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ANNUAL REPORT
CHINOOK SALMON SPAWNING STOCKS IN CALIFORNIA'S CENTRAL VALLEY, 1985

Edited by

Robert M. Kano
and Robert Reavis
Inland Fisheries Division

Inland Fisheries

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CHINOOK SALMON SPAWNING STOCKS IN CALIFORNIA'S CENTRAL VALLEY, 1985[1/]

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ABSTRACT

This report covers the 33rd annual inventory of chinook salmon, Oncorhynchus tshawytscha, spawning populations in the Sacramento-San Joaquin River system. It is a compilation of survey reports for the fall-, winter-, late-fall-, and spring-run salmon spawning populations of Central Valley streams.

Population sizes were determined 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 1985 total escapement of chinook salmon in the Central Valley was 387,753 fish. This total consisted of 356,304 fall-, 15,221 spring-, 5,048 winter- and 10,180 late-fall-run spawners. Of the total, 309,004 salmon spawned in the Sacramento River system and 77,749 in the San Joaquin River system. All spring-, late-fall-, and winter-run and 278,555 of the fall-run salmon spawned in the Sacramento River system.

The 1985 fall runs in Central Valley tributaries exceeded those seen during 1984, except in the Cosumnes, Mokelumne, and Merced rivers. While the Merced River escapement was lower than the record run seen in 1984, it was still well above the average run size of the previous ten years for that tributary. All four runs in the Sacramento River upstream of Red Bluff were also higher in 1985 than 1984.

[1/] Inland Fisheries Branch Administrative Report No. 96-4. Submitted for publication December 1996. Edited by M. Ralph Carpenter, Department of Fish and Game, Inland Fisheries Division, 1416 Ninth Street, Sacramento, California 95814.

INTRODUCTION

The Sacramento-San Joaquin River system (Figure 1), which flows through California's Central Valley, is the principle producer of chinook salmon caught in the state's ocean fisheries. Its salmon runs also contribute significantly to the ocean fisheries of Oregon and Washington. This report is the 33rd 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 noted to determine if corrective action is necessary.

GENERAL METHODS

During 1985, 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.

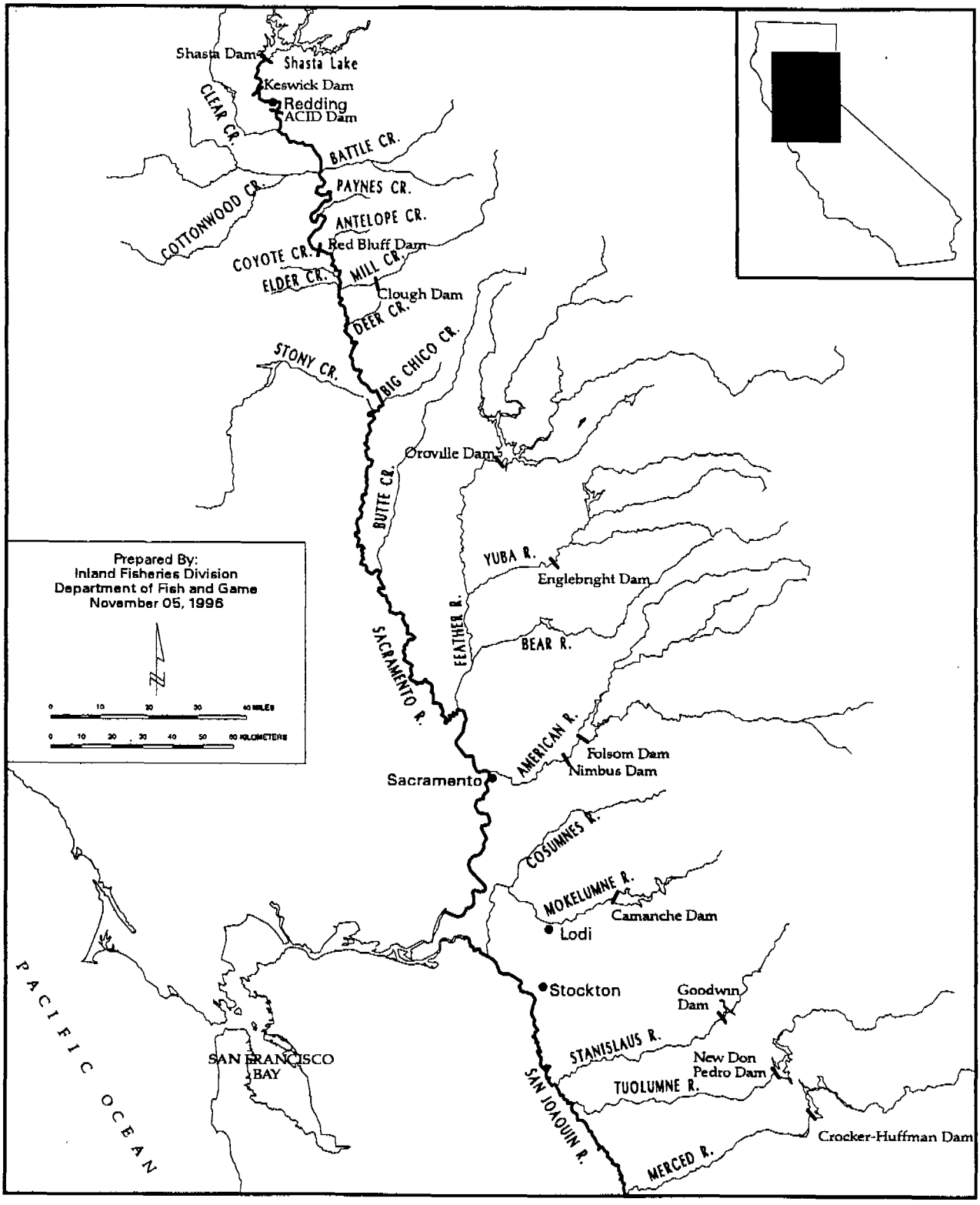

FIGURE 1. Sacramento-San Joaquin river system of California's Central Valley.

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 counts of carcasses observed during the season; all counted carcasses were cut in half to prevent recounting.

In other streams, a mark-and-recovery technique was used to estimate the spawner population. 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 was made using a modification of the Schaefer (1951) equation, which was initially used in the 1976 Central Valley spawner stock report (Hoopaugh 1978);

$$N=\sum (R_{ij}\times\frac{M_i}{R_i}\times\frac{C_j}{R_j}) -\sum_2^i M_1$$

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.

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 populations 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 and Clear creeks. Spawning distribution in the mainstem was determined from aerial redd counts.

A total of 114,356 salmon spawned during 1985 in the Sacramento River system between Keswick Dam and Red Bluff, including 92,155 fall-, 8,317 late-fall-, 3,684 winter- and 10,200 spring-run fish. Of these totals 51,647 fall- and 8,136 late-fall-run salmon spawned in the mainstem, while 40,508 and 181 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. No estimates were made for the Clear Creek late-fall run, or for the late-fall and fall runs in Cottonwood Creek, although these tributaries were surveyed.

Sacramento River Mainstem - by Richard E. Painter

Estimates of the total numbers of salmon utilizing the Sacramento River and its tributaries upstream from RBDD during 1985 were based on daily counts made by the U.S. Fish and Wildlife Service and CDFG at the dam. Counts were obtained through closed-circuit television monitoring of salmon passing through the RBDD fishways.

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 the percentage of each run seen that week during random samples of salmon in the dam's east-bank trapping facility; salmon were assigned to a run based on their relative degree of ripeness (Appendix 1).

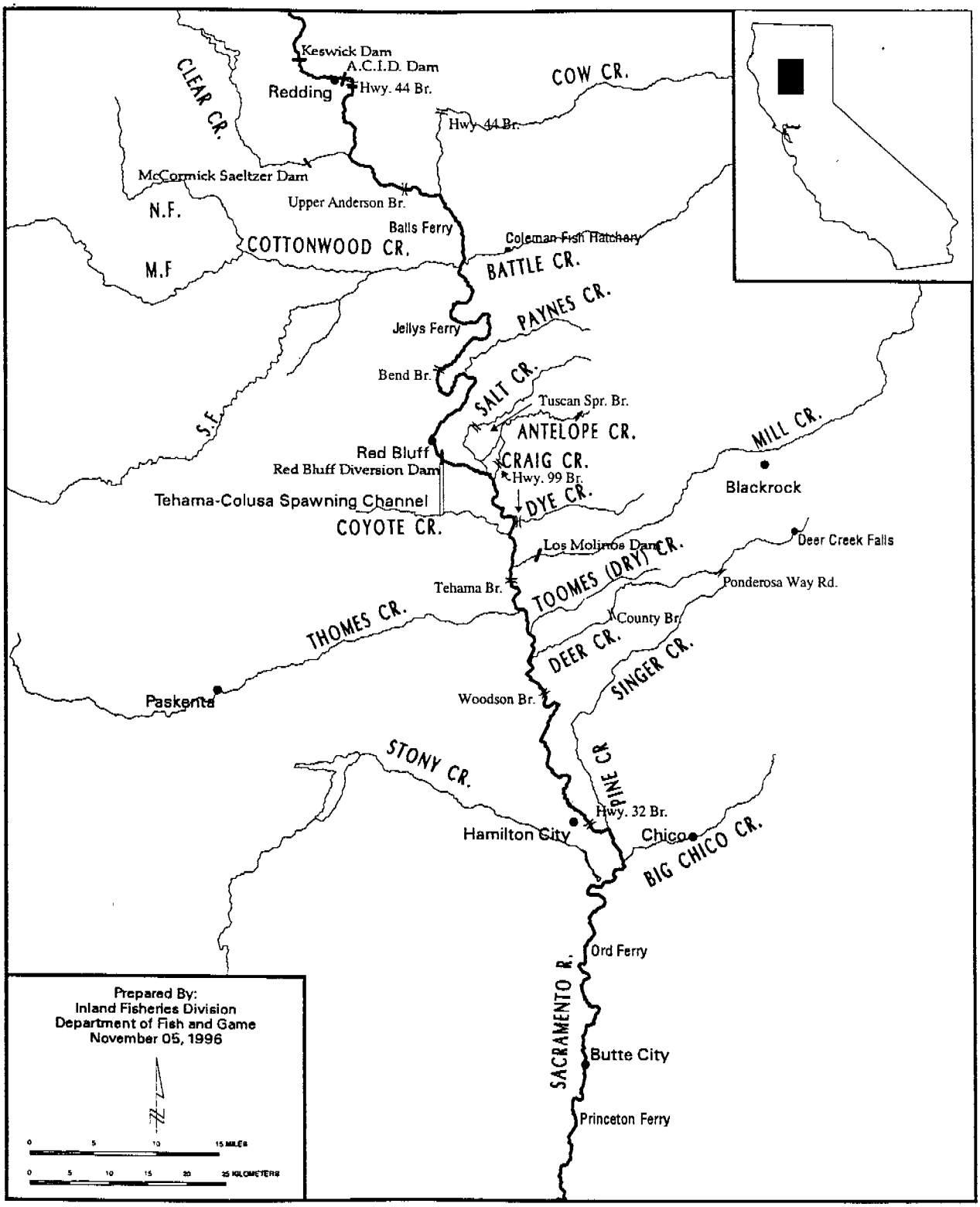

FIGURE 2. Sacramento River system from Keswick Dam downstream to Princeton Ferry.

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 usually 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 the late-fall annual run occurs in each portion of the calendar year, while usually most of the 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 1985 potential spawners for each of these two runs were calculated by adding the appropriate portion of the 1984 calendar year count that would spawn in 1985, and not including that portion of the 1985 calendar year count that would spawn in 1986. About 65% (5,481 fish) of the 1985 late-fall-run spawners, but none of the 1985 winter run, passed Red Bluff in 1984 (Appendix 1, Table 1).

For each of the four runs, the total number of potential spawners passing upstream of RBDD was reduced by the estimated numbers of that run landed by 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. Practically all salmon caught upstream of Red Bluff are landed at either fishing resorts or public boat-launching ramps. Since bi-weekly catches were only obtained from the fishing resorts, the total monthly catch was estimated by multiplying those resort landings by an average catch ratio (1.5944) between resorts and launching ramps, derived from 1967-1974 data when both sources were sampled. The total monthly catch was apportioned into each of the four runs in proportion to their relative abundance at RBDD (Appendix 2).

TABLE 1. Calculation of the 1985 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: 1984	1985	Number of potential spawners		Estimated sport catch		Estimated 1985 spawners
Late-fall	5,481	+ 2,955	= 8,436	-	119	=	8,317
Winter	--a/	3,960	= 3,960	-	276	=	3,684
Spring	--a/	10,747	= 10,747	-	547	=	10,200
Fall	--a/	97,707	= 97,707	-	5,079	=	92,628
Totals:	**5,481**	**115,371**	**120,852**		**6,021**		**114,831**

a/ No 1985 spawners passed Red Bluff in 1984.

The total number of spawners which passed RBDD was also reduced by the population estimates for some of the tributaries upstream of Red Bluff, when these were individually estimated through stream surveys. The late-fall-run estimate of Battle Creek and the late-fall- and fall-run estimates for Clear Creek were subtracted to obtain the spawner population for only the mainstem upper Sacramento River (Appendix 3). The mainstem 1985 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 8,436 late-fall potential spawners passed RBDD in 1984 and 1985. The late-fall sport-catch was estimated to be 119 salmon, resulting in 8,317 fish as a spawning population upstream of Red Bluff (Table 1). A total of 181 late-fall salmon entered Coleman Hatchery in Battle Creek, leaving 8,136 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 207 late-fall-run salmon trapped at Keswick Dam that were hauled to Coleman Hatchery for spawning. The estimated late-fall spawner population of 8,136 fish in the mainstem upper Sacramento River was an increase of 14% over the 1984 population of 7,140 fish, and was 74% of the race's average run size for 1975 through 1984 (Appendix 5).

Winter run. A total of 3,960 winter-run potential spawners passed RBDD in 1985. The winter-run sport-catch was estimated to be 276 fish, resulting in 3,684 salmon as a spawning population upstream of Red Bluff (Table 1). This race spawns primarily in the mainstem of the Sacramento River, although 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 1985 run increased by 38% over the 1984 population, it still was only 29% of the average run size for the previous 10 years (Appendix 5).

Spring run. A total of 10,747 spring-run potential spawners passed RBDD in 1985. The spring-run sport-catch was estimated to be 547 fish, resulting in 10,200 salmon 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 1985 spring-run spawner population increased 30% over the 1984 population, but was still only 83% of the average run size for the previous 10 years (Appendix 5).

Fall run. A total of 97,707 fall-run potential spawners passed RBDD in 1985. The fall-run sport-catch was estimated to be 5,079 salmon, resulting in 92,628 fish as a spawning population upstream of Red Bluff (Table 1). A total of 40,508

fish spawned in the surveyed tributaries (Battle and Clear creeks), leaving 52,120 spawners for the upper mainstem population. Several other tributaries upstream of Red Bluff usually accounted for a portion of the fall-run escapement, but this number was not determined.

The estimated 52,820 fall-run salmon upstream of Red Bluff was an increase of 26% over the 1984 population, and exceeded the average run size since 1975 by about 42%; the 1977 estimate was not used in calculation of this average since for that year the mainstem total included the Battle Creek estimate (Appendix 5).

The adult-grilse ratio for fall-run salmon passing upstream of RBDD was 81% adults (fork length [FL] ≥ 60.7 cm [23.9 in]), and 19% grilse (FL < 60.7 cm).

Mainstem spawning distribution. The 1985 salmon redd distribution in the mainstem Sacramento River from Keswick Dam downstream to Princeton Ferry (Figure 2) was determined for each run from data collected during seven airplane flights between 5 February and 16 December (Table 2). A large portion of the late-fall-run (81%), winter-run (72%), and spring-run (79%) mainstem spawning activity occurred upstream from RBDD, but only 56% of the fall-run spawning was observed in that river section.

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, but no surveys or population estimates for this tributary were made during 1985.

Fall run. Carcass counts were used to estimate the numbers of fall-run salmon that spawned in Battle Creek. Twenty-five surveys were conducted from 3 October through 30 December 1985 in the 10 km (6 mi) stretch of river downstream of Coleman Hatchery. Carcass recovery conditions were good during the entire survey period. A total of 5,924 carcasses was observed in the river, while an additional 216 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 Coleman Hatchery. Using a 48% recovery rate it was estimated that 12,792 salmon spawned naturally in Battle Creek. Combined with the 27,016 fish which entered Coleman Hatchery, the total 1985 spawner population for this tributary was 39,808 fish (Appendix 3). The 1985 spawner population for Battle Creek was 33% greater than the 1984 population and more than triple the average run size since 1975 (Appendix 5).

The composition of the fall run spawning naturally in Battle Creek was 44.2% male adults (FL ≥ 60.7 cm [23.9 in]), 50.9% female adults, and 4.9% grilse (FL < 60.7 cm), based on an

TABLE 2. Chinook Salmon 1985 Redd Distribution in the Mainstem Sacramento River, From Keswick Dam to Princeton Ferry.

River section	Late–fall run		Winter run		Spring run		Fall run	
	Redds counted a/	Proportional distribution	Redds counted b/	Proportional distribution	Redds counted c/	Proportional distribution	Redds counted d/	Proportional distribution
Keswick Dam to A.C.I.D. Dam e/	45	25.3%	6	5.8%	--	0.0%	840	10.3%
A.C.I.D. Dam to Highway 44	45	25.3%	20	19.4%	--	0.0%	562	6.9%
Highway 44 to Upper Anderson Bridge	21	11.8%	23	22.3%	--	0.0%	736	9.1%
Upper Anderson Bridge to Balls Ferry	18	10.1%	14	13.6%	--	0.0%	566	7.0%
Balls Ferry to Jellys Ferry	7	3.9%	1	1.0%	--	0.0%	1,075	13.2%
Jellys Ferry to Bend Bridge	9	5.1%	4	3.9%	--	0.0%	597	7.3%
Bend Bridge to Red Bluff Dam	0	0.0%	6	5.8%	11 f/	78.6%	163	2.0%
Red Bluff Dam to Tehama Bridge	30	16.9%	29	28.2%	--	0.0%	2,218	27.3%
Tehama Bridge to Woodson Bridge	2	1.1%	0	0.0%	--	0.0%	734	9.0%
Woodson Bridge to Hamilton City (Hwy. 32)	1	0.6%	0	0.0%	--	0.0%	402	4.9%
Hamilton City to Ord Ferry	0	0.0%	0	0.0%	--	0.0%	153	2.0%
Ord Ferry to Princeton Ferry	0	0.0%	0	0.0%	3 g/	21.4%	78	1.0%
Totals:	178		103		14		8,124	

a/ Made during an aerial survey on 5 February 1985.
b/ Made during an aerial survey on 30 May 1985.
c/ Made during an aerial survey on 16 September 1985.
d/ Total for aerial surveys made on 23 October, 6 & 20 November, and 16 December 1985.
e/ Anderson–Cottonwood Irrigation District Dam.
f/ Total redds for the river reach from Keswick Dam to Red Bluff Diversion Dam.
g/ Total redds for the river reach from Red Bluff Diversion Dam to Princeton Ferry.

examination of 5,924 carcasses. In comparison, fish entering Coleman Hatchery consisted of 39.8% male adults, 40.4% female adults, and 19.8% grilse.

Clear Creek - by Richard E. Painter

Late-fall run. Some spawning did occur in this tributary as evidenced by two redds seen during an aerial survey conducted on 2 February 1985. However, no spawning population estimate was made for Clear Creek this year.

Fall run. Aerial surveys were conducted of Clear Creek on 6 and 11 November 1985 during which 141 and 192 redds, respectively, were counted. One survey on-foot along 3.2 km (2 mi) of the creek was made on 19 December and 59 salmon carcasses, three live fish, and 69 redds were counted.

The spawning population was estimated using only the redd density observed during the 19 December survey (35 redds/mi). Using the assumptions that: a) this density was similar throughout the spawning area, b) there was a total of five miles of spawning area available in the creek, and c) each redd was used twic , each time by a different pair of salmon, then an estimated 700 fish spawned in Clear Creek in 1985; (35 redds/mi) X (5 mi of spawning area) X (4 fish/redd) = 700 spawners.

Paynes Creek - by Richard E. Painter

Fall run. Three surveys were conducted on the lower 8.1 km (5 mi) of Paynes Creek between 24 October and 14 November 1985, during which 30 redds, 19 salmon carcasses, and seven live fish were counted. However, no population estimate was made in 1985 for this tributary.

Cottonwood Creek - by Richard E. Painter

Late-fall run. During an aerial survey made on 5 February 1985, only two redds were counted. No population estimate was made in 1985 for this tributary.

Fall run. An aerial survey of Cottonwood Creek was made on 11 November 1985, during which 192 redds were counted. No population estimate was made in 1985 for this tributary.

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 individually surveyed in this area were Salt, Antelope, Craig, Mill, Toomes, Deer and Singer creeks, with spawner population estimates made only for the spring and fall runs in Mill and Deer creeks.

A total of 57,882 chinook salmon spawned in the Sacramento River system between Red Bluff and Princeton Ferry in 1985. This total consisted of 1,863 late-fall-run, 1,364 winter-run, 3,135 spring-run, and 51,520 fall-run fish (Appendix 3).

Sacramento River Mainstem - by Richard E. Painter

Late-fall run. Based on aerial redd counts made on 5 February 1985, about 1,863 late-fall-run salmon spawned in the Sacramento River mainstem between Red Bluff and Princeton Ferry.

Winter run. Based on aerial redd counts made on 30 May 1985, about 1,364 salmon of this race spawned in the Sacramento River mainstem between Red Bluff and Tehama.

Spring run. Based on an aerial survey made on 16 September 1985, about 2,713 spring-run salmon spawned in the mainstem Sacramento River downstream of Red Bluff.

Fall run. In 1985, about 50% (25,595 fish) of the fall-run mainstem Sacramento River salmon population between RBDD and Princeton Ferry spawned upstream of Tehama, with an additional 4,752 fish entering the Tehama-Colusa Spawning Channel via Coyote Creek. Downstream of Tehama, about 8,826 salmon spawned between Tehama and Woodson Bridge, about 4,833 fish spawned between Woodson Bridge and Hamilton City, about 1,849 fish spawned from Hamilton City to Ord Ferry, and about 925 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 46,780 fish. This run size was a 44% increase over the 1984 population, and 23% greater than the average run size from 1975 to 1984 (Appendix 5).

The composition of fall-run salmon entering the fish facility at Tehama-Colusa Spawning Channel was 58.5% male adults (FL $\geq$ 60.7 cm [23.9 in]), and 41.5% female adults.

Mainstem spawning distribution. Redd counts made during seven aerial surveys throughout 1985 were used to determine the general spawning distribution of the four chinook salmon runs in

the mainstem Sacramento River between Red Bluff and Princeton Ferry (Table 2). In proportion to the entire mainstem spawning activity, 19% of the late-fall-, 28% of the winter-, 21% of the spring-, and 44% of the fall-run redds were observed in this section of the river. The largest proportion of the late-fall- and fall-run redds, and all of the winter-run redds occurred from RBDD downstream to Tehama Bridge.

Salt Creek - by Richard E. Painter

Fall run. One survey was conducted on 4 December 1985 in the Tuscan Spring Bridge area of Salt Creek, during which no salmon were observed.

Antelope Creek - by Richard E. Painter

Spring run. Spring-run salmon are known to enter Antelope Creek, but no surveys or a population estimate were made for 1985.

Fall run. Seven surveys, between 7 November and 30 December 1985, were made in lower Antelope Creek from Cone Grove Park to the HWY.99-E Bridge. Five salmon carcasses and five live fish were observed, but no spawner population estimate was made.

Craig Creek - by Richard E. Painter

Late-fall run. Late-fall-run salmon are known to spawn in Craig Creek, but no surveys or a population estimate were made in 1985.

Fall run. Three surveys of Craig Creek within the stretch 1.6 km (1 mi) upstream of the HWY.99 bridge were made between 4 and 30 December 1985. Two salmon carcasses were recovered and 12 live fish were counted. No estimate of the spawning population was made.

Mill Creek - by Richard E. Painter

Late fall. Some fish of this race are known to have spawned in this stream in previous years. One survey was conducted on 31 January 1985, during which three salmon skeletons and 25 redds were counted. No population estimate was made.

Spring run. A total of 59 live salmon was observed during eight trips to upper Mill Creek (between HWY.36 to 3.2 km [2 mi] downstream of Blackrock), made from 6 September to 23 October 1985. We did not make a spring-run spawning population estimate for this tributary. However, based on their snorkeling survey,

U.S. Forest Service personnel judged the salmon population to be about 121 fish.

Fall run. Between 10 September 1985 and 3 January 1986, 13 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 384 salmon carcasses was recovered, and based on a 10% recovery rate, the fall run was estimated to be 3,840 spawners.

The 1985 fall run in Mill Creek consisted of 43.8% male adults (FL ≥ 60.7 cm [23.9 in]), 46.9% female adults, and 9.3% grilse (FL < 60.7 cm).

Toomes (Dry) Creek - by Richard E. Painter

Fall run. One survey was conducted on 3 December 1985 in the upper portion of the creek, and on 12 December in lower Toomes Creek near the Tehama-Vina Road crossing. No live salmon were observed, but one skeleton was counted. No estimate of the spawning population was made.

Deer Creek - by Richard E. Painter

Late-fall run. The spawning population of this run was not estimated for this tributary, although a survey was made on 24 January 1985, during which two salmon carcasses and 11 redds were observed.

Spring run. Although a total of 26 redds and 103 live salmon were observed during trips to a portion of the area from upper Deer Creek Falls to the Ponderosa Way crossing, we did not estimate the spring-run population. However, based on their snorkeling surveys, U.S. Forest Service personnel judged the spawning population to be about 301 salmon.

Fall run. Fourteen surveys were made in lower Deer Creek from 20 September 1985 to 2 January 1986, covering the area between its mouth and the county bridge located 3.2 km (2 mi) upstream from the Stanford-Vina Dam. A total of 90 salmon carcasses was recovered, and based on a 10% recovery rate, the estimated fall run was 900 spawners.

The fall run in Deer Creek consisted of 45.6% male adults (FL ≥ 60.7 cm [23.9 in]), 46.7% female adults, and 7.7% grilse (FL < 60.7 cm).

Singer Creek - by Richard E. Painter

Fall run. One survey was made in Singer Creek on 3 December 1985 during which no live or dead salmon were observed. No estimation of the spawning population was attempted.

Big Chico Creek to the 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, Butte and Dry creeks, and the Bear River) were based on observations made during surveys in which carcasses and live fish were counted.

A total of 136,293 chinook salmon spawned in the Sacramento River tributaries from Big Chico Creek to the American River in 1985. This total included 1,886 spring-run and 134,407 fall-run fish. Almost all of the fall run (121,215 fish) spawned in the Feather and American rivers (Appendix 3).

Big Chico Creek - by Lawrence G. Preston

Spring run. Big Chico Creek was surveyed on 19 July 1985 between Higgins Hole (located about 0.4 km [0.25 mi] upstream of the Ponderosa Hwy. bridge) and Bidwell Park, a distance of 11.2 km (7 mi). No salmon were observed, and it was felt that low spring flows prevented fish from entering the stream this year. No other attempts to determine the spawner population size were made.

Fall run. Adult salmon immigration into Big Chico Creek in 1985 was delayed due to low stream flows. During a survey conducted by canoe on 22 November, flow was 1.1 m^3/s (38 cfs), and no salmon were seen in a 4.8 km (3 mi) stretch of the creek from One Mile Road downstream to the Rose Avenue bridge.

A later survey by canoe, on 13 December from Bidwell Park Golf Course downstream 8.0 km (5 mi) to the Bidwell Mansion, was made when flows had increased to 1.3 m^3/s (46 cfs). Only one salmon carcass, and about 12 redds were observed during this survey. Based on the above observations, the 1985 fall run in Big Chico Creek was about 25 spawners.

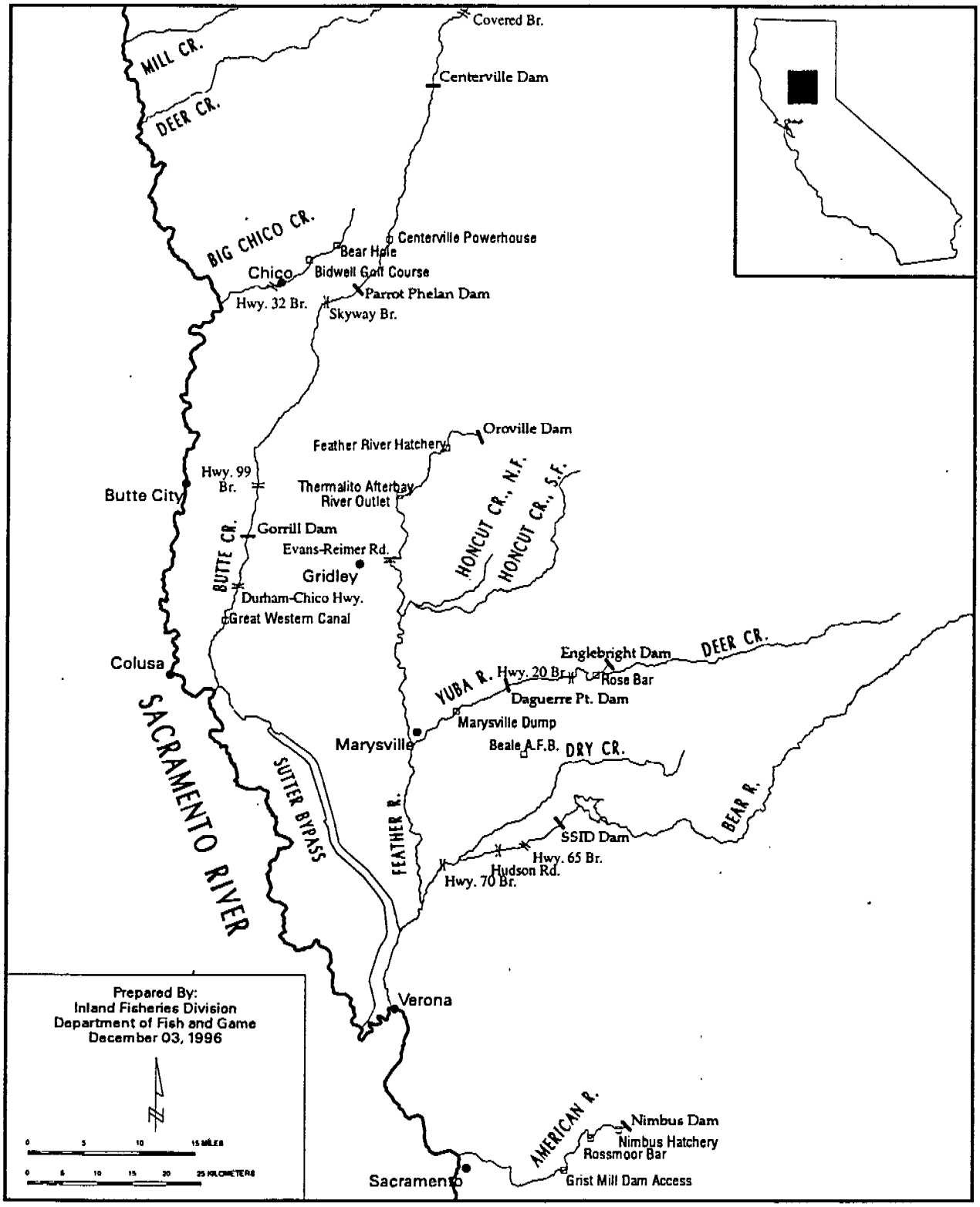

FIGURE 3. Sacramento River system from Big Chico Creek downstream to the American River.

Butte Creek - by Lawrence G. Preston

Spring run. During the 1985 spring-run immigration, Butte Creek flows were low, causing high water temperatures (19.4 - 26.6°C [67 - 80°F]). The poor stream conditions necessitated rescuing stranded adults from areas around Gorrill Dam upstream to Parrot-Phelan Dam, and relocating them to about 4.8 km (3 mi) upstream of the Covered Bridge. Two such operations were conducted on 10 May and 17 June, resulting in a total of 126 salmon being rescued. During the latter operation, about 30 dead salmon were observed in the vicinity of the HWY.99 bridge.

I conducted a spawner survey on 1 October 1985 by canoe from Centerville Powerhouse to Covered Bridge, a distance of 8.8 km (5.5 mi), and counted 36 female and 53 male salmon carcasses, 116 live salmon, 39 single redds, and 23 multiple redds. Stream flow in this section was 2.8 m^3/s (100 cfs), and water temperature was 14.4°C (58°F). On 2 October, I surveyed the 3.2 km (2 mi) section of the creek from Parrot-Phelan Dam to the Skyway Bridge, and saw four male and two female salmon carcasses, four live salmon, and one redd. On 3 October, Pacific Gas and Electric (PG&E) biologist Curtis Steitz conducted an aerial survey of Butte Creek from the Centerville Diversion Dam to Centerville Powerhouse, a stretch of 17.6 km (11 mi), and saw 12 salmon and 14 redds.

Based on the above observations, about 254 spring-run salmon spawned in Butte Creek in 1985.

Fall run. Low stream flows in Butte Creek restricted fall-run adult salmon to the stretch of river downstream of Gridley. On 15 November 1985, when flows were 1.1 m^3/s (40 cfs), I walked the 8.0 km (5 mi) stretch of the creek from Gorrill Dam to the PG&E Dam, and saw two live and 13 dead salmon. During a survey on 20 December, covering the stretch from the Durham-Chico Highway to the Great Western Canal, only one salmon skeleton was seen. Based on these observations, at most 100 fall-run salmon spawned in Butte Creek in 1985.

Feather River - by Lawrence G. Preston

Spring run. Based on counts at Feather River Hatchery (FRH) from 1 to 30 September 1985, a total of 1,632 spring-run salmon entered the hatchery (Schlicting 1987). This total consisted of 801 adult males (FL $\geq$ 68 cm [26.8 in]), 792 adult females, and 39 grilse (FL < 68 cm). The use of the 68-cm length to distinguish between grilse and adults was a departure from the traditional 60.7-cm (23.9-in) length, and was determined from analysis of length data collected earlier in the spawning season.

The period of spring-run spawning in the Feather River itself could not be distinguished from the fall-run spawning period, and no attempt was made to estimate numbers of naturally spawning spring-run salmon. Although it was assumed that most of the spring run entered FRH, two salmon, identified as spring-run through coded-wire tags, were recovered in the river during early fall-run spawner surveys. The number of spring-run salmon at FRH in 1985 was slightly higher than that seen in 1984, but still more than double the average number counted from 1975 through 1984 (Appendix 5).

Fall run. Weekly surveys of fall-run salmon were conducted in the Feather River from 14 October to 17 December 1985. The carcass mark-and-recovery techniques were used in the river reach between the hatchery barrier dam and Evans-Reimar Road. 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 relatively low 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 ranged from 48.1 m^3/s to 68.0 m^3/s (1,700 - 2,400 cfs). Except for the survey on 4 December when visibility through the water was only 1.5 m (5 ft), visibility ranged from 2.4 to 3.0 m (8 - 10 ft) during most of the period.

Moe's Ditch, a 160-m- (0.1-mi-) long side-channel adjacent to FRH was also surveyed and salmon carcasses were counted. The downstream 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 27,138 salmon spawned in the upstream low-flow section, and 22,338 fish in the downstream section. An additional 715 carcasses were counted in Moe's Ditch, and with the 5,811 fall-run salmon entering FRH, the fall-run spawning population in the Feather River was 56,002 fish. The 1985 population was a 10% increase over that of 1984, and 25% more than the 1975-1984 average run size (Appendix 5).

The composition of naturally spawning salmon, based on examination of 5,590 carcasses, was 32.3% male adults (FL $\geq$ 68 cm [26.8 in]), 5.4% male grilse (FL < 68 cm), 60.4% female adults, and 1.9% female grilse. In comparison, salmon entering the hatchery consisted of 40.0% male adults, 56.4% female adults, and 3.6% grilse (grilse were not identified by sex in the hatchery).

TABLE 3. Mark–and–recovery Data Used to Estimate the 1985 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): Oct. 14	Oct. 21	Oct. 28	Nov. 4	Nov. 11	Nov. 8	Nov. 25	Dec. 2	Dec. 9	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
Oct. 21	23	--	--	--	--	--	--	--	--	23	700 c/	1,292
Oct. 28	25	149	--	--	--	--	--	--	--	174	1,884	3,351
Nov. 4	4	22	215	--	--	--	--	--	--	241	2,142	5,049
Nov. 11		10	70	308	--	--	--	--	--	388	3,250	6,164
Nov. 18		4	24	71	258	--	--	--	--	357	2,637	4,767
Nov. 25			6	36	40	132	--	--	--	214	1,873	3,614
Dec. 2			1	4	1	27	65	--	--	98	990	2,246
Dec. 9				4	11	17	42	62	--	136	1,282	2,503
Dec. 16						7	11	17	60	95	656	1,471
Total recovered (Ri):	52	185	316	423	310	183	118	79	60		Total:	30,457
Total carcasses marked (Mi):	96	327	767	753	545	366	285	132	144			
											Adjusted estimate d/: 27,138	

a/ Includes marked carcasses recovered.

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

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. 30,457 – 3,319 = 27,138.

TABLE 4. Mark–and–recovery Data Used to Estimate the 1985 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): Oct. 22	Oct. 29	Nov. 5	Nov. 12	Nov. 19	Nov. 26	Dec. 3	Dec. 10	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
Oct. 29	14	--	--	--	--	--	--	--	14	513 c/	1,163
Nov. 5	1	38	--	--	--	--	--	--	39	777	3,331
Nov. 12		7	98	--	--	--	--	--	105	1,395	3,547
Nov. 19		4	7	47	--	--	--	--	58	1,201	4,577
Nov. 26		1	5	20	63	--	--	--	89	1,156	3,919
Dec. 3			1	7	21	68	--	--	97	1,075	3,087
Dec. 10				2	8	25	34	--	69	779	2,521
Dec. 17				1	13	5	11	23	53	554	1,824
Total recovered (Ri):	15	50	111	77	105	98	45	23		Total:	23,969
Total carcasses marked (Mi):	34	217	268	306	343	259	163	75			
									Adjusted estimate d/: 22,338		

a/ Includes marked carcasses recovered.

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

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. 23,969 – 1,631 = 22,338.

Yuba River - by Lawrence G. Preston

Spring run. The stretch of the Yuba River downstream of the mouth of Deer Creek to the HWY.20 bridge was surveyed on 9 October 1985, during which four dead and 50 live salmon, and 50 redds were observed. However, because of the inability to distinguish between spring- and fall-run fish, no estimate for the spring run was made.

Fall run. Nine weekly carcass mark-and-recovery surveys were conducted between 16 October and 12 December in the Yuba River from Rose Bar downstream to the Marysville dump. No surveys were conducted upstream of Rose Bar, although some spawning does occur between there and Englebright Dam. River flow was a constant 18.4 m^3/s (650 cfs) until the last two surveys when it increased to 23.8 m^3/s (1,000 cfs). Flows downstream of Daguerre Point Dam were usually 2.8 to 5.7 m (100-200 cfs) less than upstream of the dam, due to diversions to Hallwood-Cordua Irrigation District. Visibility through the water was at least 3.1 m (10 ft) for most of the period, only decreasing to less than 1.5 m (5 ft) during the 4 December survey.

Using carcass mark-and-recovery data, the modified Schaefer equation estimated 13,042 salmon as the spawner population between Rose Bar and the Marysville dump (Table 5). This was an increase of about 35% over the 1984 population, and slightly greater than the average run size from 1975 to 1984 (Appendix 5).

The composition of the 1985 fall run was 35.2% male adults (FL ≥ 68 cm [26.8 in]), 20.0% male grilse (FL < 68 cm), 42.4% female adults, and 2.4% female grilse.

Dry Creek (Yuba County) - by Lawrence G. Preston

Fall run. During a survey on 19 December 1985, I walked 2.4 km (1.5) of this creek on Beale Air Force Base, but did not observe any salmon nor positively identify any redds. The base warden, Richard Helms, later reported counting four redds and seeing seven salmon caught by anglers in the area, and felt that about 25 salmon entered this stream in 1985.

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

Fall run. I did not see any evidence of salmon using the Bear River, during surveys on 1 November and 6 December 1985, in the vicinities of the South Sutter Irrigation District diversion dam, and the Hudson Road, HWY.65, and HWY.70 bridges. Based on these observations, I concluded that no salmon spawned in this tributary.

TABLE 5. Mark–and–recovery Data Used to Estimate the 1985 Fall–run Chinook Salmon Spawning Population in the Yuba River From Rose Bar to the Marysville Dump.

Recovery period (j)	Number of marked carcasses recovered from marking period (i): Oct. 16–17	Oct. 23–24	Oct. 30–31	Nov. 6–7	Nov. 13–14	Nov. 20–21	Nov. 27–28	Dec. 4–5	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
Oct. 23–24	3	--	--	--	--	--	--	--	3	111 c/	1,110
Oct. 30–31	2	12	--	--	--	--	--	--	14	595	1,902
Nov. 6–7	1	3	43	--	--	--	--	--	47	778	1,935
Nov. 13–14		1	25	81	--	--	--	--	107	1,173	2,827
Nov. 20–21			7	31	89	--	--	--	127	964	2,139
Nov. 27–28			7	14	24	46	--	--	91	694	1,915
Dec. 4–5				4	5	16	10	--	35	463	1,751
Dec. 11–12				1	1	7	12	17	38	168	669
Total recovered (Ri):	6	16	82	131	119	69	22	17		Total:	14,248
Total carcasses marked (Mi):	60	33	192	319	254	224	132	52			
										Adjusted estimate d/:	13,042

a/ Includes marked carcasses recovered.

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

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. 14,248 – 1,206 = 13,042.

American River - by Phillip V. Hansen

Fall run. Weekly carcass mark-and-recovery surveys were made between 4 November and 24 December 1985 in the 15-km (9-mi) stretch of the American River from Gristmill Dam upstream to the Nimbus Hatchery racks. River flows in this section were near 45.2 m^3/s (1500 cfs) for the entire survey period, and visibility through the water ranged from 0.3 m to 2.4 m (1 - 8 ft). The spawner population in the Nimbus Basin (upstream of the Nimbus racks to Nimbus Dam) was also surveyed through counts of carcasses found along the shore or on the racks.

The salmon spawner population of the Gristmill Dam to Nimbus racks section, estimated using the modified Schaefer equation with mark-and-recovery data, was 55,146 fish (Table 6). Before the Nimbus racks were removed in November, 828 carcasses were counted in the Nimbus basin. The recovery rate of carcasses in this area was 85%, for a total of 974 salmon upstream of the racks. Combining this number with the downstream estimate and an additional 9,093 salmon which entered Nimbus Hatchery (Ducey 1987), gave a total American River 1985 fall-run spawning population of 65,213 fish. This was about 65% higher than the 1984 population, and more than one and one-half times larger the average run size from 1975 through 1984 (Appendix 5).

The composition of 857 of the carcasses used for the mark-and-recovery estimate was 35.8% male adults (FL $\geq$ 68 cm [26.8 in]), 51.7% female adults, and 12.5% grilse (FL < 68 cm). In comparison, fall-run salmon entering the hatchery in 1985 consisted of 36.8% male adults, 48.8% female adults, and 14.4% grilse.

CHINOOK SALMON POPULATIONS FOR THE SAN JOAQUIN RIVER

Salmon spawning populations were surveyed for the Cosumnes, Mokelumne, Stanislaus, Tuolumne, and Merced rivers of the San Joaquin River system (Figure 4). A total of 77,749 chinook salmon, consisting entirely of fall-run fish, spawned in the San Joaquin River tributaries in 1985 (Appendix 4).

Cosumnes River and the Mokelumne River

Cosumnes River - by Phillip V. Hansen

Fall run. In 1985, surveys of chinook salmon spawners in the Cosumnes River were conducted in late November after river flows reached a level allowing salmon access to upstream spawning habitat. Five surveys were made on-foot in the 4.0-km (2.5-mi) river stretch from Michigan Bar downstream to the HWY.16 bridge from 2 December 1985 to 2 January 1986. River flows decreased

TABLE 6. Mark–and–recovery Data Used to Estimate the 1985 Fall–run Chinook Salmon Spawning Population in the American River From the Nimbus Racks to Gristmill Dam recreation Area.

Recovery period (j)	Number of marked carcasses recovered from marking period (i): Nov. 4–5	Nov. 12–14	Nov. 18–20	Nov. 25–27	Dec. 3–4	Dec. 9–10	Dec. 16–17	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
Nov. 12–14	8	--	--	--	--	--	--	8	2,177 c/	24,491
Nov. 18–20		53	--	--	--	--	--	53	2,623	7,712
Nov. 25–27		12	63	--	--	--	--	75	2,382	9,124
Dec. 3–4		2	10	23	--	--	--	35	1,422	7,860
Dec. 9–10			2	10	13	--	--	25	708	3,841
Dec. 16–17			1	2	4	13	--	20	385	1,770
Dec. 23–24				1		5	17	23	330	1,303
Total recovered (Ri):	8	67	76	36	17	18	17		Total:	56,101
Total carcasses marked (Mi):	90	197	304	231	83	77	63			
									Adjusted estimate d/:	55,146

a/ Includ s marked carcasses recovered.

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

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. 56,101 – 955 = 55,146.

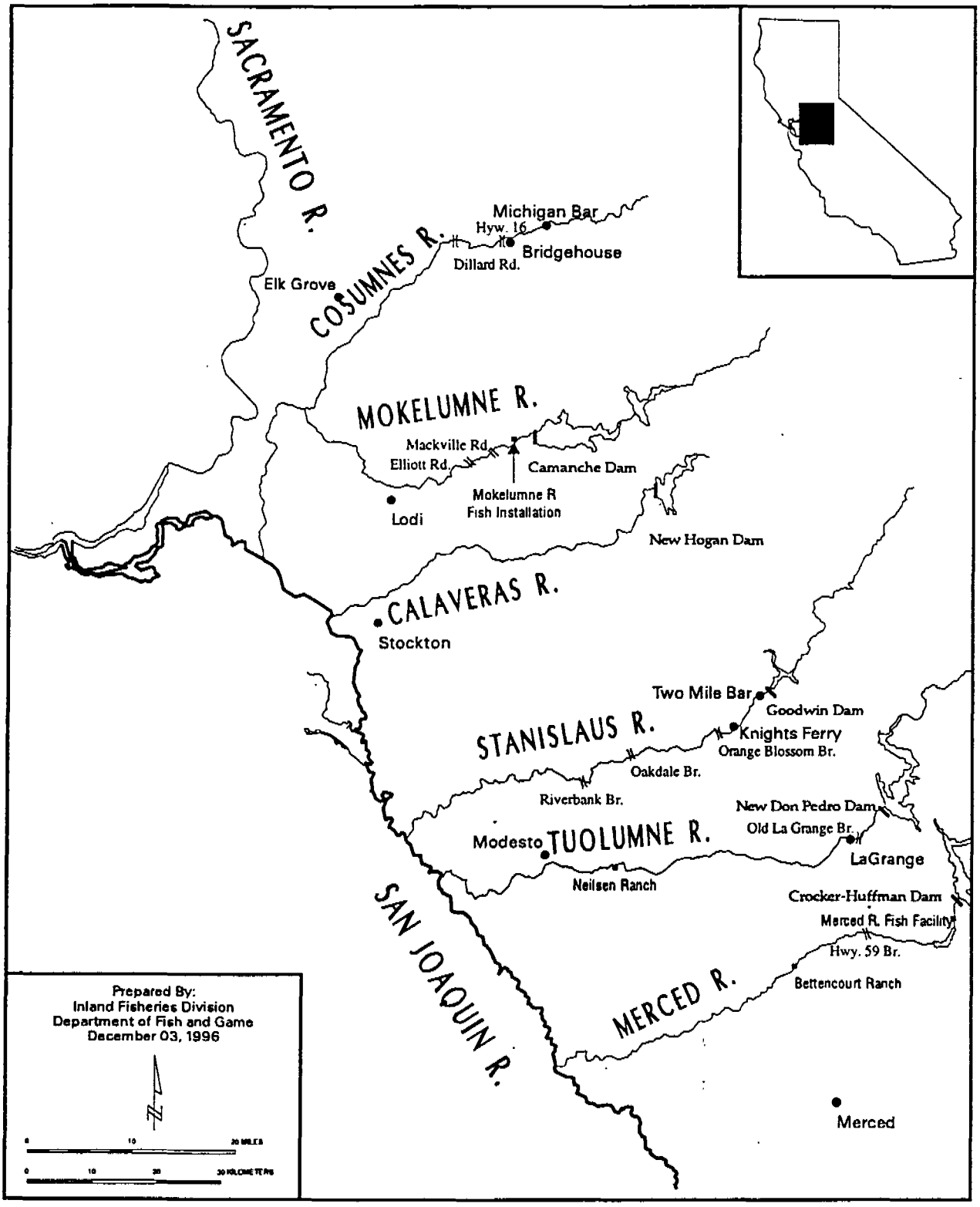

FIGURE 4. San Joaquin River system from the Merced River downstream to the Mokelumne River.

from 33.1 m^3/s (1170 cfs) at the start of the surveys to 3.4 m^3/s (121 cfs) near the end.

Eighty-six carcasses were observed at a recovery rate of 39%. It was estimated that 220 fall-run salmon spawned in the Cosumnes River in 1985. This run size was a large decrease over 1984's run of about 1000 fish, but was more typical of the low populations seen since 1978 (Appendix 5).

Mokelumne River - by Phillip V. Hansen

Fall run. In 1985, carcass surveys were conducted over a eight-week period from 7 November to 27 December in the 8-km 5-mi) stretch of this river from the Mokelumne River Fish Installation downstream to Mackville Road. River flows remained fairly constant near 5.7 m^3/s (200 cfs), with visibility through the water ranging from 0.3 m (1 ft) to 1.2 m (4 ft).

A total of 1,268 carcasses was recovered at a recovery rate of 17%, for an estimated 7,459 spawners in the run. Combined with the 223 salmon which entered the Fish Installation (Estey 1987), resulted in a total spawner population of 7,682 salmon for 1985. This was a decrease of 7% from the 1994 population, but was still well above the average of populations estimated from 1975 through 1984 (Appendix 5).

The composition of 118 of the carcasses was 26.3% male adults (FL $\geq$ 67 cm [26.4 in]), 67.0% female adults, 4.2% male grilse (FL < 67 cm), and 2.5% female grilse. In comparison, the salmon which entered the Fish Installation were 53.4% male adults, 29.1% female adults, and 17.5% grilse.

Stanislaus River to the Merced River

Stanislaus River - by James R. White

Fall run. Four surveys between 30 October and 11 December 1985 were made on-foot to count salmon carcasses and live fish in the area from Goodwin Dam to Two Mile Bar. Weekly carcass mark-and-recovery surveys were conducted between 17 October and 17 December from Knights Ferry downstream 9.6 km (6 mi) to Orange Blossom bridge; from the Orange Blossom bridge downstream to Oakdale bridge, a distance of 9.6 km (6 mi); and from the Oakdale bridge downstream 2 km (1.2 mi) to the U.S. Army Corp of Engineers' Oakdale Recreation Area (this last section was surveyed only twice). Redds were also counted during the carcass surveys in the above sections, as well as in the 9.6 km (6 mi) stretch from the Oakdale Recreation Area downstream to the Riverbank bridge. River flows during the surveys ranged from 7.6 to 8.5 m^3/s (270 - 300 cfs), and water temperature ranged from 13.3°C (56°F) in late October to 9.4°C (49°F) in mid-December.

Water clarity was high and observation conditions were excellent for most of the surveys until after 25 November.

During the surveys upstream of Two Mile Bar, 269 carcasses were counted, most of them seen in the vicinity of the Bar. For approximately 3.2 km (2 mi) downstream of Goodwin Dam the river flows in a steep-walled canyon, making much of it difficult to survey. This stretch of river contained little spawning habitat, as the substrate is primarily bedrock and boulders. Salmon were probably present throughout this area since we observed at least 40 live and 17 dead fish in the 0.8 km (0.5 mi) immediately downstream of the Dam. From these observations, it was felt that about 1,000 salmon spawned in this section of the river.

The estimated spawner population between Knights Ferry and the Oakdale Recreation Area, calculated using the modified Schaefer equation with the mark-and-recovery data, was estimated to be 11,101 salmon (Table 7). Based on redd counts, this population represented 89% of the spawners from Knights Ferry to Riverbank, so the estimated population for the entire stretch was 12,473 salmon. With the number of salmon thought to be upstream of Knights Ferry, the total estimated Stanislaus River 1985 fall-run spawner population was 13,473 salmon (Appendix 4). This run size was an increase of 18% over the 1984 population, and was the largest spawner population for this river in the past ten years (Appendix 5).

The 1985 run was composed of 34.4% male adults (FL $\geq$ 61 cm [24 in]), 56.2% female adults, 3.2% male grilse (FL < 61 cm), and 6.2% female grilse.

Tuolumne River by Maurice Fjelstad

Fall run. The 1985 fall-run salmon spawner surveys in the Tuolumne River were conducted from 29 October through 20 December, partially within a 45-day period (17 October through 1 December) of water releases from New Don Pedro Dam which, maintained stable river flows at 8.5 m^3/s (300 cfs). As in 1984, this year the period of stable flows was agreed upon with Modesto and Turlock irrigation districts to occur earlier in the spawning season, with the intention of facilitating adult salmon immigration and spawning. The 8.5-m^3/s flow level was also a departure from last season's 11.3-m^3/s (400 cfs) minimum flow, based on an in-stream flow study, which suggested that the lower flow would suffice to provide adequate spawning habitat. Flows continued at about 8.5 m^3/s even after the 45-day period due to the relatively dry preceding year. These flows allowed the spawner surveys to continue until the run had, for the most part, ended; I believe that an insignificant proportion of the run was not accounted for after surveys were terminated. Visibility through the water was good until 25 November, after which turbid conditions existed.

TABLE 7. Mark–and–recovery Data Used to Estimate the 1985 Fall–run Chinook Salmon Spawning Population in the Stanislaus River From Knights Ferry to the Oakdale Recreation Area.

Recovery period (j)	Number of marked carcasses recovered from marking period (i): Oct. 17, 28–29	Nov. 6–8	Nov. 14–15	Nov. 19–22	Nov. 25–27	Dec. 3–4	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
Nov. 6–8	16	--	--	--	--	--	16	777 c/	1,892
Nov. 14–15	5	17	--	--	--	--	22	637	1,893
Nov. 19–22	1	7	19	--	--	--	27	726	2,398
Nov. 25–27	1	5	7	22	--	--	35	713	2,556
Dec. 3–4		1	2	7	10	--	20	282	1,361
Dec. 13, 17		1	1	5	6	4	17	294	1,444
Total recovered (Ri):	23	31	29	34	16	4		Total:	11,544
Total carcasses marked (Mi):	56	97	99	129	96	22			

Adjusted estimate d/: 11,101

a/ Includes marked carcasses recovered.

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

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. 11,544 – 443 = 11,101.

Weekly carcass mark-and-recovery surveys were conducted from Old La Grange 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 from Old La Grange 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 Old La Grange bridge and Neilsen Ranch, calculated from mark-and-recovery data using the modified Schaefer equation, was estimated to be 36,290 salmon (Table 8). 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 2,577 redds was counted between Old La Grange Bridge and Neilsen Ranch. A total of 287 redds was counted in the other areas, and constituted 10% (287/2,846) of the season's redds. Assuming that the estimated 36,290 spawners represented 90% of the run, then 4,032 salmon spawned in the other areas, and the total estimated 1985 fall-run spawner population for the Tuolumne River was 40,322 salmon. This was almost three-times the run size of 1984, and was the largest population in the Tuolumne River for the past ten years (Appendix 5).

Of the 932 carcasses examined, 42.8% were male adults (FL $\geq$ 61 cm [24 in]), 53.6% were female adults, 0.9% were male grilse (FL < 61 cm), and 2.7% were female grilse.

Merced River - by Robert Reavis

Fall run. Fall-run salmon spawner surveys in the Merced River started on 7 November 1985 and ended on 13 December. River flows increased from 5.1 m^3/s (180 cfs) in November to 14.2 m^3/s (500 cfs) for the first week of December, then resuming the former level until the end of the surveys. Visibility through the water ranged from 1.8 to 2.7 m (6-9 ft) during most of the survey period.

Weekly carcass mark-and-recovery surveys were concentrated in the 16.1 km (10 mi) stream section from Crocker-Huffman Dam downstream to the HWY.59 bridge. Surveys were not possible downstream of HWY.59 due to heavy growths of water hyacinth. The spawning population in the river from the Dam to HWY.59 was calculated using the Schaefer equation with mark-and-recovery data, resulting in an estimated 10,389 salmon for this section (Table 9). The spawning population downstream of HWY.59 was derived from that of the upstream section based on the historic distribution of spawning activity from 1971 to 1981. During this period, an average proportion of 30% of the redds occurred downstream of HWY.59, so it was assumed that the spawner population for this area in 1985 was 4,452 salmon, bringing the number of in-river spawners to 14,841 fish. An additional 1,211

TABLE 8. Mark–and–recovery Data Used to Estimate the 1985 Fall–run Chinook Salmon Spawning Population in the Tuolumne River From Old LaGrange Bridge to Nielsen Ranch.

Recovery period (j)	Number of marked carcasses recovered from marking period (i): Oct. 29–31	Nov. 5–6	Nov. 12–14	Nov. 19–21	Nov. 25–27	Dec. 3–5	Dec. 10–11	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
Nov. 5–6	8	--	--	--	--	--	--	8	938 c/	3,037
Nov. 12–14	7	31	--	--	--	--	--	38	1,900	5,226
Nov. 19–21	5	18	31	--	--	--	--	54	2,542	6,530
Nov. 25–27	1	11	29	33	--	--	--	74	3,008	9,819
Dec. 3–5		4	7	16	23	--	--	50	1,879	6,881
Dec. 10–11			4	2	17	6	--	29	885	3,338
Dec. 16–20			3		2	11	4	20	498	2,286
Total recovered (Ri):	21	64	74	51	42	17	4		Total:	37,117
Total carcasses marked (Mi):	68	169	179	215	161	74	29			

Adjusted estimate d/: 36,290

a/ Includes marked carcasses recovered.

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

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. 37,117 – 827 = 36,290.

salmon were observed during Merced River Fish Facility operations (Cozart 1987), for a total 1985 fall-run spawner population of 16,052 salmon. This was a 46% decrease from the 1984 population, but still well above the average population for the past ten years (Appendix 5).

From examination of 535 of the carcasses observed during the surveys, 41.3% were male adults (FL ≥ 61 cm [24 in]), 55.7% were female adults, 0.7% were male grilse (FL < 61 cm), and 2.3% were female grilse. In comparison, salmon at Merced River Fish Facility were 42.4% male adults, 50.4% female adults, and 7.2% grilse.

SUMMARY

The 1985 Central Valley chinook salmon spawning escapement was 386,753 fish (Table 10), higher than the 1984 total of 285,464 salmon. In the Sacramento River, the late-fall run was slightly lower, and the spring run was considerably higher than last year. The winter-run population was almost double the 1984 run size, but still remained at a critically low level. The 1985 fall runs were greater than those for the previous year in almost every major tributary, except the Cosumnes, Mokelumne, and Merced rivers. Although the Merced River escapement was less than the record high 1984 run size, it still exceeded the average run size for the last ten years.

TABLE 9. Mark–and–recovery Data Used to Estimate the 1985 Fall–run Chinook Salmon Spawning Population in the Merced River From Crocker–Huffman Dam to the Highway 59 Bridge.

Recovery period (j)	Number of marked carcasses recovered from marking period (i): Nov. 7–8	Nov. 14–15	Nov. 21–22	Nov. 26–27	Dec. 5–6	Total marked carcasses recovered (Rj)	Total carcasses observed (Cj) a/	Population estimate (N) b/
Nov. 14–15	19	--	--	--	--	19	984 c/	2,204
Nov. 21–22	4	34	--	--	--	38	867	2,164
Nov. 26–27	1	20	46	--	--	67	1,467	3,636
Dec. 5–6	0	0	7	29	--	36	475	1,460
Dec. 12–13	1	3	1	7	1	13	385	1,328
Total recovered (Ri):	25	57	54	36	1		Total:	10,792
Total carcasses marked (Mi):	56	144	133	116	10			
							Adjusted estimate d/:	10,389

a/ Includes marked carcasses recovered.

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

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. 10,792 – 403 = 10,389.

TABLE 10. Summary of 1985 Sacramento-San Joaquin River System Chinook Salmon Spawning Populations.

Spawning area	Late-fall run	Winter run	Spring run	Fall run	Combined
Sacramento mainstem	9,999	5,048	12,913	98,900	126,860
Sacramento tributaries	181 a/	--	2,308 b/	179,655 c/	182,144
San Joaquin tributaries	--	--	--	77,749	77,749
Totals:	**10,180**	**5,048**	**15,221**	**356,304**	**386,753**

a/ Battle Creek population only.
b/ Estimates were not made for the Yuba River and Antelope Creek.
c/ Estimates were not made for Cottonwood, Craig, and Toomes creeks.

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APPENDIX 1. Adjusted Chinook Salmon Counts and Estimated Numbers of Each Run at Red Bluff Diversion Dam From 14 October 1984 through 4 January 1985.

Period	Adjusted salmon count a/	Number of salmon examined b/	Run proportions: Late-fall % of fish examined	Late-fall Estimated number c/	Winter % of fish examined	Winter Estimated number c/	Spring % of fish examined	Spring Estimated number c/	Fall % of fish examined	Fall Estimated number c/
14 Oct – 29 Dec '84 d/				5,481						
1985 count season										
30-Dec – 05-Jan	810	60	93.3	756	6.7	54				
06-Jan – 12-Jan	766	59	88.1	675	11.9	91				
13-Jan – 19-Jan	215	9	100.0	215	0.0	0				
20-Jan – 26-Jan	98	13	66.3	65	33.7	33				
27-Jan – 02-Feb	120	27	59.3	71	40.7	49				
03-Feb – 09-Feb	383	37	56.8	218	43.2	165				
10-Feb – 16-Feb	527	49	46.9	247	53.1	280				
17-Feb – 23-Feb	329	2	100.0	329	0.0	0				
24-Feb – 02-Mar	341	19	26.3	90	73.7	251				
03-Mar – 09-Mar	275	20	10.0	28	90.0	247				
10-Mar – 16-Mar	782	15	20.0	156	80.0	626				
17-Mar – 23-Mar	598	37	5.4	32	94.6	566				
24-Mar – 30-Mar	310	5	0.0	0	100.0	310				
31-Mar – 06-Apr	453	17	11.8	53	88.2	400				
07-Apr – 13-Apr	321	16	6.2	20	81.3	261	12.5	40		
14-Apr – 20-Apr	213	17	Total:	8,436 e/ f/	70.6	150	29.4	63		
21-Apr – 27-Apr	92	12			75.0	69	25.0	23		
28-Apr – 04-May	202	13			38.5	78	61.5	124		
05-May – 11-May	180	16			12.5	23	87.5	157		
12-May – 18-May	203	4			25.0	51	75.0	152		
19-May – 25-May	457	27			14.8	68	85.2	389		
26-May – 01-Jun	316	29			13.8	44	86.2	272		
02-Jun – 08-Jun	482	19			10.5	51	89.5	431		
09-Jun – 15-Jun	578	11			9.0	52	91.0	526		
16-Jun – 22-Jun	427	26			3.8	16	92.4	395	3.8	16
23-Jun – 29-Jun	205	5			0.0	0	100.0	205	0.0	0
30-Jun – 06-Jul	160	36			16.7	27	69.4	111	13.9	22
07-Jul – 13-Jul	379	30			Total:	3,960 e/	56.7	215	43.3	164
14-Jul – 20-Jul	1,162	7					42.9	498	57.1	664
21-Jul – 27-Jul	4,042	65					18.5	748	81.5	3,294
28-Jul – 03-Aug	3,174	35					11.4	362	88.6	2,812
04-Aug – 10-Aug	6,410	39					18.0	1,154	82.0	5,256
11-Aug – 17-Aug	8,620	92					17.4	1,500	82.6	7,120
18-Aug – 24-Aug	7,846	98					10.2	800	89.8	7,046
25-Aug – 31-Aug	9,254	48					4.2	389	95.8	8,865
01-Sep – 07-Sep	4,704	33					9.1	428	90.9	4,276
08-Sep – 14-Sep	10,115	101					3.0	303	97.0	9,812
15-Sep – 21-Sep	4,871	79					2.5	122	97.5	4,749
22-Sep – 28-Sep	7,265	75					5.3	385	94.7	6,880
29-Sep – 05-Oct	7,999	92					3.3	264	96.7	7,735
06-Oct – 12-Oct	6,061	105					11.4	691	88.6	5,370
13-Oct – 19-Oct	6,495	48					Total:	10,747 e/	100.0	6,495
20-Oct – 26-Oct	9,680	89	7.9	765					92.1	8,915
27-Oct – 02-Nov	3,634	60	18.3	665					81.7	2,969
03-Nov – 09-Nov	2,314	71	28.2	653					71.8	1,661
10-Nov – 16-Nov	1,340	81	14.8	198					85.2	1,142
17-Nov – 23-Nov	1,784	38	29.0	517					71.0	1,267
24-Nov – 30-Nov	1,237	86	74.4	920					25.6	317
01-Dec – 07-Dec	1,024	32	56.2	575					43.8	449
08-Dec – 14-Dec	709	30	60.0	425					40.0	284
15-Dec – 21-Dec	607	53	90.5	549	3.8	23			5.7	35
22-Dec – 28-Dec	279	13	92.3	258	0.0	0			7.7	21
29-Dec – 04-Jan	760	43	86.0	654	4.7	36			9.3	71
									Total:	97,707 e/
Total for 1985 calendar year g/:	121,608	2,143		9,134		4,020		10,747		97,707

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 number represents salmon passing the dam during this period in 1984 that were expected to spawn in 1985.

e/ Total estimated number of potential spawners during the 1985 calendar year.

f/ Includes a total of 207 fish trucked to Coleman National Fish Hatchery from Keswick Dam.

g/ Including late-fall- and winter-run 1986 potential spawners.

APPENDIX 2. Estimated Monthly Sport Catch of 1985 Chinook Salmon Runs in the Sacramento River between Keswick Dam and Red Bluff Diversion D

			Distribution of estimated catch by run							
			Late–fall		Winter		Spring		Fall	
Year	Month	Total sport catch a/	% at RBDD b/	Estimated catch c/	% at RBDD b/	Estimated catch c/	% at RBDD b/	Estimated catch c/	% at RBDD b/	Estimated catch c/
1984	OCT	122	7.5	9						
	NOV	100	32.3	32						
	DEC	50	79.9	40						
1985	JAN	5	88.7	4	11.3	1				
	FEB	22	55.9	12	44.1	10				
	MAR	77	11.0	8	89.0	69				
	APR	201	6.8	14	81.6	164	11.6	23		
	MAY	123	Total:	119 d/	19.4	24	80.6	99		
	JUN	105			7.0	7	92.0	97	1.0	1
	JUL	319			0.3	1	21.7	69	78.0	249
	AUG	646			Total:	276 d/	12.0	77	88.0	569
	SEP	3,380					4.6	155	95.4	3,225
	OCT	971	4.2	41			2.8	27	93.0	903
	NOV	174	34.3	60			Total:	547 d/	65.7	114
	DEC	69	72.8	50	1.7	1			25.5	18
									Total:	5,079 d/
	1985 calendar year total:			189		277		547		5,079

a/ The total catch was expanded from 1985 landings reported only from fishing resorts, by using the average ratio between both resort and boat launch area land 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 1985 spawners.

APPENDIX 3. Summary of 1985 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/	8,136 b/	3,684	10,200	52,120	74,140
Clear Creek	c/	--	--	700	700
Cottonwood Creek	c/	--	--	c/	--
Battle Creek					
Coleman National Fish Hatchery	181	--	--	27,016	27,197
Downstream of hatchery	--	--	--	12,792	12,792
(Totals for tributary):	(181)	--	--	(39,808)	(39,989)
Totals for area:	8,317	3,684	10,200	92,628	114,829
Red Bluff to Princeton Ferry					
Sacramento River mainstem					
Red Bluff to Tehama Bridge	1,685	1,364	2,713	25,595	31,357
Tehama Bridge to Woodson Bridge	119	--	--	8,826	8,945
Woodson Br. to Princeton Ferry	59	--	--	7,607	7,666
Tehama-Colusa Spawning Channel	0	--	--	4,752	4,752
(Totals for tributary):	(1,863)	(1,364)	(2,713)	(46,780)	(52,720)
Salt Creek	c/	--	--	--	--
Antelope Creek	--	--	c/	c/	--
Craig Creek	c/	--	--	c/	--
Mill Creek	c/	--	121	3,840	3,961
Toomes Creek	--	--	--	c/	--
Deer Creek	c/	--	301	900	1,201
Totals for area:	1,863	1,364	3,135	51,520	57,882
Butte Creek to American River					
Big Chico Creek	--	--	0	25	25
Butte Creek	--	--	254	100	354
Feather River					
Feather River Hatchery	--	--	1,632	5,811	7,443
Downstream of hatchery	--	--	c/	50,191	50,191
(Totals for tributary):	--	--	(1,632)	(56,002)	(57,634)
Yuba River	--	--	c/	13,042	13,042
Dry Creek (Yuba County)	--	--	--	25	25
Bear River (Sutter County)	--	--	--	0	0
American River					
American River Hatchery	--	--	--	9,093	9,093
Downstream of hatchery	--	--	--	56,120	56,120
(Totals for tributary):				(65,213)	(65,213)
Totals for area:	0	0	1,886	134,407	136,293
Sacramento River system totals:	10,180	5,048	15,221	278,555	309,004

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

b/ Includes 207 fish from Keswick Dam that were transported to and spawned at Coleman Hatchery.

c/ No estimate.

APPENDIX 4. Summary of 1985 Population Estimates for San Joaquin River System Chinook Salmon Runs.

Tributary	Estimated number of fish: Late–fall run	Winter run	Spring run	Fall run	Total
Consumnes River	--	--	--	220	220
Mokelumne River					
Mokelumne River Fish Installation	--	--	--	223	223
Downstream of installation	--	--	--	7,459	7,459
(Totals for tributary):	--	--	--	(7,682)	(7,682)
Stanislaus River	--	--	--	13,473	13,473
Tuolumne River	--	--	--	40,322	40,322
Merced River					
Merced River Fish Facility	--	--	--	1,211	1,211
Downstream of facility	--	--	--	14,841	14,841
(Totals for tributary):	--	--	--	(16,052)	(16,052)
San Joaquin River system totals:				77,749	77,749

APPENDIX 5. Summary of Sacramento – San Joaquin River System Spawning Population Estimates from 1975 through 1985.

Tributary / Race	Estimated population size											1975–1984 average
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
Sacramento River system upstream of Red Bluff (excluding Battle Creek)												
Late–fall run	19,261	15,908	9,210	12,479	10,284	9,361	6,423	4,899	14,984	7,140	8,136	10,995
Winter run	22,579	33,029	16,470	24,735	2,339	1,142	19,795	1,233	1,827	2,662	3,684	12,581
Spring run	10,234	25,095	13,453	5,669	2,856	9,363	20,655	23,156	3,854	7,823	10,200	12,216
Fall run	55,102	51,986	39,579 a/	35,500	47,758	21,961	33,289	20,567	27,326	41,805	52,820	37,255
Battle Creek												
Fall run	4,857	5,444	b/	3,652	13,159	14,443	17,205	26,795	13,983	29,893	39,808	12,943
Sacramento River mainstem downstream of Red Bluff												
Fall run	31,461	37,530	45,743	47,973	67,388	30,453	42,724	23,833	32,018	19,166	46,780	37,829
Feather River												
Spring run c/	691	699	185	202	250	269	469	1,910	1,702	1,562	1,632	794
Fall run	43,000	62,000	46,452	37,759	32,505	35,295	53,020	55,519	30,522	51,056	56,002	44,713
Yuba River												
Fall run	5,641	3,779	8,722	7,416	12,430	12,406	14,025	39,367	13,756	9,665	13,042	12,721
American River												
Fall run	39,543	28,374	48,473	21,091	47,666	49,802	64,055	43,898	35,300	39,696	65,213	41,790
Cosumnes River												
Fall run	725	0	b/	100	150	200	b/	b/	200	1,000	220	238
Mokelumne River												
Fall run	1,900	473	250	1,086	1,507	3,231	4,954	9,372	15,861	8,298	7,682	4,693
Stanislaus River												
Fall run	1,200	600	0	50	110	100	1,000	b/	500	11,439	13,473	1,500
Tuolumne River												
Fall run	1,600	1,700	450	1,300	1,183	559	14,253	7,126	14,836	13,689	40,322	5,670
Merced River												
Fall run	2,400	1,900	350	625	2,147	3,006	10,415	3,263	18,248	29,749	16,052	7,210

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.