State of California
The Resources Agency
Department of Fish and Game

KING SALMON (ONCORHYNCHUS TSHAWYTSCHA) AND SILVER SALMON (ONCORHYNCHUS KISUTCH) SPAWNING ESCAPEMENT AND SPAWNING HABITAT IN THE UPPER TRINITY RIVER, 1970[1]/

by
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SUMMARY

In the fall of 1970, a king salmon and silver salmon spawning survey was conducted on the 40-mile portion of the Trinity River from Lewiston Dam, downstream to its confluence with the North Fork Trinity River. From October 14 to December 12, 1970, 2,198 king salmon and 334 silver salmon carcasses were recovered. The 2,198 king salmon recovered on the spawning grounds represent an assumed population of 14,952 natural spawners to which 4,444 fish which entered the hatchery must be added for a total of 19,396. Assuming 60% of the silver salmon run entered Trinity River Hatchery, the 3,147 captured there represent an estimated spawning population of 5,245.

The king salmon carcasses examined were 36.3% large males, 17.9% small males, 38.3% large females, and 7.6% small females. Overall spawning success for male and female king salmon was 93.5 and 94.9% respectively. The male-to-female ratio was 1.18:1.

For silver salmon the spawning success for males and females was 100.0 and 87.1% respectively. The male-to-female ratio was 1.02:1.

The mean fork length for male king salmon was 27.1 inches and was 28.4 inches for females. For silver salmon the mean fork length for males and females was 28.4 and 28.7 inches, respectively.

Of all king and silver salmon carcasses recovered, 53.4% were found in the upper two miles of the area studied.

Since 1963, 16 out of the 17 major spawning riffles observed have shown a decrease in area of use. Lewiston Riffle, the largest spawning riffle, has decreased by 58.5% since 1963.

1/ Anadromous Fisheries Branch Administrative Report No. 73-10. Submitted July, 1972.

INTRODUCTION

Since completion of Trinity and Lewiston Dams in 1963, there have been three previous salmon surveys conducted on the Trinity River. Two of these (La Faunce, 1965; and Rogers, 1970) utilized criteria developed by Gibbs in 1956.

The purpose of the present survey was to monitor the salmon spawning escapement as it relates to post-project changes in the Trinity River and possible future exploitation of Trinity River water. More specifically, number, composition, spawning success, area utilized, and evaluation of spawning habitat was desired.

METHODS

From October 14, 1970 until December 12, 1970, a salmon carcass survey was conducted on the Trinity River (Figure 1). The area surveyed and the techniques used were the same as in previous surveys (Smith, unpublished; Rogers, 1970; and La Faunce, 1965). Gibbs (1956) covered the area in the later surveys plus areas farther upstream.

Supplemental data on relative use made of the spawning areas were obtained by an aerial redd count on November 2, 1970 (Thomas, unpublished). Each major riffle was rated on its value as a spawning area. The most important riffle, the one behind the town of Lewiston, was assigned a value of 100 and all others were rated relative to it (La Faunce, unpublished).

RESULTS AND DISCUSSION

King Salmon

During the survey, 2,198 king salmon carcasses were recovered. There were 787 males, 666 females, and 745 skeletons (Appendix Table 1)2/. Percentages of recognizable king salmon carcasses recovered were: 36.3% large males, 17.9% small males, 38.2% large females, and 7.6% small females (Appendix Table 2)3/. An additional 4,444 king salmon entered Trinity River Hatchery (Bedell, 1972).

The mean fork lengths of male and female king salmon were 27.1 and 28.4 inches, respectively (Figure 2, Appendix Table 3). Spawning success was 93.5% for males and 94.9% for females. The ratio of males to females was 1.18:1.

In the 1963, 1968, and 1969 surveys a proportionately greater number of small male k-ing salmon entered the hatchery than were found in the river populations. We also observed, as in the past surveys, that proportionately fewer small males were found spawning in Section 4, directly below the hatchery. In the

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2/ As used here, the term skeleton refers to fish too badly decomposed to enable us to determine their sex.

3/ A small fish was less than 23-7/8 inches fl. This is equivalent to the minimum commercial size limit of 26 inches total length.

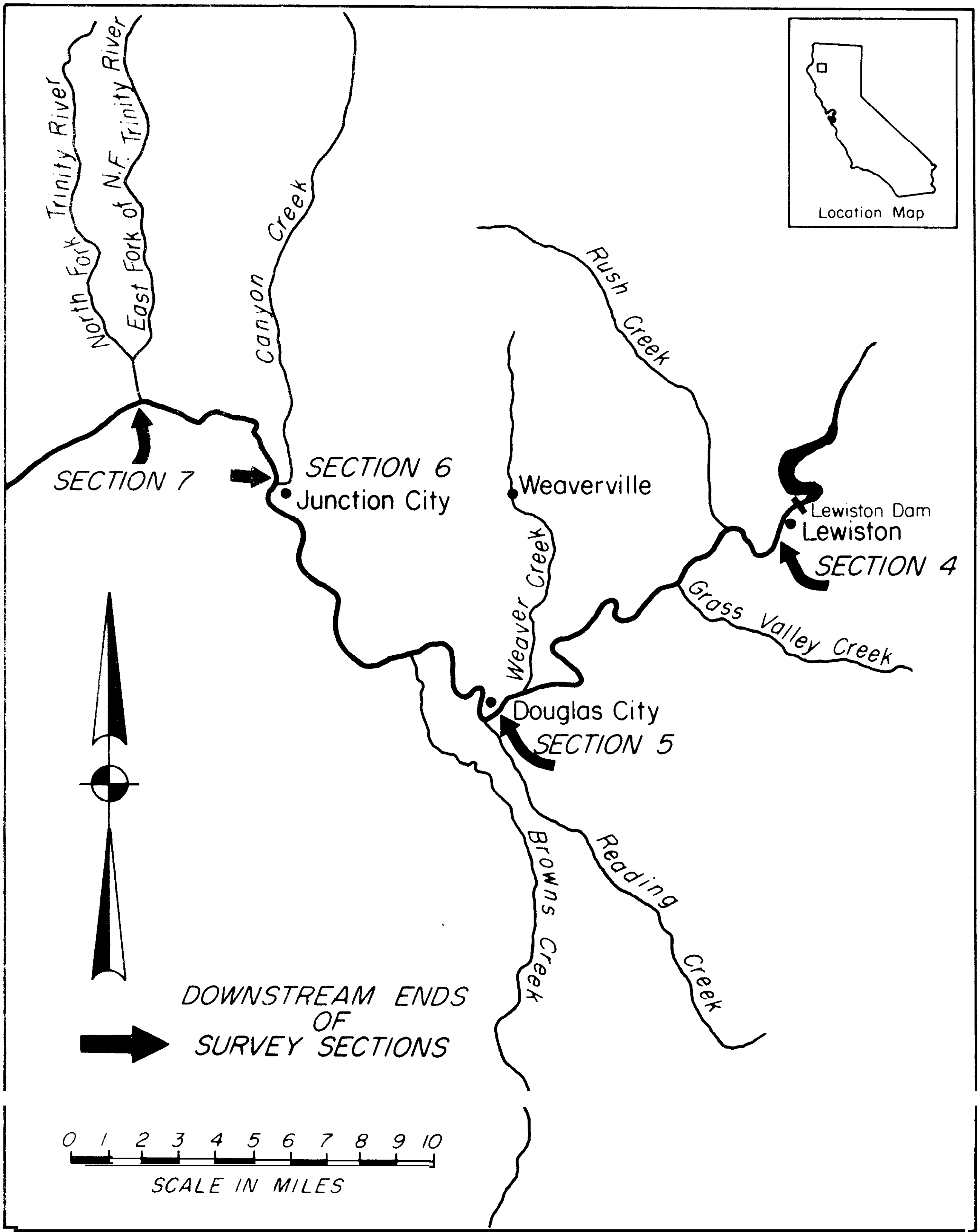

Figure 1. Map showing portion of Trinity River surveyed.

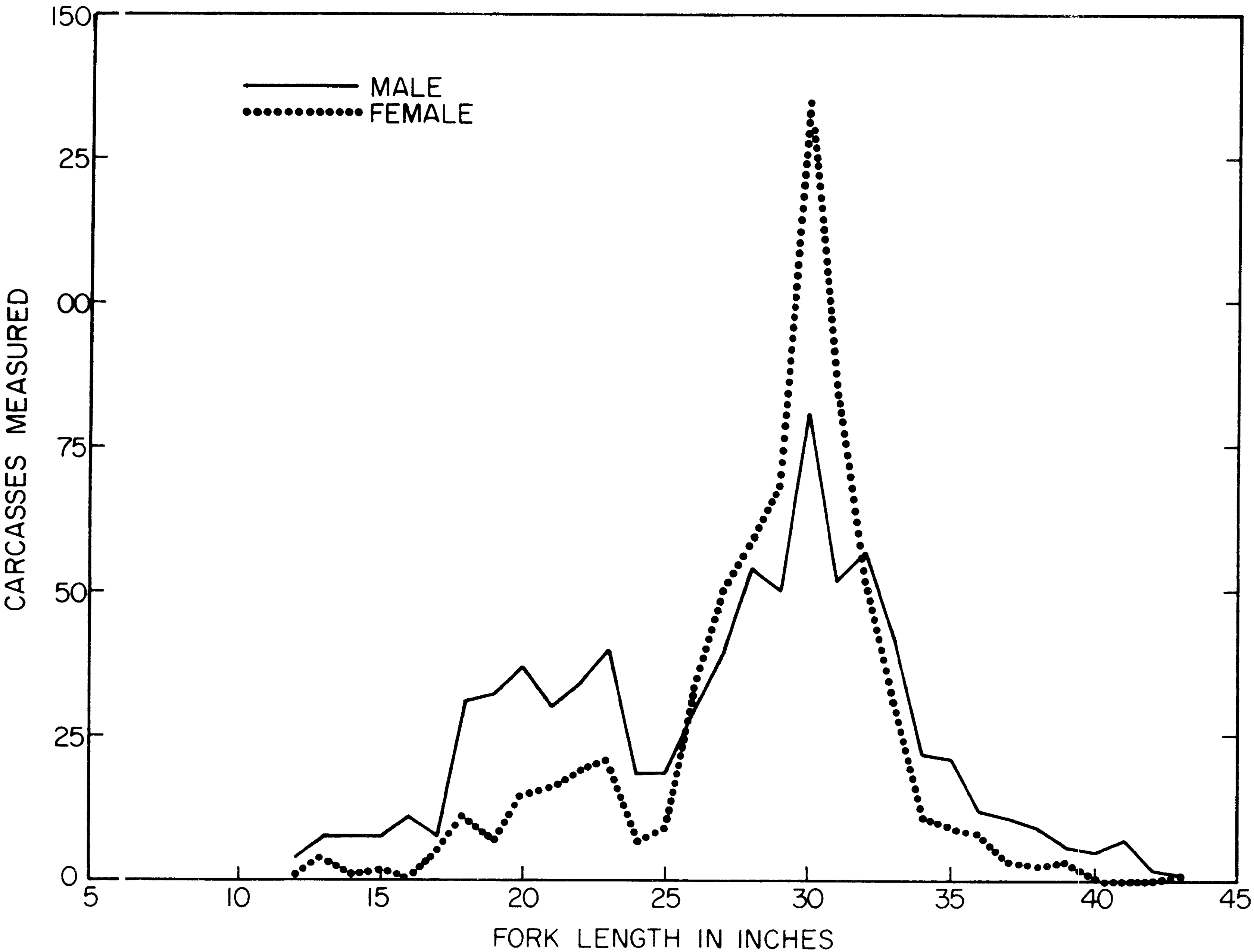

Figure 2. Length frequencies of king salmon measured during the 1970 spawning season in the Trinity River.

hatchery, 66.3% of the king salmon recovered were small males (Bedell, 1972). In the total river population and in Section 4 the percentages were 17.9 and 10.8 respectively (Table 1). Perhaps in areas of high spawning density, like Section 4, the small males are less able to compete and are forced upstream and into the hatchery (Rogers, 1970). Compounding this situation: king salmon reared in the hatchery for a year tend to stay one year less in the ocean and are smaller on their return to the hatchery (Warner, Fry, and Culver, 1961; Bedell, unpublished).

Table 1

King Salmon Spawning Population Structure, Trinity River, 1970

	All carcasses recovered in river		Section 4		Hatchery	
	Number	Percent	Number	Percent	Number	Percent
Large males	527	36.3	247	40.0	773	17.4
Small males	260	17.9	67	10.8	2,946	66.3
Females	666	45.8	304	49.2	725	16.3
TOTALS	1,453	100.0	618	100.0	4,444	100.0

Spawning success for small male king salmon was significantly less than for large males, Only 86.5% had spawned compared with 97.0% for large males. Similar observations were made in 1968 and 1969 (Rogers, 1970; Smith, unpublished). The difference between spawning success of large and small females was much less, 94.6 and 96.4%, respectively.

In 1955, Gibbs (1956) made the first spawning stock survey of the Trinity River which included the main stem and tributaries as far downstream as the North Fork4/. Gibbs used a tag-and-recovery method to estimate the spawning population of king salmon. He examined 6,019 carcasses and recovered 14.7% of his available tags. He then used various assumptions to calculate the spawning population and obtained point estimates which ranged from 27,445 to 50,126. Gibbs did not make the most obvious calculation of all, i.e. dividing the 6,019 carcasses recovered by the fraction of the available tags recovered (0.147). No reason is given for this omission. This calculation gives an estimate of 40,946 which is not far from the midpoint of his other estimates and which we are using to show the trend since 1955 (Table 2).

In 1956, Weber (1965) conducted a survey similar to that of Gibbs, but involving the tagging of more fish. Strangely, his recovery percentage was almost identical with that of Gibbs (14.7 in each instance) but Weber found more carcasses (9,866) and his estimate of the spawning run was 67,115, which he rounded to 67,000 with 95% confidence limits of 58,000 to 77,000.

4/ Moffett and Smith (1950) made surveys but did not cover the major part of the area involved in later reports.

La Faunce (1965) made a survey in 1963 in which he examined carcasses. He did no tagging; instead he assumed he had examined the same proportion of carcasses that Gibbs had encountered (except that La Faunce rounded the figure to 15% instead of using 14.7%).

Rogers (1970, and in the present paper) used the same method as La Faunce, but used 14.7%.

Smith (unpublished) reports on a tag-and-recovery experiment conducted in 1969. Unfortunately a high and not precisely determinable proportion of the fish lost their tags. A method of handling the data has not yet been agreed upon.

The five years of available data show a high point in 1963 and low in 1970 (except that in 1970, more fish did enter the hatchery than in 1969).

Table 2

Estimates of Spawning Runs in the Trinity River, 1955-1970

Publication and method of estimation	Year of survey	Carcasses observed in stream	Estimate of spawners in stream	Fish entering hatchery	Total spawning population
Gibbs, 1956 1/	1955	6,019	40,946	No hatchery	40,946
Weber, 1965 2/	1956	9,866	67,115	No hatchery	67,115
La Faunce, 1965 3/	1963	11,341	75,607	6,735	82,342
Rogers, 1970 4/	1968	3,763	25,578 5/	4,772	30,350
Smith (manuscript) 6/	1969	3,716		2,586	
Rogers, 1973 4/	1970	2,198	14,952	4,444	19,396

1/ 14.7% of available tags were recovered in carcass survey.
Gibbs makes estimates based on various assumptions. They range from 27,445 to 50,126. The 40,940 estimate listed above was obtained (not by Gibbs) by dividing 6,019 by 0.147.

2/ Weber also used the tag-and-recovery method and also recovered 14.7X of the tags.

3/ Assumes 15% of carcasses recovered and 100% of fish entering hatchery counted.

4/ Assumes 14.7% of carcasses recovered and 100% of fish entering hatchery counted.

5/ This is the estimated population as published. It and the total spawning population should be 21 fish greater (25,599 and 30,371).

6/ Method and estimate not agreed upon,

Silver Salmon

A total of 334 silver salmon were examined (Appendix Table 1). Of these, 103 were males, 101 were females, and 130 were skeletons. The mean fork lengths of male and female silver salmon were 28.4 and 28.7 inches, respectively. The spawning success was 100% for males and 87.1% for females (Appendix Table 2). The male-to-female ratio was 1.02:l. Of the 334 silver salmon carcasses recovered, 89.8% were taken in the 18 miles of river between Lewiston Dam and Douglas City.

In 1969, Smith (unpublished) estimated that 60% of the silver salmon in the Trinity River and tributaries above the North Fork entered Trinity Hatchery. In 1970, 3,147 adult silvers were processed at the hatchery (Bedell, 1972). Assuming this also represents 60% of the run, the spawning escapement becomes 5,245. Interestingly, 12 (60%) of 20 silver salmon tagged near the North Fork Trinity River in the fall of 1970 were also recovered at Trinity River Hatchery. These 20 tagged silvers resulted from a tagging program which was aborted because river flows were higher than anticipated. Although inadequate statistically they would seem to strengthen the assumption that about 60% of the silvers returned to the hatchery, but doubt is introduced by the fact that in 1969, no silver salmon were observed spawning in the tributaries, while in 1970, numerous tributaries were used. Presumably the higher flows in 1970 made the tributaries more attractive for spawning.

Comments on Habitat

All the major spawning riffles were rated subjectively and compared with ratings assigned them in 1963, 1967, 1968, and 1969. For comparison purposes, Lewis-ton Riffle was given a rating of 100 each year. Actually, all of these riffles, except the first one below Hunt Riffle, have shown a gradual decrease in use since 1963. Use on Lewiston Riffle has decreased by 58.5% since 1969 because of gravel washout (Coots, unpublished) (Figure 3).

Spawning was heaviest in the upstream portion of the spawning area; 50.3% of the king salmon carcasses were recovered in the uppermost 2 miles (Section 4) and 80.9% in the upper 18 miles (Sections 4 and 5). In 1963, 1968, and 1969, the spawning in the upper two miles was 20.8%, 34.5%, and 36.4%, respectively. Why the relative increase in use of this area is occurring is not known. It is obvious the spawning gravels are not adequate to accommodate the fish, Superimposition of redds on existing spawning areas is common. Aggravating this situation is the reduction of spawning area as a result of gravel washout (Figure 3). Recruitment of gravels from upstream sources is blocked by Lewiston Dam.

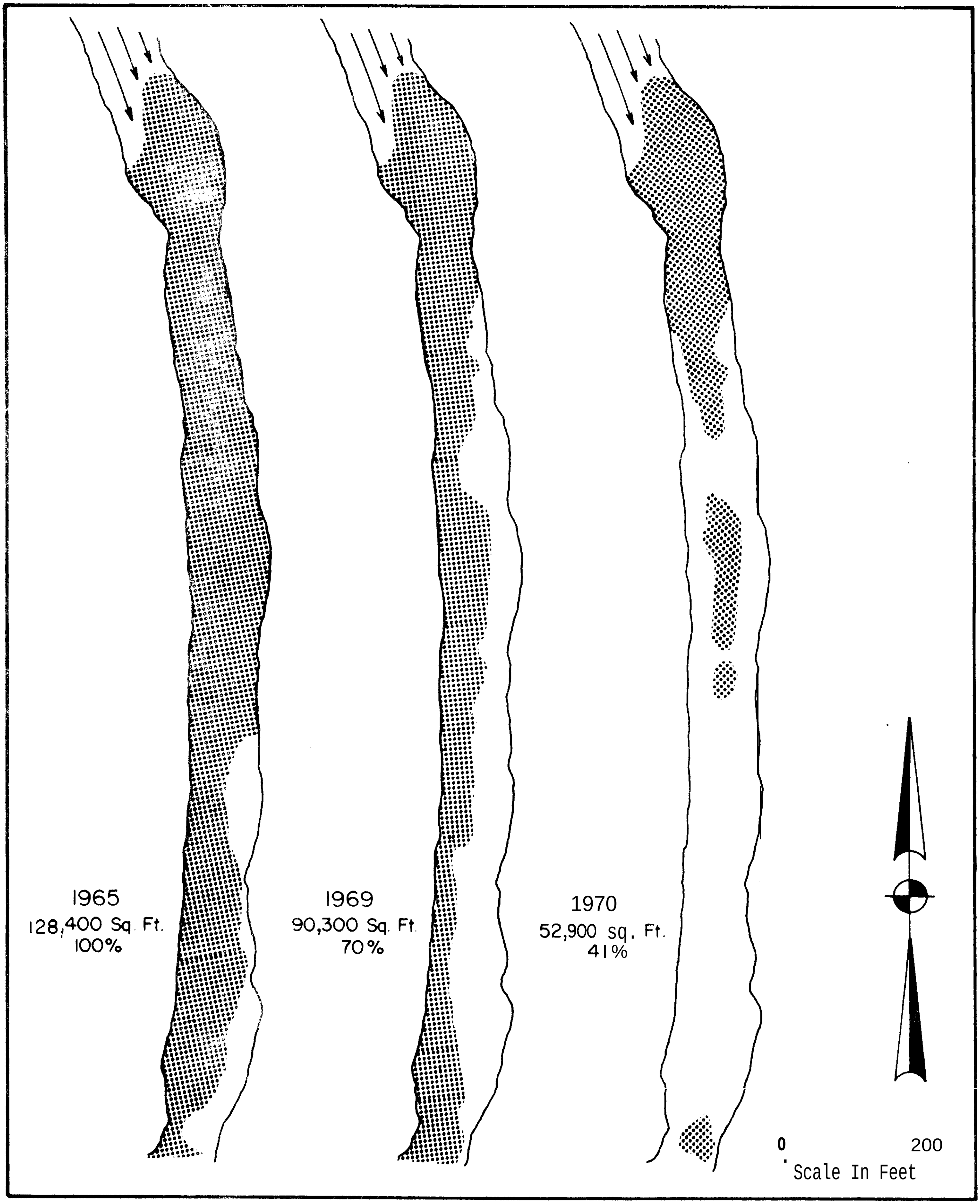

Figure 3. Maps showing Lewiston Riffle in 1965, 1969, and 1970. The area of useable spawning gravel (shaded) declined from 128,400 square feet in 1965 to 52,900 in 1970 (Coots, unpublished).

In the lower 38 miles of the study area, spawning riffle degradation is resulting from inundation, compaction, siltation, and aquatic plant encroachment. Inundation of spawning riffles has occurred above the mouths of Rush, Grass Valley, and Weaver Creeks where sand and gravel deltas have formed, partially damming the river. Below these tributaries, particularly Grass Valley Creek, sand is deposited directly upon the spawning riffles (Appendix Table 4). Compaction of gravels, and aquatic plant encroachment, although not as obvious, is occurring on nearly all former highly-used riffles.

Aerial Redd Count

An aerial redd count made on November 2 revealed 1,512 redds in the study area. Of these, 1,081 (71.5%) were counted in Sections 4 and 5 (above Douglas City).

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Appendix Table 1

Number of Salmon Carcasses Examined on the Upper Trinity River, 1970

Area	Section 1/	Distance in miles	King salmon Males	King salmon Females	King salmon Skeletons	King salmon Total	Silver salmon Males	Silver salmon Females	Silver salmon Skeletons	Silver salmon Total
Lewiston Dam to Old Lewiston Bridge	4	2	314	304	487	1,105	63	75	109	247
Lewiston Bridge to Douglas City Bridge	5	16	308	226	140	674	26	16	11	53
Douglas City Bridge to Canyon Creek	6	15	151	126	104	381	11	9	8	28
Canyon Creek to North Fork Trinity River	7	7	14	10	14	38	3	1	2	6
TOTALS		40	787	666	745	2,198	103	101	130	334

1/ River sections are the same as those used in 1963 (La Faunce, 1965).

Appendix Table 2

Salmon Carcasses Examined for Size and Spawning Success
Trinity River, 1970

KING SALMON

Sex	River sections 4	5	6	7	Total	Percent
Male over 23-7/8 inches						
Spent	239	172	91	9	511)	36.3
Ripe	8	4	4	0	16)	
under 23-7/8 inches						
Spent	58	119	43	5	225)	17.9
Ripe	9	13	13	0	35)	
TOTAL MALE	314	308	151	14	787	
Female over 23-7/8 inches						
Spent	241	183	92	10	526)	38.3
Ripe	19	1	10	0	30)	
under 23-7/8 inches						
Spent	42	40	24	0	106)	7.6
Ripe	2	2	0	0	4)	
TOTAL FEMALE	304	226	126	10	666	
Total sex determined	618	534	277	24	1,453	100.1
Skeletons	487	140	104	14	745	
GRAND TOTALS	1,105	674	381	38	2,198	

SILVER SALMON

Sex		4	5	6	7	Total	Percent
Male	Spent	63	26	11	3	103	
	Ripe	0	0	0	0	0	
TOTAL MALE		63	26	11	3	103	50.5
Female	Spent	67	14	6	1	88	
	Ripe	8	2	3	0	13	
TOTAL FEMALE		75	16	9	1	101	49.5
Total sex determined		138	42	20	4	204	100.0
Skeletons		109	11	8	2	130	
GRAND TOTALS		247	53	28	6	334	

Appendix Table 3

Length Frequencies of King Salmon and Silver Salmon Carcasses
Recovered on the Upper Trinity River, 1970

Fork length in inches	Frequency					
	King salmon			Silver salmon		
	Male	Female	Total	Male	Female	Total
12	4	1	5			
13	8	4	12			
14	8	1	9			
15	8	2	10			
16	11	0	11			
17	8	5	13			
18	31	12	43	1	0	1
19	32	7	39	1	0	1
20	37	15	52	4	1	5
21	30	16	46	2	0	2
22	34	19	53	5	1	6
23	40	21	61	7	4	11
24	18	7	25	3	6	9
25	18	9	27	3	3	6
26	29	33	62	5	5	10
27	39	50	89	6	11	17
28	54	58	112	5	9	14
29	50	68	118	10	7	17
30	81	134	215	12	29	41
31	52	84	136	17	11	28
32	57	52	109	6	9	15
33	42	31	73	8	3	11
34	22	11	33	5	2	7
35	21	9	30	1	0	1
36	12	8	20	1	0	1
37	ll	3	14	0	0	0
38	9	2	11	1	0	1
39	6	3	9			
40	5	0	5			
41	7	0	7			
42	2	0	2			
43	1	1	2			
TOTALS	787	666	1,453	103	101	204
MEAN LENGTHS	27.1	28.4	27.7	28.4	28.7	28.5

Appendix Table 4

Major Trinity River Spawning Riffles
Subjectively Rated in Comparison with Lewiston Riffle

Riffle1/	Miles below Lewis-ton Dam	Rating 1963	1967	1968	1969	1970	Primary cause of degradation
Hatchery	0.10	25	25	25	25	50	Erosion
Lewiston2/	2.00	100	100	100	100	100	Erosion
Rush Creek	4.75	25	15	1	1	0	Siltation, inundation
Grass Valley Creek	8.25	75	15	10	10	15	Siltation, delta formation
Reo Stott	10.00	25	5	1	1	40	Siltation
Below Reo Stott	11.00	15	25	20	5	10	Siltation
Above end of Steel Bridge Road	12.25	15	15	10	1	5	Siltation, compaction
End of Steel Bridge Road	13.25	25	15	15	20	5	Siltation, compaction
Above Beudel Hole3/	13.50	15	-	5	5	1	Siltation, compaction
Above Johnson Hole3/	15.00	15	c	10	10	1	Siltation, compaction
Jackson3/	16.30	15	-	0	0	5	Siltation, aquatic plants
Indian Creek	17.00	15	15	5	5	0	Delta formation
Hunt	17.50	25	75	50	50	1	Unknown
1st Below Hunt4/	17.75		25	15	15	40	
2nd Below Hunt4/	18.00		25	5	5	5	Compaction-velocity
Douglas City	18.3	25	5	0	0	0	Delta formation, siltation
Above Reading Creek3/	19.25	15	-	1	1	0	

1/ Listed in order going downstream.
2/ From 1965 to 1970, Lewiston Riffle has, because of erosion, been reduced by 58.5%.
3/ These riffles were not observed in 1967.
4/ These riffles were relatively unimportant in 1963.