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CHINOOK SALMON SPAWNER STOCKS IN
CALIFORNIA'S CENTRAL VALLEY, 1987

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Inland Fisheries Division

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ABSTRACT

This report covers the 35th 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 1987 total escapement of chinook salmon in the Central Valley was 334,362 fish. This total consisted of 302,447 fall-, 14,128 spring-, 2,045 winter- and 15,742 late-fall-run spawners. All of the spring-, late-fall-, and winter-run salmon were estimated to be in the Sacramento River system, while 26,799 fish of the fall run were in the San Joaquin River system.

Despite decreases of spawner populations from 1986 levels in most Central Valley tributaries, the total 1987 salmon stock was overall slightly larger than the previous year's. The only San Joaquin River system run to show an increase from 1986 populations was the Tuolumne River fall run. Ten-year record high late-fall and fall runs were estimated for the mainstem Sacramento River upstream of Red Bluff. The winter run in the same area continued to decrease from its critically low level.

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INTRODUCTION

The Sacramento-San Joaquin River system (Figure 1), which flows through California's Central Valley, is the principle producer of chinook salmon caught in the state's ocean fisheries. Its salmon runs also contribute significantly to the ocean fisheries of Oregon and Washington. This report is the 35th 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.

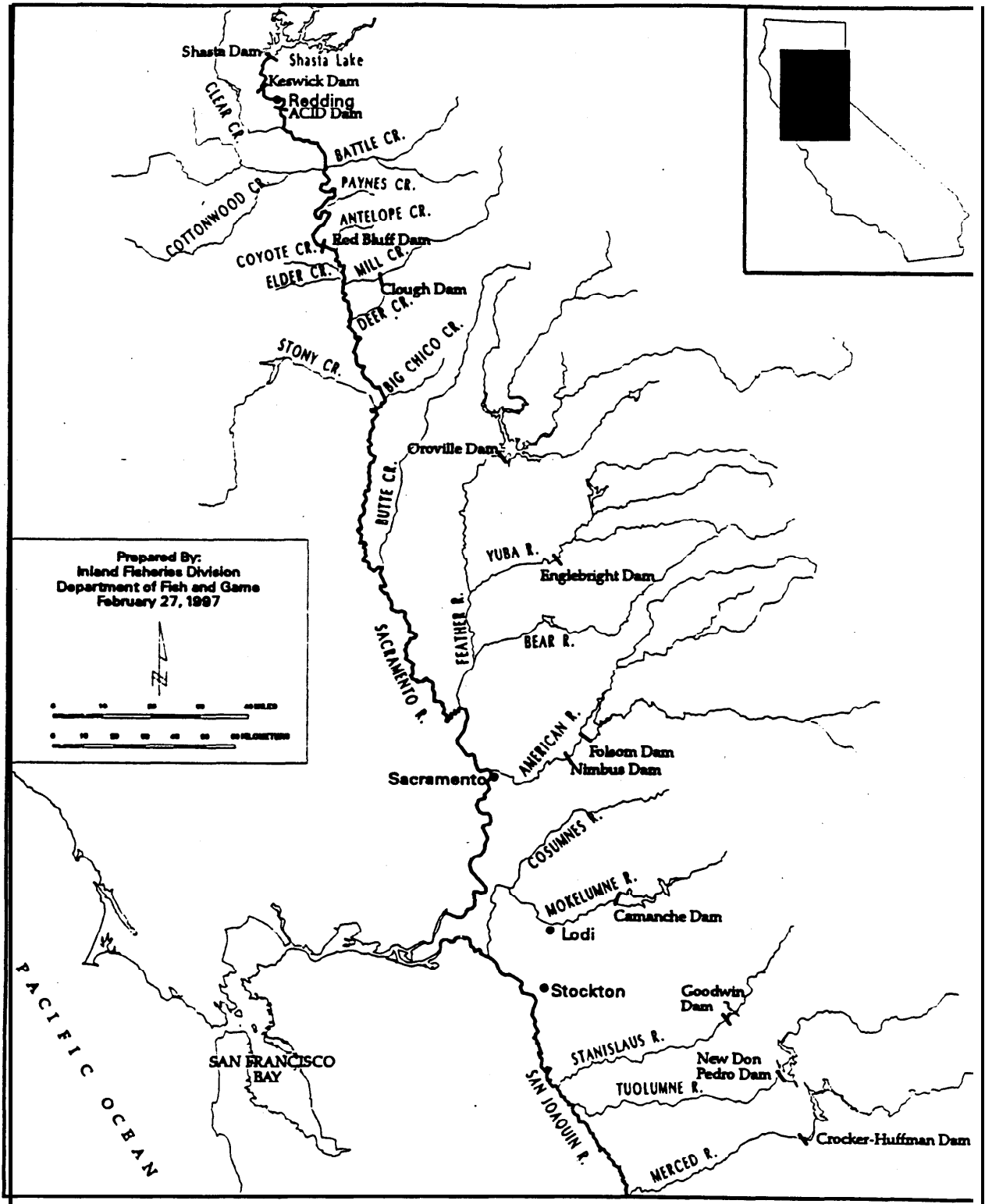


FIGURE 1. Sacramento-San Joaquin river system of California's Central Valley.

GENERAL METHODS

During 1987, 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 previous survey that were recovered in the following survey (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, fresh carcasses, identified by clear eyes, were marked with colored ribbon or tape throughout a series of surveys, and released into moving water of the stream for recovery during subsequent trips. As part of this methodology, carcasses marked during individual surveys were identified by different colors to allow calculation of an estimate for discrete periods. Again, all counted carcasses were either marked or cut in half to prevent recounting. The calculation of estimated spawner numbers from this type of mark-and-recovery data employed one of the following equations:

- 1) a modification of the Schaefer (1951) equation, which was initially used in the 1976 Central Valley spawner stock report (Hoopaugh 1978b);

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

where N = estimated spawner population for the entire survey period,

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

M_i = number of carcasses marked in the i th marking period,

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

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

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

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

2) the "Petersen" equation as presented by Ricker (1975);

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

where N = estimated spawner population,

M = total number of carcasses marked,

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

R = total number of marked carcasses recovered.

More specific details of surveys (timing, duration, location), or other estimation methods are presented under the following individual tributary headings.

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). Battle Creek was the only tributary in this area for which individual late-fall- and fall-run population estimates were made. Spawning distribution in the mainstem was determined from aerial redd counts.

In 1987, 128,889 salmon were estimated for the Sacramento River system between Keswick Dam and Red Bluff, consisting of 100,207 fall-, 15,742 late-fall-, 1,978 winter- and 10,972 spring-run fish (Appendix 2). The Battle Creek portion of the fall run was 24,249 fish. Since surveys of tributaries in this area were not conducted during spring- and winter-run spawning periods, (sic) and numbers of these fish were included in the mainstem totals.

Sacramento River Mainstem - by Richard E. Painter

Estimates of the total numbers of salmon using the Sacramento River system upstream from RBDD during 1987 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 from the dam's east-bank trapping facility (Appendix 1); salmon were assigned to a run based on their relative degree of ripeness.

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

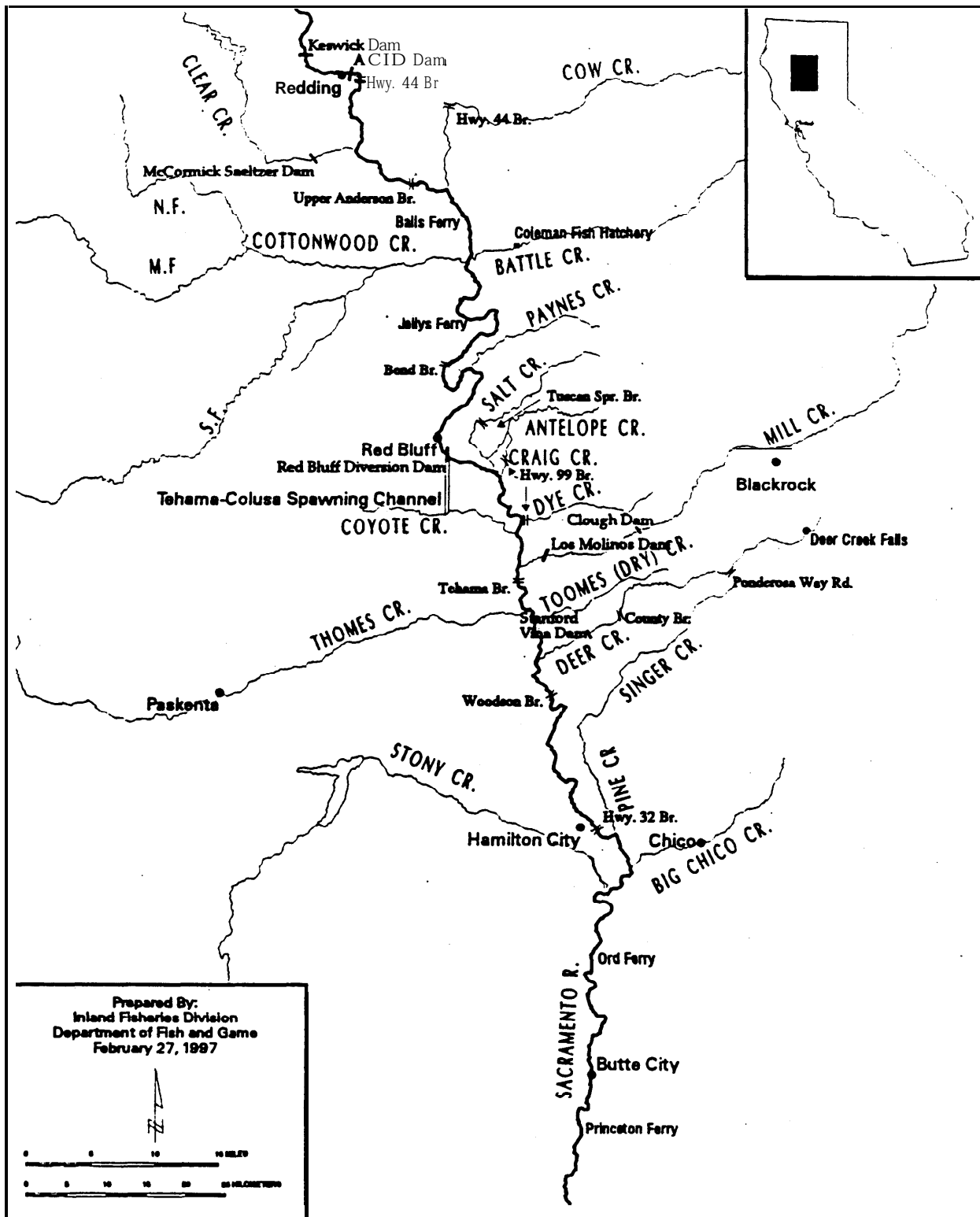


FIGURE 2. Sacramento river system from Keswick Dam downstream to Princeton Ferry.

the year. The total 1987 potential spawners for each of these two runs was obtained by adding the appropriate estimated numbers of fish from the 1986 calendar year that would spawn in 1987, and not including that portion of the 1987 calendar year estimated numbers that would spawn in 1988 (Appendix 1).

From 1 December 1986 through 31 March 1987, the RBDD gates were raised to facilitate upstream migration of the winter run of chinook salmon. Since counts for most of the 1987 late-fall- and winter-run fish passing the dam were not possible, estimated numbers of these runs for this period were calculated based on historical data. The number of 1987 late-fall-run salmon estimated from counts prior to 1 December 1986 was expanded to determine the remainder of the run, using the average of proportional distributions seen in the 1968-1985 late-fall runs. Likewise, expansion of the winter-run numbers was estimated from counts after 31 March 1987 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 (Table 1); no attempt was made to account for any other prespawning mortality in the upper river. Estimated numbers of sport-caught salmon were also determined from historical data. Late-fall-, spring-, and fall-run 1987 catches were calculated using the average percentage caught of each respective run during the 1977-1986 period. The 1987 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 1987).

To obtain the late-fall and fall-run population for only the mainstem upper Sacramento River, the number of potential spawners of these runs was reduced by the estimated population in Battle Creek (Appendix 3). The 1987 mainstem estimates included all of the winter- and spring-run salmon, as well as some late-fall-run fish for unsurveyed tributaries.

Late-fall run. A total of 16,049 late-fall 1987 potential spawners passed RBDD in 1986 and 1987 (Appendix 1). The late-fall sport-catch was estimated to be 307 salmon, resulting in 15,742 fish as a spawner population upstream of Red Bluff (Table 1). Three hundred forty-nine late-fall salmon entered Coleman National Fish Hatchery (CNFH) through Battle Creek leaving 15,393 fish as the mainstem spawner population (Appendix 2). 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 with the upper mainstem population, along with 454 late-

TABLE 1. Calculation of the 1987 spawner population for each run of chinook salmon upstream of Red Bluff Diversion Dam (RBDD).

Run	Number of fish passing dam in calendar year:		Number of potential spawners	Estimated sport catch	Estimated 1987 spawner population
	1986	1987			
Late-fall a/	10,163	+ 5,886 b/	= 16,049	- 307	= 15,742
Winter a/	57	+ 1,941 b/	= 1,998	- 20	= 1,978
Spring	-- c/	11,205	= 11,205	- 233	= 10,972
Fall	-- c/	103,063	= 103,063	- 2,856	= 100,207
Totals:	10,163	+122,095	= 132,315	- 3,416	= 128,899

a/ Estimated numbers of these runs from 1 Dec. 1986 through 31 Mar. 1987 were calculated using the historical (1968-1985) average proportional distribution.

b/ Totals of 7,827 late-fall- and 37 winter-run salmon passed RBDD in the latter part of 1987 (Appendix 1), and were not included in these counts; these fish were considered 1988 spawners.

c/ No 1987 spawners passed Red Bluff in 1986.

fall-run salmon trapped at Keswick Dam that were hauled to CNFH for spawning. The estimated late-fall spawner population of the upper Sacramento River of 15,393 fish was an increase of 49% from the 1986 population of 7,811 fish. The run was over 1 1/2 times the race's average run size from 1977 through 1986 (Appendix 4), and was the largest seen since the 1975 population of 19,261 fish (Hoopaugh 1978a).

Winter run. A total of 1,998 winter-run potential spawners passed RBDD in 1986 and 1987 (Appendix 1). The winter-run sport-catch was estimated to be 20 salmon, resulting in a spawner population upstream of Red Bluff of 1,978 fish (Table 1). The winter-run population has been critically low for the past five years, and the 1987 run size was down 17% from the 1986 population, and was only 26% of the average run size for the previous 10 years (Appendix 4).

Spring run. A total of 11,205 spring-run potential spawners passed RBDD in 1987 (Appendix 1). The spring-run sport-catch was estimated to be 233 salmon, resulting in 10,972 fish as a spawner population upstream of Red Bluff (Table 1). The 1987 spring-run spawner population was a decrease of 31% from the 1986 population, and 3% lower than the average run size for the previous 10 years (Appendix 4).

Fall run. A total of 103,063 fall-run potential spawners passed RBDD in 1987 (Appendix 1). The fall-run sport-catch was estimated to be 2,856 salmon, resulting in 100,207 fish as a spawner population upstream of Red Bluff (Table 1). A total of 24,249 fish was estimated to have entered Battle Creek, leaving 75,958 salmon for the upper mainstem population (Appendix 2). This included undetermined numbers of fall-run salmon which used other tributaries. The estimated 75,958 fall-run salmon in the mainstem Sacramento River upstream of Red Bluff was an increase of about 11% over the 1986 population. The run was almost double the average 1978-1986 population (Appendix 4), and was the largest seen since the 1969 population of 133,252 fish (Menchen 1970).

Mainstem spawning distribution. The relative redd distribution of 1987 spring- and fall-run salmon in the mainstem Sacramento River from Keswick Dam downstream to Red Bluff (Figure 2) was determined from data collected during airplane flights between 5 October and 25 November 1987 (Table 2). All the mainstem spring-run, and the majority of the fall-run (71.1%) spawning occurred upstream from RBDD.

Battle Creek - by Richard E. Painter

Late-fall, winter, and spring runs. Small numbers of these three runs have been known to spawn in Battle Creek. However, no spawner surveys were conducted during 1987, and the only available data were for late-fall-run salmon which entered CNFH (349 fish) from the creek.

Fall run. Salmon carcass counts were used to estimate the numbers of fall-run salmon in Battle Creek. Fourteen surveys were conducted from 14 October through 2 December 1987 in the 10 km (6 mi) stretch of river downstream of CNFH. A total of 2,604 carcasses was counted at a recovery rate of 45%. An additional 81 carcasses were counted in Gover's Ditch, an irrigation diversion about 1 km (0.6 mi) long located 1.6 km (1.0 mi) downstream from CNFH; a season's estimate for this ditch was not possible since it was only surveyed once. That count, added to the creek's estimated population, gave a 1987 spawner population in Battle Creek of 5,868 salmon. An additional 18,381 fish entered CNFH, bringing the total 1987 fall run-size for this tributary to 24,249 fish (Appendix 2). The 1987 population for Battle Creek was a decrease of 22% from the 1986 population, but was still 27% higher than the 19,019 fish average run-size since 1978 (Appendix 4).

The composition of fall-run salmon in Battle Creek was 52.9% male adults (fork length (FL) \geq 60.7 cm [23.9 in]), 43.7% female adults, and 3.4% grilse (FL < 60.7 cm), based on an examination of 2,604 carcasses. In comparison, fish entering CNFH consisted of 27.4% male adults, 34.0% female adults, and 38.6% grilse.

TABLE 2. Chinook salmon 1987 redd distribution in the mainstem Sacramento River, from Keswick Dam to Princeton Ferry.

River section	Late-fall run		Spring run		Fall run	
	Redds counted a/	Proportional distribution	Redds counted b/	Proportional distribution	Redds counted c/	Proportional distribution
Keswick Dam to A.C.I.D. Dam d/	- -	- -	50	32.5%	963	6.4%
A.C.I.D. Dam to Highway 44	- -	- -	38	24.7%	3,295	22.1%
Highway 44 to Upper Anderson Bridge	--	- -	20	13.0%	2,037	13.6%
Upper Anderson Bridge to Balls Ferry	--	- -	23	14.9%	1,639	11.0%
Balls Ferry to Jellys Ferry	- -	- -	4	2.6%	1,699	11.4%
Jellys Ferry to Bend Bridge	- -	- -	0	0.0%	763	5.1%
Bend Bridge to Red Bluff Dam	- -	- -	19	12.3%	221	1.5%
Red Bluff Dam to Tehama Bridge	- -	- -	--	0.0%	2,297	15.4%
Tehama Bridge to Woodson Bridge	- -	- -	--	0.0%	1,047	7.0%
Woodson Bridge to Hamilton City (Hwy. 32)	--	- -	--	0.0%	601	4.0%
Hamilton City to Ord Ferry	- -	- -	--	0.0%	299	2.0%
Ord Ferry to Princeton Ferry	- -	- -	--	0.0%	73	0.5%
	<hr/>		<hr/>		<hr/>	
	Totals:	--	154		14,934	

a/ No aerial survey was made for this run.

b/ Counts made during an aerial survey on 5 October 1987.

c/ Total of counts made during aerial surveys on 9, 13 & 28 October, and 12 & 25 November 1987.

d/ Anderson-Cottonwood Irrigation District Dam.

Clear Creek - by Richard E. Painter

Late-fall and spring runs. No spawner surveys were conducted for these runs in this tributary during 1987.

Fall run. Four surveys of Clear Creek were made between 10 November and 30 December 1987. Totals of 322 salmon carcasses, 234 live fish, and 144 redds were counted in a stream length of 3.2 km (2 mi), but no estimate of the spawner population was made.

Cottonwood Creek - by Richard E. Painter

Late-fall and spring runs. No spawner surveys were conducted for these runs in this tributary during 1987.

Fall run. Aerial surveys of Cottonwood Creek were made on 13 and 28 October, and 12 November 1987, and 297 redds were counted. No spawner population estimate was made.

Paynes Creek - by Richard E. Painter

Fall run. One survey was conducted on the lower 8.1 km (5 mi) of Paynes Creek on 14 December 1987, during which 3 redds, and 11 live salmon were counted. No spawner population estimate was 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, Antelope, Craig, Dye, Mill, Toomes, Deer and Singer creeks. Spawner estimates were possible only for the mainstem, and Mill and Deer creeks.

A total of 34,930 chinook salmon spawners was estimated for the Sacramento River system between Red Bluff and Princeton Ferry in 1987 (Appendix 2). Due to the raising of the RBDD gates, the Tehama-Colusa Spawning Channel was not operated, and no salmon were counted entering the facility. Precipitation and runoff in the upper Sacramento valley were low during the entire 1987 fall season. Stream flows were low in most tributaries until late November.

Sacramento River Mainstem - by Richard E. Painter

Late-fall run. The mainstem was not surveyed in 1987 during this run.

Winter run. Based on weekly aerial surveys between 14 April and 14 July 1987, an estimated 67 winter-run salmon were in the mainstem Sacramento River downstream of Red Bluff.

Spring run. Based on an aerial survey made on 5 October 1987, 1,639 spring-run salmon were estimated for the Sacramento River mainstem between Red Bluff and Tehama Bridge.

Fall run. Based on aerial surveys, 32,588 fall-run salmon were estimated for the mainstem Sacramento River between RBDD and Princeton Ferry. This run size was only 5% lower than the 1986 population, and 83% of the average run size from 1977 to 1986 (Appendix 4).

Mainstem spawning distribution. Redd counts made during aerial surveys from 5 October through 25 November 1987 were used to determine the relative spawning distribution of spring- and fall-run 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 spring-, and 28.9% of the fall-run redds were observed in this section of the river.

Salt Creek - by Richard E. Painter

Fall run. Only one survey was made of this tributary, and no salmon carcasses nor live fish were observed. A population estimate was not made.

Antelope Creek - by Richard E. Painter

Spring run. Spring-run salmon are known to enter Antelope Creek, but no surveys were conducted in 1987.

Fall run. Surveys between 30 October and 18 December 1987, were made in Antelope Creek from Cone Grove Park to the HWY.99-E bridge. No salmon carcasses, live fish, or redds were observed. A spawner population estimate was not made.

Craig Creek - by Richard E. Painter

Late-fall run. Late-fall-run salmon are known to enter Craig Creek, but no surveys were conducted in 1987.

Fall run. Two surveys of the entire length of Craig Creek were made on 24 November and 18 December 1987. Only two salmon carcasses were recovered, and 28 live fish and 12 redds were counted. No spawner population estimate was made.

Dye Creek - by Richard E. Painter

Fall run. Only one survey was made of this tributary, and no salmon carcasses nor live fish were observed. A population estimate was not made.

Mill Creek - by Richard E. Painter

Late-fall run Some fish of this race have been known to spawn in this stream, but no surveys were made in 1987.

Spring run. A 1987 population of 90 salmon was estimated for this tributary, based on counts made by the USFWS at Clough Dam during the spring-run immigration-u.

Fall run. Between 2 November and 3 December 1987, seven surveys were made of lower Mill Creek from the Los Molinos Mutual Water Company's upper diversion dam to the confluence with the Sacramento River. A total of 127 salmon carcasses was recovered, and based on a 45% recovery rate, the fall run was estimated to be 282 spawners.

Toomes Creek - by Richard E. Painter

Fall run. Only two surveys were made for this run in this tributary, and no salmon carcasses, live fish, or redds were observed. A population estimate was not made.

Deer Creek - by Richard E. Painter

Late-fall Run. Late-fall-run salmon are known to enter Deer Creek, but no surveys were conducted in 1987.

Spring run. A population of 200 salmon was estimated for this tributary in 1987. This estimate was made from snorkeling counts by U.C. Davis staff and the ratio, developed for the 1986 run, between fish seen in an index stream section and adults immigrating past Stanford-Vina Dam 2/.

2/ File report of 1986 and 1987 spring-run salmon surveys, from Emil Eckman to the Lassen National Forest Resource Officer, 17 November, 1987.

Fall run. Fourteen surveys were made in lower Deer Creek between 3 November and 23 December 1987, covering the area between the mouth and the county bridge located 3.2 km (2 mi) upstream from the Stanford-Vina Dam. A total of 29 salmon carcasses was recovered, and based on a 45% recovery rate, the estimated fall run was 64 spawners.

The 1987 fall run in Deer Creek consisted of 41.4% male adults (FL \geq 60.7 cm [23.9 in]), 34.4% female adults, and 24.2% grilse (FL < 60.7 cm).

Singer Creek - by Richard E. Painter

Fall run. One survey was made of Singer Creek in 1987, but no salmon carcasses or live fish were observed. No fall-run spawner population estimate was made.

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 fresh carcasses. The only other tributary in this area that was surveyed was Butte Creek.

A total of 143,734 chinook salmon was estimated for the Sacramento River tributaries from Butte Creek to the American River in 1987. This **total** consisted of 1,227 spring-run and 142,507 fall-run fish (Appendix 2).

Big Chico Creek

Fall run. Fall-run salmon are known to enter Big Chico Creek, but no surveys were conducted in 1987.

Butte Creek - by Richard Flint

Spring run. Surveys were conducted on 1 and 2 October 1987, in the 16 km (10 mi) between the Centerville Powerhouse and the Skyway Bridge. No live salmon or carcasses were observed, but seven redds were counted. The 1987 spring-run spawner population was about 14 fish.

Fall run. No surveys were made of the 1987 run in Butte Creek.

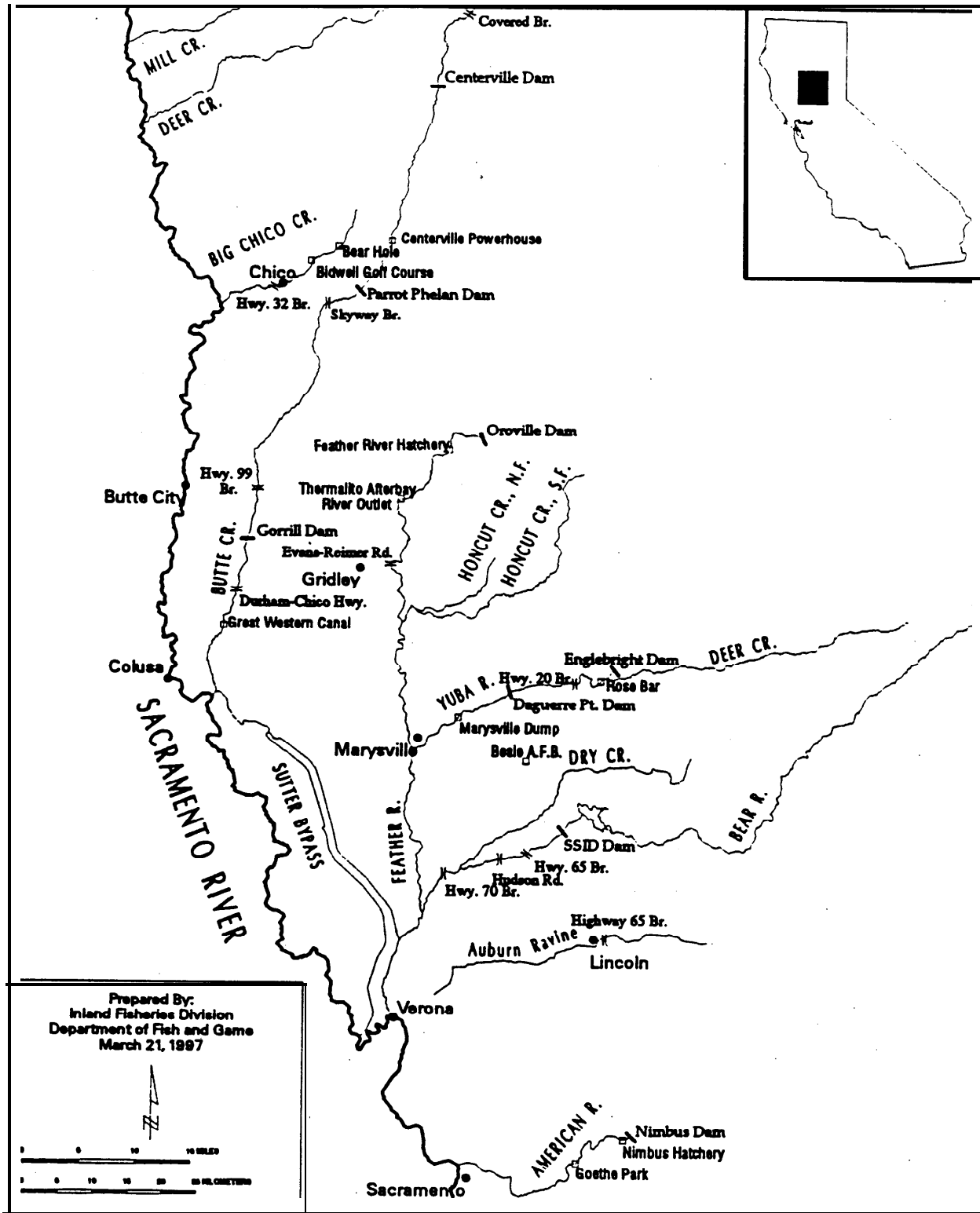


FIGURE 3. Sacramento River system from Big Chico Creek downstream to the American River.

Feather River - by Deborah L. Konnoff

Spring run. Based on counts from 2 to 30 September 1987, 1,213 spring-run salmon entered Feather River Hatchery (FRH) (Schlichting 1990). These fish consisted of 40.3% adult males (FL \geq 68 cm [26.8 in]), 36.0% adult females, and 23.7% grilse (FL < 68 cm). The use of the 68-cm length to distinguish between grilse and adults was a departure from the traditionally used 61-cm (24-in) length. This was determined from analysis of length data collected earlier in the season at FRH and during creel surveys of the Feather and American rivers, as well as from lengths of returning age-11 coded-wire-tagged salmon.

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 number of spring-run salmon at FRH in 1987 was 18% lower than that seen in 1986, but still 25% higher than the average number estimated for 1977 through 1986 (Appendix 4).

Fall run. Weekly carcass mark-and-recovery surveys of fall-run salmon were conducted in the Feather River from 5 October to 15 December 1987. Surveys covered the river reach between the hatchery barrier dam and Evans-Reimer Road. This area consisted of two sections, characterized by different flow regimes. The stream section between the hatchery barrier dam and Thermalito Afterbay Outlet, a "low-flow section", had an average stream flow of 13.2 m^3/s (467 cfs) throughout the survey period. Flow downstream of Thermalito Afterbay Outlet to Evans-Reimer Road was 36.9 m^3/s (1,304 cfs) during the surveys. Visibility through the water varied from 0.9 to 1.5 m (3-5 ft) for both sections. Moe's Ditch, a 200-m- (0.12-mi-) long channel adjacent to FRH was also included in the low-flow section surveys.

The modified Schaefer equation was used to calculate the fall-run spawner population in each of the river sections using the mark-and-recovery data (Table 3, Table 4). An estimated 25,753 salmon were in the upstream low-flow section, and 41,985 fish were in the downstream section. A total of 10,108 fall-run salmon entered FRH (Schlichting 1990), bringing the 1987 fall-run spawner population in the Feather River to 77,846 fish. The 1987 population was 40% higher than that of 1986 (Appendix 4), and was the largest run seen in this tributary since the 1960 population of about 80,000 fish (Fry and Petrovich 1970).

The composition of salmon in the river, based on examination of 3,566 carcasses, was 33.9% male adults (FL \geq 68 cm [26.8 in]), 17.5% male grilse (FL < 68 cm), 41.8% female adults, and 6.8% female grilse. In comparison, salmon entering the hatchery consisted of 30.9% male adults, 33.5% female adults, and 35.6% grilse (grilse were not identified by sex in the hatchery).

TABLE 3. Chinook salmon carcass mark-and-recovery data used to estimate the 1987 fall-run spawner population in the Feather River from the hatchery **barrier** dam to the Thermalito Afterbay Outlet.

Recovery period (i)	Number of marked carcasses recovered from marking period (i):										Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
	Oct. 5	Oct. 12	Oct. 19-20	Oct. 16-17	Nov. 2-3	Nov. 9-10	Nov. 16-17	Nov. 23	Dec. 1	Dec. 7			
Oct. 12	2	-	-	-	-	-	-	-	-	-	2	120 c/	180
Oct. 19-20		42	-	-	-	-	-	-	-	-	42	1,076	1,367
Oct. 16-17		5	161	-	-	-	-	-	-	-	166	2,051	3,720
Nov. 2-3		1	20	168	-	-	-	-	-	-	189	2,747	5,015
Nov. 9-10			6	25	216	-	-	-	-	-	247	2,548	5,859
Nov. 16-17			2	4	41	110	-	-	-	-	157	1,822	5,307
Nov. 23				0	2	20	80	-	-	-	102	1307	3,520
Dec. 1				1		1	23	55	-	-	80	715	1,902
Dec. 7							1	12	16	-	29	258	720
Dec. 15							1	3	8	9	21	151	530
Total recovered (RI):	2	48	189	198	259	131	105	70	24	9		Total:	28,120
Total carcasses marked (Mi):	3	61	346	362	613	416	271	189	69	40			

Adjusted estimate: 25,753 d/

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

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

c/ Includes carcasses observed during the first marking period, for purposes of calculating the second period population estimate.

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. 28,120 - 2,367 = 25753.

TABLE 4. Chinook salmon carcass mark-and-recovery data used to estimate the 1987 fall-run spawner population in the Feather River from the Thermalito Afterbay Outlet to Evans -Reimer Road.

Recovery period (j)	Number of marked carcasses recovered from marking period (i):								Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
	Oct. 12-13	Oct. 20	Oct. 27	Nw. 3-4	Nw. 10	Nw. 17-18	Nw. 24	Dec. 3			
Oct. 20	0	--	--	--	--	--	--	--	0	39c/	39
Oct. 27	1	2	--	--	--	--	--	--	3	354	1,888
Nw. 3-4			37	--	--	--	--	--	37	1,859	8,199
Nw. 10			2	77	--	--	--	--	79	1,881	8,532
Nw. 17-18				12	41	--	--	--	53	2,233	12,839
Nw. 24					7	71	--	--	78	1,525	6,134
Dec.3						8	18	--	26	726	3,587
Dec.8						3	16	10	29	341	1,911
Total recovered (Ri):	1	2	39	89	48	82	34	10		Total:	43,129
Total carcasses marked (Mi):	1	15	133	315	245	231	151	54			
										Adjusted estimate:	41,985 d/

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

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

c/ Includes carcasses observed during the first marking period, for purposes of calculating the second period population estimate

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. 43,129 - 1,144 = 41,985.

Yuba River - by Deborah L. Konnoff

Spring Run. Salmon of this race have been observed in the Yuba River in past years, but no surveys were conducted in 1987.

Fall run. Weekly salmon carcass mark-and-recovery surveys were conducted from 7 October through 10 December 1987 in the Yuba River from the Parks Bar bridge (HWY. 20) downstream to the Marysville dump. Surveys were not possible upstream of HWY.20 due to lack of access. River flow upstream of Daguerre Point Dam was 19.4 m^3/s (686 cfs), while flows downstream of Daguerre Point Dam were 15.5 m^3/s (547 cfs) throughout the survey period. Visibility through the water was 3.1 m (10 ft) during the surveys.

Using carcass mark-and-recovery data, the modified Schaefer equation estimated 15,648 salmon as the spawner population between the Parks Bar bridge and the Marysville dump (Table 5, Table 6). The spawner population for the area upstream of Parks Bar bridge to Rose Bar was calculated using the 1966-1971 average proportion of the total river's population constituted by spawners in this section. During those years, an average of 15.5% of the total population occurred upstream of the Parks Bar Bridge, and it was assumed that in 1987 this section's population was 2,870 salmon.

The combined estimates for both sections gave a total 1987 Yuba River spawner population of 18,518 salmon. This was a decrease of 4% from the 1986 population, and 23% greater than the average run size from 1977 to 1986 (Appendix 4).

The composition of 1,328 of the salmon carcasses examined was 34.5% male adults (FL \geq 68 cm [26.8 in]), 26.8% male grilse (FL < 68 cm), 32.2% female adults, and 6.5% female grilse.

American River - by Phillip V. Hansen

Fall run. Weekly salmon carcass mark-and-recovery surveys were made between 12 November and 22 December 1987 in the 11-km (6.8-mi) reach of the American River from the Goethe Park footbridge upstream to the Nimbus Hatchery racks. River flows in this section were 34.0 m^3/s (1200 cfs) for the entire survey period, and visibility through the water ranged from 0.6 - 1.8 m (2-6 ft). 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 along the shore or washed up on the racks.

The salmon spawner population of the Goethe Park to Nimbus racks section was 37,240 fish (Table 7). This was estimated using the Schaefer equation with mark-and-recovery data. Upstream of the Nimbus racks, 2,645 spawners were estimated, and combined with

TABLE 5. Chinook salmon carcass mark-and-recovery data used to estimate the 1987 fall-run spawner population in the Yuba River from the Parks Bar bridge to Daguerre Point Dam.

Recovery period (j)	Number of marked carcasses recovered from marking period (i):									Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
	Oct. 7	Oct. 14	Oct. 21	Oct. 28	Nw. 5	Nw. 11	Nw. 19	Nov. 25	Dec. 4			
Oct. 14	0	--	--	--	--	--	--	--	--	0	99 c/	99
Oct. 21		20	--	--	--	--	--	--	--	20	447	836
Oct. 28		2	62	--	--	--	--	--	--	64	746	1355
Nw. 5		1	7	48	--	--	--	--	--	56	1,080	2,463
Nw. 11			1	5	71	--	--	--	--	77	809	1,935
Nw. 19				3	15	52	--	--	--	70	904	2,439
Nw. 25					1	4	40	--	--	45	333	793
Dec. 4						1	6	16	--	23	244	831
Dec.10							1	3	4	8	77	518
Total recovered (Ri):	0	23	70	56	87	57	47	19	4		Total:	11260
Total carcasses marked (Mi):	4	43	127	132	209	159	110	73	40			
											Adjusted estimate: 10,367 d/	

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

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

c/ Includes carcasses observed during the first marking period, for purposes of calculating the second period population estimate.

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. 11,260 - 893 = 10,367.

TABLE 6. Chinook salmon carcass mark-and -recovery data used to estimate the 1987 fall-run spawner population in the Yuba River from Daguerre Point Dam to the Marysville dump.

Recovery period (j)	Number of marked carcasses recovered from marking period (i):							Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
	Oct. 22	Oct. 29	Nov. 6	Nov. 13	Nov. 20	Nov. 27	Dec. 2			
Oct.29	5	--	--	--	--	--	--	5	153 c/	281
Nov. 6	1	20	--	--	--	--	--	21	382	745
Nov. 13		2	20	--	--	--	--	22	476	1,398
Nov. 20		1	7	24	--	--	--	32	463	1,400
Nov. 27			1	6	35	--	--	42	376	926
Dec. 2				1	3	9	--	13	157	640
Dec. 9						4	4	8	54	291
Total recovered (Ri):	6	23	28	31	38	13	4		Total:	5,681
Total carcasses marked (Mi):	11	45	85	95	89	62	24			
									Adjusted estimate:	5,281 d/

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

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

c/ Includes carcasses observed during the first marking period, for purposes of calculating the second period population estimate.

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. 5,681 - 400 = 5,281.

TABLE 7. Chinook salmon carcass mark-and-recovery data used to estimate the 1987 fall-run spawner population in the American River from the Nimbus Racks to the Goethe Park footbridge.

Recovery period (i)	Number of marked carcasses recovered from marking period (i):						Total marked carcasses recovered (R _j)	Total carcasses observed (C _j) a/	Population estimate (N) b/
	Nov. 12- 13	Nov. 18- 19	Nov. 24-25	Dec. 2-3	Dec. 10- 11	Dec. 15-16			
Nov. 18-19	31	- -	- -	- -	- -	- -	31	3,558 c/	15,917
Nov. 24-25	3	40	- -	- -	- -	- -	43	2,005	6,959
Dec. 2-3	2	7	39	- -	- -	- -	48	2,232	7,437
Dec. 10-11	1	1	3	19	- -	- -	24	1,091	4,107
Dec. 15- 16				2	7	- -	9	293	1,782
Dec. 22	1			2	4	0	7	272	1517
Total recovered (R _i):	<u>38</u>	<u>48</u>	<u>42</u>	<u>23</u>	<u>11</u>	<u>0</u>		Total:	<u>37,719</u>
Total carcasses marked (M _i):	170	163	137	88	74	17			
								Adjusted estimate: 37,240 d/	

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

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

Includes carcasses observed during the first marking period, for purposes of calculating the second period population estimate.

d/ 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, i.e. 37,719 - 479 = 37,240.

the downstream estimate gave 39,885 spawners within the river. The distribution of this population up- and downstream of the Nimbus racks may not be accurate, since carcasses which were counted upstream of the racks were discarded downstream without being cut in half.

An additional 6,258 salmon entered Nimbus Hatchery (Ducey 1988), bringing the total American River 1987 fall-run spawner population to 46,143 fish. This was about 16% lower than the 1986 population, and about the same as the average run size (47,206 fish) from 1977 through 1986 (Appendix 4).

The composition of 649 salmon carcasses examined was 43% male adults (FL \geq 68 cm [26.8 in]), 12% male grilse (FL < 68 cm), 43% female adults, and 2% female grilse. In comparison, fall-run salmon entering the hatchery in 1987 consisted of 28.1% male adults (FL \geq 60 cm [23.6 in]), 25.3% female adults, and 46.6% grilse (FL < 60 cm).

CHINOOK SALMON SPAWNER POPULATIONS FOR THE SAN JOAQUIN RIVER SYSTEM

The Cosumnes, Mokelumne, Stanislaus, Tuolumne, and Merced rivers of the San Joaquin River system (Figure 4) were surveyed for chinook salmon spawners. A total of 26,799 salmon, consisting entirely of fall-run fish, was estimated in 1987 (Appendix 3).

Cosumnes River to the Calaveras River

Cosumnes River - by Phillip V. Hansen

Fall run. This tributary was surveyed from Michigan Bar to the Jackson highway crossing on 30 November and 14 December 1987. No salmon carcasses, live fish, or redds were observed, and it was assumed that the spawner population was zero; flows through the lower part of the river were very low until late in the year, possibly preventing salmon immigration.

Mokelumne River - by Phillip V. Hansen

Fall run. In 1987, surveys were conducted weekly from 17 November through 24 December between Camanche Dam downstream to Mackville Road. Nine salmon carcasses, 78 skeletons, and 267 live fish were observed, from which a spawner population of about 1000 salmon was thought to have been present. Combined with the 630 salmon which entered the Mokelumne River Hatchery (Estey 1988), the 1987 fall-run spawner population was 1,630 fish. This was only 23% of the 1986 population, and was 73% below the

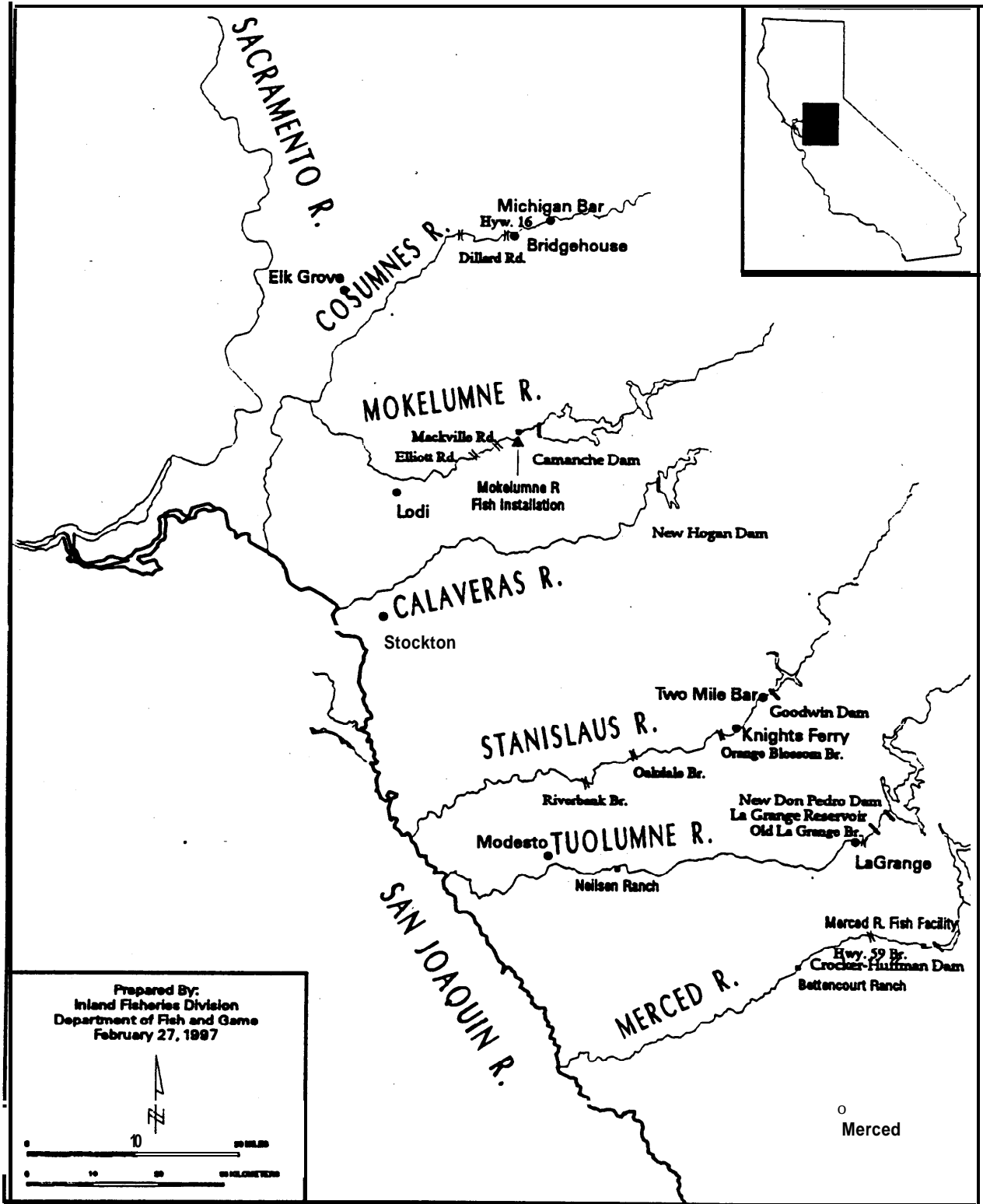


FIGURE 4. San Joaquin River system from the Merced River downstream to the Cosumnes River.

average of populations estimated from 1977 through 1986 (Appendix 4).

The composition of the salmon entering the hatchery was 9.5% male adults (FL \geq 61 cm [24 in]), 5.6% female adults, and 84.9% grilse.

Calaveras River - by Phillip V. Hansen

This tributary was not surveyed in 1987, but no salmon were seen by either irrigation district or Corp of Engineer personnel working along the river.

Stanislaus River to the Merced River

Stanislaus River - by W. George Neillands

Fall run. The 1987 fall-run salmon spawner population was estimated through carcass mark-and-recovery surveys in three areas of the Stanislaus River. Surveys between 9 November and 19 December were made on-foot in both the Goodwin Dam and Two Mile Bar areas. Surveys from 2 November through 15 December were conducted by boat from Knights Ferry downstream to the Riverbank bridge, a stretch of 30.9 km (19.2 mi). River flows in the surveyed areas ranged from 6.4 to 9.9 m^3/s (225-350 cfs), while water temperature ranged from **14.5°C (58°F)** in late October to **10°C (50°F)** in mid-December. Visibility through the water was often greater than 3.0 m (10 ft) until late November when storm runoff reduced water clarity to about 2.4 m (8 ft).

The spawner population of the Knights Ferry to Riverbank bridge section was estimated at 5,925 salmon using the Schaefer equation with the mark-and-recovery data (Table 8). For the surveys at Goodwin Dam, 100 salmon carcasses were observed, of which 40 were marked, and 22 recovered, and at Two Mile Bar, 200 carcasses were seen, 90 were marked, and 43 were recovered. Petersen estimates of 58 fish and 309 fish, respectively, were calculated for these areas.

The total estimated Stanislaus River 1987 fall-run spawner population of 6,292 salmon was only 3% lower than the 1986 population, and still almost twice the average run size for the past ten years (Appendix 4).

The 1987 run consisted of 42% male adults (FL \geq 61 cm [24 in]), 22% female adults, 26% male grilse (FL < 61 cm), and 10% female grilse, based on examination of 1,598 salmon carcasses.

TABLE 8. Chinook salmon carcass mark-and-recovery data used to estimate the 1987 fall-run spawner population in the Stanislaus River from Knights Ferry to the Riverbank bridge.

Recovery period (j)	Number of marked carcasses recovered from marking period (i):						Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
	Nov. 2	Nov. 6	Nov. 10	Nov. 17	Nov. 24	Dec. 8			
Nov. 6	1	—	—	—	—	—	1	111 c/	814
Nov. 10	2	8	—	—	—	—	10	208	555
Nov. 17		3	3	—	—	—	6	318	1,166
Nov. 24		0	2	29	—	—	31	677	921
Dec. 8		3	1	7	22	—	33	645	1,636
Dec. 15				2	8	10	20	325	1,058
Total recovered (Ri):	<u>3</u>	<u>14</u>	<u>6</u>	<u>38</u>	<u>30</u>	<u>10</u>		Total: <u>6,150</u>	
Total carcasses marked (Mi):	22	21	35	40	90	39			
								Adjusted estimate:	5,925 d/

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

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

c/ Includes carcasses observed during the first marking period, for purposes of calculating the second period population estimate.

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. $6,150 - 225 = 5,925$.

Tuolumne River - by Maurice Fjelstad

Fall run. The 1987 fall-run chinook salmon spawner surveys in the Tuolumne River were conducted from 2 November through 16 December. Carcass mark-and-recovery surveys were conducted in the river stretch from Old LaGrange Bridge downstream to Neilsen Ranch near Waterford, a distance of 27.3 km (17 mi). Redd surveys during the peak spawning period were also made of that entire stretch, and from Old LaGrange Bridge upstream to LaGrange Dam (1.6 km [1 mi]), and from Neilsen Ranch downstream to Geer Avenue (12.9 km [8 mi]). River flow during the survey period was about 5.5 m³/s (195 cfs), and visibility through the water was not less than 5 m (16.5 ft).

The spawner population in the river section between LaGrange bridge and Neilsen Ranch was estimated to be 12,243 salmon, calculated from mark-and-recovery data using the modified Schaefer equation (Table 9). The populations for the two sections up and downstream of the mark-and-recovery area were determined from their redd proportions relative to the entire surveyed reaches. The number of redds in these areas constituted 17% of the total redds from LaGrange Dam to Geer Avenue bridge. Assuming that the estimated 12,243 spawners in the mark-and-recovery area represented 83% of the run, then 2,508 salmon were in the other areas, and the total estimated 1987 fall-run spawner population for the Tuolumne River was 14,751 salmon. This was almost twice the size of the 1986 population, and 46% higher than the average run size for the previous ten years (Appendix 4); salmon populations during the past ten years have ranged from a low of 350 fish during the drought of 1977 to 40,322 fish in 1985.

The 1987 Tuolumne River fall run consisted of 2.7% male adults (FL ≥ 77 cm [30.3 in]), 66.4% male grilse (FL < 77 cm), 4.1% female adults (FL ≥ 67 cm [26.4 in]), and 26.8% female grilse (FL < 67 cm). The lengths used to separate adults from grilse were determined from length frequency distributions of 456 salmon carcasses.

Merced River - by Robert Reavis

Fall run. Fall-run salmon spawner surveys in the Merced River during 1987 started on 5 November and ended on 11 December. Weekly carcass mark-and-recovery surveys were concentrated in the 16.1 km (10 mi) section from the Merced River Fish Facility (MRFF) downstream to the HWY.59 bridge. River flows during the survey period were about 5.1 m³/s (180 cfs), with visibility through-the water generally greater than 2 m (6.6 ft).

The estimated spawner population in the river section from the MRFF to HWY.59 was 1,901 salmon, calculated using the Petersen equation with mark-and-recovery data (Table 10).

TABLE 9. Chinook salmon carcass mark-and-recovery data used to estimate the 1987 fall-run spawner population in the Tuolumne River from the Old LaGrange Bridge to Nielsen Ranch.

Recovery period (i)	Number of marked carcasses recovered from marking period (i):						Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
	Nov. 2-4	Nov. 10-12	Nov. 17-19	Nov. 23-25	Nov. 30-Dec. 3	Dec. 7-9			
Nov. 10-12	2	- -	- -	- -	- -	- -	2	188 c/	846
Nov. 17-19		23	- -	- -	- -	- -	23	659	1,647
Nov. 23-25		14	78	- -	- -	- -	92	1,412	2,953
Nov. 30-Dec. 3		5	21	81	- -	- -	107	1,360	3,010
Dec. 7-9			13	27	%	- -	136	1,464	3,082
Dec. 14-16				10	33	58	101	658	1,746
Total recovered (Ri):	2	42	112	118	129	58		Total:	13284
Total carcasses marked (Mi):	9	105	226	265	268	177			
Adjusted estimate:									12,243d/

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

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

c/ Includes carcasses observed during the first marking period, for purposes of calculating the second period population estimate.

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. 13,284 - 1,041 = 12,243.

TABLE 10. Chinook salmon carcass mark-and-recovery data used to estimate the 1987 fall-run chinook salmon spawner population in the Merced River from the Merced River Fish Facility to the Highway 59 bridge.

Recovery period	Number of marked carcasses recovered from the marking period:					Total marked carcasses recovered (R)	Total carcasses marked (M)	Total carcasses observed (C) a/	
	Nov. 5	Nov. 12	Nov. 19	Nov. 25	Dec. 4				
Nov. 5	--	--	--	--	--	--	2	--	
Nov. 12	1	--	--	--	--	1	11	25 b/	
Nov. 19		2	--	--	--	2	28	80	
Nov. 25		0	4	--	--	4	41	109	
Dec. 4		1	1	7	--	9	34	140	
Dec. 11				6	4	10	0	72	
						<u>26</u>	<u>116</u>	<u>426</u>	
Petersen estimate:							1,901 c/		

a/ Includes salmon carcasses that were marked and marked carcasses that were recovered.

b/ Includes salmon carcasses observed during the first period.

c/ Petersen estimate equation, $N = (M \times C) / R$, (Ricker 1975).

In past years, the spawner population downstream of HWY.59 to Bettencourt Ranch, a distance of 12 km (7.5 mi), was estimated from the proportion of redds occurring in that section of the river in relation to the upstream section. However, during this season dense water hyacinth growth prevented redd counts in this area, and a proportion of 40% was assumed; proportions of about 30% were seen from 1971 to 1981, with over 50% of the redds seen in this area last season. Therefore, assuming that the estimated 1,901 spawners in the upstream section represented 60% of the run, then 1,267 salmon were downstream of HWY.59, and the estimated in-river population was 3,168 salmon.

An additional 958 salmon were observed during MRFF operations (Cozart 1991), for a total 1987 fall-run spawner population of 4,126 salmon. This run size was 55% of the 1986 population, and 45% of the average for the past ten years (Appendix 4).

Based on 138 carcasses examined during the surveys, the run was composed of 31.1% male adults (FL \geq 61 cm [24 in]), 17.4% female adults, 18.9% male grilse (FL < 61 cm), and 32.6% female grilse. In comparison, salmon which entered the MRFF consisted of 41.8% male adults, 9.5% female adults, 39.4% male grilse, and 9.3% female grilse.

SUMMARY

The total estimated 1987 Central Valley chinook salmon spawner population was 334,362 fish (Table 11). This was slightly higher than the 1986 total of 328,893 salmon (Kano and Reavis 1997), even though most of the 1987 tributary runs were lower than estimated the previous year. As in the past, the majority of the 1987 population occurred in the Sacramento River system, with only 26,799 fall-run fish in the San Joaquin River system; the Tuolumne River run constituted over half of these spawners. Ten-year record high late-fall and fall runs were estimated for the mainstem Sacramento River upstream of Red Bluff. The winter run in the same area continued to decrease from its critically low level.

TABLE 11. Summary of the 1987 Sacramento-San Joaquin river system chinook salmon spawner populations.

Spawning area	Late-fall run	Winter run	Spring run	Fall run	Total
Sacramento mainstem	15,393a/	2,045	12,611	108,546	138,595
Sacramento tributaries	349b/	--	1,517c/	167,102d/	168,968
San Joaquin tributaries	--	0	--	26,799	26,799
Totals:	15,742	2,045	14,128	302,447	334,362

a/ Includes only the mainstem from Keswick Dam to Red Bluff Diversion Dam.

b/ Consists only of fish which entered Coleman Hatchery (Battle Creek).

c/ Includes Mill, Deer, and Butte creeks, and the Feather River.

d/ Includes Battle, Mill, and Deer creeks, and the Feather, Yuba, and American rivers.

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APPENDIX 1. Adjusted chinook salmon counts and estimated numbers of each run at Red Bluff Diversion Dam from 19 October 1986 through 2 January 1988.

Count period	Adjusted salmon count a/	Number of salmon examined b/	Run proportions							
			Late-fall		Winter		Spring		Fall	
			% of fish examined	Estimated number c/	% of fish examined	Estimated number c/	% of fish examined	Estimated number c/	% of fish examined	Estimated number c/
19 Oct '86 - 3 Jan '87 d/	--	--	--	10,163 e/	--	57 e/	--	--	--	--
1987-1988										
05-Jan - 11-Jan	--	--	--	1,031 e/	--	23 e/				
12-Jan - 18-Jan	--	--	--	507 e/	--	11 e/				
19-Jan - 25-Jan	--	--	--	128 e/	--	55 e/				
26-Jan - 01-Feb	--	--	--	167 e/	--	23 e/				
02-Feb - 08-Feb	--	--	--	641 e/	--	57 e/				
09-Feb - 15-Feb	--	--	--	657 e/	--	57 e/				
16-Feb - 22-Feb	--	--	--	701 e/	--	23 e/				
23-Feb - 29-Feb	--	--	--	530 e/	--	114 e/				
01-Mar - 07-Mar	--	--	--	343 e/	--	137 e/				
08-Mar - 14-Mar	--	--	--	253 e/	--	206 e/				
15-Mar - 21-Mar	--	--	--	548 e/	--	148 e/				
22-Mar - 28-Mar	--	--	--	349 e/	--	91 e/				
29-Mar - 04-Apr	--	--	--	31 e/	--	194 e/				
05-Apr - 11-Apr	216	5		Total: 16,049 f/ g/	100.0	216				
12-Apr - 18-Apr	260	34			91.2	237	8.8	23		
19-Apr - 25-Apr	83	10			90.0	75	10.0	8		
26-Apr - 02-May	123	17			41.2	52	58.8	74		
03-May - 09-May	235	26			19.2	45	80.8	190		
10-May - 16-May	339	14			21.4	73	78.6	266		
17-May - 23-May	468	11			16.7	58	89.3	418		
24-May - 30-May	401	36			0.0	0	100.0	401		
31-May - 06-Jun	362	34			2.9	10	97.1	352		
07-Jun - 13-Jun	417	71			0.0	0	98.6	411	1.4	6
14-Jun - 20-Jun	400	27			0.0	0	92.6	370	7.4	30
21-Jun - 27-Jun	477	46			6.5	31	78.3	373	15.2	73
28-Jun - 04-Jul	418	64			3.1	13	57.8	242	39.1	163
05-Jul - 11-Jul	594	43			Total: 1,998 f/	67.4	400	32.6	194	
12-Jul - 18-Jul	731	31				31.6	377	48.4	354	
19-Jul - 25-Jul	425	45				55.6	236	44.4	189	
26-Jul - 01-Aug	409	36				22.2	91	77.8	318	
02-Aug - 08-Aug	1,981	40				30.0	594	70.0	1,387	
09-Aug - 15-Aug	5,269	53				34.0	1,791	66.0	3,478	
16-Aug - 22-Aug	2,995	53				7.5	225	92.5	2,770	
23-Aug - 29-Aug	5,191	92				5.4	280	94.6	4,911	
30-Aug - 05-Sep	4,805	62				14.5	697	85.5	4,108	
06-Sep - 12-Sep	4,417	72				5.6	247	94.4	4,170	
13-Sep - 19-Sep	12,794	74				6.8	870	93.2	11,924	
20-Sep - 26-Sep	12,143	80				6.3	765	93.7	11,378	
27-Sep - 03-Oct	10,812	79				13.9	1,503	86.1	9,309	
04-Oct - 10-Oct	11,156	85				0.0	0	100.0	11,156	
11-Oct - 17-Oct	6,892	57				Total: 11,205 f/	100.0	6,892		
18-Oct - 24-Oct	8,411	62	1.6	135				98.4	8,276	
25-Oct - 31-Oct	8,041	84	4.8	386				95.2	7,655	
01-Nov - 07-Nov	6,832	89	7.9	340				92.1	6,292	
08-Nov - 14-Nov	3,946	95	23.2	915				76.8	3,031	
15-Nov - 21-Nov	2,791	46	52.2	1,457				47.8	1,334	
22-Nov - 28-Nov	1,719	31	61.3	1,054				38.7	665	
29-Nov - 05-Dec b/	--	--	--	--				--	--	
06-Dec - 12-Dec	--	--	--	--				--	--	
13-Dec - 19-Dec	--	--	--	--				--	--	
20-Dec - 26-Dec	--	--	--	--				--	--	
27-Dec - 02-Jan	--	--	--	--				--	--	
				3,340 i/				37 i/		3,000 i/
Total for the 5-Jan-87 to 2-Jan-88 period j:	116,555	1,704		13,712		1,978	11,205		Total: 103,063 f/	103,063

a/ Actual weekly counts were expanded to adjust for periods when the fishways were open and no observations were made.
 b/ Salmon in the fishway trapping facility which were examined to determine the run composition, based on relative spawning readiness.
 c/ Adjusted count x Proportion of examined fish assigned to run.
 d/ Estimated numbers represent salmon passing the dam during this period that were expected to spawn in 1987 (Kano and Reavis 1997).
 e/ Part of the late-fall-run and all of the winter-run estimated numbers based on the historical (1968-1985) average weekly proportions.
 f/ Total estimated number of potential spawners during the 1987 calendar year.
 g/ Includes a total of 454 fish trapped at Keswick Dam and trucked to Coleman National Fish Hatchery.
 h/ Red Bluff Diversion Dam gates were raised on 1 December.
 i/ Estimated number for the five-week period based on the run's historical (1968-85) average proportional distribution.
 j/ Including late-fall- and winter-run 1988 potential spawners.

APPENDIX 2. 1987 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/	15,393 b/	1,978	10,972	75,958	104,301
Clear Creek	c/	--	c/	d/	--
Cottonwood Creek	c/	--	c/	d/	--
Paynes Creek	--	--	--	d/	--
Battle Creek					
Coleman National Fish Hatchery	349	--	--	18,381	18,730
Downstream of hatchery	c/	--	--	5,868	5,868
(Totals for tributary):	(349)	(--)	(--)	(24,249)	(24,598)
Totals for area:	<u>15,742</u>	<u>1,978</u>	<u>10,972</u>	<u>100,207</u>	<u>128,899</u>
Red Bluff to Princeton Ferry					
Sacramento River mainstem					
Red Bluff to Tehama Bridge	c/	67	1,639	17,272	18,978
Tehama Bridge to Woodson Bridge	c/	--	--	7,821	7,821
Woodson Br. to Princeton Ferry	c/	--	--	7,495	7,495
Tehama-Colusa Spawning Channel	0 e/	0 e/	0 e/	0 e/	0
(Totals for tributary):	(0)	(67)	(1,639)	(32,588)	(34,294)
Salt Creek	--	--	--	d/	--
Antelope Creek	--	--	c/	d/	--
Craig Creek	c/	--	--	d/	--
Dye Creek	--	--	--	d/	--
Mill Creek	c/	--	90	282	372
Toomes Creek	--	--	--	d/	--
Deer Creek	c/	--	200	64	264
Singer Creek	--	--	--	d/	--
Totals for area:	<u>--</u>	<u>67</u>	<u>1,929</u>	<u>32,934</u>	<u>34,930</u>
Big Chico Creek to the American River					
Big Chico Creek	--	--	--	c/	--
Butte Creek	--	--	14	c/	14
Feather River					
Feather River Hatchery	--	--	1,213	10,108	11,321
Downstream of hatchery	--	--	c/	67,738	67,738
(Totals for tributary):	(--)	(--)	(1,213)	(77,846)	(79,059)
Yuba River	--	--	c/	18,518	18,518
American River					
American River Hatchery	--	--	--	6,258	6,258
Downstream of hatchery	--	--	--	39,885	39,885
(Totals for tributary):	(--)	(--)	(--)	(46,143)	(46,143)
Totals for area:	<u>--</u>	<u>--</u>	<u>1,227</u>	<u>142,507</u>	<u>143,734</u>
Sacramento River system totals:	<u><u>15,742</u></u>	<u><u>2,045</u></u>	<u><u>14,128</u></u>	<u><u>275,648</u></u>	<u><u>307,563</u></u>

a/ Includes numbers of fish for tributaries not surveyed in the river area.

b/ Includes 454 fish from Keswick Dam that were transported to and spawned at Coleman Hatchery.

c/ Tributary was not surveyed for this run.

d/ No estimate of the population was made.

e/ The Tehama-Colusa Spawning Channel was not operated.

APPENDIX 3. 1987 chinook salmon spawner population estimates for San Joaquin River system.

Tributary	Estimated number of fish				Total
	Late-fall run	Winter run	Spring run	Fall run	
<u>Cosumnes River</u>	--	--	--	0	0
<u>Mokelumne River</u>					
Mokelumne River Hatchery	--	--	--	630	630
Downstream of hatchery	--	--	--	1,000	1,000
(Totals for tributary):	--	--	--	(1,630)	(1,630)
<u>Calaveras River</u>	--	a/	--	--	--
<u>Stanislaus River</u>	--	--	--	6,292	6,292
<u>Tuolumne River</u>	--	--	--	14,751	14,751
<u>Merced River</u>					
Merced River Fish Facility	--	--	--	958	958
Downstream of facility	--	--	--	3,168	3,168
(Totals for tributary):	--	--	--	(4,126)	(4,126)
<u>San Joaquin River system totals:</u>				<u>26,799</u>	<u>26,799</u>

a/ Tributary was not surveyed.

APPENDIX 4. Summary of Sacramento - San Joaquin river system chinook salmon spawner population estimates from 1977 through 1987.

Tributary Race	Estimated population size										1977 - 1986 average	
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986		1987
<u>Sacramento River system</u>												
<u>upstream of Red Bluff</u>												
<u>(excluding Battle Creek)</u>												
Late-fall run	9,210	12,479	10,284	9,361	6,423	4,899	14,984	7,140	8,136	7,811	15,393	9,073
Winter run	16,470	24,735	2,339	1,142	19,795	1,233	1,827	2,662	3,684	2,394	1,978	7,628
Spring run	13,453	5,669	2,856	9,363	20,655	23,156	3,854	7,823	10,200	15,824	10,972	11,285
Fall run	39,579 a/	35,500	47,758	21,961	33,289	20,567	27,326	41,805	52,820	67,940	75,958	38,774 b/
<u>Battle Creek</u>												
Fall run	c/	3,652	13,159	14,443	17,205	26,795	13,983	29,893	39,808	31,252	24,249	19,019
<u>Sacramento River</u>												
<u>mainstem downstream</u>												
<u>of Red Bluff</u>												
Fall run	45,743	47,973	67,388	30,453	42,724	23,833	32,018	19,166	46,780	34,372	32,588	39,045
<u>Feather River</u>												
Spring run d/	185	202	250	269	469	1,910	1,702	1,562	1,632	1,433	1,213	961
Fall run	46,452	37,759	32,505	35,295	53,020	55,519	30,522	51,056	56,002	55,471	77,846	45,360
<u>Yuba River</u>												
Fall run	8,722	7,416	12,430	12,406	14,025	39,367	13,756	9,665	13,042	19,328	18,518	15,016
<u>American River</u>												
Fall run	48,473	21,091	47,666	49,802	64,055	43,898	35,300	39,696	65,213	55,067	46,143	47,026
<u>Cosumnes River</u>												
Fall run	c/	100	150	200	c/	c/	200	1,000	220	c/	c/	187
<u>Mokelumne River</u>												
Fall run	250	1,086	1,507	3,231	4,954	9,372	15,861	8,298	7,682	7,167	1,630	5,941
<u>Stanislaus River</u>												
Fall run	0	50	110	100	1,000	c/	500	11,439	13,473	6,497	6,292	3,317
<u>Tuolumne River</u>												
Fall run	450	1,300	1,183	559	14,253	7,126	14,836	13,689	40,322	7,404	14,751	10,112
<u>Merced River</u>												
Fall run	350	625	2,147	3,006	10,415	3,263	18,248	29,749	16,052	7,439	4,126	9,129

a/ Includes the Battle Creek estimated population.

b/ The average does not include the 1977 estimate, since Battle Creek fish were not separated out.

c/ No estimate made.

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