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CHINOOK SALMON SPAWNER STOCKS IN
CALIFORNIA'S CENTRAL VALLEY, 2000

Edited by

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Native Anadromous Fish & Watershed Branch

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ABSTRACT

This report covers the 48th annual inventory of Chinook salmon, Oncorhynchus tshawytscha, spawner populations in the Sacramento-San Joaquin River system. It is a compilation of sources estimating the late-fall-, winter-, spring-, and fall-run populations for streams which were surveyed. Estimates were based on counts of fish entering hatcheries and migrating past dams, from surveys of dead and live fish and redds in spawning areas, and from aerial counts.

The estimated 2000 total escapement of Chinook salmon in the Central Valley was 507,149 fish, which was 14% higher than in 1999. The population consisted of 483,423 fall-, 12,945 late-fall-, 9,429 spring-, and 1,352 winter-run spawners. All of the late-fall-, spring-, and winter-run salmon were in the Sacramento River system. The entire Central Valley fall run consisted of 436,558 fish in the Sacramento River system and 46,865 fish in the San Joaquin River system. In the Feather and American rivers of the Sacramento system, record high fall runs occurred. The combined fall run in the San Joaquin tributaries of Stanislaus, Tuolumne, and Merced rivers was over double the 1999 populations, but still only contributed a small portion (8%) to the total Central Valley escapement.

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INTRODUCTION

The Sacramento-San Joaquin River system (Figure 1), which flows through California's Central Valley, is the principle producer of Chinook salmon caught in the state's ocean fisheries; its salmon runs also contribute to the ocean fisheries of Oregon and Washington. This report is the 48th compilation of Chinook salmon spawner stock surveys. The spring and fall runs have been monitored since 1953, and late-fall and winter runs since 1971. The four runs are distinguished as follows:

- 1) Late-fall run. These salmon spawn mainly in the upper Sacramento River and its tributaries near and upstream of Red Bluff. They arrive in this area in early November through February, with spawning occurring from January through mid-April. Adults of this run are usually larger in physical size than fall- and winter-run salmon spawning in the same area.
- 2) Winter run. These salmon spawn almost entirely in the Sacramento River and its tributaries upstream of Red Bluff, arriving there in December through early August, with spawning occurring from April through August.
- 3) Spring run. Once widespread in Central Valley tributaries, this run has disappeared from many of the streams in which dam construction has blocked access to spawning habitat. Spring-run spawners return to the system from the ocean in late January through August; early arrivals to their natal streams oversummer in holding pools. Spawning occurs from mid-August through October.
- 4) Fall run. These are presently the most numerous and widely distributed salmon in the Central Valley. They return from the ocean during June through November and spawn from early October through late December.

Monitoring of salmon spawner escapement in Central Valley tributaries is an important component of the California Department of Fish and Game's (CDFG) fishery management effort. The primary objectives of this work are to determine size and composition of spawner populations. Any changes in spawning distribution and habitat conditions that may adversely affect salmon are noted to determine if corrective action is necessary.

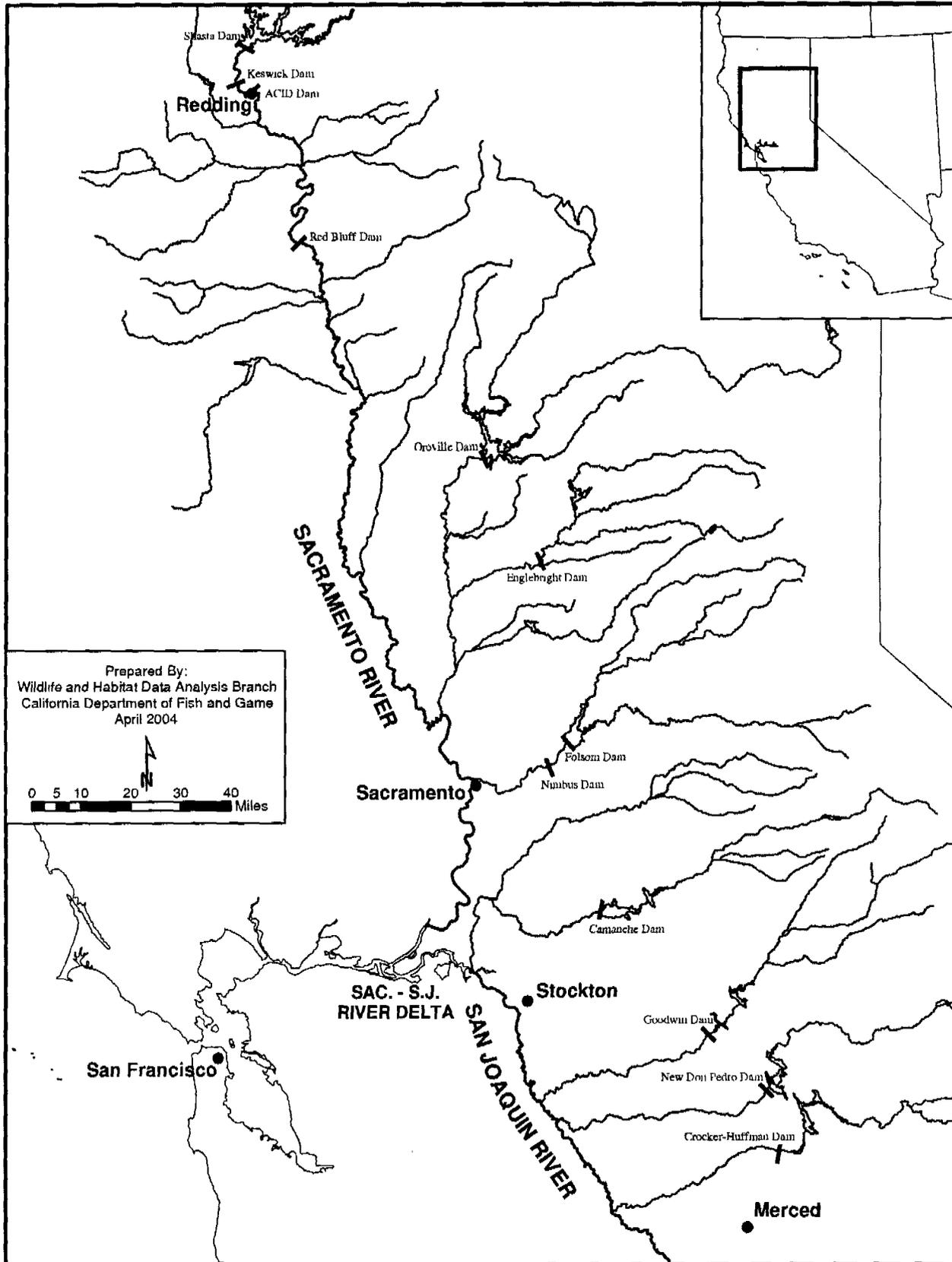


FIGURE 1. Sacramento-San Joaquin River System of California's Central Valley.

GENERAL METHODS

During 2000, spawner stock data were collected in some Central Valley tributaries known to support Chinook salmon runs by: monitoring fish entering hatcheries and migrating past dams; conducting stream surveys in holding or spawning areas for live fish, carcasses, and redds; or making aerial redd counts.

The data collected usually represented only a sampling of the tributaries' spawners. For some tributaries, data were not sufficient to calculate an estimate of the spawner population size; in some such cases, a decision of the number of spawners present was arrived at by "best professional judgement".

In other streams, salmon carcasses were marked throughout a series of survey periods. Discrete marks associated those carcasses with the individual surveys upon subsequent recovery trips. All counted carcasses were marked, or cut in half to prevent recounting. Estimated spawner numbers were calculated from mark-and-recovery data.

Specific details of surveys (e.g. timing, duration, location), or estimation methods are presented under the individual tributary sections.

In this report, adult salmon are considered those fish three years old and older. Two-year-old salmon, although sexually mature, are referred to as grilse.

CHINOOK SALMON SPAWNER POPULATIONS FOR THE SACRAMENTO RIVER SYSTEM

Keswick Dam to Red Bluff Diversion Dam ^{2/}

Spawner population sizes were estimated for the late-fall, winter, and fall runs of Chinook salmon in the Sacramento River mainstem (Figure 2) upstream of Red Bluff Diversion Dam (RBDD). Clear and Battle creeks were the only tributaries in this area for which individual fall-run population estimates were made. Spawning distribution in the mainstem was determined from aerial redd counts.

In 2000, a total of 183,886 salmon was estimated for the Sacramento River system upstream of Red Bluff, consisting of 169,586 fall-, 12,826 late-fall-, 1,325 winter- and 122 spring-run fish. The mainstem portion of the fall- run spawner population was 87,793 fish. The mainstem totals which are reported include fish for tributaries in which a run might have occurred, but where no estimates were possible; e.g., the spring runs in Clear and Battle creeks, and the fall run in Cottonwood Creek.

Sacramento River Mainstem

Estimation method from RBDD monitoring. Numbers of winter-, spring-, and fall-run salmon spawners in the Sacramento River upstream from RBDD were based on daily counts made by the U.S. Fish and Wildlife Service (USFWS), and on sampling of fish by CDFG, at the dam. Counts were obtained through video monitoring of salmon passing through the fishway ladders.

Numbers of fish counted each week (Saturday through Sunday) were adjusted for those periods when the fishways remained open but no counts were possible (e.g., turbid conditions, when no observations were made at night, and when counting took place during only part of a week due to temporary opening of the dam gates). Adjustments to lapses in daytime counts were made by interpolation. Adjustments for the non-monitored nighttime hours were made by multiplying the 14-h day counts by a "night-factor", which was generated from weekly night counts.

The adjusted weekly number of fish was apportioned among the winter, spring, and fall runs based on their relative proportions seen that week in samples of salmon from the dam's east-bank trapping facility. These sampled fish were assigned to a run by assessing when they would spawn, as indicated by physiological characteristics (coloration, scale absorption, secondary sexual development, and relative degree of ripeness).

To facilitate upstream migration of winter-run salmon, the RBDD gates were raised from the beginning of the year to 15 May, and from 15 September through the end of the year. When the

^{2/} Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2000. File Report. June 2002. CDFG-Northern California-North Coast Region (NCNCR), Red Bluff Office.

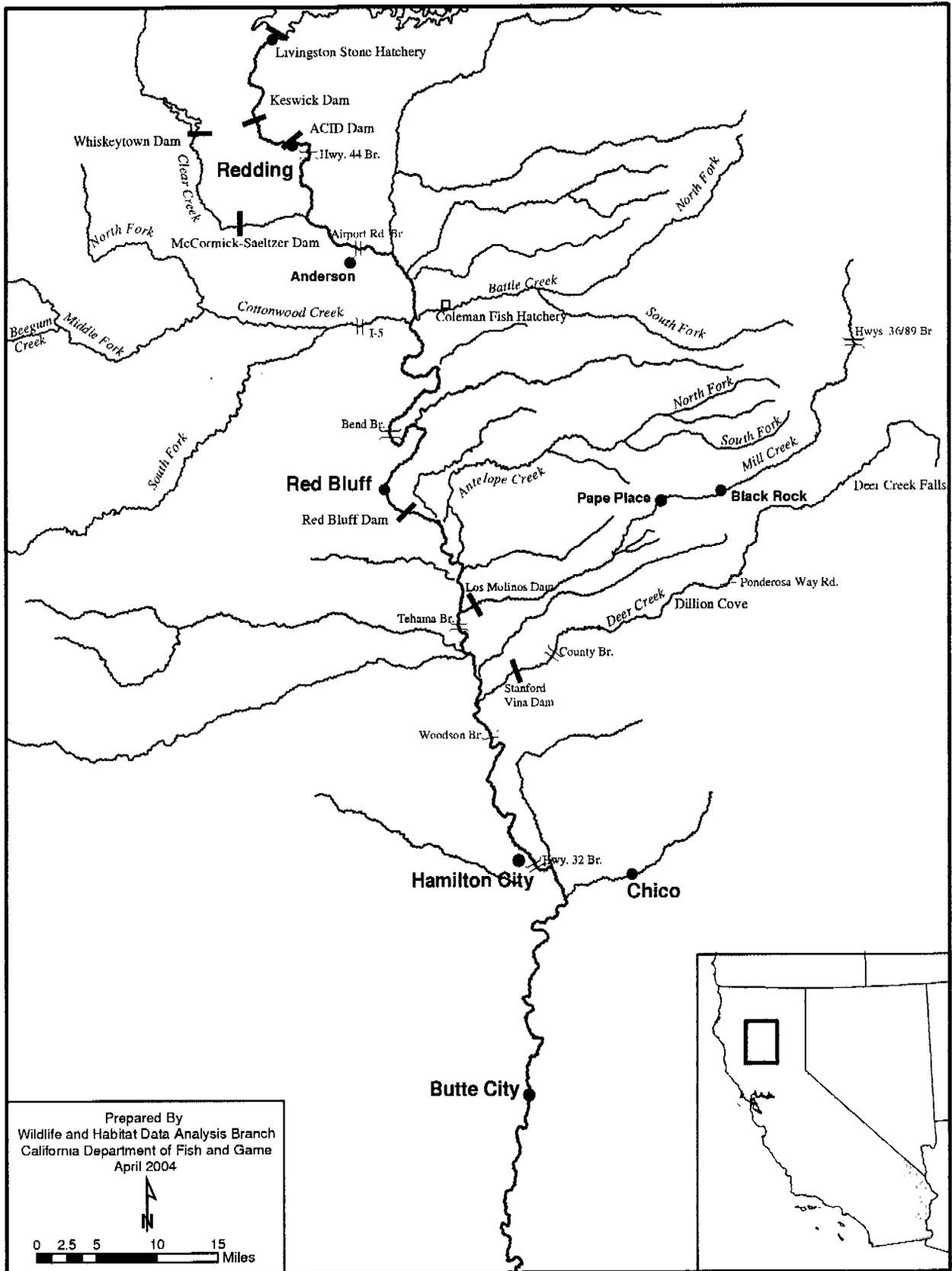


FIGURE 2. Sacramento River System from Keswick Dam downstream to Princeton Ferry.

dam gates are up, the fishways are essentially inoperable, and counts are not possible. To account for salmon passing the dam when the gates were up, total adjusted numbers from actual counts were expanded, using migrational distributions for each run based on historical data.

The migrational distributions were an average timing derived from RBDD data when the gates were down year-round, based on the 1982-1986 winter runs, and the 1970-1988 spring and fall runs (Table 1). Numbers of fish estimated from actual counts for the gates-down period in 2000 were assumed to represent the same proportion of the run as the period's historical distribution, and expanded accordingly.

The estimated fall-run salmon passing upstream of RBDD (potential spawners) was reduced by the number of fish taken in the sport fishery between Keswick Dam and Red Bluff; no attempt was made to account for any other prespawning mortality in the upper river. The number of sport-caught fall-run salmon was estimated from angler surveys conducted by CDFG upstream of RBDD. It was assumed that no winter- or spring-run fish were harvested, due to an angling closure in effect from 15 January through 16 July.

To obtain only the upper mainstem Sacramento River population of spring- and fall-run salmon, the number of potential spawners was also reduced by each run's population in upstream tributaries. To obtain the winter-run's upstream mainstem population, those potential spawners were also reduced by numbers of fish transferred from RBDD and Keswick Dam to Livingston Stone National Fish Hatchery.

Late-fall run. The RBDD gates were raised during the entire late-fall migration period, so counts of this run's fish passing the dam were not possible. Instead, the population was estimated from salmon carcass surveys in a portion of the mainstem, and from aerial redd surveys of the entire mainstem.

Weekly carcass surveys were conducted from 27 December 1999 through 25 April 2000, covering the stretch of the mainstem from Anderson-Cottonwood Irrigation District Dam (ACID) at river mile (RM) 298.5 downstream to Anderson River Park (RM 282)^{3/}. During the surveys, mean river flows upstream from ACID ranged from 150m³/s to 1,181m³/s (5300-41,700 cfs). Weekly average water clarity in the surveyed section, measured by secchi disk, ranged from 1.5m to 4.5m (5-15 ft). Water temperatures in the survey area ranged from 8.9°C to 12.2°C (48-54°F).

Most of the salmon carcasses observed were marked with colored ribbon attached to their jaws with hog rings; for each week a different color was used. Carcasses that were not marked included those that were headless, those on shore in a "leathery" condition, and those at the downstream end of the survey area which would have drifted out of the area. Unmarked carcasses, as well as those that were recovered with marks, were chopped in half to prevent recounting. Marked carcasses were returned to running water for subsequent recovery. A subsample of fresh carcasses (those with a clear eye or pink gills) were sexed and measured.

^{3/} Snider, B., B. Reavis, and S. Hill. 2000. Upper Sacramento River Late-fall-run Chinook Salmon Escapement Survey, December 1999 - April 2000. CDFG, Native Anadromous Fish and Watershed Branch, Stream Evaluation Program, Technical Report No. 00-9. 40 p.

TABLE 1. Distribution of migration for Chinook salmon runs past Red Bluff Diversion Dam. Proportions were used to expand estimated numbers of fish passing the dam for gates-down periods, to include numbers passing during gates-up periods.

Approximate monthly period	Concurrent week	Proportion of run (%) ^{1/}		
		Winter run	Spring run	Fall run
January	1	1.70		
	2	1.78		
	3	0.35		
	4	1.28		
February	5	2.38		
	6	3.12		
	7	3.08		
	8	0.97		
March	9	6.35		
	10	7.72		
	11	9.23		
	12	7.79	0.10	
	13	4.91	0.25	
April	14	7.64	0.59	
	15	8.26	0.96	
	16	9.19	1.38	
	17	3.47	1.63	
May	18	2.02	1.60	
	19	1.60	1.71	
	20	2.17	2.16	
	21	3.09	2.63	
June	22	2.03	2.86	0.01
	23	1.63	2.61	0.00
	24	1.84	2.93	0.01
	25	0.51	3.50	0.03
	26	0.76	3.10	0.08
July	27	1.60	3.67	0.10
	28	0.31	6.02	0.29
	29	1.04	4.75	0.49
	30	0.44	3.21	0.70
	31	0.01	4.12	0.96
August	32		6.97	1.68
	33		6.07	2.95
	34		6.75	3.53
	35		5.74	3.91
	36		7.22	4.54
September	37		6.68	5.59
	38		5.23	8.58
	39		3.70	9.24
	40		1.19	10.49
October	41		0.69	10.59
	42			8.97
	43			6.99
	44			6.70
November	45			4.67
	46			2.71
	47			2.23
December	48			1.68
	49	0.17		0.90
	50	0.38		0.66
	51	0.49		0.51
	52	0.71		0.19

^{1/} Distributions are averages based on the following years of data:
 -Winter-run, 1982 through 1986.
 -Spring-run, 1970 through 1988.
 -Fall-run, 1970 through 1988.

A total of 2,554 salmon carcasses was observed, but only the mark-and-recovery data for those classified as adults (fork length [FL] >71 cm [27.9 in]) were used to calculate an estimate using the Petersen formula (Appendix 1.A). Adults comprised 2,052 of the observed carcasses, of which 266 were marked and 87 subsequently recovered, for an estimate of 6,493 adult fish in the surveyed area. The adult estimate was expanded to include an approximately 24% grilse proportion, for a population of 8,552 salmon from ACID to Anderson River Park.

Based on an aerial survey of the mainstem up- and downstream of RBDD, conducted on 14 December 1999, about 97.7% of the late-fall-run spawning occurred within the mark-and-recovery area, and about 98.6% of the total redds were upstream of RBDD. The carcass survey population estimate was further expanded for an entire mainstem spawner population (8,751 fish), which was then proportioned to 8,632 fish for only the mainstem upstream of RBDD.

The late-fall population consisted of 27.2% male adults, 48.8% female adults, 20.3% male grilse (FL \leq 71 cm), and 3.7% female grilse. This composition was based on 324 fresh carcasses examined during the mark-and-recovery surveys.

The 2000 late-fall-run population of 8,632 fish for the entire mainstem upstream of RBDD was close to the 1999 estimate (8,683 fish) which was for only the carcass survey area; aerial redd data were not available to expand that year's estimate to the entire mainstem.

Winter run. The 2000 winter run at RBDD was estimated to be 1,352 salmon (1,206 natural-origin and 146 hatchery-origin fish, as differentiated by presence or absence of adipose fins). Due to the RBDD gates being open, only 15.4% of this estimate was derived from actual counts at the dam (Table 2). It was assumed that no winter-run salmon were caught in the sport-fishery upstream of RBDD. A total of 89 fish (82 from Keswick Dam and seven from RBDD) were transferred to the Livingston Stone National Fish Hatchery winter-run broodstock program, and two winter-run salmon were in Battle Creek, leaving 1,261 salmon as the upper mainstem spawner population (Appendix 2).

Based on 24 winter-run salmon sampled at RBDD, the run (including both natural- and hatchery-origin fish) consisted of 12.5% male adults, 29.2% female adults, 45.8% male grilse, and 12.5% female grilse.

The 2000 winter-run spawner population of 1,261 salmon in the mainstem upstream of RBDD was a decrease of 61% from the 1999 population, but still 8% higher than the average for 1990-1999 (Appendix 3).

Spring run. An estimated 252 salmon with spring-run characteristics passed RBDD in 2000; 81% of this estimate was derived from actual counts at the dam (Table 2). It was assumed that no spring-run salmon were caught in the sport-fishery upstream of RBDD, and a total of 181 fish, most of which were considered to be of this run, were accounted for in the upper reaches of Clear, Cottonwood and Battle creeks. The remaining 71 salmon may have spawned in the mainstem and in tributaries upstream of RBDD. However, CDFG considers this to be unlikely, as available spawning habitat in those areas are also utilized by fall-run salmon during the same periods. It was therefore judged that an estimate of mainstem spawners was not possible.

Based on 28 salmon sampled at RBDD, the spring run consisted of 71% adults and 29% grilse.

Fall run. An estimated 176,041 fall-run potential spawners passed RBDD in 2000; due to the RBDD gates being open, only 25% of this estimate was derived from actual counts at the dam (Table 2). The fall-run sport-harvest was estimated to be 6,455 salmon, during the fishing season from 16 July 2000 to 14 January 2001, leaving 169,586 fish as a spawner population in the entire system upstream of Red Bluff. A total of 81,793 spawners was estimated for Clear and Battle creeks, so the upper mainstem population was 87,793 salmon (Appendix 2). This estimated population includes salmon in other upper mainstem tributaries that were not surveyed.

TABLE 2. Estimation of 2000 winter-, spring- and fall-run Chinook salmon spawners passing Red Bluff Diversion Dam (RBDD).

Week No. of RBDD operation ^{1/}	Fishway trapping observations							Calculated No. salmon passing dam			
	Number of salmon assigned to run ^{2/}				Weekly run proportions (%)			Weekly adjusted count ^{3/}	Adjusted count apportioned by run ^{4/}		
	Winter-run	Spring-run	Fall-run	Total	Winter-run	Spring-run	Fall-run		Winter-run	Spring-run	Fall-run
20	3	1	0	4	75.0	25.0	0.0	71	54	18	0
21	7	2	0	9	77.8	22.2	0.0	77	60	17	0
22	1	2	8	11	9.1	18.2	72.7	75	7	14	55
23	5	9	13	27	18.5	33.3	48.1	299	55	100	144
24	0	4	26	30	0.0	13.3	86.7	172	0	23	149
25	4	8	36	48	8.3	16.7	75.0	135	11	22	101
26	2	1	32	35	5.7	2.9	91.4	135	8	4	124
27	2	1	26	29	6.9	3.4	89.7	204	14	7	183
28	0	0	20	20	0.0	0.0	100.0	75	0	0	75
29	0	0	315	315	0.0	0.0	100.0	1473	0	0	1,473
30	0	0	68	68	0.0	0.0	100.0	187	0	0	187
31	0	0	71	71	0.0	0.0	100.0	139	0	0	139
32	0	0	174	174	0.0	0.0	100.0	1996	0	0	1,996
33	0	0	404	404	0.0	0.0	100.0	1933	0	0	1,933
34	0	0	166	166	0.0	0.0	100.0	2657	0	0	2,657
35	0	0	109	109	0.0	0.0	100.0	1533	0	0	1,533
36	0	0	383	383	0.0	0.0	100.0	7452	0	0	7,452
37	0	0	541	541	0.0	0.0	100.0	25592	0	0	25,592
Totals	24	28	2,392	2,444	Totals ^{5/}			44,207	209	204	43,794
Portion of each run represented by calculated No. of fish ^{6/}								15.43%	80.99%	24.88%	
ESTIMATED TOTAL 2000 RUN ^{7/}:								1,352	252	176,041	

^{1/} Covers the period from 15 May through 15 September 2000, when the dam gates were in.
^{2/} Fish were assigned to a run based on coloration, scale absorption, secondary sexual characteristics, and spawning readiness. Data includes both adipose fin-clipped and non-fin-clipped salmon.
^{3/} Video counts expanded to adjust for periods when no counts were made.
^{4/} Weekly run proportion x Adjusted count
^{5/} Totals shown may be different than the sum of the numbers in the column due to spreadsheet calculations and rounding to whole numbers
^{6/} Based on historical average run distributions (Table 1)
^{7/} Calculated total for period of gates-in + Proportion of run represented = Run size of spawners migrating past RBDD

Based on fall-run salmon sampled at RBDD, the run consisted of 97.3% adults and 2.7% grilse.

The 2000 fall run of 87,793 fish in the mainstem Sacramento River upstream of Red Bluff was a decrease of 34% from the 1999 population, but still 70% higher than the average for 1990-1999 (Appendix 3).

Mainstem spawning distribution. The 2000 salmon redd relative distribution in the mainstem Sacramento River from Keswick Dam downstream to RBDD was determined from data collected through aerial surveys during the late-fall-, winter-, spring-, and fall-run spawning seasons. All of the winter- and spring-run spawning in the mainstem occurred upstream from Red Bluff (Table 3). Late-fall- and fall-run spawning in this river stretch constituted 98.6% and 90.8%, respectively, of that observed for the entire mainstem.

TABLE 3. Chinook salmon redd relative distribution observed during 2000 aerial surveys of the mainstem Sacramento River from Keswick Dam to Princeton Ferry.

River section	Late-fall run		Winter run		Spring run		Fall run	
	Redds counted ^{1/}	Proportional distribution	Redds counted ^{2/}	Proportional distribution	Redds counted ^{3/}	Proportional distribution	Redds counted ^{4/}	Proportional distribution
Keswick Dam to A.C.I.D. Dam ^{5/}	0		34	5.8%	0		82	6.4%
A.C.I.D. Dam to Highway 44 Bridge	412	93.4%	157	26.7%	12	85.7%	244	19.1%
Highway 44 Bridge to Airport Road Bridge	19	4.3%	274	46.6%	1	7.1%	228	17.9%
Airport Road Bridge to Balls Ferry Bridge	4	0.9%	32	5.4%	0		192	15.0%
Balls Ferry Bridge to Battle Creek	0		35	6.0%	1	7.1%	132	10.3%
Battle Creek to Jellys Ferry Bridge	0		10	1.7%	0		131	10.3%
Jellys Ferry Bridge to Bend Bridge	0		46	7.8%	0		116	9.1%
Bend Bridge to Red Bluff Dam	0		0		0		33	2.6%
Upstream proportion:		98.6%		100.0%		100.0%		90.8%
Red Bluff Dam to Tehama Bridge	4	0.9%	0		0		69	5.4%
Tehama Bridge to Woodson Bridge	0		0		0		11	0.9%
Woodson Bridge to Hamilton City Bridge	1	0.2%	0		0		22	1.7%
Hamilton City Bridge to Ord Ferry Bridge	1	0.2%	0		0		16	1.3%
Ord Ferry Bridge to Princeton Ferry	0		0		0		0	0.0%
Downstream proportion:		1.4%		0.0%		0.0%		9.2%
Total Redds:	441		588		14		1,276	

^{1/} Total count for three aerial surveys made from 14 December 1999 through 23 March 2000; redds were observed only during the first flight.

^{2/} Total count for 16 aerial surveys made from 28 April through 16 August 2000.

^{3/} Total count for surveys made on 29 August and 29 September 2000.

^{4/} Total count for surveys made on 17 October and 21 November 2000.

^{5/} Anderson-Cottonwood Irrigation District Dam.

Clear Creek

Late-fall run. No surveys were conducted for this run in 2000.

Spring run. Seven snorkeling-surveys by USFWS and CDFG were made in Clear Creek during 2000, from Whiskeytown Dam downstream to McCormick-Saeltzer Dam. A total of 19 adult salmon, which may have been spring-run, was counted during the period April through October, while nine redds were seen at the end of September. An estimate of the spring-run salmon spawner population was not made.

Fall run. Nine spawner surveys of Clear Creek were conducted during 10 October through 4 December 2000, in the 6.7-km (4.2-mi) stretch downstream of the former location of McCormick-Saeltzer Dam, which had been removed in September. Salmon carcasses were marked by attaching colored tape to the jaw with a hog ring, and replacing them back into running water for recovery during following surveys; different colors of tape were used to identify carcasses with distinct marking periods.

Using fresh carcass mark-and-recovery data with the Schaefer model (Appendix 1.B), the spawner population in Clear Creek downstream of McCormick-Saeltzer Dam was estimated to be 6,687 fish (Table 4). While no carcass surveys were made upstream of the dam site, four redds were observed in that area.

TABLE 4. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in Clear Creek from the former site of McCormick-Saeltzer Dam to 4.2 miles downstream ^{1/}.

Recovery period (j).	Number of marked carcasses recovered from marking period (i)							Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7			
2	8	--	--	--	--	--	--	8	259	555
3	6	57	--	--	--	--	--	63	1,010	1,778
4		6	33	--	--	--	--	39	703	1,560
5		4	16	29	--	--	--	49	540	1,040
6		1	8	15	14	--	--	38	525	1,133
7			1	11	6	25	--	43	350	668
8				0		4	3	7	63	214
9				3		3	1	7	67	222
Total recovered (R _i):	14	68	58	58	20	32	4			
Total carcasses marked (M _i)	30	117	134	101	51	58	22		Total estimate ^{4/}	7,170
									Adjusted estimate ^{5/}:	6,687

1/ Surveys were conducted from 10 October through 4 December 2000.
 2/ Includes salmon carcasses which were marked and marked carcasses that were recovered.
 3/ Schaefer (1951) estimate equation: $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$.
 4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.
 5/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (7,170 - 483 = 6,687)

Based on examination of 3,281 salmon carcasses, the fall-run spawner population of Clear Creek consisted of 47% male adults (FL ≥ 61 cm [24 in.]), 50% female adults, and 3% grilse (FL < 61 cm).

Pre-spawning mortality of female salmon in Clear Creek this season averaged one percent.

Cow Creek

Late-fall run. No surveys for this run in this tributary were made in 2000.

Fall run. An aerial redd survey was conducted on 2 November 2000, covering the creek from its confluence with the Sacramento River upstream, into the North Fork to Bella Vista water diversion, and into the South Fork to Old Cow Creek. A total of 83 redds was counted (35 in the mainstem, 15 in the North Fork, and 33 in the South Fork). An estimate of the fall-run spawner population was not made.

Cottonwood Creek

Late-fall run. No surveys were conducted for this run in 2000.

Spring run. Beegum Creek, a tributary to Cottonwood Creek, was surveyed on 24 August 2000. The 9.8 km- (6.1 mi-) stretch of the creek from its north and south forks' confluence downstream to the Hwy-36 Bridge crossing was covered by snorkeling. A total of 122 salmon was counted, and judged to constitute the 2000 spring-run spawner population for the Cottonwood Creek system.

Fall run. An aerial redd survey was conducted on 2 November 2000, covering the creek from its confluence with the Sacramento River upstream, into the North Fork to Oro, into the South Fork to the power line crossing, and into the Middle Fork to Beegum Creek. A total of 189 redds was counted (180 in the mainstem, four in the North Fork, and five in the Middle Fork). An estimate of the fall-run spawner population was not made.

Battle Creek

Late-fall run. No surveys were conducted for this run spawning naturally in Battle Creek during 2000. The only available spawner data were for 4,194 late-fall-run salmon which entered Coleman National Fish Hatchery (CNFH). These fish consisted of 31% male adults, 58% female adults, and 11% grilse.

Winter run. No in-river spawner surveys were conducted for this run. However, two salmon without clipped adipose-fins, that may have been winter-run fish, were captured at the CNFH weir and released upstream.

Spring run. No in-river spawner surveys were conducted for this run during 2000. However, trapping and video monitoring of upstream migrant salmon was conducted at the CNFH barrier dam during 7 March through 1 September. A total of 40 adult salmon, which may have been spring-run, were observed passing the weir from March through 15 July. An estimate of the Battle Creek spring run population was not made.

Fall run. Eleven carcass surveys were conducted during 4 October through 11 December 2000, covering the 5.6-km (3.5-mi) stretch of river from CNFH downstream to the old hatchery location. Salmon carcasses were marked by attaching colored tape to their jaws with hog rings, and placed into running water for recovery; different colors of tape were used to identify carcasses with distinct marking periods.

Using fresh carcass mark-and-recovery data with the Schaefer model (Appendix 1.B), the spawner population in Battle Creek downstream of CNFH was estimated to be 53,447 fish (Table 5). Combined with an additional 21,659 fish which entered CNFH, the total 2000 Battle Creek fall-run population was 75,106 salmon (Appendix 2). Although the creek upstream of CNFH was not completely surveyed, some fall-run adults were observed passing the barrier dam, and two redds were counted in that area.

Based on examination of 22,656 salmon carcasses, the fall run consisted of 36% male adults (FL \geq 61 cm [24 in.]), 62% female adults, and 2% grilse (FL<61 cm). In comparison, fall-run fish entering CNFH consisted of 52% male adults, 44% female adults, and 4% grilse.

Pre-spawning mortality of female fall-run salmon in Battle Creek averaged 26% in 2000.

The 2000 fall-run spawner population in Battle Creek of 75,106 fish was a decrease of 37% from 1999, but still 27% higher than the population average for 1990-1999 (Appendix 3).

TABLE 5. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in Battle Creek from Coleman National Fish Hatchery downstream to the old hatchery location ^{1/}.

Recovery period (j)	Number of marked carcasses recovered from marking period (i):									Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7	8	9			
2	40	--	--	--	--	--	--	--	--	40	827	2,175
3	12	56	--	--	--	--	--	--	--	68	6,798	16,217
4	2	6	282	--	--	--	--	--	--	290	5,907	13,936
5		1	37	59	--	--	--	--	--	97	3,337	8,200
6			7	30	87	--	--	--	--	124	3,605	7,301
7			0	2	19	45	--	--	--	66	1,483	4,482
8			1	1	4	2	42	--	--	50	766	1,525
9						1	10	12	--	23	331	683
10						3	2	3	7	15	187	420
11							2			2	66	192
Total recovered (R _i):	54	63	327	92	110	51	56	15	7			
Total carcasses marked (M _i):	142	147	771	232	201	181	107	31	13			
											Total estimate ^{4/} :	55,130
											Adjusted estimate ^{5/}:	53,447

1/ Surveys were conducted from 4 October through 11 December 2000.

2/ Includes salmon carcasses which were marked and marked carcasses that were recovered.

3/ Schaefer (1951) estimate equation $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$

4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.

5/ Adjusted estimate reflects the modified Schaefer equation (Hoopagh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (55,130 - 1,683 = 53,447).

Paynes Creek

Fall run. An aerial survey was made of Paynes Creek on 2 November 2000, to document the presence/absence of salmon and distribution of any spawning. The stretch of stream covered extended from the confluence with the Sacramento River to 1.6 km (1 mi) upstream of Dales Station. A total of five redds was counted, but observations were limited by dense riparian cover. An estimate of the population was not made.

Red Bluff Diversion Dam to Princeton Ferry

A total of 10,204 Chinook salmon spawners, consisting of 8,895 fall-, 1,190 spring- and 119 late-fall-run fish, was estimated for 2000 in the Sacramento River system between Red Bluff and Princeton Ferry (Figure 2).

Sacramento River Mainstem

Estimates of salmon spawner populations in the Sacramento River mainstem downstream of RBDD were derived from aerial redd counts for the entire mainstem and from the upstream mainstem population estimates. The proportional distribution of a run's redds that were upstream and downstream of RBDD was assumed to represent the distribution of that run's entire mainstem population.

Late-fall run. Aerial surveys were conducted during 14 December 1999 through 23 March 2000, but redds were only observed on the first flight. Late-fall-run redds downstream of RBDD constituted about 1.4% of the total mainstem spawning (Table 3), which was estimated to represent a spawner population of 119 fish.

Winter run. There were no redds observed in the mainstem downstream of RBDD during 16 aerial surveys conducted from 28 April through 16 August 2000 (Table 3), and it was judged that winter-run salmon did not spawn in this stretch of the river this year.

Spring run. There were no redds observed in the mainstem downstream of RBDD during aerial surveys conducted on 29 August and 29 September 2000 (Table 3), and it was judged that spring-run salmon did not spawn in this stretch of the river this year.

Fall run. Based on aerial surveys conducted on 17 October and 21 November 2000, fall-run redds downstream of RBDD constituted about 9.2% of the total mainstem spawning (Table 3), which was estimated to represent a spawner population of 8,895 fish. This estimate was about 68% lower than that of 1999, and 33% lower than the population average for 1990 to 1999 (Appendix 3).

Antelope Creek

Spring run. Snorkeling-surveys of the holding habitat of adult spring-run salmon in the upper Antelope Creek system were made on 24 and 26 July 2000. A total stream length of 26 km (16 mi) was covered, from the mouth of Little Grapevine Creek in the mainstem upstream, to the North Fork Falls, and into sections of the south fork to South Fork Falls. A total of nine adult salmon was observed, and judged to be the 2000 spring run for this system.

Fall run. No surveys were conducted for this run in 2000.

Mill Creek

Spring run. Surveys of Upper Mill Creek were made during 21 August through 18 October 2000, covering a stream length of approximately 41 km (25 mi) from the Hwy-36 Bridge crossing downstream to the powerline crossing located 4.8 km (3 mi) downstream from Little Mill Creek. Based on redd counts made through combined ground and aerial surveys, a total of 272 redds was determined to be the maximum number present, and judged to represent a spring-run population of 544 fish.

Fall run. One aerial flight and three bimonthly ground surveys were conducted of Mill Creek to count redds and determine spawning distribution. Surveys extended from the Los Molinos Mutual Water District upper diversion dam (Upper Dam) to the confluence with the Sacramento River. No fall run spawning occurred upstream of Upper Dam. The highest concentration of redds occurred between Upper Dam and Ward Dam. A maximum of 167 redds and 62 carcasses were observed. An estimate of the fall-run population was not made.

Deer Creek

Spring run. A snorkeling survey of upper Deer Creek was conducted on 8 August 2000 covering the 53-km (33-mi) stretch from Upper Deer Creek Falls downstream to Dillon Cove. A total of 637 adult salmon was counted, and judged to be the 2000 spring run in this tributary.

Fall run. One aerial flight and three bimonthly ground surveys were conducted of Deer Creek to count redds and determine spawning distribution. Surveys extended from the Deer Creek Irrigation District upper diversion dam (Upper Dam) to the confluence with the Sacramento River. No fall run spawning occurred upstream of Upper Dam. The highest concentration of spawning occurred between Leininger Road Bridge and the railroad crossing. A maximum of 121 redds and 40 carcasses were observed. An estimate of the fall-run population was not made.

Big Chico Creek to the American River

A total of 266,194 Chinook salmon was estimated for 2000 in the Sacramento River tributaries from Big Chico Creek to the American River (Figure 3). This total consisted of 8,117 spring-run and 258,077 fall-run fish (Appendix 2).

Big Chico Creek

Spring run^{4/}. A snorkeling survey was conducted on 8 August 2000 in the stretch of Chico Creek from Higgin's Hole downstream to Salmon Hole in Bidwell Park. A total of 27 salmon was counted and judged to be the spring-run spawner population in this tributary for 2000.

Fall run. No surveys were conducted for this run in 2000.

Butte Creek

Spring run^{5/}. Five snorkeling surveys were conducted during 25 August through 1 September 2000 covering the stretch from Centerville Head Dam to Parrott-Phelan Diversion Dam. In addition to 52 grilse salmon and nine salmon carcasses, between 3,924 and 4,118 live adult fish were counted. All of the salmon were observed between Quartz Bowl Pool and the covered bridge. Based on these surveys, it was judged that the maximum population of 4,118 spring-run salmon were in the creek.

Fall run^{6/}. Salmon carcass surveys were conducted during 20 October through 28 December 2000. A total of 714 carcasses were counted between Parrott-Phelan Dam and Gorrill Dam, but salmon were also observed or reported outside of that reach. An estimate of the fall-run spawner population was not made.

^{4/} Garmin, C. Big Chico Creek Spring-run Chinook Salmon Snorkel-survey, 2000. Memorandum to files. 10 August 2000. CDFG-Sacramento Valley and Central Sierra Region (SVCSR), Chico office.

^{5/} Garmin, C. Butte Creek Spring Run Chinook Salmon Survey, 2000. Memorandum to files. 12 September 2000. CDFG – SVCSR, Chico office.

^{6/} McReynolds, T. Butte Creek Fall Run Chinook Carcass Survey. Memorandum to files. 3 January 2001. CDFG – SVCSR, Chico office.

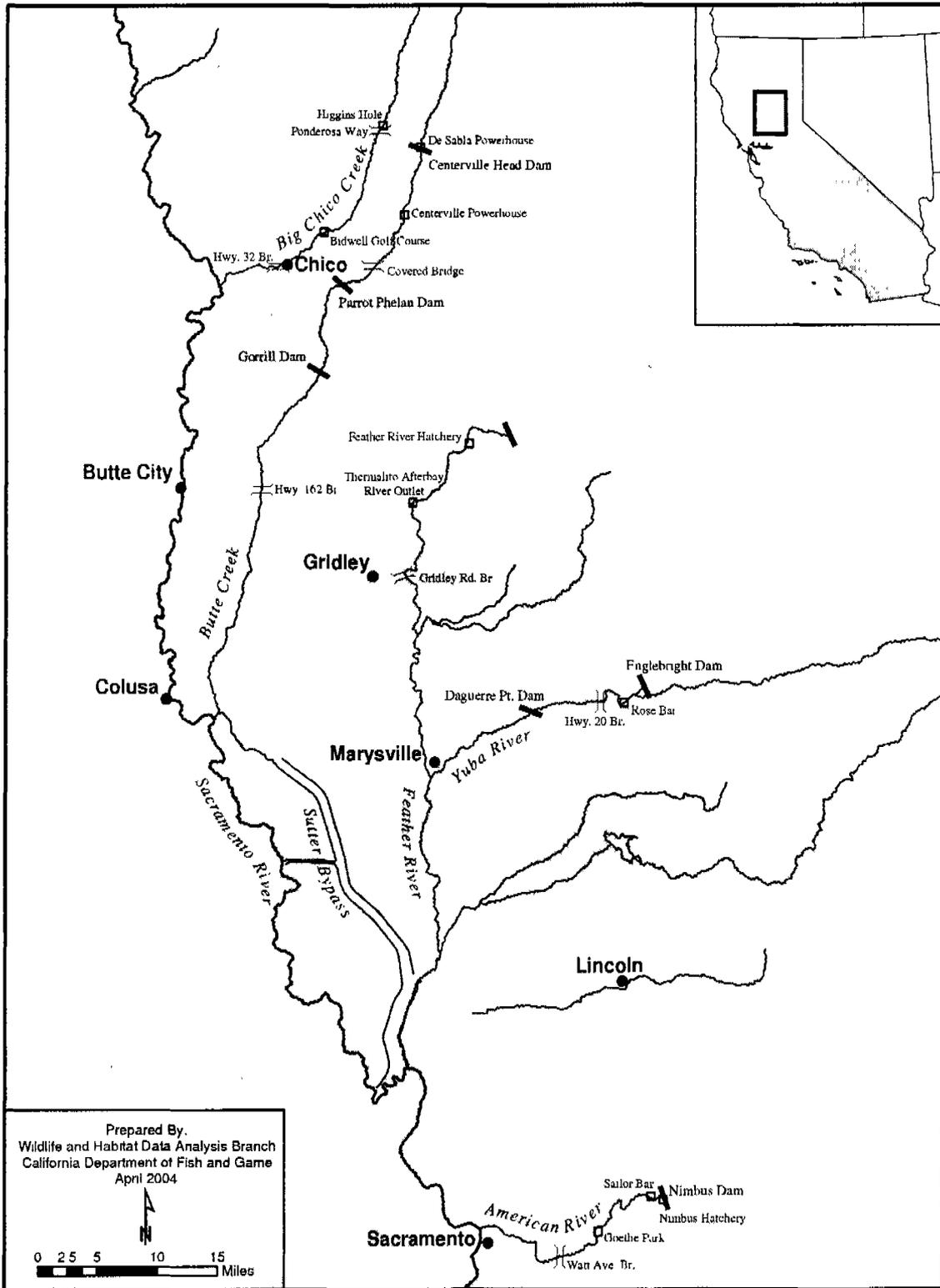


FIGURE 3. Sacramento River System from Big Chico Creek to the American River.

Feather River

Spring run. A total of 3,972 salmon classified as spring-run fish entered Feather River Hatchery (FRH) during 12-23 September 2000^{7/}. These fish consisted of 54.7% male adults, 37.4% female adults, and 7.9% grilse. In the river itself, no attempt was made to estimate numbers of spring-run salmon.

The 3,972 spring-run salmon at FRH in 2000 was 12% lower than in 1999, and 15% lower than the average for 1990-1999 (Appendix 3).

Fall run. Salmon carcass mark-and-recovery surveys were conducted in the Feather River between the hatchery barrier dam and East Gridley Road bridge during 5 September through 15 December 2000^{8/}. This stretch of river was surveyed in two sections, characterized by different flow regimes. The reach between the hatchery and Thermalito Afterbay Outlet (Section 1) had constant flows of 17.0 m³/s (600 cfs) throughout the survey periods. Flow downstream of Thermalito Afterbay to Gridley (Section 2) averaged 55.6 m³/s (1965 cfs), ranging from 111.8 m³/s (3948 cfs) at the beginning of the surveys to 45.7 m³/s (1613 cfs) near the end.

Only fresh adult carcasses were marked, with colored ribbons attached to the lower jaws with hog rings; for each marking period a different ribbon color was used. Marked carcasses were released, into the strongest flowing water within 3.3 m (10 ft) of the initial location found, for later recovery. Fresh carcasses were identified by having at least one clear eye or pink gills, while the adult distinction was a FL > 65 cm (25.6 in). The size criteria used for this distinction was determined from length frequency analysis of salmon measured during the 1999 spawning season. Fresh grilse (FL ≤ 65 cm) carcasses were counted, to determine the grilse proportion in the population, measured, and then chopped in half, as were non-fresh carcasses and those that were recovered with marks. The gender of nearly all carcasses observed was also recorded.

Schaefer (Appendix 1.B) estimates, calculated from the mark-and-recovery data, were 66,517 adult salmon for Section 1, and 41,244 adults for Section 2 (Table 6). Combining both estimates, along with an additional 73 carcasses counted during the initial survey week, resulted in a total in-river adult population of 107,834 fish. Expansion of the adult population to include a 6% grilse proportion resulted in a combined total in-river estimate of 114,717 fish. A total of 18,146 fall-run salmon entered FRH^{7/}, bringing the 2000 fall run in the Feather River to 132,863 salmon (Appendix 2).

The composition of fall-run salmon in the river, based on 53,385 carcasses examined, was 41% male adults, 53% female adults, and 6% grilse. Salmon which entered FRH consisted of 55.3% male adults (FL ≥ 55.9 cm (22 in)), 35.4% female adults, and 9.3% grile (FL < 55.9 cm).

The 2000 Feather River fall run of 132,863 fish was the highest recorded for that tributary, and over double the 1997 population; in-river estimates were not made in 1998 and 1999 (Appendix 3).

^{7/} Kastner, A. CDFG – SVCSR, Feather River Hatchery. Personal communication.

^{8/} Drury, I. Feather River Chinook Salmon Escapement, 2000. File Report. CDFG-SVCSR, Rancho Cordova office.

TABLE 6. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the Feather River from Feather River Hatchery to East Gridley Road Bridge ^{1/}.

Feather River Hatchery to Thermalito Afterbay Outlet (Section 1)															Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
Recovery period (j).	Number of marked carcasses recovered from marking period (i)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
2	18	--	--	--	--	--	--	--	--	--	--	--	--	--	18	174	266
3	11	29	--	--	--	--	--	--	--	--	--	--	--	--	40	348	555
4	2	16	78	--	--	--	--	--	--	--	--	--	--	--	96	1,155	1,767
5	1	2	29	196	--	--	--	--	--	--	--	--	--	--	228	3,203	4,597
6			12	96	204	--	--	--	--	--	--	--	--	--	312	6,492	10,307
7			3	34	125	308	--	--	--	--	--	--	--	--	470	9,616	15,156
8			8	5	25	102	402	--	--	--	--	--	--	--	542	9,155	14,741
9			0	1	7	32	123	404	--	--	--	--	--	--	567	5,540	8,304
10			1		1	8	23	74	252	--	--	--	--	--	359	3,479	5,858
11					1	0	4	18	54	235	--	--	--	--	312	2,541	4,187
12					0	0	2	4	15	58	99	--	--	--	178	1,446	2,605
13					1	0	0	2	2	19	34	49	--	--	107	1,027	1,857
14								0	0	2	7	15	41	--	65	480	983
15								1	0	0	1	6	10	12	30	218	632
Total recovered (R _i):	32	47	131	332	364	450	554	503	323	314	141	70	51	12			
Total carcasses marked (M _i):	49	76	198	472	608	700	900	731	569	514	271	127	111	21	Total estimate ^{4/} :		71,815
															Adjusted estimate ^{5/}:		66,517

Thermalito Afterbay Outlet to East Gridley Road Bridge (Section 2)															Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
Recovery period (j).	Number of marked carcasses recovered from marking period (i)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
2	0	--	--	--	--	--	--	--	--	--	--	--	--	--	0	23	23
3		1	--	--	--	--	--	--	--	--	--	--	--	--	1	39	156
4			0	--	--	--	--	--	--	--	--	--	--	--	0	78	78
5				1	--	--	--	--	--	--	--	--	--	--	1	234	5,616
6					6	--	--	--	--	--	--	--	--	--	6	219	2,628
7						10	--	--	--	--	--	--	--	--	10	455	3,144
8						1	17	--	--	--	--	--	--	--	18	705	3,635
9							2	19	--	--	--	--	--	--	21	664	2,858
10								8	21	--	--	--	--	--	29	1,062	3,820
11								3	5	3	--	--	--	--	11	1,049	4,288
12								1	2	9	16	--	--	--	28	1,913	6,891
13											4	23	--	--	27	985	4,229
14											1	11	6	--	18	723	3,513
15												3	2	3	8	233	1,229
Total recovered (R _i):	0	1	0	1	6	11	19	31	28	12	21	37	8	3			
Total carcasses marked (M _i):	7	4	23	24	72	76	96	131	94	62	57	169	46	9	Total estimate ^{4/} :		42,107
															Adjusted estimate ^{6/}:		41,244

1/ Surveys were conducted from 5 September through 15 December 2000

2/ Includes salmon carcasses which were marked and marked carcasses that were recovered.

3/ Schaefer (1951) estimate equation $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$

4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.

5/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (71,815 - 5,298 = 66,517)

6/ Adjusted estimate where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (42,107 - 863 = 41,244).

Yuba River

Spring run. During September 2000, CDFG conducted surveys of salmon spawning in the river upstream of Daguerre Point Dam^{9/}. A total of 205 redds were counted, with the majority occurring in the reach between Parks Bar upstream to Rose Bar. It was assumed that these redds represented spring-run spawning, but an estimate of the population was not made.

Fall run. Salmon carcass mark-and-recovery surveys for this run during 2000 were conducted in the Yuba River from Rose Bar downstream to Simpson Lane in Marysville^{10/}. The surveyed reach was covered in three sections: Rose Bar to Parks Bar at the Hwy. 20 bridge (Section 1), Parks Bar to Daguerre Point Dam (Section 2), and Daguerre Point Dam to Marysville (Section 3). These reaches included nearly all of the spawning areas used by Chinook salmon in the Yuba River. Some fish may have spawned in the Narrows upstream of Rose Bar to Englebright Dam, although suitable habitat is scarce in that area. Weekly surveys were conducted in Section 1 during 3 October through 12 December, in Section 2 during 3 October through 13 December, and in Section 3 from 12 October through 21 December.

Yuba River flows below Englebright Dam ranged from 27.4 m³/s to 30.8 m³/s (967-1089 cfs) during the survey periods, and remained relatively stable throughout the spawning season. Flows near Marysville ranged between 18.3 m³/s and 27.9 m³/s (645-985 cfs). The mean daily water temperature in Sections 1 and 2 ranged from 11.1°C to 12.8°C (52-55°F), while those in Section 3 ranged from the lower 60s to upper 40s fahrenheit. Visibility through the water averaged 3.3m (10 ft).

This season, both adult and grilse fresh salmon carcasses were marked; carcasses were considered fresh if they had firm flesh, at least one clear eye, and pink gills, while the adult designation was a FL \geq 64.8 cm (25.5 in). The length distinguishing adults and grilse was based on data from Yuba River salmon collected at the beginning of the 2000 season.

Marking consisted of colored flagging attached to the fish's jaw with a hog ring; different colors of tape were used to identify carcasses with distinct marking periods and survey reaches. Marked carcasses were returned into flowing water for subsequent recovery. Decayed carcasses and recovered marked carcasses were counted and then chopped in half. The sex of fresh adult carcasses was noted for determination of the male to female ratio in the population.

Using carcass mark-and-recovery data with the Schaefer model (Appendix 1.B), estimates of 4,133 adults and 470 grilse were calculated for Section 1 (Table 7), 4,979 adults and 895 grilse in Section 2 (Table 8), and 3,842 adults and 676 grilse in Section 3 (Table 9). Combining these estimates gave 14,995 total salmon as the 2000 Yuba River run.

^{9/} Drury, I. CDFG-SVCSR, Rancho Cordova office. Personal Communication.

^{10/} Jones & Stokes. 2000 Fall-run Chinook Salmon Spawning Escapement in the Yuba River. Report to the Yuba County Water Agency, Marysville, CA. J&S 00-402, June 2001.

TABLE 7. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the Yuba River from Rose Bar to Parks Bar at the Highway 20 Bridge ^{1/}.

ADULT ESTIMATE												Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
Recovery period (j).	Number of marked carcasses recovered from marking period (i):													
	1	2	3	4	5	6	7	8	9	10	11			
2	4	--	--	--	--	--	--	--	--	--	--	4	104	208
3	1	15	--	--	--	--	--	--	--	--	--	16	308	646
4		4	46	--	--	--	--	--	--	--	--	50	470	1,040
5			4	37	--	--	--	--	--	--	--	41	325	823
6			4	5	26	--	--	--	--	--	--	35	307	732
7				4	5	28	--	--	--	--	--	37	221	421
8					0	0	5	--	--	--	--	5	89	169
9					1	4	10	5	--	--	--	20	110	242
10						0	1	1	4	--	--	6	61	153
11						1	3	0	2	2	--	8	70	196
Total recovered (R _i):	5	19	54	46	32	33	19	6	6	2	0			
Total carcasses marked (M _i):	10	40	120	118	76	57	36	19	15	10	7			
													Total estimate ^{4/} :	4,631
													Adjusted estimate ^{6/}:	4,133
GRILSE ESTIMATE												Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
Recovery period (j).	Number of marked carcasses recovered from marking period (i):													
	1	2	3	4	5	6	7	8	9					
2	0	--	--	--	--	--	--	--	--	0	9	9		
3		2	--	--	--	--	--	--	--	2	34	57		
4		1	3	--	--	--	--	--	--	4	41	117		
5			1	3	--	--	--	--	--	4	45	138		
6				1	1	--	--	--	--	2	29	73		
7				2	0	0	--	--	--	2	12	36		
8					1	2	2	--	--	5	14	30		
9					1	1	0	0	--	2	13	41		
10								0	--	0	4	4		
11									1	1	6	24		
Total recovered (R _i):	0	3	4	6	3	3	2	0	0					
Total carcasses marked (M _i):	0	5	13	18	6	7	4	2	3					
													Total estimate ^{4/} :	528
													Adjusted estimate ^{6/}:	470

^{1/} Surveys were conducted from 3 October through 12 December 2000.
^{2/} Includes salmon carcasses which were marked and marked carcasses that were recovered.
^{3/} Schaefer (1951) estimate equation: $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$.
^{4/} Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.
^{5/} Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (4,631 - 498 = 4,133)
^{6/} Adjusted estimate where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (528 - 58 = 470)

Based on fresh carcasses observed during the surveys, the fall run population consisted of 46% adult males and 54% adult females. Prespawning mortality, determined from observed carcasses, was approximately 8% for female adults.

The 2000 Yuba River fall run of 14,995 salmon was 38% lower than the 1999 population, and 16% lower than the 1990-1999 average population (Appendix 3).

TABLE 8. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the Yuba River from Parks Bar at the Highway 20 Bridge to Daguerre Point Dam ^{1/}.

ADULT ESTIMATE											Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
Recovery period (j):	Number of marked carcasses recovered from marking period (i):												
	1	2	3	4	5	6	7	8	9	10			
2	9	--	--	--	--	--	--	--	--	--	9	103	206
3	3	11	--	--	--	--	--	--	--	--	14	215	551
4		1	20	--	--	--	--	--	--	--	21	385	677
5		1	12	31	--	--	--	--	--	--	44	437	860
6		0	0	10	35	--	--	--	--	--	45	445	967
7		0	4	0	10	25	--	--	--	--	39	451	958
8		0	2	0	2	9	29	--	--	--	42	244	505
9		1		3	1	2	6	2	--	--	15	108	292
10				1	0	2	1	3	3	--	10	96	438
11										0	0	44	44
Total recovered (R _i):	12	14	38	45	48	38	36	5	3	0			
Total carcasses marked (M _i)	24	38	65	92	106	82	74	32	18	11			
												Total estimate ^{4/} :	5,497
												Adjusted estimate ^{6/}:	4,979

GRILSE ESTIMATE											Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
Recovery period (j):	Number of marked carcasses recovered from marking period (i):												
	1	2	3	4	5	6	7	8	9	10			
2	0	--	--	--	--	--	--	--	--	--	0	14	14
3		3	--	--	--	--	--	--	--	--	3	43	108
4		0	0	--	--	--	--	--	--	--	0	62	62
5		1	2	3	--	--	--	--	--	--	6	68	266
6				5	5	--	--	--	--	--	10	53	155
7				1		1	--	--	--	--	2	48	328
8							0	--	--	--	0	31	31
9								0	--	--	0	12	12
10									0	--	0	9	9
Total recovered (R _i):	0	4	2	9	5	1	0	0	0	0			
Total carcasses marked (M _i)	2	10	13	24	16	11	5	5	3	3			
												Total estimate ^{4/} :	985
												Adjusted estimate ^{6/}:	895

1/ Surveys were conducted from 3 October through 13 December 2000

2/ Includes salmon carcasses which were marked and marked carcasses that were recovered

3/ Schaefer (1951) estimate equation $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$

4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.

5/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (5,497 - 518 = 4,979).

6/ Adjusted estimate where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (985 - 90 = 895)

TABLE 9. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the Yuba River from Daguerre Point Dam to the Simpson Lane Bridge in Marysville ^{1/}.

ADULT ESTIMATE

Recovery period (j):	Number of marked carcasses recovered from marking period (i):										Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7	8	9	10			
2	0	--	--	--	--	--	--	--	--	--	0	35	35
3	0	5	--	--	--	--	--	--	--	--	5	111	296
4	2	1	14	--	--	--	--	--	--	--	17	187	546
5				16	--	--	--	--	--	--	16	268	508
6				18	12	--	--	--	--	--	30	354	933
7				3	0	13	--	--	--	--	16	206	452
8				0	2	7	14	--	--	--	23	223	549
9				1	2	3	2	10	--	--	18	147	371
10								1	6	--	7	102	254
11										2	2	50	225
Total recovered (R _i).	2	6	14	38	16	23	16	11	6	2			
Total carcasses marked (M _i)	9	16	38	72	60	52	38	27	15	9			
											Total estimate ^{4/} :		4,169
											Adjusted estimate ^{6/}:		3,842

GRILSE ESTIMATE

Recovery period (j):	Number of marked carcasses recovered from marking period (i):										Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7	8	9	10			
2	1	--	--	--	--	--	--	--	--	--	1	5	5
3		1	--	--	--	--	--	--	--	--	1	18	45
4		0	0	--	--	--	--	--	--	--	0	38	38
5		1	1	0	--	--	--	--	--	--	2	34	162
6				2	0	--	--	--	--	--	2	41	287
7						1	--	--	--	--	1	31	155
8							0	--	--	--	0	20	20
9								0	--	--	0	4	4
10									0	--	0	8	8
Total recovered (R _i).	1	2	1	2	0	1	0	0	0	0			
Total carcasses marked (M _i)	1	5	5	12	9	5	8	1	1	2			
											Total estimate ^{4/} :		724
											Adjusted estimate ^{6/}:		676

1/ Surveys were conducted from 12 October through 21 December 2000

2/ Includes salmon carcasses which were marked and marked carcasses that were recovered

3/ Schaefer (1951) estimate equation $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$

4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.

5/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate $4,169 - 327 = 3,842$

6/ Adjusted estimate where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate $(724 - 48 = 676)$

American River ^{11/}

Fall run. Weekly salmon carcass mark-and-recovery surveys in the American River were conducted between 30 October 2000 and 3 January 2001, covering the 20.8-km (12.9-mi) reach from Sailor Bar downstream to the Watt Avenue bridge. Water clarity, measured by secchi disk, ranged from 1.8 m to 3.3 m (6-11 ft). Water temperature ranged from 10°C to 16.1°C (50-61°F).

This season fresh salmon carcasses were distinctly marked by attaching a hog ring and colored flagging to their jaws; different colors were used each marking period. A carcass was considered fresh if it had red to pink gills. Marked carcasses were replaced into running water for later recovery. Any carcass not tagged, as well as those recovered with tags were counted and cut in half. Length and sex were recorded for a sample of the fresh carcasses.

The salmon population of the Watt Avenue to Sailor Bar section of the river, estimated from carcass mark-and-recovery data using the Schaefer calculation (Appendix 1.B), was 99,059 fish (Table 10). In addition, 11,160 salmon entered Nimbus Hatchery ^{12/}, bringing the total American River 2000 fall-run population to 110,219 fish (Appendix 2).

TABLE 10. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the American River from Sailor Bar to the Watt Avenue Bridge ^{1/}.

Recovery period (j):	Number of marked carcasses recovered from marking period (i):								Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7	8			
2	4	--	--	--	--	--	--	--	4	1,263	5,626
3	3	50	--	--	--	--	--	--	53	2,902	8,756
4	3	7	94	--	--	--	--	--	104	5,080	14,261
5	0	1	11	87	--	--	--	--	99	6,673	25,271
6	0		4	10	109	--	--	--	123	6,116	15,560
7	0		0	1	12	70	--	--	83	4,363	12,970
8	0		0		1	15	35	--	51	3,082	12,460
9	1		1			5	3	25	35	1,417	4,355
10							1	4	5	354	1,484
Total recovered (R _i).	11	58	110	98	122	90	39	29			
Total carcasses marked (M _i):	49	170	302	385	294	275	176	83			
									Total estimate ^{4/} :		100,744
									Adjusted estimate ^{5/}:		99,059

^{1/} Surveys were conducted from 30 October 2000 through 3 January 2001
^{2/} Includes salmon carcasses which were marked and marked carcasses that were recovered.
^{3/} Schaefer (1951) estimate equation: $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$.
^{4/} Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding
^{5/} Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (100,744 - 1,685 = 99,059).

^{11/} Hanson, J. American River Fall-run Chinook Salmon Escapement Survey, October 30, 2000 – January 3 2001. File report. CDFG-SVCSR, Rancho Cordova office.

Based on examination of 939 fresh carcasses, the run consisted of 44.1% male adults (FL \geq 70 cm [27.6 in.]), 50.2% female adults (FL \geq 64 cm (25.2 in)), 5.3% male grilse (FL < 70 cm), and 0.4% female grilse (FL \leq 64 cm) . Salmon entering Nimbus Hatchery consisted of 55.6% male adults (FL > 60 cm [23.6 in.]), 36.8% female adults, 6.9% male grilse (FL < 60 cm), and 0.7% female grilse.

The 2000 run of 110,219 salmon in the American River was an increase of 69% from the previous year's population (Appendix 3), and the highest ever recorded for that tributary.

^{12/} West, T. CDFG – SVCSR, Nimbus Hatchery. Personal communication.

CHINOOK SALMON SPAWNER POPULATIONS FOR THE SAN JOAQUIN RIVER SYSTEM

The Mokelumne, Stanislaus, Tuolumne, and Merced rivers of the San Joaquin River system (Figure 4) were surveyed for Chinook salmon spawners. A total of 46,865 salmon, consisting entirely of fall-run fish, was estimated to be in this system for 2000 (Appendix 2).

Mokelumne River

Fall run. Fish passage at Woodbridge Irrigation District Dam was monitored by East Bay Municipal District, during 15 August 2000 through 23 April 2001^{13/}. Passage through the high-stage fishway was monitored with a closed-circuit, underwater video system through 6 November, after which the lake behind the dam was drawn down for the winter. Subsequently, a combination of the video system and upstream migrant trapping was used in the low-stage fishway.

A total of 7,418 salmon was counted, migrating past or relocated to upstream of the dam, during 20 August 2000 through 12 February 2001. Of these salmon, 5,524 fish entered the Mokelumne River Fish Hatchery^{14/}, so the in-river fall-run spawner population was assumed to be 1,894 fish (Appendix 2).

Based on examination of salmon at the dam the run consisted of 37% male adults (FL > 60 cm [23.6 in]), 46% female adults, and 17% grilse (FL ≤ 60 cm). The composition of the salmon entering the hatchery was 38% male adults, 46% female adults, and 16% grilse.

The 2000 spawner population of 7,418 fish in the Mokelumne River was an increase of 39% from the previous year's run, and 65% higher than the average population size for the 1990-1999 period (Appendix 3).

Stanislaus River

Fall run. Spawner surveys of the Stanislaus River were conducted during 5 October through 22 December 2000^{15/}. The 22.5-km (14-mi) stretch of the river from Knight's Ferry to Oakdale Recreation Area was covered by drift boat, while surveys were made on foot in the Goodwin Canyon area.

^{13/} Workman, M.L. Lower Mokelumne River Upstream Fish Migration Monitoring. File Report. East Bay Municipal Utilities District, Lodi Office.

^{14/} Anderson, B. CDFG – San Joaquin Valley/Southern Sierra Region (SJVSSR), Mokelumne River Hatchery. Personal communication.

^{15/} Baumgartner, S. 2000 Stanislaus River Chinook Salmon Spawning Escapement Survey. File Report. September 2001. CDFG - SJVSSR.

All salmon carcasses, except skeletons, were marked using numbered metal tags attached to their lower jaws with hog-rings; skeletons also included carcasses so decomposed that it was judged they would not retain a tag for two weeks. Marked carcasses were released, into running water at the lower end of the riffle where they were initially found, for subsequent recovery. Carcasses not marked, as well as those previously marked carcasses which were recovered, were counted and chopped in half. During the initial handling of each carcass, it was sexed and measured, and its condition was determined as either fresh or decayed; fresh carcasses were identified as having clear eyes.

The carcass marking protocol and use of numbered tags were intended to allow post-season distinction of age-class and condition, so the data could be better compiled for estimating the population through several biometric models. Analysis of the data indicated the Schaefer estimate (Appendix 1.B) was the most appropriate.

The population in the Knight's Ferry to Oakdale Recreation Area stretch was estimated to be 8,498 fish ^{16/}, using the fresh carcass mark-and-recovery data in the Schaefer model (Table 11). The run consisted of 35.8% male adults, 58.5% female adults, 1.5% male grilse, and 4.2% female grilse.

The 2000 Stanislaus River fall-run spawner population of 8,498 salmon was almost double the previous year's run (Appendix 3), and was the highest since the 1988 run of over 10,000 fish (Kano 1997).

TABLE 11. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the Stanislaus River between Knight's Ferry and Oakdale Recreation Area ^{1/}.

Recovery period (j)	Number of marked carcasses recovered from marking period (i):									Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7	8	9			
2	0	--	--	--	--	--	--	--	--	0	21	21
3		0	--	--	--	--	--	--	--	0	29	29
4			1	--	--	--	--	--	--	1	62	403
5			1	3	--	--	--	--	--	4	158	1,244
6					1	--	--	--	--	1	136	853
7					2	5	--	--	--	7	291	1,861
8					6	2	4	--	--	12	280	1,697
9					2	2	4	2	--	10	324	2,646
10							1		0	1	5	33
Total recovered (R _i).	0	0	2	3	11	9	9	2	0			
Total carcasses marked (M _i)	4	8	13	25	69	58	50	34	32			
											Total estimate ^{4/}	8,787
											Adjusted estimate ^{5/}:	8,498

1/ Surveys were conducted from 5 October through 22 December 2000.
 2/ Includes salmon carcasses which were marked and marked carcasses that were recovered
 3/ Schaefer (1951) estimate equation: $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$.
 4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.
 5/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (8,787 - 289 = 8,498).

^{16/} Heyne, T. CDFG-SJVSSR. Personal communication.

Tuolumne River

Fall run. Chinook salmon spawner surveys in the Tuolumne River were conducted from 27 September 2000 through 5 January 2001^{17/}; mark-and-recovery surveys started during the first week of October. Surveys covered the river stretch from the riffles at River Mile 51.6 downstream to Fox Grove Regional Park, a distance of 41.2 km (25.6 mi).

This season, in anticipation of a large run, every third salmon carcass was sampled and processed. All sampled carcasses, except skeletons, were marked using numbered metal tags attached to their lower jaws with hog-rings; skeletons also included carcasses so decomposed that it was judged they would not retain a tag for two weeks. Marked carcasses were released, into running water at the lower end of the riffle where they were initially found, for subsequent recovery. Carcasses not marked, as well as those previously marked carcasses which were recovered, were counted and chopped in half. During the initial handling of each carcass, its sex was determined, a length measurement was made, and a condition of either fresh or decayed was assigned; fresh carcasses were identified as having clear eyes.

The carcass marking protocol and use of numbered tags were intended to allow post-season distinction of age-class and condition, so the data could be better compiled for estimating the population through several biometric models. Analysis of the data indicated that the Schaefer estimate (Appendix 1.B) was the most appropriate.

The salmon population in the Tuolumne River upstream of Fox Grove Regional Park was estimated at 17,873 fish, using the fresh carcass mark-and-recovery data in the Schaefer model (Table 12). The run consisted of 34% male adults, 60.7% female adults, 3.2% male grilse, and 2.1% female grilse.

The 2000 fall run of salmon in the Tuolumne River was more than double the previous year's population (Appendix 3), and was the highest since the 1987 run of over 14,000 fish (Kano and Reavis 1997).

Merced River

Fall run. Weekly salmon surveys were conducted in the 39.7-km (24.7-mi) stretch of the Merced River from the Merced River Hatchery downstream to Santa Fe Road near Cressy^{18/}. Surveys were conducted from 4 October 2000 through 8 January 2001, with carcass mark-and-recovery beginning during the second week. River flows were increased, about the same time that the carcass surveys began, to attract salmon into the tributary and improve spawning conditions. The higher flows were continued for about three weeks (14 October through

^{17/} Vasques, J. 2000 Tuolumne River Chinook Salmon Spawning Escapement Survey. File report. March 2001. CDFG - SJVSSR, La Grange office.

^{18/} Beal, B. 2000 Merced River Chinook Salmon Spawning Escapement Survey Report. File Report. CDFG - SJVSSR, La Grange office.

TABLE 12. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the Tuolumne River between the riffles at river mile 51.6 and Fox Grove Regional Park ^{1/}.

Recovery period (j):	Number of marked carcasses recovered from marking period (i):												Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7	8	9	10	11	12			
2	0	--	--	--	--	--	--	--	--	--	--	--	0	3	3
3		0	--	--	--	--	--	--	--	--	--	--	0	34	34
4		0	3	--	--	--	--	--	--	--	--	--	3	154	385
5		1	3	12	--	--	--	--	--	--	--	--	16	332	923
6			1	4	27	--	--	--	--	--	--	--	32	735	1,695
7			1	0	9	23	--	--	--	--	--	--	33	993	2,655
8				4	6	30	40	--	--	--	--	--	80	1,652	4,308
9				1	1	6	17	45	--	--	--	--	70	1,295	2,975
10				3	2	7	12	25	33	--	--	--	82	1,143	2,463
11					0	1	9	15	13	21	--	--	59	718	1,583
12					0	0		3	6	4	3	--	16	324	706
13					1	1		2	3	1	5	1	14	295	942
14										1	2		3	74	178
Total recovered (R _i)	0	1	8	24	46	68	78	90	56	26	10	1			
Total carcasses marked (M _i)	2	1	20	72	101	195	190	194	102	61	27	14	Total estimate ^{4/} :		18,850
													Adjusted estimate ^{5/}:		17,873

1/ Surveys were conducted from the first week of October 2000 through 5 January 2001

2/ Includes salmon carcasses which were marked and marked carcasses that were recovered

3/ Schaefer (1951) estimate equation: $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$

4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding

5/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (18,850 - 977 = 17,873).

1 November) peaking at 38.7 m³/s (1365 cfs) on 22 October. Throughout the remainder of the survey period, flows ranged from 8.5 m³/s to 11.3 m³/s (300-400 cfs).

All salmon carcasses, except skeletons, were marked using numbered metal tags attached to their lower jaws, or near the dorsal fins, with hog-rings; skeletons included carcasses so decomposed that it was judged they would not retain a tag for two weeks. Marked carcasses were released, into running water at the lower end of the riffle where they were initially found, for subsequent recovery. Carcasses not marked, as well as those previously marked carcasses which were recovered, were counted and chopped in half. During the initial handling of each carcass, it was sexed and measured, and its condition was determined as either fresh or decayed; fresh carcasses were identified as having clear eyes.

The carcass marking protocol and use of numbered tags were intended to allow post-season distinction of age-class and condition, so the data could be better compiled for estimating the population through several biometric models. Analysis of the data indicated that the Schaefer estimate (Appendix 1.B) was the most appropriate.

A Schaefer estimate of 11,130 salmon was calculated for the river stretch from Merced River

Hatchery to Santa Fe Road (Table 13). Merced River Hatchery took in 1,946 salmon^{19/}, for a total 2000 fall-run spawner population of 13,076 fish (Appendix 2). The in-river run of the Merced River consisted of 35% male adults, 57.7% female adults, 4.8% male grilse, and 2.5% female grilse. Salmon which entered Merced River Hatchery consisted of 35.1% male adults, 47.9% female adults, 14.2% male grilse, and 2.8% female grilse.

The 2000 Merced River fall run was over three times higher than the previous year's run (Appendix 3), and the highest since the 1985 population of over 16,000 fish (Kano and Reavis 1996).

TABLE 13. Chinook salmon carcass mark-and-recovery data used to estimate the 2000 fall-run spawner population in the Merced River between Merced River Fish Facility and Santa Fe Road near Cressey ^{1/}.

Recovery period (j):	Number of marked carcasses recovered from marking period (i)										Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) ^{2/}	Population estimate (N) ^{3/}
	1	2	3	4	5	6	7	8	9	10			
2	0	--	--	--	--	--	--	--	--	--	0	9	9
3		1	--	--	--	--	--	--	--	--	1	128	896
4			2	--	--	--	--	--	--	--	2	109	2,362
5			1	5	--	--	--	--	--	--	6	180	1,507
6				1	4	--	--	--	--	--	5	265	1,716
7				1	1	5	--	--	--	--	7	210	1,478
8					1	1	2	--	--	--	4	169	1,227
9						1	0	1	--	--	2	105	1,385
10						0	0	0	1	--	1	13	46
11						1	2	0	1	0	4	110	712
12											0	63	63
Total recovered (R _i):	0	1	3	7	6	8	4	1	2	0			
Total carcasses marked (M _i):	0	7	65	40	40	59	30	19	7	2			
												Total estimate ^{4/} :	11,399
												Adjusted estimate ^{5/}:	11,130

1/ Surveys were conducted from the second week of October 2000 through 8 January 2001

2/ Includes salmon carcasses which were marked and marked carcasses that were recovered.

3/ Schaefer (1951) estimate equation: $N = \sum (R_{ij} \times (M_i/R_i) \times (C_j/R_j))$.

4/ Total may not correspond to the actual sum of the weekly estimates shown, due to spreadsheet rounding.

5/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (11,399 - 269 = 11,130)

^{19/} Cozart, M. CDFG – SJVSSR, Merced River Hatchery. Personal communication.

SUMMARY

The total estimated 2000 Central Valley Chinook salmon spawner population was 507,149 fish, consisting of 460,284 fish in the Sacramento River system and 46,865 fish in the San Joaquin River system (Table 14). This total was 14% higher than the 443,678 salmon estimated in 1999.

All of the late-fall, winter, and spring runs, and the majority of the fall run were in the Sacramento River system. In the Feather and American rivers of that system, record high fall runs occurred. The combined fall run in the San Joaquin tributaries of Stanislaus, Tuolumne, and Merced rivers was over double the 1999 populations, but still only contributed a small portion (8%) to the total Central Valley escapement.

TABLE 14. Summary of the 2000 Sacramento-San Joaquin river system Chinook salmon spawner populations.

Spawning area	Late-fall run ^{1/}	Winter run	Spring run	Fall run	Total
Sacramento River mainstem	8,751	1,350	0	96,688	106,789
Sacramento River tributaries	4,194	2	9,429	339,870	353,495
San Joaquin River tributaries	--	--	--	46,865	46,865
Totals:	12,945	1,352	9,429	483,423	507,149

^{1/} Tributary data consists only of fish which entered Coleman National Fish Hatchery (Battle Creek).

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REFERENCES

- Hoopough, David A. (ed.). 1978. King (Chinook) salmon spawning stocks in California's Central Valley, 1976. Calif. Dept. of Fish and Game, Anad. Fish. Br. Admin. Rep. No. 78-19. 33 p.
- Kano, R.M. (ed.). 1997. Annual report. Chinook salmon spawner stocks in California's Central Valley, 1988. Inland Fish. Br. Admin. Rept. 97-10. 41 p
- Kano, R.M. and R.L. Reavis (eds.). 1997. Annual report. Chinook salmon spawner stocks in California's Central Valley, 1987. Inland Fish. Br. Admin. Rept. 97-4. 37 p.
- Kano, R. and R.L. Reavis (eds.). 1996. Annual Report. Chinook salmon spawning stocks in California's Central Valley, 1985. Calif. Dept. of Fish and Game, Inland Fish. Br. Admin. Rep. No. 96-4. 39 p.
- Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Res. Bd. Canada, Bull. 191. 382 p.
- Schaefer, M.D. 1951. Estimation of size of animal populations by marking experiments. U. S. Fish and Wildl. Serv., Fish. Bull. 52: 189-203.

APPENDIX 1. Calculation methods used with carcass mark-and-recovery data to estimate Chinook salmon spawner populations.

A. The Petersen equation as revised by Chapman (Ricker 1975):

$$N = \frac{(M + 1)(C + 1)}{(R + 1)}$$

where N = estimated spawner population,

M = number of carcasses marked,

C = number of carcasses observed, including those marked and those recovered with marks, and

R = number of marked carcasses recovered.

B. A modification of the Schaefer (1951) equation, which was initially used in the 1976 Central Valley spawner stock report (Hoopaugh 1978);

$$N = \sum \left(\frac{R_{ij} \times M_j \times C_j}{R_i \times R_j} \right) - \sum {}^1_2M_i$$

where N = the estimated spawner population,

R_{ij} = carcasses marked in the i th marking period which were recovered in the j th recovery period,

M_i = carcasses marked in the i th marking period,

R_i = total marked carcasses recovered from the i th marking period,

R_j = total marked carcasses recovered during the j th recovery period,

C_j = total carcasses observed in the j th recovery period, including those with marks, and

1_2M_i = total carcasses marked from the second marking period on.
Subtraction of this factor adjusted for replacement of recovered marked fish.

APPENDIX 2. 2000 Chinook salmon spawner population estimates for the Central Valley river system.

<u>River System:</u> <u>River area</u>	Estimated number of fish					
	Tributary	Late-fall run	Winter run	Spring run	Fall run	Total all runs
<u>Sacramento River System:</u>						
<u>Keswick Dam to Red Bluff</u>						
Sacramento River mainstem						
Livingstone Stone National Fish Hatchery	--		89	--	--	89
In-river a/	8,632		1,261	b/	87,793	97,686
(Totals for tributary):	(8,632)		(1,350)		(87,793)	(97,775)
Clear Creek	c/		--	b/	6,687	6,687
Cottonwood (Beegum) Creek	c/		--	122	b/	122
Battle Creek						
Coleman National Fish Hatchery	4,194		--	--	21,659	25,853
In-river	c/		2	b/	53,447	53,449
(Totals for tributary):	(4,194)		(2)		(75,106)	(79,302)
Paynes Creek	--		--	--	b/	--
Totals for area:	12,826		1,352	122	169,586	183,886
<u>Red Bluff to Princeton Ferry</u>						
Sacramento River mainstem						
	119		0	0	8,895	9,014
Antelope Creek	--		--	9	c/	9
Mill Creek	--		--	544	b/	544
Deer Creek	--		--	637	b/	637
Totals for area:	119			1,190	8,895	10,204
<u>Big Chico Creek to American River</u>						
Big Chico Creek						
	--		--	27	c/	27
Butte Creek						
	--		--	4,118	b/	4,118
Feather River						
Feather River Hatchery	--		--	3,972		22,118
In-river	--		--	c/	114,717	114,717
(Totals for tributary):					(132,863)	(136,835)
Yuba River	--		--	b/	14,995	14,995
American River						
Nimbus Hatchery	--		--	--	11,160	11,160
In-river	--		--	--	99,059	99,059
(Totals for tributary):					(110,219)	(110,219)
Totals for area:				8,117	258,077	266,194
<u>Sacramento River System Totals:</u>	12,945		1,352	9,429	436,558	460,284

San Joaquin River System:

<u>Mokelumne River</u>						
Mokelumne River Hatchery	--		--	--	5,524	
In-river	--		--	--	1,894	
(Totals for tributary):					(7,418)	
Stanislaus River	--		--	--	8,498	
Tuolumne River	--		--	--	17,873	
<u>Merced River</u>						
Merced River Hatchery	--		--	--	1,946	
In-river	--		--	--	11,130	
(Totals for tributary):					(13,076)	
<u>San Joaquin River System Total:</u>					46,865	

a/ Late-fall run estimate only for the carcass survey area Other runs estimated from Red Bluff Diversion Dam counts

b/ An estimate of the run size was not made.

c/ Tributary was not surveyed for this run.

APPENDIX 3. Chinook salmon spawner population estimates from 1990 through 2000 in California's Central Valley major tributaries.

Tributary	Run	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	1990-1999 average
<u>Sacramento River mainstem upstream of Red Bluff</u>	Late-fall	6,892	6,611	9,356	739	291	166 a/	48 a/	b/	38,239 c/	8,683 d/	8,632 c/	—
	Winter	402	211	1,196	378	186	1,202	1,012	836	2,930	3,264	1,261	1,162
	Spring	4,198	825	371	391	862	426	378	128	1,115	b/	b/	966 e/
	Fall	32,109	20,523	23,914	33,471	44,729	53,385	71,725	98,765	5,718	133,365	87,793	51,770
<u>Battle Creek</u>	Fall f/	21,088	17,241	12,708	18,616	43,265	83,192	73,587	101,414	98,308	119,899	75,106	58,932
<u>Sacramento River mainstem downstream of Red Bluff</u>	Fall	16,175	10,108	8,315	12,760	13,817	10,549	12,361	20,531	600	27,827	8,895	13,304
<u>Feather River</u>	Spring g/	1,893	4,303	1,497	4,672	3,641	5,414	6,381	7,017	6,746	4,534	3,972	4,610
	Fall h/	6,126 g/	42,062	40,545	42,914	53,584	72,061	65,277	65,675	18,889 g/	12,927 g/	132,863	54,588 h/
<u>Yuba River</u>	Fall	i/	14,008	6,362	6,703	10,890	14,237	27,900	25,948	31,090	24,230	14,995	17,930 j/
<u>American River</u>	Fall f/	10,239	25,211	11,267	39,410	40,087	86,828	82,396	57,845	66,580	65,099	110,219	48,496
<u>Mokelumne River</u>	Fall f/	499	410	1,645	3,157	3,421	5,417	7,775	10,163	7,202	5,332	7,418	4,502
<u>Stanislaus River</u>	Fall	480	394	255	677	1,031	619	168	5,588	3,087	4,349	8,498	1,665
<u>Tuolumne River</u>	Fall	96	77	132	471	506	827	4,362	7,146	8,910	8,232	17,873	3,076
<u>Merced River</u>	Fall f/	82	119	986	1,678	3,589	2,922	4,432	3,660	4,091	4,766	13,076	2,633

a/ Only the number of salmon transferred to Coleman National Fish Hatchery; in-river estimates not made.

b/ An estimate of the run size was not made.

c/ Estimate based on carcass survey and aerial redd counts. Estimates before 1995 were based on Red Bluff Diversion Dam counts.

d/ Estimate is not for the entire mainstem, for the carcass survey area only as aerial redd counts were not available to allow expansion.

e/ 1990-1998 average.

f/ Estimate includes numbers of salmon at the tributary's hatchery.

g/ Numbers are only those salmon which entered Feather River Hatchery; in-river spawner estimates were not made.

h/ Average does not include the 1990, 1998, and 1999 estimates.

i/ Tributary was not surveyed.

j/ 1991-1999 average.