State of California
The Resources Agency
Department of Fish and Game

KING SALMON (ONCORHYNCHUS TSHAWYTSCHA) SPAWNING STOCKS OF THE CALIFORNIA CENTRAL VALLEY, 1953-1969 1/

by

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SUMMARY

This paper lists counts and estimates of king salmon (Oncorhynchus tshawytscha) spawning escapements in the Sacramento-San Joaquin River System from 1953 through 1969. Methods used are discussed.

King salmon are the only salmon of any importance in Central Valley streams. Three basically different runs of king salmon enter the Valley; fall, spring and winter run. Fall-run fish are most numerous; they enter streams in the fall or winter and usually spawn within a few weeks of their arrival. Spring-run salmon are now the least numerous; they enter in the spring, spend the summer in the deeper holes and spawn in the fall. Winter-run fish are confined to the main stem of the Sacramento River. They enter in the winter and spawn from mid-spring to early summer.

Major changes in salmon streams since 1959 include a storage dam (unladdered) on the Feather River near Oroville and a major diversion dam (laddered) on the Sacramento River near Red Bluff.

TABLE 1

SUMMARY OF SPAWNING ESCAPEMENT IN CENTRAL VALLEY
1953-1969 (in thousands of fish)

Year	Sacramento and Tributaries	Mokelumne and Cosumnes	San Joaquin Tributaries
1953	513	4	80
4	412	9	66
5	369	4	27
6	153	1.5	11
7	101	3	12
8	234	8	38
9	420	2	50
1960	415	3	53
1	251	0.1	2.6
2	251	1.2	0.6
3	292	1.5	0.3
4	304	4.2	6
5	189	2.1	5
6	187	1.3	8
7	158	3.5	20
8	191	3.2	16
9	270	6.7	45

1/ Anadromous Fisheries Administrative Report No. 70-11

INTRODUCTION

This paper lists the best available counts and estimates of king salmon spawning escapements in the Sacramento-San Joaquin River System from 1953 through 1969 (Figure 1). It is an updating of a paper of similar title covering the period 1940-1959 (Fry, 1961). The escapements from 1953-1959 appear in both papers. Prior to 1953, the available escapement data covered only scattered streams and there were no estimates for the entire valley. The escapements in 1953 were higher than any that have been recorded since; this might give the impression that pre-1953 escapements were still higher, but even though the earlier data are incomplete, we can say that spawning escapements in the years immediately prior to 1953 were on an upswing and that 1953 represents a peak.

Most of the escapement counts and estimates given in the accompanying tables were made by the California Department of Fish and Game; the remainder were by the U. S. Bureau of Sport Fisheries and Wildlife.

METHODS USED

Estimates from Carcass Counts

The largest part of the escapement figures listed are estimates made by Fish and Game crews who walked or floated the spawning area of each stream involved, counted the spawned-out salmon carcasses, estimated the proportion of carcasses that should have been recoverable under the existing water conditions and calculated the probable number of spawners in the stream. The number of trips on each section of stream varied from one in small unproductive creeks, to more than ten in some of the more important sections of heavily used streams. To prevent counting any carcass a second time, each was cut in half as it was found.

Tag and Recovery Experiments

When a tag and recovery program is used to estimate the salmon population of a stream, a substantial number of fish should be caught and tagged near the downstream end of the spawning area, then released and allowed to spawn naturally. After the fish have spawned and died, the ratio of tagged to untagged fish is determined, and the size of the entire run is calculated. Estimates from carcass recoveries can be made more reliable if preceded (in an earlier year) by one or more tag and recovery experiments in the same stream, because the proportion of tags recovered is an excellent measure of the proportion of spawned-out carcasses which can be recovered in that same stream. Unfortunately, the tag and recovery method was seldom used during the 1953-1969 period.

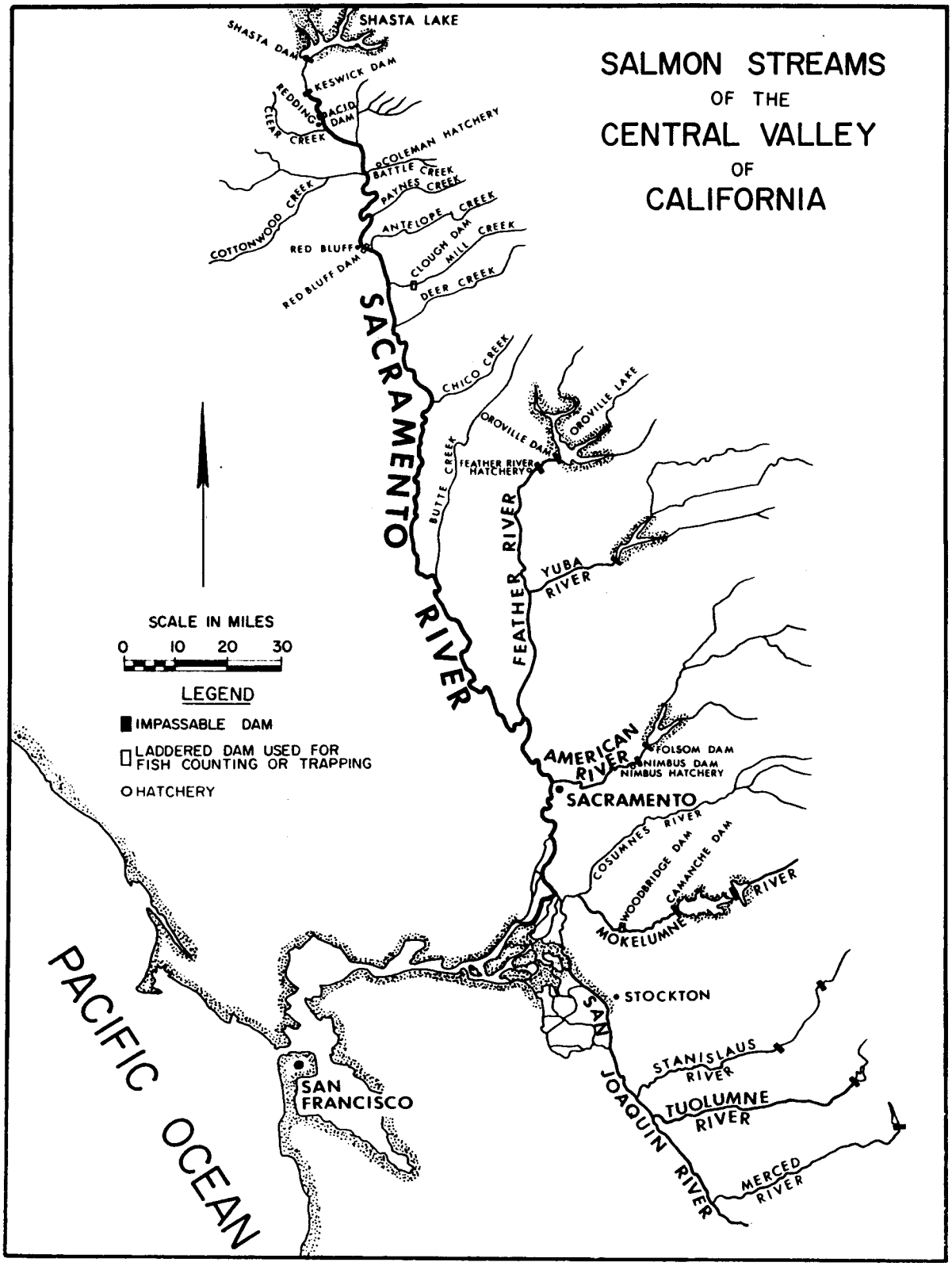

Figure 1. Salmon streams of the Central Valley. Showing salmon hatcheries impassable dams, and those laddered dams used for fish counting or trapping.

Counts

Relatively few counts of salmon were made in the Central Valley from 1953 through 1969 and all those which were made were fishway counts at dams, i.e., counting racks were not used.

When properly done under ideal conditions, counts will give an exact, or nearly exact, determination of the number of spawners going past a given point, but unfortunately counts at low dams are normally subject to several important sources of error:

1. Fish may be getting over the dam without going through the fishway. Careful observation will usually reveal whether or not this problem exists, and if it exists, how serious it is. Quite often, it is possible to make a very good estimate of the fish jumping the dam and use this figure to supplement the fishway count. The problem is usually much worse during periods of high water.

2. Fish sometimes drop back over the dam and make a second trip through the fishway. Again, careful observation will often reveal the magnitude of the problem.

3. Because of limited manpower, counting is often done only at certain times of day, usually during daylight hours. If it is practical to close the ladder when no counter is present, the closure does not interfere with the accuracy of the count, but if for any of a number of reasons, the ladder must be left open, it then becomes necessary to estimate the numbers of fish that went through during the period when the ladder was unattended.

4. Misidentification can be a problem; for example, steelhead may be mistaken for king salmon grilse, or vice-versa.

5. Probably the most important disadvantage of fishway counts is that in most instances, there is a considerable amount of spawning area below the dam, and thus the count must be supplemented by an estimate to give a true picture of the spawning run of the stream in question.

Counts at the Red Bluff Diversion Dam

In 1966 the Red Bluff diversion dam was completed on the Sacramento River a short distance down stream from the city of Red Bluff. The structure normally raises the forebay level about 12 feet above tail-water. It is equipped with 11 vertical undershot gates. These gates are lifted enough to let the Sacramento River flow under them while providing the necessary forebay elevation.

Counts have been made at the Red Bluff Diversion Dam since August of 1966.

The U. S. Bureau of Sport Fisheries and Wildlife is counting the fish which move through the two ladders--one on each bank. This is done by closed circuit television. One counter watches the two television screens and tallies the fish from both fishways as they move through a narrow gate and past a submerged window. The location of this dam is such that an accurate count of the upstream migrants at this point would include about 90 percent of the spawners in the main stem of the Sacramento River and all those in Battle, Cottonwood, Cow and Clear Creeks. Counts here would be exceedingly valuable. Eventually it may prove possible to make an accurate determination of the numbers going past this point but at present there are some serious difficulties to overcome.

Normally it is impossible to see a salmon go through the vertical undershot gates. Few or many may be dropping downstream through them and the water velocities there are such that it is not unreasonable to assume that large numbers may be moving upstream beneath the gates even when they are partly closed. We know that fish move through when the gates are wide open, and there are prolonged flood periods when the gates must be left open.

A lesser difficulty involves relatively long periods of high turbidity when it is impossible for the counter to see the fish in the fishway. Until we can determine the magnitude of salmon movement through the gates at the Red Bluff Dam the counts there cannot be regarded as more than an index of abundance.

Aerial Redd Counts

Another method of estimating salmon numbers which was occasionally used in the Central Valley involves aerial redd counts. If the water is relatively clear and shallow, a fresh salmon redd is easy to see from the air, but there are often difficulties in attempting to estimate the total number of redds in a stream. For example, it is a common occurrence for many fish to spawn so closely together that the number of individual nests cannot be determined. If winter flows are moderate, the old redds may not be smoothed out and the next season the remnants of these remains of redds can be thoroughly confusing. If the water is not clear, or if a substantial amount of spawning takes place in water that is too deep for good visibility, the problem is still further complicated.

SALMON RUNS OF THE CENTRAL VALLEY

The king salmon is the only native salmon of any importance in Central Valley streams. A relatively large-scale attempt to introduce silver salmon (O. kisutch) was started in 1956. It has proven unsuccessful. The other three species of Pacific salmon native to North America have all been taken in the Sacramento System, but the numbers involved are very small (Hallock and Fry, 1967).

There are three basically different runs of king salmon present in the Central Valley:

Fall Run

Fall-run fish enter the streams in the fall or winter and usually spawn within a few weeks of their arrival at the spawning grounds. Fall-run fish are the most numerous, and are found in most of the streams that have any salmon at all. There are many streams which have only a fall run.

There is considerable variation in the timing of fall runs in different valley streams. Fall-run salmon bound for the main stem of the Sacramento River start through the Delta in numbers in late August or early September, reach peak numbers in late September or early October and some are still going upstream in January. In general, the Sacramento tributary runs start somewhat later. The bulk of the fish enter the tributaries in October or November but, as in the main stem, a few are still going upstream in January. In some streams the run may not start upstream until December, because there is not enough water for salmon until after the first fall rains.

Late Fall Run of the Sacramento Main Stem

In the main stem of the Sacramento there is a late fall run which appears to be genetically distinct from the earlier part of the run. The fish arrive around the first of the year, and like other fall-run fish, spawn soon thereafter. They average somewhat larger than other salmon of the Central Valley. There are indications that these late fall-run fish are present in larger numbers than was formerly suspected.

Spring Run

Spring-run salmon enter the streams in the spring, spend the summer in the deeper holes and spawn in the fall. They can survive only where there are relatively low summer temperatures. When possible the spring run moves much farther upstream than the fall run, thus reaching areas where the water remains cooler. On some valley streams, dams have blocked the spring runs, and water temperatures rise rapidly as a result of reduced summer flows. In quite a few such streams, the spring run has dwindled away to extinction under these adverse conditions. By way of contrast fall-run fish in the same stream may be in quite good condition because the run does not arrive until after the water has begun to cool off. As a result, in the Central Valley, spring-run salmon have become much less numerous than those of the fall run.

The Sacramento Main Stem has the largest remaining spring run but, even though summer temperatures are no problem, this run is not doing well. Runs in the tributary streams are in even worse condition and many of those that still exist are little more than remnants.

Spring-run escapements listed in this report are not at all complete. To make a stream-by-stream estimate of the spring run would require considerably more man power than has been available for the job. Eventually counts at the Red Bluff Dam should make it possible to determine the size of the spring run in the upper Sacramento River plus the tributaries entering it above Red Bluff. All the problems involved in determining the number of salmon passing Red Bluff Dam apply to the spring run, and there is an additional difficulty in that the spring-run fish are mixed with the more numerous winter run. Proper separation of these two groups of fish would be possible, and work with that end in mind is now progressing.

Winter Run

After the completion of Shasta Dam (1943), the winter run was probably down to a few hundred fish (Slater, 1963). Since that time, these fish have increased to become the second most numerous group in the Central Valley. As used in this paper, the term winter-run is applied only to fish that enter the river in the winter and spawn from mid-spring to early summer. For all practical purposes, this run exists only in the main stem of the Sacramento River. Carcass count surveys made for the fall run pick up no winter-run fish because they do not spawn until long after the survey is completed. Annual carcass counts are not being made to estimate the winter run. During years when floods do not interfere, it should eventually be possible to get a complete count of the winter run at Red Bluff Dam since all winter-run fish spawn above this point.

MAJOR CHANGES IN SALMON STREAMS SINCE 1959

The individual salmon streams of the Central Valley are discerned in Fry, 1961 (p. 59-60). The following includes only additions and alterations to that report.

Sacramento River

Red Bluff Diversion Dam

A large diversion dam has been constructed on the Sacramento River below Red Bluff. There are two fishways, one on each bank of the river. The problems involved in counting fish at this point are discussed above under "Counts at the Red Bluff Diversion Dam".

Feather River

Oroville Dam

A major storage dam has been built above Oroville on the main stem of the Feather River. The dam is a total block to migrating salmon and has eliminated spawning in some of the main stem and all of the North Fork, Middle Fork, South Fork and West Branch. An interim facility was used from September 30, 1963 to June 30, 1967, to trap upstream migrating salmonids and transport them above the dam site during the construction period. In the fall of 1967 Oroville Reservoir began to fill.

Feather River Hatchery and Spawning Channel

A major salmon and steelhead hatchery and a large spawning channel were built by the Department of Water Resources opposite the town of Oroville to mitigate for the damage to salmon and steelhead runs resulting from the construction of Oroville Dam. The facilities are operated by the Department of Fish and Game on funds provided by Water Resources. The hatchery has a capacity of 15,000,000 eggs, and the spawning channel another 3,000,000 eggs.

Sacramento River Chinook Disease has caused catastrophic losses at this hatchery.

Sutter Butte and Great Western Diversion Dams Removed

After the construction of the Oroville Dam complex, neither Sutter Butte nor Great Western Diversion Dams were needed to divert water into their respective irrigation canals. (This is now done from Thermalito Afterbay which is an off-river reservoir filled from Oroville Dam.)

Sutter Butte Dam (5 miles below the town of Oroville) was removed on December 20, 1967, and the Great Western Dam (2 miles below Oroville) was taken out in 1969. Some additional spawning area is provided by the removal of these two structures.

Mokelumne River

Pardee Dam

Pardee Dam was the upper limit of salmon migration on the Mokelumne River from 1929 to 1963 although apparently very few fish went that far.

Camanche Dam

Camanche Dam is an impassable storage dam which was completed in 1963. It is 12 miles below Pardee Dam and cut off the best of the Mokelumne River spawning area.

Mokelumne River Spawning Channel and Hatchery

As mitigation for the loss of spawning area resulting from the construction of Camanche Dam the East Bay Municipal Utility District constructed a spawning channel with a capacity of 2,000 adult female salmon and a small hatchery (capacity to raise 100,000 steelhead to yearling size).

Woodbridge Fish Screen

For decades the lack of a fish screen on the Woodbridge Irrigation District Canal has been a major block to the rehabilitation of Mokelumne River salmon runs. When Camanche Dam was constructed the Mokelumne River was brought under more complete control and the Department could only expect a reduction in the spring flows during the period when downstream migrants were on their seaward journey. The proportion of downstream migrants lost into the Woodbridge Canal could only get greater, and the already poor survival of young salmon could only get worse. The spawning channel and the hatchery could not be expected to maintain or rebuild the salmon run if the canal remained unscreened. In May, 1968 a rotary drum screen was completed using funds provided by the Federal Anadromous Fish Act, Woodbridge Irrigation District, and the Wildlife Conservation Board.

Merced River

New Exchequer Dam

Exchequer Dam on the Merced River was not large enough to provide the water storage needed to supply increasing demands. It has been replaced by a larger dam and the storage capacity at that location has been increased from 281,000 to 1,026,000 acre feet. An agreement is now in effect under which additional water for salmon will be provided.

STREAMS NOT LISTED IN THE 1940-59 REPORT

Several streams which were formerly included under the heading "miscellaneous small tributaries" are now listed separately. These include Antelope, Bear, Clear, Cottonwood, and Cow Creeks, all of which are tributary to the Sacramento River above Deer Creek. The miscellaneous classification (others) is now much smaller.

In 1963, for the first time, the survey included several small streams which come out of the foothills and reach the Sacramento River via the Natomas East Drain or the Natomas Cross Canal, both of which enter the Sacramento River between the Feather and American Rivers. The streams in question are Secret Ravine, Miners Ravine, Antelope Creek (not the Antelope Creek listed in the previous paragraph), Auburn Ravine, and Coon Creek. Apparently in dry falls, these streams are not available to salmon. Prior to 1962, we had not known that salmon were using them at all.

COMPARISON OF AVERAGE FALL RUNS OF THE VALLEY STREAMS, 1953-1969

There are 17 fall run salmon streams in the Central Valley which we have listed by name (Figure 2). We will briefly discuss the salmon production of a few of these and the reasons why they seem to be doing well or poorly.

In most years one Valley stream, the main stem of the Sacramento River, has had more spawning salmon than all the others combined. Second and third in importance are the Feather and American Rivers, which are tributary to the Sacramento. All three of these rivers have adequate flows and pollution has not become a limiting factor in any of them. Salmon have no trouble getting from the ocean to the spawning beds. Downstream migrants have suffered losses at diversions in the streams and in the delta but such losses have presumably taken a smaller proportion of the young fish than in the San Joaquin tributaries or in the Mokelumne.

Fourth and seventh in number of salmon spawners are two San Joaquin tributaries, the Tuolumne and Stanislaus Rivers. Both of these streams have suffered serious declines and have been subject to more extreme fluctuation than the Sacramento or its major tributaries. On both the Tuolumne and the Stanislaus there are major irrigation diversions above the salmon spawning areas which result in low summer flows that are too warm for salmonids. The low flows have permitted large scale willow encroachment on the spawning beds and at times the irrigation demands have reduced the flows so early in the year that millions of young salmon have failed to make their downstream migration and have failed to survive the high summer temperatures. The Tracy Pumping Plant has withdrawn such quantities of water from the Sacramento-San Joaquin Delta that it has reversed the direction of flow in some main channels and reduced the flow past Stockton to the point where pollution there causes an oxygen block which stops the upstream migration of salmon bound for the Stanislaus, Tuolumne and Merced Rivers. In most years the oxygen block clears up in time for the salmon to reach the spawning beds. In 1961 it apparently did not clear up in time and in that year the combined runs into these three streams dropped by 95 percent. Although this disastrous season appears to have had a severe effect on upstream migrating adults, water shortages in the San Joaquin Valley have usually done more damage to the downstream migrants. Presumably this is because in a dry year the irrigation demand not only takes a larger proportion of the stream flow, but starts taking it earlier in the year when the downstream migration is heavy.

The Mokelumne River (12th on the list) is another stream that has been producing far fewer salmon than its potential. Presumably the lack of a fish screen at Woodbridge has been the major cause although pollution and low flows have also worked against the salmon. Now that the Woodbridge Fish Screen has been constructed the losses of downstream

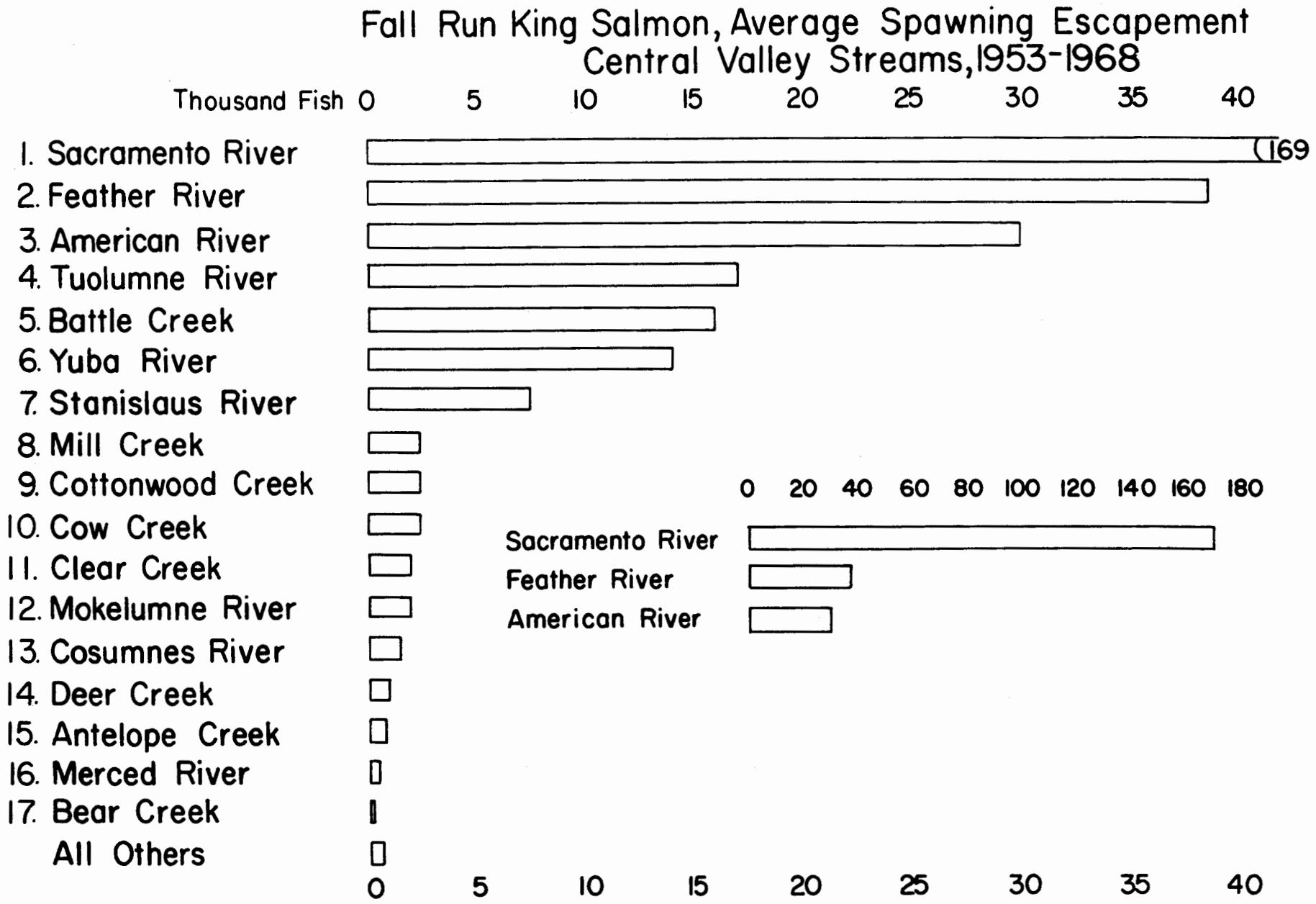

Figure 2. Average spawning escapement of Fall-run king salmon in 17 Central Valley Streams, 1953-1968.

migrants should be far less. The construction of Camanche Dam has reduced the available natural spawning area but the spawning channel constructed to mitigate for that loss is more than large enough to handle the small runs of recent years.

The spring run of the Merced River (No. 16) has disappeared entirely and the fall run has been on the ragged edge of extinction for decades primarily because of a storage and diversion schedule which has produced an extreme shortage of water at critical times. The additional storage capacity resulting from the construction of New Exchequer Dam has made it possible to obtain additional water and there seems to be hope of substantial improvement, even though the Merced still has all the problems shared by all San Joaquin tributaries.

FLUCTUATIONS IN ESCAPEMENT

The estimated escapement of the Central Valley was higher in 1953 than in any year since. This is the earliest year of record for the entire Valley. Estimates for the main stem of the Sacramento go back to 1939 and lead us to believe that the total escapement for the Valley was probably higher in 1953 than in 1939 or any year since (Figure 3).

From the peak in 1953 the escapements dropped very rapidly; 1956 and 1957 were the two lowest years since 1953 for the Central Valley total, for the main stem of the Sacramento River and for the Sacramento tributaries (Figure 4). The southern streams (Mokelumne and San Joaquin tributaries) also had very poor years during 1956 and 1957, but there have been worse ones since (Figures 5 and 6). Recovery was quite rapid and in both 1959 and 1960 there were good escapements in all major areas.

In 1961 there was a drop which affected all areas. In the Sacramento River and its tributaries the decline was not of disastrous proportions. It is our belief that in 1961 there was a drop in the number of adults which came in through the Golden Gate and that there would have been a moderate decline in all areas of the Valley even if 1961 had been a normal water year. The drought conditions that did occur had a serious additional effect on the adults that tried to move into the San Joaquin tributaries, the Mokelumne and the Cosumnes. Quite possibly it affected runs into some lesser Sacramento tributaries but we doubt that fall water conditions kept any upstream migrants from entering the Sacramento or its major tributaries.

In the San Joaquin system (as previously mentioned) the 1961 runs were down to about 5 percent of the 1960 level. The 1962 and 1963 runs were even worse [2/], and not until 1969 did the spawning escapement return to about its 1959 and 1960 level (Figure 5). The Mokelumne and Cosumnes Rivers were also badly affected in 1961. The escapement into the Mokelumne was 137 fish. The lower part of the Cosumnes was dry through

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2/ Presumably these two low years were the result of low flows and poor survival of young fish in the springs of 1959, 1960, and 1961.

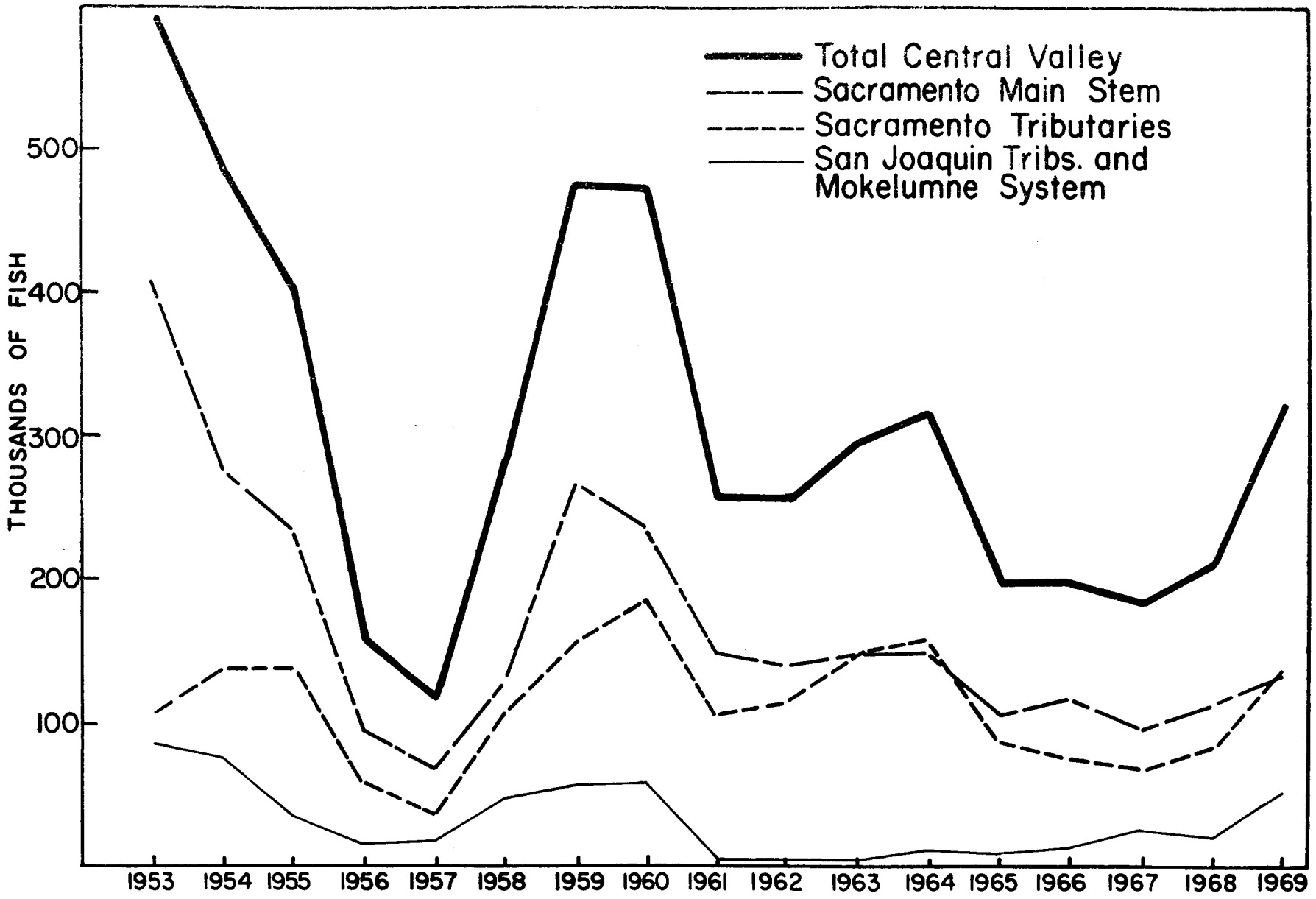

Figure 3. Fall-run king salmon spawning escapement, Sacramento-San Joaquin River Systems.

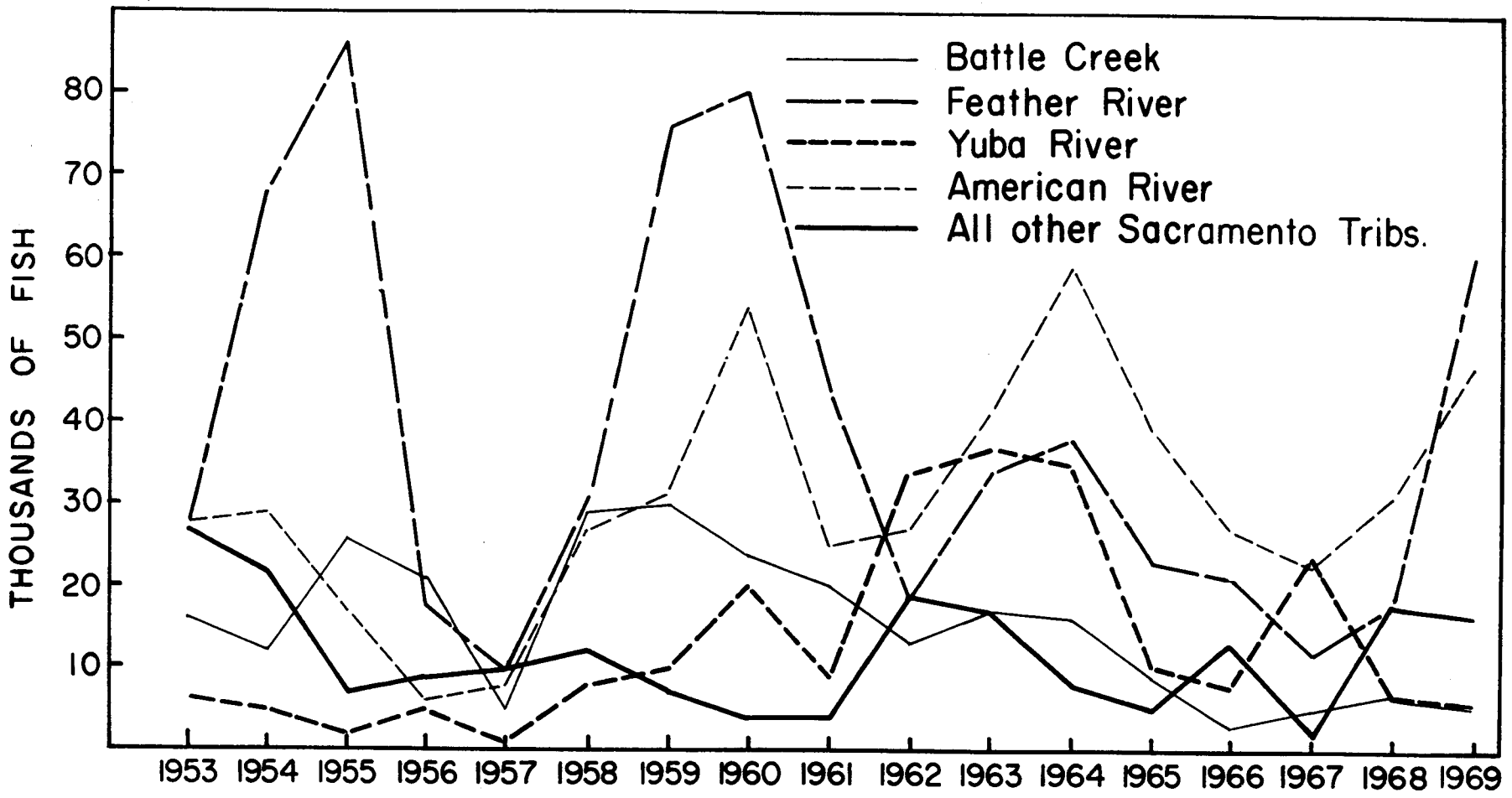

Figure 4. Fall-run king salmon spawning escapement, Sacramento tributaries.

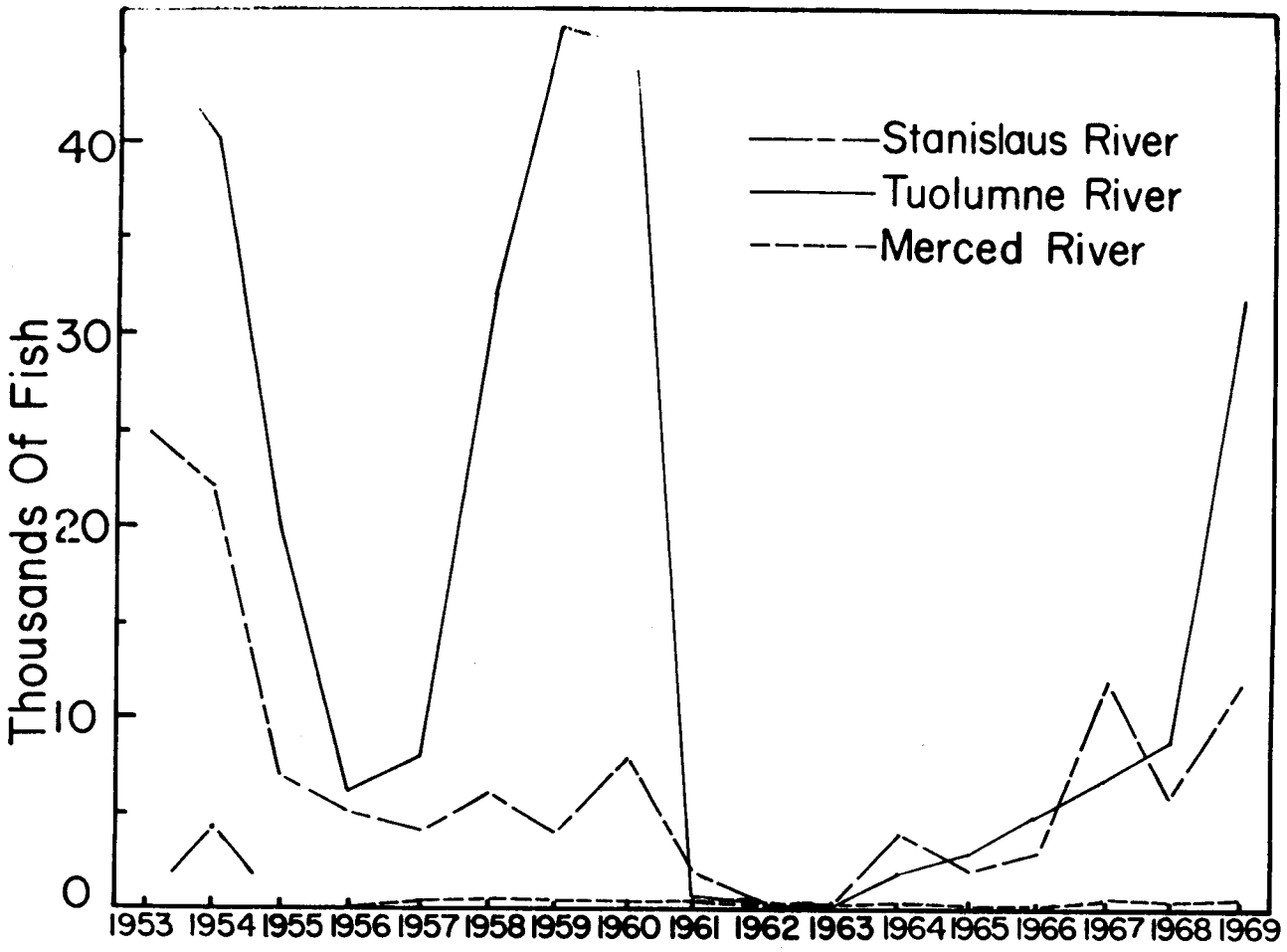

Figure 5. Fall-run king salmon spawning escapement, San Joaquin Tributaries.

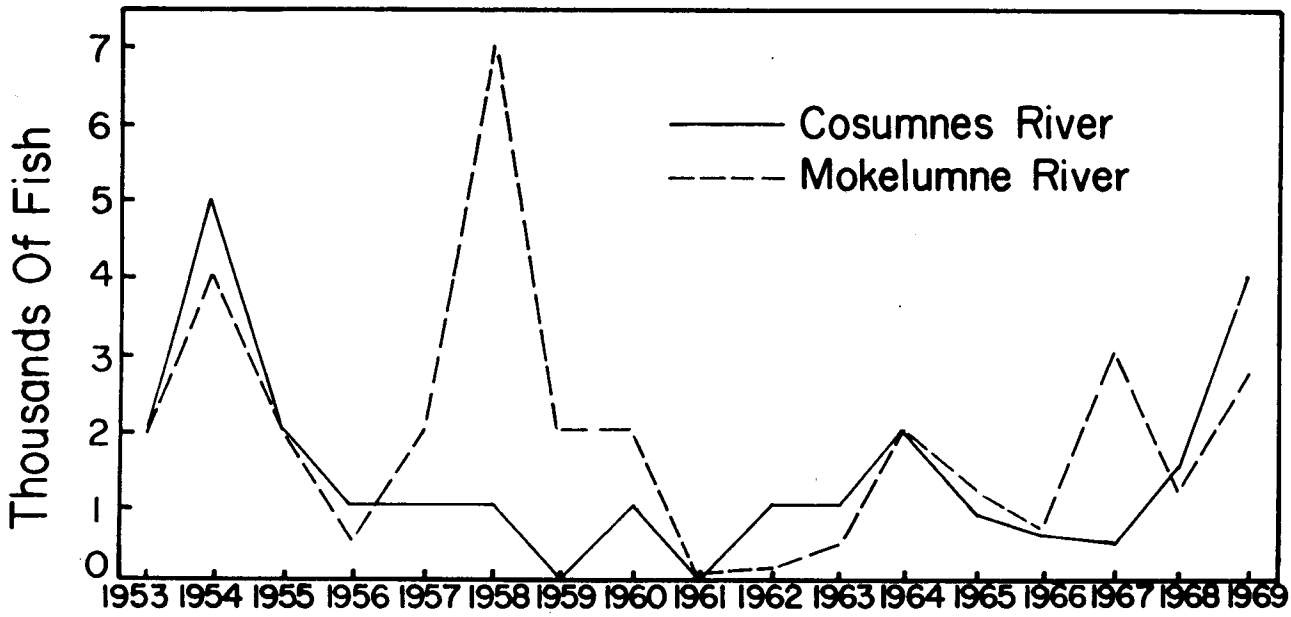

Figure 6. Fall-run king salmon spawning escapement, Mokelumne System.

November, and had very little water in December. After access for salmon became possible the survey crew made one trip to the Cosumnes and found one salmon carcass. The crew made no estimate but we feel justified in assuming that the escapement into the Cosumnes was less than 50 fish (Figure 6).

Runs in the Feather River and in the combined tributaries of the Sacramento declined after 1959. There were four poor years from 1965 through 1968 and a good recovery in 1969 (Figures 3 and 4). Construction of Oroville Dam could have been a major contributor to the Feather's decline and after the construction work had ended and fish facilities were completed it was logical for the Feather River to show improvement. The American River has showed some fluctuation, but has had no really bad years since 1957. Battle Creek has declined rather steadily since 1959 and showed no real signs of recovery in 1969.

TABLE 2

FALL RUN KING SALMON SPAWNING ESCAPEMENT
SACRAMENTO VALLEY STREAMS
(In Thousands of Fish)

YEAR	SACRAMENTO RIVER			CLEAR CREEK	COW CREEK	BEAR CREEK	BATTLE CREEK			COTTON-WOOD CR.	ANTELOPE CREEK
	Natural Spawners	Trapped for Coleman Hatchery	Total				Natural Spawners	Coleman Hatchery	Total		
1953	400a	8c	408	1.5e	3 e	0.8e	4e	12c	16	3 e	4 e
1954	270a	6c	276	3 e,b	4.5e,b	0.5e,b	4e	8c	12	1 e,b	1 e,b
1955	225a	6c	231	0.5e,b	1 3,b	0.2e,b	16b	10c	26	0.8e,b	0.9e,b
1956	91b	3c	94	2.5e,b	3 e,b	* e,b	14b	7c	21	0.7 e,b	0.3e,b
1957	60b	8c	68	0.3b	0.7b	* b	2b	3c	5	0.4b	0.8b
1958	120b	8c	128	1.6b	3 b	0.2b	14b	15c	29	0.6b	0.4b
1959	260b	7c	267	0.8b	0.7b	* b	19b	11c	30	3 b	No Est.
1960	224b	9c	233	0.9b	0.6b	0.1b	14b	10c	24	0.4b	0.2b
1961	144b	5c	149	No Est.	No Est.	No Est.	12b	8c	20	1.5b	No Est.
1962	124b	15c	139	5 b	1.5b	No Est.	8b	5c	13	6 b	0.8b
1963	142b	4c	146	10 b	No Est.	No Est.	12b	5c	17	4 b	0.3b
1964	146b	2c	148	2 b	1 b	0.1b	12b	4c	16	3 b	0.1b
1965	100b	3c	103	2 b	1 b	0.4b	6b	3c	9	0.9b	0.1b
1966	111b	4c	115	0.9b	8 b	0.4b	2b	1c	3	3 b	0.2b
1967	87b	4c	92	0.4b	0.5b	* b	2b	3c	5	0.6b	0.1b
1968	107b	3c	110	0.8b	8 b	0.3b	3b	4c	7	8 b	0.1b
1969	132b	1c	133	1.2b	6 b	0.6b	3b	3c	6	5 b	0.2b

NOTES: * Signifies 50 fish or less.
b Estimate based on carcass recoveries by Dept. of Fish and Game.
c Count by Fish and Wildlife Service.
e Estimate by Fish and Wildlife Service.

TABLE 2 (Continued)

FALL RUN KING SALMON SPAWNING ESCAPEMENT
SACRAMENTO VALLEY STREAMS (Continued)
(In Thousands of Fish)

YEAR	MILL CREEK	DEER CREEK	FEATHER RIVER			YUBA RIVER	NATOMAS DRAINAGE	AMERICAN RIVER			OTHER STREAMS	SACRAMENTO VALLEY TOTAL
			Natural Spawners	Hatchery & Sp. Channel	Total			Natural Spawners	Nimbus Hatchery	Total		
1953	10 b,d	4 e	28 b		28	6b	No Est.	28b		28	0.7e	513
1954	7 b,d	3 e,b	68 b		68	5b	No Est.	29b		29	2 e,b	412
1955	3 b,d	0.6e,b	86 b		86	2b	No Est.	9b	8d	17	* e,b	369
1956	0.9b,d	0.1e,b	18 b		18	5b	No Est.	4b	2d	6	1.5e,b	153
1957	5 b,d	2 b	10 b		10	1b	No Est.	7b	1d	8	0.2b	101
1958	4 b,d	1.3b	31 b		31	8b	No Est.	17b	10d	27	0.2b	234
1959	0.8b,d	* b	76 b		76	10b,f	No Est.	18b	13d	31	1 b	420
1960	0.9b,d	0.8b	80 b		80	20b	No Est.	25b	29d	54	* b	415
1961	1.7b,d	No est.	44 b		44	9b	No Est.	11b	14d	25	1 b	251
1962	4 b,d	2 b	19 b		19	34b	No Est.	14b	13d	27	No Est.	251
1963	1.3b,d	1.2b	34 b		34	37b	0.5b	38b	3d	41	0 b	292
1964	0.4b	0.1b	38 b,g		38	35b	1 b	38b	21d	59	0 b	304
1965	0.2b	0.2b	23 b,g		23	10b	0.2b	25b	14d	39	* b	189
1966	0.5b	0.1b	21 b,g		21	8b	No Est.	19b	8d	27	0.3b	187
1967	0.5b	0.1b	10 b,g	2 d	12	24b	0 b	18b	5d	23	0 b	158
1968	0.8b	0.3b	12 b,g	6 d	18	7b	0.1b	26b	5d	31	No Est.	191
1969	1.7b	0.8b	57 b,g	4 d	61	6b	No Est.	44b	3d	47	1.1b	270

NOTES: * Signifies 50 fish or less.
b Estimate based on carcass recoveries by Dept. of Fish and Game.
d Count by Dept. of Fish and Game.
e Estimate by Fish and Wildlife Service.
f Includes 3,500 fish which died when part of the river dried up.
g May include some spring run fish.

TABLE 3

FALL RUN KING SALMON SPAWNING ESCAPEMENT
SAN JOAQUIN AND MOKELUMNE RIVER SYSTEMS
(In Thousands of Fish)

	MOKELUMNE RIVER SYSTEM					SAN JOAQUIN RIVER SYSTEM				
YEAR	COSUMNES RIVER	MOKELUMNE RIVER			TOTAL	STANISLAUS RIVER	TUOLUMNE RIVER	MERCED RIVER	TOTAL	CENTRAL VALLEY GRAND TOTAL
		Natural Spawners	Mokelumne Spawning Channel	Total						
1953	2 b	2 d		2	4	35 b	45 b	No Est.	80	597
1954	5 b	4 d		4	9	22 b	40 b	4 b	66	487
1955	2 b	2 d		2	4	7 b	20 b	No Est.	27	400
1956	1 b	0.5d		0.5	1.5	5 b	6 b	0 b	11	166
1957	1 b	2 d		2	3	4 b	8 b	0.4b	12	117
1958	1 b	7 d		7	8	6 b	32 b	0.5b	38	281
1959	0 b	2 d		2	2	4 b	46 b	0.4b	50	473
1960	1 b	2 d		2	3	8 b	45 b	0.4b	53	471
1961	No Est.	0.1d		0.1	0.1	2 b	0.5b	0.05b	2.6	254
1962	1 b	0.2d		0.2	1.2	0.3b	0.2b	0.06b	0.6	253
1963	1 b	0.5d		0.5	1.5	0.2b	0.1b	0.02b	0.3	294
1964	2 b	1.8d	0.4d	2.2	4.2	4 b	2 b	0.04b	6	314
1965	0.8b	1.1d	0.2d	1.3	2.1	2 b	3 b	0.09b	5	196
1966	0.6b	0.2d	0.5d	0.7	1.3	3 b	5 b	0.04b	8	197
1967	0.5b	2.8d	0.2d	3	3.5	12 b	7 b	0.6b	20	181
1968	1.5b	0.7d	1 d	1.7	3.2	6 b	9 b	0.5b	16	210
1969	4 b	2.1d	0.6d	2.7	6.7	12 b	32 b	0.6b	45	321

NOTES: * Signifies 50 fish or less.
b Estimate based on carcass recoveries by Dept. of Fish and Game.
d Count by Dept. of Fish and Game.

TABLE 4

SPRING RUN KING SALMON SPAWNING ESCAPEMENT
(In Thousands of Fish)

YEAR	SACRAMENTO RIVER	BATTLE CREEK	MILL CREEK	DEER CREEK	CHICO CREEK	BUTTE CREEK	FEATHER RIVER			CENTRAL VALLEY
							Natural Spawners	Hatchery & Sp. Chan.	Total	GR. TOT.
1953	8 e	2 e	3 e	2 e	No Est.	No Est.	No Est.		No Est.	15
1954	9 e	2 e	2 d	2 e	No Est.	No Est.	3 b		3	18
1955	17 e	2 e	3 d	3 e	No Est.	0.4b	1 b		1	26
1956	7 e	2 e	2 d	3 e	No Est.	3 b	2 b		2	19
1957	No Est.	No Est.	1 d	No Est.	0.1b	2 b	0.5b	No Est.	0.5	No Est.
1958	No Est.	No Est.	2 d	No Est.	1 b	1 b	3 b,i	No Est.	3	No Est.
1959	No Est.	No Est.	1.6d	No Est.	0.2b	0.5b	4 b,i	No Est.	4	No Est.
1960	No Est.	No Est.	2 d	No Est.	No Est.	7 b	4 b,i	No Est.	4	No Est.
1961	No Est.	No Est.	1 d	No Est.	No Est.	3 b	No Est.	No Est.	No Est.	No Est.
1962	No Est.	No Est.	2 d	No Est.	0.2b	2 b	No Est.	No Est.	No Est.	No Est.
1963	No Est.	No Est.	1.3d	1.7d	0.5b	5 b	0.6b,i	No Est.	0.6	No Est.
1964	No Est.	No Est.	1.5d	3 d	0.1b	0.6b	3 d	No Est.	3	No Est.
1965	No Est.	No Est.	No Est.	No Est.	0.1b	1 b	0.7d	No Est.	0.7	No Est.
1966	No Est.	No Est.	No Est.	No Est.	0.1b	0.1b	0.3d	No Est.	0.3	No Est.
1967	No Est.	No Est.	No Est.	No Est.	0.2b	0.2b	No Est.	0.1d	0.1	No Est.
1968	No Est.	No Est.	No Est.	No Est.	0.2b	0.3b	No Est.	0.2d	0.2	No Est.
1969	20 h	No Est.	No Est.	No Est.	0.2b	0.8b	No Est.	0.3d	0.3	No Est.

NOTES: b Estimate based on carcass recoveries by Dept. of Fish and Game.
d Count by Dept. of Fish and Game.
e Estimate by Fish and Wildlife Service.
h Counts and sampling of mixed winter and spring run fish by Fish and Wildlife Service and Dept. of Fish and Game.
i May include some fall run fish.

State of California
The Resources Agency
Department of Fish and Game
Anadromous Fisheries Branch
and
Regions 2 and 4

KING (CHINOOK) SALMON SPAWNING STOCKS IN CALIFORNIA'S CENTRAL VALLEY, 1970[1/]

Edited by
R. S. Menchen
Anadromous Fisheries Branch

SUMMARY

During 1970, the California Department of Fish and Game conducted its 18th annual king (chinook) salmon (Oncorhynchus tshawytscha) spawning stock inventory of the Sacramento-San Joaquin River System. Included in this inventory are fish that spawn primarily from September through December. Fish that spawn in the upper Sacramento River from January through July are not included.

Counts of carcasses, live fish, and redds were the base for spawning estimates in most Central Valley streams. Runs in the Sacramento River above Red Bluff were counted at Red Bluff Diversion Dam. Here salmon are sampled periodically the year round to classify them as to period of spawning.

During 1970, an estimated 243,000 (243,165) king salmon spawned in the Sacramento-San Joaquin River System as compared with an estimated 342,000 fish in 1969. Of these, 205,068 (84%) spawned in the Sacramento River and its tributaries from the American River north.

King salmon counts and population estimates were as follows:

	Fall Run	Spring Run	Combined
Sacramento, Main Stem	71,002	3,652	74,654
Northern Sacramento River Tributaries (North of Chico Creek)	13,730	3,500	17,230
Southern Sacramento River Tributaries (Chico Creek and South)	112,664	520	113,184
San Joaquin River Tributaries (Including the Mokelumne and Cosumnes rivers)	38,097	None	38,097
TOTALS	235,493	7,672	243,165

1/ Anadromous Fisheries Administrative Report No. 72-2. Submitted July, 1971.

Fall-run estimates were made on all major streams and on most minor streams which have a fall run in most years. Some spring-run fish could not be separated from the fall-run fish and were included in the fall-run estimates.

Spring-run estimates are incomplete; they were made on only five streams.

Winter-run salmon spawn almost exclusively in the Main Stem Sacramento River above Red Bluff. None of these fish are included in the estimate; however, they are presented in Table 2 with the number of fall- and spring-run fish counted at the Red Bluff Diversion Dam.

INTRODUCTION

This report covers the 18th annual Central Valley king (chinook) salmon spawning-stock inventory. Estimates and counts were principally of fall-run fish; for a few streams, separate spring-run salmon stock estimates were included. Spring-run salmon were included in fall-run estimates for areas of the Feather River where an overlap in time of spawning made it impractical to separate fall- and spring-run stocks. Winter-run salmon began entering the upper Sacramento River just as the survey ended: these fish are almost entirely confined to the Main Stem of the Sacramento River. The winter-run spawning period extends from April into July; therefore few, if any, winter-run fish were included in the carcass counts. In 1970, the total spawning stock estimate of fall-run king salmon in the Central Valley was 243,000 which was a significant decrease over last year's (1969) estimate of 342,000 fish.

A summary of estimates of all streams for years 1953 through 1970 is presented in Table 1.

METHODS

Most population figures were obtained by counting dead salmon and estimating what percentage of the run was counted. Although this method may not give as accurate an estimate of salmon populations as the use of a counting station, it is at present the most economical method for large-scale statewide programs. Dependability and accuracy of this method is based primarily on two factors: (1) The relationship to tag-and-recovery studies on selected streams. In a tag-and-recovery study, fish are caught, tagged, and released near the downstream end of a spawning area. After the fish have spawned and died, as many carcasses as possible are recovered and the ratio of tagged-to-untagged fish is determined. (2) The availability of a well-trained observer who is familiar with methods of evaluation. The tag-and-recovery method has proven quite valuable as a method of training personnel to estimate the size of the run in a stream. After a man has learned from a tagging experiment the proportion of fish he can

expect to see under certain conditions such as quantity of flow, amount of turbidity, and weather conditions, he is much better able to estimate the size of the run in a stream where no tagging has been done.

Carcasses were examined for fin marks and tags. They were cut in half to determine sex and completeness of spawning and to prevent recounting on subsequent trips. Aerial counts of redds and live fish were used in conjunction with carcass recovery for population estimates in some stream sections. Additional counts were made at fishways, hatcheries, and egg-collecting stations.

During the fall of 1970 the estimated numbers of fall- and spring-run salmon that spawned in the Sacramento River System above the mouth of Chico Creek are based on a combination of counts at the Red Bluff Diversion Dam, plus spawning-bed surveys and carcass counts.

The sole basis for estimating the number of salmon that utilized the Sacramento River and its tributaries upstream from Red Bluff was the counting program of the U. S. Fish & Wildlife Service at the Red Bluff Diversion Dam. Salmon were counted by closed circuit television as they negotiated fishways at the dam. These counts were adjusted for the day and night hours when no counts were made but when the fishway remained open. The adjusted counts were then separated into numbers of fall-, winter-, and spring-run salmon. This was accomplished by regularly sampling a portion of the salmon in the trapping facility adjacent to the east bank fishway. A salmon was assigned to a particular run by taking into account the time of year it passed the dam, plus estimating by its external appearance when the fish would have spawned. Gonads of some fish were also examined.

Spawning-bed surveys and carcass counts were used to estimate the number of salmon that utilized the Sacramento River System between Chico Creek and Red Bluff.

Regions 2 and 4 surveyed streams in their respective areas and prepared individual reports. The Anadromous Fisheries Branch (AFB) surveyed streams in Region 1, served as liason between the regions to assure uniformity of methods, and compiled the regional reports into this annual report. Spawning-stock surveys were conducted by 14 Department of Fish and Game personnel as follows: AFB, four; Region 2, eight; and Region 4, two. These figures do not include personnel at counting stations.

MAIN STEM OF SACRAMENTO RIVER
(Figure 1)

by

Richard J. Hallock and John H. Rowell, Jr.
Anadromous Fisheries Branch

Fall and Spring Run

Estimate Above Red Bluff

At the Red Bluff Diversion Dam, 107,166 salmon were counted from January 4, 1970 through January 2, 1971. When compensating, by interpolation, for periods under a week when counts were not made but when the fishway was open for fish to pass, the figure becomes 114,062. No adjustment was made for the period January 18-March 14, 1970 when high water prevented all counting. An additional compensation of 4.2% is made for nighttime hours when no counts were made (10 PM-5 AM) but the fishway was open. The adjusted count for the year 1970 is 118,853 (Table 2).

During 1970, 4,551 salmon were examined at the trapping facility in the east bank fishway at the Red Bluff Diversion Dam. Sampling revealed that the adjusted salmon count (118,853) consisted of 37,919 winter-, 3,652 spring-, and 77,282 fall-run salmon (Table 2). The spring- and fall-run counts are the total runs for 1970; the winter-run counts represent the tail end of the 1969-70, and early part of the 1970-71 runs.

Based on the five-year average, 1965-59, 85% of the salmon that spawn in the fall above Red Bluff do so in the Main Stem of the Sacramento River, and 15% in tributaries. Therefore, an estimated 68,794 salmon (65,142 fall- and 3,652 spring-run fish) are credited to the Main Stem above the dam in the fall of 1970. This includes 2,844 fall-run fish trapped at Kewsick Dam and spawned artificially at Coleman Hatchery. All spring-run salmon were arbitrarily assigned to the Main Stem Sacramento River even though small numbers are known to regularly enter several tributaries above Red Bluff. We lack data which would permit us to allot numbers of spring-run salmon to any one tributary.

The number of salmon estimated to have spawned in the Main Stem Sacramento River above Red Bluff in the fall of 1970 was broken down into numbers spawning in each of several river sections according to percentages of redds observed in these sections (Table 3). We made two aerial flights to obtain this information (October 26 and November 12, 1970).

Estimate Between Chico Creek and Red Bluff

Spawning stock surveys in the Sacramento River downstream from Red Bluff Diversion Dam began on October 23 and ended on November 19, 1970. The area surveyed was from Red Bluff Diversion Dam to Squaw Hill Bridge near Corning. Although some salmon normally spawn as far downstream as Hamilton City and below, the numbers that utilize gravels downstream from Squaw Hill Bridge have been small in recent years.

Near Red Bluff, flows in the Sacramento River during the fall of 1970 were far from optimum both for salmon spawning and carcass recovery. The river fluctuated between 7,000 and 8,000 cfs during October. However, in early November the flow increased to over 17,000 cfs and remained above 15,000 cfs between November 19 and the end of the month. The flow was over 56,000 cfs on November 28. The mean monthly flow of the Sacramento River near Red Bluff during December was over 32,000 cfs. The water was murky during a good portion of the spawning period, particularly in November and December. We counted 41 salmon carcasses between Red Bluff Diversion Dam and Squaw Hill Bridge during four survey trips. These were made at key times (October 23, 28, and November 3 and 19) during the early part of the spawning season. During aerial flights on October 26 and November 12, we counted 183 redds. Of these, 176 (96%) were between Red Bluff and Tehama Bridge and 7 (4%) were between Tehama and Squaw Hill bridges.

A total estimated 74,654 salmon spawned in the Main Stem Sacramento River between Chico Creek and Keswick Dam during the fall of 1970. This figure includes 71,002 fall-run salmon, of which 65,142 spawned above and 5,860 spawned below the Red Bluff Diversion Dam; and 3,652 spring-run salmon, all of which spawned above the dam (Table 3). No estimate was made of the number of spring-run salmon that spawned below the dam, but some spring-run fish might have been included in this figure.

SACRAMENTO RIVER TRIBUTARIES NORTH OF CHICO CREEK (Figure 1)

Counts at the Red Bluff Diversion Dam were used to estimate the number of salmon that utilized the tributaries above the dam. Fifteen percent of the number counted, that spawn in the fall, was assigned to these tributaries (Table 4). For a more detailed description of methods refer to page 4. Battle Creek was the only stream surveyed above the dam; we combined the estimate from carcass recovery with the count at Coleman Hatchery to estimate the number of spawners in this stream.

Spawning-bed surveys and carcass counts were used to estimate the number of salmon that utilized tributary streams in the fall between Chico Creek and Red Bluff (Table 4). Estimates of salmon spawners in tributaries below Red Bluff include both spring- and fall-run fish where applicable.

Battle Creek and Other Tributaries Above Red Bluff Diversion Dam

Fall Run

Four survey trips were made on Battle Creek, November 5 through December 22, from Coleman National Fish Hatchery to the mouth. Carcass recovery conditions were good in the first three trips, but poor in the last trip.

A total of 332 carcasses was recovered. The run below the hatchery was estimated to be 3,320. Another 3,512 salmon entered Coleman Hatchery bringing the estimated run in Battle Creek to 6,832 fish (Table 4). An estimated 12,140 salmon spawned in the tributaries above Red Bluff Diversion Dam; hence an estimated 5,308 salmon spawned in the tributaries not including Battle Creek.

Spring Run

No estimate was made. Spring-run salmon normally spawn in Battle Creek, and some were observed in North Battle Creek near the mouth of Digger Creek during the spring and summer of 1970 by Region 1 personnel. Tagging experiments and observations have demonstrated that some spring-run salmon spend the entire summer in the Sacramento River, then move into lower Battle Creek below Coleman Hatchery and spawn in late September. Any spring-run salmon that spawned in lower Battle Creek would have been included in the fall-run salmon estimate.

Antelope Creek

Fall Run

Three trips were made on Antelope Creek, November 6, 20, and December 14. We covered about 2-3/4 miles of stream from the USGS gaging station, at the canyon mouth, to 1 mile below Cone Grove Park. On November 6, we did not recover any carcasses or see any redds or live salmon. However, it was raining and the creek was quite murky on that date making observations very difficult. Clear weather and low, clear water in the creek on the last two trips made carcass recovery conditions much better, and as a result we recovered 24 carcasses and saw 103 live salmon. The fall run was estimated to be 400 fish (Table 4).

Spring Run

No estimate was made. Spring-run salmon are known to enter Antelope Creek, but the population size is unknown.

Dye Creek

Fall Run

One survey trip was made on Dye Creek. On November 18, 1970, the creek was covered from Highway 99-E upstream to 1-1/2 miles above the Shasta Boulevard crossing. No redds, carcasses or live salmon were observed. The water was low and clear, making carcass recovery conditions good.

A few young salmon were observed in Dye Creek in the spring of 1971. These may have been diverted through a ditch from Mill Creek or they could have resulted from spawners that entered Dye Creek after November 18. However, based on the available data, we have no estimate of salmon spawning in Dye Creek in 1970.

Spring Run

None.

Mill Creek

Fall Run

Eight survey trips were made on Mill Creek between October 31 and December 28, 1970. The area covered was from the Los Molinos Mutual Water Company's upper dam to the mouth of Mill Creek. Rain and high, muddy water resulted in poor salmon carcass recovery conditions during the second survey trip on November 10. On the remaining survey trips (October 31, November 14, 25, and December 10, 22, 28) the water was stable and clear.

We counted 83 carcasses and 399 live salmon. The run was estimated to be 690 fish (Table 4).

Spring Run

Three survey trips were made on upper Mill Creek (October 4, 11, and 17, 1970). The area covered was from 4-1/2 miles above the Ponderosa Way Road Bridge at Blackrock to the mouth of Little Mill Creek. Salmon carcass recovery conditions were good with clear skies and low, clear stream flows. However, the area was not readily accessible, and there were many deep pools which make the percentage of recovery very low. We recovered 66 carcasses and observed an additional 162 live salmon. It is estimated that the run totaled 1,500 salmon (Table 4).

Toomes Creek

Fall Run

One survey trip was made on Toomes Creek (Dry Creek) in 1970. On November 18 this stream was covered from 1-1/2 miles below to 2-1/2 miles above the Vina-Tehama Road crossing. Carcass recovery conditions were excellent as the water was low and clear.

No adult salmon were observed. However, in the spring of 1971, 72,000 young-of-the-year were sampled from the creek, so apparently some fish spawned in this creek after November 18. Based on the data available, we could not make an estimate of the number of salmon that spawned in Toomes Creek in 1970.

Spring Run

None.

Deer Creek

Fall Run

Three survey trips were made on Deer Creek, November 16 and December 9 and 16. The area covered was from the mouth to the County Road Bridge, which is about 2 miles above the Stanford-Vina Dam. Although the skies were clear when the surveys were made, the stream was muddy and higher than normal resulting in poor carcass recovery conditions.

We counted 30 carcasses and 38 live salmon. An estimated 500 salmon spawned in Deer Creek (Table 4).

Spring Run

During the latter part of September, 1970, two trips were made to upper Deer Creek in the vicinity of Lower Deer Creek Falls. One trip was made by Region 1 personnel and the other by Anadromous Fisheries Branch personnel.

A total of over 200 live fish and 30 carcasses were observed, and it is estimated that the run was 2,000 salmon (Table 4).

Singer Creek

Fall Run

No survey trips were made on Singer Creek in the fall of 1970; however, in the spring of 1971 a few salmon-of-the-year were rescued from this stream. Although no estimate of adult spawners was made, some spawning obviously did take place in the fall of 1970.

SACRAMENTO RIVER TRIBUTARIES, CHICO CREEK AND SOUTHWARD
(Figure 2)

by

Jerry Staley and Richard Painter
Region 2

Chico Creek

Fall Run

No estimate. (In some years a few fall spawners have been observed in the Chico area.)

Spring Run

An inventory was taken on October 1 and 14 to determine the number of spring-run salmon in Chico Creek. As in the past, observations were made by walking from Higgins Hole downstream to the Ponderosa Way Bridge. From the bridge downstream to where the road leaves the creek, we spot-checked the main pools and riffles. No salmon or signs of spawning activity was seen.

A few salmon were observed in Bidwell Park within the city of Chico in the spring of 1970. If these fish survived the summer they might have spawned in the lower reaches of the creek where no surveys were made.

Several of the upper pools of the Iron Canyon Fishway were completely filled with gravel during the late winter and early spring runoff, which may have prevented fish from migrating upstream beyond this point. It is felt however, that during the migration period the normal spring flows enable fish to move up Chico Creek without the aid of the fishway.

Some fingerling salmon were seen in lower Chico Creek in the spring of 1971, so either some spring-run or late fall-run salmon spawned in 1970.

Butte Creek

Fall Run

No estimate. (In some years a few fall spawners have been observed below the Highway 99 Bridge.)

Spring Run

Two survey trips were made on Butte Creek between the Centerville Powerhouse and the Paradise Highway Bridge. The first trip was made September 29-30 and the second October 15-16, 1970. Recovery conditions were good as the creek was low and clear.

We recovered 57 carcasses on 2 survey trips and observed 84 single and 11 multiple redds. Based on this information, it is estimated that 285 spring-run king salmon spawned in Butte Creek in 1970 (Table 5).

Feather River

Fall Run

Weekly survey trips were conducted from October 13 to December 21, 1970. During this period the recovery conditions were judged to be good. Flows were relatively constant.

We recovered 165 fin-marked fish during the spawning-stock survey period as follows:

Mark	Origin	Area released	Age	Males	Females	Grilse*	Total
Ad-RP	Feather R. Hatchery	hatchery	3 yrs	60	76	21	157
Ad-An	"	Rio Vista	3 yrs	2	5	0	7
Ad-LV	Coleman Hatchery	hatchery	2 yrs	0	0	1	1

* Less than about 26 inches total length. These fish were not sexed.

Most of these marked fish were recovered in the area between Oroville and the Thermalito outfall; only 9 were recovered downstream from the outfall. The Ad-RP and the Ad-An marks each were from a group of 100,000 fish of the 1967 broodyear released as yearlings. The Ad-RP fish were released at the hatchery and the Ad-An marks at Rio Vista. The Ad-LV mark was from a group of 100,000 fish from the 1968 broodyear released at the size of 90/lb at Coleman Hatchery.

The estimated population of fall-run adult king salmon utilizing the Feather River from Oroville to Honcut Creek was 58,170 fish. Combining this figure with the 3,355 fish taken at Feather River Hatchery gives a total run of 61,525 fall-run salmon (Table 5).

Spring Run

No holding loss was observed in the river from June through October. No attempt was made to separate spring-run from fall-run fish during the survey trips. The number of spring-run king salmon taken at the Feather River Hatchery totaled 235.

The estimated total run of fall- and spring-run salmon in the Feather River was 61,760 fish (Table 5).

Yuba River

Fall Run

Flow conditions in the Yuba River were ideal for salmon spawning, but not for good carcass recovery during the fall of 1970. The recently completed New Bullard Bar Project by the Yuba County Water Agency began operation in 1970. Power generation at the New Narrows Powerhouse maintained flows in the Yuba River at from 3,000 to 3,800 cfs with only minor water level fluctuations throughout the salmon spawning period.

Because of higher than normal fall flows and turbid water, carcass recovery was difficult. The section of river between the Highway 20 Bridge and Daguerre Point Dam was particularly difficult to survey because willow thickets, fast currents, and multiple channels impaired access to areas where carcasses accumulate.

An estimated 56% of the 1970 run spawned upstream from the Marysville Dam site at Daguerre Point. Fish ladder operation problems at the Daguerre Point Dam may have been responsible for the higher than average percentage of salmon spawning below this point.

An aerial survey was made on November 10, and an estimated 945 redds were seen. Six survey trips were made above Daguerre Point Dam and seven below it. There were 1,377 carcasses recovered. It is estimated that 13,830 salmon spawned in the Yuba River (Table 5).

Not included in the above count were 78 carcasses with clipped dorsal fins which resulted from a plant of 100 marked ripe salmon imported from Nimbus Hatchery on the American River. The majority of these salmon died without spawning, a short time after planting. Apparently, the stress from handling and transporting of these fish was too great for them.

Spring Run

Extinct.

American River

Fall Run

A new survey method was started in the fall of 1970. Salmon carcasses were not cut in two as was done in previous years. Instead, we counted them as they were observed. The intention of the new program was to reduce the survey effort. We counted carcasses every two weeks, and it was assumed that only a small percentage of carcasses were recounted. Three trips were made this season. More trips were planned, but weather conditions prevented any surveys being made after December 15. Since the water was high for a good portion of the season, the percentage of carcasses seen was less than during a normal year.

We counted 1,234 carcasses from Nimbus racks to Watt Avenue Bridge. The estimated population in this section was 25,000 fish. An additional 3,131 carcasses were recovered upstream from the Nimbus racks. Based on an 85% recovery, we estimated that 3,680 salmon spawned between the racks and Nimbus Dam.

There were 8,629 fish that entered Nimbus Hatchery, bringing the total population estimate in the American River to 37,309 fish (Table 5).

Spring Run

Extinct.

Other Sacramento River Tributaries South of Chico Creek

Tributaries to Natomas East Drain and Natomas Cross Canal

Fall Run

No estimate.

No surveys were made of these streams this season because we lacked manpower to do so. There were adequate water flows for salmon in this area and it is entirely possible that some salmon spawned there.

Spring Run

None.

LOWER SAN JOAQUIN RIVER TRIBUTARIES
(Figure 3)

by

Jerry Staley
Region 2

Cosumnes River

Fall Run

Very heavy rains made survey conditions poor for most of the season. High flows during December washed many carcasses downstream, thereby lowering the number that could be recovered. At one time, during the period of high flows, the Michigan Bar guage recorded a flow of 5,000 cfs.

Three survey trips were made between Michigan Bar Bridge and Meiss Road. Altogether, 82 carcasses were counted and the run was estimated to be 600 fish (Table 6).

Spring Run

None.

Mokelumne River

An adult salmon trapping facility was installed in the Woodbridge fish ladder on October 21, and trapping was terminated on December 30, 1970.

Ninety-four salmon were trapped on the first day of operation. December 23 was the last day a fish was taken in the trap. For one month prior to October 21, the flow was 625 cfs. During the period of trapping it varied from 310 cfs on October 29 to 1,500 cfs on December 15. Thus there was always a good attraction flow for fish into the river system. When the trap was in operation all salmon ascending the ladder were counted and sexed. A total of 3,516 salmon were counted in this way, including 1,262 males, 766 females, 919 grilse, and 569 sex unknown. We trucked 548 salmon from Woodbridge to the Mokelumne River Spawning Channel.

I estimate that about 1,500 salmon used the ladder before the trap was installed or passed over the dam during flashboard removal. This figure is based on observations of fish going up the ladder before the trap was installed and number counted on the first day of trap operation. We counted 375 salmon redds in the river above Woodbridge during an aerial count on November 10.

When the count at the trap is added to the estimate of fish which passed the dam but were not counted, an estimate of 5,000 salmon is obtained (Table 6).

Spring Run

Extinct.

UPPER SAN JOAQUIN RIVER TRIBUTARIES
(Figure 3)

by

Jerry Goertzen
Region 4

The salmon spawning stock inventory for the Stanislaus, Tuolumne, and Merced rivers was conducted from November 9, 1970 to January 22, 1971.

Stanislaus River

Fall Run

An adult salmon trap on the Stanislaus River was installed and operated again this season by Region 4 personnel from Moccasin Creek Hatchery. The trap was located about 1/2 mile above Orange Blossom Bridge and operated from October 28 to November 19, 1970. In this period they trapped 1,079 fish of which 174 were females; of these, 109 were spawned and 515,372 eggs taken.

Salmon spawning activity in the Stanislaus River was observed as early as October 19, 1970. The heaviest spawning occurred in mid-November. On the first completed survey of the river (November 12-14), we counted 1,974 live salmon, 500 redds, and 184 carcasses. Most of these were below the salmon trap site. A few salmon entered the spawning area above the trap site before the trap was installed, but this area was not used much for spawning until the trapping was completed. Before the trap was removed, hundreds of salmon were seen milling around in pools below the trap. After it was removed, many of them moved into the upper area. Carcass recovery here was poor because, by the time the trap was removed and fish had completed spawning, the water was high, and heavy rains made dirt roads in this area impassable.

We found 30 unspawned female carcasses in the Stanislaus River during the survey period. All of these were in the near vicinity of the trap. Causes of this mortality were not known, but the delay at the trapping site seems to be a possibility.

Pre-season flows were about 200 cfs at Orange Blossom Bridge. On October 26, 1970 the flow was lowered to 90 cfs to install the salmon trap. On October 31, the flow was raised to 150 cfs for the trap operation. When the trap was removed on November 20, the flow was increased to 500 cfs. By December 5, the flow was increased to 2,000 cfs because of heavy rains, and remained high until the end of February. No major loss of eggs or fry was experienced this season from water fluctuations.

Poaching was heavy again this season prior to November 19 when the water was low and clear. After the trap was removed the flow increased and poaching decreased. Warden activity during the critical period reduced the amount of poaching considerably.

Five fin-marked salmon, three RV, one LV, and one adipose, were recovered in the Stanislaus River this season--all at the trap site. The origin of these marks in unknown.

Five survey trips were made on the Stanislaus River, and 388 carcasses were recovered. The spawning population was estimated to be 9,297 fish, including 247 retained at the trap (Table 6). The spawning population, based on carcass recovery, was composed of 31% females of all sizes, 41% males, and 28% grilse (under 23-7/8 inches FL).

Spring Run

Extinct.

Planting of Yearlings

On November 23 and 24, 1970, 40,500 king salmon yearlings were planted at Knights Ferry Bridge. These were from Stanislaus River strain, 1969 brood, raised at Moccasin Creek Hatchery.

Tuolumne River

Fall Run

The salmon run in the Tuolumne River was later than usual this season because the flow from Don Pedro Dam was shut off during the early part of the migration. Lack of flow was due to a change in operation from Old Don Pedro Dam to New Don Pedro Dam. A 200 cfs release was begun on November 10, 1970, from the new dam. This flow was barely enough to allow the fish to ascend Dennet Dam at Modesto. Fish passage was improved somewhat by placing sand bags at both ends of the dam.

Because of construction problems in Don Pedro Reservoir, the water had to be kept at a low level. When heavy rains occurred in late November, the flow from New Don Pedro had to be increased to 3,000 cfs. The flow fluctuated for the rest of the season according to the amount of rainfall. By late December, flows dropped to 900-1,000 cfs which left carcasses scattered over adjacent gravel tailings and recovery of carcasses was good.

"Market" poachers worked the river from the start of the run until after the peak of spawning. Fish and Game wardens, county sheriff's officers, and city police officers worked together to reduce the poaching problem.

Six survey trips were made on the Tuolumne River and 1,536 carcasses were recovered for an estimated population of 18,400 fish (Table 6). The spawning population, based on carcass recovery, was composed of 43% females, 40% males, and 17% grilse (males under 23-7/8 inches FL).

Spring Run

Extinct.

Merced River

Fall Run

During the months of October and November 1970, the flow in the Merced River was about 200 cfs. The flow was gradually increased to 300 cfs by December 9. The next day the flow was increased to 850 cfs where it remained until the spawning season was completed. Recovery conditions were good above Highway 59 Bridge, only fair from there downstream to Cowell Island, and poor below the Island because of gravel operations.

An artificial spawning channel, constructed by the Merced Irrigation District, went into operation for the first time this fall. It is located at the base of Crocker-Huffman Dam. A grill at the upper end of the channel was pushed out after the salmon had entered the channel. This allowed about 100 salmon to occupy the river above the dam. In addition to these, about another 100 fish spawned in the channel.

The estimated run for the Merced River this season was 4,800 fish--the largest since we started annual salmon inventories in 1953. I believe the causes for this increase were as follows: (i) planting in excess of 100,000 "yearlings" annually starting in 1967 (1965 brood fish), (ii) a significant increase in flows for salmon since 1967; and (iii) very low flow in the Tuolumne River during the early adult migration season which, when combined with the good flows in the Merced River, enticed fish from the Tuolumne to the Merced. I believe this third factor was responsible for the major part of the increase in the run this season. In the early part of the migration only a small number of salmon went into the Tuolumne River, presumably because of very low flows, yet there was a good run in the Merced at this time.

Bear Creek, a tributary to the Merced River, had a noticeable run of salmon this season. No survey was made, but there were many reports of salmon observed and caught in this stream. It is a small stream which flows through the city of Merced. Heavy rains increased the flow enough to encourage fish to enter it.

Five survey trips were made on the Merced River and 788 carcasses were recovered. The estimated population was 4,800 fish, including the estimated 100 salmon that used the new spawning channel (Table 6) but not the 100 salmon that escaped into the Crocker-Huffman pool. Some of these fish were taken by fishermen and some apparently spawned, but outmigrant survival was believed to be near zero. The Merced River spawning population, based on carcass recovery, was composed of 24% females, 46% males, and 30% grilse (males under 23-7/8 inches FL).

Spring Run

Extinct.

Planting of Yearlings

Between November 10 and 20, 1970, 184,860 "yearling" salmon (1969 brood Stanislaus River strain) were planted in the Merced River at the Bettencourt Ranch near the Shaffer Bridge. Many of these fish were seen throughout the survey season from Crocker-Huffman Dam to Cressey. Most of them were believed to have migrated towards the sea by early February.

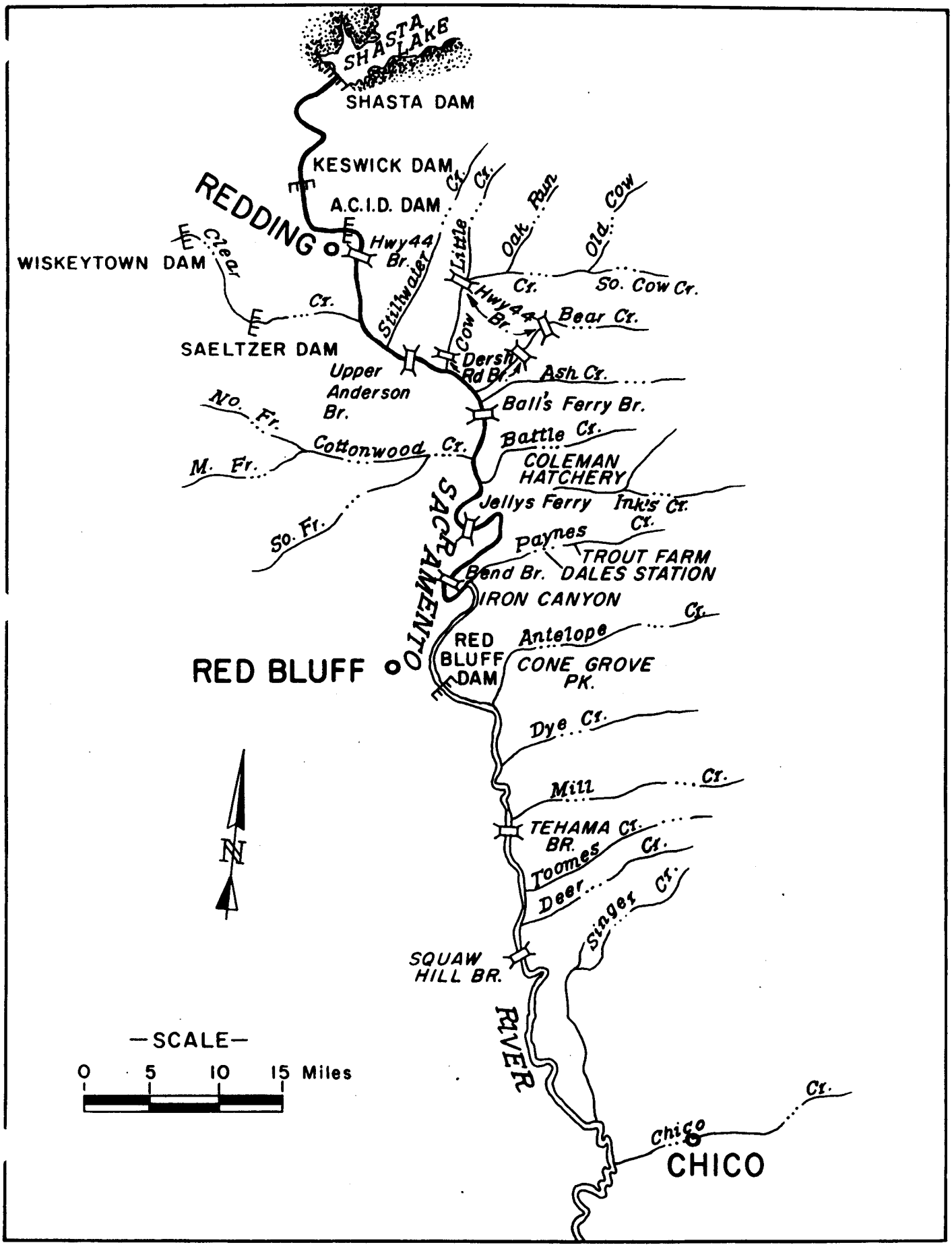

Figure 1. Upper Sacramento River and tributaries above Chico Creek covered during the 1970 king salmon spawning stock survey.

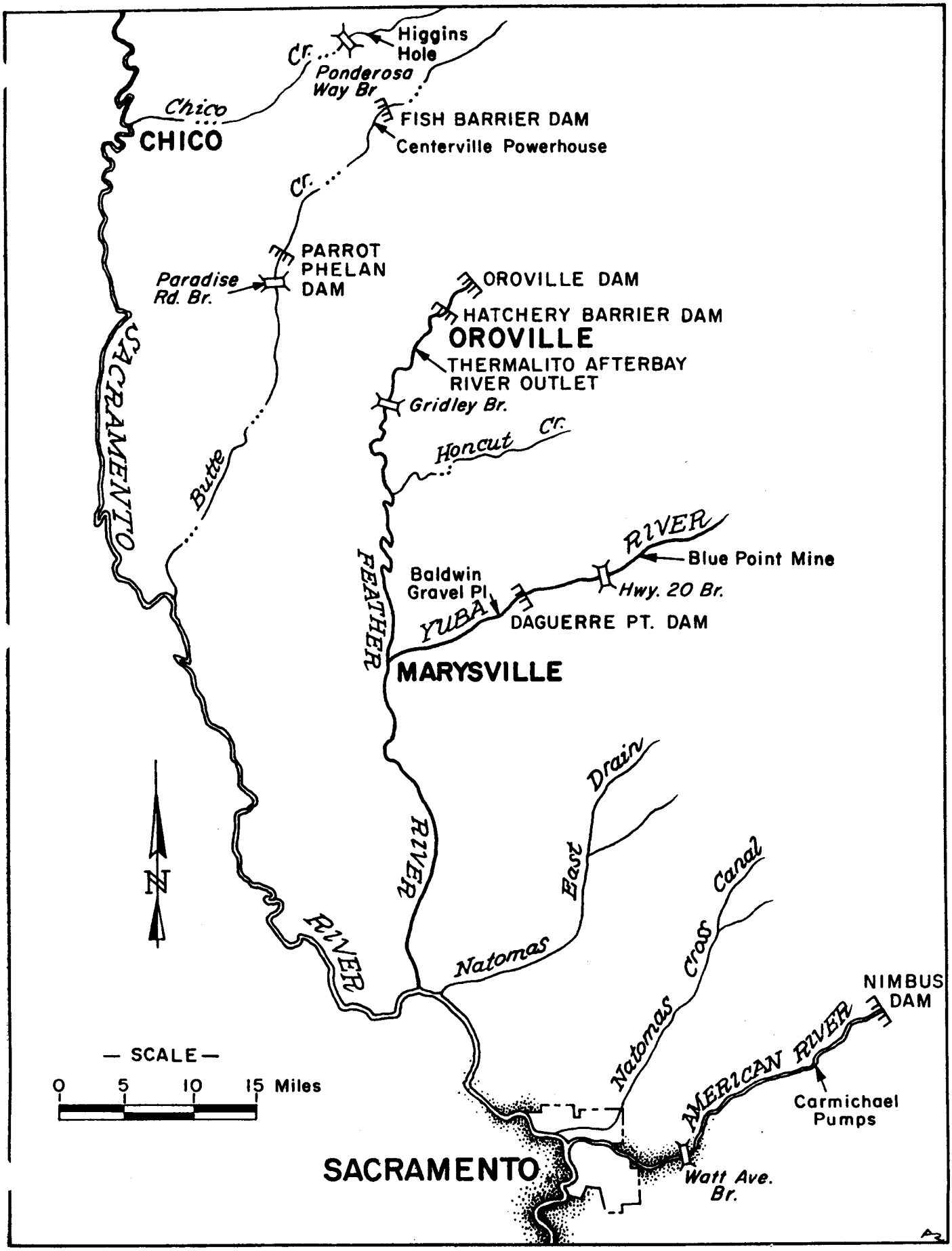

Figure 2. Sacramento River Tributaries from Chico Creek, south, covered during the 1970 King Salmon Spawning Stock Survey.

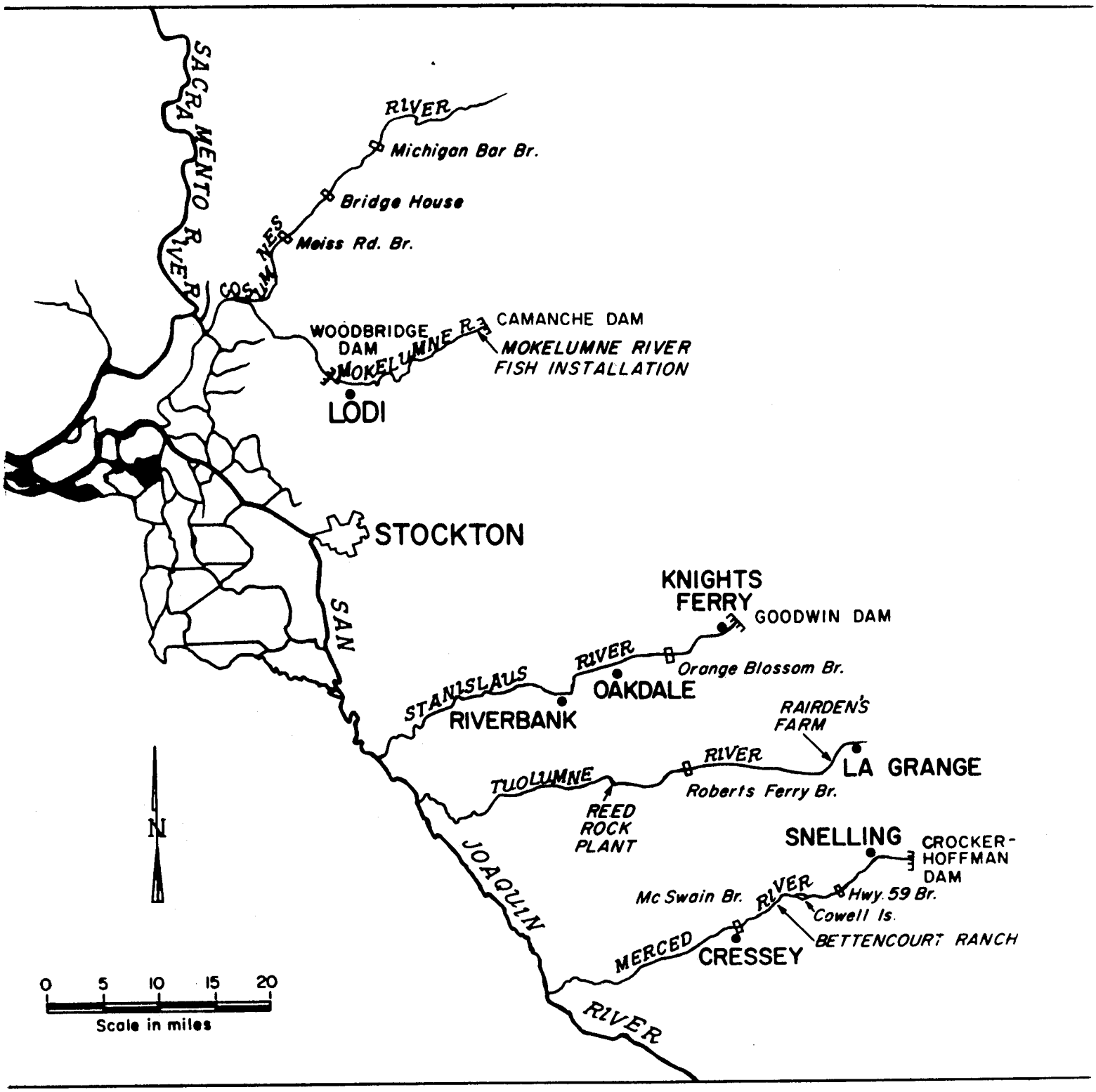

Figure 3. San Joaquin River Tributaries covered during the 1970 King Salmon Spawning Stock Survey.

LIST OF TABLES

TABLE 1

Sacramento-San Joaquin Valley King Salmon
Spawning Stock Estimates, Major Streams, 1953 - 1970
(In thousands of fish)

Year	Main Stem Sacramento River	Clear Creek	Cow Creek	Bear Creek	Cottonwood Creek	Battle Creek	Antelope Creek	Mill Creek	Deer Creek	Chico Creek
1953	408 a + 8 c	- b	- b	- b	- b	16 b + 2 c	- b	10 b + 3 c	4 b + 2 c	- c
1954	276 a + 9 c	- b	- b	- b	- b	12 b + 2 c	- b	7 b + 2 c	3 b + 2 c	- c
1955	231 a + 17 c	- b	- b	- b	- b	26 b + 2 c	- b	3 b + 3 c	* + 3 c	- c
1956	94 a + 7 c	- b	- b	- b	- b	21 b + 2 c	- b	0.9 b + 2 c	0.1 b + 3 c	- c
1957	68 a + - c	0.3 b	0.7 b	* b	0.4 b	5 b + - c	0.8 b	5 b + 1 c	2 b + - c	0.1 c
1958	128 a + - c	1.6 b	3 b	0.2 b	0.6 b	29 b + - c	0.4 b	4 b + 2 c	1.3 b + - c	1 c
1959	267 a + - c	0.8 b	0.7 b	* b	3 b	30 b + - c	- b	0.8 b + 1.6 c	* b + - c	0.2 c
1960	233 a + - c	0.9 b	0.6 b	0.1 b	0.4 b	24 b + - c	0.2 b	0.9 b + 2 c	0.8 b + - c	- c
1961	150 a + - c	- b	- b	- b	1.5 b	20 b + - c	- b	1.7 b + 1 c	- b + - c	- c
1962	139 a + - c	5 b	1.5 b	- b	6 b	13 b + - c	0.8 b	4 b + 2 c	2 b + - c	0.2 c
1963	146 a + - c	10 b	- b	- b	4 b	17 b + - c	0.3 b	1.3 b + 1.3 c	1.2 b + 1.7 c	0.5 c
1964	148 a + - c	2 b	1 b	0.1 b	3 b	16 b + - c	0.1 b	0.4 b + 1.6 c	0.1 b + 3 c	0.1 c
1965	103 a + - c	2 b	1 b	0.4 b	0.9 b	9 b + - c	0.1 b	0.2 b + - c	0.2 b + - c	0.1 c
1966	115 a + - c	0.9 b	8 b	0.4 b	3 b	3 b + - c	0.2 b	0.5 b + - c	0.1 b + - c	0.1 c
1967	92 a + - c	0.4 b	0.4 b	* b	0.6 b	5 b + - c	0.1 b	0.5 b + - c	0.1 b + - c	0.2 c
1968	110 a + - c	0.8 b	8 b	0.3 b	8 b	6 b + - c	0.1 b	0.8 b + - c	0.3 b + - c	0.2 c
1969	133 b + 20 c	1.2 b	6 b	0.6 b	5 b	6 b + - c	0.2 b	1.7 b + - c	0.8 b + - c	0.2 c
1970	71 b + 4 c	- b	- b	- b	- b	7 b + - c	0.4 b	0.7 b + 1.5 c	0.5 b + 2 c	0.0 c

Year	Butte Creek	Feather River	Yuba River	American River	Cosumnes River	Mokelumne River	Stanislaus River	Tuolumne River	Merced River	Others	Total
1953	- c	28 a + - c	6 b	28 b	2 b	2 b	35 b	45 b	- b	13	612
1954	- c	68 a + 3 c	5 b	29 b	5 b	4 b	22 b	40 b	4 b	12	505
1955	0.4 c	86 a + 1 c	2 b	17 b	2 b	2 b	7 b	20 b	- b	4	426
1956	3 c	18 a + 2 c	5 b	6 b	1 b	0.5 b	5 b	6 b	0.0 b	9	185
1957	2 c	10 a + 0.5 c	1 b	8 b	1 b	2 b	4 b	8 b	0.4 b	0.2	120
1958	1 c	31 a + 3 d	8 b	27 b	1 b	7 b	6 b	32 b	0.5 b	0.2	288
1959	0.5 c	76 a + 4 d	10 b	31 b	0.0 b	2 b	4 b	46 b	0.4 b	1	479
1960	7 c	80 a + 4 d	20 b	54 b	1 b	2 b	8 b	45 b	0.4 b	*	484
1961	3 c	44 a + - c	9 b	26 b	- b	0.1 b	2 b	0.6 b	0.05 b	1	259
1962	2 c	19 a + - c	34 b	27 b	1 b	0.2 b	0.3 b	0.2 b	0.06 b	-	257
1963	8 c	84 a + 0.6 c	37 b	41 b	1 b	0.5 b	0.2 b	0.1 b	0.02 b	0.5	303
1964	0.6 c	38 a + 3 c	35 b	59 b	2 b	2 b	4 b	2 b	0.04 b	1	322
1965	1 c	23 a + 0.7 c	10 b	39 b	0.8 b	1.3 b	2 b	3 b	0.09 b	0.2	198
1966	0.1 c	21 a + 0.3 c	8 b	27 b	0.6 b	0.7 b	3 b	5 b	0.04 b	0.3	197
1967	0.2 c	12 a + 0.1 c	24 b	23 b	0.5 b	3 b	12 b	7 b	0.6 b	-	182
1968	0.9 c	18 a + 0.2 c	7 b	31 b	1.5 b	1.7 b	6 b	9 b	0.5 b	0.1	210
1969	0.8 c	61 a + 0.9 c	5 b	47 b	4 b	3 b	12 b	32 b	0.6 b	1.1	341
1970	0.3 c	62 a + 0.2 c	14 b	37 b	0.6 b	5 b	9 b	18 b	5 b	5 **	243

a Mostly fall-run; a few spring-run fish may have been included.
b Fall-run only.
c Spring-run only.
d Mostly spring-run but may include some fall-run fish.
- No estimate.
* Less than 50 fish.
** Combined estimate of tributaries to Sacramento River above the Red Bluff Diversion Dam, except Battle Creek.

TABLE 2

1970 Red Bluff Dam Salmon Counts, Adjusted for Day and Night Hours
When No Counts Were Made, and Separated Into Winter-, Spring-, and Fall-Run Fish

Week	Adjusted salmon count	Number sampled	Winter Run percent	Winter Run number	Spring Run percent	Spring Run number	Fall Run percent	Fall Run number
(1970)								
Jan. 4-10	941	46	100	941				
11-17	591	69	100	591				
High water - No count, no estimate.								
Mar. 15-21	3,151	0*	100	3,151				
22-28	4,201	0*	100	4,201				
Mar. 29-Apr. 4	3,889	0*	100	3,889				
Apr. 5-11	6,011	360	100	6,011				
12-18	2,812	241	100	2,812				
19-25	3,141	129	90	2,827	10	314		
Apr. 26-May 2	2,817	99	92	2,592	8	225		
May 3-9	1,891	106	96	1,815	4	76		
10-16	2,022	116	87	1,759	13	263		
17-23	1,526	50	81	1,236	19	290		
24-30	760	71	44	334	56	426		
May 31-June 6	574	53	42	241	58	333		
June 7-13	251	13	46	115	54	136		
14-20	448	25	36	161	64	287		
21-27	482	33	3	14	97	468		
June 28-July 4	357	8	38	136	62	221		
July 5-11	473	31			100	473		
12-18	280	13			50	140	50	140
19-25	623	16					100	623
July 26-Aug. 1	627	23					100	627
Aug. 2-8	744	116					100	744
9-15	1,655	132					100	1,655
16-22	1,053	144					100	1,053
23-29	1,009	23					100	1,009
Aug. 30-Sept. 5	1,457	35					100	1,457
Sept. 6-12	2,397	47					100	2,397
13-19	2,712	122					100	2,712
20-26	2,956	69					100	2,956
Sept. 27-Oct. 3	5,518	70					100	5,518
Oct. 4-10	8,082	165					100	8,082
11-17	9,790	473					100	9,790
18-24	10,668	494					100	10,668
25-31	5,412	183					100	5,412
Nov. 1-7	8,108	540					100	8,108
8-14	4,458	64	12	535			88	3,923
15-21	3,736	96	16	598			84	3,138
22-28	2,409	148	10	241			90	2,168
Nov. 29-Dec. 5	2,739	0**	35	959			65	1,780
Dec. 6-12	1,692	0**	37	626			63	1,066
13-19	1,493	0**	10	149			90	1,344
20-26	1,296	70	42	544			58	752
Dec. 2-Jan 2 (1971)	1,601	58	90	1,441			10	160
	118,853	4,551		37,919		3,652		77,282

* No sampling - Assumed to be all winter-run salmon.
** No sampling - Percentages used are for corresponding weeks in 1969.

TABLE 3

Fall Spawning King Salmon Counts and Population Estimates, Main Stem of Sacramento River, 1970

	Estimated recovery rate (percent)	Number of counting trips	Number of carcasses recovered	Percent redds in each area*	Estimated spawning population
Above Red Bluff Diversion Dam		0	0	100	68,794**
Keswick Dam Fish Trap	-	-	-	-	2,844***
Keswick Dam to A.C.I.D. Dam	-	-	-	2.7	1,781
A.C.I.D. Dam to Highway #44	-	-	-	15.4	10,156
Highway #44 to Upper Anderson Bridge	-	-	-	26.0	17,147
Upper Anderson Bridge to Balls Ferry	-	-	-	34.0	22,423
Balls Ferry to Jellys Ferry	-	-	-	12.6	8,310
Jellys Ferry to Bend Bridge	-	-	-	8.6	5,672
Bend Bridge to Red Bluff	-	-	-	0.7	461
Red Bluff Diversion Dam to Squaw Hill Bridge		4	41	100	5,860
Red Bluff to Tehama Bridge	0.7	4	39	96	5,625
Tehama Bridge to Squaw Hill Bridge	0.7	4	2	4	235
Sacramento River Main Stem (Total)					74,654**

* Percent salmon redds observed between Red Bluff and Keswick Dam and Red Bluff and Squaw Hill Bridge on two airplane flights (10-26-70 and 11-12-70).

** Includes 3,652 spring-run salmon that spawned either in tributaries or main stem above Red Bluff.

*** Keswick Dam trap total for operation from 10-29-70 through 12-31-70.

TABLE 4

Fall Spawning King Salmon Counts and Population Estimates,
Sacramento River Tributaries North of Chico Creek, 1970

Streams or stream section	Estimated recovery rate (percent)	Number of counting trips	Number of carcasses recovered	Estimated spawning population		
				Spring run	Fall run	Total run
Battle Creek						
Coleman Hatchery	-	-	-	none	3,512*	
Below Hatchery	10	4	332	no est.	3,320	
Total, Battle Creek	-	-	-	no est.		(6,832)
Other tributaries between Red Bluff and Keswick Dam	-	0	-	no est.	5,308	(5,308)
Total, tributaries - Red Bluff to Keswick Dam (15%)**						12,140
Antelope Creek	6	3	24	no est.	400	(400)
[illegible] Creek	-	1	0	0	no est.	no est.
Mill Creek (lower)	12	8	83	0	690	(690)
" " (upper)	4	3	66	1,500	0	(1,500)
Toomes Creek	-	1	0	0	no est.	no est.
Deer Creek (lower)	6	3	30	0	500	(500)
" " (upper)	-	1	200***	2,000	0	(2,000)
Singer Creek	-	1	0	0	no est.	no est.
Total, tributaries - Chico Creek to Red Bluff						5,090
TOTAL, NORTHERN SACRAMENTO RIVER TRIBUTARIES				3,500	13,730	17,230

* Battle Creek trap total for operation from 9-25-70 through 12-31-70.
** 5-yr. average (1965-69) of salmon spawning in tributaries other than Battle Creek above Red Bluff in the fall.
*** Live fish, vicinity of lower Deer Creek Falls (late September, 1970).

TABLE 5

King Salmon Counts and Population Estimates Southern Sacramento River Tributaries (Chico Creek and South) 1970-71

Stream or stream section	Number of counting trips	Carcasses and skeletons counted	Estimated spawning population		
			Spring run	Fall run	Total run
Chico Creek	2	0	none	no est.	no est.
Butte Creek	2	57	285	no est.	285
Feather River (Total)	11	15,277	235	61,525	61,760
Oroville Barrier to Thermalito Outlet	(11)	(9,075)	no est.	(16,500)	
Thermalito Outlet to Gridley Bridge	(10)	(5,554)	no est.	(37,400)	
Gridley Bridge to Honcut Creek	(10)	(648)	no est.	(4,270)	
Oroville Hatchery	-	-	(235)	(3,355)	
Yuba River (Total)	7	1,377	Extinct	13,830	13,830
Blue Pt. Mine to Hwy. 20 Bridge	(6)	(143)	Extinct	(1,430)	
Hyw. 20 Bridge to Daguerre Pt. Dam	(6)	(311)	Extinct	(6,220)	
Daguerre Pt. Dam to Baldwin Gravel Pl.	(7)	(923)	Extinct	(6,180)	
American River (Total)	3	4,365	Extinct	37,309	37,309
Nimbus Racks to Carmichael Pumps	(3)	(1,103)	Extinct	(20,000)	
Carmichael Pumps to Watt Avenue Bridge	(3)	(131)	Extinct	(5,000)	
Above Nimbus Racks	(3)	(3,131)	Extinct	(3,680)	
Nimbus Hatchery	-	-	Extinct	(8,629)	
Natomas Drainage	-	-	none	no est.	no est.
TOTAL SOUTH SACRAMENTO RIVER TRIBUTARIES		21,076	520	112,664	113,184

TABLE 6

Fall-Run King Salmon Counts and Population Estimates,
San Joaquin River Tributaries*, 1970-71

Stream or stream section	Number of counting trips	Number of carcasses and skeletons counted	Estimated spawning population
osumnes River (Total)	3	92	600
Michigan Bar Bridge to Bridge House	(3)	(34)	(250)
Bridge House to Meiss Road Bridge	(3)	(58)	(350)
okelumne River	-	-	5,000**
tanislaus River	5	388	9,297
Goodwin Dam to Knights Ferry	(3)	(20)	(800)
Knights Ferry to Orange Blossom Bridge	(5)	(184)	(4,600)
Trap near Orange Blossom Bridge	(-)	-	(247)***
Orange Blossom Bridge to Oakdale	(5)	(167)	(2,800)
Oakdale to Riverbank	(5)	(17)	(850)
uolumne River (Total)	6	1,536	18,400
La Grange to Rairden's Farm	(6)	(1,076)	(10,800)
Rairden's Farm to Roberts Ferry Bridge	(6)	(292)	(4,200)
Roberts Ferry Bridge to Reed Rock Plant	(6)	(168)	(3,400)
erced River (Total)	5	788	4,800
Crocker-Huffman Dam to Highway 59 Bridge	(5)	(555)	(2,500)****
Highway 59 Bridge to Bettencourt's Ranch	(5)	(204)	(1,700)
Bettencourt's Ranch to Cressey Bridge (McSwain)	(5)	(29)	(600)
OTAL, SAN JOAQUIN RIVER TRIBUTARIES		2,804	38,097

* No spring-run fish entered these streams.
** This figure is the count made at Woodbridge Dam plus an estimate for fish not counted.
*** These fish were trapped near Orange Blossom Bridge, and the fish were spawned and their progeny are being reared to yearling size at Moccasin Creek Hatchery.
**** About 100 of these fish utilized the Merced Irrigation District's spawning channel.