted to survey Clear Creek on 22 March to note the occurrence and distribution of late-fall-run spawning but the creek was too turbid to see spawning fish, carcasses or redds. No population estimates were made for late-fall-run chinook salmon spawning naturally in Clear Creek in 1997.

Spring-Run. Clear Creek does not have a self-sustaining population of spring-run chinook salmon.

Fall Run. An estimated 8,569 fall-run chinook spawned in Clear Creek in 1997. This compares with a previous 10-year average of 3,220. Five carcass surveys were conducted on Clear Creek from 17 October to 03 December from Saeltzer Dam to 6.67 km (4.2 miles) downstream. A total of 2,753 carcasses was examined.

Using the modified Schaefer method (Taylor, 1974) of estimating population levels, 8,699 fall-run chinook salmon spawned in Clear Creek (Table 4). The Peterson method (Ricker, 1975) estimated 8,074 salmon.

TABLE 4. Population estimates of chinook salmon based on tag and recover data for Clear Creek from Saeltzer Dam to 4.2 miles downstream using Schaefer's Method, 1997.

Week of Recovery(j)	R(ij) by Week of Tagging(i) 1	2	3	4	Number Tags Recovered R(j)	Total Carcasses Counted C(j)	Population Estimate	C(j)/R(j)
Oct 23	12				12	659	2038	54.92
Oct 30	1	40			41	830	2343	20.24
Nov 06		16	50		66	866	1482	13.12
Dec 03		1	4	10	15	398	2707	26.53
Recovery R(i)	13	57	54	10			8569	
Tagged M(i)	39	135	113	106				
M(i)/R(i)	3.00	2.37	2.09	10.60				

Week of Recovery(j)	Week of Tagging Estimates 1	2	3	4	Totals
Oct 23	1977	0	0	0	1977
Oct 30	61	1918	0	0	1979
Nov 06	0	497	1373	0	1870
Dec 03	0	63	222	2813	3097
Subtotals	2038	2478	1595	2813	8923
Tags		-135	-113	-106	-354
Estimate					8569

Where $E = \frac{MC}{R}$

E = estimated population
M = total carcasses tagged
C = total carcasses encountered
R = total carcasses recaptured

$E = \frac{(393)(2753)}{134}$

E = 8,074 spawners

The Schaefer analysis will be used as the estimated number of fall-run chinook spawning in Clear Creek in 1997. Based on a sample of 2,479 carcasses, sex composition of natural spawners in Clear Creek was 3% male grilse (FL≤ 64 cm or 25.1 in), <1% female grilse, 45% male adults and 51% female adults. Two of the female carcasses were unspawned. One Ad-clipped carcasses was recovered during the surveys (Appendix Table 3).

Cow Creek

On 23 July sections of Old Cow Creek from Upper Whitmore Falls to Lower Whitmore Falls were snorkel surveyed by two divers for the occurrence of adult chinook salmon. One adult was observed at the Upper Falls and one fresh carcass was observed downstream of Upper Falls. This female carcass was bronze colored, the scales were 75% absorbed and the eggs were 5 cm in diameter. Given the external coloration of this carcass and the maturation of the eggs these salmon were most likely winter run strays. Water temperatures in Old Cow Creek are lethal for successful spawning of winter-run or spring-run chinook salmon. salmon

Late-Fall Run. Late-fall run are known to spawn in Cow Creek No surveys or population estimates were made for late-fall-run chinook salmon spawning naturally in Cow Creek in 1997.

Fall Run. No salmon carcass surveys or aerial redd surveys were made for fall-run chinook salmon spawning naturally in Cow Creek in 1997.

Cottonwood Creek

Late-Fall Run. Late-fall-run salmon are known to spawn in Cottonwood Creek. No surveys or population estimates were made made for late-fall-run chinook salmon spawning naturally in Cottonwood Creek.

Spring Run. Spring-run salmon are known to occur in Beegum Creek, a tributary to Cottonwood Creek. Beegum Creek was snorkel surveyed on 21 September from the north and south fork confluence to the Beegum Falls 4.8 km (3 miles) downstream. No salmon or evidence of salmon spawning was observed.

Fall Run. One aerial redd survey was made on 3 November to count redds. A total of 141 fall-run redds were observed from the confluence with the Sacramento River upstream 14.4 km (9 miles). Beaver dams and low flows blocked further salmon migration upstream. No population estimate was made for fall-run chinook salmon spawning naturally in Cottonwood Creek in 1997.

Battle Creek

Late-Fall-Run. Late-fall run are known to spawn in Battle Creek. No surveys or population estimates were made for late-fall-run chinook salmon spawning naturally in Battle Creek in 1997. Coleman National Fish Hatchery received 4,578 late-fall-run chinook salmon. All salmon voluntarily entering CNFH at Battle Creek. No salmon were trucked from the Keswick Dam trap on the Sacramento River this year. Sex composition for late-fall-run salmon at CNFH was 9% grilse, 47% mile adults and 44% female adults.

Spring Run. Escapement of spring-run chinook salmon into Battle Creek is based upon U.S. Fish and Wildlife Service counts of fish passing the Colman's barrier dam. During this period, it was assumed that

salmon ascending the dam were either hatchery-origin winter-run chinook salmon or naturally produced spring-run chinook salmon. Run classification was made by presence (winter run) or absence (spring run) of an adipose fin-clip. One hundred one salmon were identified as spring run. Tissue samples of the first 14 (clipped or unclipped) fish passing the barrier dam were analysized, with five identified as winter and the remainder exhibiting significant uncertainty as to race (Croci, 1997). In April, one Ad-clipped fish was trapped and identified as a fall run salmon from Feather River Hatchery. Due to the uncertainty of the origin of unclipped fish passing the barrier dam, an unknown potion of the 101 salmon identified as spring run (by virtue of the lack of not being Ad-clipped), may in fact be of natural winter run or non-clipped hatchery or natural fall run origin.

Fall Run. An estimated 101,413 fall-run chinook salmon entered Battle Creek in 1997. This compares with a previous 10-year average of 38,714. This total includes 50,670 salmon received at CNFH and 50,743 salmon spawning naturally in Battle Creek below CNFH. Salmon were fist observed spawning during an aerial redd survey on 23 September. Seven carcass surveys were made on Battle Creek between 10 October and 17 November. These surveys started at CNFH and extended downstream 5.6 km (3.5 miles) to the Old Hatchery site. A total of 15,219 fall-run chinook salmon carcasses were examined. No surveys or population estimates were made for fall-run chinook salmon which may have ascended the barrier dam at CNFH and spawned in Battle Creek upstream of the hatchery.

Using the modified Schaefer method (Taylor, 1974) of estimating population levels, 50,743 fall-run chinook salmon spawned naturally in Battle Creek (Table 5). The Peterson method (Ricker, 1975) estimated 42,586 spawners.

TABLE 5. Population estimates of chinook salmon based on tag and recovery data for Battle Creek from Coleman National Fish Hatchery to the Old Hatchery site using Schaefer's Method, 1997.

Week of Recovery(j)	R(ij) by Week of Tagging(i) 1	2	3	4	5	6	Number Tags Recovered R(j)	Total Carcasses Counted C(j)	Population Estimate	C(j)/R(j)
Oct 13	10						10	2164	16663	216.40
Oct 20		171					171	5383	16354	31.48
Oct 27		25	252				277	3540	10282	12.78
Nov 03		4	71	107			182	2550	4331	14.01
Nov 10		2	15	24	69		110	1305	2473	11.86
Nov 17				5	8	15	28	277	640	9.89
Recovery R(i)	10	202	338	136	77	15			50743	
Tagged M(i)	77	592	857	347	232	72				
M(i)/R(i)	7.70	2.93	2.54	2.55	3.01	4.80				

Week of Recovery(j)	Week of Tagging Estimates 1	2	3	4	5	6	Totals
Oct 13	16663	0	0	0	0	0	16663
Oct 20	0	15776	0	0	0	0	15776
Oct 27	0	936	8166	0	0	0	9102
Nov 03	0	164	2522	3825	0	0	6512
Nov 10	0	70	451	726	2466	0	3714
Nov 17	0	0	0	126	238	712	1077
Subtotals	16663	16946	11139	4678	2705	712	52843
Tags		-592	-857	-347	-232	-72	-2100
Estimate							50743

Where $E = \frac{MC}{R}$

E = estimated population
M = number of carcasses tagged
C = total carcasses encountered
R = total carcasses recaptured

$E = \frac{(2177)(15219)}{778}$

E = 42,586 spawners

The Schaefer analysis will be used as the estimated number of fall-run chinook spawning in Battle Creek in 1996. Based on a sample of 14,068 carcasses, sex composition for natural spawners in Battle Creek was 2% male grilse (FL≤ 64 cm or 25.1 in), less than 1% female grilse, 33% male adults, and 65% female adults. Prespawning mortality was 14%. Sex composition for fall-run chinook salmon entering CNFH was 12% grilse, 50% male adults and 38% female adults.

A total of 19 Ad-clipped carcasses were recovered during the spawning stock surveys, representing 9 tag codes (Appendix Table 3).

Paynes Creek

Fall Run. Two surveys on 30 October and 6 November 1997 were made from the confluence with the Sacramento River to the irrigation ditch intake 6.4 km (4 miles) upstream.

A total of 43 redds, 2 carcasses and 32 live salmon were observed. No population estimate was made.

Spawning populations in the Sacramento River main stem below RBDD were estimated by aerial redd counts. Fall-run population estimates were made in Mill and Deer creeks using carcass counts. Other tributaries known to occasionally have fall-run spawners but were not surveyed in 1997 include: Salt, Antelope, Craig, Dye, Toomes, Thomes, Coyote, Stoney and Singer creeks. A total of 20,912 fall-run chinook salmon spawned in the Sacramento River system between Red Bluff and Princeton Ferry in 1997 (Appendix Table 1). All fall-run salmon that spawned in unsurveyed tributaries between RBDD and Princeton Ferry were combined with those that spawned in the main stem of the Sacramento River above RBDD. The spring run consisted of 200 fish that spawned in Mill Creek and 466 fish that spawned in Deer Creek. No spawning was observed below RBDD during winter-run and spring-run salmon aerial redd surveys.

Spawning Distribution

Data collected during aerial flights over the main stem Sacramento River throughout the year showed the general salmon redd distribution of each salmon race (Table 3 and Figure 1). No winter run spawned below Red Bluff in 1997 compared to an average of 4.2% over the last 10-yr period. A total of 16.8% of the fall run spawned below RBDD in 1997.

Antelope Creek

Spring Run. On 30 July 1997 sections of Antelope Creek were snorkel surveyed to count adult spring-run chinook salmon. Surveyed sections included the north fork from McClure Place to the south fork confluence, The south fork from the confluence of Round Mountain Creek downstream to the confluence with the north fork, and from the north and south fork confluence downstream to 3.2 km (2 miles) below Paynes Place Road crossing. This 12.8 km (8 miles) section of the creek is the known holding habitat for

spring-run chinook salmon in Antelope Creek. No spring-run chinook salmon were observed. It is assumed that no spring-run chinook salmon entered Antelope Creek in 1997.

Mill Creek

Spring Run. On 1 January 1997 Clough Dam on Mill Creek was breeched by flood waters. In the past, adult spring-run chinook salmon were counted as they ascended the fish ladder on Clough Dam. With the breech in the dam, adult salmon no longer use the fish ladder. With unimpaired fish passage in lower Mill Creek, alternative methods of estimating adult spring-run chinook salmon populations in Mill Creek were implemented this year. Snorkel surveys, redd counts and carcass tag-and-recapture methods were investigated to determine the most feasible method that could be duplicated each year in Mill Creek.

From 11 August through 11 September Mill Creek was snorkel surveyed from 4.0 km (2.5 miles) downstream of the Lassen National Park Boundary to the confluence of Rancheria Creek, a distance of approximately 40 km (25 miles). Twenty-one adult spring-run salmon were observed. Visibility was poor due to the natural turbidity in Mill Creek. Due to this turbidity and poor visibility, snorkeling will be discounted as a reliable method for making adult salmon population estimates in Mill Creek.

From 2 October through 30 October two complete spawning distribution surveys were made from 4.0 km (2.5 miles) downstream of the Lassen National Park Boundary to Rancheria Creek. A total of 13 carcasses were counted. A tag-and-recapture survey on carcasses and a population estimate can not be made by using tag-and-recapture methodology on so few carcasses. Therefore, carcass surveys should be discounted for making population estimates for adult spring run in Mill Creek. The observation of 100 redds was made at the end of spawning season and it is assumed this count represents the maximum number of redds constructed. This redd count was expanded to an adult population estimate by assuming that each female constructs one redd (Nielson and Banford, 1983) and a 1:1 sex ratio of males to females: 100 redds x 1

female/redd x 2 = 200 salmon. Using redd counts to indicate relative population size, 200 spring-run salmon spawned in Mill Creek in 1997.

Fall Run. An estimated 478 fall-run chinook salmon spawned in Mill Creek in 1997. This compares with a previous 10-year average of 1,218. Fall run were first sighted in Mill Creek on 11 October. Three carcass surveys were conducted on Mill Creek from 27 October to 12 November from the canyon mouth downstream to the confluence with the Sacramento River. A distance of 12.8 km (8 miles). A total of 147 carcasses were examined.

Using the Peterson method (Ricker, 1997) of estimating population levels, 478 fall-run chinook salmon spawned in Mill Creek in 1997.

$$\text{Where } E = \frac{MC}{R}$$

E = estimated population
M = number of carcasses tagged
C = total carcasses encountered
R = total carcasses recaptured

$$E = \frac{(26)(147)}{8}$$

E = 478 spawners

Because of the small number of carcasses tagged, the Schaefer analysis was not used to estimate the population size. Based on a sample of 109 carcasses, sex composition of natural spawners in Mill Creek was 3% male grilse (FL≤ 65 cm or 25.1 in), 1% female grilse, 41% male adults and 55% female adults. All of the female carcasses were spawned. No tagged fish were found during the surveys.

Deer Creek

Spring Run. On 6 August 1997 the holding habitat of spring-run salmon was snorkel surveyed and adult salmon counted. This survey extended from Upper Deer Creek Falls downstream to Iron Mountain, a distance of approximately 33.6 km (21 miles). A total of 466 adult spring-run chinook salmon was counted.

On 15 October Deer Creek was surveyed from Upper Falls to Iron Mountain for evidence of spring-run spawning. A total of 32 live salmon, 43 carcasses and 275 redds were observed.

Fall Run. An estimated 1,203 fall-run chinook salmon spawned in Deer Creek in 1997. This compares with a previous 10-year average of 153. Fall run were first sighted in Deer Creek 7 October. Five carcass surveys were conducted on Deer Creek from 16 October to 24 November from the Upper Deer Creek Diversion Dam downstream to the Monastery. A distance of 12,8 km (8 miles). A total of 401 carcasses were examined.

Using the Peterson method (Ricker, 1975) of estimating population levels, 1,203 fall-run chinook salmon spawned in Deer Creek in 1997.

$$\text{Where } E = \frac{MC}{R}$$

E = estimated population
M = number of carcasses tagged
C = total carcasses encountered
R = total carcasses recaptured

$$E = \frac{(81)(401)}{27}$$

E = 1,203 spawners

Because of the small number of carcasses tagged, the Schaefer analysis was not used to estimate the population size. Based on a sample of 370 carcasses, sex composition of natural spawners in Deer Creek was 5% male grilse (FL≤ 65 cm or 25.1 in), 1% female grilse, 45% male Adults, and 49% female adults. All female carcasses were spawned. One tagged fish was recovered during the surveys (Appendix Table 3).

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APPENDIX TABLE 1. Summary of chinook salmon population estimates for Sacramento River System from Keswick Dam downstream to Princeton Ferry in 1997.

Area	Race			
	Late fall Run	Winter Run	"Spring" Run	Fall Run
Keswick Dam to Red Bluff				
Keswick Trap	0 a/			
Red Bluff Diversion Dam				
Sacto. River Main Stem		841		95,505
Battle Creek (Total)				(101,413)
Coleman Hatchery	4,127			50,670
Above Hatchery				a/
Below Hatchery				50,743
Clear Creek			0	8,569
Cow Creek				a/
Cottonwood Creek				a/
TOTAL SYSTEM Keswick Dam To Red Bluff	no estimate	841	189	205,487
Red Bluff to Princeton Ferry				
Sacto. River Main Stem (Total)	a/	(0)	(0)	(19,147)
Red Bluff to Tehama				8,599
Tehama to Woodson Bridge				3,096
Woodson Bridge to Hamilton City				1,605
Hamilton City to Ord Bend				1,605
Ord Bend to Princeton Ferry				4,242
Mill Creek			200	580
Deer Creek			466	1,203
Antelope Creek			0	a/
TOTAL SYSTEM Red Bluff to Princeton Ferry	no estimate	(0)	666	20,930
GRAND TOTAL SYSTEM				
Keswick to Princeton Ferry	no estimate	841	855	226,417

a/ Present, no population estimates made.

APPENDIX TABLE 2. Adjusted chinook salmon counts and estimated numbers of each run passingt Red Bluff Diversion Dam from 01 December 1996 through 03 January 1998.

			Run Proportions							
			Late-fall		Winter		Spring		Fall	
	Adjusted salmon counts a/	Number of salmon examined b/	% of fish examined	Estimated number c/	% of fish examined	Estimated number c/	% of fish examined	Estimated number c/	% of fish examined	Estimated number c/
1996										
01-Dec - 04-Jan d/						28				
1997										
05-Jan - 11-Jan						15				
12-Jan - 18-Jan						3				
19-Jan - 25-Jan						11				
26-Jan - 01-Feb						20				
02-Feb - 08-Feb						26				
09-Feb - 15-Feb						26				
16-Feb - 22-Feb						8				
23-Feb - 01-Mar						53				
02-Mar - 08-Mar						65				
09-Mar - 15-Mar						78				
16-Mar - 22-Mar						66		1		
23-Mar - 29-Mar						41		1		
30-Mar - 05-Apr						64		2		
06-Apr - 12-Apr						70		2		
13-Apr - 19-Apr						77		3		
20-Apr - 26-Apr	10	3			66.7	7	33.3	3		
27-Apr - 03-May	107	54			18.5	20	81.5	87		
04-May - 10-May						14		0		
11-May - 17-May	28	8			25.0	7	75.0	21		
18-May - 24-May	384	90			13.3	51	14.5	56	72.2	277
25-May - 31-May	255	48			4.2	11	4.2	11	91.6	233
01-Jun - 07-Jun	357	59			3.4	12	0.0	0	96.6	345
08-Jun - 14-Jun	330	76			1.3	4	0.0	0	98.7	326
15-Jun - 21-Jun	331	155			5.2	17	0.6	2	94.2	312
22-Jun - 28-Jun	287	85			1.2	3	0.0	0	98.8	284
29-Jun - 05-Jul	346	90			3.3	11	0.0	0	96.7	335
06-Jul - 12-Jul	723	200			0.5	4	0.0	0	99.5	719
13-Jul - 19-Jul	1,459	252			1.6	23	0.0	0	98.4	1,436
20-Jul - 26-Jul	2,276	183			0.0	0	0.0	0	100.0	2,276
27-Jul - 02-Aug	1,231	189			0.5	6	0.0	0	99.5	1,225
03-Aug - 09-Aug	1,266	147				0			100.0	1,266
10-Aug - 16-Aug	5,621	270				0	Total:	189 e/	100.0	5,621
17-Aug - 23-Aug	6,074	301				0			100.0	6,074
24-Aug - 30-Aug	5,742	163			Total:	841 e/f/			100.0	5,742
31-Aug - 06-Sep	13,264	139							100.0	13,264
07-Sep - 13-Sep	15,829	175							100.0	15,829
14-Sep - 20-Sep										19,164
21-Sep - 27-Sep										20,638
28-Sep - 04-Oct										23,430
05-Oct - 11-Oct										23,654
12-Oct - 18-Oct										20,035
19-Oct - 25-Oct										15,613
26-Oct - 01-Nov										14,965
02-Nov - 08-Nov										10,454
09-Nov - 15-Nov										6,053
16-Nov - 22-Nov										4,981
23-Nov - 29-Nov										3,753
30-Nov - 06-Dec										2,011
07-Dec - 13-Dec										1,475
14-Dec - 20-Dec										1,140
21-Dec - 27-Dec										425
28-Dec - 03-Jan										0
									Total:	223,355 e/
Total for 1997	55,920	2,687				841		189		223,355

a/ Actual weekly counts were expanded to adjust for periods when the fishways were open and no observations were made.
b/ Salmon in the fishway trapping facility which were examined to determine the run they belonged to, based on relative spawning readiness.
c/ Adjusted counts x Proportion of examined fish assigned to run.
d/ Estimated numbers of winter-run salmon shown for this period represent fish which passed the dam in 1996 that were expected to spawn in 1997; spring and fall-run fish counted during this period spawned in 1996, and are not shown.
e/ Total estimated number of potential spawners of 1997.
f/ Does not include hatchery origin winter-run chinook salmon (????).

APPENDIX TABLE 3. 1997 Coded-wire tag (CWT) recoveries in Battle Creek, Clear Creek, Sacramento River, Deer Creek and Red Bluff Division Dam (RBDD).

		Recapture Location				
CWT Code	Hatchery of Origin	Battle Creek	Clear Creek	Deer Creek	RBDD	Sacramento River
05-01-01-08-04	CNFH[1/]	1				
05-01-01-09-09	CNFH	1			1	
05-01-01-12-04	CNFH	2			2	
05-01-01-12-05	CNFH	2				
05-01-01-12-06	CNFH	3			2	
05-01-01-12-07	CNFH	1				
05-01-01-12-08	CNFH				1	
05-01-01-12-09	CNFH					
05-34-28	CNFH	3			2	1
05-34-29	CNFH	1			5	
05-36-21	CNFH					1
06-01-12-01-03	FRH[2/]				2	
06-01-14-04-01	FRH				2	
06-01-14-04-06	FRH				1	
06-25-30	FRH					1
06-29-29	FRH					1
06-29-34	FRH		1			1
06-31-50	FRH				1	
06-63-47	MRFI[3/]					1
10-00-00[4/]		5		1		6
Total		19	1	1	19	12

1/ CNFH = Coleman National Fish Hatchery
2/ FRH = Feather River Hatchery
3/ Merced River Fish Installation
4/ 10-00-00 = No CWT found