State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

ANNUAL REPORT
CHINOOK SALMON SPAWNER STOCKS IN CALIFORNIA'S CENTRAL VALLEY. 2002

Edited by

Robert M. Kano
Habitat Conservation Division
Native Anadromous Fish & Watershed Branch

Inland Fisheries
Administrative Report No. 2005-04

2005

CHINOOK SALMON SPAWNER STOCKS IN CALIFORNIA'S CENTRAL VALLEY, 2002[1/]

Edited by

Robert M. Kano
Habitat Conservation Division
Native Anadromous Fish & Watershed Branch

ABSTRACT

This report covers the 50th 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 2002 total escapement of Chinook salmon in the Central Valley was 935,979 fish, which was 39% higher than in 2001. The population consisted of 872,433 fall-, 38,673 late-fall-, 17,409 spring-, and 7,464 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 836,008 fish in the Sacramento River system and 36,425 fish in the San Joaquin River system. In Battle Creek of the Sacramento system, a record high fall run occurred. The fall run in the San Joaquin tributaries still only contributed a small portion (4%) to the total Central Valley escapement.

[1/] Inland Fisheries Administrative Report No. 2005-04. Submitted for publication December 2005. California Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814.

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 50th 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.

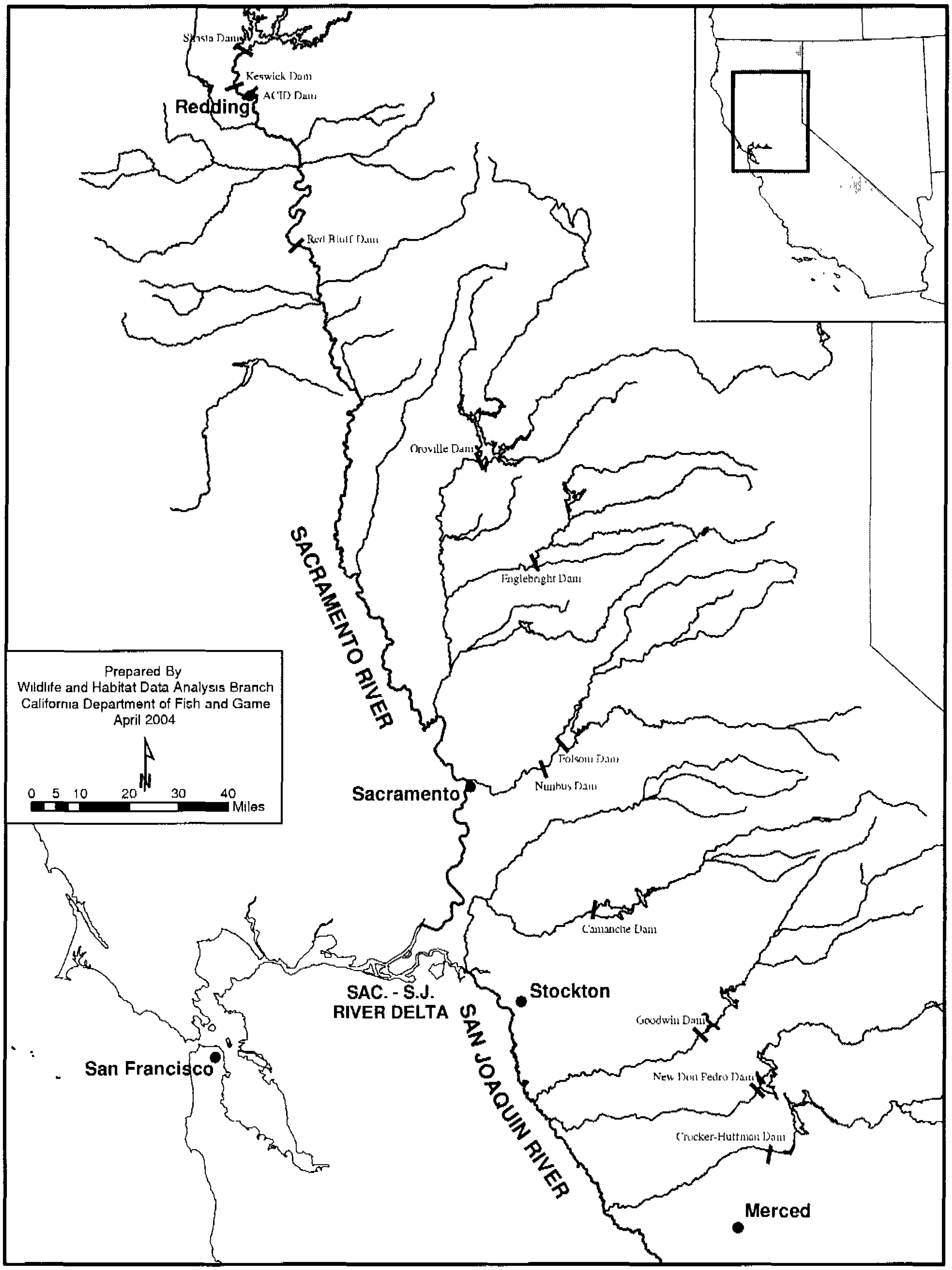

FIGURE 1. Sacramento-San Joaquin River System of California's Central Valley.

GENERAL METHODS

During 2002, 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 judgment".

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.

Keswick Dam to Red Bluff Diversion Dam

Spawner population sizes were estimated for all four runs of Chinook salmon in the mainstem Sacramento River (Figure 2) upstream of Red Bluff Diversion Dam (RBDD). Individual tributary estimates were made for the spring and fall runs in Clear and Battle creeks, and the Cottonwood Creek spring run.

In 2002, a total of 571,623 salmon was estimated for the Sacramento River system upstream of Red Bluff, consisting of 524,890 fall-, 38,673 late-fall-, 7,452 winter- and 608 spring-run fish. The mainstem portion of the fall- run spawner population was 45,523 fish.

Sacramento River Mainstem

Late-fall run. The late-fall spawner population was estimated from salmon carcass surveys in a portion of the mainstem, and from aerial redd surveys of the entire mainstem. Carcass surveys were conducted from 17 December 2001 through 5 May 2002, covering the 26.5-km (16.5-mi) stretch from Anderson-Cottonwood Irrigation District Dam (ACID) downstream to Anderson River Park [2/]. This stretch of river was covered weekly in three reaches, each surveyed on one day. During the surveys, mean weekly river flows upstream from ACID ranged from 108 m^3/s to 299 m^3/s (3804-10,564 cfs). Weekly average water clarity in the surveyed section, measured by secchi disk, ranged from 1.4 m to 4.9 m (4.7-16.3 ft). Water temperatures in the survey area ranged from 9.3 °C to 11.7 °C (48.7-53 °F).

Salmon carcasses were marked by attaching colored ribbons to their jaws with hog rings; for each week a different color was used. Marked carcasses were returned to running water for subsequent recovery. Carcasses that were not marked, as well as those that were recovered with marks, were chopped in half to prevent recounting. Measurements of fork length (FL), determination of gender, and relative egg retention of females were made for a subsample of fresh carcasses (those with a clear eye or pink gills).

The carcass processing protocols were intended to allow post-season distinction of age-class (adult or grilse, based on length), and condition (fresh or decayed), so the data could be better compiled for estimating the population through several biometric models. Analysis of the data indicated the Jolly-Seber model (Appendix 1.C) was the most appropriate.

[2/] Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002. File Report. June 2004. CDFG-Northern California-North Coast Region (NCNCR), Red Bluff Office.

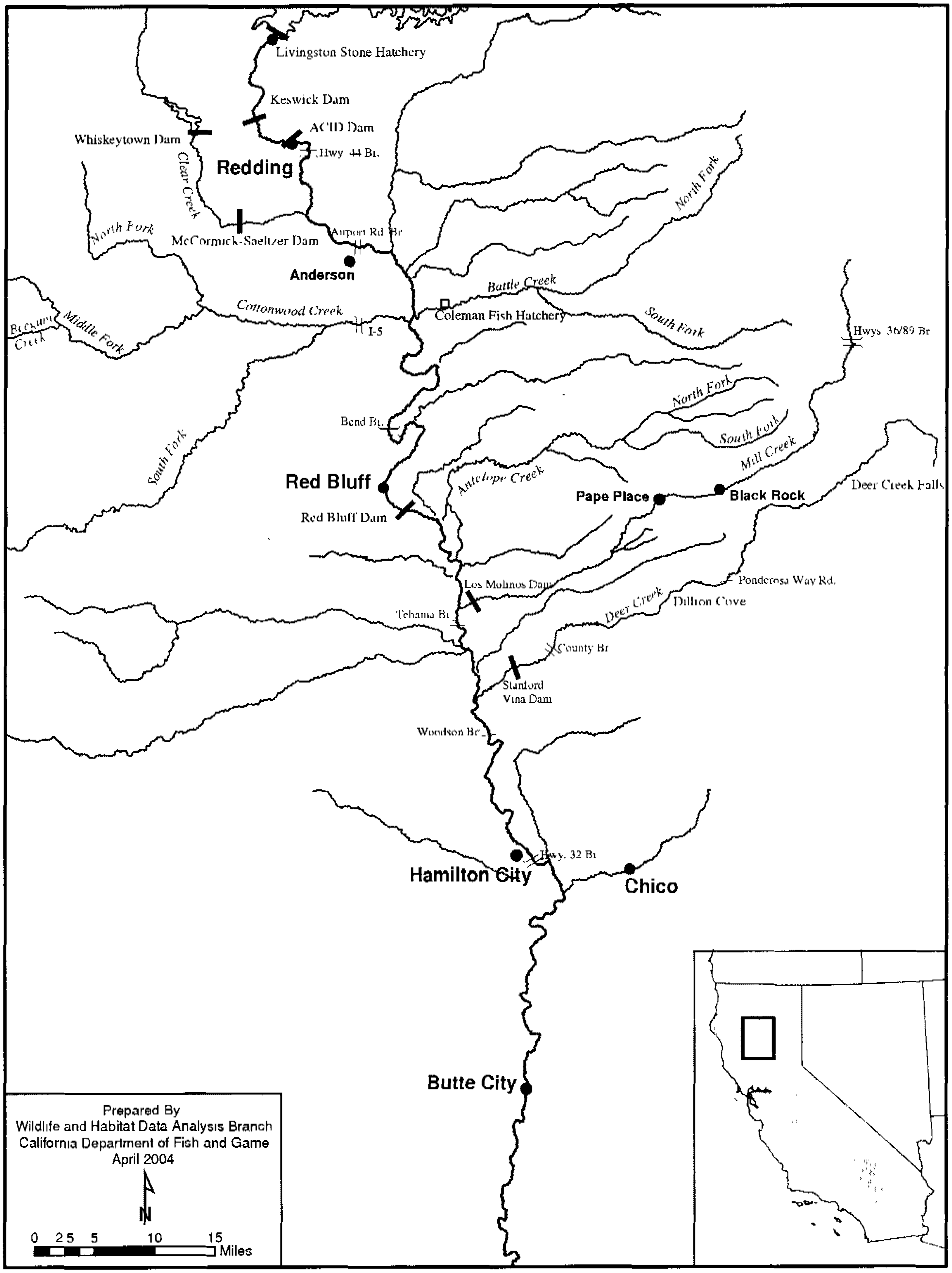

FIGURE 2. Sacramento River System from Keswick Dam downstream to Princeton Ferry.

Within the mark-and-recovery data for those carcasses classified as adults (FL > 65 cm [25.6 in]), 6,504 distinct carcasses were observed, of which 2,737 were marked and 926 subsequently recovered (Table 1), resulting in an estimate of 23,799 adult fish for the surveyed area. The adult estimate was expanded to include an approximately 1.21% grilse proportion, for a population of 24,087 salmon from ACID to Anderson River Park.

Three aerial surveys of the mainstem up- and downstream of RBDD were conducted from 1 February through 19 March 2002 (Table 2). Based on data from these surveys, approximately 66.9% of the late-fall-run spawning occurred within the mark-and-recovery area, and all of the redds were upstream of RBDD. The carcass survey population estimate was therefore expanded to 36,004 fish for the mainstem upstream of RBDD.

The late-fall population consisted of 38.1% male adults, 60.7% female adults, 0.7% male grilse (FL ≤ 65 cm), and 0.5% female grilse. This composition was based on 828 fresh carcasses examined during the mark-and-recovery surveys.

The 2002 late-fall-run population of 36,004 fish for the mainstem upstream of RBDD was almost twice that of the previous year, and 66% higher than the average for 1998, 2000, and 2001; for these years, estimates were also made from carcass survey and redd data (Appendix 3).

TABLE 1. Chinook salmon carcass mark-and-recovery data used to estimate the 2002 late-fall-run adult spawner population in the Sacramento River between the Anderson-Cottonwood Irrigation District Dam and Anderson River Park [1/].

Survey Period	Carcasses Recovered from Period																			Marked Carcasses Recovered		Carcasses Observed	Estimate for Period	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	(R_i) [2/]	(K_i) [3/]	(E_i) [4/]	(N1) [5/]	(D_i) [6/]
1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	369	6,949	5,943
2	29	--	--	--	--	--	--	-	--	--	--	--	--	--	--	--	--	--	--	29	12	965	--	2,912
3	8	16			--	--	--	--	--	--	--	--	--	--	-	--	--	-	--	24	22	600	-	1,133
4	3	13	52	.	--	--	--	--	-		--	--	--	-		--	--	--	--	68	16	186	-	809
5	1	1	32	92	--	--	--	--	--	-	--	--	--	--		--	--	--	--	126	55	800		397
6		4	4	31	57	--	--	--	--	--	--	--	--	--	--	--	--	-	--	96	47	470	--	681
7			1	7	23	38	--	-	--	--	--	--	--	--	--	--	--	-	--	69	34	448	--	757
8			3	3	7	16	33	-	--	--	--	--	--	--	--	--	--	-	--	62	14	509	--	1,263
9				2	1	1	6	21	--	-	--			--	--	--	--		--	31	46	307	--	101
10						1	2	28	42			--	--	-			-	--	--	73	25	909	-	1,166
11							1	10	4	36	--	--	--	--		--	--	--	-	51	35	438		733
12								4	1	10	53	--	--	.	--	--	--	-	-	68	56	421		154
13									4	12	23	53	--	--	--	--	--	--	--	92	33	365	--	276
14									1	3	7	11	30	--	--	--	--	-	--	52	30	200	--	137
15											5	4	9	16	--	--	--	-	--	34	18	133	--	87
16											1	1	8	5	7	--	.	--	--	22	7	96	--	163
17													1	1	3	2	--	-	-	7	8	61	-	28
18													1		1	3	3	--	--	8	6	50	--	47
19																1	2	1	--	4	6	31	--	67
20																2	1	3	4	10	-	72	--	
																			Total	926		7,430		
Total recovered (C_i)	41	34	92	135	88	56	12	63	52	61	89	69	49	22	11	8	6	4	4					
Total marked (T_i) [8/]	369	266	335	232	158	103	141	180	117	192	207	165	129	61	32	21	14	8	7	2,737 (Grand total marked)				
																				Jolly-Seber estimate [9/]:			**23,799**	

1/ Surveys were conducted from 17 December 2001 through 5 May 2002. Data shown from D. Killam, CDFG-NCNCR, Red Bluff office. Personal communication.
2/ Total recovered marked carcasses for the ith period
3/ Total marked carcasses recovered after the ith period, that were marked before the ith period
4/ Includes salmon carcasses which were marked, marked carcasses that were recovered, and unmarked carcasses that were chopped
5/ Number of carcasses in the population at the start of survey period 1
6/ Number of carcasses "joining" the population between periods i and $i + 1$
7/ Total recovered marked carcasses that were marked during the ith period
8/ Number of carcasses marked in the ith period
9/ $E = N_1 + D_1 + D_2 + ... D_i$ (Appendix 1C)

TABLE 2. Chinook salmon redd relative distribution observed during 2002 aerial surveys of the mainstem Sacramento River from Keswick Dam to Princeton Ferry.

	Late-fall run		Winter run		Spring run		Fall run	
River section	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/	489	26.8%	297	48.7%	4	3.8%	404	9.1%
A.C.I.D. Dam to Highway 44 Bridge	278	15.2%	134	22.0%	19	18.1%	276	6.2%
Highway 44 Bridge to Airport Road Bridge	452	24.8%	168	27.5%	25	23.8%	457	10.3%
Airport Road Bridge to Balls Ferry Bridge	452	24.8%	7	1.1%	22	21.0%	384	8.7%
Balls Ferry Bridge to Battle Creek	145	8.0%	3	0.5%	11	10.5%	330	7.5%
Battle Creek to Jellys Ferry Bridge	2	0.1%	0		22	21.0%	517	11.7%
Jellys Ferry Bridge to Bend Bridge	1	0.1%	0		2	1.9%	499	11.3%
Bend Bridge to Red Bluff Dam	4	0.2%	0		0		198	4.5%
Upstream proportion:		**100.0%**		**99.8%**		**100.0%**		**69.3%**
Red Bluff Dam to Tehama Bridge	0		1	0.2%	0		609	13.8%
Tehama Bridge to Woodson Bridge	0		0		0		366	8.3%
Woodson Bridge to Hamilton City Bridge	--		--		--		200	4.5%
Hamilton City Bridge to Ord Ferry Bridge	--		--		--		148	3.3%
Ord Ferry Bridge to Princeton Ferry	--		--		--		32	0.7%
Downstream proportion:				**0.2%**				**30.7%**
Total Redds:	**1,823**		**610**		**105**		**4,420**	

1/ Total count of new redds for three aerial surveys made from 1 February through 19 March 2002
2/ Total count of new redds for 13 aerial surveys made from 26 April through 20 August 2002
3/ Total count of new redds for two aerial surveys made on 4 & 26 September 2002
4/ Total count of new redds for four aerial surveys made from 10 October through 26 November 2002
5/ Anderson-Cottonwood Irrigation District Dam

Winter run. The winter-run spawner population was estimated through salmon carcass surveys in a portion of the Sacramento River mainstem, and aerial redd surveys of the entire mainstem. Carcass surveys covered the 22.5-km (14-mi) stretch from Keswick Dam downstream to the Redding Water Treatment Plant, and were conducted from 1 May through 27 August 2002 [3/]. The study area was divided into two equal-length reaches, which were surveyed on consecutive days starting with the upstream reach. After a one day pause the cycle was repeated, for 40 survey periods. Mean survey-period river flow averaged 320 m^3/s (11,300 cfs), ranging from 221 m^3/s to 425 m^3/s (7800 – 15,000 cfs). Mean survey-period temperature averaged 11.9 °C (53.4 °F), ranging from 10 °C to 13 °C (50 – 56 °F). Water clarity, measured by secchi disk, averaged 6.1 m (20 ft), ranging from 5.1 m to 6.7 m (17 – 22 ft).

Most of the surveys were conducted from two boats, each with two observers, and generally covered opposite shorelines out to the middle of the river. Efforts were made to assure adequate coverage of areas where carcasses were known to accumulate, and several short stretches of river were surveyed on foot.

Carcasses were categorized as being either fresh or decayed, and either from a fish of hatchery or natural origin. Fresh carcasses were those having firm flesh and at least one clear eye. A carcass of hatchery origin was identified by a missing adipose fin. Livingston Stone National Fish Hatchery (LSNFH) had been the exclusive winter-run salmon rearing facility in the upper Sacramento river system since 1998, and all of its juvenile fish were released with adipose fin-clips, and coded-wire tags (identifying their race, age, and origin) implanted in their snouts. It

[3/] Reavis, R.R., R.G. Titus, W.M. Snider, and J. Lyons. Upper Sacramento River Winter-run Chinook Salmon Escapement Survey, May - August 2002. CDFG, Habitat Conservation Division, Stream Evaluation Program. Technical Report No. 05-1.

was therefore assumed that any carcasses with adipose fins intact were winter-run salmon produced from in-river spawning.

For estimation of the spawner population, carcasses were marked with colored plastic ribbons attached with hog rings; colors identified the survey period that the carcass was marked. Fresh carcasses were tagged in the upper jaw, and decayed carcasses were tagged in the lower jaw. The exceptions were fresh hatchery-origin carcasses, which had the ribbon attached to the anterior portion of the backbone, since their heads were removed and saved for retrieval of the coded-wire tag. Length measurements, determination of gender, and female degree of egg retention were also recorded. Carcasses not marked, usually those in an advanced state of decay, were chopped in half. Marked carcasses were returned to flowing water near the location where they were originally found, in an attempt to simulate "natural" carcass dispersion. During subsequent surveys, previously marked carcasses that were recovered were also chopped.

The carcass processing protocols were intended to allow post-season distinction of age-class (adult or grilse, based on length), condition (fresh or decayed), and origin (hatchery or in-river), so the data could be better compiled for estimating the population through several biometric models. Analysis of the data indicated the Jolly-Seber model (Appendix 1.C) was the most appropriate.

A total of 4,959 salmon carcasses was observed, but only the mark-and-recovery data for those classified as adults (FL $\geq$ 55 cm [21.6 in] for females, and FL $\geq$ 69 cm [27.2 in] for males) were used to calculate the Jolly-Seber estimate. A total of 3,615 hatchery- and natural-origin adult carcasses (both fresh and decayed) was tagged and 2,114 of those were subsequently recovered (Table 3), resulting in an estimate of 6,663 adult fish in the surveyed area. The adult estimate was expanded to include an approximately 5.6% grilse proportion, for a population of 7,058 salmon from Keswick Dam to the Redding Water Treatment Plant.

Thirteen aerial surveys of the mainstem up- and downstream of RBDD were conducted from 26 April through 20 August 2002 (Table 2). Based on data from these surveys, approximately 95.9% of the winter-run spawning occurred within the survey area, and approximately 99.8% of the total redds were upstream of RBDD. The carcass survey population estimate was further expanded for an entire mainstem spawner population (7,360 fish), which was then proportioned to 7,348 fish for only the mainstem upstream of RBDD. In addition, a total of 104 fish (101 from Keswick Dam and three from RBDD traps) were transferred to the LSNFH winter-run broodstock program.

The winter-run population consisted of 17.6% male adults, 77.2% female adults, 4.5% male grilse (FL < 69 cm), and 0.7% female grilse (Fl < 55 cm). This composition was based on 1,753 fresh carcasses examined during the mark-and-recovery surveys.

The 2002 winter-run spawner population of 7,348 salmon in the mainstem upstream of RBDD was 9% lower than that of 2001 (Appendix 3); estimates previous to 2001 were determined from RBDD counts rather than carcass surveys.

Spring run. The spring-run mainstem spawner estimate was determined by methodology used since 1986, which involved expansion of sampling the salmon passage at RBDD during mid-May through mid-September. This interval was when the dam's gates were lowered, and its fishways were operable. Briefly, numbers of salmon counted weekly during discrete periods

Table 3. Chinook salmon carcass data used for the Jolly-Seber estimate of the 2002 winter-run adult spawner population in the Sacramento River between Keswick Dam and the Redding Water Treatment Plant [1/].

Number Recovered During Survey Period No.	Number Recovered From Survey Period No. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Total Recovery During Period	Total Carcasses Observed During Period [2]	Survey Period
1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	18	1
2	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	89	2
3	0	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	24	3
4	1	1	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	36	4
5	1	3	2	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	55	5
6	2	0	1	4	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	62	6
7	1	1	0	2	0	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	46	7
8	1	3	2	4	4	9	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	35	126	8
9		1		1	0	1	1	17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	21	64	9
10					3	0	1	14	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	30	127	10
11					1	0	1	7	5	27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	41	120	11
12					1	2	2	6	3	16	35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	65	149	12
13						0		1	1	7	9	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	42	132	13
14						2		2	1	2	3	5	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	38	156	14
15								1	1	2	1	2	10	38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	55	181	15
16								1	0		1	1	7	11	29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	50	212	16
17								1	1			3	2	7	16	50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	80	233	17
18													4	3	4	9	63	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	83	295	18
19													1	6	1	6	11	50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	75	303	19
20													0	0	3	3	4	12	90	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	112	284	20
21													1	0	0	0	3	5	11	37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	57	241	21
22														0	3	6	3	9	13	38	66	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	138	468	22
23														1	1	1	1	4	8	6	11	138	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	171	453	23
24																1	1	4	1	3	2	21	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	133	449	24
25																	1	5	0	0	5	4	13	51	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	79	305	25
26																		2	3	1	2	12	10	53	83	--	--	--	--	--	--	--	--	--	--	--	--	--	--	166	528	26
27																			2	3	3	5	10	12	17	120	--	--	--	--	--	--	--	--	--	--	--	--	--	172	502	27
28																				1	1	3	1	1	3	10	73	--	--	--	--	--	--	--	--	--	--	--	--	93	293	28
29																					1	2	2	5	7	13	28	46	--	--	--	--	--	--	--	--	--	--	--	104	325	29
30																					1	1	1	1	0	1	6	9	46	--	--	--	--	--	--	--	--	--	--	66	159	30
31																						1		0	9	2	7	9	5	20	--	--	--	--	--	--	--	--	--	53	151	31
32																								2	5	7	0	2	5	9	18	--	--	--	--	--	--	--	--	48	140	32
33																									1		0	0	2	2	1	10	--	--	--	--	--	--	--	16	35	33
34																											3	1	2	0	2	1	2	--	--	--	--	--	--	11	39	34
35																											1	1	4	2	1	2	3	2	--	--	--	--	--	16	36	35
36																												1	2	1	0	2	1	2	3	--	--	--	--	12	25	36
37																													1	0	0	0			0	0	--	--	--	1	10	37
38																													1	1	1	0			0		0	--	--	3	16	38
39																															1	2			0			0	--	3	8	39
40																																			1				0	1	7	40
Total Recovery From Period	10	10	8	15	17	19	17	50	24	54	49	35	48	66	57	76	87	91	128	89	92	187	137	125	125	153	118	69	68	35	24	17	6	4	4	0	0	0	0	GRAND TOTALS 2114	6902	
Total Carcasses Tagged From Period	18	25	14	22	35	32	32	78	36	86	66	71	85	97	108	136	145	182	203	161	161	299	225	245	190	251	202	120	128	63	43	20	9	12	6	1	4	2	2	3615		

1/ Surveys were conducted from 1 May through 27 August 2002

2/ Includes carcasses that were marked, previously marked carcasses that were recovered, and carcasses chopped were adjusted for unsampled periods, then apportioned to an individual run. The total of a run's adjusted counts was further expanded using historical distributions of migration past RBDD. For the spring run this distribution was an average run timing from year-round samplings during 1970-1988. Expansion to include passage during the gates-up period in 2002 assumed that the total adjusted count represented the same proportion of the run as the period's historical distribution.

Mainstem-only spawner populations were typically calculated by removing numbers harvested in the sport fishery and populations in upstream tributaries from a run's total estimated RBDD passage. Sport-caught salmon were estimated from angler census surveys conducted by CDFG upstream of RBDD. Upper Sacramento River system tributary populations included estimated numbers in streams which were surveyed and counts made at upstream hatcheries.

An estimated 608 salmon with spring-run characteristics passed RBDD in 2002 [4/]; 81% of this estimate was derived from actual counts at the dam (Table 4). It was assumed that no spring-run salmon were caught in the sport-fishery upstream of RBDD due to an angling closure in effect from 15 January through 16 July. A total of 335 fish, which were considered to be of this run, was accounted for in Cottonwood, Clear, and Battle creeks. The remaining 273 salmon may have spawned in the mainstem 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.

Based on 133 spring-run salmon sampled at RBDD, the run consisted of 89% adults and 11% grilse.

Fall run. The fall-run spawner population was estimated through salmon carcass surveys conducted in a portion of the mainstem, and aerial redd surveys of the entire mainstem. Weekly carcass surveys were conducted from 1 October through 18 December 2002, covering the 11.5-km (18.5 mi) stretch of the mainstem from ACID downstream to the mouth of Cow Creek [5/]. This stretch of river was covered in three separate reaches, each surveyed on one day; during the initial survey, coverage extended upstream of ACID to Keswick Dam. Mean weekly river flows ranged from 119 m^3/s to 212 m^3/s (4200-7500 cfs); flows were over 170 m^3/s (6000 cfs) during the first half of the survey period. Water clarity, measured by secchi disk, had weekly averages for most of the survey ranging from 5.5 m to 6.7 m (18-22 ft). A storm caused turbid conditions during the final period, when visibility decreased to 0.6 m (2 ft). Mean weekly water temperatures in the survey area ranged from 11.7 °C to 13.3 °C (53-57 °F).

Salmon carcasses were marked with colored ribbon attached to their jaws with hog rings; for

---

[4/] Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002. File Report. June 2004. CDFG-Northern California-North Coast Region (NCNCR), Red Bluff Office.

[5/] Reavis, R.R., R.G. Titus, W.M. Snider, and J. Lyons. Upper Sacramento River Fall-run Chinook Salmon Escapement Survey, September-December 2002. CDFG, Habitat Conservation Division, Stream Evaluation Program. Technical Report No. 05-02.

TABLE 4. Estimation of 2002 winter-, spring- and fall-run Chinook salmon spawners passing Red Bluff Diversion Dam (RBDD).

	Fishway trapping observations							Calculated No. salmon passing dam			
Week No of RBDD operation [1/]	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	17	3	0	20	85.0	15.0	0.0	496	422	74	0
21	18	12	0	30	60.0	40.0	0.0	283	170	113	0
22	22	9	0	31	71.0	29.0	0.0	117	83	34	0
23	35	21	0	56	62.5	37.5	0.0	187	117	70	0
24	126	35	70	231	54.5	15.2	30.3	586	320	89	178
25	66	33	109	208	31.7	15.9	52.4	349	111	55	183
26	12	11	74	97	12.4	11.3	76.3	303	37	34	231
27	17	1	47	65	26.2	1.5	72.3	192	50	3	139
28	13	8	40	61	21.3	13.1	65.6	147	31	19	96
29	11	0	161	172	6.4	0.0	93.6	524	34	0	490
30	5	0	281	286	1.7	0.0	98.3	2225	39	0	2,186
31	0	0	322	322	0.0	0.0	100.0	824	0	0	824
32	0	0	62	62	0.0	0.0	100.0	281	0	0	281
33	0	0	460	460	0.0	0.0	100.0	2487	0	0	2,487
34	0	0	445	445	0.0	0.0	100.0	2984	0	0	2,984
35	0	0	216	216	0.0	0.0	100.0	3120	0	0	3,120
36	0	0	258	258	0.0	0.0	100.0	8797	0	0	8,797
37	0	0	165	165	0.0	0.0	100.0	16448	0	0	16,448
Totals	342	133	2,710	3,185			Totals [5/]:	40,350	1,413	492	38,445
					Portion of each run represented by calculated No. of fish [6/]				15.43%	80.99%	24.88%
						ESTIMATED TOTAL 2002 RUN [7/]:			**9,157**	**608**	**154,540**

1/ Covers the period from 15 May through 15 September 2002, 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.
7/ Calculated total for period of gates-in ÷ Proportion of run represented = Run size of spawners migrating past RBDD.

each week a different color was used. Carcasses that were not marked included those that were headless, those on shore in a "leathery" condition, those at the downstream end of the survey area which would have drifted out of the area, and those that were in excess of what could be processed in a day. 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. Length measurements and determination of gender were made for a subsample of fresh carcasses (those with a clear eye or pink gills).

A total of 6,662 carcasses was observed, but only the mark-and-recovery data for fresh, adult carcasses were used in the Schaefer (Appendix 1.B) calculation; the adult distinction was a FL > 72 cm [28.3 in] for males, and FL > 68 cm [26.8 in] for females. From a total of 1,414 carcasses marked, and 500 subsequently recovered, an adult population of 18,347 fish was estimated (Table 5). This estimate was expanded to include an approximately 6.9% grilse proportion, for a population of 19,707 salmon for the mainstem between ACID and Cow Creek.

Four aerial surveys of the mainstem up- and downstream of RBDD were conducted from 10 October through 26 November 2002 (Table 2). Based on data from these surveys, approximately 30% of the fall-run spawning occurred within the mark-and-recovery area, and 69.3% of the total redds were upstream of RBDD. The carcass survey population estimate was

TABLE 5 Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run adult spawner population in the Sacramento River from Anderson-Cottonwood Irrigation District Dam to the confluence with Cow Creek [1/]

Recovery period (j)	Number of marked carcasses recovered from marking period (i).										Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) [2/]	Population estimate (N) [3/]
	1	2	3	4	5	6	7	8	9	10			
2	14	--	--	--	--	--	--	--	--	--	14	493	1,748
3	6	44	--	--	--	--	--	--	--	--	50	747	2,022
4	2	12	56	--	--	--	--	--	--	--	70	964	3,177
5	0	2	12	75	--	--	--	--	--	--	89	1,106	3,308
6	0	1	3	18	45	--	--	--	--	--	67	741	2,479
7	0	0	0	7	16	46	--	--	--	--	69	675	1,630
8	0	0	0	0	4	11	30	--	--	--	45	655	1,339
9	0	0	0	0	0	4	8	23	--	--	35	416	955
10	0	0	0	0	0	0	4	6	20	--	30	428	1,114
11	0	0	0	0	0	0	0	5	7	18	30	501	1,467
12	0	0	0	0	0	0	0	0	0	1	1	143	444
Total recovered (Ri)	22	59	71	100	65	61	38	23	0	0			
Total carcasses marked (Mi)	78	153	244	293	229	119	79	85	75	59		Total estimate:	19,683
												Adjusted estimate [4/]:	**18,347**

1/ Surveys were conducted from 1 October through 18 December 2002

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

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

4/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate (19,683 - 1,336 = 18,347)

therefore expanded to an entire mainstem spawner population (65,690 fish), which was then proportioned to 45,523 fish for only the mainstem upstream of RBDD.

The fall-run population consisted of 36.1% male adults, 57.2% female adults, 5.5% male grilse (FL $\leq$ 72 cm), and 1.2% female grilse (FL $\leq$ 68 cm). This composition was based on 1,182 fresh carcasses examined during the mark-and-recovery surveys.

The 2002 fall-run spawner population of 45,523 salmon in the mainstem upstream of RBDD was 21% lower than that of 2001 (Appendix 3). Although it was also 26% lower than the population average for 1992-2001, the estimates prior to 2001, ranging from 5,718 to 133,365 fish, were determined from RBDD counts rather than carcass surveys.

Clear Creek

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

Spring run. Snorkeling surveys of Clear Creek were conducted by the USFWS once during each month from April through November; additional surveys were made in September and October [6/]. The 26.4-km (16.4-mi) stretch downstream from Whiskeytown Dam was covered in six reaches on consecutive days. Based on the number of live fish observed during the August survey, which was regarded as an index of annual adult abundance, the spring-run spawner population was judged to be 66 salmon.

[6/] Newton, J.M., and M.R. Brown. 2004. Adult Spring Chinook Salmon Monitoring in Clear Creek, California, 1999-2002. USFWS Report. Red Bluff Fish and Wildlife Office, Red Bluff, California.

Fall run. Nine spawner surveys of Clear Creek were conducted during 7 October through 2 December 2002, in the 6.7-km (4.2-mi) stretch downstream of the McCormick-Saeltzer Dam site [7/]. Salmon carcasses were marked by attaching colored tags to their jaws with hog rings, and replacing them back into running water for recovery during following surveys; different tag colors 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 16,071 fish (Table 6).

Based on examination of 6,117 salmon carcasses, the fall-run spawner population of Clear Creek consisted of 47% male adults (FL ≥ 61 cm [24 in.]), 51% female adults, and 2% grilse (FL < 61 cm).

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

TABLE 6. Chinook salmon carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population of Clear Creek in the reach 4.2 miles downstream of McCormick-Saeltzer Dam [1/].

Recovery	Number of marked carcasses recovered from marking period (i).								Total marked carcasses recovered	Total carcasses observed	Population estimate
	7-Oct	15-Oct	21-Oct	28-Oct	4-Nov	11-Nov	18-Nov	25-Nov	(R_J)	(C_J) [2/]	(N) [3/]
15-Oct	5	--	--	--	--	--	--	--	5	391	1,108
21-Oct	5	47	--	--	--	--	--	--	52	828	1,820
28-Oct	2	17	49	--	--	--	--	--	68	1,823	4,719
4-Nov		5	11	71	--	--	--	--	87	1.287	3,417
11-Nov			1	32	40	--	--	--	73	1,056	3,129
18-Nov				3	9	27	--	--	39	538	1,386
25-Nov				3	5	22	6	--	36	376	977
2-Dec					2	7	13	8	30	182	511
Total recovered (Ri)	12	69	61	109	56	56	19	8			
Total carcasses marked (Mi)	34	147	167	292	179	132	56	23		Total estimate	17,067
										Adjusted estimate [4/]:	**16,071**

1/ Surveys were conducted from 7 October through 2 December 2002

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/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate (17,067 - 996 =16,071)

Cottonwood Creek

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

Spring run. Beegum Creek, a tributary to Cottonwood Creek, was surveyed monthly during March through November 2002 [7/]. The 12.2-km (7.5-mi) stretch of the creek from upstream of the North and South forks' confluence to the Hwy-36 Bridge crossing was covered by snorkeling. A total of 125 salmon was counted, and judged to constitute the 2002 spring run

[7/] Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002. File Report. June 2004. CDFG-NCNCR, Red Bluff Office.

for the Cottonwood Creek system; water temperatures in the upper 70-degree Fahrenheit may have reduced the number of actual spawners.

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

Battle Creek

Late-fall run. The USFWS monitored fish passage at the Coleman National Fish Hatchery (CNFH) barrier weir with live trapping during 1 March through 27 May 2002, and subsequently with underwater videography through 30 August 2002 [8/]. It was estimated that 33 late-fall-run adult salmon passed upstream of the barrier weir, but a complete estimate of the natural spawner population for that area could not be determined.

Prior to the monitoring period, upstream passage was blocked and the weir had directed 2,669 salmon into CNFH [9/]. These fish consisted of 44% male adults, 49% female adults, and 7% grilse.

Winter run. Based on the USFWS fish passage monitoring conducted during 1 March through 30 August 2002 at the CNFH barrier weir, it was estimated that three winter-run adult salmon passed upstream of the barrier weir [8/]. However, surveys for this run were not conducted in the upstream area, and so an estimate of the natural spawner population could not be made.

Spring run. Based on USFWS fish passage monitoring conducted during 1 March through 30 August 2002 at the CNFH barrier weir, it was estimated that 144 spring-run adult salmon passed upstream of the barrier weir [8/]. Since the monitoring period covered the entire spring-run migration, it was judged that this estimate constituted the Battle Creek spring-run population for 2002.

Fall run. Carcass surveys were conducted during 10 October through 21 November 2002, covering the 2.6-km (1.6-mi) stretch of river from Jelly's Ferry Road bridge downstream to the old hatchery location [10/]. The surveyed reach was shorter than in past seasons, in order to adequately sample the large number of carcasses that were anticipated. Salmon carcasses were marked by attaching colored tags 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 the surveyed section was estimated to be 87,373 fish (Table 7). This

---

[8/] Brown, M.R., N.O. Alston, and J.M. Newton. Monitoring Adult Chinook Salmon, Rainbow Trout, and Steelhead in Battle Creek, California, from March through November 2002. USFWS report. Red Bluff Fish and Wildlife Office.

[9/] Niemela, K. USFWS, Red Bluff Fish and Wildlife Office. Personal communication.

[10/] Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002. File Report. June 2004. CDFG-NCNCR, Red Bluff Office.

estimate was expanded to account for spawners outside of the mark-and-recovery area. In past years, when surveys extended farther upstream to CNFH, an average of approximately 22% of the observed carcasses were downstream of Jelly's Ferry Road. It was therefore assumed that the entire 2002 in-river population was 397,149 fish. Combined with an additional 66,147 fish which entered CNFH, the total Battle Creek fall-run population was 463,296 salmon (Appendix 2). Although the creek upstream of CNFH was not surveyed, some fall-run adults may have passed the barrier dam.

Based on examination of 18,257 salmon carcasses, the in-river fall run consisted of 43% male adults (FL $\geq$ 61 cm [24 in.]), 55% female adults, and 2% grilse (FL<61 cm). In comparison, fall-run fish entering CNFH consisted of 65% male adults, 29% female adults, and 6% grilse.

Pre-spawning mortality of female fall-run salmon in Battle Creek averaged 88% in 2002.

The 2002 fall-run spawner population in Battle Creek of 463,296 fish was over three times higher than in 2001 (Appendix 3), and the highest ever recorded.

TABLE 7. Chinook salmon carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in Battle Creek from Jelly's Ferry Road to the old hatchery location.

Recovery period (j)	Number of marked carcasses recovered from marking period (i):						Total marked carcasses recovered	Total carcasses observed	Population estimate
	10-Oct	17-Oct	22-Oct	30-Oct	5-Nov	14-Nov	(R_j)	(Cj) 1/	(N) 2/
17-Oct	50	--	--	--	--	--	50	3,921	8,241
20-Oct	8	111	--	--	--	--	119	5,627	13,118
30-Oct	1	4	29	--	--	--	34	4,321	28,711
5-Nov	0	0	4	23	--	--	27	2,101	7,737
14-Nov	0	0	0	1	4	--	5	1,678	27,196
21-Nov	0	0	0	3	0	5	8	764	3,067
Total recovered (R_i)	59	115	33	27	4	5			
Total carcasses marked (M_i)	124	270	244	82	78	23		Total estimate	88,070
							Adjusted estimate 3/:		**87,373**

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

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

3/ 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 (88,070 - 697 = 87,373).

A total of 26,617 Chinook salmon spawners, consisting of 22,778 fall-, 3,827 spring-, and 12 winter-run fish, was estimated for 2002 in the Sacramento River system between Red Bluff and Princeton Ferry (Figure 2).

Sacramento River Mainstem [11/]

Estimates of salmon spawner populations in the Sacramento River mainstem downstream of RBDD were derived from the upstream mainstem population estimates and from aerial redd counts for the entire mainstem. 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. Three aerial surveys were conducted during 1 February through 19 March 2002. No late-fall-run spawning was observed downstream of RBDD (Table 2), and it was assumed that there were no spawners of this run in that area.

Winter run. Based on 13 aerial surveys conducted during 26 April through 20 August 2002, winter-run redds downstream of RBDD constituted about 0.2% of the total mainstem spawning (Table 2). This was estimated to represent a spawner population of 12 fish.

Spring run. Aerial surveys were conducted on 4 and 26 September 2002. Spring-run redds were not observed downstream of RBDD (Table 2), and it was assumed that there were no spawners of this run in that area.

Fall run. Based on four aerial surveys conducted during 10 October through 26 November 2002, fall-run redds downstream of RBDD constituted about 30.7% of the total mainstem spawning (Table 2), which was estimated to represent a spawner population of 20,167 fish. This estimate was 16% higher than that in 2001, and was 52% higher than the population average for 1992 to 2001 (Appendix 3).

Antelope Creek

Spring run. A snorkeling-survey of the holding habitat of adult spring-run salmon in the upper Antelope Creek system was made on 22 July 2002 [12/]. A total stream length of 23.5 km

---

[11/] Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002. File Report. June 2004. CDFG-Northern California-North Coast Region (NCNCR), Red Bluff Office.

[12/] Harvey-Arrison, C. Memorandum to files. 20 August 2002. CDFG – NCNCR, Red Bluff Office.

(14.6 mi) was covered, from Facht Place on the mainstem upstream, to Judd Creek on the North Fork, and into sections of the south fork to South Antelope Gun Club. A total of 46 adult salmon was observed, and judged to be the 2002 spring run for this system; no salmon were seen in either the North or South forks.

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

Mill Creek

Spring run. Surveys of Upper Mill Creek covered a stream length of approximately 66 km (41 mi) from the Hwy-36 Bridge crossing downstream to the steel tower transmission line crossing located 4.8 km (3 mi) downstream from Little Mill Creek [13/]. The reach from Hwy-36 to the ranch house downstream of Black Rock was surveyed from the ground during 30 September through 15 October 2002, while an aerial survey was made from Black Rock to the powerlines on 26 September. Totals of 254 live fish, 60 carcasses, and 797 redds were observed. Based on the redds seen during the combined ground and aerial surveys, the total counted was determined to be the maximum number present, and judged to represent a spring-run population of 1,594 fish.

Fall run. Five spawner surveys of Mill Creek were made during 6 November through 4 December 2002 between the Upper Diversion Dam and the confluence with the Sacramento River [14/]. Salmon carcasses were marked by attaching colored tags to their jaws with hog-rings and replacing the fish back into running water for recovery during following surveys. No surveys were made upstream of the Upper Dam for spawning fall-run salmon. Using fresh carcass mark-and-recovery data with the Schaefer model (Appendix 1.B), the spawner population in Mill Creek was estimated to be 2,611 fish (Table 8).

The composition of fall-run salmon in Mill Creek was 53% male adults (FL $\geq$ 61cm, [24 in], 40% female adults and 7% grilse (FL < 61cm), based on an examination of 1,671 carcasses. Pre-spawning mortality of female salmon in Mill Creek this season averaged 3%.

Deer Creek

Spring run . Snorkeling surveys of upper Deer Creek were conducted on 6 and 12 August 2002 covering the 40-km (25-mi) stretch from Upper Deer Creek Falls downstream to Dillon Cove [15/]. A total of 2,185 adult salmon was counted, and judged to be the 2002 spring run

---

[13/] Harvey-Arrison, C. Mill Creek Spring-run Chinook Salmon Surveys for 2002. Memorandum to files. 10 December 2002. CDFG – NCNCR, Red Bluff Office.

[14/] Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002. File Report. June 2004. CDFG-Northern California-North Coast Region (NCNCR), Red Bluff Office.

[15/] Harvey-Arrison, C. 2002 Annual Deer Creek Adult Spring-run Chinook Salmon Survey. Memorandum to files. 3 September 2002. CDFG – NCNCR, Red Bluff Office.

TABLE 8. Chinook salmon carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in Mill Creek from the Upper Diversion Dam to the Sacramento River.

Recovery period (j):	Number of marked carcasses recovered from marking period (i):				Total marked carcasses recovered	Total carcasses observed [1/]	Population estimate [2/]
	6-Nov	13-Nov	20-Nov	26-Nov	(Rj)	(Cj)	(N)
13-Nov	10	--	--	--	10	440	660
20-Nov	12	34	--	--	46	608	952
26-Nov	6	10	21	--	37	350	612
4-Dec	4	7	27	11	49	345	572
Total recovered (Ri)	32	51	48	11			
Total carcasses marked (Mi):	48	81	91	13		Total estimate:	2,796
						Adjusted estimate [3/]:	**2,611**

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

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

3/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate (2,796 - 185 = 2,611)

in this tributary.

Fall run. Surveys were conducted in Deer Creek on 19 and 27 November 2002 to determine spawning distribution, covering the stretch from Leninger Road bridge to the Hwy-99 crossing [16/]. A total of 34 salmon carcasses was observed, but an estimate of the fall-run population was not made.

Thomes Creek

Spring run. Snorkeling surveys were conducted in two sections of the Thomes Creek Gorge upstream of Paskenta on 14 May and 12 June 2002 [17/]. A total of two salmon was observed, one during each survey. These may have been the same fish, although turbid water conditions prevented adequate visibility.

[16/] Killam, D. and C. Harvey-Arrison. Chinook Salmon Spawner Populations for the Upper Sacramento River System, 2002. File Report. June 2004. CDFG-Northern California-North Coast Region (NCNCR), Red Bluff Office.

Big Chico Creek to the American River

A total of 301,314 Chinook salmon was estimated for 2002 in the Sacramento River tributaries from Big Chico Creek to the American River (Figure 3). This total consisted of 288,340 fall-run and 12,974 spring-run fish.

Big Chico Creek

Spring run. A snorkeling survey was conducted on 8 August 2002 in the stretch of Chico Creek from Higgin's Hole downstream to Salmon Hole in Bidwell Park [17/]. No salmon were seen and it was judged that spring-run spawners did not hold in this tributary in 2002.

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

Butte Creek

Spring run. A snorkeling survey was conducted during 12-16 August 2002 covering the stretch from Quartz Bowl downstream to Parrott-Phelan Diversion Dam [18/]. Total counts of live salmon by four independent observers ranged from 6,763 to 10,721 fish. All of the salmon observed were upstream of the covered bridge. Based on these surveys, a population of 8,785 spring-run salmon were in the creek.

Fall run. Carcass surveys for fall-run salmon in Butte Creek covered the approximately 15.3-km (9.5-mi) stretch of river from Parrott-Phelan Diversion Dam downstream to Gorrill Ranch Dam, and a 0.8-km (0.5-mi) section near the Western Canal Siphon (Ward et. al. 2004). Surveys were conducted during 21 October through 12 December 2002. Fresh salmon carcasses (those with at least one clear eye and firm flesh) were marked by attaching colored ribbon to their lower jaws with hog rings, and replaced into running water near the location originally found. Different colors of marks were used to identify carcasses with distinct marking periods. Carcasses that were not marked were chopped in half, as were recoveries of previously marked ones.

Using carcass mark-and-recovery data with the Schaefer model (Appendix 1.B), the spawner population in Butte Creek between Parrot-Phelan Dam and Gorrill Dam was estimated to be 4,300 fish (Table 9). In addition, it was judged that an additional 250 salmon were upstream of Parrott-Phelan Dam (from limited observations made there), for a total of 4,550 fish in the fall run.

[17/] Garmin, C. Big Chico Creek Adult Escapement Estimate. Memorandum to files. 20 August 2002. CDFG-Sacramento Valley and Central Sierra Region (SVCSR), Chico office.

[18/] Garmin, C. Butte Creek Spring-run Chinook Salmon Spawning Escapement Survey, 2002. Memorandum to files. 4 September 2002. CDFG – SVCSR, Chico office.

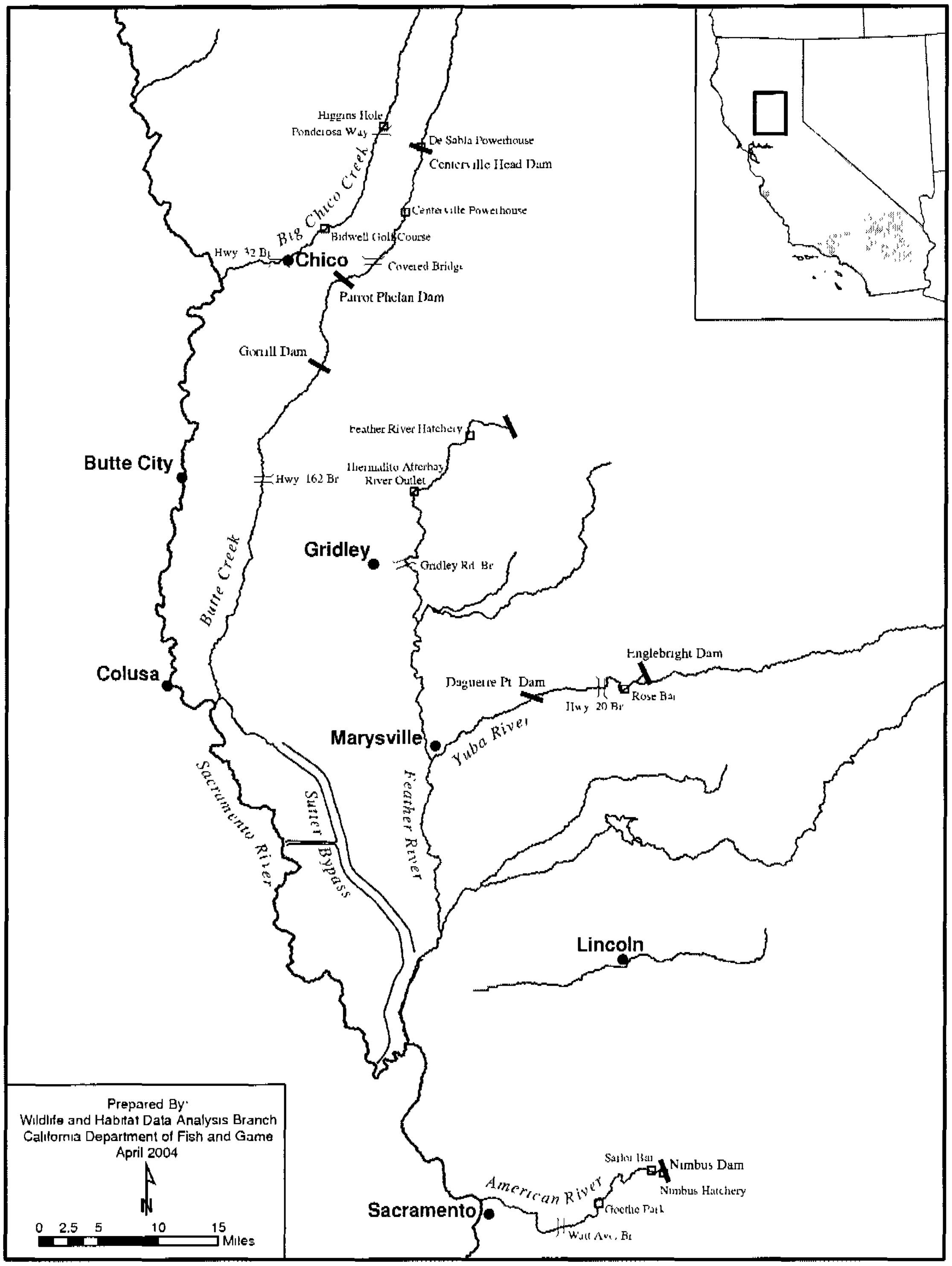

Figure 3. Sacramento River System from Big Chico Creek to the American River.

TABLE 9. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in Butte Creek from Parrott-Phelan Dam to Gorrill Dam [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	0	--	--	--	--	--	--	0	7	7
3	3	1	--	--	--	--	--	4	22	47
4	0	1	3	--	--	--	--	4	81	152
5	1		2	22	--	--	--	25	258	353
6			29	9	0	--	--	38	626	1,392
7				3	4	0	--	7	252	2,237
8				3	0	1	2	6	73	233
9							0	0	44	44
Total recovered (Ri)	4	2	34	37	4	1	2			
Total carcasses marked (Mi)	6	8	40	51	51	8	7		Total estimate	4,465
									Adjusted estimate [4/]:	**4,300**

1/ Surveys were conducted from 21 October through 12 December 2002

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/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate (4,465 - 165 = 4,300)

Feather River

Spring run. A total of 4,189 salmon classified as spring-run fish entered Feather River Hatchery (FRH) during 3-15 September 2002 [19/]. These fish consisted of 53% male adults, 42.1% female adults, and 4.9% grilse. In the river itself, no attempt was made to estimate numbers of spring-run salmon.

The 4,189 spring-run salmon at FRH in 2002 was 3% higher than in 2001, and 15% lower than the average for 1992-2001 (Appendix 3).

Fall run. Salmon carcass mark-and-recovery surveys were conducted in the Feather River between the hatchery barrier dam and Gridley Road bridge during 3 September through 20 December 2002 [20/]. This stretch of river was surveyed in two sections, upstream (Section 1) and downstream (Section 2) of Thermalito Afterbay Outlet. Carcasses were marked with colored flagging, identifying them with a specific marking period, and released into flowing water for later recovery. Carcasses not marked were counted and then chopped in half, as were those that were recovered with marks.

Schaefer (Appendix 1.B) estimates, calculated from the mark-and-recovery data, were 70,879 salmon for Section 1, and 34,101 fish for Section 2 (Table 10). Combining both estimates, along with an additional 183 carcasses counted during the initial survey week, resulted in a total in-

---

19/ Kastner, A. CDFG – SVCSR, Feather River Hatchery. Personal communication.

20/ Cavallo, B., Thompson, A., Kindopp, J., Kurth, R., and Seesholtz, A. Summary of 2002 Feather River Salmon Spawning Escapement Surveys. File report. 14 August 2003. California Department of Water Resources, Division of Environmental Services, Sacramento.

TABLE 10. Chinook salmon carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the Feather River from the hatchery barrier dam to Gridley [1/].

SECTION 1 Feather River Hatchery Barrier Dam to Thermalito Afterbay Outlet

Recovery	Number of marked carcasses recovered from marking period (i)															Total marked carcasses recovered	Total carcasses observed	Population estimate (N)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	(R_j)	(C_j) [2/]	[3/]
2	29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	29	199	427
3	3	27	--	--	--	--	--	--	--	--	--	--	--	--	--	30	468	1 255
4	1	4	90	--	--	--	--	--	--	--	--	--	--	--	--	95	1,479	2 995
5	1		30	336	--	--	--	--	--	--	--	--	--	--	--	367	2,935	5,485
6			2	102	376	--	--	--	--	--	--	--	--	--	--	480	5,768	10,614
7			2	13	71	298	--	--	--	--	--	--	--	--	--	384	5 981	13,321
8				4	17	77	360	--	--	--	--	--	--	--	--	458	7,581	15 111
9					3	7	50	438	--	--	--	--	--	--	--	498	6,009	11 182
10					1		13	82	403	--	--	--	--	--	--	499	4 032	7 851
11							1	6	64	191	--	--	--	--	--	262	1,560	3,533
12								2	5	67	109	--	--	--	--	183	1,298	2 745
13								0		19	26	52	--	--	--	97	772	1 929
14								1			2	20	30	--	--	53	379	1 000
15												2	2	18	--	22	99	279
16														2	2	4	33	179
Total recovered (R_i)	34	31	124	455	468	382	424	529	472	277	137	74	32	20	2			
Total carcasses marked (M_i)	73	85	247	845	963	873	818	976	929	659	269	208	83	57	16		Total estimate	77 907
																	Adjusted estimate [4/]	**70,879**

SECTION 2 Thermalito Afterbay Outlet to Gridley Bridge

Recovery period (j)	Number of marked carcasses recovered from marking period (i)															Total marked carcasses recovered	Total carcasses observed	Population estimate (N)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	(R_j)	(C_j) [2/]	[3/]
2	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	54	378
3		1	--	--	--	--	--	--	--	--	--	--	--	--	--	1	53	1,431
4			3	--	--	--	--	--	--	--	--	--	--	--	--	3	123	1 066
5				1	--	--	--	--	--	--	--	--	--	--	--	1	107	1,766
6				1	7	--	--	--	--	--	--	--	--	--	--	8	220	1,296
7					1	6	--	--	--	--	--	--	--	--	--	7	416	2,622
8						2	29	--	--	--	--	--	--	--	--	31	792	3 145
9							3	27	--	--	--	--	--	--	--	30	647	2 723
10							1	11	27	--	--	--	--	--	--	39	1,205	5,046
11								3	10	70	--	--	--	--	--	83	1,574	5 045
12								1	3	22	84	--	--	--	--	110	2,041	5 330
13								0		1	22	49	--	--	--	72	937	3,154
14								0			6	11	19	--	--	36	499	1 754
15								1				2	4	7	--	14	190	755
16												1			1	2	26	153
Total recovered (R_i)	2	1	3	2	8	8	33	43	40	93	112	63	23	7	1			
Total carcasses marked (M_i)	14	27	26	33	35	53	125	183	167	281	272	239	85	29	8		Total estimate	35 664
																	Adjusted estimate [6/]:	**34,101**

1/ Surveys were conducted from 3 September through 19 December 2002
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/ 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 (77,907 - 7,028 = 70,879)
5/ Adjusted estimate where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (35,664 - 1,563 = 34,101)

river population of 105,163 fish. A total of 20,507 fall-run salmon entered FRH [13/], bringing the 2002 fall run in the Feather River to 125,670 salmon (Appendix 2).

The composition of fall-run salmon in the river was 38.1% male adults (FL ≥ 68 cm [26.8 in]), 51.6% female adults, and 10.3% grilse (FL < 68 cm). Salmon which entered FRH consisted of 47.2% male adults (FL ≥ 61 cm [24 in]), 38.2% female adults, and 14.6% grilse (FL < 61 cm).

The 2002 total Feather River population of 125,670 salmon was 38% lower than in 2001, and almost 80% higher than the average for 1992-2001 (Appendix 3); 1998 and 1999 populations are not included in the average as in-river estimates were not possible for those years.

Yuba River

Spring run. Surveys were conducted to determine the extent of spring-run salmon spawning during 29 August through 20 September 2002 [21/]. The approximately 16-km (10-mi) stretch from the Narrows pool downstream to Daguerre Point Dam was covered in four reaches, surveyed during two days each week. A total of 239 new redds was counted for the period, but an estimate of the spawner population was not made.

Fall run. Salmon carcass mark-and-recovery surveys for this run during 2002 were conducted in the Yuba River from the Narrows downstream to Simpson Lane bridge in Marysville [22/]. The surveyed reach was covered in three sections: the Narrows 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 upstream of the Narrows to Englebright Dam, although suitable habitat is scarce in that area. Weekly surveys were conducted in Section 1 during 1 October through 10 December, in Section 2 during 2 October through 11 December, and in Section 3 from 10 October through 12 December.

Yuba River flows below Englebright Dam ranged from 18.3 m^3/s to 25.3 m^3/s (647-893 cfs) during the survey periods, and remained relatively stable throughout the spawning season. Flows near Marysville ranged between 11.6 m^3/s and 18.6 m^3/s (410-657 cfs). The mean daily water temperature ranged from the middle 60-degree to lower 40-degree Fahrenheit, while visibility through the water averaged 3.3 m (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 length frequency data from previous seasons' samplings.

Marking consisted of colored flagging attached to the fish's lower 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. Non-fresh carcasses and recovered marked carcasses were counted and then chopped in half. Length measurements and determination of gender were made for fresh adult carcasses.

Using carcass mark-and-recovery data with the Schaefer model (Appendix 1.B), estimates of 7,051 adults and 1,232 grilse were calculated for Section 1 (Table 11), 6,842 adults and 2,080 grilse in Section 2 (Table 12), and 4,862 adults and 1,984 grilse in Section 3 (Table 13). Combining these estimates gave 24,051 total salmon as the 2002 Yuba River population.

[21/] Drury, I. 2002 Spring-run Chinook Salmon Spawning Survey. Memorandum to files. CDFG-SVCSR, Rancho Cordova office.

[22/] Jones & Stokes. 2002 Fall-run Chinook Salmon Spawning Escapement in the Yuba River. Report to the Yuba County Water Agency, Marysville, CA. June 2003. J&S 00-402.

TABLE 11. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the Yuba River from the Narrows to Parks Bar (Section 1).

ADULT ESTIMATE

Recovery period (j)	Number of marked carcasses recovered from marking period (i)										Total marked carcasses recovered	Total carcasses observed	Population estimate
	1-Oct	8-Oct	15-Oct	22-Oct	29-Oct	5-Nov	12-Nov	19-Nov	25-Nov	3-Dec	(Rj)	(Cj) 1/	(N) 2/
8-Oct	29	--	--	--	--	--	--	--	--	--	29	497	1,114
15-Oct	3	44	--	--	--	--	--	--	--	--	47	696	1,415
22-Oct	0	7	42	--	--	--	--	--	--	--	49	788	1,284
29-Oct	0	2	10	29	--	--	--	--	--	--	41	574	1,050
5-Nov	1	1	8	9	17	--	--	--	--	--	36	410	867
12-Nov			1	5	7	37	--	--	--	--	50	358	637
19-Nov			0		1	2	14	--	--	--	17	159	378
25-Nov			1			2	4	9	--	--	16	150	314
3-Dec							4	2	8	--	14	116	289
10-Dec							1	1	2	4	8	71	246
Total recovered (Ri)	33	54	62	43	25	41	23	12	10	4			
Total carcasses marked (Mi)	74	109	97	82	62	67	57	25	26	18		Total estimate:	7,594
												Adjusted estimate 3/:	**7,051**

GRILSE ESTIMATE

Recovery period (j)	Number of marked carcasses recovered from marking period (i)										Total marked carcasses recovered	Total carcasses observed	Population estimate
	1-Oct	8-Oct	15-Oct	22-Oct	29-Oct	5-Nov	12-Nov	19-Nov	25-Nov	3-Dec	(Rj)	(Cj) 1/	(N) 2/
8-Oct	3	--	--	--	--	--	--	--	--	--	3	42	84
15-Oct		2	--	--	--	--	--	--	--	--	2	60	270
22-Oct			2	--	--	--	--	--	--	--	2	80	373
29-Oct			0	4	--	--	--	--	--	--	4	49	108
5-Nov			1	0	1	--	--	--	--	--	2	41	239
12-Nov				1		1	--	--	--	--	2	39	82
19-Nov						2	3	--	--	--	5	22	40
25-Nov						1		0	--	--	1	15	45
3-Dec									1	--	1	16	24
10-Dec									1	0	1	11	28
Total recovered (Ri)	3	2	3	5	1	4	3	0	2	0			
Total carcasses marked (Mi)	6	9	14	11	7	8	5	2	3	1		Total estimate:	1,292
												Adjusted estimate 4/:	**1,232**

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

2/ Schaefer (1951) estimate equation $N = \sum(Rij \times (Mi/Ri) \times (Cj/Rj))$

3/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate (7,594 - 543 = 7,051)

4/ Adjusted estimate where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate (1,292 - 60 = 1,232)

Based on fresh carcasses observed during the surveys, the fall run population consisted of 49% adult males and 51% adult females.

The 2002 Yuba River fall run of 24,051 salmon was 3% higher than in 2001, and 29% higher than the 1992-2001 average population (Appendix 3).

TABLE 12. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the Yuba River from Parks Bar to Daguerre Point Dam (Section 2).

ADULT ESTIMATE

Recovery period (j)	Number of marked carcasses recovered from marking period (i)											Total marked carcasses recovered	Total carcasses observed	Population estimate
	2-Oct	9-Oct	16-Oct	23-Oct	30-Oct	6-Nov	13-Nov	20-Nov	26-Nov	4-Dec	11-Dec	(Rj)	(Cj) [1/]	(N) [2/]
9-Oct	10	--	--	--	--	--	--	--	--	--	--	10	222	525
16-Oct	0	16	--	--	--	--	--	--	--	--	--	16	439	1,207
23-Oct	1		41	--	--	--	--	--	--	--	--	42	779	1,267
30-Oct			4	41	--	--	--	--	--	--	--	45	560	1,101
6-Nov			1	1	31	--	--	--	--	--	--	33	586	798
13-Nov				1	6	48	--	--	--	--	--	55	518	776
20-Nov				1	1	12	41	--	--	--	--	55	473	784
26-Nov					1	1	4	36	--	--	--	42	328	506
4-Dec							1	6	10	--	--	17	130	354
11-Dec							1	3	1	2	--	7	33	70
Total recovered (Ri)	11	16	46	44	39	61	47	45	11	2	0			
Total carcasses marked (Mi)	26	44	74	88	52	92	80	69	39	5	4		Total estimate	7,389
												Adjusted estimate [3/]:		**6,842**

GRILSE ESTIMATE

Recovery period (j)	Number of marked carcasses recovered from marking period (i)										Total marked carcasses recovered	Total carcasses observed	Population estimate
	2-Oct	9-Oct	16-Oct	23-Oct	30-Oct	6-Nov	13-Nov	20-Nov	26-Nov	4-Dec	(Rj)	(Cj) [1/]	(N) [2/]
9-Oct	1	--	--	--	--	--	--	--	--	--	1	23	69
16-Oct		0	--	--	--	--	--	--	--	--	0	57	57
23-Oct			3	--	--	--	--	--	--	--	3	93	434
30-Oct				8	--	--	--	--	--	--	8	120	120
6-Nov				2	10	--	--	--	--	--	12	117	259
13-Nov					0	4	--	--	--	--	4	86	310
20-Nov					1	1	4	--	--	--	6	80	294
26-Nov								1	--	--	1	56	616
4-Dec									0	--	0	23	23
11-Dec										0	0	11	11
Total recovered (Ri)	1	0	3	10	11	5	4	1	0	0			
Total carcasses marked (Mi)	3	6	14	10	27	18	16	11	6	4		Total estimate	2,192
											Adjusted estimate [4/]:		**2,080**

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

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

3/ 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 (7 389 - 547 6,842)

4/ Adjusted estimate where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (2,192 - 112 = 2,080).

TABLE 13. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the Yuba River from Dagurre Point Dam to Marysville (Section 3).

ADULT ESTIMATE

Recovery period (j):	Number of marked carcasses recovered from marking period (i)										Total marked carcasses recovered	Total carcasses observed	Population estimate
	10-Oct	17-Oct	24-Oct	31-Oct	7-Nov	14-Nov	21-Nov	27-Nov	5-Dec	12-Dec	(R_j)	(C_j) [1/]	(N) [2/]
17-Oct	0	--	--	--	--	--	--	--	--	--	0	76	76
24-Oct		2	--	--	--	--	--	--	--	--	2	136	517
31-Oct		2	8	--	--	--	--	--	--	--	10	219	604
7-Nov		1	0	12	--	--	--	--	--	--	13	280	583
14-Nov				3	22	--	--	--	--	--	25	499	1,185
21-Nov				0	6	30	--	--	--	--	36	449	859
27-Nov				1	1	10	15	--	--	--	27	300	791
5-Dec					0	1	1	5	--	--	7	97	405
12-Dec					1	1		1	1	--	4	42	148
Total recovered (R_i)	0	5	8	16	30	42	16	6	1	0			
Total carcasses marked (M_i):	6	19	20	31	73	76	52	29	5	1		Total estimate	5,168
												Adjusted estimate [3/]:	**4,862**

GRILSE ESTIMATE

Recovery period (j)	Number of marked carcasses recovered from marking period (i).										Total marked carcasses recovered	Total carcasses observed	Population estimate
	10-Oct	17-Oct	24-Oct	31-Oct	7-Nov	14-Nov	21-Nov	27-Nov	5-Dec	12-Dec	(R_j)	(C_j) [1/]	(N) [2/]
17-Oct	0	--	--	--	--	--	--	--	--	--	0	3	3
24-Oct		0	--	--	--	--	--	--	--	--	0	21	21
31-Oct			0	--	--	--	--	--	--	--	0	47	47
7-Nov				1	--	--	--	--	--	--	1	58	696
14-Nov					0	--	--	--	--	--	0	121	121
21-Nov						1	--	--	--	--	1	85	468
27-Nov						0	2	--	--	--	2	59	118
5-Dec						1	2	3	--	--	6	30	88
12-Dec							1		0	--	1	160	480
Total recovered (R_i)	0	0	0	1	0	2	5	3	0	0			
Total carcasses marked (M_i)	2	1	2	12	11	11	10	8	2	0		Total estimate	2,041
												Adjusted estimate [4/]:	**1,984**

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

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

3/ 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 (5,168 - 306 = 4,862)

4/ Adjusted estimate where marked carcasses (M_i) from the second marking period on were subtracted from the total estimate (2,041 - 57 = 1,984)

American River

Fall run. Salmon carcass mark-and-recovery surveys in the American River were conducted from 15 October 2002 through 2 January 2003, covering the 20.8-km (12.9-mi) stretch from Sailor Bar downstream to the Watt Avenue bridge [23/]. This stretch of river was covered in three reaches, each surveyed weekly. Mean daily river flow ranged from 35.8 m^3/s (1503 cfs) to 41.8 m^3/s (1756 cfs); the higher flows occurred in late November through early December. Visibility through the water, measured by secchi disk, ranged from 4.1 m to 1.0 m (13.5-3.3 ft). Water temperature ranged from 17.6 °C to 10.1 °C (63.4-50.2 °F).

This season only fresh adult salmon carcasses were distinctly marked by attaching colored hog rings to their upper jaws; different colors were used each marking period. A carcass was considered fresh if it had either one clear eye or pink gills, and the adult distinction was a FL > 68 cm (26.8 in). Marked carcasses were replaced into running water for later recovery. Any carcass not tagged, as well as those recovered with marks were counted and cut in half. Those carcasses found downstream of Gristmill Fishing Access were not marked, but only counted and chopped. Length measurements and determination of gender were made for a sample of the fresh carcasses.

The adult 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 106,345 fish (Table 14). This adult estimate was expanded for a 10% grilse proportion to 118,161 fish in the surveyed reaches. In addition, 9,817 fish entered Nimbus Hatchery [24/], and 6,091 salmon carcasses were removed from the Nimbus Racks, bringing the total American River 2002 fall-run population to 134,069 fish (Appendix 2).

Based on examination of 2,962 fresh carcasses, the run consisted of 38.8% male adults, 51.2% female adults, 6.5% male grilse (FL ≤ 68 cm), and 3.5% female grilse. Salmon entering Nimbus Hatchery consisted of 32.2% male adults (FL > 61 cm [24 in]), 25.3% female adults, and 36.5% grilse (FL ≤ 61 cm).

The 2002 run of 134,069 salmon in the American River was a decrease of 9% from the previous year's population, but still almost twice the average for 1992-2001 (Appendix 3).

[23/] Healey, M. Lower American River Chinook Salmon Escapement Survey, October 2002-January 2003. File report. 15 April 2003. CDFG-SVCSR, Rancho Cordova office.

[24/] West, T. CDFG – SVCSR, Nimbus Hatchery. Personal communication.

TABLE 14. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the American River from Sailor Bar to Watt Avenue [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			
2	11	--	--	--	--	--	--	--	--	--	--	11	614	2,149
3	1	16	--	--	--	--	--	--	--	--	--	17	861	3,678
4		6	81	--	--	--	--	--	--	--	--	87	2,041	4,819
5		3	7	124	--	--	--	--	--	--	--	134	5,368	17,154
6				25	297	--	--	--	--	--	--	322	12,115	30,040
7				2	30	374	--	--	--	--	--	406	11,298	24,346
8				1	1	51	165	--	--	--	--	218	7,042	18,308
9					3	3	13	53	--	--	--	72	1,999	5,732
10						1	1	5	24	--	--	31	684	2,277
11									1	7	--	8	188	699
12										1	1	2	99	433
Total recovered (R_i)	12	25	88	152	331	429	179	58	25	8	1			
Total carcasses marked (M_i)	42	108	195	490	800	913	491	172	87	30	5		Total estimate	109,636
													Adjusted estimate [4/]:	**106,345**

1/ Surveys were conducted from 15 October 2002 through 2 January 2003

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/ 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 (109,636 - 3,291 = 106,345)

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 36,425 salmon, consisting entirely of fall-run fish, was estimated to be in this system for 2002 (Appendix 2).

Mokelumne River

Fall run. Fish passage at Woodbridge Irrigation District Dam was monitored by East Bay Municipal Utilities District (EBMUD), during 16 August 2002 through 31 July 2003 [25/]. 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 through 7 January 2003, after which only the video monitoring continued.

A total of 10,759 salmon was counted migrating past the dam [26/] during 14 September 2002 through 6 January 2003. Mokelumne River Hatchery took in 7,919 salmon [27/], and the in-river fall-run spawner population was assumed to be 2,840 fish (Appendix 2).

Based on examination of 10,713 salmon at the dam, the run consisted of 40% male adults (FL > 60 cm [23.6 in]), 40% female adults, 15% male grilse (FL ≤ 60 cm), and 5% female grilse. The composition of the salmon entering the hatchery was 41.5% male adults (FL > 61 cm [24 in]), 31.7% female adults, and 26.8% grilse (FL ≤ 61 cm).

The 2002 spawner population of 10,759 fish in the Mokelumne River was an increase of 33% from the previous year's run, and 80% higher than the average population size for the 1992-2001 period (Appendix 3).

[25/] Workman, M. Lower Mokelumne River Upstream Fish Migration Monitoring. File Report. August 2003. EBMUD Fisheries and Wildlife Division. Lodi Office.

[26/] Workman, M. EBMUD. Personal communication.

[27/] Anderson, B. CDFG – San Joaquin Valley/Southern Sierra Region (SJVSSR), Mokelumne River Hatchery. Personal communication.

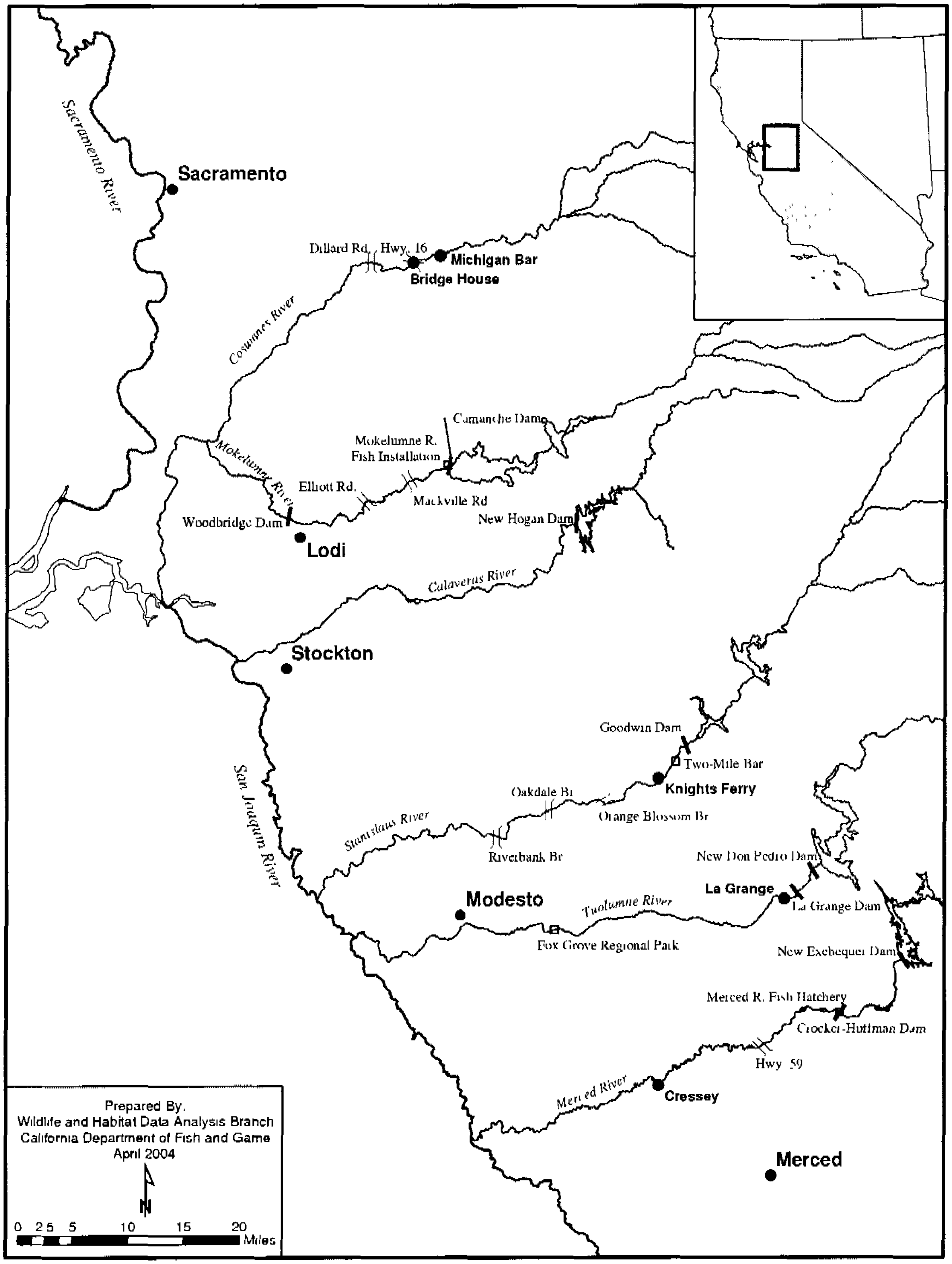

Figure 4. San Joaquin River System from the Merced River to the Mokelumne River.

Stanislaus River

Fall run. Salmon spawner surveys in the Stanislaus River were conducted weekly during 1 October through 24 December 2002 [28/]; marking-and-recovery surveys began during the second week. The 35.4-km (22-mi) stretch of the river from Knight's Ferry to Jacob Meyers Park in Riverbank was covered by drift boat, while surveys were made on foot upstream of Knight's Ferry in the 4.8-km (3-mi) section of the Goodwin Canyon area.

All salmon carcasses, except skeletons, were marked using numbered aluminum tags attached to their lower jaws with hog-rings; skeletons also included carcasses completely covered with fungus. Marked carcasses were redistributed into running water 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 measured and its gender determined, and its condition was determined as either fresh or decayed; fresh carcasses were identified as having at least one clear eye and blood still in the gills.

The carcass marking protocol and use of numbered tags were intended to allow post-season distinction of age-class (adult or grilse, based on length) and condition (fresh or decayed), so the data could be better compiled for estimating the salmon 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 Jacob Meyers Park stretch was estimated to be 7,012 fish[29/], using the fresh carcass mark-and-recovery data in the Schaefer model (Table 15). The data from surveys in the Goodwin Canyon area were not included in the Schaefer estimate calculations. The spawner population for this area was instead determined by expanding the 486 carcasses which were actually observed to an estimated 775 fish, using the overall marked fish recovery rate of the mark-and recovery surveys. The combined estimates were a total of 7,787 salmon for the 2002 fall run.

The adult-grilse composition of the population was determined from frequency distributions of basin-wide fresh carcass length measurements taken this season. Distribution data were compiled separately for each gender of hatchery- and natural-origin fish. Hatchery-origin salmon were identified as carcasses with missing adipose fins, indicating the possible presence of a coded-wire tag which was inserted at the hatchery. The length criteria used to distinguish adult from grilse salmon was a FL $\geq$ 69 cm (27.2 in) for both natural- and hatchery-origin females, a FL $\geq$ 73 cm (28.7 in) for natural-origin males, and a FL $\geq$ 70 cm (27.6 in) for hatchery-origin males. The run consisted of 30.6% male adults, 50.1% female adults, 9.2% male grilse, and 10.1% female grilse.

[28/] Guignard, J. Stanislaus River Fall Chinook Salmon Escapement Survey, 2002. File Report. March 2003. CDFG – San Joauquin Valley-Southern Sierra Region (SJVSSR).

[29/] Guignard, J. CDFG-SJVSSR. Personal communication.

TABLE 15. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the Stanislaus River from Knights Ferry to Riverbank [1/].

Recovery period (j)	Number of marked carcasses recovered from marking period (i): 1	2	3	4	5	6	7	8	9	10	Total marked carcasses recovered (R_j)	Total carcasses observed (C_j) [2/]	Population estimate (N) [3/]
2	1	--	--	--	--	--	--	--	--	--	1	1	1
3		0	--	--	--	--	--	--	--	--	0	3	3
4			0	--	--	--	--	--	--	--	0	24	24
5				5	--	--	--	--	--	--	5	202	505
6				0	33	--	--	--	--	--	33	1,045	1,966
7				1	7	98	--	--	--	--	106	1,248	2,143
8					2	44	143	--	--	--	189	1,172	1,627
9						10	53	69	--	--	132	636	919
10							14	27	15	--	56	249	419
11								0	1	0	1	11	37
12								2	8	3	13	58	208
Total recovered (R_i)	1	0	0	6	42	152	210	98	24	3			
Total carcasses marked (M_i)	1	0	0	15	79	258	270	150	56	12		Total estimate	7,852
												Adjusted estimate [4/]:	**7,012**

1/ Surveys were conducted from 1 October through 24 December 2002, marking-and-recovery began during the second week
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/ 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 (7,852 - 840 = 7,012)

The 2002 Stanislaus River fall-run spawner population of 7,787 salmon was an increase of 11% over the previous year's run, and almost 2½ times higher than the average for 1992 -2001 (Appendix 3).

Tuolumne River

Fall run. Chinook salmon spawner surveys in the Tuolumne River were conducted weekly from 1 October 2002 through 2 January 2003 [30/]; marking-and-recovery surveys started during the second week. The river stretch from the riffles at river mile 51.6 near LaGrange Dam downstream to Fox Grove Regional Park, a distance of 41.2 km (25.6 mi), was covered by both boat and ground surveys.

This season all sampled carcasses, except skeletons, were marked using numbered aluminum tags attached to their lower jaws with hog-rings; skeletons also included carcasses so decomposed or covered with fungus that it was judged they would not be recoverable. 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 gender 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, and blood remaining in their gills.

The carcass marking protocol and use of numbered tags were intended to allow post-season distinction of age-class (adult-grilse, based on length) and condition (fresh or decayed), so the

[30/] Blakeman, D. 2002 Tuolumne River Fall Chinook Salmon Escapement Survey. File Report. January 2003. CDFG - SJVSSR.

data could be better compiled for estimating the salmon 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 Park was estimated at 7,173 fish, using the fresh carcass mark-and-recovery data in the Schaefer model (Table 16).

The adult-grilse composition of the population was determined from frequency distributions of basin-wide fresh carcass length measurements taken this season. Distribution data were compiled separately for each gender of hatchery- and natural-origin fish. Hatchery-origin salmon were identified as carcasses with missing adipose fins, indicating the possible presence of a coded-wire tag which was inserted at the hatchery. The length criteria used to distinguish adult from grilse salmon was a FL $\geq$ 69 cm (27.2 in) for both natural- and hatchery-origin females, a FL $\geq$ 73 cm (28.7 in) for natural-origin males, and a FL $\geq$ 70 cm (27.6 in) for hatchery-origin males. The run consisted of 31.8% male adults, 48% female adults, 14% male grilse, and 6.2% female grilse.

The 2002 fall run of salmon in the Tuolumne River was 18% lower than that in 2001, but still 25% higher than the average for 1992-2001 (Appendix 3).

TABLE 16. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the Tuolumne River from LaGrange Dam to Fox Grove Park [1/].

Recovery period (j):	Number of marked carcasses recovered from marking period (i):											Total marked carcasses recovered	Total carcasses observed	Population estimate
	1	2	3	4	5	6	7	8	9	10	11	(Rj)	(Cj) [2/]	(N) [3/]
2	0	--	--	--	--	--	--	--	--	--	--	0	2	2
3		0	--	--	--	--	--	--	--	--	--	0	3	3
4			1	--	--	--	--	--	--	--	--	1	26	26
5				7	--	--	--	--	--	--	--	7	364	592
6				1	101	--	--	--	--	--	--	102	1,232	1,649
7					28	173	--	--	--	--	--	201	1 561	2,212
8					2	14	251	--	--	--	--	267	1,236	1 821
9						5	51	138	--	--	--	194	761	1,211
10						1	4	11	27	--	--	43	222	482
11								0	2	0	--	2	50	176
12								1	2	5	1	9	50	265
13											0	0	16	16
Total recovered (Ri)	0	0	1	8	131	193	306	150	31	5	1			
Total carcasses marked (Mi)	1	0	1	13	175	276	452	246	78	37	4		Total estimate	8,455
													Adjusted estimate [4/]:	**7,173**

1/ Surveys were conducted from 1 October 2002 through 2 January 2003, marking-and-recovery began during the second week

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/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate (8,455 - 1,282 7 173)

Merced River

Fall run. Weekly salmon surveys were conducted from 1 October 2002 through 8 January 2003, in the 39.7-km (24.7-mi) stretch of the Merced River from the Merced River Hatchery downstream to Santa Fe Road near Cressey [31/]; marking-and-recovery surveys started during the fifth week. River flows were increased, two weeks after the carcass surveys began, to attract salmon into the tributary and improve spawning conditions. The higher flows were continued for about two weeks (14-25 October) and ranged from 20.1 m^3/s to 21.5 m^3/s (710-761 cfs). Flows were decreased and stabilized at around 5.7 m^3/s (200 cfs) for the remainder of the spawning season.

All salmon carcasses, except skeletons, were marked using numbered aluminum tags attached to their lower jaws, or near the dorsal fins, with hog-rings; skeletons included carcasses completely covered with fungus. 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 measured and its gender determined, and a condition of either fresh or decayed was assigned to it; fresh carcasses were identified as having at least one clear eye.

The carcass marking protocol and use of numbered tags were intended to allow post-season distinction of age-class (adult-grilse, based on length) 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 8,866 salmon was calculated for the river stretch from Merced River Hatchery to Santa Fe Road (Table 17). Merced River Hatchery took in 1,840 salmon [32/], for a total 2002 fall-run spawner population of 10,706 fish (Appendix 2).

The adult-grilse composition of the population was determined from frequency distributions of basin-wide fresh carcass length measurements taken this season. Distribution data were compiled separately for each gender of hatchery- and natural-origin fish. Hatchery-origin salmon were identified as carcasses with missing adipose fins, indicating the possible presence of a coded-wire tag which was inserted at the hatchery. The length criteria used to distinguish adult from grilse salmon was a FL $\geq$ 69 cm (27.2 in) for both natural- and hatchery-origin females, a FL $\geq$ 73 cm (28.7 in) for natural-origin males, and a FL $\geq$ 70 cm (27.6 in) for hatchery-origin males. The in-river run of the Merced River consisted of 32% male adults, 48.6% female adults, 14.4% male grilse, and 5% female grilse. Salmon which entered Merced River Hatchery consisted of 41.5% male adults (FL $\geq$ 65 cm [25.6 in]), 40.5% female adults (FL $\geq$ 62 cm [24.4 in]), 14% male grilse (FL $<$ 65 cm), and 4% female grilse (FL $<$ 62 cm).

The 2002 Merced River fall run was similar to that of 2001, and was still over two times higher than the average for 1992-2001 (Appendix 3).

[31/] Johnson, K. 2002 Merced River Fall Chinook Salmon Escapement Survey. File Report. March 2003. CDFG - SJVSSR.

[32/] Cozart, M. CDFG – SJVSSR, Merced River Hatchery. Personal communication.

TABLE 17. Chinook salmon fresh carcass mark-and-recovery data used to estimate the 2002 fall-run spawner population in the Merced River from the hatchery to Cressey [1/].

Recovery period (j)	Number of marked carcasses recovered from marking period (i).									Total marked carcasses recovered	Total carcasses observed	Population estimate
	1	2	3	4	5	6	7	8	9	(R_j)	(C_j) [2/]	(N) [3/]
2	2	--	--	--	--	--	--	--	--	2	142	521
3	1	29	--	--	--	--	--	--	--	30	694	1,446
4		5	34	--	--	--	--	--	--	39	686	1,709
5			21	27	--	--	--	--	--	48	614	1,364
6			20	57	36	--	--	--	--	113	1,426	2,632
7			2	15	5	44	--	--	--	66	664	1,127
8				1		1	7	--	--	9	133	279
9						2	5	5	--	12	102	205
10							4	0	2	6	50	156
11								3		3	26	78
Total recovered (Ri)	3	34	77	100	41	47	16	8	2			
Total carcasses marked (Mi)	11	69	197	196	52	76	35	16	10		Total estimate	9,517
										Adjusted estimate [4/]:		**8,866**

1/ Surveys were conducted from 1 October 2002 through 8 January 2003, marking-and-recovery began during the fifth week.

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/ 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 (9,517 - 651 = 8,866)

SUMMARY

The total estimated 2002 Central Valley Chinook salmon spawner population was 935,979 fish, consisting of 899,554 fish in the Sacramento River system and 36,425 fish in the San Joaquin River system (Table 16). This total was 39% higher than the 672,583 salmon estimated in 2001.

All of the late-fall, winter, and spring runs, and the majority of the fall run were in the Sacramento River system. In Battle Creek of that system, a record high fall run occurred. The fall run in the San Joaquin tributaries continued to contribute only a small portion (4%) to the total Central Valley escapement.

TABLE 16. Summary of the 2002 Sacramento-San Joaquin river system Chinook salmon spawner populations.

Spawning area	Late-fall run 1/	Winter run	Spring run 2/	Fall run	Total
Sacramento River mainstem	36,004	7,464	--	65,690	109,158
Sacramento River tributaries	2,669	--	17,409	770,318	790,396
San Joaquin River tributaries	--	--	--	36,425	36,425
Totals:	38,673	7,464	17,409	872,433	935,979

1/ Tributary data consists only of fish which entered Coleman National Fish Hatchery (Battle Creek).
2/ Estimate not made for Sacramento River mainstem.

ACKNOWLEDGEMENTS

The editor thanks the individuals, and their affiliations, who are cited as sources for the data presented. That information, collected through their efforts, and provided through their cooperation has made this report possible.

REFERENCES

Hoopaugh, David A. (ed.). 1978. King (Chinook) salmon spawning stocks in California's Central Valley, 1976. Calif. Dept. of Fish and Game, Anadromous Fisheries Branch Administrative Report No. 78-19. 33 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.

Ward, P.D., T.R. McReynolds, and C.E. Garmin. 2004. Butte and Big Chico creeks spring-run Chinook salmon, Oncoryhnchus tshawytscha, life history investigation, 2001-2002. Calif. Dept. of Fish and Game, Inland Fisheries Administrative Report No. 2004-4. 53 p.

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);

$$N = \Sigma \left(R_{ij} \times \frac{M_i}{R_i} \times \frac{C_j}{R_j}\right) - \Sigma\, {}^{i}_{2}M_i$$

where N = the estimated spawner population,

R_{ij} = carcasses marked in the ith marking period which were recovered in the jth recovery period,

M_i = carcasses marked in the ith marking period,

R_i = total marked carcasses recovered from the ith marking period,

R_j = total marked carcasses recovered during the jth recovery period,

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

${}^{i}_{2}M_i$ = total carcasses marked from the second marking period on. Subtraction of this factor adjusted for replacement of recovered marked fish.

APPENDIX 1 (continued).

C. The Jolly-Seber calculations [33/]:

The estimated spawner population = $\mathbf{N_1 + D_1 + D_2 + \ldots D_j}$, where

N_1 = number of carcasses in the surveyed population in period 1, the first period of sampling;

$$N_1 = \frac{E_1 + (N_2 - T_1 * S_1)}{\sqrt{S_1}}$$

and,

D_i = number of carcasses joining the population between period i and $i+1$, with j being the last survey period. This accounts for carcasses "leaving" the population between survey periods.

$$D_i = \frac{(N_{i+1} - S_i) * (N_i - E_i + T_i)}{\sqrt{S_i}}$$

Variables used in the calculations are:

E_i = total number of carcasses examined for marks during the i^{th} period, including those that were marked, those with marks that were recovered, and those that were not marked.

N_i = estimated number of carcasses in the population immediately prior to each survey period.

$$N_i = \frac{b_i * (E_i + 1)}{R_i + 1}$$

where,

b_i = estimated number of marked carcasses available for recovery during each survey;

$$b_i = \frac{(T_i + 1) * (K_i)}{(C_i + 1)} + R_i$$

and,

R_i = total number of marked carcasses that were recovered during the i^{th} period.

T_i = number of carcasses marked during the i^{th} period.

S_i = survival rate of marked carcasses from period i to $i+1$;

$$S_i = \frac{b_{i+1}}{b_i - R_i + T_i}$$

33/ D. Killam. CDFG-NCNCR. Personal communication. Variable notations are those provided by source.

APPENDIX 2. 2002 Chinook salmon spawner population estimates for the Central Valley river system.

River System: / River area / Tributary	Late-fall run	Winter run	Spring run	Fall run	Total all runs
	Estimated number of fish				
Sacramento River System:					
Keswick Dam to Red Bluff					
Sacramento River mainstem					
Livingstone Stone National Fish Hatchery	--	104	--	--	104
In-river a/	36,004	7,348	273	45,523	89,148
(Totals for tributary)	(36,004) -	(7,452)		(45,523)	(89,252)
Clear Creek	c/	--	66	16,071	16,137
Cottonwood (Beegum) Creek	c/	--	125	c/	125
Battle Creek					
Coleman National Fish Hatchery	2,669	--	--	66,147	68,816
In-river	b/	b/	144	397,149	397,293
(Totals for tributary)	(2,669)		(144)	(463,296)	(466,109)
Totals for area:	**38,673**	**7,452**	**608**	**524,890**	**571,623**
Red Bluff to Princeton Ferry					
Sacramento River mainstem d/	0	12	0	20,167	20,179
Antelope Creek	--	--	46	c/	46
Mill Creek	--	--	1,594	2,611	4,205
Deer Creek	--	--	2,185	b/	2,185
Thomes Creek	--	--	2	--	2
Totals for area:	**0**	**12**	**3,827**	**22,778**	**26,617**
Big Chico Creek to American River					
Big Chico Creek	--	--	0	c/	0
Butte Creek	--	--	8,785	4,550	13,335
Feather River					
Feather River Hatchery	--	--	4,189	20,507	24,696
In-river	--	--	c/	105,163	105,163
(Totals for tributary):				(125,670)	(129,859)
Yuba River	--	--	b/	24,051	24,051
American River					
Nimbus Hatchery	--	--	--	9,817	9,817
Nimbus Basin				6,091	6,091
In-river	--	--	--	118,161	118,161
(Totals for tributary)				(134,069)	(134,069)
Totals for area:			**12,974**	**288,340**	**301,314**
Sacramento River System Totals:	**38,673**	**7,464**	**17,409**	**836,008**	**899,554**
San Joaquin River System:					
Mokelumne River					
Mokelumne River Hatchery	--	--	--	7,919	
In-river	--	--	--	2,840	
(Totals for tributary).				(10,759)	
Stanislaus River	--	--	--	7,787	
Tuolumne River	--	--	--	7,173	
Merced River					
Merced River Hatchery	--	--	--	1,840	
In-river	--	--	--	8,866	
(Totals for tributary)				(10,706)	
San Joaquin River System Total:				**36,425**	

a/ Estimates for late-fall, winter, and fall runs based on carcass survey and redd count data Spring run estimate based on Red Bluff Diversion Dam counts
b/ An estimate of the run size was not made
c/ Tributary was not surveyed for this run.
d/ Estimates based on number of in-river mainstem fish and redd counts.

APPENDIX 3. Chinook salmon spawner population estimates from 1992 through 2002 in California's Central Valley major tributaries.

Tributary	Run	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	**2002**	1992-2001 average
	Late-fall	9,356	739	291	166 a/	48 a/	b/	38,239 c/	8 683 d/	8,632 c/	18,351 c/	**36,004** c/	---
Sacramento River mainstem	Winter	1,196	378	186	1,202	1,012	836	2,930	3,264	1,350	8,189 c/	**7,348** c/	2,054
upstream of Red Bluff	Spring	371	391	862	426	378	128	1,115	b/	71	736	**273**	459 e/
	Fall	23 914	33,471	44,729	53,385	71,725	98,765	5 718	133,365	87,793	57 792 c/	**45,523** c/	61,429
Battle Creek	Fall e/	12,708	18,616	43,265	83,192	73,587	101,414	98 308	119,899	75,106	125,686	**463,296**	75,178
Sacramento River mainstem downstream of Red Bluff	Fall	8,315	12 760	13,817	10,549	12,361	20,531	600	27 827	8,895	17,360 c/	**20,167** c/	13,302
Feather River	Spring f/	1 497	4,672	3,641	5,414	6,381	7 017	6,746	4 534	3,972	4 078	**4,189**	4,795
	Fall e/	40 545	42,914	53,584	72,061	65,277	65,675	18,889 f/	12 927 f/	132,863	203 515	**125,670**	70,308 g/
Yuba River	Fall	6,362	6,703	10,890	14,237	27,900	25,948	31 090	24,230	14,995	23,392	**24,051**	18,575
American River	Fall e/	11 267	39,410	40,087	86,828	82,396	57,845	66,580	65,099	110,219	147,134	**134,069**	70,687
Mokelumne River	Fall e/	1,645	3,157	3,157	5,517	7,921	10,175	7,213	5,333	7,423	8,116	**10,759**	5,966
Stanislaus River	Fall	255	677	1,031	619	168	5,588	3,087	4 349	8,498	7,033	**7,787**	3,131
Tuolumne River	Fall	132	471	506	827	4,362	7,146	8 910	8,232	17,873	8,782	**7,173**	5,724
Merced River	Fall e/	986	1,678	3,589	2,922	4,432	3,660	4,091	4 766	13,076	10,844	**10,706**	5,004

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, unless noted other estimates were based on Red Bluff Diversion Dam counts
d/ Estimate is not for the entire mainstem, but for the carcass survey area only, aerial redd counts were not available to allow expansion
e/ Estimate includes numbers of salmon at the tributary's hatchery.
f/ Numbers are only those salmon which entered Feather River Hatchery, in-river spawner estimates were not made
g/ Average does not include the 1998 and 1999 estimates