90150

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992 - 1993 SEASON

authored by:

Bernard Aguilar, Mark Zuspan, Larry Hanson,
Barry W. Collins, Wade Sinnen, Ed Miller,
Michael Dean, and Robert Reavis.
Inland Fisheries Division

edited by:

Robert M. Kano
Inland Fisheries Division

Inland Fisheries Division
1416 Ninth Street
Sacramento, Ca. 95814

1995

Foreword

This is the fifth annual report to the United States Bureau of Reclamation (USBR) of activities conducted under the terms of Cooperative Agreement Number 1-FG-20-09820, and covers the contract period July 1, 1992 through June 30, 1993. 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
1992-1993 Season

Table of Contents

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

Table of Contents
(continued)

Chapter IV. Job IV. (continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

Table of Contents
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Tables

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Tables
(continued)

Chapter II. Job II. (continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Tables
(continued)

Chapter III. Job III. (continued)

Chapter IV. Job IV. Annual Run-size, Harvest, and Spawner Escapement Estimates for Trinity River Basin Chinook and Coho Salmon and Steelhead.

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Tables
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Tables
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Tables
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Figures

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Figures
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Appendices

Chapter I. Job I. Salmon Spawner Surveys in the Upper Trinity River Basin.

Chapter II. Job II. Capture and Coded-wire Tagging of Naturally Produced Chinook Salmon in the Trinity River Basin.

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Appendices
(continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Appendices
(continued)

Chapter IV. Job IV. (continued).

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Appendices
(continued)

Chapter IV. Job IV. (continued)

Trinity River Basin Salmon and Steelhead Monitoring Project
1992-1993 Season

List of Appendices
(continued)

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992-1993 SEASON

CHAPTER I

JOB I
SALMON SPAWNER SURVEYS IN THE UPPER TRINITY RIVER BASIN

by

Bernard Aguilar and 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 the mid-Trinity River basin from 15 September through 17 December 1992. We surveyed the mainstem Trinity River from the upstream limit of anadromous migration at Lewiston Dam to the confluence of the North Fork Trinity River. Selected portions of major tributaries that were accessible to anadromous fish were also surveyed. We examined 982 chinook salmon (Oncorhynchus tshawytscha) and 52 coho salmon (O. kisutch) carcasses during the mainstem Trinity River survey.

Chinook and coho salmon spawned throughout the entire mainstem survey area. Spawner density was highest in the uppermost 3.2 km of the river, with decreased densities in downstream survey zones. Spawner density was more uniform between survey zones than in past years. We found 44 chinook and 11 coho salmon carcasses during the tributary surveys. All chinook which spawned in the tributaries surveyed this season were fall-run.

We recovered both spring-run and fall-run chinook salmon carcasses in the survey. Spring-run chinook salmon dominated recoveries in the mainstem until early November, thereafter fall-run fish became the predominant race. Coho salmon were first noted in the mainstem survey during the first week in November, reaching peak numbers in late November, and were gone by mid-December.

Mainstem female prespawning mortality was 0.7% for spring-run chinook salmon, and 5.9% for fall-run chinook salmon. These were the lowest prespawning mortality rates for chinook salmon on record. The probable causes for the decreased pre-spawning mortality were the low spawner escapement, and increased holding and spawning habitat in downstream survey areas provided by higher river flows this year.

Based on the recovery of adipose-fin-clipped chinook salmon carcasses, we estimated that 16.1% of the spring-run and 14.0% of the fall-run chinook salmon spawners observed in the mainstem survey were of hatchery origin.

Fork lengths of spring- and fall-run chinook salmon from the mainstem Trinity River averaged 70.7 cm and 72.4 cm, respectively. Adult spring-run chinook salmon composed 81.3%, and fall-run fish composed 92.2%, of each respective run. Fork lengths of coho carcasses examined in the mainstem Trinity River averaged 65.3 cm. Adult coho composed 95.1% of the total number of coho carcasses examined in the mainstem. In the tributaries, fork lengths of fall-run chinook carcasses averaged 57.3 cm. Adult chinook composed 61.1% of the carcasses examined in the tributaries.

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-fifth 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-one (La Faunce 1965; Rogers 1970, 1973, 1982; Smith 1975; Zuspan 1991, 1992a, 1992b, 1994; and works 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 (U.S. 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 the upstream limit of anadromous fish migration at Lewiston Dam (river km 180.1) to the confluence of North Fork Trinity River, 63.4 km downstream (Figure 1). We surveyed this area once a week throughout the salmon spawning season. 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, 1990, and 1991 by TFIP (Zuspan 1991, 1992a, 1992b, 1994). 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 1992-1993 data were collected based on both zone systems. We 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, and refer to distances upstream from the mouth of the Trinity River (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 zones, 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.

All carcasses we observed were identified by species and examined for an adipose fin-clip (Ad-clip) indicating the possible presence of a coded-wire tag (CWT) in their snout. To minimize the number of Ad-clipped fish missed during the spawner survey, all carcasses recovered were passed through a CWT detector. Fish which produced a positive reading with the detector, regardless of the condition of their adipose fin, were considered Ad-clipped.

[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.

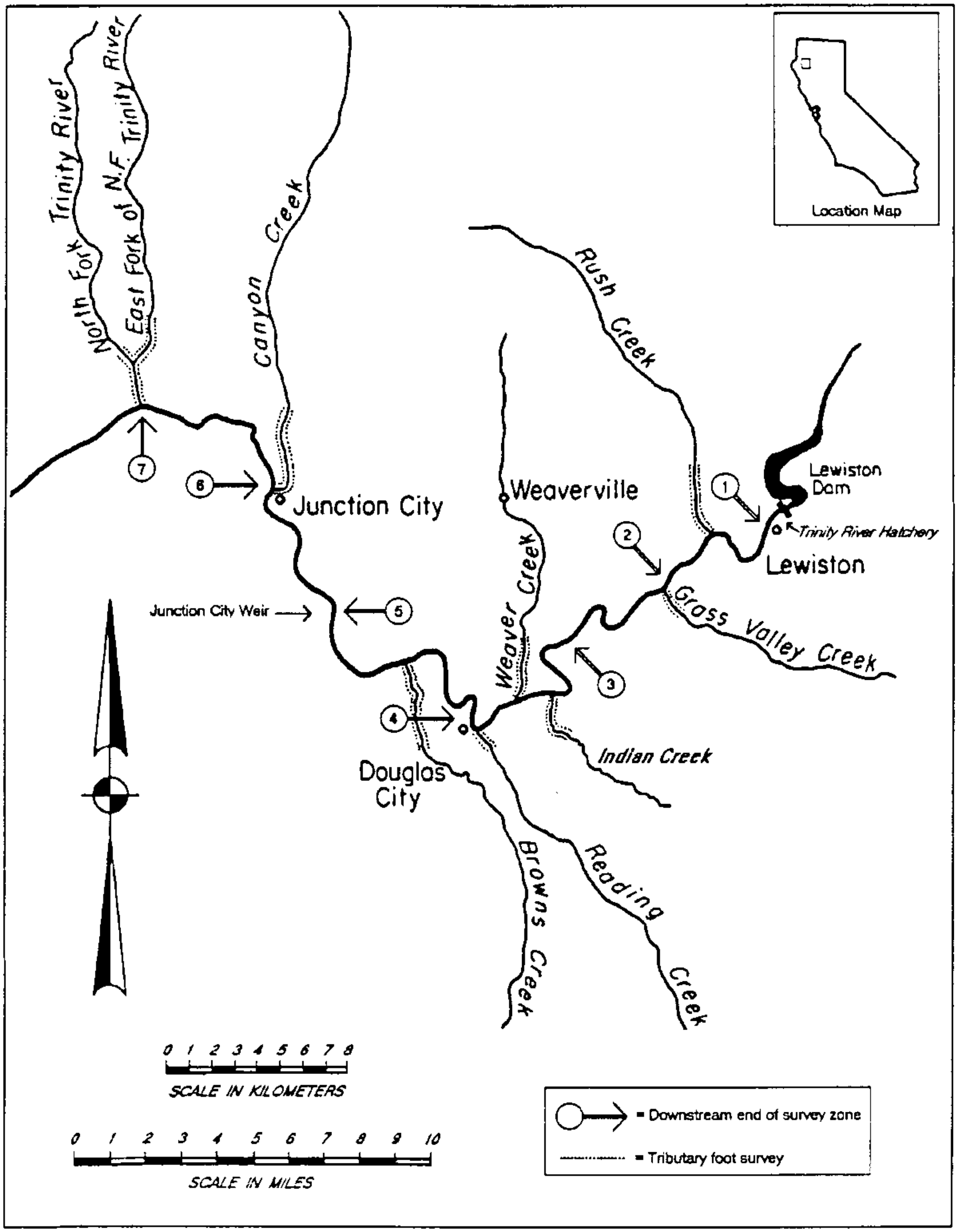


FIGURE 1. Map of the Trinity River basin showing the mainstem spawner survey zones and areas of the tributaries surveyed in the 1992-93 spawner survey.

TABLE 1. Description and lengths of river zones used in the 1992-93 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 137.1) - 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.

Carcasses 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) were placed on returning adult fish at two trapping and tagging stations for estimating escapement and harvest of adults. Spaghetti-tagged salmon also received an identifying operculum punch in order to estimate tag shedding rates. The downstream-most trapping site was Willow Creek Weir (WCW), located at RKM 32.2 on the mainstem Trinity River. The other trapping site, Junction City Weir (JCW), was located in the spawner survey area at RKM 137.1. Spring-run and fall-run chinook salmon, coho salmon, and steelhead were trapped and tagged at both WCW and JCW.

We determined spawning condition in female salmon by direct observation of their 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.

Chinook Salmon

All recovered chinook salmon carcasses were further classified into four categories for data collection purposes: 1) Ad-clipped fish; 2) Program-marked fish; 3) unmarked (no Ad-clip or Program-mark), condition-one fish; and 4) unmarked, condition-two fish. The category assigned determined the subsequent processing of each carcass.

We designated chinook salmon carcasses as either condition-one or -two, based on the extent of body deterioration. Condition-one carcasses were the freshest, having at least one clear eye and a relatively firm body. Condition-one carcasses 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 Program-marked or condition-two fish which had already been counted and chopped in half during a previous week's survey.

Heads of Ad-clipped carcasses were removed and retained for later CWT recovery and decoding.

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

Unmarked condition-one carcasses were flagged and returned to moving water for subsequent recovery. We flagged and measured the first 30 chinook carcasses from each zone and tallied the remainder. 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, upon recovery, the week of flagging could be determined. The hog rings used to attach the flagging were also color-coded to indicate in which zone they were affixed, so that we could determine the incidence of carcasses drifting into another recovery zone. A systematically collected sample of carcasses was measured to the nearest cm of fork length (FL). 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 was based on the post-season size determinations.

Unmarked condition-two carcasses were checked for the presence of a flag and, if possible, the sex and females' spawning condition were assessed. If a flag was present, the color of the flagging tape and the underlying ring were recorded. All carcasses were then cut in half to prevent future recounting.

<u>Coho Salmon</u>

All coho salmon (coho) carcasses recovered were measured (cm FL) and checked for the presence of Ad-clips or Program-marks only. When possible, sex and females' spawning condition were determined and then they were cut in half to prevent future recounting. Coho carcasses were not flagged because they would have required a separate series of flag colors to differentiate them from flagged chinook salmon. Condition-one or -two was recorded only for Program-marked and Ad-clipped coho.

Tributary Spawner Surveys

Tributaries to the mainstem Trinity River, specifically Rush Creek, Grass Valley Creek, Indian Creek, Reading Creek, Browns Creek, Weaver Creek, Canyon Creek, the 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 (Figure 1). 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. The surveys began with the onset of chinook salmon spawning in each tributary and continued until spawning ended. During the first week of our surveys, Grass Valley, Indian, and Reading creeks were the only tributaries surveyed because the others contained little water and were inaccessible to salmon.

We designated all identifiable chinook salmon carcasses into the four categories used in the mainstem spawner survey and handled them accordingly. However, spawning condition was not assessed for tributary carcasses. In past surveys, too few fish were observed in the tributaries to compose a representative sample, and most of those observed were condition-one fish which we needed to flag for spawner estimates. Coho were measured, 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 that was represented by the length of stream we surveyed. 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 proportion of redds present in a survey zone was assumed to represent the percentage of a tributary's total spawning taking place within the zone.

RESULTS AND DISCUSSION

Numbers Observed

Mainstem Trinity River Spawner Surveys

Chinook Salmon. We examined 982 chinook salmon carcasses during the mainstem spawner survey. These included 11 Ad-clipped fish, 57 Program-marked fish (two of which were Ad-clipped), 456 unmarked condition-one carcasses which we flagged, and 460 unmarked condition-two carcasses. We recovered 139 carcasses which we had flagged in previous weeks (Appendix 3). No whole fish skeletons were observed.

Coho Salmon. We did not observe any coho carcasses until the eighth week of the survey. We recovered 51 adult and 2 grilse coho carcasses, including 1 Ad-clipped and 11 Program-marked carcasses (one of which was also Ad-clipped), and did not see any whole fish skeletons (Appendix 4).

Tributary Spawner Surveys

Chinook Salmon. We found only 44 chinook salmon carcasses in the ten tributaries surveyed this season. These consisted of 36 condition-one carcasses which we flagged, 3 Program-marked carcasses, and one Ad-clipped carcass. We also counted 8 fish skeletons. We recovered 14 chinook carcasses which we had flagged in prior weeks (Appendix 5).

Coho Salmon. We examined 11 coho carcasses in the tributaries this season (Appendix 5), including two which were Program-marked. No fish skeletons were observed.

Distinguishing Between Spring and Fall Chinook Salmon Runs

Since both spring and fall runs of chinook salmon (spring chinook and fall chinook) were observed in the mainstem survey, we subjectively determined a date separating the two races based on recoveries of CWTed and Program-marked chinook salmon. Spring chinook dominated our recoveries through the eighth week of the survey ending 8 November 1992. Overlap of spring and fall chinook occurred beginning the sixth week of the survey. Fall chinook became predominate by the ninth week which began 9 November 1992. For the purposes of this report, the 225 flagged chinook carcasses recovered prior to 9 November were considered spring-run, while the 231 flagged carcasses recovered from that date onward were considered fall-run (Figure 2).

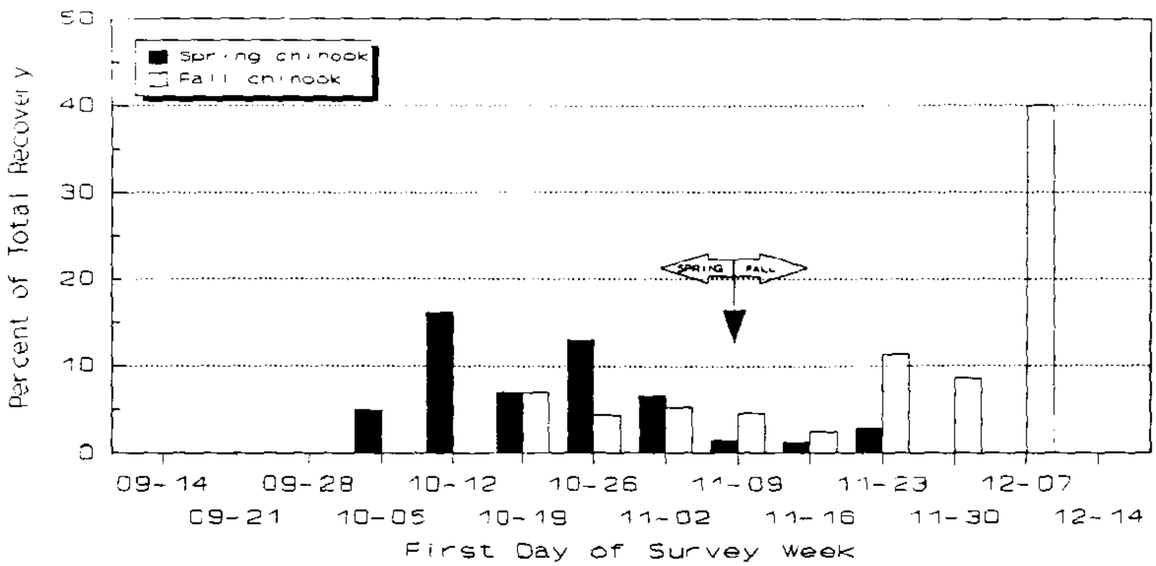


FIGURE 2. Weekly proportions of spring- and fall-run chinook salmon observed in the 1992-93 Trinity River spawner survey. The arrow shows the designated separation between the spring and fall runs.

For comparison, separation dates of spring and fall chinook in previous years were 11 October in 1988, 23 October in 1989, 29 October in 1990, and 28 October in 1991 (Zuspan 1991, 1992a, 1992b, 1994).

Size Composition

Spring-run Chinook Salmon

We measured 225 spring chinook during the mainstem survey. Adults, designated as fish >56 cm FL[2/], composed 81.3% of the spring chinook observed, while grilse (fish ≤56 cm FL) composed the remaining 18.7%. For comparison, the percentages of grilse for spring chinook sampled at JCW, and Trinity River Hatchery (TRH [RKM 180.1]) were 41.5% and 28.9%, respectively (Table 2). Data from WCW was not included in this comparison as only a small portion of the late spring chinook population was sampled there. There was a significant difference between the percentages of grilse sampled in the survey and at the two fixed sites (X^2=53.4, df=2, P<0.0001). Mainstem spring chinook ranged in size from 41 to 101 cm FL, averaging 70.7 cm FL (Figure 3).

[2/] Determined from post-season analysis of length frequency and coded-wire tag recoveries. The data used for the analysis were those collected during run-size-estimate studies (Chapter IV).

TABLE 2. Size composition of spring-run chinook salmon observed in the spawner survey and at two fixed locations in the mainstem Trinity River during the 1992-93 season.

	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey
Grilse [a]	272	533	42
Adults	384	1313	183
% Grilse	41.5%	28.9%	18.7%

a/ Spring-run chinook salmon ≤ 56 cm FL were considered grilse based on a post-season analysis of length frequency and recovered coded-wire tags.

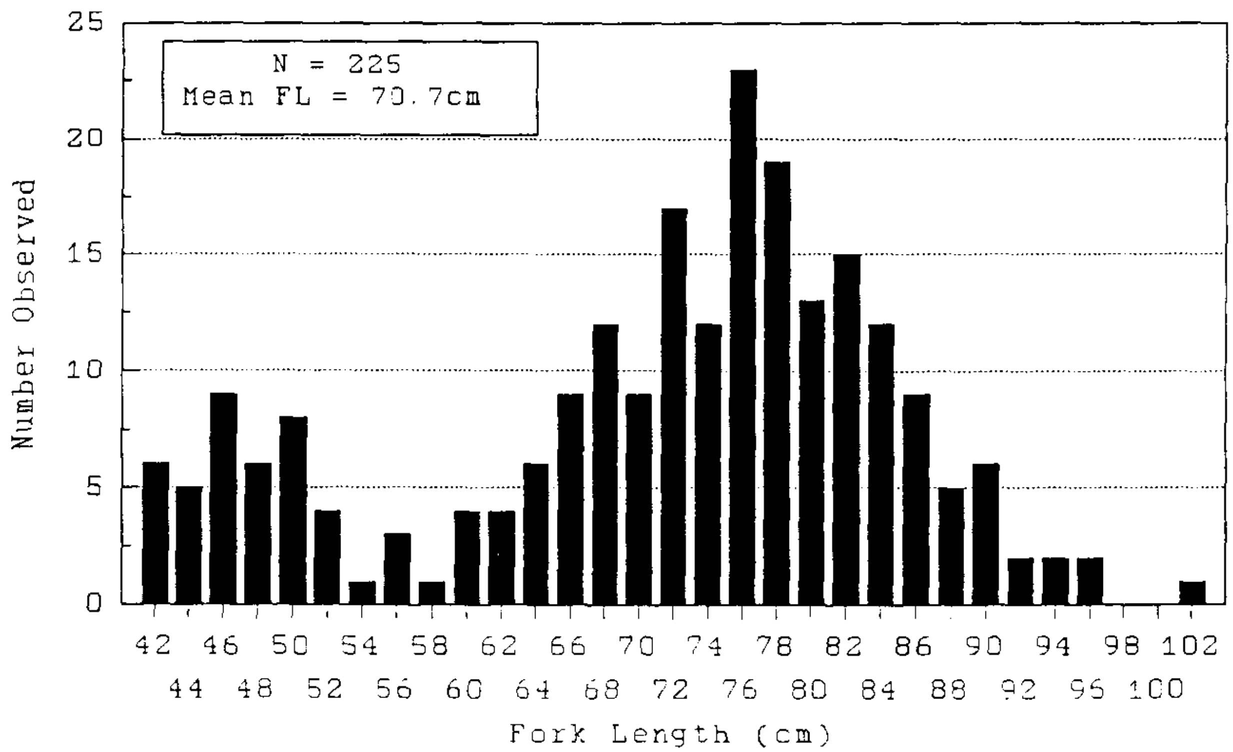


FIGURE 3. Fork length distribution, in 2-cm increments, of spring-run chinook salmon measured in the mainstem Trinity River during the 1992-93 spawner survey.

All chinook carcasses in the tributary surveys were recovered after 9 November 1992, so we assumed that no spring chinook spawned in the tributaries.

Fall-run Chinook Salmon

We measured 231 fall chinook carcasses during the mainstem survey this season. Based on a minimum size of 50 cm FL[3/] for adults, 92.2% of the fall chinook measured were adults and 7.8% were grilse (Table 3). The percentages of fall chinook grilse at the different sampling sites, including the tributary survey, ranged from 5.3% to 38.9%, and when tested for independence, the difference in grilse proportions between sites was highly significant (X^2= 1468.22, df=4, P=0). Mainstem fall chinook ranged in size from 41 to 98 cm FL, averaging 72.4 cm FL (Figure 4).

We measured 36 fall chinook carcasses in the tributaries this year. Of these, 61.1% were adults and 38.9% were grilse (Table 3). Tributary fall chinook ranged in size from 39 to 90 cm FL, averaging 57.3 cm FL.

Coho Salmon

We measured 41 coho carcasses in the mainstem Trinity River. Adults, designated as fish >50 cm FL[3/], composed 95.1% of the coho measured, with grilse composing the remaining 4.9% (Table 4). The percentages of coho grilse at the different sampling sites ranged from 4.9% to 33.8% (Table 4), but the differences were not significant (X^2= 34.89, df=3, P=0). Mainstem coho ranged in size from 41 to 84 cm FL, averaging 65.3 cm FL (Figure 5).

Sex Composition

Sex was determined only for carcasses observed during surveys in the mainstem Trinity River that were either unmarked condition-two, Program-marked, or flagged recoveries.

Chinook Salmon

We determined the sex of 522 adult chinook carcasses during the survey (212 spring-run and 310 fall-run). Of the adult spring chinook observed, 66.5% were females, while adult fall-run fish were 58.7% females. Overall, the weekly proportions of females seen in the survey were higher during the late and middle periods of each respective run (Figure 6). The seasonal trends in sex ratios noted in the previous three years' surveys showed females more predominant during the early and late weeks of the survey and lowest during the middle weeks (Zuspan 1992a, 1992b, 1994).

[3/]Determined from post-season analysis of length frequency and coded-wire tag recoveries. The data used for the analysis were those collected during run-size-estimate studies (Chapter IV).

TABLE 3. Size composition of fall-run chinook salmon observed in the spawner surveys and at three fixed locations in the Trinity River basin during the 1992-93 season.

	Willow Creek Weir	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey	Tributary spawner survey
Grilse a/	80	195	211	18	14
Adults	330	43	3,779	213	22
% Grilse	20.7%	26.4%	5.3%	7.8%	38.9%

a/ Fall-run chinook salmon ≤ 49 cm FL were considered grilse based on a post-season analysis of length frequency and coded-wire tag recoveries.

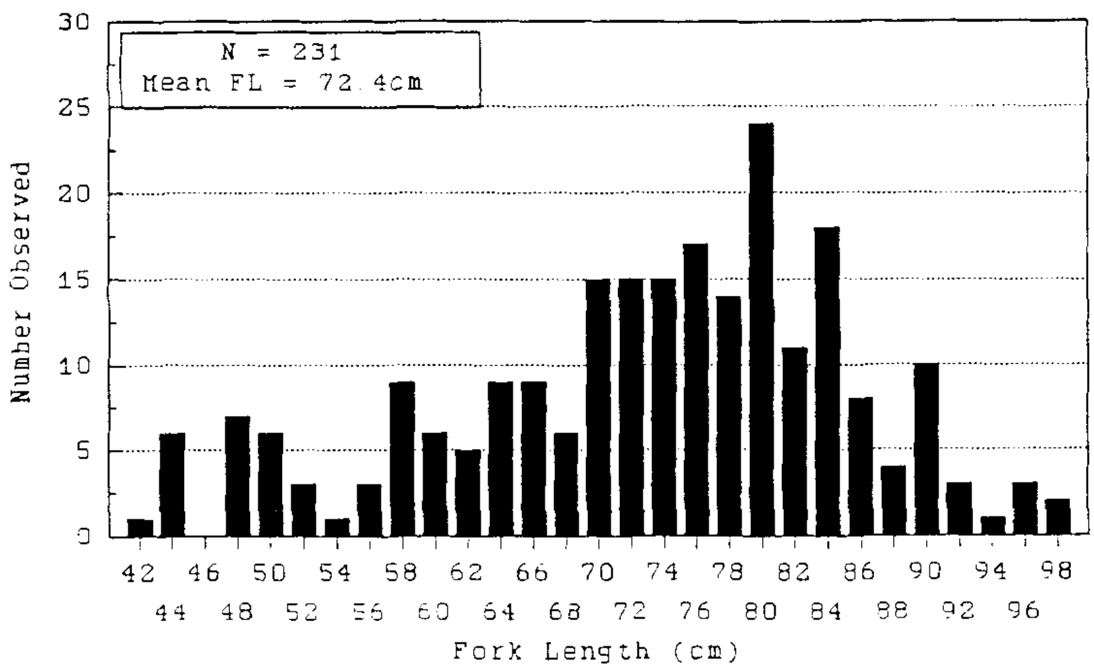


FIGURE 4. Fork length distribution, in 2-cm increments, of fall-run chinook salmon measured in the mainstem Trinity River during the 1992-93 spawner survey.

TABLE 4. Size composition of coho salmon observed in the mainstem spawner survey and at three fixed locations in the Trinity River basin during the 1992-93 season.

	Willow Creek Weir	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey
Grilse [a]	93	26	1,210	2
Adults	312	69	2,372	39
% Grilse	23.0%	27.4%	33.8%	4.9%

a/ Coho salmon ≤ 50 cm FL were considered grilse based on post-season analysis of length frequency and coded-wire tag recoveries.

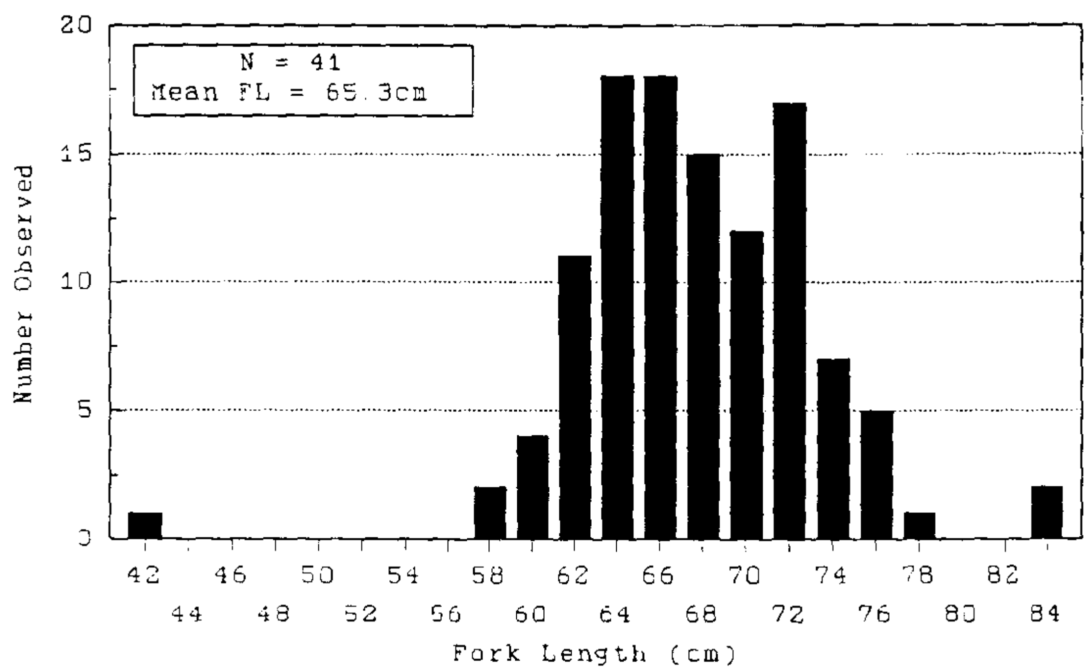


FIGURE 5. Fork length distribution, in 2-cm increments, of coho salmon measured in the mainstem Trinity River during the 1992-93 spawner survey.

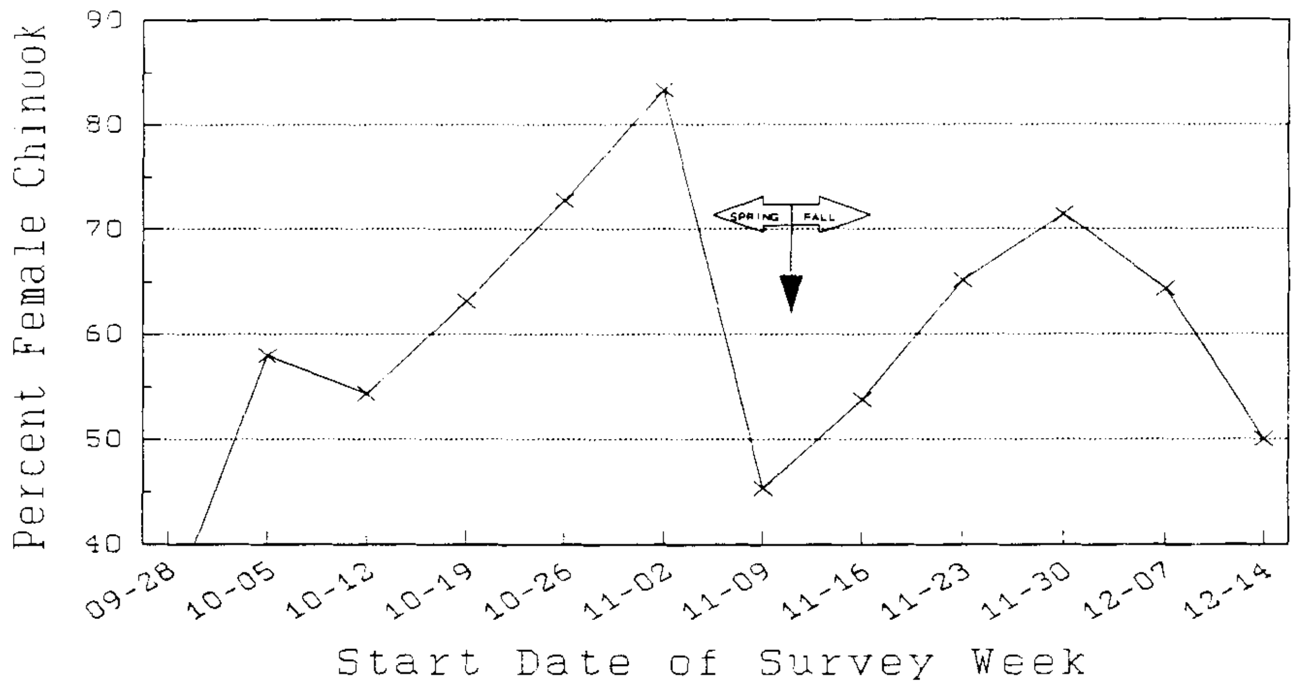


FIGURE 6. Proportions of female adult chinook carcasses observed in the mainstem Trinity River during the 1992-93 spawner survey. The arrow shows the estimated separation between the spring and fall runs.

A preponderance of adult females in the chinook run has been noted in all but two of the previous surveys. Female proportions have ranged from 73.6% to 25.8% (Appendix 6). Increased numbers of females among adult spawners result when more males than females return as grilse for a particular brood year.

Coho Salmon

We determined the sex of 51 coho, 17 (33.3%) of which were females. For comparison, 42%, 57%, 80%, and 60% of the coho examined in the 1988 through 1991 seasons, respectively, were females (Zuspan 1991, 1992a, 1992b, 1994).

Prespawning Mortality

Prespawning mortality was determined only for carcasses observed during surveys in the mainstem Trinity River that were either unmarked condition-two, Program-marked, or flagged recoveries.

Chinook Salmon

We determined the spawning condition of 185 adult female chinook salmon, including 51 spring-run and 134 fall-run fish. Prespawning mortality rates were 5.9% (3/51) and 0.7% (1/134) for female spring and fall chinook, respectively.

The overall female prespawning mortality rate for both races combined (spring- and fall-runs) was 2.2%. The lowest on record was 1.1% in 1991, with past prespawning mortality rates reported as high as 44.9% (Appendix 7).

Prespawning mortality of chinook in the Trinity River basin appears to be correlated to spawner escapement. Specifically, as spawner escapement increases so does prespawning mortality. The CDFG's Trinity River Project has developed chinook salmon escapement estimates for both runs of salmon in the Trinity River basin since 1978. Prespawning mortality was determined for the periods 1978 through 1982, and for 1987 to the present. During those periods, escapement has ranged from 6,135 to 100,913 while prespawning mortality rates have ranged from 1.1% to 44.9% (Appendix 7). With the exception of 1980, prespawning mortality generally increased with increasing escapement (Figure 7). The high prespawning mortality noted in 1980 may have been due to a sampling deficiency. During that year, only a total of 63 female chinook was checked for spawning condition. A regression analysis of escapement and prespawning mortality indicates a statistically significant correlation (R^2=0.44, P=.026) even with the 1980 data included. Without the 1980 data, the statistical significance is much greater (R^2=0.73, P=.001).

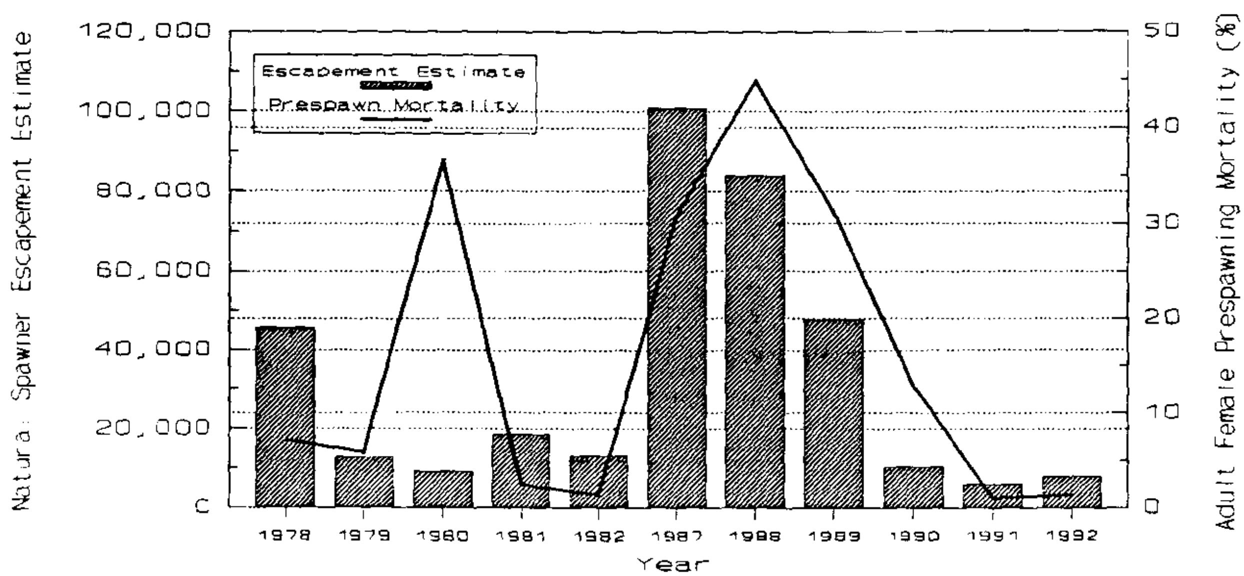


FIGURE 7. Comparison of adult chinook salmon natural spawner escapement and adult female chinook salmon prespawning mortality for the mainstem Trinity River, 1978-1982, and 1987-1992.

Coho Salmon

Seventeen adult female coho carcasses were examined for spawning condition during the survey. This sample size may not be adequate to accurately represent prespawning mortality. Of the coho examined, two (11.8%) of the fish had died prior to spawning (Appendix 4). For comparison, the prespawning mortality rates of adult female coho salmon were 25.6%, 6.2%, 13%, and 0% in 1988 through 1991, respectively (Zuspan 1991, 1992a, 1992b, 1994). Coho prespawning mortality was 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 from Zones 5, 6, and 7 were combined this year because too few flagged chinook were recovered in these individual zones. Distribution estimates are for adult fish only.

Chinook Salmon

Mainstem Trinity River. We examined 862 adult chinook salmon carcasses in the mainstem this season, excluding flag recoveries. The numbers of chinook salmon spawners ranged from 222 fish in Zone 2 to 124 fish in Zone 3 (Table 5). We recognized that carcass counts alone could not accurately describe distribution, because carcass recovery can vary from zone to zone, due to differences in stream morphology. Therefore, a recovery efficiency was calculated for each zone based on the ratio of flagged carcasses recovered to total carcasses flagged. This efficiency was used to expand the numbers of unflagged carcasses found in the respective zone, and obtain an overall weighted distribution and proportions of spawners in the entire survey area. 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 2 (Table 5). Spawner densities, based on expanded totals of unflagged carcasses in a zone and the length of the zone, was highest in Zones 1 and 3 (84.4 and 81.1 spawners/km, respectively), and decreased in a downstream direction (Table 5, Figure 8).

This pattern of relatively higher chinook salmon spawner concentrations in the upstream sections has been noted in all previous Project study years (Zuspan 1991, 1992a, 1992b, 1994), but was much less pronounced during the past two years. Spawners were much more evenly distributed throughout the mainstem during the most recent surveys (Figure 8).

It is possible that increases in river flow during the late summer and fall were responsible for the more even distribution of spawners. The flows averaged about 150 CFS higher this year

TABLE 5. Adult chinook salmon spawner distribution and estimated density by river zone during the 1992-93 Trinity River spawner survey.

Zone [a]	Zone length (km)	Number carcasses flagged	Flagged carcasses recovered	Recovery efficiency	Total unflagged observed [b]	Expanded total [c]	Percent distribution	Spawner density (fish/km) [d]
1	3.2	59	35	59.3%	160	270	9.0%	84.4
2	7.9	99	41	41.4%	222	536	17.8%	67.8
3	10.2	60	9	15.0%	124	827	27.4%	81.1
4	10.4	70	20	28.6%	139	486	16.2%	46.7
5-7[e]	31.7	103	25	24.3%	217	893	29.7%	28.2
Totals:	63.4	391	130		862	3,012	100%	
Overall:				33.2%				47.5

[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).
[e] Zones combined because too few chinook carcasses were recovered to develop recovery efficiencies for individual zones.

(450 compared to 300 CFS), in an attempt to keep river temperatures within specified criteria; although, temperatures were not significantly lower than in previous years. However, higher flows probably increased holding and spawning habitats, allowing chinook salmon to spawn farther downstream. It should also be noted that decreases in spawner escapement over the last few years may somehow have caused spawners to distribute themselves more evenly. While there has been a steady decrease in spawner escapement, the densities of spawners has become less disproportionate between the downstream zones during the past two surveys (Figure 8).

A potential source of error in the estimates was the assumption that flagged chinook salmon carcasses were recovered only in the zone in which they were originally flagged. If flagged carcasses were 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 in each zone were given a distinct hog ring color. Recoveries that were originally flagged in another zone were recorded as such. This season, all flags were recovered in the same zone in which they were originally flagged. This indicated that carcass drifting had no effect on chinook distribution estimates, similar to results in the 1990-91, and

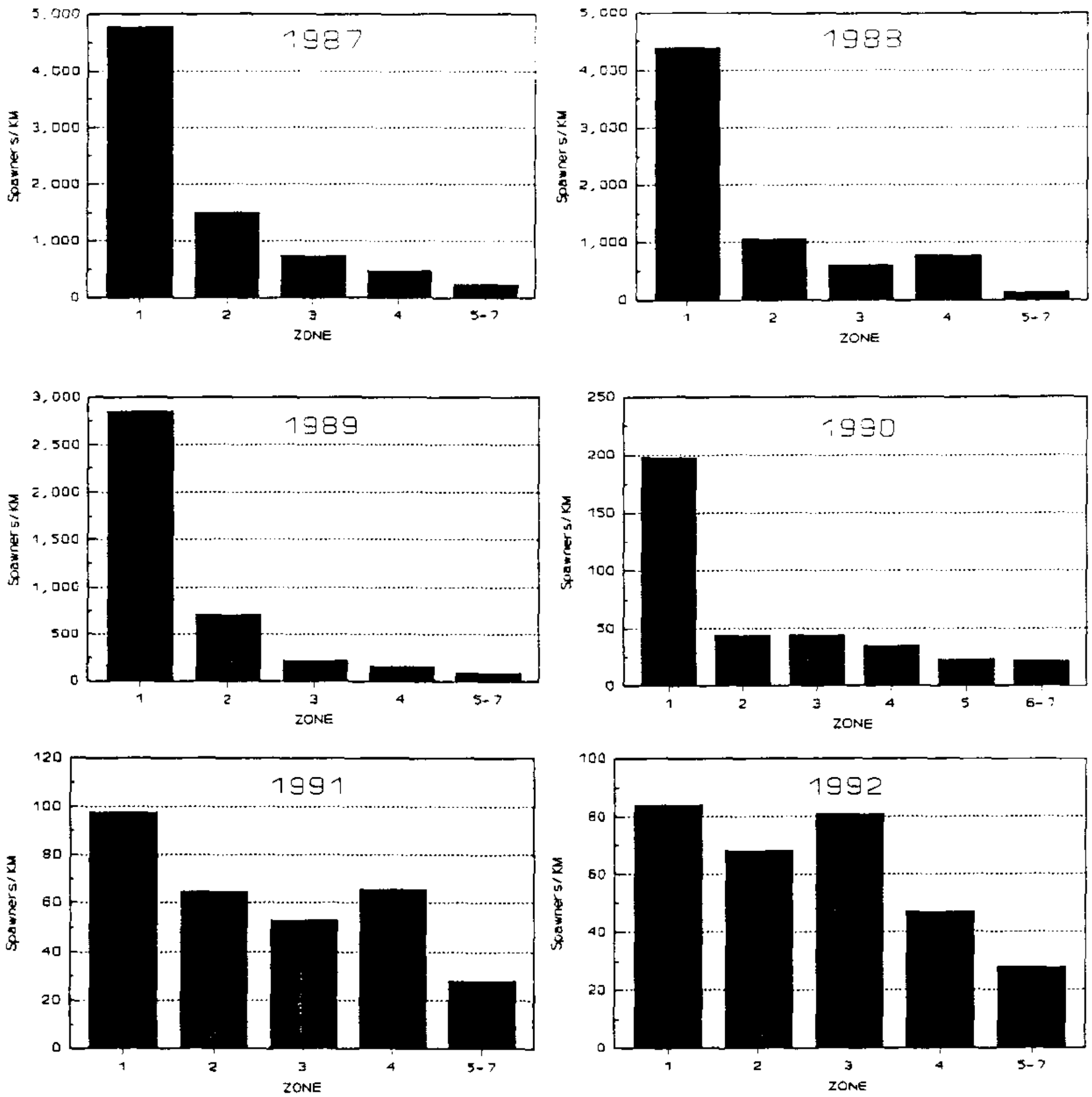


FIGURE 8. Estimated adult chinook salmon spawner density by zones during the 1987 through 1992 mainstem Trinity River spawner surveys.

1991-92 seasons (Zuspan 1992b, 1994). Even during the 1989-90 season the proportion of flags that drifted into other zones was still less than 1% (Zuspan 1992a).

Tributaries. Spawning adult chinook salmon made very limited use of tributaries this year. Few chinook salmon carcasses were observed this season, so we used redd counts to describe spawner distribution, as was the case during the 1990-91, and 1991-92 seasons (Zuspan 1992b, 1994).

We located 94 salmon redds in the nine tributaries surveyed this season. Since we could not differentiate a chinook from a coho salmon redd during the surveys, we used the relative proportion of chinook and coho salmon carcasses observed in the individual tributaries to apportion the redds by species. Based on this apportioning, there were an estimated 75.2 chinook salmon redds overall this season with individual tributary estimates ranging from 20.0 for Grass Valley Creek to 0.5 for Weaver Creek (Table 6).

Coho salmon

Mainstem Trinity River. We observed 51 adult coho carcasses in the mainstem spawner survey this year, most of which were seen in Zones 1 and 2 (Table 7). Since coho were not flagged, we estimated the numbers of coho which spawned in each zone using the recovery efficiency for that zone developed from chinook salmon flag recoveries. Coho spawner density was highest in Zone 1 (6.9 fish/km) and ranged from 4.6 to 1.0 fish/km in the other zones (Table 7).

Tributaries. We observed 11 coho carcasses during the tributary surveys. They were seen in Weaver Creek, the East Fork of the North Fork Trinity River, Rush Creek, Grass Valley Creek, Indian Creek, and Canyon Creek. (Appendix 5). When the observed redds

TABLE 6. Observed salmon redd numbers and estimated distribution for the 1992-93 Trinity River tributary spawner survey.

	Number observed			Proportional redd distribution [a]	
Tributary	Chinook carcasses	Coho carcasses	Redds	Chinook	Coho
Rush Creek	5	4	8	4.4	3.6
Grass Valley Creek	12	2	22	20.0	1.7
Indian Creek	1	1	7	4.0	3.5
Reading Creek [b]	0	0	1	1.0	0.2
Browns Creek	4	0	16	16.0	0.0
Weaver Creek	1	1	1	0.5	0.5
Canyon Creek	8	2	12	10.0	2.4
N. Fork Trinity R.(NFTR)	4	0	11	11.0	0.0
E. Fork of the NFTR	9	1	16	14.0	1.6
Totals:	44	11	94		
Overall:				75.2	18.8

[a] Computed by proportioning the redds observed by the numbers of each species observed. Chinook redds = Redds x chinook observed / (chinook observed + coho observed).

[b] Since no fish were observed in this creek, the redd proportioning was calculated by using the total chinook and coho for all creeks.

were apportioned by species, there were an estimated 18.8 coho redds overall in the tributary survey. The highest estimated number of redds (3.6) occurred in Rush Creek (Table 6).

Marked Salmon Recovery

Incidence of Program-marked Salmon

We observed Program-marks (spaghetti tags and/or operculum punches) on 36 spring and 21 fall chinook carcasses in the mainstem Trinity River spawner survey. Program-marked spring and fall chinook were recovered from both JCW and WCW (Table 8). Of the 57 Program-marked chinook salmon we observed, 33 were condition-one carcasses and 24 were condition-two carcasses.

We used only condition-one chinook salmon carcasses observed to determine the proportion of Program-marked chinook salmon in the spawner survey. 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 decomposition (Table 8).

TABLE 7. Adult coho salmon spawner estimated distribution and densities by river zone during the 1992-93 mainstem Trinity River spawner survey.

Zone [a]	Zone length (km)	Total observed	Observation efficiency [b]	Expanded total [c]	% of expanded total	Spawner density (fish/km)[d]
1	3.2	13	59.3%	22	14.2%	6.9
2	7.9	15	41.4%	36	23.2%	4.6
3	10.2	2	15.0%	13	8.4%	1.3
4	10.4	3	28.6%	10	6.5%	1.0
5-7 [e]	31.7	18	24.3%	74	47.7%	2.3
Totals:	63.4	51		155	100.0%	
Overall:			33.2%			3

[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 coho carcasses were recovered to develop observation efficiencies for individual zones.

Recovery of spring-run condition-one Program-marked chinook was over 2½ times (9.4%) that of similar fall-run fish. Spring chinook Program-marked at JCW made up a larger percentage (7.8%) of observed carcasses than those from WCW. Program-marked fall chinook from WCW (2.5%) were recovered at twice the rate of those from JCW.

We did not record the condition of coho during the survey so we could not separate out the proportion of Program-marked condition-one fish. Eleven Program-marked coho, ten from WCW and one from JCW, were recovered in the mainstem Trinity River, constituting 21.6% of all adult coho carcasses observed (Table 8).

Estimation of Adipose Fin-clipped Salmon Proportions

We recovered 11 chinook salmon carcasses and only one coho salmon carcass in the mainstem spawner survey which appeared to be Ad-clipped. Based on CWTs recovered from the chinook carcasses, three were spring-run, and three were fall-run of TRH origin (Appendix 8). One CWT was from a naturally produced chinook, more than likely a spring-run. There were four carcasses which were Ad-clipped but whose CWTs were either unreadable or shed.

The proportion of Ad-clipped chinook salmon in the spawner survey was estimated by analyzing only those Ad-clipped fish that had CWTs (Ad+CWT) and were condition-one carcasses. Carcasses in advanced decomposition (i.e. condition-two fish) were more likely to have shed their CWT. The percentage of Ad+CWTs observed in fall chinook condition-two carcasses was only 0.3% (1/337), while for condition-one carcasses, it was 1.2% (3/243). Our estimates of the Ad-clipped proportion in the spawner survey, however, were not comparable to the proportions of Ad-clipped fish observed returning to JCW, WCW, and TRH. This was because in the spawner survey we

TABLE 8. Proportions of recovered Program-marked (spaghetti-tagged & operculum-punched) adult salmon carcasses in the 1992-93 mainstem Trinity River spawner survey.

	Spring-run chinook			Fall-run chinook			Coho salmon		
Tag site	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	4	256	1.6	6	243	2.5	10	51	19.6
Junction City Weir	20	256	7.8	3	243	1.2	1	51	2.0
Totals:	24	256	9.4	9	243	3.7	11	51	21.6

[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.

considered as Ad-clipped only those carcasses that had CWTs, while at the other sites all Ad-clipped fish even without CWTs were counted. To make our estimated proportions more comparable, we expanded the numbers of condition-one Ad+CWT carcasses observed in the spawner survey by a CWT shedding rate for Ad-clipped chinook salmon observed at TRH[4/]. During this season, 26.1% (57/218) of the Ad-clipped spring chinook, and 11.3% (39/344) of the Ad-clipped fall chinook at TRH had shed their CWTs. Expanding our counts of condition-one Ad+CWT carcasses in the spawner survey by the aforementioned CWT shedding rates, 1.9% of the spring, and 1.2% of the fall chinook observed in the spawner survey were Ad-clipped.

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 ratios of Ad-clipped (hatchery-marked) chinook salmon at various locations within the river.

The proportions of Ad-clipped spring and fall chinook varied at the different recovery sites, probably partly as the result of hatchery-produced fish homing to the hatchery. Since naturally produced chinook salmon would become less abundant in upstream areas as they spawned in the lower mainstem or its tributaries, we would expect that the percentage of hatchery-produced chinook in the population would increase progressively at each upstream sampling site, and would be highest at the hatchery. Ad-clipped chinook salmon relative occurrence was highest at the hatchery, intermediate at the weirs, and lowest in the mainstem Trinity River spawner survey (Table 9). The Ad-clip ratio seen in the spawner survey may have been less than at the weirs, since the weirs captured both hatchery and natural upstream migrants, while the spawner survey emphasized in-river spawners which would be more likely to be naturally produced fish.

Spring-run Chinook Salmon

The percentage of Ad-clipped spring chinook observed at the three locations in the Trinity River basin below Lewiston Dam ranged from 1.9% to 11.8% (Table 9), and were significantly different from each other (X^2= 17.42, df=2, P=0.0006).

During 1988 through 1990, based on expansions of CWT recoveries, approximately 97% of the spring chinook recovered at TRH were of hatchery origin. But in 1991, the proportion was 65.4% (Zuspan 1994). This year, using the same methodology, an estimated 72.1%

[4/] Percent Ad-clipped chinook in spawner survey = condition-one Ad+CWT carcasses / (1 - CWT shedding rate at TRH).

of the spring chinook at TRH were of TRH origin. The apparent lower proportions during the last two seasons were artifacts of the high CWT shedding rates, which would have had the effect of decreasing the estimates of TRH-produced fish returning to the hatchery. We believed the actual percentage of hatchery-produced chinook salmon returning to TRH was similar to the higher proportions seen in previous years. Therefore, we assumed that the 11.8% Ad-clip ratio for spring-run fish observed at TRH represented a population of 100% TRH-origin chinook salmon. Since only 1.9% of the spring-run chinook salmon carcasses in the spawner survey were Ad-clipped, we estimated that 16.1% (1.9/11.8) were of hatchery origin, while the remaining 83.9% were naturally produced.

Fall-run Chinook Salmon

The Ad-clip percentage of fall-run chinook salmon ranged from 1.2% to 8.6% at the four sampling sites this season (Table 9). The differences in chinook salmon Ad-clip proportions among the four sites was statistically significant (X^2=38.86, df=3, P=0).

Since most of the fall-run chinook recovered at TRH were estimated to be of hatchery origin (based on expansions of CWT recoveries), we assumed that the 8.6% Ad-clip ratio for fall-run fish observed at TRH represented a population of 100% hatchery-produced chinook salmon. Since only 1.2% of the fall-run chinook salmon in the spawner survey were Ad-clipped, we estimated that 14.0% (1.2/8.6)

TABLE 9. Comparison of the estimated proportions of adipose fin-clipped chinook salmon in the mainstem spawner survey to those observed at three locations on the Trinity River during the 1992-93 season.

	Spring-run chinook			Fall-run chinook		
Site	Ad-clips [a]	Total [b]	% Ad-clips	Ad-clips [a]	Total [b]	% Ad-clips
Willow Creek Weir [c]	2	33	6.1	15	386	3.9
Junction City Weir	45	656	6.9	42	738	5.7
Trinity River Hatchery	218	1,846	11.8	344	3,990	8.6
Mainstem Trinity River survey	5	256	1.9	3	243	1.2

[a] All adipose fin-clipped fish were counted at the weirs and hatchery. Only condition-one carcasses with coded-wire tags were considered Ad-clipped for the spawner survey. The spawner survey recovered four spring and three fall chinook which had both Ad-clips and coded-wire tags. These numbers were expanded to account for Ad-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.

[b] Trinity River Hatchery total is an estimate based on coded-wire tag recoveries.

[c] Only a small portion of the late spring-run chinook salmon population was sampled at this site.

were of hatchery origin, while the remaining 86.0% were naturally produced.

Computational Assumptions

There were several assumptions which could be potential sources of error in using the above methods to determine the incidence of hatchery fish spawning in the river. We assumed that field personnel actually observed all possible Ad-clips (according to our criteria). Using the strict protocol similar to last year (i.e. using a CWT detector on all carcasses, and by considering only condition-one carcasses), we presumed we were successful at accounting for essentially all Ad+CWT fish during our survey. We also assumed that the probability of observing and recovering an Ad-clipped fish was the same in the survey as at the hatchery, and, most importantly, that the ratios of Ad-clipped to unmarked hatchery fish were the same in the spawner survey as at TRH. Since different chinook salmon release groups were Ad-clipped at different ratios, this last assumption is only valid if the various CWT groups occurred in the spawner survey in the same proportions as among the fish recovered at TRH.

RECOMMENDATIONS

This is the fifth year of a multi-year effort of spawner surveys in the Trinity River basin. The following recommendations should be considered:

1. Spawner survey activities should be continued, with current objectives, in FY 1993-94 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 historically 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. pp. 1-23. In: R. Carpenter, 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. Salmon spawner surveys in the upper Trinity River basin. Chapter I. Job I. pp. 1-29. 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.

Zuspan, M. 1992b. Salmon spawner surveys in the upper Trinity River basin. Chapter I. Job I. pp. 1-31. In: 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 9th St., Sacramento, CA 95814.

__________ 1994. Salmon spawner surveys in the upper Trinity River basin. Chapter I. Job I. pp. 1-37. In: K. Urquhart, and R. M. Kano (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1991-1992 Season. February 1994. 235 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

APPENDIX 1. Other sources of data.

Researcher:	Edward Miller
File report title:	Untitled
Study years:	1972-1974, 1976, 1978-1982, 1984, 1985
Available from:	Calif. Dept. Fish and Game - Region I, 601 Locust St., Redding, CA. 96001.

Researcher:	Mike Stempel
File report title:	Chinook Salmon Spawning Survey in the Upper Trinity River During the Fall of 1987
Study year:	1987 (published 1988)
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 1992-93 Trinity River spawner survey.

---

1. Lewiston Quadrangle, California-Trinity Co.; 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 1992-93 mainstem Trinity River spawner survey.

Survey week	Beginning of survey week	Adipose fin-clips	Program marks d/	Chinook flagged a/		Flags recovered b/		Unmarked chinook c/			Weekly total g/
				Adults	Grilse e/	Adults	Grilse e/	Males	Females	Unknown f/	
1	14-Sep-92	0	0	0	0	0	0	0	0	0	0
2	21-Sep-92	0	0	0	0	0	0	0	0	0	0
3	28-Sep-92	0	0	2	0	0	0	4	1	1	8
4	05-Oct-92	2	0	17	1	0	0	6	3	1	30
5	12-Oct-92	2	4 (1)	24	0	4	0	15	7	1	52
6	19-Oct-92	0	11	45	15	9	2	18	21	2	112
7	26-Oct-92	1	12	46	11	12	1	17	10	1	98
8	02-Nov-92	2	9 (1)	52	12	9	0	12	10	5	101
9	09-Nov-92	1	3	52	11	16	2	36	17	7	127
10	16-Nov-92	1	3	63	12	26	1	31	32	12	154
11	23-Nov-92	0	11	56	3	20	2	27	40	10	147
12	30-Nov-92	1	3	31	0	19	0	18	37	22	112
13	07-Dec-92	1	1	3	0	12	0	6	8	5	24
14	14-Dec-92	0	0	0	0	3	1	4	4	9	17
Totals:		11	57 (2)	391	65	130	9	194	190	76	982

a/ Chinook salmon which were flagged that week for later recovery.

b/ All recoveries that week which were flagged in previous weeks.

c/ Chinook salmon which were not flagged, adipose fin-clipped, or Program-marked and were chopped in half upon recovery.

d/ Chinook salmon which were previously marked (spaghetti tags/operculum-punched) at various sites downstream of the survey area. Numbers in parenthesis were also adipose fin-clipped in addition to Program-marked.

e/ During the survey, for tally purposes, chinook salmon <56 cm are assumed to be grilse.

f/ Chinook salmon of unknown sex.

g/ Includes all first-time observed carcasses. Does not include flagged carcass recoveries in that week.

APPENDIX 4. Summary of adult coho salmon carcasses recovered during the 1992–93 mainstem Trinity River spawner survey.

Beginning of survey week	Number Ad–clipped	Number Program–marked a/	Males	Females: Spawned	Females: Unspawned	Females: Percent unspawned	Weekly total
14 Sep 92	0	0	0	0	0	---	0
21 Sep 92	0	0	0	0	0	---	0
28 Sep 92	0	0	0	0	0	---	0
05 Oct 92	0	0	0	0	0	---	0
12 Oct 92	0	0	0	0	0	---	0
19 Oct 92	0	0	0	0	0	---	0
26 Oct 92	0	0	0	0	0	---	0
02 Nov 92	0	0	0	1	0	0.0	1
09 Nov 92	0	1	1	2	1	33.3	5
16 Nov 92	1	6 (1)	2	0	0	---	8
23 Nov 92	0	3	9	6	0	0.0	17
30 Nov 92	0	0	9	4	1	20.0	14
07 Dec 92	0	1	1	2	0	0.0	4
14 Dec 92	0	0	2	0	0	---	2
Totals:	1	11 (1)	23	15	2		51
Overall percent:						11.8	

a/ Coho salmon which were previously marked (spaghetti tags/operculum punched) downstream of the survey area.
Number in parenthesis was also Ad–clipped, and subtracted from the weekly total.

APPENDIX 5. Summary of salmon carcasses and redds observed during the 1992-93 spawner surveys in the tributaries to the Trinity River.

Tributary	Number of weeks surveyed	Kilometers surveyed	Percent of spawning occurance a/	Total redds	Chinook Adipose fin-clips	Chinook Program-marks b/	Chinook Flagged carcasses c/ Adults	Chinook Flagged carcasses c/ Grilse d/	Chinook Flags recovered	Chinook Skeletons	Chinook Weekly total e/	Coho
Rush Creek	7	3.9	50.0	8	1	1	3	1	3	1	5	4
Grass Valley Creek	8	1.3	59.4	22	0	2	8	4	5	0	12	2
Indian Creek	7	2.1	100.0	7	0	0	0	1	1	0	1	1
Reading Creek	8	0.8	100.0	1	0	0	0	0	0	0	0	0
Browns Creek	7	4.0	94.1	16	0	0	0	1	1	3	4	0
Weaver Creek	6	2.9	100.0	1	0	0	1	0	1	0	1	1
Canyon Creek	6	3.5	100.0	12	0	0	5	3	1	0	8	2
North Fork Trinity R.	7	2.4	91.7	8	0	0	0	1	0	3	4	0
E. Fork N. Fork Trinity R.	7	2.1	38.1	19	0	0	3	5	2	1	9	1
Totals:				94	1	3	20	16	14	8	44	11

a/ Estimated percent of the total chinook spawning in that tributary which occurred in the surveyed section, as determined from ground and aerial redd surveys.

b/ Chinook salmon which had been previously marked (spaghetti tags/opercle-punched) at various sites downstream of the survey area.

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

d/ During the survey, for tally purposes, chinook salmon <56 cm are assumed to be grilse.

e/ Chinook weekly totals include flagged carcasses, and skeletons. Ad-clipped and Program-marked carcass numbers are included with the flagged carcasses. Does not include flagged carcass recoveries which were made in that week.

APPENDIX 6. Sex compositions of adult chinook salmon observed during the mainstem Trinity river spawner surveys from 1942 through 1992.

		Spring-run chinook				Fall-run chinook				Total chinook			
	Literature	Males		Females		Males		Females		Males		Females	
Study year	source	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)									1769	49.7	1789	50.3
1956 a/	Weber (1965)									3149	46.3	3657	53.7
1963 a/	LaFaunce (1965)									1419	41.4	2008	58.6
1968 a/	Rogers (1970)									1244	44.5	1551	55.5
1969 a/	Smith (1975)									1054	37.0	1791	63.0
1970 a/	Rogers (1973)									527	48.7	556	51.3
1971 a/	" (1982)									1704	46.2	1987	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	1125	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)									1182	26.4	3299	73.6
1988	Zuspan (1991)	47	30.7	106	69.3	659	39.3	1016	60.7	706	38.6	1122	61.4
1989	Zuspan (1992a)	150	30.1	348	69.9	577	41.8	802	58.2	727	38.7	1150	61.3
1990	Zuspan (1992b)	39	25.7	113	74.3	50	32.9	102	67.1	89	29.3	215	70.7
1991	Zuspan (1994)	23	46.9	26	53.1	132	45.4	159	54.6	155	45.6	185	54.4
1992	Current study	71	33.5	141	66.5	128	41.3	182	58.7	199	38.1	323	61.9

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 pre-spawning mortality rates observed during the mainstem trinity River spawner surveys from 1942 through 1992.

		Spring-run chinook			Spring-run chinook			Total chinook		
Study year	Literature source	Spawned	Unspawned	Percent Unspawned	Spawned	Unspawned	Percent Unspawned	Spawned	Unspawned	Percent Unspawned
1942-1945 a/	Moffett/Smith (1950)									
1955 b/	Gibbs (1956)							2076	32	1.5
1956 b/	Weber (1965)							3438	219	6.0
1963 b/	LaFaunce (1965)							4953	328	6.2
1968 b/	Rogers (1970)							1494	124	7.7
1969 b/	Smith (1975)							1889	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 c/	Stempel (1988)			49.9			18.8			30.8
1988	Zuspan (1991)	11	27	71.1	479	372	43.7	490	399	44.9
1989	Zuspan (1992a)	194	327	62.8	1546	464	23.1	1740	791	31.3
1990	Zuspan (1992b)	76	21	21.6	104	6	5.5	180	27	13.0
1991	Zuspan (1994)	22	0	0.0	162	2	1.2	184	2	1.1
1992	Current study	48	3	5.9	133	1	0.7	181	4	2.2

a/ Pre-spawning mortality rate was not reported during these years.
b/ Spring-run and fall-run chinook salmon were not separated during these years.
c/ Overall pre-spawning mortality rates were reported but not numbers of carcasses observed.

APPENDIX 8. Release and recovery data for coded–wire–tagged salmon recovered in the 1992–93 mainstem Trinity River spawner survey.

	Release data							
CWT /a	Species	Race	Brood year	Type b/	Location c/	Date	Number	Number recovered
066147	Chinook	Spring	1987	f	Sawmill	05/23/88	185,718	1
065649	Chinook	Spring	1988	f	TRH	05/26/89	181,698	1
065632	Chinook	Fall	1988	y	TRH	10/27/89	97,569	3
B61306	Chinook	Mix d/	1988	f	Junction City	03/29–05/12/879	15,703	1
065639	Chinook	Spring	1989	y	TRH	10/01/90	102,555	1
Total:								7

a/ Coded–wire tag number for release group.
b/ Release types were: f=fingerling; y=yearling.
c/ All release locations were in the mainstem Trinity River. TRH= Trinity River Hatchery.
d/ Mixed race releases were naturally produced chinook and may include both spring– and fall–run chinook.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992-1993 SEASON

CHAPTER II

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

by

Bernard Aguilar

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 14 January through 14 June 1993.

We trapped 56,968 juvenile chinook salmon, 1,069 juvenile coho salmon (O. kisutch), and 864 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 mid-May. Weekly average fork lengths of trapped juvenile chinook salmon increased throughout the trapping period.

We adipose fin-clipped and implanted coded-wire tags into 48,423 juvenile chinook salmon, a sub-sample of which ranged in size from 29 to 118 mm, averaging 56.0 mm fork length. After adjusting for tagging mortality, tag shedding, and poor fin clips, we effectively coded-wire tagged and released 44,565 juvenile chinook salmon.

Adult chinook salmon, coded-wire tagged as juveniles by this Project, were recovered this season in the Indian gill-net fishery, at Trinity River Hatchery, and during the salmon spawner surveys. Four adults from the 1988 brood year were recovered as four-year-olds, and two from the 1990 brood year were recovered as two-year-olds.

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 references 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, 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 wee 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 three primary sites in the mainstem Trinity River this season (Figure 1). Site names and river km (RKM) locations were Lewiston at RKM 177, Hard Hat at RKM 148 and Sky Ranch at RKM 134. A fourth site at Ambrose (RKM 172) was trapped infrequently this season; a total of six trap-nights. One trap-night is defined as one fyke net set for one night. 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 sites to locate the site that would produce the highest numbers of fish at a given time. We concentrated on the Hard Hat and Sky Ranch sites as numbers of fish captured there increased.

Our trapping apparatus consisted of from one to nine 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-square exit leading into dual live boxes. Fyke nets were attached, at their mouth, to a 2.5-cm-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, when all fish trapped were counted and a sub-sample of each species was measured to the nearest mm fork length (FL).

Tagging

This season coded-wire tagging took place only at the Hard Hat and Sky Ranch sites. The tagging operations were located adjacent to the trapping sites, and conducted inside a 5.5-m-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 (MS-222[1/]); their adipose fin was removed (Ad-clip); and a coded-wire nose tag (CWT) was implanted. Tag injectors and quality control devices were purchased from Northwest Marine Technology[1/].

Because of the small size of the fish captured, half-length CWTs were used. Between two and four tagging machines were employed,

---

[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.

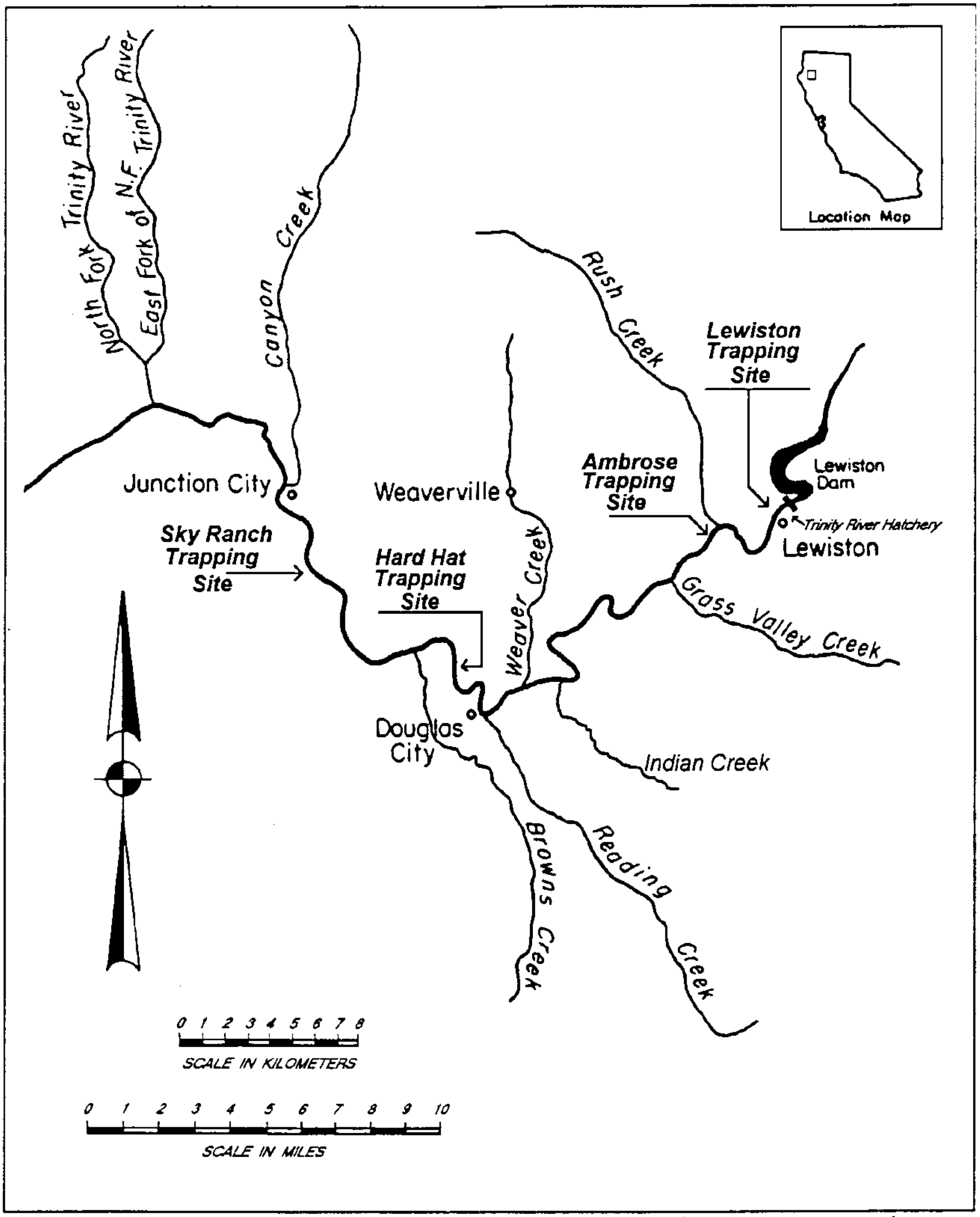


FIGURE 1. Map of the Trinity River below Lewiston Dam showing the four trapping sites used in 1993.

depending on availability of fish for tagging.

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 trapping site each evening. Fish in the quality control sample were held in cages in the river and, after a minimum of 24 hours, checked for mortality, tag retention, and Ad-clip quality. Tag retention was determined by passing fish through an electronic tag (metal) detector, and Ad-clip quality was determined by direct examination.

Coded-wire Tag Recovery

As part of ongoing studies, the CDFG recovered Ad-clipped and CWTed fish from among ocean- and inland-harvested fish, and hatchery and natural spawner returns. Heads from Ad-clipped fish were collected and their CWTs removed and decoded.

RESULTS

Trapping

We began trapping on 14 January 1993 (JW 2) and continued at varying locations and intensity through 14 June 1993 (JW 24). We discontinued trapping in early June because of decreasing catches and increasing river temperatures. The release of over 2.8 million spring- and fall-run chinook from Trinity River Hatchery (TRH) during 16-18 June 1993 (JW 24-25) further precluded trapping of only naturally produced fish for the remainder of the season.

Chinook Salmon

We captured 56,968 juvenile chinook this season. Totals by site were 293 at Lewiston, 362 at Ambrose, 13,689 at Hard Hat and, 42,624 at Sky Ranch (Appendices 2, 3, 4, and 5).

Catch-per-unit-effort (CPUE), defined as the weekly average number of fish caught per-trap-per-night-fished, varied considerably between trapping sites. The highest CPUE (394 fish/trap/night) was at the Sky Ranch site during JW 20. Maximum CPUE for each of the other sites included 159 at Hard Hat during JW 13, 77 at Ambrose during JW 10, and 51 at Lewiston during JW 4 (Figure 2, and Appendices 2, 3, 4, and 5).

We measured 9,451 chinook during the trapping season. These fish ranged in FL from 29 to 118 mm. Weekly average FLs of fish at the four trapping sites increased through time (Figure 3, Appendices 2, 3, 4, and 5). The entire week's catch at the Hard

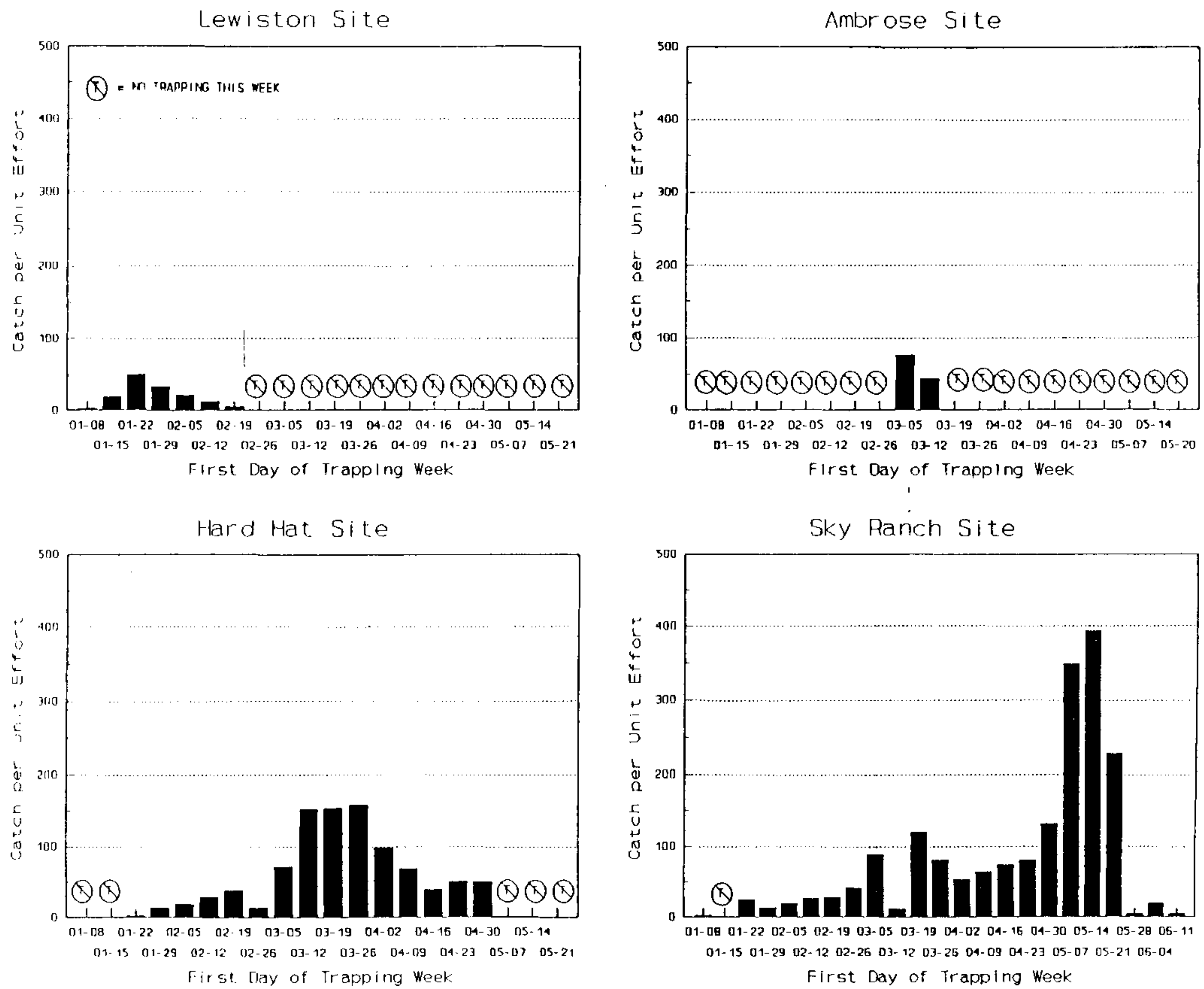


FIGURE 2. Weekly average catch (per-trap-per-night) of juvenile chinook salmon at the four trapping sites in the mainstem Trinity River during 1993.

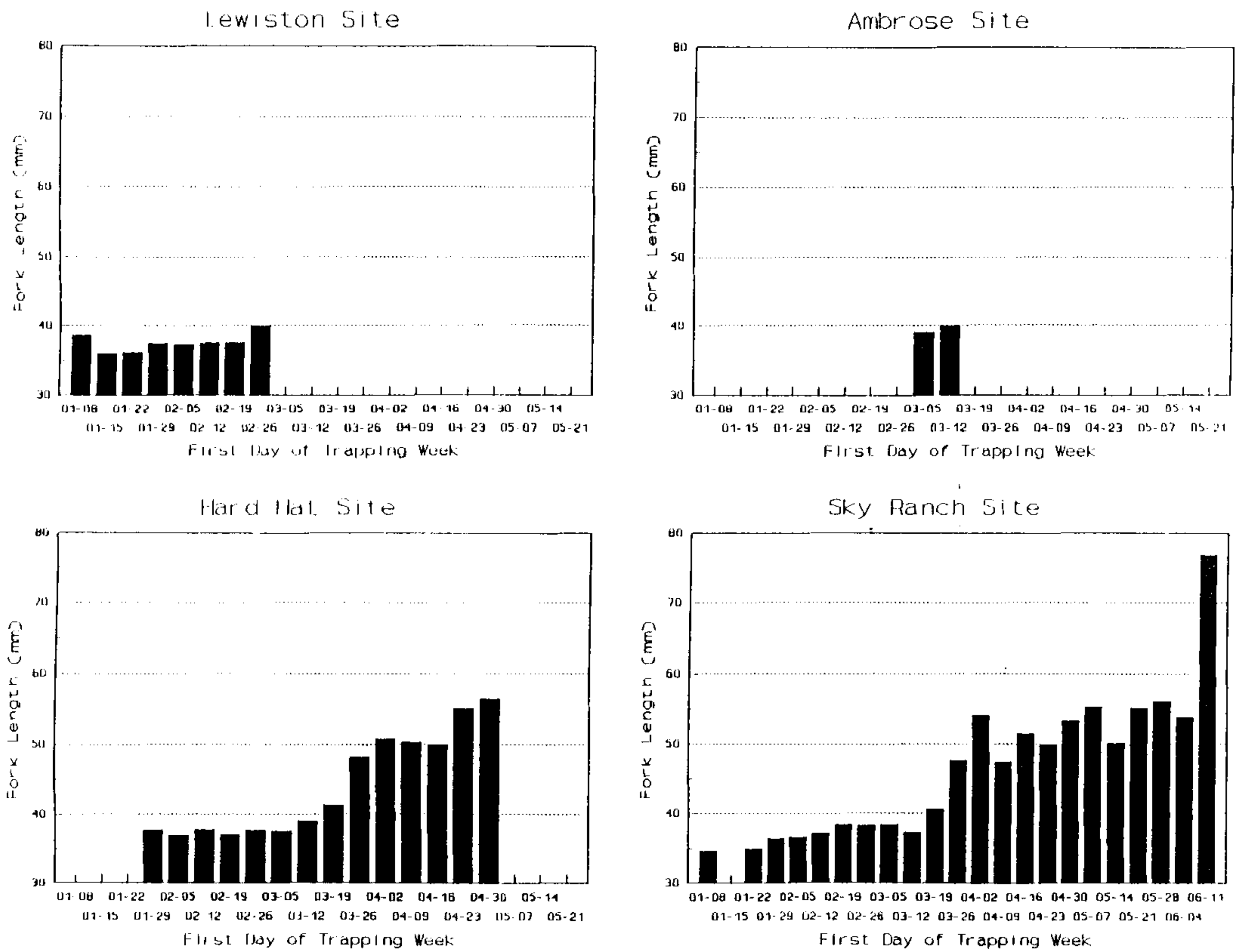


FIGURE 3. Weekly average fork lengths (mm) of juvenile chinook salmon at the four trapping sites in the mainstem Trinity River during 1993.

Hat site during JW 4 consisted of three yearling chinook which averaged 112.7 mm FL. At the Sky Ranch site, where we trapped every week through the season except one, the weekly average FL of juvenile chinook was 36.7 mm in mid-January and increased to 76.9 mm by mid-June.

Other Salmonids

We caught a total of 864 steelhead at all sites throughout the trapping season (Appendices 2, 3, 4, and 5). Catches were relatively low until mid-March, when increased numbers of hatchery-produced steelhead were captured, coincident with hatchery releases. We found that 4.9% (42/864) of the steelhead captured this season were fin-clipped, indicating they were from TRH[2/].

We caught 1,069 coho salmon this season. We captured young-of-the-year coho beginning 18 March (JW 11) at the Sky Ranch site. CPUEs of both yearling and young-of-the-year were relatively low from that time on. The highest CPUE for coho was at the Hard Hat site (21 fish/trap/night) which occurred during the third week of March (JW 13) (Appendix 4).

Tagging

Tagging operations began 26 March and continued through 26 Ma 1993. During this period, we marked (Ad-clip+CWT) and released 48,423 juvenile chinook at the Hard Hat and Sky Ranch sites combined.

Hard Hat Site

We tagged 10,092 juvenile chinook with CWT code 0601080402 at the Hard Hat site. Tagging at this site began 26 March and continued through 9 April 1993. Independent, non-overlapping estimates of tagging mortalities, poor fin-clips, and CWT shedding were based on quality control groups. After subtracting these estimates from the total tagged, we effectively marked and released 9,816 juvenile chinook from this site (Table 1).

Sky Ranch Site

We tagged 38,331 juvenile chinook with CWT codes 0601080403 throu 0601080407 at the Sky Ranch site. Tagging began 11 May and continued through 26 May 1993. We effectively marked and release 34,749 juvenile chinook from this site (Table 1).

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

TABLE 1. Naturally produced juvenile chinook salmon coded-wire tagging in the mainstem Trinity River during 1993.

Coded-wire tag code	Tagging site	Dates of release	Number tagged	Estimated tagging mortalities	Poor fin-clips	Tags shed	Number effectively tagged
0601080402	Hard Hat	03/26 - 04/09/93	10,092	144	15	117	9,816
0601080403	Sky Ranch	05/11 - 05/14/93	8,214	131	21	282	7,780
0601080404	Sky Ranch	05/14 - 05/16/93	7,912	116	0	302	7,494
0601080405	Sky Ranch	05/16 - 05/18/93	6,846	73	58	147	6,568
0601080406	Sky Ranch	05/18 - 05/26/93	5,582	568	39	61	4,914
0601080407	Sky Ranch	05/18 - 05/26/93	9,777	1,565	58	161	7,993
Totals:			48,423	2,597	191	1,070	44,565

Coded-wire Tag Recovery

The CDFG's Ocean Salmon Project estimated two chinook from the 1988 brood year (BY), CWTed by this Project in 1989, (Zuspan 1991), were recovered as four-year-olds this season in the Indian gill-net fishery (R. Dixon, CDFG, pers. comm.). Additionally, one chinook salmon from the 1988 BY, and two from the 1990 BY (two-year-olds) were recovered at Trinity River Hatchery. One chinook salmon from the 1988 BY was also recovered during this season's salmon spawner survey (see Chapter I). No recoveries of Project-CWTed fish were reported this year from the in-river sport or ocean fisheries (Table 2).

TABLE 2. Adult recoveries of coded-wire tagged naturally produced chinook salmon during the 1992-93 season.

		Recovery source						
Coded-wire tag code	Brood year	Indian gill-net fishery	In-river sport fishery	Spawner survey	Trinity River Hatchery	Ocean harvest	Average size (mm)	Age (yr)
B61306	1988	2		1	1		731	4
0601080112	1990				1		460	2
0601080114	1990				1		420	2
Totals:		2	0	1	4	0		

DISCUSSION

We were unable to capture enough juvenile chinook to reach our goal of tagging 100,000 naturally produced fish this year. Although we continued an intensive program of trapping up to 80% of the river's cross-section on a seven-day-a-week basis, our total season's trapping effort was below that of the past two years. Trapping effort this year was only 74% of last year's (327 vs. 442 trap-nights), and 87% of 1991 (327 vs. 374). As a result of the decreased trapping effort, total catch was 70% of last year (56,986/81,851), and 64% (56,986/89,208) of the 1991 total catch (Appendix 6).

As noted for the past two years (Zuspan 1992, 1994), the overall juvenile chinook CPUE has decreased. This is the direct result of poor escapement of the progenitors of each season's juvenile chinook. Natural (non-hatchery) spawner escapement for chinook salmon (spring- and fall-run) upstream of Junction City was the lowest since 1989, only 11.8% of the 1989 run (4,090 vs. 34,587), 70.4% of the 1990 run (4,090 vs. 5,811), and 75.0% of the 1991 run (4,090 vs. 5,453).

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

RECOMMENDATIONS

1. Job 2 activities should be continued in FY 1993-94.

2. In the event of a low adult chinook salmon escapement in 1993, the Project should be prepared to increase trapping effort, which will require the purchase and construction of additional trapping equipment.

3. We should continue efforts to recover coded-wire-tagged chinook harvested by anglers or returning to TRH. Efforts to recover naturally spawned code-wire-tagged fish should be increased.

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. pp. 136-140. 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. of 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. pp. 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. of 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. pp. 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. of 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. pp. 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. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

_________. 1984a. FY 1981 progress report. Task V. Salmon tagging and release monitoring. pp. 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. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

_________. 1984b. FY 1982 progress report. Task V. Salmon tagging and release monitoring. pp. 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. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

Maria, D., and B. Heubach. 1984c. FY 1983 progress report. Task V. Salmon tagging and release monitoring. pp. 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. of 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. pp. 24-33. In: R. Carpenter 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. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

__________. 1992. Capture and coded-wire tagging of naturally produced chinook in the Trinity River Basin. Chapter II. Job II. pp. 32-49. In: K. Urquhart 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.

__________. 1994. Capture and coded-wire tagging of naturally produced chinook in the Trinity River Basin. Chapter II. Job II. pp. 38-50. In: K. Urquhart and R. M. Kano (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1991-1992 Season. February 1994. 235 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 equivalents.

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

1/ Eight-day week during leap years.
2/ Eight-day week every year.

APPENDIX 2. Summary of juvenile salmonid trapping in the Trinity River at the Lewiston trap site, 8 January through 4 March 1993.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap-nights a/	Number caught	Mean FL b/ (mm)	CPUE c/	Number caught	CPUE	Number caught	CPUE
2	08-Jan	1	3	38.7	3	0	0	0	0
3	15-Jan	1	19	36.1	19	0	0	18	18
4	22-Jan	1	51	36.2	51	0	0	0	0
5	29-Jan	4	137	37.5	34	0	0	2	1
6	05-Feb	2	44	37.4	22	0	0	4	2
7	12-Feb	2	26	37.6	13	0	0	12	6
8	19-Feb	2	11	37.6	6	0	0	15	8
9	26-Feb	2	2	40.0	1	0	0	12	6
Totals:		15	293			0		63	

a/ Number of trap-nights allocated per week (i.e., 2 = 2 traps/1 night, or 1 trap/2 nights).
b/ FL = fork length.
c/ Weekly average catch per-trap per-night.

APPENDIX 3. Summary of juvenile salmonid trapping in the Trinity River at the Ambrose trap site, 5 March through 18 March 1993.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap nights a/	Number caught	Mean FL b/ (mm)	CPUE c/	Number caught	CPUE	Number caught	CPUE
10	05–Mar	3	230	39.1	77	0	0	30	10
11	12–Mar	3	132	40.1	44	0	0	11	4
Totals:		6	362			0		41	

a/ Number of trap–nights allocated per week (i.e., 2 = 2 traps/1 night, or 1 trap/2 nights).
b/ FL = fork length.
c/ Weekly average catch per–trap per–night.

APPENDIX 4. Summary of juvenile salmonid trapping in the Trinity River at the Hard Hat trap site, 22 January through 6 May 1993.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap-nights a/	Number caught	Mean FL b/ (mm)	CPUE c/	Number caught	CPUE	Number caught	CPUE
4	22-Jan	1	3 d/	112.7	3	0	0	3	3
5	29-Jan	2	27	37.7	14	0	0	11	6
6	05-Feb	2	38	37.0	19	0	0	7	4
7	12-Feb	2	58	37.8	29	0	0	8	4
8	19-Feb	2	78	37.1	39	0	0	5	3
9	26-Feb	2	28	37.7	14	0	0	3	2
10	05-Mar	4	289	37.6	72	0	0	18	5
11	12-Mar	3	458	39.0	153	0	0	29	10
12	19-Mar	12	1847	41.4	154	2	0	104	9
13	26-Mar	31	4935	48.3	159	656	21	210	7
14	02-Apr	3	4748	50.8	99	341	7	139	3
15	09-Apr	3	206	50.3	69	0	0	15	5
16	16-Apr	3	119	50.0	40	0	0	8	3
17	23-Apr	3	152	55.1	51	0	0	13	4
18	30-Apr	14	703	56.5	50	3	0	28	2
Totals:		132	13,689			1002		601	

a/ Number of trap-nights allocated per week (i.e., 2 = 2 traps/1 night, or 1 trap/2 nights).
b/ FL = fork length.
c/ Weekly average catch per-trap per-night.
d/ All chinook captured were yearlings.

APPENDIX 5. Summary of juvenile salmonid trapping in the Trinity River at the Sky Ranch trap site, 8 January through 14 June 1993.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap nights a/	Number caught	Mean FL b/ (mm)	CPUE c/	Number caught	CPUE	Number caught	CPUE
2	08-Jan	1	3	34.7	3	0	0	0	0
3	15-Jan d/	0	--	--	--	--	--	--	--
4	22-Jan	1	25	35.0	25	0	0	5	5
5	29-Jan	2	26	36.5	13	0	0	0	0
6	05-Feb	1	20	36.7	20	0	0	0	0
7	12-Feb	4	106	37.3	27	0	0	1	0
8	19-Feb	4	111	38.4	28	0	0	7	2
9	26-Feb	4	168	38.3	42	0	0	1	0
10	05-Mar	3	267	38.4	89	0	0	1	0
11	12-Mar	1	12	37.4	12	2	2	0	0
12	19-Mar	2	242	40.6	121	0	0	4	2
13	26-Mar	1	81	47.6	81	2	2	3	3
14	02-Apr	1	53	54.1	53	0	0	1	1
15	09-Apr	1	64	47.4	64	0	0	3	3
16	16-Apr	1	74	51.5	74	1	1	7	7
17	23-Apr	1	81	50.0	81	0	0	2	2
18	30-Apr	10	1,317	53.4	132	3	0	7	1
19	07-May	49	17,097	55.4	349	10	0	58	1
20	14-May	47	18,524	50.2	394	14	0	45	1
21	21-May	18	4,127	55.2	229	4	0	8	0
22	28-May	6	30	56.2	5	30	5	1	0
23	04-Jun	8	157	53.7	20	0	0	2	0
24	11-Jun	8	39	76.9	5	1	0	3	0
Totals:		174	42,624			67		159	

a/ Number of trap-nights allocated per week (i.e. 2 = 2 traps/1 night, or 1 trap/2 nights).
b/ FL = fork length.
c/ Weekly average catch per-trap per-night.
d/ No trapping this week because of high flows.

APPENDIX 6. Summary of naturally produced juvenile chinook salmon trapping effort and coded-wire tagging in the mainstem Trinity River, 1989 through 1993.

	Trapping effort				Coded-wire tagging		
Year	Trapping site	Trap-nights a/	Total chinook trapped	Season CPUE b/	Total chinook CWTed	Number effectively tagged c/	Percent of total d/
1989	Junction City	88 e/	24,874	283	22,044	15,704	71.2
1990	Lewiston	120	99,239		81,513	66,784	81.9
	Indian Cr.	30	77,142		59,385	45,349	76.4
	Totals:	150	176,381 f/	1,176	140,898	112,133	
	(Overall percent)						(79.6)
1991	Lewiston	63	848		--	--	--
	Indian Cr.	23	554		--	--	--
	Steelbridge	78	20,458		19,777	19,090	96.5
	Sky Ranch	210	67,348		60,310	53,775	89.2
	Totals:	374	89,208	239	80,087	72,865	
	(Overall percent)						(91.0)
1992	Lewiston	18	1,832		--	--	--
	Ambrose	144	16,102		8,348	8,070	96.7
	Steelbridge	114	38,817		35,043	33,195	94.7
	Sky Ranch	166	25,100		16,580	15,345	92.6
	Totals:	442	81,851	185	59,971	56,610	
	(Overall percent)						(94.4)
1993	Lewiston	15	293		--	--	--
	Ambrose	6	362		--	--	--
	Hard Hat	132	13,689		10,092	9,817	97.3
	Sky Ranch	174	42,624		38,331	33,643	87.8
	Totals:	327	56,968	174	48,423	43,460	
	(Overall percent)						(89.8)

a/ One trap night is defined as one net fished for one night.
b/ Catch per unit effort = total trapped / trap-nights.
c/ Effectively-tagged fish = tagged fish minus estimated mortalities and estimated shed tags and poor fin-clips. Estimates were based on quality control checks.
d/ Percent of total = (Number effectively tagged/Total chinook CWT) X 100
e/ In addition to fyke-net traps, a rotary trap was used during the latter portion of the trapping period.
f/ Total catch includes Trinity River Hatchery-produced juvenile chinook salmon.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992-1993 SEASON

CHAPTER III

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

by

Larry Hanson and Barry W. Collins

ABSTRACT

The California Department of Fish and Game's Natural Stocks Assessment Project monitored adult fall-run steelhead (Oncorhynchus mykiss) migration at various weirs. An insufficient number of tags, applied at our immigrant weir, were recovered to allow us to make a valid estimate of steelhead escapement in the South Fork Trinity River basin during the 1992-1993 season.

Based on the results of our creel survey of the sport fishery in the two major areas accessible to the public, we estimated that 934 anglers fished within these areas and harvested 99 adult steelhead during the 1992-1993 season. The angler harvest in the entire South Fork Trinity River basin during the 1992-1993 season could not be reliably estimated due to an insufficient number of tag returns.

Thirty-four steelhead spawning surveys were conducted in 23 tributaries of the South Fork Trinity River and Hayfork Creek. We surveyed 103.1 km of stream, observed 11 adult steelhead, and counted 98 redds. Steelhead were found to spawn mostly in pool tail-crests (48.3%), runs (28.1%), and step-runs (14.6%). The average redd area was 1.65 m^2 and the average redd depth was 32.8 cm.

We captured 408 juvenile steelhead emigrating from the upper South Fork Trinity River basin, and 1,455 from the Hayfork Creek basin. Three juvenile chinook were captured emigrating from Hayfork Creek in May, 1993. Peak emigration of Age 0+ (young-of-the-year) steelhead occurred in May and June 1993.

Juvenile steelhead habitat utilization in Eltapom Creek, a tributary to the South Fork Trinity River, varied among age groups. During the fall 1992 survey, 481 juvenile steelhead were captured. Age 0+ steelhead densities were highest in pools and cascades. Age 1+ and 2+ fish densities were highest in cascades and pools. We estimated a standing crop of 1,594 juvenile steelhead in Eltapom Creek for the period.

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 and current status of steelhead (Onchorynchus 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, sport fishery yields, and harvest rates.

A combination of human activities (e.g., road construction, timber harvest), exacerbated by flooding and wildfire, has limited steelhead production in the SFTR basin. Much of the spawning and rearing habitats have been damaged or destroyed through excessive sedimentation and stream aggradation.

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), and the California Department of Fish and Game (CDFG). Restoration and management efforts for steelhead stocks in the SFTR basin will be aided by the knowledge gained through studies of their current status, their habitat requirements, and life histories.

METHODS

Use of Standard Julian Week

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

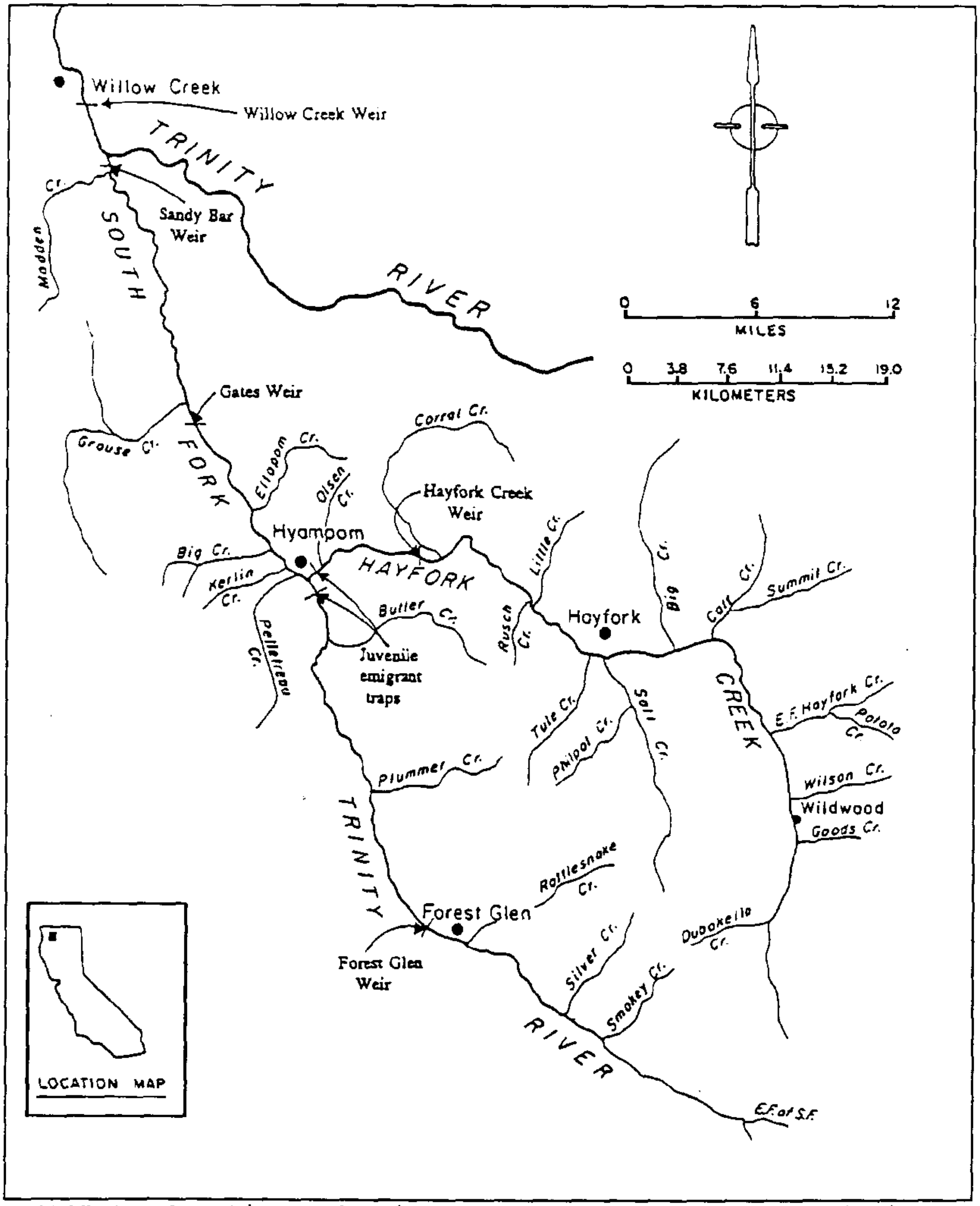


FIGURE 1. Locations of weirs and traps used to capture immigrant adult steelhead, and emigrant adult and juvenile steelhead in the South Fork Trinity River basin during the 1992-1993 season.

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, and the last day of the year is included in the 52nd week (Appendix 1). This procedure allows inter-annual comparisons of identical weekly periods.

Adult Fall-run Steelhead Trapping and Tagging

Run timing of adult fall-run steelhead into the SFTR basin was monitored with an immigrant weir located at Sandy Bar in the South Fork Trinity River at river kilometer (RKM) 2.4 (Figure 1). 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 welded to angle-iron frames with 3.2-cm horizontal bar-spacing. 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 fin clips, tags, and scars. Scars were categorized as: gill-net scars (nicks in the leading edges of dorsal and pectoral fins, sometimes combined with vertical white scars on the head); hook scars (of ocean origin when healed, of freshwater origin when not healed); predator scars (inverted 'V'-shaped marks, usually on the underbody); and 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, from 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 one-half right ventral (½RV) fin-clip. In addition, every third fish was tagged with a gray, discretely numbered $10-reward anchor tag, while the other two fish were tagged with green, discretely numbered non-reward anchor tags. This was a change from our previous years' procedure when all adult steelhead received reward tags. This was done in an attempt to discourage anglers from fishing primarily for money. The tags and fin 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 emigrant weirs). Angler harvest was to be estimated from reward tag returns.

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.

Chinook and Coho Salmon Escapement

During the operation of the Sandy Bar Weir all adult salmon caught were processed similarly to steelhead, except they were not tagged. Fish judged to be in poor condition were just identified and counted, then released to continue their upstream migration. Chinook salmon (O. tshawytscha) and coho salmon (O. kisutch) were given a right opercular punch (OPR) prior to their release. This was done so that investigators from other projects surveying the SFTR basin could identify salmon which had been caught at the Sandy Bar Weir.

Fall-run Steelhead Escapement

Downstream emigrant weirs were used to capture post-spawning steelhead emigrating from the basin in order to recover fish tagged at the Sandy Bar Weir. These tagged fish, combined with those observed during the creel surveys in the basin, served as the recapture sample for our population estimates using the Petersen method of mark and recapture (Ricker 1975, p. 78, formula 3.7).

This season only one emigrant weir was installed due to high spring flows. We assembled a weir in the SFTR near the town of Forest Glen at RKM 89.6 (approximately 150 m downstream from the Highway 36 bridge). In past years we had also operated a weir on lower Hayfork Creek near the town of Hyampom (8.0 RKM upstream from the SFTR confluence).

We constructed an Alaskan-style weir at the Forest Glen site using a series of panels 3.2 m high and 3.0 m long, supported by wooden tripods set 2.4 m apart, and joined together to block the entire river. Each panel consisted of 1.9-cm EMT conduits set 2.9 cm apart (46 per panel), and 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 with its entrance facing upstream. All steelhead recovered were measured (cm FL), and checked for spawning condition, tags, fin clips, and marks. Each fish was also sampled for scales, and given a OPR before being released downstream of the weir.

In addition to the downstream (emigrant) trap, we also installed an upstream (immigrant) trap to capture spring-run steelhead (also known as summer steelhead) and spring-run chinook salmon. This work was done in cooperation with CDFG's Trinity Fisheries Investigations Project, which was studying spring-run chinook salmon stocks in the SFTR basin. The Trinity Fisheries

Investigations Project took over the operation of the Forest Glen Weir on 29 June 1993. This report covers catches of steelhead at the Forest Glen Weir through 30 June 1993.

Creel Survey

Angler effort and harvest information for fall-run steelhead within two areas of the SFTR basin was determined from a systematic creel survey stratified by JW, section (upper/lower), day (weekend/weekday), and time periods (AM/PM; dawn to noon/ noon to dusk, respectively).

Two sections of the SFTR basin were surveyed (Figure 2). The lower survey area extended from the confluence of the SFTR with the mainstem Trinity River to 22.5 km upstream. The upper area extended through the Hyampom Valley from RKM 33.0 to RKM 50.7. These two areas covered the river reaches fished by the majority of anglers, as the lack of public roads limits access. Angler access sites had been identified from past surveys.

Survey clerks followed a set route based on a predetermined schedule, and monitored each access site for anglers. Anglers observed were interviewed for number of hours fished that day, targeted species, success, angling method, and county and state of residence. Sport-caught salmonids observed were measured (cm FL), sexed, examined for fin clips and external tags, inspected for general body condition, and scale sampled. The number of any tag observed was recorded. We classified steelhead <25 cm FL as juveniles, $\geq$25 cm FL and <41 cm FL as half-pounders, and $\geq$41 cm FL as adults.

Data were extrapolated under the assumption that angling effort, angler numbers, and steelhead harvest were constant for the duration of each stratum sampled. A ratio of the number of legal fishing hours possible during the AM or PM stratum to the hours sampled during that stratum yielded a weighting factor which was used to expand observed angler numbers, angler hours, and steelhead harvest. Expanded estimates for strata not surveyed were calculated by using average values for strata from equivalent sampling periods (i.e., for a missing weekday evening survey, the mean of all weekday PM survey samples for that section during that JW was used). Expanded estimates and actual data were combined to give an estimate of sport harvest for the season in the SFTR basin.

Tag Returns and Steelhead Harvest Estimates

All reward tags from Sandy Bar Weir that we observed during the creel surveys were left with the angler to return to us by mail. This was done so we could calculate an overall SFTR basin sport harvest for fall- and winter-run steelhead. The percentage of

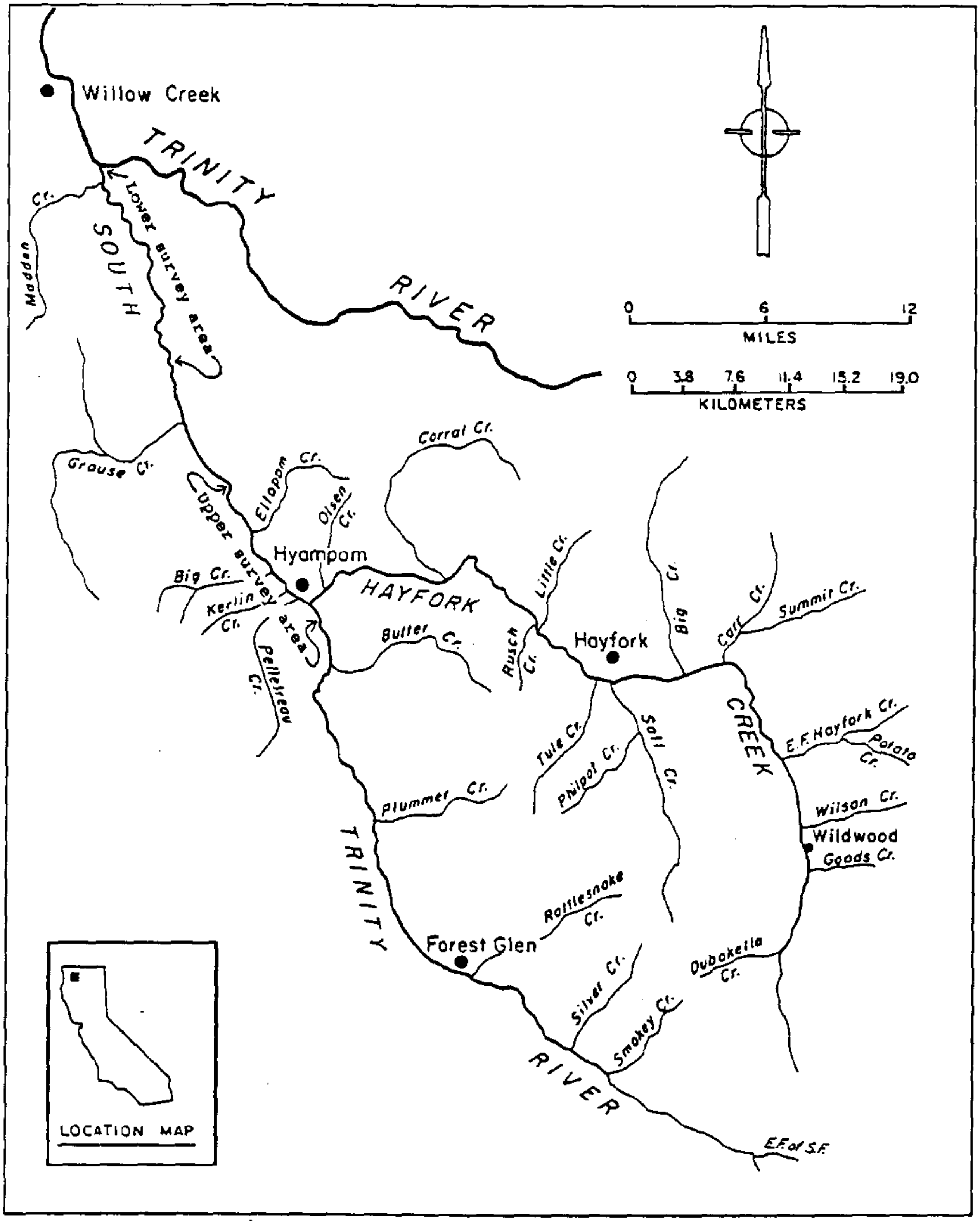


FIGURE 2. Locations of the two areas creel surveyed in the South Fork Trinity River basin during the 1992-1993 season.

reward tags caught by anglers which were not returned to us (i.e., non-response) was calculated 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 sport harvest estimate used the number of reward tags returned by anglers divided by the non-response, and the number of tags applied at the Sandy Bar Weir. The estimated sport harvest was 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.

Spawning Surveys

Project personnel conducted walking surveys of tributary streams to the SFTR and Hayfork Creek to document steelhead spawning distribution and timing. The areas surveyed included tributaries in the Hyampom Valley near the towns of Hayfork and Wildwood, and tributaries in the upper SFTR basin near the town of Forest Glen (Figure 1). Specific creeks surveyed were selected to include those which had 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 and habitat-typed designated stream reaches recording the length and type of each habitat unit, observed spawning behavior, and individual redd locations. Each habitat unit was classified as either a cascade, pool, riffle, run, or step-run. 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 evaluated steelhead spawning habitat by measuring the physical and hydraulic parameters of observed redds, and 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, from the upstream end of the redd to the highest point of the tailspill, and 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 topsetting 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 at 60% of the depth 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 an attempt 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.

Juvenile Steelhead Emigration Studies

We monitored juvenile steelhead emigration patterns by systematically trapping at two sites. One site was located in lower Hayfork Creek, 305 m upstream of its confluence with the SFTR. The other site was located in the SFTR, upstream of its confluence with Hayfork Creek, within 400 m of the Hyampom Road bridge at RKM 49.1 (Figure 1). When flow conditions permitted, we trapped once a week most of the year. During the spring period of peak juvenile steelhead emergence, 23 April - 22 July (JW 17-29), we increased trapping frequency to twice weekly.

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

Data code	Substrate type	Substrate 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	

Juvenile salmonids 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 0.33-m x 0.33-m terminal end. Trap boxes were constructed of marine plywood and hardware cloth, and measured 0.8 m x 1.2 m x 0.5 m. 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). Scale samples were systematically taken from a maximum of 10 individuals of each species, at each trap site, each sampling day.

Water temperature and stream flow were measured at the net opening each time the traps were set. Total volume of stream flow through the net was measured to the nearest 0.031 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.

Juvenile Steelhead Habitat Utilization

Habitat use by juvenile steelhead was studied in Eltapom Creek (Figure 1) in the fall of 1992 (1-3 September). Prior to sampling, the creek was surveyed and delineated into units of five basic habitat types: cascades, pools, riffles, runs, and step-runs. Sampling was conducted by electrofishing. Habitat units sampled were randomly selected in proportion to the numeric abundance of each of the five basic habitat types. Our goal was to sample one-third of the units in each habitat type.

Sample units were isolated using block nets to prevent any immigration or emigration of fish, and then electrofished. All steelhead captured were counted, measured (mm FL), sampled for scales (first five per habitat unit), and then released.

Age delineation of fish captured was based on lengths. Fish $\leq$85 mm were classified as Age 0+, fish 86-150 mm as Age 1+, and fish >150 mm as Age 2+. Numbers of fish caught were used to determine the relative densities for each age group in each habitat type based on total catch-per-area. The number of fish caught in the same type of habitat unit was expanded, based on the relative densities multiplied by the total area available in each habitat type. These figures were then totaled to give a standing crop estimate for the entire stream.

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.

After sampling, physical parameters of each unit were taken. We recorded air and water temperatures with hand-held thermometers. Water velocities (to the nearest 0.031 m/sec) were measured at 60% of the total depth from the surface along a line transverse to the flow at points one-quarter, one-half, and three-quarters of the way across the stream. Stream length and width were measured to the nearest 0.03 m.

RESULTS AND DISCUSSION

Adult Fall-run Steelhead Trapping and Tagging

The Sandy Bar Weir was operated from 1 October 1992 through 8 December 1992, when high flows washed out the weir. During this period we trapped 130 adult and one half-pounder steelhead. The first steelhead was caught on 2 October, but the majority of fish were captured during increased river flows following the first fall rains (Figure 3).

We applied 38 $10-reward and 72 non-reward tags to fall-run steelhead caught at the Sandy Bar Weir this season. Five of the steelhead captured at the Sandy Bar Weir were judged to be in poor condition and were measured and released without further handling. The remaining 126 fish were given ½RV fin clips. Fourteen of the steelhead captured at Sandy Bar Weir carried tags applied at the Willow Creek Weir, located in the Trinity River 48.4 km upstream from its confluence with the Klamath River, and 3.7 km downstream from its confluence with the SFTR. A total of 168 steelhead was tagged at the Willow Creek Weir (Mark Zuspan, Assoc. Fishery Biologist, CDFG, pers. commun.). Travel times for the Willow Creek Weir-tagged steelhead ranged from 1 to 32 days, and averaged 15.1 days (Appendix 2).

On 1 November 1992 we recovered a steelhead which had been tagged at the Sandy Bar Weir the previous year (26 October 1991) as a 61-cm-FL female. At recovery this fish had grown to 65 cm FL and had been at large for 372 days. When we had released the fish in 1991 it was given a one-half left-ventral fin clip, which was still distinguishable.

Mean FL of all 131 steelhead examined was 60.5 cm (Figure 4). There was no significant difference between the mean FL of male and female steelhead caught at the weir. Predator scars were the most common (38.2%) scars observed on steelhead trapped this year at the Sandy Bar Weir (Table 2). A lower proportion (2.3%) of steelhead captured this year bore gillnet scars as compared with last year (11.3%).

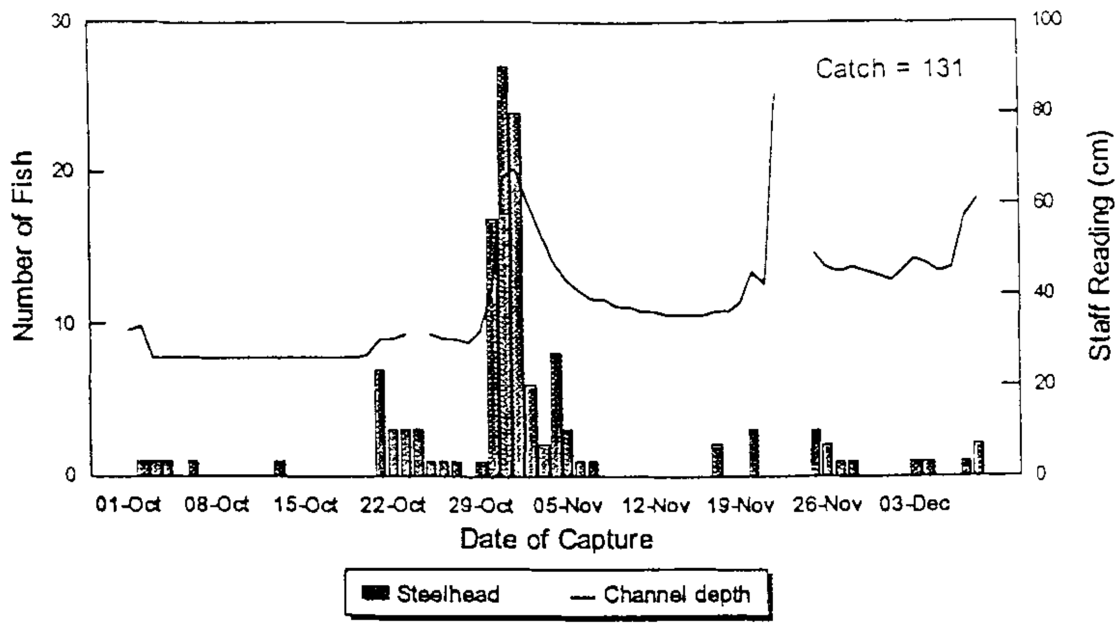


Figure 3. Daily catch of immigrant steelhead and river levels at the Sandy Bar Weir in the South Fork Trinity River from 1 October 1992 through 8 December 1992.

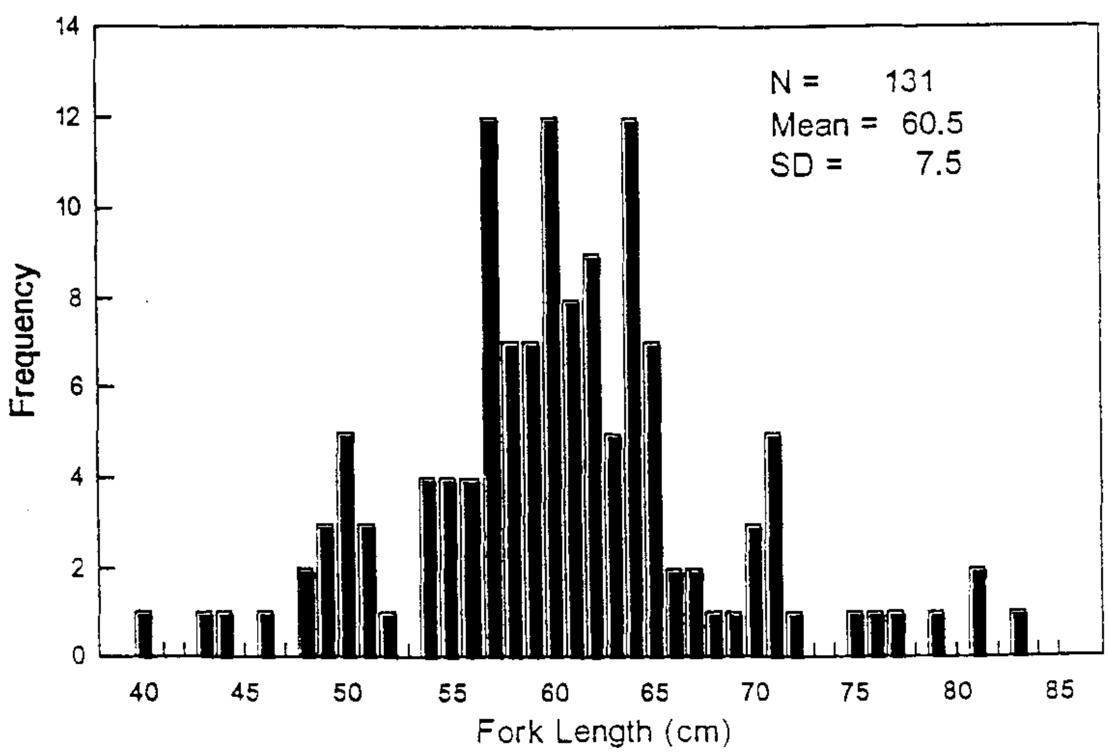


Figure 4. Length frequency distribution of immigrant steelhead captured at the Sandy Bar Weir in the South Fork Trinity River from 1 October 1992 through 8 December 1992.

TABLE 2. Scars observed on steelhead captured at the Sandy Bar Weir in the South Fork Trinity River between 1 October 1992 and 8 December 1992.

Scar type	Number of fish with scars	Percent of fish with scars	Percent of total fish captured
Gill-net scars	3	4.9	2.3
Freshwater hook scars	2	3.3	1.5
Ocean hook scars	0	0.0	0.0
Predator scars	50	82.0	38.2
Scars of unknown origin	6	9.8	4.6
Totals:	61	100.0	

Since the Sandy Bar Weir was only operated through 8 December 1992, we were certain that the steelhead caught were fall-run fish. It is possible that the SFTR basin also sustains a winter-run stock of steelhead. During the past two seasons (1990-91 and 1991-92) low river flows allowed us to continue weir operations longer, and we caught substantial numbers of steelhead during January and February (Wilson and Collins 1992, 1994). However, at this time we are not able to distinguish between fall-run and winter-run fish. The late-caught steelhead in the 1990-91 and 1991-92 seasons might have been fall-run fish which had been holding in the Trinity River. We plan to compare scales taken from steelhead during these two periods (i.e., October-November vs. January-February) to see if this will help us differentiate these stocks. Since winter-run fish remain in the ocean for a longer period before entering the river, we might be able to detect a larger ocean-growth pattern for winter-run stocks.

Chinook and Coho Salmon Escapement

Sandy Bar Weir operations originally began in 1984 to determine the size, composition, distribution, and timing of adult salmon runs in the SFTR basin. The Sandy Bar Weir at that time was operated by the CDFG's Natural Stocks Assessment Project (NSAP), Arcata Field Office. In 1988, NSAP's SFTR Steelhead Studies Project (Weaverville Field Office) also began tagging fall- and winter-run steelhead at Sandy Bar Weir to estimate their run sizes and angler harvest rates. Between 1984 and 1990, adult chinook and coho salmon were captured, tagged, and released at the Sandy Bar Weir. Salmon escapement into the basin was estimated based on the tagged to untagged ratio obtained through carcass surveys (Jong and Mills 1993). After the 1990-91 season we stopped tagging adult salmon at the weir, although we continued to count, measure, and take scale samples from these fish (Table 3).

From 1984 through 1990, escapement of fall-run chinook salmon decreased from highs of 2,649 and 1,580 fish in 1985 and 1986, respectively, to lows of 474 to 345 fish during 1987 through 1990 (Jong and Mills 1993). Escapements remained low throughout the drought years of 1987-1991. The status of fall-run chinook salmon in the SFTR basin needs to be periodically reassessed to monitor their well-being. If normal rainfall conditions continue, it will be important to determine if any recovery of this stock occurs. The NSAP is planning to conduct this work at least once during the next five years. Long-term escapement estimates are also important to assess the natural range of population fluctuations in the basin and to evaluate the effectiveness of restoration efforts.

During the 1992-93 season we caught 348 chinook salmon (158 adults >56 cm FL, and 190 grilse ≤56 cm FL) (Figure 5). The size separating grilse (age 2-yr) from adult (age >2-yr) salmon was based on the nadir in the length frequency distribution within the 50-60 cm range (Figure 6); the grilse-adult size separation

TABLE 3. Number of adult salmonids caught at the Sandy Bar Weir each fall season from 1984 through 1992.

Year	Beginning date	Ending date	No. days of weir operation	No. of chinook caught	No. of coho caught	No. of steelhead caught
1984	17-Sep-84	02-Nov-84	46	73	3	55
1985	17-Sep-85	17-Nov-85	61	176	109	207
1986	11-Aug-86	01-Nov-86	102	264	12	387
1987	16-Sep-87	24-Nov-87	69	455	17	243
1988	22-Sep-88	13-Nov-88	52	368	3	227
1989	14-Sep-89	23-Oct-89	39	52	1	37
1990	13-Sep-90	01-Mar-91	169	223	61	176
1991	04-Sep-91	11-Feb-92	160	202	135	495
1992	01-Oct-92	08-Dec-92	68	348	49	131

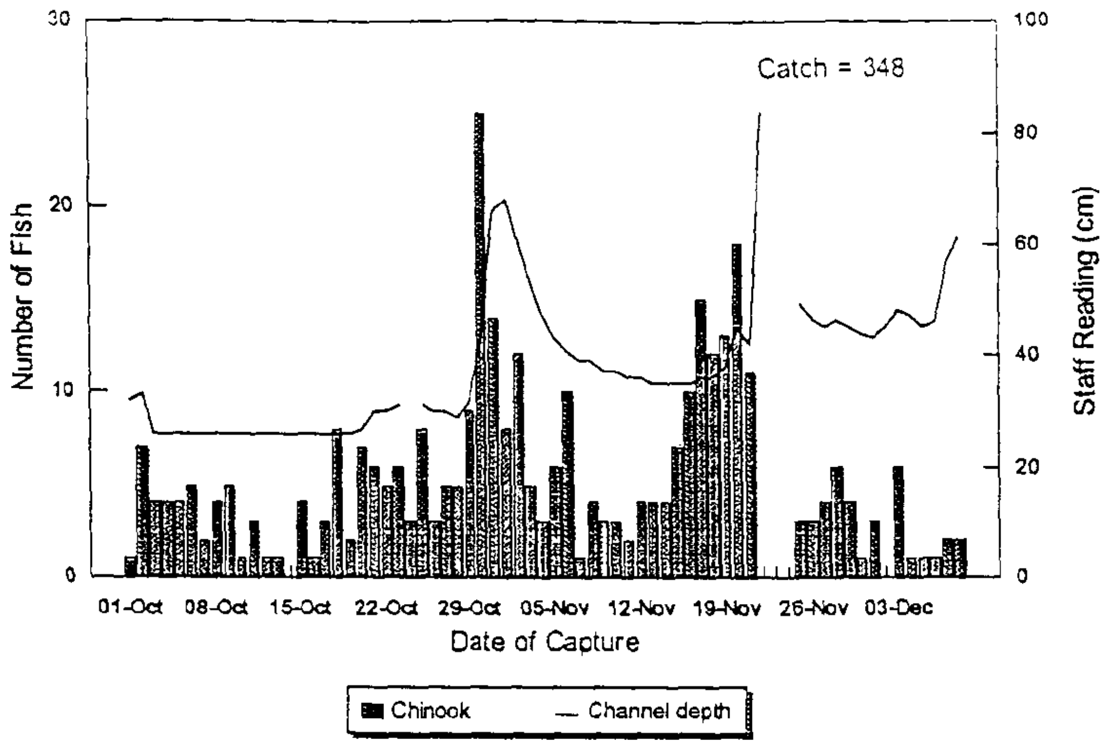


Figure 5. Daily catch of immigrant chinook salmon and river levels at the Sandy Bar Weir in the South Fork Trinity River from 1 October 1992 through 8 December 1992.

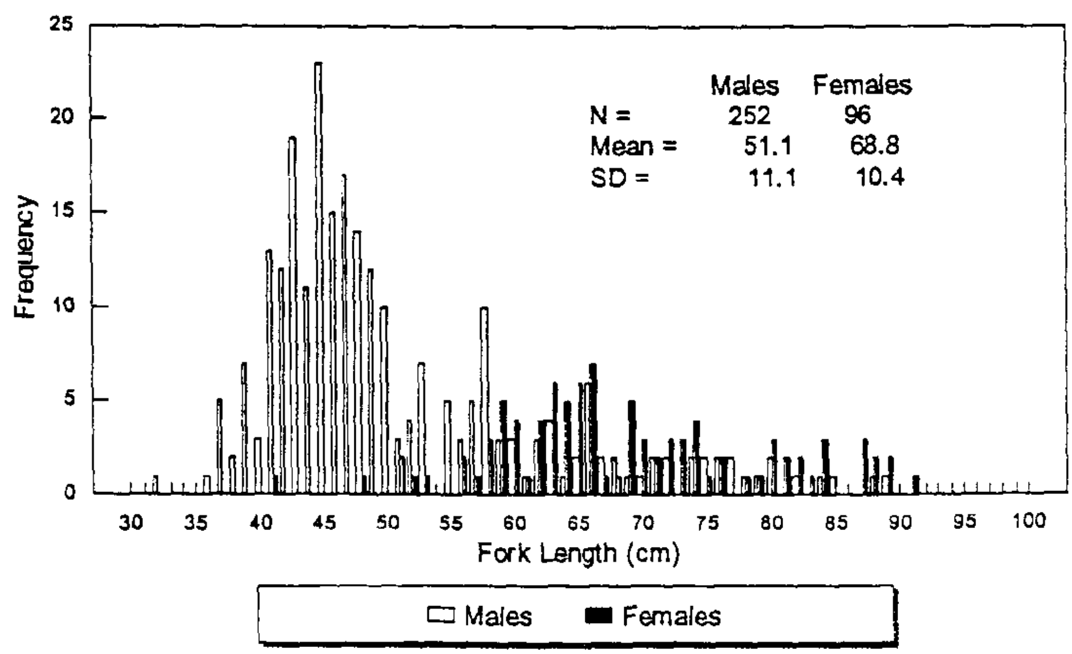


Figure 6. Length frequency distribution of immigrant chinook salmon captured at the Sandy Bar Weir in the South Fork Trinity River from 1 October 1992 through 8 December 1992.

is generally found in this size range (Bill Heubach, Assoc. Fishery Biologist, Calif. Dept. Fish Game, pers. commun.). The catch rate remained fairly consistent through mid-November, but peaked during periods of increased flow (Figure 5). Catches of chinook salmon began declining after late-November. The catch of chinook salmon consisted of 252 males (72.4%), and 96 (27.6%) females (Figure 6). The male chinook salmon catch consisted of 73.0% grilse and 27.0% adult.

The run of coho salmon began in early-November with the onset of increased flows, and was still in progress when the weir was washed out on 8 November (Figure 7). We caught 49 coho salmon, consisting of 23 (46.9%) males and 26 (53.1%) females (Figure 8). The male coho salmon catch consisted of 47.8% grilse and 52.2% adult.

Fall-run Steelhead Escapement

An Alaskan-style weir was operated in the SFTR near Forest Glen during the 1992-93 season to catch post-spawning emigrant adult steelhead, and to attempt recovery of fish tagged at the Sandy Bar Weir the previous fall. Due to high flows, the weir was not installed until 11 May 1993. Thirty-five emigrant adult steelhead were caught through 29 May (Figure 9). We opened up the weir from 30 May through 9 June due to high flows and let fish pass unhindered. No further emigrant adult steelhead were caught after this period.

No Sandy Bar Weir-tagged steelhead were recovered at the Forest Glen Weir, and only one tagged fish was observed during the creel surveys. Therefore, we were unable to reliably estimate the escapement of fall-run steelhead into the SFTR basin during the 1992-93 season. The adult salmonid emigrant and immigrant monitoring weirs were ineffective in assessing the run-size of fall-run steelhead this year because high flows, beginning in early December 1992 and continuing through early summer 1993, prevented us from sampling much of the run. This was the first normal or above-normal flow year after six consecutive dry water-years.

Nineteen (54.3%) of the 35 emigrant adult steelhead caught at the Forest Glen Weir were male, and 16 (45.7%) were female. The mean FL $\pm$ SD for males was 59.8 $\pm$ 8.8 cm (range = 45-70 cm), and 61.8 $\pm$ 5.6 cm for females (range = 51-72). The mean FL $\pm$ SD for all adult emigrant steelhead was 60.7 $\pm$ 7.5 cm (range = 45-72 cm) (Figure 10).

Ten immigrant spring-run steelhead were captured in the immigrant traps at the Forest Glen Weir. Four fish were male, four were female, and the sex of two was not determined. The mean FL $\pm$ SD for males was 51.7 $\pm$ 12.7 cm (range = 37-60 cm)

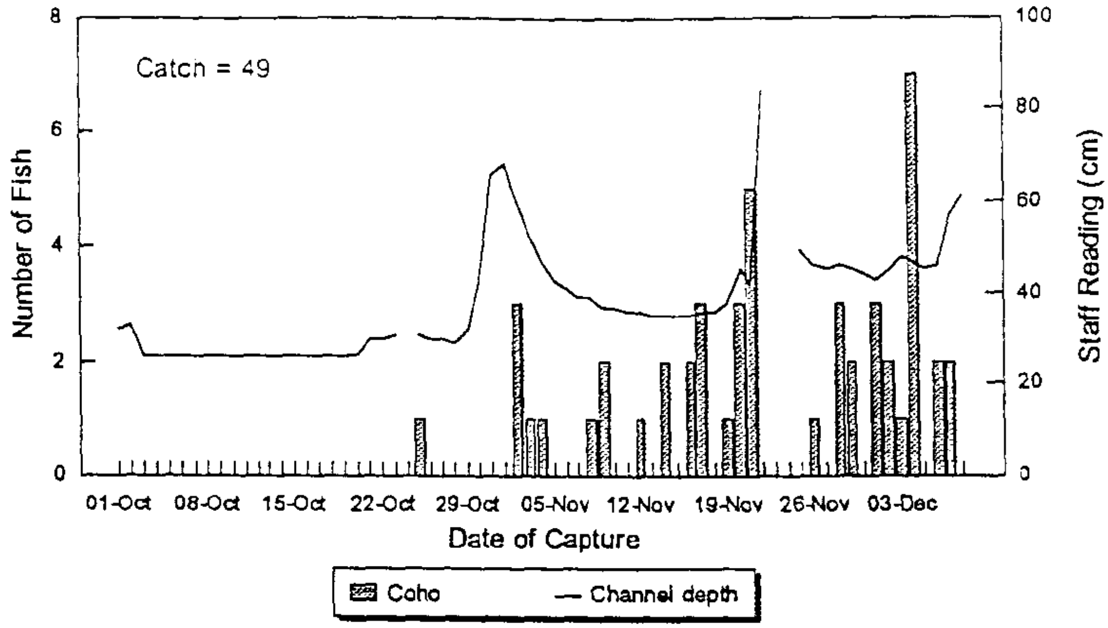


Figure 7. Daily catch of immigrant coho salmon and river levels at the Sandy Bar Weir in the South Fork Trinity River from 1 October 1992 through 8 December 1992.

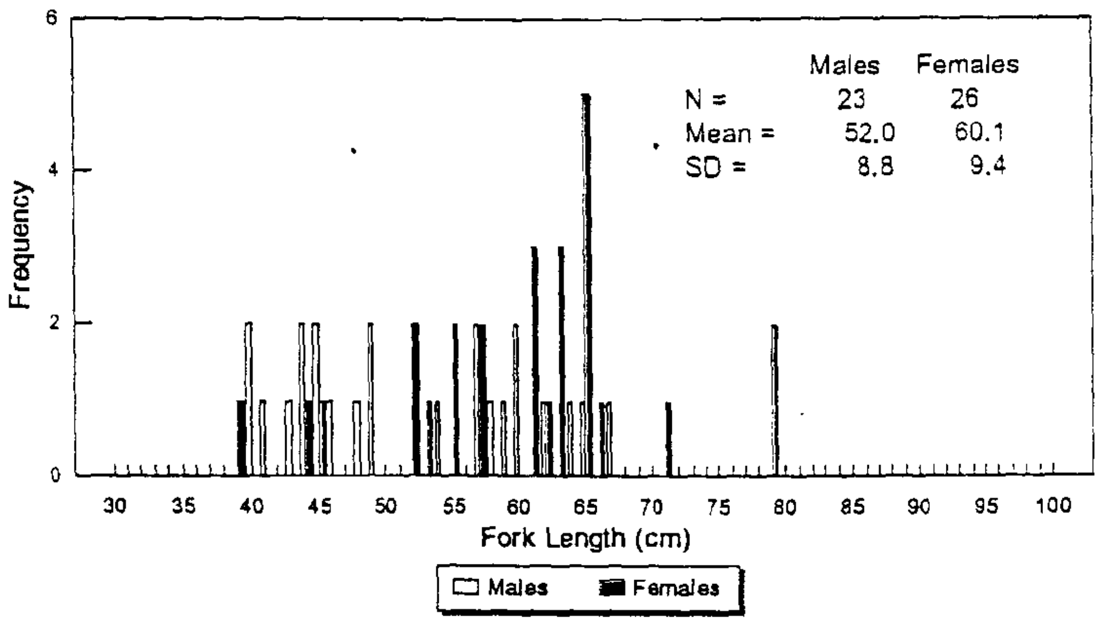


Figure 8. Length frequency distribution of immigrant coho salmon captured at the Sandy Bar Weir in the South Fork Trinity River from 1 October through 8 December 1992.

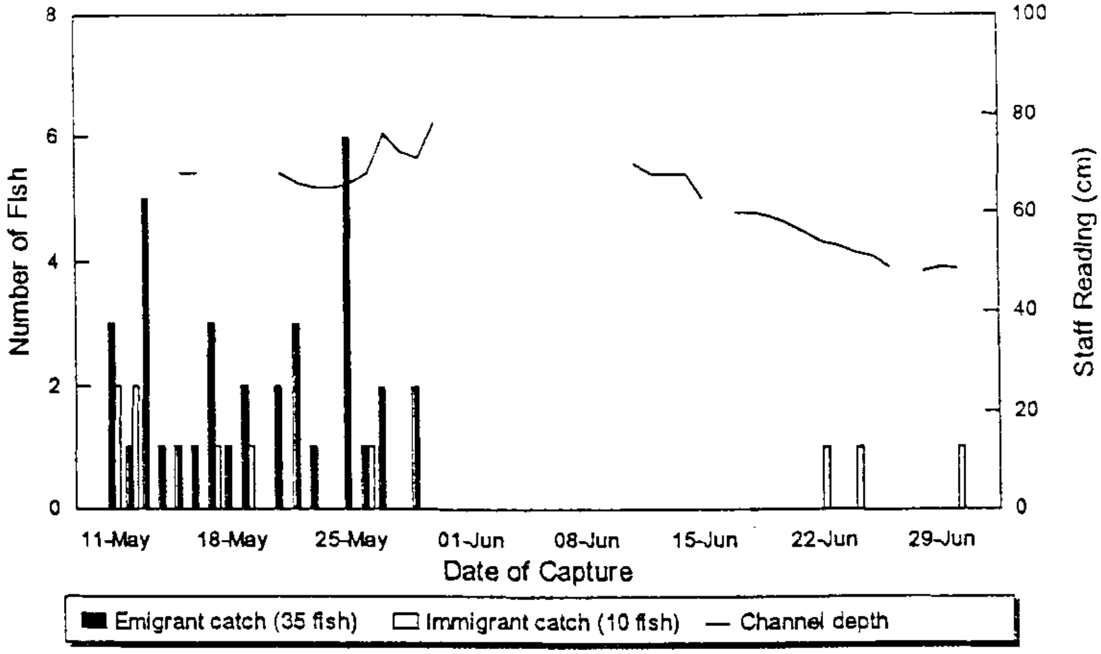


Figure 9. Daily catch of steelhead at the Forest Glen Weir in the South Fork Trinity River from 11 May through 30 June 1993.

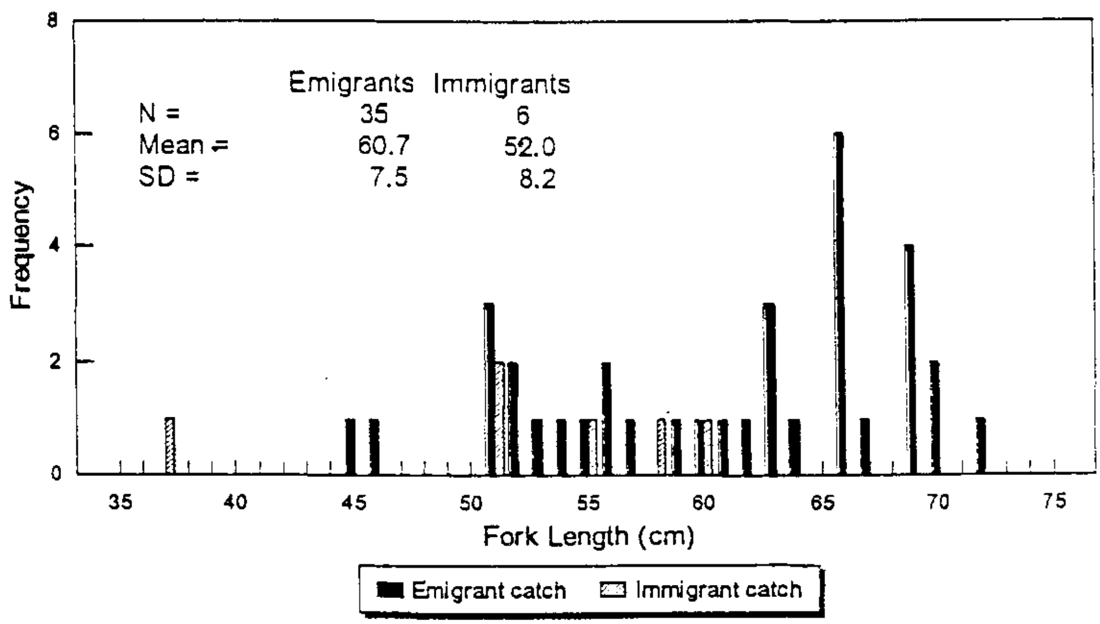


Figure 10. Length frequency distribution of steelhead captured at the Forest Glen Weir in the South Fork Trinity River from 11 May through 30 June 1993.

and 52.3 ± 2.3 cm for females (range = 51-55 cm). The mean FL ±SD for all immigrant spring-run steelhead was 52.0 ± 8.2 cm (range = 37-60 cm) (Figure 10).

Creel Survey

The creel survey was conducted on the SFTR between 22 October 1992 and 11 March 1993, an interval of 143 days. The lower survey section (Figure 2) was monitored for 23 days of this period. The upper survey section was monitored for 102 days of this period. Creel surveys were not conducted when high flows or turbidity made the river "unfishable". The upper section was "unfishable" for twenty-one (20.6%) of the days it was monitored. Water temperatures ranged from 3.9 °C to 19.4 °C during the survey.

During the survey, 117 anglers were interviewed, 15 (12.8%) on the lower section and 102 (87.2%) on the upper section (Table 4). Highest angling activity was observed in the Hyampom Valley (RKMs 40-49). Of the 117 anglers interviewed, 15 were observed fishing at multiple locations on the same day. Numbers of anglers at each site of angling activity were counted for distribution, but an angler was not recounted for effort when observed at a different location on the same day.

Thirteen adult steelhead were observed in the catch (six steelhead in the lower section and seven steelhead in the upper survey section). Two of the 13 adult steelhead observed had tags applied this year at Sandy Bar Weir; both fish were seen in the upper survey section.

Based on extrapolations of the creel survey data, an estimated 113 anglers within the lower section harvested 42 adult steelhead (Table 5), while an estimated 821 anglers within the upper section harvested an estimated 57 adult steelhead (Table 6).

County of origin was tabulated for all 117 anglers. The majority (85.5%) of the anglers encountered fishing within the SFTR basin were from Trinity county (Table 7).

Tag Returns and Steelhead Harvest

Only two tags (one reward and one non-reward), of the 110 tags applied at the Sandy Bar Weir, were returned by anglers through the mail. This was an insufficient number of recoveries to base a harvest estimate on.

Spawning Surveys

Walking surveys were conducted throughout the SFTR basin to determine steelhead spawning distribution, and an index of spawning occurrence within basin areas. Spawning surveys were

TABLE 4. Angler occurrence at access sites during the creel survey of the South Fork Trinity River basin, 1992-1993 season.

Angling access site	Location		Anglers observed a/	
	River km	River mile	Number	Percent
<u>Lower Survey Section</u>				
Sandy Bar	1.6	1.0	13	9.8
Madden Creek	2.1	1.3	0	---
Holmes Farm/Bridge	13.2	8.2	1	0.8
Todd Ranch	18.8	11.7	1	0.8
Surprise Creek area	22.2	13.8	0	---
<u>Upper Survey Section</u>				
Swinging Bridge (Gates Rd.)	32.7	20.3	1	0.8
Big Slide Campground	40.2	25.0	20	15.1
Eltapom Creek area	40.9	25.4	6	4.5
Upper Slide Creek access	40.1	25.5	9	6.8
Salmon Rock area	41.7	25.9	14	10.6
Little Rock Campground	42.0	26.1	28	21.2
Mortensen property	42.6	26.5	2	1.5
Saw Mill site	43.4	27.0	0	---
Way property	45.1	28.0	2	1.5
Hyampom airstrip	46.0	28.6	8	6.1
Pelletreau Creek mouth	46.3	28.8	0	---
Old Bridge site	47.3	29.4	1	0.8
Church access	47.9	29.8	12	9.1
County maintenance yard	48.3	30.0	4	3.0
Hayfork Creek mouth	48.8	30.3	10	7.6
Totals:			132	100.0

a/ A total of 117 individual anglers was observed. Numbers shown include multiple observations of the same angler on the same day.

TABLE 5. Observed and estimated angler use and steelhead harvest for the South Fork Trinity River lower section creel survey during the 1992-1993 season.

Dates	Julian weeks	Angler effort			
		Angler numbers		Angler hours	
		Observed	Estimated	Observed	Estimated
10/22-11/04/92	43-44	6	52.2	11.5	95.8
11/05-11/18/92	45-46	3	18.4	6.0	36.9
11/19-12/02/92	47-48	6	42.1	9.0	63.5
12/03-12/16/92	49-50	0	0	0	0
	Totals:	15	112.7	26.5	196.2

Dates	Julian weeks	Steelhead harvest					
		Adults a/		Half-pounders b/		Juveniles c/	
		Obsvrd.	Estimtd.	Obsrvd.	Estmtd.	Obsrvd.	Estmtd.
10/22-11/04/92	43-44	6	42.0	0	0	0	0
11/05-11/18/92	45-46	0	0	0	0	0	0
11/19-12/02/92	47-48	0	0	0	0	0	0
12/03-12/16/92	49-50	0	0	0	0	0	0
	Totals:	6	42.0	0	0	0	0

a/ Adult steelhead were ≥ 41 cm FL.
b/ Half-pounder steelhead were ≥ 25 cm to < 41 cm FL.
c/ Juvenile steelhead were < 25 cm FL.

conducted between 13 April and 12 June 1993 (Table 8). We surveyed and habitat-typed sections of 23 creeks (103.1 km total length), counted and flagged 98 redds, and observed 11 live adult steelhead.

Five tributaries to the SFTR and one tributary to Hayfork Creek, all within the Hyampom Valley, were surveyed between 22 April and 10 June 1993. These surveys covered 10.0 km of stream. We observed 34 redds and counted eight live adult steelhead (Table 8). Eltapom Creek continued to support the highest redd density (13.1 redds/km) observed in the SFTR basin. Observed redd density in Butter Creek this season increased to

TABLE 6. Observed and estimated angler use and steelhead harvest for the South Fork Trinity River upper section creel survey during the 1992-1993 season.

Dates	Julian weeks	Angler effort: Angler numbers Observed	Angler numbers Estimated	Angler hours Observed	Angler hours Estimated
10/22-11/04/92	43-44	5	29.0	5.5	32.2
11/05-11/18/92	45-46	21	160.3	36.0	251.2
11/19-12/02/92	47-48	21	161.2	16.5	119.9
12/03-12/16/92	49-50	8	72.7	5.5	49.2
12/17-12/31/92	51-52	14	93.8	13.0	88.5
01/01-01/14/93	01-02	12	92.3	11.5	90.0
01/15-01/28/93	03-04	8	91.7	4.0	45.9
01/29-02/11/93	05-06	6	61.0	3.0	30.5
02/12-02/25/93	07-08	3	33.8	7.0	76.0
02/26-03/11/93	09-10	14	25.8	3.5	23.1
	Totals:	102	821.4	105.5	806.5

Dates	Julian weeks	Steelhead harvest: Adults a/ Obsrvd.	Adults a/ Estmtd.	Half-pounders b/ Obsrvd.	Half-pounders b/ Estmtd.	Juveniles c/ Obsrvd.	Juveniles c/ Estmtd.
10/22-11/04/92	43-44	1	6.6	0	0	0	0
11/05-11/18/92	45-46	3	27.7	0	0	0	0
11/19-12/02/92	47-48	0	0	0	0	0	0
12/03-12/16/92	49-50	2	17.9	0	0	0	0
12/17-12/31/92	51-52	0	0	0	0	0	0
01/01-01/14/93	01-02	1	5.2	0	0	0	0
01/15-01/28/93	03-04	0	0	0	0	0	0
01/29-02/11/93	05-06	0	0	0	0	0	0
02/12-02/25/93	07-08	0	0	0	0	0	0
02/26-03/11/93	09-10	0	0	0	0	0	0
	Totals:	7	57.4	0	0	0	0

a/ Adult steelhead were ≥ 41 cm FL.
b/ Half-pounder steelhead were ≥ 25 cm and < 41 cm, FL.
c/ Juvenile steelhead were < 25 cm, FL.

TABLE 7. County of residence for anglers interviewed within the South Fork Trinity River basin during the 1992-1993 creel survey.

County of origin	Number of anglers interviewed	Percent of total anglers interviewed
Contra Costa	2	1.7
Los Angeles	2	1.7
Orange	1	0.9
Riverside	4	3.4
Sacramento	2	1.7
San Francisco	1	0.8
San Diego	2	1.7
Tehema	3	2.6
Trinity	100	85.5
Totals:	117	100.0

5.8 redds/km compared to 2.1 redds/km last season. However, redd densities in the other creeks in this area remained low.

In the Hayfork-Wildwood area, we surveyed 11 tributaries to Hayfork Creek, plus parts of the mainstem of Hayfork Creek between 13 April and 7 June 1993. These surveys covered 77.0 km of stream, and we observed 28 redds and counted three live adult steelhead (Table 8). In Big Creek we only observed seven redds this season (0.5 redds/km) compared to 53 last year (3.8 redds/km). Steelhead spawning occurrence also appeared to be lower in Little Creek, E.F. Hayfork Creek, Hayfork Creek, and Tule Creek this year. Redd densities in the other creeks in this area remained low.

In the upper SFTR basin (Forest Glen area) we surveyed five tributaries between 17 May and 12 June 1993. These surveys covered 16.1 km of stream, and we observed 36 redds, but no live adult steelhead (Table 8). Spawning occurrence in this area appears to be down this year. Good spawning gravels observed in previous years seemed to have a much higher component of fines this year, possibly a result of the high flows this year. Last year, we observed 145 redds in 24.5 km of surveyed stream.

TABLE 8. Steelhead spawning survey data for the South Fork Trinity River (SFTR) basin from 13 April to 12 June 1993.

Location	Survey dates First	Survey dates Last	Number of surveys	Stream length (km)	Total redds observed	Redds per km	Live steelhead observed
Hyampom Valley area							
Big Creek	May 18	--	1	0.8	0	0.0	0
Butter Creek	May 03	June 10	2	2.4	14	5.8	4
Eltapom Creek	May 06	June 08	2	1.3	17	13.5	4
Kerlin Creek	April 22	May 13	2	2.3	1	0.4	0
Olsen Creek	April 13	May 07	2	1.8	2	1.1	0
Pelletreau Creek	May 18	--	1	1.4	0	0.0	0
	Subtotals:		10	10.0	34	--	8
	Mean:		--	--	--	3.4	--
Hayfork-Wildwood area							
Big Creek	April 16	May 29	2	13.5	7	0.6	3
Carr Creek	April 27	--	1	4.3	0	0.0	0
Dubakella Creek	April 17	--	1	1.6	0	0.0	0
E.F. Hayfork Creek	April 21	May 12	2	8.3	3	0.4	0
Goods Creek	April 20	--	1	1.6	0	0.0	0
Hayfork Creek	May 07	May 17	1	12.5	1	0.1	0
Little Creek	May 04	June 07	2	2.3	0	0.0	0
Philpot Creek	May 19	--	1	1.9	1	0.5	0
Potato Creek	April 13	May 04	2	2.4	1	0.4	0
Rusch Creek	April 26	May 11	2	6.4	1	0.2	0
Salt Creek	April 14	May 06	2	18.5	8	0.4	0
Tule Creek	April 22	May 07	2	3.7	6	1.6	0
	Subtotals:		19	77.0	28	--	3
	Mean:		--	--	--	0.4	--
Forest Glen area							
E.F. SFTR	May 17	--	1	5.1	22	4.3	0
Plummer Creek	May 20	--	1	1.6	8	5.0	0
Rattlesnake Creek	June 12	--	1	5.7	2	0.4	0
Silver Creek	May 18	--	1	1.6	0	0.0	0
Smokey Creek	May 19	--	1	2.1	4	1.9	0
	Subtotals:		5	16.1	36	--	0
	Mean:		--	--	--	2.2	--
Grand totals:			34	103.1	98	- -	11
Grand mean:			- -		- -	0.9	

Steelhead Redd and Spawning Habitat Evaluations

We studied 77 steelhead redds throughout the SFTR basin during the 1992-93 season to assess the habitat and substrate components associated with them, and to measure physical and hydraulic characteristics of each redd. We found redds in four basic habitat types: pools, riffles, runs, and step-runs.

Forty-seven percent of the total stream length that we surveyed consisted of step-runs. Riffles comprised 24% of the stream-lengths surveyed, and runs and pools comprised 13.2% and 14.2%, respectively (Figure 11). Most of the redds (48.3%) were observed at the tails of pools in pool-riffle interchanges (pool tail-crest). Runs and step-runs were the next most frequently utilized habitat types for spawning this season, 28.1% and 14.6%, respectively (Figure 12).

The average redd area index was 1.7 m^2 (Figure 13). The average redd depth, measured 0.15 m upstream of the redd depression, was 32.8 cm (Figure 14). Average fish-nose water velocity (Figure 15) and mean water column velocity (Figure 16) was 0.6 and 0.6 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, small gravel (4-25 mm), medium gravel (25-50 mm), and large gravel (50-75 mm) made up 84.4% of the dominant substrate components, while 94.8% of the subdominant substrate components consisted of small gravel, medium gravel, large gravel, and small cobble (75-150 mm) (Table 9). The dominant substrate type in 14.3% of the redds evaluated consisted of fines; last year this figure was only 0.4%. This suggests that increased sedimentation in spawning habitats may have been a problem this year.

Embeddedness is the extent to which the larger substrate particles, such as gravels and cobbles 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). The substrate in 80.5% of the observed redds this season had an embeddedness greater than or equal to 30% (Table 9). Last year, only 39.1% of the redds we observed were in substrates which were 30% or more embedded.

Another factor which may be important to steelhead in their selection of spawning sites is the availability of cover; 88.3% of the redds we observed were associated with boulders, small woody debris, large woody debris, and undercut banks (Table 10). Additional study and analysis of SFTR steelhead redds is needed to determine the spawning habitat components that fish are

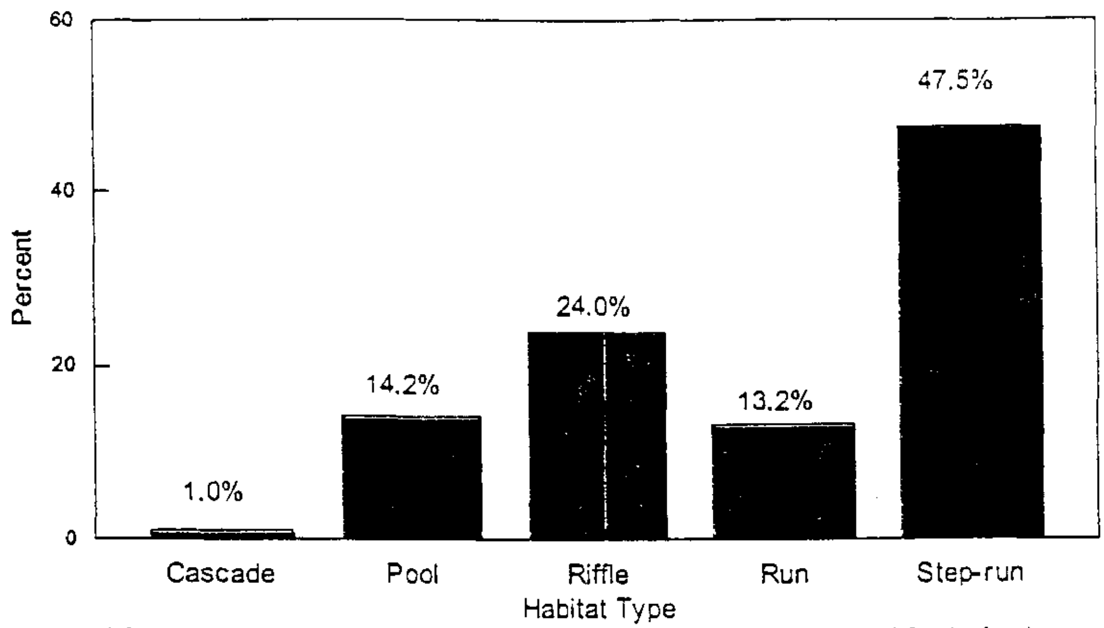


Figure 11. Total length of streams surveyed (103.1 km) distribution among the habitat types observed within the South Fork Trinity River basin during the 1992-1993 season.

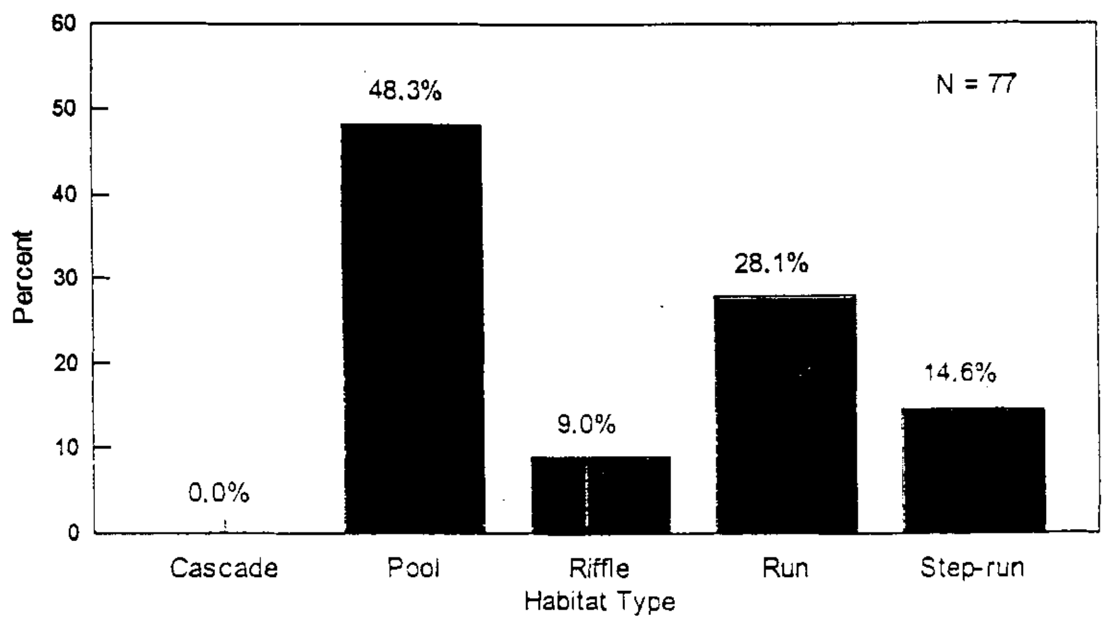


Figure 12. Relative frequency distribution of steelhead redds observed within habitat types in the South Fork Trinity River basin during the 1992-1993 season.

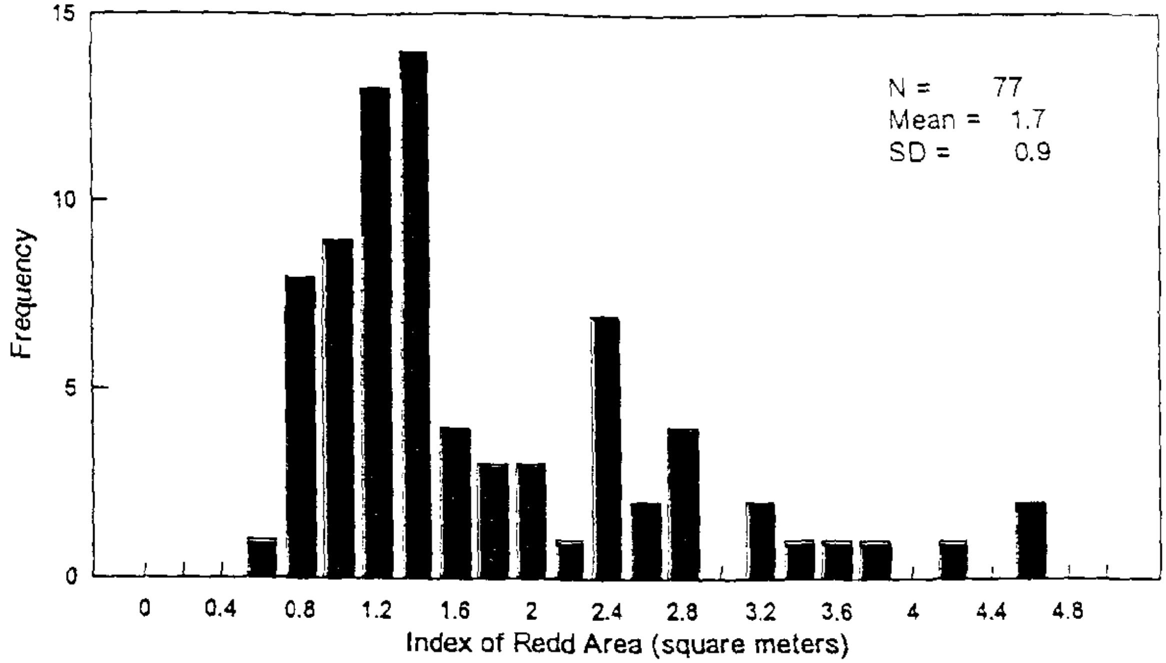


Figure 13. Frequency distribution of the index of surface area for steelhead redds examined within the South Fork Trinity River basin during the 1992-1993 season.

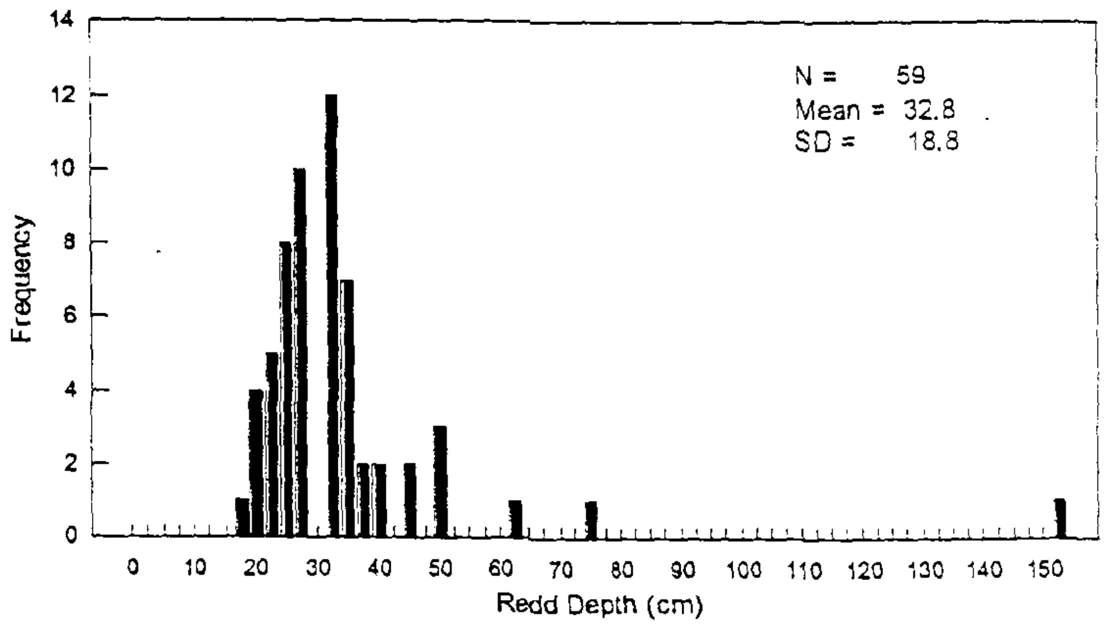


Figure 14. Frequency distribution of water depths measured 0.15 m upstream of steelhead redds observed within the South Fork Trinity River basin during the 1992-1993 season.

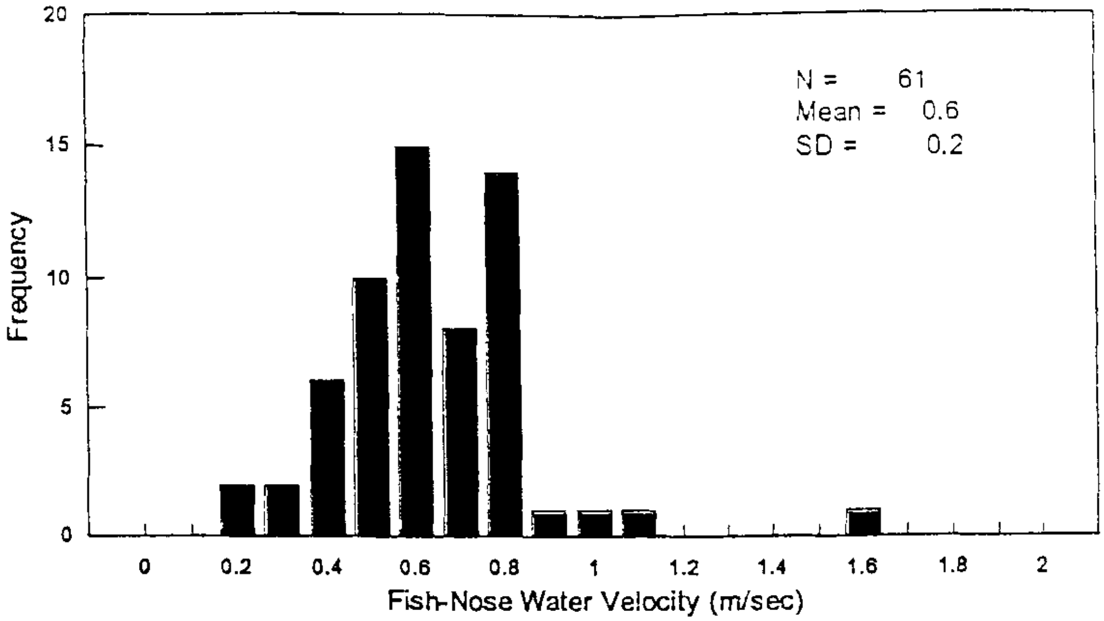


Figure 15. Frequency distribution of the fish-nose water velocity observed at steelhead redds within the South Fork Trinity River basin during 1992-1993 season.

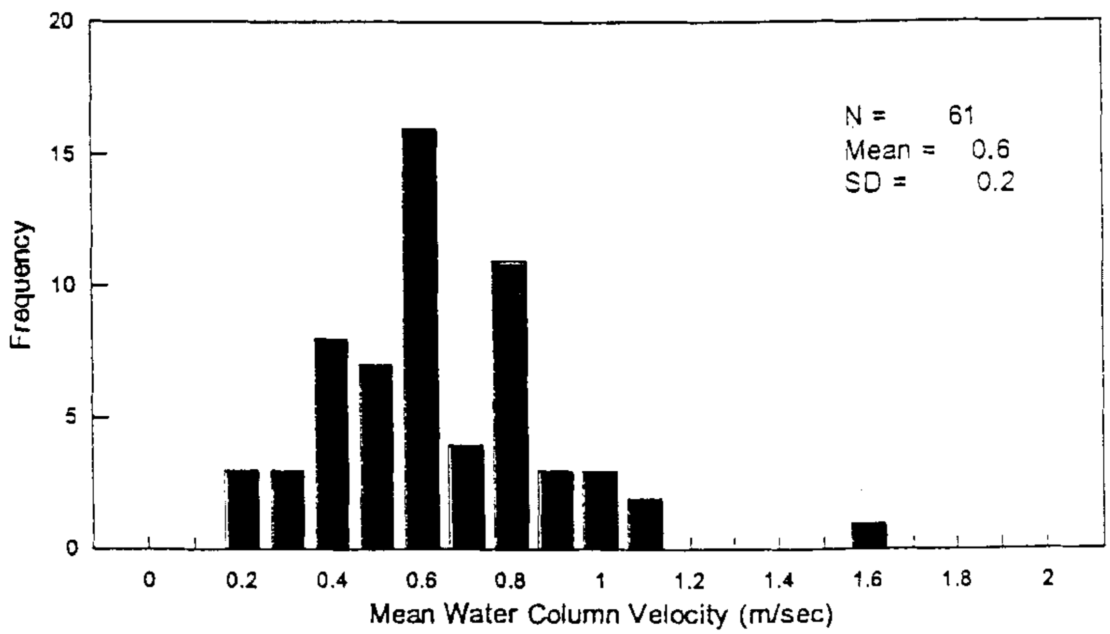


Figure 16. Frequency distribution of the mean water column velocity observed at steelhead redds within the South Fork Trinity River basin during the 1992-1993 season.

TABLE 9. Dominant and subdominant substrate compositions, and embeddedness of substrate components in steelhead redds observed in the South Fork Trinity River basin during the 1992-1993 season.

Substrate code	Substrate type	Dominant substrate		Subdominant substrate	
		Number observed	Percent	Number observed	Percent
0	Fines	11	14.3	2	2.6
1	Small gravel	32	41.6	19	24.7
2	Medium gravel	20	26.0	24	31.1
3	Large gravel	13	16.8	14	18.2
4	Small cobble	1	1.3	16	20.8
5	Medium cobble	0	---	2	2.6
6	Large cobble	0	---	0	---
7	Small boulder	0	---	0	---
8	Large boulder	0	---	0	---
9	Bedrock	0	---	0	---
	Totals:	77	100.0	77	100.0

Embeddedness code	Level of embeddedness	Number observed	Percent
0	0% - 9%	8	10.4
1	10% - 19%	0	---
2	20% - 29%	7	9.1
3	30% - 39%	26	33.7
4	40% - 49%	13	16.9
5	50% - 59%	21	27.3
6	60% - 69%	2	2.6
7	70% - 79%	0	---
8	80% - 89%	0	---
9	90% - 100%	0	---
	Totals:	77	100.0

TABLE 10. Dominant and subdominant cover types associated with steelhead redd sites examined in the South Fork Trinity River basin during the 1992-1993 season.

		Dominant cover		Subdominant cover	
Cover code	Cover type	Number observed	Percent	Number observed	Percent
0	No cover	1	1.3	6	7.8
1	Cobble	0	---	0	---
2	Boulders	10	13.0	2	2.6
3	Small woody debris	25	32.5	14	18.2
4	Large woody debris	13	16.9	9	11.7
5	Undercut bank	20	25.9	17	22.1
6	Overhanging vegetation	5	6.5	19	24.7
7	Aquatic vegetation	3	3.9	10	12.9
	Totals:	77	100.0	77	100.0

Quality of cover	Number observed	Percent
Poor	12	15.6
Fair	19	24.7
Good	46	59.7
Excellent	0	---
Totals:	77	100.0

selecting. This information, together with stream-by-stream assessments of habitat conditions 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.

Juvenile Steelhead Emigration Studies

From 2 July 1992 through 1 July 1993, we captured 1,780 Age 0+, 67 Age 1+, and 16 Age 2+ steelhead, and three juvenile chinook salmon at the SFTR and Hayfork Creek juvenile out-migrant trapping sites (Table 11). The peak emigration at these sites of Age 0+ steelhead occurred during May and June 1993. Emigration

TABLE 11. South Fork Trinity River basin juvenile salmonid weekly trapping summary for the 1992-1993 season.

			Numbers of juveniles trapped							
			Hayfork Creek				South Fork Trinity River			
			Steelhead			Chinook Salmon	Steelhead			Chinook Salmon
Year	Dates	Julian week	Age 0+	Age 1+	Age 2+	Age 0+	Age 0+	Age 1+	Age 2+	Age 0+
1992	07/02 - 07/08	27	9	0	0	0	279	3	0	0
	07/09 - 07/15	28	2	0	0	0	32	2	1	0
	07/16 - 11/04a/	29-44	-	-	-	-	-	-	-	-
	11/05 - 11/11	45	1	2	0	0	4	5	13	0
	11/12 - 11/18	46	1	3	0	0	2	1	0	0
	11/19 - 11/25	47	2	6	0	0	5	2	1	0
	11/26 - 12/02	48	2	3	0	0	2	0	0	0
	12/03 - 12/09a/	49	-	-	-	-	-	-	-	-
	12/10 - 12/16a/	50	-	-	-	-	-	-	-	-
	12/17 - 12/23	51	1	12	0	0	7	7	0	0
	12/24 - 12/31a/	52	-	-	-	-	-	-	-	-
1993	01/01 - 04/22a/	1-16	-	-	-	-	-	-	-	-
	04/23 - 04/29	17	2	0	0	0	-	-	-	-
	04/30 - 05/06	18	19	1	0	0	-	-	-	-
	05/07 - 05/13	19	45	3	0	0	-	-	-	-
	05/14 - 05/20	20	273	8	0	0	-	-	-	-
	05/21 - 05/27	21	229	7	1	3	-	-	-	
	05/28 - 06/03a/	22	-	-	-	-	-	-	-	-
	06/04 - 06/10	23	132	0	0	0	-	-	-	-
	06/11 - 06/17	24	371	0	0	0	-	-	-	-
	06/18 -06/24	25	144	0	0	0	13	1	0	0
	06/25 - 07/01	26	175	1	0	0	28	0	0	0
		Totals	1408	46	1	3	372	21	15	0

a/ No trapping conducted

of the three Age 0+ chinook salmon occurred during May 1993 (JW 21) in Hayfork Creek. More Age 0+ steelhead were caught in Hayfork Creek than the SFTR. The mean FL of Age 0+ steelhead from the 1992 brood year (BY) increased from 57 mm in July 1992 to 78 mm by December 1992. The mean FL of Age 0+ steelhead from the 1993 BY increased from 28 mm during early April 1993 to 52 mm by June 1993 (Table 12). Bi-weekly mean FLs of Age 1+ steelhead ranged from 88 to 124 mm, and of Age 2+ steelhead ranged from 159 to 240 mm. Mean FL of juvenile chinook salmon from the 1993 BY was 68 mm.

Juvenile Steelhead Habitat Utilization

Juvenile steelhead utilization of the five basic habitat types was evaluated in Eltapom Creek in the fall of 1992 (1-3 September). Prior to sampling, we identified 72 individual habitat units consisting of 2.8% cascades, 37.5% pools, 13.9% riffles, 16.7% runs, and 29.2% step-runs. We selected 24 of these units to sample: 1 cascade, 9 pools, 4 riffles, 3 runs, and 7 step-runs.

We captured a total of 481 juvenile steelhead during our sampling. The catch was composed of 80% (384 fish) Age 0+, 18% (86 fish) Age 1+, and 2% (11 fish) Age 2+ steelhead. We estimated the standing crop of juvenile steelhead at 1,594 fish (Table 13).

The highest densities of Age 0+ steelhead were observed in pools (0.27 fish/m^2) followed by cascades (0.12 fish/m^2) (Table 13). Riffle, run, and step-run densities were similar for Age 0+ fish (0.02 to 0.03 fish/m^2). The highest densities of Age 1+ steelhead occurred in pools and cascades (0.14 and 0.12 fish/m^2, respectively). Lower densities of Age 1+ fish were found in riffles, runs, and step-runs (0.002 to 0.003 fish/m^2). Age 2+ fish densities were highest in cascades and pools (0.015 and 0.012 fish/m^2, respectively). Age 2+ steelhead were also found in runs and step-runs at very low densities. Age 2+ fish were not observed in riffles during fall 1992.

Densities and standing crop estimates of juvenile steelhead have ranged widely during the last four years. The numbers of juvenile fish utilizing the available habitat in Eltapom Creek during the fall has not correlated with the number of redds observed in our spring spawning surveys (Mills and Wilson 1991; (Wilson and Mills 1992; and Wilson and Collins 1992, 1994). A possible explanation is the seasonal variation in precipitation rates. High flow periods would have an effect on emigration patterns; passive migration by young-of-the-year (Age 0+ fish) may be increased during high flow events. Data collection needs to be continued to include normal precipitation years, so a more accurate analysis can be performed on these data.

TABLE 12. Bi-weekly fork lengths of juvenile steelhead and chinook salmon captured within the South Fork Trinity River basin during the 1992-1993 season.

			Steelhead												Chinook salmon			
		Julian week		Age 0+ Fork length (mm)				Age 1+ Fork length (mm)				Age 2+ Fork length (mm)				Fork length (mm)		
Year	Date	Interval	N	Mean	Min.	Max.	N	Mean	Min.	Max.	N	Mean	Min.	Max.	N	Mean	Min.	Max.
1992	07/02 - 07/15	27-28	89	57	44	85	5	101	86	148	1	240	240	240	0	--	--	--
	07/16 - 11/04	29-44a/		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	11/05 - 11/18	45-46	8	70	50	84	11	92	89	116	13	207	158	245	0	--	--	--
	11/19 - 12/02	47-48	11	68	46	84	11	103	90	114	1	230	230	230	0	--	--	--
	12/03 - 12/16	49-50a/		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	12/17 - 12/31	51-52	8	78	65	85	19	102	87	148	0	--	--	--	0	--	--	
1993	01/01 - 04/22	01-16a/		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	04/23 - 05/06	17-18	21	28	25	39	1	88	88	88	0	--	--	--	0	--	--	--
	05/07 - 05/20	19-20	139	30	25	60	10	107	88	128	0	--	--	--	0	--	--	--
	05/21 - 06/03	21-22	41	31	27	58	6	124	88	148	2	159	150	168	3	68	63	70
	06/04 - 06/17	23-24	150	45	25	68	0	--	--	--	0	--	--	--	0	--	--	
	06/18 - 07/01	25-26	199	52	28	84	2	114	111	116	0	--	--	--	0	--	--	-

a/ Sampling not conducted.

TABLE 13. Juvenile steelhead habitat utilization observed in Eltapom Creek during fall 1992 (1-3 September).

Habitat type	Number of units	Total area (m^2)	Sampled area (m^2)	Age	Number of fish caught	Density (fish/m^2)	Standing crop estimate
Cascade	2	72.5	65.0	0+	8	0.123	9
				1+	8	0.123	9
				2+	1	0.015	1
				All	17	0.261	19
Pool	27	1518.0	337.0	0+	91	0.270	410
				1+	48	0.142	216
				2+	4	0.012	18
				All	143	0.424	644
Riffle	10	9681.0	2954.0	0+	71	0.024	233
				1+	8	0.003	26
				2+	0	0.000	0
				All	79	0.027	259
Run	12	9494.0	3685.0	0+	98	0.027	252
				1+	12	0.003	31
				2+	2	0.001	5
				All	112	0.029	288
Step-run	21	17333.0	4452.0	0	116	0.026	452
				1+	10	0.002	39
				2+	4	0.001	16
				All	130	0.029	507
Overall	**72**	**38098.4**	**11493.1**	**0+**	**384**	**0.033**	**1273**
				1+	**86**	**0.007**	**285**
				2+	**11**	**0.001**	**36**
				All	**481**	**0.042**	**1594**

Sampling was not conducted in the spring of 1993, because high flows in Eltapom Creek and the SFTR restricted access.

Steelhead Life-history Patterns

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

RECOMMENDATIONS

1. Creel surveys in the SFTR basin should continue during the 1993-94 fiscal year to document angler use. Additional information is needed on harvest levels, especially during low-flow conditions.

2. Adult steelhead spawning surveys should begin by mid-February, weather permitting.

3. Steelhead spawning habitat studies, conducted in conjunction with the spawning surveys, should be continued throughout the basin. Habitat types should be quantified during these surveys to document spawning area available to steelhead.

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

5. Juvenile steelhead habitat utilization studies should continue. A direct observation survey by snorkeling, with comparison counts by electrofishing, should be conducted on various tributaries of the SFTR and Hayfork Creek. Juvenile salmonid densities in relation to habitat, brood year production, and rearing conditions throughout the basin can be assessed through these surveys.

6. Steelhead life-history studies through 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 patterns should be compared to the freshwater portions on adult scales to better understand the total life-history patterns of steelhead within the SFTR basin.

ACKNOWLEDGEMENTS

The authors thank Judith Jackson for her assistance in preparing the tables for this report, and the entire staff of the Natural Stocks Assessment Project working on the South Fork Trinity River for their assistance in field work and data collection.

LITERATURE CITED

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.

Hunter, C. J. 1991. Better trout habitat: A guide to stream restoration and management. Island Press, Washington, D.C. 320 p.

Jong, H. W., and T. J. Mills 1993. Anadromous salmonid escapement studies, South Fork Trinity River, 1984 through 1990. Final Performance Report. Federal Aid in Sport Fish Restoration Act. California. Project No. F-51-R, Subproject No. IX, Study No. 9, Job No. 1. 130 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., P.O. Box 944209, Sacramento, CA 95814.

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. pp. 34-51. In: R. Carpenter 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., P.O. Box 944209, Sacramento, CA 95814.

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.

_____________ 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. pp. 50-92. In: K. Urquhart 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., P.O. Box 944209, Sacramento, CA 95814.

___________. 1994. Life history, distribution, run size, and angler harvest of steelhead in the South Fork Trinity River basin. Chapter III. Job III. pp. 56-102. In: K. Urquhart and R. M. Kano (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1991-1992 Season. February 1994. 235 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., P.O. Box 944209, 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. pp. 44-81. 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. of Fish and Game, Inland Fish. Div., 1416 9th St., P.O. Box 944209, Sacramento, CA 95814.

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

	Calendar dates			Calendar dates	
Julian week	Start	Finish	Julian week	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. Length of time between capture for salmonids tagged and released at Willow Creek Weir in the Trinity River, and their recapture at Sandy Bar Weir in the South Fork Trinity River during the 1992-93 season.

Tag number	Date tagged/released at Willow Creek Weir	Date recaptured at Sandy Bar Weir	Elapsed time between captures (days)
Steelhead			
W5078	09/11/92	10/06/92	25
W5114	09/28/92	10/30/92	32
W5135	10/05/92	10/30/92	25
R6101	10/05/92	10/31/92	26
R6105	10/05/92	10/30/92	25
R6148	10/07/92	10/23/92	16
R6146	10/07/92	10/31/92	24
R6158	10/08/92	10/13/92	5
W5303	10/16/92	10/30/92	14
R6358	10/22/92	10/24/92	2
R6385	10/23/92	10/30/92	7
R6368	10/23/92	10/30/92	7
W5500	10/29/92	10/30/92	1
R6435	10/30/92	11/01/92	2
		Mean:	15.1
Chinook salmon			
R6008	09/03/92	10/18/92	45
R6108	10/05/92	11/03/92	29
W5148	10/06/92	11/01/92	26
R6162	10/08/92	10/10/92	2
W5386	10/21/92	10/30/92	9
W5360	10/21/92	11/05/92	15
W5486	10/28/92	11/19/92	22
R6419	10/29/92	11/16/92	18
W5571	11/27/92	12/03/92	6
		Mean:	19.1
Coho salmon			
W5467	10/26/92	12/04/92	39
W5506	10/30/92	12/01/92	32
W5570	11/27/92	12/02/92	5
		Mean:	25.3

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992-1993 SEASON

CHAPTER IV

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

by

Mark Zuspan, Wade Sinnen, and Ed Miller

ABSTRACT

The California Department of Fish and Game's Trinity River Project conducted tagging and recapture operations from May 1992 through March 1993 to obtain chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), and fall-run steelhead (O. mykiss) run-size, angler 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 689 spring-run and 1,124 fall-run chinook salmon, 500 coho salmon, and 219 fall-run steelhead.

Based on tagged fish recovered at Trinity River Hatchery and on the return of reward tags by anglers, we estimated 4,030 spring-run chinook salmon migrated into the Trinity River basin upstream of Junction City Weir and that 298 (7.4%) were caught by anglers, leaving 3,732 fish as potential spawners. We estimated 14,164 fall-run chinook salmon migrated past Willow Creek Weir and that 9,584 of these fish continued up the Trinity River past Junction City Weir. Anglers harvested an estimated 472 (3.3%) of the fall-run chinook salmon that passed Willow Creek Weir, leaving 13,692 fish as potential spawners.

The coho salmon run in the Trinity River basin upstream of Willow Creek Weir was 10,339 fish, of which 5,683 continued their migration past Junction City Weir. Anglers harvested an estimated 24 (0.2%) of the coho salmon that migrated past Willow Creek Weir, leaving 10,315 fish as potential spawners.

An estimated 3,046 adult fall-run steelhead entered the Trinity River basin upstream of Willow Creek. Anglers harvested 292 (9.6%) of the adult fall-run steelhead that migrated past Willow Creek Weir, leaving 2,754 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 (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 in 1990. Results of these studies are available from California Department of Fish and Game (Heubach 1984a, 1984b; Heubach and Hubbell 1980; Heubach et al. 1992a, 1992b; Lau et al. 1994; Zuspan et al. 1985)

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

---

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

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

some of its tributaries (Gibbs 1956; La Faunce 1965a, 1965b, 1967; Miller 1975; Moffett and Smith 1950; Rogers 1970, 1972, 1973a, 1973b, 1982; Smith 1975; Weber 1965). These earlier efforts did not include fish which used the mainstem and tributaries of the lower Trinity River, nor attempt to determine the proportion of hatchery fish in the runs and the rates at which various runs contributed 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 1992 at the same temporary weir sites near the towns of Willow Creek and Junction City in the mainstem Trinity River that were used since 1989[3/]. The downstream site, Willow Creek Weir (WCW), was located 8.4 km upstream from the town of Willow Creek, 48.4 km upstream from the Trinity River's confluence with the Klamath River, and 131.4 km downstream from Trinity River Hatchery (TRH) (Figure 1). The upstream site, Junction City Weir (JCW), was located 9.8 km upstream from the town of Junction City, 137.1 km upstream from the Klamath River confluence, and 42.7 km downstream from TRH (Figure 1).

The WCW is used to obtain Trinity River run-size and angler harvest estimates for fall chinook, coho, and steelhead 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 operated the JCW into December to obtain run-size estimates of fall chinook, coho and steelhead in the upper Trinity River basin.

We trapped at WCW from 20 August through 2 December 1992. We trapped at the JCW from 21 May through 8 December 1992.

At both sites, we attempted to trap four to six nights per week, from 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.

3/ The weir sites used this year were in the same locations as in prior years. The reported river kms are, however, slightly different. Current locations were taken from 7.5-minute United States Geological Survey topographic maps.

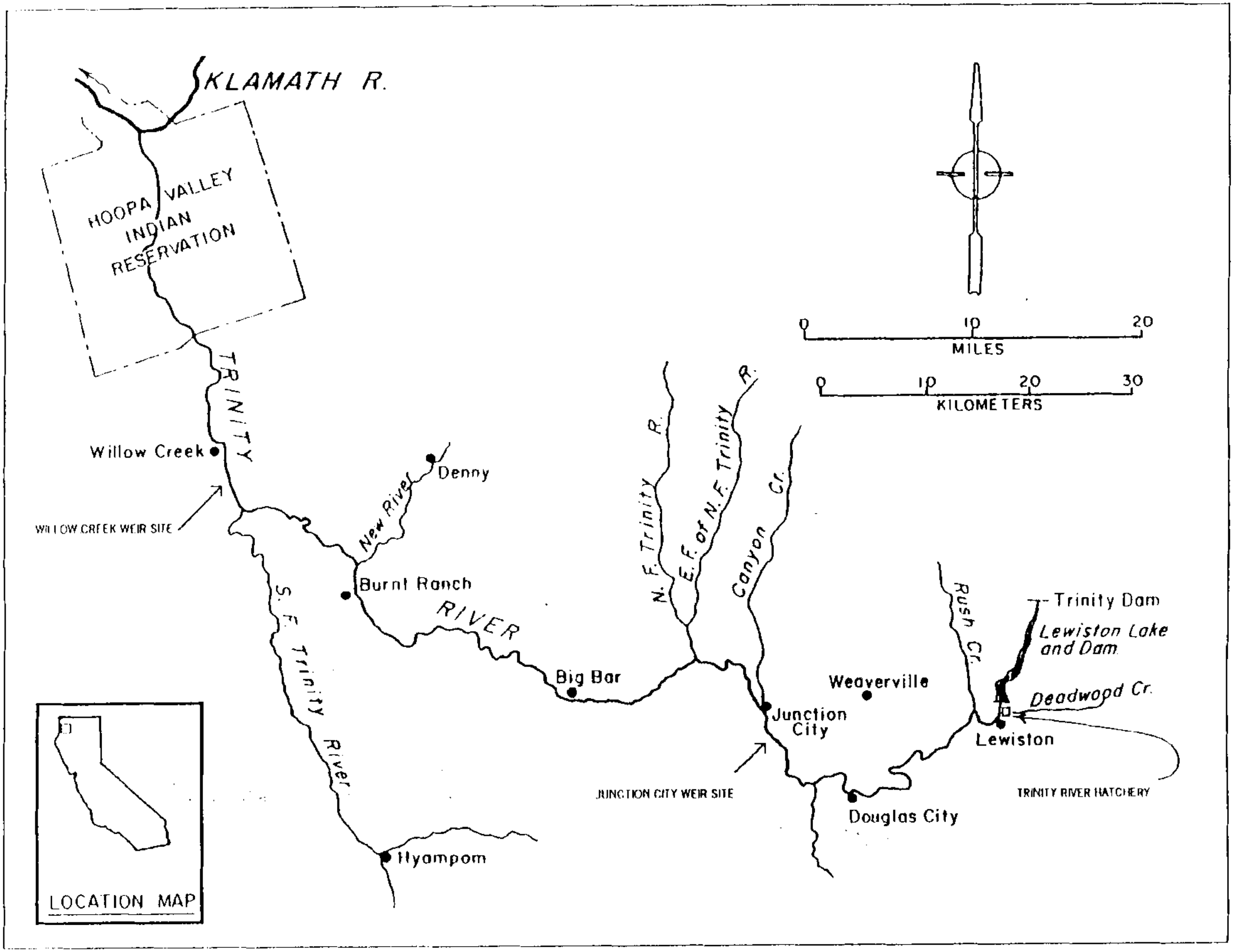


FIGURE 1. Locations of trapping and tagging weirs for anadromous salmonids near Willow Creek and Junction City in the mainstem Trinity River during the 1992-93 season.

Weir and Trap Design

Since 1989, we have used the Bertoni (Alaskan) weir design at both sites (Figure 2). The weir was supported by wooden tripods set 2.5 m apart. Weir panels consisted of 3.0-m X 1.9-cm (10-ft X ¾-in) electrical conduit spaced 5.1 cm apart on center, leaving a gap of 3.2 cm between conduits. Conduits were supported by three pieces of aluminum channel arranged 0.92 m apart, that connected to the supporting tripods.

We anchored the tripods with cable attached to 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 trap was made of 1.9-cm electrical conduit spaced 2.5 cm apart and welded into panels. The panels were wired together at the corners to produce a 2.4-m square box, which was bolted to a plywood floor and covered with plywood to prevent fish from jumping out. A fyke, also made of conduit panels, was installed in the trap. Its purpose was to guide the fish into the trap and prevent their escape.

The trap was placed on the upstream side of the weir. About 12 weir conduits were raised to allow fish to pass through the weir and into the trap.

A gate, inserted between two weir panels, allowed boat passage at both weirs. The gate was made of welded conduit panels with 2.5-cm spacing between conduits.

Processing of Fish

At both weirs, we identified all trapped salmonids to species, measured them to the nearest cm fork length (FL), and examined them for hook and gill-net scars, fin clips, and tags. Each untagged salmonid judged in good condition or unspawned was tagged with a serially numbered FT-4[4/] spaghetti tag (Project-tagged). To determine angler harvest rates upstream of the weirs, a portion of these spaghetti tags bore $10 rewards while the remaining tags were non-reward. The proportion of each species receiving reward tags was inversely related to the number of each species we expected to effectively tag during the season. In no case did we reward-tag less than one-third of the fish tagged.

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

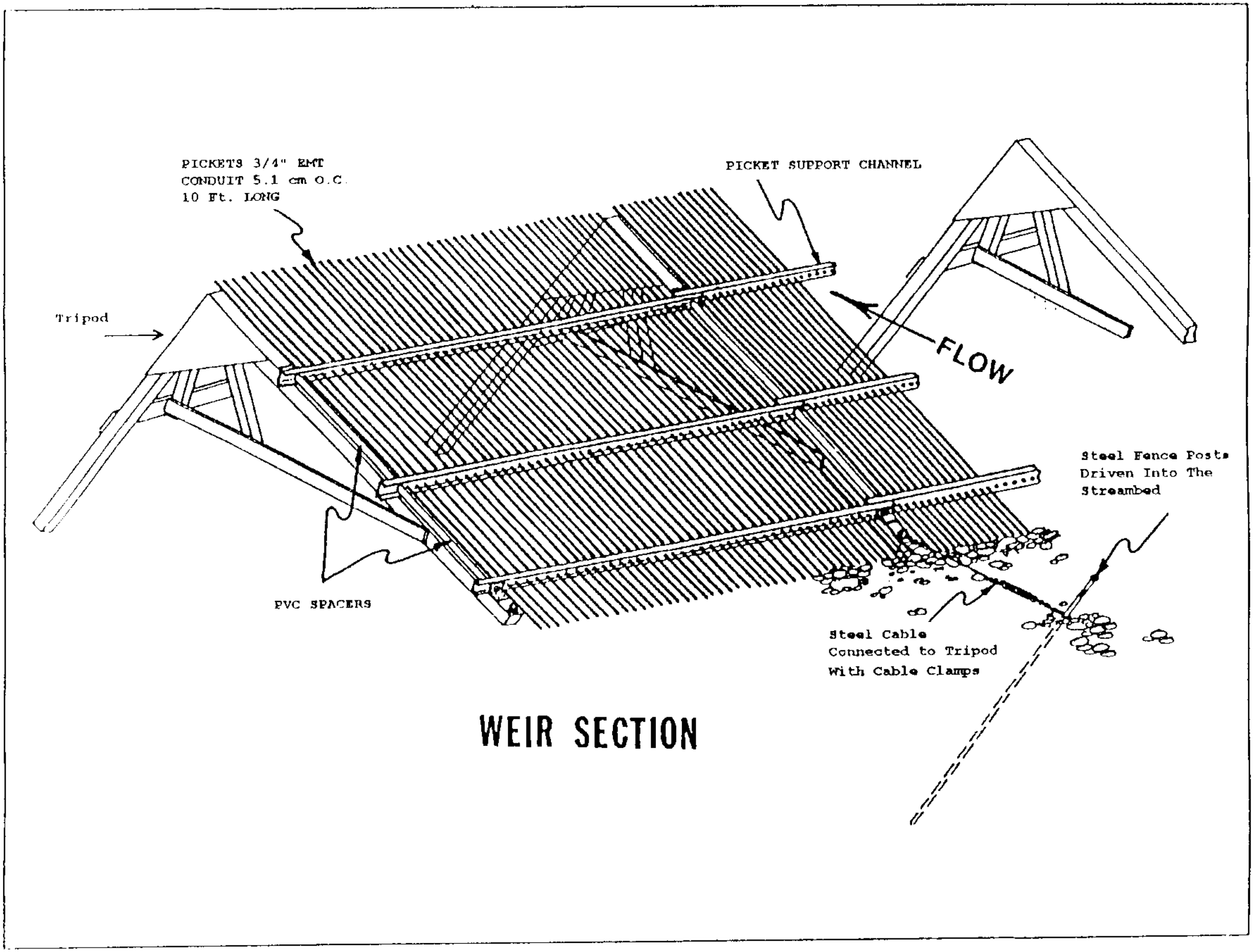


FIGURE 2. Schematic diagram of an Alaskan weir section, showing the arrangement of the tripod and weir paneling, as used in the Trinity River during the 1992-93 season.

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 punctures. Tagged steelhead did not receive a secondary mark at either weir. We released all fish at the respective capture sites immediately after processing.

Determining the Separation Between Spring and Fall Chinook Salmon Runs at the Weirs

Each year there is a temporal overlap in the spring and fall chinook runs in the Trinity River. Since the timing of runs varies between years, each season we assign a new date separating the two runs so that numbers of spring and fall chinook used to estimate the run-size and angler harvest could be determined. To make this separation, we compared the proportions of known spring and fall chinook trapped at each weir each week. The week at which the proportion of fall chinook exceeded spring chinook was designated as the first week of the fall-run at that weir. A recovered chinook was identified as either a spring or fall chinook based on two separate criteria. First, some chinook tagged at the weirs carried coded-wire tags (CWT), placed in their snouts as juveniles at the hatchery. If these fish were recovered at the hatchery or during spawning surveys, the tag's code indicated whether they were spring or fall fish. Secondly, non-CWTed chinook tagged at the weir and recovered at the hatchery were classified as either spring or fall fish based on the date they entered the hatchery. If they entered the hatchery during the period associated with the spring run (based on CWT recoveries at the hatchery) they were considered spring chinook. Those chinook entering the hatchery during the period associated with the fall run (again, based on CWT recoveries) were considered fall chinook.

Estimating Numbers of Spring and Fall 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 without CWTs entering TRH, we expanded the numbers of tags recovered from each returning CWT group by the ratio of tagged to untagged chinook salmon when they were originally released (same strain, brood year [BY], release site and date). For example, 97,569 fall chinook of CWT group 065632 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 CWTed chinook salmon released (968,475 unmarked/97,569 marked = 9.9), we multiplied the total TRH recovery numbers of CWTed chinook salmon of code group 065632 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 CWTed fish and their unmarked counterparts 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 CWT 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 CWT groups on that day.

Size Discrimination Between 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, compared against length data obtained from groups of CWTed fish that entered TRH whose exact age was known. Daily chinook salmon FL data from TRH were assigned to either spring or fall chinook only when the expansion of the number of CWTs indicated ≥90% of the chinook salmon entering TRH were from either spring or fall runs.

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

Size Discrimination Between Adult and Immature Steelhead

All steelhead ≥41 cm FL were considered adults, and steelhead <41 cm FL captured at the weirs were assumed to be half-pounders (assumed to have migrated to the ocean). 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 1992-93 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 (Ad-clipped) (potentially hatchery-marked) fish were removed for the recovery of the CWT. 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 dead by anglers as tagging mortalities, if there was no evidence they had spawned and they were recovered dead $\leq$30 days after tagging. Tagged fish recovered dead more than 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 used the information from Project-tags returned by anglers to assess sport harvest. All the tags placed on fish at the weirs were inscribed with our address so anglers could return the tags to us. If, when returned, the angler failed to indicate the date and location of their catch, we requested the information in a follow-up thank-you letter. The letter also 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 15 September through 17 December 1992. These recoveries are not reported in this Chapter, but are contained in Chapter I.

Trinity River Hatchery

The TRH fish ladder was open from 1 September 1992 through 28 March 1993. 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. Increased sorting frequency was an attempt to reduce predation by river otters (Lutra canadensis) on 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 FL initially recorded for them at the weir when they were tagged.

We removed Project-tags from unmarked (non-Ad-clipped) salmon on the initial sorting day, while Project-tags were removed from hatchery-marked (Ad-clipped) salmon the day they were spawned. On each sorting day, we gave a distinguishing fin-clip to hatchery-marked salmon before they were placed in ponds to ripen. Thus the day they initially entered the hatchery (i.e., were sorted) could be later determined when they were 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 each of these secondary-marked salmon with a shed tag, the 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 were sorted but the tags were not removed.

On the day they were spawned, we removed the heads of all Ad-clipped salmon and placed each in a plastic 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 CWT recovery and decoding. The Ocean Salmon Project provided us with a computer file of the CWTs recovered for editing and analysis.

Statistical Analyses

Effectively Tagged Fish

We estimated the number of effectively tagged fish by subtracting, from the total tagged, those fish we classified as tagging mortalities, tagged-fish recovered downstream of the tagging site, and angler-caught-and-released fish.

Run-size Estimates

We determined the run-size estimates in 1992-93 by using Chapman's version[5] of the Petersen Single Census Method:

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

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

We attempted to tag and recover enough fish to obtain 95% confidence limits within ±10% of the run-size estimate. We used

---

5/ 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).

criteria established by Chapman (1948) to select the type of confidence interval estimator.

We examined 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 were stratified by grilse and adult salmon when: 1) the proportions of grilse and adult salmon in each of the above samples were significantly different statistically; and 2) there were sufficient grilse and adult salmon recovered in the Project-tagged sample at TRH to obtain 95% confidence limits of $\pm$10% of each of the stratified portions of the run-size estimate.

If we were not able to stratify the salmon run-size estimate by grilse and adults, we used the proportions of grilse and adult salmon trapped at each weir to estimate the numbers of grilse and adults comprising the run upstream of that respective weir.

All steelhead run-size estimates were for adults only. This year, we made independent estimates of naturally and hatchery-produced steelhead. Commencing with the 1989 BY, all TRH-produced steelhead have been fin-clipped. This allowed us to distinguish naturally produced (non-fin-clipped) from hatchery-produced (fin-clipped) steelhead at the weirs. We used the proportions of non-fin-clipped and fin-clipped steelhead observed at each weir to estimate the numbers of naturally and hatchery-produced steelhead in the run upstream of that respective weir.

For the run-size estimates, we assumed that: 1) fish trapped and released at a weir were a random sample representative of the population; 2) tagged and untagged fish were equally vulnerable to recapture at 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.

Angler Harvest Rates and Harvest Estimates

Generally, anglers returned reward tags at higher rates than non-reward tags. When this was the case, we used only reward tag returns to determine harvest rates. When non-reward tags were returned at higher rates than reward tags, we combined the two to determine harvest rates.

We computed the harvest rate for each species (and race of chinook) by dividing the respective number of angler-returned tags by the number of fish we effectively tagged.

We made independent harvest rate estimates for grilse and adult salmon.

The assumptions for the numbers of effectively reward- and non-reward-tagged fish released were the same as those for determining the run-size estimate (See "Run-size Estimates", above).

We estimated the numbers of fish harvested upstream of each weir by multiplying the harvest rate (for each species and race) by the respective run-size upstream of each weir.

Other Analyses

The mean FLs of samples were compared statistically using a Student's t-test with the assumption of unequal variances (Dixon and Massey 1969). We did not conduct comparisons 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.

RESULTS AND DISCUSSION

Trapping and Tagging

Chinook Salmon

Spring-Fall Chinook Separation. Analysis of known-race WCW-tagged chinook showed that beginning JW 36 (3-9 Sept) and continuing thereafter, the proportion of fall chinook exceeded that of spring chinook. Therefore, for the purposes of this report, the 33 chinook trapped prior to JW 36 were considered spring-run while the 386 chinook trapped that week and after were considered fall chinook (Figure 3, Table 1).

Spring chinook were the predominant race at JCW through JW 37 (10-16 Sept) after which fall chinook became predominant. The 656 chinook trapped through JW 37 were considered spring chinook

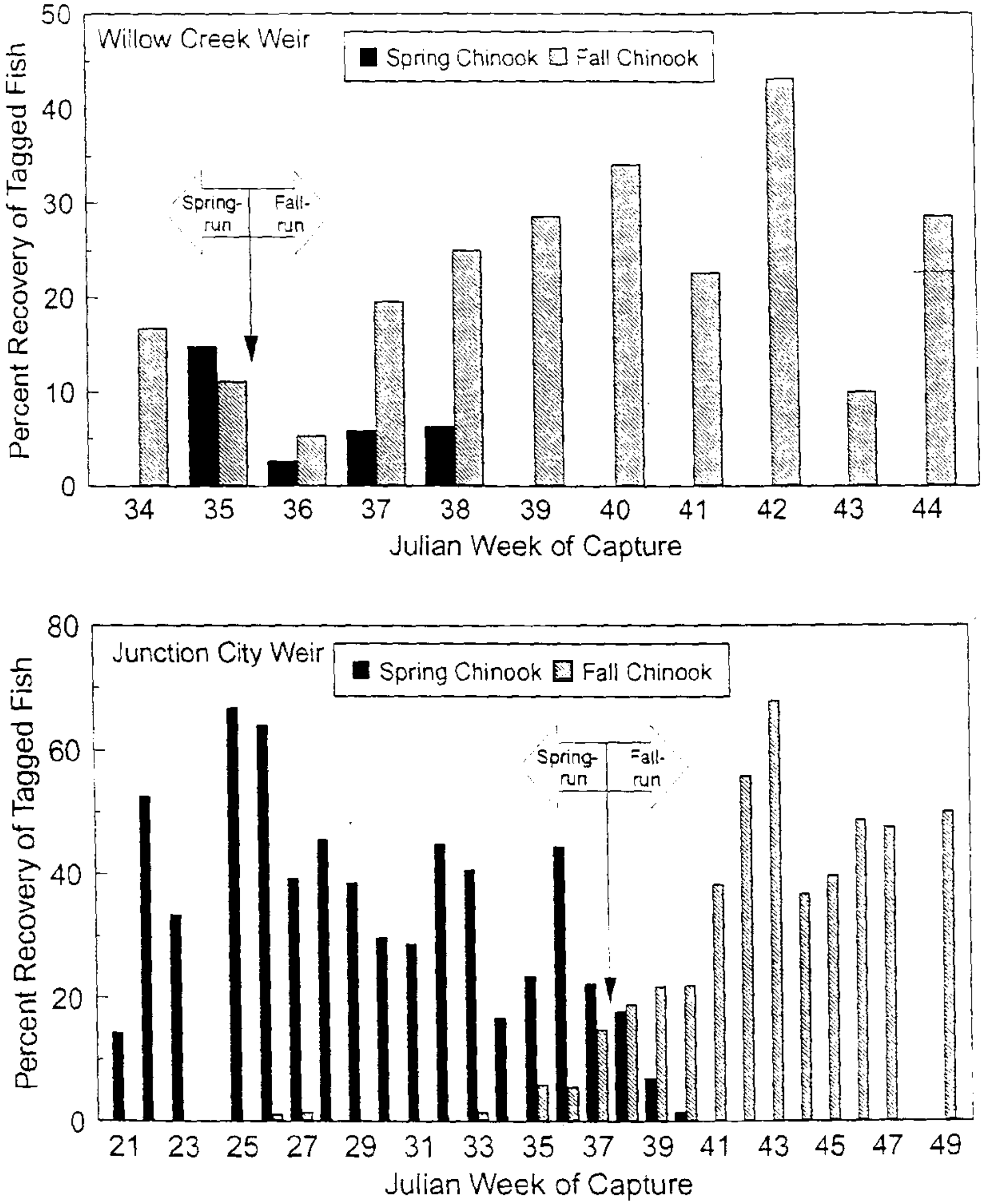


FIGURE 3. Weekly proportions of spring and fall chinook salmon at the weirs during the 1992-93 season. The arrow denotes separation of the runs for analysis. Percentages were calculated using recoveries of known spring- or fall-run tagged fish .

TABLE 1. Weekly summary of spring and fall chinook trapped in the Trinity River at Willow Creek Weir during the 1992-93 season.

Julian week	Inclusive dates	Nights trapped	Number trapped: Grilse a/	Adults	Total	Average catch (fish/night)
Spring-Run Chinook b/						
34	08/20 - 08/26	4	1	5	6	1.5
35	08/27 - 09/02	4	5	22	27	6.8
	Sub-total:	8	6	27	33	
	Sub-mean:					4.1
Fall-Run Chinook b/						
36	09/03 - 09/09	4	17	21	38	9.5
37	09/10 - 09/16	4	15	36	51	12.8
38	09/17 - 09/23	5	2	14	16	3.2
39	09/24 - 09/30	5	7	21	28	5.6
40	10/01 - 10/07	5	13	75	88	17.6
41	10/08 - 10/14	5	12	50	62	12.4
42	10/15 - 10/21	5	4	40	44	8.8
43	10/22 - 10/28	5	2	18	20	4.0
44	10/29 - 11/04	2	2	12	14	7.0
45	11/05 - 11/11	5	3	3	6	1.2
46	11/12 - 11/18	5	2	12	14	2.8
47	11/19 - 11/25	4	0	3	3	0.8
48	11/26 - 12/02	5	1	1	2	0.4
	Sub-total:	59	80	306	386	
	Sub-mean:					6.5
	Grand Total:	67	86	333	419	
	Combined Mean:					6.3

a/ Spring-run chinook grilse were ≤ 56 cm FL; fall-run chinook grilse were ≤ 49 cm FL.

b/ There was actually a temporal overlap of spring- and fall-run chinook during Julian weeks 34 through 38. For the purpose of analysis all chinook caught through Julian week 35 were considered spring-run chinook; those caught after were considered fall-run chinook.

while the 738 chinook trapped after JW 37 were considered fall chinook for the purposes of this report (Figure 3, Table 2).

Run Timing. The spring chinook run at WCW was limited to the first two weeks of trapping. Fall chinook catch at WCW peaked (17.6 fish/night) during JW 40 (1-7 Oct) and decreased gradually over the next eight weeks to 0.4 fish/night (Figure 4, Table 1).

At JCW, spring chinook catch peaked (26.3 fish/night) during JW 26 (25 Jun-1 July), decreased and peaked again (18.5 fish/night) during JW 33 (13-19 Aug). Fall chinook catch peaked at 33.0 fish/night during JW 40 (1-7 Oct) and decreased thereafter (Figure 4, Table 2).

Sizes of Trapped Fish. The average sizes of the spring chinook trapped at WCW and JCW, and that entered TRH were similar. Based on the analysis of combined FL distribution for the three sites, the size separating grilse and adult spring chinook was 56 cm FL (Figure 5). Limited information from known-age, CWTed spring chinook that entered TRH supported the 56 cm FL separation of adults and grilse (Appendix 2). Therefore, this season, we considered spring chinook in the Trinity River basin ≤56 cm FL to be grilse, while adults are >56 cm FL.

Grilse comprised 18.2%, 41.5%, and 28.9% of the spring chinook observed at WCW, JCW, and TRH, respectively.

The fall chinook FL distributions for either weir were not similar in showing the size separation between grilse and adults, but for the TRH and the combined FL distributions, 49 cm FL was the nadir (Figure 6). Size data of known-age, CWTed fall chinook entering TRH also supported the size separation (Appendix 3). Therefore, this season, we considered fall chinook in the Trinity River basin ≤49 cm FL to be grilse, while adults were >49 cm FL.

Fall chinook grilse comprised 20.7%, 26.4%, and 5.3% of the runs observed at WCW, JCW, and TRH, respectively.

Effectively Tagged Fish. We trapped 656 spring chinook at JCW, of which 610 (233 grilse and 377 adults) were effectively tagged (Appendix 4). The number effectively tagged accounted for tagging mortalities (15), poor-condition untagged fish (27), fish that died prior to tagging (3), and fish from which an angler reported removing the tag (1). The effectively tagged number included 446 (73.1%) reward-tagged fish (173 grilse and 273 adults).

We trapped 386 fall chinook at WCW, one of which was dead in the trap, 21 which were released untagged, and three fish from which anglers had removed the tags. We effectively tagged 361 fall chinook (74 grilse and 287 adults) at WCW during the 1992-93 season (Appendix 5). We placed reward tags on 172 fish (31

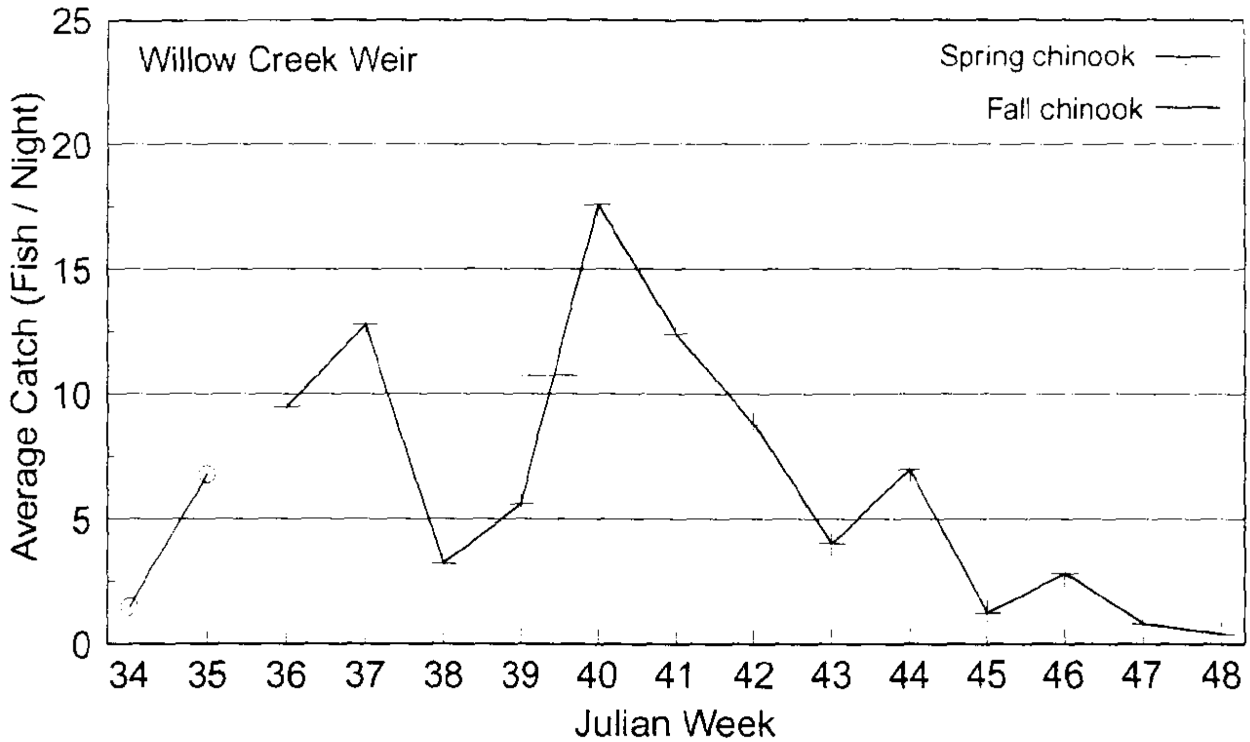
TABLE 2. Weekly summary of spring and fall chinook trapped in the Trinity River at Junction City Weir during the 1992-93 season.

Julian week	Inclusive dates	Nights trapped	Number trapped: Grilse a/	Adults	Total	Average catch (fish/night)
Spring-Run Chinook b/						
21	05/21 - 05/27	5	0	14	14	2.8
22	05/28 - 06/03	6	1	20	21	3.5
23	06/04 - 06/10	2 c/	0	6	6	3.0
24	06/11 - 06/17	0 c/	-	-	-	-
25	06/18 - 06/24	1 c/	1	17	18	18.0
26	06/25 - 07/01	4	2	103	105	26.3
27	07/02 - 07/08	4	11	63	74	18.5
28	07/09 - 07/15	4	27	52	79	19.8
29	07/16 - 07/22	4	7	6	13	3.3
30	07/23 - 07/29	4	21	6	27	6.8
31	07/30 - 08/05	4	35	7	42	10.5
32	08/06 - 08/12	4	15	14	29	7.3
33	08/13 - 08/19	4	41	33	74	18.5
34	08/20 - 08/26	4	5	7	12	3.0
35	08/27 - 09/02	4	28	6	34	8.5
36	09/03 - 09/09	4	41	13	54	13.5
37	09/10 - 09/16	4	37	17	54	13.5
	Sub-total:	62	272	384	656	
	Sub-mean:					10.6
Fall-Run Chinook b/						
38	09/17 - 09/23	4	37	42	79	19.8
39	09/24 - 09/30	4	47	54	101	25.3
40	10/01 - 10/07	4	50	82	132	33.0
41	10/08 - 10/14	3	19	75	94	31.3
42	10/15 - 10/21	2	11	32	43	21.5
43	10/22 - 10/28	3	5	48	53	17.7
44	10/29 - 11/04	2	5	14	19	9.5
45	11/05 - 11/11	6	15	112	127	21.2
46	11/12 - 11/18	4	2	39	41	10.3
47	11/19 - 11/25	4	3	37	40	10.0
48	11/26 - 12/02	2	0	3	3	1.5
49	12/03 - 12/09	3	1	5	6	2.0
	Sub-total:	41	195	543	738	
	Sub-mean:					18.0
	Grand Total:	103	467	927	1,394	
	Combined Mean:					13.5

a/ Spring-run chinook grilse were ≤ 56 cm FL; fall-run chinook grilse were ≤ 49 cm FL.

b/ There was actually a temporal overlap of spring- and fall-run chinook during Julian weeks 33 through 40. For the purpose of analysis all chinook caught through Julian week 37 were considered spring-run chinook; those caught after were considered fall-run chinook.

c/ Weir was not fished from 6/8 through 6/21/92 due to high river flows.



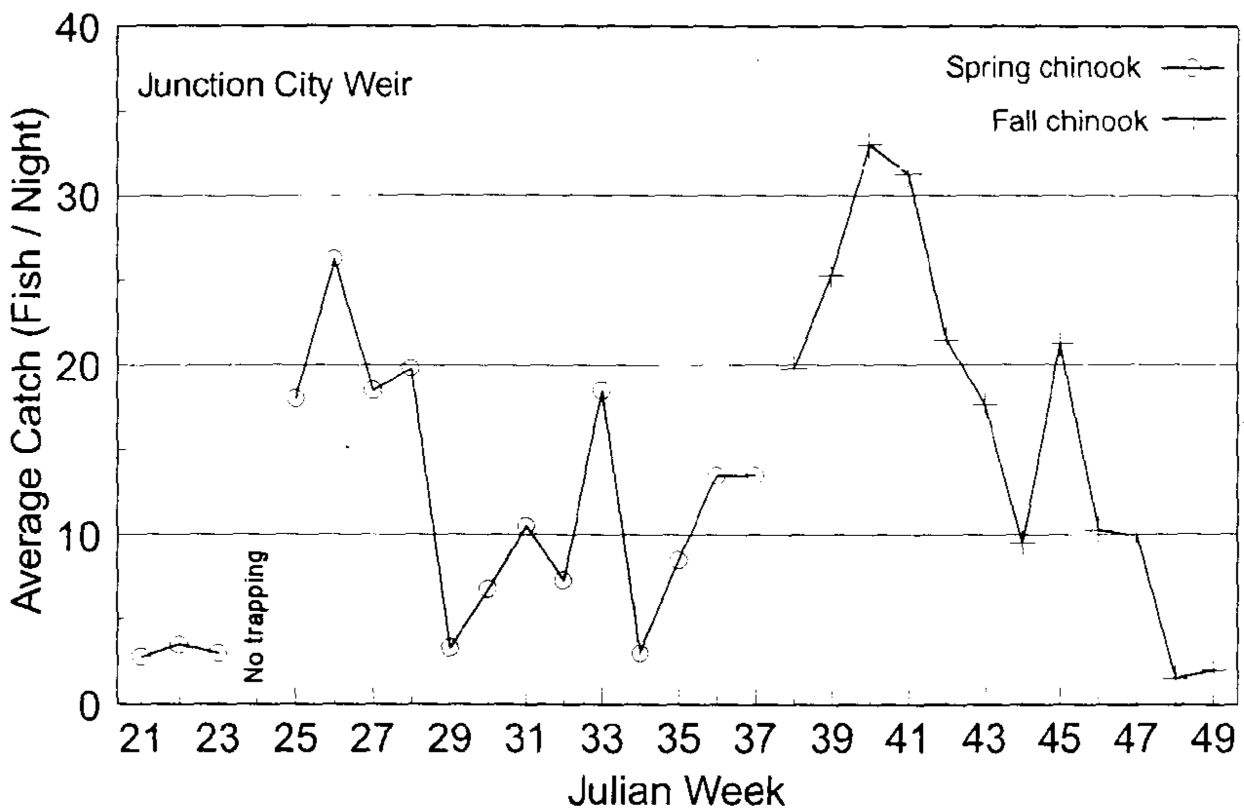


FIGURE 4. Average catch of spring- and fall-run chinook salmon each Julian week in the Trinity River at Willow Creek and Junction City weirs during the 1992-93 season.

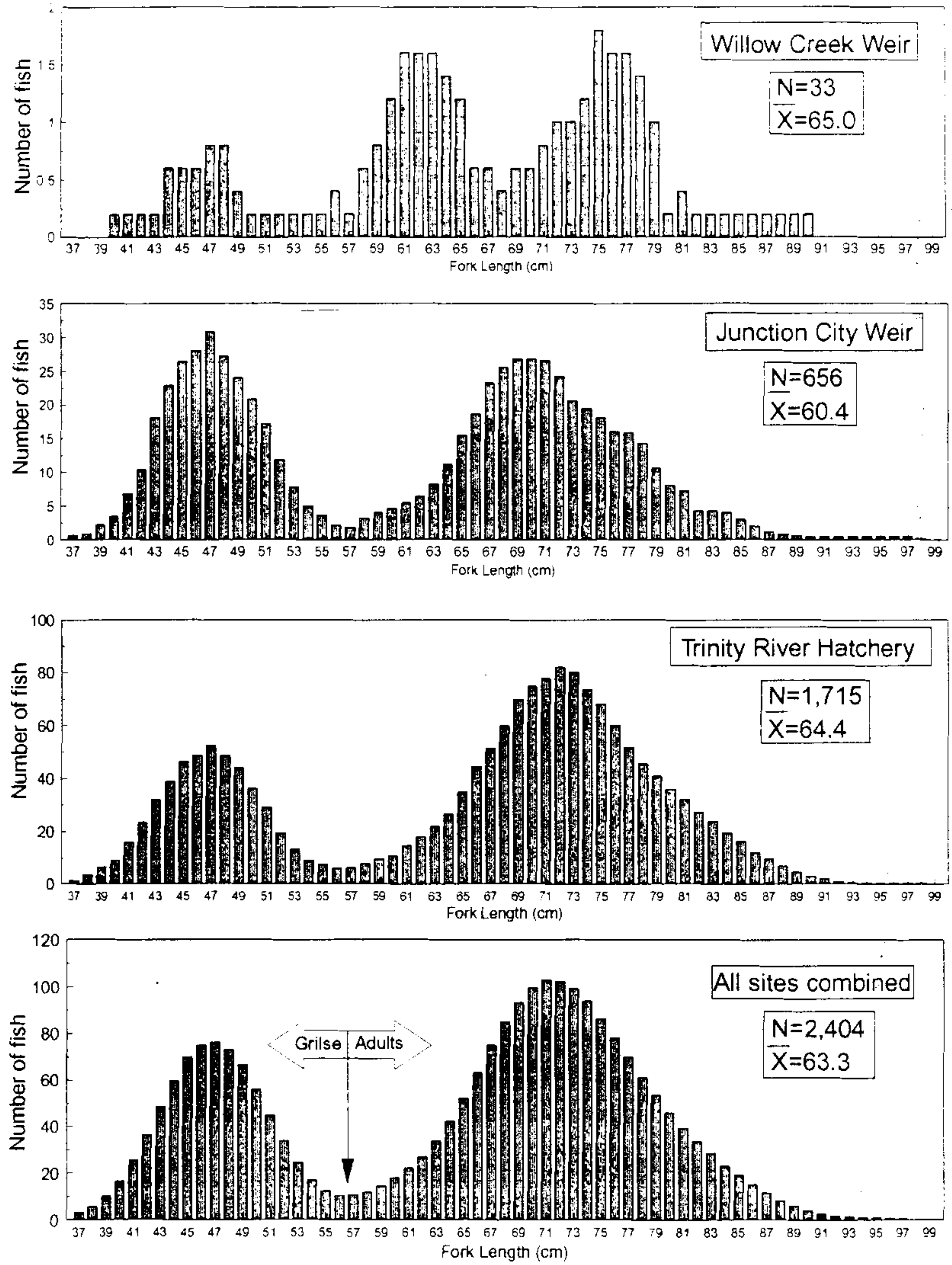


FIGURE 5. Analysis of spring-run chinook salmon lengths observed at the Trinity River weirs and Trinity River Hatchery during the 1992-93 season. The number of fish at each fork length is shown as a moving average of five, 1-cm increments.

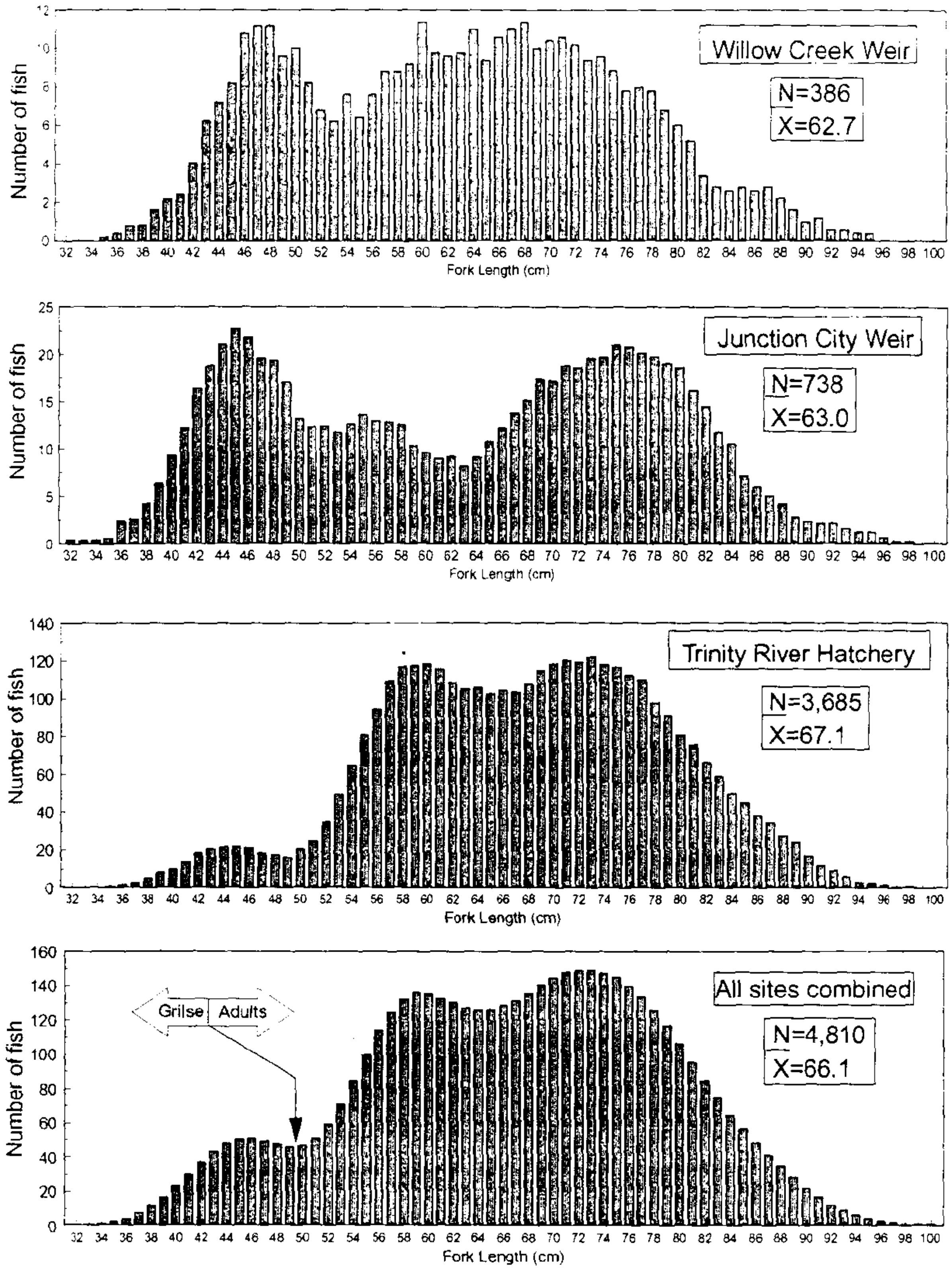


FIGURE 6. Analysis of fall-run chinook salmon lengths observed at the Trinity River weirs and Trinity River Hatchery during the 1992-93 season. The number of fish at each fork length is shown as a moving average of five, 1-cm increments.

grilse and 141 adults), or 47.6%, of the effectively tagged fall chinook at WCW.

We trapped 738 fall chinook at JCW, of which 669 (160 grilse and 509 adults) were effectively tagged (Appendix 5). The fish not effectively tagged included one dead in the trap, 67 released untagged, and one which had its tag removed by an angler.

Reward tags were placed on 249 (86 grilse and 163 adults), or 37.2%, of the effectively tagged fall chinook at JCW.

Incidence of Tags and Fin Clips. Nine of the 31 (29%) spring chinook salmon effectively tagged at WCW were recaptured at JCW. Length of time for migration between the weirs for these fish ranged from 11 to 51 d, averaging 24 d.

Ad-clipped fish comprised 6.1% (2/33) of the spring chinook seen at WCW and 6.9% (45/656) of those seen at JCW (Appendix 4). One of the two Ad-clipped spring chinook Project-tagged at WCW was recovered at TRH. Its CWT indicated it was actually a 1987 brood year fall chinook (Table 3).

Twenty-five (55.6%) of the 45 Ad-clipped spring chinook tagged at JCW were recovered at TRH. Of these, 19 were spring chinook from TRH, one was a naturally produced chinook and five had shed their CWTs (Table 3).

Twenty-one (5.8%) of the 361 fall chinook effectively tagged at WCW were recovered at JCW. Length of time to travel between the weirs for these fish ranged from 13 to 32 d, averaging 22 d.

Ad-clipped fish comprised 3.9% (15/386) of the fall chinook seen at WCW and 5.7% (42/738) of those seen at JCW (Appendix 5). Four of the 15 (26.7%) Ad-clipped fall chinook tagged at WCW were recovered at TRH, all of which were originally marked as juveniles at TRH (Table 3).

Thirteen (30.9%) of the 42 Ad-clipped fall chinook which were tagged at JCW were recovered at TRH. From these, 11 CWTs were extracted, all of which originated from TRH (Table 3).

Incidence of Gill-net and Hook Scars. At both weirs, 8.4% of the spring chinook trapped were gill-net scarred. As noted last year (Lau et al. 1994), gill-net-scarred spring chinook were on average larger than non-gill-net-scarred fish. At JCW the difference in size was statistically significant ($t=4.82$, $d.f.=86$, $P<.01$) while at WCW, it was not ($t=1.43$, $d.f.=17$, $P>.05$).

For fall chinook, 7.8% and 4.6% of the fish trapped at WCW and JCW, respectively, were gill-net-scarred. As with spring chinook, gill-net-scarred fish were larger, on average, than non-

TABLE 3. Release data and recoveries for coded-wire tagged salmon that were trapped in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1992-93 season.

Release data							Numbers recovered from tagging site: b/	
CWT a/ number	Species	Race	Brood year	Date	Number of fish	Site c/	WCW	JCW
066149	chinook	spring	1988	05/26/89	181,698	TRH		1
B61306 d/	chinook	spring	1988	03/29/98	15,703	TR		1
066148	chinook	spring	1988	10/24/89	98,820	TRH		2
065639	chinook	spring	1989	10/01/90	102,255	TRH	4	3
0601040103	chinook	spring	1990	05/28/91	196,908	TRH		13
shed tag e/	chinook						1	5
Total spring-run chinook:							5	25
065631	chinook	fall	1987	10/02/88	92,300	AP	1	
065632	chinook	fall	1988	10/27/89	97,569	TRH		7
0601040101	chinook	fall	1989	05/18/90	201,622	TRH		2
065637	chinook	fall	1989	10/16/90	23,625	TRH	1	
065634	chinook	fall	1989	10/15/90	97,810	TRH	1	1
065641	chinook	fall	1989	10/16/90	22,540	TRH	1	1
shed tag e/	chinook							2
Total fall-run chinook:							4	13
065660	coho		1989	03/18/91	51,088	TRH	11	3
065657	coho		1990	04/03/92	52,233	TRH	4	
shed tag	coho						1	1
Total coho:							16	4

a/ CWT=coded-wire tag.

b/ Tagging site: WCW=Willow Creek Weir; JCW=Junction City Weir.

c/ Release site: TRH=Trinity River Hatchery; TR=mainstem Trinity River between Lewiston Dam and the North Fork Trinity River, AP=Ambrose Ponds.

d/ The fish with this CWT was a naturally-produced chinook of unknown race. It was considered a spring-run fish because it was trapped during the time associated with the spring-run.

e/ Fish with shed CWTs were designated as spring- or fall-race based on the date they were trapped at the weirs.

gill-net-scarred fish. At both weirs, the differences were statistically significant (JCW: $t=3.61$, $d.f.=47$, $P<.01$; WCW: $t=3.52$, $d.f.=54$, $P<.01$).

Seven of the 610 effectively tagged spring chinook at JCW were ocean-hook-scarred. At WCW, none of the 361 effectively tagged fall chinook bore ocean-hook-scars.

Coho Salmon

Run timing. We trapped the first coho at WCW on 24 September 1992 (JW 39). The average weekly catch of coho peaked (35.0 fish/night) within three weeks of the first capture, then steadily decreased to 1.6 fish/night over the next three weeks. Catches remained near this level through the remainder of the trapping season, ending JW 48 (26 Nov - 2 Dec) (Figure 7). We trapped 405 coho salmon at WCW during the 1992-93 season (Table 4).

The first coho entered the JCW trap on 9 October (JW 41), approximately two weeks after they initially appeared at WCW. The coho run at JCW was characterized by three peaks occurring at two week intervals starting JW 43 (22-28 Oct). However, the average weekly catch varied only slightly, ranging from 2.0 to 5.5 fish/night throughout most of the trapping season (Figure 7). We trapped 95 coho at JCW during the 1992-93 season (Table 5).

Size of Fish Trapped. The size ranges and mean FLs of coho trapped at WCW and JCW were similar (Appendix 6). The size separating grilse and adult coho was based on the combined length data from coho trapped at WCW, JCW and that entered TRH. The nadir separating grilse and adults was 50 cm FL for TRH and JCW data, and 48 cm FL for WCW data. The combined (TRH, JCW and WCW) data showed the separation between grilse and adults was 50 cm FL (Figure 8). This year all coho $\leq$50 cm FL were considered grilse, while larger coho were adults.

Grilse coho comprised 23.0%, 27.1%, and 33.8% of the coho trapped at WCW, JCW, and TRH, respectively.

Effectively Tagged Fish. We trapped 405 coho salmon at WCW of which 403 (93 grilse and 310 adults) were effectively tagged. Two coho were not tagged because they were in poor condition. The effectively tagged coho included 202 (50.1%) reward-tagged fish (54 grilse and 148 adults).

A total of 96 coho salmon was trapped at JCW, of which five were released untagged because they were in poor condition. Thus, 91 coho (22 grilse and 69 adults) were effectively tagged (including six that were originally tagged at WCW). Reward-tagged coho composed 47.6% of the effectively tagged fish (10 grilse and 30 adults), not including the fish originally tagged at WCW.

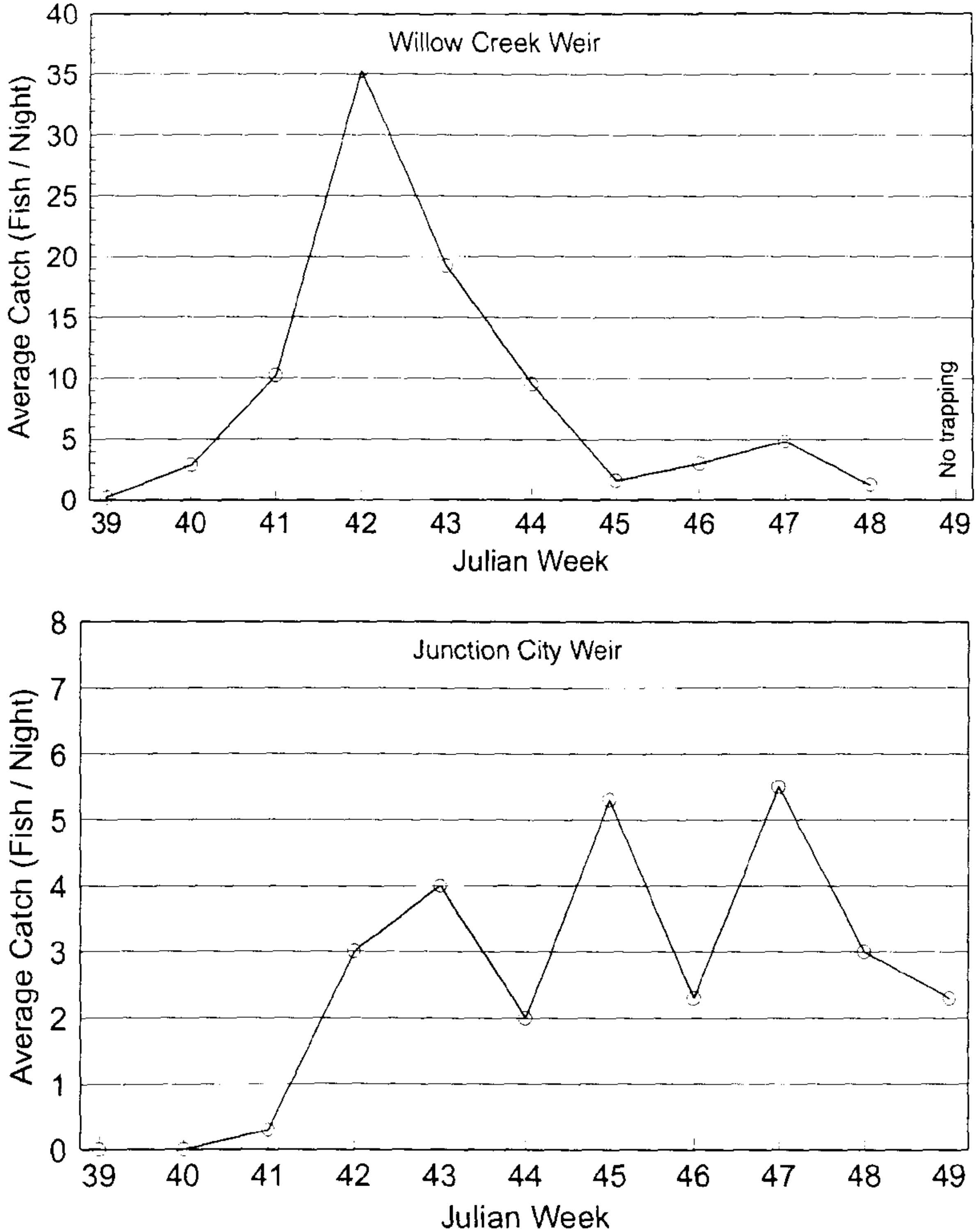


FIGURE 7. Average catch of coho salmon each Julian week in the Trinity River at Willow Creek and Junction City weirs during the 1992-93 season.

TABLE 4. Weekly summary of coho salmon trapped in the Trinity River at Willow Creek Weir during the 1992-93 season. a/

Julian week	Inclusive dates			Nights trapped	Number trapped: Grilse b/	Adults	Total	Average catch (fish/night)
34-38	08/20	-	09/23	21	0	0	0	0.0
39	09/24	-	09/30	5	0	1	1	0.2
40	10/01	-	10/07	5	3	11	14	2.8
41	10/08	-	10/14	5	12	39	51	10.2
42	10/15	-	10/21	5	45	131	176	35.2
43	10/22	-	10/28	5	13	83	96	19.2
44	10/29	-	11/04	2	4	15	19	9.5
45	11/05	-	11/11	5	4	4	8	1.6
46	11/12	-	11/18	5	6	9	15	3.0
47	11/19	-	11/25	4	4	15	19	4.8
48	11/26	-	12/02	5	2	4	6	1.2
	Totals: c/			46	93	312	405	
	Mean: c/							8.8

a/ Trapping at Willow Creek weir took place from Julian week 34 (20 August) through Julian week 48 (2 December) of 1992.

b/ Coho grilse were ≤ 50 cm FL; adults were > 50 cm FL..

c/ Based on trapping data from Julian weeks 39 through 48.

TABLE 5. Weekly summary of coho salmon trapped in the Trinity River at Junction City Weir during the 1992-93 season. a/

Julian week	Inclusive dates			Nights trapped	Number trapped: Grilse b/	Adults	Total	Average catch (fish/night)
21-40	05/21	-	10/07	77 c/	0	0	0	0.0
41	10/08	-	10/14	3	0	1	1	0.3
42	10/15	-	10/21	2	1	5	6	3.0
43	10/22	-	10/28	2	2	6	8	4.0
44	10/29	-	11/04	2	3	1	4	2.0
45	11/05	-	11/11	6	7	25	32	5.3
46	11/12	-	11/18	4	3	6	9	2.3
47	11/19	-	11/25	4	3	19	22	5.5
48	11/26	-	12/02	2	2	4	6	3.0
49	12/03	-	12/09	3	5	2	7	2.3
	Totals: d/			28	26	69	95	
	Mean: d/							3.4

a/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 49 (8 December) of 1992.

b/ Coho grilse were ≤ 50 cm FL; adults were > 50 cm FL..

c/ Weir was not fished from 6/8 through 6/21/92 due to high river flows.

d/ Based on trapping data from Julian weeks 41 through 49.

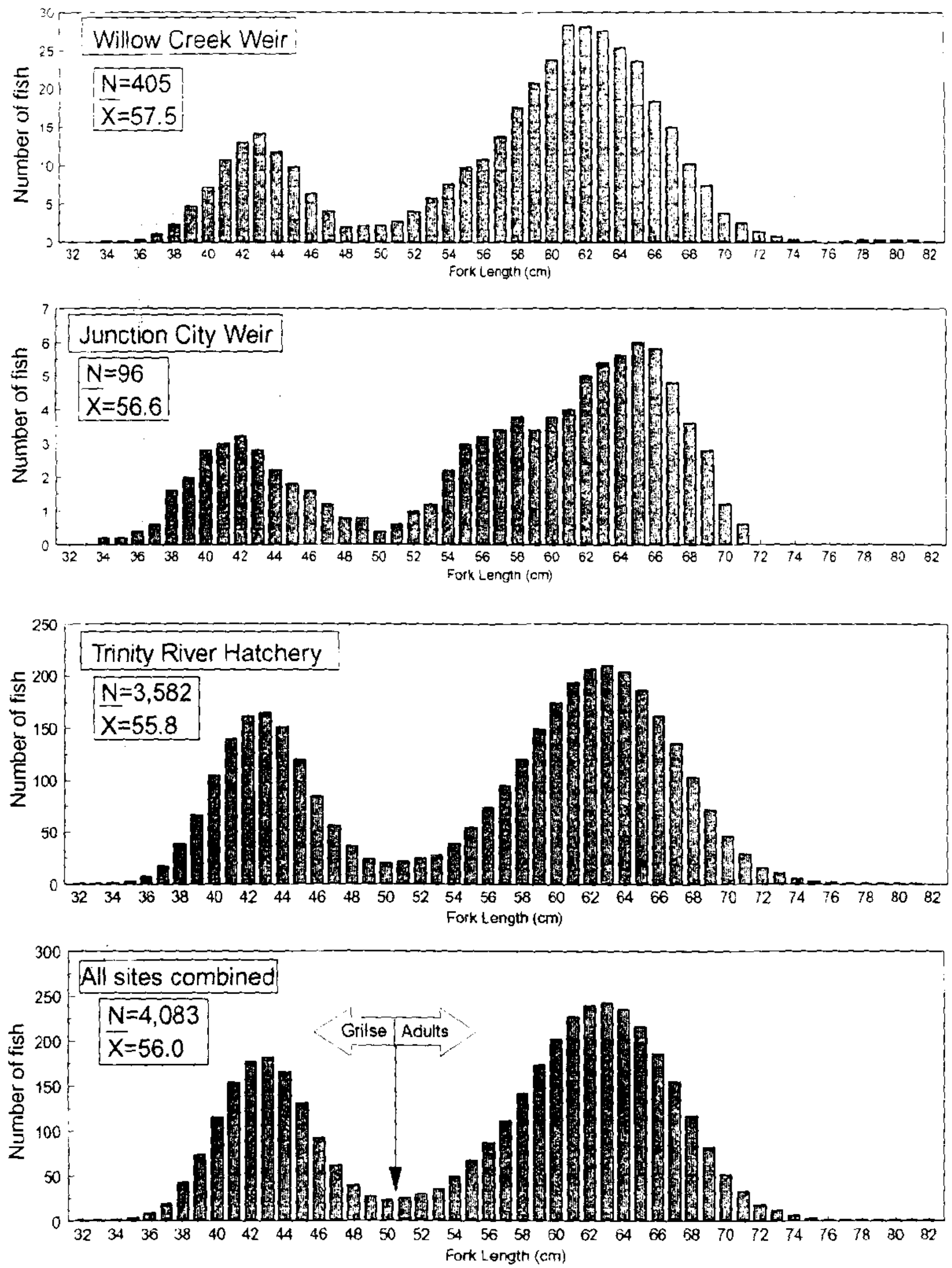


FIGURE 8. Analysis of coho salmon lengths observed at the Trinity River weirs and Trinity River Hatchery during the 1992-93 season. The number of fish at each fork length is shown as a moving average of five, 1-cm increments.

Incidence of Tags and Fin Clips. We recaptured six coho at JCW that had been tagged at WCW. Their mean migration time was 19.5 d, for a mean migration rate of 4.6 km/d. This is a faster rate of migration than was observed during the 1991 season of 3.4 km/d (Lau et al. 1994).

We trapped 37 Ad-clipped coho at WCW (10 grilse and 27 adults), which comprised 9.1% of the total WCW coho catch (Appendix 6). At JCW, 5.2% (5/96) of the coho trapped were Ad-clipped (one grilse and four adults). Sixteen Ad-clipped coho tagged at WCW and four from JCW were recovered at TRH. CWTs were extracted from 18 Ad-clipped coho, all of which were from TRH (Table 3).

Incidence of Gill-net and Hook Scars. We found gill-net scars on 2.2% and 1.1% of the coho trapped at WCW and JCW, respectively. Slightly higher incidences (4.1% and 1.8%, respectively) were observed last year (Lau et al. 1994).

We found 1.7% and 2.1% of the coho trapped at WCW and JCW, respectively, to be hooked-scarred. All of the hook scars appeared to be of freshwater origin.

Fall-run Steelhead

Run Timing. We caught steelhead each week from 20 August through 2 December (JW 34-48) at WCW (Figure 9). Peak average weekly catch (7.0 fish/night) occurred at WCW during JWs 40 (1-7 Oct) and 44 (28 Oct - 4 Nov). The number of steelhead trapped declined through the end of the trapping season. However, the steelhead run did not appear to be over when we removed the weir for the season. We trapped 190 steelhead (176 adults and 14 half-pounders) at WCW during the 1992-93 season (Table 6).

We caught steelhead intermittently at JCW from JW 27 through JW 49 (2 July - 2 December) (Figure 9). The steelhead run peaked JW 47 (19-25 November) at JCW. We trapped 29 steelhead at JCW during the 1992-93 season (Table 7).

Size of Fish Trapped. Steelhead caught at WCW, JCW, and TRH averaged 56.9, 55.3, and 49.7 cm FL, respectively (Figure 10). The average FL was smaller at TRH than the other sites, primarily because of the large number of sub-adults sampled there. Sub-adult steelhead made up 7.4%, 6.9%, and 22.4% of the steelhead trapped at WCW, JCW, and TRH, respectively. It is likely that many of the sub-adults observed at TRH were actually residualized or resident fish.

Effectively Tagged Fish. We trapped 176 adult steelhead at WCW, 10 of which were released untagged. There were no tagging mortalities, for a total of 166 effectively tagged adult steelhead (Appendix 7). Included in the total were 83 reward-tagged fish.

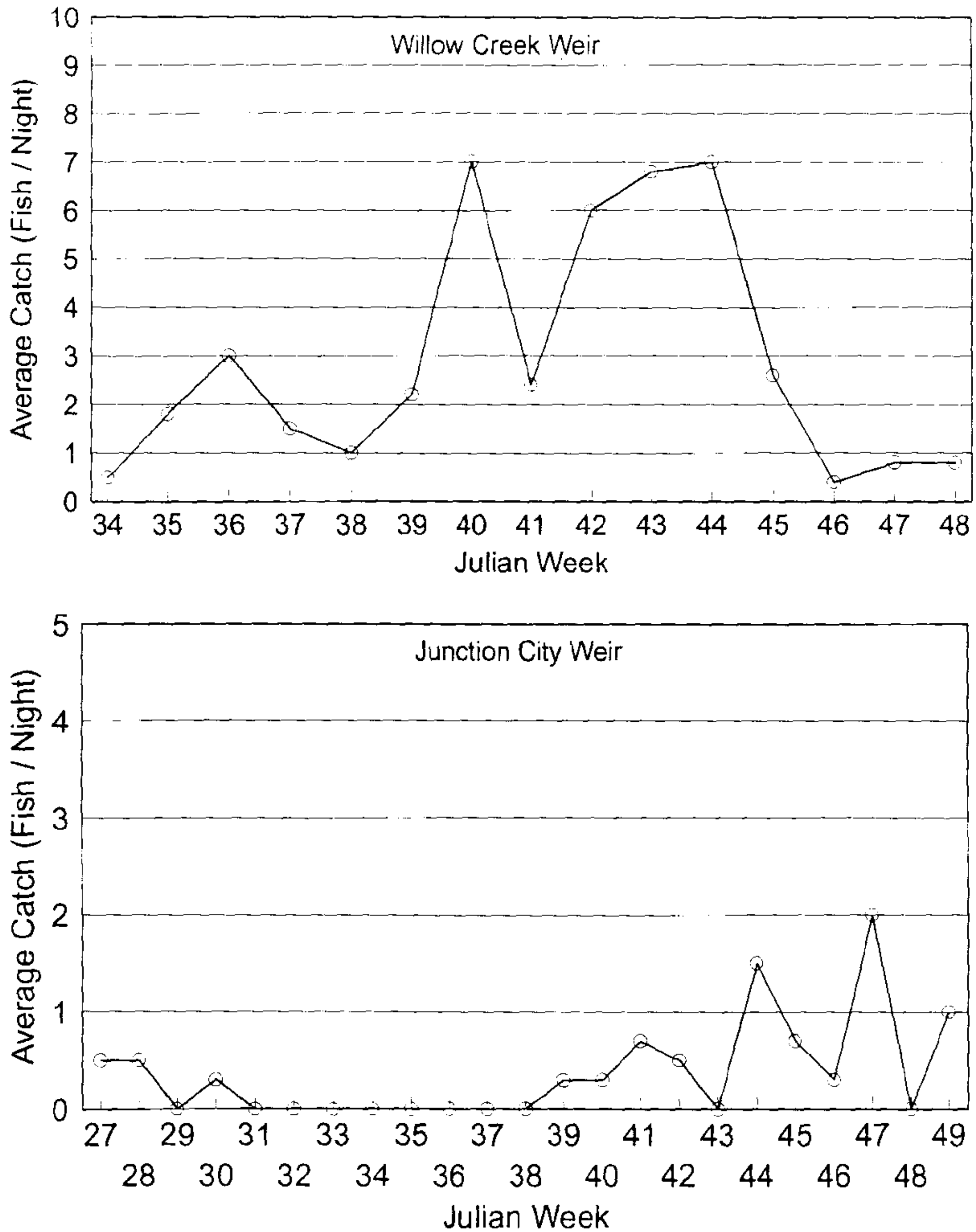


FIGURE 9. Average catch of fall-run steelhead each Julian week in the Trinity River at Willow Creek and Junction City weirs during the 1992-93 season.

TABLE 6. Weekly summary of steelhead trapped in the Trinity River at Willow Creek Weir during the 1992-93 season. a/

Julian week	Inclusive dates	Nights trapped	Number trapped: Half-pounders b/	Adults	Total	Average catch (fish/night)
34	08/20 - 08/26	4	0	2	2	0.5
35	08/27 - 09/02	4	0	7	7	1.8
36	09/03 - 09/09	4	1	11	12	3.0
37	09/10 - 09/16	4	1	5	6	1.5
38	09/17 - 09/23	5	0	5	5	1.0
39	09/24 - 09/30	5	0	11	11	2.2
40	10/01 - 10/07	5	2	33	35	7.0
41	10/08 - 10/14	5	0	12	12	2.4
42	10/15 - 10/21	5	2	28	30	6.0
43	10/22 - 10/28	5	0	34	34	6.8
44	10/29 - 11/04	2	0	14	14	7.0
45	11/05 - 11/11	5	7	6	13	2.6
46	11/12 - 11/18	5	0	2	2	0.4
47	11/19 - 11/25	4	0	3	3	0.8
48	11/26 - 12/02	5	1	3	4	0.8
	Totals:	67	14	176	190	
	Mean:					2.8

a/ Trapping at Willow Creek weir took place from Julian week 34 (20 August) through Julian week 48 (2 December) of 1992.
b/ Half-pounder steelhead were ≤ 41 cm FL; adults were > 41 cm FL.

TABLE 7. Weekly summary of steelhead trapped in the Trinity River at Junction City Weir during the 1992-93 season. a/

Julian week	Inclusive dates	Nights trapped	Number trapped: Half-pounders b/	Adults	Total	Average catch (fish/night)
21-26	05/20 - 07/01	18 c/	0	0	0	0.0
27	07/02 - 07/08	4	0	2	2	0.5
28	07/09 - 07/15	4	0	2	2	0.5
29	07/16 - 07/22	4	0	0	0	0.0
30	07/23 - 07/29	4	0	1	1	0.3
31	07/30 - 08/05	4	0	0	0	0.0
32	08/06 - 08/12	4	0	0	0	0.0
33	08/13 - 08/19	4	0	0	0	0.0
34	08/20 - 08/26	4	0	0	0	0.0
35	08/27 - 09/02	4	0	0	0	0.0
36	09/03 - 09/09	4	0	0	0	0.0
37	09/10 - 09/16	4	0	0	0	0.0
38	09/17 - 09/23	4	0	0	0	0.0
39	09/24 - 09/30	4	0	1	1	0.3
40	10/01 - 10/07	4	0	1	1	0.3
41	10/08 - 10/14	3	0	2	2	0.7
42	10/15 - 10/21	2	0	1	1	0.5
43	10/22 - 10/28	3	0	0	0	0.0
44	10/29 - 11/04	2	2	1	3	1.5
45	11/05 - 11/11	6	0	4	4	0.7
46	11/12 - 11/18	4	0	1	1	0.3
47	11/19 - 11/25	4	0	8	8	2.0
48	11/26 - 12/02	2	0	0	0	0.0
49	12/03 - 12/09	3	0	3	3	1.0
	Totals: d/	103	2	27	29	
	Mean: d/					0.3

a/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 49 (8 December) of 1992.
b/ Half-pounder steelhead were ≤ 41 cm FL; adults were > 41 cm FL.
c/ Weir was not fished from 6/8 through 6/21/92 due to high river flows.
d/ Based on trapping data from Julian weeks 27 through 49.

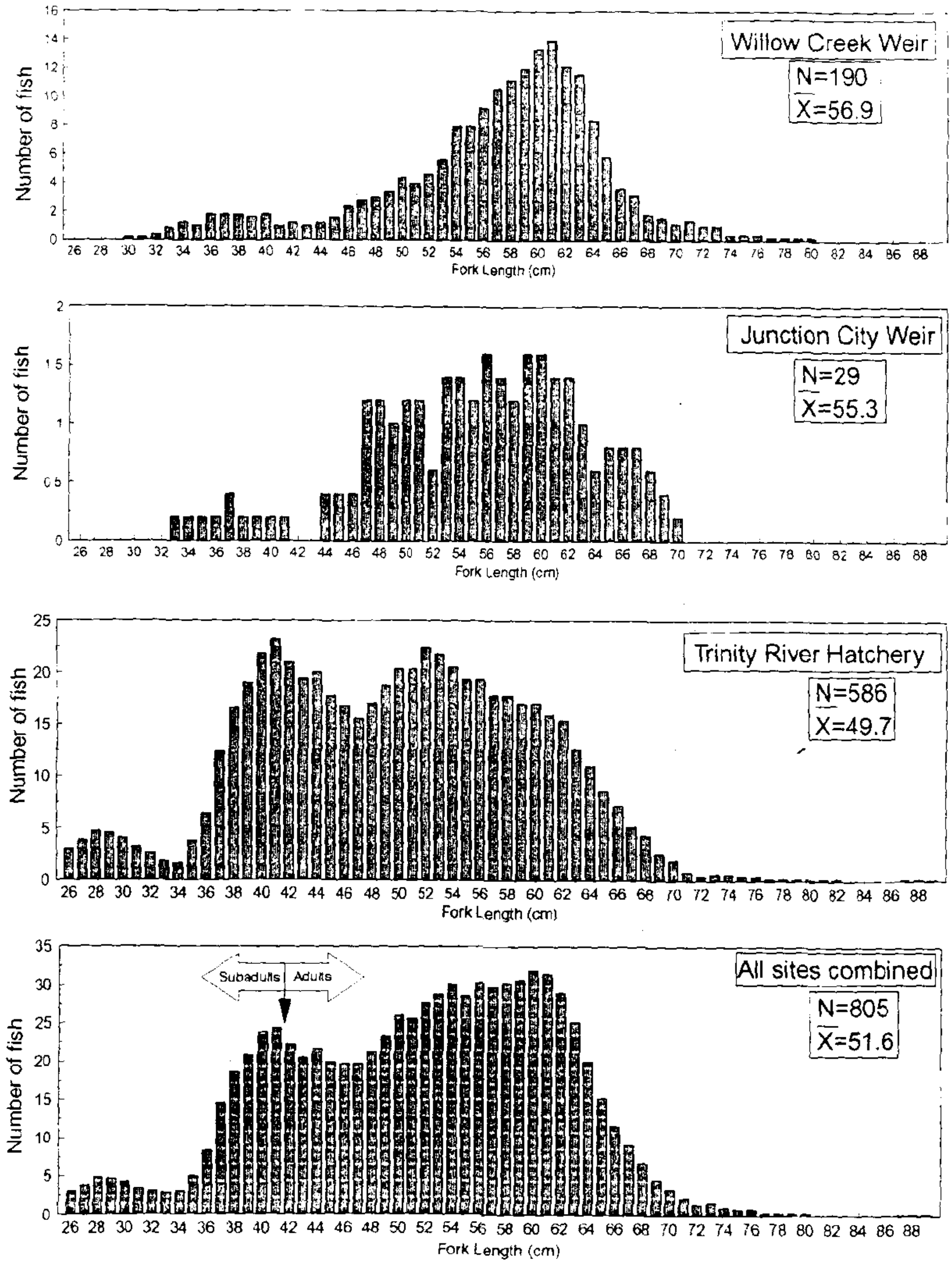


FIGURE 10. Analysis of fall-run steelhead lengths observed at the Trinity River weirs and Trinity River Hatchery during the 1992-93 season. The number of fish at each fork length is shown as a moving average of five, 1-cm increments.

We trapped and reward-tagged 27 adult steelhead at JCW this season. There were no tagging mortalities, and one tag was removed by an angler, resulting in 26 effectively tagged steelhead (Appendix 7).

Incidence of Tags and Fin Clips. We observed fin clips on 76 adult and nine subadult steelhead at WCW, and 16 adults and one subadult at JCW (Appendix 7). The bulk of these (55.3% at WCW and 70.6% at JCW) were from the 1990 BY released from TRH in March 1991 (Appendix 8). Assuming that all the TRH-produced steelhead captured at the weirs were fin-clipped[6/], 43.2% (76/176) and 59.3% (16/27) of the adults observed at WCW and JCW, respectively, were TRH-produced.

Incidence of Gill-net and Hook Scars. Five (2.8%) of the adult steelhead trapped at WCW had gill-net scars. The mean FL of the gill-net-scarred steelhead was slightly larger (60.0 cm) than the non-gill-net-scarred steelhead (56.8 cm). No gill-net-scarred steelhead were trapped at JCW.

Hook scars were observed on 3.2% (6 fish) and 3.4% (one fish) of the steelhead trapped at WCW and JCW, respectively.

Recovery of Tagged Fish

Tag Returns by Anglers

Angler Harvest Regulation. Department of Fish and Game fishing regulations can affect the return of tags each year by limiting harvest. Special quota restrictions were in place during the 1992-93 season, which decreased the number of adult chinook caught by anglers (Appendix 9).

Spring-run Chinook. Anglers returned 36 tags from spring chinook tagged at JCW. These included 32 reward (12 adults and 20 grilse) and four non-reward tags (all grilse). We estimated the harvest rate, based on the return of reward tags, at 4.4% for adults and 11.6% for grilse. The number of days between tagging and reported capture by anglers ranged from zero to 133 d, with a mean time-at-large of 40.5 d.

Fall-run Chinook. Anglers returned only 12 tags (five reward and seven non-reward) from fall chinook salmon tagged at WCW. Reward tags from 2.1% (3/141) of the adults and 6.5% (2/31) of the grilse were returned by anglers. Anglers returned non-reward

---

6/ It is possible that some unmarked TRH-produced steelhead (from the 1988 BY) were present in the run. However, based on the high percentage (94.5%) of fin-clipped steelhead at TRH this season, these fish (if any) were not very numerous (see page 129).

tags from fall chinook at the rate of 3.4% (5/146) for adults and 4.7% (2/43) for grilse. Since so few tags were returned, and non-reward tags (from adults) were returned at a higher rate than reward tags, we used reward plus non-reward tags to estimate harvest rates. The overall harvest rate of fall chinook upstream of WCW was 2.8% for adults and 5.4% for grilse.

Anglers returned only four tags from the 669 fall chinook effectively tagged at JCW. These tags included three from reward-tagged adults and one from a non-reward-tagged grilse. The overall (reward + non-reward) harvest rate upstream of JCW was 0.6% for grilse and 1.8% for adults.

Coho Salmon. We estimated the overall harvest rate of coho upstream of WCW this season to be 0.2%. Only one of the 403 coho tagged at WCW was reported caught by anglers.

No tags were returned by anglers from coho tagged at JCW. We assumed that no coho were harvested upstream of JCW this season.

Fall-run Steelhead. Anglers returned 12 tags from WCW-tagged steelhead; four non-reward and eight reward tags. Based on the reward tags returned, we estimated anglers caught 9.6% of the steelhead migrating upstream of WCW. The mean size of the fish caught was 52.9 cm FL. The steelhead were caught from zero to 159 d after being tagged, with a mean of 42 d.

Anglers returned four of the 26 reward tags from steelhead tagged at JCW. Based on the tags returned, 15.4% of the steelhead migrating upstream of JCW were caught by anglers. The mean size of the steelhead reported caught was 59.7 cm FL. Anglers captured fish from 83 to 141 d after tagging, with a mean time-at-large of 112 d.

Trinity River Hatchery

Coded-wire Tag Number 065639. Chinook from this CWT group were originally tagged as spring chinook smolts, but based on the timing of their entrance into TRH, appeared to be actually a composite of both spring and fall chinook. These fish began entering TRH early in the season, like the other spring CWT groups, but they continued through the period associated with fall chinook (Table 8). Based on the numbers and timing of these fish entering TRH, we estimated between 50% and 75% of this group were fall chinook. For analysis purposes, we considered fish from this group entering TRH after 15 October to be fall chinook while those entering before that date were considered spring chinook. Why this group consisted of fish from both runs is unknown.

TABLE 8. Recoveries of coded-wire-tagged, Trinity River Hatchery-produced, spring-run chinook salmon at Trinity River Hatchery during the 1992-93 season. a/

	Brood year									
	1987	1988		1989		1990				
	Coded-wire tag number									
Entry date b/	066147	066148	066149	0601040102	065639	065636	0601040103	065640	Shed tags c/	Total
09/14/92		4	2		2				1	9
09/17/92		13	3	1	1		4	1	16	39
09/21/92	1	5	4	0	1		1	0	3	15
09/24/92	0	4	1	0	2	1	5	0	6	19
09/28/92	1	10	1	2	1		11	1	14	41
10/01/92		6	1		1		10	0	9	27
10/05/92		8	0		2		2	0	5	17
10/08/92		0	0		2		3	1	3	9
10/13/92		0	1		2					3
10/15/92		1			1					2
10/19/92					4					4
10/22/92					5					5
10/26/92					9					9
10/29/92					1					1
11/02/92					13					13
11/03/92					1					1
11/05/92					1					1
11/09/92					2					2
11/10/92					0					0
11/12/92					0					0
11/16/92					0					0
11/17/92					0					0
11/19/92					0					0
11/23/92					0					0
11/25/92					0					0
11/30/92					0					0
12/03/92					1					1
Totals	2	51	13	3	52	1	36	3	57	218

a/ The fish ladder was open from 11 September 1992 through 28 March 1993.

b/ Entry date was the date that fish were initially sorted, although they may have actually entered the hatchery any time after the previous sorting day.

c/ No CWT were recovered from the Ad-clipped fish. Chinook with shed tags recovered after 10/13/92 were considered fall-chinook and are shown in Table 10.

Spring-run Chinook Salmon. Based on CWT recoveries, spring chinook began entering TRH on 14 September (JW 37) and continued through 15 October (JW 42) (Figure 11, Table 8). We estimated that 1,846 spring chinook (533 grilse and 1,313 adults) entered TRH during the 1992-93 season.

We recovered 12 (38.7%) of 31 Project-tagged spring chinook from WCW at TRH (Table 9). The mean FL of the Project-tagged spring chinook from WCW that entered TRH was 3.9 cm less than the mean of those effectively tagged at the weir (Appendix 4). They had been tagged at WCW from 33 to 57 d before entering TRH, with an average of 40.7 d.

We recaptured 279 spring chinook (100 grilse and 179 adults) at TRH that we had tagged at JCW, including 4 fish which had been tagged at WCW, and recovered at both JCW and TRH. Thus, we recovered 45.7% of the spring chinook which were effectively tagged at JCW (Appendix 4). There was no difference in the mean FL of effectively tagged versus TRH-recovered spring chinook from JCW. The Project-tagged spring chinook from JCW had been at liberty from 15 to 236 d (mean of 67.4 d) before entering TRH.

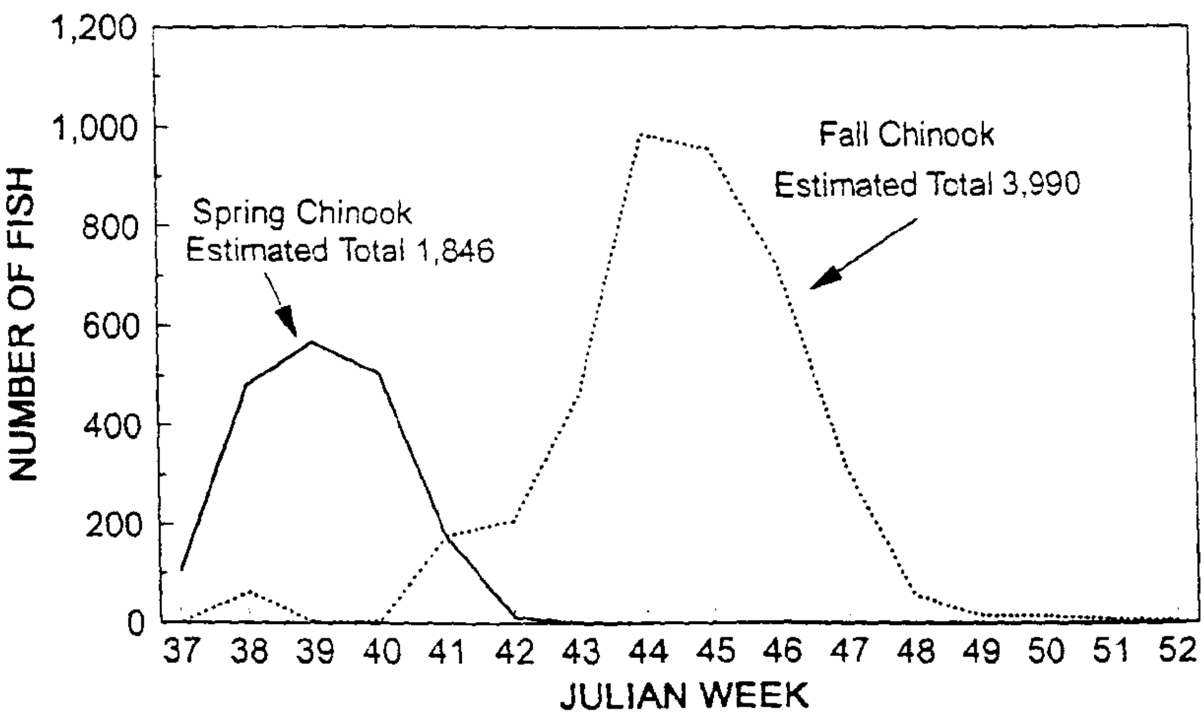


FIGURE 11. Estimated numbers of spring- and fall-run chinook salmon that entered Trinity River Hatchery during the 1992-93 season based on expansion of numbers of coded-wire-tagged fish recovered.

TABLE 9 . Total numbers and numbers of Project-tagged chinook and coho salmon that entered Trinity River Hatchery (TRH) during the 1992-93 season. a/

	Numbers of chinook salmon					Numbers of coho salmon		
	Total entering TRH d/	Spring-run from tagging site b/		Fall-run from tagging site		Total entering TRH d/	From tagging site	
Entry date c/		JCW	WCW	JCW	WCW		JCW	WCW
09/14/92	105	10						
09/17/92	348	46						
09/21/92	197	31 (1) e/	1					
09/24/92	168	23	0					
09/28/92	400	62	0	2				
10/01/92	258	32	0	4				
10/05/92	252	42 (2)	3	7	2			
10/08/92	193	17 (1)	4	9 (2)	4			
10/13/92	161	11	3	23 (2)	6	2		
10/15/92	64	2	0	13	2	4		
10/19/92	154	2	0	20	6	8		
10/22/92	139	0	0	18	3	30		1
10/26/92	323	1	0	22	6	46	2	2
10/29/92	221		1	21 (1)	8	165	5	1
11/02/92	711			40 (1)	14	385	2	10
11/03/92	55			2	1	129	0	2
11/05/92	285			5 (1)	12	385	0	11
11/09/92	632			8	17	365	1	20
11/10/92	40			0	1	22	1 (1)	3
11/12/92	236			15 (1)	3	116	4	5
11/16/92	432			21	11	381	5 (1)	27
11/17/92	56			3	0	76	4	2
11/19/92	111			8	3	319	4	15
11/23/92	150			25	1	429	7	16
11/25/92	50			4	1	297	5	10
11/30/92	56			5		214	9	9
12/03/92	8			0		73	2	1
12/07/92	7			3		48	4	0
12/14/92	13					75	2	3
12/21/92	7					10		1
12/28/92	4					0		
01/04/93						1		
01/13/93						2		
Totals:	5,836	279 (4)	12	278 (8)	101	3,582	57 (2)	139

a/ The fish ladder was open 11 September 1992 through 28 March 1993.

b/ Tagging site: JWC=Junction City Weir, WCW=Willow Creek Weir

c/ Entry date was the day that fish were initially sorted, although they may have actually entered the hatchery anytime after the previous sorting day.

d/ Numbers shown include tagged fish recovered on the same day.

e/ Numbers in parenthesis are fish tagged and released at WCW that were recaptured and re-released at JCW, and that subsequently entered TRH. They are included in the total entering TRH.

We recovered 218 Ad-clipped spring chinook at TRH, but CWTs were recovered from only 161 of these fish. The greatest returns of CWT fish were from the 1988 and 1990 BYs that had been released as smolts (CWT numbers 066148 and 0601040103, respectively) (Table 8).

Fall-run Chinook Salmon. Based on the recovery of CWTs, the first fall chinook entered TRH on 17 September 1992 (JW 38), the run peaked 2 November (JW 44), and decreased steadily through 30 November (JW 48), when the last CWTed chinook entered the hatchery (Figure 11). We estimated that 3,990 fall chinook (211 grilse and 3,779 adults) entered TRH during the 1992-93 season.

We recaptured 101 fall chinook (six grilse and 95 adults) at TRH that we had tagged at WCW (Table 9); this was 28% of those effectively tagged at the weir. These Project-tagged fish ranged from 46 to 89 cm FL, and averaged 66.8 cm FL, 3.9 cm larger than the mean size of those effectively tagged (Appendix 5). Project-tagged fish entered TRH from 12 to 46 d after tagging, averaging 28.2 d.

We recaptured 41.6% of the effectively tagged JCW-tagged fall chinook (41 grilse and 238 adults) at TRH (Table 9). These fish included eight fall chinook that had been previously tagged and released at WCW. JCW-tagged fish recaptured at TRH ranged in size from 40 to 87 cm FL, with a mean of 64.8 cm FL, similar to the mean size of all fall chinook tagged at JCW (Appendix 5). JCW-tagged fall chinook entered TRH from 3 to 41 d after tagging, averaging 11.6 d.

We recaptured 344 Ad-clipped fall chinook at TRH, and recovered 305 CWTs. TRH yearling CWT groups 065632 (1988 BY) and 065634 (1989 BY) comprised 53.4% and 13.1%, respectively, of the CWTs recovered (Table 10).

Coho Salmon. The first coho entered TRH on 13 October 1992 (JW 41), and the number entering TRH increased each week through JW 45 (4-11 November). The largest number of coho (1,045 fish) entered TRH during JW 47 (19-25 November). Coho numbers decreased rapidly during the remainder of the season with the last coho being trapped on 13 January 1993. We counted 3,582 coho (1,210 grilse and 2,372 adults) entering TRH during the 1991-92 season (Table 9).

We recovered 34.5% the effectively WCW-tagged coho (16 grilse and 123 adults) at TRH. Their mean FL (60.0 cm) was 2.6 cm greater than the mean FL of WCW effectively tagged coho (Appendix 6). Coho tagged at WCW had been at liberty from 10 to 63 d before entering TRH, with a mean time-at-large of 27.8 d.

TABLE 10. Recoveries of coded-wire-tagged, Trinity River Hatchery-produced, fall-run chinook salmon at Trinity River Hatchery during the 1992-93 seasons. a/

	Brood year												
	1987	1988						1989			1990		
	Coded-wire tag number											Shed	
Entry date b/	065633	065631	065635	065632	065522	065523	0601040101	065634	065637	065641	065638	tags c/	Total
09/17/92	1			1									2
09/21/92	0			1									1
09/24/92	0			0									0
09/28/92	0			0									0
10/01/92	0			0		1							1
10/05/92	0	1		0		0							1
10/08/92	0	0		2		0							2
10/13/92	0	0		2		0		2		1	1		6
10/15/92	0	0	1	2		0		0		1	1	2	7
10/19/92	0	0	1	6		1		1	1	0	0	5	15
10/22/92	0	0	0	6		1		0	0	1	1	0	9
10/26/92	0	1	1	11		1		3	1	1	0	4	23
10/29/92	0	1	0	9		1		0	2	4	0	1	18
11/02/92	1	1	8	24	2	3	1	7	3	1	1	7	59
11/03/92		0	0	1	0	0	1	2	1	1	3	0	9
11/05/92		1	1	13	0	2	0	3	2	1	0	3	26
11/09/92		2	4	30	2	1	3	7	3	3	1	6	62
11/10/92			1	2	0	0	0	1	0	0	0	0	4
11/12/92			0	11	0	0	1	4	1	2	1	1	21
11/16/92			2	21	1	1	0	2	1	2	1	1	32
11/17/92				3			0	2	0	0		2	7
11/19/92				7			0	1	2	1		1	12
11/23/92				6			3	5		0		5	19
11/25/92				2						1		1	4
11/30/92				3						1			4
Totals:	2	7	19	163	5	12	9	40	17	21	10	39	344

a/ The fish ladder was open from 11 September 1992 through 28 March 1993.

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

c/ No CWT were recovered from the Ad-clipped fish. Chinook with shed tags recovered before 10/15/92 were considered spring-chinook and are shown in Table 8.

We recovered 63.3% (13 grilse and 44 adults) of the effectively JCW-tagged coho[7/] at TRH (Appendix 6). These fish ranged in size from 38 to 69 cm FL, and averaged 57.3 cm FL, the same as the mean size of effectively tagged coho at JCW. The JCW-tagged coho took from 4 to 33 d to migrate to the hatchery, with a mean time-at-large of 10.4 d.

We recovered 321 CWTs from the 359 Ad-clipped coho that entered TRH (Table 11). The CWTs represented two tag-groups: Code numbers 065657 (1990 BY) and 065660 (1989 BY).

Fall-run Steelhead. The steelhead run into TRH began 26 October 1992 (JW 43) and ended 28 March 1993 (JW 13), after which the fish ladder was closed. A total of 586 steelhead (131 sub-adults and 455 adults) entered TRH during the 1992-93 season (Table 12).

Twenty-four WCW-tagged steelhead entered TRH (Table 12). They ranged in size from 48 to 68 cm FL, with a mean of 56.6 cm FL, 1.2 cm smaller than those effectively tagged (Appendix 7). Length of time for these steelhead to travel from WCW to TRH ranged from 27 to 77 d, averaging 45 d.

We recovered seven Project-tagged steelhead from JCW at TRH, including one fish that we had previously tagged at WCW (Table 12). These fish ranged from 49 to 67 cm FL, with a mean of 58.1 cm, 1.3 cm greater than the mean of those effectively tagged at the weir (Appendix 7). Length of time for JCW-tagged steelhead to travel from the weir to TRH ranged from 23 to 146 d, averaging 75.9 d.

We recovered 430 adult steelhead at TRH that had originally been fin-clipped by TFIP personnel. Fin-clipped steelhead accounted for 94.5% of the adult steelhead entering TRH. The bulk of the fin-clipped recoveries (227/430) were from the 1990 BY released as yearlings in 1991 (Appendix 8).

We also recovered 119 steelhead (including sub-adults) from the 1991 BY[8/], released as yearlings from TRH in 1992. These fish ranged in FL from 26-74 cm, averaging 38.4 cm (Appendix 10). Only 23 (19%) of this fin-clip group were >41 cm FL and considered adults. It is probable that the 96 sub-adults

---

7/ Two of these fish were tagged at WCW then recovered and re-released from JCW.

8/ The fin-clip used to mark the 1991 BY yearlings was the same as that used for a group of 1989 BY yearlings. It is probable that some of the larger steelhead with this fin-clip were from the 1989 BY.

TABLE 11. Recoveries of coded-wire-tagged, Trinity River Hatchery-produced, coho salmon at Trinity River Hatchery during the 1992-93 season. a/

	Brood year			
	1989	1990		
	Coded-wire tag number			
Entry date b/	065660	065657	Shed tags c/	Total
10/15/92	1	1	0	2
10/19/92	0	0	1	1
10/22/92	1	0	0	1
10/26/92	3	1	0	4
10/29/92	5	13	2	20
11/02/92	18	15	3	36
11/03/92	3	6	2	11
11/05/92	14	23	3	40
11/09/92	12	23	5	40
11/10/92	0	0	0	0
11/12/92	3	7	1	11
11/16/92	19	23	8	50
11/17/92	5	2	1	8
11/19/92	16	23	1	40
11/23/92	23	11	4	38
11/25/92	11	10	2	23
11/30/92	12	7	3	22
12/03/92	1	1	0	2
12/07/92	3	3	1	7
12/14/92	2	0	1	3
Totals:	152	169	38	359

a/ The fish ladder was open from 11 September 1992 through 28 March 1993.
b/ Entry date was considered the date that the fish were initially sorted, although they may have entered the hatchery anytime after the previous sorting day.
c/ No tag was recovered from the Ad-clipped fish.

TABLE 12. Total numbers and numbers of Project-tagged fall-run steelhead that entered Trinity River Hatchery each week during the 1992-93 season. a/

Julian week	Inclusive dates	Number entering TRH b/ Adults d/	Sub-adults d/	Total	Recoveries from tagging site c/ JCW e/	WCW e/
43	10/22 - 10/28/92	3	0	3	0	0
44	10/29 - 11/04/92	17	2	19	2	0
45	11/05 - 11/11/92	18	6	24	0	2
46	11/12 - 11/18/92	10	5	15	1	0
47	11/19 - 11/25/92	41	22	63	1	4
48	11/26 - 12/02/92	32	5	37	0	1
49	12/03 - 12/09/92	29	11	40	0	4
50	12/10 - 12/16/92	16	3	19	0	0
51	12/17 - 12/23/92	12	0	12	0	0
52	12/24 - 12/31/92	4	0	4	0	1
1	01/01 - 01/07/93	10	29	39	0	0
2	01/08 - 01/14/93	8	0	8	0	0
3	01/15 - 01/21/93	13	0	13	0	1
4	01/22 - 01/28/93	19	3	22	0	1
5	01/29 - 02/04/93	55	7	62	0	2
6	02/05 - 02/11/93	43	10	53	1	3
7	02/12 - 02/18/93	28	8	36	0	1
8	02/19 - 02/25/93	4	1	5	0	0
9	02/26 - 03/04/93	5	1	6	0	0
10	03/05 - 03/11/93	31	4	35	0	2
11	03/12 - 03/18/93	36	7	43	2	1
12	03/19 - 03/25/93	18	5	23	0	1
13	03/26 - 04/01/93	3	2	5	0	0
Totals:		455	131	586	7	24

a/ The fish ladder was open from 11 September 1992 through 28 March 1993.
b/ TRH=Trinity River Hatchery.
c/ Numbers recovered from each tagging site are included in the numbers entering TRH.
d/ Steelhead ≤ 41 cm FL were considered sub-adults; steelhead > 41 cm FL were considered adults
e/ Tagging site: JCW=Junction City Weir, WCW=Willow Creek Weir.

recovered were actually residualized fish which had not migrated to the ocean.

Run-size, Angler Harvest, and Spawner Escapement Estimates

We tagged and recovered too few grilse salmon to stratify our estimates by adults and grilse this year. Instead, we combined the numbers of adults and grilse tagged and recovered in order to calculate the population estimate, and then proportioned the estimate based on the ratio of adults and grilse observed at each of the weirs.

Spring-run Chinook Salmon

We estimated that 4,030 (2,359 adults and 1,671 grilse) spring chinook (including those harvested) migrated into the Trinity River basin upstream of JCW during the 1992-93 season (Table 13). Anglers caught and kept an estimated 104 (4.4%) of the adults and 194 (11.6%) of the grilse from the spring run. The spawning escapement upstream of JCW during the 1992-93 season was estimated to be 3,732 fish, including 1,846 spring chinook that entered TRH (Table 14).

Based on the Normal Approximation, the 95% confidence interval for the run-size was 3,609-4,479 fish (Table 13).

This is the third-lowest run-size estimate for spring chinook since we began operations in 1977. Run-size has ranged from 62,692 fish in 1988 to 2,381 fish in 1991 (Appendix 11).

Fall-run Chinook Salmon

We estimated that 14,164 (11,232 adults and 2,932 grilse) fall chinook (including those harvested) migrated into the Trinity River basin upstream of WCW during the 1992-93 season, and 9,584 (7,054 adults and 2,530 grilse) of these fish continued their migration upstream of JCW (Table 13). We estimated that anglers harvested 314 adults (2.8%) and 158 (5.4%) grilse from the 1992-93 fall chinook run, including 15 grilse and 127 adults caught upstream of JCW. Therefore, we estimated the Trinity River fall chinook escapement at 13,692 fish upstream of WCW and 9,442 fish upstream of JCW, including the 3,990 fall chinook that entered TRH (Table 14).

Based on the Normal Approximation, the 95% confidence interval for the fall chinook run-size upstream of WCW was 11,578-17,006 fish (Table 13).

The fall chinook run-size this year is the fourth-lowest since the current program began in 1977. The estimated run-size upstream of WCW has ranged from 147,888 fish in 1986 to 9,207

TABLE 13. Run-size estimates and confidence limits for Trinity River basin chinook and coho salmon, and fall-run steelhead during the 1992-93 season.

Species/ race	Area of Trinity River basin for run-size estimate	Stratum a/	Number effectively-tagged b/	Trinity River Hatchery recoveries: Number examined for tags c/	Trinity River Hatchery recoveries: Number of tags in sample	Run-size estimate d/	Confidence limits 1-P=0.95	Confidence limit estimator
Spring-run chinook	Upstream of Junction City Weir	Grilse	233	533	100	1,671		
		Adults	377	1,313	179	2,359		
		Total	610	1,846	279	4,030	3,609 - 4,479	Normal
Fall-run chinook	Upstream of Willow Creek Weir	Grilse	74	211	6	2,932		
		Adults	287	3,779	95	11,232		
		Total	361	3,990	101	14,164	11,578 - 17,006	Normal
Fall-run chinook	Upstream of Junction City Weir	Grilse	160	211	41	2,530		
		Adults	509	3,779	238	7,054		
		Total	669	3,990	279	9,584	8,531 - 10,701	Normal
Coho	Upstream of Willow Creek Weir	Grilse	93	1,210	16	2,378		
		Adults	310	2,372	123	7,961		
		Total	403	3,582	139	10,339	8,801 - 12,269	Poisson
Coho	Upstream of Junction City Weir	Grilse	22	1,210	13	1,539		
		Adults	69	2,372	44	4,144		
		Total	91	3,582	57	5,683	4,419 - 7,422	Poisson
Fall-run steelhead	Upstream of Willow Creek Weir	Adults	166	455	24	3,046	2,120 - 4,706	Poisson

a/ Stratum: Grilse = two-year-old salmon, Adults = three years and older salmon. Steelhead adults were fish greater than or equal to 42 cm FL.

b/ The number of effectively tagged fish was corrected for tagging mortalities.

c/ Numbers of spring- and fall-run chinook were estimated from expansion of coded-wire tag recoveries at Trinity River Hatchery.

d/ Estimates for grilse and adult salmon were based on proportioning the total run-size by the ratio of grilse to adults observed at the respective weir.

TABLE 14. Estimates of Trinity River basin chinook and coho salmon, and adult fall-run steelhead run-size, angler harvest and spawner escapements during the 1992-93 season.

Species/ race	Area of Trinity River basin for run-size estimate	Stratum a/	Run-size	Angler harvest: Harvest rate b/	Angler harvest: Number of fish c/	Spawner escapement: Natural d/	Spawner escapement: Trinity River Hatchery	Spawner escapement: Total
Spring-run chinook	Upstream of Junction City Weir	Grilse	1,671	11.6%	194	944	533	1,477
		Adults	2,359	4.4%	104	942	1,313	2,255
		Total	4,030	7.4%	298	1,886	1,846	3,732
Fall-run chinook	Upstream of Willow Creek Weir	Grilse	2,932	5.4%	158	2,563	211	2,774
		Adults	11,232	2.8%	314	7,139	3,779	10,918
		Total	14,164	3.3%	472	9,702	3,990	13,692
Fall-run chinook	Upstream of Junction City Weir	Grilse	2,530	0.6%	15	2,304	211	2,515
		Adults	7,054	1.8%	127	3,148	3,779	6,927
		Total	9,584	1.5%	142	5,452	3,990	9,442
Coho	Upstream of Willow Creek Weir	Grilse	2,378	0.0%	0	1,168	1,210	2,378
		Adults	7,961	0.3%	24	5,565	2,372	7,937
		Total	10,339	0.2%	24	6,733	3,582	10,315
Coho	Upstream of Junction City Weir	Grilse	1,539	0.0%	0	329	1,210	1,539
		Adults	4,144	0.0%	0	1,772	2,372	4,144
		Total	5,683	0.0%	0	2,101	3,582	5,683
Fall-run steelhead	Upstream of Willow Creek Weir	Natural	1,731	9.6%	166	1,540	25	1,565
		Hatchery	1,315	9.6%	126	759	430	1,189
		Total	3,046	9.6%	292	2,299	455	2,754

a/ Stratum: Grilse = two-year-old salmon, Adults = three years and older salmon, Natural = naturally produced steelhead, Hatchery = hatchery-produced steelhead. Natural and hatchery components calculated by proportioning the total run-size by the ratio of fin-clipped (hatchery) to non-fin-clipped (natural) steelhead observed at *Willow Creek Weir*.

b/ Harvest rates for spring-run chinook and steelhead were based on the return of reward-tags. Fall chinook and coho harvest rates are based on the return of reward plus non reward tags.

c/ Calculated as the run-size times the harvest rate.

d/ Calculated as run-size minus angler-harvest minus hatchery escapement.

fish in 1991 (Appendix 12), while the run-size upstream of JCW has ranged between 121,033 and 4,787 fish (Appendix 13).

Coho Salmon

We estimated that 10,339 coho (including those harvested) migrated into the Trinity River basin upstream of WCW during the 1992-93 season, and 5,683 continued their migration upstream of JCW (Table 13). An estimated 0.23% (24) of the coho were harvested upstream of WCW, but none were caught upstream of JCW. The spawning escapement estimate for coho upstream of WCW was 10,315 fish, 5,683 of which continued upstream of JCW and included 3,582 fish that entered TRH (Table 14).

The 95% confidence interval, based on the Poisson Approximation, ranged between 8,801 and 12,269 coho salmon upstream of WCW (Table 13).

Estimated coho salmon run-size upstream of WCW has ranged from 1,971 fish in 1983 to 59,079 fish in 1987 (Appendix 14), and between 2,177 and 26,370 fish for the Trinity River upstream of JCW (Appendix 15).

Adult Fall-run Steelhead

We estimated that 3,046 adult fall-run steelhead, comprised of 1,731 naturally produced and 1,315 hatchery-produced fish, migrated upstream of WCW (Table 13). From these, anglers harvested an estimated 166 and 126 naturally and hatchery-produced steelhead, respectively. Twenty-five naturally produced and 430 hatchery produced steelhead entered the hatchery, leaving 1,540 naturally produced and 759 hatchery-produced steelhead for the natural spawner escapement upstream of WCW (Table 14).

The 95% confidence interval, based on the Poisson Approximation, ranged between 2,120 and 4,706 fall-run steelhead upstream of WCW (Table 13).

The fall-run steelhead run-size above WCW this year was the lowest recorded since 1980. Intermittent estimates made since that year have ranged from 37,276 in 1989 to this year's low estimate (Appendix 16).

Too few steelhead were trapped at JCW to develop a run-size estimate for the basin upstream of that site this year. Previous run-size estimates upstream of JCW have ranged from 2,285 in 1991 to 13,574 in 1989 (Appendix 17).

RECOMMENDATIONS

1. Tagging and recapture operations for adult spring-run and fall-run chinook and coho salmon, and adult fall-run steelhead conducted in the Trinity River basin should be continued during the 1993-94 migration season, using the capture sites near Willow Creek and Junction City.

2. More detailed information should be requested from anglers returning tags, including: 1) if the fish was kept or released, and 2) if the tag was recovered from a fish found dead (carcass recovery).

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, pp. 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. of 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. pp. 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. pp. 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. pp. 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. pp. 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. Run-size, angler harvest, and spawner escapement of chinook and coho salmon in the Trinity River basin. Chapter IV. Job IV. pp. 93-145. In: K. Urquhart, and R. Carpenter (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1990-91 Season. December 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.

Lau, M., B. Heubach, and E. Miller. 1994. Annual run-size, harvest, and spawner escapement estimates for Trinity River Basin chinook and coho salmon and steelhead. Chapter IV. Job IV. pp. 103-167. In: K. Urquhart and R. M. Kano (eds.), Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1991-1992 Season. February 1994. 235 p. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

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.-Fisheries, No. 12. 71 p.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Bd. Can. No. 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. 70-16. 13 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 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, 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. pp. 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. 146 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	Inclusive dates			Julian week	Inclusive dates		
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 leap year (years divisible by 4).
b/ Eight-day week every year.

APPENDIX 2. Fork length distribution of coded-wire-tagged, Trinity River Hatchery-produced, spring-run chinook salmon recovered at Trinity River Hatchery during the 1992-93 season. a/

Fork Length (cm)	Brood year 1987	1988		1989		1990			Total
	Coded-wire tag number/age at release b/								
	066147/f	066148/y	066149/f	0601040102/f	065639/y	065636/y	0601040103/f	065640/y	
37						1			1
38									0
39									0
40							1	1	2
41							1	0	1
42							1	0	1
43							3	0	3
44							1	1	2
45							2	0	2
46							9	1	10
47					1		4		5
48					0		7		7
49					0		1		1
50					0		1		1
51					0		3		3
52					0		2		2
53					1				1
54					4				4
55					3				3
56					4				4
57					6				6
58					5				5
59					1				1
60					7				7
61				1	2				3
62				0	4				4
63			1	0	3				4
64		2	0	0	1				3
65		1	0	0	3				4
66		1	0	1	1				3
67		0	0	1	0				1
68		3	0		2				5
69		3	0		1				4
70		6	1		1				8
71		3	0		1				4
72		6	2		1				9
73		7	0						7
74		3	0						3
75		1	1						2
76		2	4						6
77	1	1	1						3
78	0	2	1						3
79	0	0	0						0
80	0	4	0						4
81	0	1	1						2
82	0	3	0						3
83	0	0	0						0
84	1	0	0						1
85		1	1						2
86		0							0
87		1							1
Totals	2	51	13	3	52	1	36	3	161
Mean FL	80.5	73.5	75.2	64.7	60.0	–	46.7	43.3	62.4

a/ The fish ladder was open from 11 September 1992 through 28 March 1993.
b/ Age at release: f = fingerlings, y = yearlings.

APPENDIX 3. Fork length distribution of coded-wire-tagged, Trinity River Hatchery-produced, fall-run chinook salmon recovered at Trinity River Hatchery during the 1992-93 season. a/

Fork Length (cm)	065633/f	065631/y	065635/f	065632/y	065522/y	065523/y	0601040101/f	065634/y	065637/y	065641/y	065638/y	Totals
	Brood year											
	1987		1988				1989				1990	
	Coded-wire tag number/age at release b/											
39											2	2
40											1	1
41											2	2
42											1	1
43											1	1
44											2	2
45											0	0
46											0	0
47											1	1
48								1				1
49								0				0
50								0	1			1
51								1	0			1
52								4	1	1		6
53								2	0	0		2
54								2	0	0		2
55								7	0	1		8
56								2	1	1		4
57							1	1	3	2		7
58							0	4	2	1		7
59							3	3	1	1		8
60				1			1	3	2	5		12
61				2			0	1	0	2		5
62				2		1	0	2	0	2		7
63				1		0	0	1	1	2		5
64				2		0	1	3	0	0		6
65				3		0	0	1	2	1		7
66				4		0	1	1	2	0		8
67				6		1	1	0	0	1		9
68				7		0	0	0	0	1		8
69			2	8		1	1	0	0			12
70			1	12		1		0	1			15
71			1	9		0		0				10
72			1	16	1	0		0				18
73			0	10	0	0		0				10
74			2	3	0	2		0				7
75			3	14	1	2		1				21
76			0	4	0	0						4
77	1	1	1	8	0	1						12
78	0	0	0	6	1	0						7
79	0	0	1	7	1	0						9
80	0	1	1	7	0	0						9
81	0	0	1	2	0	1						4
82	0	1	1	7	1	0						10
83	0	0	1	2		1						4
84	1	0	0	4		0						5
85		1	1	4		0						6
86		0	1	1		0						2
87		0	0	2		0						2
88		2	0	2		0						4
89		0	0	4		1						5
90		0	1	2								3
91		0		0								0
92		0		0								0
93		1		0								1
94				0								0
95				0								0
96				0								0
97				0								0
98				0								0
99				0								0
100				0								0
101				1								1
												0
TOTALS	2	7	19	163	5	12	9	40	17	21	10	305
Mean FL	80.5	84.7	77.2	74.7	77.2	74.7	62.2	57.8	59.9	60.3	42.0	69.7

a/ The fish ladder was open from 11 September 1992 through 28 March 1993.
b/ Age at release: f = fingerlings, y = yearlings

APPENDIX 4. Fork length distribution 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 1992-93 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad-clips c/	Effective tags d/	TRH e/ recoveries	Total trapped	Ad-clips c/	Effective tags d/	TRH e/ recoveries
36					1			
37					1			
38					1		1	1
39					1		1	0
40					7	1	5	4
41	1		1	1	7	0	6	2
42	0		0	0	18	1	16	10
43	0		0	0	19	2	19	8
44	0		0	0	39	2	34	13
45	2		2	2	31	2	26	12
46	1		1	0	25	6	20	12
47	0		0	0	26	3	22	8
48	1		1	1	33	2	31	14
49	0		0	0	21	3	17	4
50	0		0	0	15	2	15	5
51	0		0	0	9	3	7	2
52	0		0	0	8	0	6	2
53	1		1	0	6	0	4	2
54	0		0	0	1	0	0	0
55	0		0	0	1	0	1	1
56	0		0	0	2	0	2	0
57	1		1	0	1	0	1	0
58	0		0	0	4	0	4	4
59	2		2	0	8	1	6	5
60	1		1	1	5	0	5	1
61	2	1	1	1	5	0	5	4
62	3	0	3	2	5	1	5	4
63	0	0	0	0	9	0	9	3
64	2	0	2	0	17	3	17	6
65	0	0	0	0	20	0	17	8
66	1	0	1	0	26	0	26	7
67	0	0	0	0	21	0	21	12
68	0	0	0	0	32	3	32	15
69	1	0	0	0	29	1	28	17
70	1	0	1	0	26	3	26	14
71	1	0	1	0	26	2	26	16
72	1	0	1	0	20	2	20	9
73	1	0	1	0	20	0	20	13
74	1	0	1	0	11	0	11	5
75	2	0	2	1	20	0	20	11
76	4	0	4	2	19	2	19	5
77	0	0	0	0	10		10	5
78	1	0	1	0	19		18	3
79	0	0	0	0	3		3	2
80	0	0	0	0	2		2	0
81	0	0	0	0	6		6	2
82	1	1	1	1	6		6	4
83	0		0		4		4	2
84	0		0		3		3	1
85	0		0		1		1	1
86	0		0		1		1	
87	1		1		1		1	
88					0		0	
89					1		1	
90					0		0	
91					0		0	
92					1		1	
93					0		0	
94					1		1	
95					0		0	
96					0		0	
97					1		1	
Totals	33	2	31	12	656	45	610	279
Mean FL	65.0	71.5	65.0	61.1	60.4	55.4	61.3	61.3
Total grilse f/	6	0	6	4	272	27	233	100
Total adults	27	2	25	8	384	18	377	179

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 48 (2 December). Only chinook trapped through Julian week 35 were considered spring-run chinook.

b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 49 (9 December). Only chinook trapped through Julian week 37 were considered spring-run chinook.

c/ Ad-clip=Adipose fin-clipped fish.

d/ The number of effectively tagged fish excludes fish that were not tagged and tagging mortalities.

e/ TRH=Trinity River Hatchery.

f/ Spring-run chinook salmon grilse were < 57 cm FL.

APPENDIX 5. Fork length distribution 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 1992-93 season.

Fork length (cm)	Willow Creek Weir a/ Total trapped	Ad-clips c/	Effective tags d/	TRH e/ recoveries	Junction City Weir b/ Total trapped	Ad-clips c/	Effective tags d/	TRH e/ recoveries
32					1			
33					0			
34					1		1	
35					0		0	
36					0		0	
37	1		1		2		2	
38	1		1		9	1	4	
39	2		2		2	0	1	
40	0		0		8	0	6	1
41	4		2		11	0	10	1
42	4		3		17	1	13	2
43	2		2		23	0	18	5
44	10		10		23	1	19	3
45	11		11		20	1	17	7
46	9		8	1	22	1	21	7
47	9		9	0	26	4	23	10
48	15		14	4	18	2	16	5
49	12		11	1	12	0	9	0
50	11		10	0	19	1	19	4
51	1		1	0	10	1	8	1
52	11		11	1	7	0	6	4
53	6		5	1	14	0	13	8
54	5	1	3	2	12	1	9	8
55	8	0	8	2	16	1	12	7
56	8	0	7	1	14	1	13	8
57	5	0	3	0	12	1	11	10
58	12	3	11	6	11	3	10	5
59	11	0	11	5	11	1	9	7
60	8	0	7	1	15	0	14	9
61	10	0	10	2	3	0	3	3
62	16	3	16	7	8	1	8	5
63	4	1	4	3	8	0	8	5
64	10	2	10	4	12	0	11	5
65	9	0	9	6	10	1	10	3
66	16	1	16	4	8	0	8	1
67	8	0	8	3	16	1	14	8
68	10	1	9	2	15	2	14	8
69	12	1	12	2	19	2	18	13
70	11	0	10	6	17	2	17	11
71	9	0	8	4	19	2	16	8
72	10	0	10	7	14	2	14	7
73	11	1	10	2	23	2	22	4
74	10	1	8	2	19	1	18	8
75	7		7	2	22	1	22	9
76	10		10	5	20	0	20	9
77	6		6	3	22	2	22	10
78	6		6	1	22	1	20	11
79	11		9	5	16	0	16	8
80	6		6	0	20	0	20	5
81	5		5	1	16	0	15	4
82	2		2	1	19	1	19	6
83	2		2	1	10		9	5
84	2		2	0	7		7	2
85	3		2	0	7		5	3
86	4		4	1	10		10	3
87	3		2	0	2		2	2
88	1		1	0	4		4	
89	3		3	2	2		2	
90	0		0		3		2	
91	1		1		3		3	
92	0		0		0		0	
93	2		2		3		3	
94					2		2	
95					0		0	
96					1		1	
Totals	386	15	361	101	738	42	669	278
Mean FL	62.7	63.7	62.9	66.8	63.0	60.9	64.0	64.8
Total grilse f/	80	0	74	6	195	11	160	41
Total adults	306	15	287	95	543	31	509	237

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 48 (2 December). Only chinook trapped after Julian week 35 were considered fall-run chinook.

b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 49 (9 December). Only chinook trapped after Julian week 37 were considered fall-run chinook.

c/ Ad-clip=Adipose fin-clipped fish.

d/ The number of effectively tagged fish excludes fish that were not tagged and tagging mortalities.

e/ TRH=Trinity River Hatchery.

f/ Fall-run chinook salmon grilse were < 50 cm FL.

APPENDIX 6. Fork Length distribution of coho salmon trapped and tagged in the Trinity River at Willow Creek and Junction City Weirs, and recovered at Trinity River Hatchery during the 1992-93 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad-clips c/	Effective tags d/	TRH e/ recoveries	Total trapped	Ad-clips c/	Effective tags d/	TRH e/ recoveries
36	1		1		1		0	
37	0		0		0		0	
38	1		1		1		1	1
39	4		4		1		0	0
40	6		6	1	5		4	3
41	13	2	13	0	3	1	3	2
42	12	1	12	4	4	0	4	3
43	19	2	19	3	2	0	2	1
44	15	2	15	4	2	0	2	1
45	12	1	12	3	3	0	2	0
46	1	0	1	0	0	0	0	0
47	2	0	2	0	2	0	2	1
48	2	1	2	1	1	0	1	1
49	3	1	3	0	0	0	0	0
50	2	0	2	0	1	0	1	0
51	2	0	2	0	0	0	0	0
52	2	0	2	1	0	0	0	0
53	5	0	5	2	2	0	2	1
54	9	1	9	3	2	1	2	1
55	11	0	11	3	2	0	2	0
56	11	0	11	3	5	0	5	5
57	13	2	13	1	4	1	4	4
58	10	1	10	4	3	1	3	3
59	24	3	24	9	3	0	3	1
60	30	4	30	14	4	0	4	3
61	27	3	27	12	3	0	3	1
62	28	2	28	12	6	0	5	3
63	33	2	33	15	4	0	4	3
64	23	1	23	7	8	0	8	4
65	27	1	27	11	6	0	6	6
66	16	1	16	8	4	0	4	1
67	19	3	18	9	8	1	8	5
68	7	0	6	4	3		3	1
69	6	1	6	3	3		3	2
70	3	1	3	1				
71	2	0	2	0				
72	1	0	1	0				
73	1	0	1	1				
74	0	0	0					
75	0	0	0					
76	0	0	0					
77	0	0	0					
78	0	0	0					
79	1	0	1					
80	1	1	1					
Totals	405	37	403	139	96	5	91	57
Mean FL	57.5	57.6	57.4	60.0	56.8	55.4	57.4	57.3
Total grilse f/	93	10	93	16	26	1	22	13
Total adults	312	27	310	123	70	4	69	44

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 48 (2 December) of 1992.

b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 49 (9 December) of 1992.

c/ Ad-clip=Adipose fin-clipped fish.

d/ The number of effectively tagged fish excludes fish that were not tagged and tagging mortalities.

e/ TRH=Trinity River Hatchery.

f/ Coho salmon grilse were <51 cm FL.

APPENDIX 7. Fork Length distribution 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 1992-93 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Fin-clips c/	Effective tags d/	TRH e/ recoveries	Total trapped	Fin-clips c/	Effective tags d/	TRH e/ recoveries
32	1							
33	0							
34	1							
35	2				1			
36	2	2			0			
37	0	0			0			
38	4	3			0			
39	1	1			1	1		
40	2	2			0	0		
41	1	1			0	0		
42	1	1			0	0		
43	0	0			0	0		
44	2	0	2		0	0		
45	1	0	1		0	0		
46	2	0	2		2	1	2	
47	3	2	3		0	0	0	
48	4	2	4	1	0	0	0	
49	4	4	4	2	4	2	4	1
50	2	1	2	1	0	0	0	0
51	4	1	4	1	1	1	0	0
52	8	8	7	3	1	0	1	0
53	2	0	2	0	0	0	0	0
54	7	4	7	0	1	1	1	0
55	7	5	7	1	4	3	4	2
56	16	10	15	4	1	1	1	1
57	8	2	7	2	0	0	0	0
58	8	6	8	0	2	0	2	0
59	14	6	12	0	0	0	0	0
60	10	4	8	3	3	3	3	1
61	20	5	19	1	3	2	3	0
62	15	6	15	2	0	0	0	0
63	11	3	11	1	1	0	1	0
64	5	1	4	0	0	0	0	0
65	7	0	7	0	1	1	1	1
66	4	2	4	1	1	0	1	0
67	2	0	2	0	1	1	1	1
68	0	0	0	1	1		1	
69	3	1	3					
70	0	0	0					
71	3	2	3					
72	0		0					
73	1		1					
74	1		1					
75	0		0					
76	0		0					
77	0		0					
78	1		1					
Totals	190	85	166	24	29	17	26	7
Mean FL	56.9	55.0	58.5	56.6	55.3	55.5	56.8	58.1
Total half-pounders f/	14	9	0	0	2	1	0	0
Total adults	176	76	166	24	27	16	26	7

a/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 48 (2 December) of 1992.

b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 49 (9 December) of 1992.

c/ Since brood year 1990 all steelhead released from Trinity River Hatchery have been fin-clipped.

d/ The number of effectively tagged fish excludes fish that were not tagged and tagging mortalities.

e/ TRH=Trinity River Hatchery.

f/ Half-pounder fall-run steelhead were < 42 cm FL.

APPENDIX 8. Release and recovery data for Trinity River Hatchery-produced, fin-clipped and non-fin-clipped fall-run adult steelhead in the Trinity River during the 1992-93 season.

	Release data				Recovery data			
	Brood	Number		Mean	Numbers recovered at: a/			
Fin clip	year	released	Date	fork length (cm)	WCW	JCW	ANGLER	TRH
Adipose+right ventral	1989	180,967	03/18/91	21.7	17	3	2	73
Adipose+left ventral	1990	962,812	03/18/91	18.0	47	12	1	227
Right ventral	1990	1,909	03/16/92	35.2	1	0	0	107
Left ventral	1991	959,313	03/16/92	18.1	3	0	0	23
Adipose b/					8	1	0	9
Non-fin-clipped c/					100	11	6	16
Totals					176	27	9	455

a/ WCW=Willow Creek Weir, JCW=Junction City Weir, ANGLER=Angler-harvested fish, TRH=Trinity River Hatchery.

b/ Fin clip of unknown origin.

c/ Non-fin-clipped fall-run steelhead were either Trinity River Hatchery- or naturally produced.

APPENDIX 9. California Fish and Game Commission regulations that affected salmonid harvest in the Trinity River upstream of Willow Creek Weir during the 1992-93 season. [a/]

<table>
<tr><th>Body of Water</th><th>Open Season and Special Regulations.</th><th>Daily Bag and Possession Limit</th></tr>
<tr><td colspan="3">(91.1) Klamath River Below Iron Gate Dam
(I) Trinity River</td></tr>
<tr><td>2. Lewiston Dam to 250 feet downstream from Lewiston Dam.</td><td>Closed to all fishing all year.</td><td></td></tr>
<tr><td>3. From 250 feet below Lewiston Dam to Old Lewiston bridge.</td><td>Last Saturday in April through September 15. Only artificial flies with barbless hooks may be used.</td><td>2 trout, 0 salmon</td></tr>
<tr><td>4. From Old Lewiston bridge to Highway 299 West bridge at Cedar Flat.</td><td>Last Saturday in April through March 14. Only barbless hooks may be used from August 1 through December 31.</td><td rowspan="5">No more than 2 trout. No more than 1 salmon over 22 inches total length. No more than 3 salmon over 22 inches in any 7 consecutive days. No more than 8 salmon may be possessed, of which no more than 3 may be over 22 inc total lengt</td></tr>
<tr><td>5. From the Highway 299 West bridge at Cedar Flat downstream to the Hawkins Bar Bridge (Road to Denny).</td><td>Last Saturday in April through August 31. November 16 through March 14. Only barbless hooks may be used from August 1 through December 31.</td></tr>
<tr><td>6. From Hawkins Bar Bridge (Road to Denny) to the mouth of the South Fork Trinity.</td><td>Last Saturday in April through March 14. Only barbless hooks may be used from August 1 through December 31.</td></tr>
<tr><td>7. The main stem Trinity River downstream from mouth of the South Fork of the Trinity.</td><td>All year. Only barbless hooks may be used from August 1 through December 31.</td></tr>
<tr><td>8. South Fork of the Trinity River downstream from the South Fork Trinity River bridge at Hyampom.</td><td>Saturday preceding Memorial Day through Mar. 14. Only barbless hooks may be used from August 1 through December 31.</td></tr>
<tr><td>9. South Fork Trinity River main stem above the South Fork Trinity River bridge near Hyampom.</td><td>Closed to all fishing all year.</td><td></td></tr>
<tr><td>10. North Fork Trinity River above the lower boundary of the Hobo Gulch Campground.</td><td>Closed to all fishing all year.</td><td></td></tr>
<tr><td>11. New River main stem above the confluence with the East Fork.</td><td>Closed to all fishing all year.</td><td></td></tr>
<tr><td>12. All tributaries of the Trinity River not listed above.</td><td>Last Saturday in Apr. through Nov. 15; Maximum size limit: 14 inches total length.</td><td>2 trout, 0 salmon</td></tr>
<tr><td colspan="3">13... NO PERSON SHALL RETAIN ANY KING SALMON OVER 22.0 INCHES TOTAL LENGTH IN THE TRINITY RIVER AND SOUTH FORK TRINITY RIVER COMMENCING 28 DAYS AFTER THE DEPARTMENT DETERMINES THAT 50% OF THE ALLOWABLE KLAMATH RIVER BASIN SPORT CATCH HAS BEEN TAKEN BELOW THE FALLS AT COON CREEK ON THE KLAMATH RIVER IN ANY YEAR. DEPARTMENT SHALL INFORM THE COMMISSION, AND THE PUBLIC VIA THE NEWS MEDIA PRIOR TO ANY IMPLEMENTATION OF THE PROVISIONS OF THIS SUBSECTION. [b/]</td></tr>
</table>

a/ From State of California, Fish and Game Commission, California Code of Regulations for 1992, Title 14. Natural Resources, Division 1. Fish and Game Commission-Department of Fish and Game, Chapter 3, Article 3, Section 7.50 (Alphabetical List of Waters with Special Fishing Regulations).

b/ Subsection 13 became effective 5 November 1992.

APPENDIX 10 Fork length distribution 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 1992-93 season.

	Recovery location of fin-clipped fish a/														
Fork	Willow Creek Weir b/					Junction City Weir c/					Trinity River Hatchery d/				
length (cm)	RV	LV	Ad+RV	Ad+LV	Ad	RV	LV	Ad+RV	Ad+LV	Ad	RV	LV	Ad+RV	Ad+LV	Ad
25															
26												5			
27												3			
28												5			
29												4			
30												5			
31												4			
32												0			
33												3			
34												1			
35												1			
36		2										3			
37		0									2	8	1		
38		3									2	12	1	1	
39		1					1				4	24	1	2	
40		2									9	10	0	3	
41		1									6	8	0	1	
42		1									12	6	4	3	
43		0									13	4	1	3	1
44		0									12	2	3	2	0
45		0									12	1	0	0	0
46		0							1		12	0	4	2	0
47		0		2					0		10	0	0	4	0
48		0		2					0		5	1	3	7	1
49		0	2	2					2		3	0	2	7	1
50		0	0	1					0		4	0	7	9	1
51		0	0	1					1		3	1	9	13	0
52		0	1	7					0		1	1	2	18	0
53		0	0	0					0		2	0	4	12	0
54		0	2	2					1		3	0	2	18	1
55		0	2	2	1				3		2	1	4	10	0
56		1	2	6	1				1		2	0	2	16	1
57		0	0	2	0				0		3	2	2	8	0
58		0	4	1	1				0		0	0	3	14	0
59		0	1	3	2				0		3	0	0	13	0
60		1	0	2	1			2	1		1	2	5	10	0
61			1	4	0			0	1	1	2	0	2	11	1
62			1	4	1			0	0		1	0	1	13	0
63			0	3	0			0	0		0	0	2	9	0
64			0	1	0			0	0		1	1	6	5	0
65			0	0	0			0	1			0	0	4	0
66			0	2	0			0				0	2	6	1
67			0		0			1				0	0	4	0
68			0		0							0	3	2	0
69			0		1							0		1	1
70			0									0		0	
71	1		1									0		0	
72												0		1	
73												0		0	
74												1		0	
75														1	
76														0	
77														0	
78														0	
79														0	
80														0	
81														0	
82														0	
83														0	
84														0	
85														0	
86														0	
87														0	
88														0	
89														1	
Totals	1	12	17	47	8	0	1	3	12	1	130	119	76	234	9
Mean FL		42.0	56.8	56.4	59.8			62.3	54.7		46.2	38.4	53.5	55.8	55.1

a/ RV = Right ventral fin clip; 1990 brood year, released from Trinity River Hatchery on 16 March 1992.
LV = Left ventral fin clip; 1991 brood year, released from Trinity River Hatchery on 16 March 1992.
Ad+RV = Adipose and right ventral fin clip; 1989 brood year, released from Trinity River Hatchery and Sawmill Pond on 18 March 1991.
Ad+LV = Adipose and left ventral fin clip; 1990 brood year, released from Trinity River Hatchery on 18 March 1991.
Ad = Adipose fin clip; unknown origin.

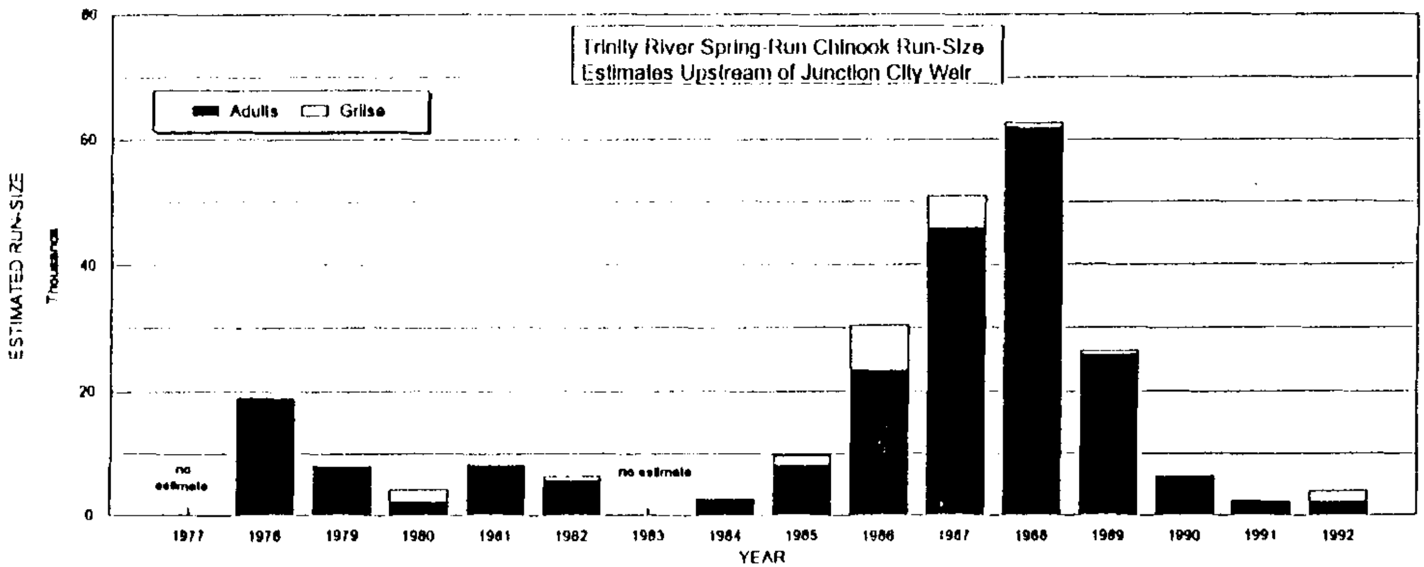
b/ Trapping at Willow Creek Weir took place from Julian week 34 (20 August) through Julian week 48 (2 December) of 1992.

c/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 49 (8 December) of 1992.

d/ The fish ladder was open 11 September 1992 through 28 March 1993.

Weir from 1977 through 1992.

Year	Run-size estimate: Grilse Number	Grilse Percent	Adults Number	Adults Percent	Total	Spawner escapements: Natural Grilse	Natural Adults	Natural Total	Trinity River Hatchery Grilse	Hatchery Adults	Hatchery Total	Angler harvest: Grilse	Adults	Total
1977	No estimates					No estimates			385	1,124	1,509	No estimates		
1978	190	1.0%	18,816	99.0%	19,006	29	14,384	14,413	153	3,680	3,833	8	752	760 a/
1979	113	1.4%	7,964	98.6%	8,077	0	5,008	5,008	113	1,658	1,771	0	1,298	1,298
1980	1,949	45.9%	2,301	54.1%	4,250	1,312	1,614	2,926	353	547	900	284	140	424
1981	347	4.2%	7,913	95.8%	8,260	242	3,362	3,604	95	2,405	2,500	10	2,146	2,156
1982	656	10.3%	5,731	89.7%	6,387	387	3,868	4,255	150	1,226	1,376	119	637	756
1983	No estimates					No estimates			228	930	1,158	No estimates		
1984	255	9.4%	2,465	90.6%	2,720	140	1,354	1,494	76	736	812	39	375	414
1985	1,434	14.8%	8,278	85.2%	9,712	799	4,897	5,696	508	2,645	3,153	127	736 b/	863
1986	7,018	23.1%	23,403	76.9%	30,421	4,335	13,371	17,706	1,461	7,083	8,544	1,222	2,949	4,171
1987	4,858	9.5%	46,016	90.5%	50,874	2,577	29,083	31,660	1,387	8,466	9,853	894	8,467	9,361
1988	720	1.1%	61,972	98.9%	62,692	241	39,329	39,570	377	13,905	14,282	102	8,738	8,840
1989	502	1.9%	25,804	98.1%	26,306	435	18,241	18,676	17	4,983	5,000	50	2,580	2,630
1990	265	4.1%	6,123	95.9%	6,388	126	2,880	3,006	104	2,433	2,537	35	810	845
1991	190	8.0%	2,191	92.0%	2,381	92	1,268	1,360	71	614	685	27	309	336
1992	1,671	41.5%	2,359	58.5%	4,030	944	942	1,886	533	1,313	1,846	194	104 c/	298



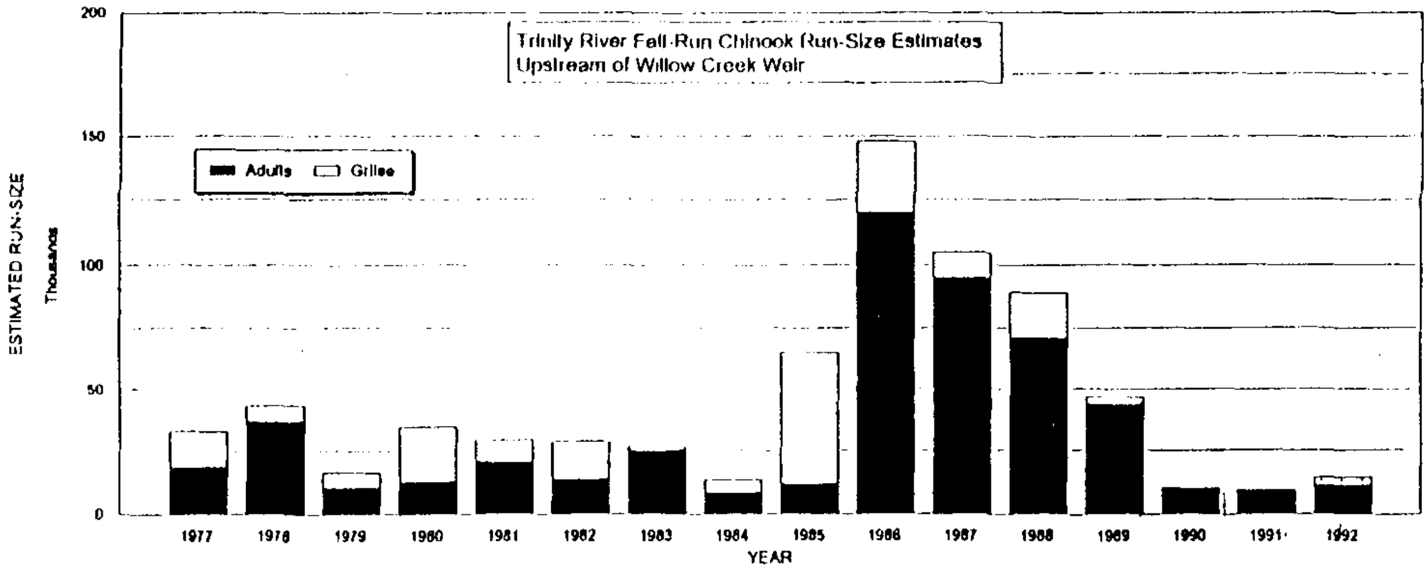
a/ The 1978 sport harvest of spring-run chinook was limited by a salmon fishing closure beginning 25 August 1978.

b/ The 1985 sport harvest of adult spring-run chinook was limited by a closure for the taking salmon greater than or equal to 56 cm total length beginning 22 September 1985.

c/ The 1992 sport harvest of adult spring-run chinook was limited by a closure for the taking chinook salmon greater than or equal to 56 cm total length beginning 5 November 1992.

APPENDIX 12. Fall-run chinook salmon run-size, spawner escapement and angler harvest estimates for the Trinity River upstream of Willow Creek Weir from 1977 through 1992.

	Run-size estimate					Spawner escapements						Angler harvest		
						Natural			Trinity River Hatchery					
	Grilse		Adults		Total	Grilse	Adults	Total	Grilse	Adults	Total	Grilse	Adults	Total
Year	Number	Percent	Number	Percent										
1977	14,318	43.5%	18,596	56.5%	32,914	9,737	13,501	23,238	2,177	2,035	4,212	2,404	3,060	5,464
1978	6,037	14.0%	37,086	86.0%	43,123	4,712	31,052	35,764	1,325	6,034	7,359	Fishing closure a/		0
1979	5,665	35.0%	10,520	65.0%	16,185	3,936	8,028	11,964	964	1,335	2,299	765	1,157	1,922
1980	21,549	62.7%	12,797	37.3%	34,346	16,837	7,700	24,537	2,256	4,099	6,355	2,456	998	3,454
1981	8,366	28.6%	20,884	71.4%	29,250	5,906	15,340	21,246	1,004	2,370	3,374	1,456	3,174	4,630
1982	14,938	52.2%	13,653	47.8%	28,591	8,149	9,274	17,423	4,235	2,058	6,293	2,554	2,321	4,875
1983	1,240	4.7%	25,138	95.3%	26,378	853	17,284	18,137	271	5,494	5,765	116	2,360	2,476
1984	4,575	34.8%	8,556	65.2%	13,131	3,416	5,654	9,070	766	2,166	2,932	393	736	1,129
1985	53,062	81.6%	11,954	18.4%	65,016	29,454	9,217	38,671	18,166	2,583	20,749	5,442	154 b/	5,596
1986	27,506	18.6%	120,382	81.4%	147,888	20,459	92,548	113,007	3,609	15,795	19,404	3,438	12,039	15,477
1987	9,325	8.9%	95,287	91.1%	104,612	5,949	71,920	77,869	2,453	13,934	16,387	923	9,433	10,356
1988	18,113	20.3%	71,309	79.7%	89,422	10,626	44,616	55,242	4,752	17,352	22,104	2,735	9,341	12,076
1989	2,991	6.4%	43,631	93.6%	46,622	2,543	29,445	31,988	239	11,132	11,371	209	3,054	3,263
1990	634	6.3%	9,358	93.7%	9,992	241	7,682	7,923	371	1,348	1,719	22	328	350
1991	681	7.4%	8,526	92.6%	9,207	382	4,867	5,249	205	2,482	2,687	94	1,177	1,271
1992	2,932	20.7%	11,232	79.3%	14,164	2,563	7,139	9,702	211	3,779	3,990	158	314 c/	472



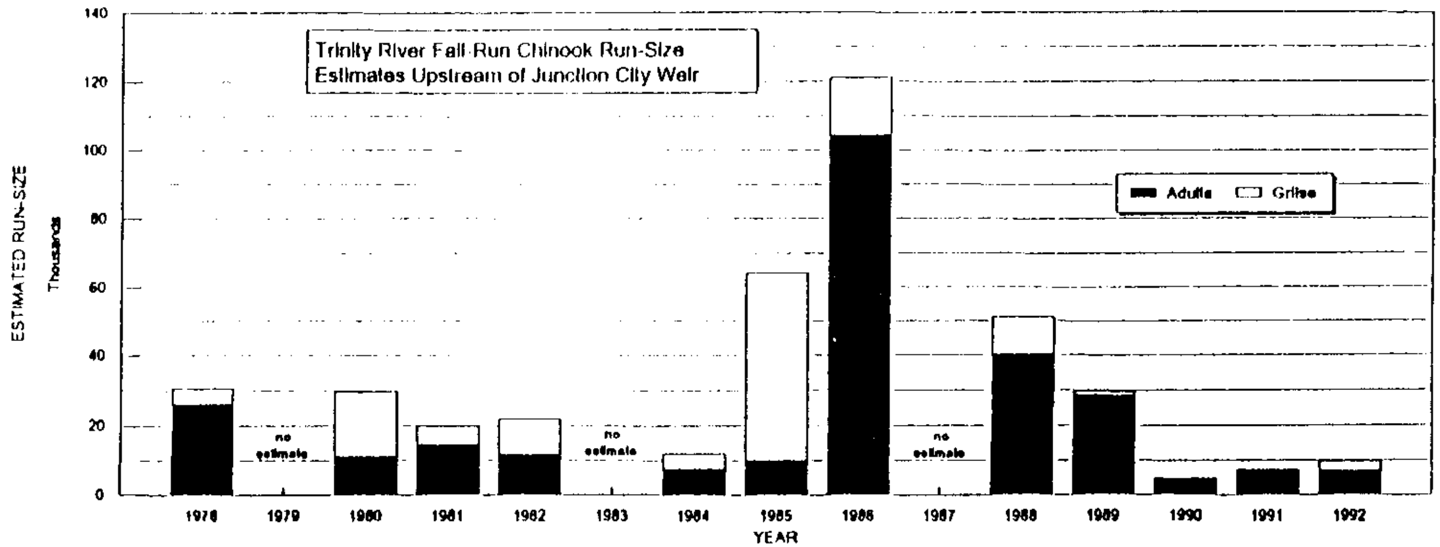
a/ The 1978 sport harvest of fall-run chinook was essentially eliminated by a salmon fishing closure beginning 25 August 1978.

b/ The 1985 sport harvest of adult fall-run chinook was limited by a closure for the taking salmon greater than or equal to 56 cm total length beginning 22 September 1985.

c/ The 1992 sport harvest of adult fall-run chinook was limited by a closure for the taking chinook salmon greater than or equal to 56 cm total length beginning 5 November 1992.

APPENDIX 15. Fall-run chinook salmon run-size, spawner escapement and angler harvest estimates for the Trinity River upstream of Junction City Weir from 1977 through 1992.

	Run-size estimate					Spawner escapements						Angler harvest		
						Natural			Trinity River Hatchery					
	Grilse		Adults		Total	Grilse	Adults	Total	Grilse	Adults	Total	Grilse	Adults	Total
Year	Number	Percent	Number	Percent										
1977			No estimates				No estimates		2,177	2,035	4,212		No estimates	
1978	4,299	14.0%	26,408	86.0%	30,707	2,974	20,374	23,348	1,325	6,034	7,359		Fishing closure a/	0
1979			No estimates				No estimates		964	1,335	2,299		No estimates	
1980	18,390	62.0%	11,271	38.0%	29,661	16,134	7,172	23,306 b/	2,256	4,099	6,355		"	
1981	5,155	26.0%	14,673	74.0%	19,828	4,151	12,303	16,454 b/	1,004	2,370	3,374		"	
1982	9,925	45.6%	11,862	54.4%	21,787	5,690	9,804	15,494 b/	4,235	2,058	6,293		"	
1983			No estimates				No estimates		271	5,494	5,765		"	
1984	4,121	34.8%	7,722	65.2%	11,843	3,355	5,556	8,911 b/	766	2,166	2,932		"	
1985	54,154	84.3%	10,072	15.7%	64,226	33,267	7,412	40,679	18,166	2,583	20,749	2,721	77 c/	2,798
1986	16,564	13.7%	104,469	86.3%	121,033	11,615	83,982	95,597	3,609	15,795	19,404	1,340	4,692	6,032
1987			No estimates				No estimates		2,453	13,934	16,387		No estimates	
1988	10,750	21.0%	40,427	79.0%	51,177	5,145	20,160	25,305	4,752	17,352	22,104	853	2,915	3,768
1989	973	3.3%	28,743	96.7%	29,716	691	16,346	17,037	239	11,132	11,371	43	1,265	1,308
1990	457	9.5%	4,330	90.5%	4,787	83	2,931	3,014	371	1,348	1,719	3	51	54
1991	552	7.6%	6,679	92.4%	7,231	338	4,088	4,426	205	2,482	2,687	9	109	118
1992	2,530	26.4%	7,054	73.6%	9,584	2,304	3,148	5,452	211	3,779	3,990	15	127 d/	142



a/ The 1978 sport harvest of fall-run chinook was essentially eliminated by a salmon fishing closure beginning 25 August 1978.

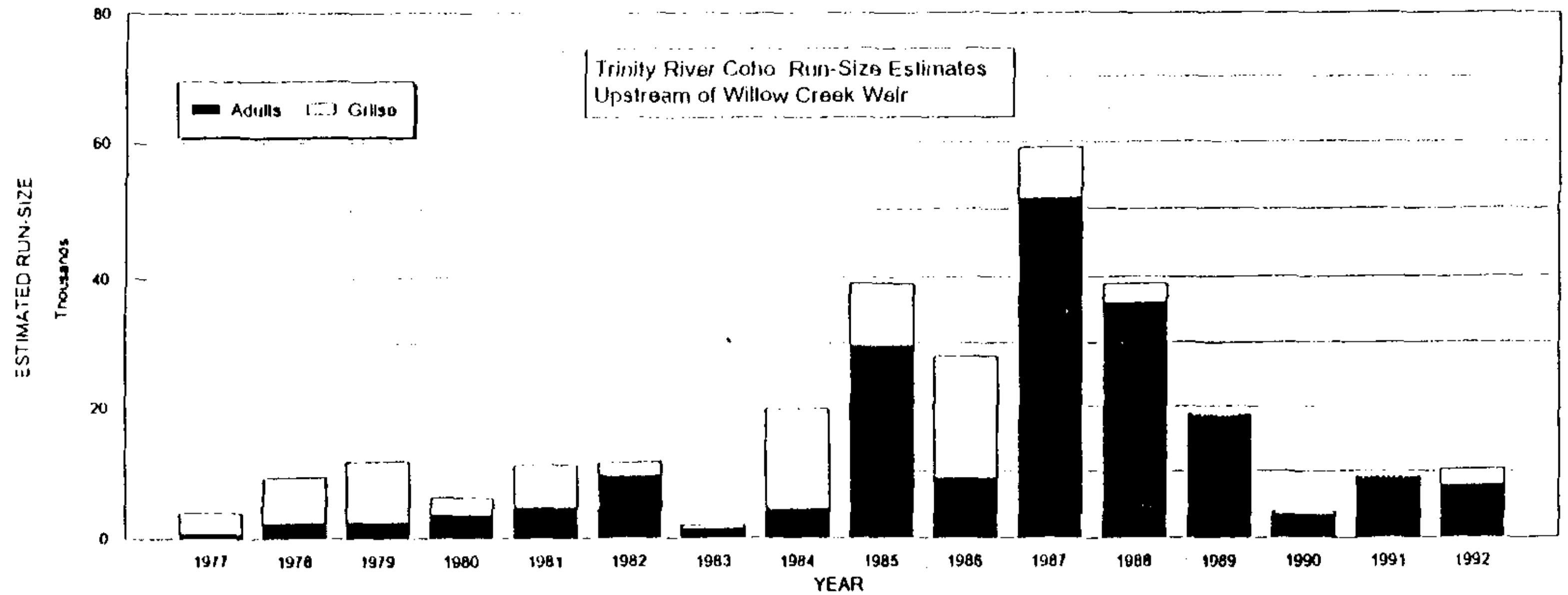
b/ The natural spawner escapement reflects an overestimate due to the unknown number of fish harvested by anglers upstream of Junction City Weir.

c/ The 1985 sport harvest of adult fall-run chinook was limited by a closure for the taking salmon greater than or equal to 56 cm total length beginning 22 September 1985.

d/ The 1992 sport harvest of adult fall-run chinook was limited by a closure for the taking chinook salmon greater than or equal to 56 cm total length beginning 5 November 1992.

APPENDIX 14. Coho salmon run-size, spawner escapement and angler harvest estimates for the Trinity River upstream of Willow Creek Weir from 1977 through 1992.

Year	Run-size estimate: Grilse Number	Grilse Percent	Adults Number	Adults Percent	Total	Spawner escapements: Grilse	Natural: Adults	Natural: Total	Trinity River Hatchery: Grilse	Adults	Total	Angler harvest: Grilse	Adults	Total
1977	3,106	80.5%	752	19.5%	3,858	1,756	25	1,781	1,230	698	1,928	120	29	149
1978	6,685	73.2%	2,447	26.8%	9,132	4,309	1,168	5,477	2,376	1,279	3,655	Fishing closure a/		0
1979	9,067	78.0%	2,557	22.0%	11,624	5,567	1,695	7,262	2,793	742	3,535	707	120	827
1980	2,499	41.0%	3,595	59.0%	6,094	954	1,817	2,771	1,545	1,778	3,323			0
1981	6,144	56.0%	4,826	44.0%	10,970	3,486	1,995	5,481	1,994	2,529	4,523	664	302	966
1982	2,021	17.5%	9,508	82.5%	11,529	1,158	5,097	6,255	823	3,975	4,798	40	436	476
1983	536	27.2%	1,435	72.8%	1,971	295	788	1,083	192	514	706	49	133	182
1984	15,208	77.2%	4,486	22.8%	19,694	6,188	2,971	9,159	7,727	1,134	8,861	1,293	381	1,674
1985	9,216	23.7%	29,717	76.3%	38,933	4,798	21,586	26,384	4,237	7,549	11,786	181	582 b/	763
1986	18,909	67.6%	9,063	32.4%	27,972	13,034	6,247	19,281	5,402	2,589	7,991	473	227	700
1987	7,253	12.3%	51,826	87.7%	59,079	3,975	28,398	32,373	2,865	20,473	23,338	413	2,955	3,368
1988	2,731	7.0%	36,173	93.0%	38,904	1,850	22,277	24,127	743	12,073	12,816	138	1,823	1,961
1989	290	1.5%	18,462	98.5%	18,752	208	13,274	13,482	77	4,893	4,970	5	295	300
1990	412	10.6%	3,485	89.4%	3,897	234	1,981	2,215	173	1,462	1,635	5	42	47
1991	265	2.9%	8,859	97.1%	9,124	164	6,163	6,327	98	2,590	2,688	3	106	109
1992	2,378	23.0%	7,961	77.0%	10,339	1,168	5,565	6,733	1,210	2,372	3,582	0	24	24

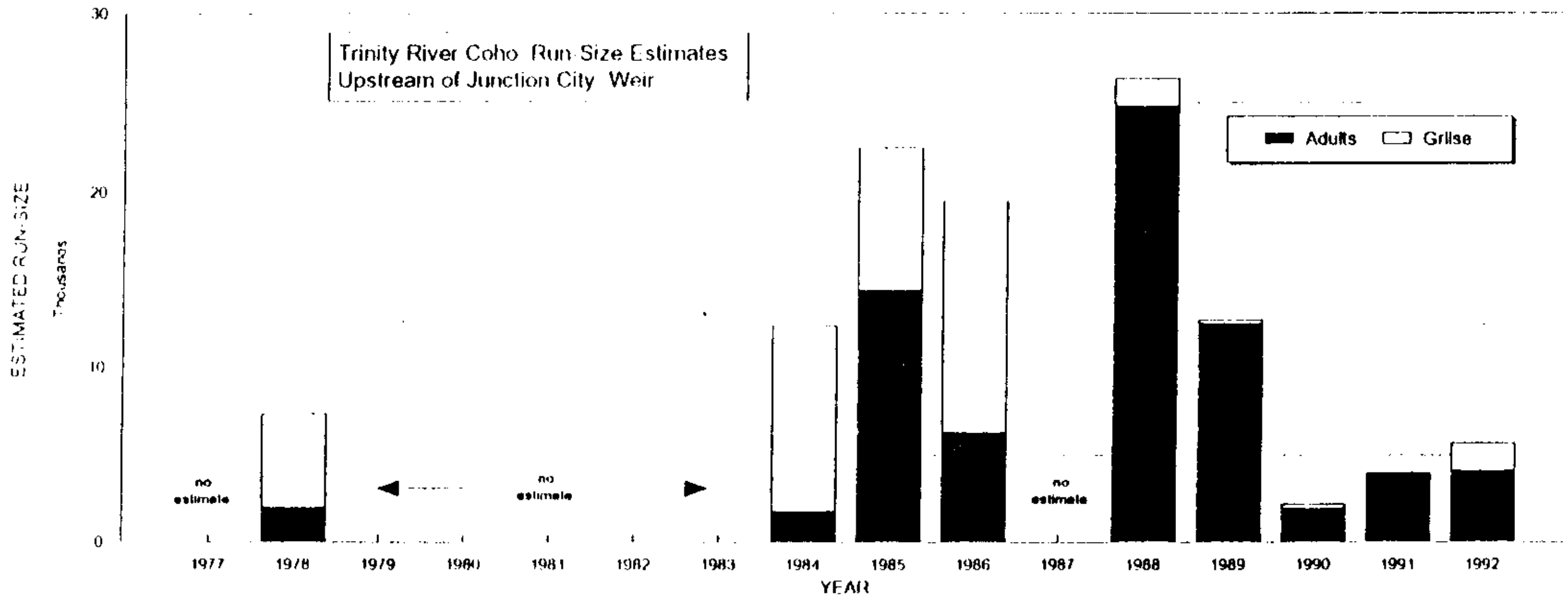


a/ The 1978 sport harvest of coho was essentially eliminated by a salmon fishing closure beginning 25 August 1978.

b/ The 1985 sport harvest of adult coho was limited by a closure for the taking salmon greater than or equal to 56 cm total length beginning 22 September 1985.

from 1977 through 1992.

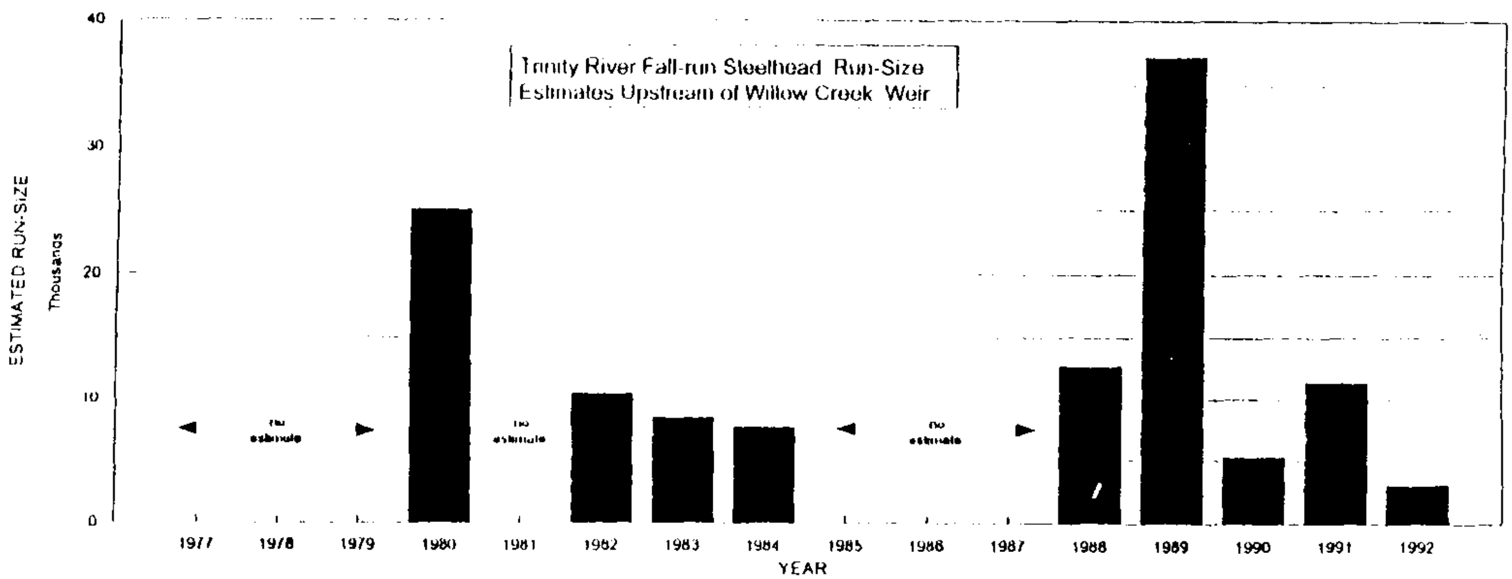
Year	Run-size estimate: Grilse Number	Grilse Percent	Adults Number	Adults Percent	Total	Spawner escapements: Grilse	Natural Adults	Total	Trinity River Hatchery: Grilse	Adults	Total	Angler harvest: Grilse	Adults	Total
1977		No estimates					No estimates		1,230	698	1,928		No estimates	
1978	5,324	72.3%	2,036	27.7%	7,360	2,948	757	3,705	2,376	1,279	3,655		Fishing closure a/	0
1979		No estimates					No estimates		2,793	742	3,535		No estimates	
1980		"					"		1,545	1,778	3,323		"	
1981		"					"		1,994	2,529	4,523		"	
1982		"					"		823	3,975	4,798		"	
1983		"					"		192	514	706		"	
1984	10,488	85.4%	1,797	14.6%	12,285	2,761	663	3,424	7,727	1,134	8,861			0
1985	8,064	35.9%	14,398	64.1%	22,462	3,827	6,849	10,676	4,237	7,549	11,786			0
1986	13,168	67.6%	6,312	32.4%	19,480	7,766	3,723	11,489	5,402	2,589	7,991			0
1987		No estimates					No estimates		2,865	20,473	23,338		No estimates	
1988	1,529	5.8%	24,841	94.2%	26,370	723	11,929	12,652	743	12,073	12,816	63	839	902
1989	196	1.6%	12,429	98.4%	12,625	118	7,461	7,579	77	4,893	4,970	1	75	76
1990	230	10.6%	1,947	89.4%	2,177	57	485	542	173	1,462	1,635	0	0	0
1991	131	3.3%	3,865	96.7%	3,996	32	1,252	1,284	98	2,590	2,688	1	23	24
1992	1,539	27.1%	4,144	72.9%	5,683	329	1,772	2,101	1,210	2,372	3,582	0	0	0



a/ The 1978 sport harvest of coho was essentially eliminated by a salmon fishing closure beginning 25 August 1978.

APPENDIX 16 Fall-run steelhead run-size, spawner escapement and angler harvest estimates for the Trinity River upstream of Willow Creek Weir from 1977 through 1992.

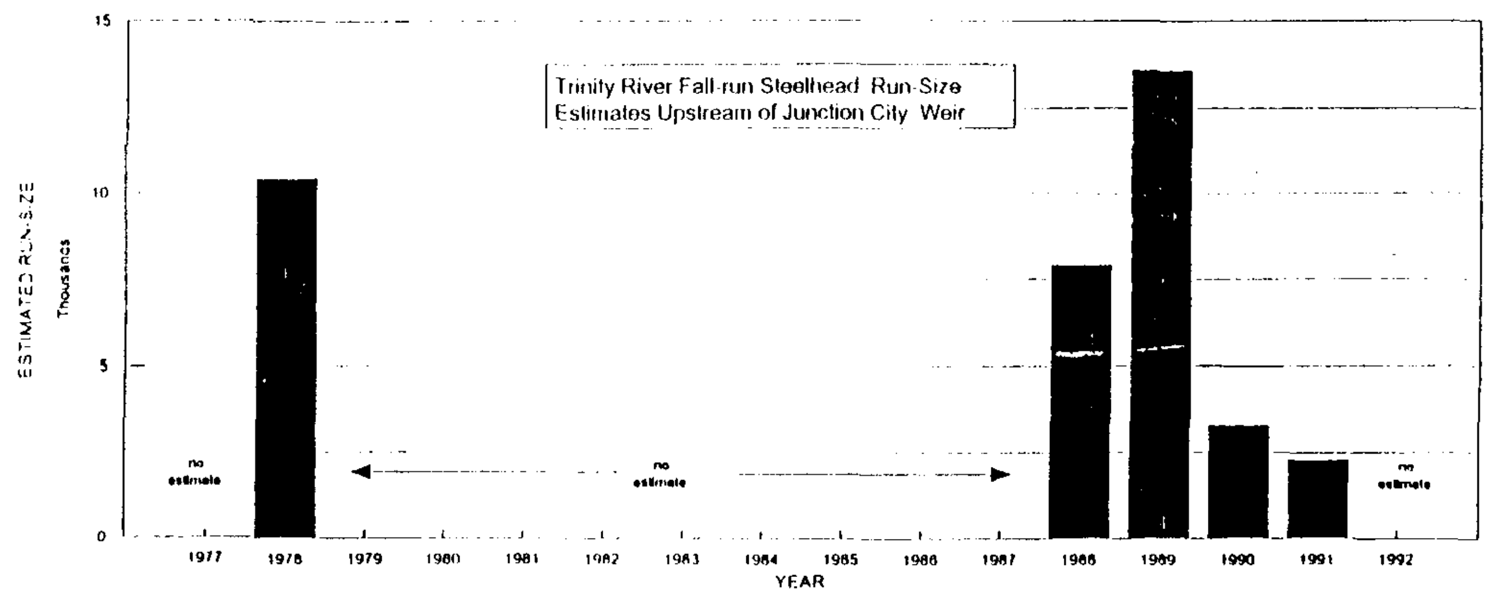
	Run-size estimate					Spawner escapement						Angler harvest		
	Hatchery a/		Wild b/				Natural		Trinity River Hatchery					
Year	Number	Percent	Number	Percent	Total	Hatchery	Wild	Total	Hatchery	Wild	Total	Hatchery	Wild	Total
1977	No estimates					No estimates			269	16	285	No estimates		
1978	"					"			628	55	683	"		
1979	"					"			329	53	382	"		
1980	8,449	33.7%	16,645	66.3%	25,094	5,101	14,462	19,563	1,903	102	2,005	1,445	2,081	3,526
1981	No estimates					No estimates			892	112	1,004	No estimates		
1982	2,106	20.0%	8,426	80.0%	10,532	971	6,889	7,860	634	79	713	501	1,458	1,959
1983	No estimates for hatchery/wild components				8,605			6,661			599			1,345
1984	"				7,833			6,430			142			1,261
1985	No estimates					No estimates					461	No estimates		
1986	"					"					3,780	"		
1987	"					"					3,007	"		
1988	No estimates for hatchery/wild components				12,743			11,926 c/			817	"		
1989	"				37,276			28,933			4,765			3,578
1990	"				5,348			3,188			930			1,230
1991	"				11,417			8,631			446			2,340
1992	1315	43.2%	1731	56.8%	3,046	759	1,540	2,299	430	25	455	126	166	292



a/ Trinity River Hatchery-produced steelhead.
b/ Naturally-produced steelhead
c/ The natural spawner escapement reflects an overestimate due to the unknown number of fish harvested by anglers upstream of Willow Creek Weir

APPENDIX 17. Fall-run steelhead run-size, spawner escapement and angler harvest estimates for the Trinity River upstream of Junction City Weir from 1977 through 1992.

	Run-size estimate					Spawner escapements						Angler Harvest		
	Hatchery a/		Wild b/			Natural			Trinity River Hatchery					
Year	Number	Percent	Number	Percent	Total	Hatchery	Wild	Total	Hatchery	Wild	Total	Hatchery	Wild	Total
1977			No estimates				No estimates		269	16	285		No estimates	
1978	3,965	38.0%	6,469	62.0%	10,434	3,059	4,603	7,662	628	55	683	278	1,811	2,089
1979			No estimates				No estimates		329	53	382		No estimates	
1980			"				"		1,903	102	2,005		"	
1981			"				"		892	112	1,004		"	
1982			"				"		634	79	713		"	
1983			"				"				599		"	
1984			"				"				142		"	
1985			"				"				461		"	
1986			"				"				3,780		"	
1987			"				"				3,007		"	
1988	No estimates for hatchery/wild component				7,907			7,090 c/			817		"	
1989			"		13,574			6,596			4,765			2,213
1990			"		3,296			1,955			930			411
1991			"		2,285			1,355			446			484
1992			No estimates				No estimates				455		No estimates	



a/ Trinity River Hatchery-produced steelhead.
b/ Naturally-produced steelhead.
c/ The natural spawner escapement reflects an overestimate due to the unknown number of fish harvested by anglers upstream of Willow Creek Weir.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992-1993 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

Mark Zuspan and Ed Miller

ABSTRACT

Between 1 July 1992 and 30 June 1993, 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 through the hatchery release facility. We effectively marked 325,835 spring-run and 307,332 fall-run chinook salmon, and 53,058 coho salmon.

Recovery operations at Trinity River Hatchery captured 921 adipose fin-clipped chinook and coho salmon. Coded-wire tags were recovered from 161 spring-run and 305 fall-run chinook salmon, and 321 coho salmon.

Run-size, in-river angler harvest, and spawner escapements of marked spring- and fall-run chinook, and coho salmon of the 1987 through 1990 brood years are presented. Complete returns are only available for both runs of chinook from the 1987 brood year, returning as two- through five-year-olds, and for coho from the 1989 brood year, returning as two- and three-year-olds.

We estimated that 210 spring-run and 547 fall-run chinook salmon from the 1987 brood year returned to the Trinity River basin upstream of Junction City Weir and Willow Creek Weir, respectively, as two- through five-year-olds during the years 1989 through 1992. We also estimated that 461 marked coho salmon from the 1989 brood year entered the Trinity River basin upstream of the Willow Creek Weir during the 1991 and 1992 seasons.

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 1 July 1992 through 30 June 1993, the California Department of Fish and Game's (CDFG) Trinity River Project marked and released chinook salmon smolts and yearlings, and one-year-old-plus (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 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 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 1991-92 season (Heubach and Miller 1994). 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 o tricaine methanesulfonate. Once anesthetized, we marked the fish by removing their adipose (Ad) fin, and injected a coded-wire tag (CWT) into their rostrum with a Northwest Marine Technologies Mark IV[1] tagging unit. Spring chinook smolts received half-length tags, while all other salmon groups received full-length tags.

After marking, fish were dropped into a funnel supplied with running water that led to a quality control device. If the fish had a CWT, the quality control device tallied it and diverted the fish into a separate rearing pond. If a fish had not received a CWT, the quality control device gave a warning signal and diverted the fish into a rejection bucket. Fish in the rejection bucket were re-tagged later that day. Periodically during the marking period, we inspected samples of fish for the placement and retention of the CWT and quality of the Ad-clip.

Salmon from a particular tag group were held together in separate rearing ponds until release. Immediately before release, a systematic sample of 300-to-500 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).

We determined the number of properly tagged and fin-clipped (effectively marked) fish released by subtracting mortalities, which occurred during and after tagging operations, and the estimated number 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 into the Trinity River through the hatchery release facility.

Coded-wire Tag Recovery

The TRH fish ladder was open from 11 September 1992 through 28 March 1993. 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 external tags[2] and fin-clips, and its sex and FL (cm) were recorded. Ad-clipped fish which were not ready to spawn were given an additional distinguishing fin-clip and placed in ponds to ripen. Later, when these fish were killed and spawned, we determined the initial day the fish was sorted from

---

[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.

[2] Trinity River Project personnel tagged returning salmon and steelhead as part of Job IV activities.

its unique fin-clip. These dates were used in Chapter IV to document the timing of the returns of hatchery fish to TRH. We removed the heads of all Ad-clipped salmon and placed each in a sealable plastic 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 extraction and decoding. We were provided with a computer file of the CWT data for editing and analysis.

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

The information 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 proportion 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 in Chapter IV (p. 102). The same sets of equations employed during the 1991-1992 season were used to determine run-size, harvest, and spawner escapement (Heubach and Miller 1994).

To estimate the numbers of the salmon above a specific weir site with a CWT, 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 group.

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

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

where, $SF_{CWT\ group}$ = number of salmon of a specific CWT 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 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 a specific CWT group available to the natural spawner escapement was:

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

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] 136.5) and Willow Creek Weir (WCW) (RKM 47.0), respectively.

RESULTS AND DISCUSSION

Fish Marking and Release

Five groups of chinook salmon reared at TRH, totaling 633,167 fish, were effectively marked (Ad-clipped and CWTed), and released into the Trinity River from the hatchery during October 1992 and June 1993 (Table 1). One group of spring chinook yearlings and two groups of fall chinook yearlings were released in October 1992. All three groups were from the 1991 BY. The two groups of yearling fall chinook were released as a replicate tag-experiment to determine variability in the numbers of CWTed fish caught in the fisheries and returning to the hatchery. Spring and fall chinook smolts of the 1992 BY were released in June 1993. We also marked coho from the 1991 BY at TRH. The coho were released into the Trinity River in March 1993 (Table 1).

e 1. Coded-wire tagging and release of spring- and fall-run chinoo d coho salmon from Trinity River Hatchery, 1992-93 season. a/

CWT b/ code	Brood year	Total number tagged	Mortality Number	Mortality %	Extrapolated shed tags & poor fin-clips Number c/	Extrapolated shed tags & poor fin-clips %	Number of tagged fish d/	Release data Date e/	Release data No./kg	Release data FL (mm) f/	Release data No. unmarked fish
Spring-run chinook salmon											
0601040106	1992	228,621	2,027	0.9%	11,556	5.1%	215,038	06/15/93	97.9	93.5	273,181
065658	1991	112,167	300	0.3%	1,070	1.0%	110,797	10/02/92	18.0	158.9	264,504
Total spring-run:		340,788	2,327	0.7%	12,626	3.7%	325,835				537,685
Fall-run chinook salmon											
065733	1992	216,059	1,976	0.9%	22,051	10.2%	192,032	06/16/93	145.9	76.9	2,150,005
065731	1991	58,925	200	0.3%	145	0.2%	58,580	10/02/92	21.3	145.5	415,850
065732	1991	56,920	200	0.4%	0	0.0%	56,720	10/02/92	21.3	145.5	402,646
Subtotal yearlings:		115,845	400	0.3%	145	0.1%	115,300				818,496
Total fall-run:		331,904	2,376	0.7%	22,196	6.7%	307,332				2,968,501
Total chinook:		672,692	4,703	0.7%	34,822	5.2%	633,167				3,506,186
Coho salmon											
065662	1991	54,353	162	0.3%	1,133	2.1%	53,058	03/29/93	17.6	165.2	331,497
Total Salmon:		727,045	4,865	0.7%	35,955	4.9%	686,225				3,837,683

a/ All releases were made into the Trinity River from the hatchery release facility.

b/ CWT = coded-wire tag.

c/ Numbers of unmarked fish were calculated from percentages of unmarked fish observed in samples taken before release and the total numbers of marked fish excluding mortalities.

d/ The number of tagged fish released = the total number of fish marked minus the mortality and the extrapolated number of fish with shed tags or poor fin clips.

e/ Chinook salmon released in June were smolts, those released in October were yearlings. Coho releases were yearling-plus fish.

f/ FL = Average fork length.

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 921 TRH-produced, Ad-clipped chinook and coho during the 1992-93 season. These consisted of 140 male and 78 female spring chinook, 184 male and 160 female fall chinook, and 262 male and 97 female coho (Table 2).

CWTs were extracted from 787 of the 921 Ad-clipped salmon recaptured. These were from 161 spring chinook, 305 fall chinook, and 321 coho.

In addition to the CWTs from TRH-produced fish, we also recovered four CWTs from fish tagged by the Trinity Fisheries Investigations Project (another element of CDFG's Klamath-Trinity Program). These were naturally produced chinook captured and tagged in the mainstem Trinity River from the BYs 1988 and 1989 (one fish each), and 1990 (two fish) (see Chapter II).

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

Spring-run Chinook Salmon

We estimated the run-size, angler harvest, and spawning escapement of the eight spring chinook CWT groups returning to the Trinity River upstream of Junction City Weir this season (Table 3). CWT group 066147 was the only spring chinook group (1987 BY smolt release) returning to TRH with a completed life cycle (ages two- through five-years-old). These fish were raised at an off-site facility while Trinity River Hatchery was being modernized. There were no 1987 BY yearling spring chinook raised. The overall return rate of CWT group 066147 was 0.113 percent, with three- through five-year-olds comprising 0.080 percent of overall returns (Table 3, Figure 1).

The other CWT groups have not yet completed their life cycles, but in general, the yearling release groups are returning as adults at rates at least three-times greater than their smolt release counterparts (Table 3, Figure 1). The 1989 BY smolt release group (CWT 0601040102) has, so far, had very poor return rates with 0.003 percent returning as three-year-olds. The comparable yearling release group (CWT 065639) returned as three-year-olds at almost 30 times that rate (0.087 percent).

It should be noted that CWT group 065639 may be composed of both fall and spring chinook. This group, from the 1989 BY, was tagged and released as yearling spring chinook (Heubach, et al. 1992). However, based on their entry dates at TRH, it appears likely that over 50% of the returning fish from this group were

Table 2. Release and recovery data for adipose fin-clipped chinook and coho salmon recovered at Trinity River Hatchery (TRH) during the 1992-93 season.

	Release data						Recovery data				
							Males		Females		
CWT a/ code	Egg source	Brood year	Date	Number	Size (No./kg)	Site	No.	FL b/	No.	FL b/	Total No.
Spring-run chinook salmon											
066147	TRH	1987	05/23/88	185,718	187.0	Sawmill rearing ponds	0	-	2	80	2
066149	TRH	1988	05/26/89	181,698	182.6	TRH	9	76	4	74	13
066148	TRH	1988	10/24/89	98,820	29.3	TRH	21	77	30	71	51
065639	TRH	1989	10/01/90	102,555	25.3	TRH	37	30	15	65	52
0601040102	TRH	1989	05/18-21/90	186,413	189.6	TRH	2	67	1	61	3
0601040103	TRH	1990	05/28/91	196,908	158.4	TRH	36	47	0	-	36
065636	TRH	1990	10/08/91	48,553	21.8	TRH	1	37	0	-	1
065640	TRH	1990	10/08/91	46,086	21.8	TRH	3	43	0	-	3
100000 c/ d/							31	63	26	72	57
						Spring-run chinook salmon totals:	140		78		218
Fall-run chinook salmon											
065633	TRH	1987	06/02/88	172,980	257.4	Ambrose rearing ponds	0	-	2	81	2
065631	TRH	1987	10/28/88	92,300	19.6	Ambrose rearing ponds	2	85	5	85	7
065635	TRH	1988	06/12/89	194,197	161.0	TRH	7	81	12	75	19
065522	TRH	1988	11/01/89	22,234	15.6	TRH	3	80	2	74	5
065523	TRH	1988	11/01/89	24,131	17.8	TRH	5	76	7	74	12
065632	TRH	1988	10/27/89	97,569	34.1	TRH	76	76	87	73	163
0601040101	TRH	1989	05/18/90	201,622	343.9	TRH	3	61	6	63	9
065634	TRH	1989	10/15-16/90	97,810	21.3	TRH	29	57	11	61	40
065637	TRH	1989	10/16/90	23,628	17.6	TRH	12	60	5	61	17
065641	TRH	1989	10/16/90	22,540	18.2	TRH	12	60	9	61	21
065638	TRH	1990	10/09/91	103,040	25.7	TRH	10	42	0	-	10
100000 c/ e/							25	63	14	66	39
						Fall-run chinook salmon totals:	184		160		344
Coho salmon											
065660	TRH	1989	03/18/90	51,088	26.4	TRH	75	61	77	63	152
065657	TRH	1990	04/03/92	52,233	15.7	TRH	163	43	6	49	169
100000 c/	TRH						24	53	14	59	38
						Coho salmon totals:	262		97		359

a/ CWT = Coded-wire tag.
b/ FL = Average fork length.
c/ 100000 = No CWT found or it was lost during recovery.
d/ Assumed to be spring-run chinook from their entry dates into Trinity River Hatchery.
e/ Assumed to be fall-run chinook from their entry dates into Trinity River Hatchery

Table 3. Run-size, percent return, in-river sport catch and spawner escapement estimates for Trinity River Hatchery-produced, coded-wire-tagged spring-run chinook salmon returning to the Trinity River upstream of Junction City Weir during the period 1989 through 1992.

Release data					Estimated returns						
CWT a/ code	Brood year	Date b/	Number	Site	Age	Run-size	% of release	River harvest	Spawning escapement TRH c/	Natural	Total
066147	1987	05/23/88	185,718	Sawmill	2	61	0.033	6	6	49	55
				Pond	3	112	0.060	15	55	42	97
					4	34	0.018	5	13	16	29
					5	3	0.002	0	2	1	3
				Totals: d/		210	0.113	26	76	108	184
				Total adults: e/		149	0.080	20	70	59	129
066149	1988	05/26/89	181,698	TRH	2	30	0.017	4	2	24	26
					3	34	0.019	5	13	16	29
					4	22	0.012	1	13	8	21
066148	1988	10/24/89	98,820	TRH	2	0	0	0	0	0	0
					3	23	0.023	3	9	11	20
					4	87	0.088	4	51	32	83
0601040102	1989	05/18-21/90	186,413	TRH	2	0	0	0	0	0	0
					3	5	0.003	0	3	2	5
065639	1989	10/01/90	102,555	TRH	2	9	0.009	1	6	2	8
					3	89	0.087	4	52	33	85
0601040103	1990	05/28/91	198,908	TRH	2	62	0.031	7	36	19	55
065636	1990	10/08/91	48,553	TRH	2	2	0.004	0	1	1	2
065640	1990	10/08/91	46,086	TRH	2	5	0.011	1	3	1	4

a/ CWT = coded-wire tag.

b/ Chinook salmon released during May were smolts, those released in October were yearlings.

c/ TRH = Trinity River Hatchery.

d/ Totals are presented only for brood year 1987. These fish have reached five years of age and are considered to have completed their life cycle.

e/ The term "adults" means chinook aged three- through five-years-olds.

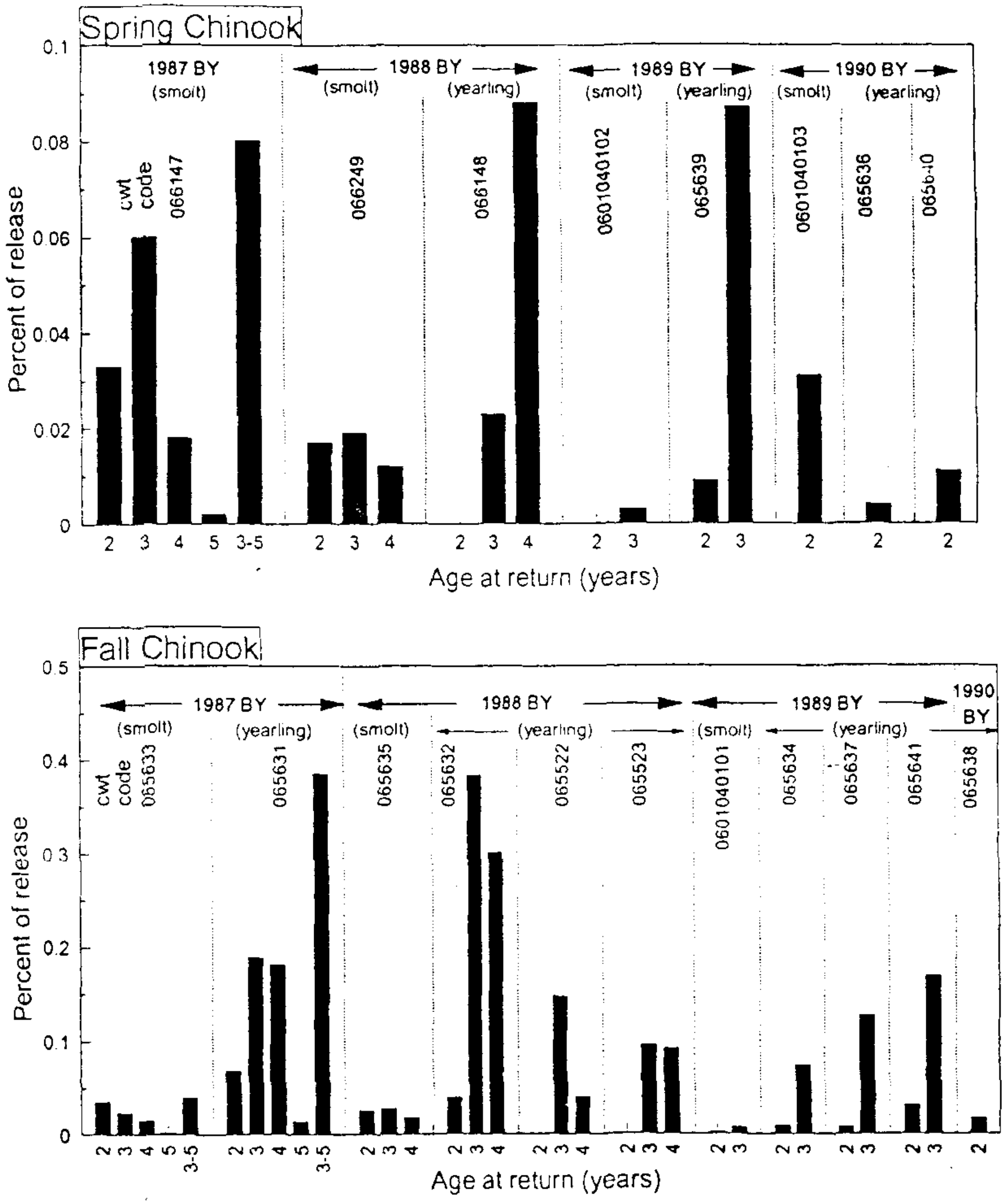


Figure 1. Trinity River in-river return rates for Trinity River Hatchery-produced, coded-wire-tagged (CWT), spring- and fall-run chinook salmon of brood years (BY) 1987-1990 during the years 1989 through 1992.

actually fall chinook (see Chapter IV, p. 123).

Fall-run Chinook Salmon

All fall chinook estimates were for the Trinity River basin upstream of the Willow Creek Weir.

Two CWT groups (065633 and 065631) completed their life cycles this season. Both of these groups, from the 1987 BY, were reared off-site at the Ambrose Ponds during hatchery modernization. The overall return of three- through five-year-olds for the yearling release group was about 10 times that of the smolt release group (0.385 vs. 0.040 percent, respectively) (Table 4, Figure 1).

The CWT group of 1988 BY yearlings (CWT 065632) returned at a rate of about 15 times greater than its smolt release counterpart (CWT code 065635) (Table 4, Figure 1). This was for overall returns of three- and four-year-old fish. Some returns can be expected during the fifth year.

Two 1988 BY fall chinook CWT groups (CWT 065522 and CWT 065523) were used in a feed-experiment conducted by Trinity River Hatchery personnel. The experiment was designed to determine if there was a difference in the adult returns of chinook raised on diets supplied by two different vendors. The adult return rates for these two groups are essentially identical (0.186 and 0.188 percent), although there appeared to be a difference in the age-at-return of the adults (Table 4, Figure 1). No two-year-old fish of either group were recovered.

TRH personnel repeated the feed-experiments with the 1989 BY, CWT groups 065637 and 065641. The return rates for both two- and three-year-old fish were higher for the CWT group 065641 (Table 4, Figure 1).

Coho Salmon

Only two CWTed coho groups returned to the Trinity River upstream of Willow Creek Weir this season. The overall return of the 1989 BY CWT group 065660 was 0.902 percent. This was composed of 0.893 percent three-year-olds and 0.010 percent two-year-olds (Table 5).

Two-year-olds from the 1990 BY (CWT 065657) returned at a relatively high rate of 0.971 percent (Table 5). It is unknown if the high return rate of these fish as two-year-olds will also be seen in high returns of this group as three-year-olds.

Table 4. Run-size, percent return, in-river sport catch and spawner escapement estimates for Trinity River Hatchery-produced, coded-wire-tagged fall-run chinook salmon returning to the Trinity River upstream of Willow Creek Weir during the period 1989 through 1992.

Release data					Estimated returns							
CWT a/ code	Brood year	Date b/	Number	Site	Age	Run-size	% of release	River harvest	Spawning escapement TRH c/	Natural	Total
065633	1987	06/02/88	172,980	Ambrose	2	60	0.035	4	10	46	56
				Pond	3	39	0.023	1	16	22	38
					4	26	0.015	4	11	11	22
					5	4	0.002	0	2	2	4
				Totals: d/		129	0.075	9	39	81	120
				Total adults: e/		69	0.040	5	29	35	64
065631	1987	10/28/88	92,300	Ambrose	2	63	0.068	4	11	48	59
				Pond	3	174	0.189	6	70	98	168
					4	168	0.182	25	72	71	143
					5	13	0.014	0	7	6	13
				Totals: d/		418	0.453	35	160	223	383
				Total adults: e/		355	0.385	31	149	175	324
065635	1988	06/12/89	194,197	TRH	2	50	0.026	2	9	39	48
					3	54	0.028	8	23	23	46
					4	34	0.018	1	19	14	33
065632	1988	10/27/89	97,569	TRH	2	39	0.040	1	7	31	38
					3	374	0.383	55	161	158	319
					4	294	0.301	8	163	123	286
065522 f/	1988	11/01/89	22,234	TRH	2	0	0.	0	0	0	0
					3	33	0.148	5	14	14	28
					4	9	0.040	0	5	4	9
065523 f/	1988	11/01/89	24,131	TRH	2	0	0.	0	0	0	0
					3	23	0.095	3	10	10	20
					4	22	0.091	1	12	9	21
0601040101	1989	05/18/90	201,622	TRH	2	5	0.002	1	2	2	4
					3	16	0.008	0	9	7	16
065634	1989	10/15/90	97,810	TRH	2	9	0.009	1	4	4	8
					3	72	0.074	2	40	30	70
065637 f/	1989	10/16/90	23,625	TRH	2	2	0.008	0	1	1	2
					3	30	0.127	1	17	12	29
065641 f/	1989	10/16/90	22,540	TRH	2	7	0.031	1	3	3	6
					3	38	0.169	1	21	16	37
065638	1990	10/09/91	103,040	TRH	2	18	0.017	1	10	7	17

a/ CWT = coded-wire tag.
b/ Chinook salmon released during May or June were smolts, those released in October or November were yearlings.
c/ TRH = Trinity River Hatchery.
d/ Totals are presented only for brood year 1987. These fish have reached five years of age and are considered to have completed their life cycle.
e/ The term "adults" means chinook aged three- through five-years-olds.
f/ Tagged and released by Trinity River Hatchery personnel.

Table 5. Run-size, percent return, sport catch and spawner escapement estimates for Trinity River Hatchery-produced, coded-wire-tagged coho salmon returning to the Trinity River upstream of Willow Creek Weir during the 1992 and 1993 seasons.

Release Data						Estimated returns					
									Spawning escapement		
CWT a/ code	Brood year	Date	Number	Site	Age	Run-size	% of release	River harvest	Hatchery	Natural	Total
065660	1989	03/18/91	51,088	TRH	2	5	.010	0	5	0	5
					3	456	.893	58	152	246	398
					Totals: b/	461	.902	58	157	246	403
065657	1990	04/03/92	52,233	TRH	2	507	.971	0	169	338	507

a/ CWT = coded-wire tag

b/ Totals are presented only for brood year 1989. These fish have reached three years of age and are considered to have completed their life cycle.

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 1993-94.

LITERATURE CITED

Heubach, B., M. Lau, and E. Miller. 1992. Survival and contribution to the fisheries and spawner escapements made by chinook and coho salmon produced at Trinity River Hatchery. Chapter V, Job V. pp. 146-157. In: K. Urquhart 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 Ninth St., Sacramento, CA 95814.

Heubach, B., and E. Miller. 1994. Survival and contribution to the fisheries and spawner escapements made by chinook and coho salmon produced at Trinity River Hatchery. Chapter V, Job V. pp. 168-179. In: K. Urquhart and R. M. Kano (eds.). Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1991-1992 Season. February, 1994. 235 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 PROJECT
1992-1993 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, marking program at Trinity River Hatchery from 5 January through 2 April 1993. Unique combinations of fin clips were given to each group of fish to permit identification of brood year upon recapture. This season we marked 15,665 steelhead held over from the 1991 brood year with an adipose and right ventral fin-clip, 13,582 of which were effectively marked and released as two-year-olds. We also marked 324,875 steelhead from the 1992 brood year with an adipose and left ventral fin-clip, 323,583 of which were effectively marked and released as yearlings.

We checked 1,000 steelhead from the 1991 brood year and 6,470 from the 1992 brood year for fin-clip accuracy prior to release. We found 0.5% from brood year 1991, and 0.11% from brood year 1992, with poor fin clips.

We monitored adult steelhead returning to Trinity River Hatchery from 14 September 1992 through 28 March 1993, when we determined migration to be completed. During that time 586 steelhead returned to Trinity River Hatchery, of which 96.9% (568/586) were fin-clipped.

Steelhead were also checked for fin clips as they entered through the Willow Creek and Junction City weirs. One hundred-ninety steelhead were observed at the Willow Creek Weir, of which 44.7% (85/190) were fin-clipped. Twenty-nine steelhead were observed at the Junction City Weir, of which 58.6% (17/29) were fin-clipped.

JOB OBJECTIVES

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 a significant part of the historic steelhead spawning and rearing habitat in the Trinity River basin, and resulted in significant downstream flow reductions. Project-induced reduction in fishery habitat and flow are among the factors contributing to the decline of annual runs of steelhead.

In October 1984, U.S. Public Law 98-541 was passed to mitigate for fish and wildlife losses. 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 restoration of fish and wildlife populations to pre-dam conditions.

Knowledge of hatchery- and naturally produced steelhead escapements into the Trinity River is a necessary component both for management recommendations and determining the effectiveness of 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 the California Department of Fish and Game's (CDFG) Trinity Fisheries Investigations Project (TFIP) marked steelhead produced at Trinity River Hatchery (TRH) as part of the first phase in meeting the Job Objectives. The second phase included the monitoring of adults returning to TRH.

METHODS

Hatchery Marking Operations

Steelhead Brood Year Selection and Growth

Steelhead from the 1991 and 1992 TRH brood years (BY) were available for marking this season. Fish of each BY were monitored throughout the season to ensure that groups being marked would meet the hatchery minimum release-size requirement of six inches. Growth was monitored and recorded by hatchery staff during weekly standard weight counts (number of fish per pound), an operating procedure used to determine the amount of food given to fish following feed 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 also culled fish while marking, placing smaller fish into holding tanks until they could be moved into hatchery ponds for further growth.

Fish Marking and Release

A crew of four markers from CDFG's TFIP marked steelhead at TRH inside a 3-m X 3-m wooden shed , positioned directly over the hatchery ponds. The shed contained a four-station marking table and a circulating fresh-water holding tank of approximately 284 liters. Fish were netted directly from the hatchery ponds, and placed into the holding tank. Another smaller holding tank with circulating fresh water was located in the center of the marking table and was used to hold fish immediately before marking. Each station was equipped with a manual counter to count each fish marked.

The marking 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 MS-222 solution. This system used 1½ cups of MS-222 per week, and was was installed to minimize fish mortality caused by overdosage of anaesthetic. Carbon dioxide (CO_2) was used to anaesthetize the last group of steelhead marked (approximately 4,600 fish) on 2 April 1993, since they were to be released before the 21-day holding period required by MS-222 use. Fresh-water and MS-222 solution temperatures were monitored regularly throughout the day.

Marking of 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. A combination of right ventral (RV) or left ventral (LV), and adipose (Ad) fin clips were used to differentiate fish from each BY and age-group-at-release. Fish marked this year from the 1991 BY were given an Ad+RV fin clip to be released as two-year-olds, and those from the 1992 BY, an Ad+LV fin clip to be released as yearlings. We randomly checked steelhead one to four times per day throughout

---

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

marking to see how well the fins were being removed. A sample of fish was netted as they exited the marking shed and checked before they entered the hatchery ponds.

We also examined a larger sample of marked steelhead immediately prior to release to determine fin-clip quality and fish size. Fish were anaesthetized with MS-222, measured to the nearest mm fork length (FL), and fin-clips were inspected. These fish were placed in a separate holding pond, and released after the 21-day holding period required by MS-222 use. Fin clipping is considered a permanent mark if the fin rays are removed to the point of attachment to the bone (Stuart 1958; Eipper and Forney 1965; Jones 1979). Fins which are less than one-half-removed are likely to regenerate, and may appear distorted at the location of the clip. Unless persons checking for fin clips specifically look for distorted rays, fish that were actually marked may be unrecognizable. We determined the number of effectively marked fish by multiplying the percentage of fish with poor fin clips by the total number of fish released, and subtracting this product from the release total. Numbers of fish released from TRH were estimated by TRH personnel using standard weight counts on a subsample of each marked group.

A sample of marked fish was checked for health and general condition through an autopsy conducted by a CDFG Fisheries Pathologist. A complete organosomatic analysis was done and results are on file with the CDFG Region-I pathologist. Results in this report are confined only to general remarks made by the pathologist. Fish were also inspected for general condition during the hatchery mark-evaluation process by Project personnel.

Recovery Operations

Recoveries of returning marked steelhead were conducted at TRH, river kilometer (RKM) 179.8, and downstream at two trapping locations; Junction City Weir (42.7 km downstream from TRH), and Willow Creek Weir (131.4 km downstream from TRH). Project personnel examined fish for fin clips, measured each to the nearest cm FL, and recorded its sex. Trinity River Project (TRP) personnel operated the Junction City and Willow Creek weirs, where they examined steelhead for fin clips, measured each to the nearest cm FL, recorded its sex, spaghetti-tagged each, then released them back into the mainstem Trinity River. Scale samples were taken from steelhead at all three recovery locations.

RESULTS AND DISCUSSION

Hatchery Marking Operation

Steelhead Brood Year Selection and Growth

Brood Year 1991 (Two-year-olds). Approximately 15,000 fish were held over from the 1992 marking season because they did not meet the minimum release size. Fish from the 1991 BY were reared at TRH, marked this season, and released as two-year-olds.

According to TRH feeding schedule records, progressive growth occurred throughout the rearing period. During April 1992, the average weight of each fish was 30.2 g, and increased to 378 g by the release date (Figure 1).

Brood Year 1992 (Yearlings). According to TRH feeding schedule records, the 1992 BY fish also grew progressively throughout the rearing cycle. Smaller grade fish were constantly culled and kept in separate hatchery ponds throughout rearing. Smaller fish were probably from eggs that were spawned out last (Laird Marshal, Assistant Manager, TRH, CDFG, pers. comm.). We

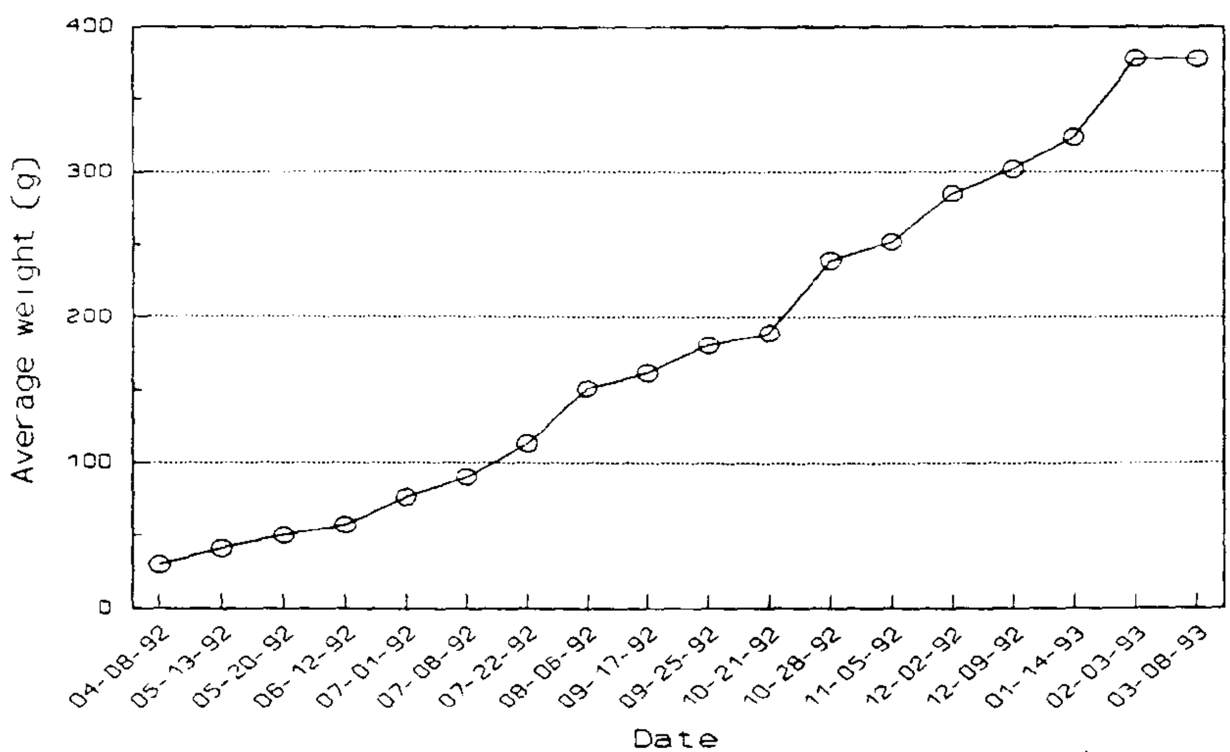


FIGURE 1. The average weights of two-year-old steelhead from the 1991 brood year reared at Trinity River Hatchery from 8 April 1992 through 8 March 1993.

identified four different size-classes in this BY from TRH feeding schedules. After 24 December 1992, we combined the three larger classes into two, and then into one size-class after 28 January 1993, when average individual weight of fish converged at 65 g. Smaller grade fish were recorded as a separate size-class throughout rearing. The average weight of fish from this BY on the date of release was 103.8 g for the larger steelhead, and 63.9 g for the smaller steelhead. Fluctuations seen in recorded size are probably the result of constant grading by TRH personnel (Figure 2).

Fish Marking and Release

This is the fourth consecutive season that Project personnel completed marking and release operations at TRH. To date, we have marked five BYs with a combination of various fin clips (Appendix 1).

Brood Year 1991 (Two-year-olds). We completed marking a total of 15,665 fish from the 1991 BY this season with an Ad+RV fin-clip combination on 5 January 1993, and released them as

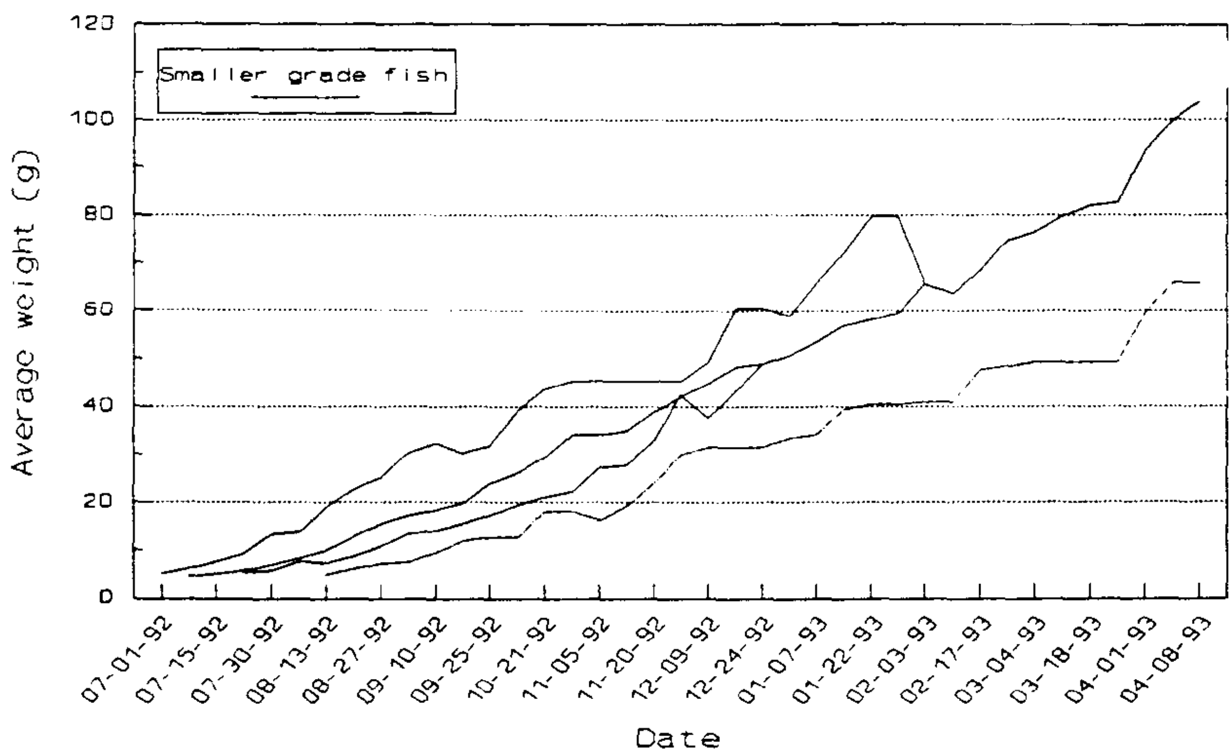


FIGURE 2. The average weights of yearling steelhead from the 1992 brood year reared at Trinity River Hatchery from 1 July 1992 through 8 April 1993. Weights of the three larger groups we combined after 28 January 1993.

two-year-olds. Releases were made into the mainstem Trinity River at TRH, the old weir site (RKM 178.6), and at Old Lewiston Bridge (RKM 176.9). Three release locations were chosen to allow increased angling opportunities over a wider area, and minimize residualism (Laird Marshal, Assistant Manager, TRH, CDFG, pers. comm.). The average size of these fish upon release was 2.6 fish/kg (Table 1).

TABLE 1. Summary of Trinity River Hatchery steelhead marking and release for the 1992-93 season.

Release group					
Brood year	Age	Numbers clipped	Fin-clip type [a]	Release date	Size at release (# fish/kg)
1991	Two-yr-old	15,665	Ad+RV	4/12/93	2.6
1992	Yearling	320,192	Ad+LV	4/12/93	9.7
1992	Yearling	4,683	Ad+LV	4/12/93	15.7

a/ Fin clips were right ventral (RV) or left ventral (LV), and adipose (Ad).

During the hatchery mark evaluation procedure, we checked 1,000 steelhead from this BY and found some dorsal and caudal fin erosion, and scale loss; an organosomatic analysis was not done because of the limited number of fish. Of the 1,000 fish examined, we found 0.5% (5/1000) were poorly fin-clipped. Six hundred of the 1,000 fish were measured. According to TRH fish planting estimates, they released a total of 13,650 fish from this BY; thus we estimated 2,015 mortalities occurred during the rearing period. Altogether, 13,582 steelhead from this BY were considered effectively marked (Table 2). At release, FLs ranged from 184 mm (7.2 in) to 421 mm (16.6 in), and averaged 322.1 mm (12.7 in) with a sample SD of 4.02 (Figure 3).

<u>Brood Year 1992 (Yearlings)</u>. We marked steelhead from this BY with an Ad+LV fin-clip combination from 14 January through 2 April 1993. Throughout this period TRH personnel continually graded fish according to size. Between 14 January and 5 March, we marked a total of 320,192 steelhead. The approximately 5,000 fish remaining were considered too small to fin clip, so marking was temporarily halted. We marked the remaining 4,683 fish from this BY on 2 April, giving us a total of 324,875 fin-clipped yearling steelhead for the season. The average size of these fish was 9.7 fish/kg for the larger fish, and 15.7 fish/kg for the smaller grade fish (Table 1).

TABLE 2. Summary of hatchery mark evaluations for steelhead fin-clipped between 5 January and 2 April 1993.

Release group						
Brood year	Age	Estimated numbers released	Fin-clip type[a]	Numbers evaluated	% Poor clips	Numbers effectively marked[b]
1991	Two-year-old	13,650	Ad+RV	1,000	0.5	13,582
1992	Yearling	323,939	Ad+LV	6,470	0.11	323,583

a/ Fin clips were right ventral (RV) or left ventral (LV), and adipose (Ad).
b/ Number of effectively marked fish = number released X ((100 - % poor clips)/100).

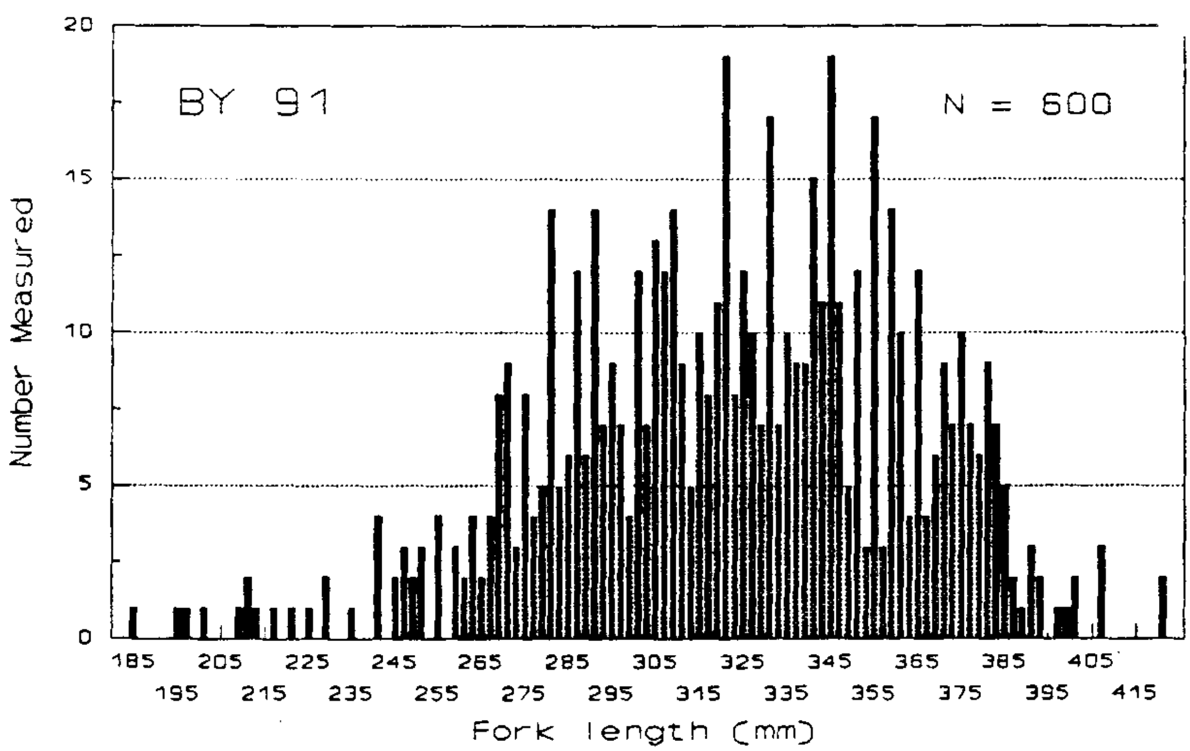


FIGURE 3. Length frequency distribution of fin-clipped two-year-old steelhead from the 1991 brood year released from Trinity Ri Hatchery on 12 April 1993.

We examined a subsample of 6,470 steelhead from the 1992 BY to see how well they were marked, and found 0.11% (7/6470) with poor fin clips. Comparing TRH fish planting estimates with the total number of fish marked, we estimate 936 mortalities occurred during the rearing process. An estimated 323,583 steelhead from this BY were effectively marked and released into the Trinity River at TRH. (Table 2).

Of the 6,470 fish examined, we measured 2,870 (44.4%). Average FLs for the two size groups were determined separately. Smaller-sized fish made up 18.4% (527/2870) of our measured sample. Fork lengths of this size group ranged from 76 mm (3.0 in) to 151 mm (5.9 in), and averaged 124.8 mm (4.9 in) with a sample SD of 1.41. Larger sized fish ranged from 152 mm (6.0 in) to 291 mm (11.5 in), and averaged 198.1 mm (7.8 in) with a sample SD of 1.96 (Figure 4).

A subsample of 20 fish was collected at TRH prior to release by the CDFG pathologist. An organosomatic analysis was done and results were determined by autopsy. Results showed some dorsal and caudal fin wear and scale loss; however, their overall general condition upon release, determined by both the pathologist and Project personnel, appeared to be excellent.

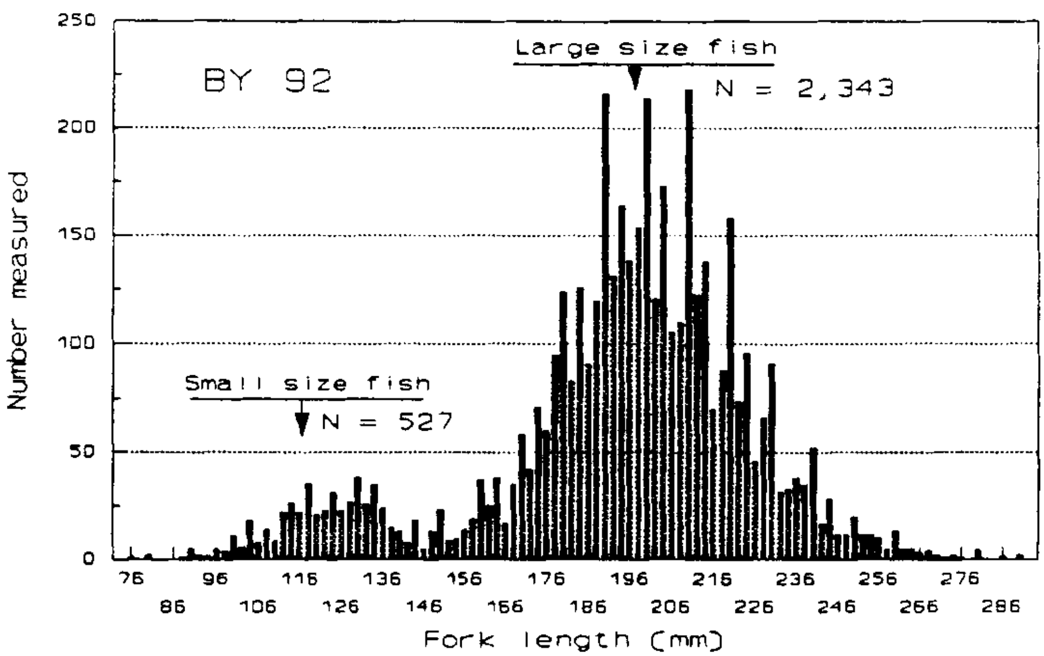


FIGURE 4. Length frequency distribution of fin-clipped yearling steelhead from the 1992 brood year released from Trinity River Hatchery on 12 April 1993.

Recovery Operations

Naturally produced 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 fresh water to spawn when they are 38 to 69 cm in total length. Life-history patterns of steelhead are variable, and growth rates may vary (Moyle 1976).

A fraction of the Trinity River steelhead run have 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[2/]. These fish are referred to as half-pounders.

In relation to life-history patterns, this was the second and third years we expected to see returns of fish which were released in 1990 and 1991 (1988, 1989 and 1990 BYs). Experimental hatchery management practices aimed at increasing adult returns were not conducted with any of these steelhead release groups.

Trinity River Hatchery

There was a significant loss of returning steelhead at TRH this year due to otter predation before recoveries could be made. Otters took fish directly from the holding tanks and fish trap, where only fish body parts were occasionally found. In addition to reducing the possible recovery of marked steelhead, fewer spawners were obtained and fewer eggs taken, which will result in a lower number of juvenile steelhead available for marking next season. Plans to trap and relocate some otters are being made and will be discussed in future reports.

Project personnel monitored steelhead returning to TRH from 14 September 1992 through 28 March 1993, when migration was completed. During that period 586 steelhead returned, of which 568 (96.9%) were fin-clipped, making up the greater proportion of returns to the hatchery. Of those marked fish, 119 (20.9%) had LV fin-clips, from the 1989 BY released as yearlings or from the 1991 BY yearling release; and 130 (22.2%) had RV fin-clips, from the 1989 BY or the 1990 BY two-year-old releases. Ad+RV fin-clips were seen on 76 (13.0%) of the marked steelhead, indicating they were from the 1989 BY yearling release; and 234 (39.9%) fish had Ad+LV fin-clips, indicating they were from the 1990 BY

2/ Hopelain, J. S. Unpublished manuscript. Age, growth, and life history of Klamath River basin steelhead (Salmo gairdnerii), as determined from scale analysis. 33 p. Available from Calif. Dept. of Fish and Game, Inland Fisheries Div., 1416 9th St., Sacramento, CA 95814.

yearling release (Appendix 1). Nine steelhead were marked with an Ad fin-clip only, origin unknown, and 18 were unmarked. Ad-clipped-only fish may have at one time been marked in conjunction with a ventral fin clip, and were probably the result of poor fin clipping and regeneration.

During the 1990-91 and 1991-92 seasons, totals of 927 and 295 steelhead, respectively, were observed at TRH. Marked fish constituted 2.4% of the 1990-91 returning fish, and 62.0% of the 1991/92 returns. Three- and four-year-old adults of the 1988 BY, released as two-year-olds, composed the largest proportions of the marked fish recovered at TRH for both those seasons (Appendix 2).

Junction City Weir

TRP personnel monitored steelhead at Junction City Weir from 21 May through 8 December 1992, when migration was complete. During that period 29 steelhead were recorded, of which 17 (58.6%) were fin-clipped. Of those marked fish, 12 (70.6%) had Ad+LV fin-clips, indicating they were from the 1990 BY; three (17.6%) had Ad+RV fin-clips, indicating they were from the 1989 BY; and one (5.9%) had a LV fin-clip, from the 1991 BY. One recovery was marked with an Ad fin-clip only, and 12 were unmarked. No RV fin-clipped steelhead were recovered at the Junction City Weir this season.

During each of the past three seasons, the total number of steelhead caught at Junction City Weir was lower than at either of the other two recovery sites. The percentage of fin-clipped fish seen at Junction City, however, was intermediate to the percentages seen at TRH and Willow Creek Weir. The marked fish recovered during the 1990-91 season could not be assigned to a BY release group because of a questionable fin clip. Four-year-olds from the 1988 BY made up the largest proportion of marked fish recovered at Junction City Weir during the 1991-92 season (Appendix 2).

Willow Creek Weir

TRP personnel monitored steelhead at Willow Creek Weir from 20 August through 2 December 1992, when migration was complete. During that period 190 steelhead were observed, of which 85 (44.7%) were fin-clipped. Of those marked fish, one (1.2%) had a RV fin-clip, from the 1988 BY; 12 (14.1%) had LV fin-clips, from the 1989 BY or from the 1991 BY. Ad+RV fin-clips were seen on 17 (20.0%) of the marked steelhead, indicating they were from the 1989 BY; and 47 (55.3%) had Ad+LV fin-clips, indicating they were from the 1990 BY. Eight recoveries had an Ad fin-clip only, and 105 were unmarked.

No marked steelhead were seen at Willow Creek Weir during the 1990-91 season. During the 1991-92 season, four-year-olds from the 1988 BY again made up the largest proportion of marked fish recoveries.

RECOMMENDATIONS

1. Marking should continue, starting at the latest possible date to allow the maximum time for fish growth. This would eliminate unnecessary delays during marking.
2. Only one marking shed should be used next season because of the low number of steelhead expected to be available.
3. Steps should be taken to reduce or eliminate otter predation upon steelhead returning to TRH.

LITERATURE CITED

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.

Jones, R. 1979. Materials and methods used in marking experime. , in fishery research. Food and Agriculture Organization of the United Nations, Fisheries Technical Paper Number 190 (FIRM/T190). Rome, Italy.

Heubach, B. 1984. Progress Report, 1981-82 Season. Task VI. Trinity River salmon and steelhead tagging program. pp. 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. 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. pp. 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. Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

Moyle, P. B. 1976. Inland Fishes of California. pp. 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. pp. 215-237. (Tagging and Marking). In: L.A. Nielson and D. L. Johnson, (eds.), Fisheries Techniques. American Fisheries Society. Virginia: Southern Printing Co. 1983.

Zuspan, M., D. Maria, and B. Heubach. 1985. Progress Report, 1982-83 Season. Task IV. Trinity River salmon and steelhead tagging program. pp. 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. 146 p. Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

APPENDIX 1. Summary of Trinity River Hatchery marked steelhead releases for the 1989-90 through 1992-93 seasons.

Marking season	Fin-clip type	Brood year	Age at release	Size at release: # Fish per kg	Size at release: Mean FL (cm)	Size at release: Range FL (cm)	Release date	Release site	Number of effectively marked fish released
1989-1990	Right ventral	1988	Two-year-old	3.5	26.6	16.0-40.0	03/15/90	TRH	50,490
	Left ventral	1989	Yearling	19.8	15.9	10.7-23.0	04/06/90	TRH	257,997
	Left ventral	1989	Yearling	22.0	—	—	04/23/90	TRH	148,000
1990-1991	Adipose + right ventral	1989	Two-year-old	2.0	—	—	03/18/91	Sawmill site	81,796
	Adipose + right ventral	1989	Two-year-old	1.6	21.7	11.0-32.0	03/18/91	TRH	99,171
	Adipose + left ventral	1990	Yearling	3.2	18.0	10.0-24.0	03/18/91	TRH	962,812
1991-1992	Right ventral	1990	Two-year-old	2.4	35.2	20.5-45.5	03/16/92	TRH	1,909
	Left ventral	1991	Yearling	17.5	18.4	7.5-28.3	03/16/92	TRH	959,313
1992-1993	Adipose + right ventral	1991	Two-year-old	2.6	32.3	18.4-42.1	04/12/93	TRH	—
				2.6	32.3	18.4-42.1	04/12/93	Old weir site	—
				2.6	32.3	18.4-42.1	04/12/93	Old Lewiston Brdg.	—
								Total	13,582
	Adipose + left ventral	1992	Yearling	9.7	19.8	15.2-29.1	04/12/93	TRH	—
				15.7	12.5	7.6-15.1	04/12/93	TRH	—
								Total	323,583

APPENDIX 2. Summary of adult steelhead recoveries made at Trinity River Hatchery (TRH), Junction City Weir (JCW), and Willow Creek Weir (WCW) during the 1990-91, 1991-92, and 1992-93 seasons.

	All recoveries			Right ventral fin clip 1/		Left ventral fin clip 2/		Adipose + right ventral fin clip 3/		Adipose + left ventral fin clip 4/		Adipose fin clip only	
Recovery season and location	Number of steelhead observed	Number of marked fish recovered	Percent of total observed	No. with mark	Percent of marks recovered	No. with mark	Percent of marks recovered	No. with mark	Percent of marks recovered	No. with mark	Percent of marks recovered	No. with mark	Percent of marks recovered
1990-1991													
TRH	927	22	2.4	15	68.2	1	4.5	1	4.5	0	--	5	22.7
JCW	138	1	0.7	0	--	0	--	0	--	0	--	1	100.0
WCW	325	0	--	0	--	0	--	0	--	0	--	0	--
Totals	1390	23		15		1		1		0		6	
(Overall Percent)			(1.7)		(65.2)		(4.4)		(4.4)		(--)		(26.0)
1991-1992													
TRH	295	183	62.0	73	39.9	24	13.1	54	29.5	31	16.9	1	0.5
JCW	103	35	34.0	12	34.3	10	28.6	8	22.9	5	14.3	0	--
WCW	638	71	11.1	49	69.0	9	12.7	7	9.9	4	5.6	2	2.8
Totals	1036	289		134		43		69		40		3	
(Overall Percent)			(27.9)		(46.4)		(14.9)		(23.9)		(13.8)		(1.0)
1992-1993													
TRH	586	568	96.9	130	22.2	119	20.3	76	13.0	234	39.9	9	1.5
JCW	29	17	58.6	0	--	1	5.9	3	17.6	12	70.6	1	5.9
WCW	190	85	44.7	1	1.2	12	14.1	17	20.0	47	22.3	8	9.4
Totals	805	670		131		132		96		293		18	
(Overall Percent)			(83.2)		(19.6)		(19.7)		(14.3)		(43.7)		(2.7)

1/ 1988 brood year, two-year-old releases; or 1990 brood year, two-year-old releases (for 1992-93 season recoveries).
2/ 1989 brood year, yearling releases; or 1991 brood year, yearling releases (for 1992-93 season recoveries).
3/ 1989 brood year, two-year-old releases.
4/ 1990 brood year, yearling releases.

ANNUAL REPORT

TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992-1993 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 Game, Trinity Fisheries Investigations Project is conducting a study of spring-run chinook salmon (Oncorhynchus tshawytscha) in the South Fork Trinity River basin. During the 1992-1993 season, we trapped and tagged returning adults, operated recovery weirs, conducted creel, snorkel, redd, and carcass recovery surveys, analyzed adult scales, and trapped emigrant juvenile salmon.

During adult trapping operations in the spring and summer of 1992, we captured 49 spring-run chinook salmon (spring chinook). Subsequently, 21 spring chinook were captured at recovery weirs, six of which had been marked at the tagging weir. During summer snorkel surveys throughout the basin, we observed 166 spring chinook, seventeen of which had been marked at the tagging weir. Based on the above recovery numbers we estimated the run-size to be 324 fish (266 adults and 58 grilse). Weir operation and snorkel surveys showed that the spring chinook run began this season in late April to early May, reached a peak in mid- to late-May, and declined through July and August.

From scale analysis, we determined that the age class distribution of returning fish was 22% two-year-olds, 40% three-year-olds, 32% four-year-olds, and 6% five-year-olds.

Pools were the primary adult summer holding habitat in the basin. Fourteen pools were located which held three or more spring chinook.

Based on tag returns and creel surveys, the angler harvest in the South Fork Trinity River basin was zero.

Spring chinook spawning began on 1 October and ended 26 October, 1992. During redd surveys we located 49 spring chinook redds. Redds were distributed upstream and downstream of Forest Glen in the South Fork Trinity River, with many downstream of Hyampom. Ten spring chinook carcasses were recovered, but only one was tagged.

By trapping emigrant juveniles, we found that spring chinook young-of-the-year emigration began in April, peaked in May, and was essentially complete by 1 July, 1993. No yearling spring chinook were captured.

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 harvest of spring-run chinook salmon in the South Fork Trinity River basin.

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 which occurred that year (LaFaunce 1967). The California Department of Fish and Game (CDFG) and the U.S. Forest Service (USFS) have made numerous attempts to count adult spring chinook (and spring-run 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 (Appendix 1). Reliable, statistically-valid population estimates were not determined during any of these efforts.

The current population of spring chinook in the SFTR is, at most, a few hundred fish. Estimates of annual run size from various sources (Appendix 1) ranged from multiples of ten to about 350 fish. The population has experienced serious decline since 1964, when the run was estimated to be 11,604 (LaFaunce 1967). Up-to-date, valid population estimates and understanding of life-history patterns are crucial to any management or restoration effort for spring chinook.

This is the third year of a proposed five-year study of SFTR spring chinook by the Trinity Fisheries Investigations Project (TFIP). Since our annual reports 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 of 1992 relate to those fish trapped and marked during the 1991-1992 reporting period. Also, most scales used for life-history determinations were obtained from fish trapped and released during the 1991-1992 reporting period.

METHODS

The study area included the lower 124 km of the SFTR, the lower 7 km of the East Fork of the SFTR, and the lower 16 km of Hayfork Creek, totaling 147 km of river. Lafaunce (1967) and USFS surveys (Appendix 1) broke this area into 16 roughly equal sections. We attempted to use these same sections for comparison, but for logistical reasons deviated slightly from their delineations (Figures 1 & 2). We also snorkel surveyed the lower 4 km of Grouse Creek.

This study is comprised of several distinct elements, each intended to generate an escapement estimate or provide information on in-stream life history or distribution.

To meet Job Objective 1, we used the Petersen mark and recapture method, with some variation. We operated a weir at which fish were trapped, tagged, and released. We recovered fish or observed tags in three ways: 1) a recapture weir in the mainstem SFTR, and one in Hayfork Creek; 2) snorkel surveys of the entire study area; and 3) carcass recoveries during the spawning season. Data from each recovery technique were intended to be used in making separate Petersen estimates. We used several recovery techniques to insure that at least one would yield statistically-valid results, and to make comparisons between the different methods. Petersen estimates represent point-in-time run-size estimates upstream of the tagging weir. Snorkel surveys were also used to determine in-river distribution, and to continue documenting run timing once the tagging weir was removed. The number and distribution of redds were determined by foot and kayak surveys (redd surveys).

To meet Job Objective 2, we utilized non-reward tag returns and a limited creel survey. Historically, poaching has been a problem in the SFTR. Non-reward tags were chosen so the potential of poaching, primarily for the reward, was not increased.

To meet Job Objective 3, we analyzed scales collected during the adult trapping operation and carcass recovery surveys, and performed emigrant juvenile trapping.

Immigrant Chinook Trapping and Tagging

Early-entering Portion of the Run

The primary trapping and tagging weir (Gates Weir) was located at river kilometer (RKM) 31.7, 16 km downstream from the township of Hyampom (Figure 1). The weir functioned as a fence across the river, guiding 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-

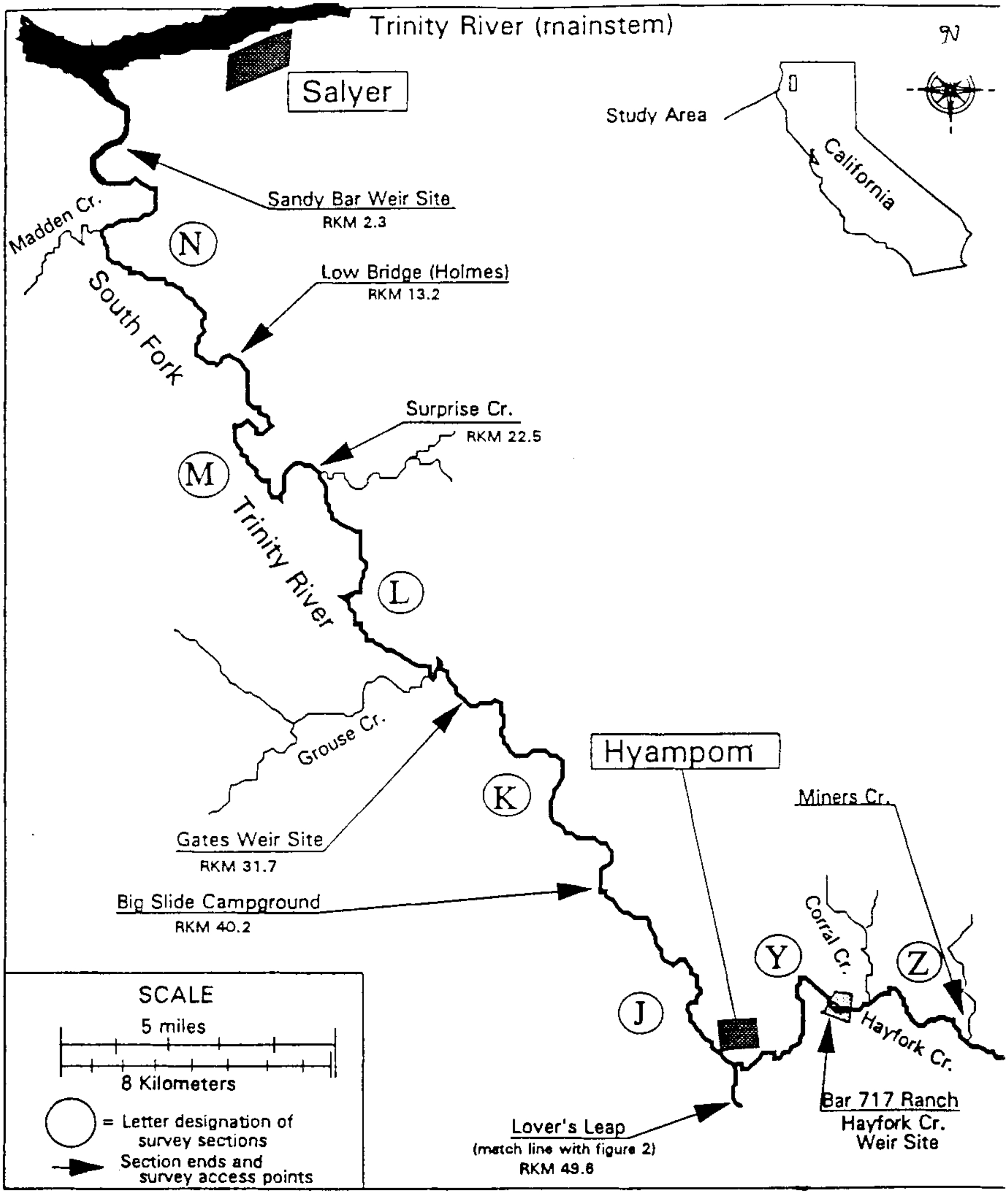


FIGURE 1. Map of the South Fork Trinity River, Hyampom and below, depicting survey sections and major tributaries (RKM = river kilometer, from the mouth of the South Fork Trinity River).

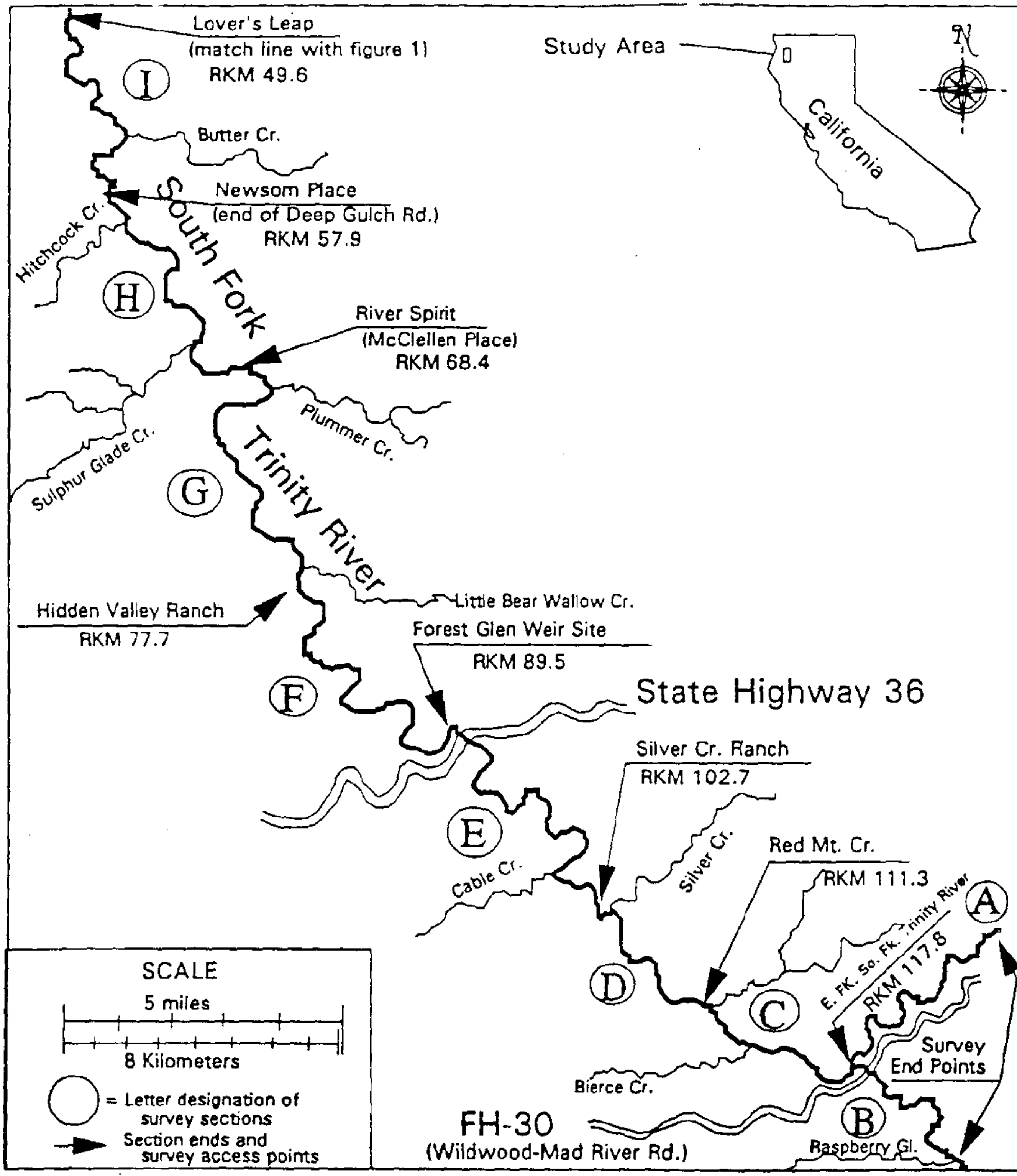


FIGURE 2. Map of the South Fork Trinity River above Hyampom depicting survey sections and major tributaries (RKM = river kilometer, from the mouth of the South Fork Trinity River).

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.

The trap was 2.4 m long by 2.4 m wide by 1.2 m high (vertical dimension) and was constructed with the weir panels described above. Two 1.2-m^2 panels were placed inside the open end of the trap forming a fyke, guiding fish inside and deterring their escape. The conduit of the upstream and side panels was sleeved with clear vinyl tubing to minimize potential abrasion to trapped fish. 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 water surface inside the trap. It was attached only at the upstream end of the trap, so if a fish were to jump and land atop the fabric, it would 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 fish. Foam pipe insulation was used in areas where unavoidable abrasion might otherwise occur. The trap was provided with a lockable plywood lid and solid plywood bottom.

Fish were netted from the trap with a knotless-nylon-mesh net , placed in a tagging cradle. The tagging cradle consisted of a frame, constructed from 1.9-cm-diameter copper pipe, measuring 100 by 50 cm, and was fitted with a nylon cradle 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 (0.32-cm holes) formed the upstream end of the cradle. Once marked and measured, fish were released by raising the sliding door.

During tagging, fish were examined for marks, scars, and general condition, their FL 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. Spring chinook from the 1992 cohort, which appeared healthy, were marked in one of two ways: either a one-half left ventral (½LV) fin clip and a numbered Floy[1/] anchor tag, or a one-half right ventral (½RV) fin clip and a Lotek[1/] implantable radio transmitter. Anchor tags were placed on the left side, just below the dorsal fin, and just posterior to the midline. Radio transmitters were inserted into the stomach of adult spring chinook through the

---

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

esophagus with the aid of a small length of 0.95-cm-diameter plastic 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. Thirty-nine spring chinook were tagged with Floy tags and nine received radio transmitters. (**Note:** Spring chinook were marked as described above during the last reporting period [1991-1992] and are discussed in the RESULTS section of this report. Spring chinook of the 1993 cohort, were marked at the end of this reporting period with a ½RV fin clip and colored anchor-tags, and will be discussed in the 1993-1994 Annual Report.) Spring-run steelhead were marked with a ½LV fin clip.

Tagged fish were 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.

After processing, fish which appeared fresh and strong were immediately released from the cradle to the river, upstream of the weir, without further handling. During periods of warm water temperature (> 15.5 °C) or when they appeared stressed, fish 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. The upstream and downstream ends were fitted with sliding plexiglass doors, each with numerous 2-cm holes allowing 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 or steel fence posts. After recovery, the upstream door was opened and fish were allowed to leave of their own volition.

Late-entering Portion of the Run

Instead of a weir operation, we conducted snorkel surveys and pool follow-up observations to determine the size and distribution of the late-entering segment of the spring chinook run. We felt that the operation of a weir during August and early September, when minimum water temperatures regularly exceed 21 °C, would result in unacceptable fish mortality.

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.

Another significant problem encountered in operating a weir at this time of year, was defining spring-run vs. fall-run chinook salmon (fall chinook), since both are often present at this time. Late-entering spring chinook were identified as those fish which were dark, brassy, and may have had other physical marks indicating they had over-summered lower in the Klamath-Trinity system. Fall chinook were identified as those fish which appeared fresh, bright, nickel-colored, and usually lacked old marks and scars.

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 utilized 1.9-cm galvanized conduit panels as the "fence", but the support and orientation of the pipe was markedly different than the Gates Weir. The conduits slid through holes in 7.6-cm-wide by 3.3-m-long aluminum channel, and contacted the natural river bottom. The aluminum channel was supported on tripods constructed of 8.9-cm x 14-cm, and 3.8-cm x 14-cm Douglas fir beams (standard mill-run). The aluminum channel was oriented horizontally and the conduit was oriented vertically. The center-to-center spacing between conduit elements was 5.7 cm, leaving a 2.5-cm gap.

The trap construction was the same as that of the Gates Weir, except that vinyl tubing was not used to sleeve the conduit elements of 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.

Digital 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 routine weir service.

Snorkel Survey

During the summer of 1992, snorkel surveys were conducted during late July and late August, and covered the entire study area (Figures 1 & 2). Our primary goal was to observe and record th numbers of marked and unmarked spring chinook for making population estimates. We also documented the number and location of over-summer holding pools utilized by three or more spring chinook. We also recorded the numbers of marked and unmarked adult spring-run steelhead seen.

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 9:30 AM and covered 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 downstream, recording the number of adult salmonids and the relative abundance of juvenile salmonids. We also noted habitat types and conditions, water temperatures, 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.

We surveyed two contiguous river sections per-day, four days-per-week. This year we surveyed the lowest sections first and progressed upstream. We were careful to minimize disturbance to fish so that fish movement from one river section to another, and possible double counting, was negligible.

Once we determined which 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 an adjacent steep bluff 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 spawning/redd surveys at the appropriate time.

Redd and Carcass Surveys

Redd and carcass surveys began in late September and continued through mid-November. We made aerial surveys by helicopter every seven to fourteen days covering 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 and local landmarks) and each was assigned a specific identification number. We measured overall redd size and position in the stream, water depth, current velocity, and estimated gravel size. We also estimated the percent fines in surrounding gravels and measured with a Marsh-McBirney[3] flow meter to estimate the total volume of water sampled. Water temperatures were monitored using hand-held thermometers or digital recording thermographs. When flow conditions permitted, we trapped two nights-per-week beginning 2 February, and increased to three nights-per-week near the end of March. We trapped on this schedule until no juvenile chinook salmon were caught for two successive trapping weeks, and emigration appeared to be complete. Results are reported by trap-night, defined as one juvenile trap, fished for one night.

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 mortalities discovered during the snorkel surveys from the effectively marked population since some over-summer mortality is normal.

Run-size Estimates

To determine the run-size above the Gates Weir, we used Chapman's version[4] of the Petersen Single Census Method (Ricker 1975):

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

N = estimated run-size; M = number of effectively tagged fish; C = the total number of spring chinook observed during snorkel or carcass recovery surveys, or at recovery weirs; and R = number of weir-tagged and -marked fish which were seen during the snorkel or carcass recovery surveys, or at recovery weirs.

In using this method, we assumed that fish trapped and marked were a random and representative sample of the population; marked 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;

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.

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).

marked and unmarked fish did not suffer 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 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 ninth week, and the last day of the year is included in the 52nd week (Appendix 2). This procedure allows inter-annual comparisons of identical weekly periods.

RESULTS AND DISCUSSION

1991-1992 Reporting Period

Trapping and Tagging (Early-entering Portion of the Run)

The following paragraph repeats results from the 1991-1992 Annual Report (Dean 1994) to allow the reader to follow the 1992 spring chinook cohort through the summer and fall covered in this report, and to more clearly understand our methodologies and results.

During the 1992 season we operated the Gates Weir for 64 days, from 27 April through 7 July 1992. During this period both immigrant and emigrant traps were maintained. Late in the trapping period we were forced to suspend trapping operations intermittently due to excessively warm minimum water temperatures. We captured, marked, and released 39 adult and 9 grilse spring chinook, 1 unspawned adult winter-run and 15 adult spring-run steelhead from the immigrant trap. One captured spring chinook escaped just prior to tagging, but scales and other data were obtained. Therefore, we captured a total of 49 spring chinook. Thirty-nine spring chinook were tagged with anchor tags and marked with a ½LV fin clip, and nine were implanted with radio tags and given a ½RV fin clip. We captured, examined, and released 65 out-migrant (spawned) adult winter-run steelhead from the emigrant trap (Table 1).

In 1992, we began catching spring chinook at the Gates Weir during the first week of May, only a few days after installation was completed. The run reached a peak from mid- through late-May (Table 1). We continued to catch fish until early July, when we were forced to remove the weir due to excessively warm minimum

TABLE 1. Trapping summary for the Gates Weir by Julian week from 27 April through 7 July 1992. The Gates Weir was 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	Adults	Grilse a/	Winter-run b/	Spring-run c/	Spawned fall and winter-run steelhead
17	4/23/92d/	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/ Grilse were chinook measuring ≤ 55 cm, adults were > 55 cm.
b/ Winter-run steelhead were upstream-migrating, sexually mature fish.
c/ Spring-run steelhead were upstream-migrating, sexually immature fish.
d/ Trapping actually began on 4/27/92.

water temperatures (>21 °C). During snorkel and pool follow-up observations, we saw that some spring chinook continued to enter the SFTR through July and into August. Therefore, the run timing for SFTR spring chinook in 1992 was early May through early August.

Spring chinook captured at the Gates Weir in 1992 averaged 59.8 cm FL (± 9.5 cm SD) (Figure 3). TFIP had previously established 55 cm FL as the length separating adults and grilse in the mainstem Trinity River. Based on our scale analyses, we have revised this cut-off to 53 cm FL for SFTR spring chinook (see Scale Analysis, page 213). Next season we will use this figure to separate adult and grilse chinook captured at the Gates Wei:

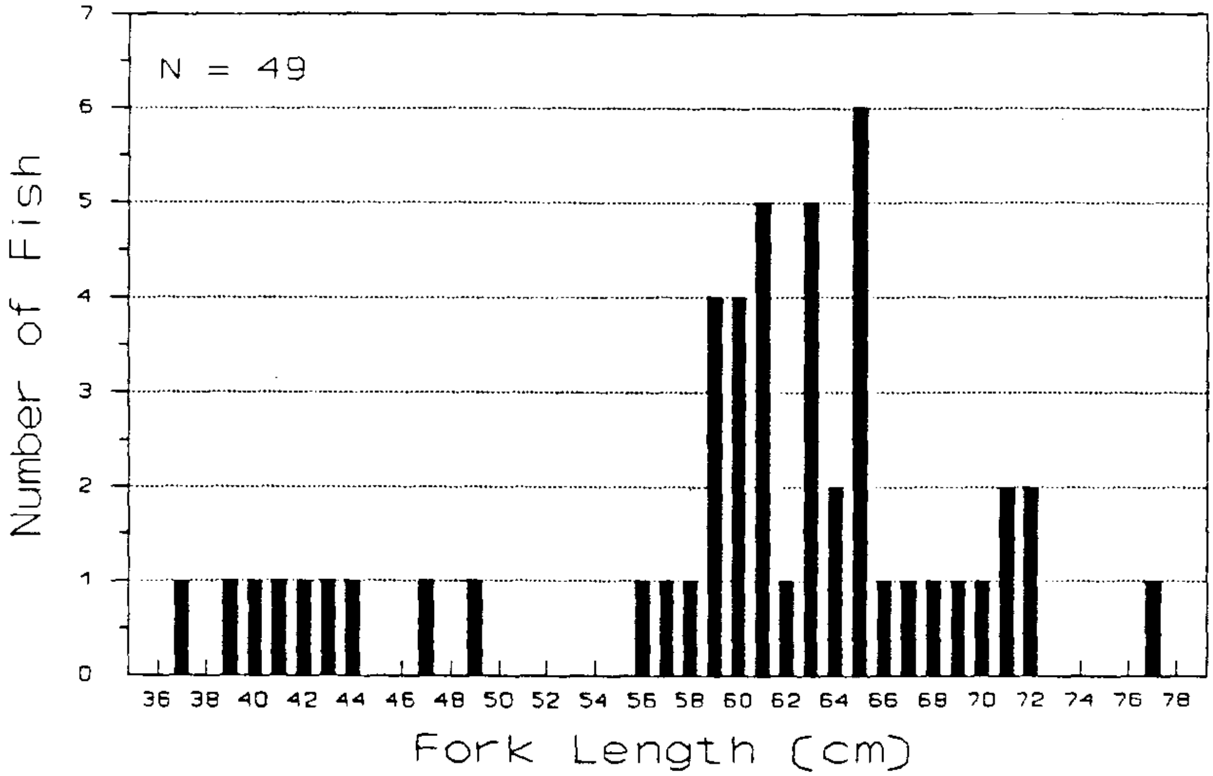


FIGURE 3. Fork length distribution of spring-run chinook salmon captured at the Gates Weir in the South Fork Trinity River from 27 April through 7 July 1992.

For chinook captured and sexed at the Gates Weir in 1992, 32 (65%) were females and 17 (35%) were males. The percentage of males was slightly higher than last year, but still surprisingly low. Smaller grilse may have escaped capture at the Gates Weir at a higher rate than larger adults, accounting for the low number of males. Of chinook re-captured and sexed at the Forest Glen recovery weir in 1992, six (40%) were females and nine (60%) were males (sex not determined for five fish).

1992-1993 Reporting Period

Observation or Recovery of Tags and Marks

Effectively Marked Fish. As stated in the METHODS section, M in the Petersen formula represents the number of marked fish minus tagging mortalities. During the last reporting period (see previous section), we captured 49 spring chinook, and tagged and released 48. We documented seven weir-related spring chinook mortalities (four radio-tagged fish and three anchor tagged-fish). Therefore, we effectively marked 41 spring chinook.

<u>Recovery Weirs.</u> We captured one spring chinook at the Hayfork Creek Weir and 20 spring chinook at the Forest Glen Weir. Of these 21 fish, six had been marked at the Gates Weir (Table 2). Six tag recoveries was inadequate for a statistically-valid Petersen estimate. However, using these numbers in the Petersen formula yields an estimate of 132 spring chinook upstream of the Gates Weir (grilse included). Including those fish seen downstream of the Gates Weir in August (39 fish counted in river sections L through N, Table 3), the late-summer spring chinook population in the SFTR was 171 fish.

The recovery weirs have not been effective at recapturing adequate numbers of Gates Weir-tagged chinook. The continued use of these weirs for this purpose should be re-evaluated.

<u>Snorkel Surveys.</u> During the July snorkel survey, we observed 133 spring chinook and 28 spring-run steelhead. Forty-five spring chinook were seen in pools downstream of the Gates Weir site, and 88 upstream of the weir site. A few of those fish seen downstream of the weir site may have moved upstream after the weir was removed. However, we are certain (through direct observations) that most of them remained in these lower holding pools until they spawned in early October. These fish were simply added to the Petersen estimate. Based on direct observations, as August progressed, fish became more and more "sedentary" and tended to stay in one pool (i.e., there was little movement from pool to pool).

Sixty-three of the spring chinook upstream of the weir site were seen well enough to positively determine if they were marked or not. In this group, 14 were marked. Utilizing these numbers in the Petersen formula, the spring chinook run-size upstream of the weir was 179 fish. Including the 45 fish seen downstream of the weir site, a run-size of 224 spring chinook was estimated for the entire SFTR in July.

During the August snorkel survey, we observed 166 spring chinook (127 upstream, and 39 downstream of the weir site) and 21 spring-run steelhead. One hundred twenty-one of the "upstream" chinook and all the steelhead were seen well enough to positively identify if marks were present or not. In this group, we observed 17 marked chinook and 2 marked steelhead. Using these numbers in the Petersen formula, the spring chinook run-size upstream of the weir site was 285 fish. Including the 39 fish seen downstream of the weir site equates to a run-size estimate of 324 fish (95% confidence limit 236 to 505; Binomial approximation) for the SFTR in August, 1992. Based on a grilse proportion of 18% seen at the Gates Weir (Table 1), the run was composed of 266 adults and 58 grilse. Tagged chinook were evenly

TABLE 2. Spring-run chinook salmon capture summary for the Forest Glen Weir during 1992. The Forest Glen Weir was located in the South Fork Trinity River 89 kilometers upstream from the mouth.

Julian week	Date of capture	Fork length (cm)	Sex	Marks a/
19	5/08/92	63	M	None
	5/10/92	72	F	None
21	5/23/92	54	M	None
	5/25/92	67	*b/	None
22	5/31/92	63	*b/	None
	6/01/92	58	F	LV/floy tag
23	6/08/92	58	M	LV/floy tag
25	6/19/92	60	M	RV c/
	6/21/92	48	M	None
	6/24/92	67	F	None
	"	64	F	None
26	6/28/92	61	*b/	None
	"	59	*b/	LV d/
	"	57	F	LV/floy tag
	"	51	*b/	None
27	7/02/92	47	M	LV/floy tag
	7/04/92	61	F	None
	7/05/92	54	M	None
29	7/16/92	43	M	None
30	7/25/92	41	M	None
	Size range: 41 to 72 cm			Total fish = 20 e/
	Average size: 57.4 cm			Total marks = 6

a/ Marks applied at Gates Weir.
b/ * = sex not determined for this fish.
c/ RV = right ventral fin-clip (radio tagged fish).
d/ LV = left ventral fin-clip (floy tag was shed).
e/ One spring-run chinook salmon captured at the Hayfork Creek Weir is not included in this total.

TABLE 3. Numbers of spring-run chinook salmon seen in the South Fork Trinity River and the East Fork of the South Fork Trinity River, by survey section, during July and August 1992 snorkel surveys.

River section	July	August
A (RKM 124)	1	0
B	0	0
C	2	3
D	0	1
E	11	11
F	29	35
G	25	30
H	7	12
I	4	15
J	6	15
K	3	5
L	43	39
M	2	0
N (RKM 0)	0	0
Totals	133	166

distributed above the Gates Weir in river sections C, E, F, G, H, and J.

The difference in the numbers of fish seen during the July and August snorkel surveys (Table 3) supports our hypothesis that fish continued immigration into the system through July and into August.

No spring chinook were seen during snorkel surveys of lower Hayfork Creek or Grouse Creek.

<u>Holding Pools.</u> We documented 14 spring chinook summer holding pools throughout the SFTR, nine upstream and five downstream of Hyampom (Figures 4 & 5). Each of these pools was occupied by at least three spring chinook during the July and August surveys. We made a distinction between pools with three or more spring

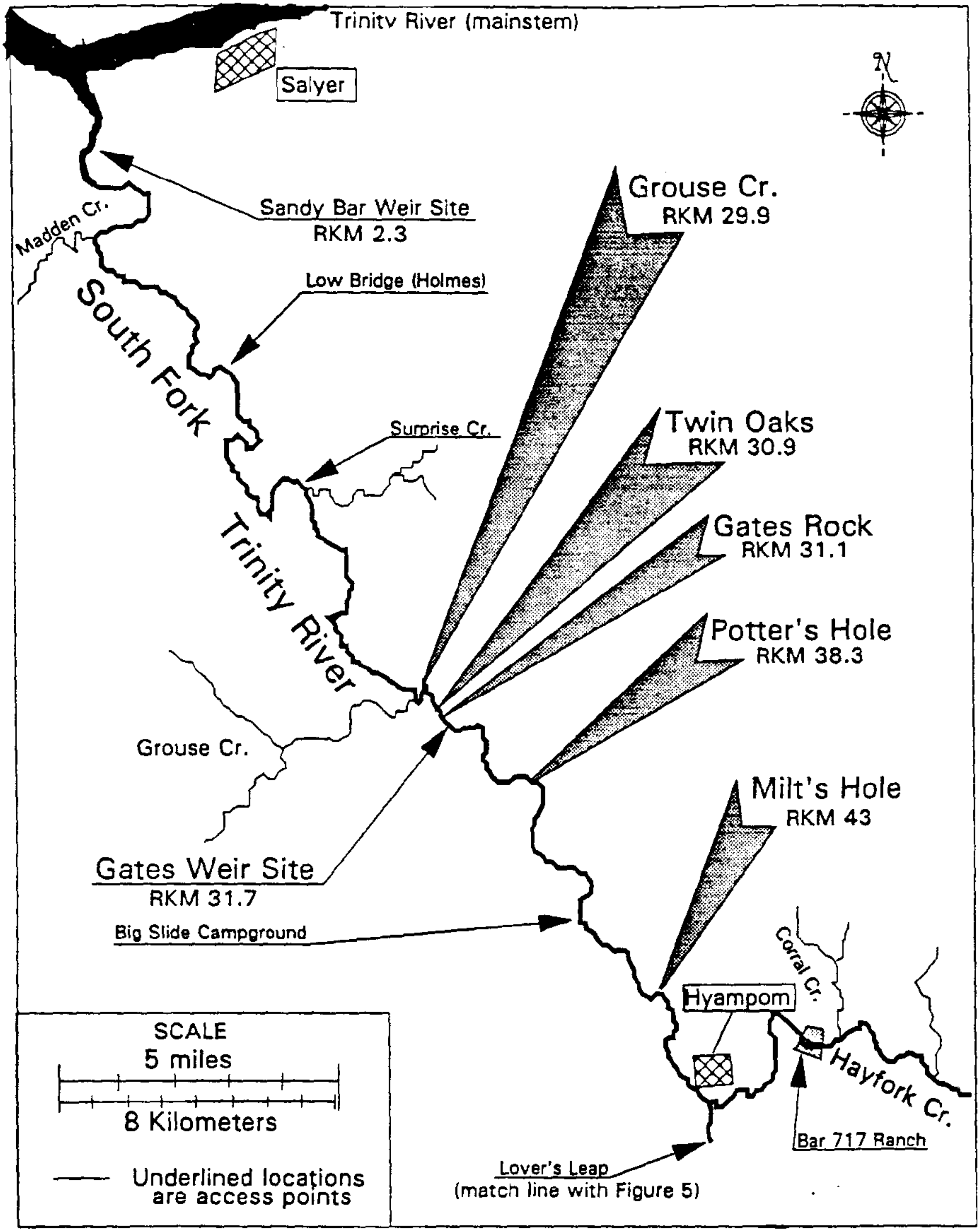


FIGURE 4. Location of summer holding pools utilized by spring-run chinook salmon in the South Fork Trinity River from Hyampom downstream during 1992 (RKM = river kilometers from the mouth).

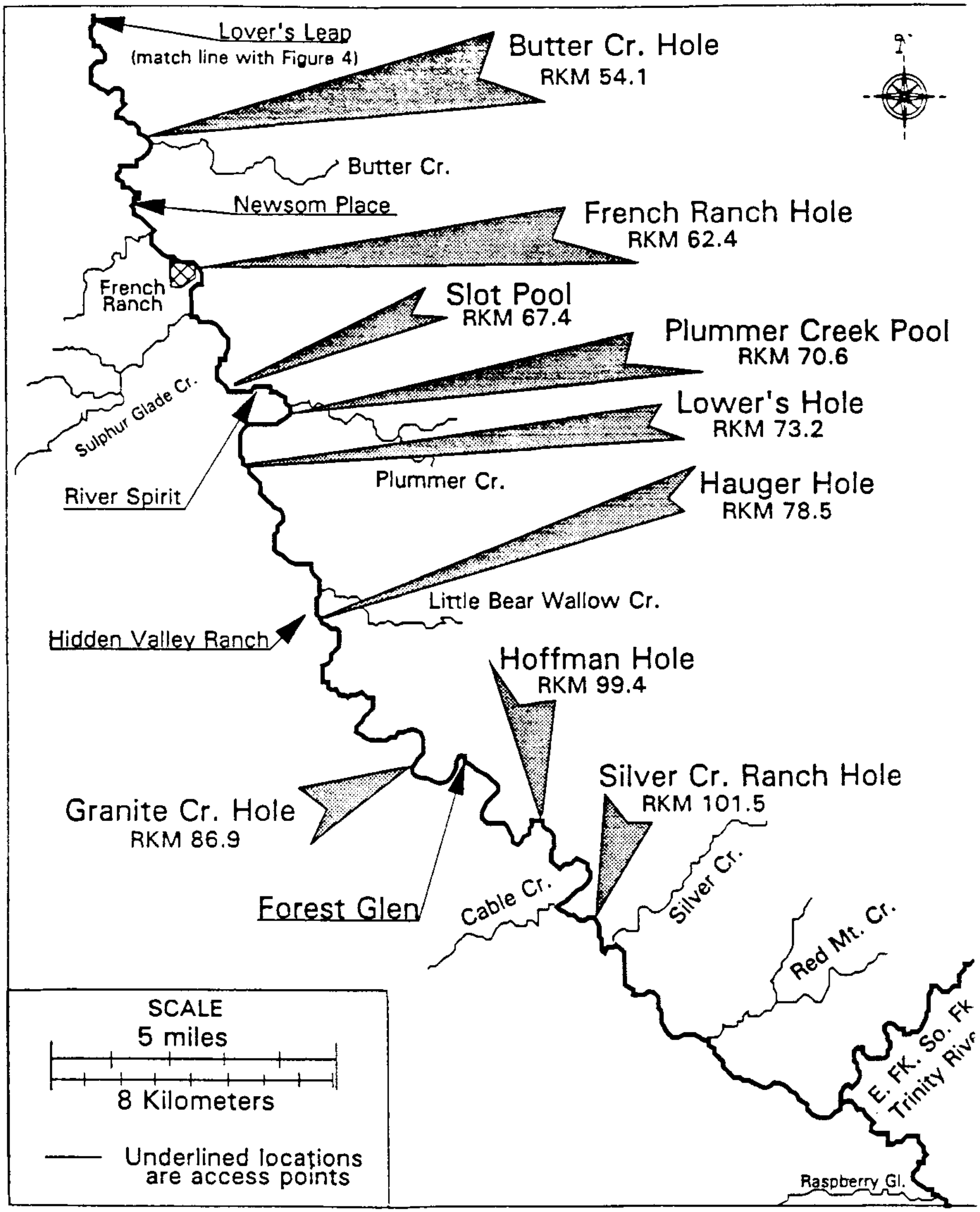


FIGURE 5. Location of summer holding pools utilized by spring-run chinook sal i: the South Fork Trinity River from Hyampom upstream during 1992 (RKM = river kilometers from the mouth).

chinook and those with fewer than three, because those pools which met this criterion were utilized consistently. Those pools which did not meet this criterion were used intermittently, or only for a short period of time. In addition, we did not feel it important to document the location of pools which held only one or two fish.

Most of the pools that we documented, contained five or more spring chinook. All but one of the pools used last season were in use again this season. Such recurrent use suggests either that these pools are providing optimal over-summer holding conditions that chinook are able to distinguish and locate, or that the number of such "good" pools is limited.

However, our snorkel observations indicated there was 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 size and depth, had good in-stream cover, and good thermal stratification (cooler bottom water), which were not being utilized by spring chinook. Also, many "good" pools were utilized by only one or two fish.
As in the upper river, many fish over-summering in those pools downstream of Hyampom survived, and spawned nearby (see Redd Surveys). This behavior was typical, as most spring chinook appeared to move less than one kilometer from their over-summering pool before spawning. This behavior was also noted by LaFaunce (1967). He implied that it may have been the result of handling and tagging stress caused by his methods. We feel this behavior is normal. He also felt that spring chinook did not over-summer, and certainly did not spawn, below Hyampom. Our surveys document that spring chinook do indeed hold and spawn in this reach of the SFTR. Whether this behavior is "normal", or is a reaction to the current drought conditions remains to be seen.

In an effort to quantify the effectiveness of the snorkel survey technique, we sometimes observed and counted spring chinook in holding pools from a nearby bluff before we surveyed the pool. In one case, we observed seven fish in a pool near Hidden Valley, prior to entering the water. When three divers snorkeled the pool, only one fish could be found. Most of the time, however, we counted 80% to 90% of the fish seen from the bluff, and on many occasions we accounted all of the fish initially seen. Therefore, we believe the snorkel survey methodology may at times only account for a fraction of the fish present.

Tag Shedding. Spring chinook which had shed Floy anchor tags were seen during both snorkel surveys and during pool follow-up observations. During the July survey, we observed that 3 of 14 (22%) spring chinook had shed their tags, and during the August survey we saw 4 of 17 (24%) fish which had shed their tags. One tagged carcass was recovered with the tag solidly in place. We chose the Floy anchor tag because it appeared to be the least invasive, least tissue-irritating of our tagging options. We are monitoring tag shedding to determine if we should continue using this tag. If anchor tags are properly inserted, they appear to hold well. However, given the sometimes adverse conditions encountered at tagging sites, tags are not always properly placed. This results in tags being shed. A tag shedding rate of 20-25% was estimated last year, and this year's data supported this estimate. Those fish which had shed their tags were all in good condition, with no signs of fungus or other tagging-related problems. The tag insertion wounds were well healed in all fish seen.

Follow-up Observations at Holding Pools. Near the end of August and through mid-September, spring chinook numbers increased in each pool. We feel that fish we had seen during the snorkel surveys in poor holding areas, such as glides and step-runs, moved into occupied holding pools. We will attempt to confirm this next season with the use of bi-colored tags which will allow us to identify individual fish by sight, and more confidently track their movements.

We also noted that, as September progressed, fish exhibited increased 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 moved into glides and riffle areas, indicating the onset of spawning.

Redd Surveys. We conducted 37 individual surveys between 30 September and 5 November 1992, and located 49 spring chinook redds. We first observed spring chinook spawning in the upper river (upstream of Forest Glen) on 3 October. Spawning incidences progressed downstream over time, and spawning was complete by 26 October. Rainy weather, high stream-flows, and poor water clarity can make river access difficult, and make finding redds impossible. Except for two rainy days, the weather and water clarity were excellent during these surveys.

Nearly equal numbers of redds were found upstream and downstream of Hyampom, but notably, no redds were found in sections A, B, or I (Figures 6 & 7). In past surveys, spawning was found to occur in section A, although LaFaunce (1967) only observed 2.5% of the mainstem SFTR spring chinook redds there. During our snorkel surveys we found no spring chinook holding in this reach. Conversely, we documented one pool in section I, near Butter Creek, holding 10 grilse and 5 adult spring chinook, and although good spawning sites occurred nearby, these fish seemed to "vanish" without constructing redds. Although no evidence was found, we suspect that these fish were "poached". As expected, no redds were found in river sections M or N, in Grouse Creek, or in Hayfork Creek.

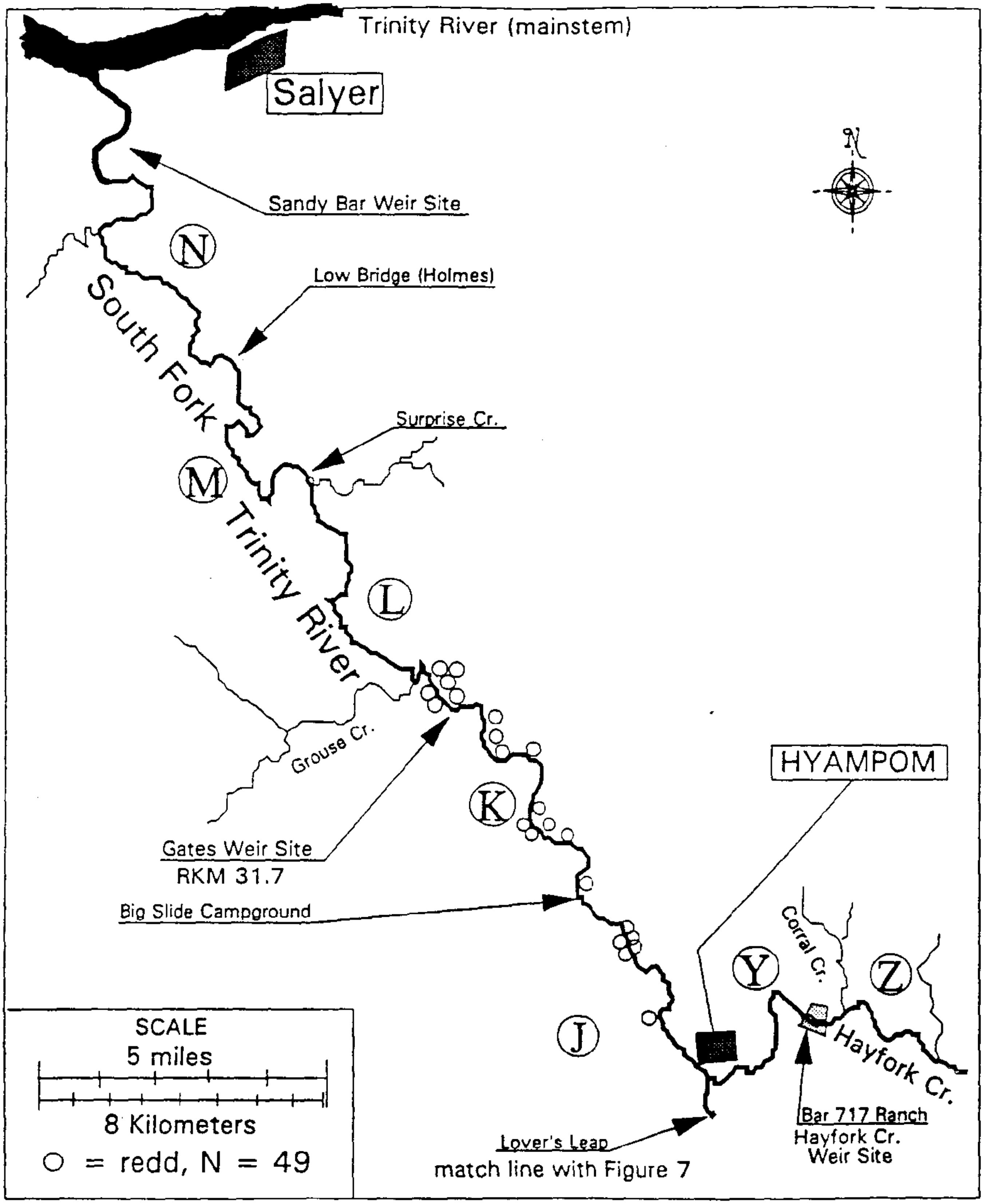


FIGURE 6. Location of spring-run chinook salmon redds in the South Fork Trinity River from Hyampom downstream in 1992 (RKM = river kilometer from the mouth).

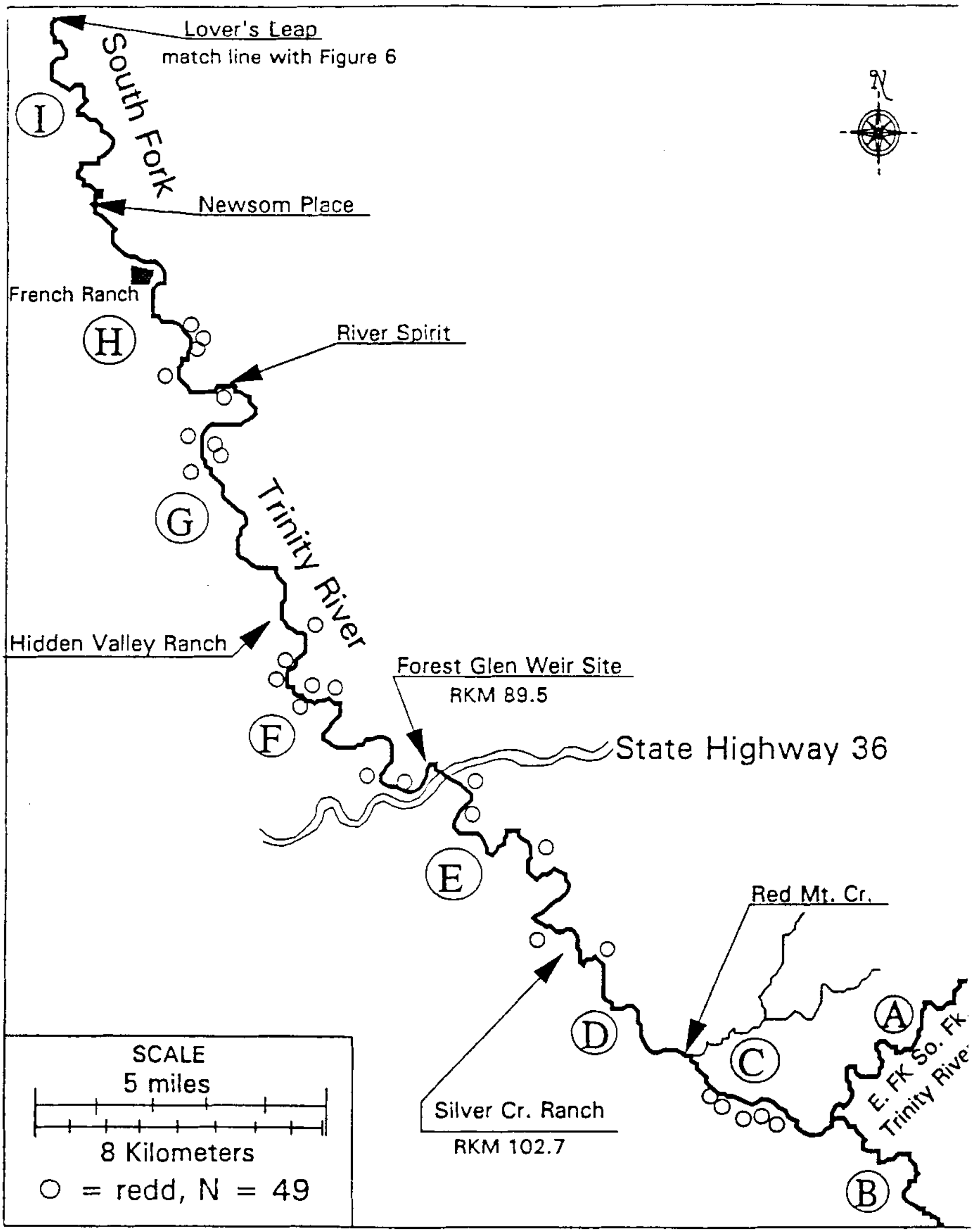


FIGURE 7. Location of spring-run chinook salmon redds in the South Fork Trinity River from Hyampom upstream in 1992 (RKM = river kilometer from the mouth).

As discussed earlier, we felt that spring chinook travelled relatively short distances from their late summer holding pools before spawning. Direct field observations, and to some extent, the distribution of redds in relation to holding pools, supported this conclusion. Next season we may be able to document this more clearly by tagging fish with colored Floy anchor tags. In several instances, fish spawned in very poor substrates (e.g., sandy, high percent fines) within a few hundred meters of their holding pool. Factors such as low stream flows, low energy reserves in spawners, warm water temperatures, or the fish's internal clock may be eliciting this behavior.

All redds were typical for chinook salmon with regard to size, location in the stream, gravel size, current velocity, and water depth (Chapman 1943; Mattson 1948; Cramer and Hammack 1952; Lindsay and Jonasson 1989; Groot and Margolis 1991). More detailed redd data will be presented in a later report.

SFTR spring chinook were observed to complete redd construction in about 24 hours, with evidence of false redd activity in almost every case. Although in a few instances redds were within a few meters of each other, we did not observe any redd superimposition (overlap). Females were observed near redds for only three to four days after redd construction was completed, and they were seldom seen defending their redd. Although individual fish could not be identified, in two instances we discovered an additional redd in isolated areas where apparently only one female was present. This led us to believe that some females may dig more than one redd. However, where spring chinook spawning densities were low (which was most of the SFTR), fish were extremely flighty and very difficult to observe on the redd, so positive correlation of fish with redds was not possible. Based on observations and assuming all redds were seen, we estimated that there were between two and three spring chinook per redd. If this estimate was accurate, then only about 125 fish survived to spawn.

Field observations and limited gravel sampling with a McNeil[5/] sampler, showed gravel in many areas contained high percentages of sand and smaller fines. Spring chinook did utilize some of these poorer areas, possibly indicating that good quality spawning sites were limited.

Carcass Recovery Surveys. We recovered ten spring chinook carcasses during redd and carcass recovery surveys. Only one carcass had been tagged at the Gates Weir. This was an

---

5/ 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.

inadequate number of tag recoveries for a statistically-valid Petersen estimate.

This season, we saw no evidence of pre-spawning mortality in SFTR spring chinook. All carcasses recovered had spawned successfully. Lindsay and Jonasson (1989) reported average pre-spawning mortality of 44% in wild spring chinook for the Deschutes River (Oregon) from 1977-81, with some years as high as 75%. They also found that fish in the Rogue River (Oregon) experienced an average mortality of 12% during the same years. For comparison, pre-spawning mortality for spring-run chinook in the mainstem Trinity River was 62.8% in 1989, but averaged much lower in other years (Zuspan 1992). Groot and Margolis (1991) reported that much lower values (less than 10%) are more typical. High pre-spawning mortality is often associated with stress factors such as high water temperatures, microbial agents, or a combination of the two.

Other Observations. On several occasions during snorkel surveys, we observed spring chinook moving upstream through high-gradient riffles and step-runs when water temperatures exceeded 22.5 °C; on one occasion the water temperature was 24 °C. It is noteworthy that these fish can withstand these temperatures. Based on weir observations, it also appears that, to some extent, warm water temperatures motivate fish to move farther upstream.

Radio Tags. Radio tagging was largely unsuccessful. An unacceptable mortality rate (four of nine radio tagged fish died within 21 days of tagging) resulted from the stress of trapping and tagging, and warm water temperatures (Barnhart and Hillemeier 1993).

Further, radio-tag signals were seldom detectable, even with the use of an airplane. On one occasion, we saw a radio-tagged fish in a large pool near RKM 70.8 during a pool follow-up (the fish was recognized by the secondary fin clip and the radio antenna). Radio signals from this fish were only picked up about once every five to ten minutes. It appears that pool depth and extensive bedrock formations somehow interfered with the signal. The inaccessible nature of the SFTR made regular tracking of tagged fish extremely difficult, and fish were quickly lost in the basin. We assisted Dr. Barnhart's project as much as possible, but due to the lack of roads and rugged terrain, the SFTR was not well-suited to the use of radio tags, or the tracking of radio-tagged fish.

The intent of Dr. Barnhart's staff was to use these radio-tagged fish to locate spring chinook summer holding pools in order to study utilized vs. non-utilized pool parameters. We have already successfully located, and will continue to locate all the significant spring chinook holding pools in the SFTR by snorkel surveys, causing little or no stress to fish. Future radio tagging of spring chinook, or spring-run steelhead, should be avoided.

Trapping and Tagging (Late-entering Portion of the Run)

We did not install the Sandy Bar Weir this season to trap and tag salmon since we felt water temperatures exceeding 18.5 °C caused unacceptable stress and mortality. Based on thermograph records from mid-summer to near the end of September, minimum water temperatures at this site have routinely exceeded this value.

However, the Sandy Bar Weir was installed this season by the Natural Stocks Assessment Project on 1 October 1992, after minimum water temperatures dropped below critical levels. Early in their operation of this weir, nine or ten chinook salmon were captured which were classified as spring-run (Carrie Wilson, Fishery Biologist, CDFG, personal communication; this weir was used to trap and tag fall- and winter-run steelhead as reported in Chapter III). However, it should be noted that the system used to classify these fish as spring-run, based on morphology and appearance may not be completely reliable.

Based on observations during snorkel surveys, pool follow-ups, and spawning surveys, we felt that most spring chinook entering the river later than mid-August encountered excessively warm water temperatures and such low flows that significant upstream migration was especially difficult. They appeared to stop their upstream migration, and held in thermally-stratified pools in, and downstream of, the Hyampom valley. Consequently, they mixed with spring chinook which had been holding there, and a few early-entering fall-run chinook. Therefore, late-entering spring chinook were isolated from the bulk of the spring chinook spawning population, and appeared to comprise a small fraction of the spring chinook run.

We are interested in the spawning fate of the few late-entering spring chinook and early-entering fall-run chinook. It is conceivable that some spawn together in late October near, and downstream of, Hyampom. This possibility raises interesting questions about natural hybridization between the two races.

Life History

Scale Analysis. We interpreted 69 of 71 scale sets obtained from immigrant chinook captured at the Gates Weir, the Forest Glen Weir, and from recovered carcasses. The unreadable sets were composed entirely of regenerated scales. Sixty-two scale sets (90%) showed an ocean-type juvenile life history, while seven (10%) showed a stream-type juvenile life history. Last inadequate number of tag recoveries for a statistically-valid Petersen estimate.

This season, we saw no evidence of pre-spawning mortality in SFTR spring chinook. All carcasses recovered had spawned successfully. Lindsay and Jonasson (1989) reported average pre-spawning mortality of 44% in wild spring chinook for the Deschutes River (Oregon) from 1977-81, with some years as high as 75%. They also found that fish in the Rogue River (Oregon) experienced an average mortality of 12% during the same years. For comparison, pre-spawning mortality for spring-run chinook in the mainstem Trinity River was 62.8% in 1989, but averaged much lower in other years (Zuspan 1992). Groot and Margolis (1991) reported that much lower values (less than 10%) are more typical. High pre-spawning mortality is often associated with stress factors such as high water temperatures, microbial agents, or a combination of the two.

<u>Other Observations.</u> On several occasions during snorkel surveys, we observed spring chinook moving upstream through high-gradient riffles and step-runs when water temperatures exceeded 22.5 °C; on one occasion the water temperature was 24 °C. It is noteworthy that these fish can withstand these temperatures. Based on weir observations, it also appears that, to some extent, warm water temperatures motivate fish to move farther upstream.

<u>Radio Tags.</u> Radio tagging was largely unsuccessful. An unacceptable mortality rate (four of nine radio tagged fish died within 21 days of tagging) resulted from the stress of trapping and tagging, and warm water temperatures (Barnhart and Hillemeier 1993).

Further, radio-tag signals were seldom detectable, even with the use of an airplane. On one occasion, we saw a radio-tagged fish in a large pool near RKM 70.8 during a pool follow-up (the fish was recognized by the secondary fin clip and the radio antenna). Radio signals from this fish were only picked up about once every five to ten minutes. It appears that pool depth and extensive bedrock formations somehow interfered with the signal. The inaccessible nature of the SFTR made regular tracking of tagged fish extremely difficult, and fish were quickly lost in the basin. We assisted Dr. Barnhart's project as much as possible, but due to the lack of roads and rugged terrain, the SFTR was not well-suited to the use of radio tags, or the tracking of radio-tagged fish.

The intent of Dr. Barnhart's staff was to use these radio-tagged fish to locate spring chinook summer holding pools in order to study utilized vs. non-utilized pool parameters. We have already successfully located, and will continue to locate all the significant spring chinook holding pools in the SFTR by snorkel

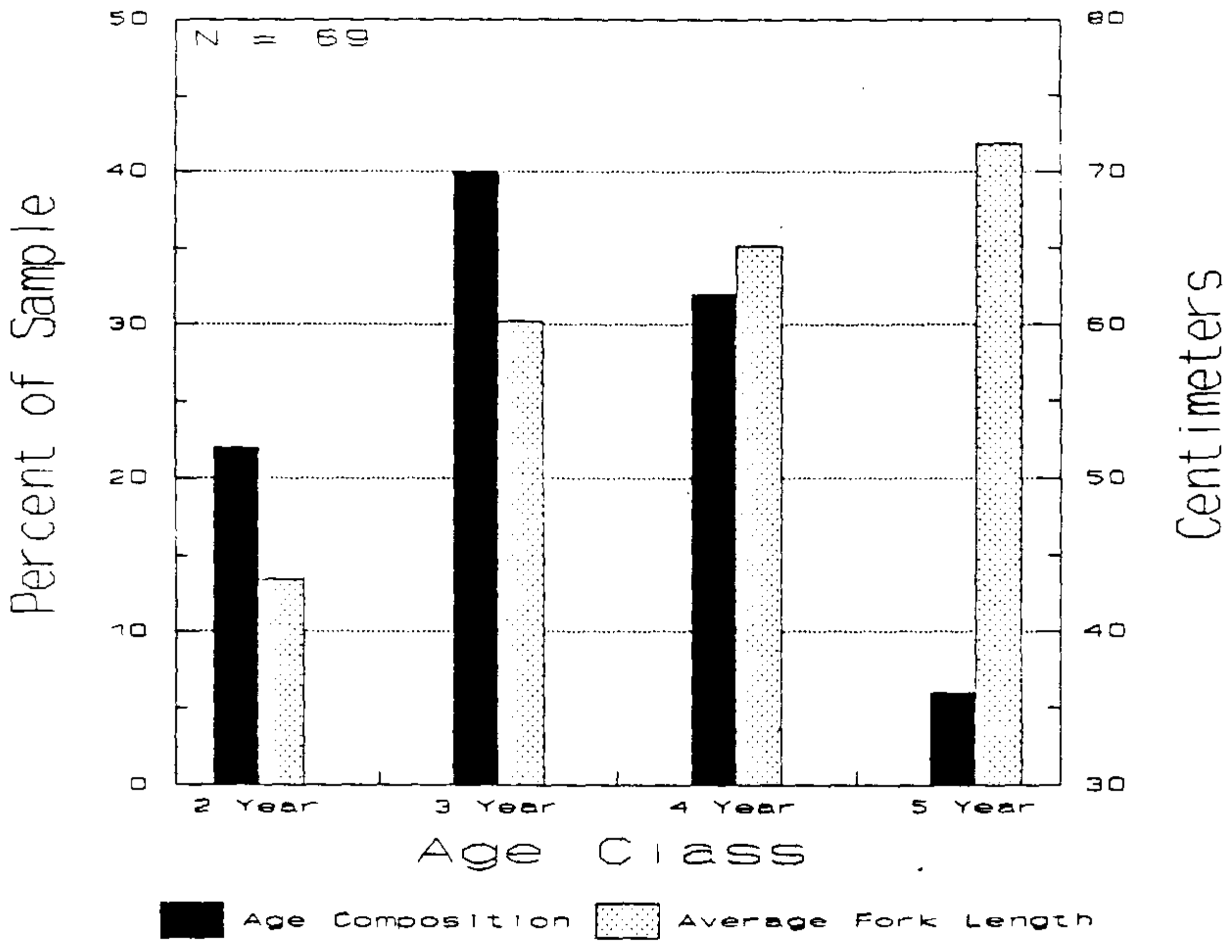


FIGURE 8. Average fork length and age-class composition of the spring chinook salmon run in the South Fork Trinity River for 1992, as determined from scale analysis.

Juvenile Emigrant Trapping. We trapped 42 nights (72 trap-nights) at the Forest Glen site between 2 February and 24 June 1993. Over this period, we captured and released only eight young-of-the-year (YOY) spring chinook (490 last season) and no yearlings (four last season). The first spring chinook YOY was captured on 14 April (JW 15), and the last on 26 May (JW 21).

Peak catch of five YOY occurred during JW week 20 (14-20 May) (Figure 10). While the number of juvenile spring chinook captured was too small to draw any valid conclusions, the beginning and peak of juvenile emigration this season closely parallelled last year's data.

The average FL of spring chinook YOY increased during trapping from 44 to 60 mm (SD ±0 to ±0.9). It was apparent from their relatively large size that spring chinook YOY first captured at Forest Glen had been out of the gravel for a few weeks. Based on FL and displacement volume data, early instream growth was slow, year's scales showed similar composition with 88% ocean- and 12% stream-type life histories.

Scale analysis showed that the 1992 run was composed of 22% two-year-olds (grilse), 40% three-year-olds, 32% four-year-olds, and 6% five-year-olds (Figure 8). For comparison, the 1991 run was composed of 17% grilse, 29% three-year-olds, 45% four-year-olds, and 9% five-year-olds. This season's fish which showed a stream-type life history consisted of five (72%) grilse, one (14%) three-year-old, and one (14%) four-year-old. Mills (Appendix 1) also noted four of 21 (19%) stream-type, fall-run chinook which returned as grilse. Last season's stream-type fish consisted entirely of three-year-olds (40%) and five-year-olds (60%). Lindsay (1985) reported age classes by scale analysis for John Day River (Oregon) spring chinook as 1-5% three-year-olds, 54-89% four-year-olds, and 8-44% five-year-olds. Virtually all these fish showed a stream-type life history.

Summer rearing habitat for juvenile salmon appears to be a significant limiting factor in the SFTR. Spring chinook which exhibit a stream-type juvenile life history may be at a disadvantage as a result of high summer water temperatures and competition with juvenile steelhead. Stream-type juvenile spring chinook utilize the SFTR above Forest Glen, and possibly some of the cooler tributaries. However, during summer snorkel surveys we have seen juvenile spring chinook only in the mainstem of tl SFTR, and never in the few tributaries we investigated.

SFTR spring chinook exhibited not only the two life-history strategies discussed above (stream- and ocean-type), but several which appeared to be intermediate. Sullivan (1989) noted similar intermediate life histories from scales of Klamath River fall-run chinook salmon. Based on our scale analysis, some juvenile spring chinook appeared to take up residency for significant blocks of time either in-river or in the estuary, prior to ocean entry. This was indicated by bands of scale growth, several circuli wide, between the obvious stream growth and obvious ocean growth.

The average FL for fish returning as two-, three-, four-, and five-year-olds was 43.4, 60.2, 65.1, and 71.8 cm, respectively (Figure 8). For comparison, last season the average FLs were 46.7, 59.3, 64.5, 66.8 cm, for the above respective age-groups.

From our scale analysis, we noted that several spring chinook older than two years were less than 55 cm, FL. Distribution of FLs for two- and three-year-olds only, showed the nadir separating grilse from adults to be nearer 53 than 55 cm (Figure 9). Therefore, we lowered the minimum adult FL to 53 cm.

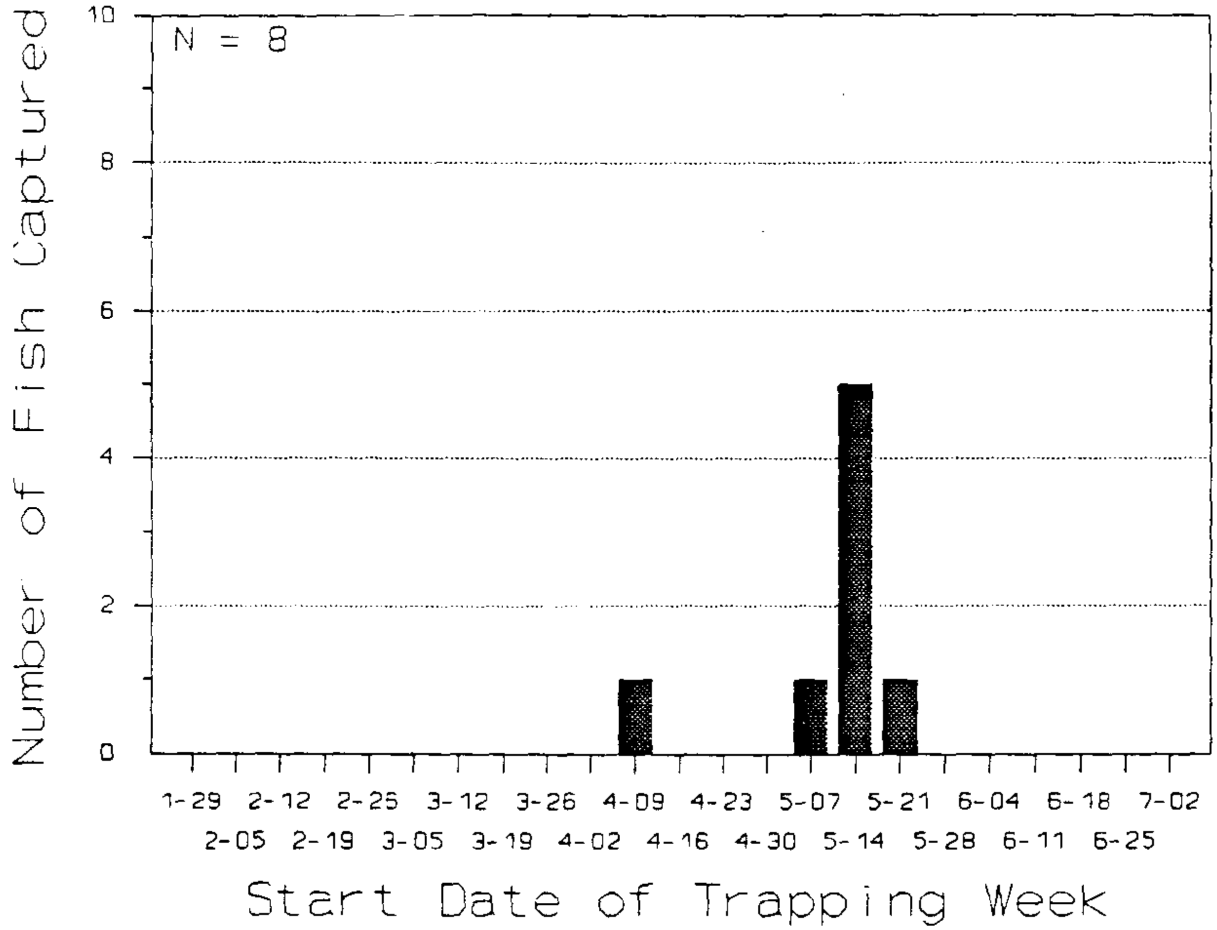


FIGURE 10. Number of juvenile spring-run chinook salmon captured each week in the South Fork Trinity River near the Forest Glen Weir from 2 February through 24 June 1993.

<u>Direct Snorkel Observations.</u> Due to high river flows and excessive turbidity this winter and spring, direct snorkel observation of emergent juvenile chinook was not possible.

<u>Angler Harvest</u>

Eleven individual creel surveys were conducted during July 1992. Thirty-two creel surveys were conducted between 23 May and 28 June 1993. We interviewed 21 anglers who fished a total of 28.5 hours. No chinook salmon were creeled, and no tags were returned. We found that fishing pressure from May through July was highest in the Hyampom area, and that the target species was primarily juvenile steelhead (which most fishermen identified as trout). Based on these data, we estimated that the legal angler harvest of spring chinook in the SFTR during the summer of 1992 <u>and</u> the spring of 1993 was zero.

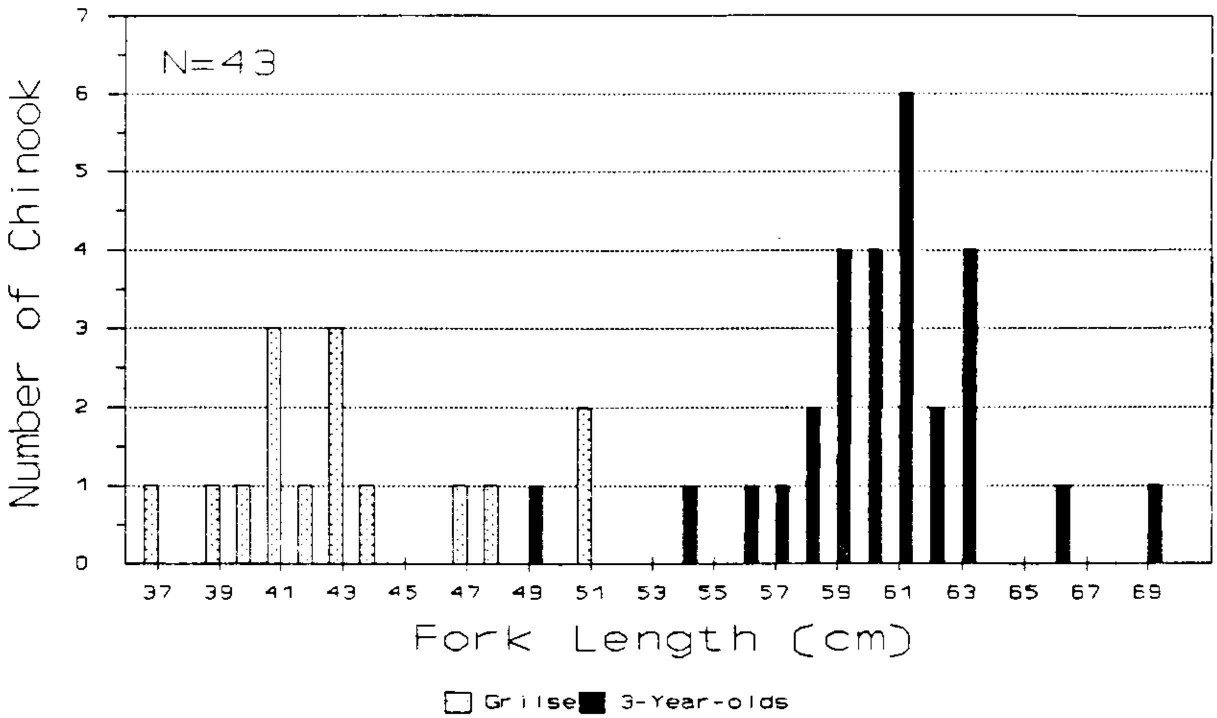


FIGURE 9. Fork length distribution of grilse and three-year-old spring-run chinook salmon in the South Fork Trinity River in 1992, as determined from scale analysis.

but within normal parameters (Mark Zuspan, Associate Fishery Biologist, CDFG, personal communication).

The catch-per-unit-effort (CPUE) at Forest Glen ranged from zero to one. CPUE is defined as the number of fish caught per trap-night. Significantly higher river flows and bad weather hampered this season's trapping effort, resulting in much lower trapping efficiency compared to last year. We consistently sampled a smaller percentage of the river, and traps were "blown-out" by high flows and debris on several occasions.

The CDFG's Natural Stocks Assessment Project trapped emigrant juvenile salmonids for 28 nights in the SFTR near Hyampom and in Hayfork Creek between 5 November 1992 and 30 June 1993. During this period, no juvenile chinook were captured in the SFTR and only three in Hayfork Creek. Unfortunately, fall-run chinook are known to also spawn above those trapping sites. Therefore, juvenile chinook salmon captured there cannot be positively identified to race. Their low catch rate and trapping efficiencies paralleled our efforts.

Coincident with the juvenile chinook trapping efforts, we captured and released 296 juvenile steelhead (1,369 last season), several hundred speckled dace, one green sunfish, and a few thousand ammocetes.

TABLE 4. Trapping summary for the Gates Weir by Julian week from 24 June through 31 July 1993. The Gates Weir is located in the South Fork Trinity River 32 kilometers upstream from the mouth.

		Immigrant trap a/			
		Spring-run chinook salmon		Steelhead	
Julian week	Start date	Adults	Grilse b/	Winter-run c/	Spring-run d/
25	6/18/93 e/	3	0	0	0
26	6/25/93	7	9	0	6
27	7/02/93	3	4	0	9
28	7/09/93	6	5	0	7
29	7/16/93	4	5	0	12
30	7/23/93	6	7	0	7
31	7/30/93	2	1	0	1
	Totals:	31	31	0	42

a/ Due to late date of weir installation, emigrant trap was not installed.
b/ Grilse are chinook measuring ≤ 53 cm, adults are > 53 cm.
c/ Winter-run steelhead are upstream-migrating, sexually-mature fish.
d/ Spring-run steelhead are upstream-migrating, sexually-immature fish.
e/ Trapping actually began on 6/23/93.

Since high river flows delayed installation of the Gates Weir, we also tagged spring chinook at the Forest Glen Weir in 1993. We installed this weir on 11 May and tagged spring chinook there until 31 July. It was operated until 31 August to recapture Gates Weir-tagged fish. We captured 44 spring chinook (27 females, 17 males) and 49 steelhead (14 spring-run and 35 downstream-migrating winter-run) during 101 days of operation. We effectively tagged 21 spring chinook at this site.

Scars

During the 1993 adult trapping season, we examined 62 spring chinook and 42 spring-run steelhead at the Gates Weir. Only 19.3% of spring chinook showed scars this year, compared to 28% last year (Table 5). Similarly, 9.5% of the steelhead had scars this year, compared to 41% last year. These numbers are not significantly lower for spring chinook, but are significantly

We certainly did not monitor all angling activity, since CDFG staff who reside in the Hyampom area reported that one local angler claimed to have caught and released "nine or ten" salmon, including one tagged fish, from the Hyampom area in July 1992. The local CDFG Warden confirmed this report.

The use of tag returns to generate angler harvest estimates is not always effective. Several local anglers told Project personnel they seldom, if ever, returned tags, even if a reward was offered. Some anglers told us that they have tags from steelhead they intended to return but "keep forgetting". Other researchers have noted similar problems (Butler 1962; Green et. al. 1983; Konstantinov 1978; Paulik 1961). Therefore, the simple lack of tag returns should not be used as documentation for lack of harvest. Consequently, we will rely more heavily on creel surveys, and less so on tag returns, to meet our objective of determining angler harvest.

Adult Trapping

During the 1993 season, we operated the Gates Weir for 34 days, between 24 June through 31 July. High river flows and late spring storms prevented us from installing the weir earlier. Spring chinook immigration continued more or less undiminished throughout this period and was still underway when we were forced to suspend operations due to excessively warm minimum water temperatures (>18.5 °C). During this period only immigrant (upstream migrating) fish were trapped, while emigrant fish were allowed to pass through the weir via a narrow fyke.

We captured and released 31 adult and 31 grilse spring chinook salmon and 42 adult spring-run steelhead. For comparison, last season we captured 49 spring chinook and only 16 spring-run steelhead. The weir was operated this season for just over one-half as long as last year and captured 27% more fish. Since an emigrant trap was not installed, no out-migrant (spawned) adult winter-run steelhead were captured (Table 4). Spring chinook captured at the Gates Weir ranged in size from 34 to 69 cm FL (Figure 11). The average FL was 52.4 cm, significantly smaller than the 59.8 cm average of last season ($X^2 = 1.5$). This average size difference was due to the higher proportion of grilse and the absence of fish over 70 cm FL during the 1993 season.

While 62 spring chinook were captured, only 51 were tagged with anchor tags and marked with a ½RV fin-clip. Spring chinook which appeared lethargic or severely stressed were released untagged and unclipped. One chinook was known to have shed the anchor tag and four weir mortalities were found. Therefore, we effectively tagged 46 spring chinook at this weir. Thirty-eight of the 42 spring-run steelhead captured were given a ½LV fin clip.

TABLE 5. Summary of scars observed on steelhead and spring-run chinook salmon captured at the Gates Weir in the South Fork Trinity River during the 1993 adult trapping season.

Scar types	Steelhead		Spring-run chinook salmon	
	Number with scar type	Percent of total with scar type	Number with scar type	Percent of total with scar type
Gill net a/	0	0	2	3.2
Fresh-hook b/	0	0	0	0
Ocean-hook c/	0	0	0	0
Predator d/	4	9.5	7	11.3
Unknown e/	0	0	3	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. Continue using color-coded tags which allow for the identification of individual fish during snorkel surveys, and especially during follow-up observations at holding pools and during redd surveys.

2. 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, or discontinue using this weir for recapture.

3. Poor spawning gravel permeability and bedload movement may be affecting spring chinook salmon egg and alevin survival. Additional studies are needed in this area.

4. Major and minor landslides are adversely affecting juvenile rearing habitat in the SFTR. Studies are needed to quantify this effect.

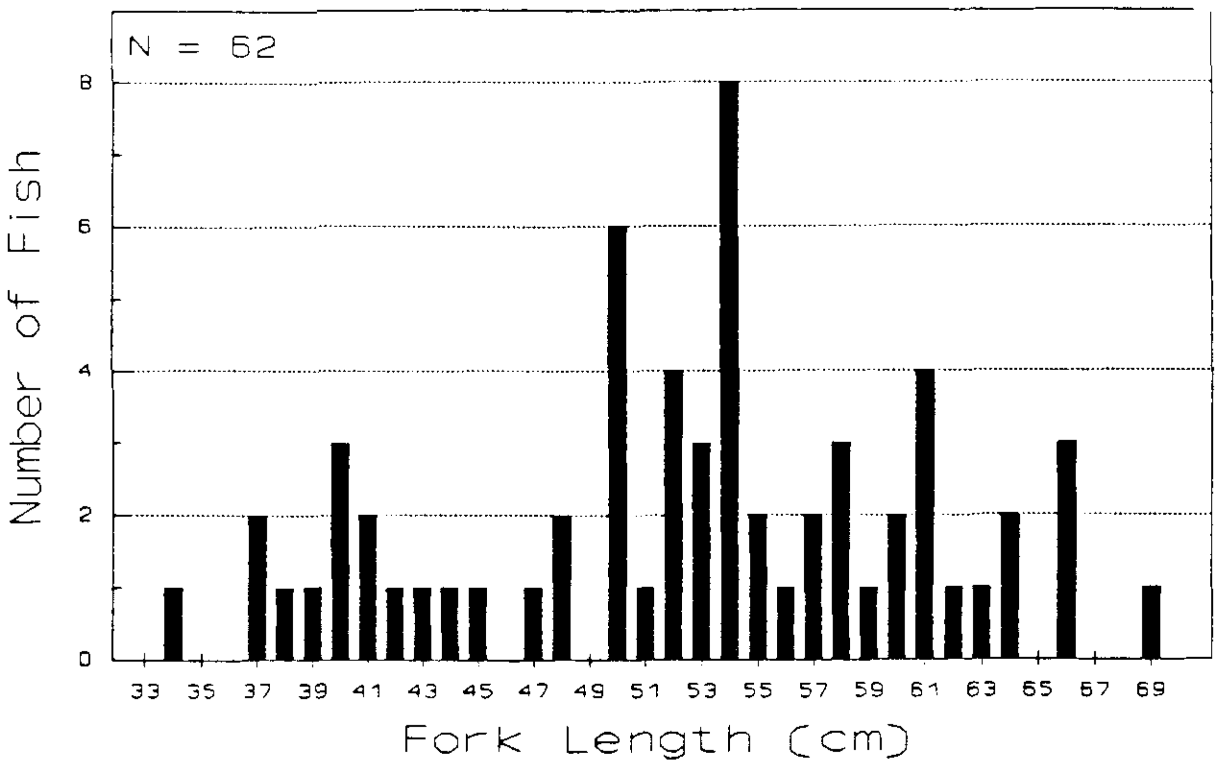


FIGURE 11. Fork length distribution for spring-run chinook salmon captured the Gates Weir in the South Fork Trinity River in 1993.

lower for steelhead (X^2 = 0.46, X^2 = 6.5, respectively).

Precipitation during this past season was near-to-above normal, and river flows were correspondingly higher. Water clarity was below normal. These factors certainly contributed to lower in-river fishing efficiencies (both gill-net and hook-and-line) resulting in a lower incidence of associated scars. The occurrence of predator scars was virtually the same for spring chinook, but less than one-half of last year's total for steelhead.

In the interest of clarity and continuity, further analysis and discussion of the above data will be covered in the next annual report (1993-94) where these spring chinook will be followed through the end of their spawning season.

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. Dept. of Fish and Game, Vol. 10, No. 4, pp. 163-172.

Sullivan, C. 1989. Juvenile life history and age composition of mature fall chinook salmon to the Klamath River, 1984-1986. Master's 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. pp. 1-29. 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. of Fish and Game, Inland Fish. Div., 1416 9th St., Sacramento, CA 95814.

LITERATURE CITED

Chapman, W. M. 1943. The spawning of chinook salmon in the main 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.

Butler, R. L. 1962. Recognition and return of trout tags by California anglers. Calif. Fish and Game, 48: 5-18.

Dean, Michael. 1994. Life history, distribution, run size, and harvest of spring chinook salmon in the South Fork Trinity River. Chapter VII. Job VII. pp. 191-227. In: K. Urquhart and R. M. Kano (eds.). Annual Report of the Trinity River Basin Salmon and Steelhead Monitoring Project, 1991 - 1992 Season. February 1994. 235 p. Available from Calif. Dept. of Fish and Game, Inland Fish. Div., 1416 Ninth Street, Sacramento, CA 95814.

Green, A. W., G. C. Matlock, and J. E. Weaver. 1983. A method for directly estimating the tag-reporting rate of anglers. Trans. Am. Fish. Soc. 112: 412-415.

Groot, C., and L. Margolis. 1991. Pacific Salmon Life Histories. UBC Press. University of British Columbia. Vancouver, B.C., Canada. 564 p.

Konstantinov, K. G. 1978. Modern methods of fish tagging. J. Ichthyol. 17(6): 924-938.

LaFaunce, D. A. 1967. 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 the John Day River system. Oregon Dept. of Fish and Wildlife. 119 p. Available from Bonneville Power Administration, Div. of Fish and Wildlife, P.O. Box 3621, Portland, Oregon 97208.

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 p.

Mattson, C. 1948. Spawning ground studies of Willamette River spring chinook salmon. Oregon Fish Commission Resource Briefs. (12): 21-32.

Paulik, G. J. 1961. Detection of incomplete reporting of tags J. Fish. Res. Bd. Can. 18: 817-832.

_________. 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.

Mills, T. Unpublished manuscript. Juvenile life history patterns of South Fork Trinity River chinook salmon as determined by adult scale analysis. 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.

APPENDIX 1. Other sources of data.

Barnhart, R. A., and D. Hillemeier. 1993. Summer habitat utilization by adult spring chinook salmon and summer steelhead, South Fork Trinity River, California. Unpublished progress report. Available from U.S. Fish and Wildlife Service, Calif. Coop. Unit, Humboldt State Univ., Arcata CA. 95521-4957.

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, USFS 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.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1992-1993 SEASON

CHAPTER VIII

JOB VIII
SPECIAL PROJECTS: TECHNICAL ANALYSES AND REPORT PREPARATION

by

Robert Reavis

ABSTRACT

I continued my assignment through the 1992-93 season 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. Reports on the first two Job VIII task studies have been completed, and previously summarized. The third and fourth studies were combined into one report and are summarized in this Chapter.

The third and fourth studies dealt with coho salmon, *Oncorhynchus kisutch*, reared at Trinity River Hatchery. The studies were conducted to determine if survival to adulthood (ages three- and four-year-old) could be increased by the following management options: (i) release of juvenile fish during the new moon nearest the vernal equinox and (ii) release of larger juvenile fish.

The results were as follows: (i) survival of hatchery-reared coho salmon was not significantly increased by releasing them on the new moon nearest the vernal equinox, and (ii) releases of smaller juvenile fish (33-41 g/fish [13.7-11.1 fish/lb]) survived better to adulthood than larger juveniles (56-123 g/fish [8.1-3.7 fish/lb]). Greater returns of smaller released fish were probably due to larger fish having a greater tendency to return as grilse.

APPENDIX 2. List of Julian weeks and their calendar date equivalents.

	Calendar dates			Calendar dates	
Julian week	Start	Finish	Julian week	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-Se
12	19-Mar	25-Mar	38	17-Sep	23-
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.

coho salmon performed similarly.

METHODS

To test a particular attribute, portions of the annual hatchery production were divided into groups, that were tagged with a coded-wire tag (CWT) having a unique code and marked with an adipose (AD) fin clip. There was one exception to this procedure: a group from the 1976 BY was marked with both a left and right ventral fin clip, and not CWTed. Portions of the annual production from the 1976 through 1978 BYs were used to determine if survival to adulthood is affected by size-at-release. Portions of the annual production from the 1979 through 1982 BYs were used to determine if the new moon nearest the vernal equinox is the optimum time to release coho salmon reared at TRH.

Our analyses of survival as related to size-at-release and lunar-phase-when-released were based on recoveries of CWTed adult fish from ocean fisheries and TRH. CWTed fish, released as juveniles into the Trinity River near TRH, were recovered as two-, three-, and occasionally as four-year-old fish. Adults were defined as three- and four-year-old fish, although over 99% of the adult coho salmon population were three-year-olds. The number of CWTed fish of each group recovered in ocean fisheries was added to the number for that CWT group returning to TRH. This sum was then divided by the number stocked to calculate the recovery rate. Relative survival within each BY was then inferred from these calculated recovery rates.

Analysis of Effects of Lunar-phase Releases on Survival

We used the following steps to determine if the new moon nearest the vernal equinox was the optimum time to release coho salmon:

1. We tested the hypotheses that there were no differences among the adult (ages three- and four-year-old) recovery rates of five groups released at various lunar phases. We tested for differences with a contingency table analysis at the 0.05 level of significance using the following formula (Zar 1984, p. 400-401):

$$X^2 = \sum_{t=1}^{k} \frac{(X_1 - n_1\overline{p})^2}{n_1\overline{pq}}$$

2. We carried out a Tukey-type multiple comparison test (Zar 1984, p. 401-402) at the 0.05 level of significance to make one-on-one comparisons between the adult recovery rate of the OLPG and each of the groups representing other lunar phases.

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.

INTRODUCTION

The California Department of Fish and Game (CDFG) has been researching hatchery stocking and rearing practices that would increase contributions to fisheries and spawner escapements of coho salmon reared at Trinity River Hatchery (TRH). This study[1/] is a part of that ongoing effort.

In cooperation with the CDFG, Nishioka et al. (1989) conducted a study at TRH and Iron Gate Hatchery to find out if the new moon nearest the vernal equinox (March 22) was the optimum time to release juvenile coho salmon; hereafter, study groups released this time will be referred to as the optimal lunar-phased group (OLPG). Their study at TRH included samples from the 1979 through 1982 brood years (BYs), but they did not include results of the 1980 and 1981 BYs in their report because El Niño conditions had drastically reduced recovery rates for these two BYs. Based on their study results, they concluded: " . . . the percent recovery of the OLPG was significantly higher than or equal to any other group in three of four occasions at the two hatcheries". We also examined the results from 1980 and 1981 BYs, and agree that El Niño did depress recovery rates. Still, we thought that the effects of El Niño should have been equal on all fish from the same BY. Therefore, the results from the 1980 and 1981 BYs could be used to evaluate lunar-phase releases, and those recoveries are analyzed in this report.

The effects of size-at-release on survival was studied as a result of earlier studies which showed that survival to adulthood of hatchery-reared chinook salmon, O. tshawytscha, and steelhead trout, O. mykiss was increased by releasing juveniles of these species at larger sizes. We conducted a study to find out if

---

1/ Reavis, R. and B. Heubach. 1993. Effects of size at release and lunar phase when released for coho salmon, Oncorhynchus kisutch, reared at Trinity River Hatchery. Inland Fish. Div. Rep. No. 93-3. Available from Calif. Dept. Fish and Game, Inland Fish. Div., 1[illegible] 9th St., Sacramento, CA 95814.

coho salmon performed similarly.

METHODS

To test a particular attribute, portions of the annual hatchery production were divided into groups, that were tagged with a coded-wire tag (CWT) having a unique code and marked with an adipose (AD) fin clip. There was one exception to this procedure: a group from the 1976 BY was marked with both a left and right ventral fin clip, and not CWTed. Portions of the annual production from the 1976 through 1978 BYs were used to determine if survival to adulthood is affected by size-at-release. Portions of the annual production from the 1979 through 1982 BYs were used to determine if the new moon nearest the vernal equinox is the optimum time to release coho salmon reared at TRH.

Our analyses of survival as related to size-at-release and lunar-phase-when-released were based on recoveries of CWTed adult fish from ocean fisheries and TRH. CWTed fish, released as juveniles into the Trinity River near TRH, were recovered as two-, three-, and occasionally as four-year-old fish. Adults were defined as three- and four-year-old fish, although over 99% of the adult coho salmon population were three-year-olds. The number of CWTed fish of each group recovered in ocean fisheries was added to the number for that CWT group returning to TRH. This sum was then divided by the number stocked to calculate the recovery rate. Relative survival within each BY was then inferred from these calculated recovery rates.

Analysis of Effects of Lunar-phase Releases on Survival

We used the following steps to determine if the new moon nearest the vernal equinox was the optimum time to release coho salmon:

1. We tested the hypotheses that there were no differences among the adult (ages three- and four-year-old) recovery rates of five groups released at various lunar phases. We tested for differences with a contingency table analysis at the 0.05 level of significance using the following formula (Zar 1984, p. 400-401):

$$X^2 = \sum_{i=1}^{k} \frac{(X_i - n_i\bar{p})^2}{n_i\bar{p}\bar{q}}$$

2. We carried out a Tukey-type multiple comparison test (Zar 1984, p. 401-402) at the 0.05 level of significance to make one-on-one comparisons between the adult recovery rate of the OLPG and each of the groups representing other lunar phases.

Analysis of Effects of Size-at-release on Survival

There were not enough samples to apply tests of significance to size-at-release results; therefore, only subjective comparisons were made. Ocean catch results of only two BYs (1977 and 1978) were available for analysis due to use of different marks on the 1976 BY groups, which would not have been equally identifiable in ocean fisheries. Hatchery return results were compared for all three BYs, as all fish entering TRH were carefully examined for any marks. The larger juvenile fish used in this port[illegible] study ranged from 56-123 g/fish (8.1-3.7 fish/lb) when [illegible] and the smaller juvenile fish ranged from 32-41 g/fish (13.9-11.1 fish/lb).

RESULTS

Analysis of Effects of Lunar-phase Releases on Survival

Based on contingency table analysis of the groups representing various moon phase releases, we concluded there were significant differences among survival to ages three years and older for all BYs ($\chi^2 = p<0.05$).

Results using the Tukey-type comparison test to find differences between the OLPG and groups released during other lunar phases were as follows (Figure 1):

1. 1979 BY - The survival of the OLPG was significantly greater than those of all other groups.

2. 1980 BY - The survival of the OLPG was less than those of the two groups released later, but the differences were not statistically significant. The OLPG survival was significantly greater than the earlier released groups.

3. 1981 BY - The survival of the OLPG was less than those of all other groups, and there was a statistically significant difference between it and the latest group released.

4. 1982 BY - The survival of the OLPG was greater than those for all other groups, but the differences between it and the groups released later were not statistically significant. The differences in survival were statistically significant between the OLPG and the earlier released groups.

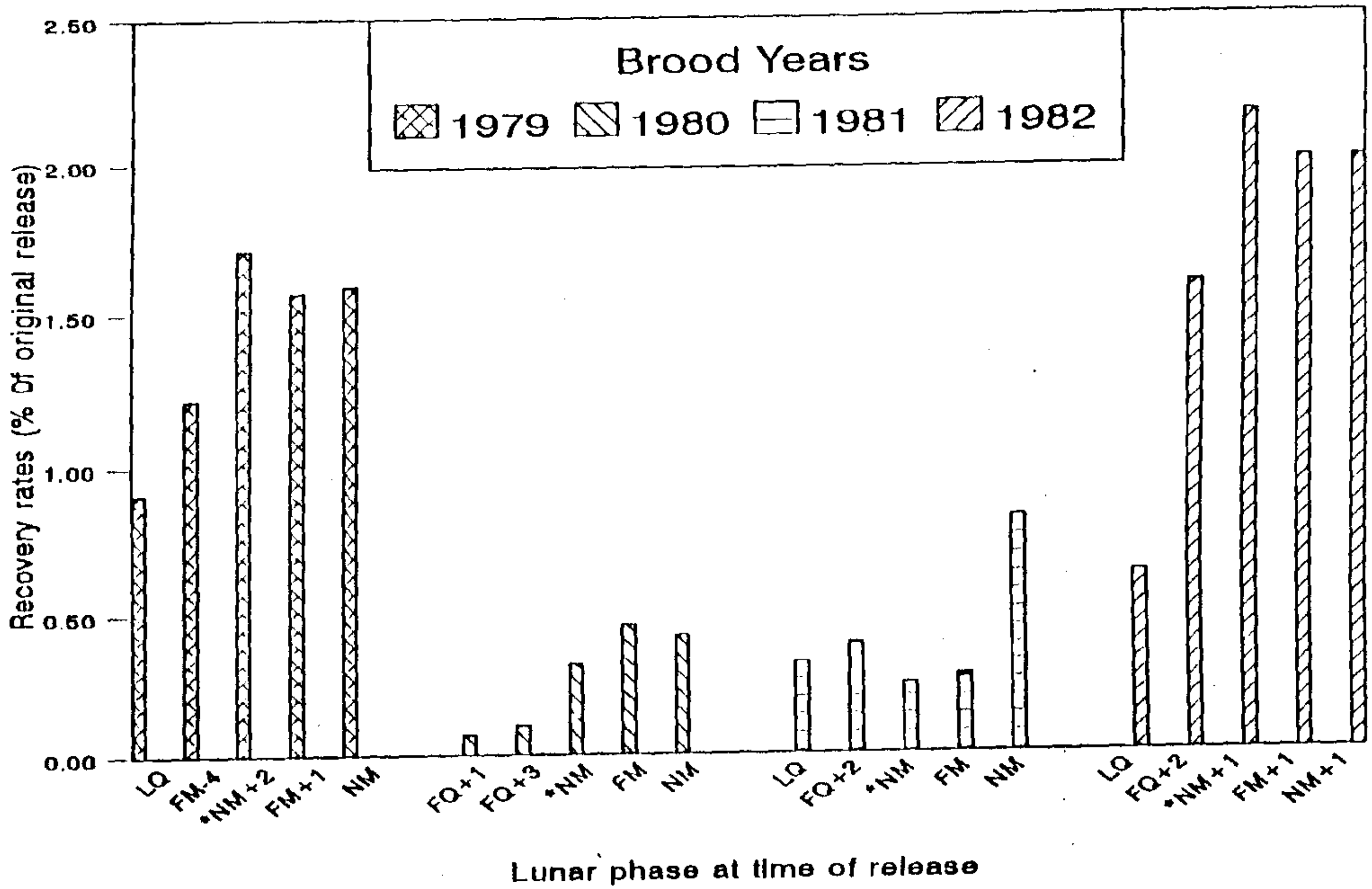


FIGURE 1. Recovery rates (ocean catch and hatchery returns) for coded-wire tagged groups of coho salmon released on the following lunar phases: last quarter(LQ), full moon(FM), first quarter(FQ), and new moon(NM). Relative survival within brood years can be inferred from recovery rates. Release dates not coinciding precisely with lunar phase are indicated as days prior (-) or days after (+) these particular phases. An * denotes releasing on the new moon nearest the vernal equinox. All fish were reared at Trinity River Hatchery.

Analysis of Effects of Size-at-release on Survival

The ocean recovery rate of adults was greater for smaller juvenile coho salmon released from the 1977 BY, and for larger juveniles released from the 1978 BY. No comparisons of ocean catch rates were made for the 1976 BY due to the use of different fin clips. Total recovery rates (ocean plus TRH recoveries) of adults were greater for the smaller fish released from the 1977 and 1978 BYs.

Adult hatchery return rates were greater for the smaller juvenile fish released in all three BYs. The grilse hatchery returns of larger released juveniles were several times greater in all BYs. These results suggest that smaller fish survived better to adulthood due the tendency of juveniles released at a larger size to return primarily as two-year-olds (Figures 2 and 3).

DISCUSSION AND CONCLUSIONS

The following two assumptions were the basis for the hypothesis that the new moon nearest the vernal equinox is the optimum time to release coho salmon: (i) prominent peak levels of plasma thyroxin (T_4) occur on the new moon nearest the vernal equinox, and (ii) survival is directly related to seawater adaptability. However, Nishioka et al. (1989) did not observe a single prominent peak of new-moon-associated T_4 rise in either the 1975 or 1982 BYs as had been observed earlier by Grau et al. (1981).

Other studies have also indicated these assumptions may not be valid. After examining the relationship between coho salmon survival to adulthood and T_4 concentration or gill (Na+K)-ATPase activity at two Oregon hatcheries, Ewing et al. (1985) concluded these relationships were poor predictors of future survival. They suggested other factors, such as ocean upwelling, may have greater effects on survival. Based on their study results, they concluded the most reliable index for predicting optimum-time-of release was a photoperiod-dependent index that does not vary with hatchery conditions (i.e., calendar dates).

Morley et al. (1988) reached a similar conclusion. Based on observation of coho salmon reared at Quinsam Hatchery, British Columbia, they concluded differences among returns of groups released at four dates (April 20, May 10, May 30, and June 19) were not due to changes in seawater adaptability.

The results from the size-at-release portion of our study suggests that survival to adulthood is greater for smaller juvenile coho salmon (32-41 g/fish [13.9-11.0 fish/lb]) than for larger juveniles (56-123 g/fish [8.1-3.7 fish/lb]). Larger juveniles returned as grilse at rates three to eight times

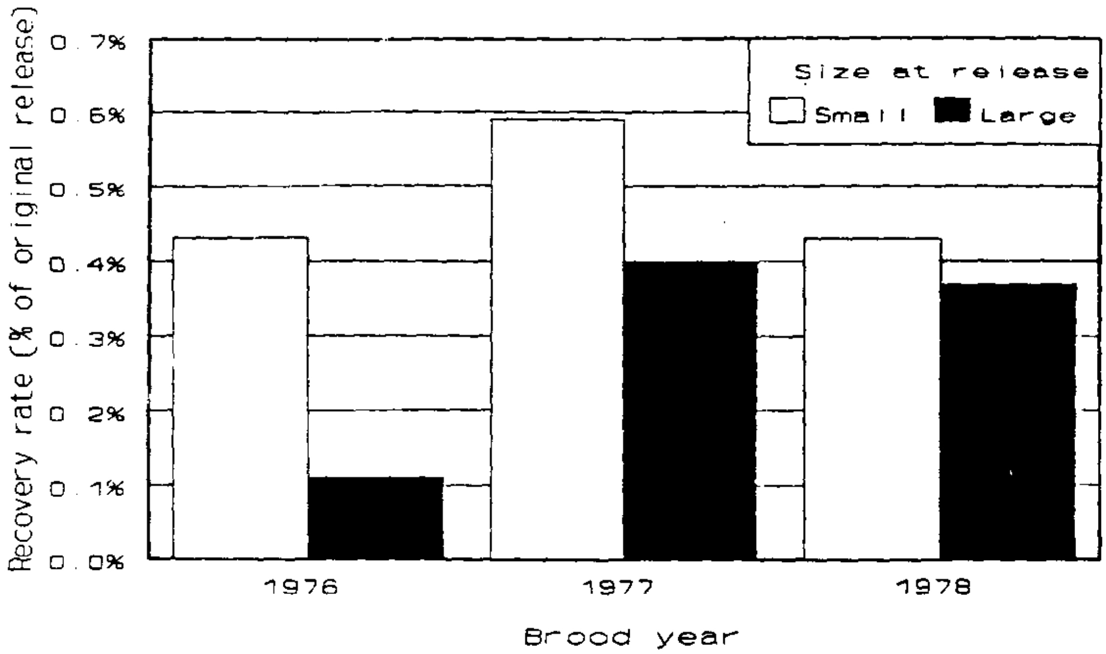


FIGURE 2. Recovery rates at Trinity River Hatchery of adult (ages three- and four-year-old) coho salmon from the 1976, 1977, and 1978 brood years for two size-at-release groups.

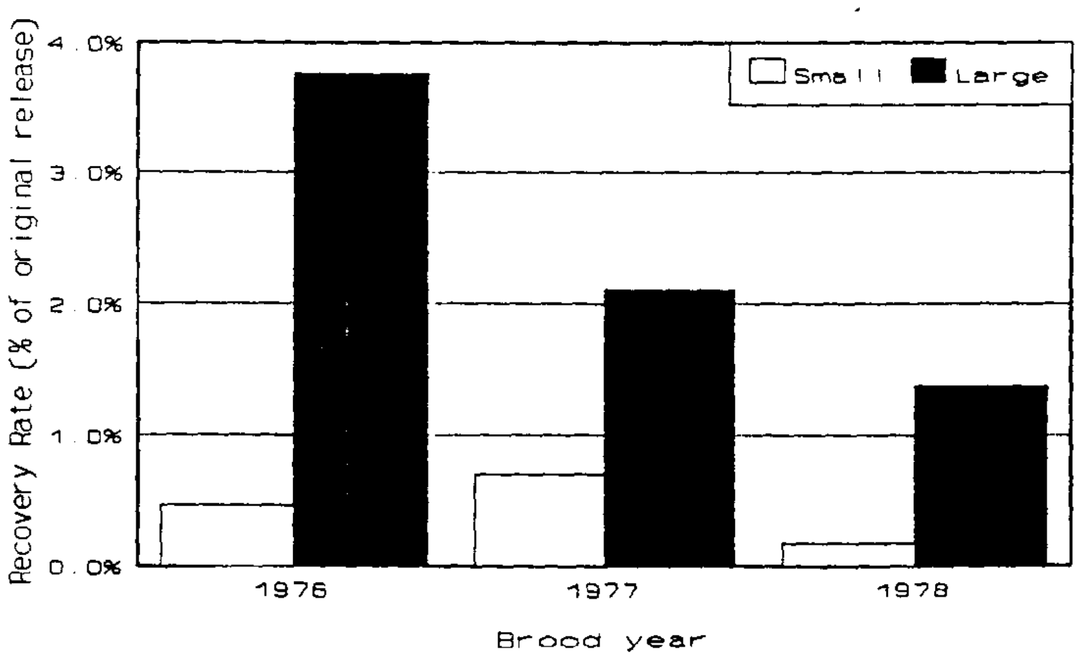


FIGURE 3. Recovery rates at Trinity River Hatchery of grilse (age two-year-old) coho salmon from 1976, 1977, and 1978 brood years for two size-at-release groups.

greater than smaller fish, thereby reducing the potential adult population. These results are consistent with observations of Morley et al. (1988). From their study of fish ranging from 20 to 31 g/fish (22.6-14.6 fish/lb) at release, they concluded that the returning percentages of grilse increased as size-at-release of fish increased.

Both Ewing et al. (1985), and Morley et al. (1988), in their respective studies, concluded that June was the optimum time to release coho salmon from the hatcheries. Unlike hatcheries in the Pacific northwest, June is not the most favorable time to release coho salmon reared at TRH. Due to warmer available water temperatures, coho salmon reared at TRH are likely to grow faster than coho salmon reared at hatcheries in the Pacific northwest. As a result, coho salmon held to June at TRH would probably be larger than the optimum release size.

We concluded that the new moon nearest the vernal equinox may not be the optimum time to release coho salmon. The relationship between seawater adaptability at the time of release and survival to adulthood is presently unclear. There may be factors of equal or greater importance affecting survival other than physiological readiness. Physiological changes measured in the hatchery may not be good predictors of what may begin to occur after fish are released from the hatchery and start to actively emigrate to the ocean.