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ANNUAL REPORT
CHINOOK SALMON SPAWNER STOCKS IN
CALIFORNIA'S CENTRAL VALLEY, 1986

Edited by

Robert M. Kano
and Robert Reavis

Inland Fisheries Division

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ABSTRACT

This report covers the 34th annual inventory of chinook salmon, Oncorhynchus tshawytscha, spawner populations in the Sacramento-San Joaquin River system. It is a compilation of reports estimating the fall-, winter-, late-fall-, and spring-run salmon spawner populations for streams which were surveyed.

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

The estimated 1986 total escapement of chinook salmon in the Central Valley was 328,893 fish. This total consisted of 292,967 fall-, 25,524 spring-, 2,394 winter- and 8,008 late-fall-run spawners. All of the spring-, late-fall-, and winter-run salmon were estimated to be in the Sacramento River system, while 28,502 fish of the fall run were in the San Joaquin River system.

The total 1986 Central Valley salmon stock was lower in comparison to that of 1985 due to decreases in all but the spring run. Fall-run spawner populations in the Stanislaus, Tuolumne, and Merced rivers of the San Joaquin system showed the largest decreases in run sizes.

In the mainstem Sacramento River upstream of Red Bluff, this was the fourth year that the spring run continued to increase in size, while the winter run remained unchanged at a critically low level.

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 34th compilation of chinook salmon spawner stock surveys; the spring and fall runs have been monitored since 1953, and late-fall and winter runs since 1971. The four runs are described as follows:

1) <u>Late-fall run</u>. 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) <u>Winter run</u>. These fish spawn almost entirely in the Sacramento River and its tributaries upstream of Red Bluff, arriving in late December through mid-July, and spawning from April to early August.

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

Monitoring of salmon spawner escapement in Central Valley tributaries is an important component of the California Department of Fish and Game's (CDFG) fishery management effort. The primary objectives of this work are to determine size and sex composition of spawner populations, and to recover coded-wire-tagged salmon. Any changes in spawning distribution and habitat conditions that may adversely affect salmon are noted to determine if corrective action is necessary.
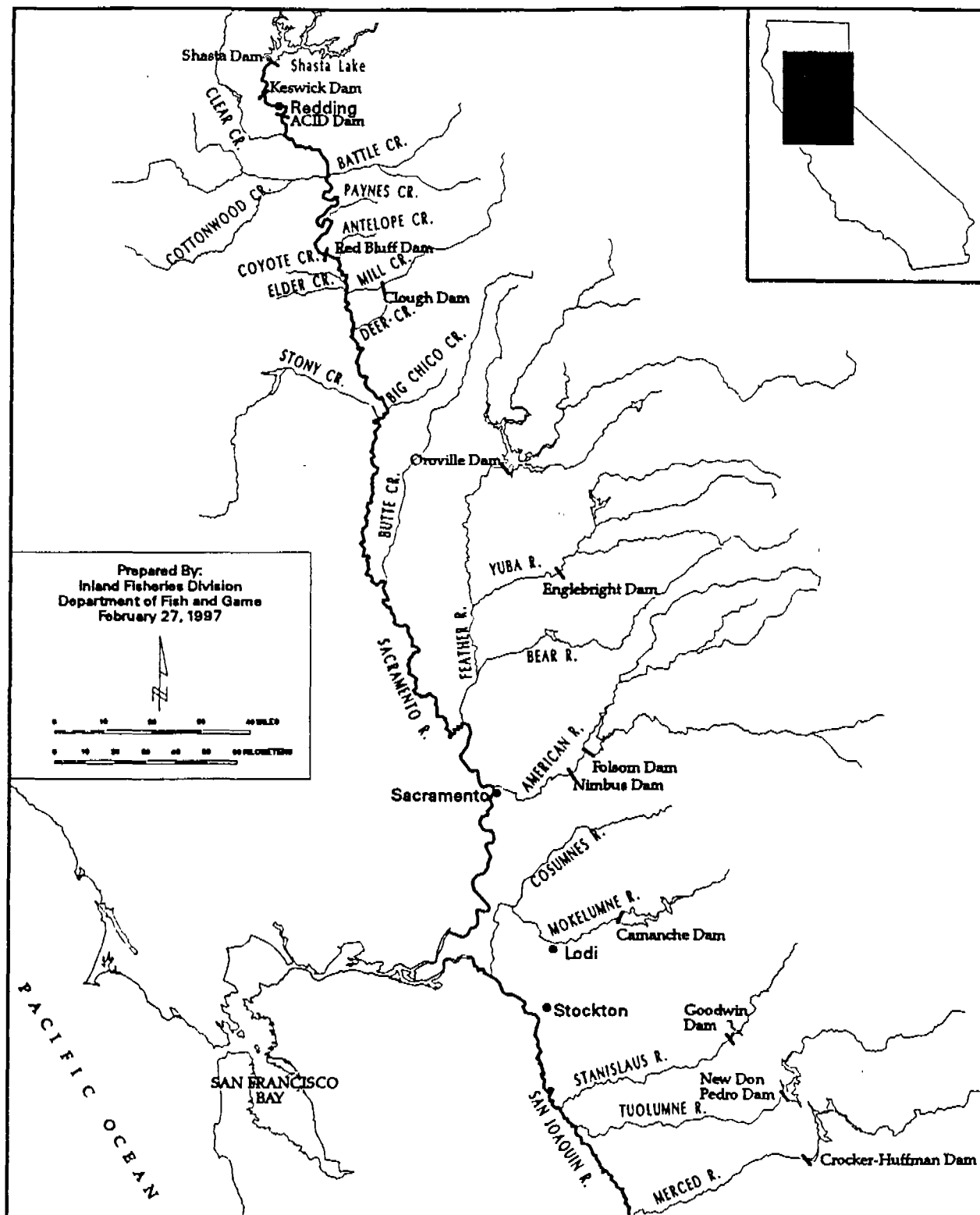
FIGURE 1. Sacramento-San Joaquin river system of California's
Central Valley.

GENERAL METHODS

During 1986, spawner stock data were collected on most Central Valley streams known to support chinook salmon runs by monitoring fish entering hatcheries and migrating past dams; conducting stream surveys in spawning areas for live fish, carcasses, and redds; or making aerial counts. The data collected usually represented only a sampling of the tributaries' spawners. For some tributaries, although surveys were conducted, data were not sufficient for a calculated determination of spawner population size; in some such cases, a decision of the number of spawners present was arrived at by "best professional judgement".

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

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

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

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

where N = estimated spawner 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 *i*th marking period,

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

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

$\sum_2^i M_i$ = 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 spawner 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 following individual tributary headings.

CHINOOK SALMON SPAWNER POPULATIONS FOR THE SACRAMENTO RIVER SYSTEM

Keswick Dam to Red Bluff Diversion Dam

Spawner population sizes were estimated for all four runs of chinook salmon in the Sacramento River mainstem (Figure 2) upstream of Red Bluff Diversion Dam (RBDD). In addition, the fall-run population of Battle Creek was estimated. Spawning distribution in the mainstem was determined from aerial redd counts.

In 1986, 125,418 salmon were estimated for the Sacramento River system between Keswick Dam and Red Bluff, consisting of 99,192 fall-, 8,008 late-fall-, 2,394 winter- and 15,824 spring-run fish (Appendix 3). The Battle Creek portion of the fall run was 31,252 fish. 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 E. Painter

Estimates of the total numbers of salmon using the Sacramento River and its tributaries upstream from RBDD during 1986 were based on daily counts made by the U.S. Fish and Wildlife Service (USFWS) and CDFG at the dam. Counts were obtained through closed-circuit television monitoring of salmon passing through the RBDD fishways.

Total numbers of fish counted each week were adjusted for those periods when the fishways remained open but no counts were possible, such as when river turbidity was high, during flood conditions when the dam gates were temporarily opened, and when no observations were made at night. Adjustments to lapses in daytime counts were made by interpolation. Adjustments for the non-monitored nighttime hours were made by multiplying the 14-h day counts by a "night-factor", generated from weekly night counts. The adjusted weekly number of fish was apportioned among the four runs based on their relative proportions seen that week in random samples of salmon from the dam's east-bank trapping facility (Appendix 1); salmon were assigned to a run based on their relative degree of ripeness.

When salmon counts were not possible for an entire week, or weekly relative proportions could not be determined, historical data was relied on. For each run, the number of salmon passing the dam that week was estimated using the run's 1968-1985 average weekly proportional distribution.
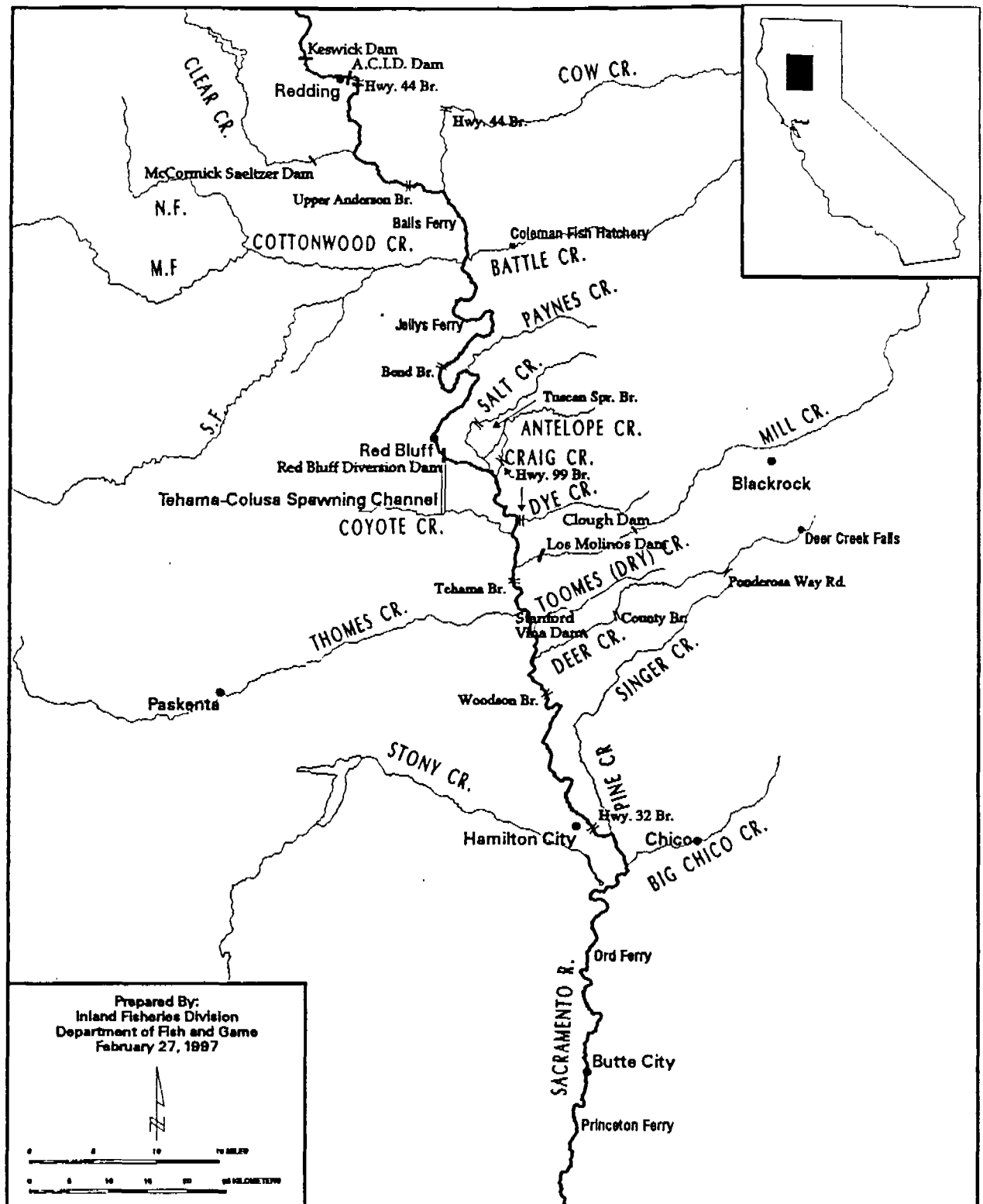
FIGURE 2. Sacramento River system from Keswick Dam downstream to Princeton Ferry.

The numbers of spring- and fall-run salmon passing RBDD in a
calendar year account for the entire annual run of these races.
However, the late-fall and winter runs for a calendar year
usually include the latter part of one annual run during the
beginning of the year, and the first part of the next run at the
end of that year. Approximately half of the late-fall annual run
occurs in each portion of the calendar year, while most of the
winter annual run usually occurs early in the year with the
smaller part of the following winter run at the end of the year.
The total 1986 potential spawners for each of these two runs was
calculated by adding the appropriate estimated numbers of fish
from the 1985 calendar year that would spawn in 1986, and not
including that portion of the 1986 calendar year estimated
numbers that would spawn in 1987. About 75% (6,179 fish) of the
1986 late-fall-run spawners, and only 3% (65 fish) of the 1986
winter run, passed Red Bluff in 1985 (Appendix 1, Table 1).

For each of the four runs, the estimated spawner population
upstream of RBDD was calculated by reducing the number of
potential spawners by the estimated number of fish 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 salmon catches were only obtained from
the fishing resorts, the total monthly catch was estimated by
multiplying the resort landings by an average catch ratio

TABLE 1. Calculation of the 1986 spawner population for each run of
chinook salmon upstream of Red Bluff Diversion Dam (RBDD).

Run	Number of fish passing dam in calendar year: 1985	1986	Number of potential spawners	Estimated sport catch	Estimated 1986 spawner population
Late-fall	6,179	+ 2,108 a/	= 8,287	- 279	= 8,008
Winter	65	+ 2,359 a/	= 2,424	- 30	= 2,394
Spring	--b/	16,691	= 16,691	- 867	= 15,824
Fall	--b/	104,874	= 104,874	- 5,682	= 99,192
Totals:	6,244	+126,032	= 132,276	- 6,858	= 125,418

a/ Totals of 10,163 late-fall- and 57 winter-run salmon passed RBDD in the latter part of 1986, and were not included
in these counts; these fish were considered 1987 spawners.
b/ No 1986 spawners passed Red Bluff in 1985.

(1.5944) between resorts and public ramps, derived from 1967-1974
data when both sources were sampled. The total monthly catch was
apportioned into each of the four runs assuming the same relative
proportions seen at RBDD (Appendix 2).

To obtain the late-fall and fall-run population for only the
mainstem upper Sacramento River, the number of potential spawners
of these runs was also reduced by the run size in Battle Creek,
which was individually estimated (Appendix 3). The mainstem 1986
estimates included all of the winter- and spring-run salmon, as
well as some late-fall-run fish for unsurveyed tributaries.

   Late-fall run. A total of 8,287 late-fall 1986 potential
spawners passed RBDD in 1985 and 1986. The late-fall sport-catch
was estimated to be 279 salmon, resulting in 8,008 fish as a
spawner population upstream of Red Bluff (Table 1). One hundred
ninety-seven late-fall salmon entered Coleman National Fish
Hatchery (CNFH) through Battle Creek leaving 7,811 fish as the
mainstem spawner population. Although some late-fall-run salmon
may have used other tributaries of the upper Sacramento River, no
spawner surveys were made in those streams. Numbers of those
fish are included with the upper mainstem population, along with
591 late-fall-run salmon trapped at Keswick Dam that were hauled
to CNFH for spawning. The estimated 7,811 late-fall fish of the
upper Sacramento River spawner population was a decrease of 4%
from the 1985 population of 8,136 fish, and was 79% of the race's
average run size from 1976 through 1985 (Appendix 5).

   Winter run. A total of 2,424 winter-run potential spawners
passed RBDD in 1985 and 1986. The winter-run sport-catch was
estimated to be 30 salmon, resulting in 2,394 fish as a spawner
population upstream of Red Bluff (Table 1). The winter-run
population has been critically low for the past five years, and
the 1986 run size was 65% of the 1985 population, and only 22% of
the average run size for the previous 10 years (Appendix 5).

   Spring run. A total of 16,691 spring-run potential spawners
passed RBDD in 1986. The spring-run sport-catch was estimated to
be 867 salmon, resulting in 15,824 fish as a spawner population
upstream of Red Bluff (Table 1). The 1986 spring-run spawner
population was an increase of 55% over the 1985 population, and
30% higher than the average run size for the previous 10 years
(Appendix 5).

   Fall run. A total of 104,874 fall-run potential spawners
passed RBDD in 1986. The fall-run sport-catch was estimated to
be 5,682 salmon, resulting in 99,192 fish as a spawner population
upstream of Red Bluff (Table 1). A total of 31,252 fish was
estimated to have entered Battle Creek, leaving 67,940 salmon for
the upper mainstem population. This number included 228 salmon
trapped at Keswick Dam and hauled to Coleman Hatchery for
spawning, as well as an undetermined number which used other
tributaries. The estimated 67,940 fall-run salmon in the

mainstem Sacramento River upstream of Red Bluff was an increase of 22% over the 1985 population, and was the largest run size estimated in the past ten years (Appendix 5).

Mainstem spawning distribution. The relative redd distribution of 1986 late-fall-, spring-, and fall-run salmon in the mainstem Sacramento River from Keswick Dam downstream to Princeton Ferry (Figure 2) was determined from data collected during airplane flights between 10 February and 4 December 1986 (Table 2). Almost all of the mainstem late-fall-run (96.5%), and the majority of the spring-run (72.3%) and fall-run (64.1%) spawning occurred upstream from RBDD.

Battle Creek - by Richard E. Painter

Late-fall, winter, and spring runs. Small numbers of these three runs have been known to spawn in Battle Creek. However, no spawner surveys were conducted during 1986, and the only available data were for late-fall-run salmon which entered CNFH (197 fish) from the creek.

Fall run. Salmon carcass counts were used to estimate the numbers of fall-run salmon in Battle Creek downstream from CNFH. Fourteen surveys were conducted from 9 October through 15 December 1986 in the 10 km (6 mi) stretch of river downstream of the hatchery. A total of 4,233 carcasses was counted at an recovery rate of 37%. An additional 67 carcasses were counted in Gover's Ditch, an irrigation diversion about 1 km (0.6 mi) long located 1.6 km (1.0 mi) downstream from CNFH. An estimate was not possible for this ditch this season since it was only surveyed once. The actual count, added to the creek's estimated population, gave an estimated that 11,508 salmon in Battle Creek downstream of CNFH. An additional 19,744 fish entered CNFH (7,263 of which were released upstream into the creek), bringing the total 1986 fall-run spawner population for this tributary to 31,252 fish (Appendix 3). The 1986 spawner population for Battle Creek was a decrease of 22% from the 1985 population, but was still almost double the average run size for the previous 10 years (Appendix 5).

The composition of fall-run salmon in Battle Creek was 42.0% male adults (FL $\geq$ 61 cm [24 in]), 52.7% female adults, and 5.3% grilse (FL < 61 cm), based on an examination of 4,233 carcasses. In comparison, fish entering Coleman Hatchery consisted of 45.8% male adults, 44.6% female adults, and 9.6% grilse.

Clear Creek - by Richard E. Painter

Late-fall and spring runs. No spawner surveys were conducted for these runs in this tributary during 1986.

TABLE 2. Chinook salmon 1986 redd distribution in the mainstem Sacramento River, from Keswick Dam to Princeton Ferry.

River section	Late—fall run		Spring run		Fall run	
	Redds counted a/	Proportional distribution	Redds counted b/	Proportional distribution	Redds counted c/	Proportional distribution
Keswick Dam to A.C.I.D. Dam d/	34	24.1%	0	0.0%	282	3.5%
A.C.I.D. Dam to Highway 44	74	52.5%	22	10.3%	696	8.7%
Highway 44 to Upper Anderson Bridge	4	2.8%	27	12.7%	1,063	13.3%
Upper Anderson Bridge to Balls Ferry	18	12.8%	54	25.4%	1,155	14.5%
Balls Ferry to Jellys Ferry	2	1.4%	35	16.4%	1,164	14.6%
Jellys Ferry to Bend Bridge	2	1.4%	16	7.5%	574	7.2%
Bend Bridge to Red Bluff Dam	2	1.4%	0	0.0%	176	2.2%
Red Bluff Dam to Tehama Bridge	5	3.5%	57	26.8%	2,042	25.6%
Tehama Bridge to Woodson Bridge	0	0.0%	2	0.9%	382	4.8%
Woodson Bridge to Hamilton City (Hwy. 32)	0	0.0%	0	0.0%	275	3.5%
Hamilton City to Ord Ferry	0	0.0%	0	0.0%	113	1.4%
Ord Ferry to Princeton Ferry	0	0.0%	0	0.0%	46	0.6%
Totals:	141		213		7,968	

a/ Counts made during an aerial survey on 10 February 1986.
b/ Counts made during an aerial survey on 8 October 1986.
c/ Total for counts made during aerial surveys on 24 October, 5 and 12 November, and 4 December 1986.
d/ Anderson—Cottonwood Irrigation District Dam.

Fall run. Four surveys of Clear Creek were made between 20 October and 2 December 1986. Totals of 429 salmon carcasses, 261 live fish, and 630 redds were counted, but no estimate of the spawner population was made.

Cottonwood Creek - by Richard E. Painter

Late-fall and spring runs. No spawner surveys were conducted for these runs in this tributary during 1986.

Fall run. Aerial surveys of Cottonwood Creek were made on 5 November and 4 December 1986, during which 290 and 182 redds, respectively, were counted. No spawner population estimate was made.

Paynes Creek - by Richard E. Painter

Fall run. Three surveys were conducted on the lower 8.1 km (5 mi) of Paynes Creek between 3 October and 19 December 1986, during which 13 redds, 37 live salmon, and 73 carcasses were counted. No spawner population estimate was made.

Red Bluff Diversion Dam to Princeton Ferry

Chinook salmon spawner populations in the mainstem Sacramento River downstream of RBDD to Princeton Ferry (Figure 2) were determined through aerial redd counts. Tributaries in this area that were individually surveyed were Antelope, Craig, Mill, Deer and Singer creeks. Spawner estimates were possible only for the mainstem, and Mill and Deer creeks.

A total of 42,098 chinook salmon spawners was estimated for the Sacramento River system between Red Bluff and Princeton Ferry in 1986 (Appendix 3). River conditions during the late-fall-run and winter-run spawning periods made surveying of these stocks impossible.

Sacramento River Mainstem - by Richard E. Painter

Late-fall and winter runs. Spawner population estimates were not made for 1986.

Spring run. Based on an aerial survey made on 8 October 1986, 6,062 spring-run salmon were estimated to be in the Sacramento River mainstem between Red Bluff and Woodson Bridge.

Fall run. Based on aerial surveys conducted on 24 October, 5 and 12 November, and 4 December 1986, 34,372 fall-run salmon were estimated for the mainstem Sacramento River between RBDD and Princeton Ferry. This run size was a 27% decrease from the 1985 population, and 87% of the average run size from 1976 to 1985 (Appendix 5).

Mainstem spawning distribution. Redd counts made during aerial surveys (10 February, 8 October, 5 and 12 November, and 12 December 1986) were used to determine the relative spawning distribution of late-fall-, spring- and fall-run salmon in the mainstem Sacramento River between Red Bluff and Princeton Ferry (Table 2). In proportion to the entire mainstem (including upstream of RBDD) spawning activity, 3.5% of the late-fall, 27.7% of the spring-, and 35.9% of the fall-run redds were observed in this section of the river.

Antelope Creek - by Richard E. Painter

Spring run. Spring-run salmon are known to enter Antelope Creek, but no surveys were conducted in 1986.

Fall run. Six surveys, between 30 October and 18 December 1986, were made in Antelope Creek from Cone Grove Park to the HWY.99-E Bridge. Ten salmon carcasses and three live fish were observed. No spawner population estimate was made.

Craig Creek - by Richard E. Painter

Late-fall run. Late-fall-run salmon are known to enter Craig Creek, but no surveys were conducted in 1986.

Fall run. Five surveys of the entire length of Craig Creek were made between 2 November and 18 December 1986. Forty salmon carcasses were recovered and 28 live fish were counted. No spawner population estimate was made.

Mill Creek - by Richard E. Painter

Late fall run. Some fish of this race have been known to spawn in this stream in previous years, but no surveys were made in 1986.

Spring run. No surveys were conducted of upper Mill Creek during the 1986 spring-run spawning period. A population of 291 fish was estimated by the USFWS, based on counts made of spring-run salmon passing Clough Dam during their immigration (Vogel 1987b).

<u>Fall run</u>. Between 4 November and 30 December 1986, 12 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 287 salmon carcasses was recovered, and based on a 50% recovery rate, the fall run was estimated to be 574 spawners.

<u>Toomes Creek</u> - by Richard E. Painter

<u>Fall run</u>. Some fish of this race have been known to spawn in this stream in previous years, but no surveys of this run were made in 1986.

<u>Deer Creek</u> - by Richard E. Painter

<u>Late-fall Run</u>. Late-fall-run salmon are known to enter Deer Creek, but no surveys were conducted in 1986.

<u>Spring run</u>. Between 12 September and 11 October 1986, surveys were made of selective spawning areas from upper Deer Creek Falls to the Ponderosa Way crossing, during which 107 live salmon were observed. However, based on counts made by the USFWS at Stanford-Vina Dam during the spring-run immigration, an estimated 543 fish of this run entered Deer Creek in 1986 (Vogel 1987a).

<u>Fall run</u>. Eight surveys were made in lower Deer Creek between 28 October and 22 December 1986, covering the area between the mouth and the county bridge located 3.2 km (2 mi) upstream from the Stanford-Vina Dam. A total of 92 salmon carcasses was recovered, and based on a 36% recovery rate, the estimated fall run was 256 spawners.

The fall run in Deer Creek consisted of 37% male adults (FL $\geq$ 61 cm [24 in]), 41% female adults, and 22% grilse (FL < 61 cm).

<u>Singer Creek</u> - by Richard E. Painter

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

Big Chico Creek to the American River

Chinook salmon spawner population estimates for the Feather, Yuba, and American rivers (Figure 3) were made from weekly mark-and-recovery surveys of fresh carcasses. Run sizes for Butte and Auburn Ravine creeks were based on observations of carcasses, live fish, and redds.

A total of 132,870 chinook salmon was estimated for the Sacramento River tributaries from Butte Creek to the American River in 1986. This total consisted of 2,804 spring-run and 130,066 fall-run fish (Appendix 3).

Big Chico Creek

Fall run. Fall-run salmon are known to enter Big Chico Creek, but no surveys were conducted in 1986.

Butte Creek - by Lawrence G. Preston

Spring run. Stream flows from February through April of 1986 facilitated immigration of spring-run chinook salmon into Butte Creek to the extent that a large sport fishery for this run developed. However, by late-May into June, water diversions had greatly reduced the flows, preventing upstream passage farther than HWY.99. About 33 salmon stranded near the Rock Plant at HWY.99 were rescued and transplanted upstream of the Covered Bridge.

Surveys were conducted from 1 through 3 October 1986, in the 27.2 km (17 mi) between the Centerville Head Dam and the Skyway Bridge. The entire stream reach was covered by helicopter, and about half of the area was surveyed by canoe. The spawner population was estimated from the number of redds observed. In reaches covered by both techniques, redd counts from canoe surveys were used, since they were generally greater than those from the air. Canoe-made redd counts were combined with the counts from those reaches covered only by helicopter, and the total 457 redds observed represented a minimum number for the survey area. Assuming that three salmon used each redd, an estimated 1,371 spring-run salmon were in Butte Creek in 1986.

Fall run. No surveys were made of the 1986 run in Butte Creek. However, fall-run salmon were observed in the Butte Sink and various reclamation district canals of this tributary.
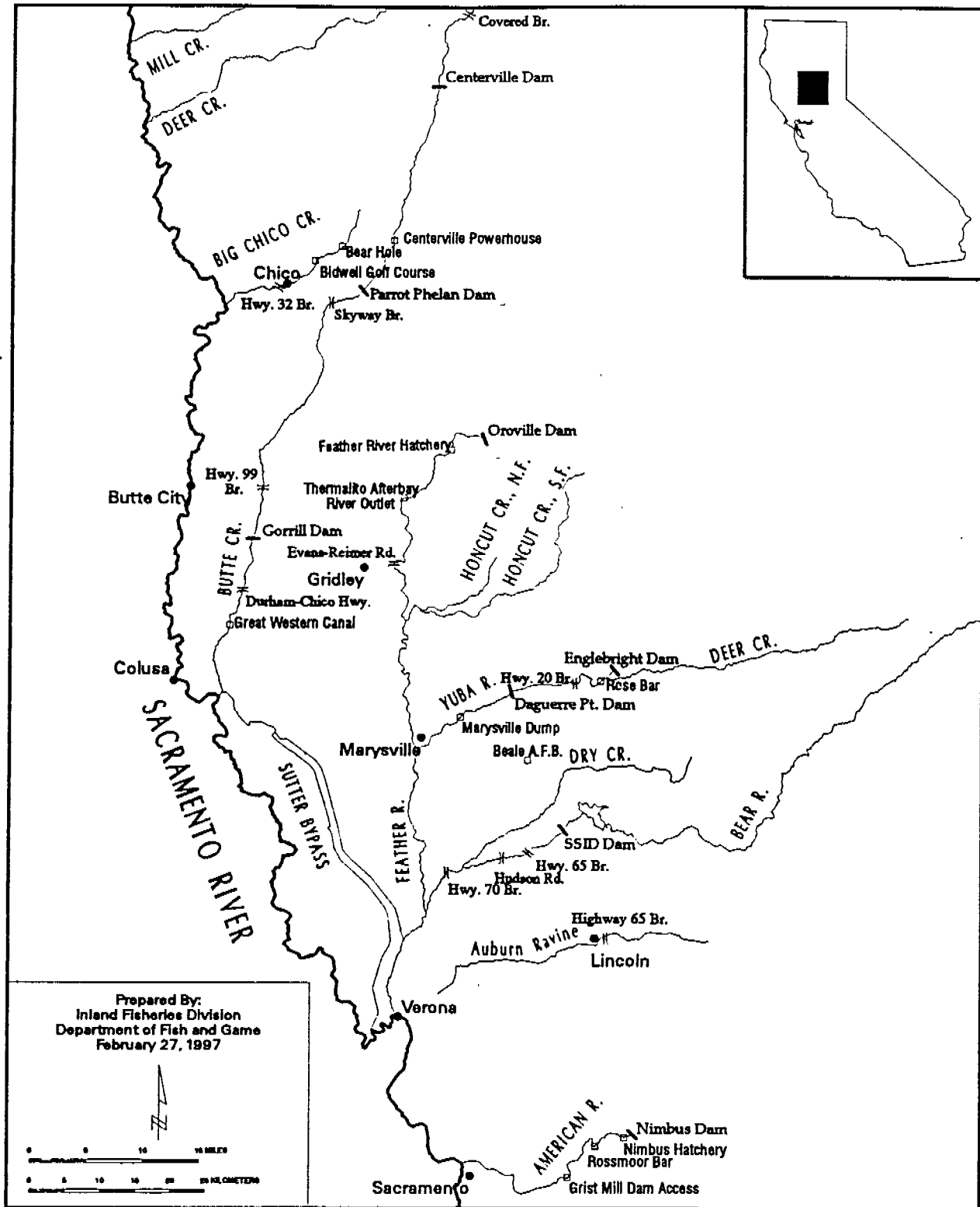
FIGURE 3. Sacramento River system from Big Chico Creek downstream to the American River.

Feather River - by Lawrence G. Preston

Spring run. Based on counts from 1 to 30 September 1986, 1,433 spring-run salmon entered Feather River Hatchery (FRH). These fish consisted of 38.1% adult males (FL $\geq$ 68 cm [26.8 in]), 48.6% adult females, and 13.3% grilse (FL < 68 cm). The use of the 68-cm length to distinguish between grilse and adults was a departure from the traditionally used 61-cm (24-in) length. This was determined from analysis of length data collected earlier in the season, as well as from lengths of returning age-II coded-wire-tagged salmon. The number of spring-run salmon at FRH in 1986 was 12% lower than that seen in 1985, but still more than 1½ times the average number estimated for 1976 through 1985 (Appendix 5).

In the river itself, the period of spring-run spawning could not be distinguished from the fall-run spawning period, and no attempt was made to estimate numbers of in-river spring-run salmon.

Fall run. Weekly carcass mark-and-recovery of fall-run salmon was conducted in the Feather River from 13 October to 9 December 1986. Surveys covered the river reach between the hatchery barrier dam and Evans-Reimer Road. This area consisted of two sections, characterized by different flow regimes. The stream section between the hatchery barrier dam and Thermalito Afterbay Outlet, a "low-flow section", had constant stream flows of 11.3 m^3/s (400 cfs) throughout the survey period. Flows downstream of Thermalito Afterbay Outlet to Evans-Reimer Road was 70.8 m^3/s (2,500 cfs) during the surveys. Visibility through the water was about 1.8 m (6 ft) in both sections.

Moe's Ditch, a 200-m- (0.12-mi-) long channel adjacent to FRH was also included in the low-flow section surveys. In past seasons, this ditch was narrow, and its fenced downstream entrance let live salmon in, while preventing carcasses from drifting out, thus allowing for a separate enumeration of spawners. However, after being damaged by high flows the previous winter, its reconstruction into a wider non-fenced channel made the same type of survey used in the past inappropriate.

The modified Schaefer equation was used to calculate the fall-run spawner population in each of the river sections using the mark-and recovery data (Table 3, Table 4). An estimated 20,340 salmon were in the upstream low-flow section, and 26,503 fish in the downstream section. A total of 8,628 fall-run salmon entered FRH (Schlicting 1988), bringing the fall-run spawner population in the Feather River to 55,471 fish. The 1986 population was essentially the same as that of 1985 (only a 1% decrease), and was still 21% greater than the 1976-1985 average run size (Appendix 5).

TABLE 3. Chinook salmon carcass mark−and−recovery data used to estimate the 1986 fall−run spawner 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. 13	Oct. 20	Oct. 27	Nov. 3	Nov. 11	Nov. 17	Nov. 24	Dec. 1			
Oct. 20	33	− −	− −	− −	− −	− −	− −	− −	33	1,019 c/	2,311
Oct. 27	7	60	− −	− −	− −	− −	− −	− −	67	1,097	2,534
Nov. 3	0	13	68	− −	− −	− −	− −	− −	81	1,642	4,330
Nov. 11	1		10	74	− −	− −	− −	− −	85	1,894	4,644
Nov. 17			5	15	76	− −	− −	− −	96	1,549	3,413
Nov. 24				6	21	69	− −	− −	96	926	2,227
Dec. 1					4	12	53	− −	69	573	1,271
Dec.8					1	3	14	17	35	354	848
Total recovered (Ri):	41	73	83	95	102	84	67	17		Total:	21,578
Total carcasses marked (Mi):	93	169	224	230	217	209	145	44			
									Adjusted estimate:		20,340 d/

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

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

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

d/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate, i.e. 21,578 − 1,238 = 20,340.

TABLE 4. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner population in the Feather River from the Thermalito Afterbay Outlet to Evans—Reimer Road.

| Recovery period (j) | Number of marked carcasses recovered from marking period (i): | | | | | | | Total marked carcasses recovered (Rj) | Total carcasses observed (Cj) a/ | Population estimate (N) b/ |
	Oct. 21	Oct. 28	Nov. 4	Nov. 12	Nov. 18	Nov. 25	Dec. 2			
Oct. 28	4	--	--	--	--	--	--	4	301 c/	1,324
Nov. 4	1	6	--	--	--	--	--	7	633	5,552
Nov. 12			18	--	--	--	--	18	1,046	5,914
Nov. 18			4	38	--	--	--	42	1,166	4,827
Nov. 25			4	12	45	--	--	61	1,102	4,418
Dec. 2				2	6	23	--	31	852	2,815
Dec. 9					3	18	13	34	558	2,484
Total recovered (Ri):	5	6	26	52	54	41	13		Total:	27,334
Total carcasses marked (Mi):	22	57	147	207	209	127	84			
									Adjusted estimate:	26,503 d/

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

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

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 carcasses marked (Mi) from the second marking period on were subtracted from the total estimate, i.e. 27,334 − 831 = 26,503.

The composition of salmon in the river, based on examination of 2,292 carcasses, was 33% male adults (FL ≥ 68 cm [26.8 in]), 8.9% male grilse (FL < 68 cm), 53.6% female adults, and 4.5% female grilse. In comparison, salmon entering the hatchery consisted of 30% male adults, 37% female adults, and 33% 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. A spawner estimate was not made for 1986, although seven salmon were counted passing Daguerre Point Dam during the spring-run immigration period.

Fall run. Nine weekly salmon carcass mark-and-recovery surveys were conducted from 14 October through 11 December 1986 in the Yuba River from the Parks Bar (HWY.20) Bridge downstream to the Marysville dump. Surveys were not possible from the HWY.20 Bridge upstream to Rose Bar due to lack of access. River flow upstream of Daguerre Point Dam was 17.0 m³/s (600 cfs) throughout the survey period. Flows downstream of Daguerre Point Dam were reduced to 8.5 - 11.3 m³/s (300-400 cfs) by diversions to Hallwood-Cordua Irrigation District. Visibility through the water was at least 3.1 m (10 ft) during most of the surveys.

Using carcass mark-and-recovery data, the modified Schaefer equation estimated 16,332 salmon as the spawner population between the Parks Bar Bridge and the Marysville dump (Table 5). The spawner population for the area upstream of Parks Bar Bridge to Rose Bar was calculated using the 1966-1971 average proportion of the total river's population constituted by spawners in this section. During those years, an average of 15.5% of the total population occurred upstream of the Parks Bar Bridge, and it was assumed that in 1986 this section's population was 2,996 salmon. The combined estimates for both sections gave a total 1986 Yuba River spawner population of 19,328 salmon. This was a increase of 48% over the 1985 population, and 43% greater than the average run size from 1976 to 1985 (Appendix 5).

The composition of 1,336 of the salmon carcasses examined was 37.5% male adults (FL ≥ 68 cm [26.8 in]), 9.2% male grilse (FL < 68 cm), 49.9% female adults, and 3.4% female grilse.

Bear River (Yuba County)

Fall run. Fall-run salmon are known to enter the Bear River, but no surveys were conducted in 1986.

TABLE 5. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner population in the Yuba River from the Parks Bar bridge (Hwy.20) 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. 14	Oct. 21	Oct. 29	Nov. 5	Nov. 13	Nov. 19	Nov. 25	Dec 3			
Oct. 21	6	— —	— —	— —	— —	— —	— —	— —	6	499 c/	2,645
Oct. 29	2	31	— —	— —	— —	— —	— —	— —	33	954	2,808
Nov 5	2	7	75	— —	— —	— —	— —	— —	84	1,415	3,279
Nov. 13		10	15	92	— —	— —	— —	— —	117	1,530	3,169
Nov. 19			3	16	100	— —	— —	— —	119	1,191	2,271
Nov.25				1	16	70	— —	— —	87	632	1,218
Dec.3				1	6	31	56	— —	94	641	1,311
Dec. 11					3	8	9	31	51	335	862
Total recovered (Ri):	10	48	93	110	125	109	65	31		Total:	17,563
Total carcasses marked (Mi):	53	134	204	217	236	211	138	91			

Adjusted estimate: 16,332 d/

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

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

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 carcasses marked (Mi) from the second marking period on were subtracted from the total estimate, i.e. 17,563 − 1,231 = 16,332.

<u>Auburn Ravine Creek</u> - by Frederick Meyer

<u>Fall run.</u> In 1986, this creek apparently received sufficient flows from canal releases upstream of Lincoln to attract fall-run salmon. In response to information of salmon spawning in the creek, from the Lincoln City Administrator Richard Ramirez, I inspected the stream with him on 3 November, and saw 12 salmon. The flow at the time was about 0.3 m^3/s (10 cfs), but the water level appeared to have recently receded. I surveyed the creek on 13 November from McBean Park Drive to 0.8 km (0.5 mi) downstream of HWY.65, counting 11 salmon carcasses, four live fish, and over 50 redds. There was also evidence of salmon fishing activity, which was later corroborated by CDFG Warden Don Stuckey. Based on these reports and observations, about 200 fall-run salmon were in this tributary.

<u>American River</u> - by Phillip V. Hansen

<u>Fall run</u>. Weekly salmon carcass mark-and-recovery surveys were made between 4 November and 22 December 1986 in the 14.5-km (9-mi) stretch of the American River from Gristmill Dam upstream to the Nimbus Hatchery racks. River flows in this section were 42.5 m^3/s (1500 cfs) for the entire survey period, and visibility through the water ranged from 2.4 - 3.0 m (8-10 ft). The spawner population in the Nimbus Basin (upstream of the Nimbus racks) was also surveyed, concurrently with the downstream section, through counts of carcasses found along the shore or washed up on the racks.

The salmon spawner population of the Gristmill Dam to Nimbus racks section, estimated using the Schaefer equation with mark-and-recovery data, was 46,908 fish (Table 6). A total of 2,464 carcasses was counted upstream of the Nimbus racks, and combined with the downstream estimate gave 49,372 spawners within the river. An additional 5,695 salmon entered Nimbus Hatchery (Ducey 1987), bringing the total American River 1986 fall-run spawner population to 55,067 fish. This was about 16% lower than the 1985 population, but still 24% greater than the average run size from 1976 through 1985 (Appendix 5).

The composition of 1,005 of the salmon carcasses examined was 45% male adults (FL $\geq$ 68 cm [26.8 in]), 8% male grilse (FL < 68 cm), 46% female adults, and 1.0% female grilse. In comparison, fall-run salmon entering the hatchery in 1986 consisted of 38% male adults (FL $\geq$ 60 cm [23.6 in]), 46% female adults, and 16% grilse (FL < 60 cm).

TABLE 6. Chinook salmon carcass mark−and−recovery data used to estimate the 1986 fall−run spawner population in the American River from the Nimbus Racks to the Grist Mill Dam access.

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. 4−5	Nov. 10−11	Nov. 17−18	Nov. 24−25	Dec. 1−2	Dec. 8−9	Dec. 12−18			
Nov. 10−11	26	−−	−−	−−	−−	−−	−−	26	2,658 c/	10,149
Nov. 17−18	5	29	−−	−−	−−	−−	−−	34	2,411	14,814
Nov. 24−25	2	3	40	−−	−−	−−	−−	45	2,214	9,381
Dec. 1−2		1	3	44	−−	−−	−−	48	1,400	4,585
Dec. 8−9			4	10	23	−−	−−	37	919	4,241
Dec. 12−18				1	3	25	−−	29	495	2,051
Dec. 22							6	6	261	2,567
Total recovered (Ri):	33	33	47	55	26	25	6		Total:	47,788
Total carcasses marked (Mi):	126	216	192	173	139	101	59			

Adjusted estimate: 46,908 d/

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

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

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

d/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where carcasses marked (Mi) from the second marking period on were subtracted from the total estimate, i.e. 47,788 − 880 = 46,908.

CHINOOK SALMON SPAWNER POPULATIONS
FOR THE SAN JOAQUIN RIVER SYSTEM

Salmon spawner populations were surveyed for the Mokelumne, Stanislaus, Tuolumne, and Merced rivers of the San Joaquin River system (Figure 4). A total of 28,502 chinook salmon, consisting entirely of fall-run fish, was estimated in 1986 (Appendix 4).

Cosumnes River to the Calaveras River

Cosumnes River

Fall run. Fall-run salmon are known to enter the Cosumnes River, but no surveys were conducted in 1986.

Mokelumne River - by Phillip V. Hansen

Fall run. In 1986, salmon carcass mark-and-recovery surveys were conducted between 7 November and 23 December from the Mokelumne River Hatchery downstream to Mackville Road. River flows ranged between 12.2 - 24.6 m^3/s (430-870 cfs), with visibility through the water ranging from 0.3 - 1.5 m (1-5 ft).

The spawner population estimate was calculated using the Petersen equation with mark-and-recovery data (Table 7). A total of 1,087 salmon carcasses was observed, of which 145 were marked, and only 30 subsequently recovered, resulting in an estimate of 5,254 fish. Combined with the 1,913 salmon which entered the Mokelumne River Hatchery (Estey 1987), the 1986 fall-run spawner population was 7,167 fish. This was a decrease of 7% from the 1985 population, but still was 36% over the average of populations estimated from 1976 through 1985 (Appendix 5).

The composition of 146 of the salmon carcasses examined was 29% male adults (FL $\geq$ 67 cm [26.4 in]), 58% female adults, 11% male grilse (FL < 67 cm), and 2% female grilse. In comparison, the salmon entering the hatchery consisted of 23% male adults, 36% female adults, and 41% grilse.

Calaveras River
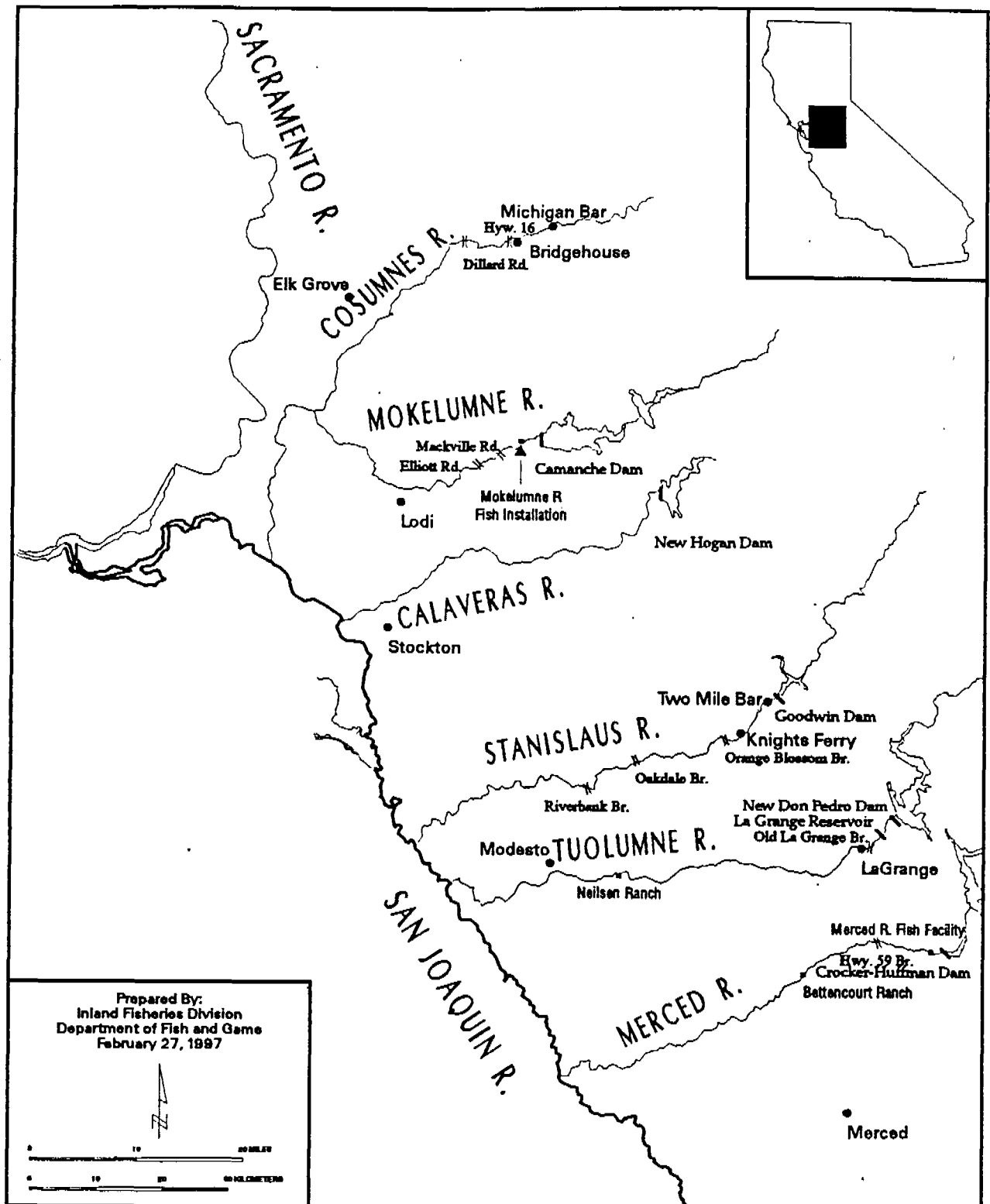
This tributary was not surveyed in 1986.

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

TABLE 7. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner population in the Mokelumne River from the Mokelumne River Hatchery to Mackville Road.

| Recovery period | Number of marked carcasses recovered from the marking period: | | | | | | Total marked carcasses recovered (R) | Total carcasses marked (M) | Total carcasses observed (C) a/ |
	Nov. 7	Nov. 12	Nov. 19	Nov. 28	Dec. 4	Dec. 11			
Nov. 19	1	0	— —	— —	— —	— —	1	24 b/	149 c/
Nov. 28			10	— —	— —	— —	10	37	219
Dec. 4			0	8	— —	— —	8	34	303
Dec. 11			0	1	4	— —	5	32	218
Dec. 19			3		1	0	4	18	129
Dec. 23						2	2	— —	69
Totals:							30	145	1,087

Petersen estimate: 5,254 d/

a/ Including carcasses which were marked and carcasses that were recovered.
b/ Includes carcasses marked on 7 and 12 November.
c/ Includes carcasses observed on 7 and 12 November.
d/ Petersen estimate equation, $N = (M \times C) / R$, (Ricker 1975).

Stanislaus River to the Merced River

Stanislaus River - by W. George Neillands

Fall run. The 1986 fall-run salmon spawner population was
estimated through carcass mark-and-recovery surveys in three
areas of the Stanislaus River. Surveys between 7 November and 11
December were made on-foot in both the Goodwin Dam and Two Mile
Bar areas. Surveys from 28 October through 8 December were
conducted by boat from Knights Ferry downstream to the Riverbank
bridge, a stretch of 30.9 km (19.2 mi). River flows in the
surveyed areas ranged from 10.8 to 18.4 m³/s (380-650 cfs), whil
water temperature ranged from 12.8°C (55°F) in late October to
9.4°C (49°F) in mid-December. Visibility through the water was
often greater than 3.0 m (10 ft) until late November when storm
runoff, foggy weather, and increased releases from Goodwin Dam
reduced water clarity.

The spawner population of each of the three areas was calculated
using the Petersen equation with the mark-and-recovery data.
During the surveys between Knights Ferry and Riverbank Bridge,
695 salmon carcasses were observed, of which 246 were marked, and
only 29 subsequently recovered, for an estimated 5,896 fish
(Table 8). For the surveys at Goodwin Dam, 100 salmon carcasses
were observed, of which 40 were marked, and 22 recovered, and at
Two Mile Bar, 200 carcasses were seen, 90 were marked, and 43
were recovered. Petersen estimates of 182 fish and 419 fish,
respectively, were calculated for these areas (Table 9, Table
10).

The total estimated Stanislaus River 1986 fall-run spawner
population of 6,497 salmon was only half of the 1985 population,
but still more than twice the average run size for the past ten
years (Appendix 5).

The 1986 run consisted of 26% male adults, 56% female adults, 13%
male grilse, and 5% female grilse, based on examination of 366
salmon carcasses.

Tuolumne River by Maurice Fjelstad

Fall run. The 1986 fall-run chinook salmon spawner surveys
in the Tuolumne River were conducted from 27 October through 5
December. Carcass mark-and-recovery was used in the river
stretch from Old LaGrange Bridge downstream to Neilsen Ranch near
Waterford, a distance of 27.3 km (17 mi). Redd counts during the
peak spawning period were also made in that entire stretch, and
from Old LaGrange Bridge upstream to LaGrange Dam (1.6 km [1
mi]), and from Neilsen Ranch downstream to Geer Avenue (12.9 km
[8 mi]).

TABLE 8. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner population in the Stanislaus River from Knights Ferry to the Riverbank Bridge.

Recovery period	Number of marked carcasses recovered from the marking period:					Total marked carcasses recovered (R)	Total carcasses marked (M)	Total carcasses observed (C) a/
	Oct. 28,30	Nov. 4,6	Nov. 13,14	Nov. 19,20	Nov. 25,26			
Oct. 28,30	--	--	--	--	--	--	16	--
Nov. 4,6	3	--	--	--	--	3	22	75 b/
Nov. 13,14	1	1	--	--	--	2	68	129
Nov. 19,20	1	1	5	--	--	7	67	175
Nov. 25,26			5	3	--	8	73	158
Dec. 5,8			1	5	3	9	0	158
Totals:						29	246	695

Petersen estimate   5,896 c/

a/ Includes carcasses which were marked and marked carcasses which were recovered.
b/ Includes salmon observed during the first period.
c/ Petersen estimate equation, $N = (M \times C)/R$, (Ricker 1975).

TABLE 9. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner population in the Stanislaus River at Goodwin Dam.

Recovery period	Number of marked carcasses recovered from the marking period:					Total marked carcasses recovered (R)	Total carcasses marked (M)	Total carcasses observed (C) a/
	Nov. 7	Nov. 12	Nov. 20	Nov. 24	Dec. 3			
Nov. 7	— —	— —	— —	— —	— —	— —	3	— —
Nov. 12	2	— —	— —	— —	— —	2	10	28 b/
Nov. 20	.	4	— —	— —	— —	4	15	29
Nov. 24			9	— —	— —	9	10	26
Dec. 3			0	3	— —	3	2	9
Dec. 11			2	1	1	4	0	8
						22	40	100

Petersen estimate: 182 c/

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

b/ Includes salmon observed during the first period.

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

TABLE 10. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner population in the Stanislaus River at Two Mile Bar.

Recovery period	Number of marked carcasses recovered from the marking period:					Total marked carcasses recovered (R)	Total carcasses marked (M)	Total carcasses observed (C) a/
	Nov. 7	Nov. 12	Nov. 20	Nov. 24	Dec. 3			
Nov. 7	— —	— —	— —	— —	— —	— —	15	— —
Nov. 12	6	— —	— —	— —	— —	6	24	38 b/
Nov. 20	1	11	— —	— —	— —	12	24	57
Nov. 24		1	12	— —	— —	13	21	65
Dec. 3				9	— —	9	6	29
Dec. 11				1	2	3	0	11
						43	90	200

Petersen estimate: 419 c/

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

b/ Includes salmon observed during the first period.

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

River flow during the survey period was about 6.5 m³/s (231 cfs), except for a 5-day period at the beginning of December when it increased to 14.9 m³/s (525 cfs). Visibility through the water was not less than 4.2 m (14 ft).

The spawner 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 6,294 salmon (Table 11). The population for the two sections up- and downstream of the mark-and-recovery area was determined from their redd proportions relative to the entire surveyed reaches. The number of redds in these areas constituted 15% of the total redds from LaGrange Dam to Geer Avenue Bridge. Assuming that the estimated 6,294 spawners in the mark-and-recovery area represented 85% of the run, then 1,110 salmon were in the other areas, and the total estimated 1986 fall-run spawner population for the Tuolumne River was 7,404 salmon. This was a decrease of 82% from the 1985 population, which was the largest run size seen in the previous ten years (Appendix 5).

For 456 of the salmon carcasses examined, 46.1% were male adults (FL ≥ 61 cm [24 in]), 47% were female adults, 5.6% were male grilse (FL < 61 cm), and 1.3% were female grilse.

Merced River - by Robert Reavis

Fall run. Fall-run salmon spawner surveys in the Merced River during 1986 started on 30 October and ended on 5 December. River flows during the survey period were about 5.1 - 5.7 m³/s (180-200 cfs), with visibility through the water generally greater than 2 m (6.6 ft); this made for good surveying conditions.

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. One survey to only count redds was made from HWY.59 downstream to Bettencourt Ranch, a distance of 12 km (7.5 mi).

The spawner population in the river section from the Dam to HWY.59, calculated using the Schaefer equation with mark-and-recovery data, was an estimated 2,987 salmon (Table 12).

The spawner population downstream of HWY.59 was based on the proportion (56%) of redds occurring in that section of the river in relation to the upstream section. Assuming that the estimated 2,987 estimated spawners in the upstream section represented 44% of the run, then 3,802 salmon were downstream of HWY.59, and the estimated in-river population was 6,789 salmon.

An additional 650 salmon were observed during Merced River Fish Facility operations (Cozart 1991), for a total 1986 fall-run

TABLE 11. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner population in the Tuolumne River from Old LaGrange Bridge to Neilsen 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/
	Oct. 27-29	Nov. 3-7	Nov. 12-14	Nov. 17-21	Nov. 24-26			
Nov. 3-7	9	— —	— —	— —	— —	9	304 c/	695
Nov. 12-14	1	20	— —	— —	— —	21	424	1,018
Nov. 17-21	3	8	22	— —	— —	33	582	1,278
Nov. 24-26	1	4	18	40	— —	63	795	1,858
Dec. 1-5			7	6	33	46	520	1,869
Total recovered (Ri):	14	32	47	46	33		Total:	6,718
Total carcasses marked (Mi):	32	77	99	112	136			

Adjusted estimate: 6,294 d/

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

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

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

d/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate, i.e. $6,718 - 424 = 6,294$.

TABLE 12. Chinook salmon carcass mark—and—recovery data used to estimate the 1986 fall—run spawner 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): | | | | | Total marked carcasses recovered (Rj) | Total carcasses observed (Cj) a/ | Population estimate (N) b/ |
	Oct. 30	Nov. 5	Nov. 13—14	Nov. 20—21	Nov. 25			
Nov. 5	5	— —	— —	— —	— —	5	103 c/	322
Nov. 13—14	3	6	— —	— —	— —	9	184	669
Nov. 20—21		2	25	— —	— —	27	209	484
Nov. 25		1	3	8	— —	12	224	850
Dec. 2—5			4	5	13	22	233	876
Total recovered (Ri):	8	9	32	13	13		Total:	3,201
Total carcasses marked (Mi):	25	35	70	57	52			

Adjusted estimate: 2,987 d/

a/ Includes carasses which were marked and marked carcasses that were 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 period population estimate.

d/ Adjusted estimate reflects the modified Schaefer equation (Hoopaugh 1978), where marked carcasses (Mi) from the second marking period on were subtracted from the total estimate, i.e. 3,201 − 214 = 2,987.

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spawner population of 7,439 salmon. This was only 46% of the
1985 population, and 13% below the average for the past ten years
(Appendix 5).

Of the 291 carcasses examined during the surveys, 44.7% were male
adults (FL ≥ 61 cm [24 in]), 48.4% were female adults, 4.5% were
male grilse (FL < 61 cm), and 2.4% were female grilse. In
comparison, salmon which entered the hatchery consisted of 41.7%
male adults, 33.4% female adults, 20.8% male grilse, and 4.1%
female grilse.

SUMMARY

The estimated 1986 Central Valley chinook salmon spawner
escapement was 328,893 fish (Table 13). This was lower than the
1985 total of 386,753 salmon. The 1986 decrease in the total
Central Valley spawner population reflected overall lower late-
fall, winter, and fall runs. The San Joaquin River system fall
run, especially in the Stanislaus, Tuolumne, and Merced rivers,
showed the largest decline from 1985 levels. The winter run
continued to remain at a critically low level.

TABLE 13. Sacramento-San Joaquin river system chinook salmon
spawner populations.

Spawning area	Late-fall run	Winter run	Spring run	Fall run	Total
Sacramento mainstem	7,811a/	2,394a/	21,886	102,312	134,403
Sacramento tributaries	197b/	--	3,638c/	162,148d/	165,983
San Joaquin tributaries	--	--	--	28,502	28,502
Totals:	**8,008**	**2,394**	**25,524**	**292,967**	**328,893**

a/ Includes only the mainstem from Keswick Dam to Red Bluff Diversion Dam.
b/ Consists only of fish which entered Coleman Hatchery (Battle Creek).
c/ Includes only Mill, Deer, Butte creeks, and the Feather River.
d/ Includes only Battle, Mill, Deer, Auburn Ravine creeks, and the
   Feather, Yuba, and American rivers.

REFERENCES

Cozart, Michael D. 1991. Annual report, Merced River Fish
    Facility, 1986-87. Calif. Dept of Fish and Game, Inland
    Fish. Admin. Rep. No. 91-11. 10 p.

Ducey, Ronald D. 1987. Annual report, Nimbus Salmon and
    Steelhead Hatchery, 1986-87. Calif. Dept of Fish and Game,
    Inland Fish. Admin. Rep. No. 87-20. 10 p.

Estey, Don F. 1987. Annual report, Mokelumne River Hatchery,
    1986-87. Calif. Dept of Fish and Game, Inland Fish. Admin.
    Rep. No. 87-21. 9 p.

Hoopaugh, David A. 1978. King (Chinook) salmon spawning stocks
    in California's Central Valley, 1976. Calif. Dept. of Fish
    and Game, Anad. Fish. Br. Admin. Rep. No. 78-19.

Kano, R.M. and R. Reavis (eds.). 1996. Annual report, Chinook
    salmon spawning stocks in California's Central Valley, 1985.
    Calif. Dept. of Fish and Game, Inland Fish. Br. Admin. Rep.
    96-4. 39 p.

Ricker, W.E. 1975. Computation and Interpretation of
    Biological Statistics of Fish Populations. Res. Bd. Canada,
    Bull. 191. 382 p.

Schaefer, M.D. 1951. Estimation of size of animal populations
    by marking experiments. U. S. Fish and Wildl. Serv., Fish.
    Bull. 52: 189-203.

Schlicting, Donald L. 1988. Annual report, Feather River
    Hatchery, 1986-87. Calif. Dept of Fish and Game, Inland
    Fish. Admin. Rep. No. 88-10. 12 p.

Vogel, D.A. 1987a. Estimation of the 1986 spring chinook salmon
    run in Deer Creek, California. U.S. Fish and Wildlife
    Service, Fisheries Assistance Office,
    Report No. FR1/FAO-87-3. 10p.

Vogel, D.A. 1987b. Estimation of the 1986 spring chinook salmon
    run in Mill Creek, California. U.S. Fish and Wildlife
    Service, Fisheries Assistance Office,
    Report No. FR1/FAO-87-12. 9p.

APPENDIX 3. 1986 chinook salmon spawner population estimates for the Sacramento River system.

River area Tributary	Estimated number of fish				
	Late-fall run	Winter run	Spring run	Fall run	Total
Keswick Dam to Red Bluff					
Sacramento River mainstem a/	7,811 b/	2,394	15,824	67,940 c/	93,969
Clear Creek	d/	--	d/	e/	--
Cottonwood Creek	d/	--	d/	e/	--
Paynes Creek	--	--	--	e/	--
Battle Creek					
Coleman National Fish Hatchery	197	--	--	12,481	12,678
Upstream of hatchery	d/	d/	d/	7,263	7,263
Downstream of hatchery	d/	d/	d/	11,508	11,508
(Totals for tributary):	(197)	(--)	(--)	(31,252)	(31,449)
Totals for area:	8,008	2,394	15,824	99,192	125,418
Red Bluff to Princeton Ferry					
Sacramento River mainstem					
Red Bluff to Tehama Bridge	e/	e/	5,856	25,264	31,120
Tehama Bridge to Woodson Bridge	e/	e/	206	4,778	4,984
Woodson Br. to Princeton Ferry	e/	e/	0	4,330	4,330
Tehama−Colusa Spawning Channel	0 f/	--	0 f/	0 f/	0
(Totals for tributary):	(--)	(--)	(6,062)	(34,372)	(40,434)
Salt Creek	--	--	--	--	--
Antelope Creek	--	--	d/	e/	--
Craig Creek	d/	--	--	e/	--
Dye Creek	--	--	--	--	--
Mill Creek	d/	--	291	574	865
Toomes Creek	--	--	--	d/	--
Deer Creek	d/	--	543	256	799
Singer Creek	--	--	--	e/	--
Totals for area:	--	--	6,896	35,202	42,098
Big Chico Creek to the American River					
Big Chico Creek	--	--	--	d/	--
Butte Creek	--	--	1,371	d/	1,371
Feather River					
Feather River Hatchery	--	--	1,433	8,628	10,061
Downstream of hatchery	--	--	d/	46,843	46,843
(Totals for tributary):	(--)	(--)	(1,433)	(55,471)	(56,904)
Yuba River	--	--	d/	19,328	19,328
Bear River	--	--	--	d/	--
Auburn Ravine Creek	--	--	--	200	200
American River					
American River Hatchery	--	--	--	5,695	5,695
Upstream of hatchery	--	--	--	2,464	2,464
Downstream of hatchery	--	--	--	46,908	46,908
(Totals for tributary):	(--)	(--)	(--)	(55,067)	(55,067)
Totals for area:	0	0	2,804	130,066	132,870
Sacramento River system totals:	8,008	2,394	25,524	264,460	300,386

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

b/ Includes 591 fish trapped at Keswick Dam that were transported to and spawned at Coleman Hatchery.

c/ Includes 228 fish trapped at Keswick Dam that were transported to and spawned at Coleman Hatchery.

d/ Tributary was not surveyed.

e/ No estimate of the population was made.

f/ The Tehama−Colusa Spawnimg Channel was not operated.

APPENDIX 4. 1986 chinook salmon spawner population estimates for the San Joaquin River system.

| | Estimated number of fish | | | | |
| | Late—fall run | Winter run | Spring run | Fall run | Total |
Tributary					
Cosumnes River	— —	— —	— —	a/	— —
Mokelumne River					
Mokelumne River Hatchery	— —	— —	— —	1,913	1,913
Downstream of hatchery	— —	— —	— —	5,254	5,254
(Totals for tributary):	— —	— —	— —	(7,167)	(7,167)
Calaveras River	— —	a/	— —	— —	— —
Stanislaus River	— —	— —	— —	6,497	6,497
Tuolumne River	— —	— —	— —	7,404	7,404
Merced River					
Merced River Fish Facility	— —	— —	— —	650	650
Downstream of facility	— —	— —	— —	6,789	6,789
(Totals for tributary):	— —	— —	— —	(7,439)	(7,439)
San Joaquin River system totals:	— —	— —	— —	28,507	28,507

a/ Tributary not surveyed.

APPENDIX 5. Summary of Sacramento—San Joaquin river system chinook salmon spawner population estimates from 1976 through 1986.

Tributary Race	Estimated population size											1976—1985 average
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	
Sacramento River system upstream of Red Bluff (excluding Battle Creek)												
Late—fall run	15,908	9,210	12,479	10,284	9,361	6,423	4,899	14,984	7,140	8,136	7,811	9,882
Winter run	33,029	16,470	24,735	2,339	1,142	19,795	1,233	1,827	2,662	3,684	2,394	10,692
Spring run	25,095	13,453	5,669	2,856	9,363	20,655	23,156	3,854	7,823	10,200	15,824	12,212
Fall run	51,986	39,579 a/	35,500	47,758	21,961	33,289	20,567	27,326	41,805	52,820	67,940	37,001 b/
Battle Creek												
Fall run	5,444	c/	3,652	13,159	14,443	17,205	26,795	13,983	29,893	39,808	31,252	16,438
Sacramento River mainstem downstream of Red Bluff												
Fall run	37,530	45,743	47,973	67,388	30,453	42,724	23,833	32,018	19,166	46,780	34,372	39,361
Feather River												
Spring run d/	699	185	202	250	269	469	1,910	1,702	1,562	1,632	1,433	888
Fall run	62,000	46,452	37,759	32,505	35,295	53,020	55,519	30,522	51,056	56,002	55,471	46,013
Yuba River												
Fall run	3,779	8,722	7,416	12,430	12,406	14,025	39,367	13,756	9,665	13,042	19,328	13,461
American River												
Fall run	28,374	48,473	21,091	47,666	49,802	64,055	43,898	35,300	39,696	65,213	55,067	44,357
Cosumnes River												
Fall run	0	c/	100	150	200	c/	c/	200	1,000	220	c/	187
Mokelumne River												
Fall run	473	250	1,086	1,507	3,231	4,954	9,372	15,861	8,298	7,682	7,167	5,271
Stanislaus River												
Fall run	600	0	50	110	100	1,000	c/	500	11,439	13,473	6,497	2,727
Tuolumne River												
Fall run	1,700	450	1,300	1,183	559	14,253	7,126	14,836	13,689	40,322	7,404	9,542
Merced River												
Fall run	1,900	350	625	2,147	3,006	10,415	3,263	18,248	29,749	16,052	7,439	8,576

a/ Includes salmon which spawned in Battle Creek.

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

c/ No estimate made.

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