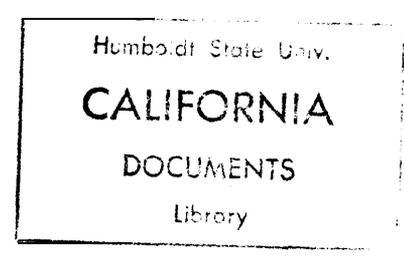


Cal Doc
F660
A3
96-3

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

**ANNUAL REPORT
CHINOOK SALMON SPAWNING STOCKS IN
CALIFORNIA'S CENTRAL VALLEY, 1984**

Edited by



Robert M. Kano
Robert Reavis
and Frank Fisher
Inland Fisheries Division

Inland Fisheries Division
Administrative Report No. 96-3
1996

CHINOOK SALMON SPAWNING STOCKS IN
CALIFORNIA'S CENTRAL VALLEY, 1984 1/

Edited by

Robert M. Kano
Robert Reavis
and Frank Fisher
Inland Fisheries Division

ABSTRACT

This report covers the 32nd annual inventory of chinook salmon, Oncorhynchus tshawytscha, spawning populations in the Sacramento-San Joaquin River system. It is a compilation of reports estimating the fall-, winter-, late-fall-, and spring-run salmon spawning populations for streams which were surveyed.

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

The estimated 1984 total escapement of chinook salmon in the Central Valley was 285,464 fish. This total consisted of 262,906 fall-, 9,408 spring-, 2,762 winter- and 10,388 late-fall-run spawners. Of the total, 221,189 salmon spawned in the Sacramento River system and 64,275 in the San Joaquin River system. All spring and late-fall salmon, 2,662 of the winter-, and 198,731 of the fall-run salmon spawned in the Sacramento River system. Except for a very small winter run in the Calaveras River, all salmon that spawned in the San Joaquin River system were fall-run fish.

The total 1984 Central Valley salmon stock was higher in comparison to that of 1983 due to significantly larger populations of fall-run spawners in Battle Creek, and in the Stanislaus and Merced rivers. The runs in Battle Creek and the Merced River were the largest estimated since surveys began in 1953. The increased numbers of fall-run spawners in these streams outweighed large decreases in the mainstem Sacramento River downstream of Red Bluff, and in the Yuba and Mokelumne rivers. The 1984 fall-run populations in the American and Tuolumne rivers were similar to those of 1983.

In the mainstem Sacramento River upstream of Red Bluff, the 1984 late-fall run spawner population was half the 1983 run size, the spring run was about doubled, and the winter run remained unchanged at a critically low level.

1/ Inland Fisheries Branch Administrative Report No. 96-3.
Submitted for publication 1996.

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 32nd compilation of chinook salmon spawning 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, where they arrive in late December through mid-July, and spawn 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 July, 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 spawning 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 spawning populations, and to recover coded-wire-tagged salmon. Any changes in spawning distribution and habitat conditions that may adversely affect salmon are observed to determine if corrective action is necessary.

GENERAL METHODS

During 1984, spawning stock data were collected on most Central Valley streams known to support sizeable chinook salmon runs by: monitoring fish entering hatcheries, in spawning channels, and migrating past dams; conducting stream surveys of spawning areas for live fish, carcasses, and redds; and making aerial counts.

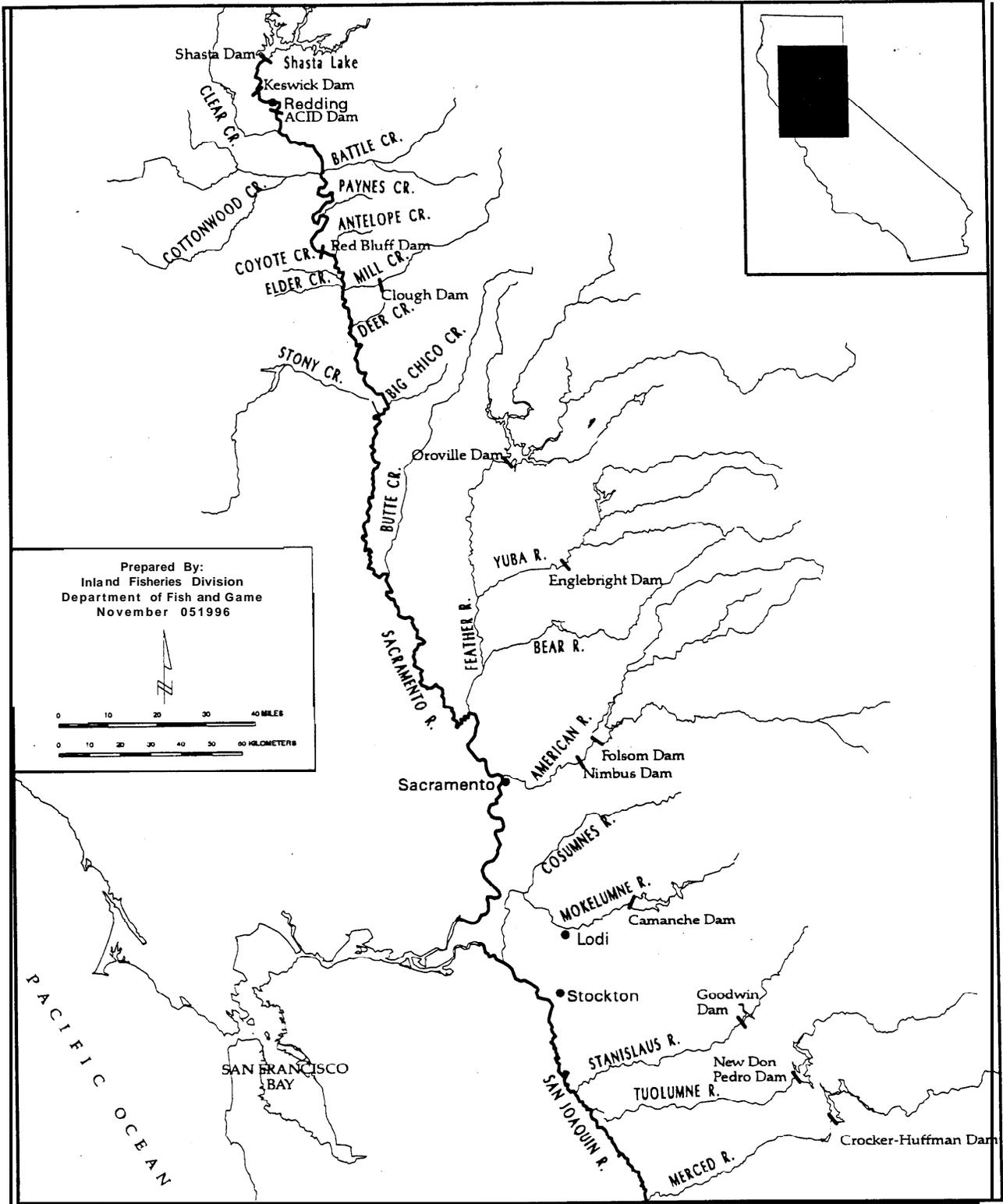


FIGURE 1. Sacramento-San Joaquin river system of California's Central Valley.

Spawner population estimates for some tributaries were derived directly-from counts of salmon carcasses based on 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 numbers of carcasses observed during the season in a tributary; all counted carcasses were cut in half to prevent recounting.

In other streams, a mark-and-recovery technique was used to obtain data for calculation of spawner population estimates. Over a series of surveys, fresh carcasses, identified by clear eyes, were marked with colored ribbon or tape 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 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 1978);

$$N = \sum (R_{1j} \times \frac{M_i}{R_i} \times \frac{C_j}{R_j}) - \sum_2^i M_i$$

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

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

M_i = number of carcasses marked in the ith marking period,

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

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

C_j = total number of all 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.

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

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

where N = estimated spawning population,

m = total number of carcasses marked,

C = total number of carcasses examined, 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 individual stream headings.

CHINOOK SALMON SPAWNING POPULATIONS FOR THE SACRAMENTO RIVER SYSTEM

Keswick Dam to Red Bluff Diversion Dam

Spawning 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). In addition, fall-run population estimates were made for Battle, Clear, Paynes, Cow, and Cottonwood creeks, while late-fall run estimates were made for Clear and Cottonwood creeks.

A total of 89,323 salmon spawned during 1984 in the Sacramento River system between Keswick Dam and Red Bluff, including 71,698 fall-, 7,140 late-fall-, 2,662 winter- and 7,823 spring-run fish. A total of 36,965 fall- and 6,540 late-fall-run salmon spawned in the mainstem, while 34,733 and 600 fish, respectively, spawned in the tributaries (Appendix 3). Surveys of tributaries in this area were not conducted during spring- and winter-run spawning periods, and numbers of these fish were included in the mainstem totals.

Sacramento River Mainstem - by Richard J. Hallock

Estimates of the total numbers of salmon utilizing the Sacramento River and its tributaries upstream from RBDD during 1984 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.

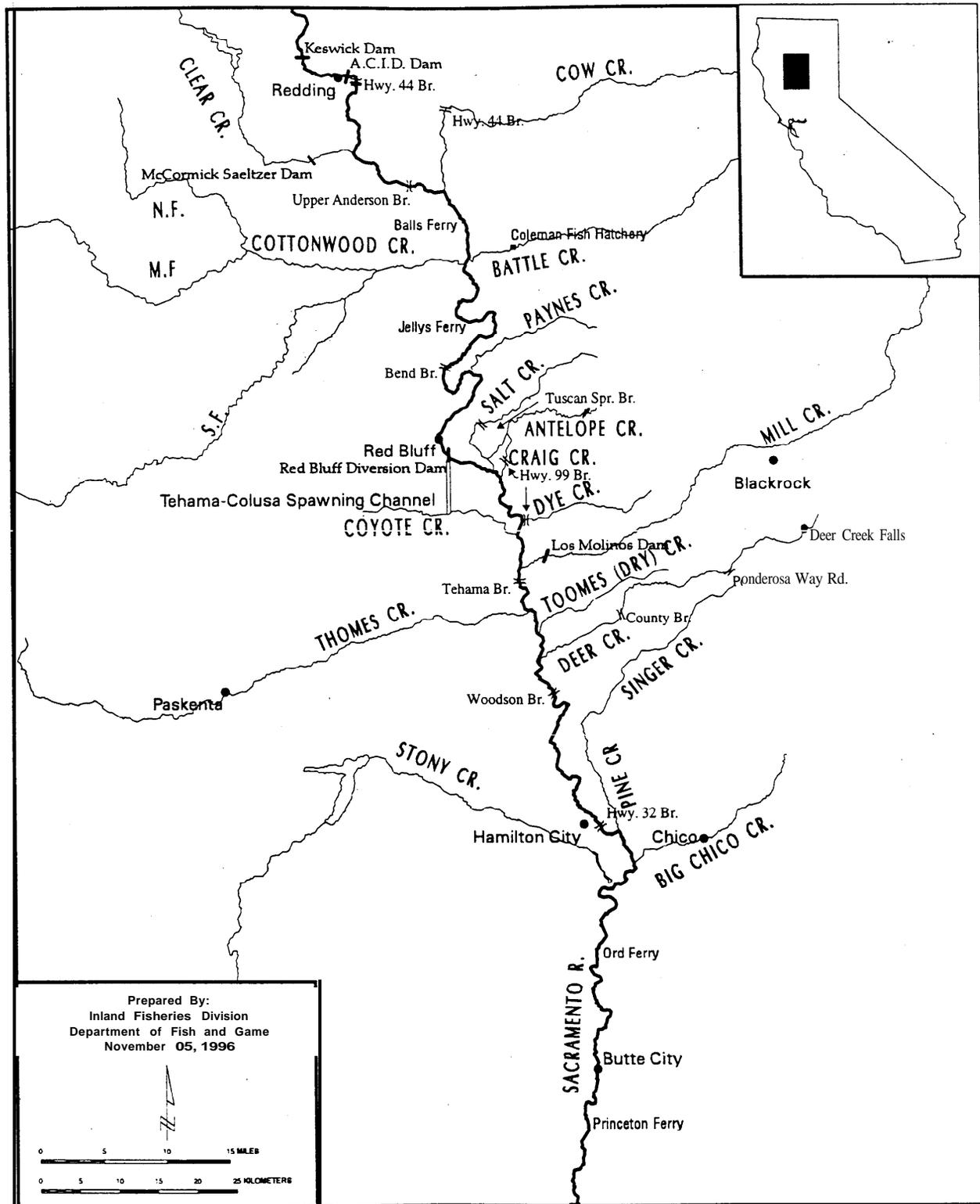


FIGURE 2. Sacramento River system from Keswick Dam downstream to Princeton Ferry.

Total weekly numbers of fish counted 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 it was necessary to open the dam gates, 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 total adjusted weekly number of fish was apportioned among the four runs, based on each run's *proportion that week in random samples of salmon from the dam's east-bank trapping facility; salmon were assigned to a run based on their relative degree of ripeness (Appendix 1).

The numbers of spring- and fall-run salmon counted passing RBDD in a calendar year accounts for the entire annual run of these races. However, for late-fall and winter runs the total calendar year count includes the latter part of one annual run during the beginning of the year, and the first part of the next run at the end of that year. Approximately half of a late-fall annual run occurs in each portion of the calendar year, while most of a winter annual run occurs early in the year and the smaller part of the following winter run at the end of the year. The total numbers of 1984 potential spawners for each of these two runs were calculated by adding the appropriate portion of the 1983 calendar year count that would spawn in 1984, and not including that portion of the 1984 calendar year count that would spawn in 1985. Accordingly, about 56% (4,009 fish) of the 1984 late-fall-run spawners, and only 5% (137 fish) of the 1984 winter run, passed Red Bluff in 1983 (Appendix 1, Table 1).

TABLE 1. Calculation of the 1984 Spawning Population for Each Run of Chinook Salmon in the Sacramento River System Upstream of Red Bluff Diversion Dam.

Run	Number of fish passing dam in calendar year:		Number of potential spawners	Estimated sport catch	Estimated 1984 spawning population
	1983	1984			
Late-fall	4,009	+ 3,154	= 7,163	- 23	= 7,140
Winter	137	+ 2,526	= 2,663	- 1	= 2,662
Spring	--a/	8,147	= 8,147	- 324	= 7,823
Fall	--a/	73,254	= 73,254	- 1,556	= 71,698
Totals :	4,164	+ 87,081	= 91,227	- 1,904	= 89,323

a/ No 1984 spawners passed Red Bluff in 1983.

For each of the four runs, the total number of spawners upstream of RBDD was calculated by subtracting the estimated numbers of fish landed by the sport fishery between Keswick Dam and Red Bluff, from the total adjusted numbers of fish passing RBDD (Table 1); no attempt was made to account for any other prespawning mortality in the upper river. Practically all salmon caught upstream of Red Bluff are landed at either fishing resorts or public boat-launching ramps. Since only bi-weekly salmon catches were obtained from all fishing resorts, the total monthly catch was estimated by multiplying the resort landings by an average catch ratio (1.59) between resorts and public ramps, derived from 1967-1974 data when both sources were sampled. The total monthly catch was also apportioned among the four runs in proportion to their relative abundance at RBDD (Appendix Table 2).

The total number of spawners which passed RBDD was also reduced by the population estimates for some of the tributaries upstream of Red Bluff, since these were individually estimated. The estimates of Battle, Clear, Paynes, Cow, and Cottonwood creeks were subtracted to give the spawner population for the late-fall and fall **runs** in the mainstem upper Sacramento River (Appendix 3). The mainstem 1984 estimates included all of the winter- and spring-run salmon as well as those fish that spawned in unsurveyed tributaries.

Late-fall run. A total of 7,163 late-fall potential spawners passed RBDD in 1983 and 1984. The late-fall sport-catch was estimated to be 23 salmon, resulting in 7,140 fish as a spawning population upstream of Red Bluff (Table 1). An estimated 400 late-fall salmon spawned in Cottonwood Creek, and 200 spawned in Clear Creek, leaving 6,540 fish as the mainstem spawner population. Although some late-fall-run salmon may have spawned in other tributaries of the upper Sacramento River, no spawning stock surveys were made in those streams. Included in the upper mainstem population were late-fall run salmon trapped at RBDD and Keswick Dam, 153 and 182 fish respectively, that were hauled to Coleman Hatchery (Battle Creek) for spawning. The estimated 7,140 fish late-fall upper Sacramento River mainstem spawner population was a decrease of 52% from the 1983 population size, and was 65% of the race's average run size for 1974 through 1983 (Appendix 5).

Winter run. A total of 2,663 winter-run potential spawners passed RBDD in 1983 and 1984. The winter-run sport-catch was estimated to be only one salmon, resulting in 2,662 fish as a spawning population upstream of Red Bluff (Table 1). This race spawns primarily in the mainstem of the Sacramento River, but some winter-run salmon have been known to spawn in Battle Creek. The winter-run population has been critically low for the past three years, and while the 1984 run size increased about 46% over the 1983 population, it was only 19% of the average run size for the previous 10 years (Appendix 5).

Spring run A total of 8,147 spring-run potential spawners passed RBDD in 1984. The spring-run sport-catch was estimated to be 324 salmon, resulting in 7,823 fish as a spawning population upstream of Red Bluff (Table 1). Spring-run salmon do spawn in some tributaries of the upper Sacramento River, especially Battle and Cottonwood creeks. However, no surveys were conducted in these streams during the spring-run spawning period, so any tributary spawners are reported as included in the mainstem population numbers. The 1984 spring-run spawner population was more than twice the 1983 population, but still only 66% of the average run size for the previous 10 years (Appendix Table 5).

Fall run. A total of 73,254 fall-run potential spawners passed RBDD in 1984. The fall-run sport-catch was estimated to be 1,556 salmon, resulting in 71,698 fish as a spawning population upstream of Red Bluff (Table 1). A total of 34,733 fish spawned in the surveyed tributaries. (Battle, Clear, Paynes, Cow, and Cottonwood creeks), leaving 36,965 spawners for the upper mainstem population. This number included 67 salmon trapped at Keswick Dam and hauled to Coleman Hatchery for spawning, as well as an undetermined number which spawned in unsurveyed tributaries; several other tributaries upstream of Red Bluff usually accounted for a portion of the fall-run escapement. The estimated 41,805 fall-run salmon upstream of Red Bluff was an increase of 53% over the 1983 population, and exceeded the average run size since 1974; the 1977 estimate was not used in calculation of this average since the Battle Creek numbers of fish were included in the mainstem total (Appendix 5).

The adult-grilse composition for fall-run salmon passing upstream of RBDD was 61% adults (fork length [FL] \geq 61 cm [24 in]), and 39% grilse (FL < 61 cm).

Mainstem spawning distribution. The 1984 late-fall-, spring-, and fall-run salmon redd distribution in the mainstem Sacramento River from Keswick Dam downstream to Princeton Ferry (Figure 2) was determined from data collected during airplane flights on 10 February, 17 September, and 27 October, respectively (Table 2). Almost all of the mainstem spring-run (93.3%) and the majority of the late-fall (66.7%) and fall (67.2%) spawning activity occurred upstream from RBDD.

Battle Creek - by Richard J. Hallock

Late-fall, winter, and spring runs. Small numbers of these three runs have been known to spawn in Battle Creek, but no surveys or population estimates were made during 1984.

Fall run. Carcass counts were used to estimate the numbers of fall-run salmon that spawned in Battle Creek downstream from Coleman Hatchery. Seventeen survey trips were conducted from 17 September through 26 December 1984 in the 10 km (6 mi) stretch of

TABLE 2. Chinook Salmon 1984 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 a/	Proportional distribution	Redds counted a/	Proportional distribution
Keswick Dam to A.C.I.D. Dam d/	9	37.5%	1	6.7%	51	4.1%
A.C.I.D. Dam to Highway 44	1	4.2%	6	40.0%	150	12.0%
Highway 44 to Upper Anderson Bridge	4	16.7%	3	20.0%	142	11.4%
Upper Anderson Bridge to Balls Ferry	2	8.3%	2	13.3%	187	15.0%
Balls Ferry to Jellys Ferry	- -	- -	2	13.3%	167	13.4%
Jellys Ferry to Bend Bridge	- -	- -	--	--	120	9.6%
Bend Bridge to Red Bluff Dam	- -	- -	--	--	21	1.7%
Red Bluff Dam to Tehama Bridge	8	33.3%	1	6.7%	302	24.3%
Tehama Bridge to Woodson Bridge	- -	- -	--	--	73	5.9%
Woodson Bridge to Hamilton City (Hwy. 32)	--	- -	--	--	18	1.4%
Hamilton City to Ord Ferry	- -	- -			9	0.7%
Ord Ferry to Princeton Ferry	- -	- -	--	--	6	0.5%
	<hr/>		<hr/>		<hr/>	
Totals:	24		15		1,246	

a/ Made during an aerial survey on 10 February 1984.

b/ Made during an aerial survey on 17 September 1984.

c/ Made during an aerial survey on 27 October 1984.

d/ Anderson- Cottonwood Irrigation District Dam.

river downstream of Coleman Hatchery. Carcass recovery conditions were good during the early part of the survey period, but poorer in November and December. A total of 2,393 carcasses was counted at an recovery rate of 30%. An additional 67 carcasses were counted, at a 20% recovery rate, in Gover's Ditch, an irrigation diversion about 1 km (0.6 mi) long located 1.6 km (1.0 mi) downstream from Coleman Hatchery. From these data, it was estimated that 8,312 salmon spawned naturally in Battle Creek. Combined with the 21,581 fish which entered Coleman Hatchery, the total 1984 spawner population for this tributary was 29,893 fish (Appendix 3). The 1984 spawner population for Battle Creek was more than double the 1983 population and was almost triple the average run size for the previous 10 years (Appendix Table 5).

The composition of the fall run spawning naturally in Battle Creek was 32.3% male adults (FL \geq 61 cm [24 in]), 53.7% female adults, and 14.0% grilse (FL < 61 cm), based on an examination of 2,272 carcasses. In comparison, fish entering Coleman Hatchery consisted of 45.2% male adults, 41.3% female adults, and 13.5% grilse.

Clear Creek - by Richard J. Hallock

Late-fall run. The 1984 spawning population in Clear Creek was about 200 fish, based on the number of redds observed during an aerial survey conducted on 10 February 1984.

Fall run. One survey of Clear Creek was made by USFWS personnel on 20 November 1984. They counted about 100 carcasses and 1,000 live salmon, and based on comparison with observations made in this tributary in 1982, it was felt that about 4,000 fish constituted the 1984 fall-run spawner population.

Paynes Creek - by Richard J. Hallock

Fall run. Four surveys were conducted on the lower 8.1 km (5 mi) of Paynes Creek between 31 October and 20 December 1984, during which sixteen redds and seven live fish were counted. Based on these observations, the 1984 fall-run spawning population of this tributary was about 90 salmon.

Cow Creek - by Richard J. Hallock

Fall run An aerial survey covering this stream from its mouth upstream to the Highway 44 crossing was made on 27 October 1984, and forty-eight redds were observed. The fall-run spawning population of Cow Creek was about 250 salmon.

Cottonwood Creek - by Richard J. Hallock

Late-fall run. During an aerial survey made on 10 February 1984, 21 redds were counted. The 1984 late-fall-run spawning population of this tributary was about 400 salmon.

Fall run. An aerial survey of the Cottonwood Creek system was made on 27 October 1984, during which a total of 81 redds was counted (28 in the North Fork, and 53 in its mainstem between the mouth of the South Fork and the Sacramento River). The fall-run spawning population was about 500 fish.

Red Bluff Diversion Dam to Princeton Ferry

Chinook salmon spawning populations in the Sacramento River system downstream of RBDD to Princeton Ferry (Figure 2) were determined through carcass surveys and aerial redd counts. Tributaries in this area that were individually estimated were Salt, Antelope, Craig, Dye, Mill, Toomes, Deer and Singer creeks.

A total of 29,364 chinook salmon spawned in the Sacramento River system between Red Bluff and Princeton Ferry in 1984. This total included 3,248 late-fall-run and 26,116 fall-run fish. Most of the late-fall run spawned in the mainstem, while the fall run consisted of 19,166 fish that spawned in the mainstem and 6,950 fish that spawned in the various tributaries which were surveyed (Appendix 3).

Sacramento River flows at Red Bluff were low in October 1984, averaging 177 m^3/s (6,250 cfs). From mid-November until the end of the month, flows increased to greater than 559 m^3/s (19,760 cfs), decreasing in December to an average 419 m^3/s (14,810 cfs). The high, and often fluctuating, flows during the latter two months made spawning stock surveys in this river section difficult.

Sacramento River Mainstem - by Richard J. Hallock

Winter and spring runs. It is unlikely that many fish of these runs spawned in the mainstem downstream of RBDD. No spawning population estimates were made for 1984.

Late-fall run. Based on an aerial survey made on 10 February 1984 about 3,098 late-fall-run salmon spawned in the Sacramento River mainstem between Red Bluff and Princeton Ferry.

Fall run. In 1984, about 70% (13,290 fish) of the fall run population in the mainstem Sacramento River between RBDD and Princeton Ferry spawned upstream of Tehama, with an additional 1,206 fish entering the Tehama-Colusa Spawning Channel via Coyote

Creek. Downstream of Tehama, about 3,215 salmon spawned between Tehama and Woodson Bridge, about 790 fish spawned between Woodson Bridge and Hamilton City, about 395 fish spawned from Hamilton City to Ord Ferry, and about 271) salmon spawned between Ord Ferry and Princeton Ferry.

The total fall-run salmon spawning population in the Sacramento River mainstem between Red Bluff and Princeton Ferry was about 19,166 fish. This run size was a 40% decrease from the 1983 population, and only 49% of the average run size from 1974 to 1983 (Appendix 5).

The composition of the fall run entering the fish facility at Tehama-Colusa Spawning Channel was 49.0% male adults (FL \geq 61 cm [24 in]), 27.8% female adults, and 23.2% grilse (FL < 61 cm).

Mainstem spawning distribution. Redd counts made during three aerial surveys (10 February, 19 September, and 27 October 1984) were used to determine the general spawning distribution of late-fall, spring-, and fall-run salmon, respectively, in the mainstem Sacramento River between Red Bluff and Princeton Ferry (Table 2). In proportion to the entire mainstem spawning activity, 33.3% of the late-fall- and 32.8% of the fall-run redds were observed in this section of the river. All of the late-fall- and spring-run redds occurred from RBDD downstream to Tehama Bridge, while 24.3% of the fall-run redds were in this area.

Salt Creek - by Richard J. Hallock

Fall run. Three surveys were conducted between 26 November and 6 December 1984 in the Tuscan Spring Bridge area of Salt Creek, during which nine live salmon were observed.. The fall-run spawning population was about 30 salmon.

Antelope Creek - by Richard J. Hallock

Spring run. Spring-run salmon are known to enter Antelope Creek, but no surveys or a population estimate were made for 1984.

Fall run. Six surveys, between 6 October and 28 December 1984, were made in Antelope Creek from Cone Grove Park to the Highway 99-E Bridge. Four salmon carcasses and six live fish were observed. The spawning population in the area surveyed was about 260 fish.

Craig Creek - by Richard J. Hallock

Late-fall run The entire length of Craig Creek, an overflow channel from lower Antelope Creek to the Sacramento River, was surveyed seven times between 23 January and 19 March 1984. Eleven salmon carcasses and 26 live fish were observed. The late-fall-run spawning population was about 150 salmon.

Fall run. Seven surveys of the entire length of Craig Creek were made between 31 October and 28 December 1984. Six salmon carcasses were recovered and 12 live fish were counted. At a carcass recovery rate of 10% the fall-run spawning population was estimated to be 60 fish.

Dye Creek - by Richard J. Hallock

Fall run. Two surveys (one by airplane) on 7 and 12 December 1984 were made of Dye Creek between Highway 99-E and the county road crossing 3.2 km (2 mi) upstream. Five salmon carcasses were recovered and four redds were observed. At a 10% carcass recovery rate, the fall-run spawning population was estimated to be 50 fish.

Mill Creek - by Richard J. Hallock

Late fall and winter runs. Some fish of these races have been known to spawn in this stream in previous years, but no surveys or estimates for these runs were made for 1984.

Spring run. A spring-run spawning population estimate was not made for this tributary, although 13 salmon carcasses were observed during four trips to upper Mill Creek (between Highway 36 to 3.2 km [2 mi] downstream of Blackrock), made from 12 to 28 September 1984.

fall run. Between 25 October and 27 December 1984, 15 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 580 salmon carcasses was recovered, and based on a 10% recovery rate, the fall run was estimated to be 5800 spawners.

The fall run in Mill Creek consisted of 32.8% male adults (FL \geq 61 cm [24 in]), 53.4% female adults, and 13.8% grilse (FL < 61 cm).

Toomes Creek - by Richard J. Hallock

Fall run. Five surveys were conducted between 15 November and 7 December 1984 in lower Toomes Creek near the Tehama-Vina Road crossing. Six live salmon were observed and five carcasses were recovered. At a 10% recovery rate, the fall-run spawning population was estimated to be 50 salmon.

Deer Creek - by Richard J. Hallock

Late-fall Run. The spawning population of this run was not estimated for this tributary, although a survey was made on 26 January 1984, during which three salmon carcasses were observed.

Spring run. The spring-run spawning population of this tributary was also not estimated. However, five surveys were made between 12 September and 11 October 1984 in upper Deer Creek from upper Deer Creek Falls to the Ponderosa Way crossing. Twenty-two redds and nine live salmon were observed.

Fall run. Seventeen surveys were made in lower Deer Creek between 4 October and 28 December 1984. The area between the mouth and the county bridge located 3.2 km (2 mi) upstream from the Stanford-Vina Dam was surveyed. A total of 68 salmon carcasses was recovered, and based on a 10% recovery rate, the estimated fall run was 680 spawners. The fall run in Deer Creek consisted of 47.9% male adults (FL \geq 61 cm [24 in]), 41.7% female adults, and 10.4% grilse (FL < 61 cm).

Singer Creek - by Richard J. Hallock

Fall run. One survey was made on Singer Creek during which two live salmon were observed. The fall-run spawner population size was about 20 salmon.

Big Chico Creek to American River

Chinook salmon spawning population estimates for the Feather, Yuba, and American rivers (Figure 3) were made from weekly mark-and-recovery surveys of fresh carcasses. Run sizes for some minor tributaries (Big Chico Creek, Butte Creek, and Bear River) were based on observations made during surveys in which carcasses and live fish were counted. Some surveys were hampered by fluctuating river flows caused by rain runoff.

A total of 102,503 chinook salmon spawned in the Sacramento River tributaries from Big Chico Creek to the American River in 1984. This total included 1,585 spring-run and 100,918 fall-run fish.

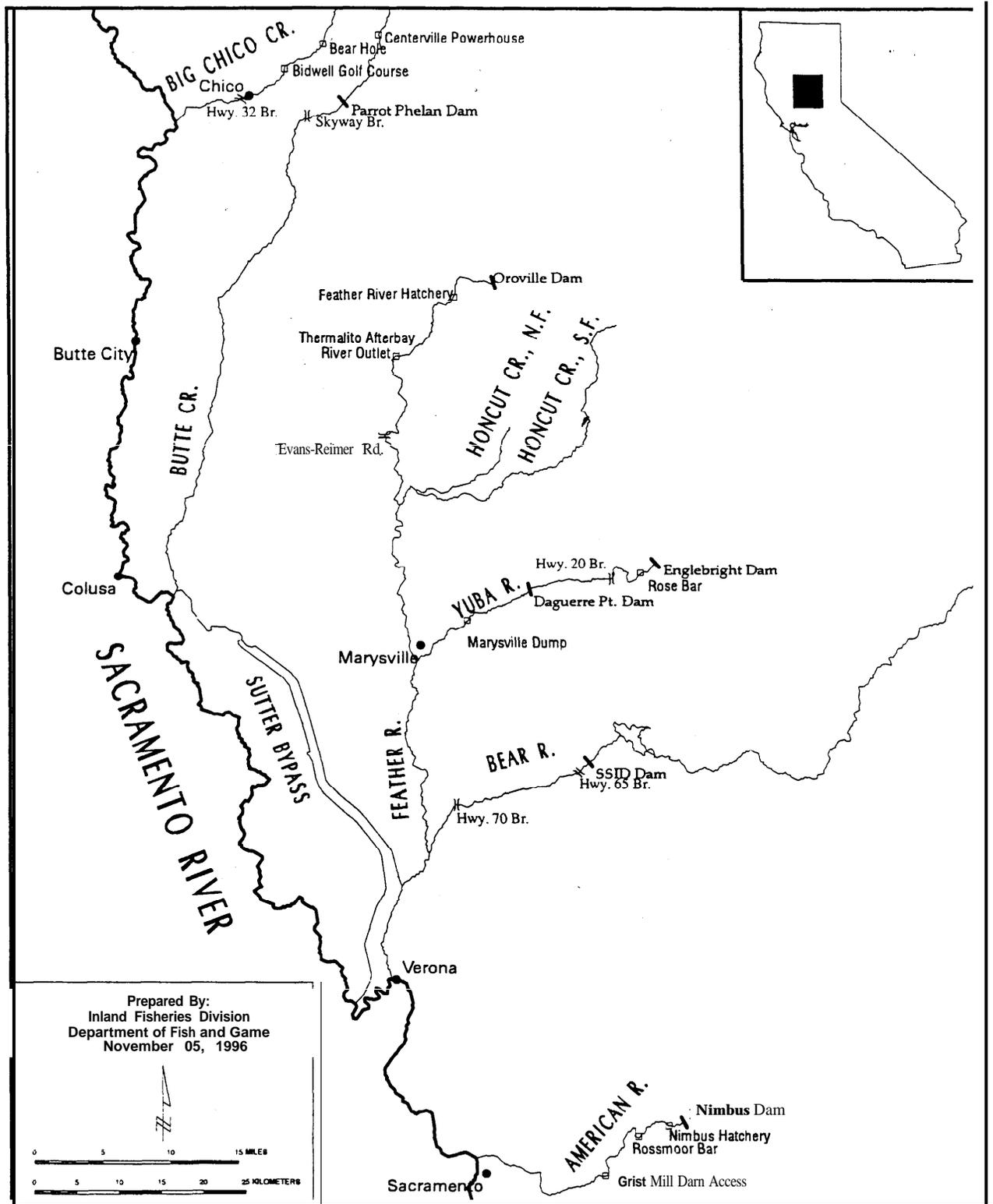


FIGURE 3. Sacramento River system from Big Chico Creek downstream to the American River.

The spring-run population spawned entirely in the Feather River. Most of the fall-run salmon spawned in the Feather and American rivers (90,753 fish) (Appendix 3).

Big Chico Creek - by Lawrence G. Preston

Spring run. Big Chico Creek was surveyed on 2 October 1984 between Higgins Hole and Ponderosa Way, a distance of 1.6 km (1.0 mi). No salmon were observed, and it was concluded that spring-run spawning did not occur in this stream this year.

Fall run. A survey by canoe was made on 4 November 1984 from Bidwell Park Golf Course downstream 8.8 km (5.5 mi) to Highway 32; most of the past years' spawning activity occurred in this section of the creek. Stream flow was 0.8 m³/s (30 cfs), water temperature was 10°C (50°F), and visibility through the water was less than 0.3 m (1 ft). Twenty-two live salmon were observed, but due to turbid water, no redds were seen. I resurveyed the section on 13 December when observation conditions were better, but only counted ten carcasses and three live salmon.

A 4.8-km (3-mi) section from the golf course upstream to Bear Hole was surveyed on-foot by Reiner Light of Chico State University on 19 November, and he observed seven dead and 46 live salmon.

Based on the above observations, the fall run in Big Chico Creek was about 200 spawners.

Butte Creek - by Lawrence G. Preston

Spring run In August 1984 Pacific Gas and Electric biologist Curtis Steitz conducted a snorkeling survey of Butte Creek from the Desabla Powerhouse to Centerville Powerhouse, a distance of 9.6 km (6 mi), and saw five salmon holding in pools. He resurveyed the section on 1 October observing three salmon on a multiple redd. On the same date I conducted a survey by canoe from Centerville Powerhouse to Parrot-Phelan Dam, a distance of 8 km (5 mi), and saw five live salmon, five single redds, and one multiple redd; no salmon were seen near the redds. Stream flows in this section were 0.8 - 1.1 m³/s (30-40 cfs), and water temperature was 14.4°C (58°F). On 2 October, I surveyed a 2.9 km (1.8 mi) section of the creek from Parrot-Phelan Dam to the Skyway Bridge, and saw no live salmon or redds. Based on the above observations, about 23 spring-run salmon spawned in Butte Creek in 1984.

Fall run. No surveys were conducted nor an estimate made for this run in Butte Creek this year. However, salmon were present in this tributary during the fall-run season as CDFG

Wildlife Protection personnel observed anglers catching them.

Feather River - by Lawrence G. Preston

Spring run Based on counts at Feather River Hatchery (FRH) from 1 to 30 September 1984, 1,562 spring-run salmon entered the hatchery (Schlichting 1986). This total consisted of 831 adult males (FL \geq 61 cm [24 inches]), 480 adult females, and 251 grilse (FL < 61 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 naturally spawning spring-run salmon. The number of spring-run salmon at FRH in 1984 was 8% lower than that seen in 1983, but more than double the average number counted from 1974 through 1983 (Appendix 5).

Fall run. Weekly surveys of fall-run salmon were conducted in the Feather River from 15 October to 10 December 1984. The carcass mark-and-recovery techniques were used in the river reach between the hatchery barrier dam and Evans-Reimar Road; in past years the downstream limit of surveys had been 3.3 km (2.0 mi) farther upstream at the Gridley Bridge. Fresh carcasses were tagged by attaching a small piece of colored ribbon to the jaw using a hog ring. The survey area consisted of two sections, characterized by different flow regimes. The stream section between the hatchery barrier dam and Thermalito Afterbay Outlet, a "Vow-flow section", had constant stream flows of 11.3 m^3/s (400 cfs) throughout the survey period. Downstream of Thermalito Afterbay Outlet to Evans-Reimar Road flows averaged 67.9 m^3/s (2400 cfs) during October, 79.3 m^3/s (2800 cfs) in November, and 141.6 m^3/s (5000 cfs) in December.

Moe's Ditch, a 160-m- (0.1-mi-) long side-channel adjacent to FRH was also surveyed and salmon carcasses were counted. The entrance to this ditch is fenced allowing live fish to enter while preventing carcasses from drifting out, and the carcass recovery efficiency was assumed to be 100%.

The modified Schaefer equation was used to calculate the fall-run naturally spawning population in each of the river sections (Table 3, Table 4). An estimated 22,524 salmon spawned in the upstream low-flow section, and 18,076 fish in the downstream section. An additional 1,169 carcasses were counted in Moe's Ditch, and 9,288 fall-run salmon entered FRH (Schlichting 1986), bringing the fall-run spawning population in the Feather River to 51,057 fish. The 1984 population was a 67% increase over that of 1983, and 10% more than the 1974-1983 average run size (Appendix 5).

The composition of the naturally spawning portion of the run, based on examination of 3,268 carcasses, was 31.5% male adults (FL \geq 61 cm [24 in]), 7.8% male grilse (FL < 61 cm), 53.2% female

TABLE 3. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population Between the Feather River Hatchery Barrier Dam and Thermalito Afterbay Outlet.

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. 15	Oct. 22	Oct. 29	Nov. 5	Nov. 13	Nov. 19	Nov. 26	Dec. 3			
Oct. 22	8	--	--	--	--	--	--	--	8	445 c/	1,399
Oct. 29	10	82	--	--	--	--	--	--	92	1,538	3,008
Nw. 5	3	28	245	--	--	--	--	--	276	1,945	3,538
Nov. 13		1	26	86	--	--	--	--	113	1,853	4,819
Nw. 19			18	40	100	--	--	--	158	1,967	4,444
Nw. 26			7	19	49	11s	--	--	190	1,784	3,477
Dec.3			5	9	26	53	118	--	211	1,343	2,466
Dec. 10					7	11	26	27	71	602	1,613
Total recovered (Ri):	21	111	301	154	182	179	144	27		Total:	24,764
Total carcasses marked (Mi):	66	201	543	439	383	312	251	111			
										Adjusted estimate d/: 22,524	

a/ Includes marked carcasses 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 recovery period population estimate.

d/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where total marked carcasses (Mi) from the second marking period on was subtracted from the total estimate, i.e. $24,764 - 2,240 = 22,524$.

TABLE 4. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population in the Feather River From 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. 16	Oct. 23	Oct. 30	Nov. 6	Nov. 14	Nov. 20	Nov. 27			
Oct. 23	--	--	--	--	--	--	--	0	- -	0
Oct. 30	3	3	- -	- -	- -	- -	- -	6	474 c/	1,238
Nov. 6		3	19	—	--	--	—	22	416	2,757
Nov. 14		3	6	13	- -	- -	- -	22	721	4,176
Nov. 20			1	6	31	- -	- -	38	644	3,144
Nov. 27			1	1	9	22	--	33	675	4,563
Dec. 4					3	4	6	13	187	3,072
Total recovered (Ri):	3	9	27	20	43	26	6		Total:	18,950
Total carcasses marked (Mi):	5	32	192	114	200	199	169			
Adjusted estimate d/: 18,076										

a/ Includes marked carcasses 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 two marking periods, for purposes of calculating the third recovery period population estimate.

d/Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where total marked carcasses (Mi) from the third marking period on was subtracted from the total estimate, i.e. $18,950 - 874 = 18,076$.

adults, and 7.5% female grilse. In comparison, salmon entering the hatchery consisted of 47.2% male adults, 48.0% female adults, and 4.8% grilse (grilse were not identified by sex in the hatchery).

Yuba River - by Lawrence G. Preston

Spring Run. Spring-run salmon have been known to spawn in the Yuba River in past years. However, no surveys or spawner estimates were made in 1984.

Fall run. Eight weekly carcass mark-and-recovery surveys were conducted from 17 October through 6 December in the Yuba River from the Highway 20 Bridge downstream to the Marysville dump. Bi-weekly surveys by canoe were also made upstream of the Highway 20 Bridge to Rose Bar. River flow upstream of Daguerre Point Dam was 28.3 m³/s (1000 cfs) through the first week of November, increasing to 70.8 m³/s (2500 cfs) during the last survey period. Consequently, visibility through the water diminished from 1.5 - 3.0 m (5-10 ft) during the beginning surveys to 0.6 - 0.9 m (2-3 ft) at the end. Flows downstream of Daguerre Point Dam were usually 2.8 - 5.7 m (100-200 cfs) less than upstream of the dam, due to diversions to Hallwood-Cordura Irrigation District.

Using carcass mark-and-recovery data, the modified Schaefer equation estimated 8,167 salmon as the spawner population between the Highway 20 and the Marysville dump (Table 5). Insufficient numbers of marked carcasses were recovered upstream of Highway 20 Bridge to Rose Bar for a Schaefer estimate of this area. Instead, this section's population was estimated using the average proportion of the total river's spawning population that this section constituted from 1966 to 1971. During those years, an average of 15.5% of the total population occurred upstream of the Highway 20 Bridge, so it was assumed that in 1984 this section's population was 1,498 salmon. The combined estimates for both sections was a total Yuba River spawning population of 9,665 salmon. This was a decrease of about 30% from the 1983 population, and only 71% of the average run size from 1974 to 1983 (Appendix 5).

The composition of 5,570 of the carcasses examined was 30.4% male adults (FL ≥ 61 cm [24 in]), 18.6% male grilse (FL < 61 cm), 43.1% female adults, and 7.9% female grilse.

Bear River (Yuba County) - by Lawrence G. Preston

Fall run. The Bear River had not been surveyed in past years on a regular basis. Surveys in 1984 to count live salmon, carcasses, and redds were conducted between 26 October and 12 December; salmon were first noted in the river on 7 November.

TABLE 5. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population in the Yuba River From the Highway 20 Bridge 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. 17	Oct. 25	Oct. 31	Nov. 7	Nov. 15	Nov. 21	Nov. 28			
Oct. 25	7	--	--	--	--	--	--	7	272 c/	915
Oct. 31	2	10	--	--	--	--	--	12	265	1351
Nov. 7	2	5	18	--	--	--	--	25	339	1,455
Nov.15		3	6	11	--	--	--	20	323	1,877
Nov. 21			1	3	7	--	--	11	211	1,401
Nov. 28			1		4	6	--	11	161	1,182
Dec. 6			1		1		5	7	74	454
Total recovered (Ri):	11	18	27	14	12	6	5		Total: 8,635	
Total carcasses marked (Mi):	37	98	110	96	83	49	32			
									Adjusted estimate: 8,167	

a/ Includes marked carcasses 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 recovery period population estimate.

d/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where total marked carcasses (Mi) from the second marking period on was subtracted from the total estimate, i.e. 8,635 - 468 = 8,167.

Six surveys on-foot or by canoe were made within the seven-week period, covering the 15.2-km (9.5-mi) river reach from the South Sutter Irrigation District (SSID) diversion dam downstream to the Highway 70 Bridge. Within this section of river, the stretch between Patterson's Sand and Gravel Plant to Highway 65 was not surveyed, while the stretch upstream of the gravel plant to the SSID dam was only covered three times. River flows during most of the surveys was about 0.06 m³/s (29 cfs), but increased to 8.4 m³/s (300 cfs) by the last survey. Visibility through the water ranged between 0.3 to 1.0 m (1 - 3 ft).

A total of 26 live fish or carcasses and 57 redds were counted during the survey period. Based on these observations, about 300 salmon were in the 1984 fall-run spawner population of the Bear River.

American River - by Mike Meinz

Fall run. Weekly carcass mark-and-recovery surveys were made between 5 November and 18 December 1984 in the 12.9-km (8-mi) stretch of the American River from Gristmill Dam upstream to the Nimbus Hatchery racks. River flows in this section ranged from 56.6 m³/s (2000 cfs) to 141.6 m³/s (5000 cfs), and visibility through the water ranged from 0.6 to greater than 1.5 m (2 - 5 ft). Generally, water clarity diminished when flows exceeded 56.6 m³/s, which was the case during six of the seven surveys, making recovery of marked carcasses difficult. 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 number of recovered marked carcasses was low during half of the surveys in the section from Gristmill Dam to the Nimbus racks, precluding calculation of a population estimate with the modified Schaefer equation. For the entire survey period, 3,212 carcasses were counted, 586 of which were marked with colored ribbon and released, and only 73 marked carcasses were recovered. Using these data with the Petersen equation, the spawner population downstream of the Nimbus racks was 25,784 salmon (Table 6).

A total of 1,663 carcasses was counted upstream of the Nimbus racks. The racks were removed three weeks before the end of the season, so this number is a minimum actual population for this section. Combining this number with the downstream estimate gives 27,447 spawners within the river. An additional 12,249 salmon entered Nimbus Hatchery (Ducey 1987), bringing the total American River 1984 fall-run spawning population to 39,696 fish. This was about 8% higher than the 1983 population, and 90% of the average run size from 1974 through 1983 (Appendix 5).

TABLE 6. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population in the American River From the Nimbus Hatchery Racks to Gristmill Dam.

Recovery period	Number of marked carcasses recovered from the marking period:						Total carcasses marked (M)	Total marked carcasses recovered (R)	Total carcasses observed (C)
	Nov. 5-6	Nov. 13-14	Nov. 19-20	Nov. 26-27	Dec. 3-4	Dec. 10-11			
Nov. 5-4	--	---	--	--	--	--	47	--	--
Nov. 13-14	3	--	--	--	--	--	102	3	369 a/
Nov. 19-20	0	3	--	--	--	--	155	3	552
Nov. 26-27	1	4	22	--	--	--	129	27	901
Dec. 3-4		0	2	15	--	--	%	17	808
Dec. 10-11		1	4	9	8	--	57	19	629
Dec. 17-18						4	--	4	253
Totals:							586	73	3,212
							Petersen estimate b/: 25,784		

a/ Includes salmon observed during the first period.

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

The composition of the 586 marked carcasses was 46.0% male adults (FL \geq 61 cm [24 in]), 46.0% female adults, and 8.0% grilse (FL < 61 cm). In comparison, fall-run salmon entering the hatchery in 1984 consisted of 37.1% male adults (FL \geq 60 cm [23.6 in]), 46.9% female adults, and 16.0% grilse (FL < 60 cm).

CHINOOK SALMON POPULATIONS FOR THE SAN JOAQUIN RIVER

Salmon spawning populations were surveyed for the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers of the San Joaquin River system (Figure 4). A total of 64,275 chinook salmon, consisting almost entirely of fall-run fish, spawned in the San Joaquin River tributaries in 1984 (Appendix 4).

Cosumnes River to the Calaveras River

Cosumnes River - by Mike Mainz

Fall run. In 1984, sporadic surveys to observe numbers of chinook salmon in the Cosumnes River were conducted after river flows reached a level allowing salmon access to upstream spawning habitat in mid-November. Surveys were made on-foot in the 4.0-km (2.5 mi) river reach from Michigan Bar downstream to the Highway 16 Bridge on 29 November and 12 December. After aerial observations on 21 December noted a large number of redds in the river downstream of Highway 16 to within 3.2 km (2.0 mi) upstream of Dillard Road, this area and the previously covered stretch were surveyed on 24 December. River flows at Michigan Bar ranged from 22.7 m³/s (800 cfs) during the initial survey to 5.7 m³/s (200 cfs) during the last survey; visibility through the water ranged from greater than 1.5 m (5 ft) to less than 1.5 m, respectively.

Three live salmon and 162 carcasses were counted during the three ground surveys. Based on these limited observations and counts, about 1,000 fall-run salmon spawned in the Cosumnes River in 1984. This spawner population was a large increase over 1983's run of 200 fish. Estimates of spawner numbers in this river have only been made for seven of the previous ten years, and have usually been a few hundred salmon (Appendix 5).

Mokelumne River - by Mike Mainz

Fall run. In 1984, carcass mark-and-recovery surveys were conducted over a seven-week period from 9 November to 21 December in the Mokelumne River from the Fish Installation downstream to Mackville Road. River flows ranging from 17.0 - 22.6 m³/s (600-800 cfs) made carcass recovery difficult, although observation

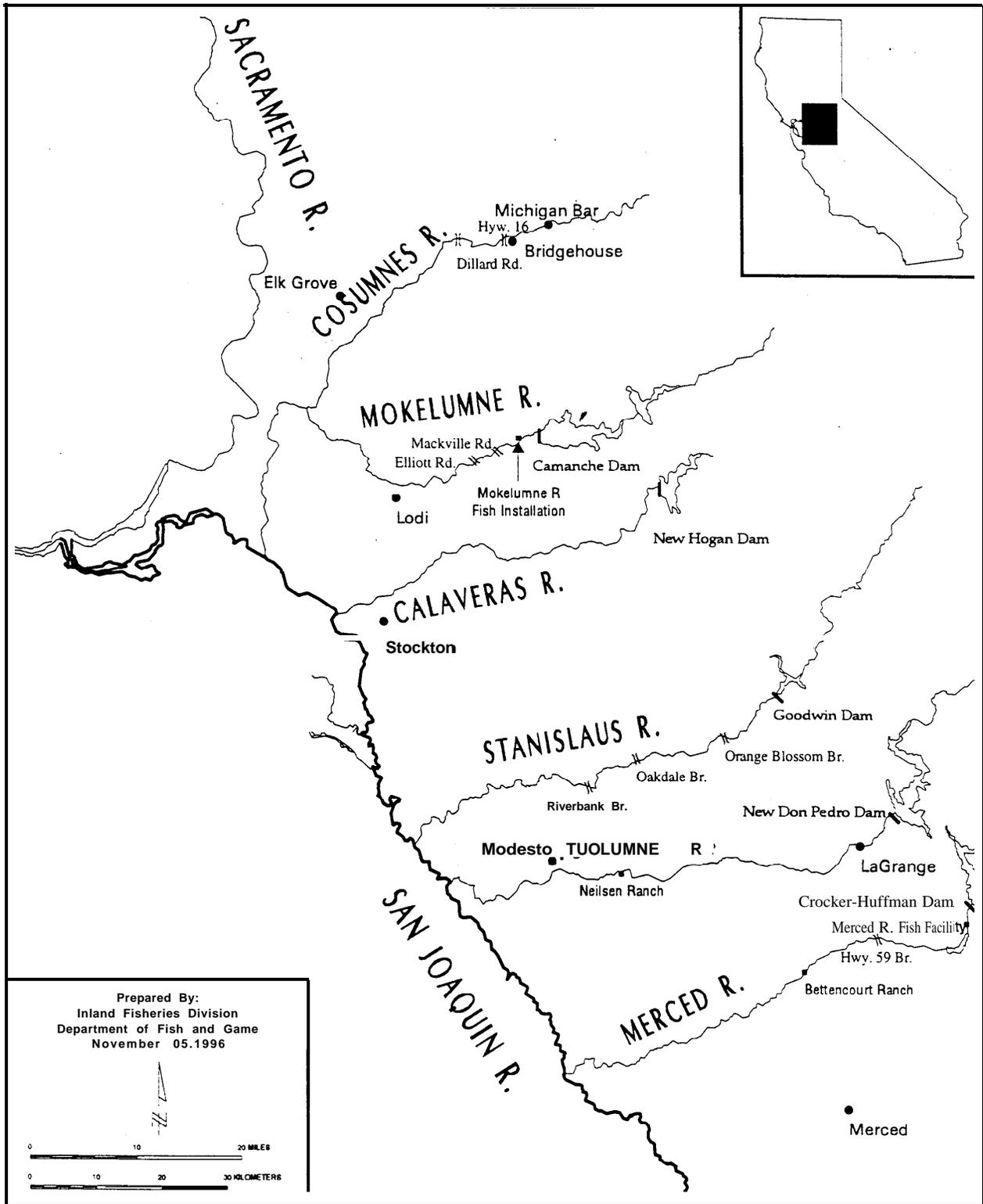


FIGURE 4. San Joaquin River system from the Merced River downstream to the Mokelumne River.

conditions were good, with visibility through the water exceeding 1.5 m (5.0 ft).

A spawner population estimate was calculated with the Petersen equation, since marked carcass recoveries were low during the first and last recovery periods (Table 7). A total of 1246 carcasses was observed, of which 302 were marked, and only 46 subsequently recovered. From these data, 8,298 fall-run salmon were estimated as the 1984 spawner population. This was a decrease of 48% from the 1983 population, but was twice the average of populations estimated from 1974 through 1983 (Appendix 5).

A total of 959 fall-run salmon entered the Mokelumne River Fish Installation (Estey 1987). These fish were not spawned there, but were released unmarked back into the river, so they were considered part of the river's natural escapement estimate. This relatively low number of salmon entering the installation may have been due to low attraction flows near its fish ladder. In 1984, flow releases, previously made from Camanche Dam adjacent to the ladder, were through a new powerhouse located 200 m (0.1 mi) downstream from the ladder.

The composition of the 302 carcasses which were marked was 42% male adults (FL \geq 61 cm [24 in]), 53% female adults, 2% male grilse (FL < 61 cm), and 3% female grilse.

Calaveras River - by Fred Meyer

Winter run. Irrigation district personnel at Bellota Weir and CDFG Warden Lt. Dennis Del Nero reported seeing between 10 and 100 salmon in the river during January 1984. A 62-cm female salmon was taken by an angler from a pool immediately downstream of Hogan Dam on 28 April (trout season opener). Based on these observations the 1984 winter run was about 100 salmon.

Stanislaus River to Merced River

Stanislaus River - by James R. White

Fall Run. The 1984 fall-run spawner surveys covered four sections of the Stanislaus River. Four surveys between 26 October and 7 December were made to count salmon carcasses and live fish on-foot in the area of Two Mile Bar. Weekly carcass mark-and-recovery surveys between 23 October and 12 December were conducted from Knights Ferry downstream to Orange Blossom Bridge, a river reach of 9.6 km (6 mi); from the Orange Blossom Bridge downstream to Oakdale Bridge, a distance of 9.6 km (6 mi); and from the Oakdale Bridge downstream to Riverbank Bridge, a reach

TABLE 7. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population Between the Mokelumne River Fish Installation and Mackville Road.

Recovery period	Number of marked carcasses recovered from the marking period:						Total carcasses marked (M)	Total marked carcasses recovered (R)	Total carcasses observed (C)
	Nov. 9	Nov. 16	Nov. 21	Nov. 30	Dec. 7	Dec. 13			
Nov. 9	--	--	--	--	--	--	31	--	--
Nov. 16	1	--	--	--	--	--	69	1	146
Nov. 21		9	--	--	--	--	62		176
Nov.30		3	10	--	--	--	51	13	293
Dec. 7		1	4	7	--	--	57	12	334
Dec. 13		1		2	6	--	32	9	179
Dec. 21						2	--	2	136
							Totals: 302	46	1,264
								Petersen estimate b/: 8,298	

a/ Includes salmon observed during the first period.

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

of 11.2 km (7 mi). River flows in the surveyed sections ranged from 7.6 to 10.8 m³/s (270 - 380 cfs), with visibility through the water often greater than 3.0 m (10 ft). Turbid water was a problem for observation only during the survey on 13 November.

During the mark-and-recovery surveys between Knights Ferry and Riverbank Bridge 1,125 carcasses were observed, of which 383 were marked, and only 38 subsequently recovered. The spawner population of this section, calculated using the Petersen equation, was estimated to be 11,339 salmon (Table 8). For the surveys of Two Mile Bar, 66 carcasses and 14 live fish were counted. Based on these observations, about 100 salmon spawned in this area, making a total estimated Stanislaus River 1984 fall-run spawner population of 11,439 salmon (Appendix 4). This was a huge increase over the 1983 population of 500 fish, and was the largest spawner population for this river in the past ten years, (Appendix 5).

The length frequency distribution of 386 of the carcasses examined in 1984 suggested that the separation between grilse and adults was 56 cm FL (22 in), rather than the more commonly accepted separation length of 61 cm (24 in). Based on this smaller length, the 1984 run consisted of 37.8% male adults (FL ≥ 56 cm), 45.6% female adults, 11.9% male grilse (FL < 56 cm), and 4.7% female grilse; with the 61-cm separation, the composition was 24.3%, 36.9%, 22.4%, and 16.4%, respectively.

Tuolumne River - by Maurice Fjelstad

Fall Run. The 1984 fall-run chinook salmon spawner surveys in the Tuolumne River were conducted from 1 through 30 November, within a 45-day period (17 October through 3 December) of water releases from New Don Pedro Dam which maintained stable river flows at 11.3 m³/s (400 cfs). The period of stable flows, an operational provision of the Don Pedro Project, was agreed upon with Modesto and Turlock irrigation districts to occur earlier in 1984 than in past years (the period usually started on 5 November). The intention was to facilitate earlier adult salmon immigration and spawning, thus allowing earlier juvenile emigration to avoid adverse spring-time stream conditions. An added benefit was the decreased possibility of stranding spawners, since flows normally fluctuated greatly within a 24-hour period, sometimes dropping to as low as 8.5 m³/s (300 cfs). After 3 December, the fluctuating flows resumed, precluding further surveys; however, based on the last surveys conducted, spawning was completed by late November.

Weekly carcass mark-and-recovery surveys were conducted from LaGrange Bridge downstream to Neilsen Ranch (formerly Reed Gravel Plant) near Waterford, a distance of 27.3 km (17 mi). Surveys during the peak spawning period were also made to count redds

TABLE 8. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population in the Stanislaus River From Knights Ferry to Riverbank.

Recovery period	Number of marked carcasses recovered from the marking period:							Total carcasses marked (M)	Total marked carcasses recovered (R)	Total carcasses observed (C)	
	Oct. 23	Oct. 29-31	Nov. 5-6	Nov. 13-14	Nov. 19-20	Nov. 26-27	Dec. 2-4				
Oct. 23	- -	- -	- -	- -	- -	- -	--	2	- -	- -	
Oct. 29-31	1	- -	- -	- -	- -	- -	- -	39	1	47 a/	
Nov. 5-6		2	- -	- -	- -	- -	- -	112	2	143	
Nov. 13-14		1	1	- -	- -	- -	- -	54	2	118	
Nov. 19-20		1	2	3	- -	- -	- -	97	6	344	
Nov. 26-27			2	3	7	- -	- -	54	12	245	
Dec. 2-4				1	2	7	- -	25	10	194	
Dec. 11-12					2	1	2	- -	5	34	
								Totals:	383	38	1,125

Petersen estimate b/: 11,339

a/ Includes carcasses observed during the first period.

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

from LaGrange Bridge upstream to LaGrange Dam (1.6 km [1 mi]), and from Neilsen Ranch downstream to Geer Avenue (12.9 km [8 mi]).

The spawning population in the river section between LaGrange Bridge and Neilsen Ranch, calculated from mark-and-recovery data using the modified Schaefer equation, was estimated to be 12,457 salmon (Table 9). The spawning population for the two sections up- and downstream of the mark-and-recovery area was determined from their relative redd proportions. A total of 936 redds was counted between LaGrange Bridge and Neilsen Ranch. A total of 92 redds was counted in the other areas, and constituted 9% (92/1028) of the total redds. Assuming that the estimated 12,457 spawners represented 91% of the run, then 1,232 salmon spawned in the other areas, and the total estimated 1984 fall-run population for the Tuolumne River was 13,689 salmon. This was about an 8% decrease from the 1983 population, but still well above the average population for 1974 through 1983 (Appendix 5).

For 848 of the carcasses examined, 24.5% were male adults (FL \geq 61 cm [24 in]), 23.0% were female adults, 42.2% were male grilse (FL < 61 cm), and 10.3% were female grilse.

Merced River - by Robert Reavis

Fall run. Fall-run salmon spawner surveys in the Merced River during 1984 started on 1 November and ended on 13 December. River flows increased from 5.1 m³/s (180 cfs) at the beginning of the surveys to 34 m³/s (1200 cfs) just prior to 21 November, where they remained until the end of the surveys. The increased flows adversely affected survey efficiency. Visibility through the water was nearly 3.1 m (10 ft) when surveys began, but decreased to 0.3 m (1 ft) once flows increased.

Weekly carcass mark-and-recovery surveys were concentrated in the 16.1-km (10-mi) stream section from Crocker-Huffman Dam downstream to the Highway 59 Bridge. Two surveys only to count fish and redds were made from Highway 59 downstream to Bettencourt Ranch, a distance of 11.2 km (7 mi).

The spawning population in the river section from the Dam to Highway 59, was calculated using the Petersen equation with mark-and-recovery data. A total of 2,735 salmon carcasses was observed, of which 382 were marked with colored plastic ribbon attached to the jaw with a hog ring, with 54 subsequently recovered, producing an estimated 19,348 salmon for this section (Table 10).

The spawning population downstream of Highway 59 was derived from that of the upstream section based on the historical distribution of spawning activity from 1971 to 1981. During this period, an

TABLE 9. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population in the Tuolumne River From LaGrange Bridge to Nielsen Ranch.

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. 1-2	Nov. 6-9	Nov. 13-16	Nov. 20-23			
Nov. 6-9	4	- -	- -	- -	4	347 c/	1,195
Nov. 13-16	3	32	- -	- -	35	974	3,151
Nov. 20-23	2	10	71	- -	83	1,458	4,960
Nov. 27-30		9	25	45	79	1,062	3,813
Total recovered (Ri):	9	51	%	45		Total:	13,119
Total carcasses marked (Mi):	31	164	329	169			
					Adjusted estimate d/ 12,457		

a/ Includes marked carcasses 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 recovery period population estimate.

d/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where total marked carcasses (Mi) from the second marking period on was subtracted from the total estimate, i.e. 13,119 - 662 = 12,457.

TABLE 10. Marking and Recovery Data Used to Estimate the 1984 Fall-run Chinook Salmon Spawning Population in the Merced River From Crocker-Huffman Dam to the Highway 59 Bridge.

Recovery period	Number of marked carcasses recovered from the marking period:						Total carcasses marked (M)	Total marked carcasses recovered (R)	Total carcasses observed (C)
	Nov. 1-2	Nov. 8-9	Nov. 15-16	Nov. 20-21	Nov. 30	Dec. 7			
Nov. 1 -2	--	--	--	--	--	--	51	- -	- -
Nov. 8-9	4	- -	- -	- -	- -	- -	84	4	296a/
Nov. 15- 16		8	- -	- -	- -	- -	139	8	1,180
Nov. 20-21		1	23	- -	- -	- -	77	24	633
Nov. 30			5	3	- -	- -	25	8	286
Dec. 7			1	1	1	- -	6	3	180
Dec. 13			2	2	3	0	- -	7	160
						Totals:	382	54	2,735
							Petersen estimate b/:		19,348

a/ Includes carcasses observed during the first period.

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

average proportion of 30% of the redds occurred downstream of Highway 59, so it was assumed that the spawner population for this area in 1984 was 8,292 salmon, bringing the number of in-river spawners to 27,640 fish.

An additional 2,109 salmon were observed during Merced River Fish Facility operations (Cozart 1987), for a total 1984 fall-run spawner population of 29,749 salmon. This was a 63% increase over the 1983 population, and the largest population estimated since surveys began in 1953 (Appendix 5).

From examination of 448 of the carcasses observed during the 1984 survey, 35% were male adults (FL > 56 cm [22 in]), 40% were female adults, 16% were male grilse (FL < 56 cm), and 9% were female grilse.

SUMMARY

The estimated 1984 Central Valley chinook salmon spawner escapement was 285,464 fish (Table 11). This was considerably higher than the 1983 total of 230,243 salmon. The 1984 increase in the total Central Valley run was due to record fall runs in Battle Creek and the Cosumnes, Stanislaus, and Merced rivers, and above average fall runs in the mainstem Sacramento River upstream of RBDD and in the Feather and Mokelumne rivers. Fall runs in the mainstem Sacramento River downstream of Red Bluff and in the Yuba River decreased from 1983 populations, while Tuolumne and American River population sizes were similar to 1983 numbers. In the Sacramento River upstream of RBDD the late-fall run was less than half of the 1983 population, but the spring run was about doubled. The winter run remained at a critically low level.

TABLE 11. Sacramento-San Joaquin River System Chinook Salmon Spawning Populations.

Spawning area	Late-fall run	Winter run	Spring run	Fall run	Combined
Sacramento mainstem	9,638	2,662	7,823	56,131	76,254
Sacramento tributaries	750	--	1,585	142,600	144,935
San Joaquin tributaries	--	100	--	64,175	64,275
Totals:	10,388	2,762	9,408	262,906	285,464

REFERENCES

- Cozart, Michael D. 1987. Annual report, Merced River Fish Facility, 1984-85. Calif. Dept of Fish and Game, Inland Fish. Admin. Rep. No. 87-9. 18 p.
- Ducey, Ronald D. 1987. Annual report, Nimbus Salmon and Steelhead Hatchery, 1984-85. Calif. Dept of Fish and Game, Inland Fish. Admin. Rep. No. 87-7. 17 p.
- Estey, Donald F. 1987. Annual report, Mokelumne River Hatchery, 1984-85. Calif. Dept of Fish and Game, Inland Fish. Admin. Rep. No. 87-8. 8 p.
- Hoopough, David A. 1978. King (Chinook) salmon spawning stocks in California's Central Valley, 1975. Calif. Dept. of Fish and Game, Anad. Fish. Br. Admin. Rep. No. 77-12.
- Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Res. Bd. Canada, Bull. 191. 382 p.
- Schaefer, M. D. 1951. Estimation of size of animal populations by marking experiments. U. S. Fish and Wildl. Serv., Fish. Bull. 52:189-203.
- Schlicting, Donald L. 1987. Annual report, Feather River Hatchery, 1984-85. Calif. Dept of Fish and Game, Inland Fish. Admin. Rep. No. 87-3. 13 p.

APPENDIX 1. Adjusted Chinook Salmon Counts and Estimated Numbers of Each Run at Red Bluff Diversion Dam from 16 October 1983 through 29 December 1984.

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/
16 Oct - 31 Dec '83 d/			4,009				137			
1984										
01-Jan - 07-Jan	283	93	72.0	204	28.0	79				
08-Jan - 14-Jan	247	97	89.7	222	10.3	25				
15-Jan - 21-Jan	217	1	100.0	217	0.0	0				
22-Jan - 28-Jan	380	33	87.9	334	12.1	46				
29-Jan - 04-Feb	219	9	66.7	146	33.3	73				
05-Feb - 11-Feb	544	103	82.5	449	17.5	95				
12-Feb - 18-Feb	368	38	94.7	348	5.3	20				
19-Feb - 25-Feb	399	5	100.0	399						
26-Feb - 03-Mar	425	21	42.9	182	57.1	243				
04-Mar - 10-Mar	708	52	50.0	354	50.0	354				
11-Mar - 17-Mar	575	45	35.6	205	64.4	370				
18-Mar - 24-Mar	104	3	33.3	35	66.7	69				
25-Mar - 31-Mar	119	2	50.0	59	50.0	60				
01-Apr - 07-Apr	466	57	Total:	7,163 e/ f/	66.7	311	33.3	155		
08-Apr - 14-Apr	156	18			72.2	113	27.8	43		
15-Apr - 21-Apr	308	4			75.0	231	25.0	77		
22-Apr - 28-Apr	224	29			51.7	116	48.3	108		
29-Apr - 05-May	178	4			25.0	44	75.0	134		
06-May - 12-May	179	8			37.5	67	62.5	112		
13-May - 19-May	148	12			8.3	12	91.7	136		
20-May - 26-May	160	12			33.3	53	66.7	107		
27-May - 02-Jun	190	34			26.5	50	73.5	140		
03-Jun - 09-Jun	120	6			33.3	40	66.7	80		
10-Jun - 16-Jun	160	10			10.0	16	90.0	144		
17-Jun - 23-Jun	242	23			8.7	21	91.3	221		
24-Jun - 30-Jun	220	18					100.0	220		
01-Jul - 07-Jul	207	29			6.9	14	93.1	193		
08-Jul - 14-Jul	201	47			2.1	4	97.9	197		
15-Jul - 21-Jul	661	113			Total:	2,663 e/	46.0	304	54.0	357
22-Jul - 28-Jul	589	40					40.0	236	60.0	353
29-Jul - 04-Aug	1,430	187					42.8	612	57.2	818
05-Aug - 11-Aug	3,380	64					67.2	2,271	32.8	1,109
12-Aug - 18-Aug	3,499	107					30.8	1,078	69.2	2,421
19-Aug - 25-Aug	1,856	36					8.3	154	91.7	1,702
26-Aug - 01-Sep	4,679	174					16.1	753	83.9	3,926
02-Sep - 08-Sep	5,572	209					5.3	295	94.7	5,277
09-Sep - 15-Sep	4,979	254					3.1	154	96.9	4,825
16-Sep - 22-Sep	7,952	320					2.8	223	97.2	7,729
23-Sep - 29-Sep	4,872	266					Total:	8,147 e/	100.0	4,872
30-Sep - 06-Oct	9,462	152							100.0	9,462
07-Oct - 13-Oct	11,754	318							100.0	11,754
14-Oct - 20-Oct	4,671	116	3.4	159					96.6	4,512
21-Oct - 27-Oct	5,385	186	29.0	1,562					71.0	3,823
28-Oct - 03-Nov	4,878	132	7.6	371					92.4	4,507
04-Nov - 10-Nov	4,416	116	10.3	455					89.7	3,961
11-Nov - 17-Nov	1,027	61	41.0	421					59.0	606
18-Nov - 24-Nov	857	7	42.9	368					57.1	489
25-Nov - 01-Dec	703	141	46.1	324					53.9	379
02-Dec - 08-Dec	592	70	70.0	414					30.0	178
09-Dec - 15-Dec	412	17	64.7	267					35.3	145
16-Dec - 22-Dec	289	6	100.0	289						
23-Dec - 29-Dec	900	56	94.6	851					5.4	49
									Total:	73,254 e/ g/
Total for 1984 calendar year h/:	92,562	3,961		8,635		2,526		8,147		73,254

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

b/ Salmon in the fishway trapping facility which were examined to determine the run they belonged to, based on relative spawning readiness.

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

d/ Estimated numbers of late-fall- and winter-run salmon shown for this period represent fish which passed the dam in 1983 that were expected to spawn in 1984; spring and fall run fish counted during this period spawned in 1983, and are not shown.

e/ Total estimated number of potential spawners for 1984.

f/ Includes a total of 153 fish from RBDD and 192 from Keswick Dam that were trucked to Coleman National Fish Hatchery.

g/ Includes 67 fish from Keswick Dam that were trucked to Coleman Hatchery.

h/ Including late-fall- and winter-run 1985 potential spawners.

APPENDIX 2. Estimated Monthly Sport Catch of Chinook Salmon Runs in the Sacramento River between Keswick Dam and Red Bluff during 1984.

Year	Month	Total sport catch a/	Distribution of catch by run							
			Late-fall		Winter		Spring		Fall	
			% at RBDD b/	Estimated catch c/	% at RBDD b/	Estimated catch c/	% at RBDD b/	Estimated catch c/	% at RBDD b/	Estimated catch c/
1983	OCT	187	1.5	3		0		0	98.5	184
	NOV	71	27.5	20		0		0	72.5	51
	DEC			0		0		0		0
			Total:	23 d/						
1984	JAN			0		0		0		0
	FEB			0		0		0		0
	MAR			0		0		0		0
	APR			0		0		0		0
	MAY			0		0		0		0
	JUN			0		0		0		0
	JUL	110		0	1.3	1	61.6	68	37.1	41
	AUG	705		0		0	32.9	232	67.1	473
	SEP	875		0		0	2.7	24	97.3	851
	OCT	122	7.5	9		0		0	92.5	113
	NOV	100	32.3	32		0		0	67.7	68
	DEC	50	79.9	40		0		0	20.1	10
1984 calendar year total:				81		1 d/		324 d/		1,556 d/

a/ Total catch was expanded from 1984 landings reported from only fishing resorts, using the average ratio (1.59) between both resort and boat launch area landings seen during 1967 - 1974.

b/ Proportion of salmon in the Red Bluff Diversion Dam fishway trapping facility which was assigned to the run, as determined by relative spawning readiness.

c/ Monthly sport catch x Run proportion.

d/ Total catch of 1984 spawners.

APPENDIX 3. Summary of 1984 Population Estimates for Sacramento River System Chinook Salmon Runs.

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/ Battle Creek	6,540 b/	2,662	7,823	36,965 c/	53,990
Coleman National Fish Hatchery				21,581	21,581
Downstream of hatchery	d/	d/	d/	8,312	8,312
(Totals for tributary):				(29,893)	(29,893)
Clear Creek	200	--	--	4000	4,200
Paynes Creek	--	--	--	90	90
Cow Creek	--	--	--	250	250
Cottonwood Creek	400	--	--	500	900
Totals for area:	7,140	2,662	7,823	71,698	89,323
Red Bluff to Princeton Ferry					
Sacramento River mainstem					
Red Bluff to Tehama	3,098	--	--	13,290	16,388
Tehama to Woodson Bridge		--	--	3,215	3,215
Woodson Br. to Princeton Ferry		--	--	1,455	1,455
Tehama-Colusa Spawning Channel		--	--	1,206	1,206
(Totals for tributary):	(3,098)	d/	d/	(19,166)	(22,264)
Salt Creek	--	--	--	30	30
Antelope Creek	--	--	d/	260	260
Craig Creek	150	--	--	60	210
Dye Creek	--	--	--	50	50
Mill Creek	d/	d/	d/	5,800	5,800
Toomes Creek	--	--	--	50	50
Deer Creek	d/	--	d/	680	680
Singer Creek	--	--	--	20	20
Totals for area:	3,248			26,116	29,364
Big Chico Creek to American River					
Big Chico Creek	--	--	0	200	200
Butte Creek	--	--	23	d/	23
Feather River					
Feather River Hatchery	--	--	1,562	9,288	10,850
Downstream of hatchery	--	--	d/	41,769	41,769
(Totals for tributary):			(1,562)	(51,057)	(52,619)
Yuba River	--	--	d/	9,665	9,665
Bear River (Yuba County)	--	--	--	300	300
American River					
American River Hatchery	--	--	--	12,249	12,249
Downstream of hatchery	--	--	--	27,447	27,447
(Totals for tributary):				(39,696)	(39,696)
Totals for area:			1,585	100,918	102,503
Sacramento River system totals:	10,388	2,662	9,408	198,732	221,190

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

b/ Includes 182 fish from Keswick Dam and 153 fish from Red Bluff Diversion Dam that were transported to and spawned at Coleman Hatchery.

c/ Includes 67 fish from Keswick Dam that were trucked to Coleman Hatchery.

d/ No estimates were made.

APPENDIX 4. Summary of 1984 Population Estimates for San Joaquin River System
Chinook Salmon Runs.

Tributary	Estimated number of fish		
	Winter run	Fall run	Total
<u>Cosumnes River</u>	a/	1,000	1,000
<u>Mokelumne River</u>	a/	8,298	8,298
<u>Calaveras River</u>	100	--	100
<u>Stanislaus River</u>	a/	11,439	11,439
<u>Tuolumne River</u>	a/	13,689	13,689
<u>Merced River</u>			
Merced River Hatchery		2,109	2,109
Downstream of hatchery		27,640	27,640
(Totals for tributary):	a/	(29,749)	(29,749)
San Joaquin River system totals:	100	64,175	64,275

a/ Run not present.

APPENDIX 5. Summary of Sacramento-San Joaquin River System Chinook Salmon Spawning Population Estimates from 1974 through 1984.

Tributary Race	Population size											1974-1983 average
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	
<u>Sacramento River system upstream of Red Bluff (excluding Battle Creek)</u>												
Late-fall run	6,083	19,261	15,908	9,210	12,479	10,284	9,361	6,423	4,899	14,984	7,140	10,889
Winter run	18,536	22,579	33,029	16,470	24,735	2,339	1,142	19,795	1,233	1,827	2,662	14,169
Spring run	3,800	10,234	25,095	13,453	5,669	2,856	9,363	20,655	23,156	3,854	7,823	11,814
Fall run	49,253	55,102	51,986	39,579 a/	35,500	47,758	21,961	33,289	20,567	27,326	41,805	38,082
<u>Battle Creek</u>												
Fall run	3,901	4,857	5,444	b/	3,652	13,159	14,443	17,205	26,795	13,983	29,893	10,344
<u>Sacramento River mainstem downstream of Red Bluff</u>												
Fall run	27,970	31,461	37,530	45,743	47,973	67,388	30,453	42,724	23,833	32,018	19,166	38,709
<u>Feather River</u>												
Spring run c/	198	691	699	185	202	250	269	469	1,910	1,702	1,562	658
Fall run	65,946	43,000	62,000	46,452	37,759	32,505	35,295	53,020	55,519	30,522	51,056	46,202
<u>Yuba River</u>												
Fall run	17,809	5,641	3,779	8,722	7,416	12,430	12,406	14,025	39,367	13,756	9,665	13,535
<u>American River</u>												
Fall run	61,796	39,543	28,374	48,473	21,091	47,666	49,802	64,055	43,898	35,300	39,696	44,000
<u>Cosumnes River</u>												
Fall run	285	725	0	b/	100	150	200	b/	b/	200	1,000	166
<u>Mokelumne River</u>												
Fall run	1,422	1,900	473	250	1,086	1,507	3,231	4,954	9,372	15,861	8,298	4,006
<u>Stanislaus River</u>												
Fall run	750	1,200	600	0	50	110	100	1,000	b/	500	11,439	431
<u>Tuolumne River</u>												
Fall run	1,150	1,600	1,700	450	1,300	1,183	559	14,253	7,126	14,836	13,689	4,416
<u>Merced River</u>												
Fall run	2,000	2,400	1,900	350	625	2,147	3,006	10,415	3,263	18,248	29,749	4,435

a/ Includes salmon which spawned in Battle Creek.

b/ No estimate made.

c/ Numbers are only those salmon which entered Feather River Hatchery; natural spawner estimates were not made.