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CHINOOK SALMON SPAWNER STOCKS IN CALIFORNIA'S CENTRAL VALLEY, 1989

Edited by

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Inland Fisheries Division

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ABSTRACT

This report covers the 37th annual inventory of chinook salmon, Oncorhynchus tshawytscha, spawner populations in the Sacramento-San Joaquin River system.- It is a compilation of reports estimating the fall-, winter-, late-fall-, and spring-run salmon spawner populations for streams which were surveyed.

Estimates were made from counts of fish entering hatcheries and migrating past dams, from surveys of dead and live fish and redds on spawning areas, and from aerial counts.

The estimated 1989 total escapement of chinook salmon in the Central Valley was 205,990 fish. This total consisted of 181,864 fall-, 12,171 spring-, 539 winter-, and 11,416 late-fall-run spawners. All of the spring-, late-fall-, and winter-run salmon were estimated to be in the Sacramento River system, while 3,493 fish of the fall run were in the San Joaquin River system.

Due to decreases of spawner populations in most Central Valley tributaries, the total 1989 salmon stock was 32% lower than in 1988; however, late-fall salmon in the upper Sacramento River had a run size similar to that of 1988. The winter run in the mainstem Sacramento River was at a record low level.

[1/] Inland Fisheries Administrative Report No. 98-2. Submitted for publication February 1998. 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% Central Valley, is the principle producer of chinook salmon caught in the state's ocean fisheries. Its salmon runs also contribute significantly to the ocean fisheries of Oregon and Washington. This report is the 37th 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 described as follows:

1) Late-fall run. These fish 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 early April. Adults are usually larger in physical size than the fall- and winter-run fish spawning in the same area.

2) Winter run. These fish spawn almost entirely in the Sacramento River and its tributaries upstream of Red Bluff, arriving in late December through mid-July, and spawning from April to early 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 March through June, oversummer in holding pools, and spawn from late August through early October.

4) Fall-run. These are presently the most numerous and widely distributed salmon in the Central Valley. They enter the river from the ocean in June through November and spawn from early October through early January.

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 sex composition of spawner populations, and to recover coded-wire-tagged salmon. Any changes in spawning distribution and habitat conditions that may adversely affect salmon are noted to determine if corrective action is necessary.

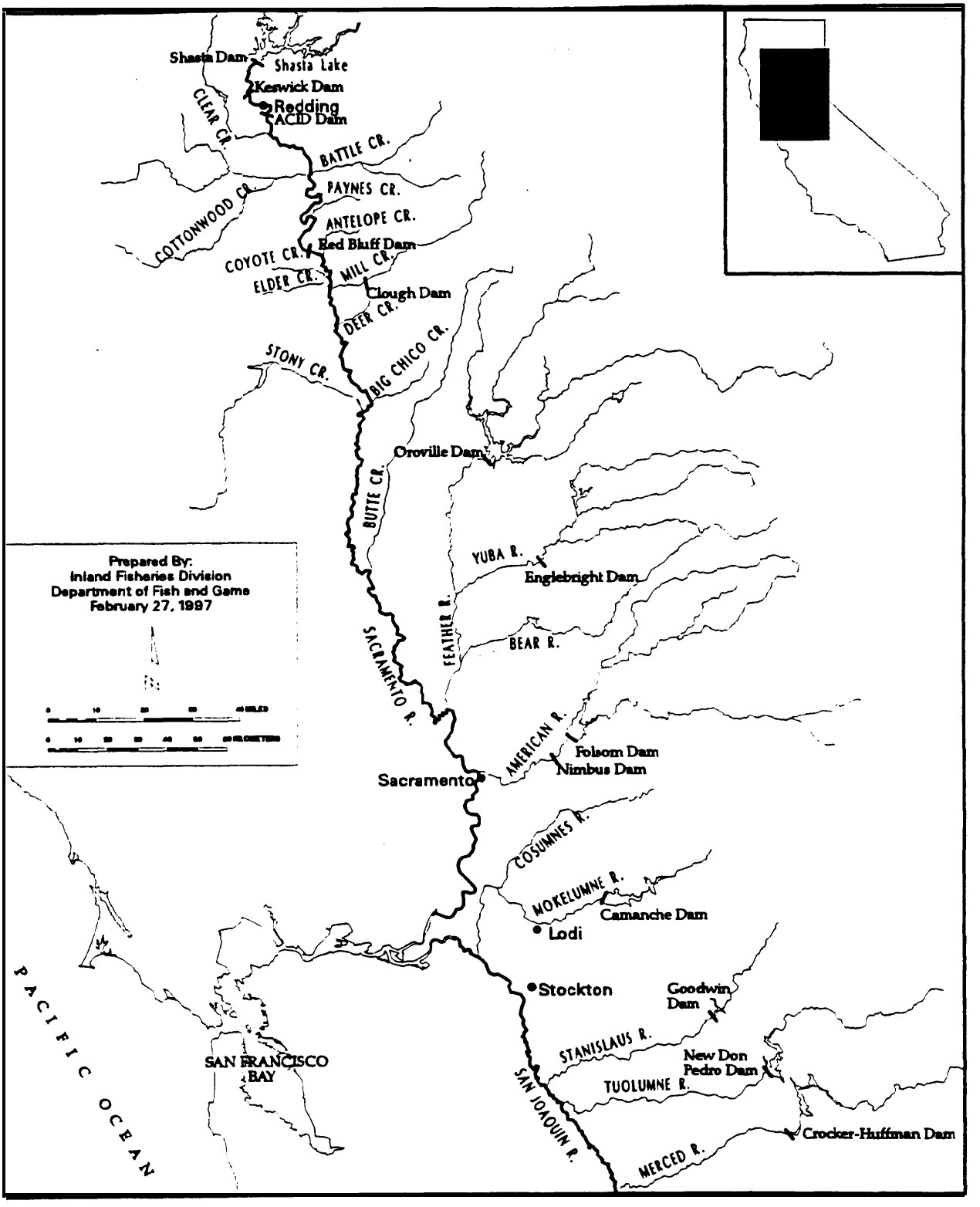

FIGURE 1. Sacramento-San Joaquin river system of California's Central Valley.

GENERAL METHODS

During 1989, spawner stock data were collected in most Central Valley tributaries known to support chinook salmon runs by: monitoring fish entering hatcheries and migrating past dams; conducting stream surveys in spawning areas for live fish, carcasses, and redds; or making aerial counts.

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

Calculated estimates of spawner populations most often employed an expansion of data based on marking and recovering salmon carcasses. Estimates for some tributaries were derived directly from counts of carcasses based on a surveying efficiency. The proportion of carcasses marked during a single previous survey that were recovered in following surveys (recovery rate) was used to expand the number of carcasses observed during the season in a tributary; all counted carcasses were cut in half to prevent recounting.

In other streams, carcasses were marked throughout a series of surveys. Upon recovery during subsequent trips, discrete marks applied to the carcasses allowed identification with individual surveys. All counted carcasses were either marked ***or*** cut in half to prevent recounting. Estimated spawner numbers were derived from this type of mark-and-recovery data using appropriate biometric calculations (Appendix 1).

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

CHINOOK SALMON SPAWNER POPULATIONS FOR THE SACRAMENTO RIVER SYSTEM

Keswick Dam to Red Bluff Diversion Dam

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

In 1989, 98,816 salmon were estimated for the Sacramento River system between Keswick Dam and Red Bluff, consisting of 81,727 fall-, 11,416 late-fall-, 527 winter- and 5,146 spring-run fish (Appendix 3). The mainstem portions of the fall- and late-fall-run spawner population were 48,526 and 11,351 fish, respectively. All winter-run, and almost all of the spring-run salmon (5,139) were in the mainstem. The mainstem totals reported include those fish for tributaries which may have had a run in them, but for which no surveys were made; i.e. the late-fall run in Clear Creek, and the late-fall and winter runs in Battle Creek.

Sacramento River Mainstem - by Richard E. Painter

Estimates of the total numbers of salmon using the Sacramento River system upstream from RBDD during 1989 were based on daily counts made by the U.S. Fish and Wildlife Service (USFWS) and CDFG at the dam. Counts were obtained through closed-circuit television monitoring of salmon passing through the RBDD fishways.

Total numbers of fish counted each week were adjusted for those periods when the fishways remained open but no counts were possible, such as when river turbidity was high, during flood conditions when the dam gates were temporarily opened, and when no observations were made at night. Adjustments to lapses in daytime counts were made by interpolation. Adjustments for the non-monitored nighttime hours were made by multiplying the 14-h day counts by a "night-factor", generated from weekly night counts. The adjusted weekly number of fish was apportioned among the four runs based on their relative proportions seen that week in random samples of salmon taken from the dam's east-bank trapping facility; salmon were assigned to a run based on their relative degree of ripeness (an indication of when it was believed that they would spawn).

The numbers of spring- and fall-run salmon passing RBDD in a calendar year account for the entire annual run of these races.

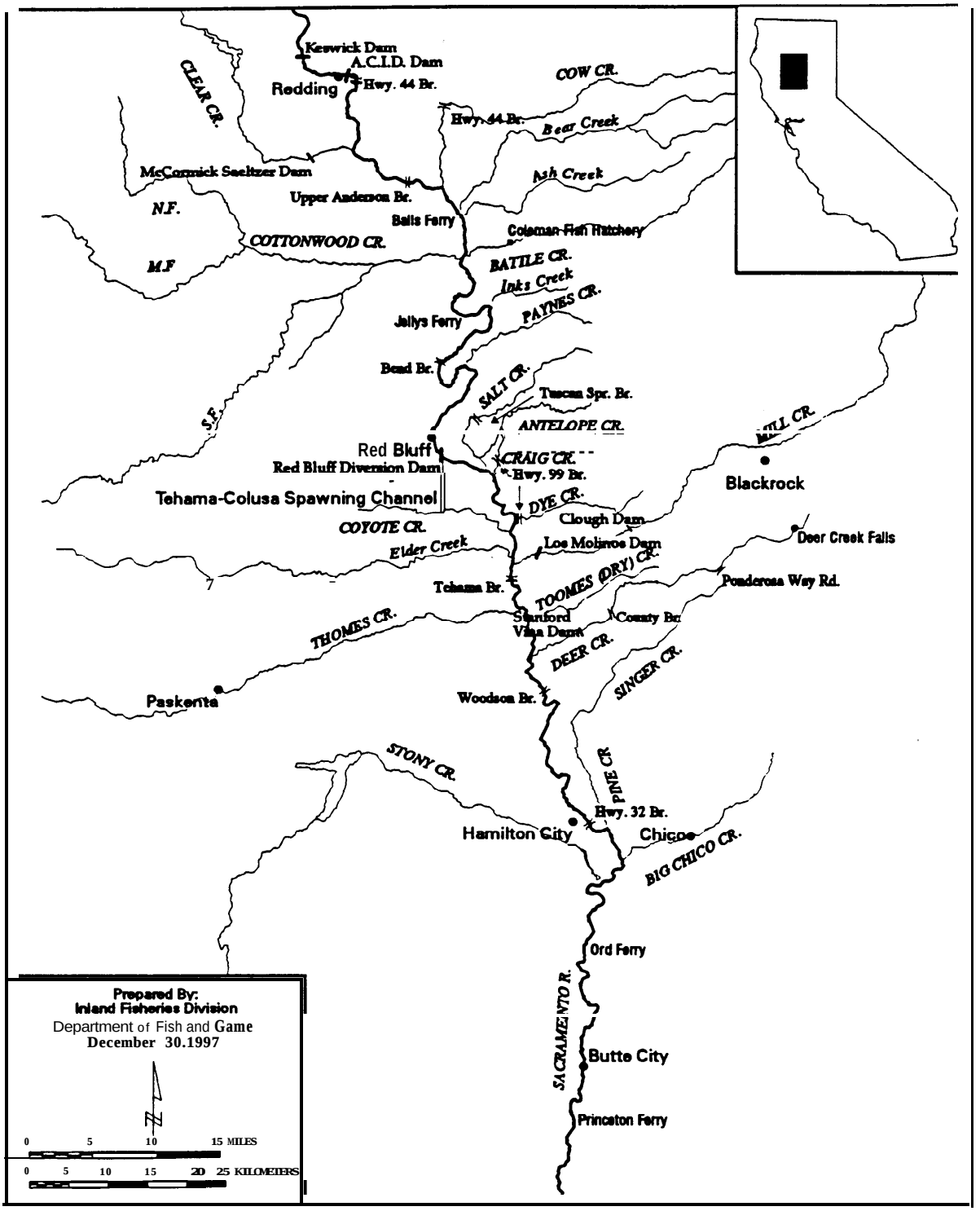

FIGURE 2. Sacramento River system from Keswick Dam downstream to Princeton Ferry.

However, the late-fall and winter runs for a calendar year usually include the latter part of one annual run during the beginning of the year, and the first part of the next annual run at the end of that year. Approximately half of the late-fall annual run occurs in each portion of the calendar year, while most of the winter annual run usually occurs early in the year, with the smaller part of the following annual winter run at the end of the year. The total 1989 potential spawners for each of these two runs was obtained by adding the appropriate estimated numbers of fish from the 1988 calendar year that would spawn in 1989, and not including that portion of the 1989 calendar year estimated numbers that would spawn in 1990.

The RBDD gates were raised during periods from 30 November 1988 through 11 April 1989 to facilitate upstream migration of the winter run of chinook salmon. When the dam gates are open the fishways are essentially inoperable, and counts are not possible. Estimated numbers of late-fall-, winter-, and fall-run salmon for these periods were calculated based on historical data. The numbers of 1989 late-fall- and fall-run salmon, estimated from counts made prior to opening the gates, were expanded to determine the remainder of the run, using the average of proportional distributions seen in the 1968-1985 runs (when the gates were closed year-round). Likewise, expansion of winter-run salmon numbers, from counts after the gates were again closed in April 1989, was made using that run's 1968-1985 average proportional distribution.

For each of the four runs, the estimated spawner population upstream of RBDD was further defined by reducing the number of potential spawners by the estimated number of fish landed in the sport fishery between Keswick Dam and Red Bluff; no attempt was made to account for any other prespawning mortality in the upper river. The numbers of sport-caught salmon were-also estimated from historical data. Late-fall-, spring-, and fall-run 1989 catches were calculated using the average percentage caught of each respective run during the 1977-1986 period. The 1989 winter-run catch was estimated using the 1970-1975 average catch percentage. Late-fall and winter-run estimated catches were also adjusted to account for a shortened sport fishing season (an angling closure for salmon was in effect from 31 January through 30 March 1989).

To obtain the late-fall-, spring-, and fall-run populations for only the mainstem upper Sacramento River, the numbers of potential spawners was reduced by the appropriate numbers of each run in Battle Creek. The 1989 mainstem estimates included all of the winter-, as well as some spring and late-fall-run fish for unsurveyed tributaries.

Late-fall run. An estimated 11,639 late-fall 1989 potential spawners passed RBDD in 1988 and 1989 (Appendix 2). The late-fall sport-catch was estimated to be 223 salmon, leaving 11,416

TABLE 1. Calculation of the 1989 spawner population for each run of chinook salmon upstream of Red Bluff Diversion Dam.

Run	Number of fish passing dam in calendar year: 1988	1989	Number of potential spawners	Estimated sport catch	Estimated 1988 spawner population
Late-fall a/	5,971	+ 5,668 b/	= 11,639	223	= 11,416
Winter a/	9	+ 523 b/	= 532	5	= 527
Spring	-- c/	5,255	= 5,255	109	= 5,146
Fall	-- c/	84,056	= 84,056	2,329	= 81,727
Totals:	5,980	+ 95502	= 101,482	- 2,666	= 98,816

a/ Estimated numbers of these runs from 30 Nov. 1988 through 1 1 Apr. 1989 were calculated using the historical (1968-1985) average proportional distribution.

b/ Totals of 3,788 late-fall- and 8 winter-run salmon passed RBDD in the latter part of 1989 (Appendix 2). and were not included in these counts; these fish were considered 1990 spawners.

cl No 1989 spawners of these runs passed Red Bluff in 1988.

fish (Table 1) as a spawner population upstream of Red Bluff. Sixty-five late-fall salmon entered Coleman National Fish Hatchery (CNFH) through Battle Creek, leaving 11,351 fish as the mainstem spawner population (Appendix 3). Although some late-fall-run salmon may have used other tributaries of the upper Sacramento River, no spawner surveys were made in those streams. Numbers of those fish are included in the upper mainstem population, along with 817 late-fall-run salmon trapped at Keswick Dam that were hauled to CNFH for spawning. The estimated 11,351 fish late-fall spawner population for the upper Sacramento River was similar in size to the 1988 population of 11,324 fish, and 18% higher than the race's average run size from 1979 through 1988 (Appendix 5).

Winter run. An estimated 532 winter-run 1989 potential spawners passed RBDD in 1988 and 1989 (Appendix 2). The winter-run sport-catch was estimated to be five salmon, leaving a spawner population of 527 fish (Table 1) upstream of Red Bluff. Some winter-run salmon may have used Battle Creek, but no spawner surveys were made in that stream. Numbers of those fish are included in the upper mainstem population, along with 18 winter-run salmon trapped at Keswick Dam and 24 from RBDD that were hauled to CNFH for spawning. The 1989 winter-run spawner population upstream of RBDD was the lowest ever recorded, 75% lower than the 1988 population, and only 13% of the average run size for the previous 10 years (Appendix 5).

Spring run. An estimated 5,255 spring-run potential spawners passed RBDD in 1989 (Appendix 2). The spring-run sport-catch was estimated to be 109 salmon, leaving 5,146 fish as the spawner population upstream of Red Bluff (Table 1). Seven spring-run salmon entered CNFH and were released upstream, so the mainstem portion of the run as 5,139 fish (Appendix 3).

The 1989 spring-run spawner population upstream of RBDD was a decrease of 14% from the 1988 population, and only 45% of the average run size for the previous 10 years (Appendix 5).

Fall run. An estimated 84,056 fall-run potential spawners passed RBDD in 1989 (Appendix 2). The fall-run sport-catch was estimated to be 2,329 salmon, leaving 81,727 fish as a spawner population upstream of Red Bluff (Table 1). A total of 33,201 fish was estimated for Battle and Clear creeks, and the upper mainstem population was 48,526 salmon (Appendix 3). This population included fall-run salmon which used other tributaries to the mainstem that were not surveyed. The fall run in the Sacramento River system upstream of Red Bluff was a decrease of 26% from the 1988 population, but was still 10% higher than the average 1979-1988 population (Appendix 5).

Mainstem spawning distribution. The 1989 relative redd distribution of the four runs of salmon in the mainstem Sacramento River from Keswick Dam downstream to Red Bluff was determined from data collected by airplane during each run's spawning season. All the mainstem late-fall- and spring-run, nearly all (97.9%) of the winter-, and 82.9% of the fall-run spawning occurred upstream from RBDD (Table 2).

Clear Creek - by Richard E. Painter

Late-fall. No spawner surveys were conducted for these runs in this tributary during 1989.

Fall run. Eleven weekly mark-and-recovery surveys of Clear Creek were made between 2 October and 11 December 1989, in the 6.4 km (4 mi) stretch of river downstream from McCormick-Saeltzer Dam. Totals of 1,115 salmon carcasses, 655 live fish, and 624 redds were counted. A seasonal marked-fish recovery rate of 51.8% was used to expand the observed carcass numbers to an estimated 2,153 salmon as the 1989 spawner population.

An aerial survey was also made on 8 November 1989 from McCormick-Saeltzer Dam downstream to the creek's confluence with the Sacramento River, and a total of 122 redds was counted.

Based on a sample of 750 salmon carcasses, the spawner population consisted of 42.0% male adults (FL ≥ 64 cm [25.2 in]), 42.9% female adults, and 15.1% grilse (FL < 64 cm). Prespawning mortality averaged 1.5%.

TABLE 2. Chinook salmon relative redd distribution during 1989 in the mainstem Sacramento River from Keswick Dam to Princeton Ferry.

River section	Late-fall run		Winter run		Spring run		Fall run	
	Redds counted a/	Proportional distribution	Redds counted b/	Proportional distribution	Redds counted c/	Proportional distribution	Redds counted d/	Proportional distribution
Keswick Dam to A.C.I.D. Dam e/	0	0.0%	3	6.4%	0	0.0%	328	6.2%
A.C.I.D. Dam to Highway 44	0	0.0%	26	55.3%	35	34.7%	1,100	20.8%
Highway 44 to Upper Anderson Bridge	11	39.3%	10	21.3%	45	44.6%	1,079	20.4%
Upper Anderson Bridge to Balls Ferry	6	21.4%	1	2.1%	17	16.8%	820	15.6%
Balls Ferry to Jellys Ferry	8	25.6%	0	0.0%	4	4.0%	799	15.1%
Jellys Ferry to Bend Bridge	1	3.6%	6	12.8%	0	0.0%	223	4.2%
Bend Bridge to Red Bluff Dam	2	7.1%	0	0.0%	0	0.0%	28	0.6%
Red Bluff Dam to Tehama Bridge	0	0.0%	0	0.0%	0	0.0%	535	10.1%
Tehama Bridge to Woodson Bridge	0	0.0%	1	2.1%	0	0.0%	246	4.7%
Woodson Bridge to Hamilton City (Hwy. 32)	0	0.0%	0	0.0%	0	0.0%	67	1.3%
Hamilton City to Ord Ferry	0	0.0%	0	0.0%	0	0.0%	49	0.9%
Ord Ferry to Princeton Ferry	0	0.0%	0	0.0%	0	0.0%	7	0.1%
Totals:	28		47		101		5,281	

a/ Counts made during aerial surveys on 18 January 1989.

b/Counts made during 13 aerial surveys from 13 April and 11 August 1989.

c/ Counts made during aerial surveys on 14 September and 2 October 1989.

e/Counts made during four aerial surveys from 9 October through 20 November 1989.

d/Anderson -Cottonwood Irrigation District Dam.

Cow Creek - by Richard E. Painter

Spring Run. The north fork of Cow Creek historically supported a small spring-run salmon population. However, no salmon were seen during a snorkeling survey of a 3.2 km (2 mi) stretch of the creek on 13 September 1989. No estimate of the run was made.

Fall Run. A survey was made of a 5.6 km (3.5 mi) stretch of the south fork of Cow Creek on 6 October 1989. Three surveys of the mainstem were made from the confluence of the north and south forks to 6.9 km (4.3 mi) downstream during the period 1-15 November. Totals of 138 salmon carcasses,-95 live fish, and 95 redds were counted.

Aerial redd surveys were also made of the creek from 1 October through 4 December 1989. The lower 8.8 km (5.5 mi) of the north fork was covered three times, the lower 11.3 km (7 mi) of the south fork five times, and the mainstem from the confluence of both forks to the Sacramento River four times. A total of 76 redds was seen in the north fork, 63 redds in the south fork, and 225 redds in the mainstem. However, it was difficult to distinguish between old and fresh redds, so the totals may represent some repeated counts. The maximum numbers of redds counted for a single survey were 30, 23, and 70 in the north fork, south fork, and mainstem, respectively.

No estimate of the Cow Creek fall-run population was made.

Based on a sample of 121 salmon carcasses, the Cow Creek run consisted of 38.0% male adults (FL ≥ 64 cm [25.2 in]), 46.3% female adults, and 15.7% grilse (FL < 64 cm).

Bear Creek - by Richard E. Painter

Fall Run. Bear Creek was surveyed from its mouth to 16.9 km (10.5 mi) upstream. The lower reach of this stretch was covered on 16 November 1989, and the upper reach was surveyed on 1 December. A total of 36 salmon carcasses, one live fish, and 30 redds was counted. A population estimate was not made.

Ash Creek - by Richard E. Painter

Fall Run. Ash Creek was surveyed from its mouth to 8.3 km (5.2 mi) upstream. The lower reach of this stretch was covered on 24 November 1989, and the upper reach was surveyed on 1 December. A total of seven salmon carcasses was counted. Neither live fish nor redds were observed. A population estimate was not made.

Cottonwood Creek - by Richard E. Painter

Spring run. A 1.6 km (1.0 mi) stretch of the south fork of Cottonwood Creek was surveyed by snorkeling on 11 September 1989. No salmon carcasses, live fish, or redds were observed. It was felt that low flow conditions made holding pools too shallow, and the water too warm (17.2-19.5° [63-67°]) to support a spring run.

Fall run. One ground survey and five aerial surveys of Cottonwood Creek were made from 9 October through 4 December 1989.

The ground survey covered the lower 8.3 km (5.2 mi) of the creek's mainstem, where 34 salmon carcasses, 14 live fish, and 18 redds were counted.

Aerial redd surveys covered the lower 18.3 km (8.0 mi) of the north fork, the lower 31.3 km (19.4 mi) of the south fork, and the 35 km (21.7 mi) of the mainstem from its mouth to the confluence with the north fork. Only 1 redd was observed in the north fork. Totals of 43 redds in the south fork, and 772 redds in the mainstem were counted. However, it was difficult to distinguish between old and fresh redds, so the totals may represent some repeated counts. The maximum numbers of redds counted for a single survey were 26 in the south fork, and 333 in the mainstem.

A fall-run population estimate was not made.

Battle Creek - by Richard E. Painter

Late-fall, winter, and spring runs. No spawner surveys were conducted for the 1989 runs in Battle Creek. The only available spawner data were for 65 late-fall run salmon taken into CNFH, and seven spring-run salmon which entered CNFH and were released upstream.

Fall run. Twelve weekly surveys were conducted from 2 October through 18 December 1989. Surveys covered the 5.6 km (3.5 mi) stretch of river between CNFH and the old hatchery location, and Gover's Ditch, an irrigation diversion about 1 km (0.6 mi) long located 1.6 km (1.0 mi) downstream from CNFH. A total of 8,906 salmon carcasses were observed, and based on a recovery rate of 47.3%, the in-river fall run was estimated to be 18,829 fish. Combined with an additional 12,219 fish which entered CNFH (233 of which were released upstream), the total Battle Creek fall-run population was 31,048 salmon (Appendix 3).

The composition of fall-run salmon in Battle Creek was 32.8% male adults (fork length (FL) > 64 cm [25.2 in]), 62.1% female adults, and 5.1% grilse (FL ≤ 64 cm), based on an examination of 6,609

carcasses. In comparison, fish entering CNFH consisted of 50.4% male adults, 34.8% female adults, and 14.8% grilse.

The total 1989 fall run size for Battle Creek of 31,048 fish was only 46% of the record 1988 run, but was still 7% higher than the average run size for 1979 through 1988 (Appendix 5).

Inks Creek - by Richard E. Painter

Fall Run. One survey of Inks Creek was made on 7 November 1989, covering the 5.6 km (3.5 mi) stretch from its mouth to the confluence with the south fork. Ten salmon carcasses, four live fish, and three redds were observed. A population estimate was not made.

Paynes Creek - by Richard E. Painter

Fall run. Four surveys were conducted on the lower 7.2 km (4.5 mi) of Paynes Creek between 3 October and **16** November 1989. Totals of 24 salmon carcasses, five live fish, and **13** redds were observed. A spawner population estimate was not made.

Red Bluff Diversion Dam to Princeton Ferry

Chinook salmon spawner populations in the mainstem Sacramento River downstream of RBDD to Princeton Ferry (Figure 2) were determined through aerial redd counts. Tributaries in this area that were individually surveyed were Salt, New, Antelope, Craig, Dye, Coyote, Elder, Mill, Thomes, Toomes, Deer, and Stoney creeks. Population estimates were made only for the mainstem, and Mill and Deer creeks.

A total of 12,638 chinook salmon spawners was estimated for the Sacramento River system between Red Bluff and Princeton Ferry in 1989 (Appendix 3). This total consisted of 12 winter-, 647 spring-, and 11,979 fall-run salmon.

Due to the RBDD gates being opened, the Tehama-Colusa Spawning Channel was not operated, and no salmon were counted entering that facility.

Sacramento River Mainstem - by Richard E. Painter

Late-fall run. During a single aerial survey on 18 January 1989, no redds were observed in the mainstem Sacramento River downstream of Red Bluff, and this run's population in this area was assumed to be zero.

Winter run. Based on 13 weekly aerial surveys between 13 April and 11 August 1989, an estimated 12 winter-run salmon were in the mainstem Sacramento River downstream of Red Bluff to Tehama.

Spring run. The mainstem Sacramento River downstream of Red Bluff was covered by a single aerial survey on 14 September 1989; although a second flight was made during the spring-run spawning period, only the mainstem upstream of Red Bluff was covered. No redds were observed in the mainstem downstream of RBDD, and the spring-run population in this area was assumed to be zero.

Fall run. Based on four aerial surveys from 9 October through 20 November 1989, 10,056 fall-run salmon were estimated for the mainstem Sacramento River between RBDD and Princeton Ferry. This run size was only 46% of the 1988 population, and 7% higher than the average run size from 1979 to 1988 (Appendix 5).

Mainstem spawning distribution. Redd counts made during the aerial surveys in 1989 were used to determine the relative spawning distribution of the four runs of salmon in the mainstem Sacramento River between Red Bluff and Princeton Ferry (Table 2). In proportion to the entire mainstem (including upstream of RBDD) spawning activity, none of the late-fall-, 2.1% of the winter-, none of the spring-, and 17.1% of the fall-run redds were observed this section of the river.-

Salt Creek - by Richard E. Painter

Fall run. One survey was made on 22 November 1989 of a 2.5 km (1.5 mi) section of Salt Creek, 12.5 km (7.7 mi) upstream from its mouth. The creek was accessible to upstream migration of salmon only after a heavy rainstorm in late October. Three carcasses, and no live fish or redds were observed. A population estimate was not made.

New Creek - by Richard E. Painter

Fall Run. One survey of New Creek from the HwY.99E bridge to the Salt Creek confluence was made on 29 November 1989. No salmon carcasses, live fish, or redds were observed. A population estimate was not made.

Antelope Creek - by Richard E. Painter

Spring run. Three surveys of the upper section of Antelope Creek were made from 1 through 15 August 1989. Only two live adult salmon were observed. A population estimate was not made.

Fall run. Surveys in Antelope Creek were made on 27 October and 4 December 1989. The first survey covered the stretch of creek starting 5.0 km (3.1 mi) from its mouth to 10.5 km (6.5 mi) upstream. The second survey covered approximately one-tenth of this same stretch. Totals of 25 salmon carcasses, nine live fish, and 27 redds were observed. A spawner population estimate was not made.

Crais Creek - by Richard E. Painter

Late-fall run. Late-fall-run salmon are known to enter Craig Creek, but no surveys were conducted in 1989.

Fall run. Four surveys of Craig Creek were made between 31 October and 5 December 1989 in a 1.3 km (0.75 mi) stretch of stream starting 0.8 km (0.5 mi) upstream of its mouth. Totals of five salmon carcasses, 23 live fish, and seven redds were observed. A spawner population estimate was not made.

Dye Creek - by Richard E. Painter

Fall run. A survey of the 2.4 km (1.5 mi) stretch of Dye Creek 4.2 km (2.6 mi) upstream of its mouth was made on 4 December 1989. No salmon carcasses, live fish, or redds were observed. When this survey was made there was insufficient flow in this tributary to accommodate spawners. An estimate of the population was not made.

Coyote Creek - by Richard E. Painter

Fall Run. Surveys were made of Coyote Creek on 14 November and 7 December 1989 from its mouth to the Tehama-Colusa Spawning Channel. One hundred salmon carcasses, 11 live fish, and 60 redds were counted, but a spawner population estimate was not made. Despite the number of salmon which may have been in the creek, any spawning which did occur would not have produced surviving young since the creek became dewatered when the RBDD dam gates were raised.

Elder Creek - by Richard E. Painter

Fall Run. Weekly surveys of a 0.8 km (0.5 mi) stretch of this tributary starting 5.4 km (3.4 mi) upstream of its mouth were made in October, November, and early December 1989. When the last survey was conducted, the stream had become dry. No salmon carcasses, live fish, or redds were observed. A population estimate was not made.

Mill Creek - by Richard E. Painter and Colleen Harvey

Spring run. In 1989, spring-run salmon were monitored immigrating past Clough Dam. Passage through a 1.2-m long by 0.45-m diameter (4-ft L x 1.5-ft D) tunnel located at the upstream end of the fish ladder, was recorded by a Smith-Root Model 602 electronic fish counter. A total of 556 upstream-passages was counted from 27 April through 27 June 1989. This period covered an estimated 98.7% of the historic (1954-1963) spring-run migration past the dam[2/], and an expansion (556/.987) to account for the entire run resulted in an estimated 563 salmon for 1989.

During the spring-run spawning period the stretch of upper Mill Creek 4.8 km (3.0 mi) upstream from Blackrock was snorkeled on 9 August 1989. Three representative sections of a stretch of stream from the Hwy.36 Bridge to Blackrock were also snorkeled between 27 September and 5 October. Totals of only two salmon carcasses, 15 live fish, and 12 redds were observed.

Fall run. Between 4 October and 5 December 1989, eight surveys were made of the lower 13.0 km (8.0 mi) of Mill Creek, during which a total of 667 live salmon and 458 redds was counted. A total of 551 salmon carcasses was also recovered, and based on a 35.2% recovery rate, the fall run was estimated to be 1,565 spawners.

The composition of the fall run, based on examination of 334 carcasses, was 48.8% male adults (FL > 64 cm [25.2 in], 42.8% female adults, and 8.4% grilse (FL ≤ 64 cm). Prespawning mortality was 2.8%.

Thomes Creek - by Richard E. Painter

Fall Run. A ground survey was conducted on 4 December 1989 from the mouth of Thomes Creek to 10 km (6.2 mi) upstream, during which three salmon carcasses, no live fish, and 13 redds were counted. On the same date, an aerial survey covered an additional 30.1 km (18.7 mi) stretch upstream to Paskenta, and seven redds were observed. A spawner population estimate was not made.

Toomes (Dry) Creek - by Richard E. Painter

Fall run. The upper section of Toomes Creek was surveyed on 9 November 1989, and the lower section on 5 December. The lower

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[2/] Memorandum to Eldon Hughes from W. VanWoert, Mill Creek Counting Station. California Department of Fish and Game, Central Valley Project Office. May 1964. 7p.

section was dry, with only isolated pools. No salmon carcasses, only two live fish, and no redds were observed. A population estimate was not made.

Deer Creek - by Richard E. Painter

Spring run. In August 1989, spring-run salmon were counted by snorkeling a section of the creek from Deer Creek Falls to 10.5 **km** (6.5 mi) downstream. This stream section was shorter than the "indicator reach used to develop a relationship between snorkeling counts and Stanford-Vina dam ladder counts of salmon in 1986, and to estimate the run size in 1987[3/]; in that relationship, the indicator reach count represented 31% of the run. This year's stream section was assumed to represent 28.6% of the run, and the total snorkeling count of 24 salmon was expanded to 84 fish for the 1989 run.

Fall run. Six surveys were made in lower Deer Creek between 25 October and 6 December 1989, covering the 7.7 km (4.8 mi) stretch of stream between the monastery and the Leininger Bridge. Fifty-one live salmon and 65 redds were observed. A total of 129 salmon carcasses was also recovered, and based on a 36.0% recovery rate, the fall run was estimated to be 358 spawners.

The composition of the fall run, based on examination of 105 carcasses, was 32.4% male adults (FL > 64 cm [25.2 in], 30.5% female adults, and 37.1% grilse (FL ≤ 64 cm). Prespawning mortality averaged 6.2%.

Stoney Creek - by Richard E. Painter

Fall run. On 30 November 1989, a ground survey covered Stoney Creek from the Hwy.I-5 bridge to 16.7 km (10.4 mi) downstream. On 4 December, an aerial survey was made of the creek from its mouth to 31.2 km (19.4 mi) upstream. During both surveys the stream from its mouth to the Glenn-Colusa Irrigation Ditch was dry. No salmon carcasses or live fish, and only two redds were observed. A spawner population estimate was not made.

3/ File report of 1986 and 1987 spring-run salmon surveys, from Emil Eckman, U.S. Forest Service, to the Lassen National Forest Resource Office, 17 November 1987.

Big Chico Creek to the American River

Chinook salmon spawner population estimates for the Feather, Yuba, and American rivers (Figure 3) were made from weekly mark-and-recovery surveys of salmon carcasses. The only other tributary in this area that was surveyed was Butte Creek.

A total of 91,043 chinook salmon was estimated for the Sacramento River tributaries from Butte Creek to the American River in 1989. This total consisted of 6,378 spring-run and 84,665 fall-run fish (Appendix 3).

Big Chico Creek - by Mary Faustini

Spring run. Three snorkeling surveys during May-June 1989 were made of Big Chico Creek through Upper and Lower Bidwell Park, but no adult salmon were observed in this area. On **15** June, seven adult salmon were counted in Higgins Hole, a holding pool approximately 0.8 km (0.5 mi) upstream of Ponderosa Way; this pool is considered to be the upper extent to which salmon migrate in this creek. The stretch between Bidwell Park and Ponderosa Way was not surveyed, but it is possible more salmon were holding there. The spring-run population was not estimated.

Fall run. Fall-run salmon are known to enter Big Chico Creek, but no surveys were conducted in 1989.

Butte Creek - by Mary Faustini

Spring run. Snorkel surveys were conducted, on 29-30 June and 24-25 August 1989, of spring-run salmon holding areas from the Centerville Head Dam to the Helltown Bridge. Counts of live salmon ranged from 875 to 1,010 fish.

Spawner surveys were conducted during 3-5 October 1989, in the river stretch from the Centerville Head Dam to the Covered Bridge. PG&E biologists reported excellent water clarity in the stretch from the Head Dam to the Powerhouse, and counted 270 salmon carcasses, 230-240 live fish, and 275-300 redds. DFG biologists surveyed the stretch of stream from the Powerhouse to the Covered Bridge, where visibility through the water was poor due to turbidity. Totals of 79 salmon carcasses, 267 live fish, and 303 redds were observed. Based on these combined observations it was felt that the spring-run spawner population was about 1,300 salmon. This was comparable to the 1988 spring run of 1,290 fish which was the largest since the 1963 population of 4600 salmon (Menchen 1964).

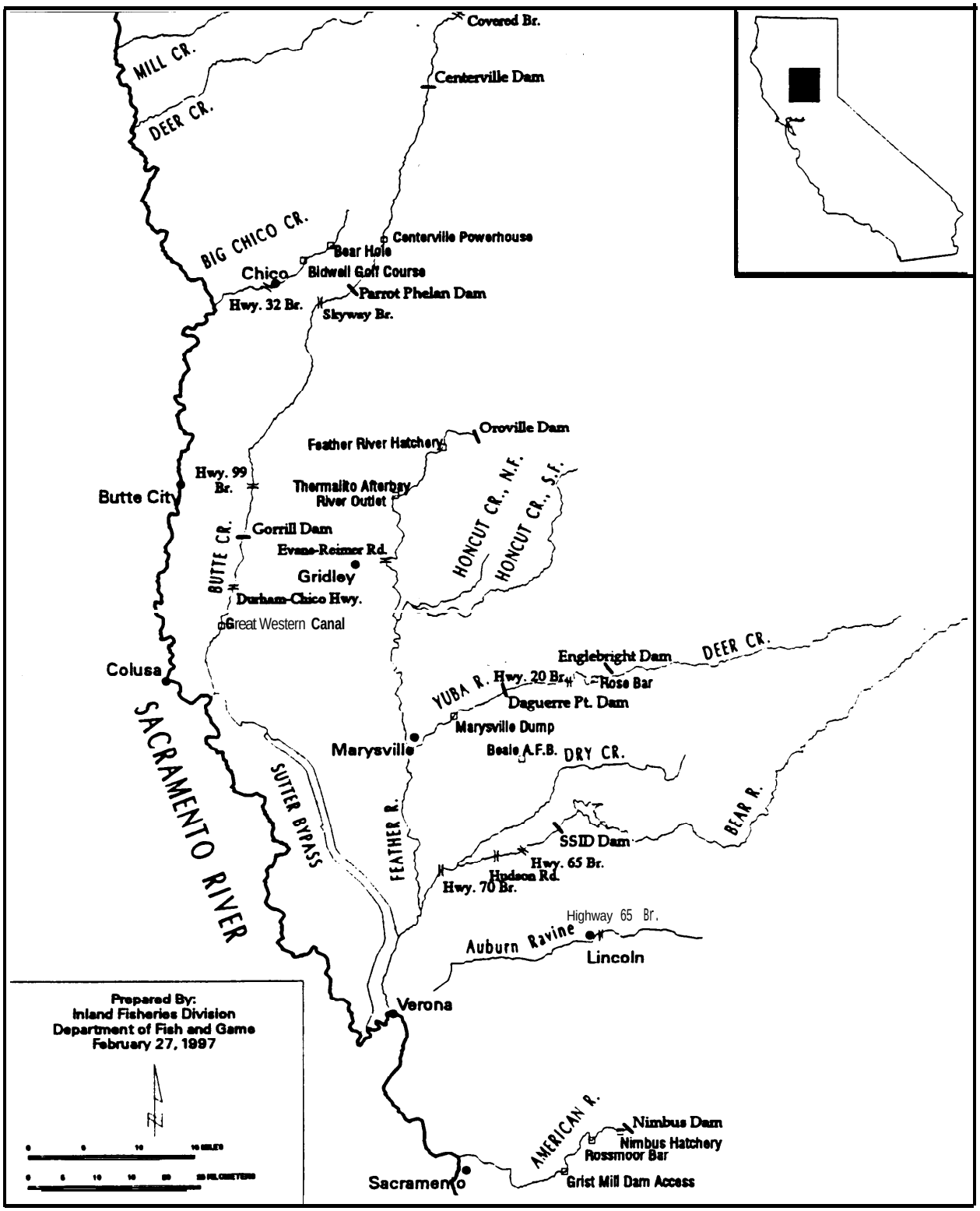

FIGURE 3. Sacramento River system from Big Chico Creek downstream to the American River.

Fall run. Three surveys of Butte Creek from HwY.99 to Midway Road were made between 16 October and 15 November 1989. Only five live salmon were observed. A population estimate of the fall run was not made.

Feather River - by Mary Faustini

Spring run. From 7 September through 1 October 1989, 5,078 salmon classified as spring-run fish (Schlicting 1993) entered Feather River Hatchery (FRH). These fish consisted of 43.5% male adults (FL ≥ 68 cm [26.8 in]), 42.9% female adults, and 13.6% grilse (FL < 68 cm). In the river itself, the period of spring-run spawning could not be distinguished from the fall-run spawning period, and no attempt was made to estimate numbers of in-river spring-run salmon.

The 5,078 spring-run salmon at FRH in 1989 was 34% lower than the 1988 run (which was the highest ever recorded), but still almost three times the average number observed in the past 10 years (Appendix 5).

Fall run. Weekly carcass mark-and-recovery surveys of fall-run salmon were conducted in the Feather River from 10 October to 12 December 1989. The river between the hatchery barrier dam and East Gridley Road was covered. This area was surveyed in two sections, characterized by different flow regimes. The stream section between the hatchery barrier dam and Thermalito Afterbay Outlet, a "low-flow section", had stream flows ranging from 17.3 to 19.2 m^3/s (610-680 cfs) throughout the survey period. Flow downstream of Thermalito Afterbay Outlet to East Gridley Road ranged from 50.9 to 169.8 m^3/s (1800-6000 cfs), with the higher flows occurring toward the end of the survey period. Visibility through the water in the upstream section ranged from 1.8-3.0 m (6-10 ft) throughout the surveys. In the downstream section, visibility during the first and last week of surveys was less than 0.3 m (1.0 ft), but otherwise ranged from 1.8 to 2.4 m (6-8 ft).

This season, only adult salmon carcasses, regardless of their state of decomposition, were marked for use in estimating the population. This was a change in procedure from past seasons when only fresh adult and grilse carcasses were marked. Fresh, clear-eyed carcasses were marked on the upper jaw, while decayed carcasses were marked on the lower jaw. Due to the large run size this year, at times it was only possible to mark about one-tenth of the decayed carcasses seen.

Schaefer (Appendix l.B) estimates, calculated from the mark-and-recovery data, for the upstream low-flow section were 26,997 adult salmon, and 9,490 adults for the downstream section (Table 3, Table 4). Combining these numbers and expanding for a 10% grilse proportion gave a total in-river estimate of 40,541 fish.

TABLE 3. Chinook salmon carcass mark-and-recovery data used to estimate the 1989 fall-run adult spawner population in the section of the Feather River from Feather River Hatchery to the Thermlito Afterbay Outlet. a/

Recovery period (j)	Number of marked carcasses recovered from marking period (i): 1	2	3	4	5	6	7	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) b/	Population estimate (N) c/
2	42	--	--	--	--	--	--	42	996	2,430
3	7	88	- -	- -	- -	- -	- -	95	2,973	9,084
4	1	25	228	- -	- -	- -	- -	254	2,693	7292
5		2	36	181	--	- -	- -	219	1,854	4,672
6			5	42	107	- -	- -	154	916	2,699
7				1	18	30	--	49	410	1,300
8				1	2	3	28	34	303	810
9					1		6	7	352	939
Total recovered (Ri):	50	115	269	225	128	33	34		Total:	29226
Total carcasses marked (Mi):	122	357	717	559	402	106	88			
								Adjusted estimate d/: 26,997		

a/ Surveys were conducted from 10 October to 12 December 1989.

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

c/Schaefer (1951) estimate equation: $N = \Sigma (Rij \times (Mi/Ri) \times (Cj/Rj))$.

d/ 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, i.e. 29226 – 2,229 = 26,997.

TABLE 4. Chinook salmon carcass mark-and-recovery data used to estimate the 1989 fall-run adult spawner population in the section of the Feather River from Thermalito Afterbay Outlet to the East Gridley Road. a/

Recovery period (j)	Number of marked carcasses recovered from marking period (i): 1	2	3	4	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) b/	Population estimate (N) c/
2	9	- -	- -	- -	9	424	2,968
3		13	- -	- -	13	505	3263
4			38	- -	38	427	1,631
5			1	12	13	265	**1,847**
6				1	1	15	108
Total recovered (Ri):	9	13	39	13			Total: 9,817
Total carcasses marked (Mi):	63	84	149	94			
					Adjusted estimate d/:		**9,490**

a/ Surveys were conducted from 5 November to 10 December 1389.

b/ includes salmon carcasses which were marked and marked carcasses that were recovered.

c/ Schaefer (1951) estimate equation: $N = \Sigma (Rij \times (Mi/Ri) \times (Cj/Rj))$.

d/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, i.e. 9,817 – 327 = 9,490.

A total of 7,578 fall-run salmon entered FRH (Schlicting 1993), bringing the 1989 fall run in the Feather River to 48,119 fish.

The composition of salmon in the river, based on examination of 3,719 fresh carcasses, was 42% male adults (FL ≥ 68 cm [26.8 in]), 48% female adults, and 10% grilse (FL < 68 cm). In comparison, salmon entering FRH consisted of 42.1% male adults, 43.4% female adults, and 14.5% grilse.

The 1989 population of 48,119 salmon was only slightly lower than both that of the previous year and the average population from 1979 to 1988 (Appendix 5).

Yuba River - by Mary Faustini

Spring Run. A survey of the Yuba River from Englebright Dam to 1.6 km (1.0 mi) upstream of Parks Bar bridge (Hwy. 20) was conducted on-foot on 6 October 1989. Approximately 150 live salmon and 140-160 redds were observed. An estimate of the spawner population was not made.

Fall run. Weekly salmon carcass mark-and-recovery surveys were conducted from 12 October through 6 December 1989 in the Yuba River from the Parks Bar bridge (Hwy.20) downstream to Marysville. Surveys of the fall run were not conducted upstream of Hwy. 20. River flow upstream of Daguerre Point Dam ranged from 23.6 to 26.1 m^3/s (833-923 cfs), while downstream of the dam flows were 20.1 to 20.7 m^3/s (710-730 cfs) throughout the survey period.

This season, only adult carcasses, regardless of their state of decomposition, were marked for use in estimating the population. This was a change in procedure from past seasons when only fresh adult and grilse carcasses were marked. Fresh, clear-eyed carcasses were marked on the upper jaw, while decayed carcasses were marked on the lower jaw.

Using carcass mark-and-recovery data with the Schaefer calculations (Appendix l.B), 5,762 adult salmon were estimated as the spawner population between the Hwy.20 bridge and Marysville (Table 5). The estimate was expanded to include a 16% grilse proportion, for a total population of 6,860 fish in the surveyed area. The spawner population for the area upstream of Hwy. 20 to Rose Bar was calculated assuming that spawners in this section constituted a 10% proportion of the total river's population. Including this section's population of 762 salmon, the total estimated 1989 Yuba River spawner population was 7,622 salmon.

The composition of the run based on examination of fresh carcasses was 43% male adults (FL ≥ 68 cm [26.8 in]), 41% female adults, and 16% grilse (FL < 68 cm).

TABLE 5. Chinook salmon carcass mark-and-recovery data used to estimate the 1989 fall-run adult spawner population in the Yuba River from the Parks Bar Bridge (Hwy. 20) to Simpson Lane in Marysville. a/

Recovery period (j)	Number of marked carcasses recovered from marking period (i): 1	2	3	4	5	6	7	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) b/	Population estimate (N) c/
2	1	- -	- -	- -	- -	- -	- -	1	105	315
3		3	- -	- -	- -	- -	- -	3	99	668
4		1	15	--	--	--	--	16	229	580
5			5	32	--	--	--	37	580	1,208
6				0	19	--	--	19	187	1,309
7				2	9	11	--	22	242	1313
8				0	2	1	23	26	215	447
9				1	1		5	7	160	383
Total recovered (Ri):	1	4	20	35	31	12	28		Total:	6,223
Total carcasses marked (Mi):	3	27	45	72	217	57	43			
								Adjusted estimate d/:		**5,762**

a/ Surveys were conducted from 12 October through 6 December 1989.

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

c/ Schaefer (1951) estimate equation: $N = \Sigma (Rij \times (Mi/Ri) \times (Cj/Rj))$.

d/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, i.e. 6,223 – 461 = 5,762.

The 1989 run of 7,622 salmon was 85% of the previous year's population, and only 47% of the average run size from 1979 to 1988 (Appendix 5).

American River - by Maury Fjelstad

Fall run. Weekly salmon carcass mark-and-recovery surveys were conducted between 7 November and 28 December 1989 in the 14.5-km (9-mi) reach of the American River from the Grist Mill access upstream to the Nimbus Hatchery racks. River flows in this section averaged 67.9 m^3/s (2400 cfs), but varied greatly during the survey period. Flows ranged from 42.5 to 113.9 m^3/s (1500-4022 cfs), resulting in water level fluctuation of up to 1 m (3 ft) in some parts of the river; as a consequence, some of the redds were possibly dewatered.

The spawner population in the Nimbus Basin (upstream of the Nimbus racks) was also surveyed, concurrently with the downstream section, through counts of carcasses found washed up on the racks or along the shore.

This season, only adult carcasses, regardless of their state of decomposition, were marked for use in estimating the population. This was a change in procedure from past seasons when only fresh adult and grilse carcasses were marked. Fresh, clear-eyed carcasses were marked on the upper jaw with colored engineer's flagging attached by hog rings, while decayed carcasses were marked on the lower jaw. Due to the large numbers of spawners, at times it was only possible to mark about half of the decayed carcasses seen. Marked carcasses were either replaced into running water when possible, or left in place in backwater areas.

The adult salmon spawner population of the Goethe Park to Nimbus racks section, estimated from mark-and-recovery data using the Schaefer model (Appendix l.B) was 15,179 fish (Table 6). The adult estimate was expanded to include a 14% grilse proportion, for a total of 17,650 fish in this section. Upstream of the Nimbus racks, 1,533 spawners were estimated. The two combined estimates gave 19,183 salmon within the river. An additional 9,741 salmon entered Nimbus Hatchery (Ducey 1991), bringing the total American River 1989 fall-run population to 28,924 fish.

The composition of 1,070 fresh salmon carcasses examined was 40% male adults (FL ≥ 68 cm [26.8 in]), 46% female adults, 13% male grilse (FL < 68 cm), and 1% female grilse. In comparison, fall-run salmon entering the Nimbus Hatchery in 1989 consisted of 42.1% male adults (FL ≥ 60 cm [23.6 in)), 42.6% female adults, and 5.3% grilse (FL < 60 cm).

The 1989 run of 28,923 salmon was about 14% lower than the previous year's population, and 60% of the average run size from 1979 through 1988 (Appendix 5).

TABLE 6. Chinook salmon carcass mark-and-recovery data used to estimate the 1989 fall-run adult spawner population in the American River from the Nimbus Racks to the Grist Mill Access. a/

Recovery period (j)	Number of marked carcasses recovered from marking period (i): 1	2	3	4	5	6	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) b/	Population estimate (N) c/
2	15	--	--	--	—	--	15	533	1,399
3	0	24	—	—	--	—	24	1,054	5,125
4	1	3	106	--	—	--	110	1,583	2,893
5		1	23	84	--	--	108	1,701	2,406
6		0	7	12	67	--	86	1,122	2,551
7		1	1	2	8	59	71	785	1392
8			2			2	4	124	209
Total recovered (Ri):	16	29	139	98	75	61		Total:	15,975
Total carcasses marked (Mi):	42	141	241	126	188	100			

Adjusted estimate d/: 15,179

a/ Surveys were conducted from 7 November to 28 December 1989.

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

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

d/ 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, i.e. 15,975 – 7% = 15,179.

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 3,493 salmon, consisting entirely of fall-run fish, was estimated for 1989 (Appendix 4).

Cosumnes River to the Calaveras River

Cosumnes River

Fall run. This tributary was not surveyed.

Mokelumne River

Fall run. A spawner population of about 200 salmon was thought to have been present. Combined with the 81 salmon which entered the Mokelumne River Hatchery (Estey 1992), the 1989 fall-run spawner population was 281 fish. The composition of the salmon entering the hatchery was 28.4% male adults (FL ≥ 61 cm [24 in]), 32.1% female adults, and 39.5% grilse (Fl < 61 cm).

The 1989 run was only 53% of the previous year's population, and was only 5% of the average population size estimated from 1979 through 1988 (Appendix 5).

Calaveras River

This tributary was not surveyed in 1989.

Stanislaus River to the Merced River

Stanislaus River - by Steven 3. Baumgartner

Fall run. The 1989 Stanislaus River fall-run salmon spawner population was estimated using data collected during carcass mark-and-recovery surveys conducted from 21 October through 29 December. Surveys were made on-foot in the Goodwin Dam and Two Mile Bar areas, while the 30.9 km (19.2 mi) stretch from Knights Ferry downstream to Riverbank was covered by boat. River flows at the Orange Blossom Bridge ranged from 4.9 to 8.4 m^3/s (175-297 cfs), while water temperatures ranged from 14.3°C (57.3°F) in late October to 10°C (50°F) in late December. Visibility through the water was often greater than 3.0 m (10 ft)

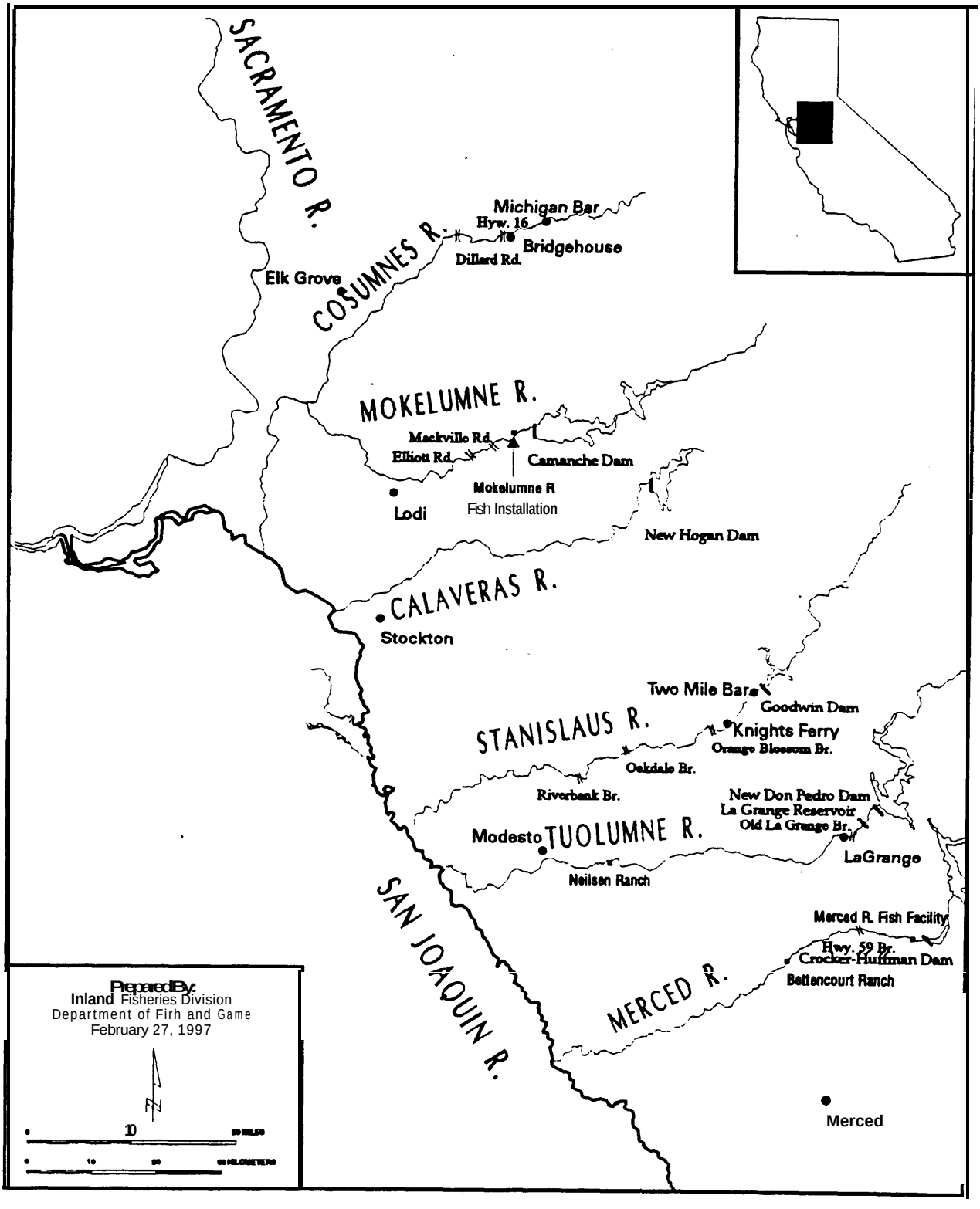

FIGURE 4. San Joaquin River system from the Merced River downstream to the Cosumnes River.

except during a late-October storm which obscured the water surface for a short period.'

This season, fresh and decayed adult salmon carcasses and only fresh grilse carcasses were marked using plastic ribbon attached to a jaw with a hog-ring. Combinations of colors and patterns of ribbons differentiated categories of carcasses each week. Marked carcasses were released into running water for subsequent recovery. Carcasses of decayed grilse salmon and skeletons were only counted and chopped in half to prevent recounting.

The carcass marking protocol was intended to allow use of the data in estimating the population with either the Schaefer or Jolly-Seber models (Appendix l.B or l.C). Post-season analysis of the data indicated that the Schaefer estimation was the more appropriate technique.

The salmon population of the Knights Ferry to Riverbank section was estimated at 1,311 fish using the fresh adult and grilse mark-and-recovery data with the Schaefer calculations (Table 7). Petersen (Appendix l.A.2) estimates of 43 fish and 156 fish were calculated for the Goodwin Dam and Two-Mile Bar areas, respectively. The combined estimates resulted in a 1989 fall run of 1,510 fish for the Stanislaus River.

The run consisted of 41% male adults (FL ≥ 61 cm [24 in]), 56.1% female adults, 1.0% male grilse (FL < 61 cm), and 1.9% female grilse, based on examination of fresh salmon carcasses.

The total estimated Stanislaus River 1989 fall-run spawner population of 1,511 salmon was a decrease of 85% from the previous year's population, and only 30% of the average run size for the past ten years (Appendix 5).

Tuolumne River - by John C. Polzine

Fall run. The 1989 fall-run chinook salmon spawner surveys in the Tuolumne River were conducted from 24 October through 29 December. The run started later than in past seasons, partially due to low flow conditions in the river. Poor water quality in the south Sacramento-San Joaquin Delta may also have delayed immigration. River flows downstream of LaGrange Dam were 5.1 m^3/s (180 cfs) through the end of November and decreased to 3.4 m/s (120 cfs) by mid-December. Flows averaged 4.6 m^3/s (163 cfs) during the surveys, and visibility through the water was usually not less than 5 m (16.5 ft). Water temperature decreased from 13.3°C (56°F) in October to 10.9°C (51.6°F) in late December.

Carcass mark-and-recovery surveys were conducted in the river stretch from Old LaGrange Bridge downstream to Fox Grove Regional

TABLE 7. Chinook salmon carcass mark-and-recovery data used to estimate the 1989 fall-run spawner population in the Stanislaus River from Knights Ferry to Riverbank. a/

Recovery period (j)	Number of marked carcasses recovered from marking period (i): 1	2	3	4	5	6	7	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) b/	Population estimate c/
2	2	- -	- -	- -	- -	- -	- -	2	63	189
3		9	- -	- -	- -	- -	- -	9	137	259
4			20	--	-- --		—	20	164	239
5			3	18	--	--	--	21	186	287
6			1	7	16	--	--	24	143	233
7					1	8	- -	9	84	153
8					4	2	9	15	55	82
9						3		3	17	31
Total recovered (Ri):	2	9	24	25	21	13	9		Total:	1,473
Total carcasses marked (Mi):	6	17	35	39	35	24	12			
								Adjusted estimate d/:		**1,311**

a/ Surveys were conducted from 21 October to 29 December 1989.

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

c/ Schaefer (1951) estimate equation: $N = \Sigma(Rij \times (Mi/Ri) \times (Cj/Rj))$.

d/ 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, i.e. 1,473 – 162 = 1,311.

Park, a distance of 38.5 km (24 mi). This season, fresh and decayed adult salmon carcasses and only fresh grilse salmon carcasses were marked using plastic ribbon attached to a jaw with a hog-ring. Combinations of colors and patterns of ribbons differentiated categories of carcasses each week. Marked carcasses were released into running water for subsequent recovery. Carcasses of decayed grilse salmon and skeletons were only counted and chopped in half to prevent recounting.

The carcass marking protocol was intended to allow use of the data in estimating the population with either the Schaefer or Jolly-Seber models (Appendix l.B and l.C). Post-season analysis of the data indicated that the Schaefer estimation was the more appropriate technique.

The population in the river section between Old LaGrange Bridge and Fox Grove Regional Park was estimated to be 1,179 salmon, using the fresh carcass mark-and-recovery data with the Schaefer calculations (Table 8). Based on redd counts made by Turlock Irrigation District personnel, an additional 96 fish were estimated for the river stretches up- and downstream of the mark-and recovery survey area. The total estimated 1989 fall-run spawner population for the Tuolumne River was 1,275 salmon.

The run consisted of 45% male adults (FL $\geq$ 61 cm [24 in]), 51.5% female adults, 3% male grilse (FL < 61 cm), and 0.5% female grilse. The lengths used to separate adults from grilse were determined from length frequency distributions of 367 fresh salmon carcasses.

The 1989 run of 1,275 fall-run salmon was 22% of the previous year's population, and only 11% of the average run size for 1979 to 1988 (Appendix 5); salmon populations during the past ten years have ranged from a low of 559 fish in 1980 to the record high of 40,322 fish in 1985.

Merced River - by Sharon N. Shiba

Fall run. Weekly carcass mark-and-recovery surveys were conducted in the 16.1 km (10 mi) stretch of the Merced River from Crocker-Huffman Dam downstream to the HWY.59 bridge. Surveys began on 24 October 1989 and were completed on 5 January 1990. Redd surveys of the river downstream of HWY. 59 were not possible this year, due to water hyacinth growth.

River flows during the survey period ranged from 0.95 to 4.9 m^3/s (34-173 cfs), and water temperatures decreased from 17.8°C (64°F) in late October to 9.48°C (49°F) in January. Visibility through the water was greater than 2 m (6.6 ft) throughout the survey period.

TABLE 8. Chinook salmon carcass mark-and-recovery data used to estimate the 1989 fall-run spawner population in the Tuolumne River from the Old LaGrange Bridge to Fox Grove Regional Park. a/

Recovery period (j)	Number of marked carcasses recovered from marking period (i): 1	2	3	4	5	6	7	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) b/	Population estimate (N) c/
2	1	--	2 - -	- -	- -	- -	- -	1	15	15
3		2	- -	- -	- -	- -	- -	2	80	280
4			22	- -	- -	- -	- -	22	151	209
5			5	39	- -	- -	- -	#	159	267
6			4	4	16	- -	- -	24	122	234
7				1	1	14	- -	16	loo	183
8				2	2	6	23	33	96	158
9						2	2	4	48	81
Total recovered (Ri):	1	2	31	46	19	22	25		Total:	1,427
Total carcasses marked (Mi):	1	7	43	79	40	40	39			
								Adjusted estimate d/:		**1,179**

a/ Surveys were conducted from 24 October to 29 December 1989.

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

c/ Schaefer (1951) estimate equation: N = ∑(Rij x (Mi/Ri) x (Cj/Rj)) .

d/ 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, i.e. 1,427 – 248 = 1,179.

This season, fresh and decayed adult salmon carcasses and only fresh grilse salmon carcasses were marked using plastic ribbon attached to a jaw with a hog-ring. Combinations of colors and patterns of ribbons differentiated categories of carcasses each week. Marked carcasses were released into running water for subsequent recovery. Carcasses of decayed grilse salmon and skeletons were only counted and chopped in half to prevent recounting.

The carcass marking protocol was intended to allow use of the data in estimating the population with either the Schaefer or Jolly-Seber models (Appendix l.B and l.C). However, due to the low number of carcasses marked, the Petersen equation (Appendix l.A.2) was a more appropriate estimation.

A total of 75 salmon carcasses was examined, of which 48 were marked, and 25 subsequently recovered. From these data, 190 fish were estimated for the river stretch from the Crocker-Huffman Dam to Hwy.59. The spawner population downstream of Hwu.59 was estimated by assuming the same relative distribution of fish as for last season; in 1988, based on redd counts, 45% of the spawning occurred in that section of the river relative to the upstream mark-and-recovery survey section. Assuming that the estimated 190 fish in the upstream section represented 55% of the run, then 155 salmon were downstream of Hwy.59, and the estimated in-river population was 345 salmon. An additional 82 salmon were observed during Merced River Fish Facility (MRFF) operations (Cozart 1992), for a total 1989 fall-run spawner population of 427 salmon.

Based on 57 carcasses examined during the surveys, the run was composed of 38.6% male adults (FL ≥ 66 cm [26 in]), 59.6% female adults, 1.8% grilse (FL < 66 cm). In comparison, salmon which entered the MRFF consisted of 40.2% male adults (FL ≥ 61 cm [24 in]), 40.2% female adults, 19.6% grilse (FL < 61 cm). The separation length between the in-river adult and grilse was determined by the nadir in the length frequency distribution of carcasses measured.

One hundred-sixty-six salmon which had strayed from the San Joaquin River were "rescued from the San Luis Canal and Los Banos Wildlife Area bypass channel from 5 November through 18 December 1989. The total number of fish present in the western Merced County drainage system was judged to be about twice as many as rescued.

The 1989 Merced River fall-run population of 427 salmon was only 9% of the previous year's run size, and only 4% of the average run size for 1979 through 1988 (Appendix 5).

SUMMARY

The total estimated 1989 Central Valley chinook salmon spawner population was 205,990 fish (Table 9).

This was 32% lower than the 1988 total of 302,811 salmon (Kano 1997). However, the upper Sacramento River mainstem late-fall run, the Battle Creek fall run, and the Feather River spring run still remained well above their average run sizes of the previous ten years.

As in the past, most of the 1989 salmon run occurred in the Sacramento River system. The Stanislaus, Tuolumne, and Merced rivers of the San Joaquin River system had the largest decline of fall-run spawners, with a combined total of 3,212 fish; this was only 16% of the combined total estimated in 1988. The winter run in the upper mainstem Sacramento River was a record low with only 539 salmon.

TABLE 9. Summary of the 1989 Sacramento-San Joaquin river system chinook salmon spawner populations.

Spawning area	Late-fall run	**Winter** run	**Spring** run	Fall run	Total
Sacramento mainstem	11,351	539	5,139	58,582	75,611
Sacramento tributaries	65a/	--	7,032b/	l19,789c/	126,886
San Joaquin tributaries	==	--	--	3,493	3,493
Totals:	**11,416**	**539**	**12,171**	**181,864**	**205,990**

a/ Consists only of fish which entered Coleman Hatchery (Battle Creek).
b/ Includes Battle, Mill, Deer, and Butte creeks, and the Feather River.
c/ Includes Clear, Battle, Mill, and Deer creeks, and the Feather, Yuba, and American rivers.

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

A. The Petersen equation:

1.

$$N = \frac{M \times C}{R}$$

or,

2. Chapman's version in Ricker (1975);

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

where N = estimated spawner population,

M = number of carcasses marked,

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

R = number of marked carcasses recovered.

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

$$N = \sum \left(R_{ij} \times \frac{M_i}{R_i} \times \frac{C_j}{R_j}\right) - \sum_2^i M_i$$

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

$\sum_2^i M_i$ = total carcasses marked from the second marking period on. Subtraction of this factor adjusted for replacement of recovered marked fish.

C. The Jolly-Seber model as modified by Boydstun (1994):

$E = N_1 + D_1 + D_2 + \ldots D_j$, where

E = the estimated spawner population

N_1 = number of carcasses in the surveyed population in period 1, the first "week" of spawning, and

D_i = number of carcasses joining the population between period i and i+l, with j being the last survey period.

Three basic quantities are first calculated:

1) An estimate of the number of marked carcasses available for recovery during each survey (B_i):

$$B_i = \frac{(T_i+1)\times(K_i)}{(R_i+1)} + (M_i+1)$$

- To estimate B_j, the number of marked carcasses in the population just before the last survey, it is assumed that the proportion of marked carcasses in the last survey is the same as the estimated proportion in the previous survey, and:

$$B_j = \frac{B_{j-1} \times M_j}{M_{j-1}}$$

2) An estimate of the number of carcasses in the population immediately before each survey (N_i):

$$N_i = \frac{B_i \times (C_i+1)}{M_i+1}$$

and,

3) An estimate of the "survival rate" of marked carcasses from the ith to the ith+l periods (S_i):

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

- to estimate survival of carcasses from period 1 to period:

$$S_1 = \frac{B_2}{T_1}$$

In the above equations, the variables are defined as:

T_i = number of carcasses marked in the ith period,

K_i = total marked carcasses recovered after the ith period that were marked before the ith period,

R_i = total recovered marked carcasses that were marked in the ith period,

M_i = total recovered marked carcasses for the ith period, and

C_i = number of carcasses examined for marks during the ith period, including those marked and recovered marks in the period.

D_i can then be calculated:

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

and,

N_1 can also be calculated, assuming equal sampling efficiency between weeks 1 and 2:

$$N_1 = \frac{N_2 \times C_1 \div C_2}{\sqrt{S_1}}$$

(The use of the square root of S_i in the denominator of the above two equations is a further modification by Frank Fisher, CDFG, personal comm.)

APPENDIX 2. Adjusted Chinook Salmon Counts and Estimated Numbers of Each **Run** at Red Bluff Diversion Dam From 23 October 1988 through 30 December 1989. a/

Count period	Adjusted salmon count b/	Number of salmon examined c/	Distribution of runs: Late-fall % of fish examined	Late-fall Estimated number d/	Winter % of fish examined	Winter Estimated number d/	Spring % of fish examined	Spring Estimated number d/	Fall % of fish examined	Fall Estimated number d/
23 Oct - 31 Dec '88 e/	- -	- -	- -	5,971	- -	9	- -	- -	- -	- -
1989										
01 - Jan - 07-Jan	--	--	--	798 U	--	9 f/				
08-Jan - 14-Jan	--	--	--	776 f/	--	9 f/				
15-Jan - 21-Jan	--	--	--	377 f/	--	2 f/				
22-Jan - 28-Jan	--	--	--	357 f/	--	7 f/				
29-Jan - 04-Feb	- -	- -	- -	439 u	--	13 u				
05-Feb - 11-Feb	- -	- -	- -	132 f/	--	17 u				
12-Feb - 18-Feb	- -	- -	- -	305 f/	--	16 U				
19-Feb - 25-Feb	--	--	--	538 f/	--	5 f/				
26-Feb - 04-Mar	--	--	--	404 f/	--	34 f/				
05-Mar - 11-Mar	--	--	--	263 U	--	41 f/				
12-Mar - 18-Mar	--	--	--	214 U		49 u				
19-Mar - 25-Mar	--	--	--	--		42U		5 f/		
26-Mar - 01-Apr	- -	- -	--	255 f/	--	26 U		13 u		
02-Apr - 08-Apr	- -	- -	- -	223 f/	--	41 u		31 u		
09-Apr - 15-Apr	- -	- -	- -	171 u	--	104 u		103 f/		
16-Apr - 22-Apr	94	30	Total g/: 11,639 h/		13.3	13	86.7	81		
23-Apr - 29-Apr	52	17'			5.9	3	94.1	4	9	
30-Apr - 06-May	128	21			4.8	6	952		122	
07-May - 13-May	129	7			14.3	18	71.4	92	143	18
14-May - 20-May	141	14			7.0	10	35.8		50	57.2 81
21-May - 27-May	57	9			- -	- -	44.4	25	55.6	32
28-May - 03-Jun	149	17			5.9	9	23.5	35	70.6	105
04-Jun - 10-Jun	309	45			4.4	14	15.6	48	80.0	247
11-Jun - 17-Jun	253	53			1.9	5	5.7	14	92.4	234
18-Jun - 24-Jun	201	27			3.7	7	11.1	22	85.2	171
25-Jun - 01-Jul	320	3 9			--	--	103	33	89.7	287
02-Jul - 08-Jul	422	10			--	--	10.0	42	90.0	380
09-Jul - 15-Jul	1,487	85			12	18	11.8	175	87.0	1,294
16-Jul - 22-Jul	587	62			- -	- -	6.5	38	935	549
23-Jul - 29-Jul	206	41			2.4	5	14.6	30	83.0	171
30-Jul - OS-Aug	254	10			Total g/:	532 i/	40.0	102	60.0	152
06-Aug - 12-Aug	1203	67					19.4	233	80.6	970
13-Aug - 19-Aug	3,455	95					21.1	729'	78.9	2,726
20-Aug - 26-Aug	3,369	66					152	512	84.8	2,857
27-Aug - 02-Sep	4,306	80					10.0	431	90.0	3,875
03-Sep - 09-Sep	5,578	83					10.8	602	892	4,976
10-Sep - 16-Sep	10,349	101					5.9	611	94.1	9,738
17-Sep - 23-Sep	17,763	103					1.9	337	98.1	17,426
24-Sep - 30-Sep	6,632	83					72	478	92.8	6,154
01-Oct - 07-Oct	6,619	93					32	212	96.8	6,407
08-Oct - 14-Oct	6,708	59					Total g/:	5,255	100.0	6,708
15-Oct - 21-Oct	5,752	38							100.0	5,752
22-Oct - 28-Oct	6.053	76	2.6	157					97.4	5,896
29-Oct - 04-Nov	2,599	51	7.8	203					92.2	2,396
OS-Nov - 11-Nov	1,858	44	182	338					81.8	1,520
12-Nov - 18-Nov	1.116	55	473	528					52.7	588
19-Nov - 25-Nov	730	36	63.9	466					36.1	264
26-Nov - 02-Dec	504	--	j/	322					j/	182
03-Dec - 09-Dec										
10-Dec - 16-Dec				1,744 u		8 f/				1,900 f/
17-Dec - 23-Dec										
24-Dec - 30-Dec										
									Total g/:	84,056
Total for **1989 calendar year** k/:	89,383	1,617		9,427		531		5,255		84,056

a/ **Red Bluff Diversion** Dam gates were raised for most of the period from 1 Decemba 1988 through 11 **April** 1989, and from **3-30** December 1989.

b/ Actual weekly counts were expanded to adjust for periods when the **fishways** were open and no observations were made.

c/ Salmon in the tishway trapping **facility which** were **examined** to determine the run composition, **based on relative spawning readiness.**

d/ Adjusted count x Proportion of examined fish assigned to run.

e/ Estimated numbers represent salmon passing the dam during this period in **1988 that were expected to spawn in 1989 (Kano 1997).**

U Due to the dam gates being raised, no counts were possible. Estimated numbers based on historical **(1968-1985)** average proportional run distribution.

g/ Total estimated number of potential spawners for the 1989 calendar year.

h/ Includes 817 **fish** trapped at Keswick Dam and **trucked to Coleman National Fish Hatchery.**

i/ Includes 18 fish trapped at Keswick Dam and 24 at Red Bluff Dam that were **trucked** to **Coleman** National Fish Hatchery.

j/ Trap was not operated. Proportion assumed to be the same as for the previous week.

k/ Including late-fall- and winter-run 1990 potential spawners

APPENDIX 3. 1989 Chinook Salmon Spawner Population Estimates for the Sacramento River System.

River area / Tributary	Estimated number of fish: Late-fall run	Winter run	spring run	Fall run	Total
Keswick Dam to Red Bluff					
Sacramento River mainstem a/	11,351 b/	527 c/	5,139	48,526	65,543
Clear Creek	-- d/	- -	--	2.153	2,153
Cow Creek	- -	--	-- e/	- - e/	- -
Bear Creek	- -	--	--	- - e/	- -
Ash Creek	- -	--	--	- - e/	- -
Cottonwood Creek	- -	--	0	- - e/	- -
Battle Creek					
Coleman National Fish Hatchery	65	--	- -	11,986	12,051
Upstream of hatchery	- -	--	7	233	240
Downstream of hatchery	-- d/	-- d/	- - d/	18,829	18,829
(Totals for tributary):	(65)	- -	(7)	(31,048)	(31,120)
Inks Creek	- -	- -	- -	- - e/	- -
Paynes Creek	- -	- -	- -	- - e/	- -
Totals for area:	11,416	527	5,146	81,727	98,816
Red Bluff to Princeton Ferry					
Sacramento River mainstem					
Red Bluff to Tehama Bridge	0	12	0	5,712	5,724
Tehama Bridge to Woodson Bridge	0	0	0	2,708	2,708
Woodson Br. to Princeton Ferry	0	0	0	1,636	1.636
Tehama-Colusa Spawning Channel f/	- -	- -	- -	- -	- -
(Totals for tributary):	(0)	12)	(0)	(10,056)	(10,068)
Salt Creek	- -	- -	- -	- - e/	- -
New Creek	- -	- -	- -	-- e/	- -
Antelope Creek	- -	- -	-- e/	- - e/	- -
Craig Creek	-- d/	- -	- -	- - e/	- -
Dye Creek	- -	- -	- -	- - e/	- -
Coyote Creek	- -	- -	- -	- - e/	- -
Elder Creek	- -	- -	- -	- - e/	0
Mill Creek	- -	- -	563	1,565	2,128
Thomas Creek	- -	- -	- -	- - e/	- -
Toomcs (Dry) Creek	- -	- -	- -	- - e/	- -
Deer Creek	- -	- -	84	358	442
Stoney Creek	- -	- -	- -	- - e/	- -
Totals for area:	0	12	647	11,979	12,638
Butte Creek to American River					
Big Chico Creek	- -	- -	- -	- - d/	- -
Butte Creek	--	- -	1,300	- - e/	1,300
Feather River					
Feather River Hatchery	- -	- -	5,078	7578	12,656
In -river	- -	- -	- - d/	40,541	40,541
(Totals for tributary):	--	- -	(5,078)	(48,119)	(53,197)
Yuba River	- -	- -	-- e/	7,622	7,622
American River					
Nimbus Hatchery	- -	- -	- -	9,741	9,741
In -river	--	- -	- -	19,183	19,183
(Totals for tributary):	--	- -	- -	(28,924)	(28,924)
Totals for • ru:	0	0	6,378	84,665	91,043
Sacramento River system totals:	11,416	539	12,171	178,371	202,497

a/ Includes numbers of fish for tributaries in this river area that were not surveyed or for which an estimate was not made.
b/ Includes 817 fish from Keswick Dam that were transported to and spawned at Coleman Hatchery.
c/ Includes 18 fish from Keswick Dam and 24 fish from Red Bluff Diversion Dam that were transported to Coleman Hatchery.
d/Tributary was not surveyed for this run.
e/ An estimate of the run size was not made.
f/Due to the Red Bluff Diversion Dam gates being open, the spawning channel was not operable.

APPENDIX 4. 1989 Chinook Salmon Spawner Population Estimates for the San Joaquin River System.

Tributary	Numbers of fall-run fish
Cosumnes River	a/
Mokelumne River	
Mokelumne River Fish Installation	81
In-river	200
(Total for tributary):	(281)
Calaveras River	a/
Stanislaus River	1,510
Tuolumne River	1,275
Merced River	
Merced River Fish Facility	82
In-river	345
(Total for tributary):	(427)
San Joaquin River system totals:	3,493

a/ Tributary was not surveyed.

APPENDIX 5. Chinook salmon spawner population estimates from 1979 through 1989 in California's Central Valley tributaries.

Tributary Race	Estimated number of fish											1979-1988 average
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	
Sacramento River system upstream of Red Bluff (excluding Battle Creek)												
Late-fall run	10,284	9,361	6,423	4,899	14,984	7,140	8.136	7,811	15,393	11,324	11,351	9,576
Winter run	2,339	1,112	19,795	1,233	1,827	2,662	3,684	2,394	1,978	2,075	527	3,913
Spring run	2,856	9,363	20,655	23,156	3,854	7,823	10,200	15,824	10,972	9,568	5,139	11,427
Fall run	47,758	21,961	33,289	20,567	27,326	41,805	52,820	67,940	75,958	64,170	48,526	45,359
Battle Creek a/												
Fall run	13,159	14,443	17,205	26,795	13,983	29,893	39,808	31,252	24,249	67,475	31,048	27,826
Sacramento River mainstem downstream of Red Bluff												
Fall run	67,388	30,453	42,724	23,833	32,018	19,166	46,780	34,372	32,588	21,250	10,056	35,057
Feather River a/												
Spring run b/	250	269	469	1.910	1,702	1,562	1,632	1,433	1,213	6,833	5,078	1,727
Fall run	32,505	35,295	53,020	55,519	30,522	51,056	56,002	55,471	77,846	49,036	48,119	49,627
Yuba River												
Fall run	12,430	12,406	14,025	39,367	13,756	9.665	13,042	19,328	18,518	9,000	7,622	16,154
American River a/												
Fall run	47,666	49,802	64,055	43,898	35,300	39,696	65,213	55,067	46,143	33,514	28,923	48,035
Cosumnes River												
Fall run	150	200	c/	c/	200	1,000	220	c/	c/	100	d/	187
Mokelumne River a/												
Fall run	1,507	3,231	4,954	9,372	15,861	8,298	7,682	7,167	1,630	528	281	6,023
Stanislaus River												
Fall run	110	100	1,000	c/	500	11,439	13,473	6,497	6,292	10,212	1,510	4,962
Tuolumne River												
Fall run	1,183	559	14,253	7,126	14,836	13,689	40,322	7,404	14,751	5,779	1,275	11,990
Merced River a/												
Fall run	2,147	3,006	10,415	3,263	18,248	29,749	16,052	7,439	4,126	4,592	427	9,904

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

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

c/ No estimate made.

d/ Tributary was not surveyed.