State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

ANNUAL REPORT
CHINOOK SALMON SPAWNING STOCKS IN CALIFORNIA CENTRAL VALLEY, 1981

by

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Administrative Report No. 83-2

1983

CHINOOK SALMON SPAWNING STOCKS IN CALIFORNIA'S CENTRAL VALLEY, 1981[1/]

by

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ABSTRACT

This report covers the 29th annual inventory of chinook salmon, Oncorhynchus tshawytscha, spawning populations in the Sacramento-San Joaquin River system. It is a compilation of estimates of fall- and spring-run chinook salmon spawning populations for every stream in the Sacramento-San Joaquin system which supports a significant spawning run, and partial counts of late-fall- and winter-run chinook salmon.

Estimates are made from counts of fish entering hatcheries and spawning channels, fish migrating past dams, carcasses and live fish on spawning areas, and aerial redd counts.

The estimated 1981 total escapement of chinook salmon in the Central Valley was 309,416. This total includes 260,798 fall-, 22,105 spring-, 19,795 winter- and 6,718 late-fall-run spawners. Of the total, 278,794 spawned in the Sacramento River system and 30,622 in the San Joaquin River system. All of the spring-, winter- and late-fall salmon, as well as 230,176 of the fall-run salmon spawned in the Sacramento River system. All salmon that spawned in the San Joaquin were fall-run fish (Table 8).

The estimated 1981 escapement of fall spawning (fall- plus spring-run) chinook salmon in the Central Valley was 282,903; this figure slightly exceeds the historic average (1953-1980) of 279,600 and greatly exceeds the 1980 estimate of 184,605.

The total 1981 run for all races in the Central Valley was the largest since 1973. The fall run in the San Joaquin River system was by far the largest since 1971 and may have been the result of high flows during March and April 1979, which permitted good survival of downstream-migrant-juvenile salmon.

[1/] Anadromous Fisheries Branch Administrative Report No. 83-2
Submitted February 1983.

Salmon counts of all four races at Red Bluff Diversion Dam and their sport catches above the dam are shown in Appendix Tables 1 and 2, respectively. Spawning populations for all Central Valley streams are summarized in Appendix Tables 3-5. Fin mark and coded-wire-tag recoveries are presented in Appendix Tables 6 and 7.

INTRODUCTION

This report covers the 29th annual chinook salmon spawning stock inventory for the California Central Valley (Figure 1). The Sacramento-San Joaquin River system, which flows through the valley, is the principal producer of chinook salmon caught in California's ocean fisheries and also contributes significantly to the ocean fisheries of Oregon and Washington. Spring and fall runs have been monitored since 1953, and late-fall and winter runs have been monitored since 1971. The four runs are described as follows:

1) Late-fall run. These fish are mainly confined to the upper Sacramento River, which they enter from early November through February and spawn from January through early April. They are usually larger than the fall- and winter-run fish spawning in the same area.

2) Winter run. Most are confined to the upper Sacramento River, which they enter from early January through mid-June and then spawn from April to early August.

3) Spring run. Once widespread in the Central Valley, these fish have disappeared from many of the streams as a result of dam construction. Spring run enter the Sacramento River from March to July and spawn from late August to early October.

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

Monitoring of salmon spawning escapement in the Central Valley is an important component of the Department of Fish and Game's fishery management effort. The primary objectives of this work are to determine size and sex composition of spawning populations and to recover tagged or marked salmon to determine their contribution to river spawning escapement. Other objectives are to observe any changes in spawning distribution and habitat conditions that may adversely affect salmon and determine if corrective action is necessary.

GENERAL METHODS

During 1981, spawning stock data were collected on all Central Valley streams known to support sizeable chinook salmon runs by observing potential spawners passing through fishways, conducting stream surveys where numbers of live fish, carcasses, and redds were enumerated, and making aerial redd counts. In some

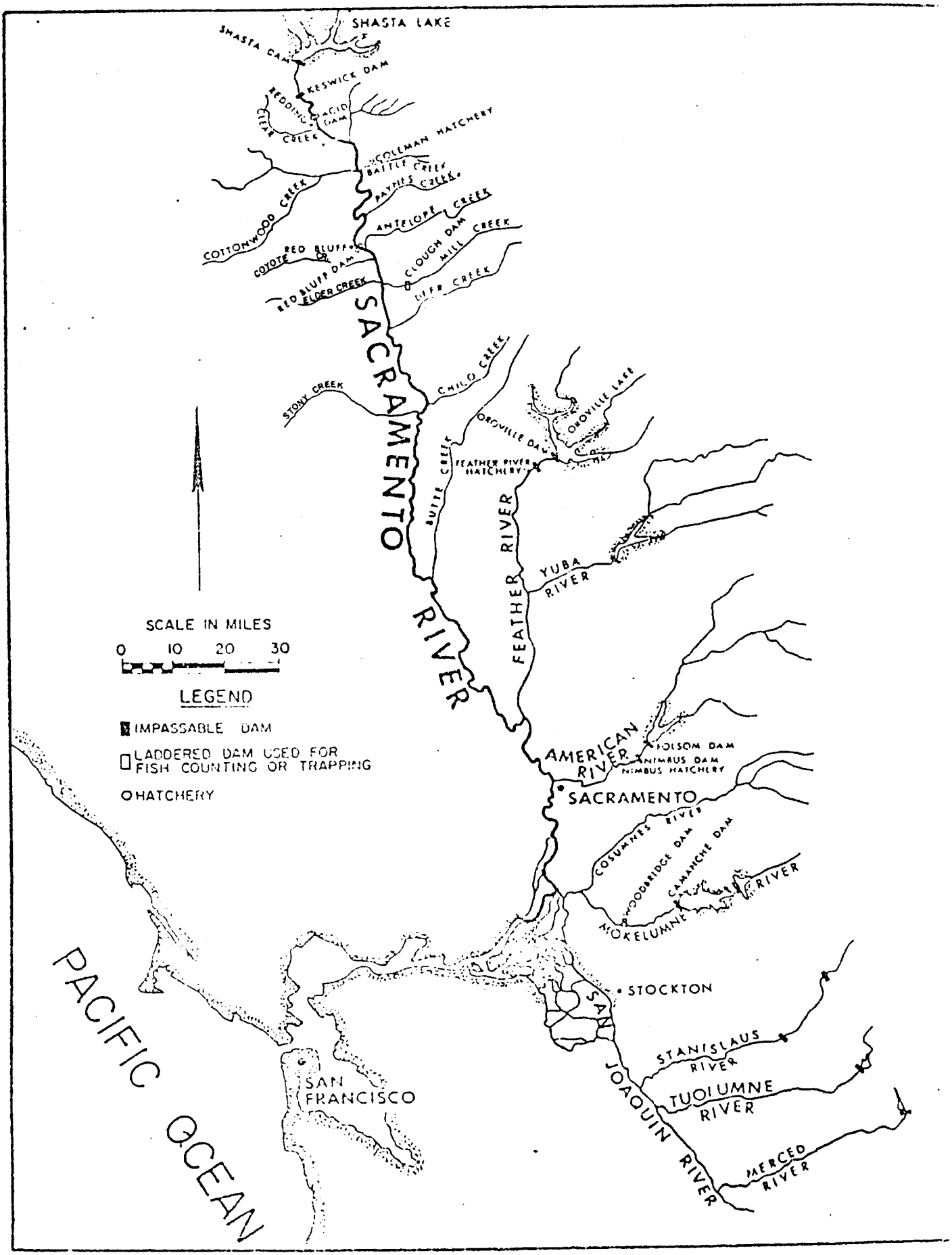

FIGURE 1. Salmon streams in the California Central Valley

streams, carcasses were tagged and released, and subsequent recovery rates of tagged carcasses were used in estimating spawning populations. Unless otherwise stated, all counted carcasses were cut in half or tagged to prevent recounting on subsequent trips. Specific methods and results are presented under the individual stream headings.

CHINOOK SALMON SPAWNING POPULATIONS FOR THE SACRAMENTO RIVER SYSTEM

Keswick Dam to Red Bluff Diversion Dam

by

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Estimates were made of all four spawning populations in the upper Sacramento River main stem using fish counts at Red Bluff Diversion Dam (Figure 2). In addition, fall run population estimates were made for Battle, Clear,and Cottonwood creeks using carcass counts and returns to Coleman Hatchery. Aerial redd counts were conducted to determine spawning distribution in the Sacramento River main stem.

A total of 100,613 salmon spawned in the Sacramento River system between Keswick Dam and Red Bluff in 1981 including 53,445 fall-, 6,718 late-fall-, 19,795 winter- and 20,655 spring-run fish (Table 1). All spring- and winter-run fish spawned in the main stem. The late-fall run included 6,423 that spawned in the main stem and 295 that spawned artificially at Coleman Hatchery. The fall run consisted of 26,261 that spawned in the main stem and 27,184 that spawned in tributaries (Table 1 and Appendix Table 3).

Sacramento River Main Stem

Estimates of the total numbers of salmon utilizing the Sacramento River and its tributaries upstream from Red Bluff Diversion Dam during 1981 were based on daily counts made by the U.S. Fish and Wildlife Service and the Department of Fish and Game at Red Bluff Diversion Dam. The counts were obtained by closed circuit television observations of salmon passing through the fishways (Appendix Table 1).

Weekly counts were adjusted for periods when the fishways remained open but no counts were made: during periods when the river was turbid, when flood conditions made it necessary to open the gates of the dam, and during night hours when no counts were made. Count adjustments for the daytime lapses were made by interpolation. Adjustment for the nighttime hours consisted of multiplying the 14-h day counts by a "night factor" developed from weekly night counts.

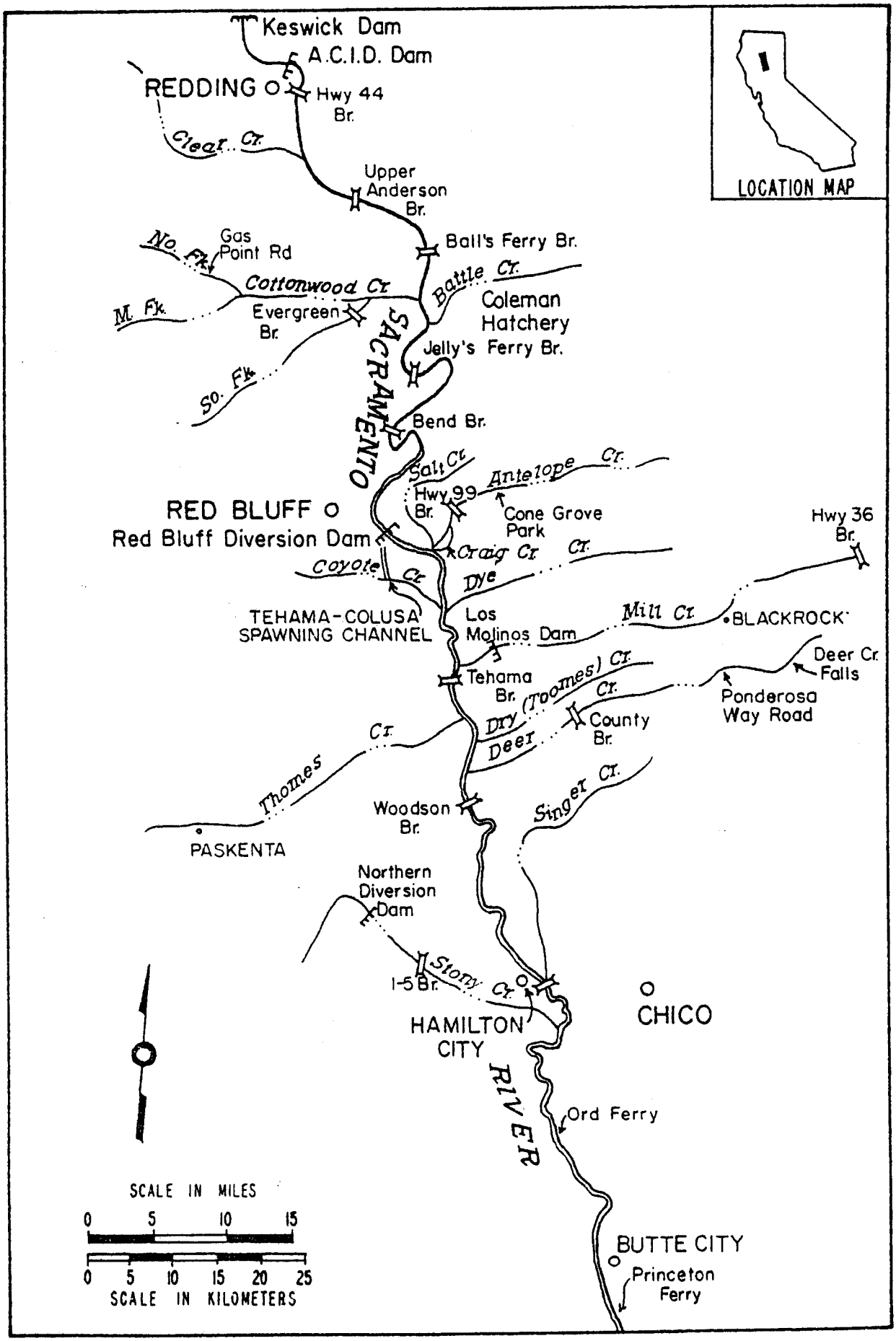

FIGURE 2. Upper Sacramento River above Princeton Ferry.

The adjusted weekly totals were separated into numbers of late-fall-, winter-, spring-, and fall-run salmon by examining fish entering the trapping facility adjacent to the east bank fishway and estimating, by their degree of ripeness, when they would spawn. To convert the adjusted numbers of salmon in each of the four runs passing the dam into the numbers that actually spawned, the estimated number of salmon landed by sportsmen in the Sacramento River between Keswick Dam and Red Bluff was subtracted from each corresponding run (Appendix Table 2). No attempt was made to measure any other forms of mortality in the upper river prior to spawning.

The estimated salmon sport catch at resorts was obtained by visiting all fishing resorts once every other week to obtain the number of salmon landed during the previous 2 weeks. To estimate the total catch, the resort catch was multiplied by 1.5944, a factor derived from sampling resorts and public boat launching ramps in the area during the 8-year period from 1967-74. Practically all salmon caught in this section of the river are landed at either the resorts or public boat launching ramps. To break down the total catch into the numbers landed from each of the four runs, it was assumed that salmon from the various runs are caught in proportion to their abundance, as indicated by counts at Red Bluff Diversion Dam (Table 1 and Appendix Table 2).

While a calendar year count includes total annual runs passing the dam for spring- and fall-run salmon, it represents only part of the total annual run of late-fall salmon and often only part of the winter-run fish, since both of these runs usually begin passing Red Bluff in one calendar year and finish in the next. Generally, a calendar year count of the late-fall run will include approximately the latter half of one run during the first part of the year, and the first half of the next late-fall run at the end of the year.

The same calendar year will usually include most of a winter run early in the year, and the first small portion of the subsequent winter run at the end of the year. Accordingly, about 37% of the 1980-81 late-fall-run salmon (all destined to spawn in 1981) passed Red Bluff in 1980. Less than 1% of the 1980-81 winter run occurred during 1980. To arrive at the total numbers of 1981 spawners in these two runs, it is necessary to add the appropriate portion of the 1980 calendar year count that would spawn in 1981 and delete that portion of the 1981 calendar year count which will spawn in 1982.

To obtain the Sacramento River main stem spawning population above Red Bluff, estimates for Battle, Clear, and Cottonwood creeks were subtracted from runs passing Red Bluff Diversion Dam. Salmon that spawned in all unsurveyed tributaries are included in the main stem estimate.

Late-fall run. An estimated 6,807 late-fall-run salmon migrated over Red Bluff Diversion Dam. Of the total, 89 were caught by anglers, leaving 6,718 to spawn (Table 1). Of these, 148 were trapped at Keswick Dam in the winter of 1980-81 and hauled to Coleman Hatchery to be spawned (Figure 2) Another 147 entered Coleman Hatchery via Battle Creek, thus leaving 6,423 to spawn naturally. Although some late-fall-run salmon spawned in tributaries to the Sacramento River other than Battle Creek, no spawning stock surveys were made in these streams at the time they spawned and all late-fall salmon (except the 295 that were utilized at Coleman Hatchery) are considered in this report to have spawned in the main stem Sacramento River. The 6,718 spawners is 38% of the 1971-80 average of 17,646 (excluding 1974 when flooding resulted in inaccurate counts).

TABLE 1. Calculation of Chinook Salmon Runs and Spawning Populations, Sacramento River System Above Red Bluff Diversion Dam, 1981

Run	Fish passing dam in calendar year 1980		1981		Potential 1981 spawners (Runs)		Estimated 1980-81 sport catch above dam		Estimated 1981 spawning populations
Late fall 1980-81	2,528	+	4,279	=	6,807	-	89	=	6,718
Winter 1980-81	30	+	20,011	=	20,041	-	246	=	19,795
Spring 1981	0	+	21,025	=	21,025	-	370	=	20,655
Fall 1981	0	+	53,744	=	53,744	-	299	=	53,445
Late fall 1981-82	0	+	4,113	=	*/		+/		
Winter 1981-82	0	+	29	=	*/		+/		
Totals	2,558		99,059		101,617		1,004		100,613

*/ Fish in this run spawn in 1982, not 1981.
+/ This run started passing the dam late in 1981, but was not completed in 1981. Additional salmon will be added to both the run and sport catch in early 1982.

Winter run. An estimated 20,041 winter-run salmon passed over Red Bluff Diversion Dam. Of these, an estimated 246 were caught by anglers, leaving 19,795 to spawn naturally (Table 1). This total is 84% of the 1971-80 average (excluding 1974) of 23,691.

Spring run. An estimated 21,025 spring run passed over Red Bluff Diversion Dam. Of these, about 370 were estimated to have been caught by anglers, leaving 20,655 to spawn naturally (Table 1). This greatly exceeds the 1971-80 average of 9,000. Although some spring run spawn in tributaries to the Sacramento River, especially Battle and Cottonwood creeks, no spawning stock surveys were made in these streams at the time they spawned. Therefore, all spring-run salmon above Red Bluff are considered in this report to have spawned in the main stem.

Fall run. An estimated 53,744 fall-run salmon passed over Red Bluff Diversion Dam. An estimated 299 were caught by anglers leaving 53,445 to spawn. Of these, 17,205 entered Battle Creek, 2,951 were hauled from Keswick Dam to Coleman Hatchery, and 7,028 spawned in Clear and Cottonwood creeks. This left a total of 26,261 to spawn naturally in the main stem (Table 1). Fish spawning in tributaries other than Battle, Clear, and Cottonwood creeks are considered to have spawned in the main stem. The total of 53,445 fall-run spawners above Red Bluff Diversion Dam approximates the previous 10-yr average of 51,183.

Spawning Distribution

Data collected during two airplane flights (19 October and 6 November 1981) over the main stem of the Sacramento River indicated the general salmon redd distribution of fall spawning salmon and the relative number of salmon that spawned on the riffles above Princeton Ferry (Table 2). Redd counts showed 62.4% of the main stem fall spawning activity occurred upstream from Red Bluff Diversion Dam; this approximates the 1974-80 average of 60% (1974 was the first year aerial surveys were made). The most heavily used area was between Balls Ferry and Jellys Ferry (Figure 2 and Table 2).

Battle Creek

Late-fall, winter, and spring runs. Small numbers of all three runs are known to spawn in Battle Creek, but no surveys or population estimates were made during 1981. There were 147 late-fall-run salmon that entered Coleman Hatchery from Battle Creek in January and February 1981 and 148 were hauled from Keswick Dam to Coleman Hatchery.

Fall run. An estimated 17,205 fall-run salmon spawned in Battle Creek during 1981. This greatly exceeds the previous 10-yr average of 7,081 (excluding the 1977 drought year when fish were hauled from Red Bluff Diversion Dam). The estimate includes 10,272 salmon spawned artificially at Coleman Hatchery and 6,933 that spawned in Battle Creek between Coleman Hatchery and the Sacramento River. An additional 2,951 fall-run salmon were hauled from Keswick Dam and spawned at Coleman Hatchery.

TABLE 2. Estimated Redd Distribution of Fall Spawning Chinook Salmon, Main Stem of Sacramento River Keswick Dam to Princeton Ferry, Based on Aerial Redd Counts, 1981.

Area	Redds counted			Average redds	
	Oct. 19	Nov. 6	Total	Number	Percent
Keswick Dam to A.C.I.D. Dam	0	72	72	36	1.7
A.C.I.D. Dam to Highway 44	45	73	118	59	2.8
Highway 44 to Upper Anderson Bridge	140	348	488	244	11.7
Upper Anderson Bridge to Balls Ferry	206	403	609	305	14.6
Balls Ferry to Jellys Ferry	257	512	769	385	18.4
Jellys Ferry to Bend Bridge	170	239	409	205	9.8
Bend Bridge to Red Bluff Diversion Dam	57	85	142	71	3.4
Red Bluff Diversion to Tehama	450	418	868	434	20.8
Tehama to Woodson Bridge	163	155	318	159	7.6
Woodson Bridge to Hamilton City	135	176	311	156	7.5
Hamilton City to Ord Ferry	22	41	63	32	1.5
Ord Ferry to Princeton Ferry	0	8	8	4	0.2
Totals	1,645	2,530	4,175	2,090	100.0

Carcass recovery data were used to estimate the numbers of salmon that spawned in Battle Creek below Coleman Hatchery. Ten trips were made on lower Battle Creek from 7 October 1981 through 7 January 1982. Carcass recovery conditions were good during the early part of the recovery period, but poor in late November and early December. A total of 1,040 carcasses was recovered and the estimated 6,933 total spawners was based on an estimated recovery rate of 15%.

Clear Creek

Fall run. Ten survey trips were made on Clear Creek by Department of Fish and Game personnel under contract with the Department of Water Resources. A salmon carcass-mark and recovery procedure (Schaefer method for stratified populations) was used to estimate the spawning population. A total of 647 carcasses was recovered, at an overall estimated recovery rate of 18%. The spawning population was estimated to be 3,672.

Cottonwood Creek

Fall run. Three survey trips were made on Cottonwood Creek by U.S. Fish and Wildlife Service personnel. The area covered was the main stem of Cottonwood Creek, from its confluence with the Sacramento River to the mouth of the North Fork, the North Fork from its mouth to Gas Point Road, the Middle Fork for five miles above its junction with the North Fork, and the South Fork from its mouth to Evergreen Bridge. A carcass-mark and recapture procedure (Schaefer method for stratified populations) was used. A total of 410 carcasses was recovered at an estimated recovery efficiency of 12.2%. The spawning population was estimated to be 3,356.

Red Bluff Diversion Dam to Princeton Ferry

by

Richard J. Hallock
Anadromous Fisheries Branch

Spawning populations in the Sacramento River main stem were estimated by carcass count surveys and aerial counts. Carcass counts were conducted and spawning escapement was estimated on the following six tributary streams: Antelope, Craig, Mill, Thomes, Deer, and Stony creeks (Figure 2). No estimates were made on Salt, Singer, or Toomes creeks.

A total of 45,631 salmon spawned in the Sacramento River system between Red Bluff and Princeton Ferry (Chico Creek) in 1981, including 40,340 in the main stem, 2,384 that entered the Tehama-Colusa Fish Facility via Coyote Creek, and 2,907 that spawned in tributaries; all were fall-run fish. No estimates were made of any spring-, late-fall-, or winter-run salmon that might have spawned in this area.

River flows in the upper Sacramento River at Red Bluff were quite low in September and October 1981, averaging about 147 m^3/s (5,200 cfs) and

82.1 m^3/s (2,900 cfs), respectively. In November, it was not until mid month that flows reached over 113m^3/s (4,000 cfs). However, from mid-November through December, flows greater than 142m^3/s (5,000 cfs) occurred eight times.

Precipitation and runoff in the upper Sacramento Valley were low during the early part of the 1981 fall spawning season. Low flows existed in most tributaries to the upper Sacramento River until mid-November. However, from mid-November through December there was considerable fluctuation in stream flows, with extended periods of high water which made surveys of spawning stocks difficult.

Sacramento River Main Stem

Late-fall, winter, and spring runs. While it is likely some fish from each of these runs spawned in the main stem, no spawning population estimates were made. Any spring-run spawners are included in the fall-run total.

Fall run. An estimated 25,824 fall-run salmon spawned in the main stem of the Sacramento River between Red Bluff Diversion Dam and Tehama during 1981 (Figure 2 and Table 2). This total included 23,440 that spawned in the river and 2,384 salmon that entered the Tehama-Colusa Spawning Channel via Coyote Creek (Figure 2). Spawning stock surveys in the main stem of the Sacramento River between Red Bluff and Tehama began on 8 October and ended 11 December 1981. During this period, seven complete trips were made and 586 salmon were recovered. Based on river conditions, carcass counts and total survey effort (including two airplane flights) the carcass recovery rate was estimated to be 2.5%.

An estimated 8,867 fall-run salmon spawned in the main stem of the Sacramento River between Tehama and Woodson Bridge (Figure 2). Between 7 October and 11 November 1981, six surveys were completed and 133 salmon carcasses were recovered. Based on survey effort (including two airplane flights, river conditions, and carcass counts) the carcass recovery rate was estimated to be 1.5%.

While spawning between Woodson Bridge and Princeton Ferry (Figure 2) in the past has often been insignificant, based on two air surveys in 1981, the spawning population was estimated to be 8,033 (Woodson Bridge to Hamilton City--6,550, Hamilton City to Ord Ferry--1,317, and Ord Ferry to Princeton Ferry--166).

A grand total of 42,724 chinook salmon spawned in the Sacramento River main stem from Red Bluff to Princeton Ferry (Figure 2), which exceeds the 1970-79 average of 34,923.

Spawning Distribution

Data collected during two airplane flights (19 October and 6 November 1981)

over the main stem of the Sacramento River showed the general salmon redd distribution of fall-spawning salmon and indicated the relative number of salmon that spawned on the riffles above Princeton Ferry. Redd counts showed that 37.6% of the main stem fall-spawning activity occurred downstream from Red Bluff Diversion Dam. This is close to the 40% average for the years 1974 through 1980. The most heavily used area was between Red Bluff Diversion Dam and Tehama (Figure 2 and Table 2)

Antelope Creek

Spring run. Spring-run salmon regularly enter Antelope Creek but the population size is unknown. No population estimate was made in 1981.

Fall run. Four survey trips were made on Antelope Creek between Cone Grove Park and the 99-E Highway Bridge (Figure 2). A total of 61 salmon carcasses was recovered. Based on an estimated recovery rate of 15%, the salmon population totaled 407 fish.

Craig Creek

Fall run. Craig Creek is an overflow channel from lower Antelope Creek. Four survey trips were made on Craig Creek between its beginning below Cone Grove Park and its confluence with the Sacramento River. Fifteen salmon carcasses were recovered. Based on an estimated carcass recovery rate of 15%, the spawning population totaled 100 fish.

Mill Creek

Late-fall, winter, and spring runs. Small numbers of late-fall and winter runs are known to have spawned in this stream during past years. Fifteen live spring-run salmon and two redds were observed during one survey trip on lower Mill Creek, from Highway 36 to Blackrock; no estimate of total spring-run spawners was made for 1981.

Fall run. Seven trips were made on lower Mill Creek, from the Los Molinos Mutual Water Company's upper diversion dam to its confluence with the Sacramento River (Figure 2) between 2 October 1981 and 6 January 1982. A total of 102 carcasses was recovered. Based on a 10% recovery rate, the fall run was estimated to be 1,020.

Thomes Creek

Fall run. Nine survey trips were made on Thomes Creek by Department of Fish and Game personnel under contract with the Department of Water Resources. A salmon carcass mark and recovery procedure (Schaefer method for stratified populations) was used to estimate the spawning population in the creek downstream from Paskenta. A total of 58 salmon carcasses was recovered at an estimated efficiency of 34.7%. The total population, most of which spawned in the channel between the Tehama-Colusa Canal turnout (wasteway) and Thomes Creek, was estimated to be 167.

Deer Creek

Spring run. Four survey trips were made for spring-run salmon on upper Deer Creek. The area partially covered was from upper Deer Creek Falls to the Ponderosa Way Road crossing (Figure 2). Only nine redds were observed. No estimate was made.

Fall run. Six survey trips were made on lower Deer Creek between 20 October 1981 and 5 January 1982. The area covered was from the mouth upstream to the county bridge, located about 3.2 km (2 miles) upstream from the Stanford-Vina Dam. A total of 82 salmon carcasses was recovered. Based on a 10% recovery rate, the estimated fall run totaled 820 spawners.

Stony Creek

Fall run. This is the only survey made on Stony Creek in recent years. Five survey trips were made between the confluence with the Sacramento River and the North Diversion Dam (which is a part of the U.S. Bureau of Reclamation's Orland Project) located about 5 miles upstream from the I-5 Bridge (Figure 2). The survey was conducted from 10 December 1981 through 15 February 1982; few fish were seen after early January. A total of 38 carcasses was found. The Schaefer method for stratified populations was used to estimate escapement. Based on a 9.7% recovery rate, the estimated spawning population was 393 salmon.

Butte Creek to American River

Tributaries surveyed were Butte Creek, Feather River, Yuba River, and American River (Figure 3). The Schaefer Method (1951) as described by Taylor (1974*b*) was used to make the estimated escapement in all streams except Butte Creek. With this method, fresh dead salmon with clear eyes were tagged by attaching a small piece of colored ribbon to the jaw; the color indicated the date of tagging. The carcass was then placed into running water for future recovery.

Butte Creek - by Richard Flint, Region 2

Late-fall and winter run. Fresh salmon were caught by anglers in Butte Creek from January through March 1981 below Highway 99, indicating the presence of these runs, but no spawning estimates were made.

Fall run. Salmon were numerous after the first heavy rains in November. However, no counts were attempted because of high water.

Spring run. Spring flows were sufficient to provide fish passage during April, but decreased greatly in May. Fish were seen in early May below Howard Slough Dam in the Butte Sink, but likely perished later when no water passed below the Western Canal, located upstream (Figure 3).

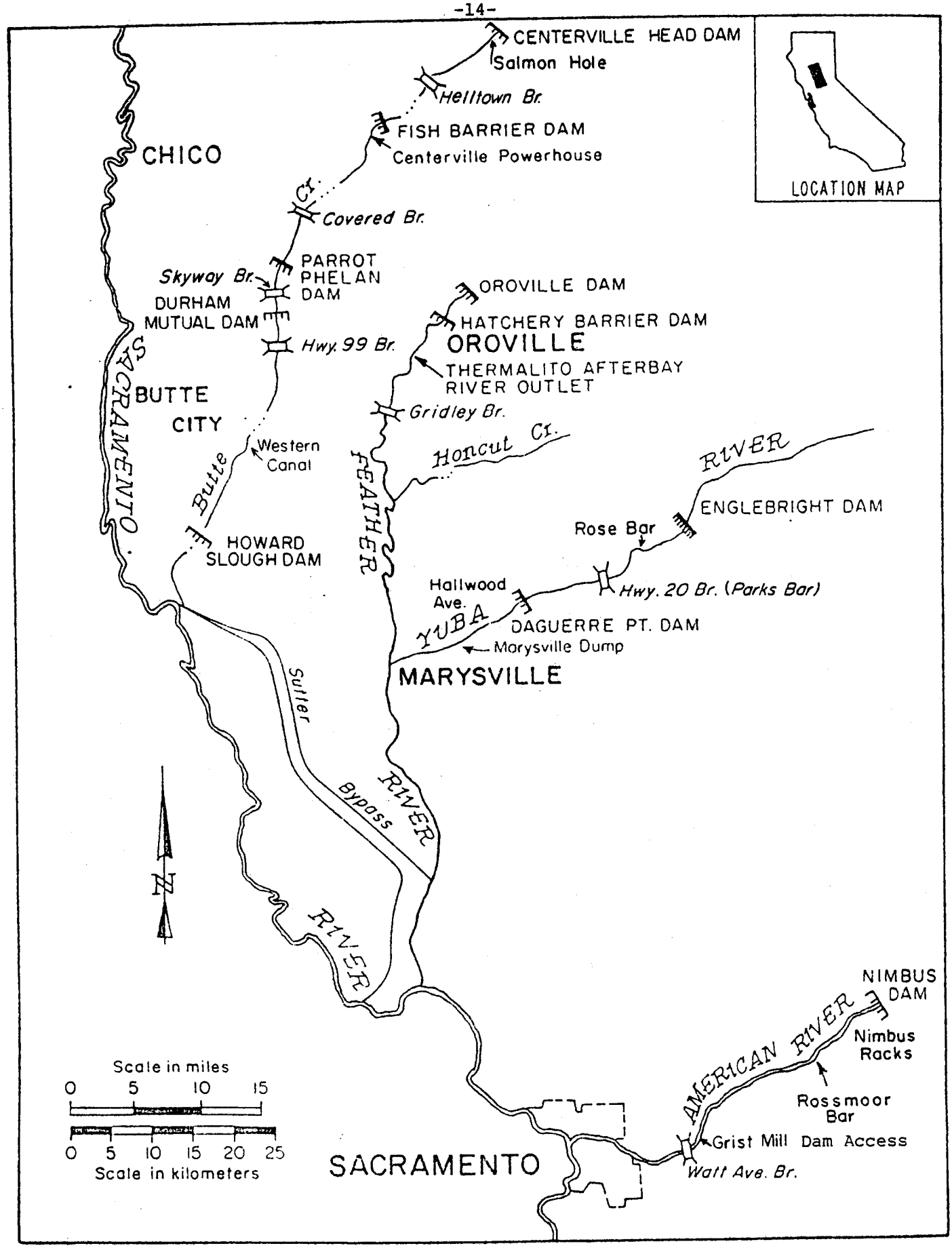

FIGURE 3. Sacramento River tributaries from Chico Creek south.

About 300 salmon accumulated in early May below the Parrott-Phelan Dam (Figure 3), located about 12 miles above Western Canal. Rains later in the month allowed about 30% of these fish to pass upstream. Under normal water conditions, fish passage over this dam has been difficult. Fish were attracted to high velocities off the apron and were not able to find the entrance to the ladder. The ladder was replaced with a Denil Fishway during April 1981, which will improve passage for the 1982 run.

Flow above the Centerville Powerhouse was 1.1 m^3/s (40 cfs) on 4 June, allowing many salmon to move upstream into the canyon (Figure 3). Twelve salmon were found dead near the old fish barrier after a power outage spilled water and drew fish upstream.

Methods of survey included counting redds, live fish,and carcasses. This was carried out from a canoe, by divers, and from a helicopter. Surveys were made in June, July,and October.

The initial survey by canoe was carried out between the Centerville Powerhouse and the Covered Bridge on 2 June; two live salmon were seen (Figure 3). Pacific Gas & Electric Company divers counted 22 live salmon in an early June survey and 30 live salmon on 3 July in the big pool below the Centerville Powerhouse. On 1 October, a survey was conducted by canoe between the Covered Bridge and Durham Mutual Dam (Figure 3); 4 single redds, 4 carcasses, and 68 live salmon were seen. An additional survey by canoe scheduled for the upstream area was cancelled due to murky water. A helicopter survey by Pacific Gas & Electric Company was made on 2 October from Centerville Head Dam to Parrott-Phelan Dam, and the following were observed: 2 redds in the Big Pool, 1 redd in mid canyon, 1 carcass above Helltown Bridge, and 6 multiple redds, 22 single redds,and 50 live fish below Centerville Powerhouse (Figure 3).

Recovery conditions during October surveys were poor and the portion of the run seen is unknown. The minimum salmon count was 145 fish,including 22 fish seen in the Salmon Hole. Based on the above observations, there were roughly 250 spring run that survived through the summer to spawn. This approximates the previous 10-yr average of 223.

Feather River - by Lawrence G. Preston, Region 2

Spring run. Spring- and fall-run salmon both spawn in the fall, making it impossible to distinguish the two strains during the spawning period. In this report, the 469 salmon (211 adult males, 145 adult females, and 113 jacks) entering Feather River Hatchery before 1 October have been designated spring run. It is assumed a similar number spawned in the river, resulting in an estimated total of about 1,000 spring-run salmon in the Feather River.

There were reports of anglers catching salmon during the spring and early summer. One of the coded-wire-tagged spring-run carcasses was recovered in Moe's Ditch near the hatchery and another was taken from a fish caught by an angler near Gridley (Figure 3).

Fall run. The 1981 spawning stock survey began on 1 October and was completed on 14 December. High water forced termination after 25 November of surveys for the area downstream from Thermalito Outlet. Water clarity ranged from 1.2-3.0 m (4-10 ft) through 10 November and for the remainder of the season it decreased to 0.9 m (3 ft) and less.

The section from Feather River Fish Barrier Dam to Thermalito Outlet or "low flow section" was surveyed without interruption (Figure 3). Flows were a constant 11.3 m^3/s (400 cfs) with the exception of 25 November, when flow reached 793 m^3/s (28,000 cfs). Using the Schaefer Method, escapement was estimated at 22,386 (Table 3).

The next section was located between Thermalito Outlet and Gridley Bridge (Figure 3). Due to high flows, the last survey was made on 10 November. Using the Schaefer Method, escapement up to 10 November was estimated at 12,265 (Table 4). Based on the pattern of recoveries in the low flow section and returns to the hatchery, the spawning run was estimated to be about 62.5% complete. The 12,265 figure was, therefore, expanded to 19,624.

The most downstream area surveyed was located between Gridley Bridge and Honcut Creek (Figure 3). Typically, only a small fraction of the total Feather River salmon run spawns in this section. Therefore, less survey effort was allotted. Three survey trips were made. A total of 306 carcasses was seen. Of these, 39 were tagged with colored ribbons; 7 were later recovered, resulting in an estimated run of 1,705 salmon. The Schaefer Method was not employed because of the low number of tags recovered. To compensate for early termination of survey efforts due to high water, it was assumed the spawning season was only 62.5% complete, resulting in an estimate of 2,728 spawners.

A total of 8,282 fall-run salmon entered Feather River Hatchery between 1 October and 10 November, when the ladder was closed. Estimated spawning distribution is as follows:

Section	Population estimate	Percent distribution
Feather River Hatchery	8,282	15.6
Oroville Fish Barrier Dam to Thermalito Outlet	22,386	42.2
Thermalito Outlet to Gridley Bridge	19,624	37.0
Gridley Bridge to Honcut Creek	2,728	5.2
TOTAL	53,020	

The estimated total run of 53,020 approximates the previous 10-year average of 49,043. From the 2,518 fresh carcasses examined on this river, 40.5% were adult males (≥ 60.7 cm or 23.9 inches), 50.0% were adult females, 5.4% were male grilse (< 60.7 cm or 23.9 inches), and 4.1% were female grilse. In the hatchery sex composition was: 39.9% adult males, 47.7% adult females, and 12.4% grilse of both sexes.

Coded wire tag recoveries from carcasses found in the Feather River are as follows:

Coded wire tag number	No. tags recovered	Estimated total number of tags in river
6-58-11	1	21
6-58-12	1	21
6-58-16	1	21
6-62-3	1	21
6-62-6	1	21
6-62-8	2	42
TOTALS	7	147

Fresh carcasses made up 2,518/53,020, or about 1 in 21 fish.

Yuba River - by Lawrence G. Preston, Region 2

Spring run. Salmon are occasionally taken by anglers during the spring and early summer, indicating a few spring run are present in the river. Both spring- and fall-run salmon spawn during the fall, making it impossible to distinguish the races at that time. Although no data are available to accurately gauge run size, a conservative estimate of 200 spring-run salmon spawned in the Yuba River. It is likely a small but insignificant number of spring run are misidentified as fall run during the fall spawning survey.

Fall run. The 1981 Yuba River spawning stock survey was started on 28 September and terminated on 9 December. Most survey efforts were concentrated between Parks Bar (Hwy. 20 Bridge) and the Marysville Dump (Figure 3); the area upstream from Parks Bar was occasionally examined.

TABLE 3. Population Estimates of Chinook Salmon Based on Tag and Recovery Data for the Feather River from Feather River Fish Barrier to Thermalito River Outlet, Using Schaefer's Method, 1981.

Recovery period (j)	Tagging period (i) Oct. 6	Oct. 12	Oct. 19	Oct. 26	Nov. 3	Nov. 9	Nov. 16	Nov. 24	Nov. 30	Dec. 7	Number tagged observed (Rj)	Total number carcasses (Cj)*	Population estimate (N)
Oct. 19		2									2	189	277
Oct. 26	2	5	31								38	757	2,088
Nov. 3		7	6	68							81	1,137	2,941
Nov. 9		1	2	25	121						149	1,540	3,306
Nov. 16				5	26	76					107	1,791	5,239
Nov. 24					3	16	91				110	1,506	5,629
Nov. 30						7	7	9			23	376	1,524
Dec. 7							9	29	4		42	442	2,112
Dec. 14						1	2	4	1	15	23	254	1,015
Total tagged fish recovered (Ri)	2	15	39	98	150	100	109	42	5	15			24,131+
Total fish tagged (Mi)	3	22	119	261	305	325	423	202	33	55			

*Includes tagged fish recovered.
+Total tagged fish from second week on must be subtracted 24,131-1745=22,386.

$$\text{Population estimate (N)} = \sum (Rij \cdot \frac{Mi}{Ri} \cdot \frac{Cj}{Rj}) - \sum_2^i Mi$$

TABLE 4. Population Estimates of Chinook Salmon Based on Tag and Recovery Data for Feather River from Thermalito River Outlet to Gridley Bridge Using Schaefer's Method, 1981.

Recovery period (j)	Tagging Periods (i) Oct. 20	Oct. 27	Nov. 4	Nov. 10	Number tagged observed (Rj)	Total number carcasses (Cj)*	Population estimate (N)
Oct. 27	1				1	325	4,338+
Nov. 4		26			26	916	
Nov. 10		7	62		69	1,303	3,303
Nov. 17			12	62	74	1,282	5,179
Total tagged fish recovered	1	33	74	62			12,820‡
Total fish tagged (Mi)	17	102	183	270			

*Includes tagged fish recovered.

+Due to the low number of fish tagged and subsequent lone tag recovery from the 20 October tag/recovery period, data from the 20 October and 27 tag recovery periods were combined.

‡The number of fish tagged from the second week on must be subtracted 12,820-555=12,265.

Fish observed during the 20 October through 17 November represent an estimated 5/8 of the total run. The 12,265 is therefore expanded to 19,624.

$$\text{Population estimate (N)} = \sum (Rij \cdot \frac{Mi}{Ri} \cdot \frac{Cj}{Rj}) - \sum_2^i Mi$$

River flows and water clarity are tabulated below:

Date	Flows above Daguerre Point	Flows below Daguerre Point	Water clarity
September 28	7.0 m^3/s (600 cfs)	-	3m (10 ft)
October 5	"	-	"
October 14-16	"	12.5 m^3/s (440 cfs)	"
October 21-23	"	12.3 m^3/s (435 cfs)	"
October 28-30	"	12.2 m^3/s (395 cfs)	0.9-2.1m (3.7 ft)
November 5-7	18.4 m^3/s (650 cfs)	11.6 m^3/s (410 cfs)	3m (10 ft)
November 12-13	"	19.8 m^3/s (700 cfs)	0.6-1.2m (2.4 ft)
November 19-20	45.3 m^3/s (1,600 cfs)	34.0 m^3/s (1,200 cfs)	0-0.3m (0.1 ft)

The Schaefer Method (1951) was used to estimate the spawning population between Parks Bar and the Marysville Dump. The data collected between 15 October (when the first carcasses were seen) and 13 November were used. Data collected after that time were not used because high flows washed down untagged carcasses from above Parks Bar, biasing the ratio of tagged-to-untagged carcasses. During the survey period, an estimated 8,296 salmon spawned in this section of the Yuba River (Table 5). It was estimated about 30% of total seasonal run spawned after the 13 November survey, resulting in total estimated run of 11,851 fish.

Assuming 15.5% of the entire river run spawns above Parks Bar (based on observations made during the 1966-71 surveys), the 11,851 figure was expanded to a total fall run of 14,025 spawners for the entire river. This exceeds the previous 10-yr average of 10,723.

The fractions of salmon spawning by area were:

Section	Percent of total	Estimated spawning population
I. Rose Bar to Parks Bar Bridge	15.5%	2,174
II. Parks Bar Bridge to Daguerre Point Dam	57.5%	8,064
III. Daguerre Point Dam to Hallwood Avenue	23.3%	3,268
IV. Hallwood Avenue to Marysville Dump	3.7%	519
Totals	100.0%	14,025

From the 1,083 fresh carcasses examined, 43.5% were adult males ($\geq$ 60.7 cm or 23.9 inches), 42.4% were adult females, 8.5% were male grilse (<60.7 cm or 23.9 in) and 5.6% female grilse.

Two coded-wire-tagged chinook salmon were recovered during the last 2 weeks of October. Both fish were coded wire tag #6-58-13 indicating they were fall-run chinook salmon of Feather River origin, planted in August at Port Chicago near the Carquinez Straits.

TABLE 5. Population Estimate of Chinook Salmon Based on Tag and Recovery Data for the Yuba River from Parks Bar (Hwy. 20 Bridge) to Marysville Dump, Using Schaefer's Method, 1981.

Recovery period (j)	Tagging period (i) Oct. 15-16	Oct. 22-23	Oct. 29-30	Nov. 5-6	Number tagged observed (Rj)	Total number carcasses counted (Cj)*	Population estimate (N)
Oct. 22-23	5				5	228	1,505
Oct. 29-30		22			22	355	1,454
Nov. 5-6		9	52		61	946	2,317
Nov. 12-13			9	76	85	1,004	3,561
Total tagged fish recovered (Ri)	5	31	61	76			8,837+
Total fish tagged (Mi)	33	127	132	282			

* Includes tagged fish recovered.

\+ Total tagged fish from second week on must be subtracted 8,837-541=8,296

$$\text{Population estimate (N)} = \sum (Rij \cdot \frac{Mi}{Ri} \cdot \frac{Cj}{Rj}) - \sum_2^i Mi$$

To compensate for period after 13 November, the 8,296 was expanded by 30% which gave an estimate of 11,851 This figure is further expanded by 15.5% to include that portion of the run spawning above Parks Bar, resulting in an estimated run of 14,025 for the entire river.

Because fresh fish examined made up 1,083/14,025 or about 1/13, each coded-wire-tagged fish represents about 13 fish. Therefore, an estimated 26 chinook salmon with coded wire tag #6-58-13 spawned in the Yuba River in 1981.

American River - by Mike Meinz, Region 2

Fall run. The annual American River spawning stock survey was conducted from 2 November through 18 December 1981. The river was divided into the following two sections which were surveyed weekly:

I. Nimbus Racks to Rossmoor Bar
II. Rossmoor Bar to Grist Mill Dam Access

The Schaefer Model (Schaefer 1951), was used for estimating the population. The accuracy of this year's estimate was affected by high water flows (142-481 m^3/s or 5,000-17,000 cfs) and turbid conditions (clarity less than 0.3 m or 1 ft). As a result, tag recovery efficiency was poor in all but the first three weeks of this year's survey. During the first 3 weeks conditions were good, i.e., water flows were 42.5 m^3/s (1,500 cfs) and water clarity was always greater than 1.2 m (4 ft). Assuming the estimated escapement for the first three weeks (21,731) was about half of the total, the estimated annual escapement to the river was 43,462. This assumption is based on findings reported in past spawning stock surveys: 1) from 27 to 60% of the total escapement occurs during the first three weeks of the run, and 2) hatchery personnel and author feel the run was several weeks early.

A total of 20,593 salmon spawners entered Nimbus Hatchery. However, the ladder was closed earlier than usual (29 November 1981) because the egg goal had been reached. No estimate was made of salmon spawning above Nimbus Racks because high flows forced the removal of the racks before any spawned-out carcasses were found. Combining the river estimates with the hatchery counts yield a total spawning escapement of 64,055. This exceeds the previous 10-yr average of 46,784.

From the 659 fresh carcasses examined, 42.8% were adult males ($\geq$60.7 cm or 23.9 inches), 48.3% were adult females, 4.7% were male grilse (< 60.7 cm or 23.9 inches), and 4.2% were female grilse.

Six of the 659 fresh carcasses examined had adipose fin clips and coded wire tags. Three of the tags originated from Feather River Hatchery and the other three from the Mokelumne River Fish Installation. The relationship of the fresh carcasses seen to the estimated total river run of 43,462 is 1:66, implying that each salmon with a missing adipose represents 66 in the run.

CHINOOK SALMON POPULATIONS FOR THE SAN JOAQUIN RIVER

Salmon spawning populations in the San Joaquin River tributaries were estimated by counting carcasses, redds, live fish, and hatchery returns. Streams surveyed were the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers (Figure 4).

Cosumnes River to the Calaveras River

by

Mike Meinz
Region 2

Cosumnes River

Fall run. Since there was no water in the lower Cosumnes until early December, salmon were not able to enter the stream until late in the season. The upper section between Michigan Bar and Bridgehouse was surveyed on 2 December 1981; four live salmon and one dead salmon were seen. No further counts were made due to high flows during the remainder of December. An estimate of the annual run was not made.

Mokelumne River

Fall run. The annual Mokelumne River spawning stock survey was conducted from 6 November through 16 December 1981. Carcass counts were usually made from the Mokelumne River Fish Installation to Mackville Road Bridge (Figure 4). However, during the peak of the run, the survey was extended downstream another 2.4km (1.5 miles) to the Claude-Wood Gravel Works or 9.7km (6 miles) to the Elliot Road Bridge (Figure 4).

Flows (4.2-12.7 m^3/s or 150-450 cfs) during the survey were conducive to accurate sampling until 16 December 1981, after which they exceeded 8.0 m^3/s (3,000 cfs) and were unsafe to survey. Water clarity throughout the survey exceeded 1.2m (4 ft).

The chinook salmon population was estimated by tagging fresh carcasses with colored ribbon that was attached to the jaw with a hog ring. The carcass was then placed into running water for future recovery. The Schaefer Model (Schaefer 1951), as modified by Taylor (1974*b*) for estimating a changing population, was used (Table 6). A total of 723 carcasses was recovered and the estimated number of spawners, based on the model, was 4,454. No ribbon tags were recovered until the 3rd week of the survey. Therefore, to estimate the number of spawners migrating into

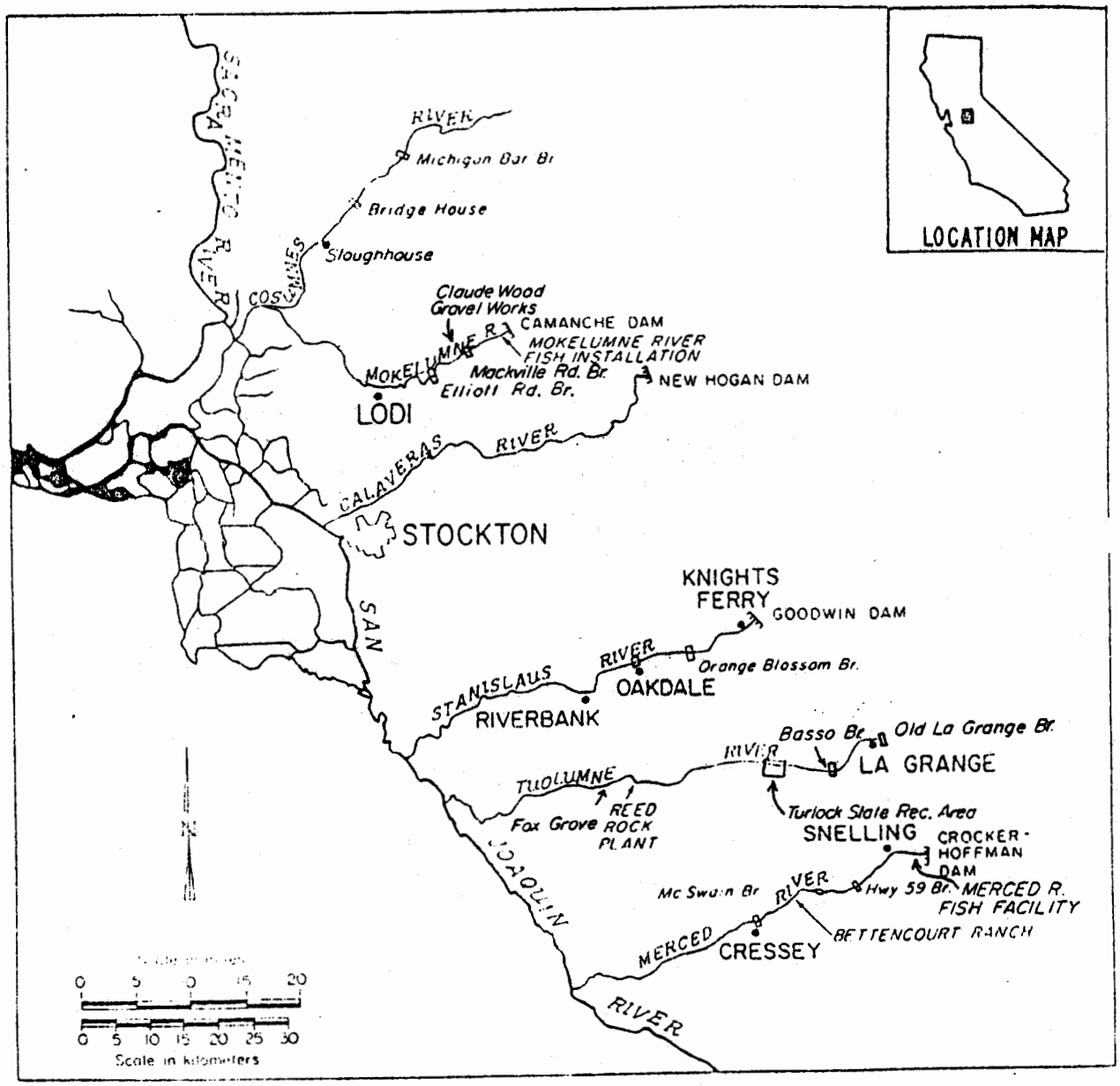

FIGURE 4. San Joaquin River tributaries.

TABLE 6. Mokelumne River Estimate of Chinook Salmon Based on Tag and Recovery Data from the Mokelumne River Fish Installation to 1.3 Miles Downstream of Mackville Road, 1981.

Recovery period (j)	Period of tagging (i) Nov. 6	Nov. 13	Nov. 19	Nov. 24	Dec. 4	Dec. 11	Dec. 16	Number tagged observed (Rj)	Total number carcasses (Cj)*	Population estimate (N)
Nov. 13	0							0	10 +	
Nov. 19		0						0	86 +	
Nov. 24			5					5	145	1,607
Dec. 4			1	5				6	258	1,534
Dec. 11					3			3	123	717
Dec. 16					3	2		5	101	676
Total tagged fish recovered (Ri)	0	0	6	5	6	2				4,534 ++
Total fish tagged (Mi)	1	7	32	29	35	16				

* Includes tagged fish recovered.

\+ Totals were included in third week's carcass counts to estimate Cj/Rj.

++ Total tagged fish from Nov. 24 on must be subtracted 4,534 - 80 = 4,454.

$$\text{Population estimate (N)} = \sum (Rij \cdot \frac{Mi}{Ri} \cdot \frac{Cj}{Rj}) - \sum_{2}^{i} Mi$$

Approximately 500 salmon were in the stream after survey was terminated, resulting in a total of 4,954.

the river during this period, the carcasses chopped during the first two weekly surveys were included in the 3rd week's recovery total.

Approximately 500 salmon remained in the river when the survey was discontinued due to high flows. Combining these fish with the river estimate of the earlier migrating fish yields a total spawning escapement of 4,954. This greatly exceeds the previous 10-yr average of 1,877.

A total of 1,367 salmon entered Mokelumne River Fish Installation. No fish were spawned at the installation this season. The 1,367 entering the facility were released back into the river to spawn naturally. These fish were included in the 4,954 fish total.

From the 136 fresh carcasses examined, 25.7% were adult males ($\geq$60.7 cm or 23.9 inches), 53.0% were adult females, 11.0% were male grilse (< 60.7 cm or 23.9 inches), and 10.3% were female grilse. Four of the 136 fresh carcasses examined had adipose fin clips and a coded wire tag (all with the tag #6-48-11), of Mokelumne River Fish Installation origin. The relationship of fresh carcasses to the estimated river run of 4,954 is 1:36, indicating that each salmon with a missing adipose fin represents 36 in the run.

Calaveras River

Winter run. No salmon were observed in the Calaveras River during 1981. Normally salmon are seen in the river sometime between January and April by Army Corps of Engineers personnel working at New Hogan Reservoir (Figure 4). However, none was observed this year. In addition, no salmon were observed by Department of Fish and Game personnel creel checking the river in April when juveniles have been caught in the past by anglers fishing for trout. A more extensive survey will be conducted in 1982.

Stanislaus River to Merced River

by

Maurice Fjelstad
Region 4

Stanislaus River

Fall run. Two complete surveys were conducted from Knights Ferry to Riverbank Bridge from 4 November through 12 November 1981 (Figure 4). Flows were about 6.8m^3/s (240 cfs). Good water clarity resulted in excellent recovery conditions. Unusually large runs in the Tuolumne and Merced rivers forced shifting more attention to those streams and a reduction of survey effort on the Stanislaus River. A total of 41 carcasses was observed.

The maximum run based on this cursory examination was 1,000 spawners.

Tuolumne River

Fall run. Surveys were made between LaGrange Dam and Fox Grove (Geer Avenue) from 4 November through 16 December 1981 (Figure 4). Scheduled dry year releases averaged 5.7m^3/s (200 cfs) during the survey. Good water clarity resulted in excellent recovery conditions.

The Schaefer Method (Schaefer 1951) as modified by Taylor (1974*b*) was used to estimate run size for the following traditionally surveyed stream sections (Figure 4):

I. About 91.4 m (300 ft) above Old LaGrange Bridge to Basso Bridge (4.8 km or 3 miles).
II. Basso Bridge to Turlock Lake State Recreation Area (12.1 km or 7.5 miles).
III. Turlock Lake State Recreation Area to Reed Rock Plant (12.9 km or 8 miles).

Seven complete survey trips were made in these sections. Carcasses were tagged by attaching a small colored plastic ribbon to the jaw with a hog ring and then releasing the carcass into running water for later recovery. The color of the tag indicated date of release. A total of 4,819 carcasses was observed; of these, 664 were tagged and 334 subsequently recovered. Based on the above method, an estimated 12,173 salmon spawned in these sections (Table 7). Included in this total are an estimated 139 fish that spawned before the survey started; this estimate was obtained by multiplying the reciprocal of the seasonal tag recovery rate (664/334) by the number (70) of carcasses observed on 4 and 5 November. When it was apparent the 1981 spawning run was going to be the largest in recent years, survey efforts were expanded to include the areas from 300 ft above Old LaGrange Bridge up to LaGrange Dam and from Reed Rock Plant down to Fox Grove. The number of spawners in these sections were estimated by the following procedure:

$$\frac{\text{Estimated number of spawners in adjacent Section (I or III).}}{\text{Redd count in adjacent Section (I or III).}} \times \text{Redd count in newly surveyed section.} = \text{Estimated number spawners in newly surveyed section.}$$

An estimated 1,134 fish spawned in the section above Old LaGrange Bridge and 946 in the section below Reed Rock Plant.

The combined estimated total spawners for all sections is 14,253, which is the greatest number of spawners since 1971 when the run was 22,000. Since 1971, runs have averaged only 1,670.

From the 2,048 fish sexed, 25.3% were female adults (≥60.7 cm or 23.9 inches), 15.3% were female grilse (< 60.7 cm or 23.9 inches), 43.1% were adult males and 16.3% were male grilse.

TABLE 7. Tuolumne River Estimate of Chinook Salmon Based on Tag Recovery Data from Approximately Old La Grange Bridge to Reed Rock Plant, 1981.

Recovery period (j)	Tagging period (i) Nov. 4,5	Nov. 12,13,14	Nov. 18,19,20	Nov. 24,25,27	Dec. 1,2,3	Dec. 9,10,11	Number tagged observed (Rj)	Total number carcasses (Cj)*	Population estimate (N)
Nov. 4,5							0	70	139+
Nov. 12,13,14	9						9	785	1,939
Nov. 18,19,20	6	35					41	1,509	3,520
Nov. 24,25,27	1	9	84				94	1,537	2,948
Dec. 1,2,3	1	13	31	52			97	1,441	2,696
Dec. 9,10,11		1	9	19	31		60	578	1,080
Dec. 15,16			4	9	12	8	33	215	473
Total tagged fish recovered (Ri)	17	58	128	80	43	8			12,795‡
Total fish tagged (Mi)	42	134	239	140	83	26			

* Includes tagged fish recovered.

\+ To estimate escapement prior to startof survey, the 70 carcasses observed on 4 and 5 November were multiplied by 664/334 the seasonal ratio of total tags released to total tags recovered.

‡ Total tagged fish from second week on must be subtracted 12,795 - 622 = 12,173.

$$\text{Population estimate (N)} = \left\{ (Rij \cdot \frac{Mi}{Ri} \cdot \frac{Cj}{Rj}) = \left\{ \frac{i}{2} Mi \right.\right.$$

This estimate was further expanded to 14,253 to include the 1,134 fish that spawned above Old La Grange Bridge and 946 fish that spawned below Reed Rock Plant.

Merced River

Fall run. Spawning stock surveys began on 3 November and were completed on 2 December 1981. Traditionally, the river has been divided into the following sections (Figure 4):

I. Crocker Huffman Dam to Highway 59 Bridge (16.0 km or 10 miles).
II. Highway 59 Bridge to Bettencourt Ranch (12.1 km or 7.5 miles).
III. Bettencourt Ranch to Santa Fe Road at Cressy (11.3 km or 7 miles).

As in previous years, water hyacinth prevented boat passage which eliminated any surveys downstream from Highway 59 Bridge. Flows were about 5.1 m^3/s (180 cfs) which is the minimum dry year release. Observation conditions were good.

To estimate run size, fresh carcasses were tagged by attaching a numbered plastic green tag to the jaw with a hog ring, and then releasing it into running water for later recovery. A total of 1,856 carcasses was observed. Of these, 175 were tagged and 54 were later recovered. To compensate for the fish that spawned and died after 2 December, it was assumed the spawning season was 88% completed; the projected number of carcasses that would have been observed, had survey efforts continued, was 2,109. The correction value of 88% spawning completed was based on observations made in the Tuolumne River and at the Merced River Fish Facility.

The following Ricker (1958) formula was used:

$$N = \frac{MC}{R}$$

where: N = size of run in upper section

M = number of carcasses tagged

C = assumed number of carcasses examined if survey efforts had continued until mid-December

R = number of tags recovered

Actual computations were: $N = \frac{(175)\ (2,109)}{54} = 6,835$

Based on an 8 out of a 10 year average from 1971 to 1981 during years when surveys could be carried out in the lower river, an estimated 72% of the average yearly spawning effort occurred above Highway 59 Bridge. An estimated 9,491 spawners for 1981 was projected from this assumption. There were 924 spawners which entered Merced River Fish Facility, resulting in a total estimated river run of 10,415.

This was the largest run since regular surveys were started in 1953 and more than double the next largest of 4,750, which occurred in 1970.

From the carcasses sexed, 34.0% were female adults (> 60.7 cm or 23.9 inches), 15.4% were female grilse (< 60.7 cm or 23.9 inches), 37.2% were male adults and 13.4% were male grilse.

SUMMARY

During 1981, the California Department of Fish and Game conducted its 29th annual chinook salmon spawning stock inventory of the Sacramento-San Joaquin River system.

This report deals with the four races of chinook salmon recognized in the Central Valley: late-fall-, winter-, spring-,and fall-runs.

In the San Joaquin River system and the Sacramento River system downstream from Red Bluff, spawning stock estimates were made by the Department of Fish and Game. These estimates were based on carcass counts, aerial redd counts, and live fish counts. Estimates for the Sacramento River system above Red Bluff were based primarily on U.S. Fish and Wildlife Service counts of fish passing Red Bluff Diversion Dam and on Department of Fish and Game sampling at the dam.

The estimated 1981 Central Valley chinook salmon spawning escapement was 309,416 fish (Table 8).

The 1981 fall run was the largest since 1973. The most dramatic increases occurred in the Mokelumne, Tuolumne and Merced rivers. The Mokelumne River had the largest run since 1958; the Tuolumne River had the largest run since 1971; and the Merced River had the largest run since regular surveys were started in 1953.

Fall spawning escapement in the Feather and American rivers was 50 and 28% greater, respectively, in 1981 than 1980, while total spawners in the Yuba River were almost the same in 1980 and 1981.

The fall spawning escapement of 74,100 above Red Bluff Diversion Dam continues to be far below the 1964-69 average of 129,000 observed prior to the construction of the dam. This has been partially offset in recent years by increased runs below the dam where 42,724 fall-run salmon spawned in 1981; this greatly exceeds the 1964-69 average of 8,000 fish.

Salmon counts at Red Bluff Diversion Dam and sport catches above the dam are shown in Appendix Tables 1 and 2, respectively. Spawning populations for all Central Valley streams are summarized in Appendix Tables 3-5. Fin mark and coded-wire-tag recoveries are presented in Appendix Tables 6 and 7.

TABLE 8. Sacramento-San Joaquin System Chinook Salmon Spawning Population, 1981.

Spawning Area	Late-fall Run	Winter Run	Spring Run	Fall Run	Combined
Sacramento mainstem	6,423	19,795	20,655	68,985	115,858
Sacramento tributaries	295		1,450	161,191	162,936
San Joaquin tributaries				30,622	30,622
Totals	6,718	19,795	22,105	260,798	309,416

REFERENCES

Reavis, R.L. 1981. Chinook salmon spawning stocks in California's Central Valley, 1980. Calif. Dept. of Fish and Game, Anad. Fish. Br. Admin. Rep. No. 81-7. 36 p.

Ricker, W.E. 1958. Handbook of computations for biological statistics of fish populations. Red. Bd. Canada, Bull. 119, 300 p.

Taylor, S.N. 1974*a*. King (chinook) salmon spawning stocks in California's Central Valley, 1972. Calif. Dept. Fish and Game, Anad. Fish. Br. Admin. Rep. No. 74-6. 32p.

_____ 1974*b*. King (chinook) salmon spawning stocks in California's Central Valley, 1973. Calif. Dept. Fish and Game, Anad. Fish. Br. Admin. Rep. No. 72-12. 32p.

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

APPENDIX TABLE 1. Red Bluff Diversion Dam Weekly Adjusted Salmon Counts, 19 October 1980 through 2 January 1982.

Week	Adjusted salmon count	Number sampled	Late-fall run percent	Late-fall run number	Winter run percent	Winter run number	Spring run percent	Spring run number	Fall run percent	Fall run number
1980										
Dec. 19-27	Runs in Progress			2,528*		30*				
1981										
Dec.28-Jan.3	381	50	86.0	328	14.0	53				
Jan. 4 -10	341	98	85.7	292	14.3	49				
11 -17	1,130	227	72.2	816	27.8	314				
18 -24	1,334[a]	246	76.4	1,019	23.6	315				
25 -31	16[a]	25	92.0	15	8.0	1				
Feb. 1 - 7	355	1	100.0[b]	355	0.0[b]	0				
8 -14	1,164	no sample	63.2[b]	736	36.8[b]	428				
15 -21	320	no sample	54.0[b]	173	46.0[b]	147				
22 -28	715	no sample	52.1[b]	372	47.9[b]	343				
Mar. 1 - 7	1,792	319	6.0	108	94.0	1,684				
8 -14	4,187	337	0.6	25	99.4	4,162				
15 -21	318	70	5.7	18	94.3	300				
22 -28	69	4	25.0	17	75.0	52				
29-Apr.4	151	30	3.3	5	96.7	146				
Apr. 5 -11	2,620	303		6,807	100.0	2,620				
12 -18	4,426	221			98.6	4,364	1.4	62		
19 -25	805	38			89.5	720	10.5	85		
26-May 2	1,154	96			87.5	1,010	12.5	144		
May 3 - 9	769	49			73.5	565	26.5	204		
10 -16	1,333	109			84.4	1,125	15.6	208		
17 -23	480	66			65.2	313	34.8	167		
24 -30	717	54			42.6	305	57.4	412		
May 31-Jun. 6	1,155	95			44.2	511	55.8	644		
Jun. 7 -13	671	41			14.6	98	85.4	573		
14 -20	438	49			16.3	71	83.7	367		
21 -27	219	60			6.7	15	93.3	204		
28-Jul. 4	357	60			10.0	36	90.0	321		
Jul. 5-11	326	79			5.1	17	94.9	309		
12 -18	421	56			5.3	22	92.9	391	1.8	8
19 -25	372	6					100.0	372		
26-Aug.1	434	94			4.3	19	95.7	415		

(Continued on next page)

APPENDIX TABLE 1. Red Bluff Diversion Dam Weekly Adjusted Salmon Counts, 19 October 1980 through 2 January 1982 (continued).

Week	Adjusted Salmon count	Number sampled	Late-fall run percent	Late-fall run number	Winter run percent	Winter run number	Spring run percent	Spring run number	Fall run percent	Fall run number
1981										
Aug. 2-Aug.8	597	77			13.0	78	81.8	488	5.2	31
9 -15	1,388	195			9.2	128	87.7	1,217	3.1	43
16 -22	1,683	285					86.3	1,452	13.7	231
23 -29	2,742	159				20,041	92.4	2,534	7.6	208
30 -Sept.5	7,205	194					69.6	5,015	30.4	2,190
Sept.6 -12	5,459	190					39.0	2,129	61.0	3,330
13 -19	6,328	292					16.4	1,038	83.6	5,290
20 -26	7,627	139					16.5	1,258	83.5	6,369
27 -Oct.3	6,361	161					11.8	751	88.2	5,610
Oct. 4 -10	9,126	276					2.9	265	97.1	8,861
11 -17	3,828	73							100.0	3,828
18 -24	3,592	122						21,025	100.0	3,592
25 -31	5,909	175							100.0	5,909
Nov.1 -Nov. 7	5,386	156	12.8	689					87.2	4,6[illegible]
8 -14	3,225	80	43.8	1,413					56.2	1,812
15 -21	927	12	16.7	155					83.3	772
22 -28	343	11	9.0	31					91.0	312
29-Dec.5	1,048	126	63.5	665					36.5	383
Dec. 6 -12	853	80	85.0	725					15.0	128
13 -19	291	49	73.5	214					26.5	77
20 -26	197[c]	no sample	63.5[d]	125	8.0[d]	16			28.5	56
27 -Jan.2	116	" "	83.1[d]	96	11.3[d]	13			5.6	7
										53,744
Total 1981 (calendar year)	103,201	5,735		8,392		20,040		21,025		53,744

*Portion of run passing RBDD during 1980, and expected to spawn during 1981 For a weekly breakdown of numbers, see 1980 Central Valley Spawning Stock Estimates (Reavis, 1981).

[ ] Indicates the size of the salmon run passing RBDD with the potential of spawning during calendar year 1981.

a/ Night factor- unweighted mean of percent of night count from weeks 11-17 January 1981, and 1-7 February 1981.
b/ Based on a 5-yr av. (1976-80).
c/ Determined by averaging week before and week after.
d/ Based on a 6-yr av. (1975-80).

APPENDIX TABLE 2. Estimated Monthly Chinook Salmon Sport Catch in the Sacramento River between Keswick Dam and Red Bluff Diversion Dam, Divided into Landings from the Four Runs that Spawned there in 1981, Based on Their Percentages (Occurrence) in the Counts at Red Bluff Diversion Dam.

Year	Month	Catch	Late-fall run percent	Late-fall run catch	Winter run percent	Winter run catch	Spring run percent	Spring run catch	Fall run percent	Fall run catch
1980	Oct.	438	1.9	8					96.6	423
	Nov.	254	9.4	24					90.6	230
	Dec.	18	44.5	8	5.5	1			50.0	9
1981	Jan.	2	76.6	2	23.4	0				
	Feb.	67	64.2	43	35.8	24				
	Mar.	150	2.7	4	97.3	146				
	Apr.	44		89	97.5	43	2.3	1		
	May	27			70.4	19	29.6	8		
	Jun.	6			33.3	2	66.7	4		
	Jul.	65			4.6	3	93.9	61	1.5	1
	Aug.	250			3.2	8	89.2	223	7.5	19
	Sept.	195				246	35.4	69	64.6	126
	Oct.	116					3.4	4	96.6	112
	Nov.	54	24.1	13					75.9	41
	Dec.	1	100.0	1						
1981 Total (Calendar year)		977		63		245		370		299

[ ] = Total catch from run that spawned in 1981.

APPENDIX TABLE 3. Summary of Chinook Salmon Population Estimates for the Sacramento River System, 1981.

	Late-fall run	Winter run	Spring run	Fall run	Total
Keswick Dam to Red Bluff*					
Sacramento River Mainstem+	6,423	19,795	20,655	26,261	73,134
Battle Creek (Total)	‡			(17,205)	
Coleman Hatchery	295‡			13,223	13,518
Below Hatchery				6,933	6,933
Clear Creek				3,672	3,672
Cottonwood Creek				3,356	3,356
TOTAL Keswick Dam to Red Bluff	6,718	19,795	20,655	53,445	100,613
Red Bluff to Princeton Ferry					
Sacramento River Mainstem				(42,724)	
Red Bluff to Tehama				23,440	23,440
Tehama to Woodson Bridge				8,867	8,867
Woodson Bridge to Princeton Ferry				8,033	8,033
Tehama-Colusa Spawning Channel				2,384	2,384
Antelope Creek				407	407
Mill Creek				1,020	1,020
Thomes Creek				167	167
Deer Creek				820	820
Craig Creek				100	100
Stoney Creek				393	393
TOTAL Red Bluff to Princeton Ferry				45,631	45,631
Butte Creek to American River					
Butte Creek			250		250
Feather River (Total)			(1,000)	(53,020)	
Hatchery			469	8,282	8,751
Below Hatchery			531	44,738	45,269
Yuba River			200	14,025	14,225
American River				(64,055)	
Hatchery				20,593	20,593
Below Hatchery				43,462	43,462
TOTAL Butte Creek to American River			1,450	131,100	132,550
GRAND TOTAL, SACRAMENTO RIVER SYSTEM	6,718	19,795	22,105	230,176	278,794

*Includes other tributaries except Battle, Clear and Cottonwood creeks.

+Spawning populations equals total run (adjusted Red Bluff Dam counts) minus the sport catch and estimates of surveyed tributaries. Includes salmon hauled from Keswick Dam to other locations.

‡148 salmon were hauled from Keswick Dam and 147 entered Coleman Hatchery via Battle Creek.

APPENDIX TABLE 4. Summary of Chinook Salmon Spawning Population Estimates for the San Joaquin River System, 1981.

Area	Winter run	Fall run	Total
Cosumnes River		No est.	
Mokelumne River		4,954	4,954
Calaveras River	0		0
Stanislaus River		1,000	1,000
Tuolumne River		14,253	14,253
Merced River		(10,415)	
Fish Facility		924	924
Below Fish Facility		9,491	9,491
TOTALS		30,622	30,622

APPENDIX TABLE 5. Sacramento-San Joaquin Valley Chinook Salmon Spawning Stock Estimates, 1964-1980, in Thousands of Fish. Spawning Stock Estimates from 1953-1963 Can Be Found in Taylor (1974a)

	Sacramento River system above Red Bluff, excluding Battle Creek				Battle creek	Sacramento main stem below Red Bluff	Feather River		Yuba River	American River	Cosumnes River	Mokelumne River	Stanislaus River	Tuolumne River	Merced River	Others[a]
Year	Late-fall	Winter	Spring	Fall	Fall	Fall	Spring	Fall	Fall	Fall	Fall	Fall	Fall	Fall	Fall	All races combined
1964	[b]	[b]	[b]	150[c]	16	6	3	38[c]	35	59	2	2	4	2	0.04	7
1965	[b]	[b]	[b]	107[c]	9	2	0.7	23[c]	10	39	0.8	1.3	2	3	0.09	2
1966	[b]	[b]	[b]	124[c]	3	3	0.3	21[c]	8	27	0.6	0.7	3	5	0.04	1
1967	[b]	[b]	[b]	84[c]	5	9	0.1	12[c]	24	23	0.5	3	12	7	0.6	1
1968	[b]	[b]	[b]	116[c]	6	12	0.2	18[c]	7	31	1.5	1.7	6	9	0.5	2
1969	[b]	[b]	20	130	6	18	0.3	61[c]	5	47	4	3	12	32	0.6	5
1970	[b]	[b]	4	70	7	6	0.2	62[c]	13	37	0.6	5	9	18	5	5
1971	17	53	6	59	5	23	0.5	47[c]	6	52	0.5	5	14	22	4	5
1972	33	35	7	36	5	15	0.3	47[c]	9	25	1.6	1.1	4	5	3	3
1973	22	23	7	44	8	17	0.2	74[c]	24	95	0.9	3	1.2	2	1.1	6
1974	6	19	4	49	4	28	0.2	66	18	62	0.3	1.4	0.8	1.1	2	8
1975	18	23	10	55	5	36	0.7	43	6	40	0.7	1.9	1.2	1.6	2.4	15
1976	16	33	25	57	5	36	0.7	62	4	28	0	0.5	0.6	1.7	1.9	1
1977	9	16	13	40[d]	[b]	46	0.2	46	9	48	0	0.3	0	0.4	0.4	3
1978	12	25	6	35	4	48	0.2	38	7	21	0.1	1.1	0.05	1.3	0.6	3
1979	10	2	3	48	13	67	0.25	33	12	48	0.15	1.5	0.11	1.2	2.1	2
1980	9	1	9	22	14	30	0.7	35	13	50	0.2	3.2	0.1	0.5	2.8	2
1981	7	20	21	29	17	43	1.0	53	13	64	-	5.0	1.0	14.3	10.4	10

[a] This includes streams which a few hundred chinook salmon enter most years (e.g., Mill, Deer, and Dye creeks) as well as streams which chinook salmon enter only in wet years (e.g., Dry and Singer creeks and the Calaveras River).

[b] No estimate.

[c] Some spring-run fish may have been included in the fall-run estimate.

[d] Includes Battle Creek.

APPENDIX TABLE 6. Coded-Wire Tags from Chinook Salmon Carcasses Recovered in Central Valley Streams North of the Feather River and at Coleman Hatchery, 1981.

CWT Code	Hatchery of Origin	Number of Recoveries by Location					
		Coleman	Tehama-Colusa	Mill Creek	Red Bluff DD	Unknown	Total
H5-2-6	USF&WS	1					1
H5-2-7	"	2					2
H5-3-1	"	8					8
H5-3-2	"	6					6
H5-3-4	"	1					1
H5-3-5	"	8					8
H5-3-6	"	3					3
5-3-20	"	1	8				9
5-4-52	"	1	5				6
5-6-18	"		5				5
5-6-19	"		6		1		7
5-6-20	"	1					1
6-41-2	Feather R.		3		1		4
6-41-3	"	7	3				10
6-41-4	"	7	6				13
6-41-5	"		3				3
6-41-6	"	1	1				2
6-41-7	"	1	5				6
6-41-8	"	1	2				3
6-48-9	Mokelumne		1				1
6-48-10	"		2				2
6-48-12	"	1	15				16
6-48-13	"	1	1				2
6-48-14	"	2	3				5
6-48-15	"		1				1

(Continued on next page)

APPENDIX TABLE 6. Coded-Wire Tags from Chinook Salmon Carcasses Recovered in Central Valley Streams North of the Feather River and at Coleman Hatchery, 1981 (continued).

CWT Code	Hatchery of Origin	Number of Recoveries by Location					
		Coleman	Tehama-Colusa	Mill Creek	Red Bluff DD	Unknown	Total
6-58-11	Feather		1				1
6-58-12	"		1				1
6-58-13	"		26				26
6-58-16	"	2	18				20
6-58-17	"	3	12				15
6-58-18	"	12	51				63
6-60-12	Coleman	3	2				5
6-60-13	"	6					6
6-60-14	"	6					6
6-60-15	"	8					8
6-60-22	"	56	6				62
6-60-23	"	67					67
6-62-3	Feather R.	1	3				4
6-62-5	"		1				1
6-62-6	"	3	5	2			10
6-62-7	"		1				1
6-62-8			2				2
6-62-9		3	4				7
6-62-11			1			1	2
6-62-12		2	10				12
TOTALS		225	214	2	2	1	444

APPENDIX TABLE 7. Coded-Wire Tag from Chinook Salmon Carcasses Recovered in Central Valley Streams and Hatcheries from the Feather River and South, 1981.

Code	Hatchery of Origin	Number of Recoveries by Location								
		Feather R. Hry.	Nimbus Hry.	Mokelumne R. F.I.	Merced R. F.F.	Feather R.	Yuba R.	American R.	Mokelumne R.	Total
6-41-1	Feather	1								1
6-41-3	"	1								1
6-41-4	"	2	1							3
6-41-6	"	1								1
6-46-10	Merced				2					2
6-46-11	"				30					30
6-48-9	Mokelumne		3					3		6
6-48-10	"	5						2		7
6-48-11	"		4	53				4	4	65
6-48-12	"	1	11	5	2			4		23
6-48-14	"			1						1
6-48-15	"	2		4						6
6-58-9	Feather	1								1
6-58-11	"	7				2				9
6-58-12	"	29				1		1		31
6-58-13	"	7	1				2			10
6-58-16	"	3	1			1				5
6-58-17	"	6						1		7
6-58-18	"	4		1	1					6
6-58-19	"	17								17
6-62-3	Feather	4				1				5
6-62-4	"	2								2
6-62-5	"	1	1							2
6-62-6	"	7	1			1		2		11
6-62-7	"	24								24
6-62-8	"	38	1			3				42
6-62-9	"	22				1		1		24
6-62-10	"	14				3				17
6-62-11	"	15	1							16
6-62-12	"	25				2		3		30
TOTALS		239	25	64	35	15	2	21	4	405