

SPAWNING POPULATION ESTIMATES
of
KING & SILVER SALMON
in
FIVE NORTH COAST STREAMS
CALIFORNIA
1954

by

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INTRODUCTION

The following report has been written in an effort to provide information on the numbers of salmon spawning in five small coastal streams. The information was acquired in the process of regular carcass recovery work in connection with the salmon marking program. First priority work was that of covering as many streams as possible to effect maximum carcass recovery. In addition redd counts, live fish counts and other pertinent field observations were recorded with the intent of making population estimates. All population figures in this report are estimates and indicate general magnitude. It is not the intent of the writer to pretend finite accuracy in computing exact populations.

FIELD ROUTINE

CARCASS COUNTS. This activity has been described in previous reports (1952 & 53) and will not be described here in detail. Carcasses were examined for fin-marks, measured to fork-length to the nearest centimeter, checked for gonad condition and sex. The information was then recorded according to species,-- king or silver.

LIVE FISH COUNTS. While walking the streams for carcass recovery, all live salmon seen were recorded by species.* However, there are two circumstances that can introduce errors into these counts.

First: It is never possible to see and record all live fish present in a stream. (1) Turbid water would lower the effectiveness of this type of count. (2) Even with fairly clear water, it is never possible to see all fish in the larger, deeper holes. (The small size of the creeks involved lowers this error.) (3) The small size of the "Jacks" or "Grilse" makes it more difficult to see them,

* King Salmon (Oncorhynchus Tshawytscha) and Silver Salmon (Oncorhynchus Kisutch) are the only salmon species of importance in these streams.

especially the silver jacks. In general however, the water conditions this year were close to ideal. Rainfall was in moderate quantities and quite constant. Thus except for a storm in late December, water fluctuations were not extreme and turbidity was at a minimum. These conditions provided for a more accurate live-fish count than could usually be expected in this area. Second: Another possibility for error in live fish counts is that of counting one fish several times if they were moving about in the stream. Several techniques were used to keep this error low. (1) Pools and riffles were always approached slowly and carefully to avoid frightening the fish before a count was made. If the fish were frightened, the observer remained quiet; tallied any fish seen leaving the area and made a re-count after the fish had calmed down. (2) If possible a pool was observed from a vantage point such as a high bank, a log or stump. (3) Live fish in an area were counted before proceeding with carcass recovery. Another confusion factor had to be solved quite differently.

It is possible for some of the same live fish to be present when the observer makes several periodic checks of an area. The fact that kings appeared three quite distinct runs in Mill Creek & Prairie Creek helped prevent over-lapping counts. When the first run was checked, all live fish were tallied regardless of appearance. On the second and third runs however, "old" spawned out "sore tails" were not counted as they likely were survivors of the preceeding run. It should also be emphasized that our counts were made when each run was at its peak. Frequent observations were made to keep informed and to determine the proper timing of each count. The silver salmon of Elk River, Lindsey and Freshwater creeks appeared in each creek in one run and thus facilitated fairly accurate counts there.

These live fish counts were used to assist in determining the percent of the run being recovered as carcasses. Also, the live fish counts in themselves were an indication of the magnitude of the runs.

REDD COUNTS. Redd counts were made during the regular carcass recovery runs. For the most part, due to ideal water conditions, the redd counts were made rather easily. In the clear water, gravel disturbance was easily noted. Also the undisturbed gravel retained its coating of brown algae which further emphasized redds digging. The clean bright gravel of the redds was quite a contrast to the surrounding brown algae on the undisturbed gravel. By the end of the spawning season, the undisturbed gravel was losing the algae coating. However, even at this time freshly dug redds were quite obvious. Several difficulties were encountered, however. In an area where redds were close together or overlapping, it was difficult to determine the actual number of redds present. Clearly defined redds were tallied; questionable ones were not counted. This system tended to make the counts low but it did prevent an exaggerated estimate of spawners. This was an especially important concept where silver salmon are present. They often make a number of "test holes" before constructing a redd. Also, silvers may make sporadic, shallow diggings after spawning. These phenomena have been repeatedly observed by the author and Mr. Gunderson. Thus by tallying only clearly defined redds we eliminated counts of false redds.

POPULATION ESTIMATES

Two approaches are used in calculating the total spawning populations. The purpose of dual calculations is to expose any major discrepancies,

if they were present. Discrepancies do exist, as is evident in the following calculations. However, since the intent of this report is to show only the general magnitude of the runs in these streams, I do not believe the discrepancies invalidate the observations and resultant estimates.

ESTIMATES BASED ON REDD COUNTS. It was not possible to differentiate the redds dug by king salmon from those dug by silver salmon. Location in the stream was no indication as to species responsible. Although silvers did not spawn downstream in larger flows and riffles where kings were active, the king spawning did extend far upstream including the areas preferred by silvers. Since field observations could not provide the answer, and because both species were spawning simultaneously in the same areas, some method had to be devised to calculate the number of redds dug by each species. The most logical approach to determine the redd composition was to establish a correlation with the carcass recovery.

Indications were that the ratio of carcasses recovered to the total number of spawners did not differ radically between kings and silvers. This being true, the species composition of the carcass count should apply to the redd count. For example, if 75% of the carcasses were king salmon then it would seem logical that 75% of the redds were dug by kings. No differences of spawning habits are known which should invalidate this assumption. In Table I, carcass recovery is used to calculate the number of redds dug by each species.

After the number of redds by each species has been determined, there still remains the question,--what is the relationship between the total number of redds and the total population? The salmon counts for four seasons from Benbow Dam and one season from Sweasey Dam were

tallied. In both instances the sex ratio of king salmon was "1.5 males per 1 female". For silver salmon there were "1.3 males per female". If this ratio can be applied to the redds then it could be stated that for every king salmon redd there were two and one-half fish present in the stream. By the same token there were two and one-third (2.3) silver salmon per redd. Table II summarizes these calculations.

Table III uses the redd calculations and "fish-per-redd factor" to calculate the spawning populations of the five creeks.

ESTIMATES BASED ON CARCASS CUTTING. There was no method of statistically computing the "rate of carcass recovery." Based upon field observations, estimates were now made as to what percent of the total run was being recovered as carcasses. These estimates are higher than the recovery rate expected on the Sacramento River. Due to the small size of the streams this higher recovery rate does not seem too far out of line. Muddy water and fluctuations of water flow were the factors adversely affecting recovery.

In Mill, Lindsey and Freshwater Creeks it was believed that carcass recovery accounted for about twenty-five percent (25%) of the run. In Elk River, muddy water kept the carcass recovery low and made observations difficult. Ten percent (10%) recovery was probably maximum. In Prairie Creek quite the reverse was true. The water shed is mainly within a state park. The water in the main spawning area remains clear and has a minimum of fluctuation. About one-third (33 1/3%) of the carcasses were recovered.

Table IV summarizes the spawning estimates based on carcass recovery.

ESTIMATES BASED ON LIVE FISH AND CARCASS COUNTS. It is very difficult to prevent duplication in live fish counts and carcass counts. Fish that are ^{alive} observed on one field trip may be counted again as a carcass on a subsequent trip. As previously explained, every effort was made to prevent this from happening. If the fish appear in one run or several distinct runs, this error is minimized. Such was the case this year. These combined counts are included only for comparison with the other sets of figures. At best, the combined count could represent a minimum figure.

TABLE I
CARCASS COUNTS BY STREAM
NORTH COAST AREA

1954

SILVER vs. KING RATIO:--TO BE APPLIED TO REDD COUNTS

STREAM		CARCASS COUNTS			REDD COUNTS		
Creek	Section or Tributary	SS Carcasses	KS Carcasses	% SS	Total Actual Counts	Calc. KS Redds	Calc. SS Redds
Mill Creek	Forks to Breen Bridge	14	301	4.6	326	311	15
	West Fork	35	411	8.5	519	475	44
	East Fork	26	151	17.2	387	320	67
					<u>1232</u>	<u>1106</u>	<u>126</u>
Prairie Creek	Prairie Creek down to Hatchery	57	172	33.1	240	160	80
	Lost Man Cr.	8	13	61.5	30	12	18
					<u>270</u>	<u>172</u>	<u>98</u>
Elk River	North Fork	40	none	100.0	105	0	105
	South Fork	37	1	97.3	100	3	97
					<u>205</u>	<u>3</u>	<u>202</u>
Lindsey Creek	Lindsey Cr.	19	3	72.0	43	12	31
	Grassey Cr.	8	none	100.0	57	0	57
	Squaw Cr.	6	none	100.0	none	0	0
					<u>100</u>	<u>12</u>	<u>88</u>
Fresh- water Creek	Freshwater Cr.	44	4	91.0	58	5	53
	Cloney Gulch Cr.	39	none	100.0	26	0	26
	Little Fresh- water Cr.	8	none	100.0	10	0	10
					<u>94</u>	<u>5</u>	<u>89</u>

TABLE II
SEX RATIO OF SALMON
DATA FROM FISH LADDER COUNTING STATIONS
1949-1954

<u>STATION</u>	<u>NUMBER OF FISH</u>	<u>SEX RATIO</u>
Benbow 1949-54	Kings - 23,448 males 15,131 females	Kings - 1.54 males/female
	Silvers-19,390 males 14,648 females	Silvers - 1.32 males/female
Sweasey 1954	Kings - 255 males 170 females	Kings - 1.53 males/female
	Silvers - Count too small for valid ratio	

TABLE III

SALMON SPAWNING POPULATION ESTIMATES FOR FIVE COASTAL STREAMS
 BASED ON REDD COUNTS
 NORTH COAST CALIFORNIA
 FALL 1954

STREAM	REDD COUNT*		FISH PER REDD FACTOR		ESTIMATED SPAWNING POPULATION	
	Kings	Silvers	Kings	Silvers	Kings	Silvers
Mill Creek						
Fork to Breen Br.	311	15	2.5	2.3	778	34
West Fork	475	44			1187	101
East Fork	320	67			<u>800</u>	<u>154</u>
TOTAL					2765	289
Prairie Creek						
From Hatchery upstream	160	80	2.5	2.3	400	184
Lost Man Creek	12	18			<u>30</u>	<u>41</u>
TOTAL					430	225
Elk River						
North Fork	0	105	2.5	2.3	0	244
South Fork	3	97			<u>8</u>	<u>223</u>
TOTAL					8	467
Lindsey Creek						
Upper Lindsey	12	31	2.5	2.3	30	71
Grassey Creek	0	57			0	131
Squaw Creek	0	0			<u>0</u>	<u>0</u>
TOTAL					30	202
Freshwater Creek						
Freshwater	5	53	2.5	2.3	12	122
Cloney Gulch Creek	0	26			0	60
Little Freshwater	0	10			<u>0</u>	<u>23</u>
TOTAL					12	205

As Calculated in Table I

TABLE IV

SALMON SPAWNING POPULATION ESTIMATES FOR FIVE COASTAL STREAMS
ESTIMATES BASED ON CARCASS COUNTS
NORTH COAST CALIFORNIA
FALL 1954

STREAM	CARCASSES RECOVERED		PERCENT OF RECOVERY (Estimated)	ESTIMATED SPAWNING POPULATION	
	KS	SS		KS	SS
Mill Creek					
West Fork	411	35	25%	1644	140
East Fork	151	26		604	104
Forks to Breen Bridge	301	14		1204	56
TOTAL	863	75		3452	300

Prairie Creek					
	172	57	33 1/3%	516	171
Lost Man Creek (a trib.)	13	8		39	24
TOTAL	185	65		555	195

Elk River					
North Fork	none	40	10%	none	400
South Fork	1	37		10	370
TOTAL	1	77		10	770

Lindsey Creek					
(Trib.)	3	19	25%	12	76
Grassey Creek	none	8		none	32
Squaw Creek	none	6		none	24
TOTAL	3	33		12	132

Freshwater Creek					
(Trib.)	4	44	25%	16	176
Cloney Gulch Creek	none	39		none	156
Little Freshwater	none	8		none	32
TOTAL	4	91		16	364

TABLE V

COMBINED COUNTS OF LIVE FISH AND CARCASSES OF FIVE COASTAL STREAMS

NORTH COAST CALIFORNIA

FALL 1954

<u>STREAM</u>	<u>LIVE FISH COUNTS</u>		<u>CARCASS COUNTS</u>		<u>COMBINED COUNTS LIVE FISH & CARCASSES</u>	
	<u>KS</u>	<u>SS</u>	<u>KS</u>	<u>SS</u>	<u>KS</u>	<u>SS</u>
Mill Creek	930	30	863	75	1793	105
Prairie Creek	78	26	185	65	263	91
Elk River	3	185	1	77	4	262
Lindsey Creek	2	35	3	33	5	68
Freshwater Creek	none	16	4	91	4	107

DISCUSSION

It is obvious that the two methods of computing populations present two different answers. However, the difference between the two sets of figures is not great.

Since the object of this survey was to determine the general magnitude of spawning populations, I believe that this purpose has been fulfilled. From this study of salmon we at least know whether the runs in these five streams numbered in the hundreds or in the thousands. Within reasonable limits, the data indicate which hundred or thousand figure applies.

It is probable that population estimates based on redd counts could be regarded as minimum figures. By comparing figures in Tables I and II, it will be noted that the redd count rather closely approaches^e the combined number of live fish and carcasses in these streams. The combined count of live fish and carcasses would be the lowest number of fish that could be present in the stream. Since the redd count closely approaches the fish and carcass count, and there are usually several fish per redd, it becomes evident that the actual spawning population would exceed the number of observed fish and carcasses. Since the redd count was kept low by not tallying indistinct and questionable redds, and overlapping and superimposed redds were not always distinguishable, it appears rather certain that the population estimates based on redd counts would also be lower than the actual spawning population. The estimates for Prairie and Lindsey Creeks based on redd counts exceed the estimates based on carcass counts. This discrepancy no doubt results from the difficulty of estimating the percent of the run which is recovered as carcasses. It has been found by other workers that population estimates based on redd counts provide low figures. This has been proven a number of times on the Sacramento and Trinity Rivers.

CONCLUSIONS

Under normal circumstances redd counts, carcass counts, and live fish counts do not provide accurate population estimates on coastal streams of California. These counts do provide information to indicate the general magnitude of the runs. This is probably the best that can be accomplished without a costly system of weirs or a complete tagging and recovery program. Such programs would be difficult to conduct because of extreme water level fluctuations on the coastal streams.

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SUMMARY

In addition to routine carcass recovery work in the fall of 1954, data was gathered to estimate total salmon spawning populations in five small coastal streams.

Types of data gathered were:--

1. Carcass Counts
2. Live Fish Counts
3. Redd Counts

Estimated spawning populations based on redd counts are:--

Mill Creek	2765 KS	289 SS
Prairie Creek	430 KS	225 SS
Elk River	8 KS	467 SS
Lindsey Creek	30 KS	202 SS
Freshwater Creek	12 KS	205 SS

Estimated spawning populations based on carcass counts are:--

Mill Creek	3452 KS	300 SS
Prairie Creek	555 KS	195 SS
Elk River	10 KS	770 SS
Lindsey Creek	12 KS	132 SS
Freshwater Creek	16 KS	364 SS