State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991 - 1992 SEASON

authored by:

Mark Zuspan, Barry W. Collins, Carrie E. Wilson, Michael Lau,
Bill Heubach, Ed Miller, Bernard Aguilar,
Michael Dean, and Robert Reavis.
Inland Fisheries Division

edited by:

Kevan Urquhart
and
Robert M. Kano
Inland Fisheries Division

Inland Fisheries Division
1416 Ninth Street
Sacramento, Ca. 95814

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Foreword

This is the fourth annual report to the United States Bureau of Reclamation (USBR) of activities conducted under the terms of Cooperative Agreements Numbers 8-FC-20-07100 and 1-FG-20-09820, and covers the contract period July 1, 1991 through June 30, 1992. The second Cooperative Agreement expanded Jobs 3, 4 and 5, and added Jobs 7 and 8. The field work was conducted by personnel of the California Department of Fish and Game's (CDFG) Klamath-Trinity Program, specifically its Trinity River Project (TRP), Trinity Fisheries Investigations Project (TFIP), and Natural Stocks Assessment Project (NSAP).

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Chapter III. Job III. (continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Tables

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Tables
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Tables
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Tables
(continued)

Chapter IV. Job IV. (continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Tables
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Tables
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Figures

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Figures
(continued)

Chapter III. Job III. (continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Appendices

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Appendices
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1991-1992 Season

List of Appendices
(continued)

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991-1992 SEASON

CHAPTER I

JOB I
SALMON SPAWNER SURVEYS IN THE UPPER TRINITY RIVER BASIN

by

Mark Zuspan

ABSTRACT

Staff of the California Department of Fish and Game's Trinity Fisheries Investigations Project conducted a mark-and-recovery, salmon spawner survey of a portion of the mid-Trinity River basin from 16 September through 19 December 1991. We surveyed the mainstem Trinity River from the upstream limit of anadromous migration at Lewiston Dam to a point 63.4 km downstream at the confluence of the North Fork Trinity River. Selected portions of its major tributaries that were accessible to anadromous fish were also surveyed. We examined 690 chinook salmon (Oncorhynchus tshawytscha) and 127 coho salmon (O. kisutch) carcasses during the mainstem Trinity River survey.

Chinook and coho salmon spawned throughout the entire mainstem survey section, but spawner density was highest in the uppermost 3.2 km of river, generally decreasing in a downstream direction. Few salmon spawned in the tributaries this year. We found only 29 chinook and 12 coho salmon during the tributary surveys.

Only 1.2% of the fall-run chinook salmon and none of the spring-run chinook and coho salmon females died prior to spawning. These are the lowest prespawning mortality rates for chinook salmon on record. The probable cause for the high spawning success was the low spawner escapement and resulting low spawning density in comparison to previous years.

We recovered both spring-run and fall-run chinook salmon in the survey. Spring-run chinook salmon dominated recovery until late October, thereafter fall-run fish became the predominant race. Coho salmon were first noted in the mainstem Trinity River survey during mid-October, their numbers peaked in mid-November, and they were essentially gone by mid-December.

Based on the recovery of adipose fin-clipped chinook salmon, we estimate that none of the spring-run and 66.9% of the fall-run chinook salmon spawners observed in the survey were of hatchery origin. We could not determine the proportion of spawning coho salmon which were of hatchery origin because fish from the 1988 brood year released from the hatchery were not adipose fin-clipped.

Fork lengths of adult spring- and fall-run chinook salmon from the mainstem Trinity River averaged 74.9 cm (range: 57-94 cm) and 68.8 cm (range: 52-91 cm), respectively. Adult chinook salmon composed 97.5% of the spring-run chinook salmon and 95.3% of the fall-run chinook salmon with grilse composing the remainder. Fork lengths of adult coho in the mainstem Trinity River averaged 68.5 cm (range: 58-85). Adult coho salmon composed 99.1% of the fish measured with grilse composing the remainder. Adult fall-run chinook salmon in the tributaries averaged 63.5 cm FL (range: 54-74 cm) and composed 92.9% of the fish measured, with grilse composing the remainder.

JOB OBJECTIVES

1. To determine, through a system of spawning ground surveys, the distribution of naturally spawning chinook and coho salmon in the mainstem Trinity River and its tributaries upstream of, and including the North Fork Trinity River.

2. To determine the incidence of pre-spawning mortality among naturally spawning salmon in the mainstem Trinity River and its tributaries upstream of, and including the North Fork Trinity River.

3. To determine the size, sex composition, and incidence of marked and tagged individuals among the naturally spawning populations in the mainstem Trinity River and its tributaries upstream of, and including the North Fork Trinity River.

4. To determine spawner distributions within the mainstem Trinity River upstream of the North Fork Trinity River.

INTRODUCTION

This year the California Department of Fish and Game's (CDFG) Trinity Fisheries Investigations Project (TFIP) completed the twenty-fourth salmon spawner survey conducted in the mainstem Trinity River since 1942. The first three surveys (Moffett and Smith 1950, Gibbs 1956, and Weber 1965) were fishery evaluations prior to the construction of Lewiston Dam. The remaining twenty (La Faunce 1965; Rogers 1970, 1973, 1982; Smith 1975, Zuspan 1991, 1992a, 1992b; and work by Miller and Stempel [Appendix 1]) were designed to evaluate the effects of the existing dam on the salmon resource.

In 1984, The Trinity River Basin Fish and Wildlife Management Program was enacted by Congress (Public Law 98-541). This law appropriated approximately $57 million to be spent for fishery and wildlife restoration, and monitoring within the Trinity River basin.

This survey, and those scheduled for following years by CDFG's TFIP, will help to evaluate the effectiveness of increasing spawning and holding habitat within the basin through habitat improvement efforts that are part of the restoration program.

METHODS

Mainstem Trinity River Spawner Survey

Our study area included the mainstem Trinity River from its upstream limit to anadromous fish migration at Lewiston Dam (river km 180.1) to the confluence of North Fork Trinity River, 63.4 km downstream (Figure 1). Previous studies have divided the river into either a four- or seven-zone system. The seven-zone system (Table 1) was used in 1987 by the United States Fish and Wildlife Service (USFWS) (Stempel Appendix 1) and again in 1988, 1989 and 1990 by TFIP (Zuspan 1991, 1992a, 1992b). Prior to this, with the exception of Moffett and Smith 1950, all surveys were based on a system using four zones in the river reach below Lewiston Dam (Gibbs 1956; La Faunce 1965; Rogers 1970, 1973, 1982; Smith 1975; Weber 1965; and work by Miller [Appendix 1]). Our 1991-1992 data were collected based on both zone systems. We have summarized data in this report based only on the seven-zone system as it allows comparisons of different river sections in finer detail. By also recording data using the four-zone system, we will be able to compare historic and current trends in other reports.

River kilometers (RKM) for location references were taken from a series of 7.5 minute United States Geological Survey topographic maps (Appendix 2).

TFIP staff conducted the survey using 12-ft Avon[1/] inflatable rafts equipped with rowing frames. Raft crews consisted of a rower, and one or two personnel to recover carcasses. To increase coverage of the highly productive upper two sections, two rafts were used simultaneously, with one covering each side of the river. Carcasses were recovered on foot along the shore or, in deep water, from the rafts with long handled gigs. We surveyed the entire mainstem Trinity River study section once a week throughout the salmon spawning season.

We determined spawning condition in female salmon by direct observation of the ovaries. Fish were classified as either spawned or unspawned based on egg retention. Females which retained over 50% of their eggs were classified as unspawned. Male spawning condition was not assessed, as its determination was considered to be too subjective.

All carcasses we observed were identified by species and examined for an adipose fin-clip (Ad-clip) indicating the presence of a coded-wire tag (CWT) in their snout. To increase our likelihood

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[1/] The use of brand or trade names is for identification purposes only, and does not imply the endorsement of any product by the CDFG.

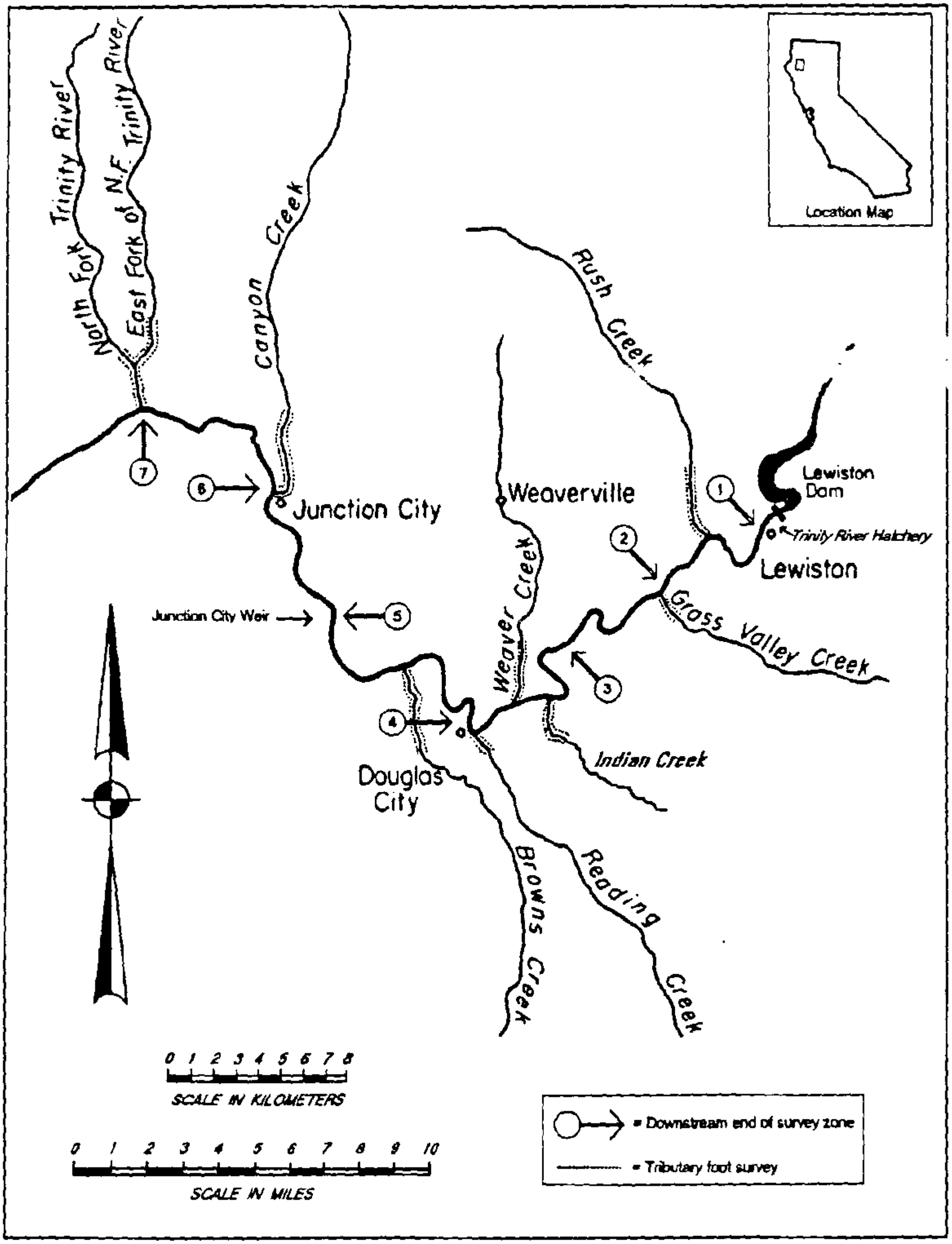

FIGURE 1. Map of the Trinity River basin showing the mainstem spawner survey zones and areas of tributaries surveyed in the 1991-92 spawner survey.

TABLE 1. Description and lengths of river zones used in the 1991-92 mainstem Trinity River spawner survey.

River zone	Length (km)	Zone description
1	3.2	Lewiston Dam (RKM[a] 180.1) - Old Lewiston Bridge (RKM 176.9)
2	7.9	Old Lewiston Bridge (RKM 176.9) - Browns Mtn. Bridge (RKM 169.0)
3	10.2	Browns Mtn. Bridge (RKM 169.0) - Steel Bridge (RKM 158.8)
4	10.4	Steel Bridge (RKM 158.8) - Douglas City Camp (RKM 148.4)
5	12.0	Douglas City Camp (RKM 148.4) - Junction City Weir (RKM 136.4)
6	12.5	Junction City Weir (RKM 136.4) - McCartney Pond (RKM 123.9)
7	7.2	McCartney Pond (RKM 123.9) - mouth of North Fork Trinity (RKM 116.7)

[a] RKM = distance from the mouth of the river in km.

of recovering all Ad-clipped fish, we passed all recovered salmon through a coded-wire tag detector. In this manner, fish that carried a coded-wire tag but had an unidentifiable adipose fin-clip were identified as an Ad-clip fish. Fish were further examined for the presence of an external tag (spaghetti tag) and an operculum punch, applied as part of an ongoing study by the Trinity River Project of the CDFG's Klamath-Trinity Program. Spaghetti tags and operculum punches (Program marks) are placed on returning adult fish by CDFG staff at two trapping and tagging stations downstream of the spawner survey area, to monitor escapement and harvest of returning adult salmonids. The spaghetti-tagged salmon also receive an identifying operculum punch in order to estimate tag shedding rates of fish tagged at the two sites. The most downstream trapping site is Willow Creek Weir, located at RKM 32.2 on the mainstem Trinity River. The other trapping site, Junction City Weir, is located in the spawner survey area at RKM 136.4. Spring-run and fall-run chinook salmon, coho salmon, and steelhead are trapped and tagged at both Willow Creek and Junction City weirs.

Chinook Salmon

We classified all chinook salmon carcasses as either condition one or two, based on the extent of body deterioration.

Condition-one fish were the freshest, having at least one clear eye and a relatively firm body. Condition-one fish were assumed to have died within one week prior to recovery. Condition-two fish were in various advanced stages of decomposition and assumed to have died more than one week prior to recovery. We did not count partially intact fish skeletons, because they could have represented Project-marked or condition-two fish which had already been counted and chopped in half during a previous week's survey.

All chinook salmon we recovered were further classified into four categories: 1) Ad-clipped fish; 2) Program-marked fish; 3) condition-one, unmarked fish; 4) condition-two, unmarked fish. The category assigned determined what data we collected from each fish.

We determined the species and condition (i.e. one or two) of Ad-clipped fish. Heads of Ad-clipped fish were removed and retained for later CWT recovery and decoding.

Program-marked fish were sexed and their spawning condition assessed. We removed any spaghetti tags and then cut the fish in half with a machete to prevent recounting in future weeks. Spaghetti tags had a unique number which allowed determination of the date and location of tagging.

Condition-one fish which were neither Ad-clipped nor Program-marked were flagged and returned to moving water for subsequent recovery, and a systematically collected sample of them were measured to the nearest cm fork length (FL). Flags consisted of plastic surveyor's tape wrapped tightly around a colored hog ring and affixed to the left mandible of the carcass. The surveyor's tape was wrapped so tightly around the hog ring, that it amounted to no more than a colored coating, with less than 2.5 cm of tape extending from the hog ring at any time. Flag colors were changed weekly so that, on recovery, the week of flagging could be determined. The hog rings used to attach the flagging were color-coded to indicate in which zone they were affixed, so that we could determine the incidence of carcasses drifting into another recovery zone. Chinook $\leq$ 55 cm were preliminarily classified as grilse during the carcass surveys. Actual grilse to adult ratios for the whole population of chinook salmon in this year's run were determined from post-season evaluations of length frequency and CWT data. Adult and grilse salmon analysis in this report is based on the post-season size determinations.

Condition-two fish which were neither Ad-clipped or Program-marked were checked for the presence of a flag and, if possible, the sex and spawning condition were assessed. If a flag was present, the color of the flagging tape and the underlying ring were recorded, and all fish were then cut in half to prevent later recovery and re-counting of the same fish.

Coho Salmon

All coho salmon collected were measured (cm FL) and checked for the presence of Ad-clips or Program-marks. When possible, sex and spawning condition were determined and then all coho salmon were cut in half to prevent future re-counting. Coho carcasses were not used in the flagging experiment, since they would have required a separate series of flag colors to segregate them from flagged chinook salmon.

Tributary Spawner Surveys

Tributaries to the mainstem Trinity River, [illegible] Creek, Grass Valley Creek, Indian Creek, Reading Creek, Browns Creek, Weaver Creek, Canyon Creek, East Fork of the North Fork Trinity River, and the mainstem North Fork Trinity River, were surveyed on foot once a week throughout the chinook salmon spawning season. Sections surveyed for each tributary ranged in length from 0.5 to 2.5 km, and were chosen based on accessibility and their historic use by chinook salmon spawners (Figure 1). The survey began with the onset of chinook salmon spawning in each tributary and continued until spawning ended (Table 2). The lower reach of Weaver Creek was dry and inaccessible to salmon until 21 November, so the survey of that tributary was delayed until that date.

TABLE 2. Trinity River tributaries surveyed in the 1991-92 spawner survey.

Tributary	Length surveyed (km)	Number of surveys	Date Start	Date End	Percent of total [a]
Rush Creek	2.4	8	10/22/91	12/12/91	100.0
Grass Valley Creek	0.8	8	10/22/91	12/22/91	100.0
Indian Creek	1.3	8	10/21/91	12/11/91	100.0
Reading Creek	0.5	8	10/21/91	12/11/91	100.0
Browns Creek	2.5	8	10/23/91	12/13/91	100.0
Weaver Creek [b]	1.8	3	11/21/91	12/13/91	100.0
Canyon Creek	2.2	8	10/21/91	12/11/91	66.7
N. Fork Trinity R.	1.5	8	10/23/91	12/10/91	78.0
E. Fork of N. Fork Trinity R.	1.3	8	10/21/91	12/10/91	69.0

[a] Estimated percent of the total chinook spawning in that tributary that occurred in the survey section.

[b] The survey did not begin until 21 November in Weaver Creek because its stream bed was dry prior to that date.

We classified all identifiable chinook salmon recovered into the four categories used in the mainstem spawner survey and handled them accordingly (see page 6). However, sex and prespawning condition were assessed only for fish collected from the mainstem Trinity River. Too few fish were observed in the tributaries to compose an adequate sample and most of those observed were condition-one fish which we needed to flag for spawning escapement estimates. Coho salmon were counted and cut in half upon recovery. Chinook salmon redds, when observed for the first time, were counted and recorded.

Aerial flights and ground-truthing surveys were made of each tributary to determine the percentage of the total available spawning area within each tributary represented by each of our ongoing spawner survey zones. Flights were made during the peak of spawning activity to observe redds and locate the upstream limit of spawning. Follow-up ground-truthing surveys were made, when necessary, to make total redd counts for both the whole tributary and its spawner survey zone. The percentage of the total redds occurring in a survey zone during the aforementioned count was assumed to represent the percentage of the total spawning in each tributary that took place within the survey zone.

RESULTS AND DISCUSSION

Numbers Observed

Mainstem Trinity River Spawner Surveys

Chinook Salmon. We examined 690 chinook salmon carcasses during the spawner survey. These included 30 Ad-clipped fish, 73 Program-marked fish (five also ad-clipped), 251 unmarked condition-one fish which we flagged, and 270 unmarked condition-two fish. We also recaptured and re-examined 87 fish which we had flagged in previous weeks. No whole skeletons were observed (Appendix 3).

Coho Salmon. We recovered 127 coho salmon carcasses in the spawner survey, including one Ad-clipped and 17 Program-marked fish (Appendix 4), and did not see any whole skeletons.

Tributary Spawner Surveys

Chinook Salmon. We found only 29 chinook salmon carcasses in the nine tributaries surveyed this season. These included 14 condition-one fish which we flagged and 15 skeletons. Included in the fish we flagged were four Program-marked fish. We re-examined four chinook which we had flagged in prior weeks (Appendix 5).

<u>Coho Salmon</u>. We examined 12 coho salmon in the tributaries this season, and no skeletons were observed (Appendix 5).

Separating Spring- and Fall-run Chinook in the Survey

We only considered chinook salmon recovered in the mainstem Trinity River in determining a date to separate the two chinook salmon runs. Both spring- and fall-runs of chinook salmon were observed in the mainstem survey. A date separating the two races was determined from CWTed and Program-marked chinook salmon. Spring-run chinook salmon dominated our recoveries through the fifth week of the survey ending 20 October 1991. Some overlap of spring- and fall-run chinook salmon occurred during the sixth week ending 27 October 1990. Fall-run chinook salmon became predominate by the seventh week of the survey which began 28 October 1991. For the purposes of this report, all chinook recovered prior to 28 October are considered spring race while those recovered from that date onward are considered fall race (Figure 2).

For comparison, the date separating spring and fall-run chinook in previous years was 11 October in 1988, 23 October in 1989, and 29 October in 1990 (Zuspan 1991, 1992a, 1992b).

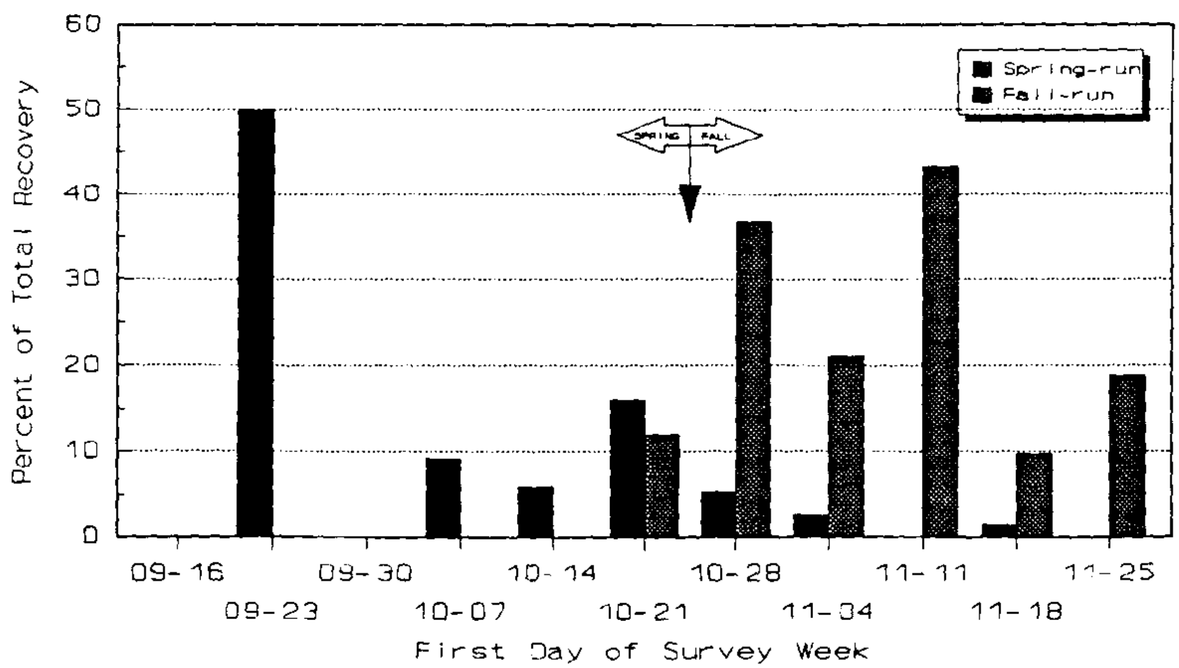

FIGURE 2. Weekly proportion of spring- and fall-run chinook salmon observed in the 1991-92 Trinity River spawner survey. The arrow indicates the date separating the spring from the fall run.

Size Composition

Spring-run Chinook Salmon

Mainstem Trinity River. We measured 81 spring-run chinook salmon to the nearest cm FL during the survey. Adults are fish >53 cm FL[2] (Bill Heubach Calif. Dept. Fish and Game, pers. comm.) and composed 97.5% (79/81) of the spring-run chinook salmon observed in the survey, while grilse (fish $\leq$ 53 cm FL) composed the remaining 2.5% (2/81) (Table 3, Figure 3). For comparison, the percentage of grilse in the spring-run chinook sampled at Junction City Weir, and Trinity River Hatchery ranged between 8% and 10% (Table 3). Data from Willow Creek Weir are not included in this analysis as only a small portion of the late spring-run chinook salmon population was sampled there. There was a significant difference in the percentage of grilse sampled in the survey and at the two fixed sites (X^2=6.03, df=2, P=0.049).

Tributaries. Based on the date at which we first observed spawning activity, we assume that only fall-run chinook were recovered in the tributaries.

Fall-run Chinook Salmon

Mainstem Trinity River. We measured (cm FL) 170 fall-run chinook salmon this season. Based on a minimum of 52 cm FL[2] for adults (Bill Heubach Calif. Dept. Fish and Game, pers. comm.), 95.3% of the fall-run chinook salmon measured were adults and 4.7% were grilse (Table 4, Figure 4). The percentage of fall-run chinook salmon grilse at the different sampling sites, including the tributary survey, ranged from 12.1% to 4% (Table 4) and when tested for independence, the difference was highly significant (X^2=34.38, df=4, P=.00001). The reason for the difference in rates between the sample sites is unknown.

Tributaries. We measured (cm FL) 14 chinook salmon in the tributaries this year. Of these, 92.9% were adults (>52 cm FL) and 7.1% were grilse (Table 4).

Coho Salmon

We measured (FL cm) 113 coho salmon in the mainstem Trinity River. Adults are fish >49 cm FL[2] (Bill Heubach Calif. Dept. Fish and Game, pers. comm.) and composed 99.1% of the coho measured, with grilse composing the remaining 0.9% (Table 5, Figure 5). The percentage of coho salmon grilse at the different sampling sites ranged from 4.1% to 0.9% (Table 5), but the differences were not significant (X^2=3.275, df=3, P=.351).

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[2] Determined from post-season analysis of length frequency and coded-wire tag recovery.

TABLE 3. Numbers and percentages of spring-run chinook salmon grilse observed in the spawner survey and at two fixed locations in the mainstem Trinity River during the 1991-92 season.

	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey
Grilse [a]	25	71	2
Adults	285	614	79
% Grilse	8%	10%	2%

a/ Spring-run chinook salmon ≤ 53 cm FL are considered grilse based on a post-season analysis of length frequency and coded-wire tags.

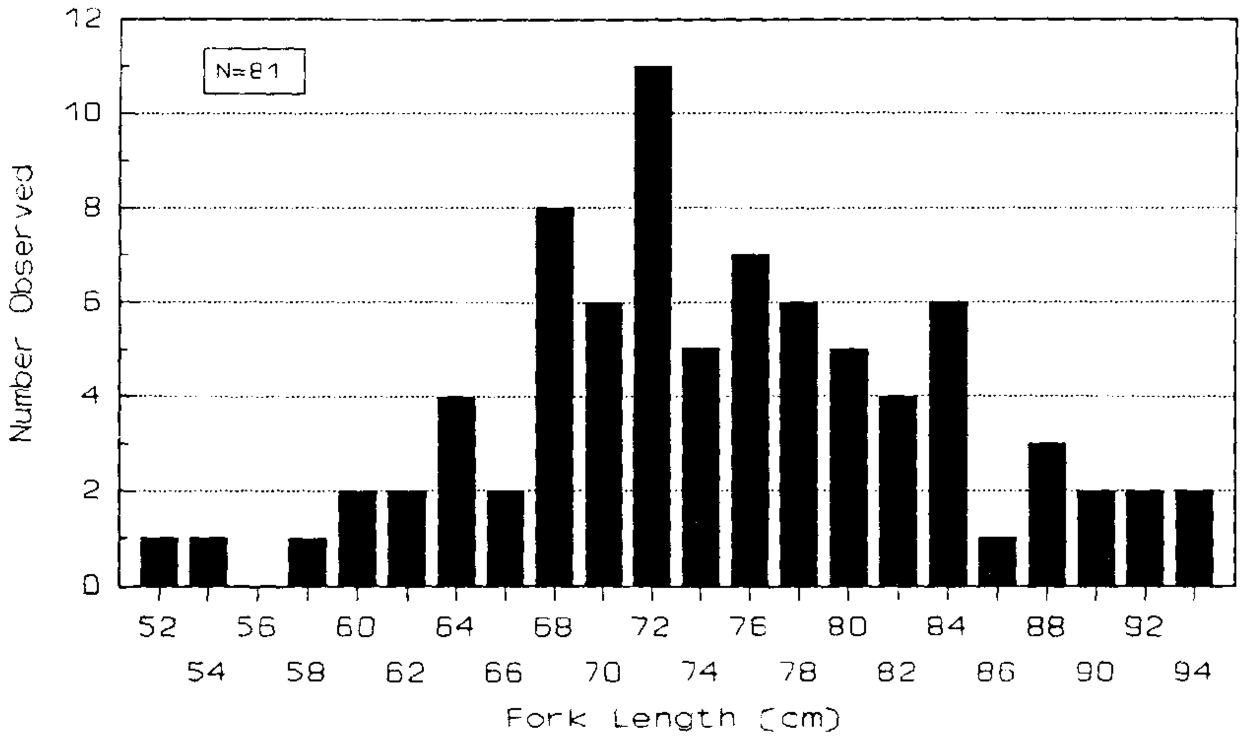

FIGURE 3. Fork length distribution, in 2-cm increments, of spring-run chinook salmon measured in the mainstem Trinity River during the 1991-92 spawner survey.

TABLE 4. Numbers and percentages of fall-run chinook salmon grilse observed in the spawner surveys and at three fixed locations in the Trinity River basin during the 1991-92 season.

	Willow Creek Weir	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey	Tributary spawner survey
Grilse [a]	38	59	205	8	1
Adults	916	430	2,482	162	13
% Grilse	4.0%	12.1%	7.6%	4.7%	7.1%

a/ Fall-run chinook salmon ≤52 cm FL are considered grilse based on a post-season analysis of length frequency and coded-wire tags.

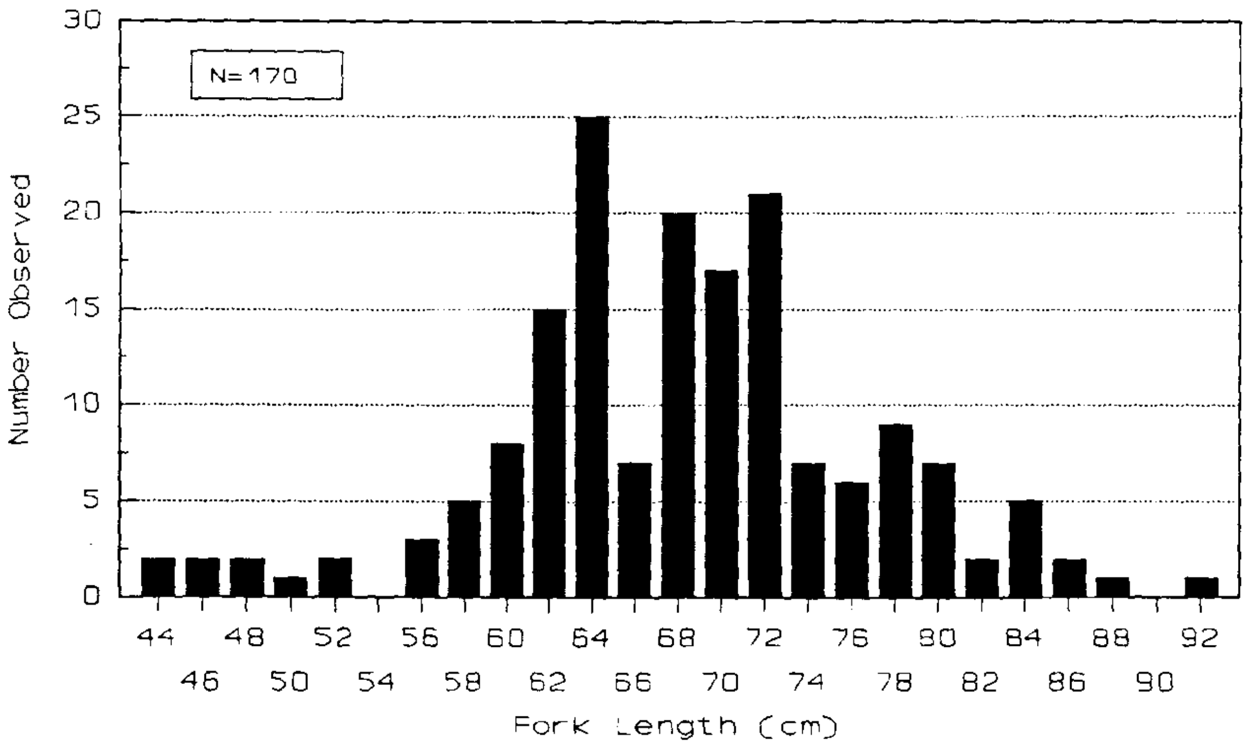

FIGURE 4. Fork length distribution, in 2-cm increments, of fall-run chinook salmon measured in the mainstem Trinity River during the 1991-92 spawner survey.

TABLE 5. Numbers and percentages of coho salmon grilse observed in the spawner surveys and at three fixed locations in the Trinity River basin during the 1991-92 season.

	Willow Creek Weir	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey
Grilse a/	21	8	106	1
Adults	585	215	2,509	112
% Grilse	3.5%	3.6%	4.1%	0.9%

a/ Coho salmon ≤49 cm FL are considered grilse based on post-season analysis of length frequency and coded-wire tags.

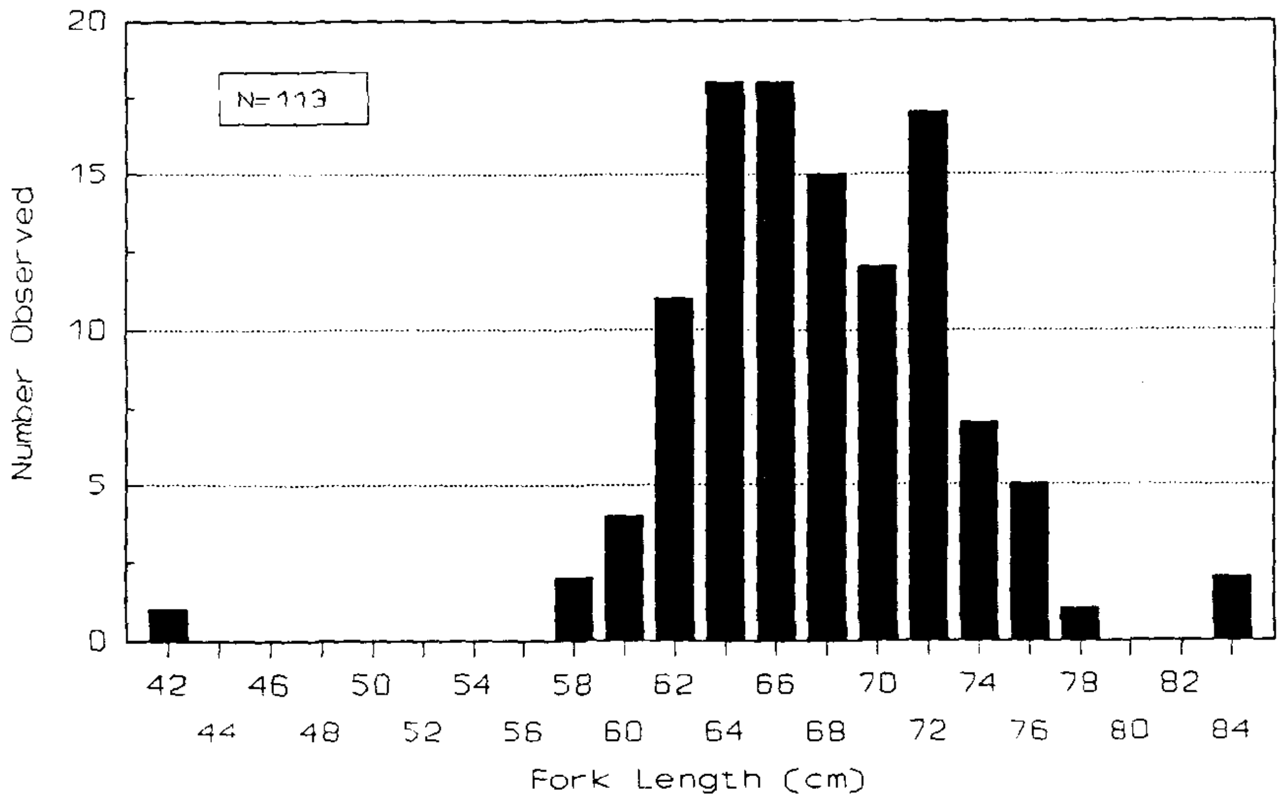

FIGURE 5. Fork length distribution, in 2-cm increments, of coho salmon measured in the mainstem Trinity River during the 1991-92 spawner survey.

Sex Composition

Sex was determined only for fish recovered from the mainstem Trinity River that were either condition-two unmarked fish, Program-marked fish, or flagged fish recaptured in the carcass survey.

Chinook Salmon

We determined the sex of 340 adult chinook salmon during the survey (49 spring-run and 291 fall-run). Of the adult spring-run chinook salmon observed, 53.1% were females, while adult fall-run fish were 54.1% females. The percentage of females in the survey was generally highest during the early and late weeks of the survey and lowest during the middle weeks (Figure 6). This seasonal trend in sex ratio was also noted in the previous two year's surveys (Zuspan 1992a, 1992b). However, the trend was not as pronounced this year as in the past. The preponderance of adult females in the chinook salmon run has been noted in all but two of the previous surveys and has ranged from 73.6% to 25.8% (Appendix 6). The preponderance of females among adult fish results when males return as grilse,

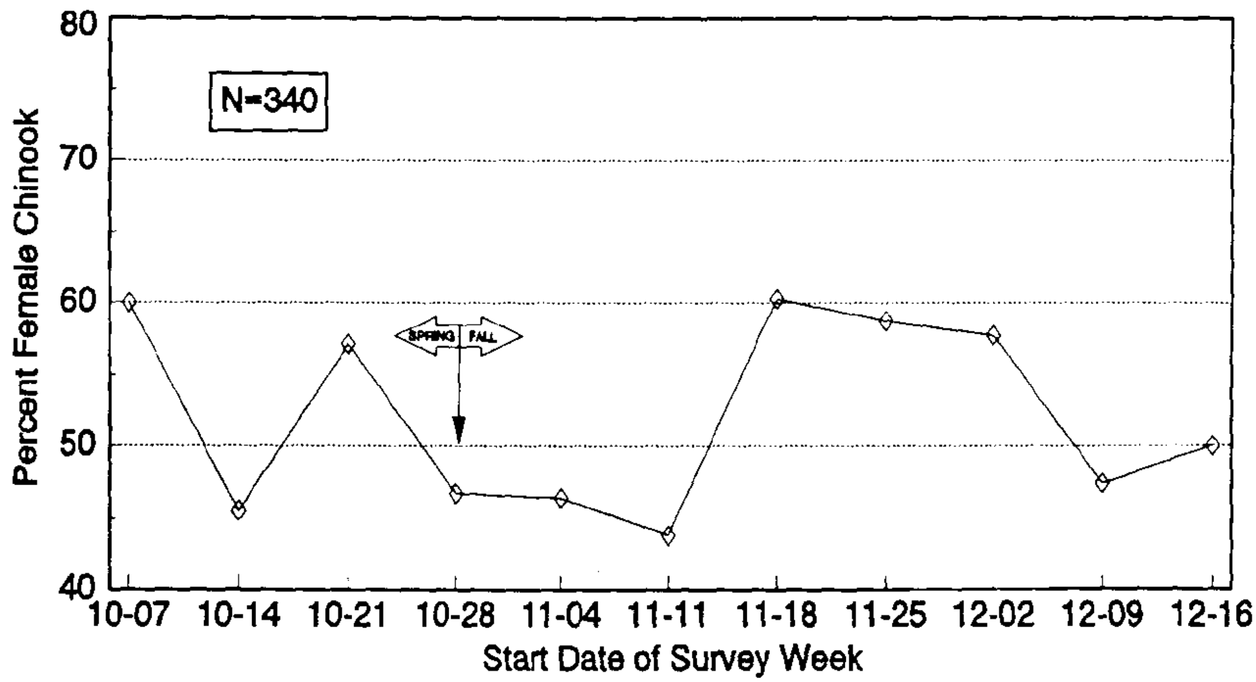

FIGURE 6. Percent females in the adult chinook salmon population observed in the mainstem Trinity River during the 1991-92 spawner survey. The arrow indicates the date separating the spring from the fall run.

thereby decreasing the number of males left to return as adults.

Coho Salmon

We determined the sex of 109 coho, 60% (65) of which were females. For comparison, 42%, 57%, and 80% of the coho we examined in 1988, 1989, and 1990, respectively, were females (Zuspan 1991, 1992a, 1992b). Like female chinook salmon, coho salmon females were more prevalent early and late in survey (Figure 7).

Prespawning Mortality

Prespawning mortality was determined only for fish recovered in the mainstem Trinity River that were either condition-two unmarked fish, Program-marked fish, or flagged fish recaptured in the carcass survey.

Chinook Salmon

We determined the spawning condition of 186 adult female chinook salmon, including 22 spring-run and 164 fall-run fish. Prespawning mortality was 0% (0/22) and 1.2% (2/164) for spring- and fall-run female chinook salmon, respectively.

The overall prespawning mortality rate of both races of female chinook salmon was the lowest on record, at 1%. For comparison, overall (spring- and fall-run) prespawning mortality of female chinook salmon has ranged from 1.5% to 44.9%, averaging 12.8% during previous surveys (Appendix 7).

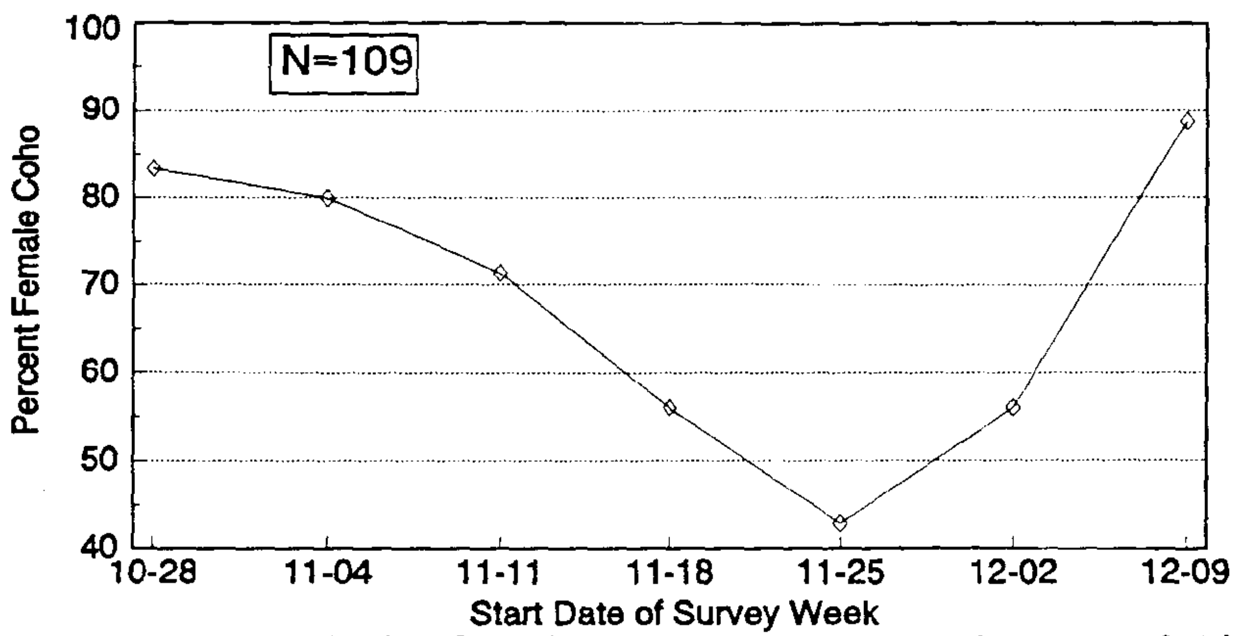

FIGURE 7. Percent females in the adult coho salmon population observed in the mainstem Trinity River during the 1991-92 spawner survey. Data were plotted only when the sample size was ≥ 5.

Prespawning mortality of chinook salmon in the Trinity River basin appears to be related to spawner escapement and, therefore spawner density. Specifically, as spawner escapement increases so does prespawning mortality. The CDFG's Trinity River Project has developed chinook salmon escapement estimates in the Trinity River basin since 1978. Prespawning mortality rates are available for the periods of 1978 through 1982 and for 1987 to the present. During the periods where both escapement estimates and prespawning mortality rates are available, escapement has ranged from 6,135 to 100,913 while prespawning mortality rates have ranged from 1.1% to 44.9% (Table 6). With the exception of 1980, prespawning mortality generally increases with increasing escapement (Figure 8). The high prespawning mortality rate noted in 1980 may be a sampling error. During that year, only 63 female chinook were checked for spawning condition. A regression analysis of escapement and prespawning mortality indicates a significant correlation (R^2=.406, P=0.048) even with the 1980 data included. Without the 1980 data, the significance is much greater (R^2=.709. P=0.004).

TABLE 6. Adult chinook salmon natural spawner escapement estimates and adult female chinook salmon prespawning mortality rates for the Trinity River, 1978-1982 and 1987-1991.

	Adult chinook salmon natural spawner escapement estimates			Female adult prespawning chinook salmon mortality		
Year	Spring-run [a]	Fall-run [b]	Total	Spring-run	Fall-run	Overall [c]
1978	14,384	31,052	45,436	[d]	[d]	7.2%
1979	5,008	8,028	13,036	"	"	6.0%
1980	1,614	7,700	9,314	"	"	36.5%
1981	3,362	15,340	18,702	"	"	2.6%
1982	3,868	9,274	13,142	"	"	1.5%
1987	28,993	71,920	100,913	49.9%	18.8%	30.8%
1988	39,329	44,616	83,945	71.1%	43.7%	44.9%
1989	18,241	29,445	47,686	62.8%	23.1%	31.3%
1990	2,880	7,682	10,562	21.6%	5.5%	13.0%
1991	1,268	4,867	6,135	0.0%	1.2%	1.1%

[a] Spring-run chinook salmon escapement estimates are for fish migrating above Junction City Weir.
[b] Fall-run chinook salmon escapement estimates are for fish migrating above Willow Creek Weir.
[c] Overall is spring-run plus fall-run chinook salmon.
[d] The prespawning mortality was only given as an overall rate, not by the separate runs.

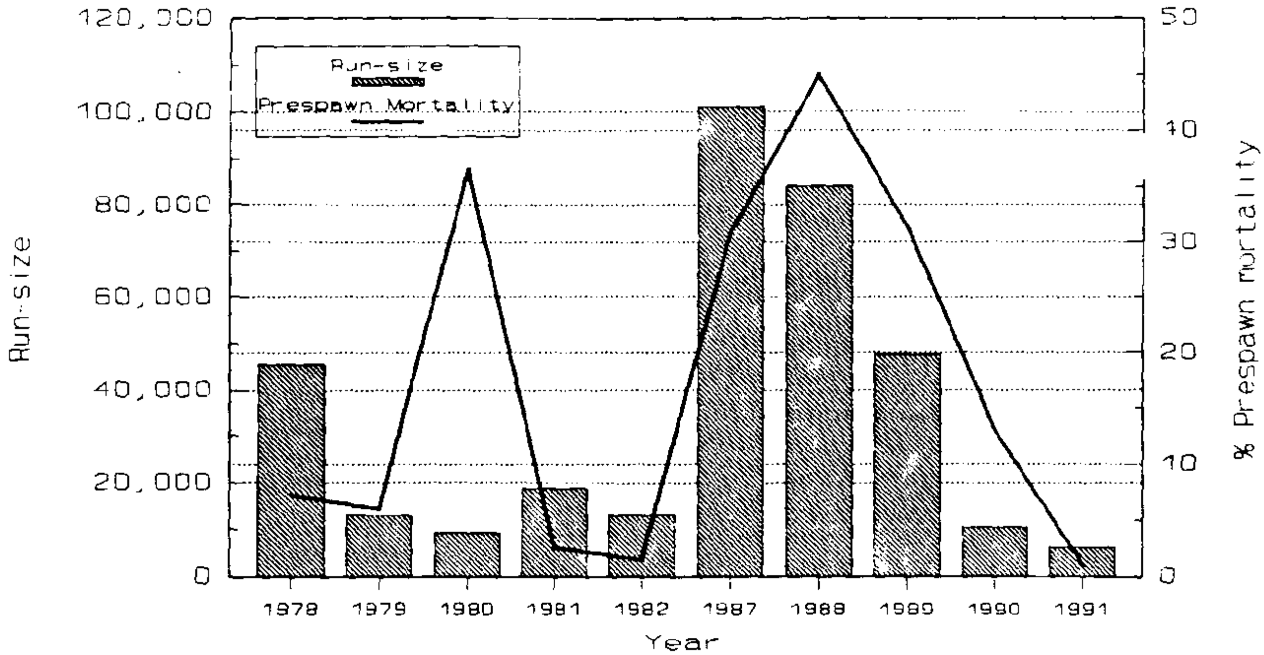

FIGURE 8. Adult chinook salmon natural spawner escapement and adult female chinook salmon prespawning mortality rates for the Trinity River, 1978-1982 and 1987-1991.

Coho Salmon

Sixty-four adult female coho salmon were examined for spawning condition during the survey. None (0/64) of the fish examined died prior to spawning. For comparison, in 1988, 1989, and 1990, the prespawning mortality rate of adult female coho salmon was 25.6%, 6.2%, and 13%, respectively (Zuspan 1991, 1992a, 1992b). Coho prespawning mortality rates were not reported in surveys prior to 1988.

Salmon Spawner Distribution

Salmon spawner distribution in the mainstem Trinity River is presented based on the seven-zone system first used in 1987 (Stempel [Appendix 1]). The results of Zones 5, 6 and 7 were combined this year because too few flagged chinook were recovered in these individual zones to make reliable estimates. Distribution estimates are for adult fish only. This is because grilse and adult salmon are recovered in the survey at different rates; a fact that would force us to stratify the distribution estimate. Also grilse are relatively unimportant to the spawner escapement as they are predominantly males and frequently do not spawn because of competition from larger, older males.

Chinook Salmon

Mainstem Trinity River. We examined 678 adult chinook salmon this season, excluding flag recoveries. The numbers of chinook salmon spawners were greatest in upstream zones, decreasing from a high of 195 fish in Zone 1 to 65 fish in Zone 3 (Table 7). We recognize that carcass counts alone cannot be used to accurately describe distribution, because recovery efficiency can vary from zone to zone, due to differences in stream morphology. Therefore, the percentage of flags recovered for each zone was used to determine the recovery efficiency of that zone (Table 7). Even based on the total number of chinook salmon recovered divided by the different recovery efficiency rates for each zone, the percent of chinook salmon spawners decreased downstream in successive zones below Zone 1 (Table 7). Spawner density, in terms of spawners per river km, was highest in the uppermost section (98 spawners/km), and decreased steadily in a downstream direction (Table 7, Figure 9).

This pattern of higher chinook salmon spawning concentrations in the upstream sections has been noted in each of the five previous years (Zuspan 1991, 1992a, 1992), but was much less pronounced this year (Figure 9). Chinook salmon spawners were much more evenly distributed throughout the survey area this year.

It is possible that an increase in river flow during the late summer and fall was responsible for the more even distribution of spawners seen this year. In an attempt to keep river temperatures within specified criteria, the flow during the late summer and fall averaged about 150 cubic-feet-per-second (CFS) higher this year

TABLE 7. Adult chinook salmon spawner distribution and estimated density, by river zone, in the 1991-92 Trinity River spawner survey.

Zone [a]	Zone length (km)	Number flagged	Flags recovered	% flags recovered	Total unflagged observed [b]	Expanded total [c]	% of expanded total	Spawners per km [d]
1	3.2	71	44	62%	195	315	10.7%	98
2	7.9	62	23	37%	191	516	17.6%	65
3	10.2	25	3	12%	65	542	18.5%	53
4	10.4	29	4	14%	94	671	22.9%	64
5-7	31.7	53	8	15%	133	887	30.3%	28
Totals:	63.4	240	82		678	2,931	100%	
Means:				34%				46

[a] Zones described in Figure 1 and Table 1.
[b] Total adult chinook salmon observed, excluding flag recoveries.
[c] Computed from: (Total unflagged observed/(% flags recovered/100)).
[d] Computed from: Expanded total/Zone length (km).

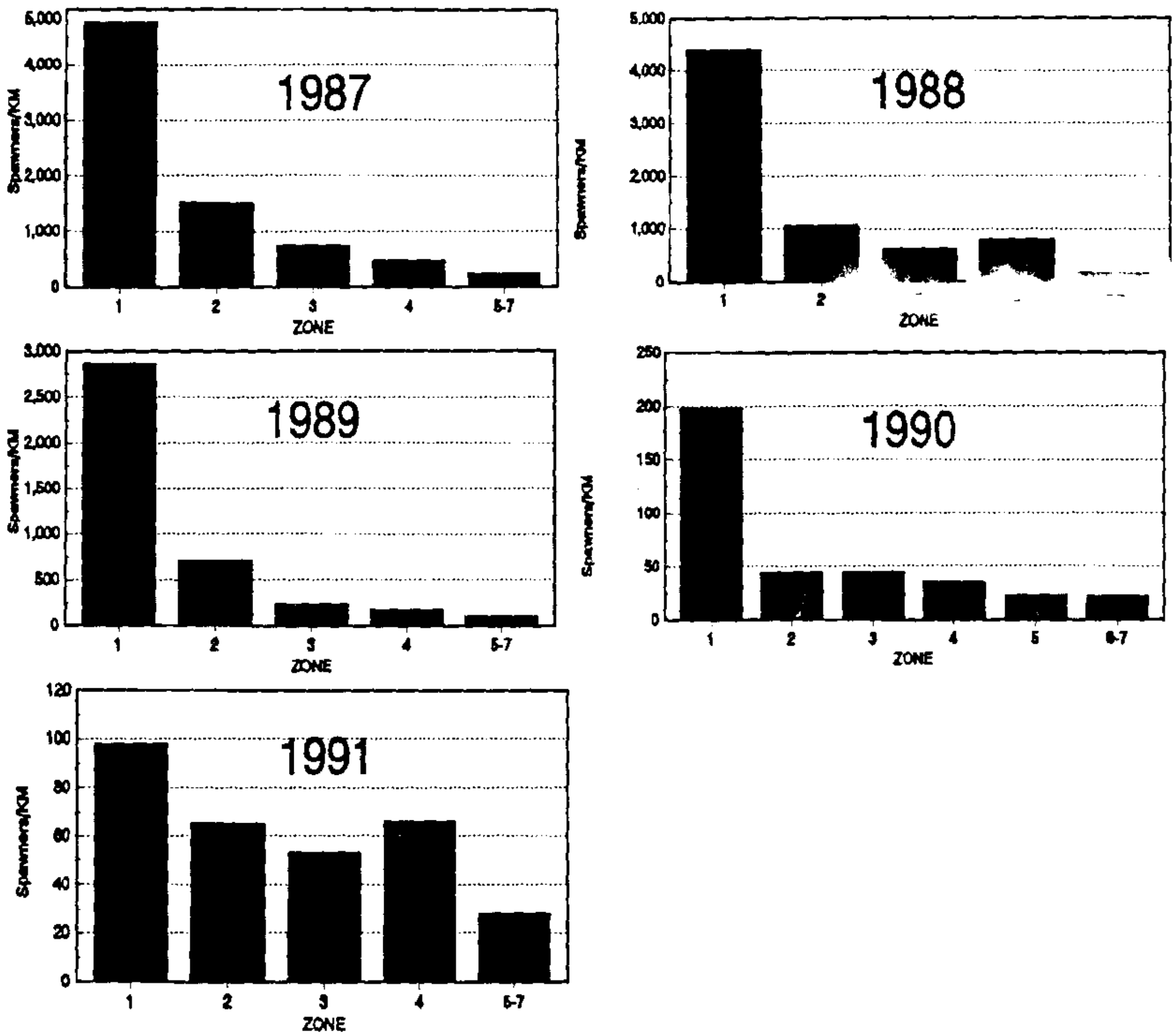

FIGURE 9. Estimated adult chinook salmon spawning density, in spawners per river km, measured during the 1987 through 1991 mainstem Trinity River spawner surveys.

than in previous years (450 versus 300 CFS). While the higher flows probably lowered temperatures this year, they were not significantly lower than in previous years. It may be that the higher flows increased the holding and spawning habitat to a point that allowed chinook salmon to spawn in the lower reaches of river. It should also be noted that the decreases in spawner escapements over the last few years may have somehow caused spawners to distribute themselves more evenly. However, while there has been a steady decrease in annual spawner escapements in the last few years

(Table 6), the proportion of spawners in each zone remained approximately the same until this year (Figure 9).

As noted in previous years (Zuspan 1991, 1992a, 1992b), a potential source of error in this estimate is the assumption that flagged chinook salmon carcasses are recovered only in the zone that they were originally flagged. If flagged fish are recovered in downstream zones, it would tend to increase the efficiency estimate in the recovery zone while decreasing the estimate in the flagging zone.

To determine the extent that carcasses drifted from one zone to another, fish flagged this year in each zone were again given a distinct hog ring color. Recoveries that were originally flagged in another zone were recorded as such. This season, all 87 of the flags were recovered in the same zone in which they were originally flagged. This indicates that carcass drifting had no effect on chinook distribution estimates, as was the case in the 1990-91 season (Zuspan 1992b). In the 1989-90 season the proportion of flags that drifted into other zones was less than 1% (Zuspan 1992a).

Tributaries. Spawning adult chinook salmon made very limited use of tributaries this year. Too few chinook salmon were observed to make a mark-and-recovery spawner estimate, so we used redd counts to describe spawner distribution, as was the case last year (Zuspan 1992b).

We located 51 salmon redds in seven of the nine tributaries surveyed this season. Since we could not differentiate a chinook from a coho salmon redd during the survey, we used the relative proportion of chinook and coho salmon observed in the individual tributaries to apportion the redds by species. Based on this apportioning, there were 35 chinook salmon redds observed this season with counts in the individual tributaries ranging from nine to zero (Table 8, Appendix 5).

Coho salmon

Mainstem Trinity River. We observed 127 adult coho salmon in the mainstem spawner survey this year, most of which were seen in Zones 1 and 2 (Table 9). We estimated the total number of coho salmon which spawned in each zone by dividing the actual number of carcasses observed by the recovery efficiencies for that zone that were developed from chinook salmon flag recoveries. Coho salmon spawning density was highest in Zone 4 (19 spawners/km) and ranged from 18 to 5 spawners per km in the other zones (Table 9).

Tributaries. We recovered 12 coho salmon during the tributary surveys. They were recovered in Weaver Creek, North Fork Trinity River, and East Fork of the North Fork Trinity River (Appendix 5). When the observed redds were apportioned by species

TABLE 8. Salmon redd numbers and distribution observed in the 1991-92 Trinity River tributary spawner survey.

Tributary	Number observed: Chinook carcasses	Coho carcasses	Redds	Proportional redd distribution [a]: Chinook	Coho
Rush Creek	3	0	5	5	0
Grass Valley Creek [b]	0	0	5	4	1
Indian Creek	0	0	0	0	0
Reading Creek	0	0	0	0	0
Browns Creek	8	0	6	6	0
Weaver Creek	0	3	4	0	4
Canyon Creek	9	0	9	9	0
N. Fork Trinity R.	5	4	9	5	4
E. Fork of the N. Fork	4	5	13	6	7
Totals:	29	12	51	35	16

[a] Computed by proportioning the redds observed by the species observed. Chinook redds = Redds x chinook observed / (chinook observed + coho observed).
[b] Since no fish were observed in this creek, redds were proportioned by the total chinook and coho for all creeks.

(see page 20), there were an estimated 16 coho redds observed in the tributary survey (Table 8). Estimated redd counts ranged from seven to zero in the individual tributaries.

Marked Salmon Recovery

Program marks

We observed Program marks (spaghetti tags or operculum punches) on 14 spring-run and 59 fall-run chinook salmon in the mainstem Trinity River spawner survey. Program-marked spring- and fall-run chinook salmon were recovered from both Junction City and Willow Creek weirs (Table 10). Of the 73 Program-marked chinook we observed, 27 were condition-one fish and 46 were condition-two fish. Seventeen Program-marked coho, seven from Willow Creek Weir and ten from Junction City Weir, were also recovered in the mainstem Trinity River.

We used only condition-one chinook salmon to determine the actual percentage of Program-marked chinook salmon in the spawner survey.

TABLE 9. Adult coho salmon spawner distribution and estimated density, by river zone, in the 1991-92 Trinity River spawner survey.

Zone [a]	Zone length (km)	Total observed	Observation efficiency [b]	Expanded total [c]	% of expanded total	Spawners per km [d]
1	3.2	35	62%	56	9.6%	18
2	7.9	30	37%	81	13.9%	10
3	10.2	11	12%	92	15.8%	9
4	10.4	27	13%	193	33.0%	19
5-7 [e]	31.7	24	15%	160	27.4%	5
Totals:	63.4	128		582	100.0%	
Means:			34%			9

[a] Zones described in Figure 1 and Table 1.
[b] Observation efficiency equals the total recovery rate of flagged chinook salmon in each zone.
[c] Computed from: Total observed/(observation efficiency/100).
[d] Computed from: Expanded total/Zone length (km).
[e] Zones combined because too few chinook salmon were recovered to develop observation efficiencies for individual zones.

This is because we were more likely to correctly identify a Program mark on a fresh (i.e. condition-one) fish than one in an advanced state of decay. The percentage of condition-one salmon recovered in the survey which had been marked at the two tagging sites ranged from 3.3% to 7.7% for chinook salmon (Table 10).

We did not record the condition of coho salmon during the survey so we can not analyze the Program marks of condition-one fish. However, for fish of all conditions, 13.4% (17/127) of the coho salmon recovered were Program-marked (Table 10).

<u>Adipose Fin-clips and Coded-wire Tags</u>

We recovered 30 chinook salmon and one coho salmon in the spawner survey which appeared to be Ad-clipped. Based on their CWTs, one was a spring-run chinook salmon, 26 were fall-run chinook salmon, and four fish did not have CWT's (Appendix 8). All of the CWT recoveries were of Trinity River Hatchery origin.

To minimize the number of Ad-clipped fish missed during the spawner survey, all fish recovered were passed through a coded-wire tag detector. Fish which produced a positive reading with the detector, regardless of the condition of their adipose fin, were considered Ad-clipped.

TABLE 10. Program-marked salmon recovered during the 1991-92 mainstem Trinity River spawner survey.

Tag site	Spring-run chinook			Fall-run chinook			Coho Salmon		
	Program marks [a/b/]	Total observed [b/]	% Program marks	Program marks [a/b/]	Total observed [b/]	% Program marks	Program marks	Total observed [c/]	% Program marks
Willow Creek Weir	3	91	3.3	10	201	5.0	7	127	5.5
Junction City Weir	7	91	7.7	7	201	3.5	10	127	7.9
Totals:	10	91		17	201		17	127	

[a/] Program marks include spaghetti tags and operculum punches.
[b/] Only condition-one chinook salmon were used for this count.
[c/] Both condition-one and condition-two coho salmon were used for this count.

The percentage of Ad-clipped fish in the spawner survey is best estimated by considering only those Ad-clipped fish that had CWTs (Ad+CWT) and were condition-one fish, as fish in advanced decay (i.e. condition-two fish) were more likely to have shed their CWT. For example, the Ad+CWT rate of fall-run chinook salmon condition-two fish was only 3.5% (12/342) while for condition-one fish it was 7.5% (15/201). However, this method does not produce an estimate of Ad-clipped fish that can be directly compared with the estimate of Ad-clipped fish returning to the weirs or TRH. This is because we consider Ad-clipped fish in the spawner survey to be only those fish that have CWTs, while at the other sites they count fish with Ad-clips regardless of their having a CWT. To make the two estimates comparable, we expanded the number of Ad+CWT fish observed in the spawner survey by the CWT shedding rate for chinook salmon observed at TRH[3/]. For example, of the 60 Ad-clipped spring-run chinook salmon observed at TRH, only 45 (75.0%) had CWTs indicating a 25.0% natural CWT shedding rate for these fish. For fall-run chinook the CWT shedding rate at TRH was 5.1% (16/317). Expanding our counts of Ad-clip+CWT fish in the spawner survey by the aforementioned CWT shedding rates, 0% and 7.9% of the spring- and fall-run chinook salmon observed in the spawner survey were Ad-clipped.

The percentage of Ad-clipped spring- and fall-run chinook salmon varied at the different recovery sites, probably as the result of hatchery-produced fish homing to the hatchery. Since naturally produced chinook salmon also spawn in the lower mainstem or its tributaries, we would expect the percentage of hatchery-produced, Ad-clipped chinook salmon in the population to increase at each sampling site proceeding upstream, and to be highest at the hatchery. The Ad-clipped chinook salmon rate was highest at the hatchery, intermediate at the weirs, and lowest in the mainstem

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[3/] % CWTs observed/(1-(% at TRH with shed tags/100))

TABLE 11. Numbers and percentages of adipose fin-clipped chinook salmon observed in the mainstem spawner survey and at three fixed locations in the Trinity River basin during the 1991-92 season.

	Spring-run chinook			Fall-run chinook		
Site	Ad-clips [a]	Total	% Ad-clips	Ad-clips	Total	% Ad-clips
Willow Creek Weir		[b]		79	954	8.3
Junction City Weir	19	310	6.1	40	489	8.2
Trinity River Hatchery	60	685	8.8	316	2,687	11.8
Mainstem Trinity River survey [c]	0	91	0.0	16 [d]	201	8.0

[a] Adipose fin-clipped fish.
[b] Only a small portion of the late spring-run chinook salmon population was sampled at this site.
[c] Only condition-one fish with coded-wire tags from the spawner survey were used in this analysis. All fish were used at the other three sites.
[d] Only 15 adipose fin-clipped fish with coded-wire tags were observed. This number was expanded to account for adipose fin-clipped fish which may have shed their tags. Coded-wire tag shedding rates were from this year's Trinity River Hatchery coded-wire tag recovery records.

Trinity River spawner survey (Table 11). Ad-clip rates in the spawner survey may have been less than at weirs downstream, as the weirs captured a fraction of all upstream migrants, both hatchery and natural fish, while the spawner survey emphasized in-river spawners which would be more likely to be naturally produced fish. The reason that chinook salmon trapped at Willow Creek had a slightly higher Ad-clip rate that those trapped at Junction City weir is unknown.

We cannot analyze the Ad-clip rates of coho salmon this year. This is because the returning adults are from a brood year that was not marked (Ad+CWT) at TRH.

Incidence of Hatchery-produced Chinook Salmon

We determined the incidence of hatchery-produced chinook salmon among the carcasses seen in the spawner survey by comparing the rate of Ad-clipped (hatchery-marked) chinook salmon at various locations within the river.

Spring-run Chinook Salmon

The percentage of Ad-clipped spring-run chinook salmon observed at the three locations in the Trinity River basin below Lewiston Dam ranged from 0% to 8.8% (Table 11), and were significantly different (X^2=9.98, df=2, P=0.007) from each other.

During the previous three years, most (approximately 97%) of the spring-run chinook salmon recovered at TRH were of hatchery origin (Bill Heubach, Calif. Dept. of Fish and Game, pers. comm., based on expansions of CWT recoveries). This year, using the same methodology, only an estimated 65.4% of the spring-run chinook at TRH salmon were of TRH origin (Bill Heubach, Calif. Dept. of Fish and Game, pers. comm.). This apparent low rate is an artifact of the high CWT shedding rate for spring-run chinook this year. Since only Ad-clipped fish with CWTs can be used for the expansion, the 25%[4] shedding rate for spring-run chinook salmon had the effect of decreasing the estimate of TRH-produced fish returning to the hatchery. We believe the actual percentage of TRH-produced spring-run chinook salmon returning to TRH this year is similar to previous years. Therefore, we assume that the 8.8% Ad-clip rate for spring-run fish observed at TRH represents a population of 100% TRH-origin chinook salmon. Since no condition-one Ad+CWT spring-run chinook salmon were recovered in our survey, we feel that essentially all of the spring-run chinook spawning in our survey zones were naturally produced (non-hatchery).

Fall-run Chinook Salmon

The Ad-clip percentage of fall-run chinook salmon ranged from 8.0% to 11.8% at the four sampling sites this season (Table 11). The differences in chinook salmon Ad-clip rates among the four sites is statically significant (X^2=13.78, df=3, P=0.003).

Since most (93.3%) of the fall-run chinook recovered at TRH are estimated to be of hatchery origin (Bill Heubach, Calif. Dept. of Fish and Game, pers. comm., based on expansions of CWT recoveries), we assumed that the 11.8% Ad-clip rate for fall-run fish observed at TRH represents a population of 100% hatchery-produced chinook salmon. Since only 7.9% of the fall-run chinook salmon in the spawner survey were Ad-clipped, we estimated that 66.9% (7.9/11.8) were of hatchery origin, while the remaining 33.1% were naturally produced.

Computational Assumptions

There are several assumptions which could be potential sources of error in using the aforementioned method to determine the incidence of hatchery fish spawning in the river. We assume that field personnel actually observed all possible Ad-clips in the survey. Using the strict protocol developed this year (i.e. using a tag detector on all fish and considering only condition-one fish) we feel we were successful at identifying essentially all Ad+CWT fish in the survey. We are also assuming that the probability of observing and recovering an Ad-clipped fish is the same in the

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[4] Only 45 of the 60 Ad-clipped spring-run chinook salmon entering TRH had coded-wire tags. This indicates a 25% shedding rate for these fish.

survey as at the hatchery, and, most importantly, that ratios of Ad-clipped to unmarked hatchery fish are the same in the spawner survey as at TRH. Since different chinook salmon release groups are Ad-clipped at different rates, this last assumption is only valid if the various CWT groups occur in the spawner survey in the same proportions as among the fish recovered at TRH.

RECOMMENDATIONS

This is the fourth year of a multi-year effort of spawner surveys in the Trinity River basin. The following recommendations should be considered for inclusion in next year's spawner survey.

1. Spawner survey activities should be continued, with current objectives, in FY 1992-93 and beyond.

2. To increase the number and accuracy of our Ad-clip salmon recoveries, we should continue to pass all salmon through a tag detector. This should allow us to more reliably estimate the proportion of hatchery and naturally produced fish spawning in the wild.

3. Flows from Lewiston Dam should be increased during the late summer to mid-fall period from the base 300 CFS to approximately 450 CFS. The purpose of the higher flows would be to distribute chinook salmon spawners more evenly in the mainstem Trinity River. A more even distribution of spawners should also lead to a decrease in prespawning mortality. The increased flows could be especially important during years of high escapement when chinook salmon in the Trinity River have suffered unusually high prespawning mortality.

LITERATURE CITED

Gibbs, E. D. 1956. A report on king salmon, Oncorhynchus tshawytscha, in the upper Trinity River, 1955. Calif. Dept. Fish and Game, Inland Fish. Admin. Rep. No. 56-10. 14 p.

La Faunce, D. A. 1965. King (chinook) salmon spawning escapement in the upper Trinity River, 1963. Calif. Dept. Fish and Game, Mar. Res. Admin. Rep. No. 65-3. 10 p.

Moffett, J. W., and S. H. Smith. 1950. Biological investigations of the fishery resources of the Trinity River, Calif. USFWS Spec. Sci. Rep., Fish. Bull. No. 12. 71 p.

Rogers, D. W. 1970. A king salmon spawning escapement and spawning habitat survey in the upper Trinity River and its tributaries, 1968. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 70-16. 13 p.

_____________ 1973. King salmon, Oncorhynchus tshawytscha, and silver salmon, Oncorhynchus kisutch, spawning escapement and spawning habitat in the upper Trinity River, 1970. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 73-10. 14 p.

_____________ 1982. A spawning escapement survey of anadromous salmonids in the upper Trinity River, 1971. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 82-2. 11 p.

Smith, G. E. 1975. Anadromous salmonid spawning escapements in the upper Trinity River, 1969. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 75-7. 17 p.

Weber, G. 1965. North coast king salmon spawning stock survey 1956-57 season. Calif. Dept. Fish and Game, Mar. Res. Admin. Rep. No. 65-1. 34 p.

Zuspan, M. 1991. Salmon spawner surveys in the upper Trinity River Basin. Chapter I. Job I. p. 1-23. In: Carpenter, R. and K. Urquhart (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1988-1989 Season. August 1991. 51 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, Ca. 95814.

Zuspan, M. 1992a. Salmon spawner surveys in the Upper Trinity River Basin. Chapter I. Job I. p. 1-29. In: Urquhart, K. (ed.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1989 -1990 Season. June 1992. 140 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, Ca. 95814.

Zuspan, M. 1992b. Salmon spawner surveys in the Upper Trinity River Basin. Chapter I. Job I. p. 1-31. In: Urquhart, K. and R. Carpenter (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1990-1991 Season. December 1992. 186 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, Ca. 95814.

APPENDIX 1. Other sources of data.

Miller, E. 1972. (Untitled file report) Summary of the 1972 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1973. (Untitled file report) Summary of the 1973 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1974. (Untitled file report) Summary of the 1974 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1976. (Untitled file report) Summary of the 1976 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1978. (Untitled file report) Summary of the 1978 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1979. (Untitled file report) Summary of the 1979 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1980. (Untitled file report) Summary of the 1980 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1981. (Untitled file report) Summary of the 1981 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1982. (Untitled file report) Summary of the 1982 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

_________. 1984. (Untitled file report) Summary of the 1984 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

Miller, E. 1985. (Untitled file report) Summary of the 1985 spawner survey in the upper Trinity River basin. Available from Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

Stempel, M. 1988. Chinook salmon spawning survey in the upper Trinity River during the fall of 1987. USFWS file report. Available from USFWS F.A.O., P.O. Box 1450, Weaverville, Ca 96093.

APPENDIX 2. List of maps used to identify the river km of locations used during the 1991-92 Trinity River spawner survey.

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1. Lewiston Quadrangle, California; 7.5 Minute Series (Topographic). N4037.5-W12245/7.5, Ref. 649-1C, U.S. Dept. of the Interior, Geological Survey; modified for USDA Forest Service; Provisional Edition 1982, Revised 1983; 1:24,000; 71 X 56 cm; b/w.

2. Weaverville Quadrangle, California-Trinity Co.; 7.5 Minute Series (Topographic). N4037.5-W12252.5/7.5, Ref. 649-2C, U.S. Dept. of the Interior, Geological Survey; modified for USDA Forest Service; Provisional Edition 1982, Revised 1983; 1:24,000; 71 X 56 cm; b/w.

3. Junction City Quadrangle, California-Trinity Co.; 7.5 Minute Series (Topographic). N4037.5-W12300/7.5, Ref. 650-1C, U.S. Dept. of the Interior, Geological Survey; modified for USDA Forest Service; Provisional Edition 1982, Revised 1984; 1:24,000; 71 X 56 cm; b/w.

4. Dedrick Quadrangle, California-Trinity Co.; 7.5 Minute Series (Topographic). N4045-W12300/7.5, Ref. 668-4C, U.S. Dept. of the Interior; Geological Survey; modified for USDA Forest Service; Provisional Edition 1982, Revised 1984; 1:24,000; 71 X 56 cm; b/w.

5. Helena Quadrangle, California-Trinity Co.; 7.5 Minute Series (Topographic). N4045-W12307.5/7.5, Ref. 668-3C, U.S. Dept. of the Interior, Geological Survey; modified for USDA Forest Service; Provisional Edition 1982, Revised 1984; 1:24,000; 71 X 56 cm; b/w.

Appendix 3. Summary of chinook salmon carcasses recovered during the 1991-92 mainstem Trinity River spawner survey.

Survey week	Date begun	Ad-clips c/	Program marks d/	Chinook flagged b/ Adults	Grilse e/	Flag recovery f/	Unmarked chinook a/ Males	Female Spawned	Unspawned	Percent unspawned	Unknown g/	Week totals h/
1	16-Sep	0	0	0	0	0	0	0	0	---	0	0
2	23-Sep	0	1	1	0	0	0	0	0	---	0	2
3	30-Sep	0	0	2	0	0	0	0	0	---	1	3
4	07-Oct	0	3	30	0	0	1	2	0	0	1	37
5	14-Oct	0	2	30	2	2	11	9	0	0	6	60
6	21-Oct	1	8	16	0	8	7	7	0	0	3	42
7	28-Oct	0	2	17	0	5	7	6	0	0	2	34
8	04-Nov	3	10 (1)	26	0	1	11	8	0	0	8	65
9	11-Nov	6	8 (3)	30	3	4	13	11	0	0	12	80
10	18-Nov	14	15 (1)	42	3	7	29	34	0	0	13	149
11	25-Nov	3	12	35	3	25	24	27	0	0	14	118
12	02-Dec	3	10	10	0	20	20	20	2	9	8	73
13	09-Dec	0	2	1	0	12	10	7	0	0	2	22
14	16-Dec	0	0	0	0	3	2	2	0	0	1	5
Totals:		30	73 (5)	240	11	87	135	133	2		71	690
Average:										1		

a/ Includes chinook salmon which were not flagged, Ad-clipped, or Program-marked and were chopped in half upon recovery.
b/ Includes chinook salmon which were flagged that week for later recovery.
c/ Adipose fin-clipped chinook salmon.
d/ Includes chinook salmon which were previously marked (spaghetti tags/operculum punched) at various sites downstream of the survey area. Numbers in parenthesis were also Ad-clipped.
e/ During the survey, prior to analysis of this year's CWT data, chinook salmon <56 cm are assumed to be grilse, for tally purposes.
f/ Includes all recoveries that week which were flagged in previous weeks.
g/ Includes chinook salmon of unknown sex.
h/ Includes all newly observed chinook salmon. Does not include flagged fish recoveries which were re-examined that week.

Appendix 4. Summary of coho salmon carcasses recovered during the 1991-92 mainstem Trinity River spawner survey.

Survey week	Date begun	Ad-clips a/	Program marks b/	Males	Female coho: Spawned	Female coho: Unspawned	Female coho: Percent unspawned	Female coho: Unknown c/	Week totals
1	16-Sep	0	0	0	0	0	---	0	0
2	23-Sep	0	0	0	0	0	---	0	0
3	30-Sep	0	0	0	0	0	---	0	0
4	07-Oct	0	0	0	0	0	---	0	0
5	14-Oct	0	0	0	0	0	---	0	0
6	21-Oct	0	0	1	1	0	0	0	2
7	28-Oct	0	0	1	5	0	0	0	6
8	04-Nov	0	1	1	4	0	0	0	6
9	11-Nov	0	5	4	9	0	0	1	19
10	18-Nov	0	5	11	14	0	0	0	30
11	25-Nov	1	1	12	9	0	0	0	23
12	02-Dec	0	3	11	14	0	0	0	28
13	09-Dec	0	1	1	8	0	0	0	10
14	16-Dec	0	1	2	0	0	---	0	3
Totals:		1	17	44	64	0		1	127
Average:							0		

a/ Adipose fin-clipped coho salmon.

b/ Includes coho salmon which were previously marked (spaghetti tags/operculum punched) downstream of the survey area.

c/ Includes female coho for which spawning condition was not assessed.

Appendix 5. Summary of salmon carcasses and redds observed during the 1991-92 spawner surveys in tributaries to the Trinity River between Lewiston Dam and the North Fork Trinity River.

Tributary	Kilometers surveyed	Percent of total spawning b/	Weeks surveyed	Chinook Ad-clips c/	Chinook Program marks d/	Chinook Flagged fish a/ Adults	Chinook Flagged fish a/ Grilse d/	Chinook Flags recovered	Chinook Skeletons	Chinook Total f/	Redd count	Coho
Rush Creek	3.9	100	8	0	1	1	1	0	1	3	5	0
Grass Valley Creek	1.3	100	8	0	1	0	0	0	0	0	5	0
Indian Creek	2.1	100	8	0	0	0	0	0	0	0	0	0
Reading Creek	0.8	100	8	0	0	0	0	0	0	0	0	0
Browns Creek	4.0	100	8	0	0	2	0	0	6	8	6	0
Weaver Creek	2.9	100	3	0	1	0	0	0	0	0	4	3
Canyon Creek	3.5	67	8	0	1	3	1	1	5	9	9	0
North Fork Trinity R.	2.4	78	8	0	0	3	0	3	2	5	9	4
E. Fork N. Fork Trinity	2.1	69	8	0	0	2	1	0	1	4	13	5
Totals:				0	4	11	3	4	15	29	51	12

a/ Chinook salmon carcasses which were flagged and returned to the tributary.

b/ Percent of the total chinook salmon spawning in the tributary that occured in the survey area, determined from ground and aerial redd surveys.

c/ Adipose fin-clipped chinook salmon.

d/ Includes chinook salmon which were previously marked (spaghetti tagged/operculum punched) at various sites downstream of the survey area.

e/ During the survey, prior to analysis of this year's coded-wire tag data, chinook salmon <56 cm were assumed to be grilse, for tally purposes.

f/ Chinook totals include flagged fish, and skeletons. Ad-clipped and Program- marked fish are included in the flagged column. Does not include flagged fish recoveries which were re-examined that week.

Appendix 6. Sex compositions of adult chinook salmon observed during mainstem Trinity River spawner surveys from 1942 thorugh 1991.

		Spring-run chinook				Fall-run chinook				Total chinook			
		Males		Females		Males		Females		Males		Females	
Study year	Researcher	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1942-1945 a/	Moffett/Smith (1950)									201	35.6	364	64.4
1955 a/	Gibbs (1956)									1,769	49.7	1,789	50.3
1956 a/	Weber (1965)									3,149	46.3	3,657	53.7
1963 a/	LaFaunce (1965)									1,419	41.4	2,008	58.6
1968 a/	Rogers (1970)									1,244	44.5	1,551	55.5
1969 a/	Smith (1975)									1,054	37.0	1,791	63.0
1970 a/	Rogers (1973)									527	48.7	556	51.3
1971 a/	" (1982)									1,704	46.2	1,987	53.8
1972 a/	Miller (1972)									499	38.7	791	61.3
1973 a/	" (1973)									404	38.7	641	61.3
1974 a/	" (1974)									706	38.6	1,125	61.4
1976 a/	" (1976)									195	30.5	444	69.5
1978 a/	" (1978)									420	32.9	855	67.1
1979 a/	" (1979)									89	48.9	93	51.1
1980 a/	" (1980)									43	55.8	34	44.2
1981 a/	" (1981)									66	34.2	127	65.8
1982 a/	" (1982)									100	28.4	252	71.6
1984 a/ b/	" (1984)									276	74.2	96	25.8
1985 a/ b/	" (1985)									796	51.6	748	48.4
1987 a/	Stempel (1988)									1,182	26.4	3,299	73.6
1988	Zuspan (1991a)	47	30.7	106	69.3	659	39.3	1,016	60.7	706	38.6	1,122	61.4
1989	Zuspan (1992a)	150	30.1	348	69.9	577	41.8	802	58.2	727	38.7	1,150	61.3
1990	Zuspan (1992c)	39	25.7	113	74.3	50	32.9	102	67.1	89	29.3	215	70.7
1991	Current study	23	46.9	26	53.1	132	45.4	159	54.6	155	45.6	185	54.4

a/ Spring-run and fall-run chinook salmon were not reported separately.

b/ Grilse chinook salmon were included in these counts.

Appendix 7. Female chinook salmon prespawning mortality rates observed during mainstem Trinity River spawner surveys from 1942 through 1991.

		Spring-run chinook			Fall-run chinook			Total chinook		
Study year	Researcher	Spawned	Unspawned	Percent unspawned	Spawned	Unspawned	Percent unspawned	Spawned	Unspawned	Percent unspawned
1942-1945 a/	Moffett/Smith (1950)									
1955 b/	Gibbs (1956)							2,076	32	1.5
1956 b/	Weber (1965)							3,438	219	6.0
1963 b/	LaFaunce (1965)							4,953	328	6.2
1968 b/	Rogers (1970)							1,494	124	7.7
1969 b/	Smith (1975)							1,889	23	1.2
1970 b/	Rogers (1973)							632	34	5.1
1971 a/	" (1982)									
1972 b/	Miller (1972)							791	110	12.2
1973 b/ c/	" (1973)									12.0
1974 b/ c/	" (1974)									9.1
1976 b/ c/	" (1976)									8.4
1978 b/ c/	" (1978)									7.2
1979 b/ c/	" (1979)									6.0
1980 b/ c/	" (1980)									36.5
1981 b/ c/	" (1981)									2.6
1982 b/ c/	" (1982)									1.5
1984 a/	" (1984)									
1985 a/	" (1985)									
1987 b/	Stempel (1988)			49.9			18.8			30.8
1988	Zuspan (1991a)	11	27	71.1	479	372	43.7	490	399	44.9
1989	Zuspan (1992a)	194	327	62.8	1,546	464	23.1	1,740	791	31.3
1990	Zuspan (1992c)	76	21	21.6	104	6	5.5	180	27	13.0
1991	Current study	22	0	0.0	162	2	1.2	184	2	1.1

a/ Prespawning mortality rate was not reported during these years.

b/ Spring-run and fall-run chinook salmon were not separated during these years.

c/ Overall prespawning mortality rates were reported but not individual counts.

Appendix 8. Release and recovery data for coded-wire-tagged salmon recovered in the 1991-92 mainstem Trinity River spawner survey.

	Release Information							
CWT # a/	Species	Race	Brood year	Type b/	Location c/	Date	Number released	Number recovered
06-55-23	Chinook	Fall	1988	Ff	TRH	06/19/89	196,249	1
06-56-31	Chinook	Fall	1987	Fy	Ambrose	10/28/88	93,300	16
06-56-32	Chinook	Fall	1988	Fy	TRH	10/27/89	97,569	4
06-56-33	Chinook	Fall	1987	Ff	Ambrose	06/02/88	172,980	2
06-56-35	Chinook	Fall	1988	Ff	TRH	06/12/89	194,197	3
06-61-47	Chinook	Spring	1987	Sf	Sawmill	05/23/88	185,718	1
Total:								27

a/ Coded-wire tag (CWT) number for the release group.

b/ Hatchery release types include: Fy=fall yearling, Ff=fall fingerling, Fy+ =fall yearling plus, Sy=spring yearling, Sf=spring fingerling.

c/ All release locations are in the mainstem Trinity River. TRH=Trinity River Hatchery.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991-1992 SEASON

CHAPTER II

JOB II
CAPTURE AND CODED-WIRE TAGGING OF NATURALLY PRODUCED CHINOOK SALMON IN THE TRINITY RIVER BASIN

by

Mark Zuspan

ABSTRACT

Staff of the California Department of Fish and Game's Trinity Fisheries Investigations Project conducted a trapping and coded-wire tagging operation for naturally produced, juvenile chinook salmon (Oncorhynchus tshawytscha) on the mainstem Trinity River below Lewiston Dam from 13 January through 26 May 1992.

We trapped 81,851 juvenile chinook salmon, 500 juvenile coho salmon (O. kisutch), and 5,542 juvenile steelhead (O. mykiss) at four locations during the study. Peak catch-per-unit-effort for juvenile chinook salmon measured at the trapping site where we had the most consistent effort occurred in late April. Weekly average fork lengths of trapped juvenile chinook salmon tended to increase throughout the trapping period.

We adipose fin-clipped and implanted coded-wire tags into 59,971 juvenile chinook salmon, a sub-sample of which ranged in size from 29 to 110 mm, averaging 57.7 mm fork length. After adjusting for tagging mortality, tag shedding, and poor fin clips, we effectively coded-wire tagged and released 56,610 juvenile chinook salmon.

We estimate six chinook salmon from the 1988 brood year, coded-wire tagged by this Project, were harvested in the ocean as three-year-olds this season. Additionally, one chinook salmon from this group was recovered at Trinity River Hatchery.

JOB OBJECTIVE

To capture, mark (adipose fin-clip), tag (binary-coded wire), and release representative groups (up to 100,000 fish/group) of naturally produced chinook salmon fry/fingerlings in the mainstem Trinity River and/or selected Trinity River tributary streams, for use in subsequent determinations of their survival and contributions as adults to the ocean and river fisheries and spawning escapements.

INTRODUCTION

The Trinity River system in Northern California is a major producer of chinook salmon (hereafter called chinook) for the Klamath River basin. Knowledge of fry- or fingerling-to-adult survival, harvest, and spawner escapement of these stocks is crucial to wise management of chinook in the basin.

Recent legislation (U. S. Public Law 98-541, enacted in 1984) has resulted in a major effort to restore the fishery resources in the Trinity River basin to pre-Trinity-Project conditions. Emphasis for this effort is placed on naturally produced chinook. Survival, catch, and escapement data for these fish will help to evaluate the effectiveness of these restoration efforts.

Previous coded-wire-tagging studies of juvenile chinook in the Trinity River basin have focused on hatchery-produced chinook and made inferences to naturally produced chinook based on those results (Heubach and Hubbell 1979, Heubach 1980, Maria and Heubach 1981, 1984a, 1984b, 1984c).

In this study, the California Department of Fish and Game's (CDFG) Trinity Fisheries Investigations Project (TFIP) personnel trapped, adipose fin-clipped, coded-wire tagged (CWT), and released naturally produced juvenile chinook. Subsequent studies of these fish as adults, by TFIP and other projects of the CDFG's Klamath-Trinity Program, will be used to determine survival, harvest, and spawning escapement for this important component of the Trinity River basin's chinook stocks.

METHODS

Use of Standard Julian Week

Weekly sampling data collected by Project personnel at the trapping sites are presented in Julian Week (JW) format. Each JW is one of a consecutive set of 52 weekly periods, beginning 1 January, regardless of the day of the week on which 1 January falls. The extra day in leap years is added to the ninth week, and the last day of the year is included in the 52nd week (Appendix 1). This procedure allows between-year comparisons of identical weekly periods.

Trapping

We conducted trapping at four primary sites in the mainstem Trinity River this season. Site names and river km (RKM) locations were: 1) Lewiston at RKM 177, 2) Ambrose at RKM 172, 3) Hard Hat at RKM 148, and 4) Sky Ranch at RKM 134 (Figure 1).

We began trapping on 13 January 1992 and finished on 26 May 1992. Our primary objective was to capture up to 100,000 juvenile chinook for coded-wire tagging. To that end, we trapped sporadically at each of the four sites to locate the site that would produce the highest numbers of fish at a given time.

Our trapping apparatus consisted of from one to seven fyke nets measuring 3.1 m wide by 1.2 m high at the mouth, by 7.6 m long, tapering to a 0.33-m by 0.33-m exit leading into dual live boxes. Fyke nets were attached, at their mouth, to a 2.5-cm (1-in) diameter galvanized pipe frame of the same dimensions as the net mouth, which was connected by ropes to metal posts driven into the stream bed. The nets were normally set in the late afternoon and recovered mid-morning the next day.

All fish trapped were counted and a sub-sample of each species was measured to the nearest mm of fork length (FL).

Tagging

Tagging took place only at the Ambrose, Hard Hat, and Sky Ranch sites. The tagging sites were located adjacent to the trapping sites. Tagging was conducted inside a 5.5 m- (18 ft-) long office trailer converted for that purpose. A 3.5 KW generator was used to supply the electrical needs of the operation (tagging machines, pumps, lights).

Captured juvenile chinook were anesthetized with tricaine methanesulfonate (MS222)[1/], their adipose fin removed, and a coded-wire tag implanted. Tag injectors and quality control devices were purchased from Northwest Marine Technology[1/]. Because of the small size of the fish captured, 1/2-length tags were used. Between two and four tagging machines were employed, depending on availability of fish for tagging.

[1/] Use of brand names is for identification purposes only, and does not imply the endorsement of any product by the California Department of Fish and Game.

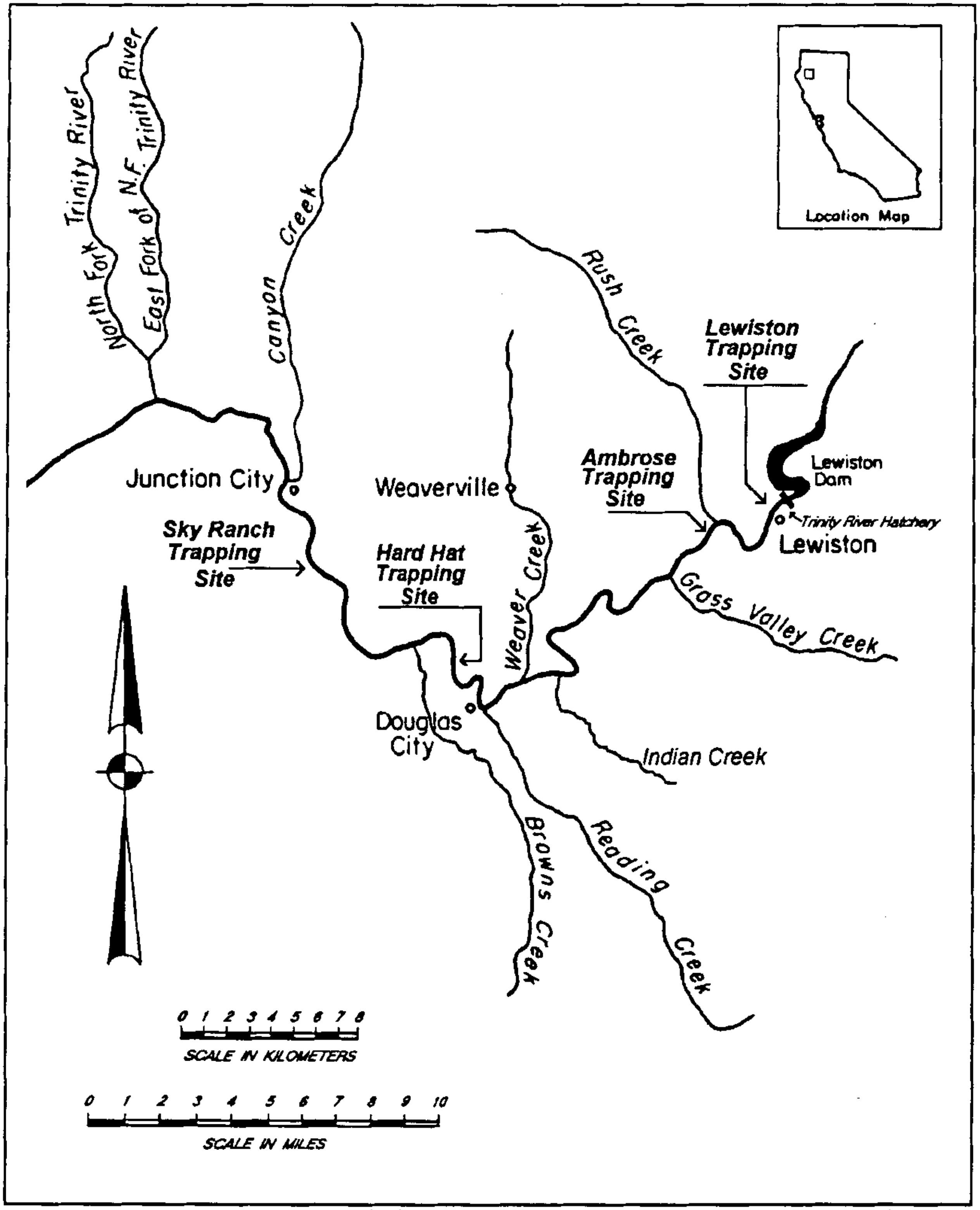

FIGURE 1. Map of the Trinity River below Lewiston Dam showing the four trapping sites used in 1992.

A sample of 100 fish from each day's tagging was held for quality control, and the remainder were released back into the river at the tagging site throughout the day. Fish in the quality control sample were put into holding cages kept in the river and, after a minimum of 24 hours, checked for mortality, tag retention, and adipose fin-clip (Ad-clip) effectiveness. Tag retention was determined by passing fish through an electronic tag (metal) detector, and Ad-clip effectiveness was determined by direct examination.

Recovery

As part of ongoing studies, the CDFG recovers Ad-clipped and CWT fish from among ocean- and inland-harvested fish, and hatchery and natural spawner returns. Heads from Ad-clipped fish are collected and their coded-wire tags removed and decoded.

RESULTS

Trapping

We began trapping on 13 January 1992 and continued at varying locations and intensity through 26 May 1992 (Table 1). We discontinued trapping in late May because of decreasing catches and rising river temperatures. Also, the release of 210,188 spring-run chinook from Trinity River Hatchery (TRH) on 5 June 1992 precluded further trapping of only naturally produced fish for the remainder of the season.

Chinook Salmon

We captured 81,851 juvenile chinook this season. Totals by site were: 1) 1,832 at the Lewiston Site, 2) 16,102 at the Ambrose Site, 3) 38,817 at the Hard Hat Site and, 4) 25,100 at the Sky Ranch Site (Appendices 2, 3, 4, 5).

Catch-per-unit-effort (CPUE), measured as the weekly average number of fish caught per-night per-net fished, varied considerably between trapping sites (Figure 2, and Appendices 2, 3, 4, 5). The highest CPUE (487) was at the Ambrose Site followed by the Sky Ranch Site (450), the Hard Hat Site (434), and the Lewiston Site (356).

We measured the FLs of 11,102 chinook during the trapping season. These fish ranged in FL from 29 to 142 mm. Weekly average FLs of fish at the four trapping sites generally increased though time (Figure 3, Appendices 2, 3, 4, 5). At the Sky Ranch Site, where we trapped every JW through the season, the average FL of juvenile chinook was 36.7 mm in mid-January and increased to 65.1 mm by late May (Figure 3).

TABLE 1. Number of traps set per Julian week at each trapping site in the mainstem Trinity River during 1992.

Julian week	Start date	Lewiston	Ambrose	Hard Hat	Sky Ranch
2	Jan-08	1			
3	Jan-15	1	1		2
4	Jan-22	1	28		4
5	Jan-29	1	3		6
6	Feb-05	1	1		3
7	Feb-12	1	1		1
8	Feb-19	1	1		1
9	Feb-26	4	1		5
10	Mar-05	1	15		1
11	Mar-12	1	37		1
12	Mar-19	0	36	2	9
13	Mar-26	4	20	2	2
14	Apr-02	0		9	12
15	Apr-09	1		14	10
16	Apr-16			5	6
17	Apr-23			31	22
18	Apr-30			51	2
19	May-07				42
20	May-14				31
21	May-21				6
Totals:		18	144	114	166

Other Salmonids

We caught 5,542 steelhead this season. Steelhead were caught at all sites throughout the trapping season (Appendices 2, 3, 4, 5). Catches were relatively low until mid-March when large numbers of hatchery-produced steelhead were captured, coincident with hatchery releases. We found that 36.6% of the steelhead captured

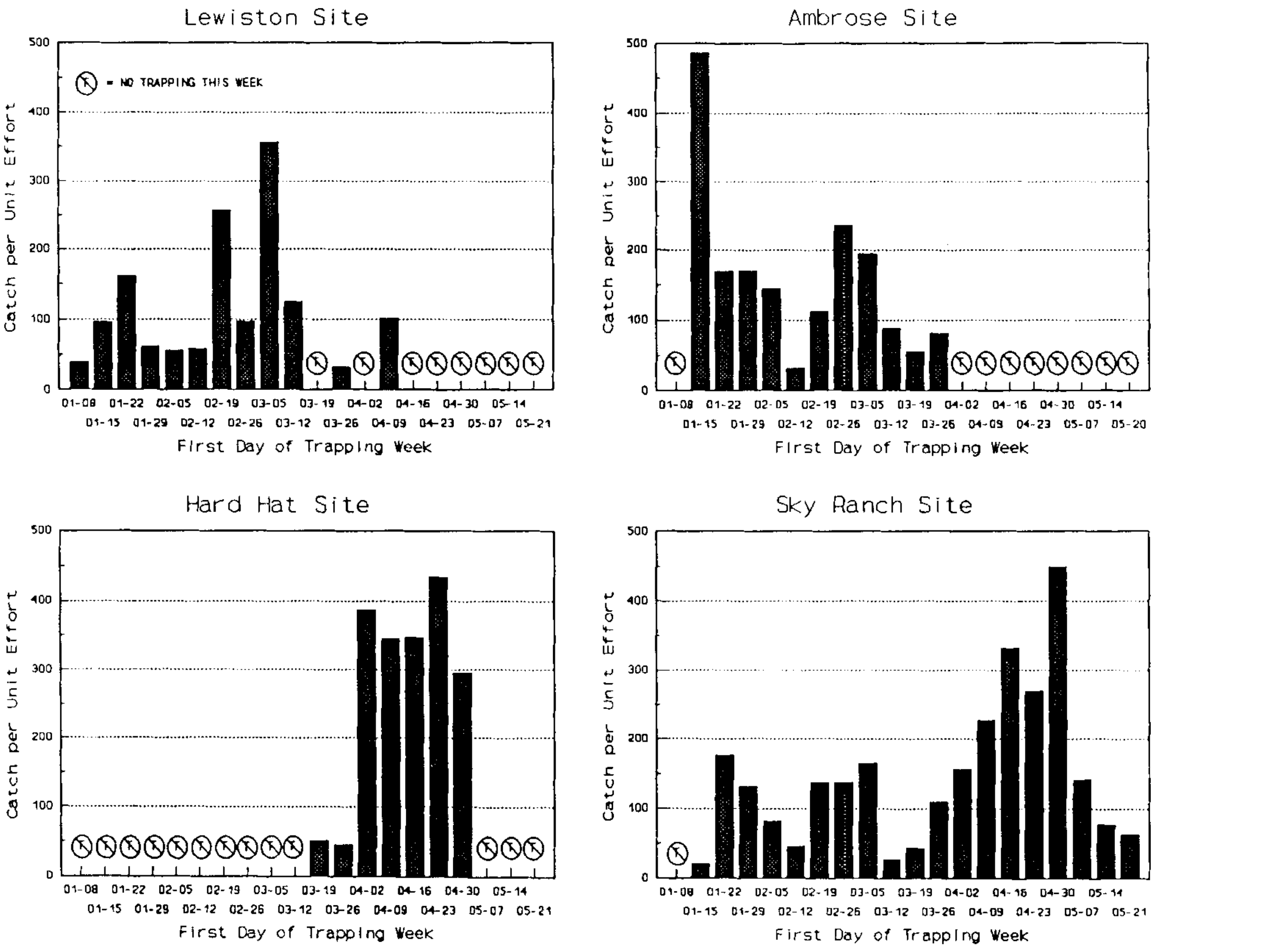

FIGURE 2. Weekly average catch of juvenile chinook salmon per-trap per-night at the four trapping sites in the mainstem Trinity River during 1992.

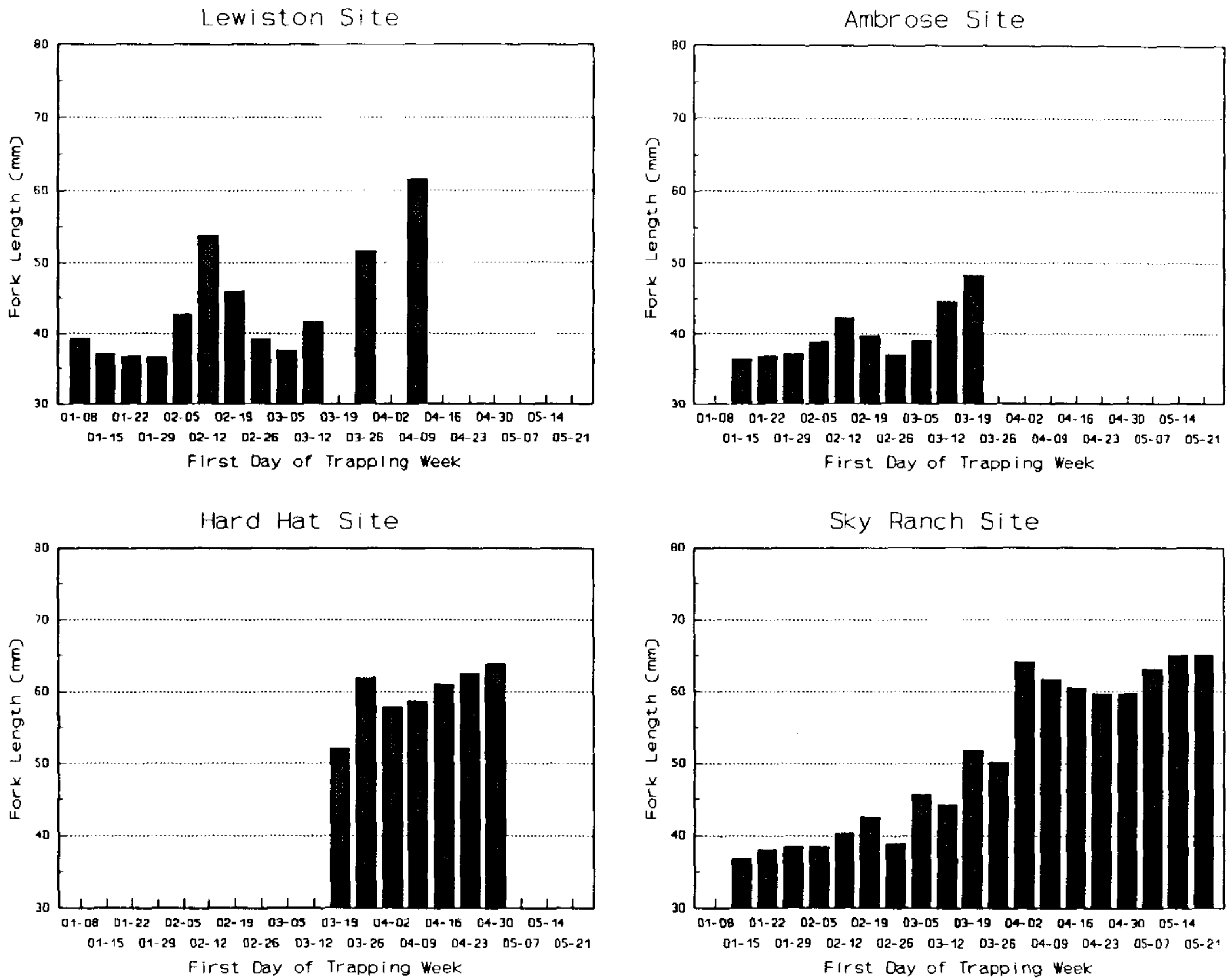

FIGURE 3. Weekly average fork lengths (mm) of juvenile chinook salmon captured at the four trapping sites in the mainstem Trinity River during 1992.

this season were fin-clipped, indicating they were from TRH[2].

We caught 500 coho salmon this season. Only yearlings were captured prior to 12 February, afterward, both yearlings and young-of-the-year were caught. The highest catch for coho was at the Hard Hat site (14 fish/trap/night) and occurred during mid-February (Appendix 3).

Tagging

Tagging operations began 13 March and continued through 18 May 1992. During this period, we marked (Ad+CWT) and released 59,971 juvenile chinook. Tagging took place at the Ambrose, Hard Hat, and Sky Ranch sites.

Ambrose Site

At the Ambrose Site, we tagged 8,348 juvenile chinook with coded-wire tag number 6-1-8-3-1. Tagging at this site began 13 March and continued through 30 March 1992. Independent, non-overlapping estimates, based on quality control groups, of tagging mortality, poor fin clips, and the number of coded-wire tags that were shed are shown in Table 2. After subtracting these estimates from the total tagged, we effectively CWT and released 8,070 juvenile chinook from this site (Table 2).

Hard Hat Site

At the Hard Hat Site, we tagged 35,043 juvenile chinook with coded-wire tag numbers 6-1-8-3-3, 6-1-8-3-6, 6-1-8-3-7, and 6-1-8-3-8 (Table 2). Tagging at this site began 9 April and continued through 7 May 1992. Independent, non-overlapping estimates, based on quality control groups, of tagging mortality, poor fin clips, and the number of coded-wire tags that were shed are shown in Table 2. After subtracting these estimates from the total tagged, we effectively CWT and released 33,195 juvenile chinook from this site (Table 2).

Sky Ranch Site

Tagging began 10 April and continued through 18 May 1992 at the Sky Ranch Site. During this period, we tagged 16,580 fish with coded-wire tag numbers 6-1-8-3-4, 6-1-8-3-9, and 6-1-8-3-10 (Table 2). Independent, non-overlapping estimates, based on quality control groups, of tagging mortality, poor fin clips, and the number of coded-wire tags that were shed are shown in Table 2. After subtracting these estimates from the total tagged, we effectively CWT and released 15,345 juvenile from this site (Table 2).

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[2] Beginning with the 1989 brood year, all steelhead produced at TRH have been fin-clipped prior to release (Aguilar 1992).

TABLE 2. Summary of juvenile chinook salmon coded-wire tagging in the mainstem Trinity River during 1992.

Coded-wire tag number	Tagging site	Dates of release	Number tagged	Estimated tagging mortalities	Poor fin clips	Tags shed	Number effectively tagged
6-1-8-3-1	Ambrose	3/13-3/30/92	8,348	54	37	187	8,070
6-1-8-3-3	Hard Hat	4/9-4/24/92	9,700	267	44	331	9,058
6-1-8-3-6	Hard Hat	4/24-2/29/92	9,896	191	0	64	9,641
6-1-8-3-7	Hard Hat	4/29-5/5/92	10,848	517	0	95	10,236
6-1-8-3-8	Hard Hat	5/5-5/7/92	4,599	329	0	10	4,260
Subtotals:			35,043	1,304	44	500	33,195
6-1-8-3-4	Sky Ranch	4/10-4/30/92	9,863	312	0	143	9,408
6-1-8-3-9	Sky Ranch	5/11-5/18/92	3,405	301	0	28	3,076
6-1-8-3-10	Sky Ranch	5/11-5/18/92	3,312	419	0	32	2,861
Subtotals:			16,580	1,032	0	203	15,345
Grand Totals:			59,971	2,390	81	890	56,610

Coded-Wire Tag Recovery

The CDFG's Ocean Salmon Project estimates that seven chinook from the 1988 brood year, coded-wire tagged by this Project in 1989 (Zuspan 1991), were recovered as three-year-olds this year. These included three each from the Oregon and California ocean fishery, and one from Trinity River Hatchery (Richard Dixon, Calif. Dept. Fish and Game, pers. comm.). One two-year-old fish from this coded-wire tag group was recovered during spawner surveys last year in the North Fork Trinity River (Zuspan 1992b). No other recoveries of Project-tagged fish were reported this year.

DISCUSSION

We were unable to capture enough juvenile chinook to reach our goal of tagging 100,000 naturally produced fish this year. This was the direct result of poor escapement of the progenitors of this year's juvenile chinook. Natural (non-hatchery) spawner escapement for chinook salmon (spring- plus fall-run) above Junction City was the lowest on record, only 15.4% of the 1989 run (5,453 vs 34,587) and 92.1% of last year's run (5,453 vs. 5,811)[3/].

Because of the low catches, we instigated an intensive trapping program, trapping up to 80% of the river's cross section on a seven-day-a-week basis. Trapping effort this year was 1.2 times that of last year (442 vs. 374 trap nights), and 3.9 times that of 1990 (442 vs. 143). Total juvenile chinook catch this year was 91.8% (81,851 vs. 89,208) of last year's and only 50.6% (81,851 vs. 161,730) of that in 1990[4/] (Zuspan 1992a, 1992b). In a pattern noted last year (Zuspan 1992b), both the overall juvenile chinook CPUE and adult escapement of their progenitors were down similar amounts. The 1991 adult chinook escapement (spring- plus fall-run) was 92.1% of the 1990 escapement and 15.4% of the 1989 escapement, while the CPUE for 1992 juvenile chinook was 77.6% of that in 1991 and 16.4% of that in 1990.

While it seems unlikely that there is a linear relationship between adult escapement and production, trapping during the last three years suggest an important correlation.

RECOMMENDATIONS

1. Job 2 activities should be continued in FY 1992-93.

2. In the event of a low chinook salmon escapement in 1992, the Project should be prepared to increase our trapping effort. This will require the purchase and construction of additional trapping equipment.

3. We should continue our efforts to recover coded-wire tagged chinook that are harvested by anglers or that return to TRH. Efforts to recover code-wire tagged fish spawning naturally should be increased.

[3/] Spawner escapement estimates from Bill Heubach, Calif. Dept. Fish and Game, pers. comm.

[4/] We trapped both naturally and hatchery-produced chinook salmon in 1990. This analysis considers only the effort expended and fish trapped prior 18 May 1990, the date TRH chinook were released.

LITERATURE CITED

Aguilar, B. 1992. Survival and contributions to the fisheries and spawner escapements made by steelhead produced at Trinity River Hatchery. Chapter VI. Job VI. p. 136-140. In: K. Urquart (ed.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1989-1990 Season. June 1992. 140 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Heubach, B., and P. Hubbell. 1979. FY 1978 progress report. Task V. Salmon tagging and release monitoring. p. 1-5. In: P. M. Hubbell (ed.), Evaluation Report--FY 1978. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. January 1979. 65 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Heubach, B. 1980. FY 1979 progress report. Task V. Salmon tagging and release monitoring. p. 75-79. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. September 1980. 141 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Maria, D., and B. Heubach. 1981. FY 1980 progress report. Task V. Salmon tagging and release monitoring. p. 7-12. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. Tasks II, V and VII. December 1981. 23 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

________________________. 1984a. FY 1981 progress report. Task V. Salmon tagging and release monitoring. p. 6-15. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. Tasks II, V, VII. October 1984. 24 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Maria, D., and B. Heubach. 1984b. FY 1982 progress report. Task V. salmon tagging and release monitoring. p. 5-13. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. Tasks II, V. November 1984. 13 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

________________________ 1984c. FY 1983 progress report. Task V. Salmon tagging and release monitoring. p. 1-11. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. Task V. November 1984. 11 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Zuspan, M. 1991. Capture and coded-wire tagging of naturally produced chinook in the Trinity River Basin. Chapter II. Job II. p. 24-33. In: Carpenter, R. and K. Urquhart (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1988-1989 Season. August 1991. 51 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, Ca. 95814.

________. 1992a. Capture and coded-wire tagging of naturally produced chinook in the Trinity River Basin. Chapter II. Job II. p. 30-43. In: K. Urquhart (ed.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1989-1990 Season. June 1992. 140 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, Ca. 95814.

________. 1992b. Capture and coded-wire tagging of naturally produced chinook in the Trinity River Basin. Chapter II. Job II. p. 32-49. In: Urquhart, K., and R. Carpenter (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1990-1991 Season. December 1992. 186 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, Ca. 95814.

Appendix 1. List of Julian weeks and their calendar date equivalents.

Julian week	Calendar dates Start	Finish	Julian week	Calendar dates Start	Finish
1	01-Jan	07-Jan	27	02-Jul	08-Jul
2	08-Jan	14-Jan	28	09-Jul	15-Jul
3	15-Jan	21-Jan	29	16-Jul	22-Jul
4	22-Jan	28-Jan	30	23-Jul	29-Jul
5	29-Jan	04-Feb	31	30-Jul	05-Aug
6	05-Feb	11-Feb	32	06-Aug	12-Aug
7	12-Feb	18-Feb	33	13-Aug	19-Aug
8	19-Feb	25-Feb	34	20-Aug	26-Aug
9 a/	26-Feb	04-Mar	35	27-Aug	02-Sep
10	05-Mar	11-Mar	36	03-Sep	09-Sep
11	12-Mar	18-Mar	37	10-Sep	16-Sep
12	19-Mar	25-Mar	38	17-Sep	23-Sep
13	26-Mar	01-Apr	39	24-Sep	30-Sep
14	02-Apr	08-Apr	40	01-Oct	07-Oct
15	09-Apr	15-Apr	41	08-Oct	14-Oct
16	16-Apr	22-Apr	42	15-Oct	21-Oct
17	23-Apr	29-Apr	43	22-Oct	28-Oct
18	30-Apr	06-May	44	29-Oct	04-Nov
19	07-May	13-May	45	05-Nov	11-Nov
20	14-May	20-May	46	12-Nov	18-Nov
21	21-May	27-May	47	19-Nov	25-Nov
22	28-May	03-Jun	48	26-Nov	02-Dec
23	04-Jun	10-Jun	49	03-Dec	09-Dec
24	11-Jun	17-Jun	50	10-Dec	16-Dec
25	18-Jun	24-Jun	51	17-Dec	23-Dec
26	25-Jun	01-Jul	52 b/	24-Dec	31-Dec

a/ Eight-day week in each year divisible by 4.
b/ Eight-day week every year.

Appendix 2. Summary of juvenile salmonid trapping in the Trinity River at the Lewiston Trapping Site, 8 January through 9 April 1992.

Julian week	Date begun	Trap nights a/	Chinook Number	Chinook Mean FL (mm)	Chinook CPUE b/	Coho Number	Coho CPUE b/	Steelhead Number	Steelhead CPUE b/
2	8-Jan	1	40	39.3	40	0	0	1	1
3	15-Jan	1	96	37.1	96	1	1	0	0
4	22-Jan	1	161	36.7	161	0	0	1	1
5	29-Jan	1	62	36.6	62	0	0	0	0
6	05-Feb	1	56	42.7	56	0	0	3	3
7	12-Feb	1	59	53.8	59	5	5	2	2
8	19-Feb	1	257	45.9	257	2	2	22	22
9	26-Feb	4	387	39.1	97	1	0	24	6
10	05-Mar	1	356	37.5	356	1	1	12	12
11	12-Mar	1	125	41.6	125	5	5	13	13
12	19-Mar	0							
13	26-Mar	4	131	51.7	33	1	0	138	35
14	02-Apr	0							
15	09-Apr	1	102	61.6	102	0	0	19	19
Totals:		18	1,832			16		235	

a/ Number of trap-nights allocated per week (ie. 2=2 traps/1 night or 1 trap/2 nights).

b/ Weekly average catch per-trap per-night.

Appendix 3. Summary of juvenile salmonid trapping in the Trinity River at the Ambrose Trapping Site, 15 January through 26 March 1992.

Julian week	Date begun	Trap nights a/	Chinook Number	Chinook Mean FL (mm)	Chinook CPUE b/	Coho Number	Coho CPUE b/	Steelhead Number	Steelhead CPUE b/
3	15-Jan	1	487	36.5	487	0	0	1	1
4	22-Jan	28	4,741	36.8	169	0	0	7	0
5	29-Jan	3	511	37.2	170	0	0	1	0
6	05-Feb	1	145	38.9	145	2	2	3	3
7	12-Feb	1	32	42.3	32	14	14	10	10
8	19-Feb	1	112	39.7	112	9	9	1	1
9	26-Feb	1	236	37.0	236	9	9	41	41
10	05-Mar	15	2,913	39.1	194	31	2	449	30
11	12-Mar	37	3,277	44.6	89	247	7	1,005	27
12	19-Mar	36	2,016	48.3	56	62	2	1,587	44
13	26-Mar	20	1,632	c/	82	16	1	1,105	55
Totals:		144	16,102			390		4,210	

a/ Number of trap-nights allocated per week (ie. 2=2 traps/1 night or 1 trap/2 nights).

b/ Weekly average catch per-trap per-night.

c/ Fork lengths not taken this week.

Appendix 4. Summary of juvenile salmonid trapping in the Trinity River at the Hard Hat Trapping Site, 19 March through 30 April 1992.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap nights a/	Number	Mean FL (mm)	CPUE b/	Number	CPUE b/	Number	CPUE b/
12	19-Mar	2	102	52.1	51	0	0	2	1
13	26-Mar	2	90	61.9	45	0	0	8	4
14	02-Apr	9	3,486	57.8	387	0	0	42	5
15	09-Apr	14	4,825	58.6	345	0	0	89	6
16	16-Apr	5	1,735	61.0	347	1	0	4	1
17	23-Apr	31	13,459	62.5	434	4	0	308	10
18	30-Apr	51	15,120	63.8	296	9	0	357	7
Totals:		114	38,817			14		810	

a/ Number of trap-nights allocated per week (ie. 2=2 traps/1 night or 1 trap/2 nights).

b/ Weekly average catch per-trap per-night.

Appendix 5. Summary of juvenile salmonid trapping in the Trinity River at the Sky Ranch Trapping Site, 15 January through 21 May 1992.

Julian week	Date begun	Trap nights a/	Chinook Number	Chinook Mean FL (mm)	Chinook CPUE b/	Coho Number	Coho CPUE b/	Steelhead Number	Steelhead CPUE b/
3	15-Jan	2	42	36.7	21	0	0	1	1
4	22-Jan	4	702	38.0	176	0	0	1	0
5	29-Jan	6	789	38.4	132	0	0	5	1
6	05-Feb	3	247	38.4	82	0	0	1	0
7	12-Feb	1	46	40.3	46	0	0	2	2
8	19-Feb	1	137	42.5	137	1	1	3	3
9	26-Feb	5	686	38.8	137	25	5	11	2
10	05-Mar	1	165	45.6	165	1	1	2	2
11	12-Mar	1	27	44.1	27	2	2	0	0
12	19-Mar	9	389	51.8	43	4	0	17	2
13	26-Mar	2	217	50.2	109	3	2	4	2
14	02-Apr	12	1,873	64.1	156	1	0	82	7
15	09-Apr	10	2,266	61.7	227	1	0	45	5
16	16-Apr	6	1,994	60.5	332	0	0	11	2
17	23-Apr	22	5,930	59.6	270	4	0	97	4
18	30-Apr	2	900	59.6	450	0	0	0	0
19	07-May	42	5,918	63.1	141	20	0	23	1
20	14-May	31	2,397	65.1	77	14	0	29	1
21	21-May	6	375	65.1	63	4	1	53	9
Totals:		166	25,100			80		387	

a/ Number of trap-nights allocated per week (ie. 2=2 traps/1 night or 1 trap/2 nights).

b/ Weekly average catch per-trap per-night.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991-1992 SEASON

CHAPTER III

JOB III
LIFE HISTORY, DISTRIBUTION, RUN SIZE AND ANGLER HARVEST OF STEELHEAD IN THE SOUTH FORK TRINITY RIVER BASIN

by

Barry W. Collins and Carrie E. Wilson

ABSTRACT

The California Department of Fish and Game's Natural Stocks Assessment Project monitored adult fall-run and winter-run steelhead (Oncorhynchus mykiss) migration at various weirs and estimated an escapement of 3,741 steelhead into the South Fork Trinity River basin during the 1991-1992 season.

Based on the results of our creel survey in the two major areas accessible to the public, we estimated that 1,580 anglers fished within these areas and landed 224 adult fall-run and winter-run steelhead, two half-pounders, two juvenile steelhead, and five fall-run chinook salmon during the 1991-1992 season. The angler harvest rate during the 1991-1992 season, in the entire South Fork Trinity River basin, was estimated from mail-returns of reward tags from adult fall-run and winter-run steelhead. The sport harvest rate was estimated to be 20.2% (756 fish).

Adult steelhead spawning stock surveys were conducted on 26 streams that are tributaries to the South Fork Trinity River and to Hayfork Creek. We surveyed 134.4 km of stream, observed nine adult steelhead, and counted 262 redds.

The characteristics of steelhead spawning habitat within the South Fork Trinity River basin were evaluated by measuring various physical and hydraulic parameters of steelhead redds. Steelhead were found to spawn mostly in step-runs (42.8%) and pools (36.7%). The average redd area was 1.24 m^2 and the average redd depth was 23.1 cm. The average fish-nose water velocity and average mean water column velocity where redds were observed were 0.39 and 0.42 m/sec, respectively.

We captured 1,896 juvenile steelhead emigrating from the upper South Fork Trinity River basin and 7,127 from the Hayfork Creek basin. Peak emigration of Age 0+ steelhead occurred during May and June 1992, while peak emigration of Age 0+ (young-of-the-year) chinook salmon occurred during May 1992.

Juvenile steelhead habitat utilization in Eltapom Creek, a tributary to the South Fork Trinity River, varied among age groups. During the fall 1991 survey, Age 0+ steelhead densities were highest in riffles and cascades, while in spring 1992 densities were the lowest in these two habitat types. Age 1+ fish densities in the fall were highest in cascades and pools; in spring their densities were about equal in all habitats except runs, where densities were about 1/2 that in other habitats.

JOB OBJECTIVES

1. To determine the size, composition, distribution, and timing of the adult steelhead runs in the South Fork Trinity River basin.

2. To determine the angler harvest of adult steelhead in the South Fork Trinity River basin.

3. To determine the life history patterns of the South Fork Trinity River basin steelhead stocks.

4. To determine the seasonal use made by juvenile steelhead of various habitat types within selected South Fork Trinity River tributaries.

5. To describe relationships between habitat parameter and seasonal juvenile steelhead standing crops.

INTRODUCTION

The life histories of steelhead (Oncorhynchus mykiss) populations within the South Fork Trinity River (SFTR) basin (Figure 1) are of concern because population numbers are believed to have dropped significantly in the last 30 years; however, little data are available regarding juvenile steelhead life history patterns, adult steelhead run sizes, spawner distributions, sportfishery yields, and harvest rates. As a result of poor habitat management within the SFTR basin, the 1964 flood severely impacted the area, damaging or destroying spawning and rearing habitats through excessive sedimentation. A combination of human activities (i.e., road construction, timber harvest, and recreation) exacerbated by natural events (i.e., wildfire and flooding) continue to curtail steelhead production within the basin by degrading in-stream habitat quality. Restoration of salmon and steelhead habitat within the basin is a high priority of the Trinity River Basin Fish and Wildlife Task Force, the U.S. Forest Service (USFS [Shasta-Trinity National Forest]), and the California Department of Fish and Game (CDFG). These restoration efforts will be guided by the knowledge gained through this study of the current status of steelhead stocks, their habitat requirements, and their life histories.

METHODS

Use of Standard Julian Week

Weekly sampling data collected by Project personnel at the weirs are presented in Julian week (JW) format. Each JW is defined as one of a consecutive set of 52 seven-day (weekly) periods,

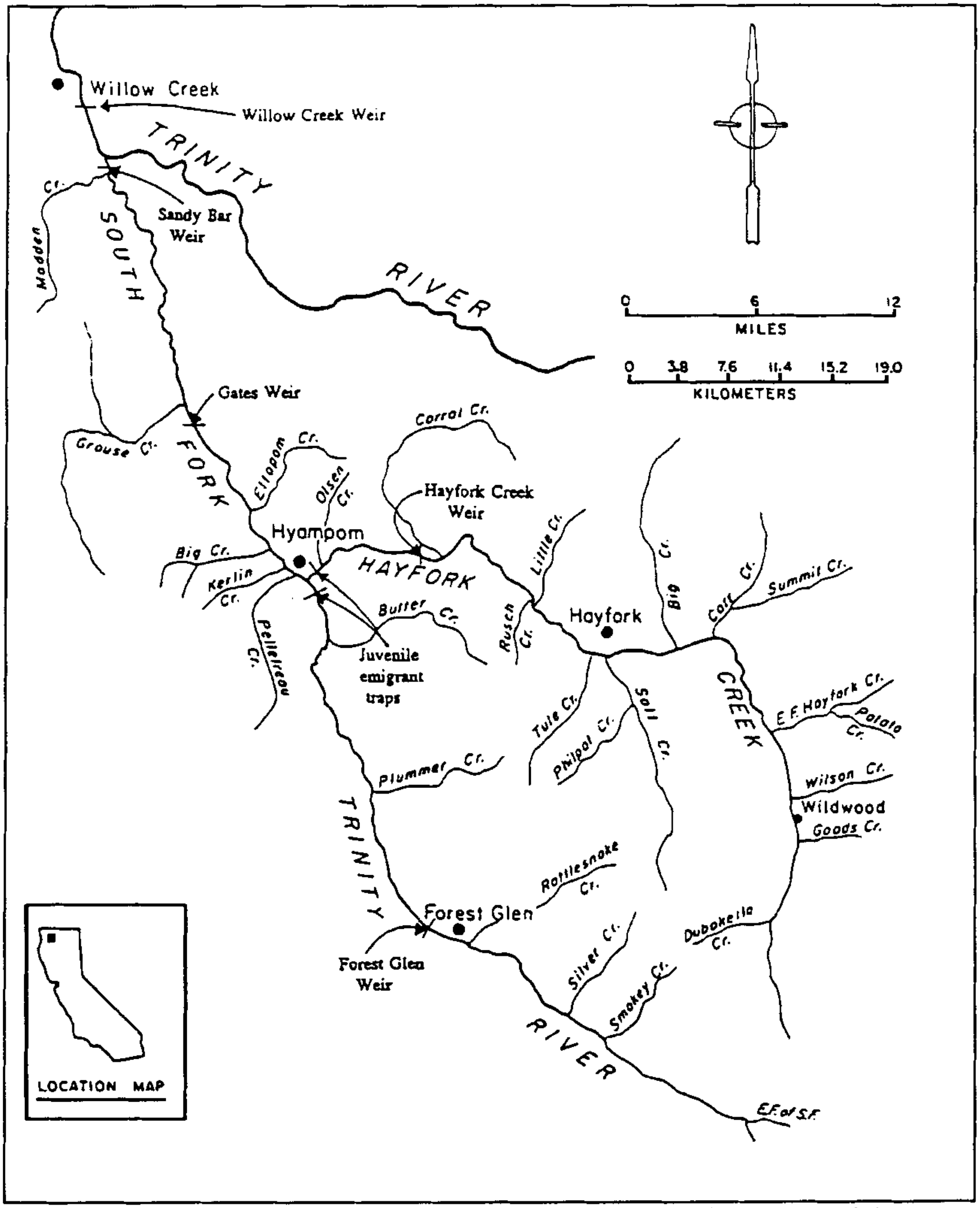

Figure 1. Locations of weirs and traps used to capture immigrant adult steelhead, and emigrant adult and juvenile steelhead in the South Fork Trinity River basin during the 1991-1992 season.

beginning 1 January, regardless of the day of the week on which 1 January falls. The extra day in leap years is included in the 9th week, and the last day of the year is included in the 52nd week (Appendix 1). This procedure allows annual comparisons of identical weekly periods.

Adult Steelhead Run Timing

To assess the timing of the adult steelhead run into the SFTR basin, we trapped immigrant adult steelhead at the Sandy Bar Weir within the SFTR basin. The Sandy Bar Weir was located on the SFTR at river km (RKM) 2.4, and operated from 5 September 1991 through 11 February 1992. The weir consisted of a series of panels, measuring 1.2 m high and 1.5 m wide constructed of 1.9-cm EMT (electrical metallic tubing) conduit with 3.2 cm horizontal bar spacing welded to angle iron frames. The panels were wired end to end and supported with metal fence posts. A trap (2.4 m wide x 2.4 m long x 1.2 m high), with sides constructed from the same weir panels, and flooring and top from marine plywood, was placed in the river thalweg with its fyke entrance facing downstream. The weir panels were tied in with the trap and extended outward across the river guiding upstream migrating fish into the trap. Small mesh netting was strung above the weir to prevent fish from jumping over.

Each steelhead captured was examined for: 1) fin clips, 2) tags, 3) gill net scars (nicks in the leading edges of dorsal and pectoral fins, sometimes combined with vertical white scars on the head), 4) hook scars (of ocean origin when healed, of freshwater origin when not healed), 5) predator scars (inverted 'V'-shaped marks, usually on the underbody), and 6) other scars of unknown origin. Steelhead were measured to the nearest cm fork length (FL), and their sex recorded. A scale sample was removed from the left side of each weir-caught fish, in an area slightly posterior to the anterior insertion of the dorsal fin, just above the lateral line. Each scale sample was placed between waterproof paper within a coin envelope and labeled with collection date, collection site, method of collection, sex, and FL (cm) of the fish.

All adult steelhead in good condition were marked with a 1/2 left ventral (LV) fin clip and a discretely numbered $10-reward anchor tag. To avoid excessive tagging mortality, we did not tag fish which were severely stressed by the weir capture and handling process, or those which appeared in generally poor physical condition. Tag recoveries were later used to estimate harvest rates and population abundance. Angler harvest rates were estimated from reward tag returns. The tags and clips were applied with the intention of computing a Petersen population estimate (Ricker 1975) based on the ratio of tagged to untagged fish observed in later recovery efforts (creel census and weirs for emigrant fish).

Creel Survey

Angler effort and harvest information for fall- and winter-run steelhead within two areas of the SFTR basin was determined from a systematic stratified creel survey, conducted from 1 November 1991 through 14 March 1992. The creel survey was conducted in two subsections of the lower SFTR basin (Figure 2). The lower survey area extended from the confluence of the SFTR with the main-stem Trinity River upstream for a distance of 22.5 km. The upper, Hyampom, area extended through the Hyampom Valley from RKM 33.0 to RKM 50.7. These two creel survey areas cover the river reaches fished by the majority of anglers, as public access is limited outside of these two areas due to the lack of public roads. Angler access sites in each creel survey area were identified prior to the survey period. The creel survey was further stratified by JW (Appendix 1), day (weekend/weekday), and time periods (am/pm: dawn to noon and noon to dusk, respectively). We extrapolated data for each stratum that was not surveyed by using average values for strata from equivalent sampling periods (i.e. for a missing weekday evening survey, the mean of all weekday pm's in that JW). Estimated and actual data were combined to estimate total catch for the season in these areas.

During the creel survey, clerks followed a set route based on a predetermined schedule, and monitored each access site for anglers. Anglers observed fishing during the survey periods were contacted and interviewed for hours fished that day, success, angling method, and county or state of residence. Sport-caught steelhead observed were measured (cm FL), and examined for fin clips and external tags. The number of any tag observed was recorded, the fish's sex determined, its spawning condition noted, and a scale sample taken. We classified steelhead < 25 cm FL as juveniles, ≥ 25 cm and < 35 cm as half-pounders, and ≥ 35 cm as adults (Kesner and Barnhart 1972). Water clarity was measured with a secchi disk in designated pool areas in both sections daily. When the river was judged to be "unfishable" due to high turbidity, no survey effort was recorded.

Tag Return and Steelhead Harvest Rates

All reward tags from Sandy Bar Weir that we observed during the creel surveys were left with the angler for them to return to us by mail. This was done so that we could calculate an overall SFTR basin sport harvest rate for fall- and winter-run steelhead. We estimated the sport harvest rate from the percentage of $10-reward tags returned by anglers corrected for non-response, based on the following assumptions: 1) that all tagged fish caught in the sport fishery were recognized as such by anglers, 2) no tags were shed, and 3) there was no differential mortality between tagged and untagged fish. The percentage of reward tags caught

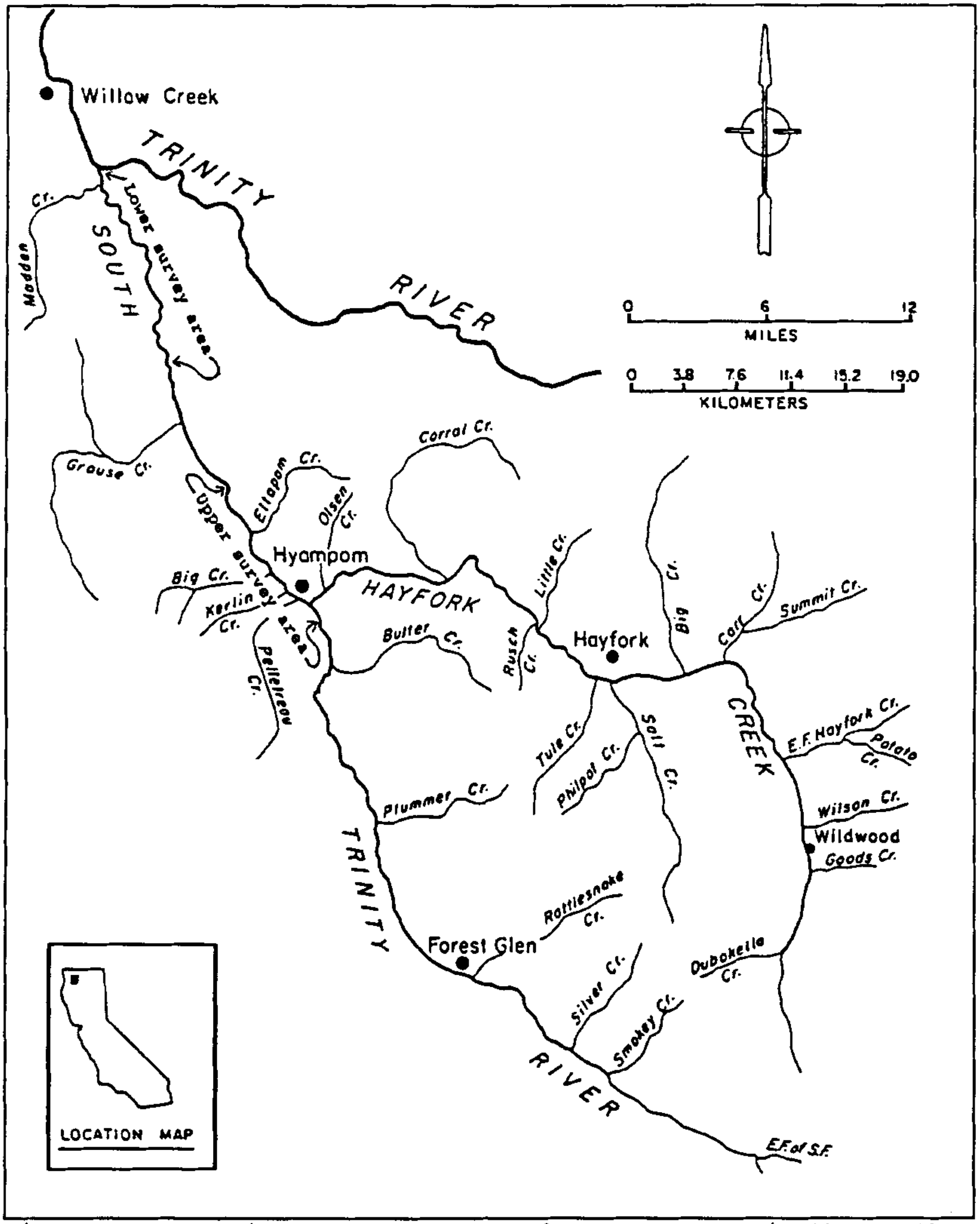

Figure 2. Locations of the two creel survey areas in the South Fork Trinity River basin surveyed during the 1991-1992 season.

by anglers which were not returned to us (i.e., non-response rate) was estimated from the number of reward tags we observed during our creel surveys, and the number of those tags which were subsequently returned to us by mail. The estimated sport harvest rate was determined from the number of reward tags returned by anglers divided by the non-response rate and the number of tags applied at the Sandy Bar weir.

Spawner Surveys

Project personnel conducted walking surveys of tributary streams to the SFTR and Hayfork Creek to document steelhead spawning distribution and timing. The surveys were conducted from 3 April through 1 June 1992. The areas surveyed included: 1) tributaries to the SFTR and to Hayfork Creek in the Hyampom Valley area, 2) tributaries to the SFTR in the upper SFTR basin near the town of Forest Glen, and 3) tributaries to Hayfork Creek near the town of Hayfork, and in the upper Hayfork Creek drainage near the town of Wildwood (Figure 1). Specific creeks surveyed were selected to include those which historically attracted spawning steelhead, and to replicate areas examined in previous CDFG surveys (Miller 1975; Mills and Wilson 1991; Rogers 1972, 1973; Wilson and Collins 1992; Wilson and Mills 1992).

Most streams were surveyed twice. During the first survey, two people walked designated stream reaches recording the length and type of each habitat unit, and observing spawning behavior and individual redd locations. Each habitat unit was classified as either a cascade, pool, riffle, run, or step-run. Last year we did not distinguish step-run units from run units when recording habitat types, but we now believe that the characteristics of step-runs may be a very important factor in redd location. Redds were flagged with surveyor's tape, with the survey date and field notebook description number recorded on the tape. The tape was then attached to nearby structures (such as root-wads, shrubs, or bushes). During the second survey, redd characteristics (area and depth), site descriptions (substrate and cover composition), and stream conditions (water velocities) were compiled for individual redds. New redds established since the first survey were included.

Steelhead Redd and Spawning Habitat Evaluations

We characterized steelhead spawning habitat within the SFTR basin by measuring the physical and hydraulic parameters of redds we observed in spawning areas, and by recording the characteristics and quality of the substrate and associated cover.

Length and width measurements were taken of each redd using a meter stick or tape measure. Length was measured from the head of the redd to the highest point of the tailspill, and width was measured perpendicularly across the widest point of the redd. An index of the surface area occupied by the redd area was calculated as the product of the length and width. Water depths were taken using a graduated top-setting wading rod and water velocities were measured with an electronic flow meter. Two separate water velocity measurements were taken: mean water column velocity (MWCV) and fish-nose water velocity (FNWV). MWCV measurements were taken 60% below the water surface and FNWV measurements were taken 0.12 m above the substrate. Redd substrate composition was determined by assessing the average size of the dominant and subdominant components, and the percent embeddedness of each (Hampton 1988) (Table 1). The water velocity measurements and the substrate analysis were all made approximately 0.15 m upstream of the redd in order to simulate prespawning hydraulic and substrate conditions. Distance to the closest cover, escape or resting place, was noted as well as the dominant habitat type in which the redd was located.

Table 1. Criteria used to describe the size of dominant and subdominant spawning gravel substrate.

Code	Description	Size range (mm)
0	Fines	< 4
1	Small gravel	4 - 25
2	Medium gravel	25 - 50
3	Large gravel	50 - 75
4	Small cobble	75 - 150
5	Medium cobble	150 - 225
6	Large cobble	225 - 300
7	Small boulder	300 - 600
8	Large boulder	> 600
9	Bedrock	

Adult Steelhead Recoveries at Emigrant Weirs

Downstream emigrant weirs were assembled on lower Hayfork Creek near the town of Hyampom (8.0 river kilometers upstream from the SFTR confluence), on the SFTR near the town of Forest Glen (approximately 150 m below the Highway 36 bridge, RKM 89.6), and on the SFTR below the Hyampom Valley (off of Gates Road at RKM 31.7) to capture post-spawning steelhead emigrating from the basin. Hereafter, these three weirs are referred to as the Hayfork Creek Weir, Forest Glen Weir, and the Gates Road Weir, respectively. We constructed Alaskan-style weirs at the Hayfork Creek and Forest Glen sites, and the CDFG's Trinity Fisheries Investigations Project constructed a weir-panel type weir at the Gates Road site on the SFTR. The Alaskan-style weirs were constructed using a series of panels 3.2 m high and 3.0 m long and supported by wooden tripods set 2.4 m apart and joined together to block the entire river. Each panel contained 1.9-cm EMT conduit pickets set 2.9 cm apart (46 per panel), secured through three aluminum channel sections on the face of the weir. A trap constructed of welded conduit panels and containing a fyke entrance was placed in the river thalweg. All steelhead recovered were: 1) measured (cm FL), 2) given a right operculum punch (ROP), 3) checked for spawning condition, tags, fin clips, and marks, 4) sampled for scales, and 5) released.

In addition to the downstream (emigrant) traps, we also installed upstream (immigrant) traps at each weir to capture spring-run steelhead entering the SFTR basin. These fish were not tagged, but were given a 1/2 left ventral fin-clip (1/2LV) at the Gates Road Weir to prevent any later recounting at the other two upstream weirs. We had also given immigrant fall- and winter-run steelhead caught at the Sandy Bar Weir the same secondary mark (1/2LV). However, we believed that we could distinguish fall- and winter-run steelhead tagged and marked at the Sandy Bar weir from spring-run steelhead marked at the Gates Road Weir, based on the presence or absence of a tag or tag-scar, their sexual maturity, the general coloration and condition of the fish, and fin regeneration of the fall- and winter-run fish.

SFTR Adult Fall-run and Winter-run Steelhead Escapement Estimate

We estimated the adult fall- and winter-run steelhead escapement into the SFTR basin using the Petersen method of mark and recapture (Ricker 1975, p. 78, formula 3.7) by tagging adult steelhead at the Sandy Bar Weir and recovering them through the emigrant weirs (Hayfork Creek Weir, Forest Glen Weir and Gates Road Weir) and creel surveys. Spring-run steelhead at the emigrant weirs were differentiated from fall- and winter-run steelhead by their sexual maturity, coloration, and general condition. Confidence limits were calculated using the Poisson approximation method (Chapman 1948).

Juvenile Steelhead Emigration Studies

We monitored juvenile steelhead emigration patterns by systematically trapping at two sites within the SFTR basin in lower Hayfork Creek, 305 m upstream of its confluence with the SFTR, and in the SFTR upstream of its confluence with Hayfork

Creek, within 0.4 km on either side of the Hyampom Road bridge at RKM 49.1 (Figure 1). When flow conditions permitted, we trapped on a weekly basis throughout most of the year, but increased trapping frequency to every third night during the spring period of peak juvenile steelhead emergence 23 April - 22 July (JW 17-29). Juvenile steelhead were captured using fyke nets attached to trap boxes. The nets were constructed of 1.3-cm nylon mesh, had a 1.8-m x 2.4-m upstream opening and extended 10.1 m to a trap attachment frame at the terminal end. Trap boxes were constructed of marine plywood and hardware cloth, and measured 0.8 m x 1.2 m at the opening and were 0.5 m deep. One or two fyke-net traps were fished overnight in the river or stream, for 16 to 24 hour periods, and examined the following morning.

Captured fish were identified to species and enumerated. The first 50 individuals of each species removed from the traps were measured for FL (mm), and scale samples were systematically taken from a maximum of 10 juvenile steelhead, at each trap site, each sampling day. Flows through the net were measured at the net opening, and total volume of stream flows were estimated to the nearest 0.03 m/sec using either a pygmy meter or a Marsh-McBirney[1/] flow meter. Water temperatures were monitored using hand-held thermometers or digital recording thermographs.

Habitat Use by Juvenile Steelhead

Seasonal habitat use by juvenile steelhead was studied in Eltapom Creek (Figure 1) during fall 1991 (10-13 September) and spring 1992 (8-12 June). Prior to sampling fish during each season's study, the creek was first surveyed and habitat-typed into individual units of the five basic habitat types: cascades, pools, riffles, runs, and step-runs. Our goal was to sample 1/3 of the available habitat units. In September 1991 we sampled 24 of 70 (34%) units and in June 1992 we sampled 26 of 71 (37%) units. Habitat units were randomly selected for sampling in proportion to the numeric abundance of each of the five basic habitat types.

Sample units were isolated using block nets to prevent any immigration or emigration of fish, and then electrofished. We recorded air and water temperatures with hand-held thermometers, and water velocities (to the nearest 0.03 m/sec) for each individual habitat unit and took photos of each unit sampled. Water velocities were measured at 60% of the total depth from the surface along a line transverse to the flow at points 1/4, 1/2, and 3/4 of the way across the stream. Stream length and width were measured to the nearest 0.03 m in each habitat unit.

1/ The use of brand names is for identification purposes only, and does not imply the endorsement of any product by the California Department of Fish and Game.

All captured steelhead were counted, measured (mm FL), sampled for scales (first five fish per habitat unit), and then released. During the fall 1991 survey, fish ≤85 mm were classified as Age 0+, fish 86-150 mm as Age 1+, and fish >150 mm as Age 2+. During the spring 1992 survey, fish ≤60 mm were classified as Age 0+, fish 61-150 mm as Age 1+, and fish >150 mm as Age 2+. We will attempt to refine the age-length relationship through scale analysis. The relative age distribution was determined for fish from each basic habitat type, based on length frequencies. The data were in turn used to determine the relative densities of each age group in each habitat type. The total number of juvenile steelhead present in the entire stream during each survey was then extrapolated, based on the available area.

Last year we intended to use either the two-step or the Zippin method to estimate abundance (Hankin 1986, Price 1982). However, the two-step method proved unsatisfactory because in several cases more fish were caught on the second pass than the first, leading to negative abundance estimates. In addition, several other cases yielded equal numbers of fish on both passes, which leads to division by zero in the formula. The abundance estimates calculated last year using the Zippin method were identical to the total number of fish caught in most of the units sampled. Therefore, density estimates were based on the total number of fish caught, rather than on an estimated number of fish present. This year we have also decided to report density estimates just based on the total number of fish caught.

We have conducted similar studies during fall 1989, 1990 and 1991 and spring 1991 (Wilson and Collins 1992; Wilson and Mills 1992).

RESULTS AND DISCUSSION

Adult Steelhead Run Timing

The Sandy Bar Weir operated from 5 September 1991 through 11 February 1992, trapping 493 adult fall- and winter-run steelhead. The first steelhead was trapped on 5 October 1992 (Figure 3). Steelhead entered the SFTR basin throughout this period. Immigration peaks occurred during late October, November, and January. We believe we monitored the entire fall-run population and most of the winter-run population of adult steelhead immigrating past Sandy Bar, although we know that the run continued after 11 February 1992 based upon immigrants trapped at our upper SFTR basin weirs (Hayfork Creek, Forest Glen and Gates Road weirs) later in the season. The timing of the steelhead runs seems to depend more on environmental conditions (storm events with accompanying high flows) than calendar dates. The periodic increases in steelhead capture numbers at the Sandy Bar weir directly coincided with storm events.

Twenty-one of the 493 steelhead captured at the Sandy Bar Weir carried tags previously applied at the Willow Creek Weir; 612 steelhead tags were applied at Willow Creek (personal communication, Michael Lau, Calif. Dept. Fish and Game). We tagged the remaining 472 fish with $10-reward anchor tags and gave all 493 steelhead 1/2 LV fin clips. Mean FL of all 493 steelhead examined was 63 cm (Figure 4). Gillnet scars (20.1%) and predator scars (57.2%) were the most common scars seen on steelhead trapped at the weir (Table 2). Travel times for the 21 fish previously tagged at the Willow Creek Weir ranged from one to 71 days, and averaged 27.5 days (Appendix 2).

Creel Survey

The creel survey was conducted on the SFTR between 1 November 1991 and 14 March 1992, an interval of 135 days. The lower survey section (Figure 2) was monitored for angler activity on 102 days and a creel survey conducted on 73 days of this period. The upper survey section was monitored for 135 days and a creel survey conducted on 93 days of this period. Creel surveys were not conducted when high flows made the river unfishable. The river in the lower survey section was subjectively judged to be "unfishable", due to high-flows and turbidity, after 11 February 1992. At this point we ceased surveys in the lower section. The upper section was judged "unfishable" for nine (9.6%) of the days it was monitored.

During the survey, 283 anglers were interviewed, 13 (4.6%) within the lower section and 270 (95.4%) within the upper section. Peak angling activity (54.2%) was observed within the upper survey section at the Hayfork Creek mouth, Little Rock Campground, and Big Slide Campground, with the rest of the anglers' effort distributed over a range of other sites. Of the 283 anglers interviewed, 48 were observed fishing at multiple locations on the same day. Each site of angling activity was counted, but an angler was not recounted when observed at a different location on the same day (Table 3).

Forty-two adult steelhead and one adult chinook salmon were observed in the catch (10 steelhead and one chinook salmon in the lower section and 32 steelhead in the upper survey section). One half-pounder and one juvenile steelhead were also observed in the upper section. Eighteen of the 42 adult steelhead observed carried tags from Sandy Bar Weir (three in the lower survey section and 15 in the upper survey section). Based on extrapolations of the creel survey data, an estimated 79 anglers within the lower section landed 59 adult steelhead and five chinook salmon (Table 4), while an estimated 1,501 anglers within the upper section landed an estimated 165 adult steelhead, two half-pounder steelhead, two juvenile steelhead and no chinook salmon (Table 5).

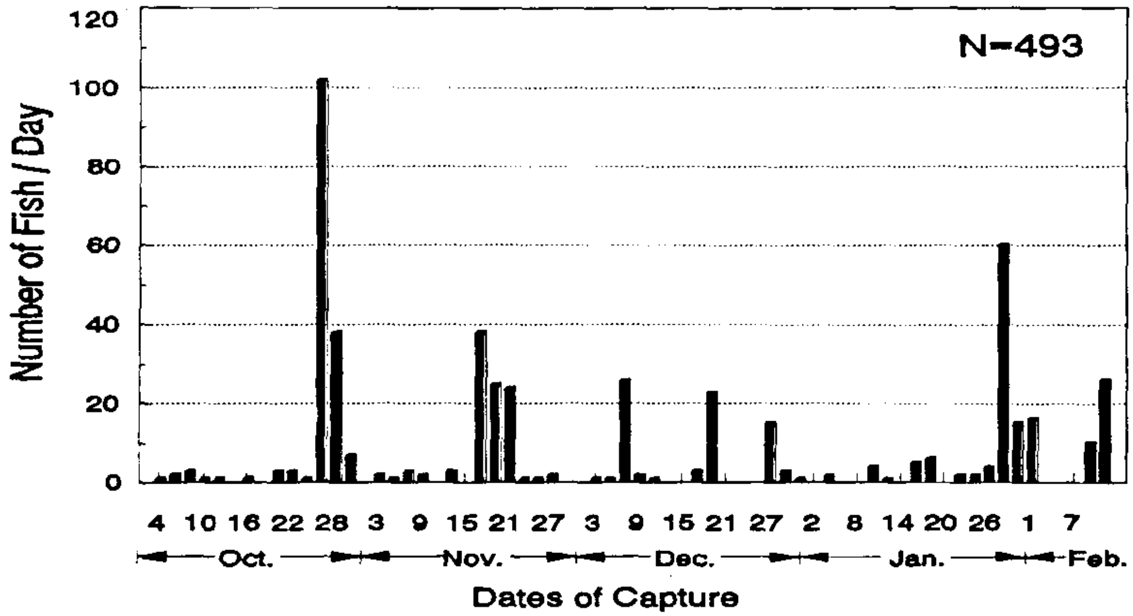

Figure 3. Daily catch of immigrant adult steelhead at the Sandy Bar Weir in the South Fork Trinity River from 5 September 1991 through 11 February 1992.

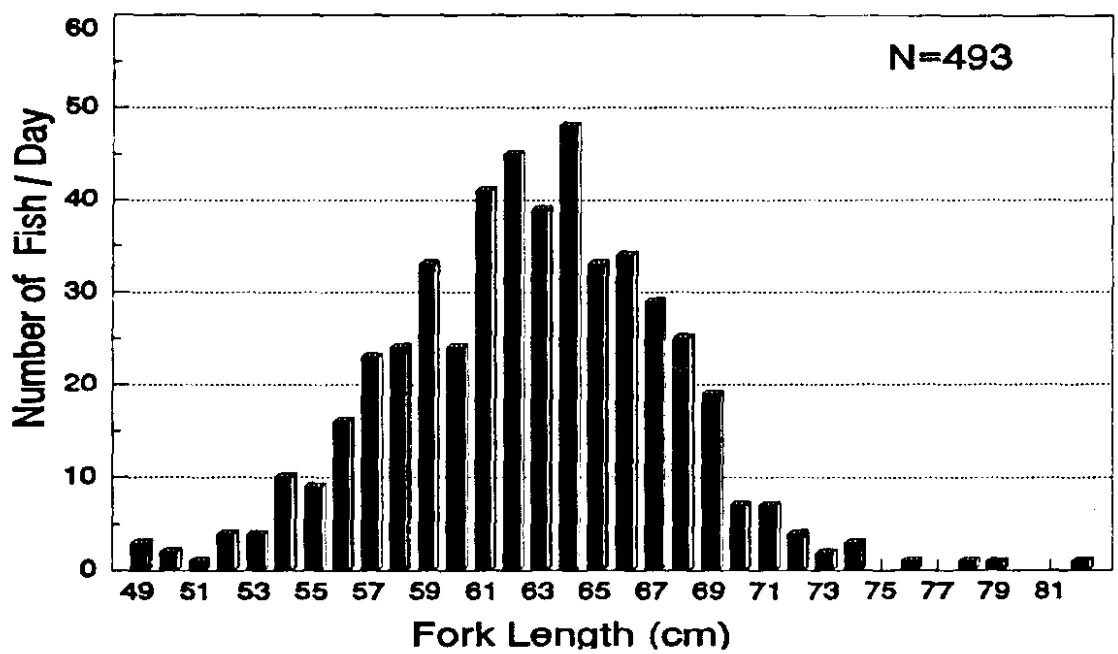

Figure 4. Length frequency distribution of immigrant adult steelhead captured at the Sandy Bar Weir in the South Fork Trinity River from 5 September 1991 through 11 February 1992.

Table 2. Scars and injuries observed on adult steelhead captured at the Sandy Bar Weir in the South Fork Trinity River between 5 September 1991 and 11 February 1992.

Scar or injury	Number of fish with scars	Percent of fish with scars	Percent of total fish captured
Gill net scars	56	20.1	11.3
Freshwater hook scars	13	4.7	2.6
Ocean hook scars	19	6.8	3.8
Predator scars	159	57.2	32.1
Scars of unknown origin	31	11.2	6.3
Totals:	278	100.0	

County of origin was tabulated for all 283 anglers. The majority (93.6%) of the anglers fishing within the SFTR basin were from Trinity county (Table 6).

Excluding the unfishable days, water clarity ranged from 55 to 150+ cm in the lower survey section and from 17 to 150+ cm in the upper survey section. Water temperatures ranged from 2.2 to 13.3° C and averaged 7.2° C in the lower survey section, while the upper survey section ranged from 3.3 to 15.6° C and averaged 7.8° C.

Tag Returns and Steelhead Harvest Rates

Fifty-three of the 472 tags applied at the Sandy Bar Weir were returned by anglers through the mail indicating a harvest rate of 11.3%. However, only 10 of 18 tags observed in the creel survey were later returned by anglers indicating a response rate of 55.6%. Dividing the number of tags returned through the mail by this response rate gives us a corrected tag return of 95.3 tags, yielding a corrected harvest rate of 20.2% for adult steelhead (95% Poisson confidence interval [C.I.] = 15% to 26%).

Spawner Surveys

Walking surveys were conducted throughout the SFTR basin between 3 April and 1 June 1992 to document numbers and locations of spawning steelhead (Table 7). We surveyed and habitat-typed sections of 26 creeks (134.4 km total length), counted and flagged 262 redds, and observed nine adult steelhead.

Table 3. Distribution of angler use among the various access sites surveyed in the creel survey of the South Fork Trinity River basin during the 1991-1992 season.

Location	River Km	River Mile	Angler Number	Angler Percent
Lower Survey Section				
Sandy Bar[a]	1.6	1.0	8	2.4
Madden Creek/Sandy Bar[a]	2.1	1.3	5	1.5
Holmes Farm/Bridge	13.2	8.2	0	0.0
Todd Ranch	18.8	11.7	0	0.0
Surprise Creek Area	22.2	13.8	0	0.0
Upper Survey Section				
Swinging Bridge	32.7	20.3	5	1.5
Big Slide Campground[a]	40.2	25.0	47	14.3
Eltapom Creek Area[a]	40.9	25.4	21	6.4
Upper Slide Creek	41.0	25.5	14	4.2
Salmon Rock Area[a]	41.7	25.9	13	3.9
Little Rock Campground[a]	42.0	26.1	61	18.4
Mortensen Property[a]	2.6	26.5	4	1.2
Saw Mill Site	43.4	27.0	9	2.7
Way Property	45.1	28.0	13	3.9
Hyampom Airstrip[a]	46.0	28.6	34	10.3
Pelletreau Creek Mouth	46.3	28.8	2	0.6
Old Bridge Site	47.3	29.4	4	1.2
Church Access[a]	47.9	29.8	13	3.9
Co. Maintenance Yard[a]	48.3	30.0	7	2.1
Hayfork Creek Mouth[a]	48.8	30.3	71	21.5
All Other Areas	--	--	0	0.0
Totals			331	100.0

a/ Forty-eight anglers were observed fishing at multiple locations on the same day. Although their angling activity was enumerated, they were not recounted as part of the total angler effort observed at a different location the same day (331 sites of angler activity - 48 anglers at multiple sites = 283. anglers).

Table 4. South Fork Trinity River creel survey data, angler use and steelhead harvest estimates for the lower survey section during the 1991-1992 season.

Dates	Julian week	Angler numbers Observed	Angler numbers Estimated	Angler hours Observed	Angler hours Estimated
10/29-11/11	44-45	5	29	13.0	68.6
11/12-11/25	46-47	5	31	3.0	18.1
11/26-12/09	48-49	1	8	2.0	16.7
12/10-12/23	50-51	0	0	0	0
12/24-01/07	52-01	2	11	4.0	24.9
01/08-01/21	02-03	0	0	0	0
01/22-02/04	04-05	0	0	0	0
02/05-02/18	06-07	0	0	0	0
02/19-03/04	08-09	-	-	-	-
03/05-03/18	10-11	-	-	-	-
	Totals	13	79	22.0	128.3

Dates	Julian week	Steelhead Adults a/ Observed	Adults a/ Estimated	Half-pounders b/ Observed	Half-pounders b/ Estimated	Juveniles c/ Observed	Juveniles c/ Estimated
10/29-11/11	44-45	8	50	0	0	0	0
11/12-11/25	46-47	1	5	0	0	0	0
11/26-12/09	48-49	0	0	0	0	0	0
12/10-12/23	50-51	0	0	0	0	0	0
12/24-01/07	52-01	1	4	0	0	0	0
01/08-01/21	02-03	0	0	0	0	0	0
01/22-02/04	04-05	0	0	0	0	0	0
02/05-02/18	06-07	0	0	0	0	0	0
02/19-03/04	08-09	-	-	-	-	-	-
03/05-03/18	10-11	-	-	-	-	-	-
	Totals	10	59	0	0	0	0

a/ Adult steelhead are ≥ 35 cm, FL.
b/ Half-pounder steelhead are ≥ 25 cm and < 35 cm, FL.
c/ Juvenile steelhead are < 25 cm, FL.

Table 5. South Fork Trinity River creel survey data, angler use and steelhead harvest estimates for the upper survey section during the 1991-1992 season.

Dates	Julian week	Angler numbers Observed	Angler numbers Estimated	Angler hours Observed	Angler hours Estimated
10/29-11/11	44-45	13	84	12.5	65.4
11/12-11/25	46-47	25	120	59.5	332.0
11/26-12/09	48-49	27	161	24.5	133.1
12/10-12/23	50-51	43	206	82.5	404.2
12/24-01/07	52-01	84	367	129.5	552.8
01/08-01/21	02-03	23	109	25.5	131.5
01/22-02/04	04-05	24	131	34.0	180.9
02/05-02/18	06-07	6	77	7.5	110.0
02/19-03/04	08-09	19	205	34.0	298.0
03/05-03/18	10-11	6	41	7.0	43.3
	Totals	270	1501	416.5	2251.2

		Steelhead					
	Julian	Adults a/		Half-pounders b/		Juveniles c/	
		Observed	Estimated	Observed	Estimated	Observed	Estimated
10/29-11/11	44-45	5	43	1	2	1	2
11/12-11/25	46-47	4	14	0	0	0	0
11/26-12/09	48-49	4	15	0	0	0	0
12/10-12/23	50-51	11	57	0	0	0	0
12/24-01/07	52-01	8	36	0	0	0	0
01/08-01/21	02-03	0	0	0	0	0	0
01/22-02/04	04-05	0	0	0	0	0	0
02/05-02/18	06-07	0	0	0	0	0	0
02/19-03/04	08-09	0	-	-	-	-	-
03/05-03/18	10-11	0	-	-	-	-	-
	Totals	32	165	1	2	1	2

a/ Adult steelhead are ≥ 35 cm, FL.
b/ Half-pounder steelhead are ≥ 25 cm and < 35 cm, FL.
c/ Juvenile steelhead are < 25 cm, FL.

Table 6. County of residence for anglers interviewed within the South Fork Trinity River basin during the 1991-1992 creel survey.

County of origin	Number	Percent
Trinity	265	93.6%
Sacramento	7	2.5%
Humboldt	4	1.4%
San Francisco	2	0.7%
Nevada	1	0.4%
Mariposa	1	0.4%
San Diego	1	0.4%
Tehama	1	0.4%
Out-of-State	1	0.4%
Total:	283	100.0%

The East Fork of the South Fork Trinity River and Eltapom Creek contained the highest redd densities of all creeks surveyed (15.0 and 10.0 redds/km, respectively), followed by Plummer Creek and Smokey Creek (7.9 and 5.9 redds/km, respectively). These same four creeks also had the highest observed densities last year. These areas of high redd concentration all had good spawning habitat and were contained in drainages that are fairly stable geologically, and have not been too adversely affected by logging activities or by the catastrophic 1964 flood. The lowest redd densities were found in the Hayfork Valley in creeks affected by livestock grazing or poor logging practices, both of which contribute to heavy siltation of the creeks. Most creeks in the SFTR basin show signs of progressive habitat degradation due to the sedimentation of stream systems, resulting in the loss of appropriate spawning gravel sites and the filling in of pools. The low-flow conditions during the past six years of drought has probably intensified the problem by restricting spawning to the more degraded areas of stream systems.

Hyampom Valley Area

We surveyed seven tributaries to the SFTR and two tributaries to Hayfork Creek, all within the Hyampom Valley, between 8 April and 1 June 1992. These surveys covered a total of 13.2 km of stream. We observed 23 redds and four live adult steelhead (Table 7).

Big Creek. Big Creek, a small tributary to the SFTR (RKM 42.8), is located 5.6 km downstream from the town of Hyampom. A natural barrier of cascades exists 0.8 km upstream from the

Table 7. Steelhead spawner survey data for the South Fork Trinity River basin from 3 April through 1 June 1992.

Location	Survey dates First	Survey dates Last	No. of surveys	Length surveyed (km)	New redds observed	Redds observed per km	Live steelhead observed
Hyampom Valley							
Big Creek	4/10	--	1	0.8	1	0.9	0
Butter Creek	4/21	6/01	2	2.4	5	2.1	2
Corral Creek	4/22	--	1	0.2	0	0.0	0
Eltapom Creek	4/08	5/18	2	1.3	13	10.0	0
Grouse Creek	4/27	5/07	2	1.6	0	0.0	0
Kerlin Creek	4/16	5/22	2	2.4	1	0.4	0
Madden Creek	4/30	5/27	2	1.9	0	0.0	0
Olsen Creek	4/09	5/13	2	1.8	3	1.7	2
Pelletreau Creek	4/21	5/19	2	0.8	0	0.0	0
Subtotals:			16	13.2	23	--	4
Hayfork-Wildwood							
Big Creek	4/09	5/08	2	14.0	53	3.8	1
Carr Creek	5/04	--	1	4.3	0	0.0	0
Dubakella Creek	4/24	--	1	1.6	0	0.0	0
E.F. Hayfork Creek	4/07	5/05	2	8.4	5	0.6	0
Goods Creek	4/29	--	1	1.4	0	0.0	0
Hayfork Creek	4/22	5/29	5	31.1	10	0.3	2
Little Creek	5/07	5/21	2	2.3	4	1.7	1
Philpot Creek	4/08	--	1	2.1	0	0.0	0
Potato Creek	4/08	5/09	2	2.4	1	0.4	0
Rusch Creek	4/23	5/13	2	6.0	0	0.0	0
Salt Creek	4/15	5/23	2	17.1	8	0.5	0
Tule Creek	4/03	5/11	2	6.0	13	2.2	0
Subtotals:			23	96.7	94	--	4
Forest Glen							
E.F. South Fork	5/07	--	1	5.2	78	15.0	0
Plummer Creek	5/05	--	1	3.4	27	7.9	0
Rattlesnake Creek	5/01	5/29	2	10.6	19	1.8	1
Silver Creek	5/12	--	1	2.4	4	1.7	0
Smokey Creek	5/13	--	1	2.9	17	5.9	0
Subtotals:			6	24.5	145	--	1
Grand totals:			43	134.4	262	--	9

confluence and a hydropower plant is located adjacent to the creek 30.5 m below the cascades. We surveyed the 0.8 km of Big Creek from the confluence to the barrier on 10 April 1992. The stream bed contains numerous pools and large boulders but lacks suitable spawning gravels to support much spawning activity. The only spawning area available is found in the gravels in front of the culvert exiting the powerhouse. One redd was observed there.

Butter Creek. Butter Creek, a tributary to the SFTR (RKM 54.2), is located 3.2 km south of the town of Hyampom. This creek contains areas of extreme bank sloughing in the lower 0.4 km section due to early logging activities exacerbated by the floods of 1964 and 1986. However, most of the creek upstream of this area contains large holding pools and some areas of suitable spawning habitat. Butter Creek Falls exists 2.4 km from the confluence creating a natural barrier to anadromous fish passage. We surveyed the 2.4 km below the falls on 21 April and 1 June 1992, counted five steelhead redds and observed two adult steelhead.

Corral Creek. Corral Creek, a tributary to Hayfork Creek (RKM 10.0), is located east of the town of Hyampom. Corral Creek is a medium-sized stream with mountainous headwaters which flows through a narrow, steep-sided canyon. A slide has created a complete barrier to anadromous passage 0.2 km from its confluence with Hayfork Creek. Watershed vegetation consists of dense stands of douglas fir, ponderosa pine, and mixed hardwoods. Cascades and pools are abundant but areas of suitable spawning gravel are scarce. We surveyed the lower 0.2 km of Corral Creek on 22 April 1992 but observed no redds or adult steelhead.

Eltapom Creek. Eltapom Creek, a tributary to the SFTR (RKM 40.9), is located 8.0 km north of the town of Hyampom and flows through a narrow canyon consisting of steep rock and oak covered slopes which were badly damaged by fire in 1987. Pools and spawning habitat are very common throughout, with spawning gravels in the upper reaches less compacted and more suitable for spawning than those in the middle and lower reaches. Pools are numerous and pool cover consists mostly of root-wad and bedrock structures. Riparian vegetation is fair, with creek canopy consisting mainly of alders. A waterfall exists 1.3 km from the confluence, creating a natural barrier to anadromous fish passage. We surveyed the lower 1.3 km of the creek on 8 April and 18 May 1992 and counted 13 redds.

Grouse Creek. Grouse Creek, a tributary to the SFTR (RKM 31.1), is located north of the town of Hyampom. The stream has a complete barrier (Devastation Slide) to anadromous fish passage 2.6 km from its confluence with the SFTR. The lower 2.6 km section has a high gradient, and the few areas containing available spawning gravel are highly cemented with sediment. A geological assessment of the Grouse Creek barrier was completed by the U. S. Forest Service, Lower Trinity River Ranger District in 1989 and indicated that rearing conditions above the barrier for juvenile salmonids are fair to good. We surveyed the lower 1.6 km of Grouse Creek on 27 April and 7 May 1992 but counted no redds or adult steelhead.

Kerlin Creek. Kerlin Creek, a tributary to the SFTR (RKM 44.3), is located in the Hyampom Valley. Kerlin Creek flows through a gulch with highly eroded cliffs approximately 5.0 m in height. Many of the riparian trees along the creek are undercut and in the streambed. The stream substrate is composed predominately of cobbles, mostly about 30 cm in their largest dimension. Kerlin Creek contains no suitable pool habitat and the spawning gravel generally suffers from heavy siltation and sedimentation. We surveyed the lower 2.4 km of Kerlin Creek on 16 April and 22 May 1992, and observed one redd but no adult steelhead.

Madden Creek. Madden Creek, a tributary to the SFTR (RKM 2.4), is located just west of the town of Salyer and south of the town of Willow Creek. The creek flows through a steep and heavily forested drainage, with anadromous fish habitat confined to the lower 1.9 km. The drainage has experienced extensive timber harvest and fine sediments are accumulating in the watershed. We surveyed Madden Creek from the mouth upstream for 1.9 km on 30 April and 27 May 1992, but observed no redds or adult steelhead.

Olsen Creek. Olsen Creek, a tributary to Hayfork Creek (RKM 0.6), is located just east of the town of Hyampom. The USFS has put in numerous fish habitat improvement structures in this system, but spawning habitat is limited. The upper 2.4 km section runs through a steep narrow canyon containing numerous falls ranging between 1.1 and 4.6 m in height, which may be natural barriers to anadromous fish passage. Two debris blockages in the lower 0.8 km which were believed to be complete barriers in past years, except during very high flow conditions, were removed by the California Conservation Corps (CCC) prior to this year's survey. We surveyed the lower 1.8 km of the creek on 9 April and 13 May 1992, and observed three redds and two live adult steelhead.

Pelletreau Creek. Pelletreau Creek, a tributary to the SFTR (RKM 46.7), is located west of the town of Hyampom. Only the uppermost section contains adequate holding pools, while the remainder of the creek is composed mainly of a cemented gravel substrate, unsuitable for spawning. This creek was severely damaged by the 1964 flood and is reported to have 10.7 m of gravel sitting on top of the original creek bed in this lower section. Pelletreau Creek contains a cascade barrier to anadromous fish passage 0.8 km upstream from its mouth. Although this is a perennial stream, complete water diversion during summer months leaves the lower 0.3 km section dry. We surveyed the lower 0.8 km of the creek on 21 April and 19 May 1992, and observed no redds.

Hayfork Creek Basin near Hayfork and Wildwood

We surveyed 12 tributaries to Hayfork Creek, plus parts of the mainstem of Hayfork Creek between 3 April and 29 May 1992. These surveys covered a total of 96.7 km of stream, and we observed 94 redds and counted four adult steelhead (Table 7).

Big Creek. Big Creek, a major tributary to Hayfork Creek (RKM 43.8), is located in the Hayfork Valley east of the town of Hayfork. This creek has been very productive in the past, with spawning gravel fairly abundant in the middle and upper survey sections. Pools are common, and riparian vegetation is medium to dense. The USFS and California Conservation Corps (CCC) crews have installed numerous fish habitat enhancement structures in this creek. During the winter months, the habitat is excellent. However, a property owner diverts most of the creek for watering livestock pastures during the rest of the year. The water diversions are located 2.4 km and 4.8 km upstream from the confluence with Hayfork Creek, and limit the habitat for fish in this lower section. We surveyed the lower 14.0 km of the creek between 9 April and 8 May 1992, counted 53 redds and observed one adult steelhead.

Carr Creek. Carr Creek, a tributary to Hayfork Creek (RKM 47.8), flows through part of the upper Hayfork Valley. This valley section is heavily impacted by livestock, the riparian zone is heavily grazed, and cattle crossings are numerous, causing heavy suspended sediment throughout the section. Beaver dams are numerous throughout the creek, with one causing a total fish passage barrier below the Double G Ranch. Spawning habitat is limited, pools are small (most less than 1.0 m deep) and several low water barriers exist. We surveyed the lower 4.3 km of Carr Creek on 4 May 1992 and observed no redds or adult steelhead.

Dubakella Creek. Dubakella Creek, a tributary to upper Hayfork Creek (RKM 78.4), is located south of the town of Wildwood. The upper 2.1 km section flows through a steep narrow canyon containing mostly cascades with accompanying high-velocity flows. The slope gradient levels out in the lower 1.1-km section, but sections with spawning gravel are limited. Large and small woody debris cover is abundant throughout this stream system and the riparian zone vegetation consists primarily of alders. We surveyed the lower 1.6 km of the creek on 24 April 1992 and observed no redds or adult steelhead.

East Fork of Hayfork Creek. The East Fork of Hayfork Creek, a major tributary to Hayfork Creek (RKM 58.2), is located north of the town of Wildwood. The creek is very rocky in many areas, but does contain areas of good spawning habitat, mainly where the CCC crews have built spawning gravel recruitment structures. Most of the spawning activity we noted has occurred in the latter areas. The upper 3.2-km section contains numerous pools and riffles, and areas of spawning gravel are abundant. The remaining 4.2 km, from the East Fork Road bridge to its confluence with Hayfork Creek, is a steady, declining gradient containing fast-moving water and little spawning habitat. The primary riparian zone consists of alders and willows. Secondary growth consists of cedars, firs, and pines. Most of the basin has been hydraulically mined. These operations are most evident in the main basin in the form of large tailing piles. In general, nearly all of the East Fork of Hayfork Creek drainage has been altered from its natural topography. We surveyed 8.4 km of the East Fork of Hayfork Creek on 7 April and 5 May 1992, from its confluence with Hayfork Creek to the confluence with the North Fork of the East Fork of Hayfork Creek, observing 5 redds.

Goods Creek. Goods Creek, a tributary to Hayfork Creek (RKM 45.6), is located near Wildwood. Steelhead habitat was poor due to the low flow conditions, spawning areas were limited, and creek sedimentation was heavy. A beaver dam, which caused a barrier to anadromous fish migration in 1990, had been removed. We surveyed the lower 1.4 km on 29 April 1992, and observed no redds.

Hayfork Creek. Hayfork Creek is the major tributary to the SFTR (RKM 30.1). Most of the creek above the Hayfork Valley is composed of boulders and large rubble unsuitable for spawning. Some upper reaches of Hayfork Creek contain a few areas of suitable spawning habitat, but beaver dams are creating a serious siltation and sedimentation problem resulting in cemented gravels. The section flowing through the Hayfork Valley contains a minimal amount of spawning gravel, but the habitat is poor, with little or no cover, very few pools, and warm water temperatures in the summer. We surveyed sections from the upper Hayfork Valley at the Dubakella Creek confluence to the confluence of the SFTR in those areas that were accessible and where we knew spawning habitat existed. We surveyed 31.1 km of the creek between 22 April and 29 May 1992, and counted 10 redds and two adult steelhead.

Little Creek. Little Creek, a tributary to Hayfork Creek (RKM 29.0), is located west of the town of Hayfork. The USFS has constructed habitat improvement structures in the stream, and there are areas of suitable spawning habitat. We surveyed the lower 2.3 km of the creek between 7 May and 21 May 1992, and counted four redds and one adult steelhead.

Philpot Creek. Philpot Creek, a tributary to Salt Creek (RKM 11.1), is located in the Hayfork Valley. It is composed of long stretches of bedrock substrate and contains some areas of suitable spawning gravels. A dense canopy of riparian vegetation makes walking the stream in its lower section impossible. We surveyed the lower 2.1 km of the creek on 8 April 1992 and counted no redds.

Potato Creek. Potato Creek, a tributary to East Fork of Hayfork Creek (RKM 3.1), flows through an extremely steep-sided basin in the upper reaches, which gradually moderates toward its mouth. The streambed itself is also very steep with cascades becoming frequent 2.4 km upstream from its confluence with East Fork of Hayfork Creek. Potato Creek flows in a northerly direction surrounded by moderately dense stands of douglas fir, alder, and maple. Spawning gravels are less abundant in the upper reaches, however, juvenile rearing habitat is available. We surveyed the lower 2.4 km on 8 April and 9 May 1992, and counted one redd.

Rusch Creek. Rusch Creek, a tributary to Hayfork Creek (RKM 28.5), is located west of the town of Hayfork. This is a perennial stream running through mountainous terrain with fairly dense shade canopy provided by Douglas fir, yew trees, bigleaf maple, and alder trees. The creek contains numerous fish habitat improvement structures for bank stabilization, pool scouring, and spawning gravel recruitment, but spawning habitat is very limited. The upper 3.2 km are very steep, with many cascades and no spawning habitat present. Steelhead rearing habitat was fair throughout the creek. Pools were primarily boulder- and log-formed, with pool cover provided mostly by rock and woody debris. Several complete and low-flow barriers were noted 6.0 km from the confluence. We surveyed the lower 6.0 km of the creek between 23 April and 13 May 1992, and counted no redds.

Salt Creek. Salt Creek, a major tributary to Hayfork Creek (RKM 37.0), runs through the Hayfork Valley. The lower section flows through pasture land where the creek is very open and exposed, and steelhead habitat is poor. Some pools are present but are lacking in cover, with the riparian vegetation consisting of alders and willows. The upper and middle sections contain better habitat with deeper pools and a denser canopy. Spawning habitat exists, but many of these areas are located within pastures and contain numerous cattle crossings, disturbing available spawning areas. Riparian vegetation is also heavily grazed, reducing cover and increasing sun exposure. We surveyed Salt Creek from its mouth upstream for 17.1 km between 15 April and 23 May 1992, and counted 8 redds.

Tule Creek. Tule Creek, a tributary to Hayfork Creek (RKM 35.9), flows through the Hayfork Valley. Spawning habitat in the lower section is poor, due to a clay hardpan substrate. The upper section contains many large, deep pools, and spawning habitat is more readily available. Primary riparian cover is alders and oaks. CDFG personnel removed a beaver dam located in the lower 4.0 km, which was a low-flow barrier during spring 1990. We surveyed the lower 6.0 km of the creek on 3 April and 11 May 1992, and observed thirteen redds.

Upper South Fork Trinity River Basin near Forest Glen

We surveyed five tributaries to the SFTR in the upper SFTR basin area between 1 and 29 May 1992. These surveys covered 24.5 km of stream, and we observed 145 redds and one adult steelhead (Table 7).

East Fork of the South Fork Trinity River. The East Fork of the SFTR, (RKM 118.0), is located in the Yolla Bolla region south of Highway 36. The upper 3.2-km section flows through a rugged, steep-sided canyon and is composed mostly of riffles and runs, while the lower section levels out into a low-gradient stream that is composed predominantly of cascades and large, deep pools. Spawning gravels were found throughout the surveyed section. We surveyed the lower 5.2 km on 7 May 1992, and counted 78 redds.

Plummer Creek. Plummer Creek, a tributary to the upper SFTR (RKM 70.3), flows through a steep-sided canyon. Firs and alders dominate the canopy, while aquatic and riparian vegetation provide plentiful stream cover. Spawning gravels were plentiful and located mainly at the ends of pools. Few runs were observed due to the fairly steep gradient of this section. Many of the firs growing on the canyon slopes were burned during the Friendly Fire of 1987. A slide which dammed the stream and was then blown out with high flows is located approximately 1.2 km above the confluence with the SFTR. The quality of habitat below the slide is poorer than that above; pools in the lower reach are filled in, riparian vegetation has been removed, and spawning gravels show signs of sedimentation. Our survey crew was of the opinion that the slide occurred after the fire. We surveyed the lower 3.4 km of Plummer Creek on 5 May 1992, and counted 27 redds.

Rattlesnake Creek. Rattlesnake Creek, a tributary to the SFTR (RKM 91.7), is located in the Forest Glen area. The upper and middle sections contain spawning habitat, but the lower section is composed mainly of cascades and very large pools. We surveyed the lower 10.6 km of the creek on 1 and 29 May 1992, and counted 19 redds and one adult steelhead.

Silver Creek. Silver Creek, a tributary to the SFTR (RKM 102.7), is located south of Forest Glen in a very steep-sloped, mountainous region. Spawning habitat is not abundant, but juvenile steelhead habitat is good throughout the survey reach. High-gradient cascades are prevalent in the lower section. We surveyed the lower 2.4 km of the creek on 12 May 1992, and observed four steelhead redds.

Smokey Creek. Smokey Creek, a tributary to the SFTR (RKM 104.1), is located south of Forest Glen. Smokey Creek is characterized by a wide floodplain with abundant spawning habitat and large pools. We surveyed the lower 2.9 km of the creek on 13 May 1992, and observed 17 redds.

Steelhead Redd and Spawning Habitat Evaluations

We studied 262 steelhead redds throughout the SFTR basin during the 1991-92 season to assess their associated habitat and substrate components, and to measure the physical and hydraulic characteristics of each individual redd. We found redds in four basic habitat types: pools, riffles, runs, and step-runs. Fifty percent of the total stream length in the basin we surveyed consisted of step-runs. Pools, riffles, and runs each comprised about 16% of the basin stream-lengths surveyed (Figure 5). Most (42.8%) of the redds we observed were located in step-runs. However, steelhead also seemed to have the preferred the pool-riffle interchange (riffle-crest) at the tail of pools for spawning, because while pools comprised only 15% of the available habitat (based on stream length), 36.7% of the redds observed were found in these riffle-crest areas of pools (Figure 6). Riffles and runs each accounted for about 10% of the redds observed.

The average redd area was 1.24 m^2 (Figure 7) and the average redd depth, measured 0.15 m upstream of the redd depression, was 23.1 cm (Figure 8). Average fish-nose water velocity (Figure 9) and mean water column velocity (Figure 10) were 0.39 and 0.42 m/sec, respectively.

The composition of the substrate provides information on the stream's suitability for spawning, insect production, and instream cover (Hunter 1991). Of the steelhead redds evaluated, the dominant and subdominant substrate components in about 90% of the redds consisted of medium gravel (25-50 mm), large gravel (50-75 mm) and small cobble (75-150 mm) in various combinations (Table 1), with an average embeddedness in the 20-29% category (Table 8). Embeddedness is the extent to which the larger substrate particles, such as boulders, cobbles, or gravels, are surrounded or covered by fine sediment. Current research indicates that when the substrate becomes more than 30% to 40% embedded, there is an accompanying loss of spawning habitat (Hunter 1991). However, this measure is very subjective and a more quantitative procedure would be beneficial. Another factor which may be important to steelhead in their selection of spawning sites is the availability of cover; 85% of the redds we observed were associated with boulders, small woody debris, large woody debris, and undercut banks (Table 9). Additional study and analysis of SFTR steelhead redds is needed to determine what spawning habitat components the fish are selecting. This

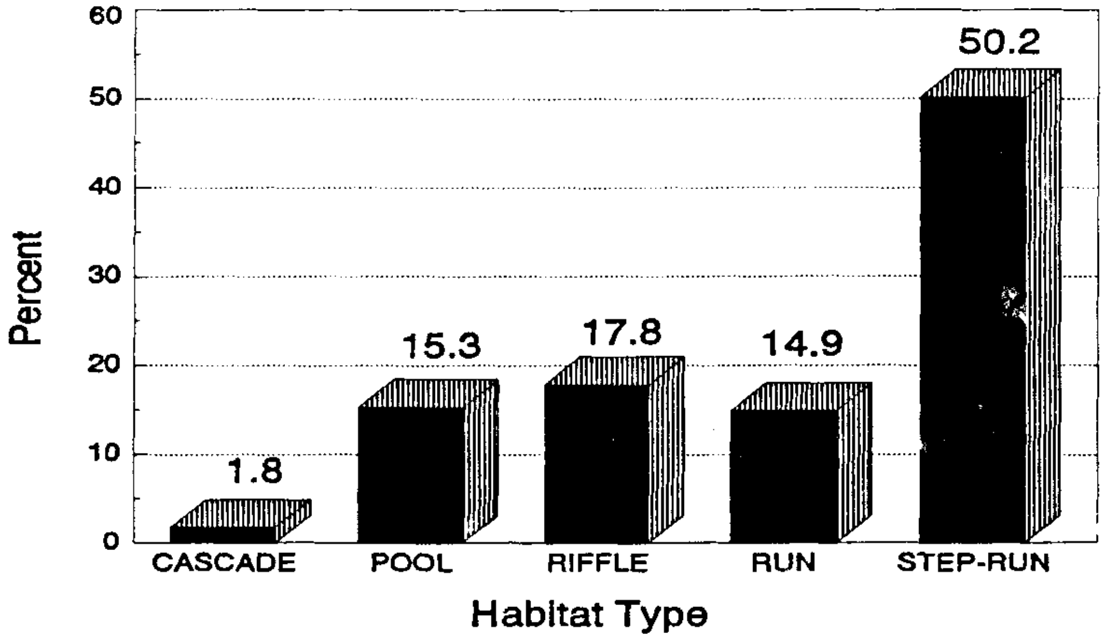

Figure 5. Distribution of the total length of streams surveyed among the habitat types observed within the South Fork Trinity River basin during the 1991-1992 season.

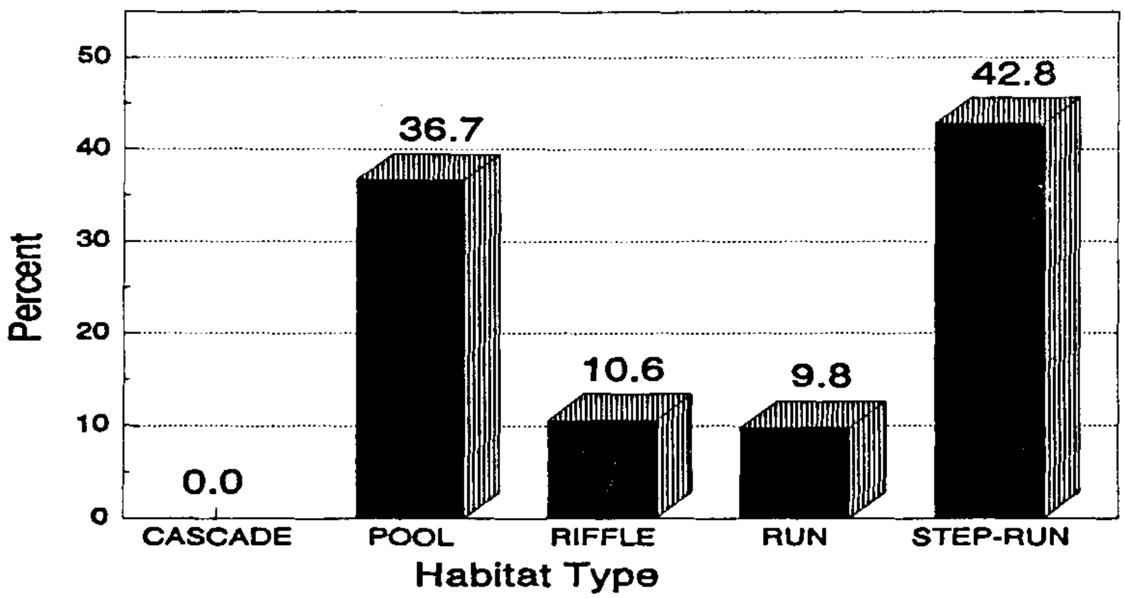

Figure 6. Relative frequency distribution of steelhead redds observed within habitat types in the South Fork Trinity River basin during the 1991-1992 season.

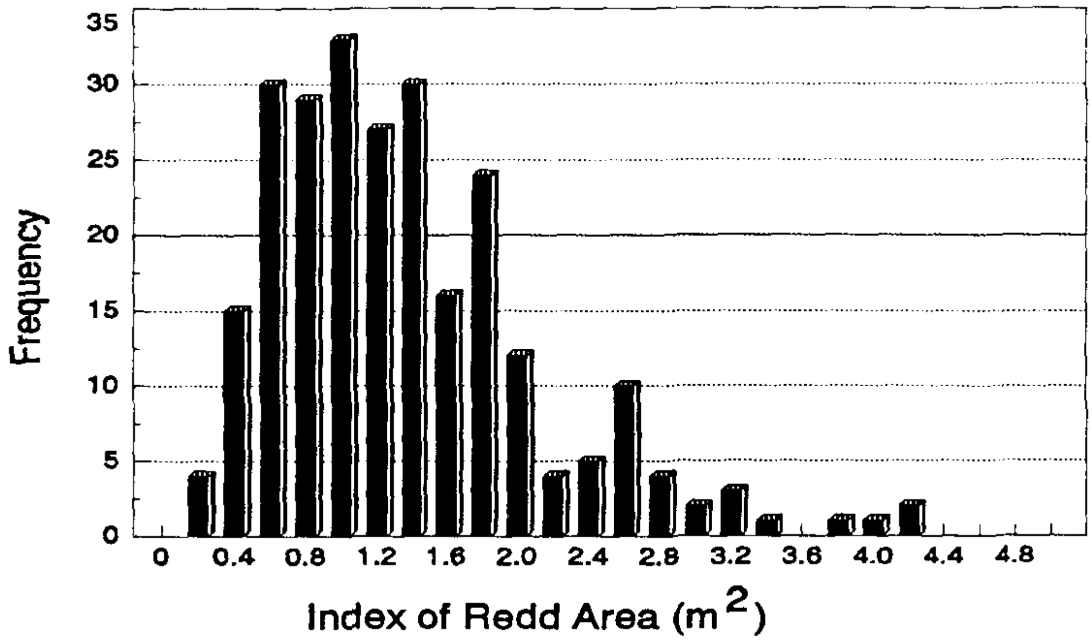

Figure 7. Frequency distribution of the index of surface area for 253 steelhead redds examined within the South Fork Trinity River basin during the 1991-1992 season.

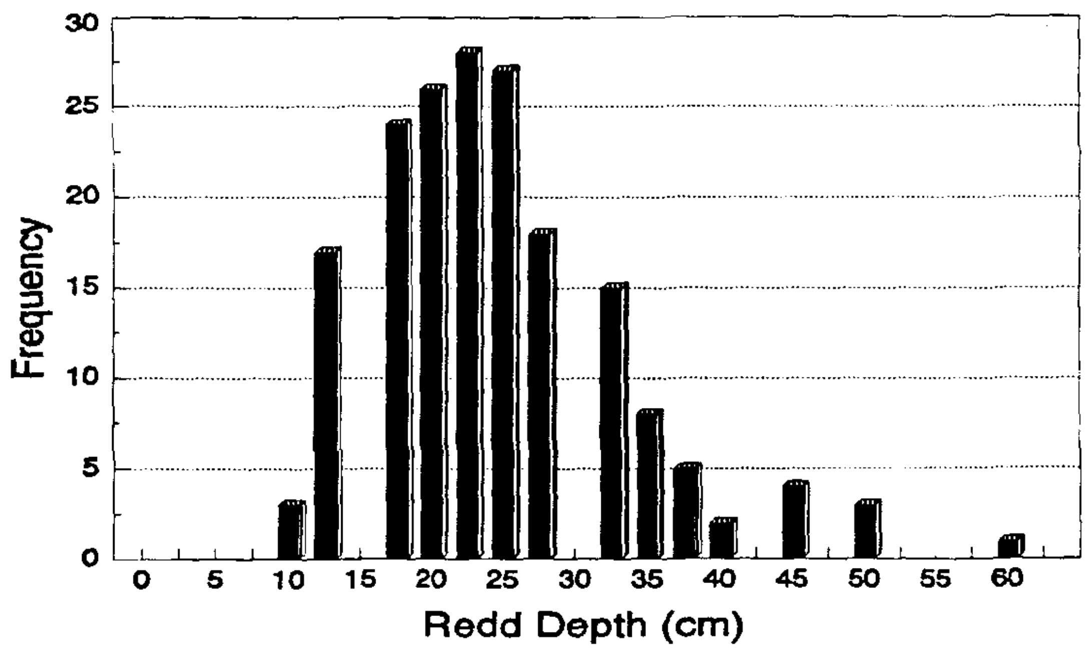

Figure 8. Frequency distribution of water depths measured 0.15 m upstream of 181 steelhead redds observed within the South Fork Trinity River basin during the 1991-1992 season.

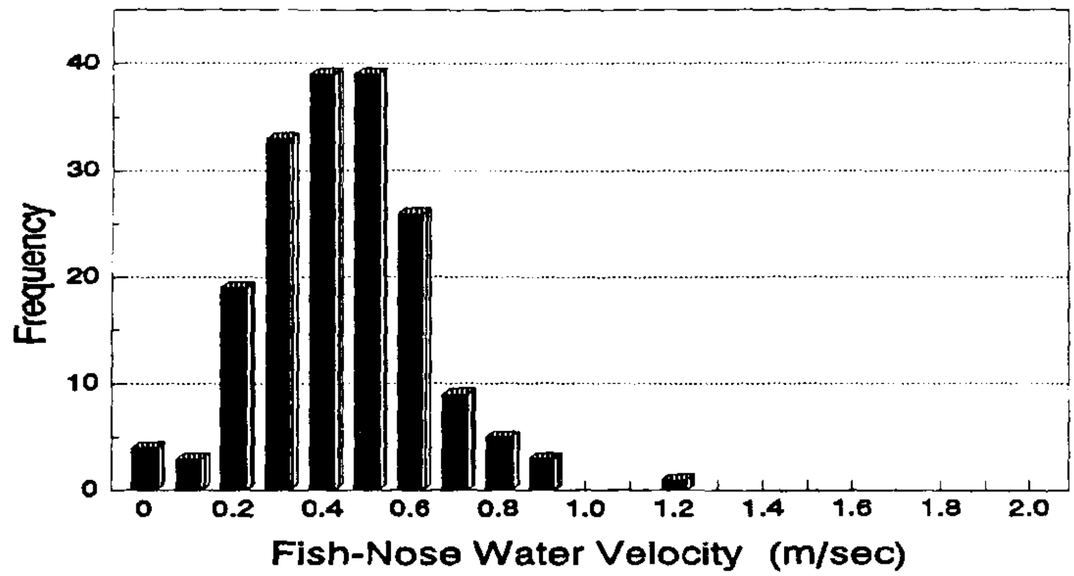

Figure 9. Frequency distribution of the fish-nose water velocity observed at 181 steelhead redds within the South Fork Trinity River basin during 1991-1992 season.

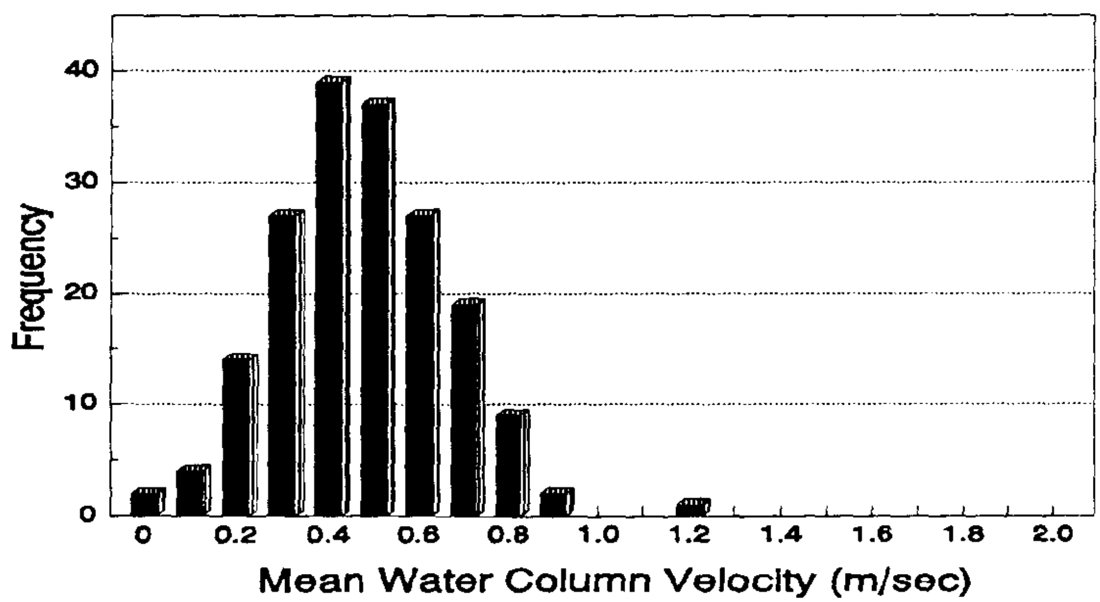

Figure 10. Frequency distribution of the mean water column velocity observed at 181 steelhead redds within the South Fork Trinity River basin during the 1991-1992 season.

Table 8. Dominant and subdominant substrate composition and embeddedness of substrate components from steelhead redds observed in the South Fork Trinity River basin during the 1991-92 season.

		Dominant		Subdominant	
Code	Substrate	Observed	Percent	Observed	Percent
0	Fines	1	0.4%	1	0.4%
1	Small gravel	11	4.3%	6	2.4%
2	Medium gravel	61	24.1%	75	29.6%
3	Large gravel	142	56.1%	86	34.0%
4	Small cobble	36	14.2%	67	26.5%
5	Medium cobble	0	0.0%	9	3.6%
6	Large cobble	2	0.8%	7	2.8%
7	Small boulder	0	0.0%	2	0.8%
8	Large boulder	0	0.0%	0	0.0%
9	Bedrock	0	0.0%	0	0.0%
	Totals:	253	100.0%	253	100.0%

Code	Level of embeddedness	Number of redds observed	Percent of total
0	0% - 9%	25	9.9%
1	10% - 19%	62	24.5%
2	20% - 29%	67	26.5%
3	30% - 39%	69	27.3%
4	40% - 49%	21	8.3%
5	50% - 59%	8	3.2%
6	60% - 69%	1	0.4%
7	70% - 79%	0	0.0%
8	80% - 89%	0	0.0%
9	90% - 100%	0	0.0%
	Totals:	253	100.0%

Table 9. Dominant and subdominant cover habitat or vegetation associated with steelhead redd sites examined in the South Fork Trinity River basin during the 1991-1992 season.

		Dominant		Subdominant	
Code	Cover type	Observed	Percent	Observed	Percent
0	No cover	11	4.3%	56	22.1%
1	Cobble	2	0.8%	6	2.4%
2	Boulders	67	26.5%	54	21.3%
3	Small woody debris	41	16.2%	41	16.2%
4	Large woody debris	61	24.1%	33	13.0%
5	Undercut bank	45	17.8%	19	7.5%
6	Overhanging vegetation	14	5.5%	38	15.0%
7	Aquatic vegetation	12	4.7%	6	2.4%
	Totals:	253	100.0%	253	100.0%

Quality of cover	Observed	Percent
Poor	58	22.9%
Fair	93	36.8%
Good	82	32.4%
Excellent	20	7.9%
Totals:	253	100.0%

information, together with stream-by-stream assessment of habitat condition and spawning activity, is needed to help determine the basin's capacity to support steelhead spawning and production. This information will also help to direct and evaluate habitat restoration efforts.

Adult Steelhead Recovery at Emigrant Weirs

Project personnel operated two Alaskan-style weirs during the season to recover post-spawning, emigrant adult steelhead. The Hayfork Creek Weir was operated for 77 days, from 28 March through 24 June 1992 (Figure 11). The Forest Glen Weir operated

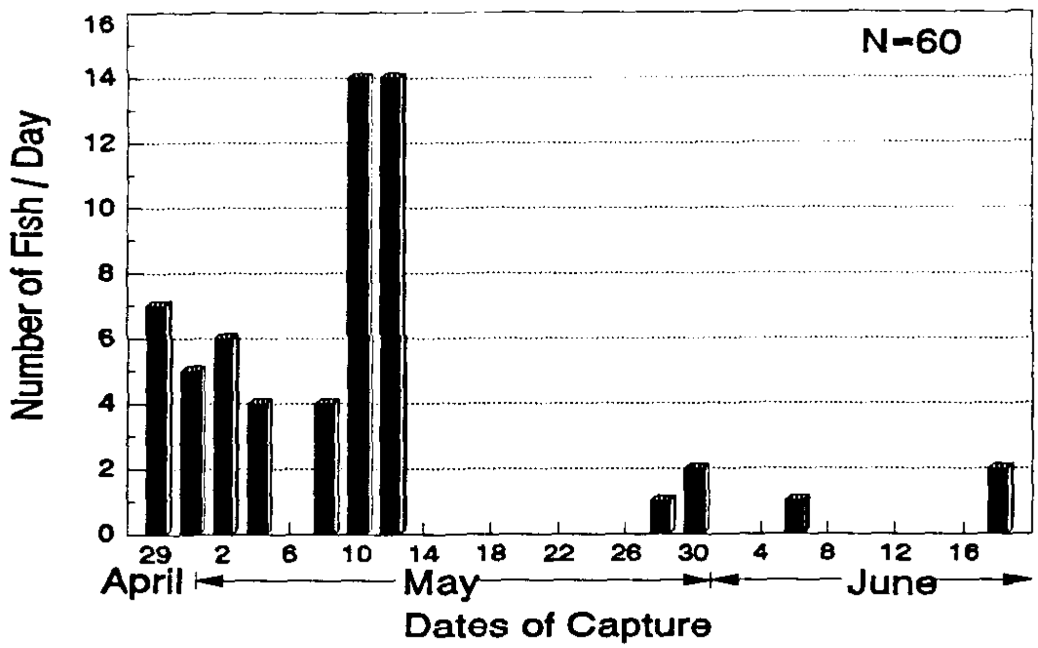

Figure 11. Daily catches of post-spawning (emigrant) fall- and winter-run adult steelhead at the Hayfork Creek Weir in the South Fork Trinity River basin from 28 March through 24 June 1992.

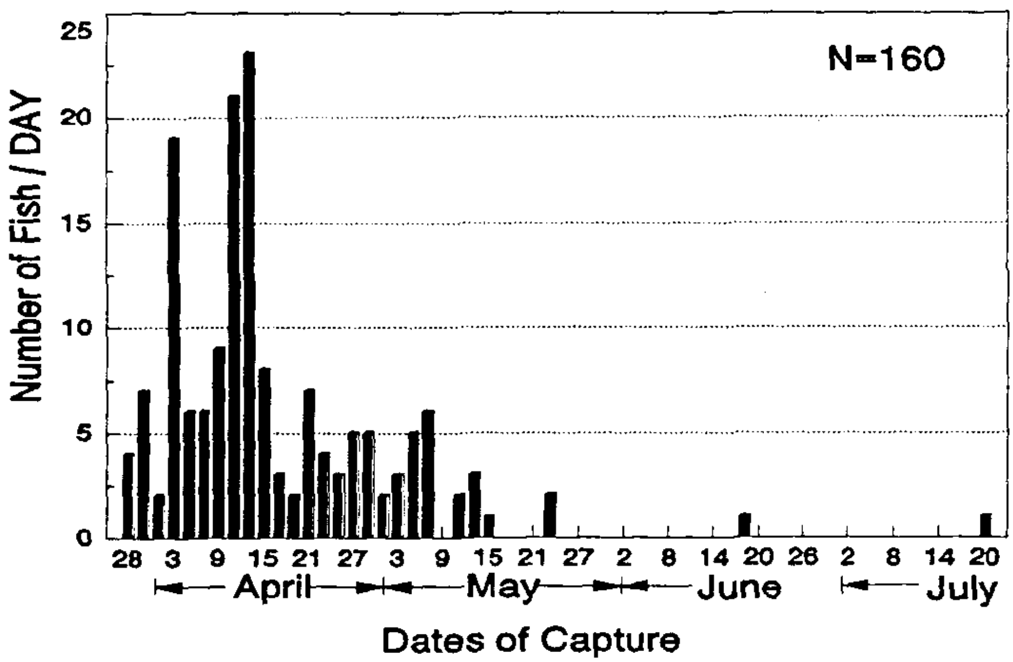

Figure 12. Daily catches of post-spawning (emigrant) fall- and winter-run adult steelhead at the Forest Glen Weir in the South Fork Trinity River basin from 27 March through 3 August 1992.

for 128 days, from 27 March through 3 August 1992 (Figure 12).

In addition to our two weirs, CDFG's Trinity Fisheries Investigations Project personnel operated the Gates Road Weir (weir-panel-style) downstream from our two weirs on the SFTR at RKM 31.7 for 70 days, from 28 April through 7 July 1992 (Figure 13).

We captured 251 emigrant fall- and winter-run steelhead in the three weirs: 60 in the Hayfork Creek Weir, 160 in the Forest Glen Weir, and 31 in the Gates Road Weir. Twenty of these fish had been tagged at the Sandy Bar Weir, and the remaining 231 were unmarked. Of the 251 fish trapped at the three emigrant weirs, 122 (49%) were male, 127 (51%) were female, and 2 were of unknown sex. Mean FL for males was 63.4 cm, (range: 45-77 cm), and 61.5 cm for females (range: 41-77). Mean FL for all fish was 62.3 cm (range: 41-77 cm) (Figure 14).

Eighteen immigrant spring-run steelhead were captured in the immigrant traps (which were a part of the emigrant weirs): none in the Hayfork Creek Weir, three in the Forest Glen Weir, and 15 in the Gates Road Weir (Figure 15). Five fish were male and 13 were female. Mean FL for males was 57.2 cm (range: 51-64 cm) and 58.2 cm for females (range: 49-67 cm). Mean FL for all fish was 57.9 cm (range: 49-67 cm) (Figure 16).

Adult Steelhead Escapement Estimate

Of the 493 fall- and winter-run steelhead tagged, fin-clipped, and released at the Sandy Bar Weir between 5 September 1991 and 11 February 1992, only 38 were recovered: 18 in the creel surveys, 11 at the Hayfork Creek Weir, nine at the Forest Glen Weir, and none at the Gates Road Weir.

Two hundred fifty-seven unmarked steelhead were also recovered: 26 through creel surveys, 49 at the Hayfork Creek Weir, 151 at the Forest Glen Weir, 31 and at the Gates Road Weir. Based upon these numbers, an estimated 3,741 adult steelhead (95% Poisson C.I.= 2,749-5,260) escaped into the SFTR basin during the 1991-1992 season.

Although the tagging weirs were an effective method of assessing steelhead run-size and run-timing this year, they cannot always be relied on. This was the sixth dry water-year in a row, but unpredictable weather and high river flows make weir operation in the winter difficult or impossible during most normal and wet water-years. Since our weirs cannot be operated under high-flow conditions, we may not be able to monitor the entire run during normal and wet water-years; therefore, we need to determine if alternative methods are available to gather this type of information.

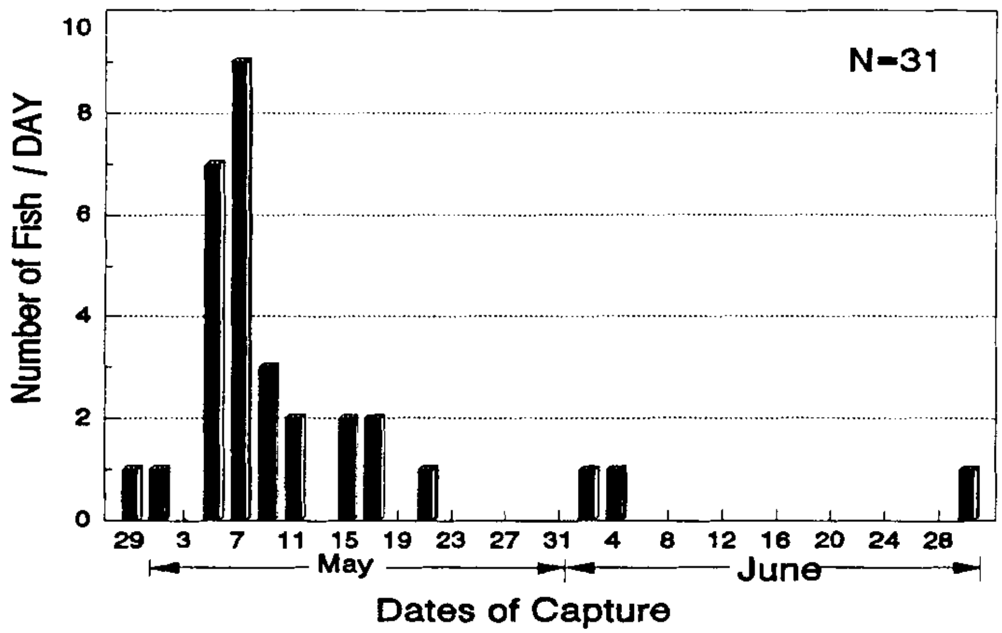

Figure 13. Daily catches of post-spawning (emigrant) fall- and winter-run adult steelhead at the Gates Road Weir from 28 April through 7 July 1992.

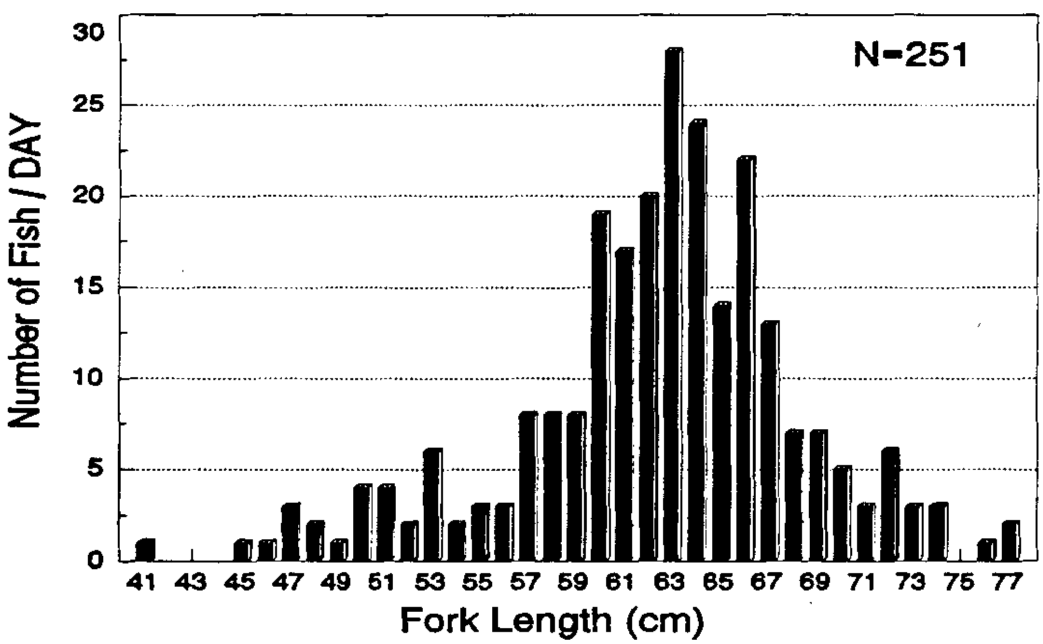

Figure 14. Length frequency distribution of post-spawning (emigrant) fall- and winter-run adult steelhead trapped at the Hayfork Creek, Forest Glen and Gates Road weirs in the South Fork Trinity River basin from 27 March through 3 August 1992.

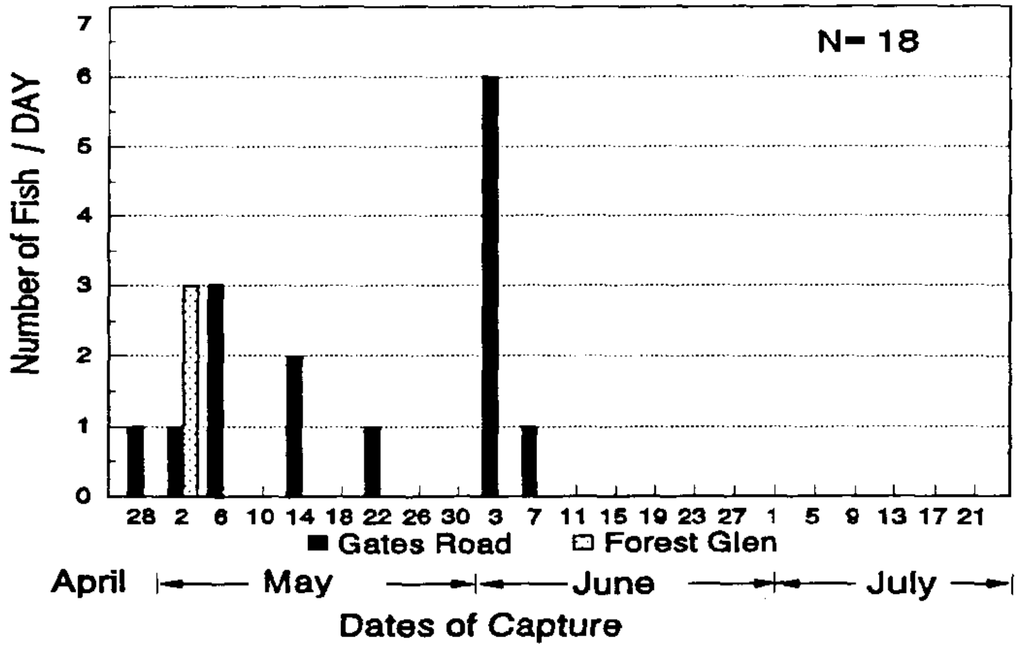

Figure 15. Daily catches of immigrant, spring-run adult steelhead at the Forest Glen and the Gates Road weirs in the South Fork Trinity River from 27 March through 3 August 1992.

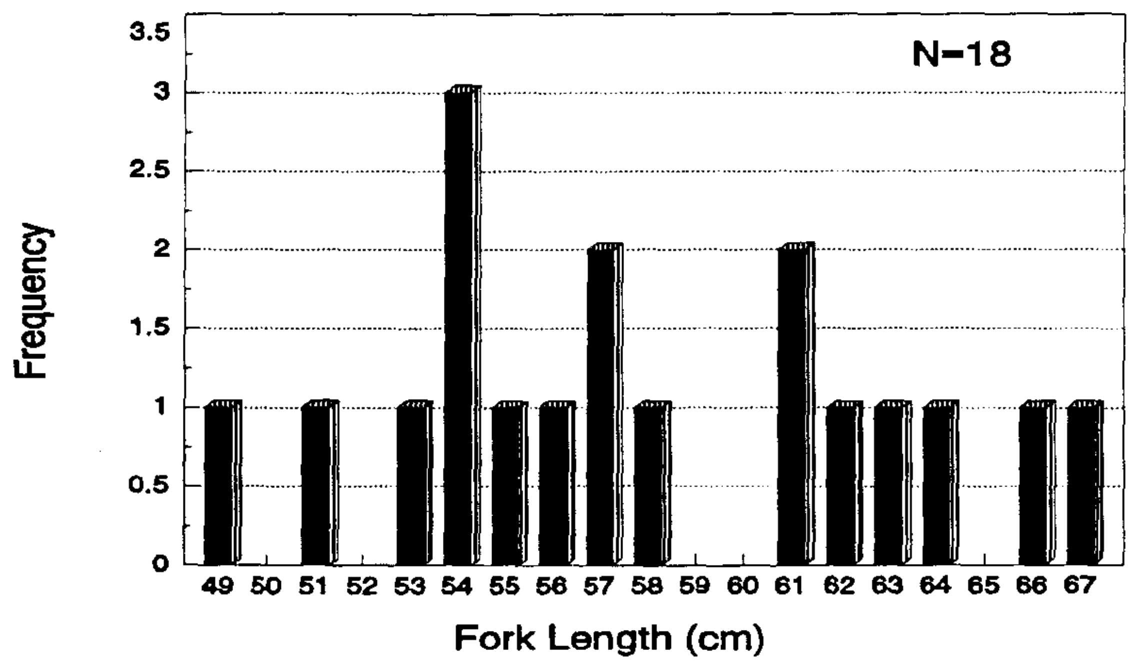

Figure 16. Length frequency distribution of immigrant, spring-run adult steelhead at the Forest Glen and Gates Road weirs from 27 March through 3 August 1992.

Juvenile Steelhead Emigration Studies

From 1 July 1991 through 30 June 1992, we captured 8,904 Age 0+, 114 Age 1+, and 5 Age 2+ steelhead, and 241 juvenile chinook salmon at the Hayfork Creek and SFTR juvenile out-migrant trapping sites (Figure 1, Table 10). The peak emigration at these sites of Age 0+ steelhead occurred during May and June 1992, while peak emigration of Age 0+ chinook salmon occurred during May 1992. Age 0+ steelhead were more abundant in Hayfork Creek and chinook salmon were more abundant in the SFTR (Table 10). The mean FL of Age 0+ steelhead from the 1991 brood year (BY) increased from 51 mm in July 1991 to 73 mm by December 1991.

The mean FL of weekly samples of Age 0+ steelhead from the 1992 BY increased from 30 mm during early April 1992 to 54 mm by June 1992 (Table 11). Mean FL's of weekly samples of Age 1+ steelhead ranged from 91 to 129 mm, and Age 2+ steelhead ranged from 152 to 214 mm (Table 11). Mean FL's of weekly samples of juvenile chinook salmon from the 1992 BY ranged from 56 to 76 mm (Table 11).

Habitat Use by Juvenile Steelhead

Juvenile steelhead utilization of the five basic habitat types we used for habitat typing, was evaluated in Eltapom Creek during fall 1991 (10-13 September) and spring 1992 (8-9 June). During fall 1991 we identified 70 individual habitat units consisting of: 2.9% cascades, 40.0% pools, 34.3% riffles, 11.4% runs, and 11.4% step-runs. We selected 24 of these units to sample: 1 cascade, 9 pools, 8 riffles, 3 runs, and 3 step-runs. During spring 1992 we identified 71 individual units: 2.8% cascades, 38.0% pools, 15.5% riffles, 14.1% runs and 29.6% step-runs. We selected 26 of these units to sample: 1 cascade, 10 pools, 4 riffles, 4 runs, and 7 step-runs. During spring 1992 many of the riffles observed the previous fall were reclassified as step-runs. The average depth, from all habitat units combined, increased from 23 cm in the fall to 30 cm in the spring, and average water velocity increased from 0.20 m/sec to 0.95 m/sec. The mean water and air temperatures as measured by a hand-held thermometer during the fall survey were 15.0° C and 17.3° C, respectively. During the spring mean water and air temperatures were 15.4° C and 23.7° C, respectively. During the fall 1991 survey, we estimated the standing crop of juvenile steelhead at 3,055 fish composed of: 86% Age 0+, 11% Age 1+, and 3% Age 2+ fish (Table 12). The highest densities of Age 0+ fish were observed in riffles (0.79 fish/m^2) and cascades (0.62 fish/m^2), followed by step-runs and pools (0.39 and 0.30 fish/m^2, respectively). The highest densities of Age 1+ fish were in cascades and pools (0.10 and 0.09 fish/m^2, respectively), followed by riffles and step-runs (0.06 and 0.05 fish/m^2, respectively), with the lowest densities observed in runs (0.02

Table 10. South Fork Trinity River basin juvenile salmonid trapping summary for the 1991-92 season.

			Numbers Trapped							
			Hayfork Creek				South Fork Trinity River			
			Steelhead			Chinook	Steelhead			Chinook
Year	Dates	Julian week	Age 0+	Age 1+	Age 2+	Age 0+	Age 0+	Age 1+	Age 2+	Age 0+
1991	07/02 - 07/08	27	73	2	0	0	11	0	0	1
	07/09 - 07/15	28	4	0	0	0	10	0	0	0
	07/16 - 07/22	29	0	0	0	0	3	1	0	0
	07/23 - 07/29	30	-	-	-	-	-	-	-	-
	07/30 - 08/05	31	-	-	-	-	-	-	-	-
	08/06 - 08/12	32	-	-	-	-	-	-	-	-
	08/13 - 08/19	33	-	-	-	-	-	-	-	-
	08/20 - 08/26	34	-	-	-	-	-	-	-	-
	08/27 - 09/02	35	-	-	-	-	-	-	-	-
	09/03 - 09/09	36	-	-	-	-	-	-	-	-
	09/10 - 09/16	37	-	-	-	-	-	-	-	-
	09/17 - 09/23	38	-	-	-	-	-	-	-	-
	09/24 - 09/30	39	-	-	-	-	-	-	-	-
	10/01 - 10/07	40	-	-	-	-	-	-	-	-
	10/08 - 10/14	41	-	-	-	-	-	-	-	-
	10/15 - 10/21	42	-	-	-	-	-	-	-	-
	10/22 - 10/28	43	-	-	-	-	-	-	-	-
	10/29 - 11/04	44	-	-	-	-	-	-	-	-
	11/05 - 11/11	45	-	-	-	-	-	-	-	-
	11/12 - 11/18	46	-	-	-	-	-	-	-	-
	11/19 - 11/25	47	1	1	1	0	1	0	1	1
	11/26 - 12/02	48	0	0	0	0	0	0	0	0
	12/03 - 12/09	49	1	2	0	0	2	1	0	0
	12/10 - 12/16	50	-	-	-	-	-	-	-	-
	12/17 - 12/23	51	0	0	0	0	2	0	0	0
	12/24 - 12/31	52	0	0	0	0	5	1	0	0

(continued)

Table 10. South Fork Trinity River basin juvenile salmonid trapping summary for the 1991-92 season (continued).

			Numbers Trapped							
			Hayfork Creek				South Fork Trinity River			
			Steelhead			Chinook	Steelhead			Chinook
Year	Dates	Julian week	Age 0+	Age 1+	Age 2+	Age 0+	Age 0+	Age 1+	Age 2+	Age 0+
1992	01/01 - 01/07	1	-	-	-	-	-	-	-	-
	01/08 - 01/14	2	-	-	-	-	-	-	-	-
	01/15 - 01/21	3	0	0	0	0	0	1	0	2
	01/22 - 01/28	4	0	0	1	0	1	1	0	0
	01/29 - 02/04	5	3	0	0	0	3	2	0	1
	02/05 - 02/11	6	-	-	-	-	-	-	-	-
	02/12 - 02/18	7	-	-	-	-	-	-	-	-
	02/19 - 02/25	8	-	-	-	-	-	-	-	-
	02/26 - 03/04	9	0	0	0	0	0	0	0	0
	03/05 - 03/11	10	1	0	0	0	0	2	0	1
	03/12 - 03/18	11	-	-	-	-	-	-	-	-
	03/19 - 03/25	12	-	-	-	-	-	-	-	-
	03/26 - 04/01	13	0	13	0	0	0	15	1	1
	04/02 - 04/08	14	27	9	0	0	0	14	1	15
	04/09 - 04/15	15	-	-	-	-	-	-	-	-
	04/16 - 04/22	16	-	-	-	-	-	-	-	-
	04/23 - 04/29	17	180	1	0	0	27	22	0	17
	04/30 - 05/06	18	1109	0	0	1	44	21	0	27
	05/07 - 05/13	19	1760	0	0	0	196	1	0	58
	05/14 - 05/20	20	306	0	0	0	116	2	0	14
	05/21 - 05/27	21	792	0	0	0	447	0	0	71
	05/28 - 06/03	22	1302	0	0	0	311	0	0	17
	06/04 - 06/10	23	1022	1	0	2	399	0	0	9
	06/11 - 06/17	24	312	1	0	1	154	0	0	3
	06/18 - 06/24	25	166	0	0	0	54	0	0	0
	06/25 - 07/01	26	36	0	0	0	23	0	0	0
		Totals:	7095	30	2	4	1809	84	3	237

Table 11. Fork lengths of bi-weekly samples of juvenile steelhead and chinook salmon captured within the South Fork Trinity River basin during the 1991-92 season.

			Steelhead												Chinook Salmon			
			Age 0+				Age 1+				Age 2+							
			Fork length (mm)				Fork length (mm)				Fork length (mm)				Fork length (mm)			
Year	Dates	Julian weeks	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max
1991	07/02 - 07/15	27-28	95	53	43	79	3	119	105	130	0	-	-	-	1	85	85	85
	07/16 - 07/29	29-30	3	51	44	59	1	123	123	123	0	-	-	-	0	-	-	-
	07/30 - 08/12 a/	31-32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	08/13 - 08/26 a/	33-34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	08/27 - 09/09 a/	35-36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	09/10 - 09/23 a/	37-38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	09/24 - 10/07 a/	39-40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10/08 - 10/21 a/	41-42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10/22 - 11/04 a/	43-44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11/05 - 11/18 a/	45-46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11/19 - 12/02	47-48	2	73	72	73	1	106	106	106	2	214	193	235	1	94	94	94
	12/03 - 12/16	49-50	4	71	56	82	2	113	93	132	0	-	-	-	0	-	-	-
	12/17 - 12/31	51-52	7	63	51	70	1	122	122	122	0	-	-	-	0	-	-	-
1992	01/01 - 01/14 a/	01-02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	01/15 - 01/28	03-04	1	55	55	55	2	108	86	129	1	168	168	168	2	100	98	102
	01/29 - 02/11	05-06	6	76	65	85	1	91	91	91	0	-	-	-	1	90	90	90
	02/12 - 02/25 a/	07-08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	02/26 - 03/11	09-10	1	80	80	80	2	94	90	98	0	-	-	-	1	90	90	90
	03/12 - 03/25 a/	11-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	03/26 - 04/08	13-14	26	30	29	31	51	96	75	138	2	155	145	164	16	56	47	89
	04/09 - 04/22 a/	15-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	04/23 - 05/06	17-18	220	32	25	47	44	99	78	134	0	-	-	-	45	68	47	81
	05/07 - 05/20	19-20	381	38	24	63	1	129	129	129	0	-	-	-	54	73	60	90
	05/21 - 06/03	21-22	400	48	27	70	0	-	-	-	0	-	-	-	82	74	57	97
	06/04 - 06/17	23-24	350	54	35	79	1	124	124	124	1	152	152	152	15	76	66	97
	06/18 - 07/01	25-26	173	53	27	73	0	-	-	-	0	-	-	-	0	-	-	-

a/ = Not sampled.

Table 12. Juvenile steelhead habitat utilization observed in Eltapom Creek during fall 1991 (10-13 September).

Habitat types	Number of habitat units	Total available area (m^2)	Area sampled (m^2)	Age	No. of fish	Mean density (Fish/m^2)	Estimated fish per available area
Cascades	2	75.25	67.82	0+	42	0.62	47
				1+	7	0.10	8
				2+	1	0.01	1
				All	50	0.74	55
Pools	28	1,720.40	476.82	0+	144	0.30	520
				1+	42	0.09	152
				2+	18	0.04	65
				All	204	0.43	736
Riffles	24	2,007.63	604.52	0+	475	0.79	1,577
				1+	34	0.06	113
				2+	6	0.01	20
				All	515	0.85	1,710
Runs	8	768.59	352.10	0+	67	0.19	146
				1+	6	0.02	13
				2+	0	0.00	0
				All	73	0.21	159
Step-runs	8	884.63	442.41	0+	171	0.39	342
				1+	20	0.05	40
				2+	6	0.01	12
				All	197	0.45	394
Total:	70	5,456.50	1,943.67	0+	899		2,632
				1+	109		325
				2+	31		98
				All	1,039		3,055

fish/m^2). Age 2+ fish were most prominent in pools (0.04 fish/m^2), but were also found in riffles, cascades, and step-runs (0.01 fish/m^2 each). Age 2+ fish were not observed in runs during fall 1991.

During the spring 1992 survey we estimated the standing crop of juvenile steelhead at 4,718 fish composed of: 88% Age 0+, 11% Age 1+, and 1% Age 2+ fish (Table 13). The densities of Age 0+ fish were relatively high in all habitat types (0.56 - 0.76 fish/m^2) except in cascades, where observed density was about 1/3 that of the others (0.20 fish/m^2 each). Densities of Age 1+ fish were about equal in all habitat types (0.08 - 0.10 fish/m^2 each), except in runs, where density was about 1/2 that of the others (0.05 fish/m^2 each). Age 2+ fish were essentially only observed in pools and step-runs (0.01 fish/m^2 each), but one fish was found in a run (0.002 fish/m^2).

Steelhead Life-history Patterns

No juvenile steelhead scales were analyzed this year because of a lack of time and trained personnel.

Table 13. Juvenile steelhead habitat utilization observed in Eltapom Creek during spring 1992 (8-9 June).

Habitat types	Number of habitat units	Total available area (m^2)	Area sampled (m^2)	Age	No. of fish	Mean density (Fish/m^2)	Estimated fish per available area
Cascades	2	121.89	114.46	0+	23	0.20	24
				1+	12	0.10	13
				2+	0	0.00	0
				All	35	0.31	37
Pools	27	1,995.61	806.63	0+	504	0.62	1,247
				1+	73	0.09	181
				2+	8	0.01	20
				All	585	0.73	1,447
Riffles	12	1,134.82	446.37	0+	251	0.56	638
				1+	39	0.09	99
				2+	0	0.00	0
				All	290	0.65	737
Runs	10	1,016.55	511.88	0+	341	0.67	677
				1+	24	0.05	48
				2+	1	0.00	2
				All	366	0.72	727
Step-runs	21	2,070.22	477.48	0+	365	0.76	1,583
				1+	40	0.08	173
				2+	3	0.01	13
				All	408	0.85	1,769
Total:	71	6,256.79	2,356.81	0+	1,484		4,169
				1+	188		514
				2+	12		35
				All	1,684		4,718

RECOMMENDATIONS

1. Creel surveys in the SFTR basin should continue during the 1992-93 Fiscal Year (FY) to document angler use. Additional information is needed on harvest rates, especially during low-flow conditions.

2. Adult steelhead spawner surveys should begin by 15 February weather permitting. Habitat types should be quantified during these surveys to document spawning area available to steelhead.

3. Steelhead spawning habitat studies, conducted in conjunction with the spawner surveys, should be continued throughout the basin. The quantification of available habitat will help us identify preference criteria.

4. The operation of the Alaskan weirs in Hayfork Creek and in the SFTR at Forest Glen to capture emigrant, post-spawning steelhead was effective and should continue.

5. Juvenile steelhead habitat utilization studies should continue. Other seasons should also be surveyed for comparisons with results from spring and fall. Eltapom Creek is one of the streams in the basin that is in fairly good condition with respect to sediment loads. Our habitat utilization studies should be extended to other streams that are in marginal and poor condition in order to assess their impacts on juvenile rearing.

6. Steelhead life history studies through Optical Pattern Recognition System scale analysis should continue with emphasis on the juvenile freshwater phase to assess the juvenile age structure in the basin and to determine if distinctive scale circuli patterns exist. Later these should be compared to freshwater portions on adult scales to better understand the total life history patterns of steelhead within the SFTR basin.

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LITERATURE CITED

Chapman, D. G. 1948. A mathematical study of confidence limits of salmon populations calculated from sample tag ratios. Int. Pac. Sal. Fish. Comm. Bull. 2, p. 69-85.

Hampton, M. 1988. Development of habitat preference criteria for anadromous salmonids of the Trinity River. Available from U.S. Dept. Int., Fish and Wildl. Serv., Div. Ecol. Serv., Sacramento, California. 93 p.

Hankin, D. G. 1986. Sampling designs for estimating the total number of fish in small streams. Res. Pap. PNW-360. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Or. 33 p.

Hunter, C. J. 1991. Better Trout Habitat: A Guide to Stream Restoration and Management. Island Press, Washington, D.C. 320 p.

Kesner, W. D. and R. A. Barnhart. 1972. Characteristics of the fall-run steelhead (Salmo gairdnerii) of the Klamath River system with emphasis on the half-pounder. Calif. Fish and Game. 58(3):204-220.

Miller, E. E. 1975. A steelhead spawning survey of the tributaries of the upper Trinity River and upper Hayfork Creek drainages, 1973. Calif. Dept. of Fish and Game, Anad. Fish. Admin. Rep. No. 75-5. 8 p.

Mills, T. J. and C. E. Wilson. 1991. Life history, distribution, run size, and angler harvest of steelhead in the South Fork Trinity River basin. Chapter III. Job III. p. 34-51. In: Carpenter, R. and K. Urquhart (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1988-1989 Season. 51 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Price, D. G. 1982. A Fishery Resource Sampling Methodology for Small Streams. Pacific Gas and Electric Company, Department of Engineering Research, Rep. 420-81.141. 49 p.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board Can. #191. 382 p.

Rogers, D. W. 1972. A steelhead spawning survey of the tributaries of the upper Trinity River and upper Hayfork Creek drainages, 1971. Calif. Dept. of Fish and Game, Anad. Fish. Admin. Rep. No. 72-12. 6 p.

Rogers, D. W. 1973. A steelhead spawning survey of the tributaries of the upper Trinity River and upper Hayfork Creek drainages, 1972. Calif. Dept. of Fish and Game, Anad. Fish. Admin. Rep. No. 73-5a. 8 p.

Wilson, C. E. and B. W. Collins. 1992. Life history, distribution, run size, and angler harvest of steelhead in the South Fork Trinity River basin. Chapter III. Job III. p. 50-92. In: Urquhart, K. and R. Carpenter (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1990-1991 Season. December 1992. 186 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Wilson, C. E. and T. J. Mills. 1992. Life history, distribution, run size, and angler harvest of steelhead in the South Fork Trinity River basin. Chapter III. Job III. p. 44-81. In: Urquhart, K. (ed.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1989-1990 Season. June 1992. 140 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Appendix 1. List of Julian weeks and their calendar date equivalents.

Julian week	Calendar dates Start	Calendar dates Finish	Julian week	Calendar dates Start	Calendar dates Finish
1	01-Jan	07-Jan	27	02-Jul	08-Jul
2	08-Jan	14-Jan	28	09-Jul	15-Jul
3	15-Jan	21-Jan	29	16-Jul	22-Jul
4	22-Jan	28-Jan	30	23-Jul	29-Jul
5	29-Jan	04-Feb	31	30-Jul	05-Aug
6	05-Feb	11-Feb	32	06-Aug	12-Aug
7	12-Feb	18-Feb	33	13-Aug	19-Aug
8	19-Feb	25-Feb	34	20-Aug	26-Aug
9 a/	26-Feb	04-Mar	35	27-Aug	02-Sep
10	05-Mar	11-Mar	36	03-Sep	09-Sep
11	12-Mar	18-Mar	37	10-Sep	16-Sep
12	19-Mar	25-Mar	38	17-Sep	23-Sep
13	26-Mar	01-Apr	39	24-Sep	30-Sep
14	02-Apr	08-Apr	40	01-Oct	07-Oct
15	09-Apr	15-Apr	41	08-Oct	14-Oct
16	16-Apr	22-Apr	42	15-Oct	21-Oct
17	23-Apr	29-Apr	43	22-Oct	28-Oct
18	30-Apr	06-May	44	29-Oct	04-Nov
19	07-May	13-May	45	05-Nov	11-Nov
20	14-May	20-May	46	12-Nov	18-Nov
21	21-May	27-May	47	19-Nov	25-Nov
22	28-May	03-Jun	48	26-Nov	02-Dec
23	04-Jun	10-Jun	49	03-Dec	09-Dec
24	11-Jun	17-Jun	50	10-Dec	16-Dec
25	18-Jun	24-Jun	51	17-Dec	23-Dec
26	25-Jun	01-Jul	52 b/	24-Dec	31-Dec

a/ Eight-day week in each year divisible by 4.
b/ Eight-day week every year.

Appendix 2. Travel times of steelhead caught at the Sandy Bar Weir in the South Fork Trinity River which had been previously tagged at the Willow Creek Weir in the Trinity River during the 1991-92 season.

Date tagged at Willow Creek Weir	Date recaptured at Sandy Bar Weir	Travel days between weirs
23 August 1991	8 October 1991	46
23 August 1991	10 October 1991	48
24 October 1991	26 October 1991	2
23 August 1991	26 October 1991	64
16 August 1991	26 October 1991	71
22 August 1991	26 October 1991	65
28 August 1991	26 October 1991	59
2 October 1991	26 October 1991	24
10 October 1991	26 October 1991	16
30 October 1991	31 October 1991	1
30 October 1991	6 November 1991	7
30 October 1991	18 November 1991	19
29 October 1991	18 November 1991	20
15 November 1991	19 November 1991	4
20 November 1991	21 November 1991	1
18 October 1991	21 November 1991	34
20 November 1991		15
29 November 1991		9
10 December 1991		18
		7.5

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ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991-92 SEASON

CHAPTER IV

JOB IV
ANNUAL RUN-SIZE, HARVEST, AND SPAWNER ESCAPEMENT ESTIMATES FOR TRINITY RIVER BASIN CHINOOK AND COHO SALMON AND STEELHEAD

by

Michael Lau, Bill Heubach and Ed Miller

ABSTRACT

The California Department of Fish and Game's Trinity River Project conducted tag and recapture operations from May 1991 through December 1991 to obtain chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), and fall-run steelhead (O. mykiss) run-size, in-river harvest, and spawner escapement estimates in the Trinity River basin. We placed weirs in the Trinity River near the towns of Junction City and Willow Creek, and trapped 372 spring-run and 1,443 fall-run chinook salmon, 826 coho salmon, and 741 fall-run steelhead.

Based on tagged fish recovered at Trinity River Hatchery and on the return of reward tags by anglers, we estimate 2,381 spring-run chinook salmon migrated into the Trinity River basin upstream of Junction City Weir and that 336 (14.1%) were caught by anglers, leaving 2,045 fish as potential spawners. We estimate 9,207 fall-run chinook salmon migrated past Willow Creek Weir and that 7,231 of these fish continued up the Trinity River past Junction City Weir. Anglers harvested an estimated 1,271 (13.8%) of the fall-run chinook salmon that passed Willow Creek Weir, leaving 7,936 fish as potential spawners.

The coho salmon run in the Trinity River basin upstream of Willow Creek Weir was 9,124 fish, of which 3,996 continued their migration past Junction City Weir. Anglers harvested an estimated 109 (1.2%) of the coho salmon that migrated past Willow Creek Weir, leaving 9,015 fish as potential spawners.

An estimated 11,417 adult fall-run steelhead entered the Trinity River basin upstream of Willow Creek Weir, and 2,285 continued their migration upstream of Junction City Weir. Anglers harvested 2,340 (20.5%) of the adult fall-run steelhead that migrated past Willow Creek Weir, leaving 9,077 fish as potential spawners.

JOB OBJECTIVES

1. To determine the size, composition, distribution and timing of adult chinook and coho salmon, and steelhead runs in the Trinity River basin.

2. To determine the angler harvest and spawner escapements of Trinity River chinook and coho salmon, and steelhead.

INTRODUCTION

The California Department of Fish and Game's (CDFG) Trinity River Project (TRP) conducts annual tagging and recapture operations for adult chinook and coho salmon, and fall-run steelhead in the mainstem Trinity River. This effort determines the composition (species, race, and proportion of hatchery-marked[1/] or Project-tagged[2/] fish), distribution, and timing of the chinook and coho salmon, and fall-run steelhead runs in the Trinity River basin. Recaptures of hatchery-marked or Project-tagged fish are used to develop run-size, angler harvest, and spawner escapement estimates for each chinook and coho salmon, and steelhead run.

This is a continuation of studies that began in 1977 with the trapping, tagging, and recapture of fall-run chinook salmon (fall chinook), coho salmon (coho), and fall-run steelhead (steelhead) in the Trinity River in order to determine run-size and angler harvest rates. In 1978, similar studies were added to include spring-run chinook salmon (spring chinook). Steelhead were dropped from the program in 1985 through 1989 and reinstated last year (fall 1990).

The earlier studies were funded variously by the U.S. Bureau of Reclamation (USBR), and with Anadromous Fish Act funds administered by the U.S. Fish and Wildlife Service and National Marine Fisheries Service. The USBR (PL 98-541) has funded the program from 1 October 1989 through the present.

Prior to the current program, all efforts to measure salmon and steelhead populations in the Trinity River basin had been restricted to portions of the upper mainstem Trinity River and certain of its tributaries, or the South Fork Trinity River and some of its tributaries (Gibbs 1956; La Faunce 1965a, 1965b, 1967; Miller 1975; Moffett and Smith 1950; Rogers 1970, 1972,

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1/ Adipose fin clipped and coded-wire tagged (Ad+CWT), hatchery-produced chinook and coho salmon.

2/ Spaghetti tags applied by CDFG personnel to returning sea-run fish.

1973a, 1973b, 1982; Smith 1975; Weber 1965). These earlier efforts did not include fish which use the mainstem and tributaries of the lower Trinity River, or attempt to determine the proportion of hatchery fish in the runs and the rates at which various runs contribute to the fisheries. To develop a comprehensive management plan for the Trinity River basin, all salmon stocks utilizing the basin must be considered.

METHODS

Trapping and Tagging

Trapping Locations and Periods

Trapping and tagging operations were conducted by TRP personnel from May through December 1991 at the same temporary weir sites near the towns of Willow Creek and Junction City in the mainstem Trinity River that were used in 1989 and 1990. The downstream site, Willow Creek Weir (WCW), was located 6.7 km upstream of the town of Willow Creek, 46.8 km upstream of the Trinity River's confluence with the Klamath River, and 136.4 km downstream from Trinity River Hatchery (TRH) (Figure 1). The upstream site, Junction City Weir (JCW), was located 6.4 km upstream of the town of Junction City, 133.2 km upstream from the Klamath River confluence, and 45.5 km downstream of TRH (Figure 1).

The WCW is used to obtain run-size and angler harvest estimates of fall chinook and coho, and steelhead in the Trinity River basin as far downstream as possible. The JCW is used to obtain run-size and angler harvest estimates of spring chinook as far downstream as is feasible during periods of high spring flows. We continue to operate the JCW through December to obtain run-size estimates of fall chinook and coho salmon and steelhead in the upper Trinity River basin.

We trapped at the JCW from 21 May through 13 December 1991, except from 28 May through 5 June when high flows prevented operation. We trapped at WCW from 24 August through 13 December 1991.

At both sites, we attempted to trap four to six nights per week, mid-afternoon on Monday through Friday or Sunday morning. We trapped and tagged fish only at water temperatures <21°C to avoid severely stressing the fish.

Weir and Trap Design

As in the previous two seasons, we used the Bertoni (Alaskan) weir design at both weir sites (Figure 2). The weir was supported by wooden tripods set 2.5 m apart. The weir panels were composed of 2.4-m X 2.54-cm (8-ft. X 1-in.) electrical

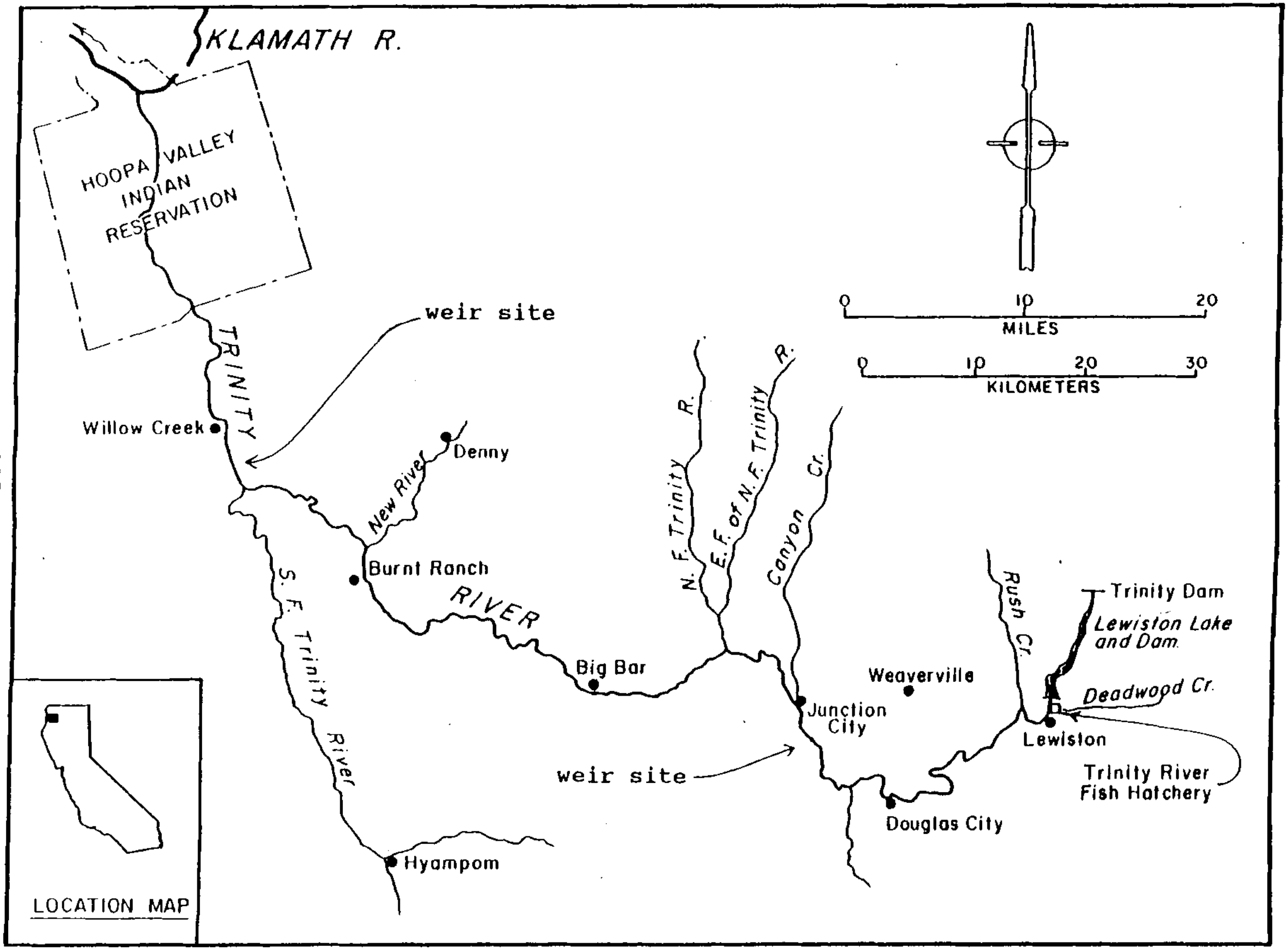

FIGURE 1. Locations of trapping and tagging weirs for anadromous salmonids near Willow Creek and Junction City in the mainstem Trinity River during the 1991-92 season.

conduit with the centers spaced 5.4 cm apart. The conduit was supported by three pieces of aluminum channel arranged 0.92 m apart, that connected to the supporting tripods. We anchored the tripods with 1.8-m stakes driven into the stream bottom. The weir panels were angled, with the top of the weir standing 1.8 m above the river bottom (Figure 2).

The weir guided fish toward a fyke leading to a trap which measured 2.4 m square and 1.2 m high, and was covered with wood panels to prevent the fish from jumping out of the trap. The trap sides and fyke leading into the trap consisted of 2.54-cm (1.0-in.) electrical conduit welded into panels. The conduit centers were spaced 5.4 cm apart, the same spacing as in the weir panels. The trap entrance was created by elevating the weir conduit allowing fish to enter the fyke and trap.

A gate, inserted between two weir panels, was used to allow boat passage at both weirs. It was modified from the previous years' design by reducing the conduit center spacing from 7.0 cm to 5.4 cm, so that it was similar to the weir and trap. The overall gap between the conduit was reduced to 2.54 cm. The conduit spacing on the gate was reduced to prevent salmonids from 35 to 50 cm fork length (FL) from passing through the gate. During the previous seasons, we noted that salmonids <50 cm were passing through the weir at the location of the gate. (Heubach et al. 1992a, 1992b).

<u>Processing of Fish</u>

At both weirs, we identified all trapped salmonids to species, measured them to the nearest cm (FL), and examined them for hook and gill-net scars, hatchery marks (fin clips) and tags. All untagged salmonids judged in good condition or unspawned were tagged with a serially numbered FT-4[3/] spaghetti tag (Project-tagged). To determine angler harvest rates upstream of JCW, various proportions of each species received $10-reward tags at rates inversely related to the numbers of each species we expected to effectively tag during the season. Therefore, all spring chinook, 62% of the fall chinook, 82% of the coho, and all adult steelhead received reward tags, the remainder non-reward tags. This was the second year of a three-year experiment to determine the relative return rates, by anglers above Willow Creek Weir, of the non-reward, $10-, and $20-reward tags. We attempted to tag equal, one-third proportions of the fall chinook, coho and steelhead at WCW with each of the three spaghetti tag types (non-reward, $10-, and $20-reward tags).

3/ The use of brand or trade names is for identification purposes only, and does not imply the endorsement of any product by the CDFG.

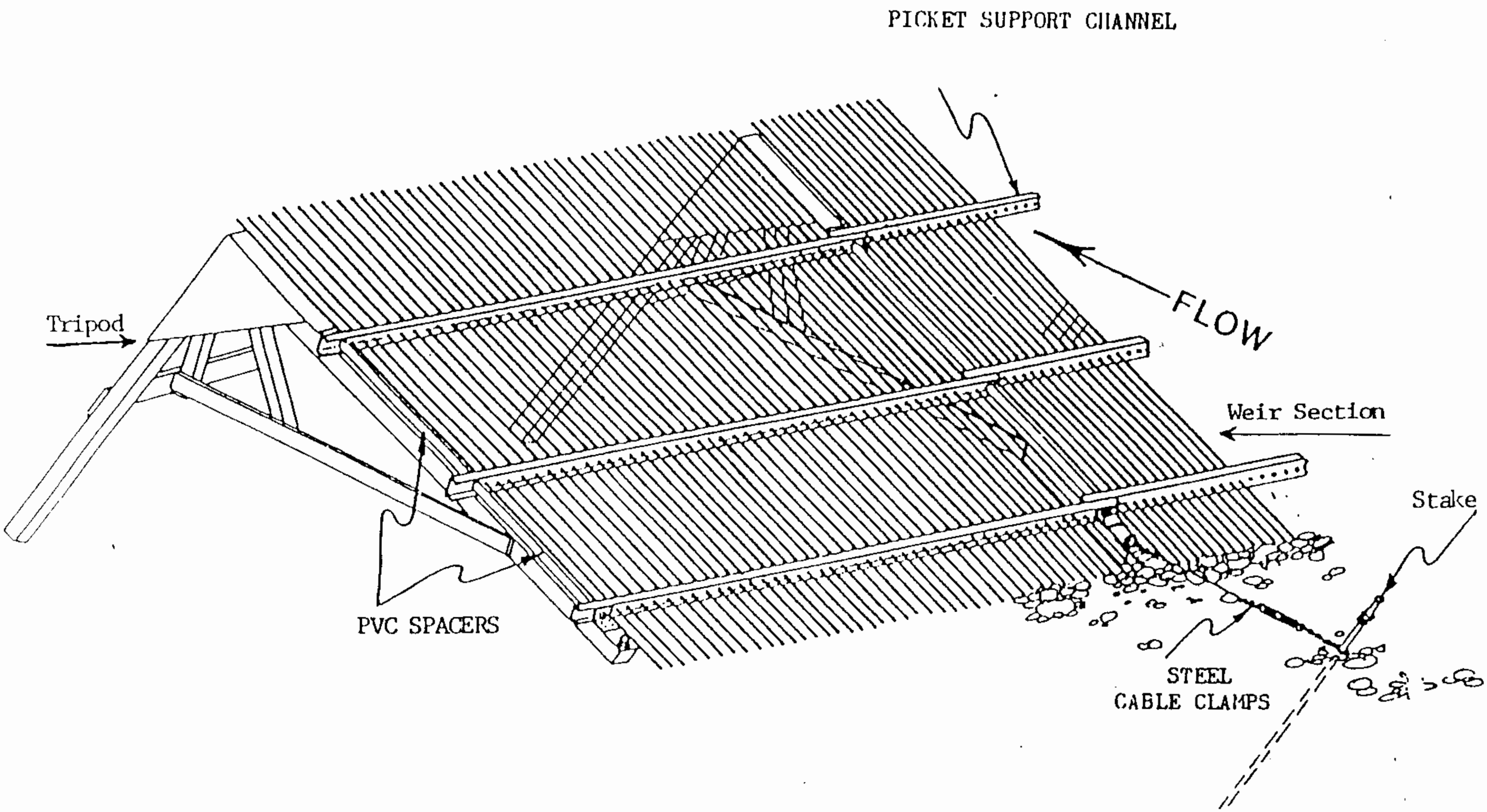

FIGURE 2. Schematic diagram of an Alaskan weir section, showing the arrangement of the tripod and weir paneling, as used in the Trinity River during the 1991-92 season.

We applied non-reward tags on 26% of the fall chinook, 31% of the coho salmon, and 31% of the steelhead trapped. We applied $10-reward tags on 36% of the fall chinook, 33% of the coho, and 33% of the steelhead trapped. While 35% of the fall chinook, 33% of the coho and 32% of the steelhead trapped received $20-reward tags. Our objective was to recover a sufficient number of tags to statistically compare the return rates of the three tag denominations.

To determine tag shedding rates, we removed one-half of the left ventral fin from all spring chinook tagged at JCW. We gave all fall chinook and coho tagged at WCW a single 6.4-mm diameter puncture on the left operculum, while those tagged at JCW received two. The tagged steelhead did not receive a secondary mark at either weir. We released all fish at the respective capture sites immediately after processing.

Separation of Spring- and Fall-run Chinook Salmon at the Weirs

Each year there is a temporal overlap in the annual spring and fall chinook runs in the Trinity River. Since the timing of each run varies between years, we assign a specific date each season separating the two runs so that numbers of spring and fall chinook can be determined for the run-size and angler harvest estimates. This year we could not use the recovery of fish which were both hatchery-marked and Project-tagged to separate the runs, as was done in 1989-90 and 1990-91 (Heubach et. al. 1992a, 1992b). Too few hatchery-marked salmon were captured and tagged, and consequently too few double marked (Project-tagged and hatchery-marked) fish were recovered. Therefore, we used the entry date of Project-tagged salmon into TRH and the coloration of the chinook salmon at the weir as a subjective indicator of the length of time the fish had been in the river. During the transition period of the run at the weir from spring to fall chinook, dark-colored fish were considered to be late-migrating spring chinook while light-colored fish were considered to be recently migrating fall chinook.

We determined that the spring run was over at both weirs when the light-colored chinook salmon clearly outnumbered the dark-colored chinook salmon. We verified this occurrence by comparing the date that Project-tagged chinook entered TRH to the date that known-race, hatchery-marked chinook entered the hatchery.

Separation of Spring- and Fall-run Chinook Salmon at Trinity River Hatchery

As at the weirs, there is an overlap in the migration of spring and fall chinook into TRH. To estimate the respective numbers of spring and fall chinook entering TRH, we expanded the numbers of tags recovered from each returning CWT group by the ratio of tagged to untagged chinook salmon that occurred when they were originally released (same strain, brood year, release site and date). For example, 97,569 fall chinook of CWT code 6-61-46, plus 968,475 unmarked fall chinook were released directly from TRH in September 1987. Since there were 9.9 unmarked chinook salmon released for every CWT chinook salmon released (968,475 unmarked/97,569 marked = 9.9), we multiplied the total number of CWT chinook salmon of code group 6-61-46 by 9.9 to estimate the number of unmarked chinook of that release group that returned to TRH. In doing so, we assumed that return rates to TRH of both CWT and unmarked salmon were the same.

If more chinook salmon entered the hatchery on a particular sorting day than could be accounted for by the expansion of all of the coded-wire-tag groups, we assumed the additional fish were naturally produced. We designated these fish as spring- or fall-run in the same proportions that were determined by the expansion of the coded-wire-tag groups on that day.

Separation of Adult and Grilse Salmon

We designated the size separating an adult fish from a grilse for spring and fall chinook, and coho based on length frequency data obtained at the two trapping sites and at TRH, evaluated against length data obtained from groups of CWT fish that entered TRH whose exact age was known. Daily chinook salmon FL data from TRH were assigned to either spring or fall chinook when the coded-wire-tag extrapolations indicated ≥90% of the chinook salmon entering TRH were either spring-run or fall-run fish. Daily FL data from TRH were not used when coded-wire-tag extrapolations indicated the chinook salmon entering TRH were <90% of a specific run.

The length data collected at the weirs and TRH were smoothed with a moving average of five, 1-cm FL increments to determine the nadir separating grilse and adults.

Adult Steelhead

All steelhead >41 cm FL were considered adults, steelhead ≤41 cm captured at the weirs were assumed to be half-pounders (assumed to have migrated to the ocean) while steelhead ≤41 cm FL that entered TRH were classified as sub-adults, since we did not know whether they had migrated to the ocean or were resident steelhead.

Recovery of Tagged Fish

River Surveys

River surveys were not conducted in the 1991-92 season because very few dead, tagged fish were recovered during river surveys in the previous seasons. We continued to recover dead, tagged fish at the weirs. We examined dead salmonids for tags, fin clips, and spawning condition, and measured them to the nearest cm FL. Heads of adipose fin-clipped (potentially hatchery-marked) fish were removed for the recovery of the coded-wire tag. After examination, the carcasses were cut in half to prevent recounting.

Tagging Mortalities

We defined all tagged salmonids recovered dead at the weir or reported by anglers as tagging mortalities, if there was no evidence they had spawned and they were recovered dead ≤30 days after tagging. Tagged fish recovered dead >30 days after tagging, or those that had spawned, regardless of the number days after tagging, were not considered tagging mortalities.

Angler Tag Returns

We processed Project tags returned by anglers to assess sport harvest rates. If not provided with the original tag return, we requested anglers to provide the date and location of their catch in a follow-up thank-you letter. The letter informed them of the fish's tagging date and location.

Salmon Spawner Surveys

The Trinity River Fisheries Investigation Project (TFIP), another element of CDFG's Klamath-Trinity Program, conducted salmon spawner carcass surveys in the mainstem Trinity River and its spawning tributaries from Lewiston to the confluence of, and including the North Fork Trinity River (Figure 1). Staff of the TFIP routinely provided us records of the species, tag number, date, and recovery location of Project-tagged fish seen during surveys from 16 September through 19 December 1991.

Trinity River Hatchery

The TRH fish ladder was open from 16 September 1991 through 27 March 1992. Hatchery personnel conducted fish sorting and spawning operations two days per week through December, and up to seven days per week and twice daily from 2 January through 27 March 1992. More frequent sorting beginning in January was an attempt to reduce suspected predation by river otters (*Lutra canadensis*) of steelhead in the fish ladder and holding raceway. We considered the initial day a fish was observed during sorting as the day it entered the hatchery.

On all sorting days, salmon and steelhead entering TRH were identified to species, sexed, and examined for tags, fin clips, and secondary tagging marks. We measured all salmon to the nearest cm FL, except those that were Project-tagged fish from the weirs. Project-tagged salmon and steelhead recovered at TRH were assigned the original FL recorded for them at the weir where they were originally tagged.

We removed Project tags from unmarked (no Ad+CWT) salmon on the initial sorting day, while Project tags were removed from hatchery-marked (Ad+CWT) salmon the day they were spawned. On each sorting day, we gave a distinguishing fin clip to hatchery-marked salmon that were placed in ponds to ripen, so the day it initially entered the hatchery (i.e. was sorted) could be determined when it was spawned. Salmon with a secondary tagging mark and no tag were measured to the nearest cm FL and sexed. At the end of the season, we assigned these secondary-marked salmon which had shed their tag, a tag number from a fish of the same species, FL, sex, and weir location where they were originally tagged and released. Tag numbers of the recovered Project-tagged steelhead were recorded the initial day the steelhead was sorted but the tag was not removed.

On the day they were spawned, we removed the heads of all hatchery-marked salmon and placed each in a zip-lock bag with a serially numbered tab noting the date and location of recovery, species, sex, and FL. Salmon heads were given to the CDFG's Ocean Salmon Project for tag recovery and decoding. The Ocean Salmon Project provided us with a computer file of the coded-wire tags recovered for editing and analysis.

Statistical Analyses

Effectively-tagged Fish

We estimated the number of 'effectively tagged' fish by subtracting tagging mortalities of unspawned fish recovered at the weir, dead, tagged fish reported by anglers, and tagged fish recovered or reported downstream of the tagging site from the total numbers of each species tagged at the respective tagging sites.

Run-size Estimates

We determined the run-size estimates for salmon and steelhead migrating into the Trinity River basin above WCW and JCW in 1991-92 by using Chapman's[4/] version of the Petersen Single Census Method (Ricker 1975):

$$N = \frac{(M+1)\ (C+1)}{(R+1)}, \text{ where}$$

4/ Chapman, D. G. 1951. Some properties of the hypergeometric distribution with applications to zoological census. Univ. Calif. Publ. Stat. 1:131-160, As cited in Ricker (1975).

N = estimated run size, M = the number of 'effectively tagged' fish, C = the number of fish examined at TRH, and R = the number of tags recovered (including fish with a secondary tagging mark and no tag) in the hatchery sample.

We attempted to effectively tag and recover enough tagged fish to obtain 95% confidence limits of ±10% of the run-size estimate. Confidence limits were determined according to the criteria established by Chapman (1948). In this analysis, the type of confidence interval estimate used is based on the number of tags recovered and the ratio of tagged to untagged fish in the recovery sample.

Each year, we examine the grilse and adult composition of the effectively tagged salmon, the sample of Project-tagged salmon recovered at TRH, and the untagged sample of salmon at TRH to determine if the run-size estimate should be stratified by grilse and adults. Run-size estimates are stratified by grilse and adult salmon when: 1) the proportions of grilse and adult salmon in the effectively tagged sample, the Project-tagged sample of salmon recovered at TRH, and the untagged sample of salmon at TRH are significantly different statistically; and 2) there are sufficient grilse and adult salmon recovered in the tagged sample at TRH to obtain 95% confidence limits of ±10% of each of the stratified portions of the run-size estimate.

If we do not stratify the salmon run-size estimate by grilse and adults, we use the proportions of grilse and adult salmon trapped at the respective weirs to estimate the numbers of grilse and adults comprising the run.

All steelhead run-size estimates are for adults only.

For the run-size estimates, we assumed: 1) fish trapped and released from the weir were a random sample representative of the population; 2) tagged and untagged fish were equally vulnerable to recapture (entering TRH); 3) all Project tags and secondary tagging marks were recognized upon recovery; 4) tagged and untagged fish were randomly mixed throughout the population and among the fish recovered at TRH; and 5) we accounted for all tagging mortalities.

<u>Angler Harvest Rates</u>

Only $10- and $20-reward tags returned by anglers were used to determine angler harvest rates. Each angler harvest rate estimate was computed as the number of reward tags returned by anglers divided by the number of effectively reward-tagged fish released.

The assumptions for the numbers of effectively reward- and non-reward-tagged fish released are the same as those for determining the run-size estimate (See "Run-size Estimates" above). In addition, the numbers of effectively reward-tagged fish released were corrected for tag shedding by multiplying the total number of reward-tagged fish by the percentage of tagged fish recovered at TRH that had not shed their tag.

The confidence limits surrounding the point harvest rate estimate were determined from tables for the binomial distribution. We attempt to effectively reward tag enough fish to obtain 95% confidence limits of ±10.0% of the harvest rate.

Angler Harvest Estimates

We estimated the numbers of fall chinook, coho, and steelhead upstream of WCW, and spring chinook upstream of JCW harvested by anglers by multiplying the run-size estimate above the respective weir site by the harvest rate estimate.

The absolute number of fall chinook, coho, and steelhead harvested by anglers in the Trinity River upstream of JCW was determined by multiplying the respective percentage of WCW-tagged fish reported caught upstream of the JCW by the total angler harvest estimate upstream of WCW[5/].

Other Analyses

The mean FLs of samples were compared statistically using a Student's t-test. We did not conduct tests for sample sizes <20 fish and differences in such cases were not considered statistically different. We analyzed the percentages or ratios of adults and grilse, marked and unmarked fish, and the angler return of non-reward and reward tags in samples by Chi-square. A continuity correction (Yates correction) was used for contingency tables of one degree of freedom (Dixon and Massey 1969).

Use of Standard Julian Week

Weekly sampling data collected by Project personnel at the weirs are presented in Julian week (JW) format. Each JW is defined as one of a consecutive set of 52, weekly periods, beginning 1 January, regardless of the day of the week on which 1 January falls. The extra day in leap years is included in the ninth week (Appendix 1). This procedure allows inter-annual comparisons of identical weekly periods.

5/ Number of fish harvested by anglers above WCW x proportion of Project-tagged fish caught above JCW.

RESULTS AND DISCUSSION

Trapping and Tagging

Spring-run Chinook Salmon

Run Timing. During the first week at WCW the 62 chinook salmon which were trapped appeared to be primarily spring-run fish. All of the chinook trapped after the first week were clearly fall chinook (Table 1).

The first spring chinook entered JCW 5 June (JW 23). The number of spring chinook trapped each week increased and peaked JW 27 (2-8 July) and decreased substantially during the next week although there were two minor peaks in the run during JW 30 (23-29 July) and JW 33 (13-19 August)(Figure 3). We considered the spring-run to be over JW 36 (3-9 September) at JCW. We trapped 310 spring chinook at JCW during the 1991-92 season (Table 1).

Size of Trapped Fish. The sizes of the spring chinook trapped at WCW and JCW, and that entered TRH were essentially the same (Table 2, Figure 4). Based on a moving average of 5, 1-cm increments, the nadir in the FL separating grilse and adult spring chinook was 53 cm at JCW (Figure 4). There was no nadir separating grilse and adult spring chinook at WCW or that entered TRH. However, the size separating grilse and adults of known-age, hatchery-marked spring chinook that entered TRH also appeared to be 53 cm FL (Appendix 2). Therefore, during the 1991-92 season, we consider spring chinook in the Trinity River basin ≤53 cm FL to be grilse, while adults are larger.

During the 1991-92 season, 11% of the spring chinook trapped at WCW and 8.1% of those trapped at JCW were grilse, similar to the proportion of spring chinook grilse in the TRH sample (10%) (Table 2). The low proportion of grilse is typical of the upper Trinity River basin spring run (Heubach 1984a, 1984b; Heubach et al. 1992a, 1992b).

Incidence of Tags and Hatchery Marks. None of the spring chinook salmon tagged at WCW were recaptured at the JCW during the spring run.

None of the spring chinook trapped at WCW were hatchery-marked, while 19 (6.5%) of the fish trapped at JCW were hatchery-marked (Table 2). The mean FL of the hatchery-marked spring chinook was over 3 cm less than the unmarked fish, although there were too few hatchery-marked fish trapped to test statistically (Table 3).

Of the 16 hatchery-marked spring chinook spaghetti tagged at JCW, six were subsequently recovered in the spawner survey or at TRH.

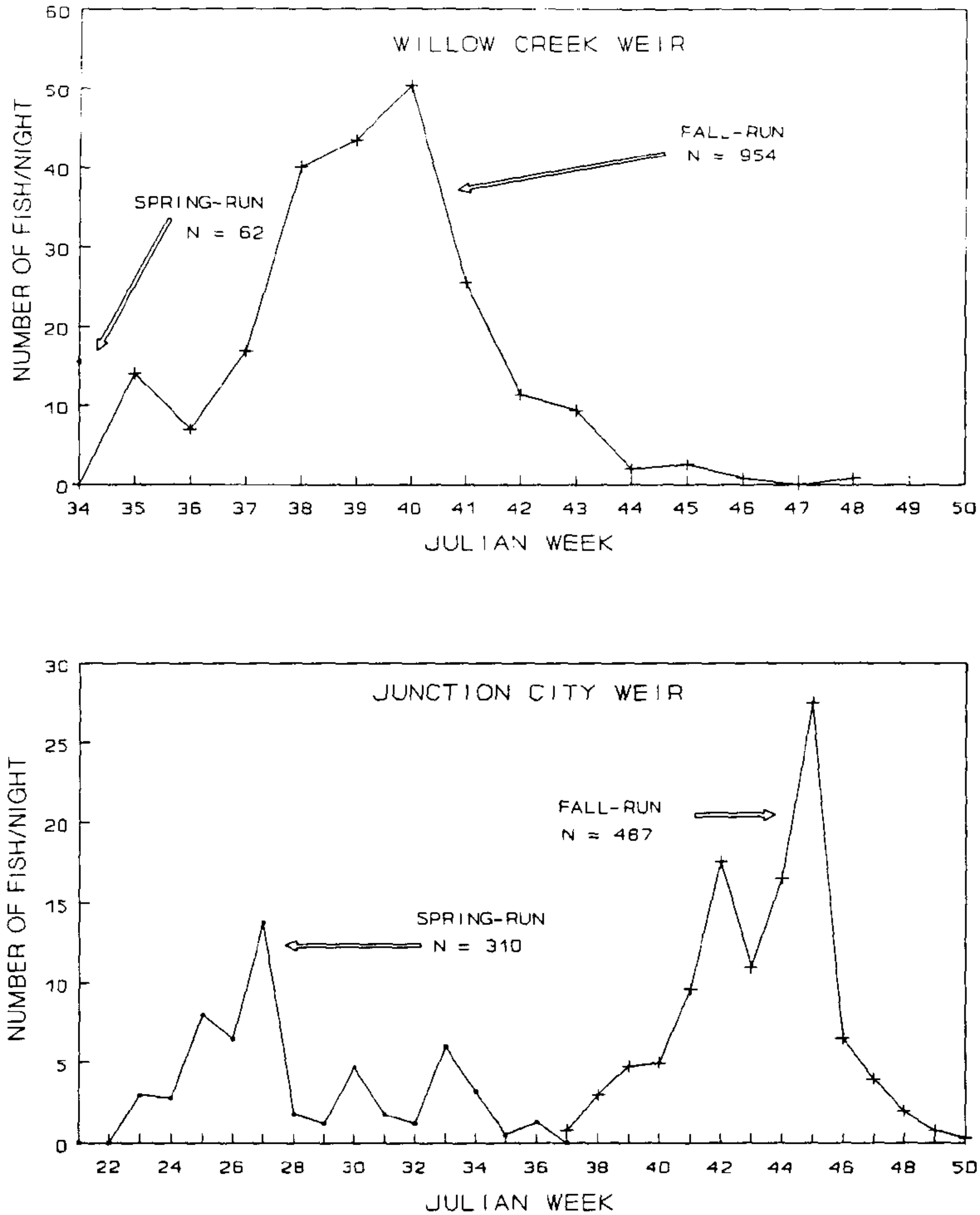

Figure 3. Average numbers of spring- and fall-run chinook salmon trapped per night each Julian week in the Trinity River at Willow Creek and Junction City weirs during the 1991-92 season.

TABLE 1. Weekly summary of spring-run and fall-run chinook salmon trapped in the Trinity River at Willow Creek and Junction City weirs during the 1991-92 season.

Julian week (dates)	Willow Creek Weir a/ Nights trapped	Willow Creek Number trapped Grilse	Willow Creek Number trapped Adults	Willow Creek Number trapped Totals	Willow Creek Fish/ night	Junction City Weir b/ Nights trapped	Junction City Number trapped Grilse	Junction City Number trapped Adults	Junction City Number trapped Totals	Junction City Fish/ night
Spring-run chinook c/										
21 (05/21-05/27)						4	0	0	0	0.0
22 (05/28-06/03) d/						0	-	-	-	-
23 (06/04-06/10)						4	1	11	12	3.0
24 (06/11-06/17)						4	0	11	11	2.8
25 (06/18-06/24)						5	2	38	40	8.0
26 (06/25-07/01)						6	2	37	39	6.5
27 (07/02-07/08)						6	1	82	83	13.8
28 (07/09-07/15)						6	3	8	11	1.8
29 (07/16-07/22)						6	2	5	7	1.2
30 (07/23-07/29)						6	2	26	28	4.7
31 (07/30-08/05)						6	2	9	11	1.8
32 (08/06-08/12)						6	0	7	7	1.2
33 (08/13-08/19)						6	4	32	36	6.0
34 (08/20-08/26)	4	7	55	62	15.5	6	3	16	19	3.2
35 (08/27-09/02)	-	-	-	-	-	4	1	1	2	0.5
36 (09/03-09/09)	-	-	-	-	-	3	2	2	4	1.3
Sub-totals	4	7	55	62		78	25	285	310	
Sub-means e/					15.5					4.0
Fall-run chinook f/										
35 (08/27-09/02)	4	5	51	56	14.0	-	-	-	-	-
36 (09/03-09/09	4	1	27	28	7.0	-	-	-	-	-
37 (09/10-09/16)	5	6	78	84	16.8	5	2	2	4	0.8
38 (09/17-09/23)	4	10	150	160	40.0	5	4	11	15	3.0
39 (09/24-09/30)	5	8	209	217	43.4	5	7	17	24	4.8
40 (10/01-10/07)	4	4	197	201	50.3	5	6	19	25	5.0
41 (10/08-10/14)	4	2	100	102	25.5	5	9	39	48	9.6
42 (10/15-10/21)	4	0	45	45	11.3	5	5	83	88	17.6
43 (10/22-10/28)	4	0	37	37	9.3	5	7	48	55	11.0
44 (10/29-11/04)	4	1	7	8	2.0	5	8	75	83	16.6
45 (11/05-11/11)	4	0	10	10	2.5	4	8	102	110	27.5
46 (11/12-11/18)	4	1	2	3	0.8	2	1	12	13	6.5
47 (11/19-11/25)	4	0	0	0	0.0	4	1	15	16	4.0
48 (11/26-12/02)	4	0	3	3	0.8	2	0	4	4	2.0
49 (12/03-12/09)	4	0	0	0	0.0	4	1	2	3	0.8
50 (12/10-12/16)	4	0	0	0	0.0	4	0	1	1	0.3
Sub-totals	66	38	916	954		60	59	430	489	
Sub-means e/					14.5					8.2
GRAND TOTALS	70	45	971	1,016		138	84	715	799	
COMBINED MEANS e/					14.5					5.8

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991.
c/ Spring-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.
d/ Junction City Weir was unfishable due to high flows.
e/ Computations are based on numbers from the first Julian week that chinook salmon were trapped through the end of the sampling period.
f/ Fall-run chinook salmon grilse are ≤51 cm FL; adults are >51 cm FL.

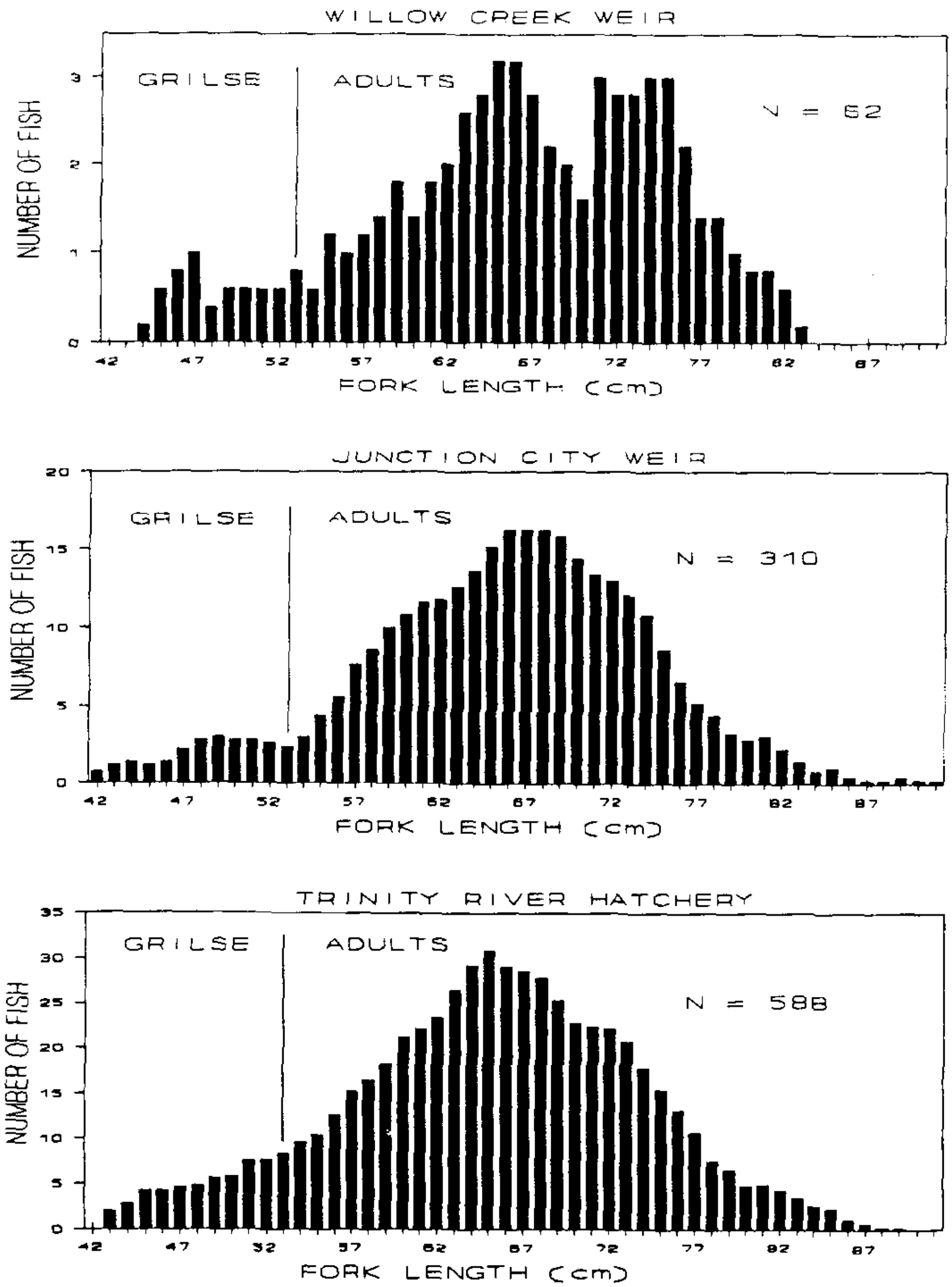

Figure 4. Fork lengths of spring-run chinook salmon trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1991-92 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line indicates the size (53 cm FL) separating grilse and adult spring-run chinook salmon.

TABLE 2. Fork lengths of spring-run chinook salmon trapped and tagged in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1991-92 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/	Total trapped	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/
42					3	1	2	
43					1	0	1	
44					0	0	0	
45	3		3		2	0	2	
46	0		0		1	0	1	
47	0		0		2	0	2	1
48	1		1		2	0	2	0
49	1		1		4	1	4	2
50	0		0		5	2	5	3
51	1		1		2	0	2	2
52	0		0		1	0	1	0
53	1		1		2	0	2	1
54	1		1		3	0	3	0
55	1		1	1	4	0	3	2
56	0		0	0	5	1	5	3
57	3		3	1	8	1	8	2
58	0		0	0	8	0	7	6
59	2		2	0	13	1	12	4
60	2		2	1	9	1	9	1
61	2		2	0	12	0	12	4
62	1		1	0	12	1	12	6
63	2		2	0	12	0	11	4
64	3		3	0	14	2	14	2
65	5		5	0	13	0	13	8
66	3		3	1	17	1	17	8
67	3		3	2	20	0	19	7
68	2		2	0	17	0	17	4
69	1		1	0	14	0	14	2
70	2		2	0	13	0	12	3
71	2		1	0	15	2	14	4
72	1		1	0	13	0	13	1
73	4		3	1	12	1	12	1
74	5		5	1	12	2	12	1
75	2		2	0	8	0	8	0
76	3		3	1	9	2	9	1
77	1		1		2		2	0
78	0		0		2		2	0
79	1		1		5		4	1
80	2		2		4		4	0
81	1		1		3		3	1
82					0		0	0
83					3		3	1
84					1		1	
85					0		0	
86					0		0	
87					1		1	
88					0		0	
89					0		0	
90					0		0	
91					1		1	
TOTALS	62	0	60	9	310	19	301	86
Mean FL	65.7	-	65.5	66.1	65.8	62.8	65.9	63.3
Grilse f/	7	0	7	0	25	4	24	9
Adults	55	0	53	9	285	15	277	77

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991. Only chinook salmon trapped through 23 August 1991 are considered spring-run chinook. See Table 7 for fork lengths of chinook salmon trapped after 23 August.

b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991. Only chinook salmon trapped through 8 September 1991 are considered spring-run chinook. See Table 7 for fork lengths of chinook salmon trapped after 8 September.

c/ The fish were adipose fin clipped and coded-wire tagged and released from Trinity River Hatchery during previous years.

d/ The number of effectively tagged fish is corrected for fish that were not tagged and tagging mortalities.

e/ TRH=Trinity River Hatchery.

f/ Spring-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.

TABLE 3. Size difference between fin-clipped or scarred vs. non-fin-clipped or unscarred groups of spring- and fall-run chinook and coho salmon, and fall-run steelhead trapped in the Trinity River at Willow Creek and Junction City weirs during the 1991-92 season.

	Willow Creek Weir					Junction City Weir				
		Fork Length (cm)					Fork Length (cm)			
Species/ race	Comments	Range	Mean	Sample size	t-value a/	Comments	Range	Mean	Sample size	t-value a/
Spring-run chinook	With Ad b/	-	-	0		With Ad b/	42-76	62.8	19	
	Without Ad	45-81	65.7	62	- /c	Without Ad	42-91	66.0	291	-
	With gill-net scars	57-76	68.6	16		With gill-net scars	61-84	70.0	28	
	Without gill-net scars	45-81	65.7	46	-	Without gill-net scars	42-91	65.3	282	0.36
	With hook scars	73	73.0	1		With hook scars	53-91	71.4	20	
	Without hook scars	57-76	65.6	61	-	Without hook scars	42-87	65.4	290	0.39
Fall-run chinook	With Ad b/	53-77	65.7	79		With Ad b/	36-78	64.5	42	
	Without Ad	42-93	65.5	875	0.03	Without Ad	32-89	62.2	445	0.21
	With gill-net scars	56-84	69.7	118		With gill-net scars	57-80	69.4	27	
	Without gill-net scars	42-93	64.9	836	0.74	Without gill-net scars	32-89	62.0	460	0.48
	With hook scars	43-87	64.5	30		With hook scars	36-80	66.3	18	
	Without hook scars	42-93	65.5	924	0.08	Without hook scars	32-89	62.3	469	-
Coho	With Ad b/	57-74	44.5	2		With Ad b/	46	46	1	
	Without Ad	37-74	63.0	602	-	Without Ad	46-70	63.4	221	-
	With gill-net scars	57-74	65.8	24		With gill-net scars	63-69	65.5	4	
	Without gill-net scars	37-74	62.8	580	0.18	Without gill-net scars	41-75	63.3	218	-
	With hook scars	51-68	61.5	25		With hook scars	46-71	63.6	9	
	Without hook scars	37-74	63.0	579	0.13	Without hook scars	41-75	63.3	213	-
Fall-run Steelhead	Fin-clipped d/	34-73	60.1	74		Fin-clipped d/	34-73	52.9	36	
	Non-fin-clipped	33-82	60.8	564	0.09	Non-fin-clipped	36-74	60.7	67	0.64
	With gill-net scars	56-82	62.6	20		With gill-net scars	55-63	58.0	3	
	Without gill-net scars	33-78	60.7	618	0.02	Without gill-net scars	34-74	58.0	100	-
	With hook scars	55-71	63.0	21		With hook scars	35-68	60.2	5	
	Without hook scars	33-82	60.7	617	0.17	Without hook scars	34-74	57.9	98	-

a/ None of the t values were statistically significance, ($p < 0.05$).
b/ Ad = adipose fin clip.
c/ "-" A t-test was not conducted for samples sizes < 20 fish.
d/ Includes any fin clip.

Two fish were from the 1987 brood year (BY), one fish each was from the 1986 and 1988 BYs, and two fish were without a CWT (Table 4).

Incidence of Gill-net and Hook Scars. Sixteen (25.8%) of the spring chinook trapped at WCW and 28 (9.0%) of the spring chinook trapped at JCW were gill-net scarred. At both weirs the mean FLs of the gill-net-scarred fish were larger than the non-gill-net-scarred fish, although in neither case were they statistically different (Table 3).

As in 1989-90 and 1990-91, we examined the tagging mortality and recovery at TRH of gill-net-scarred vs. non-gill-net-scarred spring chinook tagged at JCW (Tables 5 and 6). Two of the 28 (7.1%) Project-tagged fish with gill-net scars were recovered dead at the weir compared to 7 of the 282 (2.5%) non-gill-net-scarred fish. After correcting for the tagging mortality, five of the 26 (19.2%) gill-net-scarred spring chinook and 81 of the 275 (29.5%) non-gill-net-scarred fish were recovered at TRH. The differences in the tagging mortality and recovery rate of effectively tagged, gill-net-scarred and non-gill-net-scarred spring chinook were not statistically different (Tables 5 and 6). However, these results follow the trend observed in the last two seasons of slightly higher tagging mortality rates and lower hatchery recovery rates of gill-net-scarred than non-gill-net-scarred spring chinook (Heubach et al. 1992a, 1992b).

When we pooled the results of the tagging mortality of gill-net-scarred and non-gill-net-scarred spring chinook for the last three seasons, the difference was highly significantly (Table 5). However, the recovery rates of the effectively-tagged gill-net-scarred and non-gill-net-scarred spring chinook at TRH were not statistically different, even though in all years there was a slightly higher recovery rate of the non-gill-net-scarred fish (Table 6). We conclude that there has been a slightly higher tagging mortality of gill-net-scarred spring chinook at JCW during the last three seasons. The recovery rate of effectively-tagged gill-net-scarred spring chinook also appears to be less than the rate for non-gill-net-scarred fish, even after correcting for the differences in the tagging mortality of gill-net-scarred fish.

Only one spring chinook at WCW was hook scarred while 20 hook-scarred fish were trapped at JCW. Collectively, 14 of the fish had ocean-hook scars while seven were freshwater-hook scars. The mean FL of the hook-scarred spring chinook trapped at JCW was 6 cm greater than the non-hook-scarred fish, although the difference was not statistically significant (Table 3).

TABLE 4. Release and recovery data for Trinity River Hatchery-produced, coded-wire-tagged chinook salmon that were trapped in the Trinity River at Willow Creek and Junction City weirs, and recovered on spawning surveys or at Trinity River Hatchery during the 1991-92 season.

Release data						Tagging site	
CWT number a/	Brood year	Race	Date	Age b/	Number	Willow Creek Weir	Junction City Weir
6-61-46	86	Spring-run chinook	09/24/87	Y	101,030	0	1
6-61-47	87	Spring-run chinook	05/23/88	F	185,718	0	2
6-61-48	88	Spring-run chinook	10/24/89	Y	98,820	0	1
6-56-39	89	Spring-run chinook	10/01/90	Y	102,555	1 c/	0
Shed tag d/						0	2
6-56-33	87	Fall-run chinook	06/02/88	F	172,980	5	2
6-56-31	87	Fall-run chinook	10/28/88	Y	92,300	6	1
6-56-35	88	Fall-run chinook	06/12/89	F	194,197	1	3
6-56-32	88	Fall-run chinook	10/27/89	Y	97,959	19	6
6-55-22	88	Fall-run chinook	11/01/89	Y	22,234	1	0
6-55-23	88	Fall-run chinook	11/01/89	Y	24,131	0	1
6-56-34	89	Fall-run chinook	10/15/90	Y	97,810	0	1
Shed tag d/						1	3
TOTALS						34	23

a/ CWT=coded wire tag.
b/ Y=yearling, F=fingerling
c/ The fish was trapped and tagged as a fall-run chinook salmon at Willow Creek Weir.
d/ No coded-wire tag was recovered from the fish.

TABLE 5. Chi-square analysis of the number of gill-net-scarred and non-gill-net-scarred spring-run chinook salmon tagged and recovered dead in the Trinity River at Junction City Weir during the 1989-90 through 1991-92 seasons.

	Gill-net-scarred			Non-gill-net-scarred				
Season	Total tagged	Recovered dead	%	Total tagged	Recovered dead	%	Chi-square	P
1989-90	207	14	6.8	1,259	38	3.0	6.23	<0.02
1990-91	151	5	3.3	981	18	1.8	0.79	<0.40
1991-92	28	2	7.1	282	7	2.5	0.65	<0.55

TABLE 6. Chi-square analysis of the number of gill-net-scarred and non-gill-net-scarred spring-run chinook salmon effectively tagged in the Trinity River at Junction City Weir and recovered at Trinity River Hatchery during the 1989-90 through 1991-92 seasons.

	Gill-net-scarred			Non-gill-net-scarred				
Season	Effectively tagged a/	Recovered at TRH b/	%	Effectively tagged a/	Recoverd at TRH b/	%	Chi-square	P
1989-90	193	36	18.7	1,221	232	19.0	0.00	-
1990-91	146	49	33.6	963	391	40.6	2.34	<0.15
1991-92	26	5	19.2	275	81	29.5	0.76	<0.40

a/ The number of effectively tagged fish is corrected for fish that were not tagged and tagging mortalities.
b/ TRH=Trinity River Hatchery.

Fall-run Chinook Salmon

Run Timing. The fall run began at the WCW 27 August 1991 (JW 35). The numbers of fall chinook trapped decreased during the second week of trapping, then increased through JW 40 (1-7 October) when the run peaked (Figure 3). The fall run then decreased sharply through JW 42 (15-21 October) and gradually thereafter. We trapped the last fall chinook 29 November 1991 (JW 48), suggesting the run was over in the lower Trinity River when we removed the weir. We trapped 954 fall chinook at WCW during the 1991-92 season (Table 1).

The fall run began at JCW 10 September (JW 37), two weeks after it began at WCW. The fall run increased each week through JW 42 (15-21 October), decreased slightly the next week, and peaked JW 45 (5-11 November), five weeks after the peak at WCW (Figure 3). The numbers trapped each week decreased substantially during JW 46 (12-18 November) and gradually thereafter. We trapped the last fall chinook at JCW on 11 December (JW 50), two days before we removed the weir for the season. We trapped 489 fall chinook at JCW during the 1991-92 season (Table 1).

Size of Fish Trapped. The fall chinook trapped at WCW appeared slightly larger than those trapped at JCW (Table 7), although their mean FLs were not significantly different ($t=0.86$, $p<0.05$).

The size separating grilse and adult fall chinook was 51 cm FL at both weirs and at TRH. This season, we consider all fall chinook $\leq$51 cm FL to be grilse, whereas larger fall chinook are considered adults (Figure 5). Grilse composed 4.0% and 12% of the fall chinook trapped at WCW and JCW (Table 7), respectively, while at TRH, 7.6% of the fall chinook were grilse. The differences in the proportions of grilse and adult fall chinook at the two weirs and TRH were highly significantly ($X^2=10.0$, $p<0.01$). The reason for the differences in the grilse/adult ratios at the three sites is unknown.

Incidence of Tags and Hatchery Marks. Forty-four WCW-tagged chinook were recaptured at JCW during the fall run (after 9 September 1991). Two of the fish were trapped and tagged at WCW as spring chinook, but they were recaptured at the JCW during the fall run. Excluding these two fish, the fall chinook took from 14 to 58 days to migrate to the JCW, with a mean of 29 days, for a mean migration rate of 3.1 km/d. The mean number of days (approximately four weeks) it took for the WCW-tagged fall chinook to migrate to the JCW is slightly less than the five weeks difference in the peaks of the fall run occurring at the two weirs. The mean migration rate of the fall chinook from WCW to the JCW this year was essentially identical to that in 1990

TABLE 7. Fork lengths of fall-run chinook salmon trapped and tagged in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1991-92 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/	Total trapped f/	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/
32					1		1	
33					0		0	
34					0		0	
35					1		1	
36					1	1	1	
37					2	0	2	
38					0	0	0	
39					0	0	0	
40					0	0	0	
41					2	0	2	2
42	1		1	1	2	0	2	0
43	3		2	0	4	1	3	2
44	6		5	2	5	0	5	1
45	3		3	0	7	0	7	2
46	6		5	1	11	0	10	0
47	4		4	1	4	0	4	0
48	3		3	0	8	0	8	4
49	5		5	2	3	0	2	0
50	3		3	1	5	0	4	2
51	4		4	1	3	0	3	0
52	8		7	2	5	0	5	2
53	3	2	3	1	4	1	3	0
54	5	0	5	2	6	0	6	0
55	8	0	8	4	4	0	4	1
56	19	2	18	12	3	0	2	1
57	24	0	24	14	16	0	13	6
58	26	2	25	10	16	0	15	9
59	38	6	37	19	24	3	24	14
60	51	3	51	25	22	3	22	9
61	51	3	51	20	30	2	28	21
62	52	5	51	21	37	4	34	19
63	67	6	63	15	37	3	34	17
64	55	6	55	17	35	3	33	15
65	57	4	56	21	29	1	29	9
66	58	5	57	19	27	3	26	7
67	47	6	45	16	17	5	16	7
68	39	2	39	10	13	0	13	2
69	37	6	34	5	15	2	14	3
70	30	4	26	3	12	2	12	4
71	40	3	39	6	13	2	12	3
72	26	5	26	5	11	1	10	3
73	35	1	32	0	9	0	7	2
74	25	4	22	4	7	1	6	1
75	21	2	20	1	7	1	7	0
76	25	1	24	2	8	0	8	0
77	18	1	17	3	2	1	2	0
78	6		6	0	3	2	3	0
79	13		12	1	6		6	1

(continued)

TABLE 7. Fork lengths of fall-run chinook salmon trapped and tagged in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1991-92 season (continued).

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/	Total trapped f/	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/
80	7		7		7		6	1
81	4		3		1		1	
82	9		9		0		0	
83	2		1		1		1	
84	3		3		0		0	
85	2		2		0		0	
86	1		1		0		0	
87	1		1		0		0	
88	0		0		0		1	
89	1		0		1		1	
90	0		0					
91	1		1					
92	0		0					
93	1		1					
TOTALS	954	79	917	267	487	42	459	170
Mean FL	65.5	65.7	65.4	62.5	62.5	64.5	62.5	61.6
Grilse g/	38	0	35	9	59	2	55	13
Adults	916	79	882	258	428	40	404	157

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991. Only chinook salmon trapped after 23 August are considered fall-run chinook. See Table 2 for fork lengths of chinook salmon trapped through 23 August.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991. Only chinook salmon trapped after 8 September are considered fall-run chinook. See Table 2 for fork lengths of chinook salmon trapped through 8 September.
c/ The fish were adipose fin clipped and coded-wire tagged, and released from Trinity River Hatchery during previous years.
d/ The number of effectively tagged fish is corrected for fish that were not tagged and tagging mortalities.
e/ TRH=Trinity River Hatchery.
f/ The total does not include two adult fall-run chinook salmon that were not measured at Junction City Weir.
g/ Fall-run chinook salmon grilse are ≤51 cm FL; adults are >51 cm FL.

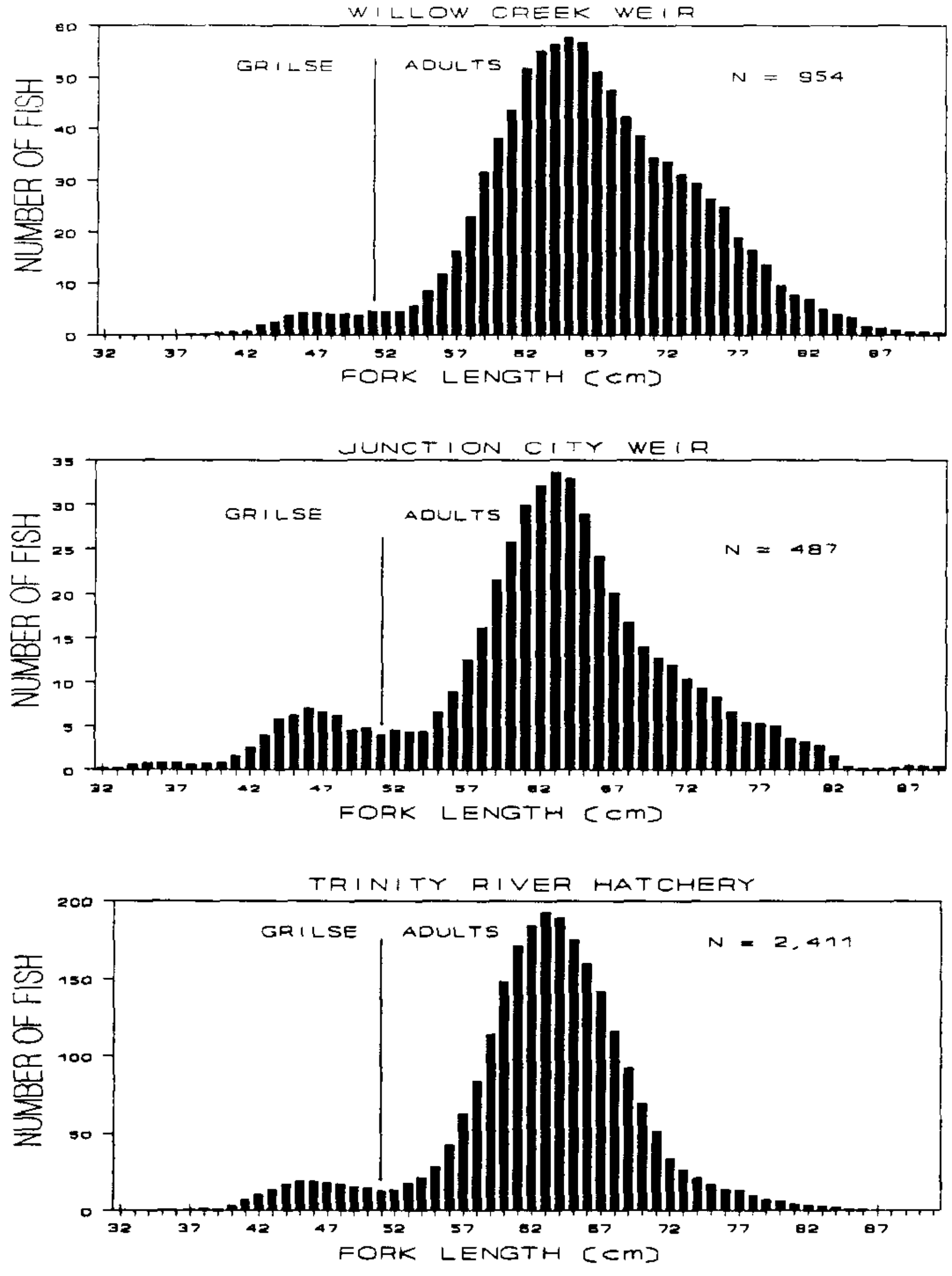

Figure 5. Fork lengths of fall-run chinook salmon trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1991-92 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line indicates the size (51 cm FL) separating grilse and adult fall-run chinook salmon.

and slightly slower than the migration rate in 1989 (Heubach et al. 1992a, 1992b).

Seventy-nine (8.3%) and 42 (8.6%) of the fall chinook trapped at WCW and JCW, respectively, were hatchery-marked fish (Table 5). The mean FLs of the hatchery-marked fall chinook were slightly larger than the unmarked fish trapped at each weir, but the differences were not statistically significant (Table 3).

We recovered coded-wire tags from 32 of the 33 fall chinook that had been trapped and spaghetti-tagged at WCW and recovered in the carcass survey or recaptured at TRH. All but one of the CWT fall chinook were from the 1987 and 1988 BYs produced at TRH (Table 4). The majority (82.3%) of the fish had been released as yearlings. One CWT grilse, spaghetti tagged at WCW as a fall chinook was later discovered to be a spring-run fish.

We recovered coded-wire-tags from 14 of the 17 fall chinook that had been trapped at JCW and entered TRH. All but one of the CWT fish were from the 1987 and 1988 BYs produced at TRH (Table 4), the majority (70.5%) had been released as yearlings.

<u>Incidence of Gill-net and Hook Scars.</u> Gill-net scars were observed on 5.5% and 12.4% of the fall chinook trapped at WCW and JCW, respectively. The difference was significant ($X^2 = 13.9$, $p<0.01$). The mean FLs of the gill-net-scarred fall chinook at WCW and JCW were not significantly different from the FLs of the non-gill-net-scarred fall chinook captured at the respective weirs (Table 3).

Because fewer gill-net-scarred fall chinook were seen at JCW than at WCW, we examined the recovery of WCW-tagged gill-net-scarred and non-gill-net-scarred fall chinook at JCW and TRH. The recovery of WCW-tagged gill-net-scarred and non-gill-net-scarred fall chinook at JCW was essentially the same at 4.6% and 4.9%, respectively. However, 30.4% of the effectively-tagged, non-gill-net-scarred fall chinook tagged at WCW were recovered at TRH compared to 18.5% of the gill-net-scarred fish, the difference being significant ($X^2=5.97$, $p<0.025$).

We also compared the recovery rates at TRH of gill-net-scarred and non-gill-net-scarred fall chinook tagged at JCW. Eleven of the 27 (40.7%) gill-net-scarred fish and 159 of the 432 (36.8%) non-gill-net-scarred fall chinook were recovered at TRH. The difference was not statistically significant ($X^2=0.04$, $p>0.80$).

The lower recovery rate of WCW-tagged, gill-net-scarred fall chinook at TRH compared to non-gill-net-scarred fish appears to be due to differences in their survival or behavior after these fish passed JCW, because there was no difference in the recovery rate of gill-net-scarred vs. non-gill-net-scarred fall chinook at

JCW. Whatever the reason for the relatively low recovery rate at TRH of gill-net-scarred fish tagged at WCW, it did not occur with the gill-net-scarred fall chinook tagged at JCW.

There were no differences in the recapture rates of tagged gill-net-scarred and non-gill-net-scarred fall chinook salmon during the previous two seasons (Heubach et al. 1992a, 1992b), and we do not know the reason for the difference this year. However, recapture rates of the gill-net-scarred and non-gill-net-scarred fall chinook should be examined in future years to determine any effects the Indian gill-net fishery may have on the chinook fall-run.

Thirty (3.1%) of the fall chinook trapped at WCW and 18 (3.7%) of the fall chinook trapped at JCW were hook scarred. Most of the hook scars on fish from WCW were of ocean origin (63.3%), whereas most of the hook scars on fish from JCW were of freshwater origin (72.2%). The mean FLs of the hook-scarred fall chinook at the WCW and JCW were similar to the non-hook-scarred fish at the respective weir sites (Table 3).

Coho Salmon

Run Timing. We trapped the first coho at WCW on 16 September 1992 (JW 37). The coho catches increased gradually through JW 39 (24-30 September), and then rapidly through JW 42 (15-21 October), when the run peaked (Figure 6). The numbers of coho trapped decreased dramatically the next week and more slowly thereafter. While we did not trap any coho salmon during JWs 47 through 49 (19 November-9 December) at WCW, one coho was trapped the day before the weir was removed for the season. We trapped 604 coho salmon at WCW during the 1991-92 season (Table 8).

The first coho entered the JCW trap 11 October (JW 41), approximately four weeks after they initially appeared at the WCW. While the coho run peaked during JW 45 (5-11 November) three weeks after it occurred at the WCW, there was a second smaller peak during JW 47 (19-25 November) (Figure 6). For comparison, the difference in trapping peaks between the two weirs during the 1990-91 season was only one week (Heubach et al. 1992b). We trapped the last coho at the JCW on 6 December 1991, one week before trapping operation ended for the season. We trapped 222 coho at JCW during the 1991-92 season (Table 8).

Size of Fish Trapped. The size ranges and mean FLs of coho trapped at WCW and JCW were similar (Table 9). The size separating grilse and adult coho is based on the coho that were trapped at JCW and that entered TRH (Figure 7), because a nadir separating grilse and adults was not apparent at WCW. The nadir separating grilse and adult coho at the JCW and TRH was 49 cm FL (Figure 7). Therefore, in this report we consider all coho ≤49 cm FL grilse, while larger coho are considered adults. All of

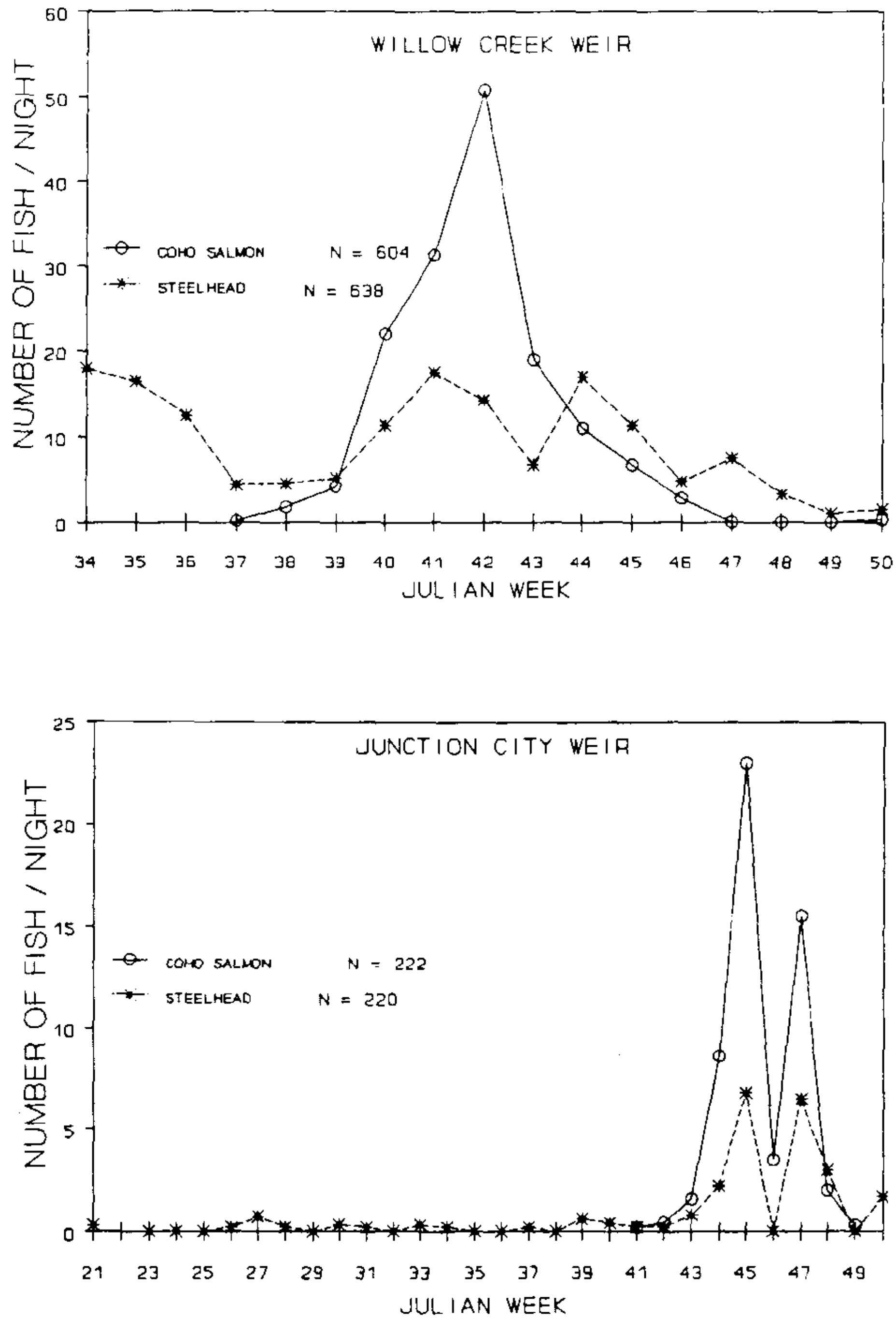

Figure 6. Average numbers of coho salmon and fall-run steelhead trapped per night each Julian week in the Trinity River at the Willow Creek and Junction City weirs during the 1991-92 season.

TABLE 8. Weekly summary of coho salmon trapped and tagged in the Trinity River at Willow Creek and Junction City weirs during the 1991-92 season.

Julian Week (dates)	Willow Creek Weir a/					Junction City Weir b/				
		Number trapped					Number trapped			
	Nights trapped	Grilse c/	Adults	Totals	Fish/ night	Nights trapped	Grilse c/	Adults	Totals	Fish/ night
21-36 (05/21-09/09)	12	0	0	0	0.0	78	0	0	0	0.0
37 (09/10-09/16)	5	0	1	1	0.2	5	0	0	0	0.0
38 (09/17-09/23)	4	1	6	7	1.8	5	0	0	0	0.0
39 (09/24-09/30)	5	1	20	21	4.2	5	0	0	0	0.0
40 (10/01-10/07)	4	0	88	88	22.0	5	0	0	0	0.0
41 (10/08-10/14)	4	3	122	125	31.3	5	0	1	1	0.2
42 (10/15-10/21)	4	10	193	203	50.8	5	0	2	2	0.4
43 (10/22-10/28)	4	2	74	76	19.0	5	2	6	8	1.6
44 (10/29-11/04)	4	1	43	44	11.0	5	2	41	43	8.6
45 (11/05-11/11)	4	0	27	27	6.8	4	3	89	92	23.0
46 (11/12-11/18)	4	0	11	11	2.8	2	0	7	7	3.5
47 (11/19-11/25)	4	0	0	0	0.0	4	0	62	62	15.5
48 (11/26-12/02)	4	0	0	0	0.0	3	0	6	6	2.0
49 (12/03-12/09)	4	0	0	0	0.0	4	0	1	1	0.3
50 (12/10-12/16)	4	1	0	1	0.3	3	0	0	0	0.0
TOTALS d/	58	19	585	604		40	7	215	222	
MEAN d/					10.4					5.6

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991.

b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991.

c/ Coho salmon grilse are ≤49 cm FL; adults are >49 cm FL.

d/ Based on computations beginning from the first Julian week that coho salmon were trapped through the end of the sampling period.

TABLE 9. Fork lengths of coho salmon trapped in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1991-92 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/	Total trapped	Ad+CWT c/	Effectively tagged d/	Recovered at TRH e/
37	1		1					
38	0		0					
39	0		0					
40	0		0					
41	0		0		1		1	1
42	2	1	2		0		0	0
43	2	0	1		0		0	0
44	2	0	2		0		0	0
45	0	0	0		1		1	1
46	1	0	1		3	1	3	3
47	3	1	3		2		2	1
48	2		2		0		0	0
49	6		5		0		0	0
50	2		1		0		0	0
51	2		2		1		1	1
52	5		5		2		2	2
53	3		3		0		0	0
54	9		7	1	1		1	1
55	11		10	3	5		5	2
56	15		15	4	7		6	4
57	14		13	4	9		9	4
58	22		21	6	1		1	0
59	30		29	7	10		9	7
60	23		23	4	12		11	8
61	34		34	11	12		11	8
62	45		44	16	11		8	6
63	49		48	17	14		14	10
64	53		51	25	21		20	12
65	57		56	23	24		24	15
66	58		57	16	22		22	14
67	57		56	13	18		17	7
68	39		38	7	10		10	8
69	22		22	4	18		18	15
70	19		19	6	10		10	7
71	7		7	3	5		5	5
72	7		6	1	1		1	1
73	0		0	0	0		0	
74	2		2	1	0		0	
75					1		1	
TOTALS	604	2	586	172	222	1	213	143
Mean FL	62.9	44.5	63.0	63.7	63.3	47.0	63.0	63.3
Grilse f/	19	2	17	0	7	1	7	6
Adults	585	0	569	172	215	0	206	137

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991.
c/ The fish were adipose fin clipped and coded-wire tagged and released from Trinity River Hatchery 18 March 1991.
d/ The number of effectively tagged fish is corrected for fish that were not tagged and tagging mortalities.
e/ TRH=Trinity River Hatchery.
f/ Coho salmon grilse are ≤49 cm FL; adults are >49 cm FL.

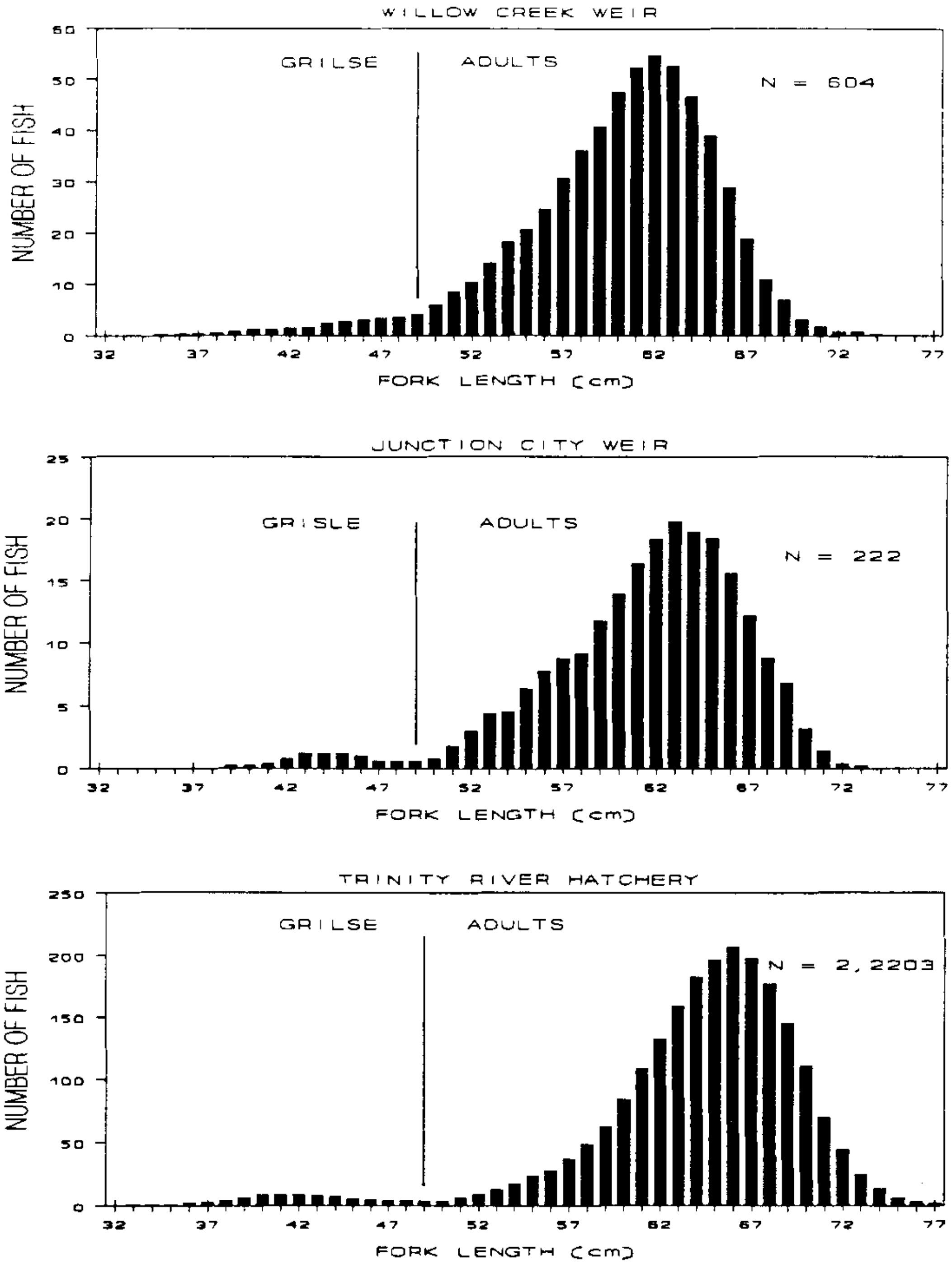

Figure 7. Fork lengths of coho salmon trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1991-92 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line indicates the size (49 cm FL) separating grilse and adult coho salmon.

the hatchery-marked coho that entered TRH this season were <49 cm FL (Appendix 3).

Grilse coho comprised approximately 3.2% and 3.3% of the coho trapped at WCW and JCW, respectively, essentially the same as the fraction of those entering TRH (3.6%). This suggests the modifications made to the weir boat gates this year were effective in preventing coho <50 cm FL from passing through the weirs.

Incidence of Tags and Hatchery Marks. We recaptured 27 coho at JCW that had been tagged at WCW. Their mean migration time was 27 d, for a mean migration rate of 3.4 km/d. The mean number of days the coho were at liberty between the weirs is slightly greater than the three-week difference in the peaks in the coho runs at the two weirs.

We trapped two hatchery-marked grilse coho at WCW and one at JCW (Table 9). These fish were probably returning 1989 BY coho that had been released from TRH on 13 March 1991.

Incidence of Gill-net and Hook Scars. Gill-net scars were observed on 4.1% and 1.8% of the coho trapped at WCW and JCW, respectively. The mean FLs of the gill-net-scarred coho at WCW and JCW were not significantly different than the non-gill-net-scarred fish at each site (Table 3).

None of 27 coho tagged at the WCW that were recaptured at JCW were gill-net scarred. This finding does not appear to be related to survival of the gill-net-scarred coho however, because 32% (7/22) of the effectively-tagged gill-net-scarred and 29% (165/564) of the non-gill-net-scarred coho tagged at WCW entered TRH. Also, three of four gill-net-scarred JCW-tagged coho entered the hatchery.

We found 4.0% each of the coho trapped at WCW and JCW to be hook scarred. Collectively, 64% of the hook scars appeared to be of freshwater origin. The mean FLs of the hook-scarred and non-hook-scarred coho trapped at WCW and JCW were similar (Table 3).

Fall-run Steelhead

Run Timing. We trapped steelhead during the first week (20-26 August 1991 [JW 34]) of operations at WCW and continued to catch them every week of the season there. The largest number of steelhead was trapped the first week followed by three weeks of progressively lower numbers (Figure 6). We trapped relatively large numbers of steelhead again at WCW during JWs 40 through 42 (1-21 October). The numbers of steelhead trapped peaked again in JW 44 (29 October-4 November) and generally declined through the end of the trapping season (13 December 1991). However, the steelhead run did not appear to be over when we removed the weir for the season. We trapped 638 steelhead at the WCW during the 1991-92 season (Table 10).

One steelhead entered the trap the first night of trapping at JCW, but we did not see another steelhead there until 26 June 1991 (JW 26). We trapped steelhead intermittently at JCW from JW 26 through JW 43 (25 June-28 October) (Figure 6). The steelhead run peaked JW 45 (5-11 November) and 47 (19-25 November 1991) at JCW and declined thereafter. We trapped 103 steelhead at JCW during the 1991-92 season (Table 10). It appeared that the coho and steelhead runs at WCW and JCW were synchronous, as they were in the 1990-91 season (Heubach et al. 1992b).

Size of Fish Trapped. The size ranges and mean FLs of steelhead trapped at WCW and JCW appeared similar (Table 11). Half-pounder steelhead (≤ 41 cm FL) made up 2.0% and 9.7% of the steelhead trapped at WCW and JCW, respectively. In contrast, approximately 22.2% of the steelhead that entered TRH were sub-adults (Figure 8). The higher proportion of steelhead ≤41 cm FL entering TRH in comparison to those trapped at the weirs is probably due to non-migrating resident steelhead entering the hatchery and not half-pounder steelhead passing the weirs.

Incidence of Tags and Hatchery Marks. We trapped 74 fin-clipped steelhead at WCW, 67% of which were from the 1988 BY, released from TRH in March 1990 (Appendix 4). Thirty-six fin-clipped steelhead were trapped at JCW, 36% of which were from the 1988 BY (Table 11).

The proportion of fin-clipped (TRH-produced) to non-fin-clipped steelhead (both naturally and hatchery-produced steelhead) was higher in the latter part of the steelhead runs at both weirs. For example, 17 (6.7%) of the 254 steelhead trapped at WCW through the mid-season nadir in JW 39 (24-30 September 1991) were fin clipped, while 57 (14.8%) of the 384 steelhead trapped after that period were fin clipped. The difference was significant (X^2= 9.12, p<0.05). While only two (14.3%) of the 14 steelhead trapped at JCW through 16 September (JW 37) were fin clipped, 34 (38.2%) of the 89 were fin clipped after that week. Although this difference was not statistically significant (X^2= 2.1, p<0.15), the trends at both weirs may indicate that the early portion of their steelhead runs were composed primarily of late-migrating spring-run steelhead, while the later migration period at both weirs were composed mostly of fall-run steelhead. For this report, however, we will consider all steelhead trapped as fall run.

The ranges in FLs and mean FLs of fin-clipped and non-fin-clipped steelhead trapped at WCW were essentially the same (Table 3). The mean FL of fin-clipped steelhead at JCW was 7.8 cm less than

TABLE 10. Weekly summary of fall-run steelhead trapped in the Trinity River at Willow Creek and Junction City weirs during the 1991-92 season.

Julian Week (dates)	Willow Creek Weir a/					Junction City Weir b/				
		Number trapped					Number trapped			
	Nights trapped	Half-pounders c/	Adults	Total	Fish/ night	Nights trapped	Half-pounders c/	Adults	Totals	Fish/ night
21 (05/21-05/27)	-	-	-	-	-	4		1	1	0.3
22 (05/28-06/03) d/	-	-	-	-	-	0	-	-	-	-
23 (06/04-06/10)	-	-	-	-	-	4		0	0	0.0
24 (06/11-06/17)	-	-	-	-	-	4		0	0	0.0
25 (06/18-06/24)	-	-	-	-	-	5		0	0	0.0
26 (06/25-07/01)	-	-	-	-	-	6		1	1	0.2
27 (07/02-07/08)	-	-	-	-	-	6		4	4	0.7
28 (07/09-07/15)	-	-	-	-	-	6		1	1	0.2
29 (07/16-07/22)	-	-	-	-	-	6		0	0	0.0
30 (07/23-07/29)	-	-	-	-	-	6		2	2	0.3
31 (07/30-08/05)	-	-	-	-	-	6		1	1	0.2
32 (08/06-08/12)	-	-	-	-	-	6		0	0	0.0
33 (08/13-08/19)	-	-	-	-	-	6		2	2	0.3
34 (08/20-08/26)	4	1	71	72	18.0	6		1	1	0.2
35 (08/27-09/02)	4	1	65	66	16.5	4		0	0	0.0
36 (09/03-09/09)	4	3	47	50	12.5	3		0	0	0.0
37 (09/10-09/16)	5	0	22	22	4.4	5		1	1	0.2
38 (09/17-09/23)	4	1	17	18	4.5	5		0	0	0.0
39 (09/24-09/30)	5	0	26	26	5.2	5	1	2	3	0.6
40 (10/01-10/07)	4	1	44	45	11.3	5	1	1	2	0.4
41 (10/08-10/14)	4	0	70	70	17.5	5	0	1	1	0.2
42 (10/15-10/21)	4	1	56	57	14.3	5	1	0	1	0.2
43 (10/22-10/28)	4	1	26	27	6.8	5	0	4	4	0.8
44 (10/29-11/04)	4	3	65	68	17.0	5	0	11	11	2.2
45 (11/05-11/11)	4	0	45	45	11.3	4	5	22	27	6.8
46 (11/12-11/18)	4	0	19	19	4.8	2	0	0	0	0.0
47 (11/19-11/25)	4	0	30	30	7.5	4	2	24	26	6.5
48 (11/26-12/02)	4	0	13	13	3.3	3		9	9	3.0
49 (12/03-12/09)	4	0	4	4	1.0	4		0	0	0.0
50 (12/10-12/16)	4	1	5	6	1.5	3		5	5	1.7
TOTALS	70	13	625	638		138	10	93	103	
MEAN					9.1					0.7

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991.
c/ Half-pounder fall-run steelhead are ≤41 cm FL; adults are >41 cm FL.
d/ Junction City Weir was unfishable due to high flows.

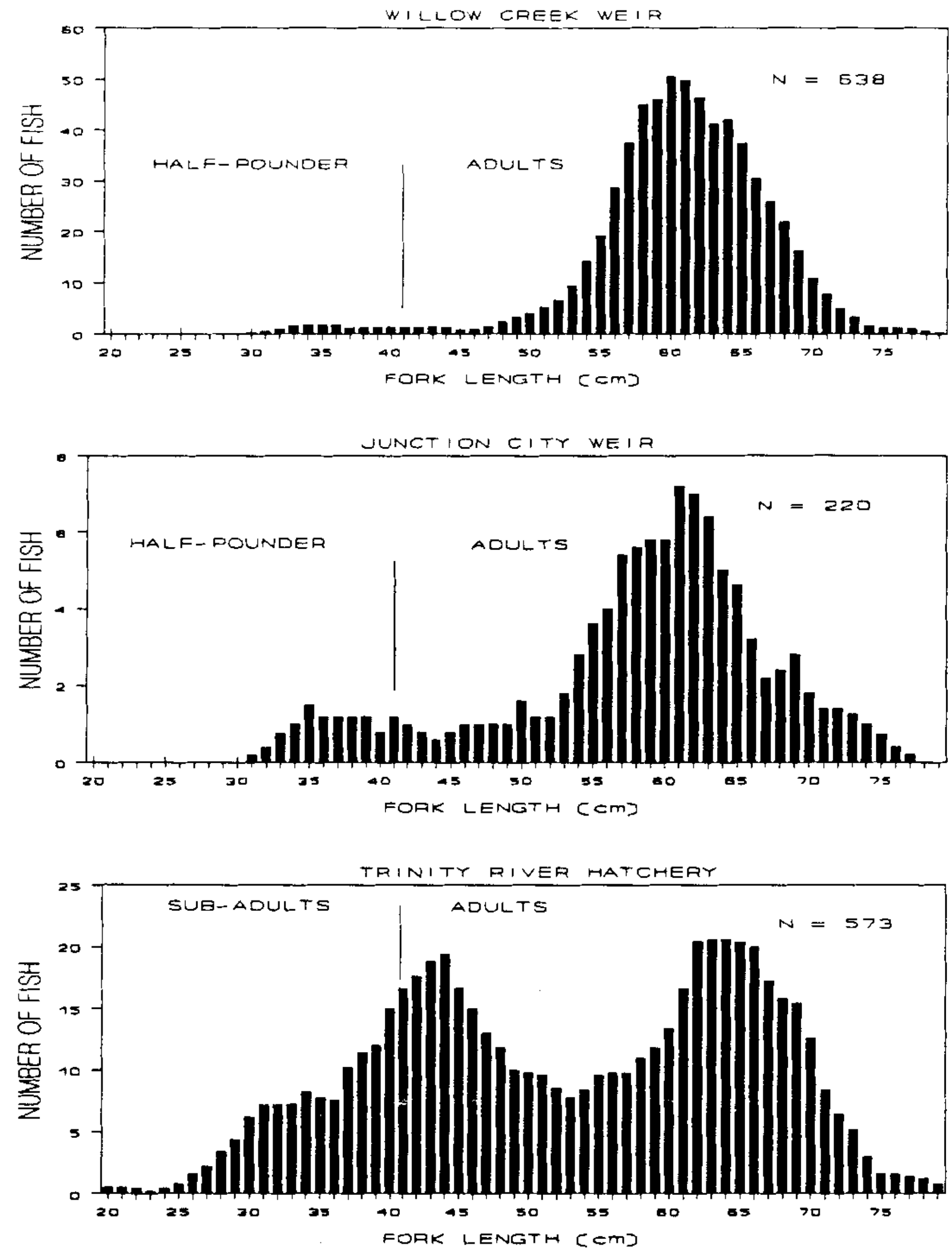

Figure 8. Fork lengths of fall-run steelhead trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1991-92 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line indicates the size (41 cm FL) separating half-pounder (sub-adult) and adult fall-run steelhead.

TABLE 11. Fork lengths of fall-run steelhead trapped and tagged in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1991-92 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Fin-clipped c/	Effectively tagged d/	Recovered at TRH e/	Total trapped	Fin-clipped c/	Effectively tagged d/	Recovered at TRH e/
33	1							
34	4	2			1	1		
35	1	0			1	1		
36	1	1			2	1		
37	2	1			2	2		
38	1	1			0	0		
39	1	1			1	1		
40	1	1			1	1		
41	1	1			2	2		
42	3	1	3		0	0		
43	1	1	1		2	2		
44	1	0	1		0	0		
45	1	0	1		0	0		
46	0	0	0		1	0	1	
47	1	0	1		1	1	1	1
48	2	1	2		3	1	3	0
49	4	1	4		0	0	0	0
50	5	0	5		0	0	0	0
51	4	0	3		1	0	1	1
52	5	0	5		4	2	4	1
53	8	0	8		1	1	1	0
54	11	0	10		0	0	0	0
55	19	1	19		3	1	3	0
56	28	1	26		6	2	6	0
57	30	1	30		8	2	8	0
58	55	3	55		3	0	3	0
59	55	4	54	2	7	2	7	0
60	57	1	56	1	4	1	4	0
61	33	1	32	0	7	1	7	1
62	52	7	51	4	8	4	8	4
63	52	4	51	3	10	1	10	3
64	38	8	38	2	6	3	6	1
65	31	8	30	2	1	1	1	0
66	37	11	37	1	0	0	0	0
67	29	5	29	3	6	1	6	2
68	17	1	17	0	3	0	3	1
69	15	3	14	3	1	0	1	0
70	11	0	11	0	2	0	2	0
71	9	1	7	1	2	0	2	1
72	2	1	2	1	1	0	1	1
73	2	1	2		1	1	1	
74	1		1		1		1	
75	2		2					
76	1		1					
77	0		0					
78	2		2					
79	0		0					
80	0		0					
81	0		0					
82	1		1					
TOTALS	638	74	612	23	103	36	91	17
Mean FL	60.7	60.1	61.2	64.8	58.0	52.9	60.6	62.2
Half-pounders f/	13	8	0	0	10	9	0	0
Adults	625	66	612	23	93	27	91	17

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991.
c/ The fish were fin clipped and released from Trinity River Hatchery in 1989 and 1990. See Appendix 5 for the fork lengths of fall-run steelhead with the distinguishing fin clips.
d/ The number of effectively tagged fish is corrected for fish not tagged and tagging mortalities.
e/ TRH = Trinity River Hatchery
f/ Half-pounder fall-run steelhead are ≤41 cm FL; adults are >41 cm FL.

the non-fin-clipped steelhead, although the difference was not statistically significant (Table 3).

Incidence of Gill-net and Hook Scars. Twenty steelhead trapped at WCW had gill-net scars. The mean FL of the gill-net-scarred steelhead was slightly larger than that of the non-gill-net-scarred steelhead, but the difference was not significantly different (Table 3). Only three gill-net-scarred steelhead were trapped at JCW.

Hook scars were observed on 3.3% and 4.8% of the steelhead trapped at WCW and JCW, respectively. At both weirs the hook-scarred steelhead appeared to be slightly larger than the non-hook-scarred fish, although both differences were not significant (Table 3).

Recovery of Tagged Fish

Tagging Mortalities

Spring-run Chinook Salmon. We trapped 310 spring chinook at JCW, all of which were tagged. Nine tagged fish (2.9% of those trapped) were recovered dead at the weir or were reported dead by anglers. We effectively tagged 301 spring chinook (24 grilse and 277 adults) at JCW during the 1991-92 season (Table 2). All were reward tagged. After correcting for tag loss, 298 spring chinook were effectively reward tagged.

Fall-run Chinook Salmon. We trapped 954 fall chinook at WCW, one of which was dead in the trap, 32 were released untagged, and four tagged fish were recovered dead at the weir or reported dead by anglers. We effectively tagged 917 fall chinook (35 grilse and 882 adults) at WCW during the 1991-92 season. We placed reward tags on 721 (26 grilse and 695 adults [78.6%]) of the effectively-tagged fall chinook at WCW (Table 7). After correcting for tag loss, we effectively reward tagged 702 fall chinook at WCW.

We trapped 489 fall chinook at JCW, released 28 untagged, and recovered two of the tagged fish dead at weir. Therefore, we effectively tagged and released 459 fall chinook (55 grilse and 404 adults) at JCW during the 1991-92 season. Reward tags were placed on 254 (53 grilse and 201 adults [53.3%]) of the effectively-tagged fall chinook at JWC (Table 7). After correcting for tag loss, a total of 250 fish was effectively reward tagged at JCW.

Coho Salmon. We trapped 604 coho at WCW, two of which died in the trap; we released 15 untagged, and one tagged fish was found dead soon after tagging. Thus, we effectively tagged 586 coho (17 grilse and 569 adults) at WCW, including 400 with a reward tag (all adults) (Table 9). No adjustment for tag loss was necessary since all of the coho from WCW that reached TRH retained their spaghetti tags.

We trapped 222 coho at JCW, and released nine fish untagged. There were no tagging mortalities. Thus, 213 coho (seven grilse and 206 adults) were effectively tagged at JCW, including 180 with reward tags (Table 9). We adjusted the number of reward-tagged coho to 177 to compensate for tag shedding.

Fall-run Steelhead. We trapped 638 steelhead at WCW, 26 of which were released untagged. There were no tagging mortalities, leaving 612 effectively-tagged adult steelhead (Table 11). Included in the total were 415 reward-tagged fish. No adjustment for tag loss was necessary since all of the steelhead from WCW that reached TRH retained their spaghetti tags.

We trapped 103 steelhead at JCW, 12 of which were released untagged. We did not recover any dead steelhead. Therefore, we effectively tagged 91 adult steelhead, all but one with reward tags (Table 11). After correcting for tag loss, we effectively reward tagged 85 steelhead. Ten of the reward-tagged steelhead were fish that had been tagged and released at WCW and recaptured and rereleased at JCW.

Tag Returns by Anglers

Spring-run Chinook Salmon. Anglers returned 42 reward tags (one grilse and 41 adults) of 298 effectively-reward-tagged spring chinook, for an overall harvest rate of 14%. In past years, the harvest rate of spring chinook in the Trinity River basin upstream of Junction City has typically ranged from 13% to 16%, but has been as high as 26% (Heubach 1984a, 1984b; Heubach and Hubbell 1980; Heubach et al. 1992; Zuspan et al. 1985). The mean FL of the spring chinook caught by anglers was 65.5 cm, similar to the mean for those spring chinook effectively tagged at the weirs (Table 2). The number of days between tagging and reported capture by anglers ranged from 5 to 98 d., with a mean of 41 d.

Fall-run Chinook Salmon. Anglers returned 104 tags from fall chinook salmon tagged at WCW; seven non-reward tags, 45 $10-reward tags and 52 $20-reward tags. We estimate that 14% of the fall chinook were harvested in the Trinity River upstream of WCW. This harvest rate is typical of the Trinity River basin fall chinook harvest upstream of Willow Creek. Harvest rates usually have been greater than 10% (Heubach 1984a, 1984b; Heubach and Hubbell 1980; Heubach et al. 1992; Zuspan et al. 1985) with the exception of a low of 3.5% in 1990 and 6.5% in 1989 (Heubach et al. 1992). Anglers caught 19.2% (5/26) of the effectively-tagged grilse and 13.6% (92/676) of the effectively-tagged adults. The difference was not statistically significant (X^2=0.23, p=0.60).

The mean FL of the fall chinook from WCW caught by anglers was 63.7 cm, similar to the mean for all effectively-tagged fall chinook from that location (Table 7). Anglers caught these fish from 1 to 60 d after being tagged, for an average of 23 d.

Anglers returned only four tags from the 250 fall chinook effectively reward tagged at JCW. Therefore, anglers caught 2% of the fall chinook in the Trinity River that passed JCW. The average size of the fish caught was 64.2 cm FL, again similar to the average of those effectively tagged at JCW (Table 7). Anglers caught these fish from 5 to 35 d after tagging, for a mean of 18 d.

Coho Salmon. Anglers returned tags from five WCW-tagged coho; two $10-reward tags and three $20-reward tags. We estimate the harvest rate of coho upstream of WCW was 1% (5/400). The mean size of the fish was 63.8 cm FL, similar to that of all the effectively-tagged coho from WCW (Table 9). The fish were caught from 8 to 34 d after being tagged, for a mean of 27 d.

Only one $10-reward tag was returned from 177 coho effectively tagged at JCW. We estimate that anglers caught only 0.6% of the coho salmon that passed JCW. The angler caught this fish 12 d after it was tagged and released at JCW. The low harvest of coho salmon in the Trinity River this year is consistent with results of earlier studies (Heubach 1984a, 1984b; Heubach and Hubbell 1980; Heubach et al. 1992a, 1992b; Zuspan et al. 1985).

Fall-run Steelhead. Anglers returned 98 tags from WCW-tagged steelhead; 13 non-reward tags, 41 $10-reward tags, and 44 $20-reward tags. Based on the reward tags returned, we estimate anglers caught 20% of the steelhead migrating upstream of WCW. The mean size of the fish was 60.3 cm FL, similar to that of all the effectively-tagged steelhead from WCW (Table 11). The steelhead were caught from 2 to 212 d after being tagged, for a mean of 55 d.

Anglers returned nineteen tags from steelhead tagged at JCW; one non-reward tag, 16 $10-reward tags, and two $20-reward tags. The two $20-reward tags were from fish that were tagged and released from WCW and recaptured and rereleased at JCW. Based on the reward tags returned, 21% of the steelhead migrating upstream of JCW were caught by anglers. The mean size of the steelhead reported caught was 58.4 cm FL, similar to that of all the effectively-tagged steelhead tagged from JCW (Table 11). Anglers captured fish from 4 to 174 d after tagging, for a mean of 66 d.

Analyses of Non-reward and Reward Tag Returns

Fall-run Chinook Salmon. Anglers returned 3.7% of the non-reward tags, 13.0% of the $10-reward tags, and 14.9% of the $20-reward tags applied to fall chinook salmon at WCW. The differences are highly significant (X^2=15.9, p<0.01 [Table 12]). The difference in the return rates of $10-reward and $20-reward tags was not statistically significant (X^2=0.6, p=0.41).

Coho Salmon. Anglers returned none of the non-reward, 1.0% of the $10-reward, and 1.5% of the $20-reward tags, but the differences were not statistically significant (Table 12).

Fall-run Steelhead. Anglers returned 6.6% of the non-reward, 19.3% of the $10-reward, and 21.7% of the $20-reward tags. The differences are highly significant (X^2=19.4, p<0.01 [Table 12]). The difference in return rates of $10- and $20-reward tags was not statistically significant (X^2=0.2, p=0.75).

Although anglers returned the $20-reward tags at a greater rate than the other tag denominations, the rate was not statistically different from that of the $10-reward tags. We believe the $20-reward tags may have encouraged some anglers to retrieve dead salmon from the river in hopes of finding a reward tag. Some anglers who returned a $20-reward tag stated in their return letters that they had released the fish after extracting the tag. This may explain the relatively high tag shedding rate of fall chinook tagged at WCW. Also, some reward-tagged chinook were reported to have been caught late in the spawning season, evidence that the fish were found dead in the river. A few anglers reported they had caught up to five reward-tagged fish, an unlikely probability.

With the possibility that some anglers are resorting to illegal activities in order to catch a reward-tagged fish or are retrieving dead reward-tagged fish, we recommend that the application of $20-reward tags be discontinued in 1992. We will continue to use $10-reward tags.

Salmon Spawner Survey

Spring-run Chinook Salmon. Personnel of the TFIP recovered one spring chinook tagged at WCW, and ten that had been tagged at JCW in the salmon spawner survey. The ten fish from JCW averaged 68.8 cm FL, 2.9 cm greater than the mean for all spring chinook effectively tagged at JCW. However, this mean size difference was not significant (t=0.1, p<0.05). TFIP personnel recovered these fish from 67 to 148 d after they were released at JCW, with a mean of 101 d.

Fall-run Chinook Salmon. Personnel of the TFIP recovered 19 fall chinook in the spawner survey that had been tagged at WCW. They ranged in size from 58 to 76 cm FL, with a mean of 67.2 cm FL, which was 1.8 cm larger than the mean FL for all tagged fall chinook at WCW. This size difference was not significant (t=0.1, p<0.05). They had been tagged and released from 20 to 84 d before being recovered on the survey, with a mean of 54 d.

Twelve JCW-tagged fall chinook were recovered on the spawner survey. They ranged in size from 58 to 78 cm FL, with a mean of 66 cm FL, 3.5 cm greater than the mean FL for all chinook tagged at JCW. The difference in mean size between the two groups was not significant ($t=0.1$, $p<0.05$). The fish were caught from 10 to 33 d after release, with a mean of 22 d.

Coho Salmon. Four coho salmon that had been tagged at WCW were recovered in the spawner survey. They ranged in size from 60 to 68 cm FL, with a mean of 63.8 cm FL, over 5 cm greater than the mean FL for all tagged coho at WCW. However, this mean size difference was not significant ($t=0.27$, $p<0.05$). Personnel recovered these fish from 32 to 50 d after tagging, with a mean of 41 d.

TFIP personnel recovered nine coho in the spawner survey that we tagged at JCW. They ranged in size from 49 to 70 cm FL, and averaged 61.6 cm FL, 1.4 cm less than the mean for all tagged coho at JCW. This mean size difference was not significant ($t=0.01$, $p<0.05$). TFIP personnel recovered these coho from 11 to 28 d after tagging at JCW, with a mean of 17 d.

Except for spaghetti-tagged coho from JCW, the mean FLs of spaghetti-tagged spring and fall chinook, and coho recovered in the spawner surveys were greater than the average for each of the original groups of fish at the respective weirs. Small sample sizes of recovered tagged fish may have resulted in the lack of significant differences between the recovered and original tagged groups. The apparently larger mean size of tagged fish recovered in the spawner survey is consistent with data collected during similar surveys in past years (Smith 1975, Heubach 1984, 1984b; Heubach et. al. 1992b, Zuspan et. al. 1985). It is possible that larger fish were more easily observed and recovered in the spawner surveys than smaller fish, or that predators removed the smaller fish more readily before they could be recovered.

Trinity River Hatchery

Spring-run Chinook Salmon. Based on coded-wire tag recoveries, all of the 629 chinook salmon that entered TRH from 16 September through 7 October 1991 were spring-run fish. Their median entry date was 26 September (JW 39) and the last spring chinook entered the hatchery on 24 October 1991 (JW 43) (Table 13, Figure 9). We estimate 685 spring chinook (71 grilse and 614 adults) entered TRH during the 1991-92 season.

We recaptured 86 spring chinook (nine grilse and 77 adults) at TRH that we had tagged at JCW, including one fish which had shed its tag. Thus, we recovered 28.6% of the spring chinook which were tagged at JCW (Table 13). Their median entry date was the

TABLE 12. Angler-return rates of non-reward and reward tags applied to fall-run chinook and coho salmon, and fall-run steelhead in the Trinity River at Willow Creek Weir during the 1991-92 season.

Species	Effective numbers of tags applied and returned by anglers a/									Chi-square	P
	Non-reward			$ 10 Reward			$ 20 Reward				
	Applied	Returned	(%)	Applied	Returned	(%)	Applied	Returned	(%)		
Fall-run chinook	191	7	(3.7)	354	46	(13.0)	348	52	(14.9)	15.9	< 0.01
Coho	186	0	(0.0)	201	2	(1.0)	199	3	(1.5)	2.7	0.10
Fall-run steelhead	196	13	(6.6)	212	41	(19.3)	203	44	(21.7)	19.4	< 0.01

a/ The number of effectively-tagged fish is corrected for tagging mortalities and tag shedding.

TABLE 13. Total numbers and numbers of Project-tagged chinook and coho salmon that entered Trinity River Hatchery during the 1991-92 season. a/

Entry date b/	Julian week	Chinook salmon: Number entering TRH c/	Spring run, Tagged at: Willow Creek Weir	Spring run, Tagged at: Junction City Weir	Fall run, Tagged at: Willow Creek Weir	Fall run, Tagged at: Junction City Weir	Coho salmon: Number entering TRH c/	Coho, Tagged at: Willow Creek Weir	Coho, Tagged at: Junction City Weir
09/16	37	127		17					
09/19	38	41		7					
09/23		116		20					
09/26	39	85 *	1	16 *					
09/30		94	1	8					
10/03	40	87	1	7	1	2			
10/07		79	0	5	1	0	1		
10/10	41	40	1 *	3	2	0	0		
10/15	42	132	3	2	6	3	1	1	
10/17		61	0	0	10	12 (2)d	1	0	
10/21		197	1	1	25	17 (1)	4	0	1
10/24	43	244	1		26	22 (3)	11	3	0
10/28		295			38	12 (1)	25	2	0
10/31	44	249			26 *	7	180	15	3 (1
11/04		434 *			50	8 *	118	16	12 (5
11/07	45	288			24	23 (2)	319	34	11 (1
11/12	46	360			34	47 (2)	481	39 *	63 * (5
11/14		113			11	5	210 *	9	2
11/18		221			5	5	508	17	12 (1
11/21	47	65			6	2 (1)	426	15	5 (1
11/25		28			1	2	235	14	28 (1
11/27	48	9			1	1 (1)	78	3	3
12/02		2				1	64	1	3
12/06	49	0				0	12	0	
12/09		4				1	7	1	
12/12	50	1					7	2	
TOTALS		3,372	9	86	267	170 (13)	2,688	172	143 (15

a/ The fish ladder was open 16 September 1991 through 27 March 1992.
b/ Entry date is considered the day the fish were initially sorted, although they may have entered the hatchery at any time after the previous sorting period.
c/ Numbers shown include tagged fish that were recovered the same day. TRH= Trinity River Hatchery.
d/ Figures in parenthesis are fish that were tagged and released at Willow Creek Weir and recaptured and rereleased at Junction City Weir, and that subsequently entered Trinity River Hatchery. They are included in totals shown.
* Median entry date (midpoint of total number of fish recovered) into Trinity River Hatchery. The first and secon asterisks in the first column of numbers shown for chinook salmon are the estimated median entry dates of sprin and fall-run chinook into Trinity River Hatchery respectively.

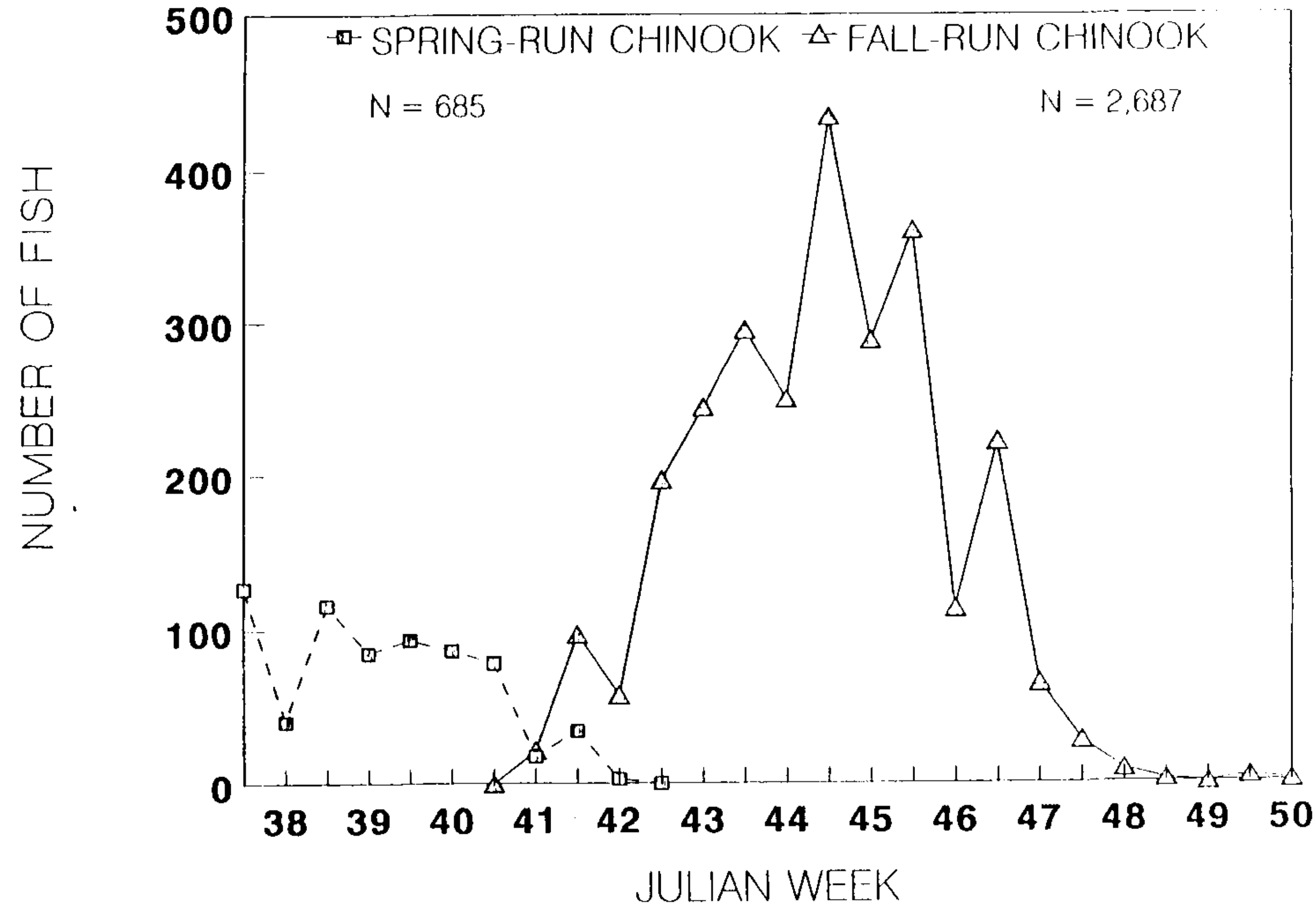

FIGURE 9. Estimated numbers of spring- and fall-run chinook salmon that entered Trinity River Hatchery during the 1991-92 season. The fish ladder was open from 16 September 1991 through 27 March 1992.

same as for all spring chinook combined, 26 September 1991 (JW 39). The mean FL of the Project-tagged spring chinook from JCW that entered TRH was 2.6 cm less than the average for all spring chinook effectively tagged at the weir. The difference was not statistically significant ($t=0.32$, $p<0.05$) (Table 2). The Project-tagged spring chinook from JCW had been at liberty from 19 to 108 d (mean of 76 d) before entering TRH.

We recovered nine (15.0%) of 60 Project-tagged spring chinook from WCW at TRH (Table 13). Their median entry date was 10 October (JW 41), approximately two weeks after the median entry date for all spring chinook combined.

The mean FL of the Project-tagged spring chinook from WCW that entered TRH was similar to that of all spring chinook effectively tagged at the weir (Table 2). They had been tagged at WCW from 34 to 63 d before entering TRH, for an average of 50 d.

We recovered 60 hatchery-marked spring chinook at TRH, but CWTs were recovered from only 45 of these fish (Table 14). The greatest returns of CWT fish were from the 1987 and 1988 BYs that had been released as smolts. The median entry date into TRH of all hatchery-marked spring chinook was 23 September 1991.

Fall-run Chinook Salmon. The first fall chinook entered TRH 10 October 1991 (JW 41), the run peaked 4 November (JW 44), and decreased steadily through 12 December (JW 50), when the last chinook entered the hatchery (Figure 9). The median entry date of all fall chinook was 4 November 1991 (Table 13). We estimate 2,687 fall chinook (205 grilse and 2,482 adults) entered TRH during the 1991-92 season.

We recaptured at TRH 267 fall chinook (nine grilse and 258 adults) that we had tagged at WCW, 29% of those effectively tagged at the weir (Table 7). Seven of these fish had shed their spaghetti tags. The median entry date of the Project-tagged fish from WCW was 31 October 1991 (JW 44). These Project-tagged fish ranged from 42 to 79 cm FL, and averaged 62.5 cm FL, nearly 3 cm less than those effectively tagged (Table 7). However, the difference was not significant ($t=0.64$, $p>0.05$). These Project-tagged fish entered TRH from 13 to 62 d after tagging, averaging 34 d, for a mean migration rate of 3.9 km/d.

We recaptured 170 (13 grilse and 157 adults [37%]) JCW-tagged fall chinook, including three fish that shed their spaghetti tags (Table 13). These counts included fall chinook that had been tagged and released at WCW, and recaptured and rereleased at JCW. The median entry date of the Project-tagged fish from JCW was 4 November 1991 (JW 44), the same as for all fall chinook combined. The Project-tagged fish recaptured at TRH ranged in size from 41 to 80 cm FL, with a mean of 61.6 cm FL, similar to the size of all fall chinook tagged at JCW (Table 7). Project-

TABLE 14. Entry dates of coded-wire-tagged, Trinity River-strain, spring-run chinook salmon recovered at Trinity River Hatchery during the 1991-92 season. a/

	Brood year	1986	1987	1988		1989		
	Tag code	06-61-46	06-61-47	06-61-49	06-61-48	06-56-39		
	Release date	09/24/87	05/23/8	05/26/89	10/24/8	10/01/90		
Entry date b/	Julian week						Shed tag c/	Totals
09/16	37	3	3	4	2		7	19
09/19	38	1	0	1	0		0	2
09/23			4	3	0		3	10 *
09/26	39		3	2	4		3	12
09/30			1	1	1	1	1	5
10/03	40		1	1	1	1	0	4
10/07			1	0	0	1	1	3
10/10	41			1	0	0		1
10/15					1	2		3
10/17	42					1		1
TOTALS		4	13	13	9	6	15	60

a/ The fish ladder was open from 16 September 1991 through 27 March 1992.
b/ Entry date is considered the date the fish were initially sorted, although they may have entered the hatchery any time after the previous sorting period.
c/ No tag was recovered from the marked fish. All chinook salmon that shed a tag and were recovered from 16 September through 15 October are considered spring-run; salmon that shed tags and were recovered after 15 October are considered fall-run.
* = Median entry date (midpoint of total number of fish recovered) into Trinity River Hatchery.

tagged fall chinook from JCW entered TRH 2 to 30 d after tagging, averaging 9 d. Their average migration rate was 4.6 km/d, which appears slightly faster than that for fall chinook tagged at WCW.

We recaptured 317 hatchery-marked fall chinook at TRH, and recovered 301 CWTs (Table 15). Fall chinook from the 1987 and 1988 BYs released as yearlings composed 73% of the CWT fish recovered at TRH. The median entry date of the hatchery-marked fall chinook was 31 October 1991 (JW 44).

Coho Salmon. The first coho entered TRH on 7 October 1991 (JW 40). The number of coho entering TRH remained low through the end of JW 42 (21 October) but increased rapidly thereafter through JW 46 (12-18 November), when the run peaked (Figure 10). The median entry date was 14 November (JW 46). The number of coho entering TRH decreased thereafter through 12 December 1991 (JW 50), the last day coho entered the hatchery. We counted 2,688 coho (98 grilse and 2,590 adults) entering TRH during the 1991-92 season (Table 13).

We recovered 172 coho (all adults) at TRH that had been tagged at WCW. Thus, we recovered 29.4% of the coho effectively tagged at WCW. All of these coho had retained their spaghetti tag. The median entry date of Project-tagged coho that entered TRH was 12 November 1991 (JW 46) (Table 13). The coho ranged in size from 54 to 74 cm FL, and averaged 63.7 cm FL, essentially the same size as all coho effectively tagged at WCW (Table 9). The Project-tagged coho entered TRH from 8 to 63 d after tagging with a mean of 30 d. Their mean migration rate was 4.4 km/d.

We recovered 143 coho (six grilse and 137 adults) at TRH that had been tagged at JCW, including 15 coho originally tagged at WCW that were recaptured and rereleased at JCW. Thus, we recovered 67% of the coho effectively tagged at JCW (Table 13). The total also included two coho that had shed their tags. The median entry date of all Project-tagged coho from JCW was 11 November 1991 (JW 46). These fish ranged in size from 41 to 72 cm FL and averaged 63.3 cm FL, essentially the same as the size of all coho effectively tagged at JCW.

The Project-tagged coho from JCW took from 2 to 27 d to migrate to the hatchery, for a mean of 8 d. Their mean migration rate was 5.6 km/d. The 14 coho originally tagged at WCW that were recaptured and rerelease at JCW migrated at an average rate of 3.6 km/d from WCW to JCW, and from there to TRH at 5.8 km/d.

We recovered five CWTs from eight hatchery-marked coho that entered TRH. All the fish were from the 1989 BY that were released in March 1991 as yearlings (Table 16). We did not expect any hatchery-marked adult coho this year, as none of the coho from the 1988 BY produced at TRH were marked during the

TABLE 15. Entry dates of coded-wire-tagged, Trinity River-strain, fall-run chinook salmon recovered at Trinity River Hatchery during the 1991-92 season. a/

Brood year		1987		1988				1989					
Tag code		06-56-33	06-56-31	06-56-35	06-56-32	06-55-22	06-55-23	060104010	06-56-34	06-56-37	06-56-41		
Release date		06/02/88	10/28/88	06/12/89	10/27/89	11/01/89	11/01/89	05/18/90	10/15/90	10/16/90	10/16/90		
Entry date b/	Julian week											Shed tag c/	Totals
10/10	41	1											1
10/15	42	0	7		3		1						11
10/17		0	5		6		0		1			1	13
10/21		3	4	4	11	2	0		1			2	27
10/24	43	3	13	2	6	4	3		0			0	31
10/28		1	12	2	17	3	2	1	0		1	2	41
10/31	44	1	11	10	23	2	0	0	0		0	0	47 *
11/04		2	9	0	32	3	1	0	1		2	3	53
11/07	45		3	1	14		2	0	0	1		3	24
11/12	46		3	2	27		1	0	0			3	36
11/14			2	2	6			0	1			2	13
11/18			1		12			1					14
11/21	47		1		1								2
11/25			1		3								4
TOTALS		11	72	23	161	14	10	2	4	1	3	16	317

a/ The fish ladder was open from 16 September 1991 through 27 March 1992.

b/ Entry date is considered the date the fish were initially sorted, although they may have entered the hatchery any time after the previous sorting period.

c/ No tag was recovered from the marked fish. All chinook salmon that shed their tag and were recovered after 15 October are considered fall-run chinook; salmon that shed their tag and were recovered through 15 October 1991 are considered spring-run chinook.

* Median entry date (midpoint of total number of fish recovered) into Trinity River Hatchery.

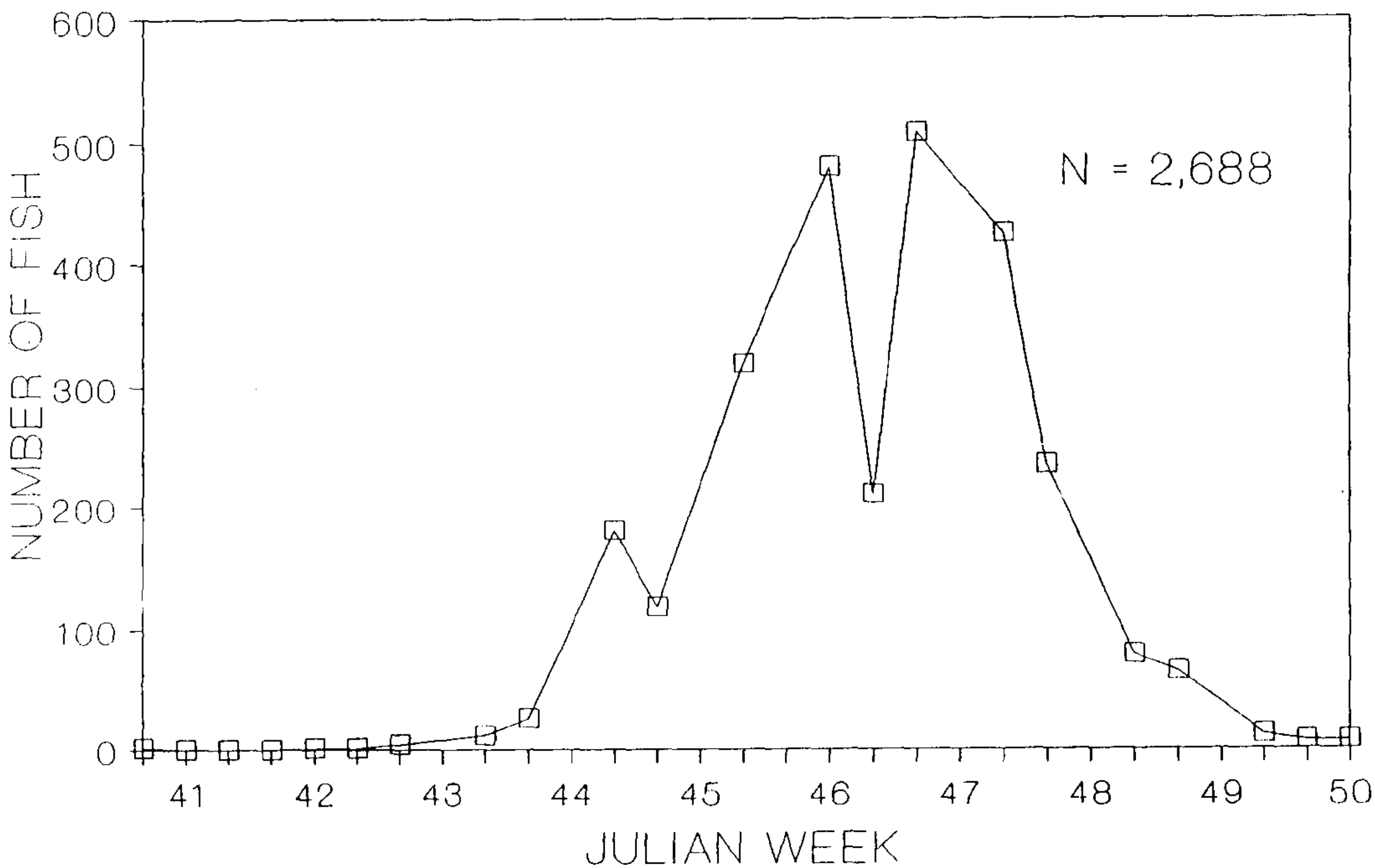

Figure 10. Numbers of coho salmon that entered Trinity River Hatchery during the 1991-92 season. The fish ladder was open from 16 September 1991 through 27 March 1992.

TABLE 16. Entry dates of coded-wire-tagged, Trinity River-strain, coho salmon recovered at Trinity River Hatchery during the 1991-92 season. a/

	Brood year	1989		
	Tag code	06-56-60		
	Release date	03/18/91		
Entry date b/	Julian week	Number recovered	No tag c/	Totals
10/31	44	4		4
11/04		0		0
11/07	45	1	1	2
11/12	46		1	1
11/14			0	0
11/18			0	0
11/21	47		1	1
Totals		5	3	8

a/ The fish ladder was open from 16 September 1991 through 27 March 1992.

b/ Entry date is considered the date the fish were initially sorted, although they may have entered the hatchery any time after the previous sorting period.

c/ No tag was recovered from the marked fish.

spring of 1990.

<u>Fall-run Steelhead.</u> The first steelhead entered TRH on 7 October 1991 (JW 40), but the numbers entering the hatchery remained low through JW 45 (5-11 November) (Figure 11). Relatively large numbers of steelhead entered the hatchery from JW 44 through 48 (29 October-2 December), then decreased and remained low from JW 49 through 3 (3 December 1991-21 January 1992). The number of steelhead entering the hatchery again increased substantially JW 5 through 12 (29 January-25 March 1992). The last steelhead entered the hatchery 27 March 1992 (JW 13) when the fish ladder was closed. The temporal distributions in the entry of adult and sub-adult steelhead into the hatchery appeared to be essentially the same. The median entry date of all steelhead into TRH was JW 6 (2-11 February 1992). A total of 573 steelhead (127 sub-adults and 446 adults) entered TRH during the 1991-92 season (Table 17).

We recovered 423 steelhead at TRH that had originally been fin clipped by TFIP personnel (Appendix 4)[6/]. The 1988 and 1989 BYs released in March 1990 and March 1991, respectively, as two-year-olds composed 78% of the fin-clipped steelhead entering TRH (Appendix 4). It is possible that some of the fin-clipped steelhead entering TRH which we thought were from the 1988 BY were actually 1990 BY fish that had been given a similar fin clip before being released 16 March 1991 (JW 11).

Ninety-four percent of the sub-adult and 68% of the adult steelhead that entered TRH were fin clipped, the difference being highly significant (X^2=33.7, p<.01). This difference may be due to a large number of non-migratory, (i.e. resident) sub-adult steelhead produced at the hatchery reentering TRH. Steelhead of the 1990 BY released from TRH on 16 March 1991 (JW 11) could have reentered the hatchery in sufficient numbers to increase the proportion of fin-clipped sub-adult steelhead returning to the hatchery. Not all of the steelhead released in 1990 that returned to TRH in 1991 were >41 cm FL, so some would have been considered sub-adults (Appendix 5). The mean FL of non-fin-clipped adult steelhead that entered TRH, 62.5 cm, was greater than the fin-clipped adult steelhead, 55.3 cm FL, although the difference was not significant (t=1.20, p<0.20).

Twenty-three Project-tagged steelhead from WCW entered TRH (Table 17). The first nine entered the hatchery during JWs 46 and 47 (12 November-25 November 1991), but the majority entered the hatchery after JW 2 (8-14 January 1992). The median entry week of these Project-tagged steelhead was JW 6 (5-11 February

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<u>6</u>/ Does not include two adipose and one right pectoral fin-clipped steelhead.

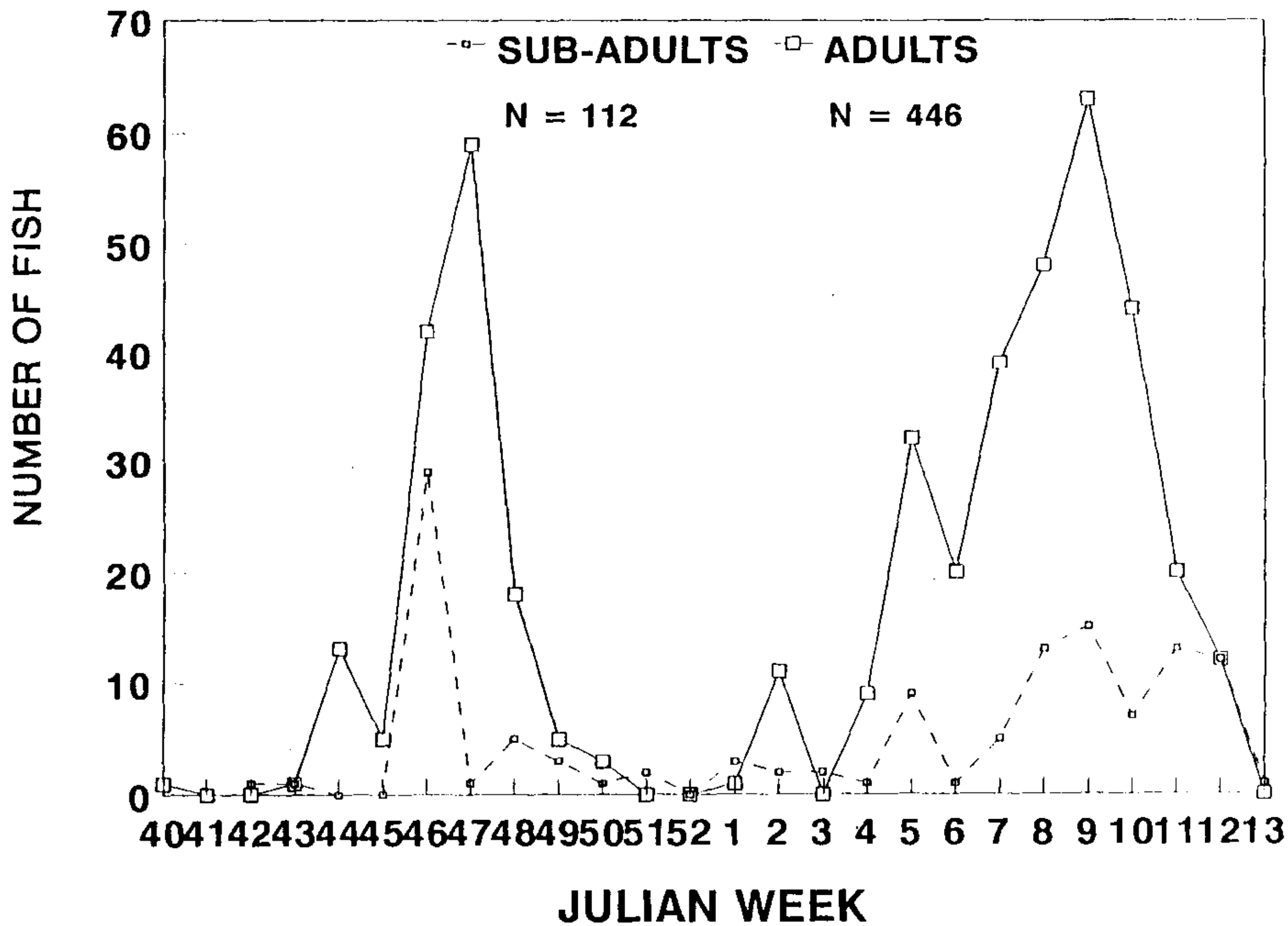

FIGURE 11. Numbers of sub-adult (≤41 cm FL) and adult (>41 cm FL) steelhead that entered Trinity River Hatchery each Julian week during the 1991-92 season. The fish ladder was open from 16 September 1991 through 27 March 1992.

Table 17. Total numbers and numbers of Project-tagged fall-run steelhead recovered at Trinity River Hatchery during the 1991-92 season. a/

Julian week b/ (dates)		Number entering TRH c/	Tagged at: Willow Creek Weir	Tagged at: Junction City Weir	
40	(10/01-10/07)	1		1	
41	(10/08-10/14)	0		0	
42	(10/15-10/21)	1		0	
43	(10/22-10/28)	2		0	
44	(10/29-11/04)	13		1	
45	(11/05-11/11)	5		0	
46	(11/12-11/18)	71	6	7 *	(1) d/
47	(11/19-11/25)	60	3	3	
48	(11/26-12/02)	23	0	0	
49	(12/03-12/09)	8	0	2	
50	(12/10-12/16)	4	0	0	
51	(12/17-12/23)	2	0	0	
52	(12/24-12/31)	0	0	0	
01	(01/01-01/07)	4	0	0	
02	(01/08-01/14)	13	1	0	
03	(01/15-01/21)	2	0	0	
04	(01/22-01/28)	10	0	0	
05	(01/29-02/04)	41	1	0	
06	(02/05-02/11)	21 *	1 *	1	
07	(02/12-02/18)	44	3	0	
08	(02/19-02/25)	61	3	0	
09	(02/26-03/04)	78	3	1	
10	(03/05-03/11)	51	1	0	
11	(03/12-03/18)	33	1	1	
12	(03/19-03/25)	24			
13	(03/26-04/01)	1			
TOTALS		573	23	17	(1)

a/ The fish ladder was open from 16 September 1991 through 27 March 1992.

b/ Entry week is considered the week the fall-run steelhead were initially sorted, although they may have entered the hatchery any time after the last sorting period of the previous week.

c/ Numbers shown include tagged fish recovered the same day. TRH=Trinity River Hatchery.

d/ Figures in parenthesis are fish tagged and released at Willow Creek Weir and recaptured and rereleased at Junction City Weir that subsequently entered Trinity River Hatchery. They are included in the totals shown.

*= Median entry week (midpoint of total fish recoveries) at Trinity River Hatchery.

1992), the same as the untagged steelhead. The Project-tagged steelhead from WCW that were recaptured at TRH ranged in size from 59 to 72 cm FL, with a mean of 64.8 cm FL, 3.6 cm greater than the mean of all steelhead effectively tagged at the weir (Table 11). However, the difference was not significant ($t=0.43$, $p<0.05$). We tagged these steelhead at WCW from 32 to 153 d before they entered TRH, with a mean of 97 d. They migrated at a mean rate of 1.4 km/d.

We recaptured 17 Project-tagged steelhead from JCW at TRH, including one fish that we tagged and released at WCW and recaptured and rereleased at JCW. One fish had shed its tag. The first Project-tagged steelhead from JCW entered the hatchery during JW 40 (1-7 October 1991). Unlike the Project-tagged steelhead from WCW, most of the steelhead tagged at JCW entered TRH before mid-December (Table 17). The median entry week of steelhead tagged at JCW was JW 46 (12-18 November), nearly three months before that of Project-tagged steelhead from WCW and untagged steelhead. In the 1990-91 season, the median entry week of the Project-tagged steelhead from JCW into TRH was JW 7 (12-18 February), which was one week later than all steelhead and three weeks later than the Project-tagged steelhead from WCW (Heubach et al. 1992b). We do not know the reason for their earlier entry into the hatchery this year. Recaptured Project-tagged steelhead from JCW ranged from 47 to 72 cm FL with a mean of 62.1 cm FL, essentially the same as the mean for all effectively tagged fish at the weir (Table 11). The fish entered TRH from 8 to 132 d after they were tagged, for a mean 35 d. They had migrated at an average rate of 1.2 km/d, essentially the same rate as Project-tagged fish from WCW.

Run-size, Angler Harvest, and Spawner Escapement Estimates

We did not stratify the spring chinook run-size estimates upstream of JCW and fall chinook and coho upstream of both WCW and JCW by grilse and adults this year. We tagged and recovered too few grilse to estimate the grilse run-size within ±10% at 95% confidence limits. Therefore, our non-stratified estimates used the respective proportions of grilse and adult spring chinook at JCW, and coho at WCW or JCW to define the grilse/adult composition of each run-size estimate. Since there was such a large disparity between the grilse/adult composition of fall chinook at WCW vs. JCW, we used the grilse/adult composition at TRH for the fall chinook runs upstream of both weirs. We made no attempt to stratify the adult steelhead run-size estimate by naturally vs. hatchery-produced fish because we believe that the fin-clipped, hatchery-produced steelhead released from TRH during 1989 and 1990 were not fully recruited as adult steelhead during the 1991-92 season.

Spring-run Chinook Salmon

We estimate 2,381 spring chinook (including those eventually harvested) migrated into the Trinity River basin upstream of JCW during the 1991-92 season (Table 18). Anglers caught an estimated 14.1% (336) of the spring run (Table 19). Thus, the spawning escapement above JCW was estimated to be 2,045 fish, including the 685 spring chinook that entered TRH (Table 19).

The 1991-92 season spring chinook salmon run-size and spawner escapement estimates are the lowest since the monitoring program began in 1978.

Fall-run Chinook Salmon

We estimate 9,207 fall chinook (including those eventually harvested) migrated into the Trinity River basin upstream of WCW during the 1991-92 season, and 7,231 of these fish continued their migration upstream of JCW (Table 18). Anglers harvested an estimated 13.8% (1,271) of the fall chinook passing WCW, including 118 fish caught upstream of JCW (Table 19). Therefore, we estimate 7,936 fall chinook spawned in the Trinity River basin upstream of WCW, and 7,113 of those fish spawned in the Trinity upstream of JCW, including 2,687 fall chinook that entered TRH (Table 19).

The 1991-92 fall chinook run-size estimate upstream of WCW was 785 fish less than in the 1990-91 season, which was the previous low since 1977, when the monitoring program began.

Coho Salmon

We estimate 9,124 coho (including those eventually harvested) migrated into the Trinity River basin upstream of WCW during the 1991-92 season, and 3,996 of these fish continued their migration upstream of JCW (Table 18). An estimated 1.2% (109) of the coho were harvested by anglers upstream of WCW, 24 of which were caught up-stream of JCW (Table 19). Thus, the spawning escapement estimate for coho upstream of WCW was 9,015 fish, including 3,972 fish that spawned upstream of JCW, 2,688 of which entered TRH.

The 1991-92 coho run size upstream of WCW is nearly 2.5 times that of the 1990-91 season, but only about one-half the size of the 1989-90 season run (Heubach et al. 1992a, 1992b).

Adult Fall-run Steelhead

We estimate 11,417 adult fall-run steelhead migrated upstream of WCW (including those harvested by anglers); 2,285 steelhead continued their migration upstream of JCW (Table 18). Anglers harvested an estimated 20.5% (2,340) of the steelhead upstream of

Table 18. Data used to generate Trinity River basin chinook and coho salmon, and fall-run steelhead run-size estimates during the 1991-92 season.

Species/ race	Area of estimate	Size class	Number effectively tagged a/	Number examined for tags	Number of tags in sample	Run-size estimate	Confidence limits 1-P = 0.95
Spring-run chinook	Trinity River basin above Junction City Weir	Grilse b/	24	71	9	190	
		Adults	277	614	77	2,191	
		Total	301	685	86	2,381	1,913 - 2,895 c/
Fall-run chinook	Trinity River basin above Willow Creek Weir	Grilse d/	35	205	9	681	
		Adults	882	2,482	258	8,526	
		Total	917	2,687	267	9,207	8,225 - 10,321 e/
Fall-run chinook	Trinity River basin above Junction City Weir	Grilse d/	55	205	13	552	
		Adults	404	2,482	157	6,679	
		Total	459	2,687	170	7,231	6,260 - 8,364 e/
Coho	Trinity River basin above Willow Creek Weir	Grilse f/	17	98	0	265	
		Adults	569	2,590	172	8,859	
		Total	586	2,688	172	9,124	7,906 - 10,544 e/
Coho	Trinity River basin above Junction City Weir	Grilse f/	7	98	6	131	
		Adults	206	2,590	137	3,865	
		Total	213	2,688	143	3,996	3,480 - 4,687 e/
Fall-run steelhead	Trinity River basin above Willow Creek Weir	Adults g/	612	446	23	11,417	7,464 - 15,997 c/
Fall-run steelhead	Trinity River basin above Junction City Weir	Adults g/	91	446	17	2,285	1,396 - 3,320 c/

a/ The number of effectively tagged fish is corrected for tagging mortalities.
b/ Spring-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.
c/ Confidence limits were estimated by Poisson approximation.
d/ Fall-run chinook salmon grilse are ≤51 cm FL; adults are >51 cm FL.
e/ Confidence limits were estimated by Normal approximation.
f/ Coho salmon grilse are ≤49 cm FL; adults are >49 cm FL.

Table 19. Trinity River basin chinook and coho salmon, and fall-run steelhead run-size, angler harvest, and spawner escapement estimates during the 1991-92 season.

Species/ race	Area of estimate	Size class	Run-size	Angler harvest	(%)	Spawner escapement: Natural	Spawner escapement: Trinity River Hatchery	Spawner escapement: Total
Spring-run chinook	Trinity River basin above Junction City Weir	Grilse a/	190	27		92	71	163
		Adults	2,191	309		1,268	614	1,882
		Total	2,381	336	(14.1)	1,360	685	2,045
Fall-run chinook	Trinity River basin above Willow Creek Weir	Grilse b/	681	94		382	205	587
		Adults	8,526	1,177		4,867	2,482	7,349
		Total	9,207	1,271	(13.8)	5,249	2,687	7,936
Fall-run chinook	Trinity River basin above Junction City Weir	Grilse b/	552	9		338	205	543
		Adults	6,679	109		4,088	2,482	6,570
		Total	7,231	118	(1.6)	4,426	2,687	7,113
Coho	Trinity River basin above Willow Creek Weir	Grilse c/	265	3		164	98	262
		Adults	8,859	106		6,163	2,590	8,753
		Total	9,124	109	(1.2)	6,327	2,688	9,015
Coho	Trinity River basin above Junction City Weir	Grilse c/	131	1		32	98	130
		Adults	3,865	23		1,252	2,590	3,842
		Total	3,996	24	(0.06)	1,284	2,688	3,972
Fall-run steelhead	Trinity River basin above Willow Creek Weir	Adults d/	11,417	2,340	(20.5)	8,631	446	9,077
Fall-run steelhead	Trinity River basin above Junction City Weir	Adults d/	2,285	484	(21.2)	1,355	446	1,801

a/ Spring-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.
b/ Fall-run chinook salmon grilse are ≤51 cm FL; adults are >51 cm FL.
c/ Coho salmon grilse are ≤49 cm FL; adults are >49 cm FL.
d/ Fall-run steelhead adults are > 41 cm FL.

WCW, 484 of which were caught upstream of JCW. Thus, we estimate the spawning escapements of adult fall-run steelhead at 9,077 and 1,801 fish upstream of WCW and JCW, respectively, 446 which entered TRH (Tables 18, 19).

RECOMMENDATIONS

1. Tag and recapture operations for adult spring-run and fall-run chinook and coho salmon, and adult fall-run steelhead being conducted in the Trinity River basin should be continued during the 1992-93 migration season, using the capture sites near Willow Creek and Junction City.

2. The use of $20-reward tags should be discontinued because of evidence that it encouraged anglers to fish exclusively for a reward-tagged fish and to recover dead salmon during the spawning season. Use of the $10-reward tags should be continued at both weir sites.

LITERATURE CITED

Chapman, D.G. 1948. A mathematical study of confidence of salmon populations calculated from sample tag ratios. Int. Pac. Sal. Fish. Comm. Bull. 2, p 69-85.

Dixon, W. and F. Massey. 1969. Introduction to Statistical Analysis. McGraw-Hill Book Co., New York, N.Y. 638 p.

Gibbs, E. D. 1956. A report on the king salmon, Oncorhynchus tshawytscha, in the upper Trinity River, 1955. Calif. Dept. Fish and Game, Inland Fish. Admin. Rep. No. 56-10. 14 p.

Heubach, B. 1984a. Progress report 1980-81 season. Task VI. Trinity River salmon and steelhead tagging program. p. 92-151. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. Tasks I and VI. November 1984. 151 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

__________. 1984b. Progress report 1981-82 season. Task VI. Trinity River salmon and steelhead tagging program. p. 49-106. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. Tasks I and VI. December 1984. 106 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Heubach, B., and P. M. Hubbell. 1980. FY 1979 Progress report. Task VI. Lower Trinity River salmon and steelhead tagging program. p. 80-132. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. September 1980. 141 p. Available from California Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Heubach, B., M. Lau, and M. Boucke. 1992a. Run-size, angler harvest, and spawner escapement of chinook and coho salmon in the Trinity River basin. Chapter IV. Job IV. p. 82-127. In: K. Urquhart (ed.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1989-90 Season. June 1992. 140 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Heubach, B., M. Lau, and E. Miller. 1992b. Annual run-size, harvest, and spawner escapement estimates for Trinity River Basin chinook and coho salmon and steelhead. Chapter IV. Job IV. pp. 93-145. In: Urquhart, K. and R. Carpenter (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1990-1991 Season. November 1992. 186 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

La Faunce, D. A. 1965a. King (chinook) salmon spawning escapement in the upper Trinity River, 1963. Calif. Dept. Fish and Game, Mar. Res. Admin. Rep. No. 65-3 10 p.

_______________. 1965b. A steelhead spawning survey of the upper Trinity River system, 1964. Calif. Dept. Fish and Game, Mar. Res. Admin. Rep. No. 65-3. 5 p.

_______________. 1967. A king salmon spawning survey of the South Fork Trinity River, 1964. Calif. Dept. Fish and Game, Mar. Res. Admin. Rep. No. 67-10. 13 p.

Miller, E. E. 1975. A steelhead spawning survey of the tributaries of the upper Trinity River and upper Hayfork Creek drainages, 1973. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 75-5. 8 p.

Moffett, J. W. and S. H. Smith. 1950. Biological investigations of the fishery resources of Trinity River, California. USFWS Spec. Sci. Rep.-- Fish., (12) : 71 p.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Bd. Can. #191. 382 p.

Rogers, D. W. 1970. A king salmon spawning escapement and spawning habitat survey in the upper Trinity River and its tributaries, 1968. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 73-5a. 8 p.

____________. 1972. A steelhead spawning survey of the tributaries of the upper Trinity River and upper Hayfork Creek drainage, 1971. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. 72-12. 6 p.

____________. 1973a. A steelhead spawning survey of the tributaries of the upper Trinity River and upper Hayfork Creek drainage, 1972. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 73-5a. 8 p.

___________. 1973b. King salmon (Oncorhynchus tshawytscha) and silver salmon (Oncorhynchus kisutch) spawning escapement and spawning habitat in upper Trinity River, 1970. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 73-10. 14 p.

___________. 1982. A spawning escapement survey of anadromous salmonid in the upper Trinity River, 1971. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 82-2. 11 p.

Smith, G. E. 1975. Anadromous salmonid spawning escapements in the upper Trinity River, California, 1969. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 75-7. 17 p.

Weber, G. 1965. North coast king salmon spawning stock survey, 1956-57 season. Calif. Dept. Fish and Game, Mar. Res. Admin. Rep. No. 65-1. 34 p.

Zuspan, M. G., D. Maria and B. Heubach. 1985. Progress report 1982-83 season. Task IV. Trinity River salmon and steelhead tagging program. p. 62-146. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations - Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Item No 5. January 1985. 145 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

Appendix 1. List of Julian weeks and their calendar date equivalents.

Julian week	Calendar dates Start	Finish	Julian week	Calendar dates Start	Finish
1	01-Jan	07-Jan	27	02-Jul	08-Jul
2	08-Jan	14-Jan	28	09-Jul	15-Jul
3	15-Jan	21-Jan	29	16-Jul	22-Jul
4	22-Jan	28-Jan	30	23-Jul	29-Jul
5	29-Jan	04-Feb	31	30-Jul	05-Aug
6	05-Feb	11-Feb	32	06-Aug	12-Aug
7	12-Feb	18-Feb	33	13-Aug	19-Aug
8	19-Feb	25-Feb	34	20-Aug	26-Aug
9 a/	26-Feb	04-Mar	35	27-Aug	02-Sep
10	05-Mar	11-Mar	36	03-Sep	09-Sep
11	12-Mar	18-Mar	37	10-Sep	16-Sep
12	19-Mar	25-Mar	38	17-Sep	23-Sep
13	26-Mar	01-Apr	39	24-Sep	30-Sep
14	02-Apr	08-Apr	40	01-Oct	07-Oct
15	09-Apr	15-Apr	41	08-Oct	14-Oct
16	16-Apr	22-Apr	42	15-Oct	21-Oct
17	23-Apr	29-Apr	43	22-Oct	28-Oct
18	30-Apr	06-May	44	29-Oct	04-Nov
19	07-May	13-May	45	05-Nov	11-Nov
20	14-May	20-May	46	12-Nov	18-Nov
21	21-May	27-May	47	19-Nov	25-Nov
22	28-May	03-Jun	48	26-Nov	02-Dec
23	04-Jun	10-Jun	49	03-Dec	09-Dec
24	11-Jun	17-Jun	50	10-Dec	16-Dec
25	18-Jun	24-Jun	51	17-Dec	23-Dec
26	25-Jun	01-Jul	52 b/	24-Dec	31-Dec

a/ Eight-day week in each year divisible by 4.
b/ Eight-day week every year.

APPENDIX 2. Fork lengths of coded-wire-tagged, Trinity River-strain spring-run chinook salmon recovered at Trinity River Hatchery during the 1991-92 season. a/

Brood year	1986	1987	1988		1989		
Tag code	06-61-46	06-61-47	06-61-49	06-61-48	06-56-39		
Release date	09/24/87	05/23/88	05/26/89	10/24/89	10/01/90		
Fork length (cm)						Shed tag b/	Totals
43					1		1
44					2		2
45					0		0
46					1		1
47					0		0
48					1		1
49					1		1
50						1	1
51				1		0	1
52				1		0	1
53				1		0	1
54				1		0	1
55				0		0	0
56				0		1	1
57				0		0	0
58				2		1	3
59				1		0	1
60		1		1		0	2
61		0		1		0	1
62		2	2			4	8
63		1	0			1	2
64		0	4			0	4
65		1	1			0	2
66		0	0			0	0
67		1	1			0	2
68		0	0			0	0
69		0	0			0	0
70	1	2	4			2	9
71	1	0	1			0	2
72	0	0				0	0
73	0	1				0	1
74	1	1				3	5
75	0	1				0	1
76	0	1				1	2
77	0	1				0	1
78	1					0	1
79						0	0
80						1	1
TOTALS	4	13	13	9	6	15	60
Mean FL	73.2	68.8	66.4	56.2	45.7	66.2	63.7

a/ The fish ladder was open from 16 September 1991 through 27 March 1992.
b/ No tag was recovered from the marked fish. All chinook salmon that shed a tag and were recovered 16 September through 15 October are considered spring-run chinook; salmon that shed tags and were recovered after 15 October 1991 are considered fall-run chinook.

APPENDIX 3. Fork lengths of coded-wire-tagged, Trinity River-strain coho salmon recovered at Trinity River Hatchery during the 1991-92 season. a/

Brood year 1989

Tag code 06-56-60

Release date 03/18/91

Fork length (cm)	Number recovered	No tag b/	Totals
39		1	1
40		0	0
41	2	1	3
42	1	1	2
43	0		0
44	0		0
45	2		2
Totals	5	3	8
Mean FL	42.8	40.7	42.0

a/ The fish ladder was open from 16 September 1991 through 27 March 1992.
b/ No tag was recovered from marked fish.

APPENDIX 4. Release and recapture data for Trinity River Hatchery-produced, fin-clipped and non-fin-clipped fall-run steelhead in the Trinity River during the 1991-92 season.

	Release data				Recapture data			
Fin clip	Brood year	Number released	Date	Mean fork length (cm)	Willow Creek Weir	Junction City Weir	Angler tag returns	Trinity River Hatchery
Right ventral a/	1988	50,490	03/15/90	26.6	50	13	8	178
Left ventral	1989	405,997	03/6, 23/90	15.9	11	10	3	53
Adipose, right ventral	1989	181,673	03/18/91	21.9	7	8	3	154
Adipose, left ventral	1990	965,075	03/18/91	17.9	4	5	0	38
Adipose b/	-	-	-	-	2	0	0	2
Right pectoral b/	-	-	-	-	0	0	0	1
Non-fin clipped c/					564	67	103	147
TOTALS					638	103	117	573

a/ Some right ventral fin-clipped fall-run steelhead that entered Trinity River Hatchery may be 1990 brood year fish that were released from the hatchery 16 March 1992.
b/ Fin clip is of unknown origin.
c/ Non-fin-clipped fall-run steelhead are either Trinity River Hatchery- or naturally produced.

APPENDIX 5. Fork lengths of Trinity River Hatchery-produced, fin-clipped fall-run steelhead trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1991-92 season.

	Willow Creek Weir a/					Junction City Weir b/				Trinity River Hatchery /c					
Fork length (cm)	RV d/	LV /e	Ad RV f/	Ad LV g/	Ad h/	RV d/	LV e/	Ad RV f/	Ad LV g/	RV d/	LV e/	Ad RV f/	Ad LV g/	Ad h/	RP i/
20													1		
21													0		
22													0		
23													0		
24													0		
25													0		
26													2		
27												1	1		
28												3	1		
29												1	2		
30												3	3		
31										1		5	1		
32										0		10	0		
33										0	1	8	0		
34										0	0	1	1		
34				2				1		1	0	2	3		
35				0				1		1	1	7	3		
36				1				0	1	0	0	7	1		
37			1	0				0	2	0	0	4	2		
38			0	1				0	0	1	0	11	4		
39			1					0	1	3	0	8	1		
40			1					1	0	2	0	9	3		
41			1					2	0	2	1	17	3		
42			1					0	0	1	0	10	5		
43			1					1	1	6	0	13	1		
44			0					0		2	1	15			
45			0					0		5	0	11			
46			0					0		2	1	4			
47			0					1		5	0	1			
48			1					1		5	1	0			
49		1								5	1	1			
50		0								5	3	0			
51		0								7	0	0			
52		0				1	1			2	2	0			
53		0				0	1			1	3	0			
54		0				0	0			2	4	0			
55		0			1	0	1			5	4	0		1	
56		1			0	1	1			5	6	0		0	
57		1			0	0	2			3	4	0		0	
58	1	2			0	0	0			1	3	0		1	
59	1	3			0	0	2			7	2	0			
60	1	1			0	0	1			5	4	0			
61	0	1			0	1	0			8	3	0			
62	6	0			0	3	1			11	2	0			
63	3	1			0	1				14	1	0			
64	7				1	3				11	1	0			
65	8					1				9	0	0			1
66	11					0				10	1	2			
67	5					1				12	3				
68	1					0				5					
69	3					0				3					
70	0					0				6					
71	1					0				3					
72	1					0				0					
73	1					1				0					
74										1					
TOTALS	50	11	7	4	2	13	10	8	5	178	53	154	38	2	1
Mean FL	65.2	58.3	41.4	35.5	59.5	62.7	57.0	41.4	38.4	58.7	56.5	40.1	36.1	57.5	66.0

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 50 (13 December) of 1991.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1991.
c/ The fish ladder was open 16 September 1991 through 27 March 1992.
d/ RV = Right ventral fin clip; 1988 brood year, released from Trinity River Hatchery 15 March 1990. It is possible that 1990 brood year fish with a similar fin clip released 16 March 1992, also entered the hatchery after that date.
e/ LV = Left ventral fin clip; 1989 brood year, released from Trinity River Hatchery 6 and 23 March 1990.
h/ Ad = Adipose fin clip; unknown origin.
i/ RP = Right pectoral fin clip; unknown origin.
f/ AdRV = Adipose and right ventral fin clip; 1989 brood year, released from Trinity River Hatchery and Sawmill Pond 18 March 1991.
g/ AdLV = Adipose and left ventral fin clip; 1990 brood year, released from Trinity River Hatchery 18 March 1991.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991-92 SEASON

CHAPTER V

JOB V
SURVIVAL AND CONTRIBUTIONS TO THE FISHERIES AND SPAWNER ESCAPEMENTS MADE BY CHINOOK AND COHO SALMON PRODUCED AT TRINITY RIVER HATCHERY

by

Bill Heubach and Ed Miller

ABSTRACT

Between 1 July 1991 and 30 June 1992, the California Department of Fish and Game's Trinity River Project marked (adipose fin-clipped and binary coded-wire tagged) five groups of chinook salmon (Oncorhynchus tshawytscha) and one group of coho salmon (O. kisutch) at Trinity River Hatchery. The fish were released into the Trinity River below the hatchery. We marked 292,916 spring-run and 309,456 fall-run chinook salmon, and 52,233 coho salmon.

Recovery operations at Trinity River Hatchery captured 385 adipose fin-clipped chinook and coho salmon. Coded-wire tags were recovered from 45 spring-run and 301 fall-run chinook salmon, and five coho salmon.

Run-size, angler harvest, and spawner escapements of marked spring- and fall-run chinook of the 1986 through 1990 brood years are presented. Complete returns were only available for fish from the 1986 brood year, returning as two- through five-year-olds. Based on coded-wire tags collected from 1988 through 1991, we estimate that 2,063 spring-run and 5,191 fall-run chinook salmon from the 1986 brood year returned to the Trinity River basin upstream of Junction City Weir and Willow Creek Weir, respectively, as two- through five-year-olds. An estimated 12 coho salmon of the 1989 brood year also entered the Trinity River basin upstream of the Willow Creek Weir this season.

JOB OBJECTIVES

To determine relative return rates and the contribution to spawning escapement and the fisheries made by chinook and coho salmon produced at Trinity River Hatchery, and to evaluate experimental hatchery management practices aimed at increasing adult returns.

INTRODUCTION

During the period of 1 July 1991 through 30 June 1992, the California Department of Fish and Game's (CDFG) Trinity River Project marked (adipose fin-clipped and coded-wire tagged [Ad+CWT]) and released chinook salmon smolts and yearlings, and yearling+ coho salmon produced at Trinity River Hatchery (TRH), and recaptured fish from previously marked brood years (BY) returning to TRH. Similar marking studies began at TRH in 1977 with the marking and release of fall-run chinook salmon (fall chinook) from the 1976 BY. Beginning with the 1977 BY, representative, marked subsets of TRH-produced fish have been included in all releases of smolt, yearling, and yearling+ spring-run (spring chinook) and fall chinook released from TRH and its associated off-site rearing locations. Beginning in 1978, representative samples of coho salmon (coho) were marked and released from TRH in most years, except BY's 1987 and 1988.

These earlier studies were funded variously by the U.S. Bureau of Reclamation (USBR), and with Anadromous Fish Act funds administered by the U.S. Fish and Wildlife Service. The current program has been funded by the USBR since 1 October 1989.

These marking studies are designed to provide survival rates and catch-to-escapement ratios for spring and fall chinook and coho salmon reared at TRH. State and Federal management agencies need to evaluate the contributions of salmon produced at TRH to the various fisheries and spawner escapements in the Trinity River basin, in order to properly manage hatchery production and fishery harvest.

METHODS

Fish Marking and Release

Marking and release methods were similar to those used in the 1990-91 season. Salmon selected for marking at TRH were crowded into a small area beneath a marking shed situated over their rearing pond. After crowding, fish were dip-netted into a 152.4 x 61.0 x 76.2-cm wooden holding tank in the tagging shed through which water from the pond was circulated. We dip-netted approximately 25 fish at a time from the holding tank into pans containing an anesthetic solution of tricaine methanesulfonate

(MS 222[1/]). Once anesthetized, we marked the fish by removing their Ad fin and injecting a CWT into their rostrum. A NMT MK 4[1/] tagging unit was used to tag smolt spring chinook with half-length CWTs, and yearling chinook and coho with full-length tags.

After marking, fish were dropped into a funnel supplied with running water that led to a quality control device. The quality control device magnetized the CWT, detected the tag, and tallied the tagged fish. Tagged fish continued through the funnel and dropped into a rearing pond situated next to the pond containing the unmarked fish. If a fish had not received a CWT, the quality control device gave a warning signal and diverted the fish into a funnel leading to a rejection bucket. Periodically, fish in the rejection bucket were re-anesthetized, re-tagged, and dropped into the funnel leading to the quality control device. Periodically during the marking period, we inspected samples of fish for the depth of CWT insertion, tag retention, and quality of the fin clip.

All tagged fish from a particular mark group were held in separate rearing ponds until release. Immediately before the marked salmon were released, a systematic sample of 300 to 400 fish from each tag group was examined for CWT retention and the quality of the Ad clip, and measured to the nearest mm fork length (FL).

The total number of "effectively-marked" (properly tagged and fin-clipped) fish released was calculated by subtracting mortalities, during and after tagging operations, and the estimated numbers of fish that had shed CWTs or were improperly fin clipped from the total fish marked.

All tagged fish of a particular CWT group were released concurrently with unmarked fish of the same strain, BY, and size in the Trinity River immediately below TRH.

Coded-wire Tag Recovery

The TRH fish ladder was open from 16 September 1991 through 27 March 1992. Hatchery personnel conducted fish sorting and spawning operations two days per week.

Fish were sorted by species and spawning condition. Each fish was examined for Project tags and fin clips, and its sex and FL (cm) were recorded. Marked fish which were not ready to spawn were given a distinguishing fin clip and placed in ponds to ripen. Later, when the fish were killed and spawned we

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[1/]The use of brand names is for identification purposes only, and does not imply the endorsement of any product by the CDFG.

determined the initial day the fish was sorted from its unique fin clip. These dates were used in Chapter IV to document the timing of the returns of hatchery fish to TRH. At this time, we removed heads of all Ad-marked salmon and placed each in a zip-lock bag with a serially numbered tab noting the date, location recovered, species, sex, and FL. Salmon heads were frozen and given to the CDFG/Ocean Salmon Project for tag recovery and decoding (Ocean Salmon Project personnel provided us with a computer file of the CWT recovery data for editing and analysis).

Run-size, Contribution to Fisheries and Spawner Escapement of Coded-wire Tagged Salmon

The data needed to estimate the numbers of the salmon of a specific CWT group that returned to the Trinity River basin, and contributed to the fisheries and spawner escapement are: 1) run size; 2) the proportions of the run comprised by the various CWT groups; and 3) the harvest rate. Methods to determine the run-size and harvest estimates are presented as a part of Task IV (pp 103 - 167). The same sets of equations employed during the 1990-91 season were used to determine run-size, harvest, and spawner escapement (Heubach, et al. 1992). To estimate numbers of the salmon with a CWT above a specific weir site , we used the equation:

$$N_{CWT} = \frac{NW_{ADclip}}{NW} \times \frac{NH_{ADCWT}}{NH_{ADclip}} \times N_{run\text{-}size\ estimate}$$

where, N_{CWT} = estimated number of the specific species of salmon above the weir with a CWT; NW_{ADclip} = number of salmon observed at the weir with an Ad clip; NW = total number of salmon observed at the respective weir; NH_{ADCWT} = number of salmon observed at TRH with an Ad clip <u>and</u> a CWT; NH_{ADclip} = total number of Ad-clipped salmon observed at TRH; and $N_{run\text{-}size\ estimate}$ = run-size estimate.

Using the various CWT groups recovered at TRH, we estimated the fraction of the population upstream of the weir with a specific CWT with the equation:

$$F_{CWT\ group} = \frac{NH_{CWT\ group}}{NH_{ADCWT}}$$

where, $F_{CWT\ group}$ = fraction of the salmon population with a specific CWT code; and $NH_{CWT\ group}$ = number of salmon observed at TRH with a specific CWT code.

We estimated the total number of chinook salmon upstream of the weir with a specific CWT code with the equation:

$$N_{CWT\ group} = N_{CWT} \times F_{CWT\ group}$$

where, $N_{CWT\ group}$ = estimated total number of salmon of a specific CWT code group.

The estimated number of fish from each CWT code group caught in the Trinity River sport fishery upstream of the weir was then estimated by the equation:

$$SF_{CWT\ group} = N_{CWT\ group} \times N_{harvest\ rate\ estimate}$$

where, $SF_{CWT\ group}$ = number of salmon of a specific tag-code group caught in the Trinity River sport fishery; and $N_{harvest\ rate\ estimate}$ = harvest rate estimate.

We estimated the total number of fish of a specific CWT code group available to the spawner escapement by the equation:

$$N_{CWT\ escapement} = N_{CWT\ group} - SF_{CWT\ group}$$

where, $N_{CWT\ escapement}$ = the total number of salmon of a specific CWT group available to the spawner escapement.

The estimated number of salmon of specific CWT code group available to natural spawner escapement is:

$$N_{CWT\ natural\ escapement} = N_{CWT\ escapement} - NH_{CWT\ group}$$

where, $N_{CWT\ natural\ escapement}$ = the estimated number of a specific CWT group contributing to natural spawning escapement.

All estimates for spring and fall chinook are for the Trinity River upstream of Junction City Weir (JCW) (river km [RKM] 136.4) and Willow Creek Weir (WCW) (RKM 46.8), respectively.

RESULTS AND DISCUSSION

Fish Marking and Release

Five groups of chinook salmon reared at TRH, totaling 602,372 fish, were marked (Ad+CWT), and released into the Trinity River below the hatchery during October 1991 and June 1992 (Table 1). Two groups of spring chinook yearlings and one group of fall chinook yearlings were released in October 1991. All three groups were from the 1990 BY. The two groups of yearling spring chinook were released as a replicate tag experiment to determine variability in the numbers of CWT fish caught in the fisheries and returning to the hatchery. Spring and fall chinook smolts of the 1991 BY were released in June 1992. We also marked (Ad+CWT) coho from the 1990 BY at TRH. The coho were released into the Trinity River below TRH in April 1992 (Table 1).

Fall chinook from the 1990 BY which were released as yearlings were the survivors of a pandemic of Infectious Hematopoietic Necrosis (IHN) that occurred during the spring of 1991 (Heubach, et al. 1992). The 1990 BY spring chinook were also exposed to the disease but suffered little mortality. There was very little mortality of these spring and fall chinook during marking, suggesting they were in good condition (Table 1). Hatchery personnel considered the fish to be in excellent condition when released.

Spring and fall chinook of the 1991 BY released as smolts were not exposed to any pathogens, so far as we know, and mortality during and following marking was very low (Table 1). They were also considered to be in excellent condition when released.

The 1990 BY coho released in April 1992 were infected with Bacterial Kidney Disease (BKD), Corynebacterium spp., at various times while being reared at TRH, but there was no apparent mortality due to the disease. Also, there was very little mortality while they were being marked (Table 1). Hatchery personnel considered them to be in fair condition when released because they still tested positive for BKD.

All chinook and coho tag groups were released concurrently with unmarked fish of the same BY, strain, and size.

Coded-wire Tag Recovery

We recaptured 385 marked (Ad+CWT) chinook and coho at TRH during the 1991-92 season. CWTs were recovered from 45 spring chinook, 301 fall chinook, and five coho (Table 2). Spring chinook from the 1987 and 1988 BYs, released as smolts, comprised 58% of the CWTed spring chinook we recovered, while the remainder were 1986, 1988 and 1989 BY fish released as yearlings. Fall chinook of the 1987 and 1988 BYs, released as yearlings, comprised 77% of the

TABLE 1. *Code-wire-tagged (CWT) and unmarked chinook and coho salmon releases from Trinity River Hatchery from 1 July 1991 through 30 June 1992.* a/

CWT code	Brood year	Species/race	Total number tagged	Mortality b/		Extrapolated tag shed/poor fin clip c/	Number of tagged fish released d/	Release date	Release size		Unmarked fish released
									No./kg	FL (mm	
06-56-36	1990	Spring-run chinook	51,359	478	(0.9)	2,328 (4.6)	48,553	10/08/91	21.8	151.2	505,623
06-56-40	1990	Spring-run chinook	52,740	745	(1.4)	5,909 (11.4)	46,086	10/08/91	21.8	151.4	e/
06-56-38	1990	Fall-run chinook	111,418	135	(0.1)	8,243 (7.4)	103,040	10/09/91	25.7	143.6	540,870
Yearling subtotals:			215,517				197,679				1,046,493
6-1-4-1-5	1991	Spring-run chinook	210,665	477	(0.2)	11,911 (5.6)	198,277	06/05/92	74.8	104.1	19,111
6-1-4-1-4	1991	Fall-run chinook	211,463	157	(0.1)	4,890 (2.3)	206,416	06/22/92	85.0	104.9	375,123
Smolt subtotals:			422,128				404,693				394,234
TOTAL CHINOOK:			637,645				602,372				1,440,727
06-56-57	1990	Coho	53,200	415	(0.8)	552 (1.0)	52,233	04/03/92	15.7	180.2	387,290
TOTAL COHO:			53,200				52,233				387,290
GRAND TOTAL SALMON:			690,845				654,605				1,828,017

a/ All relesases were into the Trinity River directly below the hatchery.
b/ Absolute number followed by percent in parenthesis.
c/ Absolute number followed by percent in parenthesis. The percent mortality is based on the total number of fish marked minus mortality.
d/ The number of tagged fish released = the total number of fish marked minus mortality and the extrapolated number of fish with a shed tag or poor fin clip.
e/ Unmarked release is included with fish of tag code 06-56-36.

TABLE 2. Release and 1988-89 through 1991-92 season recovery data of coded-wire-tagged chinook and coho salmon produced at Trinity River Hatchery during the 1986-87 through 1990-91 seasons. a/

Release data							Trinity River Hatchery recovery data			
									Mean fork length (cm)	
CWT b/ code	Race	Brood year	Date	Number	Size (#/kg)	Site	Season recovered	CWT b/ recoveries	Male	Female
				Chinook salmon						
06-61-46	Spring-run	1986	09/24/87	101,030	39.6	TRH c/	88-89	48	45 (47) d/	44 (1)
							89-90	285	65 (210)	64 (75)
							90-91	264	73 (106)	71 (158)
							91-92	4	78 (1)	72 (3)
06-61-47	Spring-run	1987	05/23/88	185,718	187.0	Sawmill Pond	89-90	6	50 (6)	- (0)
							90-91	55	64 (23)	64 (32)
							91-92	13	70 (4)	68 (9)
06-61-49	Spring-run	1988	05/26/89	181,698	182.6	TRH	90-91	2	52 (2)	- (0)
							91-92	13	66 (10)	68 (3)
06-61-48	Spring-run	1988	10/24/89	98,820	29.3	TRH	90-91	0	- (0)	- (0)
							91-92	9	56 (7)	58 (2)
06-56-39	Spring-run	1989	10/01/90	102,555	25.3	TRH	91-92	6	46 (6)	- (0)
100000 e/	Spring-run f/						91-92	15	65 (9)	67 (6)
06-56-33	Fall-run	1987	06/02/88	172,980	257.4	Ambrose Pond	89-90	10	51 (10)	- (0)
							90-91	16	60 (12)	62 (4)
							91-92	11	70 (7)	72 (4)
06-56-31	Fall-run	1987	10/28/88	92,300	19.6	Ambrose Pond	89-90	11	47 (11)	(0)
							90-91	70	56 (56)	61 (14)
							91-92	72	71 (33)	72 (39)
06-56-35	Fall-run	1988	06/12/89	194,197	161.0	TRH	90-91	9	48 (9)	- (0)
							91-92	23	66 (12)	66 (11)
06-56-32	Fall-run	1988	10/27/89	97,569	34.1	TRH	90-91	7	42 (7)	- (0)
							91-92	161	61 (119)	62 (42)
06-55-22 g/	Fall-run	1988	11/01/89	22,234	15.6	TRH	90-91	0	- (0)	- (0)
							91-92	14	64 (8)	64 (6)
06-55-23 g/	Fall-run	1988	11/01/89	24,131	17.8	TRH	90-91	0	- (0)	- (0)
							91-92	10	61 (7)	64 (3)
601040101	Fall-run	1989	05/18/90	201,622	189.2	TRH	91-92	2	54 (1)	60 (1)
06-56-34	Fall-run	1989	10/15/90	97,810	21.3	TRH	91-92	4	43 (4)	- (0)
06-56-37 g/	Fall-run	1989	10/16/90	23,628	17.6	TRH	91-92	1	44 (1)	- (0)
06-56-41 g/	Fall-run	1989	10/16/90	22,540	18.2	TRH	91-92	3	44 (3)	- (0)
100000	Fall-run h/						91-92	16	63 (11)	63 (5)
				Coho salmon						
06-56-60	Fall-run	1989	03/18/91	51,088	26.4	TRH	91-92	5	43 (5)	
100000	Fall-run						91-92	3	41 (3)	- (0)

a/ Only coded-wire-tagged groups that entered Trinity River Hatchery during the 1990-91 season are listed.
b/ CWT=coded-wire tag.
c/ TRH=Trinity River Hatchery.
d/ Sample size is in parenthesis.
e/ 100000=no coded-wire tag was found or it was lost during recovery.
f/ Assumed to be spring-run chinook salmon by entry date into Trinity River Hatchery.
g/ Tagged and released by Trinity River Hatchery personnel.
h/ Assumed to be fall-run chinook salmon by entry date into Trinity River Hatchery.

CWTed fall chinook we recovered.

The five CWTed coho recovered were grilse from the 1989 BY. We did not expect to see any marked adult coho from TRH during the 1991-92 season, because none of the 1988 BY coho produced at the hatchery were marked.

In addition to the CWTs from TRH-produced fish recovered this year at TRH, we recovered a CWT chinook that had been tagged and released by the Trinity River Fisheries Investigation Project (another element of CDFG's Klamath-Trinity Program). This naturally produced fish had been captured, tagged and released as a juvenile between 29 March and 12 May 1989 in the Trinity River near Junction City. We also recaptured a CWT chinook that had been tagged and released by U. S. Forest Service personnel on 13 November 1990 in Horse Linto Creek, a tributary to the Trinity River.

Run-size and Contribution to Fisheries and Spawner Escapement of Coded-wire-tagged Salmon

We estimate that 0.05% of the 1986 BY spring chinook released from TRH in May 1987 as smolts (CWT code 061412), and 1.9% of the fish released as yearlings (CWT code 065639), returned to the Trinity River basin upstream of JCW. Yearlings from the 1986 BY returned as two- through five-year-olds, but fish released as smolts returned only as two- through four-year-olds. An estimated 225 of the returning marked 1986 BY spring chinook were caught above JCW by anglers, leaving 1,828 available for spawner escapement (Table 3).

We estimate only 0.21% of the 1986 BY fall chinook released as yearling+ (CWT code 066310) returned to the Trinity River basin upstream of WCW as three- and four-year-olds. None of these fish returned as two-year-olds. Only 0.07% of the three groups of 1986 BY released as smolts returned to the Trinity River basin upstream of WCW as two- through four-year-olds (Table 3).

Conversely, nearly 4.5% of the 1986 BY fall chinook released as yearlings returned to the Trinity River basin upstream of WCW. Another 1.4% of a group of yearlings released as part of a TRH feed experiment also returned. None of the fish from the six tag groups of the 1986 BY fall chinook returned as five-year-olds.

The poor survival and return of the 1986 BY may be due to mortality from IHN after being released from the hatchery or the off-site rearing ponds. The fish showed the symptoms of IHN while being reared but mortality was difficult to assess at the off-site rearing ponds.

TABLE 3. Run-size, sport catch, and spawner escapement estimates for 1986 through 1989 brood years, Trinity River Hatchery-produced, coded-wire-tagged chinook and coho salmon in the Trinity River upstream of Willow Creek and Junction City weirs during the 1988-89 through 1991-92 seasons. a/

	Release data					Return data					
									Spawning escapement		
Race	CWT b/ code	Brood year	Date c/	Number	Site	Age	Run-size	River harvest	Hatchery	Natural	Total
					Chinook salmon						
Spring-run	066145	1986	5/28/87	197,113	TRH d/	2	10	1	7	2	9
						3	71	7	15	49	64
						4	22	3	11	8	19
						5	0	0	0	0	0
Spring-run	066146	1986	9/24/87	101,030	TRH	2	66	9	48	9	57
						3	1,344	134	285	925	1,210
						4	540	71	264	205	469
						5	10	1	4	5	9
Spring-run	066147	1987	5/23/88	185,718	Sawmill Pond	2	61	6	6	49	55
						3	112	15	55	42	97
						4	34	5	13	16	29
Spring-run	066249	1988	5/26/89	181,698	TRH	2	30	4	2	24	26
						3	34	5	13	16	29
Spring-run	066148	1988	10/24/89	98,820	TRH	2	0	0	0	0	0
						3	23	3	9	11	20
Spring-run	061412	1989	5/18,21/90	186,413	TRH	2	0	0	0	0	0
Spring-run	065639	1989	10/1/90	102,555	TRH	2	9	1	6	2	8
Fall-run	065626	1986	6/11,17/87	202,486	TRH	2	76	11	20	45	65
						3	68	5	19	44	63
						4	7	0	3	4	7
						5	0	0	0	0	0
Fall-run	065629 e/	1986	6/11/87	99,118	Sawmill Pond	2	11	2	3	6	9
						3	32	2	9	21	30
						4	12	0	5	7	12
						5	0	0	0	0	0
Fall-run	065630 e/	1986	6/27/87	92,351	Ambrose pond	2	26	4	7	15	22
						3	51	4	14	33	47
						4	9	0	4	5	9
						5	0	0	0	0	0
Fall-run	065627	1986	9/21/87	100,320	TRH	2	1,602	242	424	936	1,360
						3	2,645	185	738	1,722	2,460
						4	219	8	88	123	211
						5	0	0	0	0	0
Fall-run	065628 f/	1986	9/24/87	26,730	TRH	2	170	26	45	99	144
						3	197	14	55	128	183
						4	10	0	4	6	10
						5	0	0	0	0	0
Fall-run	066310 f/	1986	2/29/88	26,650	TRH	2	0	0	0	0	0
						3	51	4	14	33	47
						4	5	0	2	3	5
						5	0	0	0	0	0

(continued)

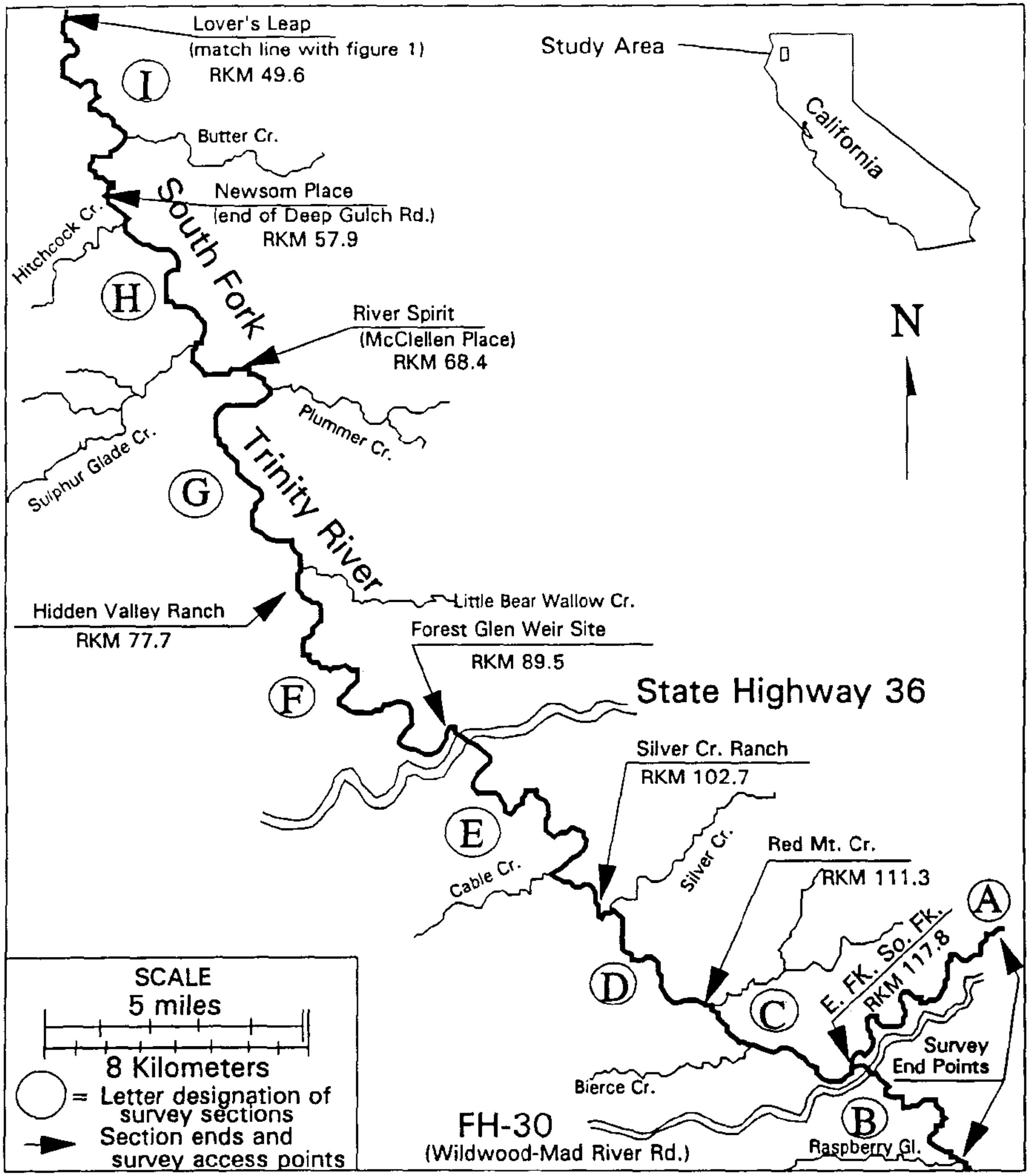

FIGURE 2. Map of the South Fork Trinity River above Hyampom depicting survey sections and major tributaries. (RKM = river kilometer from the mouth of the South Fork Trinity River).

We estimate 12 marked coho grilse from the 1989 BY returned to the Trinity River basin upstream of WCW, five of which entered TRH.

RECOMMENDATIONS

Coded-wire tagging and release of smolt and yearling chinook and coho, and the monitoring of adult salmon returns at Trinity River Hatchery should be continued in 1992-93.

LITERATURE CITED

Heubach B., M. Lau, and E. Miller. 1992. Survival and contribution to the fisheries and spawner escapement made by chinook and coho salmon produced at Trinity River Hatchery. Chapter V. Job V. p 147-157. <u>In:</u> K. Urquhart (ed.). Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1990-1991 Season. December, 1992. 186 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 Ninth St., Sacramento, CA. 95814.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJEC
1991-1992 SEASON

CHAPTER VI

JOB VI
SURVIVAL, AND CONTRIBUTIONS TO THE FISHERIES AND SPAWNER ESCAPEMENTS MADE BY STEELHEAD PRODUCED AT TRINITY RIVER HATCHERY

by

Bernard C. Aguilar

ABSTRACT

Staff of the California Department of Fish and Game's Trinity Fisheries Investigations Project conducted a steelhead, Oncorhynchus mykiss, marki program at Trinity River Hatchery intermittently from 1 October 1991 thro n 18 March 1992. Unique combinations of fin clips were given to each group of fish to permit identification of brood year upon recapture. This season we marked 2,834 steelhead held over from the 1990 brood year with a right ventral fin clip, to be released as two-year-olds, and 968,025 steelhead from the 1991 brood year with a left ventral fin clip, to be released as yearlings.

We checked 80 steelhead from the 1990 brood year and 22,538 from the 1991 brood year for fin clip accuracy prior to release. We found 0.0% from brood year 1990 and 0.9% from brood year 1991 had poor fin clips.

We monitored adult steelhead returning to Trinity River Hatchery from 16 September 1991 through 27 March 1992, when migration was determined to have been completed. During that time, 295 steelhead returned to Trinity River Hatchery, of which 62.0% (183/295) were fin-clipped.

Steelhead were also checked for fin clips as they were recovered at the Willow Creek and Junction City weirs. Six hundred thirty-eight steelhead were recovered at the Willow Creek weir, of which 11.1% (71/638) were fin-clipped. One hundred three steelhead were recovered at the Junction City weir, of which 34.0% (35/103) were fin-clipped.

JOB OBJECTIVE

To determine relative return rates and contributions to spawning escapements and the fisheries made by steelhead produced at Trinity River Hatchery, and to evaluate experimental hatchery management practices aimed at increasing adult returns.

INTRODUCTION

The completion of the Trinity River Division of the Central Valley Project (15 May 1963) blocked access to approximately 16% of the historic steelhead spawning and rearing habitat in the Trinity River basin, and resulted in an approximately 80% reduction in flow past the Lewiston dam site (Hubbell, 1973; Ca. Dept. of Fish and Game, 1965). These project-induced reductions in fishery habitat and flow are among the major factors contributing to the decline of annual runs of steelhead in the Trinity River system.

In October 1984, U.S. Public Law 98-541 was enacted. This act, commonly referred to as the Trinity River Basin Fish and Wildlife Restoration Act, authorized the expenditure of $57 million over a 10-year period to implement a program to restore fish and wildlife populations in the Trinity system to pre-dam conditions.

One of the major goals of the California Department of Fish and Game's (CDFG) Klamath-Trinity Program is to develop fishery harvest management recommendations which are compatible with the goal of restoring full, natural salmon and steelhead production in the Trinity River and its tributaries downstream from Lewiston Dam. Knowledge of hatchery- and naturally-produced steelhead escapements into the Trinity River is needed to develop those recommendations. To differentiate between naturally-produced and hatchery-produced steelhead, all steelhead reared at Trinity River Hatchery from 1978 through 1981 were systematically fin clipped before being released. Run size and escapement estimates of hatchery-produced and naturally-produced steelhead were made during the 1978-79, 1980-81, and 1982-83 seasons. (Heubach and Hubbell 1980; Heubach 1984; Zuspan et al. 1985).

This year, staff of CDFG's Trinity Fisheries Investigations Project (TFIP) continued to mark steelhead produced at Trinity River Hatchery (TRH) as part of the first half of our Project's efforts to meet the Job Objective. The second half, which began last season, includes the monitoring of adults returning to TRH.

METHODS

In-hatchery Fish Growth

The amount of feed given to fish reared at TRH is determined by taking weekly standard weight counts (number of fish per pound), and then fish are fed according to suggested manufacturers' recommendations (Gary Ramsden, Manager, Trinity River Hatchery, CDFG, pers. comm.). The average weights of individual fish, reported in this chapter, were based on these weight count data from TRH feeding schedules. Project personnel graded fish during the marking process and placed smaller fish into holding tanks until they could be moved into hatchery ponds for further growth.

Marking Operations

Staff of CDFG's TFIP marked steelhead at TRH inside two wooden sheds measuring 3 m X 3 m, positioned directly over the hatchery ponds. Positioning the sheds over the ponds allowed access for two crews of four markers each, to effectively net fish into each shed and mark them. Each shed was equipped with a four-station marking table and a holding tank (approximately 284 liters), through which fresh, hatchery pond-water was circulated. Fish were netted directly from the hatchery ponds and placed into the holding tank located inside the shed. A smaller holding sink, also equipped with circulating fresh, pond water, was locate n the center of each marking table. One shed was equipped with a recirculating tricaine methanesulfonate (MS-222[1/]) system (approximately 76 liters), which was changed at least once per day with fresh aqueous MS-222 solution. This system used 1.5 cups of MS-222 per week. The recirculating MS-222 system was installed to minimize fish mortality caused by overdoses of anaesthetic. The other shed had separate, non-circulating MS-222 sinks at the four work stations, with each marker responsible for controlling their own MS-222 concentrations. No comparisons were made of MS-222 usage between the two sheds. The temperatures of the fresh water and MS-222 solutions of both sheds were monitored regularly throughout the day.

Marking steelhead involved anaesthetizing them with MS-222, removing one or more of their fins by clipping, and releasing them into a pond reserved for marked fish. To keep count of fish marked, each marking station was equipped with a manual counter to tally each fish as it was marked. A combination of right ventral (RV) or left ventral (LV) and adipose (Ad) fin clips was used to differentiate each fish's brood year (BY) and age at release. Fish marked during this season were from the 1990 BY

1/ The use of brand names is for identification purposes only and does not imply the endorsement of any product by CDFG.

(given a RV fin clip), to be released as two-year-olds, and from the 1991 BY (given a LV fin clip), to be released as yearlings.

Numbers of fish released from TRH were estimated by TRH personnel, using the standard weight count method on a subsample of marked fish at the time of release.

Hatchery Mark Evaluations

We monitored the effectiveness of our fin-clipping operation by randomly checking steelhead one to four times per day throughout the marking period, to see how well the fins were removed. We netted a sample of fish as they exited each marking shed and checked them before they were placed into the hatchery ponds. We recorded the number of fish which were poorly fin-clipped, marked them with the appropriate fin clip, then placed them into the hatchery pond reserved for marked fish. Project personnel were notified immediately of any poorly fin-clipped fish, so that they could pay closer attention to marking.

To determine overall fin clip accuracy, we examined a sample of the marked steelhead just prior to release. These fish were anaesthetized with MS-222, measured to the nearest mm fork length (FL), and checked for how well the fin was removed during the marking process. Fin-clipping is considered a permanent mark if the rays are removed to the point of attachment to the bone (Stuart 1958; Eipper and Forney 1965; Jones 1979). Fins which were less than half removed were likely to regenerate, with fin rays appearing distorted at the location of the clip. Unless personnel checking for fin clips on returning adults specifically looked for distorted rays, fish that were poorly marked would be unrecognizable. We determined the number of effectively-marked fish by multiplying the percent of fish with poor fin clips by the total number of fish released, and subtracting this product from the total.

Fish Health Assessment

A subsample of marked fish were autopsied by a CDFG pathologist prior to release for health and general condition. A complete organosomatic analysis was done and results are on file with the pathologist, Region I, California Department of Fish and Game. Results reviewed in this report are confined only to general remarks by the pathologist. Project personnel also visually inspected the fish for general condition during the hatchery mark-evaluation process.

Recovery Operations

Project personnel monitored steelhead returning to TRH from 16 September 1991 through 27 March 1992. We examined the fish for fin clips, measured each to the nearest cm FL, and recorded their sex. Steelhead were also checked by Trinity River Pro; t (TRP) personnel during their operation of the Willow Creek weir, located 132.0 km downstream of TRH, from 20 August through 13 December 1991, and at the Junction City weir, located 42.4 km downstream of TRH, from 21 May through 13 December 1991.

RESULTS AND DISCUSSION

In-hatchery Fish Growth

Brood Year 1990 (two-year-olds)

These fish were held over from last season, unmarked, because they did not meet minimum release size requirements. Holdover fish from this BY were reared at TRH, marked this season, and released as two-year-olds.

According to TRH feeding schedule records, the average weight of these fish in April 1991 was 20 fish/lb or 22.7 gm each. To minimize handling mortalities, weight counts were not taken on these fish from 12 September 1991 through 18 February 1992. At the time of release, their average individual weight was 412 gm (Figure 1).

Brood Year 1991 (yearlings)

According to TRH feeding schedule records, these fish grew progressively throughout the rearing cycle. Beginning 11 September, TRH personnel graded fish by size, and feed was decreased for a short period. This resulted in a small drop of average individual weight from 12.8 to 10.8 gms. The average weight of marked fish at the time of release was 56.7 gms each (Figure 2).

Between 16 January and 13 February 1992, the average individual weight of the smaller fish separated during the grading process temporarily declined, probably due to the high number of small fish placed into the pond during that period (Gary Ramsden, Manager, TRH, CDFG, pers. comm.). By 12 March 1992, the average weight of the smaller-grade fish was 23.9 gms (Figure 2). These small- grade fish will be held over at TRH, marked next season, and will be released as two-year-olds in the spring of 1993.

Marking Operations

This season, we marked 2,834 fish held over from the 1990 BY wit a RV fin clip, to be released as two-year-olds, and 968,025 fisl from the 1991 BY with a LV fin clip, to be released as yearling: Both groups were released in March 1992 (Table 1). There were ı experimental hatchery management practices to evaluate this season.

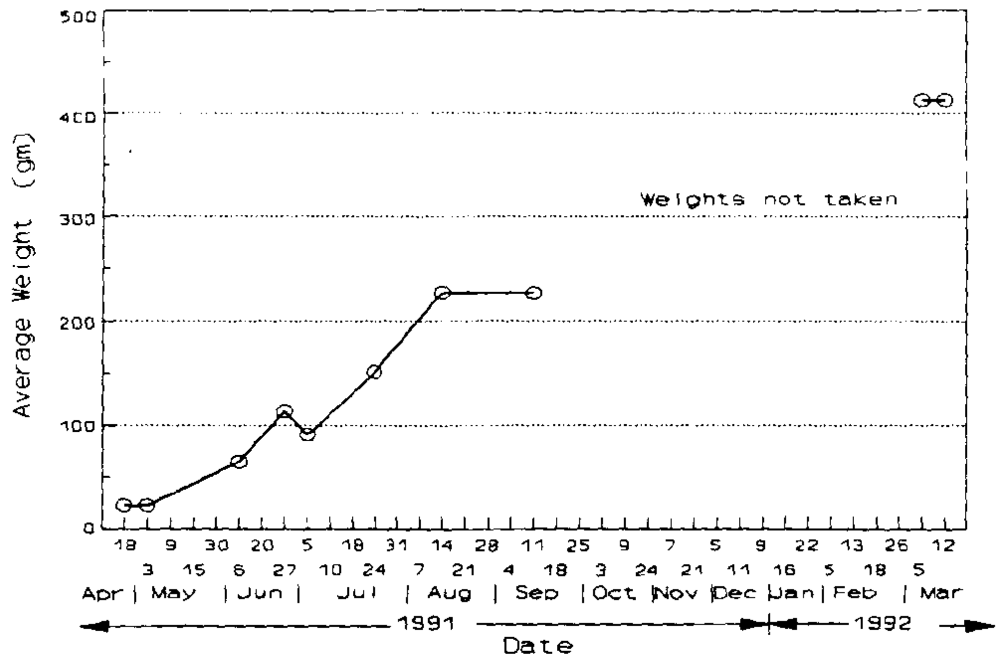

FIGURE 1. Average weight of two-year-old steelhead from the 1990 brood year reared at Trinity River Hatchery from 18 April 1991 through 12 March 1992.

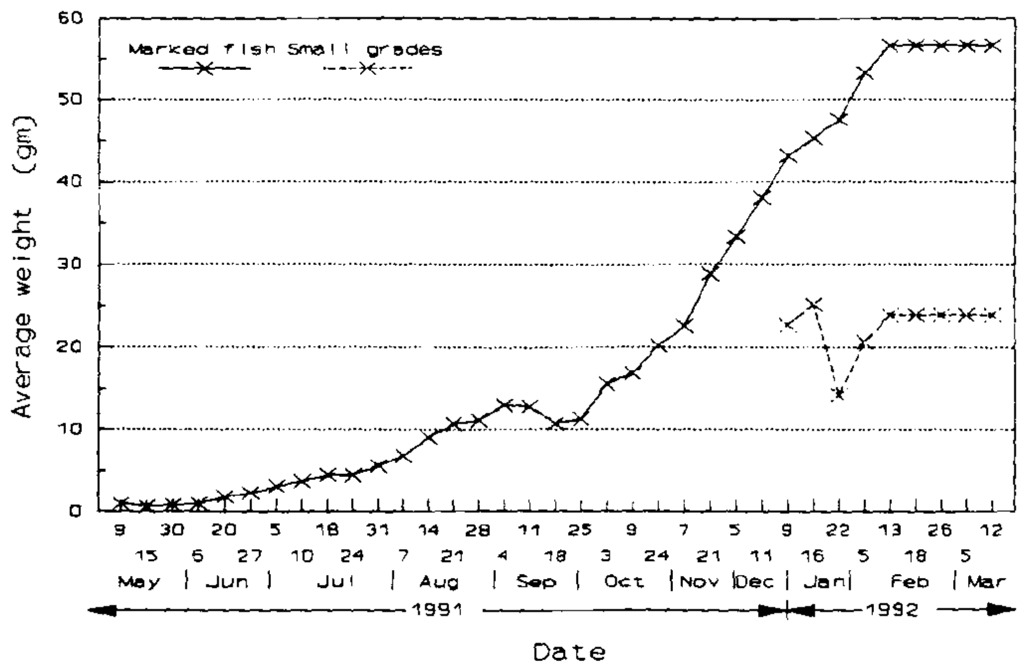

FIGURE 2. Average weight of yearling steelhead from the 1991 brood year reared at Trinity River Hatchery from 9 May 1991 through 12 March 1992.

TABLE 1. Summary of steelhead fin-clipping operations at Trinity River Hatchery from 1 October 1991 through 18 March 1992.

Release group					
Brood year	Age	Number clipped	Fin clip type[a]	Release date	Size (#/kg)
1990	Two-yr-old	2,834	RV	3/16/92	2.4
1991	yearling	968,025	LV	3/16/92	17.5

a/ RV = right ventral, LV = left ventral.

Brood Year 1990 (two-year-olds)

We had previously marked 970,617 steelhead from this BY with an Ad+LV fin clip during the winter of 1990, and released them as yearlings in the spring of 1991 (Aguilar 1992). By the 1991 release date, approximately 3,000 fish from this BY were too small to mark, and so were held and reared at TRH a second year in order to reach the minimum release size of 152.4 mm (6 in) FL. We began marking a remaining 2,834 steelhead from this BY on 1 October 1991. These fish were reared at TRH until 16 March 1992, and released as two-year-olds into the mainstem Trinity River at TRH. The average weight of these fish at release was 2.4 fish/kg (Table 1).

Brood Year 1991 (yearlings)

We marked 438,184 steelhead from this BY with a LV fin clip from 1 October through 30 October 1991. Throughout this period, TRH personnel graded fish according to size. On 30 October, the management at TRH determined that the remaining fish (approximately 512,000) were too small and would need added rearing time to increase growth, so marking was temporarily discontinued.

We resumed marking on 6 January 1992, and marked 487,987 steelhead through 7 February 1992, when TRH management again determined the remaining fish (approximately 60,000) were too small to mark. Once again, marking was temporarily halted.

We resumed marking for the third time on 16 March 1992, the day pond screens were pulled to allow the fish to enter the mainstem Trinity River at TRH. We marked 41,854 steelhead through 18 March 1992. These fish were held at TRH until evaluation of hatchery marks could be made before they were released. The average size of fish from this BY at release was 17.5 fish/kg

(Table 1). Approximately 10,000 - 11,000 fish from this BY that were considered too small to mark are being held at TRH. These fish will be marked next season and released as two-year-olds.

Hatchery Mark Evaluations

Brood Year 1990 (two-year-olds)

We examined a subsample of 80 steelhead from the 1990 BY to see how well their fins were removed during the marking process. We did not find any poorly fin-clipped fish, thus all steelhead released from this BY were considered effectively marked (Table 2).

According to TRH staff estimates, they released 1,909 steelhead from the 1990 BY, and had 925 mortalities during the holding period prior to release. At the release date, the FL of these fish ranged from 205 to 455 mm, and averaged 351.8 mm, with a sample S.D. of 5.36 (Figure 3).

Brood Year 1991 (yearlings)

From 10 through 20 March 1992, we examined a subsample of 22,538 fish to assess the quality of their fin-clips. We measured the FLs of 4,500 of the fish in this subsample. We found 192 (0.9%) fish from this BY which were poorly fin-clipped. There were no mortalities recorded by TRH personnel, thus 959,313 (99.1%) of the steelhead from this BY were effectively marked and released (Table 2). Their FLs ranged from 75 to 283 mm, and averaged 183.6 mm FL with a sample SD of 1.95 (Figure 4).

TABLE 2. Summary of steelhead hatchery-mark evaluations from 1 October 1991 through 20 March 1992.

Release group						
Brood year	Age	Number released[a]	Fin clip type[b]	Number evaluated	% Poor clips	Number effectively marked[c]
1990	two-yr-old	1,909	RV	80	0.0%	1,909
1991	yearling	968,025	LV	22,538	0.9%	959,313

a/ Number released = total number of fish marked adjusted for holding mortalities.
b/ RV = right ventral, LV = left ventral.
c/ Number of effectively marked fish = number with accurate fin clips = number released X ((100 - % poor clips)/100).

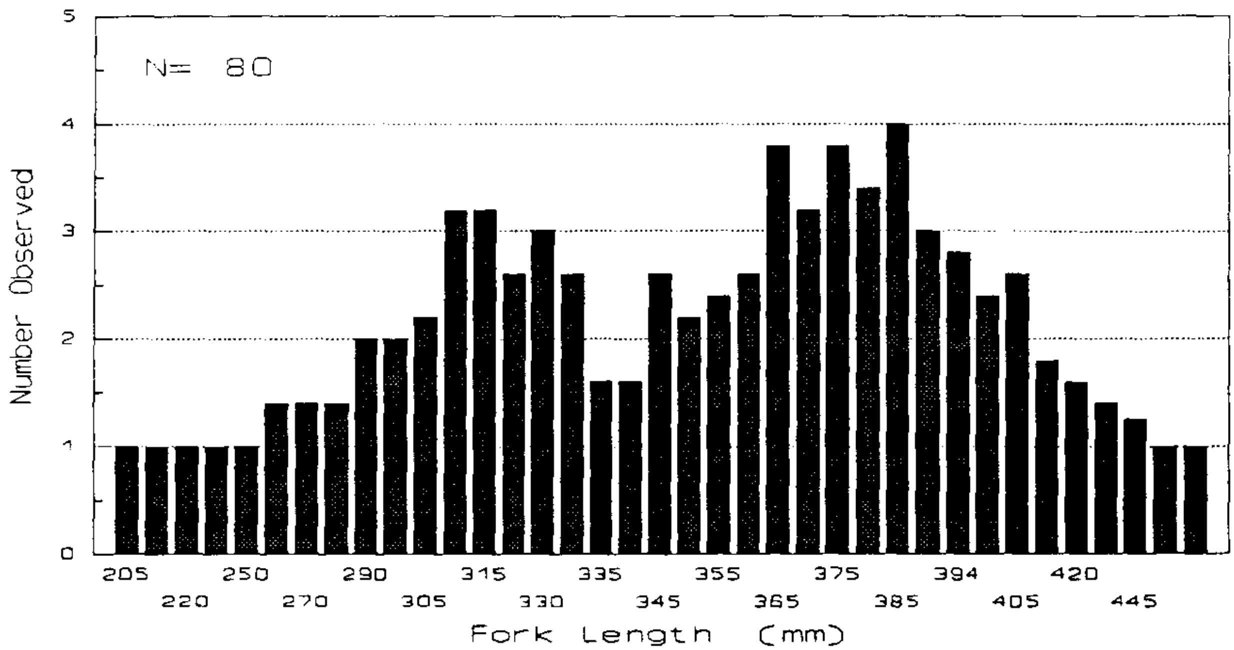

FIGURE 3. Length frequency of marked two-year-old steelhead from the 1990 brood year released from Trinity River Hatchery on 16 March 1992.

Fish Health Assessment

Brood Year 1990 (two-year-olds)

A pathological health assessment by autopsy was not done because of the limited number of fish from this brood year. We checked 80 fish during the hatchery mark-evaluation procedure, and found a fungus-like growth on three fish. We also found some fin erosion. Overall, the fish released from this BY showed signs of stress, probably because of handling them at a larger size.

Brood Year 1991 (yearlings)

A subsample of 20 fish was collected at TRH by a CDFG pathologist, prior to the release of marked fish. A complete organosomatic analysis and autopsy were done. Results showed some dorsal fin wear and scale loss; however, the general condition of these fish, as determined by both the pathologist and Project personnel, appeared to be good.

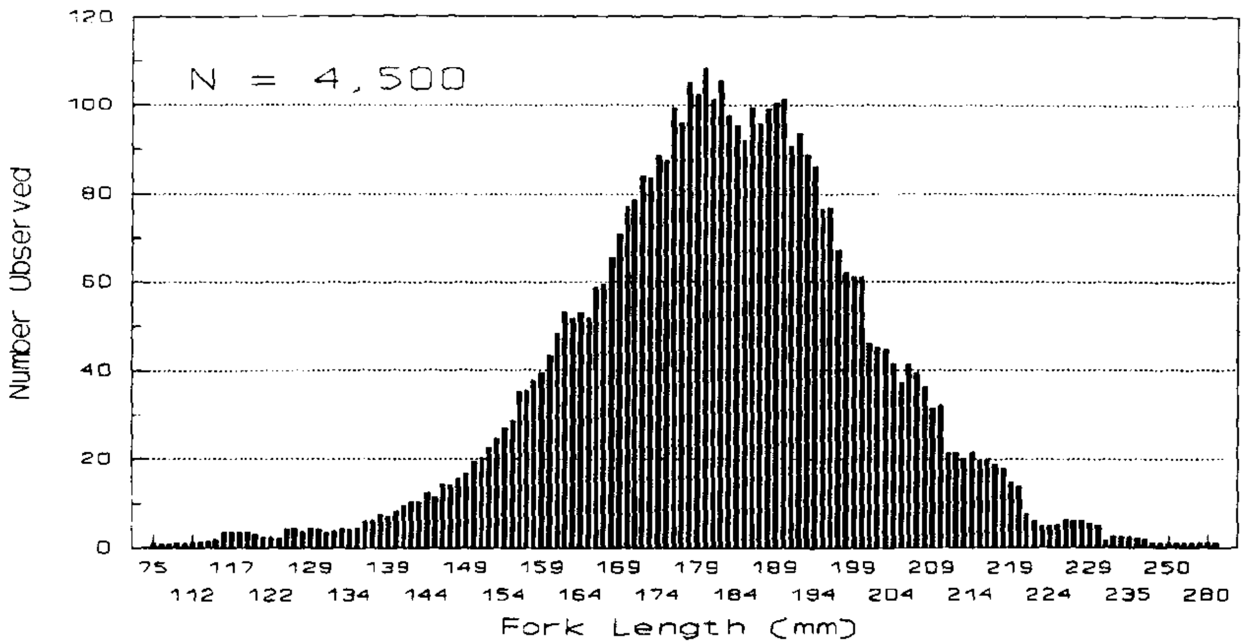

FIGURE 4. Length frequency of marked yearling steelhead from the 1991 brood year released from Trinity River Hatchery on 16 March 1992.

Recovery Operations

Juvenile steelhead migrate to sea after spending one to three years in fresh water. They usually stay one to two years in salt water, then return to freshwater to spawn when they are 38 to 69 cm in total length. Life-history patterns of steelhead are variable, however, and growth rates may vary (Moyle 1976).

A fraction of the Trinity River steelhead run has a unique life-history pattern in that they will stay less than one year in salt water, and return to fresh water after several months (Hopelain 1987). These fish are referred to as half-pounders.

This was the first year we expected to see returns of fish which were marked and released in 1990 (1988 and 1989 BYs). Steelhead produced at TRH were the majority (183/295) of returns to the hatchery during this reporting period, and made a significant contribution to spawner escapement.

Trinity River Hatchery

Many returning adult steelhead were lost at TRH before we could recover them, due to predation by otters. Otters took fish directly from the holding tanks and fish trap, and, occasionally, only body parts were found. Because of this, fewer eggs were taken, and we expect the number of steelhead available for marking will be considerably lower next season.

Project personnel monitored steelhead returning to TRH from 16 September 1991 through 27 March 1992, when migration was complete. During that period, 295 steelhead returned to TRH, of which 183 (62.0%) were fin-clipped. Of those: 24 (8.1%) were marked with a LV fin-clip, with FL ranging from 33 to 68 cm, indicating they were from the 1989 BY, returning as three-year-olds; 73 (24.7%) were marked with a RV fin-clip with FL ranging from 31 to 75 cm, indicating that the majority (65/73) of these were from the 1988 BY, returning as four-year-olds; 54 (18.3%) were marked with a Ad+RV fin-clip indicating they were from the 1989 BY; 31 (10.5%) were marked with a Ad+LV fin-clip indicating they were from the 1990 BY, and 1 was marked with a right pectoral fin-clip, of unknown origin. Last season, 927 steelhead returned to TRH, six of which were marked fish from the 1988 BY returning as three-year-olds.

Junction City Weir

Personnel from the TRP recovered 103 steelhead from the Junction City weir, 35 (34.0%) of which were fin-clipped. Of those: 5 (4.9%) were marked with a Ad+LV fin-clip indicating they were from the 1990 BY; 8 (7.8%) were marked with a Ad+RV fin-clip indicating they were from the 1989 BY; 10 (9.7%) were marked with a LV fin-clip indicating they were from the 1989 BY; and 12 (11.7%) were marked with a RV fin-clip indicating they were from the 1988 BY.

Willow Creek Weir

Personnel from the TRP recovered 638 steelhead at the Willow Creek weir, 71 (11.1%) of which were fin-clipped. Of those: 49 (7.7%) were marked with a RV fin-clip indicating they were from the 1988 BY; 9 (1.4%) were marked with a LV fin-clip indicating they were from the 1989 BY; 7 were marked with a Ad+RV fin-clip indicating they were from the 1989 BY; 4 were marked with a Ad+LV fin-clip indicating they were from the 1990 BY; and 2 had an adipose fin-clip only, of unknown origin. Adipose-clipped fish may have been previously marked with a corresponding ventral clip; however, regeneration may have occurred.

RECOMMENDATIONS

Marking should begin as late as possible next season, to allow as much time as possible for the fish to grow. This would prevent intermittent marking, and allow for continuous fin clipping throughout the season.

LITERATURE CITED

Aguilar, B. 1992. Survival and contribution to the fisheries and spawner escapement made by chinook salmon produced at Trinity River Hatchery. Chapter VI. Job VI. p. 158-169 In: K. Urquhart (ed.) Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1991 season. June 1992. 186 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

California Dept. of Fish and Game. 1965. California Fish and Wildlife Plan. Volume III. Supporting Data. Part B-Inventory Salmon-Steelhead and Marine Resources. October 1, 1965. p. 323-679.

Eipper, A., and J. Forney. 1965. Evaluation of partial fin-clips for marking largemouth bass, walleyes, and rainbow trout. New York Fish and Game Journal 12:233-240.

Heubach, B. 1984. Progress report, 1981-82 Season. Task VI. Trinity River salmon and steelhead tagging program. p. 49-106. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations-Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. Tasks I and VI. December 1984. 106 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

Heubach, B. and P. M. Hubbell. 1980. FY 1979 progress report. Task VI. Lower Trinity River salmon and steelhead tagging program. p. 80-132. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations-Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. September 1980. 141 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

Hopelain, J. S. 1987. Age, growth, and life history of Klamath River basin steelhead (Salmo gairdnerii), as determined from scale analysis. 33 p. (Mimeo). Available from Calif. Dept. of Fish and Game, Inland Fisheries Div., 1416 9th St., Sacramento, CA 95814.

Hubbell, P. M. 1973. Program to identify and correct salmon and steelhead problems in the Trinity River Basin. A report to the Trinity River Basin Fish and Wildlife Task Force. August 1973. 70 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

Jones, R. 1979. Materials and methods used in marking experiments in fishery research. Food and Agriculture Organization of the United Nations, Fisheries Technical Paper Number 190 (FIRM/T190). Rome, Italy.

Moyle, P. B. 1976. Inland Fishes of California. p. 131-132. Univ. of Calif. Press, Berkeley, CA. 405 p.

Stuart, T. A. 1958. Marking and regeneration of fins. Freshwater Salmon Fisheries Research, Edinburgh, Scotland 22. In: Nielson, L. A., and D. L. Johnson, (eds.), Fisheries Techniques. American Fisheries Society. Virginia: Southern Printing Co.; 1983:p.215-237. (Tagging and Marking).

Zuspan, M., D. Maria, and B. Heubach. 1985. Progress report, 1982-83 Season. Task IV. Trinity River salmon and steelhead tagging program. p. 62-146. In: P. M. Hubbell (ed.), Progress Report. Fishery Investigations-Trinity River. Trinity River Basin Fish and Wildlife Task Force Priority Work Item No. 5. January 1985. 84 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

ANNUAL REPORT

TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991-1992 SEASON

CHAPTER VII

JOB VII
LIFE HISTORY, DISTRIBUTION, RUN SIZE, AND HARVEST OF SPRING CHINOOK SALMON IN THE SOUTH FORK TRINITY RIVER BASIN

by

Michael Dean

ABSTRACT

The California Department of Fish and Games' Trinity Fisheries Investigations Project is conducting a study of spring-run chinook salmon (Oncorhynchus tshawytscha) in the South Fork Trinity River basin. In this effort, we trapped and tagged returning adults, operated recovery weirs, performed creel, snorkel, spawner, redd, and carcass recovery surveys, analyzed adult and juvenile scales, and performed emigrant juvenile trapping.

During adult trapping operations in the spring and summer of 1991, we captured, marked, and released 42 spring-run chinook salmon. Subsequently, 14 spring-run chinook salmon were captured at recovery weirs. Two captured fish had been marked at the tagging weir. During summer snorkel surveys throughout the basin, we observed 66 spring-run chinook salmon. Four fish had been marked at the tagging weir. Due to the low number of mark recoveries, a statistically valid run-size estimate was not obtained. However, based on the above recovery numbers we estimated the run-size to be 232 fish (192 adults and 40 grilse). Based on scale analysis, we determined that the age class distribution of returning fish was 17% two-year-olds, 29% three-year-olds, 45% four-year-olds, and 9% five-year-olds.

Pools were the primary adult summer holding habitat in the basin. Significant numbers of spring-run chinook salmon were found in only eight of the pools we located.

Based on tag returns and creel surveys, the angler harvest was near zero.

Spring-run chinook salmon spawning began on 3 October and ended 26 October. During redd surveys we located 25 spring-run chinook salmon redds. Redds were distributed above and below Forest Glen with only one below Hyampom. Only one chinook salmon carcass was recovered.

Using emigrant juvenile trapping, we determined that spring-run chinook salmon young-of-the-year emigration began on 9 April and ended on 1 July. Yearling spring-run chinook salmon emigrate during winter and early spring.

JOB OBJECTIVES

1. To determine the size, composition, distribution, and timing of the adult spring chinook salmon run in the South Fork Trinity River basin.

2. To determine the angler harvesı f spring-run chinook salmon in the South Fork Trinity River ɒasin.

3. To determine life-history patterns of spring-run chinook salmon produced in the South Fork Trinity River basin.

INTRODUCTION

This study is designed to be a thorough evaluation of the life history of spring-run chinook salmon (spring chinook), (Oncorhynchus tshawytscha) within the South Fork Trinity River (SFTR) basin. This is the first major study of spring chinook in this basin. The only other study was conducted in the late summer and fall of 1964 prior to the devastating flood that occurred that year (LaFaunce 1964). The California Department of Fish and Game (CDFG) and the U.S. Forest Service (USFS) have ⁻⁻de numerous attempts to count adult spring chinook (and spring-ı steelhead) in the SFTR in order to track population trends and evaluate post-flood habitat recovery. These efforts have been sporadic, short term, and made no attempt to determine complete life history (see Appendix 1). Reliable, statistically valid population estimates were not determined.

The size of the current population of spring chinook in the SFTR is not known. Estimates of annual spawner escapements from various sources (Appendix 1) range from multiples of ten to a few hundred fish. It is certain that the population has experienced serious decline since 1964, when the run was estimated to be 11,604 (LaFaunce 1964). A current, valid population estimate and understanding of life history patterns is crucial to any management or restoration effort.

This is the second year of a proposed five-year study of SFTR spring chinook by the CDFG's Trinity Fisheries Investigations Project (TFIP). Since our annual reports normally cover the period from 1 July through 30 June, the snorkel survey, redd and carcass recovery surveys and other observations made during summer and fall relate to those fish trapped and marked during the 1990-1991 reporting period. Also, scales used for life history determinations were obtained from fish trapped and released during the 1990-1991 season.

METHODS

The study area includes the lower 132 km of the SFTR, the lower 7 km of the East Fork of the SFTR, and the lower 16 km of Hayfork Creek, totaling 155 km of river. Lafaunce (1964) broke this area into 16 roughly equal sections. We attempted to use these same sections for comparison, but for logistical reasons deviated slightly (Figures 1 & 2). We also snorkel surveyed the lower 4 km of Grouse Creek.

This study is comprised of several distinct elements, each generating an escapement estimate or providing information on in-stream life history or distribution.

To meet job objective one, we used the Petersen mark and recapture method, with some variation. We operated a weir at which fish were trapped, tagged, and released. We attempted to recover fish or observe tags in three ways: 1) we operated two recapture weirs (in the mainstem SFTR and in Hayfork Creek); 2) we observed over-summering fish during snorkel surveys of the entire study area; and 3) we attempted to recover carcasses during the spawning season. All data were to be used in making separate Petersen estimates.

To meet job objective two, we utilized non-reward tag returns and a limited creel survey. Historically, poaching has been a problem on the SFTR. Non-reward tags were chosen so as not to increase the potential of poaching for the reward.

To meet job objective three, we analyzed scales collected during the adult trapping operation, performed emigrant juvenile trapping, and made direct snorkel observations of heavily utilized spawning areas prior to, and during the time we expected to see emergent fry.

Immigrant Chinook Trapping and Tagging

Early-entering Portion of the Run

The trapping weir (Gates Weir) was located at river kilometer (RKM) 31.7, 16 km downstream of the township of Hyampom (Figure 1). The weir functions as a fence across the river designed to guide adult fish into a trap. The weir was constructed of 1.5-m wide by 1.2-m high panels, which reached completely across the river. Each panel was constructed of 1.9-cm (diameter) galvanized conduit welded horizontally on 5.7-cm centers to 2.5-cm by 2.5-cm steel angle iron uprights. Panels were wired together with steel tie-wire, and supported with conventional steel fence posts driven into the river bottom. Netting was placed atop the panels to prevent fish from jumping over the weir.

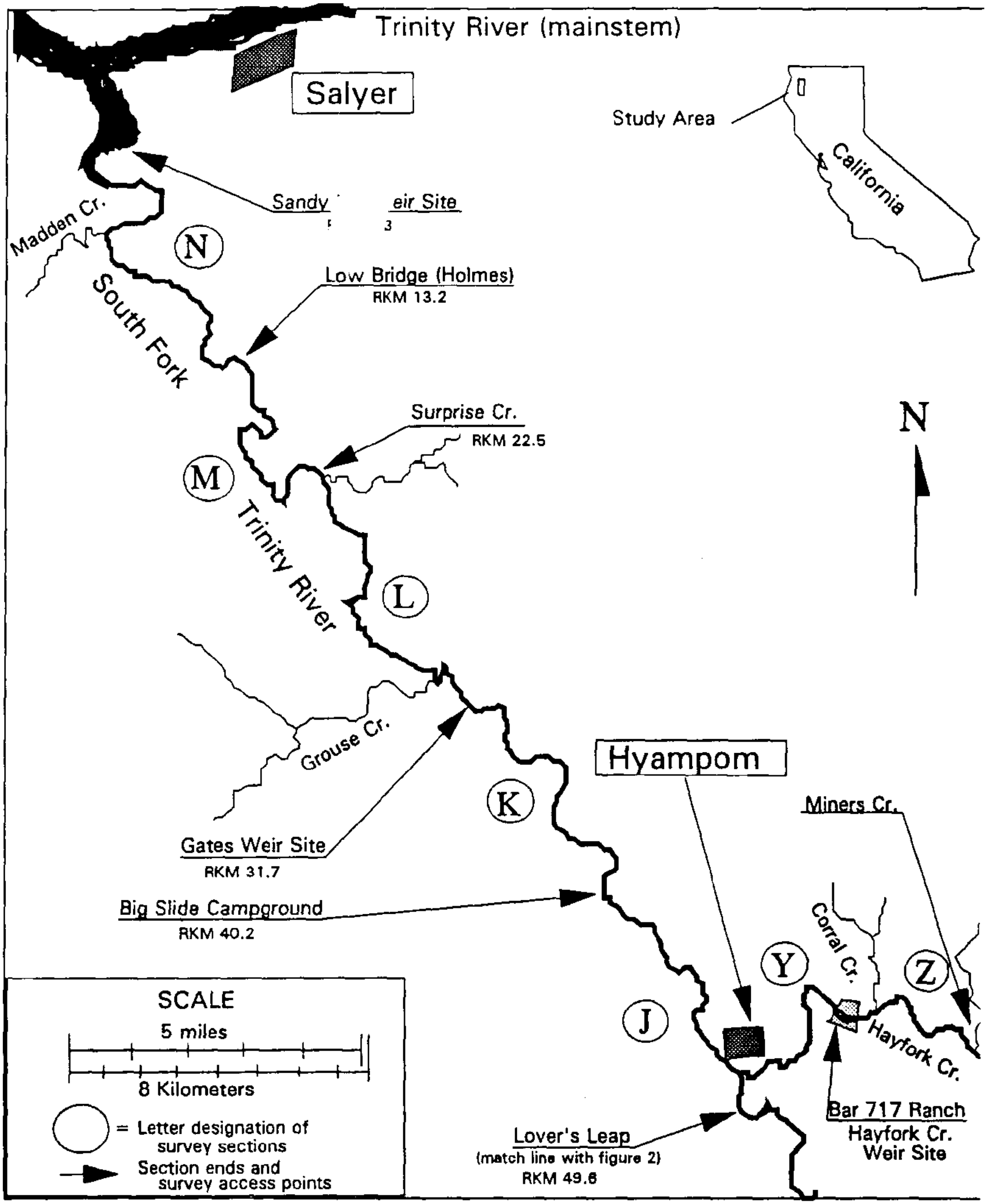

FIGURE 1. Map of the South Fork Trinity River, Hyampom and below, depicting surv sections and major tributaries. (RKM = river kilometer, from the mouth of the Sc Fork Trinity River).

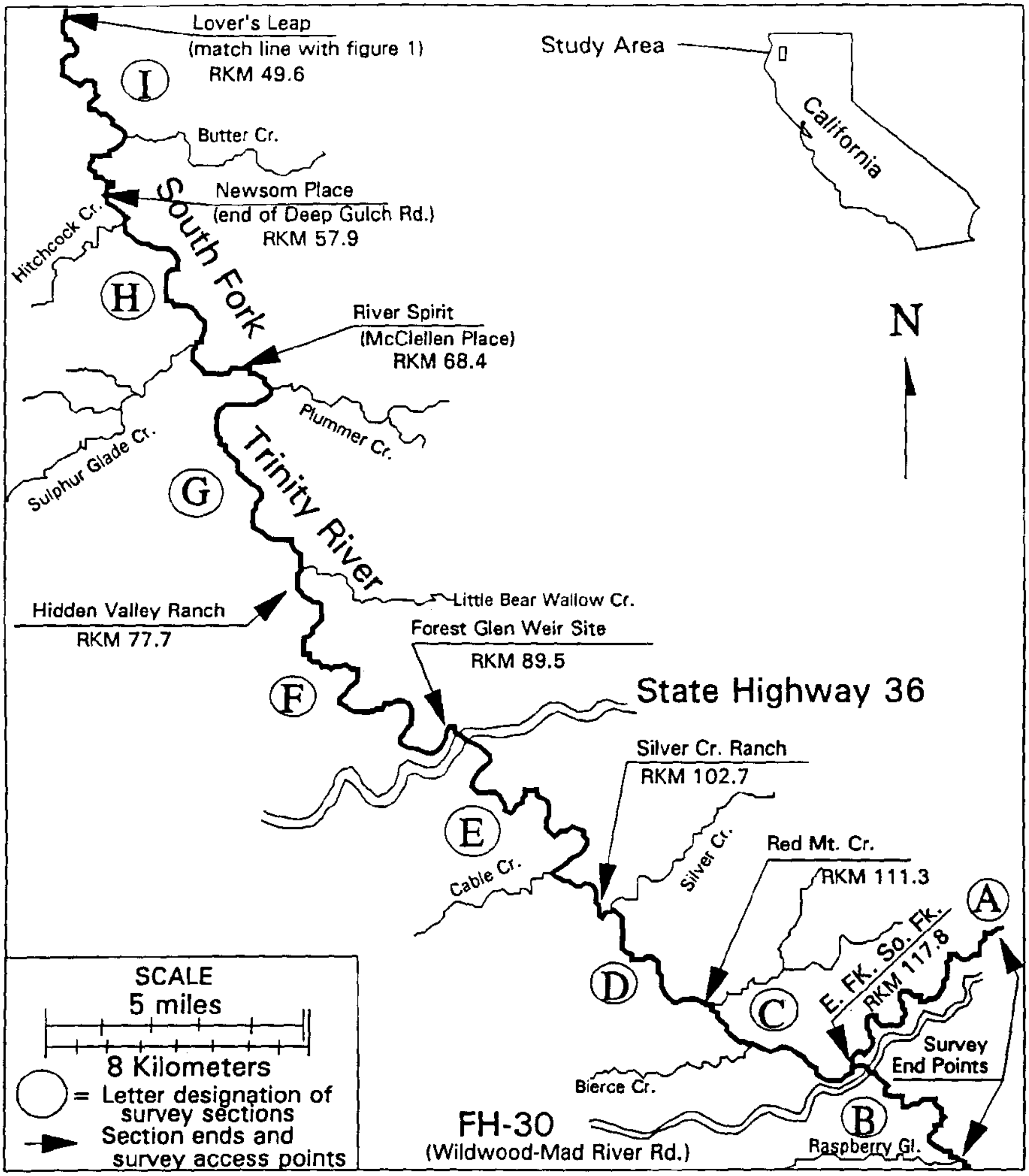

FIGURE 2. Map of the South Fork Trinity River above Hyampom depicting survey sections and major tributaries. (RKM = river kilometer from the mouth of the South Fork Trinity River).

The trap was 2.4 m long by 2.4 m wide by 1.2 m high (vertical depth) and was constructed with weir panels described above. Two 1.1-m panels were placed inside to form a fyke which led fish into the trap and deterred their escape. The conduit of the upstream and side panels was sleeved with clear vinyl tubing in an effort to minimize potential abrasion to trapped fish. In an effort to make fish more at ease in the trap and less likely to try to jump out, a piece of dark blue nylon fabric was floated on the surface of the water. It was attached inside the trap at the upstream end only. If a fish were to jump and land atop the fabric, the fabric would simply sink allowing the fish to settle back into the water. This device also provided cover and made fish difficult to see from outside the trap. Great care was taken to insure that there were no sharp projections, wire, etc. inside the trap which might injure trapped fish. Foam pipe insulation was used in areas where unavoidable abrasion might occur. The trap was provided with a lockable plywood lid and solid plywood bottom.

Once trapped, fish were netted with a knotless, nylon-mesh net and placed in a tagging cradle. The tagging cradle consisted of a frame constructed from 1.9-cm copper pipe, measuring 100 by 50 cm which was fitted with a nylon cradle to hold fish, and a metric ruler for measuring fork lengths (FL). The cradle assembly was designed to slide into a channel in the front of the trap. A sliding door made from perforated aluminum plate (0. - cm holes) formed the upstream end. Once marked, fish could be released by opening the sliding door.

Once in the tagging cradle, fish were examined for marks, scars, and general condition, their FL was measured to the nearest cm, and a scale sample was taken. A small knife was used to collect scales from the left side of the fish just below the dorsal fin.

Since we saw no ill effects resulting from tagging a portion of the 1991 cohort, all of the 1992 cohort was tagged, either with a one-half left-ventral (LV) fin clip and a Floy[1/] anchor tag, or a one-half right-ventral (RV) fin clip and a Lotek[1/] implantable radio transmitter. The Floy tag was placed on the left side, just below the dorsal fin, and just posterior to its midline. Each radio tag was inserted into the stomach of an adult chinook salmon through the esophagus, with the aid of a small length of 0.95-cm diameter PVC pipe. The radio tagging operation was done in cooperation with a project led by Dr. Roger Barnhart of the U.S. Fish and Wildlife Service, California Cooperative Fishery Unit, Humboldt State University. [**Note:** Tagged spring chinook

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1/ The use of brand names is for identification purposes only and does not imply the official endorsement of any product by he California Department of Fish and Game.

discussed in the RESULTS section of this report refer to those marked during the last reporting period (1990-1991 season). Only half the number of these fish captured were actually tagged (Floy + ½LV), while the other half were fin clipped only (½RV). Discussion of fish tagged and marked in the manner noted above, including radio tagged fish, will be reported in the 1992-1993 Annual Report].

Tagged fish were then sprayed with a 10-20% aqueous solution of Propolyaqua[2/] (artificial slime) to help prevent infection caused by the removal of mucus during handling. Spraying was focused on areas such as the caudal peduncle, scale sample site, and the tag location. Care was taken to insure that the head, operculum, and gills were not sprayed with the solution.

Fish which appeared fresh and strong were then released directly from the cradle to the river (upstream) without further handling. During periods of warm water temperature (> 15.5° C) or when fish appeared stressed, they were allowed to swim from the cradle into a recovery tube and held there for at least 60 minutes. The recovery tubes were made from plastic pipe measuring 3.5 m long by 25 cm in diameter. Both the upstream and downstream ends were fitted with sliding plexiglass doors, each with numerous 2-cm holes to allow ample water to flow through the tube. The tubes were oriented with their long axis parallel to the current and held on the river bottom with large rocks. Once the recovery time was over, the upstream door was opened and fish were allowed to leave of their own accord.

Late-entering Portion of the Run

We also installed and operated a trapping weir of similar construction to the one described above, in the lower SFTR at Sandy Bar (RKM 2.4), in order to assess any late-entering portion of the spring chinook salmon run. This weir was installed on 4 September 1991 and was operated by TFIP until 1 October. On 1 October the Natural Stocks Assessment Project (NSAP) moved the weir 100 m upstream to a more stable winter site, where they operated it until 11 February 1992.

The only problem we encountered in operating this weir was defining spring-run vs. fall-run chinook salmon (fall chinook), considering that both may be present at the same time. We defined late-entering spring chinook as those fish which were dark, brassy, and may have had other physical marks which indicated they had over-summered lower in the Klamath-Trinity

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2/ The use of brand names is for identification purposes only and does not imply the official endorsement of any product by the California Department of Fish and Game.

system. Those chinook salmon which appeared fresh, bright, nickel colored, and usually lacked old marks and scars, were defined as fall-run.

Recapture Weirs

Two Alaskan-style weirs were operated in the basin as recovery stations. These weirs were located in Hayfork Creek at Bar 717 Ranch, 8 km upstream from its confluence with the SFTR, and in the mainstem SFTR at Forest Glen Campground (RKM 89.5) (Figure 1). The Alaskan weir also utilizes 1.9-cm galvanized conduit as the "fence", but the support and orientation of the pipe is markedly different than the Gates Weir. The conduit slides through holes in 7.6-cm wide by 3.3-m long aluminum channel and contacts the natural river bottom. The aluminum channel is supported on tripods constructed of 10.2-cm x 15.2-cm and 5.1-cm x 15.2-cm Douglas fir beams. The aluminum channel is oriented horizontally and the conduit is oriented vertically. The spacing between the conduit centers is 5.7 cm. The trap construction is also the same as that noted above, except that vinyl tubing was not used for pipe sleeves in the Hayfork Creek trap. Fish captured in these traps were netted, examined for marks, scars, and general condition, then immediately released. Artificial slime was also applied to each fish just prior to release.

All weirs were operated 7 days per week, 24 hours per day. Each was serviced every morning and often staffed 24 hours per day during busy holiday weekends.

Digitally recording thermographs were used to continually monitor water temperatures at the weir sites. Thermographs were protected inside a steel casing and chained to each weir. Hand held thermometers were used to check water temperature each morning during the routine weir service and prior to the deployment of thermographs.

Snorkel Survey

The snorkel survey was conducted during late June, July, and August of 1991 and covered the entire survey area (Figures 1 & 2). Our primary goal was to count the number of spring chinook salmon and adult steelhead, and to document the number of tagged spring chinook observed in the population. We also documented the number and location of over-summer holding pools utilized by three or more spring chinook.

We used teams of two to three individuals, equipped with mask, snorkel, wetsuit, anti-slip footwear or fins, notepads, and appropriate safety gear (e.g. rescue rope and first aid kit). We typically entered the river at approximately 09:30 and covere 7.0 to 10.5 km of river per day, depending on the length and difficulty of each river section. Each team floated or swam down the river, and recorded the number of adult salmonids and the relative abundance of juvenile salmonids. We also noted habitat types and condition, water temperature, presence of tributaries and their respective temperatures, and the presence or absence of summer holding habitat. The most difficult task was finding adult fish. We spent a great deal of effort searching beneath undercut rocks, ledges, vegetation, overhangs, etc., where fish often hid to avoid divers. Some sections required a good deal of walking and investigation of pools, step-runs, pocket water, and other habitat types which afforded good cover.

Once we determined what pools were being utilized by spring chinook, we made follow-up observations of fish at these sites. We used binoculars from a vantage point which afforded a good view, without the fish being aware of us. Almost every pool had a steep bluff associated with it which was ideal for this purpose. Our goals were to determine if fish were moving into or out of the pools, assess summer mortality, make counts and look for tagged and marked fish, and to observe pre-spawning behavior in order to begin our spawner surveys at the appropriate time.

Redd and Carcass Surveys

Surveys began in mid-September and continued through mid-November. We used an aerial survey conducted by helicopter every seven to fourteen days to cover the entire river to ensure we were performing ground surveys frequently enough, and to observe overall trends. Each river section was covered more thoroughly by two-person crews, on foot or in kayaks. When redds were located, their location was documented (by RKM), each was assigned a specific identification number, and the following parameters were measured: over-all size, position in the stream, water depth, current velocity, and gravel size. We also estimated the percent fines in surrounding gravels and noted various aspects of fish behavior (e.g. female present or absent, evidence of false redd activity, estimated time spent on redd). We repeated the surveys until two consecutive trips noted no new redds or live fish.

The carcass recovery effort was conducted in the same manner as redd surveys and focused on those areas where redds and spawning fish were seen during previous surveys. Carcasses were examined for tags and tag scars, fin clips, spawning success, and signs of predation, and a scale sample was taken. Their species, sex, FL, and general condition were also noted. We attempted to correlate each carcass with a known redd. We hoped to be able to determine if redds might actually contain eggs, based on the spawning success of the correlated carcass. We also hoped to determine a tag shedding rate from recovered carcasses.

Angler Harvest

The angler harvest estimate was generated based upon tag returns and creel surveys. The creel survey was limited this season to seven days due to time and personnel constraints, and was conducted only in sections J and K of the Hyampom basin (Figure 1). This creel survey area covered that portion of the river where over-summering spring chinook were most likely to be caught by anglers. Angler access sites in the creel survey area were identified prior to the survey period. Upstream of RKM 48, fishing was allowed, but harvest of salmonids greater than 35 cm in total length was prohibited. Therefore, no creel survey was attempted above this point.

During the creel survey, clerks followed a set route based on a predetermined schedule, and examined each access site for anglers. Anglers observed fishing during the survey periods were contacted and interviewed for hours fished that day, success, angling method, and county or state of residence. Sport-caught chinook were measured (FL, cm), and examined for fin clips and external tags. The number of any tag observed was recorded, the fish's sex determined, and its spawning condition noted. Scale samples were taken from creeled fish in the same manner as for fish from the Gates Weir.

Life-history Patterns

In-stream life-history patterns were determined from analysis of adult and yearling scales, juvenile emigrant trapping, and snorkel observations of spawning areas performed during late winter and spring.

Scale Analysis

Scales obtained from immigrant chinook trapped at the Gates Weir and from emigrant yearling chinook trapped at the Forest Glen Weir were cleaned and mounted between two glass microscope slides. Scales were then examined with a microfiche reader. The number of annuli, and patterns on the scale indicating ocean- or stream-type life history were noted. An ocean-type life history was indicated by the presence of the first annulus outside the point of ocean entry. A stream-type life history was indicated by the presence of the first annulus inside the point of ocean entry (Snyder 1931, Mills 1986, Sullivan 1989). The point of ocean entry was identified by the first obvious, pronounced increase in the distance between circuli, as measured outward from the scale nucleus. The number of circuli were counted and the radial distance (mm) measured from the scale focus to the mark indicating ocean entry, the first annulus, between each annulus, and from the last annulus to the scale margin. Each scale set was examined by two readers and their results comp ed. If the readers were in agreement, we assumed the interpretat n was correct. If readers were not in agreement, both readers re-examined the scale set together to determine the correct interpretation.

Juvenile Emigrant Trapping

We monitored juvenile emigration patterns by trapping in the SFTR at Forest Glen, 400 m below the Highway 36 river crossing. We chose this location for three reasons: 1) in our field work or in the literature, we found no evidence of fall chinook spawning this far upstream, so we reasonably were sure that any juvenile chinook salmon captured would be spring-run fish; 2) more than one-half of the spring chinook redds we documented during the 1991 season were less than 12 km upstream of this point; and 3) this site afforded easy access and was less subject to high storm flows than areas farther downstream.

Juveniles were captured using fyke nets attached to trap boxes. The nets were constructed of 1.3-cm nylon mesh, had a 1.8-m- by 2.4-m- upstream opening and extended 10.1 m to a trap attachment frame at the terminal end. Trap boxes were constructed of plywood and hardware cloth, and measured 0.8 m wide by 1.2 m long and 0.5 m in depth (vertical dimension). The fyke-net traps were placed in the river overnight, normally 24 hours, and captured fish were examined the following morning. To minimize the chances of current-induced fish mortality, we placed two trap boxes in tandem so that the current velocity in the last box was less than 0.3 m-per-second. We also formed an enclosure inside the back trap box using hardware cloth with 1.3-cm holes, which allowed chinook salmon fry safe refuge from much larger Age 1+ and 2+ juvenile steelhead.

Captured fish were identified to species and enumerated. Individual chinook salmon and steelhead were measured for FL (mm). The displacement volume was then measured for chinook salmon caught each day. Scale samples were taken from yearling chinook salmon and some steelhead captured. Flows through the net were measured with a Marsh-McBirney[3/] flow meter. The total volume sampled was then estimated. Water temperatures were monitored using hand-held thermometers or digital recording thermographs. When flow conditions permitted, we trapped one night-per-week beginning in mid-January, but increased to two nights-per-week once emigration began. We trapped on this schedule until no juvenile chinook salmon were caught for two successive trap weeks, and we felt that emigration was complete.

3/The use of brand names is for identification purposes only, and does not imply the endorsement of any product by the California Department of Fish and Game.

Snorkel Survey Observations

We made snorkel surveys in the area below Silver Creek Ranch (RKM 101.6 to RKM 99) during February, March, and April of 1992, attempting to observe newly emergent chinook salmon fry. Our intent was to document the timing of emergence to support data from fyke-net trapping and to document fry post-emergence behavior. We utilized the same snorkel methods discussed above, except that we covered only about two to three km of river. We chose this location because it had a relatively high density of redds and good water clarity, even during winter.

During snorkel surveys, we used small dipnets to sweep along stream margins, especially in submerged vegetation. We also used dipnets held at the bottom, perpendicular to stream flow while we disturbed the bottom (gravel and cobble) just upstream. In this fashion any alevins or fry dislodged from the bottom would be caught in the net.

Statistical Analyses

Effectively-marked Fish

We determined the number of effectively-marked fish by subtracting the number of tagging or marking mortalities recovered at or near the Gates Weir from the number of marked fish. Mortality was considered to be a result of the tagging operation if the fish was discovered dead within 30 days of processing. We did not subtract those mortalities discovered during the snorkel surveys from the effectively-marked population since some over-summer mortality is normal.

As reported in the 1990-1991 Annual Report, during that trapping season we systematically applied anchor tags to every other spring chinook captured, and marked the other half of the spring chinook captured with a RV fin clip only. We assumed that both fin clips and tags would be visible to personnel at recovery weirs and during carcass surveys, but that only tags would be visible during snorkel surveys. Therefore, only half the number of fish marked were considered effectively-marked fish for the snorkel survey run-size estimate purposes.

Run-size Estimate

To determine the run-size above the Gates Weir, we used Chapman's version[4/] of the Petersen Single Census Method (Ricker 1975):

4/ Chapman, D.G. 1951. Some properties of the hypergeometric distribution with applications to zoological sample censuses. Univ. Calif. Publ. Stat. 1:131-160.; as cited in Ricker (1975).

$$N = \frac{(M+1)\ (C+1)}{(R+1)}, \text{ where}$$

N = estimated run size; M = number of fish effectively tagged or marked at the Gates Weir; C = the total number of chinook salmon observed during snorkel or carcass recovery surveys, or at recovery weirs; and R = number of fish tagged or marked at the tagging weir which were later seen during the snorkel or carcass recovery surveys, or at recovery weirs.

In using this method, we assumed that fish trapped and marked or tagged were a random and representative sample of the population; marked or tagged, and unmarked fish were equally likely to be observed in snorkel and carcass surveys, and captured at recovery weirs; tagged and marked fish were randomly distributed throughout the population; marked or tagged, and unmarked fish did not suffer any differential mortality; all tagged and marked salmon were recognized upon recovery at weirs or during the carcass recovery survey; and that only tagged fish would be recognized as such during snorkel surveys.

Use of Standard Julian Week

Some data collected are presented in Julian Week (JW) format. Each JW is defined as one of a consecutive set of 52 weekly periods, beginning 1 January, regardless of the day of the week on which 1 January falls. The extra day during leap years is added to the 9th week, and the last day of the year is included in the 52nd week. This procedure allows inter-annual comparisons of similar weekly periods.

RESULTS AND DISCUSSION

1991 Reporting Period

Trapping and Tagging (early-entering portion of the run)

The following results are repeated from the 1990-1991 Annual Report to allow the reader to follow the 1991 spring chinook cohort through the summer and fall, and to more clearly understand our methodologies and results.

We operated the Gates Weir for 80 days, from 28 April through 18 July 1991. During this period, both immigrant and emigrant traps were maintained. We captured, marked, and released 34 adult and nine grilse spring chinook, eight unspawned adult fall- or winter-run and 18 adult spring-run steelhead from the immigrant trap. We captured, examined, and released 39 out-migrant (spawned) adult winter-run steelhead from the emigrant trap (Table 1). We effectively marked 39 chinook salmon at the Gates Weir, 19 with Floy anchor tags and 20 with a RV fin-clip.

TABLE 1. Trapping summary for the Gates Weir by Julian week from 28 April through 18 July 1991. The Gates Weir is located in the South Fork Trinity River 32 kilometers upstream from the mouth.

		Immigrant trap				Emigrant trap
		Spring-run chinook salmon		Steelhead		
Julian week	Start date a/	Adults	Grilse b/	Fall- and winter-run c/	Spring-run d/	Spawned fall- and winter-run steelhead
17	4/23/91	0	0	0	0	0
18	4/30/91	0	0	3	0	14
19	5/07/91	1	0	1	0	3
20	5/14/91	3	1	0	0	4
21	5/21/91	2	1	4	0	8
22	5/28/91	1	0	0	0	2
23	6/04/91	4	0	0	0	3
24	6/11/91	4	0	0	1	1
25	6/18/91	10	0	0	4	
26	6/25/91	2	3	0	4	1
27	7/02/91	2	4	0	5	1
28	7/09/91	4	0	0	1	1
29	7/16/91	1	0	0	3	0
	TOTALS:	34	9	8	18	39

a/ Trapping actually began on 4/28/91.
b/ Grilse are chinook salmon measuring ≤ 55 cm FL; adults are > 55 cm FL. This length cut-off is subject to revision (Zuspan 1992).
c/ Fall- and winter-run steelhead are upstream-migrating, sexually mature fish.
d/ Spring-run steelhead are upstream-migrating, sexually immature fish.

In 1991, we began catching spring chinook at the Gates Weir during the second week of May. The run appeared to reach its peak during early to mid-June (Table 1). We continued to catch fish until mid-July when we were forced to remove the weir due to excessively warm water temperatures (>21°C). Based on snorkel observations, we feel that some spring chinook continued to enter the SFTR until the end of July. Therefore, the run timing i

1991 for spring chinook in the SFTR was from early May through late July.

Spring chinook captured at the Gates Weir averaged 60.4 cm FL (± 9.6 cm S.D.) (Figure 3). TFIP has established 55 cm FL as the length separating adults and grilse in the mainstem Trinity River. We may revise this length cut-off for SFTR fish based on scale analyses. However, we have not yet read enough scales to make a final determination. Length data for steelhead captured at the Gates Weir are being reported in the Annual Report for Job III and will not be discussed here.

Of the chinook captured and sexed at the Gates Weir, 26 were females and 12 were males. Small grilse may have gotten through the Gates Weir at a higher rate than larger adults, accounting for the lower male count. Of the chinook recaptured and sexed at the Forest Glen recovery weir, seven were females and six were males.

1992 Reporting Period

Observation or Recovery of Tags and Marks

Recovery Weirs. No spring chinook were captured at the Hayfork Creek Weir, while 14 were captured at the Forest Glen Weir. Of these 14 fish, two were RV fin-clipped, indicating that they were processed through the Gates Weir (Table 2). No tagged fish were recovered. This number of mark recoveries was inadequate for a valid Petersen estimate.

Snorkel Surveys. We observed 66 spring chinook and nine spring-run steelhead during snorkel surveys. Twelve of the spring chinook were seen below the Gates Weir. Four of these fish may have moved above the weir after its removal. However, most remained below the weir until at least mid-September. All twelve were included in the run-size estimate.

Throughout the surveys, only three anchor-tagged spring chinook were seen. One additional spring chinook was observed with a LV fin-clip and an obvious tag scar. No fish were seen with the right ventral fin-clip. Therefore, we observed four marked spring chinook among the 54 seen above the weir. Unfortunately, this number of mark recoveries is insufficient for a statistically valid Petersen estimate. However, utilizing these numbers in the Petersen formula, and based on field observations, we estimate the run-size to be 232 fish.

In some pools, we observed spring chinook from a nearby bluff before conducting the snorkel survey. In one case, we observed four fish in a pool near Hidden Valley prior to entering the water. However, while snorkeling, only one fish could be found.

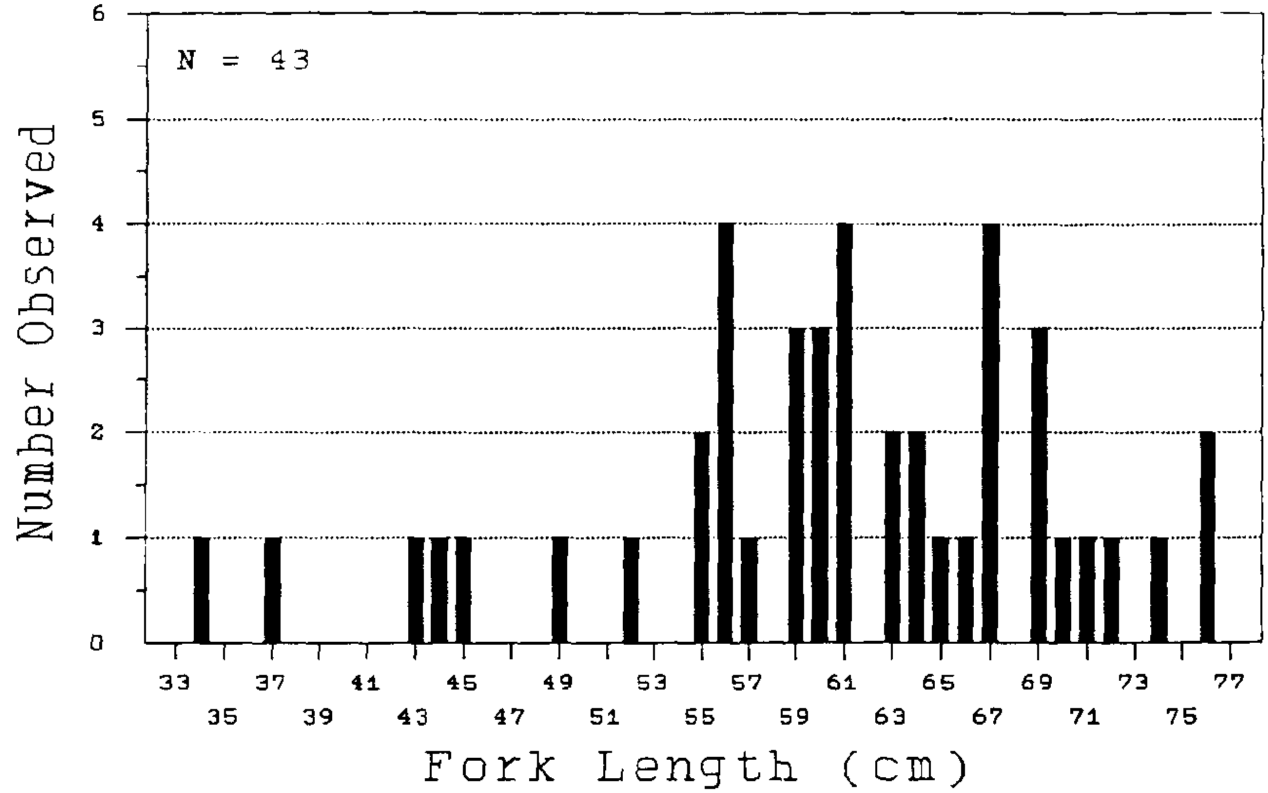

FIGURE 3. Fork length distribution of spring-run chinook sa. .on captured at the Gates Weir in the South Fork Trinity River from 28 April through 18 July 1991.

Therefore, we believe the snorkel survey may only provide a lower estimate of the number of fish.

One of five spring chinook was observed to have shed its tag. Based on this small sample size, it appears that a tag shedding rate of 20 to 25% is possible.

No spring chinook were seen during surveys of lower Hayfork Creek or Grouse Creek.

Follow-up Observations at Holding Pools. Near the end of August and through mid-September, spring chinook numbers increased in each pool. We assumed fish we had seen during the snorkel survey in poor holding areas, such as glides and step-runs, had moved into holding pools. However, since we could not identify individual fish, this could not be confirmed. We also noted that, as September progressed, fish exhibited more and more chasing behavior and some pairing was apparent. This may be an important clue in determining when fish are nearing spawning condition. In the last several days of September, spring chinook began leaving pools and moving into glides and riffle areas, indicating the onset of spawning.

TABLE 2. Spring-run chinook salmon recapture summary for the Forest Glen Weir during the 1991 season. The Forest Glen Weir is located in the South Fork Trinity River 89 kilometers upstream from the mouth.

Julian week	Date of capture	Fork length (cm.)	Sex	Marks a/
24	6/11/91	67	F	None
	6/13/91	74	F	None
25	6/18/91	59	M	None
	6/22/91	72	F	None
	"	71	F	None
	"	50	b/	None
26	6/28/91	65	M	None
	6/29/91	60	M	None
	7/01/91	62	F	None
27	7/02/91	79	M	None
	7/04/91	63	F	RV c/
	"	40	M	None
	7/07/91	72	M	None
28	7/13/91	67	F	RV c/
	Size range:	40 to 79		Total fish = 14
	Average size:	64.4		Total marks = 2

a/ Marks applied at Gates Weir.
b/ Sex was not determined for this fish.
c/ RV = right ventral fin-clip.

Spawner and Redd Surveys. We performed 30 individual surveys between 18 September and 6 November, and located 25 spring chinook redds. Twenty-four redds were distributed almost equally above and below Forest Glen (Figure 4); one was found well below Hyampom at RKM 38.3, and is not shown in Figure 4. Three spring chinook were seen to over-summer in the pool immediately upstream of this redd. Spring chinook spawning was most concentrated in river section E, near Silver Creek Ranch. All redds were typical for spring chinook salmon with regard to size, location in the stream, gravel size, current velocity, and water depth (Chapman

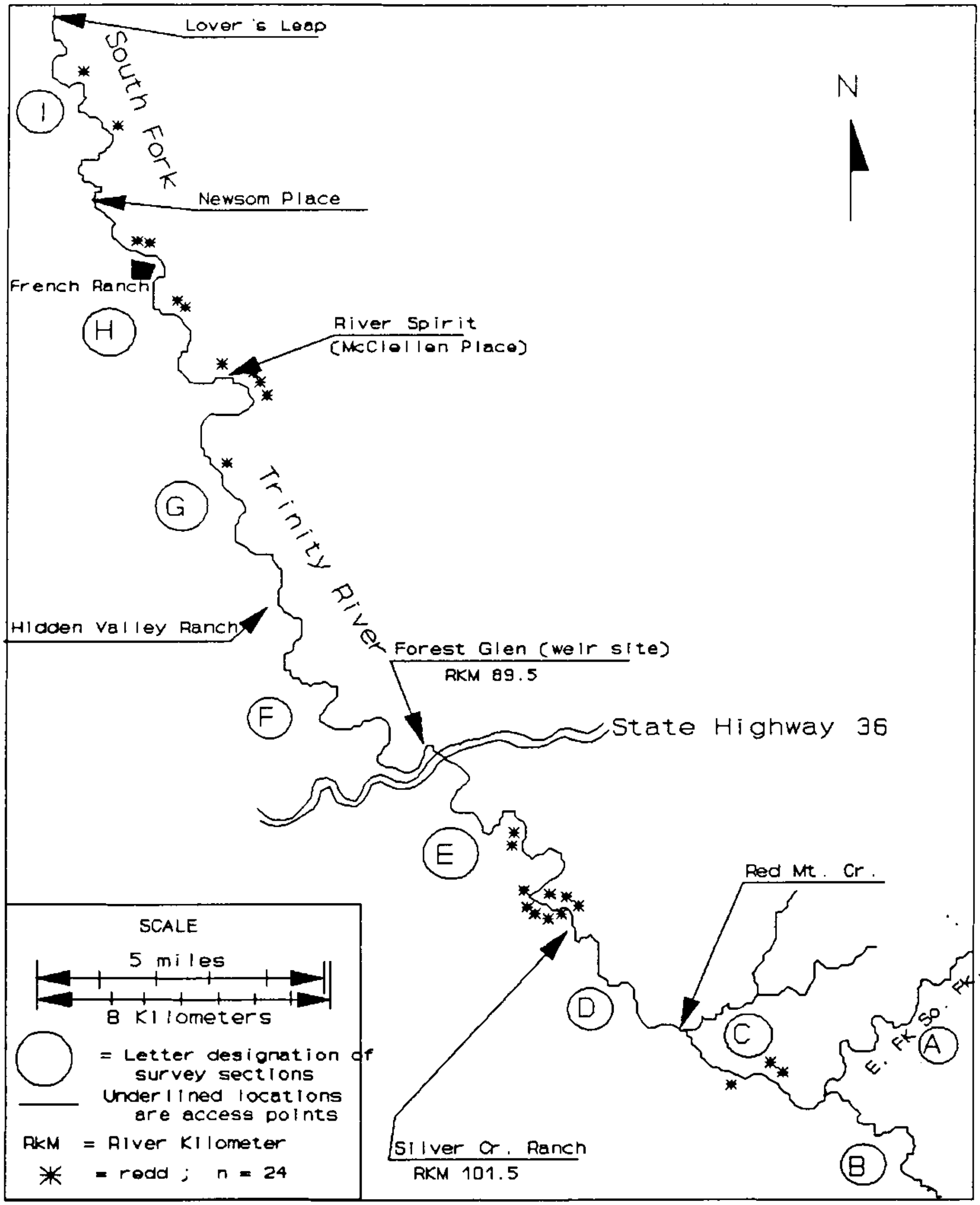

FIGURE 4. Location of 24 of 25 spring-run chinook salmon redds found in the South Fork Trinity River during the 1991 season.

1943; Mattson 1948; Cramer & Hammack 1952; Lindsay & Jonasson 1989; Groot and Margolis 1991). No spring chinook were seen spawning in Hayfork Creek. The weather and water clarity were excellent during these surveys.

Based on observations, we estimated that there were between two and three spring chinook per redd. If this estimate is accurate, then only about 65 fish survived to spawn. However, it is conceivable that we missed a few redds in the upper river (sections A, B, C, and D), and that there was considerably more spawning occurring than we accounted for.

SFTR spring chinook were observed to complete redd construction in about 24 hours, with evidence of false redd activity in almost every case. Females could be found in the area of the redd for only three-to-four days after redd completion. They were never seen to defend their redd. Although individual fish could not be identified, in two instances we discovered two redds in isolated areas where only one female was observed. This led us to believe that females might dig more than one redd. Spawning commenced in the upper river on 3 October and progressed downstream. Spawning was completed by the end of the third week of October (26 October). Although, in a few instances, redds were within a few meters of each other, we did not observe any overlapping of redds.

Carcass Recovery Surveys. We were able to recover only one spring chinook carcass during our redd and carcass recovery surveys. This carcass was discovered on 11 October just above the Butter Creek pool. It was a fresh, unspawned 60-cm FL female with a clear LV fin-clip, but no apparent tag scar. No cause of death was apparent. This may have been the tagged fish we knew to be holding in the Butter Creek pool. Lindsay and Jonasson (1989) reported average pre-spawning mortality rates in wild spring chinook of 44% for the Deschutes River (Oregon) from 1977-81, with some years as high as 75%. The Rogue River (Oregon) experienced average rates of 12% for the same period (Lindsay and Jonasson 1989). For comparison, pre-spawn mortality rates for spring-run chinook in the mainstem Trinity River averaged 62.8% in 1990 (Zuspan 1992). Groot and Margolis (1991) reported that much lower rates (less than 10%) are more typical. High pre-spawn mortality rates are often associated with stress factors such as high water temperature, microbial agents, or a combination of the two (Groot and Margolis 1991).

We found remnants of chinook carcasses (various fins and skull bones) in several areas, but these observations are of little value except to indicate a degree of predation and scavenging which we felt was occurring. River otter and mink were the primary predators and scavengers. As evidenced by tracks and scat traces, bear activity was light in spring chinook spawning areas.

Other Observations. On several occasions during snorkel surveys, we observed spring chinook moving upstream through high-gradient riffles and step-runs when water temperatures were greater than 22.5°C. On one occasion, the water temperature was 24°C. It is noteworthy that these fish can not only tolerate these temperatures, but appear to be able to migrate in them. It may be that such warm temperatures motivate fish to move farther upstream.

Our snorkel observations suggest there is no shortage of over-summer holding habitat for the current population of spring chinook in the SFTR. We found numerous pools which appeared to be of adequate depth, had good in-stream cover, and good thermal stratification (cool bottom water) which were not being utilized by spring chinook. We documented eight spring chinook summer-holding pools spread throughout the SFTR, primarily above Hyampom (Figures 5 & 6). Each of these pools was occupied by at least three spring chinook; most had five or more. We also documented one pool downstream of Hyampom where spring chinook not only over-summered, but survived to spawn (see Spawner and Redd Surveys, p. 209).

During the juvenile trapping effort and other field observations, we saw numerous green sunfish in the SFTR, especially lower Hayfork Creek. On two occasions, we electrofished a large backwater pool about 1 km above the Gates Weir. We estimated many as 200 sunfish in this pool, representing at least three age-classes. Stomach content analysis showed that the larger of these fish were piscivorous. Sunfish were also seen in the main river-channel. This question is beyond the scope of this project, but we are concerned that large numbers of these fish could be responsible for significant predation on emigrant juvenile salmonids.

Trapping and Tagging (late-entering portion of the run)

We operated the weir at Sandy Bar for 26 days from 4 September to 1 October, attempting to capture late-entering spring chinook. During this period, we captured one grilse spring chinook, one adult fall chinook and two adult fall- or winter-run steelhead. During the period of operation, river flows were low and efficiency of the weir was considered 100%.

Water temperatures in the lower river during this period ranged from 19 to 28 °C, averaging 21 °C. The mainstem Trinity at the SFTR confluence is consistently much cooler (by 4 to 6 °C). We feel that this temperature difference would inhibit most chinook from entering the SFTR during August and September. The low number of spring chinook captured supports this idea. Also, during this time of year, flows in the SFTR can be so low as to make significant upstream migration difficult. Consequently, y

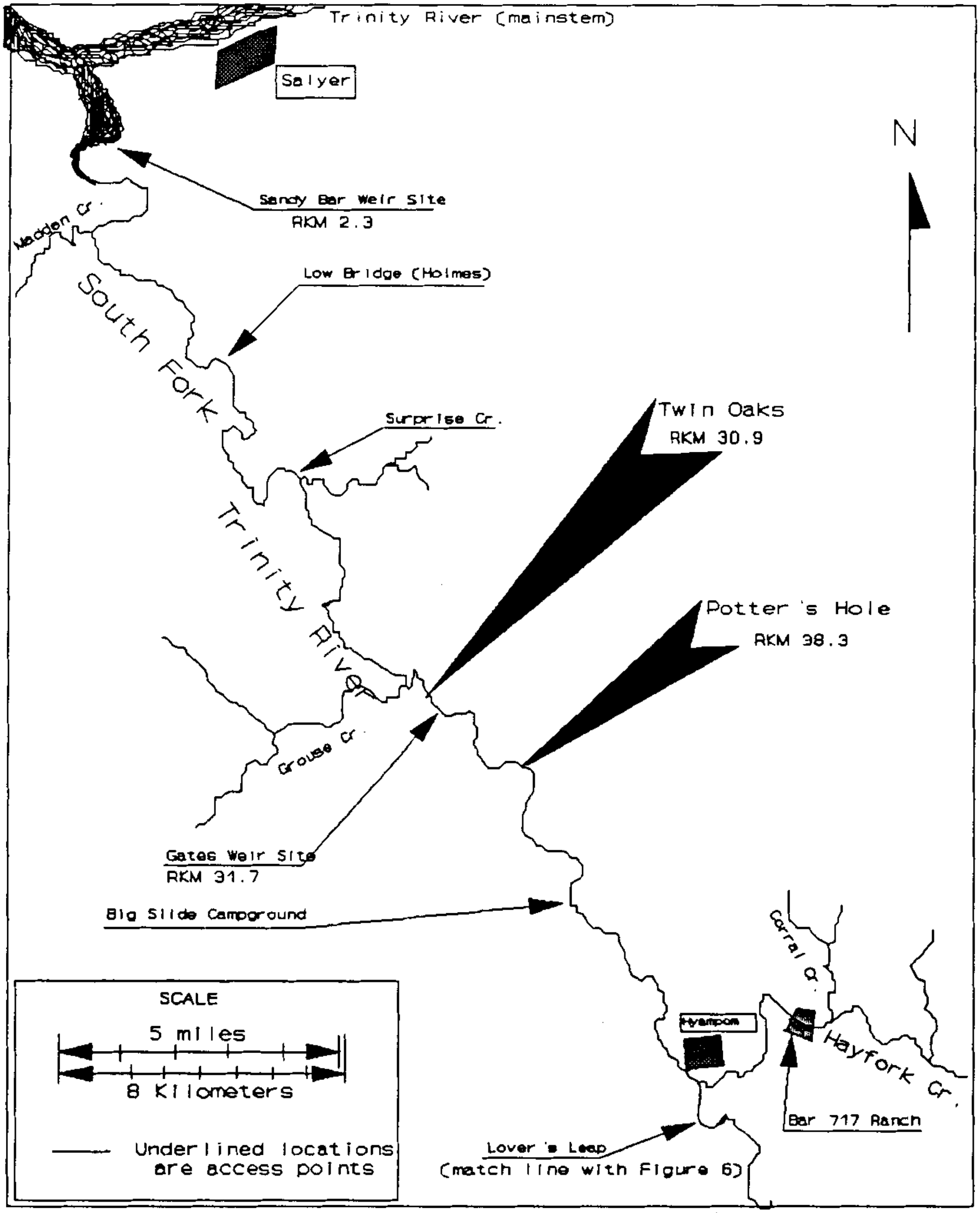

FIGURE 5. Location of summer holding pools utilized by spring-run chinook salmon during 1991 from Hyampom downstream to the mouth of the South Fork Trinity River. (RKM = river kilometers from mouth).

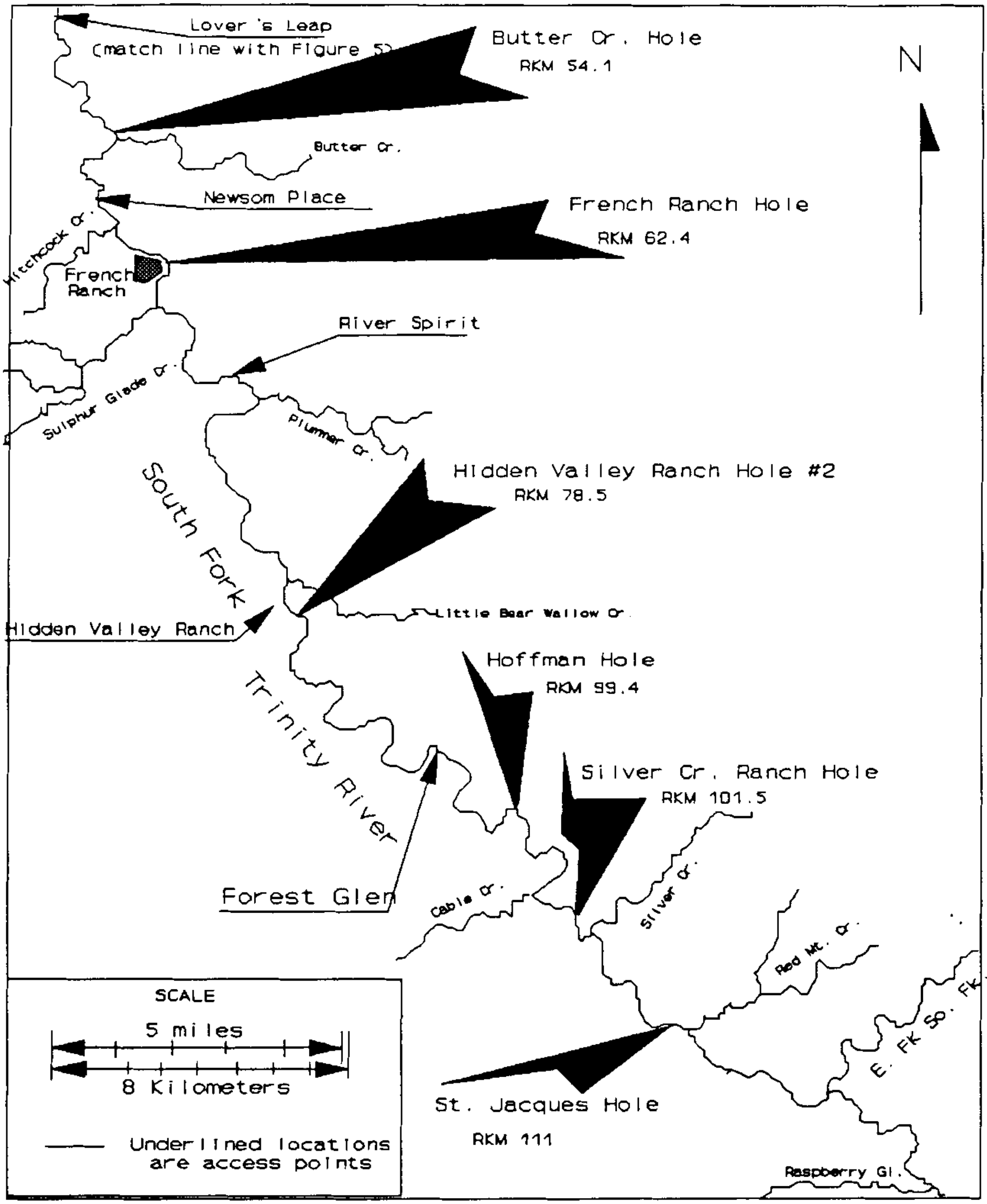

FIGURE 6. Location of summer holding pools utilized by spring-run chinook salmon in the South Fork Trinity River during 1991 from Hyampom upstream. (RKM = river kilometers from the mouth).

late-entering spring chinook would likely enter the river with early-entering fall-run chinook. As a result, differentiating between spawners of the two races would be very difficult.

Life History

Scale Analysis. We were able to interpret 42 of 43 scale sets recovered from immigrant chinook marked and released at the Gates Weir this season. The one unreadable set was composed entirely of regenerated scales which precluded analysis. Thirty-seven scale sets (88%) showed an ocean-type juvenile life history, while five (12%) showed a stream-type life history.

Of the 42 scale sets, seven fish (17%) were two-year-olds (grilse), 12 (29%) were three-year-olds, 19 (45%) were four-year-olds, and four (9%) were five-year-olds (Figure 7). Interestingly, of the five stream-type fish, two were three-year-olds, while three were five-year-olds. Lindsay and Jonasson (1985) reported age classes by scale analysis for spring chinook from the John Day River as 1-5% three-year-olds, 54-89% four-year-olds, 8-44% five-year-olds. Virtually all these fish were stream-type (Lindsay 1985).

The average FL for returning SFTR spring chinook in age groups two- through five-years was 46.7, 59.3, 64.5, and 66.8 cm, respectively (Figure 7).

Juvenile Emigrant Trapping. We trapped at the Forest Glen site for 41 nights between 16 January and 9 July 1992. Over this period, we captured and released 490 young-of-the-year (YOY) and four yearling spring chinook. The emigration of yearling spring chinook was scattered throughout the winter and early spring. We captured the first spring chinook YOY on 9 April along with the last yearling. The peak of spring chinook YOY emigration at Forest Glen was between late April and early June (Figure 8).

Natural Stocks Assessment Project (NSAP) personnel trapped emigrant juvenile salmonids for 37 nights in the SFTR near Hyampom between 9 November 1991 and 15 July 1992, as part of Job III. Unfortunately, fall-run chinook are known to spawn above this trapping site. Therefore, juvenile chinook salmon captured here cannot be positively separated by race. Also, fewer chinook salmon were trapped at the Hyampom site compared to Forest Glen (Figure 9). Due to higher flows near Hyampom, trapping in the main channel was seldom feasible, and when possible, a smaller percentage of the river was trapped, accounting for the difference in catch.

NSAP's results were almost identical to ours in the number of yearling chinook salmon captured (six compared to four) and in the timing of yearling and YOY emigration (Figure 9). Only four

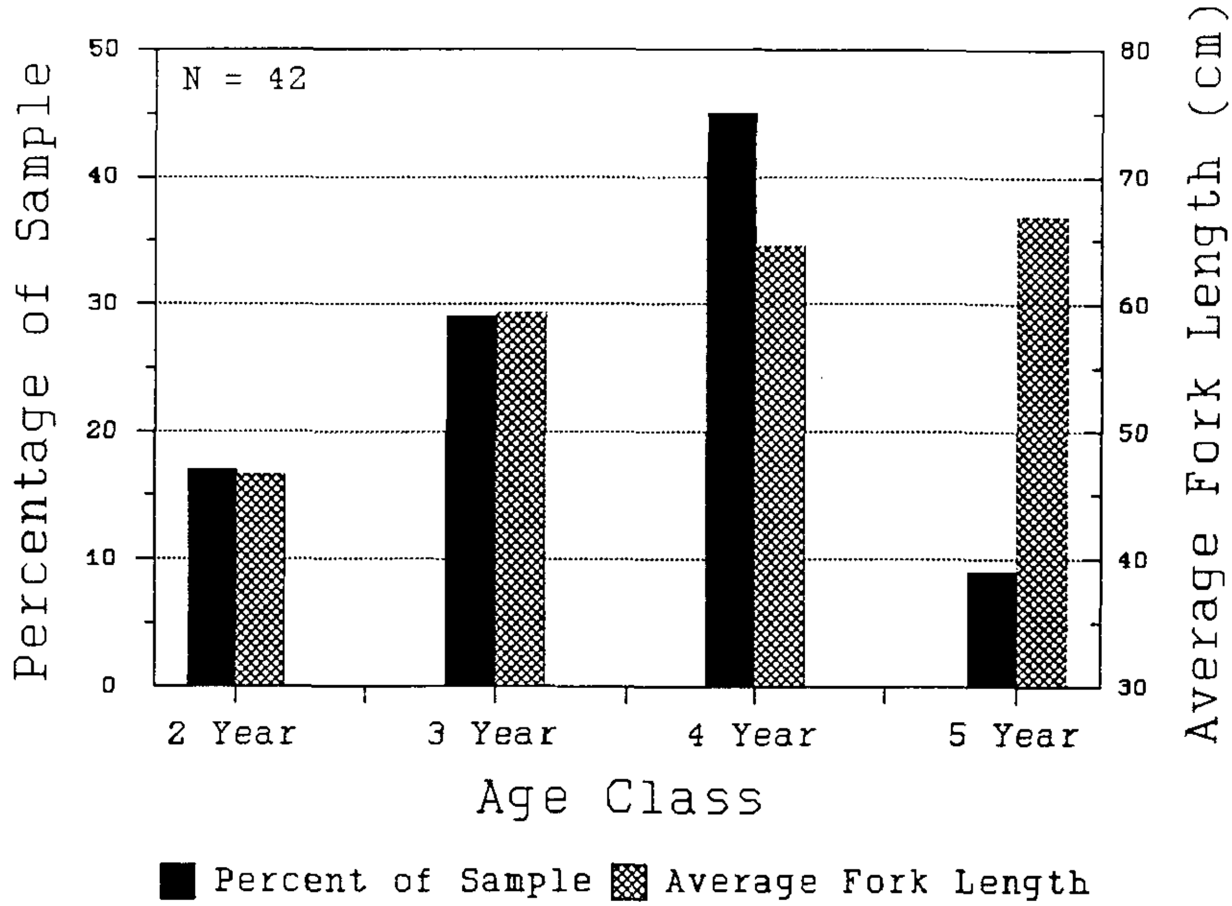

FIGURE 7. Average fork length by age class, and age composition by percentage of spring-run chinook salmon captured at Gates Weir in the South Fork Trinity River during 1991, as determined from scale analysis.

of six yearling chinook captured by NSAP staff are shown in Figure 9; two were captured in early November (these were omitted from the graph so that Figures 8 and 9 could be shown with similar axes). In early April the average FL for chinook salmon trapped by NSAP staff at Hyampom was 53.6 mm, compared to 53.8 mm at our Forest Glen site. By the end of May the average FLs had increased to 74 mm at Hyampom and 67 mm at Forest Glen. This difference may represent the growth that occurs between these two points. However, comparisons between our Forest Glen data and NSAP's Hyampom data must be made with caution. The NSAP juvenile trap location is such that juvenile fall-run chinook may also be captured.

Only one juvenile chinook salmon was captured by NSAP staff in the Hayfork Creek trapping operation. Since no spring chinoo were seen to over-summer or spawn in Hayfork Creek, we assume that this fish was from fall-run stock.

The catch-per-unit-effort (CPUE) at Forest Glen varied from zero to a high of 84. CPUE is defined as the number of fish caught per trap, per day. The average FL for YOY increased over the period from 53.8 to 91.7 mm (Figure 10). It was apparent that spring chinook YOY first captured at Forest Glen had been out of the gravel for some time, as evidenced by their relatively large size.

Yearling spring chinook measured 87, 89, 100, and 116 mm; the smallest caught first and the largest caught last. From our trapping operation and trapping performed by NSAP, it appears that yearling spring chinook emigrate during winter and early spring and do not mix with emigrant YOY to any significant extent. This life history strategy is represented by a small percentage of the population. It is not yet known how significant this life history strategy may be to the survival to spring chinook in the SFTR.

Coincident with this effort we captured and released 1,369 juvenile steelhead, 826 speckled dace, four green sunfish, five golden shiners, and a few thousand ammocetes.

<u>Snorkel Survey Observations.</u> We did not see yearling spring chinook during winter and early spring snorkel surveys. We observed five spring chinook YOY on 9 April, the first date we captured spring chinook YOY in fyke net traps at our Forest Glen trap site. These fish averaged 45 mm in length and were found in edgewater, among fine plant roots. Much of the SFTR in this section provides good edgewater habitat, as well as good habitat among large cobbles. Due to very cold water temperatures and fast flows, we were unable to document the use of the cobble habitat. Other habitat types in the section were apparently unused. No schooling behavior was noted in any habitat type.

Based on information presented by Alderdice and Velson (1978) and Dill (1969), we expected to see emergent fry in mid-March. Our field observations indicate that this time frame is accurate. Therefore, it took about 150 days from the time eggs were deposited until fry emerged from gravel. We also discovered that some fry take refuge in edgewater vegetation after emerging from the gravel. They appear hold there until foraging behavior and swimming abilities develop, a period of about 30 days. Reiser (1981) reported that fry were first seen in pools just upstream of redds. We did not see this behavior.

<u>Angler Harvest</u>

Seven individual creel surveys were performed during June of 1991. We saw no chinook salmon creeled, and no tags have been returned. CDFG staff members who reside in the Hyampom area

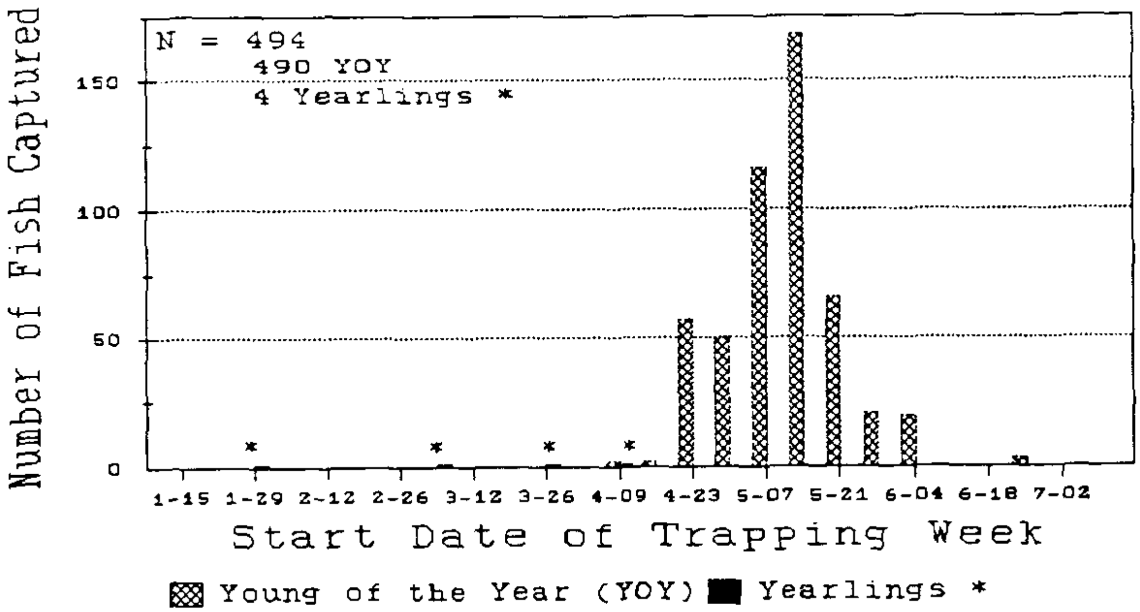

FIGURE 8. Temporal distribution of emigrant, juvenile spring-rur chinook salmon captured at the Forest Glen Weir in the South Fork Trinity River during the 1992 season.

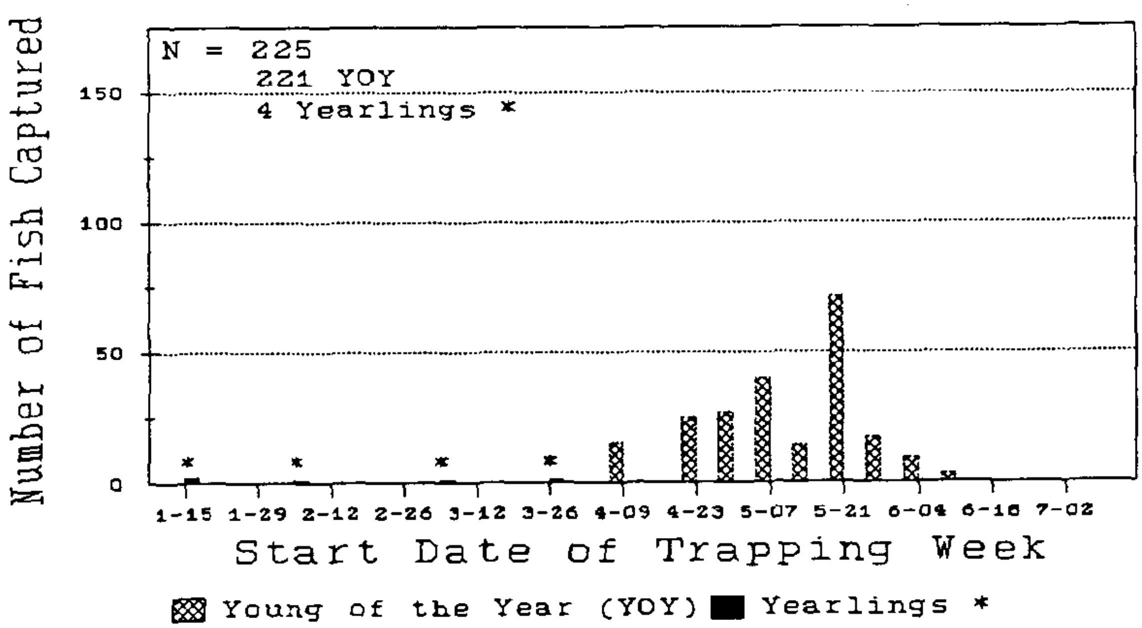

FIGURE 9. Temporal distribution of emigrant, juvenile chinook salmon (spring and fall race) captured by the Natural Stocks Assessment Project in the South Fork Trinity River near Hy on during the 1992 season.

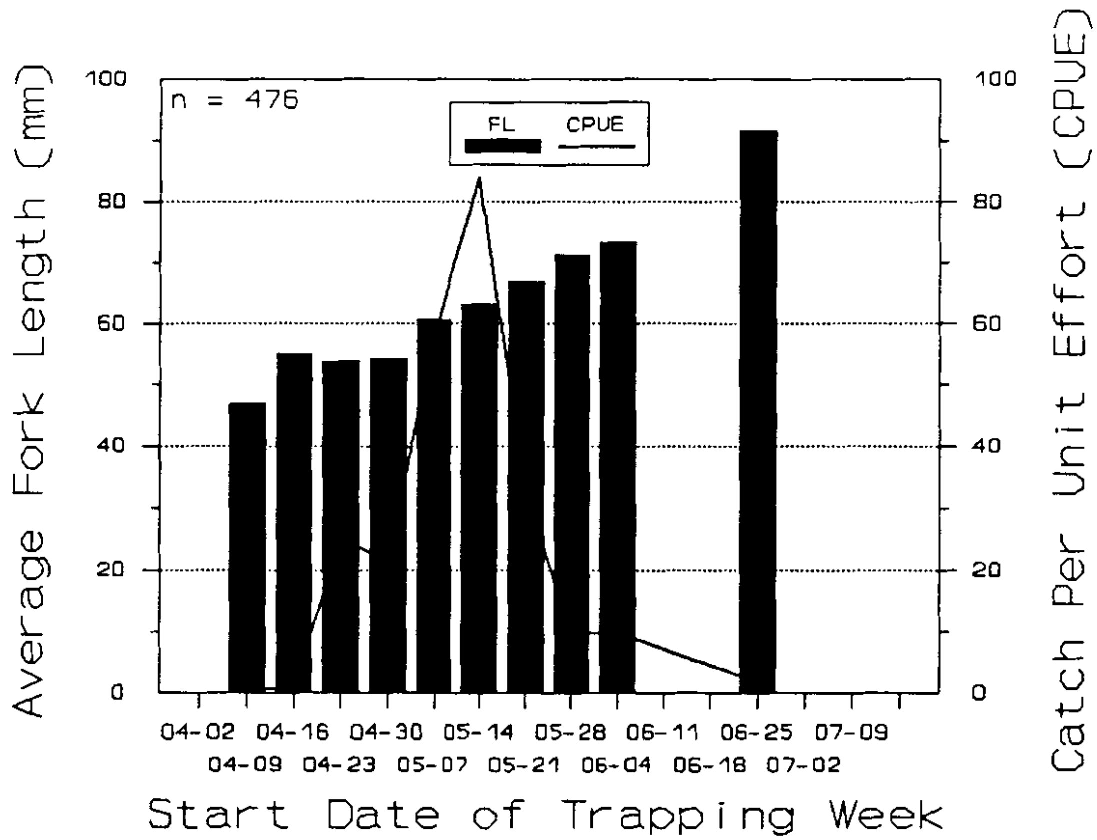

FIGURE 10. Average fork length (FL) and catch-per-unit-effort (CPUE) by trapping week for juvenile spring-run chinook salmon captured in the South Fork Trinity River near the Forest Glen Weir from 2 April through 9 July 1992.

received no reports of chinook salmon being caught anywhere in the SFTR this season. Based on these data, we believe the angler harvest of spring chinook in the SFTR in 1991 was zero.

<u>Thermographs</u>

Thermographs worked very well and will continue to be used to monitor river temperatures. Our primary purpose for monitoring river temperatures at the weir sites is to detect unacceptably high minimums where handling fish could cause lethal stress. Daily average water temperatures at the Gates Weir ranged from 14 to 22 °C between 29 April and 29 June. The Gates Weir was removed from operation on 24 June because minimum daily water temperatures reached 21 °C. Daily diurnal temperature variations ranged between 3 and 5 °C (Figure 11).

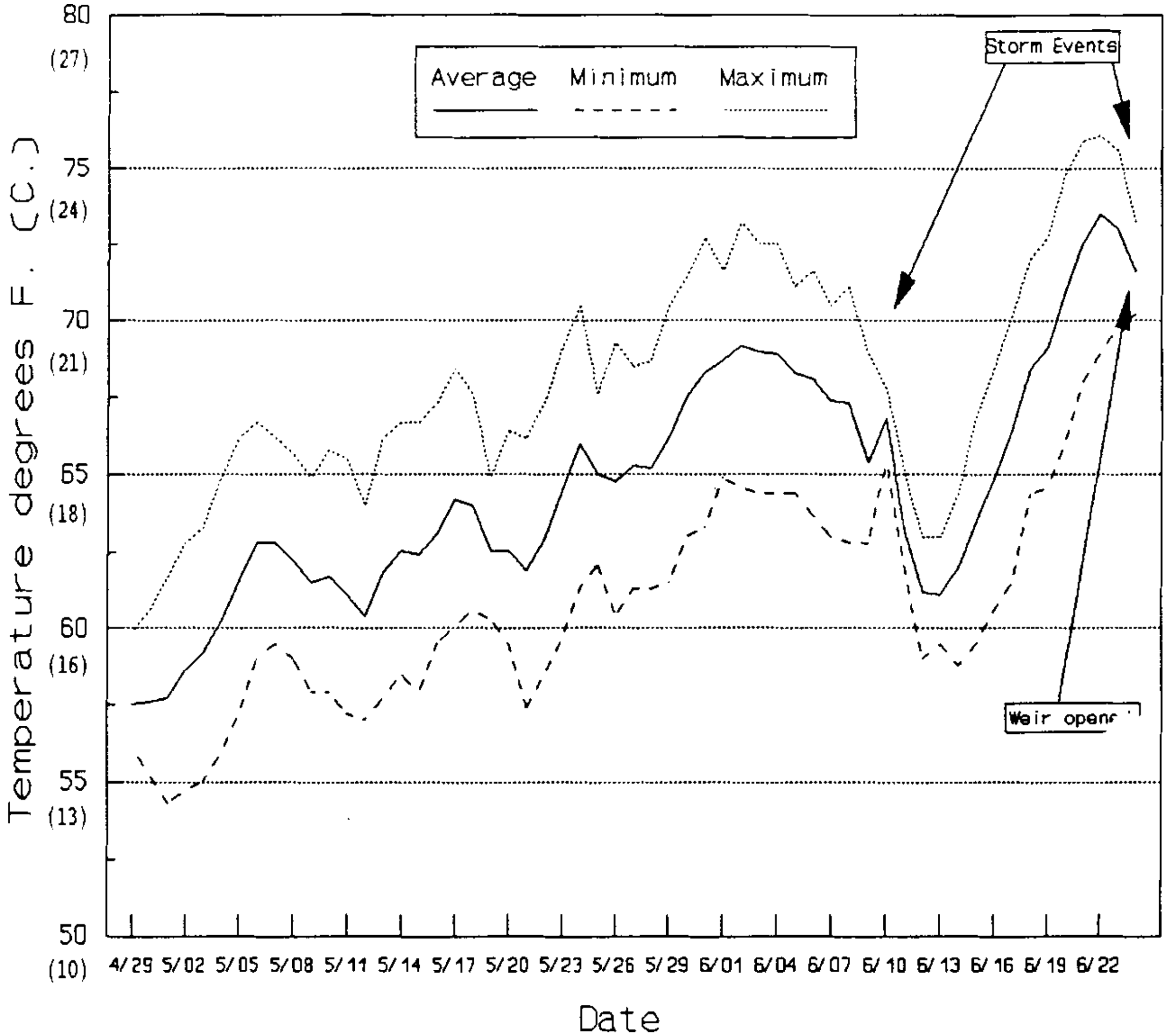

FIGURE 11. Water temperature variation at the Gates Weir in the South Fork Trinity River from 29 April through 24 June 1992.

Adult Trapping

During the 1992 season we operated the Gates Weir for 64 days, from 27 April through 7 July 1992. Late in the trapping period we were forced to suspend trapping operations intermittently due to excessively warm minimum water temperatures. During this period both immigrant and emigrant traps were maintained. We captured, marked, and released 39 adult and nine grilse spring chinook, one unspawned adult winter-run and 15 adult spring-run steelhead from the immigrant trap. We captured, examined, and released 65 out-migrant (spawned) adult fall- and winter-run steelhead from the emigrant trap (Table 3). Thirty-nine chinook

TABLE 3. Trapping summary for the Gates Weir by Julian week from 27 April through 7 July 1992. The Gates Weir is located in the South Fork Trinity River 32 kilometers upstream from the mouth.

		Immigrant trap				Emigrant trap
		Spring-run chinook salmon		Steelhead		
Julian week	Start date a/	Adults	Grilse b/	Winter-run c/	Spring-run d/	Spawned fall- and winter-run steelhead
17	4/23/92	0	0	1	1	0
18	4/30/92	1	0	0	3	22
19	5/07/92	1	1	0	1	33
20	5/14/92	9	0	0	0	5
21	5/21/92	8	0	0	0	2
22	5/28/92	7	1	0	0	1
23	6/04/92	6	1	0	0	1
24	6/11/92	2	1	0	2	0
25	6/18/92	5	0	0	1	0
26	6/25/92	0	0	0	2	1
27	7/02/92	1	5	0	5	0
	TOTALS:	40	9	1	15	65

a/ Trapping actually began on 4/27/92.
b/ Grilse are chinook measuring ≤ 55 cm.; adults are > 55cm. This length cut-off is subject to revision (Zuspan 1992).
c/ Fall- and winter-run steelhead are upstream-migrating, sexually mature fish.
d/ Spring-run steelhead are upstream-migrating, sexually immature fish.

were tagged with anchor tags and marked with a one-half LV fin-clip, and nine were implanted with radio tags and given a one-half RV fin-clip. Further analysis and discussion of these data will be covered in the next annual report where these spring chinook will be followed through the end of their spawning season.

Gillnet, Hook, and Predator Scars

During the 1992 adult trapping season, we examined 49 spring chinook and 81 steelhead at the Gates Weir. Only 28% of spring chinook showed scars this year, compared to 67% last year

(Table 4). Conversely, 41% of the steelhead had scars this yea , compared to only 15% last year. These numbers are significantly different ($X^2 = 10.0$, $X^2 = 12.0$, respectively). The composition of scar types on steelhead was generally comparable to last year with the exception of predator scars, which were up by 24%. Gill-net scars on spring chinook were 18% lower than last season. It has been reported by fisheries staff of the Hoopa Valley Tribe (M. Orcutt, telephone conversation), that the gill-net fishing effort for spring chinook in the lower Klamath-Trinity system was less intense this season compared to other years. Interestingly, we saw no hook scars on spring chinook this year compared to 13.9% last year. Angling regulations and open seasons were much more restrictive this year, and may have contributed to these observations.

TABLE 4. Summary of scars observed on steelhead and spring-run chinook salmon captured at the Gates Weir in the South Fork Trinity River during the 1992 season.

	Steelhead		Spring-run chinook salmor	
Scar types	Number with scar type	Percent of total captured with scar type	Number with scar type	Percent of total captured with scar type
Gill net a/	5	6	4	8
Fresh-hook b/	2	3	0	-
Ocean-hook c/	0	-	0	-
Predator d/	22	27	6	12
Unknown e/	4	5	4	8

a/ Gill-net scars are defined as nicks in the leading edge of the dorsal or pectoral fins, usually accompanied by individual or multiple lines on the sides of the fish.
b/ Fresh-hook scars are unhealed perforations or tears around the mouth which result from the fish being hooked in fresh water.
c/ Ocean-hook scars are healed hook scars, usually accompanied by noticeable scar tissue.
d/ Predator scars are longitudinal scratches or inverted "v" shaped marks along the body of the fish, usually spaced close together and may be accompanied by scale loss.
e/ Unknown scars are those which do not fit any of the above categories.

RECOMMENDATIONS

1. Snorkel surveys should be performed in late July in as short a time frame as possible for a better delineation of spring-run chinook salmon distribution and a more accurate count for the Petersen estimate. The snorkel surveys should also be repeated near the end of August to document any re-distribution of adult and grilse salmon.

2. Follow-up observations of summer holding pools should be continued to document immigration and emigration, pre-spawning behavior, and to count the numbers of tagged and untagged chinook salmon in each pool.

3. An attempt should be made to evaluate the efficiency of the snorkel survey technique.

4. Discontinue the trapping operation aimed at the late-entering portion of the spring chinook salmon run since only one spring-run fish was caught this season. Also, during drought years, excessive water temperatures and low flows appear to inhibit, and possibly prohibit, any significant late-entering segment of the run. River temperatures should be monitored in the lower river to document extremes.

5. Consider using several different color-coded tags which would allow for the identification of individual fish during snorkel surveys, and especially during follow-up observation at holding pools.

6. Consider moving the SFTR recovery weir nearer to Hyampom in an effort to recapture more marked fish which would allow for a more valid population estimate.

7. Poor spawning gravel permeability and bedload movement may be affecting spring chinook salmon egg and alevin survival. Additional studies are needed in this area.

LITERATURE CITED

Alderdice, D. F., and F. P. J. Velson. 1978. Relation between temperature and incubation time for eggs of chinook salmon. Journal Fisheries Research Board of Canada, 35: 69-75.

Chapman, W. M. 1943. The spawning of chinook salmon in the mai Columbia River. Copeia 1943: 168-170.

Cramer, F. K. and D. F. Hammack. 1952. Salmon research at Deer Creek, California. United States Fish and Wildlife Service Special Scientific Reports, Fish. No. 67. 16 p.

Dill, L. M. 1969. The Sub-gravel behavior of pacific salmon larvae. p. 89-100. In: T. G. Northcote (ed.), Symposium o Salmon & Trout in Streams. H. R. MacMillian Lectures in Fisheries, Univ. of British Columbia, Vancouver, B.C. Canada.

Groot, C., and L. Margolis. 1991. Pacific Salmon Life Histories. UBC Press. University of British Columbia. Vancouver, B.C. Canada. 564 p.

LaFaunce, D. A. 1964. A king salmon spawning survey of the South Fork Trinity River. Calif. Dept. of Fish and Game, Mar. Res. Admin. Rep. No. 67-10., 1964. 13 p.

Lindsay, R. B. 1985. Study of wild spring chinook salmon in th John Day River system. Oregon Dept. of Fish and Wildlife. Available from Bonneville Power Administration, Div. of Fis and Wildlife, P.O. Box 3621, Portland, Oregon 97208. 119 p

Lindsay, R. B., and B. Jonasson. 1989. Spring chinook salmon in the Deschutes River, Oregon. Oregon Dept. of Fish and Wildlife. Fish. Div. Information Reports, 89-4. 92 pp.

Mattson, C. 1948. Spawning ground studies of Willamette River spring chinook salmon. Oregon Fish Commission Resource Briefs, (12): 21-32.

Mills, T. 1986. Juvenile life history patterns of South Fork Trinity River chinook salmon as determined by adult scale analysis. Calif. Dept. of Fish and Game, Anad. Fish. Br. Admin. Rep. (manuscript). 20 p.

Reiser, D. W. 1981. Influence of streamflow reductions on salmonid embryo development and fry quality. Idaho Water & Energy Resources Research Institute, University of Idaho. 154 p.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Can. No. 191. 382 p.

Snyder, J. O. 1931. Salmon of the Klamath River, California. Calif. Div. of Fish and Game, Vol. 10, No. 4, p. 163-172.

Sullivan, C. 1989. Juvenile life history and age composition of mature fall chinook salmon to the Klamath River, 1984-1986. Masters Thesis. Humboldt State University, Arcata, California 95521. 69 p.

Zuspan, M. 1992. Salmon spawner surveys in the upper Trinity River basin. Chapter I. Job I. p. 1-29. In: Urquhart, K. (ed.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1989-90 season. June 1992. 140 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA. 95814.

APPENDIX 1. Other sources of data.

Fox, C. 1972. Report to supervisor; United States Forest Service, Shasta-Trinity National Forest. 2 August 1972. 15 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Freese, L. 1979. Summary report for survey of the South Fork Trinity River, Shasta-Trinity National Forest, U.S.F.S. 2 October 1979. 93 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

_________. 1982. Personal communication to E. Gerstung, Region I, California Department of Fish and Game, 27 February 1982. 2 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Gerstung, E. 1990. Observations of summer steelhead and spring chinook in the Forest Glen area, 8 October 1985. 3 p. (file memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Healy, T. 1969. Letter to Fisheries Management Supervisor, Region I, Calif. Dept. of Fish and Game, 29 September 1969. 1 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

LaFaunce, D. A. 1980. Letter to Fisheries Management Supervisor, Region I, Calif. Dept. Fish and Game, 20 August 1980. 1 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Lee, D. 1976. Letter to Fisheries Management Supervisor and file, Region I, Calif. Dept. of Fish and Game, 25 October 1976. 1 p. (memo). Available from TFIP, P.O.Box 1185, Weaverville, Ca. 96093.

Miller, E. 1974. Letter to Associate Biologist LaFaunce, Region I, Calif. Dept. of Fish and Game, 23 September 1974. 4 p. (memo with maps). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

_________. 1975. Letter to Associate Biologist LaFaunce, Region I, Calif. Dept. of Fish and Game, 26 August 1975. 6 p. (memo with maps). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Mitchell, W. 1985. 1984 Salmonid survey for the South Fork Trinity River. Letter to project coordinator, USFS. 2 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Rogers, D. 1970. Letter to Associate Biologist LaFaunce, Region I, Calif. Dept. of Fish and Game, 2 August 1970. 1 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

________. 1971. Letter to Associate Biologist LaFaunce, Region I, Calif. Dept. of Fish and Game, 26 August 1971. 1 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Ross, C., and H. Hawks. 1975. Report to supervisor, Shasta-Trinity National Forest, USFS, 12 June 1975. 5 p. (memo with forms and map). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Strate, B., and T. Underwood. 1982. Report to supervisor, Yolla Bolla Ranger District, USFS, 7 July 1982. 8 p. (memo with survey forms and map). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Wood, R. 1989. Letter to Associate Fishery Biologist Phil Baker, Region I, Calif. Dept. Fish and Game, 9 September 1989. 2 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

Zustak, J. 1986. Letter to USFS Fisheries Planning Unit, Shasta-Trinity National Forest, 22 September 1986. 2 p. (memo). Available from TFIP, P.O. Box 1185, Weaverville, Ca. 96093.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1991-1992 SEASON

CHAPTER VIII

JOB VIII
SPECIAL PROJECTS: TECHNICAL ANALYSES AND REPORT PREPARATION

by

Robert Reavis

ABSTRACT

I began my assignment on 1 April 1991 to compile, analyze, and report or edit back-year accumulations of file data. These data were collected during studies to determine if alternative hatchery practices could potentially increase survival to adulthood of salmon reared at Trinity River Hatchery (TRH). Reports on the first two Job 8 task studies have been completed, and summaries follow. I have begun analysis on the third and fourth studies, which will be combined into one report.

The goal of the first study was to determine if survival of fall-run chinook salmon could be improved by releasing them into the Trinity River at downstream sites. Results showed survival of fingerlings was increased by releasing them into the lower Trinity River (at Willow Creek and Hoopa), but homing tendency to return to TRH as spawners was reduced. Results for yearlings did not clearly show survival was increased by releasing them into the upper Trinity River (at Junction City and Lime Point).

The goal of the second study was to compare survival of fall-run chinook salmon based on age at release. Three age-at-release types were examined: fingerlings (reared 6 to 7 months), yearlings (reared 10 to 13 months), and yearlings plus (reared 13 to 15 months). Results showed older fish survived better and contributed more to fisheries and spawner escapements as adults. Younger fish were always larger (FL) at age 2 and generally at age 3; all release types were of similar size at age 4.

JOB OBJECTIVES

1. To provide for the compilation, analysis, write-up or editing of multi-year accumulations of previously collected file data on Trinity River basin salmon and steelhead that are beyond the scope of current Project activities.

2. To provide timely, as-needed technical support to the Project Supervisor in responding to unprogrammed information and data analysis requests regarding Trinity River basin salmon and steelhead stocks.

TASK 1 REPORT

COMPARISONS OF SURVIVAL AND HOMING TENDENCY FOR TAGGED GROUPS OF FALL-RUN CHINOOK SALMON, ONCORHYNCHUS TSHAWYTSCHA, REARED AT TRINITY RIVER HATCHERY AND STOCKED AT SEVERAL LOCATIONS IN THE TRINITY RIVER WITH ESTIMATES OF CONTRIBUTION TO FISHERIES AND SPAWNER ESCAPEMENTS[1/]

INTRODUCTION

The goal of the study was to determine if survival of hatchery-reared fall-run chinook salmon could be increased by releasing them at downstream sites. This determination was based on survival comparisons between groups of tagged fish released near Trinity River Hatchery (TRH) and at various downstream sites. The comparisons were made for two age-at-release types: fingerlings released in June, and yearlings released in October or November.

This study was carried out by taking a portion of the annual hatchery production of TRH; dividing that portion into groups to represent a release at a particular site; tagging the groups then releasing them into the Trinity River; collecting recovery data obtained from surveys of the fisheries and at TRH; calculating ocean catch rates and using these rates to infer relative survival; comparing survival of groups from the same brood year (BY) and age-at-release; and estimating the contributions to the fisheries for all groups in the study.

1/ Reavis, R. and B. Heubach. 1993. Comparisons of survival and homing tendency for tagged groups of fall-run chinook salmon, Oncorhynchus tshawytscha, reared at Trinity River Hatchery and stocked at several locations in the Trinity River with estimates of contribution to fisheries and spawner escapements. Inland Fish. Div. Admin. Rep. No. 93-11 available from Calif. Dept. Fish and Game, Inland Fish. Div., P.O. Box 944209 Sacramento, CA 94244-2090.

METHODS

For each BY (1977 through 1979) of the initial phase of the study, two groups of fingerlings were released into the Trinity River: one near TRH and the other at a downstream site. The downstream sites were Tish Tang Campground (1977 BY) located 153 river kilometers (RKM) below TRH, Hoopa (1978 BY) located 159 RKM below TRH, and Willow Creek (1979 BY) located 138 RKM below TRH. For each BY (1982 through 1984) of the second phase of the study, groups of both fingerlings and yearlings were released at TRH and three downstream sites: Steelbridge, located 15 RKM below TRH; Junction City, located 50 RKM below TRH; and Lime Point, located 61 RKM below TRH.

We used the following criteria to compare performance of groups from the same BY and age-at-release:

1. Hypothesis testing using the sign test (Siegel 1956) at the 0.05 level of significance to compare survival of fingerlings released at TRH with those released at downstream sites. We assumed equal mortality in the ocean for groups from the same BY and of the same age, and differences in ocean catch rates are due to mortality that occurs during the post-release freshwater emigration phase. There were only three BYs of results for yearlings, which were not enough for hypothesis testing.

2. Mortality-rate estimates experienced by hatchery-released fish during emigration. We calculated mortality rates for the sections of the Trinity River between TRH and the downstream release sites using the following formula from Hallock and Reisenbichler (1979):

$$1-(R_{TRH}/R_{ds})$$

where,
R_{TRH} = ocean catch rate of adults for tag-code group released near TRH and R_{ds} = ocean catch rate of adults for group released at downstream site.

3. Homing tendency rates for groups released at downstream sites. Homing tendency rate is a measurement of the behavioral tendency of fish released downstream to return to TRH, compared to fish released at TRH. The homing tendency rate was calculated using a formula provided by Hallock and Reisenbichler (1979). The homing tendency rate is the quotient of two ratios:

$$(H_{ds}/O_{ds})/(H_{TRH}/O_{TRH})$$

where,

H_{ds}/O_{ds} = return rate to TRH divided by ocean catch rate for the group released at a downstream site, and H_{TRH}/O_{TRH} = the return rate to TRH divided by ocean catch rate for the group released at TRH.

Estimates of contributions to the ocean fisheries were obtained from the Pacific States Marine Fisheries Commission (1991). Estimates of contributions to the inland gill-net fisheries were obtained from the U S Fish and Wildlife Service (Arcata, CA) and the Hoopa Valley Tribal Council's Fishery Department. Estimates of contributions to the Klamath River sport fishery were expansions from data provided by the Department of Fish and Game's (DFG's) Klamath River Project. Estimates of contributions to the Trinity River sport fishery and natural spawner escapement were obtained from DFG's Trinity River Project. Finally, counts were made of all fish entering TRH.

RESULTS

The results of our evaluation of hatchery versus downstream releases were as follows:

1. The survival of fingerlings was increased by releasing them downstream (sign test for $x = 0$, $p < 0.05$, and $n = 5$); mortalities observed when fingerlings from the 1977 BY were released downstream precluded the inclusion of that sample in the test. Survival, as indicated by ocean catch rates, was nearly 10 times greater for fingerlings from the 1979 BY released at Willow Creek than for those released near TRH. For the five BYs for which comparisons are available, the average survival rate was nearly four times greater for groups released at the downstream-most sites than for those released near TRH.

2. Estimated mortality rates for fingerlings were calculated for five sections of stream. The mortality rates of these sections were as follows: TRH to Steelbridge - 0.13, TRH to Junction City - 0.43, TRH to Lime Point - 0.49, TRH to Willow Creek - 0.90, and TRH to Hoopa - 0.70. Estimated mortality rates of yearlings were calculated for three sections of stream. These rates were as follows: TRH to Steelbridge - 0.08, TRH to Junction City - 0.15, and TRH to Lime Point - 0.07.

3. Homing tendency rates for the groups of fingerlings released at downstream sites, compared with groups of the same BY released at TRH were as follows: Steelbridge - 0.37, Junction City - 0.48, Lime Point - 0.56, Willow Creek -

0.21, and Hoopa - 0.07. The rates for yearlings were as follows: Steelbridge - 0.74, Junction City - 0.48, and Lime Point - 0.52.

The BY contribution rates (% of original release) to the fisheries and spawner escapements ranged from 0.28% to 2.52% for fingerlings released at TRH and from 0.34% to 7.22% for fingerlings released downstream. The contribution rates for yearlings ranged from 2.00% to 13.03% for fish released at TRH and 2.92% to 7.95% for fish released downstream.

CONCLUSIONS AND RECOMMENDATIONS

Survival of fall-run chinook salmon fingerlings was increased by releasing them at downstream sites. Results for fish released at Hoopa and Willow Creek suggest survival can potentially be increased from four to ten fold. It appears that survival is related to the distance downstream from TRH that fingerlings are released.

Selection of a planting location for fingerlings will involve a tradeoff between survival and homing tendencies. A greater fraction of the fish released downstream will survive, but a lesser fraction of these survivors will return to TRH. However, the results show total hatchery return rates of fingerlings can be greater for those fish released downstream, when homing tendencies are offset by improved survival.

Relative survival was consistent in the ocean, gill-net, and inland sport fisheries, and spawner escapements. That is, when ocean catch was high, so was inland gill-net catch, inland sport catch, and spawner escapement; and, when ocean catch was low, so was gill-net, inland sport catch, and spawner escapement.

LITERATURE CITED

Hallock, R.J., and R.R. Reisenbichler. 1979. Evaluation of returns from chinook salmon, Oncorhynchus tshawytscha, released as fingerlings from Coleman and Nimbus hatcheries and in the Sacramento River estuary. Unpublished office report available from Dept. of Fish and Game, Inland Fisheries Div., 1416 Ninth St., Sacramento, CA 95814

Pacific States Marine Fisheries Commission. 1991. Coast wide Coded-wire tag database. Portland, Oregon

Siegel, S. 1956. Nonparametric Statistics for the Behavioral Sciences. McGraw-Hill Book Co., Inc. 1956

TASK 2 REPORT

SURVIVAL AND GROWTH COMPARISONS OF FINGERLING, YEARLING AND YEARLING-PLUS FALL-RUN CHINOOK SALMON, *ONCORHYNCHUS TSHAWYTSCHA*, REARED AT TRINITY RIVER HATCHERY[2/]

INTRODUCTION

This study was conducted to compare the relationship between age at release and survival to adulthood (three-, four-, and five-year-old fish) for fall-run chinook salmon reared at Trinity River Hatchery (TRH). Three age-at-release types selected for this study were: fingerlings - released at 6 to 7 months; yearlings - released at 10 to 12 months; and yearlings-plus - released at 15 to 17 months. Relative survival within each brood year (BY) was inferred from recovery rates of coded-wire tags (CWT) collected during surveys of ocean commercial and sport fisheries, inland gill-net and sport fisheries, and at TRH.

This study was carried out by taking a sample of the annual hatchery production from the 1977, 1978, 1979, 1983, 1984, and 1986 BYs. Each sample was then divided into three groups representing fingerlings, yearlings, and yearlings-plus. The groups were then tagged with CWTs, marked with an adipose-fin clip (Ad), and released into the Trinity River near the hatchery. Tags were later recovered during surveys of the fisheries and at the hatchery.

METHODS

We used the following criteria to compare performance within BYs of fingerlings, yearlings, and yearlings-plus:

1. Hypothesis testing using the sign test (Siegel 1956) at the 0.05 level of significance to compare survival rates of groups representing different ages at release. We used catch rates to infer relative survival rates. We tested the hypotheses that fingerlings and yearlings, or yearlings and yearlings-plus survive at the same rate.

2/ Reavis, R. and B. Heubach. 1993. Survival and growth comparisons of fingerling, yearling and yearling-plus fall-run chinook salmon, *Oncorhynchus tshawytscha*, reared at Trinity River Hatchery. Inland Fish. Div. Admin. Rep. No. 93-10 available from Calif. Dept. Fish and Game, Inland Fish. Div., P.O. Box 944209, Sacramento, CA 94244-2090.

2. Ocean recovery and hatchery return rates by year class for the three age-at-release types. We estimated the percentage of total recovery that occurred at ages 2 througl 5 years.

3. Length at age. Analysis of mean fork length (FL) at age for fish returning to TRH had been made by Hankin (1990) fo: tag-code groups from the 1977, 1978, and 1979 BYs. His results are presented in this report to provide a compariso: with our results for the 1983, 1984 and 1986 BYs. He compared mean FL at ages 2, 3, and 4 years based on separation of confidence intervals (±95%).

We calculated confidence intervals (±95%) for the mean FL a' age for tag-code groups from the 1983, 1984 and 1986 BYs, but observed overlap. We used analysis of variance to determine if there were differences among the three release types. Then we used a Tukey Studentized Range Test to determine which of the release types were different (Zar 1984).

RESULTS

The results of comparisons of fish based on age at release are as follows:

1. Survival to adulthood, as shown by the paired-sample sigr test, was greater for yearlings than for fingerlings and greater for yearlings-plus than for yearlings ($p = 0.05$, $n = 5$, and $x = 0$ for both tests). Survival to adulthood, as suggested by total mean recovery rate comparisons, was several times greater for older fish. The mean recovery rate of the five BYs was 5.6 times greater for yearlings than fingerlings, and 2.1 times greater for yearlings-plus than for yearlings.

2. The percentages of recoveries by year class for fingerlings taken in the ocean fisheries were: age 2 - 2%, age 3 - 87%, and age 4 - 11%. The percentages for yearlings were: age 3 - 70% and age 4 - 30%. Percentages for yearlings-plus were: age 3 - 30% and age 4 - 70%.

The percentages of returns to TRH by year class for fingerlings were as follows: age 2 - 57%, age 3 - 38%, and age 4 - 5%. Percentages of returns for yearlings were: age 2 - 26%, age 3 - 62% and age 4 - 12%. The percentages of return for yearlings-plus were: age 2 - 15%, age 3 - 73%, and age 4 - 12%.

3. Based on separation of confidence intervals (±95%), Hankin (1990) made the following conclusions: i) the mean FLs at age for fingerlings returning to TRH were greater at ages 2 and 3 than yearlings and yearlings-plus; ii) yearlings were always larger than yearlings-plus at age 2 and 3, and iii) there were no differences among types at age 4. The 1979 BY releases were affected by the El Niño that occurred in 1983 and resulted in reduced growth. Our results for the 1983, 1984, and 1986 BYs were similar to Hankin's results. We observed that fish released at a younger age were larger at age 2 and generally larger at age 3. We had results from only one BY available for age 4 fish, and these results did not show any differences among release types.

CONCLUSIONS

Based on study results, we made the following conclusions:

1. Fish released at an older age survive better to adulthood and in turn contribute more to fisheries and spawner escapements.

2. Fish released at an older age contribute more to fisheries and escapement as older fish (four- and five-year-olds).

3. Greater fraction of fish released at a younger age mature earlier and return to TRH as two-year-old fish.

4. Fish released at a younger age grow faster until age 4, when all age-at-release types achieve equal size.

LITERATURE CITED

Hankin, D.G. 1990. Effects of month of release of hatchery-reared chinook salmon on size at age, maturation schedule, and fishery contribution. Oregon Dept. of Fish and Wildlife Inform. Rep. No. 90-4 37 p.

Siegel, S. 1956. Nonparametric Statistics for the Behavior Sciences. McGraw-Hill Book Company, Inc., 312 p.

Zar, J.H. 1984. Biostatistical Analysis. 2nd ed., Prentice Hall, Englewood Cliffs, New Jersey. 718 p.