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CHINOOK (KING) SALMON CARCASS SURVEY
SHASTA RIVER
1980

by

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INTRODUCTION

The Shasta River was surveyed in the fall of 1980 to determine the accuracy of mark-recapture methodology involving carcass tagging for estimating fall chinook salmon abundance.

The Shasta River flows in a northerly direction, draining the Shasta valley, and has confluence with the Klamath River at river mile 176.3. It supports a major spawning run of chinook salmon and steelhead trout, as well as a minor spawning run of coho salmon. A fish counting station, Shasta Racks, is located approximately 150 yd upstream from the mouth.

Carcass surveys have not been conducted on the Shasta River in the past. Region 1 personnel have conducted aerial redd counts on the Shasta River since 1974. The Shasta Racks present a control situation whereby all fish migrating upstream may be counted. This situation allows the estimates of upstream carcass survey results to be compared with actual numbers of fish present in the system.

METHODS

The Shasta River, downstream from its confluence with Big Springs Creek, and Big Springs Creek were surveyed to determine areas of chinook salmon spawning and accessibility (Figure 1). A short section between Montague pumps and the Highway 3 bridge crossing, approximately 4.5 miles, was not surveyed. This section was typical of reaches of stream above and below. In all, a total of 25.5 miles was surveyed.

Three sections were chosen which had fair to good salmon spawning and relatively good accessibility. Section 1, a 1.5-mile reach of Big Springs Creek was surveyed on foot (Figure 2). Section 2, a 5.0-mile reach from the Highway 3 bridge downstream to the Highway 263 bridge, was surveyed from a small 8 ft-aluminum pram (Figure 3). Section 3, a 3.3-mile reach from the Green Meadows gabion downstream to a point approximately 0.2 miles below the large green Highway 263 bridge crossing, was surveyed on foot (Figure 4).

Similar methods of carcass surveying, as described by Hoopaugh (1978)[1/], were used during this survey. Fresh carcasses (clear eyes or firm flesh) were tagged on the lower jaw with color-coded hog rings and the carcasses replaced where found. Surveyor's tape was tied to the hog rings, a different color used each week. Carcasses which were not fresh were cut in half with a machete.

1/ Hoopaugh, David A. 1978. King (chinook) salmon spawning stocks in California's Central Valley, 1976. Anadromous Fisheries Branch Report No. 78-19.

During subsequent weeks tagged carcasses, which were reocvered, were cut in half to prevent recounting, and recovery ratios were determined.

DESCRIPTION OF STUDY AREAS

Section 1 - Big Springs Creek

This stream is fed by Big Springs. Water clarity was excellent and aquatic vegetation was abundant. Redds were observed scattered throughout this section with largest concentrations on the lower one-half of the section.

Section 2 - Montague Reach

The upper two miles are typified by meandering, slower-flowing waters. Few redds were observed in this area. The lower three miles had increased velocities and a greater number of redds. The largest concentration of redds were seen in the one mile reach immediately upstream from the Highway 263 bridge.

Section 3 - Canyon Reach

Surveys began at the upstream reach of the bagion spawning area. A large concentration of redds were seen in this area. The river throughout this area had highest velocities of the three surveyed reaches. The river was narrower and had little meandering. Spawning occurred throughout this entire section.

The area from Big Springs Creek/Shasta River downstream to the Highway 3 road bridge were not included in the carcass survey because: 1) few redds were noted; and 2) no salmon carcasses and few live salmon were observed in this reach (approximately 15 miles).

POPULATION ESTIMATES

Population estimates were computed in four different ways: 1) Schaefer (Table 1); 2) Petersen; 3) Darrock (Table 2) population models; and 4) by a direct percent recovery method. Comparison of total estimates by the four different methods is shown in Table 3.

Coverage of total spawning areas in the Shasta River was estimated at 55%. The four estimates given in Table 2 were expanded to reflect 100% coverage.

The Schaefer/Darrock methods were relatively similar in estimates, 3,520 and 3,842, respectively. Similarity, the Petersen/Percent Recovery methods were 4,620 and 4,631 respectively.

DISCUSSION

Actual numbers of chinook salmon which passed through the Shasta Racks was 8,096 (3,762 adults and 4,334 grilse). All methods used for estimating the population gave estimates below that of the actual number of fish. The Schaefer model estimate was 43.5% of actual numbers. The Petersen method was 57.1% of the actual numbers. The Darrock model estimated 47.5% of the total number and the Percent Recovery method estimated 57.2%.

Several factors could possibly account for differences in estimated and actual numbers of chinook salmon spawning in the Shasta River. They are: 1) introduction of biased sampling procedures; 2) incorrect estimate of percent spawning area sampled; and 3) physical condition of Shasta River.

Although sampling procedures were designed to eliminate introduction of biases, the possibility exists that various personnel have different sampling capabilities.

TABLE 1. Shasta River--1980 Carcass Survey Summary.
Schaefer Table

A. Tag Recovery Data

Recovery period(j)	Tagging periods(i) 1 (10-22)	2 (10-30)	3 (11-5)	4 (11-12)	R_j	C_j	C_j/R_j
1. (10-30)	30	-	-	-	30	459	15.30
2. (11-5)	8	50	-	-	58	296	5.10
3. (11-12)	11	9	17	-	37	204	5.51
4. (11-18)	-	5	5	22	32	131	4.09
Recovered tags(R_i)	49	64	22	22			
Applied tags(M_i)	84	126	85	72			
M_i/R_i	1.71	1.97	3.86	3.27			

B. Computed Estimates ($N = N_{ij} = (R_{ij} \times M_i/R_i \times C_j/R_j)$

	1.	2.	3.	4.	Total
1.	785	-	-	-	785
2.	70	502	-	-	572
3.	103	98	362	-	563
4.	-	41	48	294	383
TOTAL	958	641	410	294	2,303

Sample area estimate is (2,303 minus 367) 1,936.
Based on 55% coverage of spawning areas, total spawner estimate is 3,520 (1.461 adults and 2,059 grilse).

Table 2. Darrock Method. Shasta River 1980 carcass survey.

```
HE4
Enter recovery matrix (M):
? 30,8,11,0,0,50,9,5,0,0,17,5,0,0,0,22
Enter tagging vector (A):
?84,126,85,172

The M matrix is:
 30          8          11          0
 0           50         9           5
 0           0          17          5
 0           0          0           22

The A vector is:

 84
 126
 85
 72

The Rho vector is:

 .928677
 1.46599
 4.03743
 3.27273

The P vector is:

 1.0768
 .682133
..247682
 .305556

Enter vector of unmarked in second sample (U):
?429,238,167,99

The U prime vector is:
 429          238          167          99

The estimate of N is:
 1745.56

*******End of PRIMARY*******
```

TABLE 3. Comparison of Population Estimates Using Four Different Methods

Stream	Population estimate method[5] Schaefer[1]	Petersen[2]	Darrock[3]	Percent Recovery[4]
Shasta River	3,520	4,620	3,842	4,631

1/ Schaefer Method $N = N_{ij} = (R_{ij} \times M_i/R_i \times C_j/R_j)$

2/ Petersen Method $\frac{(C + 1)\ (M + 1)}{(R + 1)}$

3/ Darrock Method Estimate (W) + No. Fish Marked

4/ Percent Recovery $\frac{C}{(R/M)}$

5/ All estimate corrected to reflect 100% coverage of spawning areas.

was 41.4/58.6% as calculated from

Figure 1. Shasta River showing

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5/ All estimate corrected to reflect 100% coverage of spawning areas.

Estimates of spawning area sampled were made by: 1) surveying entire system for spawning; 2) comparing our estimates of spawning areas with aerial redd counts by Region 1 personnel; 3) locating spawning area and percent of spawning on maps; and 4) comparing surveyed area to unsurveyed area for total mileage and percent spawning.

It was not possible to make actual redd counts as water flow, depth width and clarity were limiting factors. It should be noted that flows were low this year as compared with normal years, making survey conditions excellent. Additionally, these conditions, although good, definitely affected out ability for carcass recoveries.

Carcass surveys should be similarly conducted for several more years. Results may then be compared to determine which population estimate method is most accurate.

The Shasta River is a unique upper Klamath River tributary in that its physical characteristics are not similar to any other upper tributaries. Therefore, results of this comparative carcass survey estimating cannot, and should not, be correlated to results of carcass surveys on the Salmon or Scott rivers, Bogus Creek and other small tributaries on the main stem upper Klamath River.

Peak carcass recovery occurred during the week of October 26 through November 1, 1980. Peak chinook salmon passage at the racks occurred during the week of October 12 through 18, 1980 (743 audlts, 781 grilse, 1,524 total).

The adult/grilse ratio, as counted at the racks, was 46.5/53.5%. This ratio was 41.4/58.6% as calculated from carcass survey data.

The percentage of grilse to adult counted at the Shasta Racks this season was drastically higher than that of the 1979 season.

Year	Grilse	Male	Female	Total adults
1979	1,038	-	-	7,194
1980	4,334	2,259	1,503	3,762

Random fork length samples were taken during the surveys. A total of 78 FL measurements were taken for grilse (≤57 cm) and mean FL was 48.2 cm (s - 5.06). Ninety-two (92) adults were measured for FL with a mean of 74.2 cm (s = 10.27).

TAG RECOVERIES

A total of eight tage were found during the carcass surveys. Seven tags were USFWS jaw tags which had been applied at the mouth of the Klamath River. One CDFG spaghetti tag was also recovered. This tag was applied during seining operations at the Highway 101 bridge area.

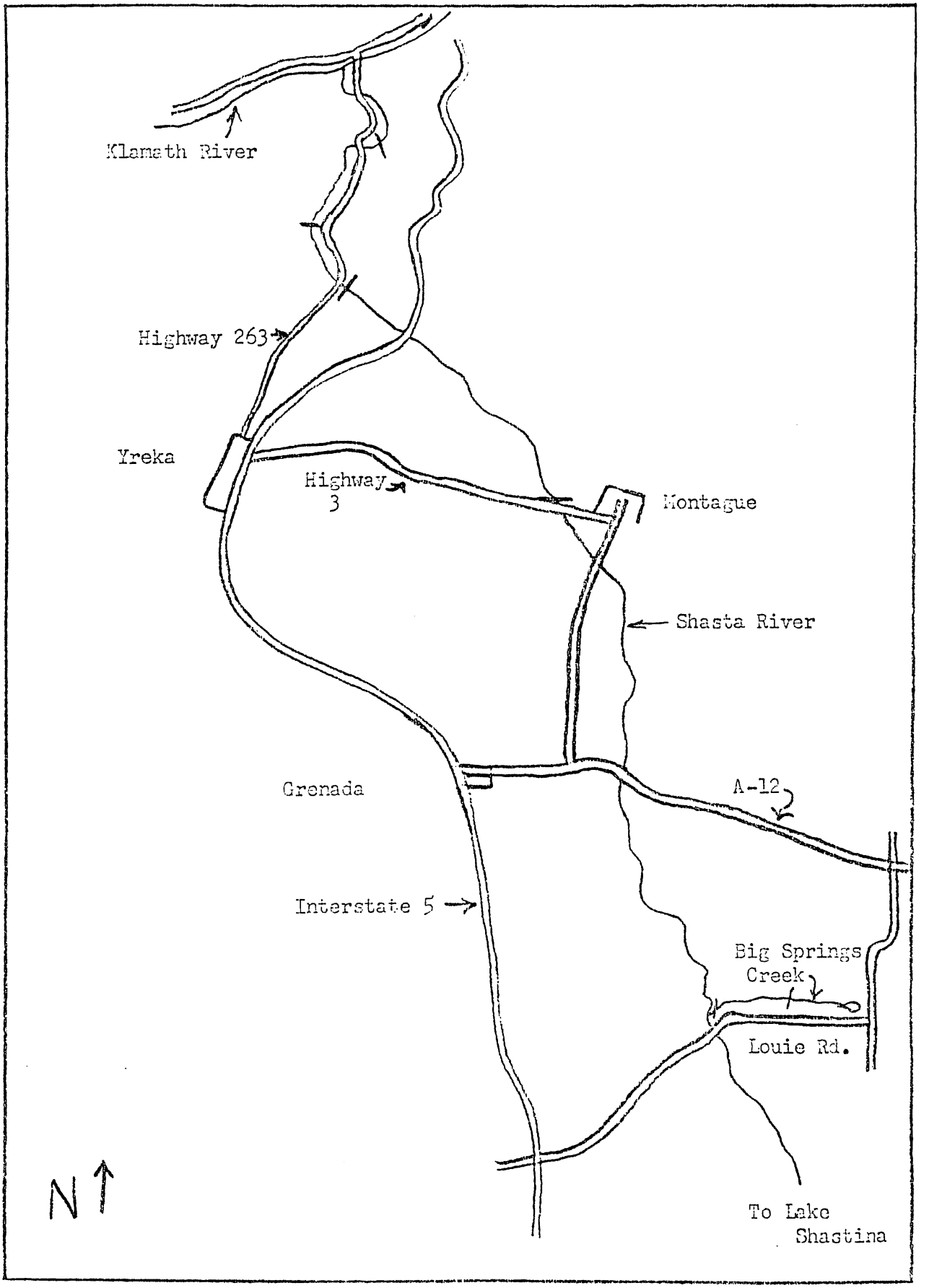

Figure 1. Shasta River showing king salmon carcass surveyed areas.

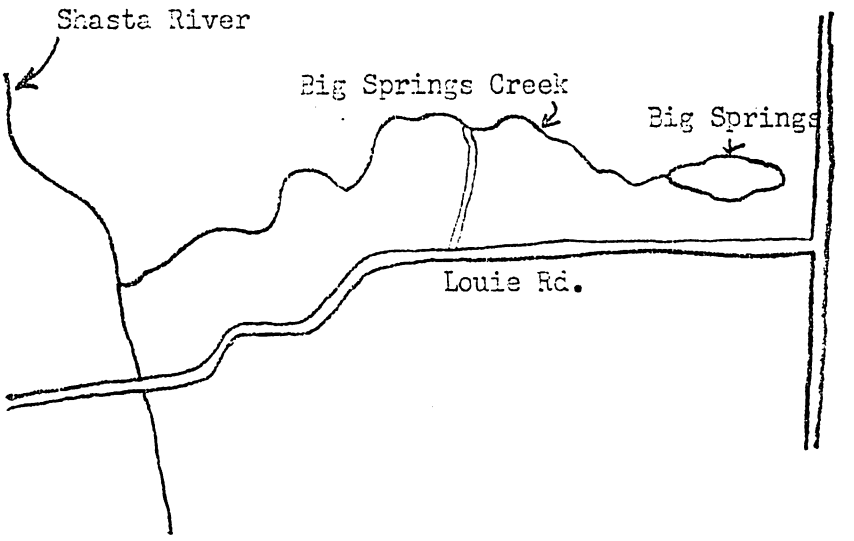

Figure 2. Big Springs Creek

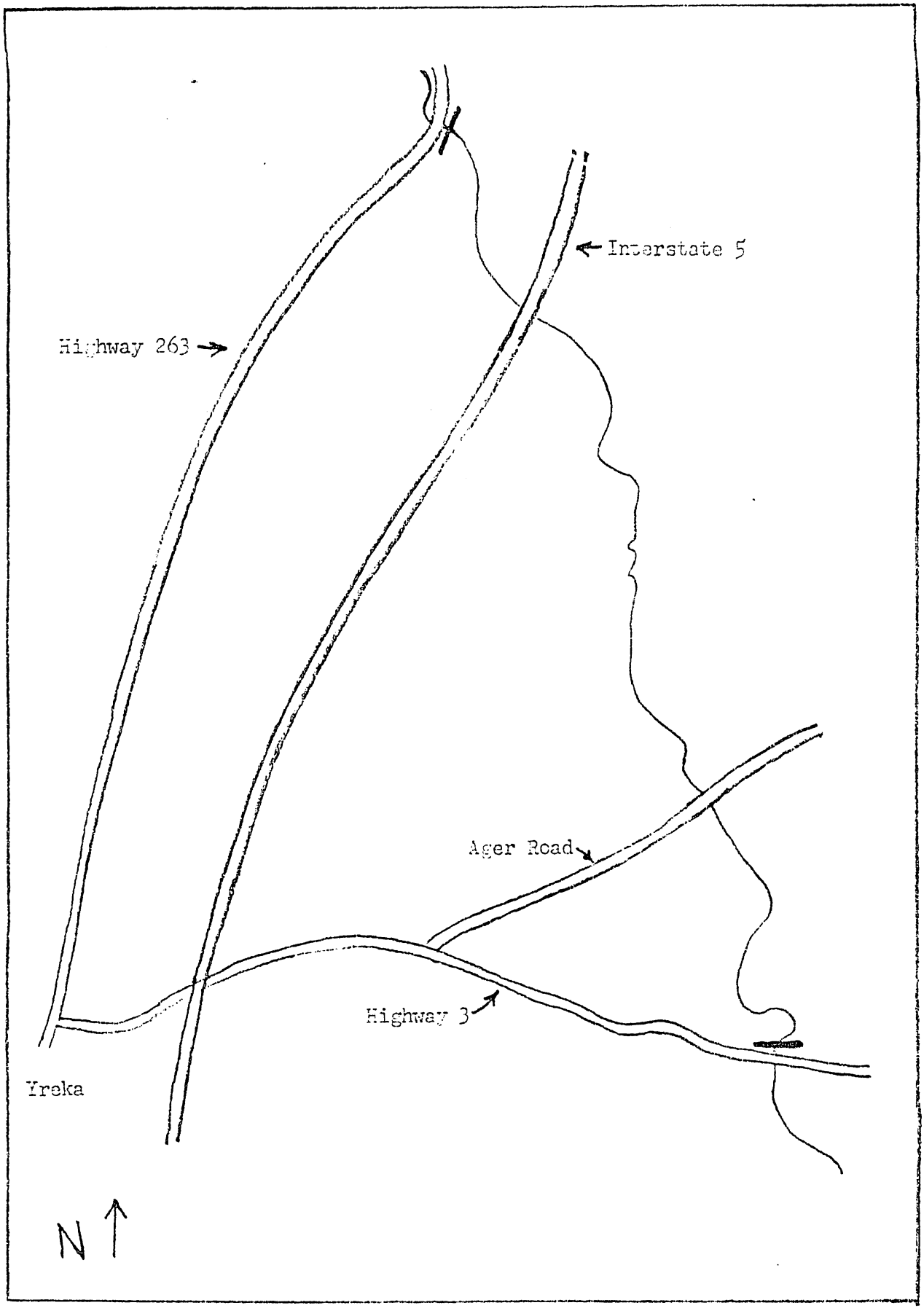

Figure 3. Montague area of Shasta River.

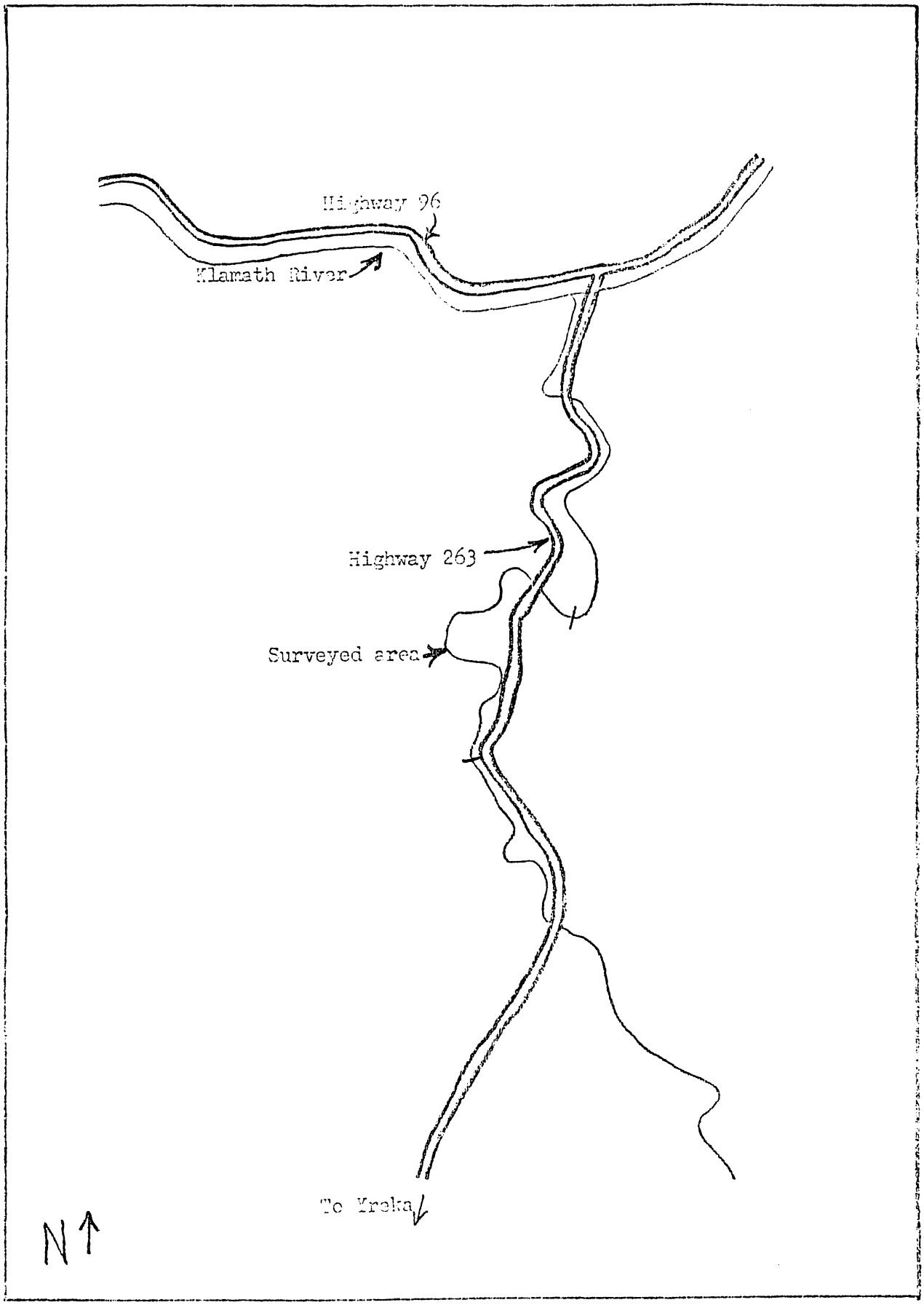

Figure 4. Canyon area of Shasta River.

APPENDIX A

LENGTH FREQUENCY (cm)

SPECIES King Salmon (Carcasses) LOCATION Shasta River DATE 10/11-1981 NAME

	Grilse			Adult			
.0	3.0			6.0			.0
.1	.1			.1			.1
.2	.2			.2			.2
.3	.3 I		1	.3			.3
.4	.4			.4			.4
.5	.5			.5			.5
.6	.6			.6			.6
.7	.7			.7			.7
.8	.8			.8 III		3	.8
.9	.9			.9 II		2	.9
.0	4.0			6.0 III		3	.0
.1	.1 IIII	I	6	.1 III		3	.1
.2	.2 IIII		5	.2 IIII		4	.2
.3	.3 III		4	.3 IIII		4	.3
.4	.4 IIII		4	.4 II		2	.4
.5	.5 IIII	IIII	10	.5 III		3	.5
.6	.6 I		1	.6 II		2	.6
.7	.7 IIII		4	.7 I		1	.7
.8	.8 III		3	.8 II		2	.8
.9	.9 IIII	III	8	.9 III		3	.9
.0	5.0 IIII		5	7.0 III		3	.0
.1	.1 IIII	I	6	.1 II		2	.1
.2	.2 IIII		4	.2 IIII		5	.2
.3	.3 III		3	.3 I		1	.3
.4	.4 IIII		4	.4 IIII	II	7	.4
.5	.5 III		3	.5 III		3	.5
.6	.6 IIII		4	.6 II		2	.6
.7	.7 III		3	.7 III		3	.7
.8	.8			.8 II		2	.8
.9	.9			.9 IIII		4	.9
.0	.0			8.0 IIII		4	.0
.1	.1			.1 III		3	.1
.2	.2			.2 II		2	.2
.3	.3			.3 II		2	.3
.4	.4			.4 I		1	.4
.5	.5			.5 I		1	.5
.6	.6			.6 I		1	.6
.7	.7			.7 I		1	.7
.8	.8			.8			.8
.9	.9			.9 III		3	.9
.0	.0			9.0 III		3	.0
.1	.1			.1			.1
.2	.2			.2 II		2	.2
.3	.3			.3 II		2	.3
.4	.4			.4 II			.4
.5	.5			.5			.5
.6	.6			.6 I		1	.6
.7	.7			.7			.7
.8	.8			.8			.8
.9	.9			.9			.9

n= 73
x= 53.2cm
s= 5.06

n= 92
x= 74.2cm
s= 10.27

n= 87

FG-1600
5-29-74

APPENDIX TABLE B

Tag Number	Recovery Date	Tagging Date	FL(cm)
A 438	10-22-80	8-19-80	43
C 107	"	8-22-80	71
A 475	10-30-80	8-20-80	45
L 03975	"		
B 168	11- 5-80	8-22-80	50
B 179	"	8-22-80	50
A 352	11-12-80	8-16-80	45
B 134	"	8-21-80	51

USFWS Tags - Axxx, Bxxx, Cxxx
CDFG Tags - L 0xxxx