State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1990 - 1991 SEASON

Inland Fisheries Division
1416 Ninth St, Room 1251
Sacramento, Ca. 95814

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Foreword

This is the third annual report to the United States Bureau of Reclamation (USBR) of activities conducted under the terms of Cooperative Agreements Numbers 8-FC-20-07100 and 1-FG-20-09820, and covers the contract period July 1, 1990 through June 30, 1991. The second Cooperative Agreement expanded Jobs 3, 4 and 5, and added Jobs 7 and 8. The field work was conducted by personnel of the California Department of Fish and Game's (CDFG) Klamath-Trinity Program, specifically its Trinity River Project (TRP), Trinity Fisheries Investigations Project (TFIP), and Natural Stocks Assessment Project (NSAP).

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ANNUAL REPORT
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1990-1991 SEASON

CHAPTER I

JOB I
SALMON SPAWNER SURVEYS IN THE UPPER TRINITY RIVER BASIN

by

Mark Zuspan

ABSTRACT

Staff of the California Department of Fish and Game's, Trinity Fisheries Investigations Project conducted a mark-and-recovery, salmon spawner survey of a portion of the mid-Trinity River basin from 17 September through 20 December 1990. We surveyed the mainstem Trinity River from the upstream limit of anadromous migration at Lewiston Dam to a point 63.4 km downstream at the confluence of the North Fork Trinity River. Selected portions of its major tributaries that were accessible to anadromous fish were also surveyed. We examined 752 chinook salmon (Oncorhynchus tshawytscha) and 61 coho salmon (O. kisutch) carcasses during the survey.

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

Approximately 22% of the spring-run, 5% of the fall-run chinook, and 13% of the coho salmon females died prior to spawning. While these chinook salmon prespawning mortality rates are lower than in the previous two years, they are still excessively high. Limited holding and spawning habitat in the upper mainstem is the probable cause of the high prespawning mortality.

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

Based on the recovery of adipose fin-clipped chinook salmon, we estimate that 30.2% of the spring-run and 36.7% of the fall-run chinook spawners observed in the survey were of hatchery origin.

Fork lengths of adult spring- and fall-run chinook salmon from the mainstem Trinity River averaged 73.4 cm (range: 55-99 cm) and 72.2 cm (range: 54-91 cm), respectively. Adult chinook salmon composed 96.6% of the spring run and 87.5% of the fall run with grilse composing the remainder. Coho were not measured during the survey.

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-third 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 nineteen (La Faunce 1965, Rogers 1970, 1973, 1982; Miller 1972, 1973, 1974, 1976, 1978, 1979, 1980, 1981, 1982, 1984, 1985; Smith 1975, Stempel 1988, and Zuspan 1991a, 1992a) were designed to evaluate the effects of the existing dam on the salmon resource.

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

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

METHODS

Mainstem Trinity River Spawner Survey

Our study area included the mainstem Trinity River from its upstream limit to anadromous fish migration at Lewiston Dam (River km 180.1) to the confluence of North Fork Trinity River, 63.4 km downstream (Figure 1). Previous studies have divided the river into either a four- or seven-zone system. The seven-zone system (Table 1) was used in 1987 by the United States Fish and Wildlife Service (USFWS) (Stempel 1988) and again in 1989 by TFIP (Zuspan 1992a). 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; Miller 1972, 1973, 1974, 1976, 1978, 1979, 1980, 1981, 1982, 1984, 1985; Smith 1975; Weber 1965; Zuspan 1991a). Our 1990-1991 data were collected based on both zone systems. We will summarize 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 subsequent reports.

River kms for locations used in the 1989-90 spawner survey (Zuspan 1992a) were taken from sources including; 1) a previous spawner survey (Stempel 1988); 2) a river mile index (Pacific Southwest Inter-Agency Committee 1973), and a United States Forest Service map of Trinity National Forest. However, due to the poor resolution of the map and inconsistencies in the referenced reports, minor errors in river location were made in the 1989-90 report. Therefore, for this report and those in future years, all river location references will be taken from a series of 7.5-minute, United States Geological Survey topographic maps (Appendix 1).

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

We determined spawning condition in female salmon by direct observation of the ovaries. Fish were classified as either

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

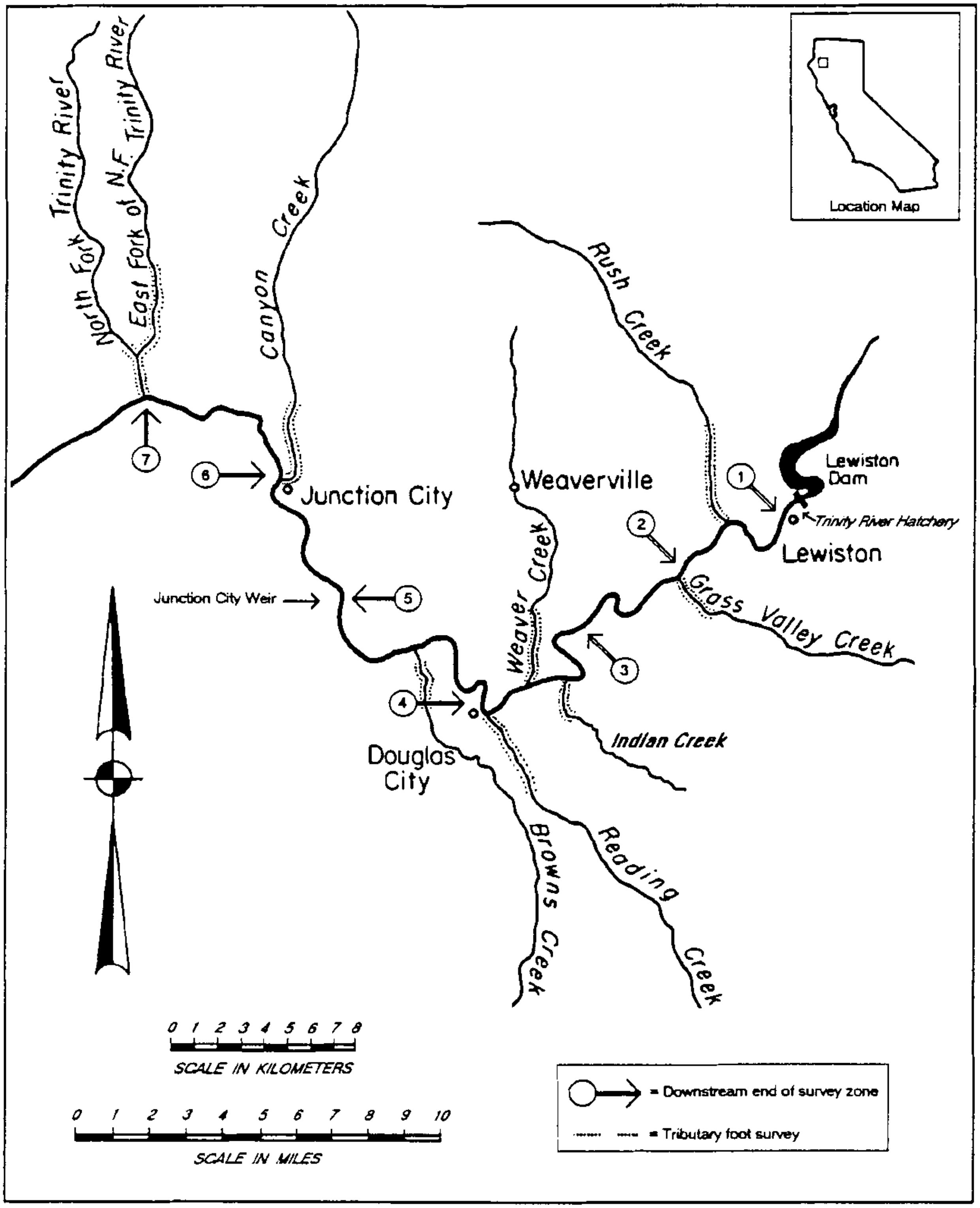

FIGURE 1. Map of the Trinity River basin showing the mainstem spawner survey zones and areas of the tributaries surveyed in the 1990-91 spawner survey (seven-zone system - Stempel 1988).

TABLE 1. Description and lengths of river zones used in the 1990-91 mainstem Trinity River spawner survey.

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

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

spawned or unspawned based on egg retention. Females which retained over 50% of their eggs were classified as unspawned. Male spawning condition was not assessed, as its determination was considered to be too subjective.

All carcasses we observed were identified by species and examined for an adipose fin-clip (Ad-clip) indicating the presence of a coded-wire tag (CWT) in their snout. To increase our likelihood of recovering all Ad-clipped fish, we considered any fish with a missing or otherwise imperfect adipose fin to be Ad-clipped. Fish were further examined for the presence of an external tag (spaghetti tag) and an operculum punch, applied as part of an ongoing study by other elements of the CDFG's Klamath-Trinity Program[2]. Spaghetti tags and operculum punches (Program marks) are placed on returning adult fish by CDFG staff at three trapping and tagging stations downstream of the spawner survey area, to monitor escapement and harvest of returning adult salmonids. The spaghetti-tagged salmon also receive an identifying operculum punch in order to estimate tag shedding

2/ Specifically the CDFG's Trinity River and Klamath River projects.

rates of fish tagged at the three sites. The first site is located at the mouth of the Klamath River where returning fall-run chinook salmon, coho salmon, and steelhead are captured in a seine and tagged. The second site upstream is Willow Creek Weir, located at river km 32.2 on the mainstem Trinity River. The last site is Junction City Weir at river km 136.4 on the mainstem Trinity River. Spring-run and fall-run chinook salmon, coho salmon, and steelhead are trapped and tagged at both Willow Creek and Junction City weirs.

Chinook Salmon

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

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

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

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

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

Condition-two fish which were neither Ad-clipped nor Program-marked were checked for the presence of a flag and, if possible, their sex and spawning condition was assessed. If a flag was present, the color of the flagging tape and the underlying ring were recorded, and all fish were then cut in half to prevent later recovery and re-counting of the same fish.

Coho Salmon

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

Tributary Spawner Surveys

Tributaries to the mainstem Trinity River, specifically Rush Creek, Grass Valley Creek, Indian Creek, Reading Creek, Browns Creek, Weaver Creek, Canyon Creek, East Fork of the North Fork Trinity River, and the mainstem North Fork Trinity River, were surveyed on foot once a week throughout the chinook salmon spawning season. Sections surveyed for each tributary ranged in length from 1.9 to 4.0 km, and were chosen based on accessibility and their historic use by chinook salmon spawners (Figure 1). The survey began with the onset of chinook salmon spawning in each tributary and continued until spawning ended (Table 2).

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

Aerial flights and ground-truthing surveys were made of each tributary to determine the percentage of the total available spawning area within each tributary represented by each of our

TABLE 2. Trinity River tributaries surveyed in the 1990-91 spawner survey.

Tributary	Length surveyed (km)	Weeks surveyed	Date Start	Date End	Percent of total [a]
Rush Creek	4.0	6	10/30/90	12/06/90	100.0
Grass Valley Creek	2.4	6	10/31/90	12/06/90	100.0
Indian Creek	1.9	6	11/02/90	12/03/90	100.0
Reading Creek	3.5	6	10/29/90	12/06/90	100.0
Browns Creek	2.4	6	10/29/90	12/06/90	50.0
Weaver Creek	3.2	6	10/31/90	12/03/90	100.0
Canyon Creek	4.0	6	11/02/90	12/03/90	100.0
N. Fork Trinity R.	2.4	6	11/02/90	12/03/90	100.0
E. Fork of the N. Fork	4.0	6	11/02/90	12/03/90	100.0

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

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

RESULTS AND DISCUSSION

Numbers Observed

<u>Mainstem Trinity River Spawner Surveys</u>

<u>Chinook Salmon</u>. We examined 752 chinook salmon during the spawner survey. These included 53 Ad-clipped fish, 75 Program-marked fish (eight also Ad-clipped), 435 unmarked condition-one fish which we flagged, and 197 unmarked condition-two fish. We also recaptured and re-examined 145 fish which we had flagged in previous weeks (Appendix 2). No whole skeletons were observed.

<u>Coho Salmon</u>. We recovered 61 coho salmon in the spawner survey, including one Ad-clipped and one Program-marked fish (Appendix 3), and did not see any whole skeletons.

Tributary Spawner Surveys

Chinook Salmon. We found only seven chinook salmon in the nine tributaries surveyed this season. These included one Ad-clipped fish, five condition-one fish which we flagged, and one skeleton. We re-examined two chinook which we had flagged in prior weeks (Appendix 4).

Coho Salmon. One coho salmon was examined in the tributaries this season (Appendix 4), and no skeletons were observed.

Spring- and Fall-run Chinook Salmon Spawning Intervals

Only chinook salmon recovered in the mainstem Trinity River were used to determine spring- and fall-run spawning intervals. Both spring and fall races of chinook salmon were observed in the mainstem survey. A date separating the two races was determined from CWTed and Program-marked chinook salmon. Spring-run chinook salmon dominated our recoveries through the sixth week of the survey ending 21 October 1990. Some overlap of spring- and fall-run chinook salmon occurred during the sixth week ending 28 October 1990. Fall-run chinook salmon became predominant by the seventh week of the survey which began 29 October 1990. For the purposes of this report, all chinook recovered prior to 29 October 1990 are considered spring race while those recovered from that date onward are considered fall race (Figure 2).

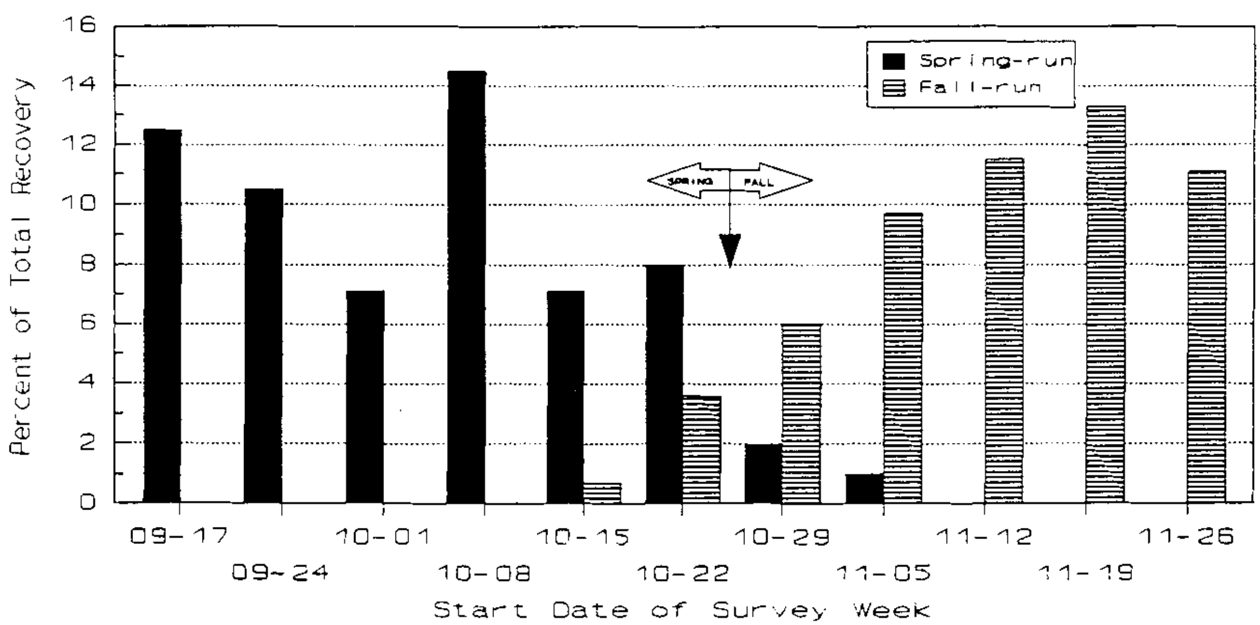

FIGURE 2. Chinook salmon spawning interval determined from weekly carcass recoveries of coded-wire-tagged and Program-marked fish in the 1990-91 Trinity River spawner survey. The arrow indicates the date separating the spring from the fall run.

For comparison, the dates separating spring- and fall-run chinook in previous years were 11 October in 1988 and 23 October in 1989 (Zuspan 1991a, 1992a).

Size Composition

Spring-run Chinook Salmon

Mainstem Trinity River. We measured 236 spring-run chinook salmon to the nearest cm fork length (FL) during the survey. Adults (fish > 54 cm[3/] FL [Bill Heubach, Calif. Dept. Fish and Game, pers. comm.]) composed 96.6% (228/236) of the spring-run chinook salmon observed in the spawner survey, while grilse (fish ≤ 54 cm FL) composed the remaining 3.4% (8/236) (Table 3, Figure 3). For comparison, the percentages of grilse in the spring-run chinook sampled at Junction City Weir and Trinity River Hatchery in 1990-91 were 2.9% and 4.1%, respectively. There was no significant difference in the percentage of grilse sampled the three sites (X^2=0.277, df=2, p=0.871).

Tributaries. Based on the date at which we first observed spawning activity, we concluded that no spring-run chinook salmon were recovered in the tributaries this season.

Fall-run Chinook Salmon

Mainstem Trinity River. We measured (cm FL) 192 fall-run chinook salmon this season. Adults (fish > 53 cm FL[3/] [Bill Heubach, Calif. Dept. Fish and Game, pers. comm.]) composed 87.5% of the fall-run chinook salmon observed in the spawner survey,

TABLE 3. Numbers and percentages of spring-run chinook salmon grilse observed in the spawner survey and at two fixed locations in the Trinity River basin during the 1990-91 season.

	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey
Grilse [a/]	48	104	8
Total	1,160	2,537	236
% Grilse	4.1%	4.1%	3.4%

a/ Spring-run chinc ,k salmon ≤ 54 cm FL are considered grilse based on post-season analysis of length frequency and coded-wire tags.

3/ Determined from post-season analysis of length frequency and coded-wire tag recovery.

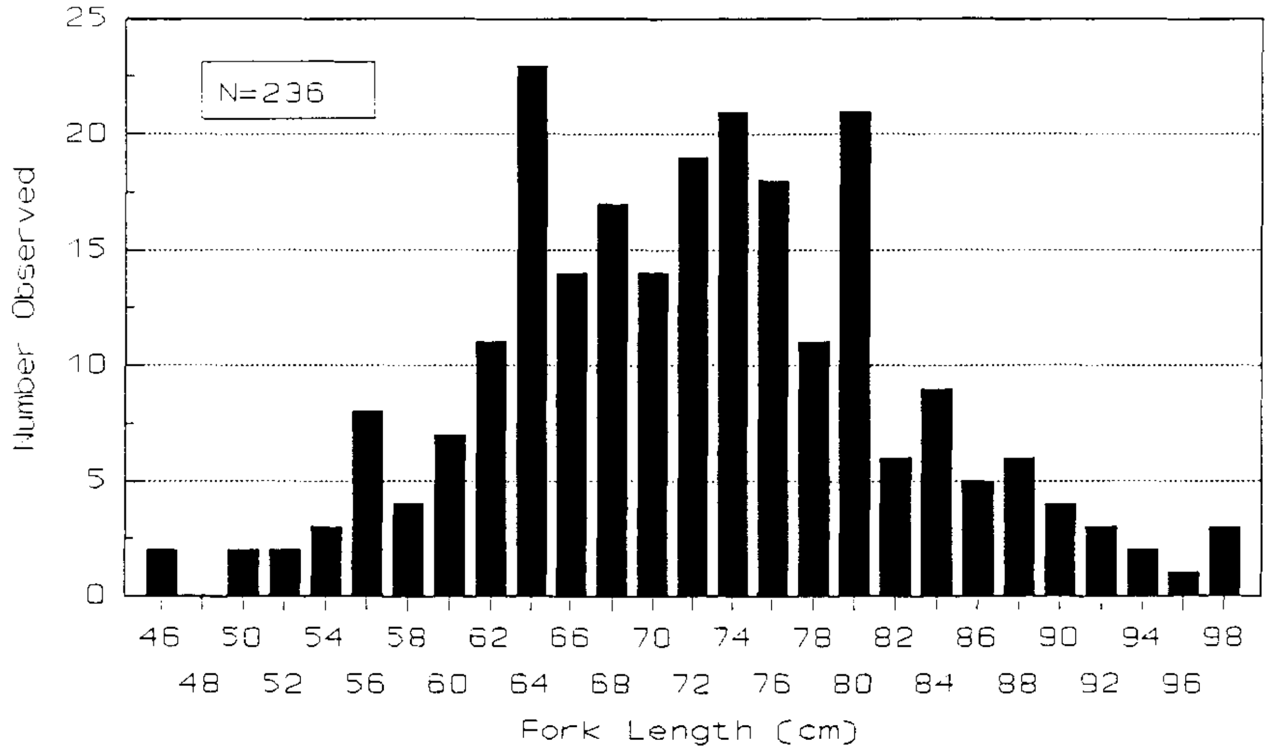

FIGURE 3. Fork length distribution, in 2-cm increments, of spring-run chinook salmon measured in the mainstem Trinity River during the 1990-91 spawner survey.

while grilse (fish ≤53 cm FL[3/]) composed the remaining 12.5% (Table 4, Figure 4). The percentages of fall-run chinook salmon grilse at the different sampling sites ranged from 6.3% to 21.6% (Table 4), and the differences were highly significant (X^2=72.9, df=3, p<0.001). The reason for the differences in proportions between the sample sites is unknown.

Tributaries. Only five chinook salmon were measured during the tributary survey this season. Four of the five (80%) were adults.

Sex Composition

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

TABLE 4. Numbers and percentages of fall-run chinook salmon grilse observed in the spawner surveys and at three fixed locations in the Trinity River basin during the 1990-91 season.

	Willow Creek Weir	Junction City Weir	Trinity River Hatchery	Mainstem spawner survey
Grilse [a/]	34	58	371	24
Total	536	608	1,719	192
% Grilse	6.3	9.5	21.6	12.5

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

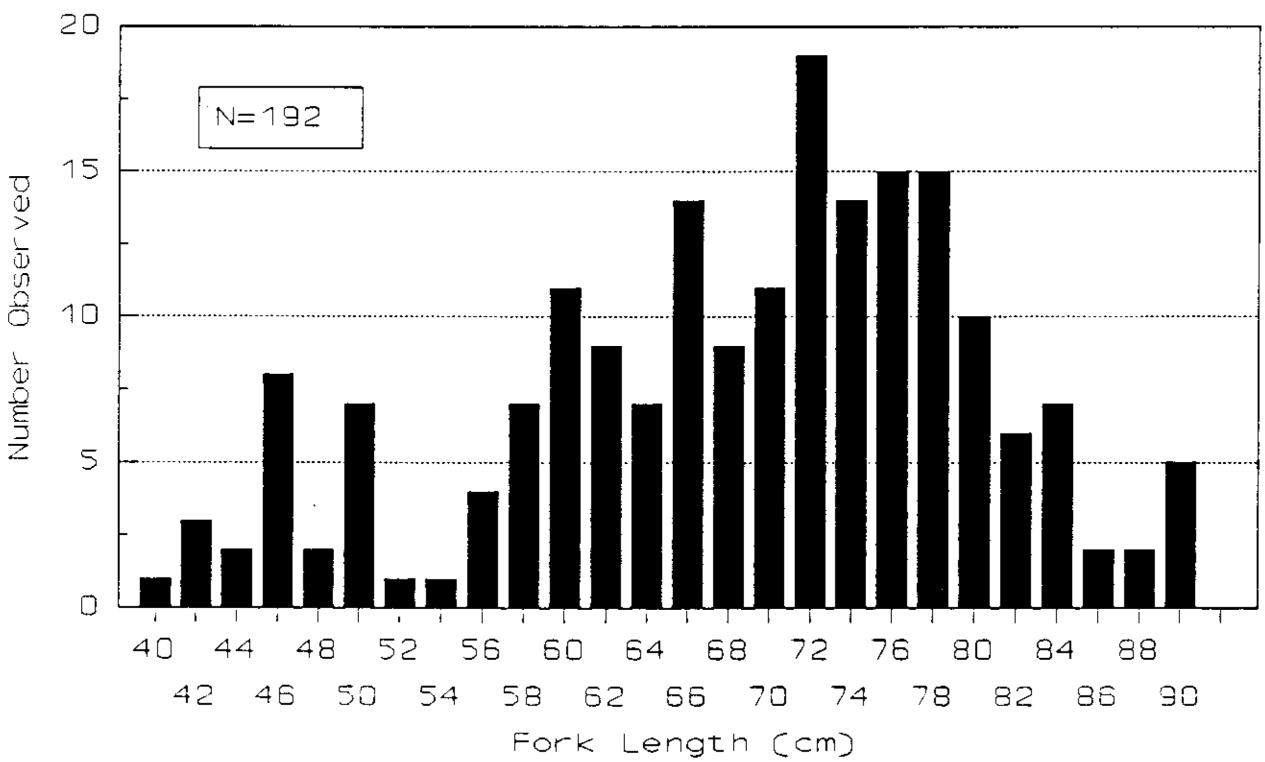

FIGURE 4. Fork length distribution, in 2-cm increments, of fall-run chinook salmon measured in the mainstem Trinity River during the 1990-91 spawner survey.

Chinook Salmon

We determined the sex of 304 adult chinook salmon during the survey (152 spring-run and 152 fall-run). Of the adult spring-run chinook salmon observed, 74.3% were females, while adult fall-run fish were 67.1% females. The percentages of females in the survey were generally highest during the early and late weeks of the survey and lowest during the middle weeks (Figure 5). The preponderance of females in the adult chinook salmon run has been noted in all but two of the previous surveys and has ranged from 73.6% to 25.8% (Appendix 5). The preponderance of females among adult fish results when males return as grilse, thereby decreasing the number of males left to return as adults.

Coho Salmon

We determined the sex of 59 coho, 80% (47) of which were females. For comparison, 42.4% and 57.1% of the coho we examined in 1988 and 1989, respectively, were females (Zuspan 1991a, 1992a). Not enough coho salmon were recovered this year to evaluate seasonal trends in their sex ratio. Last year, the seasonal trend in sex ratio for coho salmon was similar to that of chinook (Zuspan 1992a).

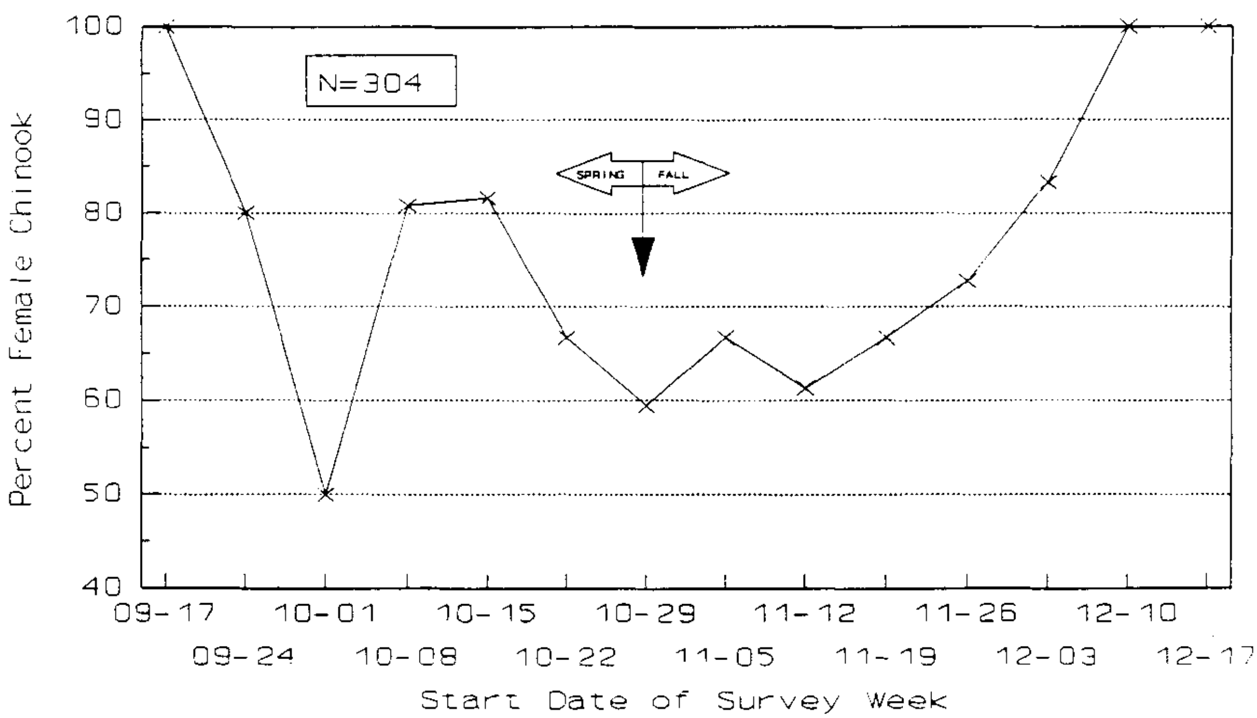

FIGURE 5. Percent females in the adult chinook salmon population observed in the mainstem Trinity river during the 1990-91 spawner survey. The arrow indicates the date separating the spring from the fall run.

Prespawning Mortality

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

Chinook Salmon

We determined the spawning condition of 207 adult female chinook salmon, including 97 spring-run and 110 fall-run fish. Prespawning mortality was 22% (21/97) and 5% (6/110) for spring- and fall-run female chinook salmon, respectively. Prespawning mortality rates were generally higher early in the survey and decreased through time (Figure 6). The higher prespawning mortality rate for female spring-run chinook salmon is probably related to the added stress imposed by the extended time they spend in the river.

The overall prespawning mortality rate of both races of female chinook salmon was 13.0%. For comparison, overall (spring- and fall-run) prespawning mortality of female chinook salmon has ranged from 1.5% to 44.9%, averaging 12.8% during previous surveys (Appendix 6).

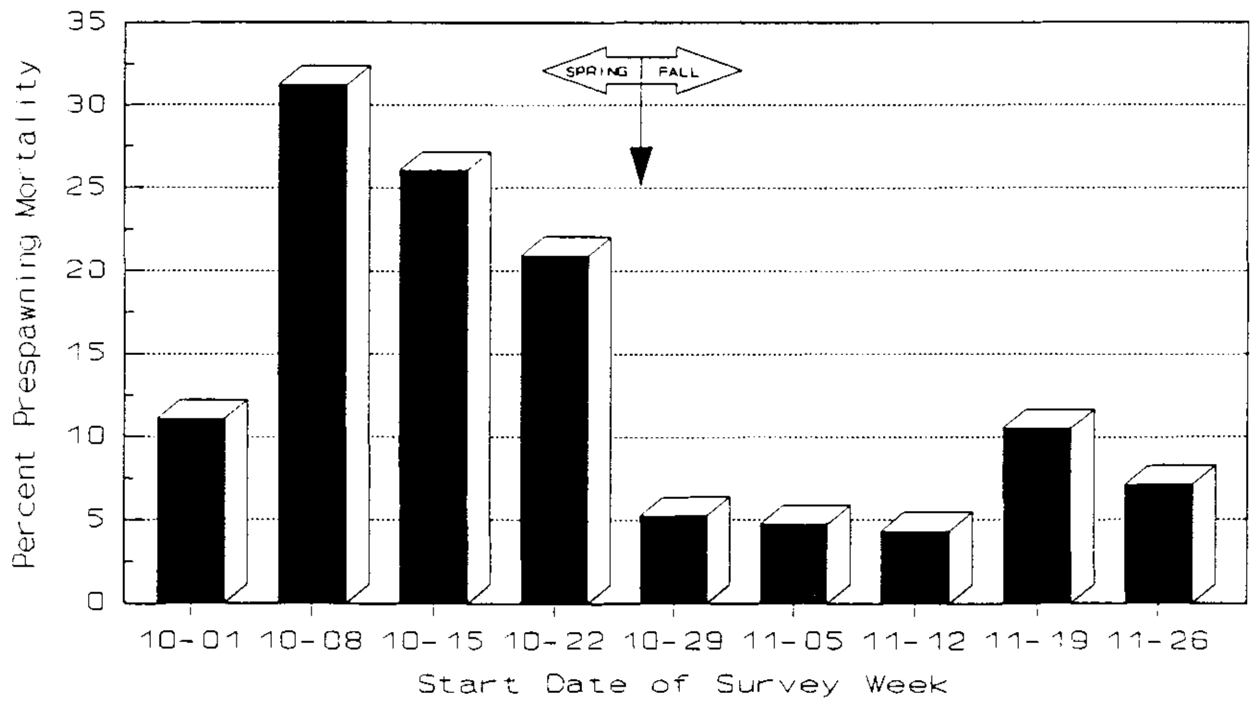

FIGURE 6. Adult female chinook salmon prespawning mortality observed in the mainstem Trinity River during the 1990-91 spawner survey. The arrow indicates the date separating the spring from the fall run.

Coho Salmon

Forty-seven adult female coho salmon were examined for spawning condition during the survey. The prespawning mortality rate for these fish was 13% (6/47). For comparison, in 1988 and 1989, the prespawning mortality rates of adult female coho salmon were 25.6% and 6.2%, respectively (Zuspan 1991a, 1992a). Coho prespawning mortality rates were not reported in surveys prior to 1988.

Salmon Spawner Distribution

Salmon spawner distribution in the mainstem Trinity River is presented based on the seven-zone system first used in 1987 (Stempel 1988). The results of Zones 6 and 7 were combined this year because too few flagged chinook were recovered in these individual zones to make reliable estimates. Distribution estimates are for adult fish only. This is because grilse and adult salmon are recovered in the survey at different rates; a fact that would force us to stratify the distribution estimate. Also grilse are relatively unimportant to the spawner escapement as they are predominantly unimportant to the spawner escapement as they are predominantly males and frequently do not spawn because of competition from larger, older males.

Chinook Salmon

Mainstem Trinity River. We examined 716 adult chinook this season, excluding flag recoveries. The numbers of chinook salmon spawners were greatest in upstream zones, decreasing from a high of 314 fish in Zone 1 to 38 fish in Zone 5 (Table 5). We recognize that carcass counts alone cannot be used to accurately describe distribution because recovery efficiency can vary from zone to zone, due to differences in stream morphology. Therefore, the percentage of flags recovered for each zone was used to determine the recovery efficiency of that zone (Table 5). Even based on the total number of chinook salmon recovered divided by the different recovery efficiency rates for each zone, the percent of chinook salmon spawners decreased downstream in successive zones below Zone 1 (Table 5). Spawner density, in terms of spawners per river km, was also highest in the uppermost section (198 spawners/km), and decreased steadily in a downstream direction (Table 5, Figure 7).

As noted in previous years (Zuspan 19ᶜ1a, 1992a), a potential source of error in this estimate is the assumption that flagged chinook salmon carcasses are recovered only in the zone that they were originally flagged. If flagged fish are recovered in downstream zones, it would tend to increase the efficiency estimate in the recovery zone while decreasing the estimate in the flagging zone.

TABLE 5. Adult chinook salmon spawner distribution and density by river zone in the 1990-91 Trinity River spawner survey.

Zone [a]	Zone length (km)	Number flagged	Flags recovered	% flags recovered	Total unflagged observed [b]	Expanded total [c]	% of expanded total	Spawners per km [d]
1	3.2	173	86	49.7%	314	632	25.3%	198
2	7.9	58	18	31.0%	108	348	13.9%	44
3	10.2	37	7	18.9%	85	449	18.0%	44
4	10.4	26	3	11.5%	42	364	14.6%	35
5	12.0	22	3	13.6%	38	279	11.2%	23
6-7	19.7	86	26	30.2%	129	427	17.1%	22
Totals:	63.4	402	143		716	2,499	100%	
Means:				35.6%				39

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

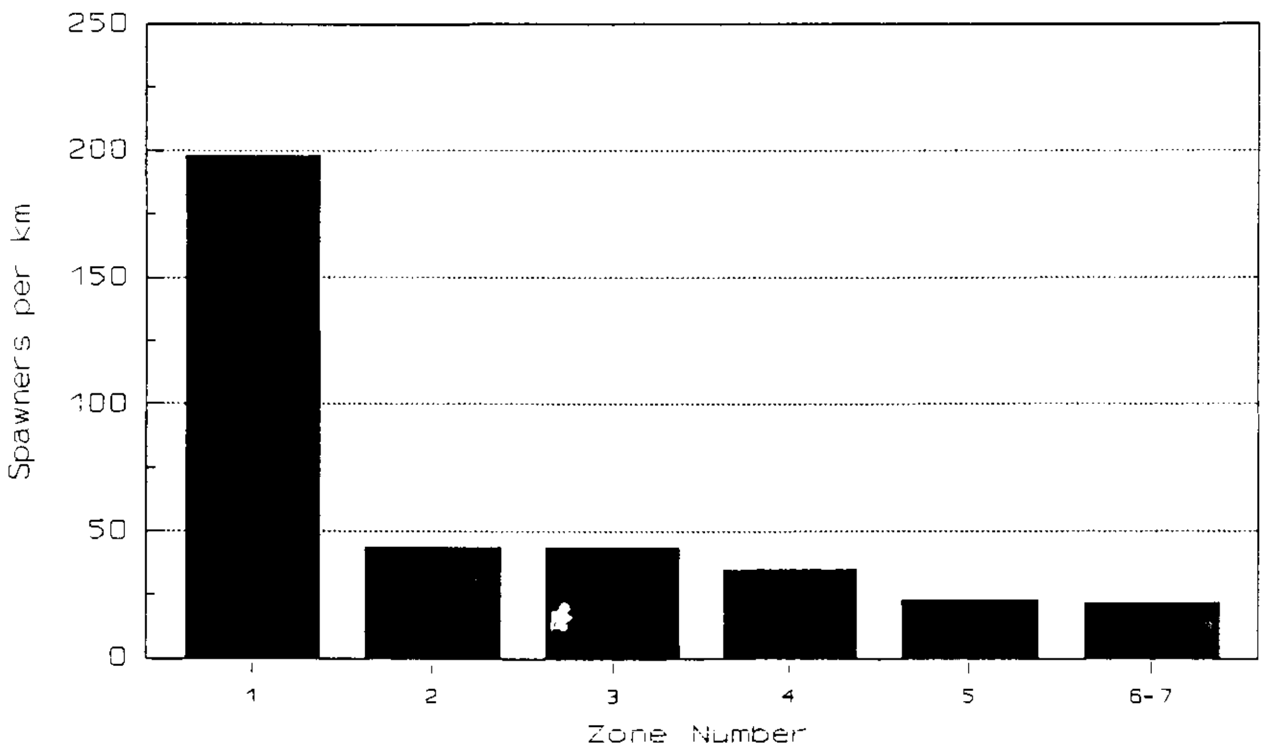

FIGURE 7. Adult chinook salmon spawning density, in spawners per river km, observed in the 1990-91 mainstem Trinity River spawner survey.

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 of the 143 flags recovered were found in the same zone in which they were originally flagged. This indicates that carcass drifting had no effect on chinook salmon distribution estimates.

Tributaries. Spawning adult chinook salmon made very limited use of tributaries this year. Since so few chinook salmon were examined (seven, excluding flag recoveries), redd counts were used to describe spawner distribution.

We located 21 chinook salmon redds during the tributary survey. Redds were observed in only four of the nine tributaries surveyed. The mainstem of the North Fork Trinity River had 10 redds, followed by the East Fork of the North Fork with eight, Canyon Creek with two, and Browns Creek with one (Appendix 4).

Coho salmon

Mainstem Trinity River. We observed only 61 adult coho salmon in the mainstem spawner survey this year, most of which were seen in Zones 1 and 2 (Table 6). We estimated the total number of coho salmon which spawned in each zone by dividing the actual number of carcasses observed by the recovery efficiencies for that zone developed from chinook salmon flag recoveries. Like chinook salmon, coho spawning density was highest in the uppermost zone (11 spawners/km). Downstream of Zone 1, coho spawner density ranged form 6 to 2 spawners per km (Table 6).

Tributaries. We recovered only one coho salmon during the tributary surveys. It was recovered in the East Fork of the North Fork Trinity River (Appendix 4).

Marked Salmon Recovery

Program Marks

We observed Program marks (spaghetti tags or operculum punches) on 37 spring-run and 38 fall-run chinook salmon in the mainstem Trinity River spawner survey. All of the spring-run chinook salmon were tagged at Junction City Weir. Of the fall-run chinook salmon recovered, 27 were from Junction City Weir, 8 from Willow Creek, 2 from both Junction City and Willow Cr ek weirs, and 1 from the Klamath River mouth. Of the 75 Program-marked chinook observed, 62 were condition-one fish, while the remainder were condition-two fish. The single weir-marked coho observed in the survey was from Junction City weir.

Only condition-one fish were used to determine the actual percentage of Program marks in the spawner survey. This is

TABLE 6. Adult coho salmon spawner distribution and density by river zone in the 1990-91 Trinity River spawner survey.

Zone [a]	Zone length (km)	Total observed	Observation efficiency [b]	Expanded total [c]	% of expanded total	Spawners per km [d]
1	3.2	18	49.7%	36	15.0%	11
2	7.9	11	31.0%	35	14.7%	4
3	10.2	3	18.9%	16	6.6%	2
4	10.4	7	11.5%	61	25.2%	6
5	12.0	5	13.6%	37	15.2%	3
6-7	19.7	17	30.2%	56	23.3%	3
Totals:	63.4	61		241	100.0%	
Means:			35.6%			4

[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).

because we were more likely to correctly identify a Program mark on a fresh (i.e. condition-one) fish than one in advanced decay. The percentage of condition-one chinook salmon recovered in the survey which had been marked at the three tagging sites ranged from 10.5%[4/] to 0.4% (Table 7).

Adipose Fin Clips and Coded-wire Tags

We recovered 53 chinook salmon and one coho salmon in the spawner survey which appeared to be Ad-clipped. Based on their CWTs, 9 were spring-run chinook salmon, 11 were fall-run chinook salmon, and 34 fish did not have CWT's (Appendix 7). Nineteen of the CWT recoveries were from chinook salmon produced at Trinity River Hatchery, while one was from a naturally produced chinook salmon originally trapped and tagged in the mainstem Trinity River under other Program activities (Zuspan 1991b).

4/ Two fall-run chinook salmon were tagged at Willow Creek Weir, recovered at Junction City Weir, and recovered in the spawner survey. These two Program-marked fish were included in the counts of both weirs.

TABLE 7. Program mark recoveries from condition-one chinook salmon during the 1990-91 mainstem Trinity River spawner survey.

	Spring-run chinook			Fall-run chinook		
Tag site	Program marks [a]	Total observed [b]	% Program marks	Program marks	Total observed	% Program marks
Willow Creek Weir [c]	0	295	0.0	10	238	4.2
Junction City Weir	28	295	9.5	25 [d]	238	10.5
Klamath River mouth [c]	0	295	0.0	1	238	0.4
Totals:	28			36		

[a] Program marks include spaghetti tags and operculum punches.
[b] Total number of condition-one chinook salmon observed during the mainstem Trinity River spawner survey.
[c] Only fall-run chinook salmon were tagged at these sites.
[d] Includes two Program marks which were also observed at Willow Creek Weir.

The high percentage of apparently Ad-clipped chinook salmon without CWTs (63%) was probably the result of misidentifying Ad-clips. To minimize the number of Ad-clipped fish missed during the spawner survey, as noted last year (Zuspan 1992a), surveyors were instructed to consider any fish that had a missing or deformed adipose fin an Ad-clipped fish. While this procedure apparently resulted in misidentifying non-Ad-clipped fish as Ad-clipped, it probably allowed for the collection of nearly all the actual Ad-clipped fish.

The percentage of Ad-clipped fish in the spawner survey is best estimated by considering only those Ad-clipped fish that had CWTs (Ad+CWT) and were condition-one fish, as Ad-clips could not be reliably determined on fish in advanced decay (i.e. condition-two fish). However, this method does not produce an estimate of Ad-clipped fish that can be directly compared with the estimate of Ad-clipped fish returning to the weirs or TRH. This is because we consider Ad-clipped fish in the spawner survey to be only those fish that have CWTs, while at the other sites they count fish with Ad-clips irrespective of their having a CWT. To make the two estimates comparable, the number of Ad+CWT observed in the spawner survey was expanded by the CWT shedding rate for chinook salmon observed at TRH. For example, of the 379 Ad-clipped spring-run chinook salmon observed at TRH, 345 (91.1%) had CWTs, indicating a 8.9% CWT shedding rate for these fish. The CWT shedding rate for fall-run chinook salmon at TRH was 4.1%. Expanding our counts of Ad+CWT fish in the spawner survey by the aforementioned CWT shedding rates, 4.5% and 4.7% of the spring- and fall-run chinook salmon observed in the spawner survey were Ad-clipped.

The percentage of Ad-clipped spring- and fall-run chinook salmon varied at the different recovery sites, probably as the result of hatchery-produced fish homing to the hatchery (Table 8). Since naturally produced chinook salmon also spawn in the lower mainstem or its tributaries, we would expect the percentage of hatchery-produced, Ad-clipped chinook salmon in the population to increase at each sampling site proceeding upstream, and to be highest at the hatchery. This is the case for both chinook salmon runs at the weir sites and the hatchery (Table 8). However, the percentage of Ad-clipped salmon was lower in the mainstem Trinity River spawner survey than at any other sample site (Table 8). Ad-clip rates in the spawner survey may have been less than at weirs downstream, as the weirs captured a fraction of all upstream migrants, both hatchery and natural fish, while the spawner survey emphasized in-river spawners which would be more likely to be naturally produced fish.

Incidence of Hatchery-produced Chinook Salmon

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

Spring-run Chinook Salmon

The percentage of Ad-clipped spring-run chinook salmon observed at the three locations in the Trinity River basin below Lewiston Dam ranged from 4.5% to 14.9% (Table 8), and are significantly

TABLE 8. Numbers and percentages of adipose fin-clipped salmon observed in the mainstem spawner survey and at three fixed locations in the Trinity River basin during the 1990-91 season.

	Spring-run chinook			Fall-run chinook		
Site	Ad-clips[a]	Total	% Ad-clip	Ad-clips	Total	% Ad-clips
Willow Creek Weir	0	0		32	536	6.0
Junction City Weir	146	1,160	12.5	40	608	6.6
Trinity River Hatchery	379	2,537	14.9	220	1,719	12.8
Mainstem Trinity River survey[c]	11[b]	243	4.5	9	192	4.7

[a] Adipose fin-clipped fish.

[b] Only 10 adipose fin-clipped fish with coded-wire tags were observed. This number was expanded to account for adipose fin-clipped fish which may have shed their tags. Coded-wire tag shedding rates were from this year's Trinity River Hatchery coded-wire tag recovery records.

[c] Only condition-one fish with coded-wire tags from the spawner survey were used in this analysis. All fish were used at the other three sites.

different (X^2=17.76, df=2, p=0.0001) from each other.

Since most (97%) of the spring-run chinook salmon recovered at TRH are estimated to be of hatchery origin (Bill Heubach, Calif. Dept. of Fish and Game pers. comm., based on expansions of CWT recoveries), we assume that the 14.9% Ad-clip rate for spring-run fish observed there can be used to represent the ad-clip rate for a population of 100% TRH-origin chinook salmon. It is not possible to use the original hatchery Ad-clip rates to determine the proportion of hatchery vs. wild fish returning to TRH, because the proportion of hatchery-produced chinook salmon groups that are Ad-clipped varies annually, and returns to TRH are a varying mix of brood years. In addition, different brood years may have experienced different rates of mortality among marked vs. unmarked fish. Since our survey recovered Ad-clipped spring-run chinook salmon at only 30.2% (4.5/14.9) of the Ad-clip rate observed at TRH, we estimated that 30.2% of the spring-run chinook salmon observed in the survey were of TRH origin while the remaining 69.8% were naturally produced.

Fall-run chinook Salmon

The Ad-clip percentage of fall-run chinook salmon was lowest in the spawner survey (4.7%) followed by Willow Creek Weir (6.0%), Junction City Weir (6.6%), and TRH (12.8%) (Table 8). The differences in chinook salmon Ad-clip rates among the four sites is statically significant (X^2=32.3, df=3, p<0.001).

Since most (92%) of the fall-run chinook recovered at TRH are estimated to be of hatchery origin (Bill Heubach, Calif. Dept. of Fish and Game, pers. comm., based on expansions of CWT recoveries), we assumed that the 12.8% Ad-clip rate for fall-run fish observed at TRH could be used to represent the ad-clip rate for a population of 100% hatchery-produced chinook salmon. Since only 4.7% of the fall-run chinook salmon in the spawner survey were Ad-clipped, we estimated that 36.7% (4.7/12.8) were of hatchery origin, while the remaining 63.3% were naturally produced.

Computational Assumptions

There are several assumptions which could be potential sources of error in using the aforementioned method to determine the incidence of hatchery fish spawning in the river. We assume that field personnel actually observed all possible Ad-clips in the survey. The recognition of an Ad-clip, even on fish in relatively good condition, can be difficult. We are also assuming that the probability of observing and recovering an Ad-clipped fish is the same in the survey as at the hatchery, and, most importantly, that ratios of Ad-clip to unmarked hatchery fish are the sane in the spawner survey as at TRH. Since different chinook salmon release groups are Ad-clipped at different rates, this last assumption is only valid if the various CWT groups occur in the spawner survey in the same proportions as among the fish recovered at TRH.

RECOMMENDATIONS

1. Annual spawner survey activities should be continued, with current objectives, in FY 1991-92 and beyond.

2. To increase the number and accuracy of our Ad-clip fish recoveries, all chinook salmon with questionable Ad-clips should be passed through a tag detector. This should allow us to more reliable estimate the proportion of hatchery and naturally produced fish spawning in the wild. Additionally, the increased effort will insure better recovery of naturally produced Ad-clipped chinook which will be returning as adults beginning in 1991.

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APPENDIX 1. List of maps used to identify the river km of locations used during the 1990-91 Trinity River spawner survey.

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

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

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

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

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

APPENDIX 2. Summary of chinook salmon carcasses recovered during the 1990-91 mainstem Trinity River spawner survey.

							Unmarked chinook a/					
								Females				
Survey week	Date begun	Ad-clips c/	Program marks d/	Chinook flagged b/ Adults	Grilse e/	Flag recovery f/	Males	Spawned	Unspawned	Percent unspawned	Unknown g/	Week totals h/
1	17-Sep	0	1	5	0	0	0	1	0	0	1	8
2	24-Sep	2	0	17	0	4	0	0	0		0	19
3	01-Oct	5	5 (1)	11	0	1	2	4	0	0	1	27
4	08-Oct	10	8 (1)	48	1	6	2	3	3	50	1	75
5	15-Oct	9	8	93	5	11	2	5	2	29	17	141
6	22-Oct	8	15 (4)	61	2	28	6	11	3	21	8	110
7	29-Oct	0	9 (1)	29	1	9	4	6	1	14	3	52
8	05-Nov	7	9	51	8	18	7	6	0	0	16	104
9	12-Nov	5	8	40	8	25	2	8	0	0	8	79
10	19-Nov	2	9	24	7	23	3	4	0	0	14	63
11	26-Nov	5	2 (1)	16	1	11	0	5	0	0	8	36
12	03-Dec	0	0	7	0	4	1	4	0	0	8	20
13	10-Dec	0	1	0	0	5	0	3	0	0	9	13
14	17-Dec	0	0	0	0	0	0	1	0	0	4	5
Totals:		53	75 (8)	402	33	145	29	61	9		98	752
Average:										13		

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

APPENDIX 3. Summary of coho salmon carcasses recovered during the 1990-91 mainstem Trinity River spawner survey.

Survey week	Date begun	Ad-clips a/	Program marks b/	Males	Female coho Spawned	Female coho Unspawned	Female coho Percent unspawned	Week totals
1	17-Sep	0	0	0	0	0		0
2	24-Sep	0	0	0	0	0		0
3	01-Oct	0	0	0	0	0		0
4	08-Oct	0	0	0	0	0		0
5	15-Oct	0	0	0	1	0	0	1
6	22-Oct	0	0	0	6	0	0	6
7	29-Oct	0	0	2	4	1	20	7
8	05-Nov	1	0	0	1	1	50	3
9	12-Nov	0	0	2	4	3	43	9
10	19-Nov	0	0	4	10	0	0	14
11	26-Nov	0	0	2	8	1	11	11
12	03-Dec	0	0	0	4	0	0	4
13	10-Dec	0	1	1	1	0	0	3
14	17-Dec	0	0	1	2	0		3
Totals:		1	1	12	41	6		61
Average:							13	

a/ Adipose fin-clipped coho salmon.

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

APPENDIX 4. Summary of salmon carcasses and redds observed during the 1990-91 spawner surveys in tributaries to the Trinity River between Lewiston Dam and North Fork Trinity River.

		Percent		Chinook								
	Kilometer	of total	Weeks		Program	Flagged fish a/		Flags			Redd	
Tributary	surveyed	spawning b/	surveyed	Ad-clips c/	marks d/	Adults	Grilse e/	recovered	Skeletons	Total f/	count	Coho
Rush Creek	4.0	100	6	0	0	0	0	0	0	0	0	0
Grass Valley Creek	2.4	100	6	0	0	0	0	0	0	0	0	0
Indian Creek	1.9	100	6	0	0	0	0	0	0	0	0	0
Reading Creek	3.5	100	6	0	0	0	0	0	0	0	0	0
Browns Creek	2.4	50	6	0	0	0	0	0	0	0	1	0
Weaver Creek	3.2	100	6	0	0	0	0	0	0	0	0	0
Canyon Creek	4.0	100	6	0	0	0	0	0	0	0	2	0
North Fork Trinity R.	2.4	100	6	1	0	1	0	1	0	1	10	0
E. Fork N. Fork Trinity	4.0	100	6	0	0	3	1	1	1	5	8	1
Totals:				1	0	4	1	2	1	6	21	1

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

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

c/ Adipose fin-clipped fish.

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

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

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

APPENDIX 5. Sex composition of adult chinook salmon observed during mainstem Trinity River spawner surveys from 1942 through 1990.

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

a/ Spring-run and fall-run chinook salmon were not reported separately.
b/ Grilse chinook salmon were included in these counts.

APPENDIX 6. Female chinook salmon prespawning mortality rates observed during mainstem Trinity River spawner surveys from 1942 through 1990.

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

a/ Prespawning mortality rate was not reported during these years.
b/ Spring-run and fall-run chinook salmon were not separated during these years.
c/ Overall prespawning mortality rates were reported but not individual counts.

APPENDIX 7. Release and recovery data for coded-wire tagged salmon recovered in the 1990-91 mainstem Trinity River spawner survey

	Release Information							
CWT # a/	Species	Race	Brood year	Type b/	Location c/	Date	Number released	Number recovered
06-56-27	Chinook	Fall	1986	Fy	TRH	Sep-1987	100,320	8
06-56-30	Chinook	Fall	1986	Ff	Ambrose	Jun-1987	92,351	1
06-56-31	Chinook	Fall	1987	Fy	Ambrose	Oct-1988	92,300	4
06-61-46	Chinook	Spring	1986	Sy	TRH	Sep-1987	101,030	8
06-61-47	Chinook	Spring	1987	Sy	Sawmill	May-1988	185,718	1
B6-13-06	Chinook	Fall	1988	Wild	Junction City	Apr&May-1989	26,650	1
Total:								23

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

b/ Hatchery release types include; Fy=fall yearling, Ff=fall fingerling, Fy+=fall yearling plus, Sy=spring yearling, Sf=spring fingerling; Wild=naturally produced and reared.

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

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1990-1991 SEASON

CHAPTER II

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

by

Mark Zuspan

ABSTRACT

Staff of the California Department of Fish and Game's Trinity Fisheries Investigations Project conducted a trapping and coded-wire tagging operation for naturally produced, juvenile chinook salmon (*Oncorhynchus tshawytscha*) on the mainstem Trinity River below Lewiston Dam from 16 January through 26 May 1991.

We trapped 89,208 juvenile chinook salmon, 903 juvenile coho salmon (*O. kisutch*), and 7,275 juvenile steelhead (*O. mykiss*) at four locations during the study. Peak catch-per-unit-effort for juvenile chinook salmon was at the most downstream site, occurring early May. Weekly average fork lengths of trapped juvenile chinook salmon tended to increase throughout the trapping period.

We adipose fin-clipped and implanted coded-wire tags into 80,087 juvenile chinook salmon, a sub-sample of which ranged in size from 36 to 95 mm fork length. After adjusting for tagging mortality, tag shedding, and poor fin clips, we effectively coded-wire tagged and released 72,865 juvenile chinook salmon.

One two-year-old chinook salmon that had been coded-wire tagged near Junction City in 1988 was recovered this year during spawner surveys in the North Fork Trinity River.

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 spawning escapement of these stocks is crucial to wise management of chinook in the basin.

Federal 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 and coded-wire tagged (Ad+CWT), and released naturally produced juvenile chinook. Subsequent studies of these fish as adults, by TFIP and other projects of the CDFG's Klamath-Trinity Program, will be used to determine survival, harvest, and spawning escapement for this important component of the Trinity River basin's chinook stocks.

This is the third year of the study. Previous years (Zuspan 1991b and 1992b) dealt only with the tagging aspect of the study. This report, and those to follow, will also address the recovery of tagged fish as adults.

METHODS

Use of Standard Julian Week

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

Trapping

We trapped at four primary sites in the mainstem Trinity River this season. Site names and river km (RKM) locations were: 1) Lewiston at RKM 175, 2) Steel Bridge at RKM 159, 3) Indian Creek at RKM 153, and 4) Sky Ranch at RKM 136 (Figure 1).

Trapping began 16 January and was concluded 26 May 1991. Our primary objective was to capture up to 100,000 juvenile chinook for coded-wire tagging. To that end, we trapped sporadically at each of the four sites to locate the site that would produce the highest numbers of fish at a given time.

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

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

Tagging

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

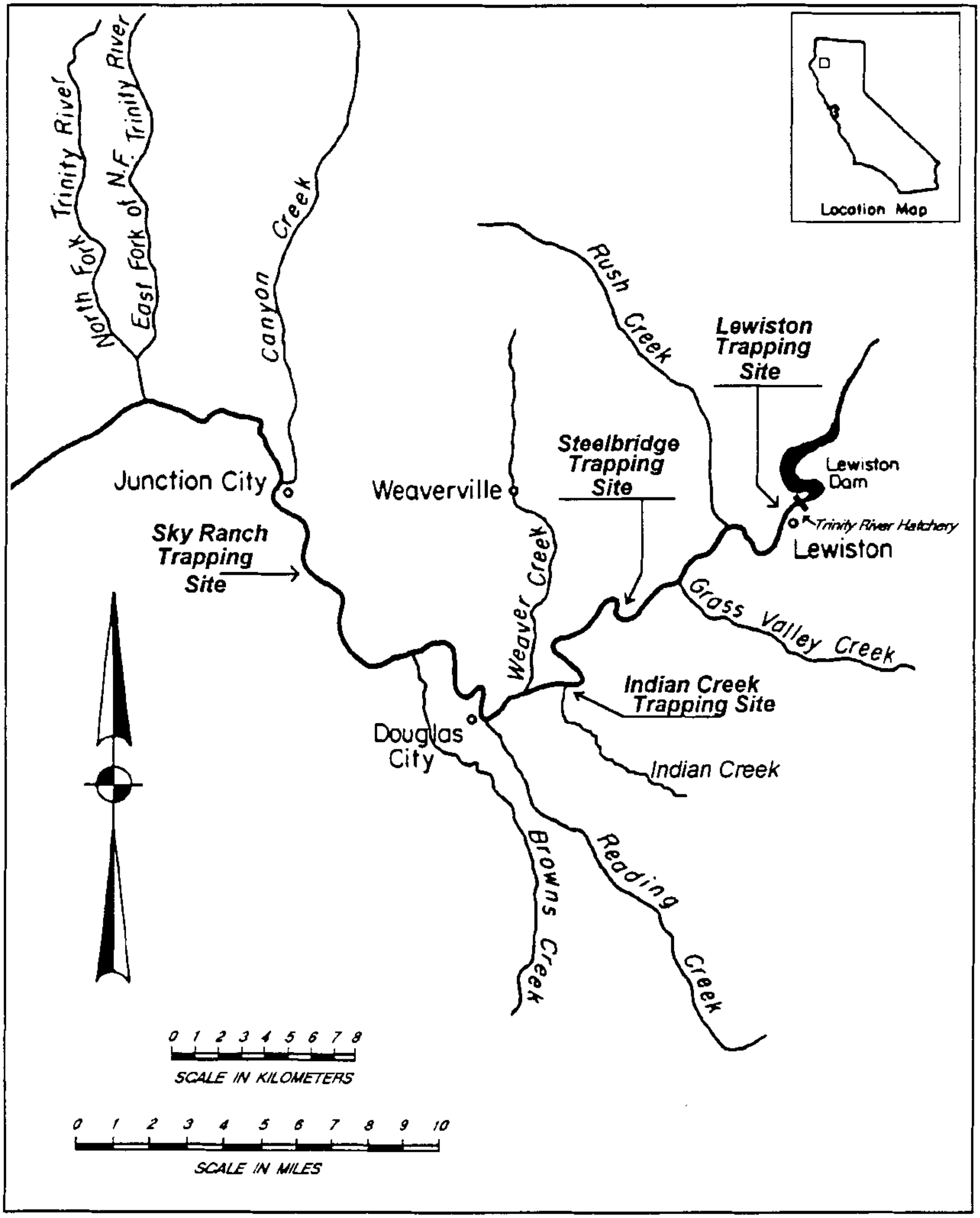

FIGURE 1. Map of the Trinity River below Lewiston Dam showing the four trapping sites used in 1991.

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

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

Recovery

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

RESULTS

Trapping

We began trapping 16 January, and continued at varying locations and intensities through 26 May 1991 (Table 1). In late May, high flows (914 m/sec) from experimental dam releases and the coincident release of approximately 1.9 million juvenile chinook from Trinity River Hatchery (TRH) precluded further trapping of naturally produced fish for the season.

Chinook Salmon

We captured 89,208 juvenile chinook this season. Totals by site were, 1) 848 at the Lewiston Site, 2) 20,458 at the Steel Bridge Site, 3) 554 at the Indian Creek Site and, 4) 67,348 at the Sky Ranch Site (Appendices 2, 3, 4, 5).

Catch-per-unit-effort (CPUE), measured as /eekly average number of fish caught per-night per-net fished, varied considerably

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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.

TABLE 1. Number of traps set per Julian week at each trapping site in the mainstem Trinity River during 1991.

Julian week	Start date	Lewiston	Steel Bridge	Indian Creek	Sky Ranch
3	Jan-15	2		1	
4	Jan-22	2		1	
5	Jan-29	4		1	
6	Feb-05	4		2	
7	Feb-12	6		1	
8	Feb-19	3		1	
9	Feb-26	6		2	
10	Mar-05	9		2	1
11	Mar-12	6		2	
12	Mar-19	5		1	3
13	Mar-26	8		3	2
14	Apr-02	4		2	2
15	Apr-09	3	4	2	
16	Apr-16	1	29	1	1
17	Apr-23		38	1	
18	Apr-30		11		49
19	May-07				61
20	May-14				48
21	May-21				43
Totals:		65	82	23	210

between trapping sites (Figure 2, and Appendices 2, 3, 4, 5). The highest CPUE (485) was at the Sky Ranch Site followed by the Steel Bridge Site (438), Indian Creek Site (192), and the Lewiston Site (84).

We measured the FLs of 2,151 chinook during the trapping season. These fish ranged in FL from 24 to 97 mm. Weekly average FLs of fish at the four trapping sites generally increased though time (Figure 3, Appendices 2, 3, 4, 5). Average FL of juvenile chinook was 37.0 mm in late January and increased to 68.7 mm by late May.

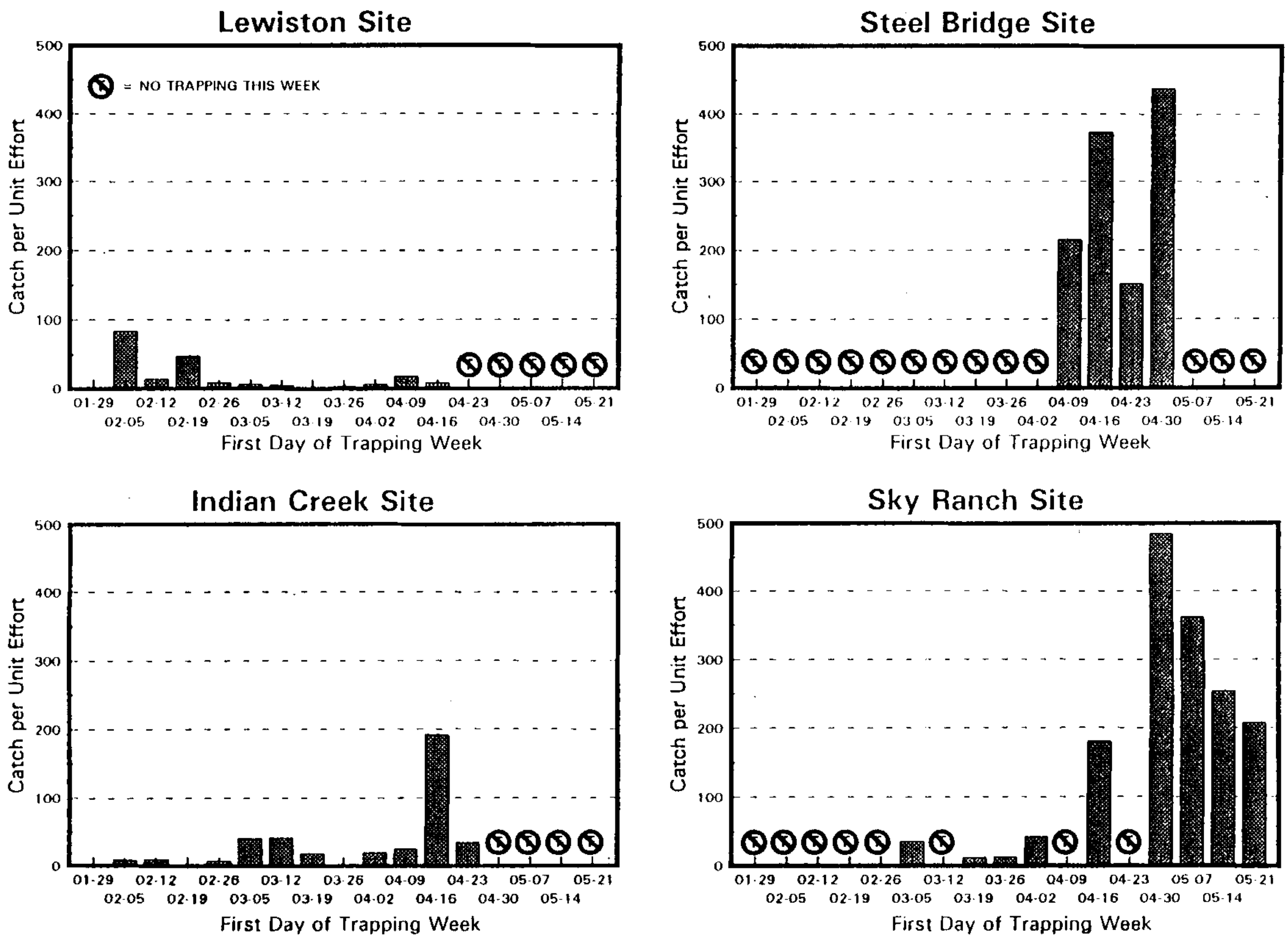

FIGURE 2. Weekly average catch of juvenile chinook salmon per-trap per-night at the four trapping sites in the mainstem Trinity River during 1991.

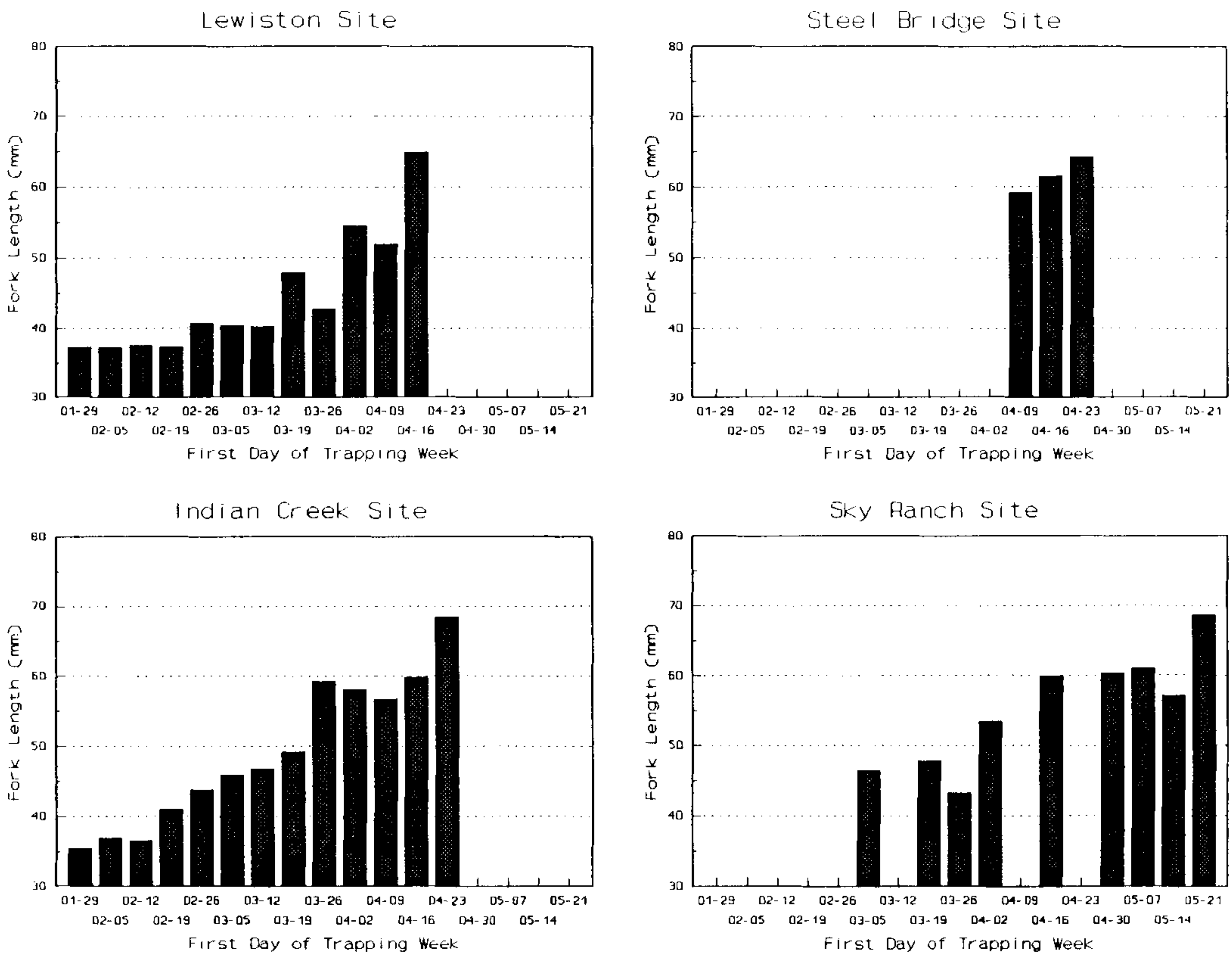

FIGURE 3. Weekly average fork lengths (mm) of juvenile chinook salmon captured at the four trapping sites in the mainstem Trinity River during 1991.

Other Salmonids

We captured 7,275 steelhead this season. Steelhead were caught at all the sites throughout the trapping season (Appendices 2, 3, 4, 5). Catches were relatively low until mid-March, when we began catching large numbers of hatchery-produced steelhead. About 85% of the steelhead captured this season were fin-clipped, indicating they were from TRH[2/].

We captured 903 coho salmon this season, both yearlings and young-of-the-year (YOY). YOY were first noted during the Julian week beginning 12 March 1991. Previously, we trapped only yearlings (Appendices 2, 3, 4, 5).

Tagging

Tagging operations began 18 April and continued through 27 May 1991. During this period, we marked (Ad+CWT) and released 80,087 juvenile chinook. Tagging took place at both the Steel Bridge and Sky Ranch sites.

Steel Bridge Site

At the Steel Bridge Site, we tagged 19,777 juvenile chinook with coded-wire tag number 6-1-8-1-12. Tagging at this site began 18 April and continued through 2 May 1991. The independent, non-overlapping estimates, based on quality control groups, of tagging mortality, poor fin clips, and the numbers of coded-wire tags that were shed are shown in Table 2. After subtracting these estimates from the total tagged, we effectively CWT and released 19,090 juvenile chinook (Table 2).

TABLE 2. Summary of juvenile chinook salmon coded-wire tagging in the mainstem Trinity River during 1991.

Coded-wire tag number	Tagging site	Dates of release	Number tagged	Estimated tagging mortalities	Poor fin clips	Tags shed	Number effectively tagged
6-1-8-1-12	Steel Bridge	4/18-5/02/91	19,777	192	0	495	19,090
6-1-8-1-13	Sky Ranch	5/3-5/27/91	29,550	2,426	0	384	26,741
6-1-8-1-14	Sky Ranch	5/3-5/27/91	30,760	2,712	45	969	27,034
Totals			80,087	5,330	45	1,848	72,865

2/ In 1990-91, all steelhead produced at TRH were fin-clipped prior to release (Aguilar 1992).

Sky Ranch Site

Tagging began 3 May and continued through 27 May 1991 at the Sky Ranch Site. During this period, we tagged 29,550 fish with coded-wire tag number 6-1-8-1-13, and 30,760 fish with coded-wire tag number 6-1-8-1-14. The independent, non-overlapping estimates, based on quality control groups, of tagging mortality, poor fin clips, and the numbers of coded-wire tags that were shed are shown in Table 2. After subtracting these estimates from the total tagged, we effectively CWT and released 26,741 juvenile chinook with coded-wire tag number 6-1-8-1-13 and 27,034 with coded-wire tag number 6-1-8-1-14 (Table 2).

Coded-Wire Tag Recovery

One two-year-old fish, which had been tagged in 1989, was recovered this season by TFIP personnel during spawner surveys in the North Fork Trinity River (Zuspan 1992c). That fish was one of 15,704 juvenile chinook CWT and released near Junction City in 1989 (Zuspan 1991b). It is of interest to note that, while this fish had been trapped and tagged in the mainstem Trinity River upstream of the North Fork Trinity River, it apparently strayed into the North Fork Trinity River to spawn. No other recoveries of Project-tagged fish were reported this year.

DISCUSSION

We were unable to capture enough juvenile chinook to reach our goal of tagging 100,000 naturally produced fish this year. This was the direct result of poor escapement of the progenitors of this year's juvenile chinook. Natural spawner escapement for chinook salmon (spring- plus fall-run) above Junction City was the lowest ever recorded.

Because of the low catches, we instigated an intensive trapping program, trapping up to 80% of the river's cross section on a seven-day-a-week basis. Trapping effort this year was 2.6 times that of last year (374 vs. 143 trap nights), while the total juvenile chinook catch was only 55.2% (89,208 vs. 161,730) of last year's[3/] (Zuspan 1992b). Both the overall juvenile chinook CPUE and adult escapement of their progenitors were down a similar amount when compared to the previous year. The 1990 adult chinook escapement was 16.8% of the 1989 escapement (5,811 vs. 14,587 [Bill Heubach, CDFG, pers. comm.]), while the CPUE for

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3/ Last year (1990) we trapped both naturally and hatchery-produced chinook salmon. The comparison with this year's data considers only the effort expended and fish trapped prior to 18 May 1990, the date chinook salmon were released from TRH, in order to compare only naturally produced fish.

1991 juvenile chinook was 23.1% of that in 1990.

While it seems unlikely there is a linear relationship between adult escapement and production, trapping this year does suggest an important correlation.

RECOMMENDATIONS

1. Job 2 activities should be continued in FY 1991-92.

2. In the event of a low chinook escapement in 1991, the Project should be prepared to increase our trapping efforts. This will require the purchase and construction of additional trapping equipment.

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

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

Julian week	Calander dates		Julian week	Calander dates	
	Start	Finish		Start	Finish
01	Jan. 01	Jan. 07	27	Jul. 02	Jul. 08
02	Jan. 08	Jan. 14	28	Jul. 09	Jul. 15
03	Jan. 15	Jan. 21	29	Jul. 16	Jul. 22
04	Jan. 22	Jan. 28	30	Jul. 23	Jul. 29
05	Jan. 29	Feb. 04	31	Jul. 30	Aug. 05
06	Feb. 05	Feb. 11	32	Aug. 06	Aug. 12
07	Feb. 12	Feb. 18	33	Aug. 13	Aug. 19
08	Feb. 19	Feb 25	34	Aug. 20	Aug. 26
09	Feb. 26	Mar. 04 [a/]	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. 29	Nov. 04
19	May 07	May 13	45	Nov. 05	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 [b/]

[a/] Eight-day week in each year which is divisible by 4.

[b/] Eight-day week every year.

Appendix 2. Summary of juvenile salmonid trapping in the Trinity River at the Lewiston Site, 15 January through 16 April 1991.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap nights a/	Number	Avg FL (mm)	CPUE b/	Number	CPUE b/	Number	CPUE b/
3	15-Jan	2	1	36.0	1	3	2	0	0
4	22-Jan	2	0		0	0	0	0	0
5	29-Jan	4	8	37.4	2	2	1	8	2
6	05-Feb	4	336	37.3	84	4	1	3	1
7	12-Feb	6	82	37.6	14	2	0	2	0
8	19-Feb	3	145	37.4	48	0	0	2	1
9	26-Feb	6	51	40.7	9	3	1	20	3
10	05-Mar	9	59	40.4	7	5	1	10	1
11	12-Mar	6	32	40.3	5	77	13	165	28
12	19-Mar	5	9	47.9	2	53	11	948	190
13	26-Mar	8	34	42.7	4	87	11	527	66
14	02-Apr	4	27	54.6	7	24	6	638	160
15	09-Apr	3	55	52.0	18	7	2	449	150
16	16-Apr	1	9	64.9.	9	9	9	10	10
Totals:		63	848			276		2,782	

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

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

Appendix 3. Summary of juvenile salmonid trapping in the Trinity River at the Steel Bridge Site, 9 April through 30 April 1991.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap nights a/	Number	Avg FL (mm)	CPUE b/	Number	CPUE b/	Number	CPUE b/
15	09-Apr	4	865	59.2	216	6	2	981	245
16	16-Apr	25	9,035	61.6	361	189	8	1,024	41
17	23-Apr	38	5,744	64.3	151	43	1	309	8
18	30-Apr	11	4,814	c/	438	18	2	114	10
Totals:		78	20,458			256		2,428	

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

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

c/ Fork lengths were not taken this week.

Appendix 4. Summary of juvenile salmonid trapping in the Trinity River at the Indian Creek Site, 15 January through 23 April 1991.

Julian week	Date begun	Trap nights a/	Chinook Number	Chinook Avg FL (mm)	Chinook CPUE b/	Coho Number	Coho CPUE b/	Steelhead Number	Steelhead CPUE b/
3	15-Jan	1	0		0	7	7	7	7
4	22-Jan	1	0		0	4	4	1	1
5	29-Jan	1	2	35.5	2	1	1	1	1
6	05-Feb	2	17	36.9	9	14	7	18	9
7	12-Feb	1	10	36.6	10	2	2	4	4
8	19-Feb	1	1	41.0	1	1	1	1	1
9	26-Feb	2	16	43.8	8	8	4	13	7
10	05-Mar	2	81	45.9	41	13	7	37	19
11	12-Mar	2	83	46.8	42	3	2	13	7
12	19-Mar	1	19	49.2	19	7	7	27	27
13	26-Mar	3	6	59.3	2	5	2	22	7
14	02-Apr	2	40	58.1	20	2	1	58	29
15	09-Apr	2	52	56.7	26	0	0	64	32
16	16-Apr	1	192	59.9	192	0	0	20	20
17	23-Apr	1	35	68.5	35	4	4	2	2
Totals:		23	554			71		288	

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

Appendix 5. Summary of juvenile salmonid trapping in the Trinity River at the Sky Ranch Site, 5 March through 21 May 1991.

			Chinook			Coho		Steelhead	
Julian week	Date begun	Trap nights a/	Number	Avg FL (mm)	CPUE b/	Number	CPUE b/	Number	CPUE b/
10	05-Mar	1	36	46.4	36	12	12	47	47
11	12-Mar	0							
12	19-Mar	3	36	47.9	12	35	12	60	20
13	26-Mar	2	26	43.3	13	3	2	6	3
14	02-Apr	2	85	53.5	43	3	2	13	7
15	09-Apr	0							
16	16-Apr	1	180	59.9	180	3	3	7	7
17	23-Apr	0							
18	30-Apr	49	23,783	60.3	485	53	1	477	10
19	07-May	61	22,073	61.0	362	62	1	614	10
20	14-May	48	12,184	57.1	254	47	1	422	9
21	21-May	43	8,945	68.7	208	82	2	131	3
Totals:		210	67,348			300		1,777	

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

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

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1990-1991 SEASON

CHAPTER III

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

by

Carrie E. Wilson and Barry W. Collins

ABSTRACT

The California Department of Fish and Game's Natural Stocks Assessment Project monitored adult steelhead (Oncorhynchus mykiss) migration at various weirs and estimated an escapement of 2,326 steelhead into the South Fork Trinity River basin during the 1990-1991 year.

Based on the results of our creel survey, we estimate 981 anglers fished within the basin landing 43 adult steelhead and five chinook salmon within the 1990-1991 season. The harvest rate of adult steelhead is estimated to be 0.10.

Adult steelhead spawning stock surveys were conducted on 22 streams tributary to the South Fork Trinity River and to Hayfork Creek. We surveyed 120.0 km, observed 7 adult steelhead and counted 239 redds.

The characteristics of steelhead spawning habitat within the South Fork Trinity River basin were evaluated by measuring various physical and hydraulic parameters of steelhead redds.

We captured 1,006 juvenile steelhead emigrating from the upper South Fork Trinity River basin and 1,807 from the Hayfork Creek basin. Peak emigration of Age 0+ steelhead and Age 0+ chinook salmon occurred during May 1991.

Juvenile steelhead habitat utilization in Eltapom Creek, a tributary to the South Fork Trinity River, varied among age groups. During fall 1990, Age 0+ and Age 1+ fish occurred in about equal densities in pools and riffles, but Age 0+ fish were more abundant in runs and step-runs than Age 1+ fish. During spring 1991, steelhead densities were much lower; Age 0+ fish were more abundant than Age 1+ fish in riffles and step-runs, while Age 1+ fish were more abundant in pools. Both age classes of steelhead were equally abundant in runs during the spring 1991 survey.

Six hundred-forty sets of juvenile steelhead scale samples were collected and 280 sets were read and interpreted for indications of various life history characteristics.

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 parameters and seasonal juvenile steelhead standing crops.

INTRODUCTION

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

METHODS

Use of Standard Julian Week

Weekly sampling data collected by Project personnel at the weirs are presented in Julian week (JW) format. Each JW is defined as one of a consecutive set of 52 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 9th week,

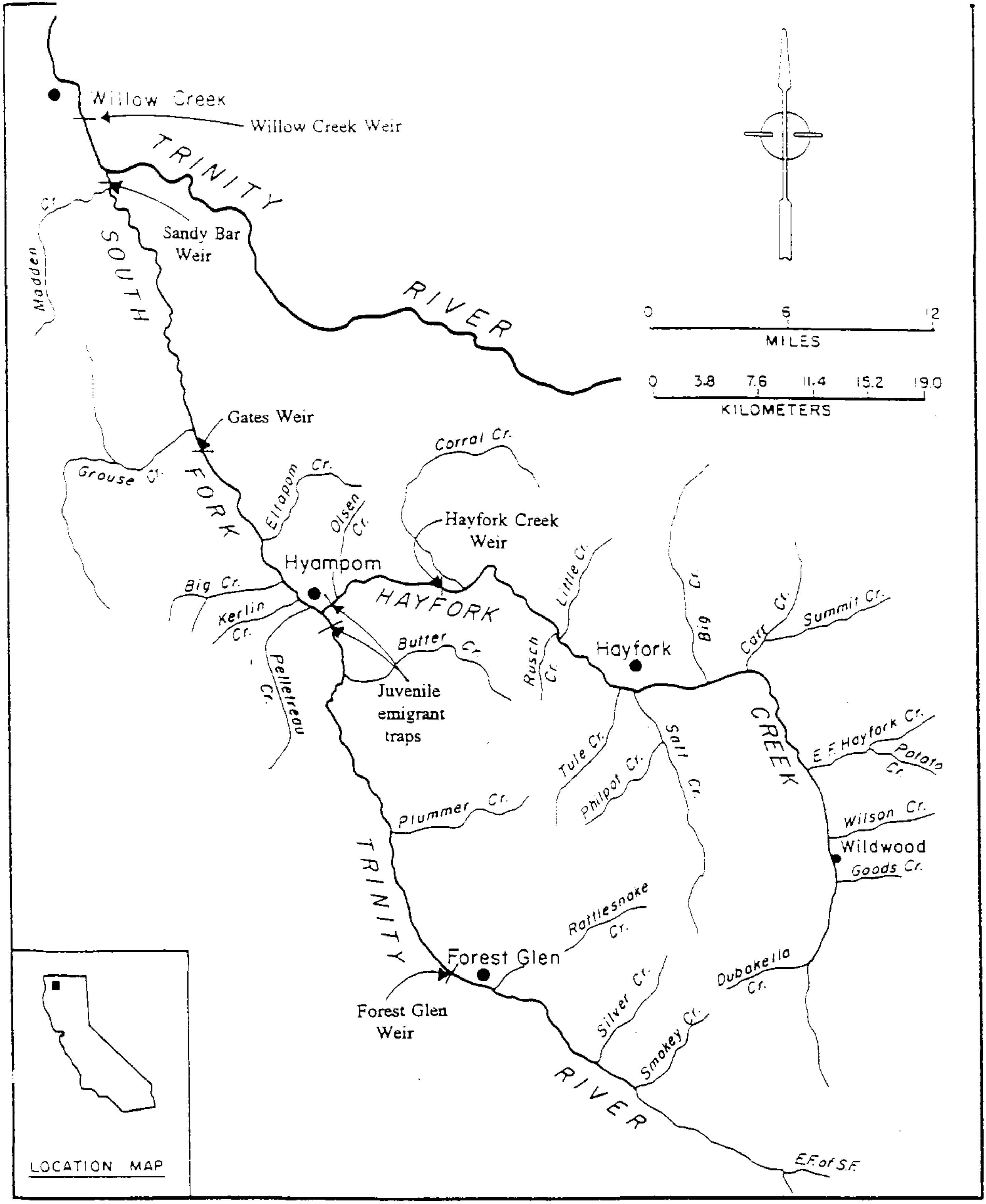

Figure 1. Locations of weirs and traps used to capture immigrant adult steelhead, and emigrant adult and juvenile steelhead in the South Fork Trinity River basin during the 1990-1991 season.

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 Steelhead Run Timing

To assess the timing of the adult steelhead run into the SFTR basin, we trapped immigrant adult steelhead at the Sandy Bar Weir within the SFTR basin. The Sandy Bar Weir was located on the SFTR at river km (RKM) 2.4, and operated from 13 September 1990 through 1 March 1991. An Alaskan-style weir was constructed using a series of panels 3.2 m high and 3.0 m long set 2.4 m apart and joined together to block the entire river. Each panel contained 1.9-cm EMT (electrical metallic tubing) conduit pickets set 2.9 cm apart (46 per panel), secured through three aluminum channel sections on the face of the weir. A cubic trap consisting of welded conduit panels was constructed in the river thalweg, with an entrance made by opening a portion of the weir and connecting the weir and trap with a fyke entrance.

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

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

Creel Survey

Angler harvest of steelhead within the SFTR basin was determined from a systematic stratified creel survey, conducted from 22

September 1990 through 30 April 1991. The creel survey was conducted in two subsections of the lower SFTR basin (Figure 2). The lower survey area extended from the confluence of the SFTR with the mainstem Trinity River upstream for a distance of 22.5 km. The upper, Hyampom, area extended through the Hyampom Valley from RKM 33.0 to RKM 50.7. These two creel survey areas cover the river reaches fished by the majority of anglers, as public access is limited outside of these two areas due to the lack of public roads. Angler access sites in each creel survey area were identified prior to the survey period. The creel survey was further stratified by JW (Appendix 1), day (weekend/weekday), and time periods (am/pm: dawn to noon and noon to dusk, respectively). We extrapolated data for each stratum that was not surveyed by using average values for strata from equivalent sampling periods (i.e., for a missing weekday evening survey: the mean of all weekday pm's in that JW). Estimated and actual data were combined for season totals.

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

Tag Return and Steelhead Harvest Rates

We estimated sport harvest rate from the percent of $10-reward tags returned by anglers, based on the following assumptions: 1) a 100% response rate by anglers, 2) that all tagged fish caught in the sport fishery were recognized as such by anglers, 3) no tags were shed, and 4) there was no differential mortality between tagged and untagged fish. The estimated harvest rate of adult steelhead within the SFTR basin was determined from the number of reward tags returned by anglers divided by the number of tags applied at the weir.

Spawner Surveys

Project personnel conducted walking surveys of tributary streams to the SFTR and Hayfork Creek to document steelhead spawner distribution and the occurrence of spawning activity. The surveys were conducted from 27 March through 29 May 1991. The areas surveyed included: 1) tributaries to the SFTR and to

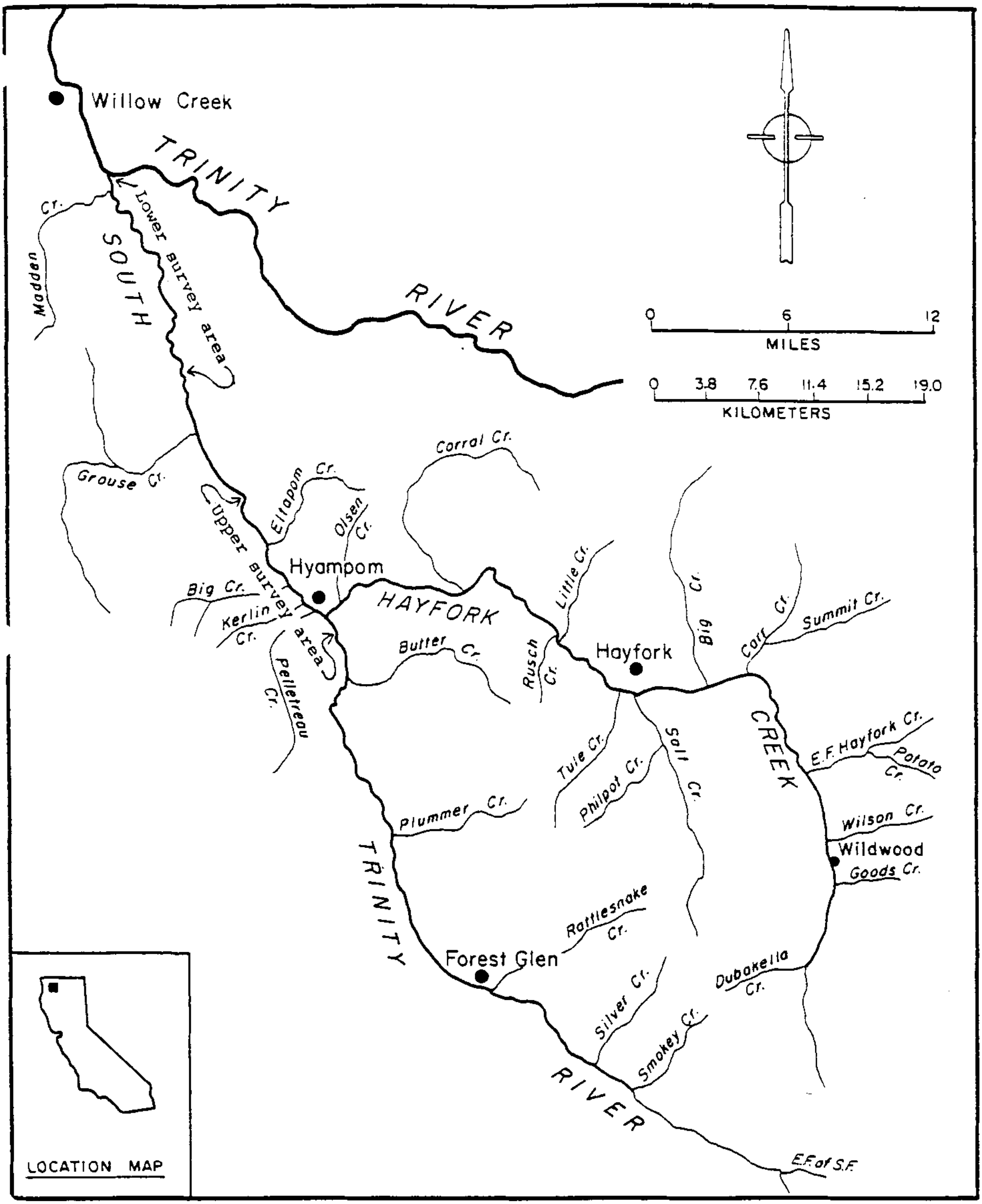

Figure 2. Locations of the two creel survey areas in the South Fork Trinity River basin surveyed during the 1990-91 season.

Hayfork Creek in the Hyampom Valley area, 2) tributaries to the SFTR in the upper SFTR basin near the town of Forest Glen, and 3) tributaries to Hayfork Creek near the town of Hayfork, and in the upper Hayfork Creek drainage near the town of Wildwood (Figure 1). Specific creeks surveyed were selected to include those which historically attracted spawning steelhead, and to replicate areas examined in previous CDFG surveys (Miller 1975; Mills and Wilson 1991; Rogers 1972, 1973; Wilson and Mills 1992).

During each survey, two people walked designated stream reaches carrying field notebooks to record observed spawning behavior, individual redd locations, redd site descriptions, and stream conditions. Redds were flagged with surveyors tape attached to nearby structures (such as root-wads, shrubs, or bushes) with the survey date and field notebook description number recorded on the tape.

Steelhead Redd and Spawning Habitat Evaluations

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

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

Adult Steelhead Recoveries at Emigrant Weirs

Emigrant weirs were assembled on lower Hayfork Creek near the town of Hyampom (8.0 RKM from the SFTR confluence), on the SFTR near the town of Forest Glen (approximately 150 m below the Highway 36 bridge, RKM 89.6), and on the SFTR below the Hyampom Valley (off of Gates Road at RKM 31.7) to capture post-spawning steelhead emigrating from the basin. Hereafter, these three weirs are referred to as the Hayfork Creek Weir, the Forest Glen Weir, and the Gates Road Weir, respectively. We constructed

Table 1. Criteria used to describe the size of dominant and subdominant spawning gravel substrate (Hampton 1988).

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

Alaskan-style weirs at the Hayfork Creek and Forest Glen sites, and the Trinity Fisheries Investigations Project constructed a weir-panel-type weir at the Gates Road site on the SFTR. The weir panels were 1.2 m high x 1.5 m wide, and constructed of 1.9-cm EMT conduit with 3.2 cm horizontal bar spacing. All steelhead recovered were: 1) measured (cm FL); 2) given an operculum punch at the upper two weirs (left at Hayfork Creek Weir, right at Forest Glen Weir), but were not punched at Gates Road Weir; 3) checked for spawning condition, tags, fin clips or marks; 4) sampled for scales; and 5) released.

In addition to the downstream traps, we also installed upstream traps at each weir to capture spring-run and late winter-run steelhead entering the SFTR basin. Steelhead captured in upstream traps which appeared sexually immature were classified as spring-run fish; if they were sexually mature, they were classified as winter-run fish. These fish were given a 1/2 left ventral (LV) fin clip at the Gates Road Weir to prevent any later recounting at the other two weirs.

Adult Steelhead Escapement Estimate

We estimated the adult steelhead escapement into the SFTR basin using the Petersen method of mark and recapture (Ricker 1975, p. 78, formula 3.7) by marking adult steelhead at the Sandy Bar Weir and recovering them through the emigrant weirs (Hayfork Creek Weir, Forest Glen Weir and Gates Road Weir) and creel surveys. Confidence limits were calculated using the poisson approximation method (Chapman 1948).

Juvenile Steelhead Emigration Studies

We monitored juvenile steelhead emigration patterns by systematically trapping at two sites within the SFTR basin in lower Hayfork Creek, 305 m upstream of its confluence with the SFTR, and in the SFTR upstream of its confluence with Hayfork Creek, within 0.4 km either side of the Hyampom Road bridge at RKM 49.1 (Figure 1). Flow conditions permitting, we trapped on a weekly basis throughout most of the year, but increased trapping frequency to every third night during the spring period of peak juvenile steelhead emigration (22 April through 30 June 1991). Juvenile steelhead were captured using fyke nets attached to trap boxes. The nets were constructed of 1.3-cm nylon mesh, had a 1.8-m x 2.4-m upstream opening and extended 10.1 m to a trap attachment frame at the terminal end. Trap boxes were constructed of marine plywood and hardware cloth, and measured 0.8 m x 1.2 m at the opening and were 0.5 m deep. One or two fyke-net traps were placed in the river or stream overnight, for 16 to 24 hour periods, and examined the following morning.

Captured fish were identified to species and counted. The first 50 individuals of each species removed from the traps were measured for FL (mm), and scale samples were systematically taken from a maximum of 10 juvenile steelhead, at each trap site, each sampling day. Flow through the net was measured at the net opening, and total volume of stream flow was estimated to the nearest 0.3 m/sec, using either a pygmy meter or a Marsh-McBirney[1/] flow meter. Water temperatures were monitored using hand-held thermometers or digital recording thermographs.

Habitat Use by Juvenile Steelhead

We studied seasonal habitat use by juvenile steelhead in Eltapom Creek (Figure 1) during fall 1990 (29 August - 4 September) and spring 1991 (3 - 6 June). Prior to each season's study, the creek was first surveyed and habitat-typed into 72 units of the five basic habitat types: cascades, pools, riffles, runs and step-runs. Twenty-four (33%) of the 72 habitat units were randomly selected for sampling in proportion to the numeric abundance of each of the five basic habitat types.

We conducted a similar study during fall 1989 to duplicate an earlier Humboldt State University study (Glase and Barnhardt 1989). In the earlier study, Glase and Barnhardt had habitat-

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

typed the stream into 101 habitat units using only four basic habitat types to describe the stream: cascades, pools, riffles and runs. In our fall 1990 and spring 1991 surveys, however, we included the "step-run" as a fifth basic habitat type, and reorganized the habitat unit designations into 72 units of the five basic habitat types: cascades, pools, riffles, runs and step-runs.

Sample units were isolated using block nets to prevent any immigration or emigration of fish, and then electrofished. During the spring survey, the voltage setting on the electro-shocking unit was set so young-of-the-year fish would not be shocked. This was a misunderstanding on the part of the field crew doing the survey. Although some young-of-the-year fish were caught, their numbers were not representative of the relative abundance of their age group in the survey area. We recorded air and water temperatures, and water velocities (to the nearest 0.031 m/sec) for each of the 72 habitat units and took photos of each habitat unit we sampled. Water velocities were measured at 60% of the total depth from the surface along a line transverse to the flow at points 1/4, 1/2, and 3/4 of the way across the stream. Stream length and width were measured to the nearest 0.03 m in each habitat unit.

All captured steelhead were counted, measured (mm FL), sampled for scales (first five fish per habitat unit), and then released. During the fall 1990 survey, fish $\leq$ 85 mm were classified as Age 0+, fish 86-150 mm as Age 1+, and fish > 150 mm as Age 2+. During the spring 1991 survey, fish $\leq$ 60 mm were classified as Age 0+, fish 61-150 mm as Age 1+, and fish > 150 mm as Age 2+. We will attempt to refine the age-length relationship over the course of a year with additional scale analysis. The relative age distribution was determined for fish from each basic habitat type. These data were in turn used to determine the relative densities of each age group in each habitat type. The total number of juvenile steelhead present in the entire stream during each survey was then extrapolated, based on the available area.

Steelhead Life History Patterns

Steelhead life history patterns were described from intensive analysis of scales from juvenile fish. Juvenile steelhead scale samples have been collected since 1988 by CDFG personnel through downstream outmigrant trapping and electrofishing projects. Adult scale samples were also collected during the creel surveys, and at our immigrant and emigrant weirs. Unfortunately, we have found the first two years of growth patterns on adult scales hard to interpret. Thus, emphasis this year was placed on a more intensive study of juvenile scales in order to better understand the patterns of scale development and growth associated with the early life history phase of juvenile fish. This will greatly assist in the interpretation of adult scales in the future.

All scales collected in the field were taken to the lab for processing. Each adult scale sample was cleaned, dried, then mounted between two glass microscope slides. Scale samples from juvenile steelhead did not usually require cleaning. The cleaning process involved soaking scales in distilled water to soften them. Softened scales were rubbed between thumb and forefinger to remove debris. If debris persisted, scales were soaked in a 5% detergent solution made up with distilled water, and then rubbed again as mentioned previously. Softened tissue and debris that continued to adhere to scales after these cleaning processes was peeled off using blunt tipped forceps.

Juvenile steelhead scales were examined to determine age and freshwater life history. Scale samples were read using the Optical Pattern Recognition System (OPRS). The OPRS method digitizes, measures, and records distances for each freshwater circuli on each scale examined. Statistical and graphic software can then be used to analyze scale data. Annuli were determined by the cutting or crossing-over of circuli, incompleteness of circuli, and narrowing of the distance between circuli. A year of growth was considered to be the time from the formation of the last circulus of an annulus to the formation of the last circulus of the succeeding annulus. Circuli between annuli were counted and measured relative to the entire scale length.

RESULTS AND DISCUSSION

Adult Steelhead Run Timing

The Sandy Bar Weir operated from 13 September 1990 through 1 March 1991, trapping 176 adult steelhead, with the first trapped on 17 September 1990 (Figure 3). Steelhead entered the SFTR basin throughout this period, showing no distinctive immigration peak periods. We feel we measured most of the steelhead run at Sandy Bar but know that the run continued after 1 March 1991 based upon immigrants trapped at our upper SFTR basin weirs (Hayfork Creek, Forest Glen and Gates Road weirs) later in the season. Steelhead immigration and run-timing seems to be more dependent on environmental conditions (storm events with accompanying high flows) rather than calendar dates. The periodic increases in steelhead capture numbers at the weir directly coincided with storm events.

Ten of the 176 steelhead captured at the Sandy Bar Weir carried tags previously applied at the Willow Creek Weir (Figure 1). We tagged the remaining 166 fish with $10-reward anchor tags and gave all 176 steelhead 1/2 RV fin clips. Mean FL of all 176 steelhead examined was 60.0 cm (Figure 4). Gill-net scars (37.6%) and predator scars (29.0%) were the most common scars seen on steelhead trapped at the weir (Table 2). Travel times for the 10 fish previously tagged at the Willow Creek Weir ranged

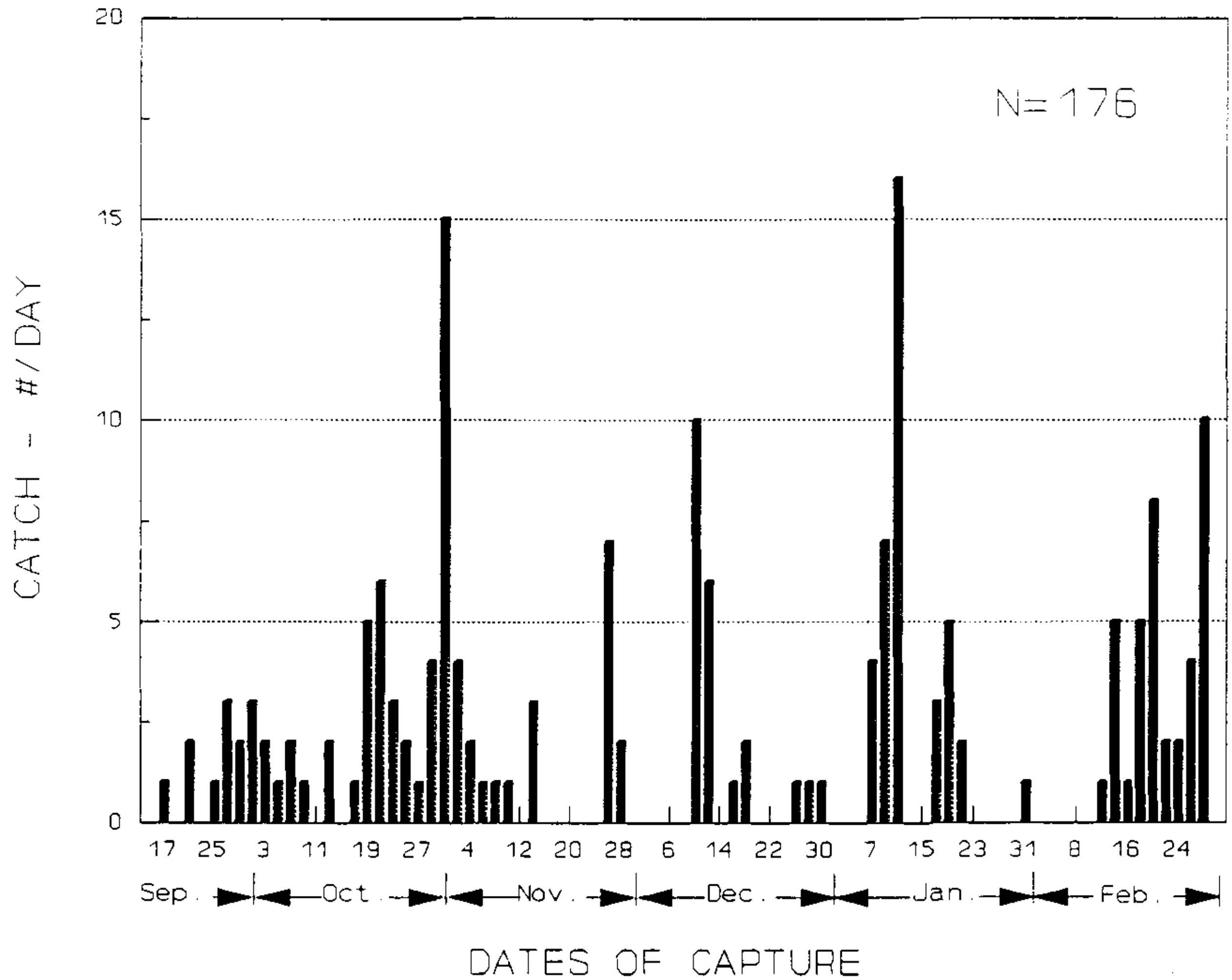

Figure 3. Daily catches of immigrant adult steelhead at the Sandy Bar Weir in the South Fork Trinity River from 13 September 1990 through 1 March 1991.

from 2 to 84 days (d), and averaged 37 d (Appendix 2).

Creel Survey

The creel survey was conducted on the SFTR between 22 September 1990 and 30 April 1991, an interval of 221 d. The lower survey section (Figure 2) was monitored for angler activity on 162 d and a creel survey conducted on 86 d of this period. The upper survey section was monitored for 210 d and a creel survey conducted on 108 d of the period. Creel surveys were not conducted when monitoring indicated no anglers were present or flows were high enough to prevent successful angling. The river in the lower survey section was considered "unfishable", based on high flow or turbidity observations, for four (2.5%) of the days

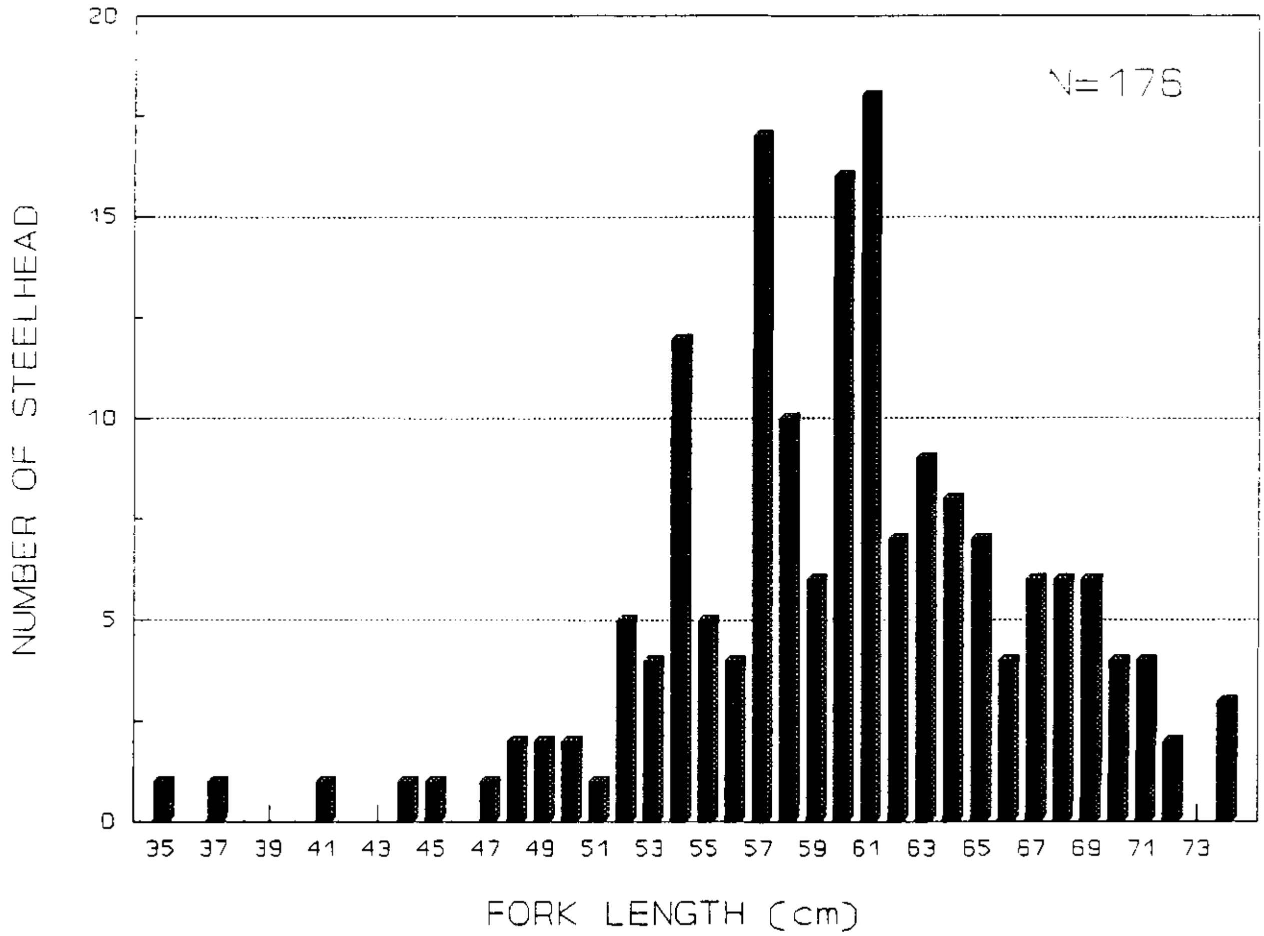

Figure 4. Length frequency distribution of immigrant adult steelhead captured at the Sandy Bar Weir in the South Fork Trinity River from 13 September 1990 through 1 March 1991.

Table 2. Scars and injuries observed on adult steelhead captured at the Sandy Bar Weir in the South Fork Trinity River between 13 September 1990 and 1 March 1991.

Scar or Injury	Number of fish with scars	Percent of fish with scars	Percent of total fish captured
Gill Net Scars	53	38	30
Freshwater Hook Scars	2	1	1
Ocean Hook Scars	3	2	2
Predator Scars	51	36	29
Scars of Unknown Origin	32	23	18
Totals	141	100	

it was surveyed and throughout the month of March 1991, while the upper section was determined "unfishable" for four (1.9%) of the days it was surveyed.

During the survey, 136 anglers were interviewed, 33 (24.3%) within the lower section and 103 (75.7%) within the upper section. Peak angling activity (22.6%) was observed within the upper survey section, in the lower Hyampom Valley near Big Slide Campground, with the rest of the anglers' effort distributed over a range of other sites. Of the 136 anglers interviewed, 28 were observed fishing at multiple locations in the upper survey section on the same day. Each site of angling activity was counted but the angler was not recounted when observed at a different location on the same day (Table 3).

Five adult steelhead and one adult chinook salmon were observed in the catch (all in the upper survey section). No half-pounder steelhead were observed in either section. Based on extrapolations of the creel survey data, an estimated 207 anglers within the lower section landed no adult steelhead (Table 4), while an estimated 774 anglers within in the upper section landed an estimated 43 adult steelhead and five chinook salmon (Table 5). County of origin was tabulated for 136 anglers. The majority (89.0%) of the anglers fishing within the SFTR basin were from Trinity and Humboldt counties (Table 6).

Excluding the unfishable days, water clarity ranged from 2 to 150+ cm in the lower survey section, and from 14 to 150+ cm in the upper survey section. Water temperatures ranged from 3° to 21° C and averaged 10° C in the lower survey section, while the upper survey section ranged from 1° to 17° C and averaged 8° C.

Tag Returns and Steelhead Harvest Rates

Three steelhead tagged at the Sandy Bar Weir were observed in the catch, and all three tags were subsequently returned by anglers, indicating a 100% response rate. The estimated harvest rate of 8% for adult steelhead (95% Poisson confidence interval [C.I.]: 5% to 14%) was determined by dividing the total number of tags returned by anglers (14), by the number of reward tags applied (167).

Spawner Surveys

We conducted walking surveys of 22 creeks (120.0 km total length) throughout the SFTR basin between 27 March and 29 May 1991 to document numbers and locations of spawning steelhead (Table 7). We counted and flagged 239 redds, and observed seven adult steelhead.

Table 3. Distribution of angler use among the various access sites surveyed in the creel survey of the South Fork Trinity River basin during the 1990-91 season.

Location	River Km	River Mile	Angler Number	Angler Percent
Lower Survey Section				
Sandy Bar	1.6	1.0	19	11.6
Madden Creek/Sandy Bar	2.1	1.3	7	4.3
Holmes Farm/Bridge	13.2	8.2	0	0.0
Todd Ranch	18.8	11.7	5	3.0
Surprise Creek Area	22.2	13.8	2	1.2
Upper Survey Section				
Swinging Bridge	32.7	20.3	2	1.2
Big Slide Campground[a/]	40.2	25.0	37	22.6
Eltapom Creek Area [a/]	40.9	25.4	16	9.8
Upper Slide Creek	41.0	25.5	4	2.4
Salmon Rock Area [a/]	41.7	25.9	10	6.1
Little Rock Campground[a/]	42.0	26.1	18	11.0
Mortensen Property[a/]	42.6	26.5	7	4.3
Saw Mill Site	43.4	27.0	0	0.0
Way Property	45.1	28.0	0	0.0
Hyampom Airstrip[a/]	46.0	28.6	2	1.2
Pelletreau Creek Mouth	46.3	28.8	1	0.6
Old Bridge Site	47.3	29.4	0	0.0
Church Access[a/]	47.9	29.8	5	3.0
Co. Maintenance Yard[a/]	48.3	30.0	12	7.3
Hayfork Creek Mouth[a/]	48.8	30.3	14	8.5
All Other Areas	--	--	3	1.8
Totals:			164	100.0

a/ Twenty-eight anglers were observed fishing at multiple locations on the same day. At each site, their angling activity was enumerated, but the angler was not recounted as part of the total angler effort when observed at a different location the same day (164 sites of angler activity - 28 anglers at multiple sites = 136 anglers).

Table 4. South Fork Trinity River creel survey data, angler use and steelhead harvest estimates for the lower survey section during the 1990–91 season.

Lower Section

Dates	Julian week	Angler numbers		Angler hours		Steelhead harvest: Adults a/		Steelhead harvest: Half-pounders b/		Steelhead harvest: Juveniles c/	
		Observed	Estimated	Observed	Estimated	Observed	Estimated	Observed	Estimated	Observed	Estimated
09/17–09/30	38–39	2	12	7.0	42.0	0	0	0	0	0	0
10/01–10/14	40–41	0	0	0	0	0	0	0	0	0	0
10/15–10/28	42–43	0	0	0	0	0	0	0	0	0	0
10/29–11/11	44–45	5	24	8.5	40.4	0	0	0	0	0	0
11/12–11/25	46–47	12	79	10.5	76.6	0	0	0	0	0	0
11/26–12/09	48–49	4	25	5.0	22.3	0	0	0	0	0	0
12/10–12/23	50–51	0	0	0	0	0	0	0	0	0	0
12/24–01/07	52–01	0	0	0	0	0	0	0	0	0	0
01/08–01/21	02–03	6	44	6.0	43.8	0	0	0	0	0	0
01/22–02/04	04–05	0	0	0	0	0	0	0	0	0	0
02/05–02/18	06–07	4	23	3.5	19.8	0	0	0	0	0	0
02/19–03/04	08–09	0	0	0	0	0	0	0	0	0	0
03/05–03/18	10–11	–	–	–	–	–	–	–	–	–	–
03/19–04/01	12–13	–	–	–	–	–	–	–	–	–	–
04/02–04/15	14–15	–	–	–	–	–	–	–	–	–	–
04/16–04/29	16–17	–	–	–	–	–	–	–	–	–	–
04/30–05/13	18–19	–	–	–	–	–	–	–	–	–	–
	Totals	33	207	40.5	244.9	0	0.0	0	0.0	0	0

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

Table 5. South Fork Trinity River creel survey data, angler use and steelhead harvest estimates for the upper survey section during the 1990-91 season.

Upper Section

						Steelhead harvest					
	Julian	Angler numbers		Angler hours		Adults a/		Half-pounders b/		Juveniles c/	
Dates	week	Observed	Estimated	Observed	Estimated	Observed	Estimated	Observed	Estimated	Observed	Estimated
10/01-10/14	40-41	0	0	0	0	0	0	0	0	0	0
10/15-10/28	42-43	3	2	1.5	12.0	0	0	0	0	0	0
10/29-11/11	44-45	7	37	14.0	77.4	0	0	0	0	0	0
11/12-11/25	46-47	7	49	14.5	100.8	0	0	0	0	0	0
11/26-12/09	48-49	8	55	5.0	30.3	0	0	0	0	0	0
12/10-12/23	50-51	2	11	2.0	9.8	1	4	0	0	0	0
12/24-01/07	52-01	6	30	2.0	15.0	1	7	0	0	0	0
01/08-01/21	02-03	12	66	9.5	52.1	0	0	0	0	0	0
01/22-02/04	04-05	14	81	12.5	83.1	2	12	0	0	0	0
02/05-02/18	06-07	13	81	14.0	70.4	0	0	0	0	0	0
02/19-03/04	08-09	6	32	6.5	40.5	1	5	0	0	0	0
03/05-03/18	10-11	4	54	3.0	35.0	0	0	0	0	0	0
03/19-04/01	12-13	6	78	11.0	155.6	0	0	0	0	0	0
04/02-04/15	14-15	8	115	28.5	587.8	0	0	0	0	0	0
04/16-04/29	16-17	7	83	16.0	201.1	1	15	0	0	0	0
04/30-05/13	18-19	0	0	0	0	0	0	0	0	0	0
	Totals	103	774	140	1,470.9	5	43	0	0.0	0	0.0

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

Table 6. County of residence for anglers interviewed within the South Fork Trinity River basin during the 1990-1991 creel survey.

County of Origin	Number	Percent
Contra Costa	1	0.7
Humboldt	25	18.4
Lake	2	1.5
Los Angeles	2	1.5
Napa	1	0.7
Orange	1	0.7
Placer	1	0.7
San Francisco	2	1.5
Shasta	4	2.9
Solano	1	0.7
Trinity	96	70.6
Totals	136	100.0

The East Fork of the South Fork Trinity River and Plummer Creek, both in the Forest Glen area, contained the highest redd densities of all creeks surveyed (10.8 and 6.6 redds/km, respectively). Eltapom Creek contained the highest redd density (6.2 redds/km) in the Hyampom area. These areas of high redd concentration all had good spawning habitat and were contained in drainages that were fairly stable geologically, and had not been adversely affected by logging activities or by the catastrophic 1964 flood. The lowest redd densities were found in the Hayfork Valley in creeks affected by livestock grazing or poor logging practices, both contributing to heavy siltation of the creeks. Site descriptions of individual creeks and the counts of their surveys are as follows:

Hyampom Valley Area

We surveyed four tributaries to the SFTR and one tributary to Hayfork Creek, all within the Hyampom Valley, between 10 April and 15 May 1991. These surveys covered a total of 8.7 RKMs. We observed 21 redds and three live adult steelhead (Table 7).

Big Creek. Big Creek, a small tributary to the SFTR (RKM 42.8), is located 5.6 km downstream from the town of Hyampom. A natural barrier of cascades exists 0.8 km upstream from the confluence and a hydropower plant is located adjacent to the creek 30.5 m below the cascades. We surveyed the 0.8 km of Big

Table 7. Steelhead spawner survey data for the South Fork Trinity River basin from 27 March through 29 May 1991.

Location	Survey dates first	Survey dates last	Number of surveys	Length surveyed (km)	New redds observed	Redds observed per km	Live steelhead observed
Hyampom Valley Area							
Big Creek	May 07	– –	1	0.8	1	1.2	0
Butter Creek	May 01	May 14	2	2.4	9	3.8	3
Eltapom Creek	Apr 30	May 15	2	1.3	8	6.2	0
Olsen Creek	Apr 10	May 10	2	2.1	1	0.5	0
Pelletreau Creek	May 06	– –	1	0.8	2	2.5	0
		Subtotals	8	7.4	21	– –	3
		Means	– –	– –	– –	2.8	– –
Hayfork–Wildwood Area							
Big Creek	Apr 09	May 20	3	12.6	23	1.8	2
Carr Creek	Apr 29	Apr 30	2	4.8	2	0.4	0
Dubakella Creek	Apr 23	May 22	2	2.4	0	0.0	0
E.F. Hayfork Creek	Mar 27	May 14	3	6.4	17	2.7	0
Goods Creek	Apr 24	May 15	2	1.6	1	0.6	0
Hayfork Creek	May 08	May 24	2	23.0	48	2.1	0
Little Creek	May 08	May 20	2	1.6	3	1.9	0
Philpot Creek	Apr 23	– –	1	2.6	0	0.0	0
Potato Creek	Apr 22	May 05	2	2.4	0	0.0	0
Rusch Creek	Apr 24	May 28	2	6.0	13	2.2	0
Salt Creek	Mar 28	May 16	2	17.7	15	0.8	1
Tule Creek	Apr 04	May 08	2	3.7	2	0.5	0
		Subtotals	25	84.8	124	– –	3
		Means	– –	– –	– –	1.5	– –
Forest Glen Area							
E.F. South Fork	May 03	May 06	2	4.8	52	10.8	1
Plummer Creek	May 23	– –	1	3.2	21	6.6	0
Rattlesnake Creek	May 07	May 29	2	10.9	9	0.8	0
Silver Creek	May 04	– –	1	2.4	0	0.0	0
Smokey Creek	May 05	– –	1	2.4	12	5.0	0
		Subtotals	7	23.7	94	– –	1
		Means	– –	– –	– –	4.0	– –
	Grand	Totals	40	115.9	239	– –	7
	Grand	Means	– –		– –	2.1	– –

Creek on 7 May 1991 from the confluence to the barrier. The stream bed contains numerous pools and large boulders but lacks suitable spawning gravels to support much active spawning activity. The only spawning area available is found in the gravels in front of the culvert exiting the powerhouse. One redd was observed there.

Butter Creek. Butter Creek, a tributary to the SFTR (RKM 54.2), is located 3.2 km south of the town of Hyampom. This creek contains areas of extreme bank sloughing in the lower 0.4-km section due to early logging activities exacerbated by the floods of 1964 and 1986. However, most of the creek upstream of this area contains large holding pools and some areas of suitable spawning habitat. Butter Creek Falls exists 2.4 km from the confluence creating a natural barrier to anadromous fish passage. We surveyed the 2.4 km on 1 May and 14 May 1991, counted nine steelhead redds, and observed three adult steelhead.

Eltapom Creek. Eltapom Creek, a tributary to the SFTR (RKM 40.9), is located 8.0 km north of the town of Hyampom and flows through a narrow canyon consisting of steep rock and oak covered slopes which were badly damaged by fire in 1987. Pools and spawning habitat are very common throughout, with spawning gravels in the upper reaches less compacted and more suitable for spawning than those in the middle and lower reaches. Pools are numerous and pool cover consists mostly of root-wad and bedrock structures. Riparian vegetation is fair with creek canopy consisting mainly of alders. A waterfall exists 1.3 km from the confluence, creating a natural barrier to anadromous fish passage. We surveyed the lower 1.3 km of the creek on 30 April and 15 May 1991, and counted eight redds, total.

Olsen Creek. Olsen Creek, a tributary to Hayfork Creek (RKM 0.6), is located just east of the town of Hyampom. The USFS has put in numerous habitat improvement structures in this system, but spawning habitat is limited. The upper 2.4-km section runs through a steep narrow canyon containing numerous falls ranging between 1.1 and 4.6 m which may be natural barriers to anadromous fish passage, and two debris blockages were found in the lower 0.8 km section which are believed to be complete barriers except during very high flow conditions. We surveyed 2.1 km of the creek on 10 April and 10 May 1991, and observed one redd.

Pelletreau Creek. Pelletreau Creek, a tributary to the SFTR (RKM 46.7), is located west of the town of Hyampom. Only the uppermost section contains adequate holding pools, while the remainder of the creek is composed mainly of a cemented gravel substrate, unsuitable for spawning. This creek was severely damaged by the 1964 flood and is reported to have 10.7 m of gravel sitting on top of the original creek bed in this lower section. Pelletreau Creek contains a cascade barrier to anadromous fish passage 0.8 km upstream from the mouth. Although this is a perennial stream, complete water diversion during summer months leaves the lower 0.3-km section dry. We surveyed 0.8 km of the creek on 6 May 1991 and observed two redds.

Hayfork Creek Basin Near Hayfork and Wildwood

We surveyed 11 tributaries to Hayfork Creek, plus parts of the mainstem of Hayfork Creek between 27 March and 28 May 1991. These surveys covered a total of 87.6 km. We observed 124 redds and counted three adult steelhead (Table 7).

Big Creek. Big Creek, a major tributary to Hayfork Creek (RKM 43.8), is located in the Hayfork Valley east of the town of Hayfork. This creek has been very productive in the past, with spawning gravel fairly abundant in the middle and upper survey sections. Pools are common, and riparian vegetation is medium to dense. California Conservation Corps (CCC) crews and the USFS have installed numerous habitat enhancement structures in this stream. During the winter months, the habitat is excellent. However, a property owner diverts most of the creek for watering livestock pastures during the rest of the year. The water diversions are located 2.4 km and 4.8 km upstream from the confluence with Hayfork Creek, and limit the habitat for fish in this lower section. We surveyed 12.6 km of the creek between 9 April and 20 May 1991, counted 23 redds, and observed two adult steelhead.

Carr Creek. Carr Creek, a tributary to Hayfork Creek (RKM 47.8), flows through part of the upper Hayfork Valley. This valley section is heavily impacted by livestock, the riparian zone is heavily grazed, and cattle crossings are numerous, causing heavy suspended sediment throughout the section. Beaver dams are numerous throughout the creek, with one causing a total fish passage barrier below the Double G Ranch. Spawning habitat is limited, pools are small (most less than 1.0 m deep) and several low-water barriers exist. We surveyed 4.8 km of Carr Creek between 29 April and 30 April 1991, and observed two redds.

Dubakella Creek. Dubakella Creek, a tributary to upper Hayfork Creek (RKM 78.4), is located south of the town of Wildwood. The upper 2.1 km section flows through a steep narrow canyon containing mostly cascades with accompanying high velocity flows. The slope gradient levels out in the lower 1.1-km section, but sections with spawning gravel are limited. Large and small woody debris cover is abundant throughout t'is stream system and the riparian zone vegetation consists primarily of alders. We surveyed 2.4 km of the creek between 23 April and 22 May 1991, and observed no redds or adult steelhead.

East Fork of Hayfork Creek. The East Fork of Hayfork Creek, a major tributary to Hayfork Creek (RKM 58.2), is located north of the town of Wildwood. The creek is very rocky in many areas but does contain areas of good spawning habitat, mainly where CCC crews have built spawning gravel recruitment structures. Most of the noted spawning activity has occurred in the latter areas. The upper 3.2-km section contains numerous pools and riffles, and areas of spawning gravel are abundant. The remaining 4.2 km, from the East Fork Road bridge to the confluence with Hayfork Creek, is a steady, declining gradient containing fast moving water and little spawning habitat. The primary riparian zone consists of alders and willows. Secondary growth consists of cedars, firs and pines. Most of the basin has been hydraulically mined. These operations are most evident in the main basin in the form of large tailing piles. In general, nearly all of the East Fork of Hayfork Creek drainage has been altered from its natural topography. We surveyed 6.4 km of the East Fork of Hayfork Creek on 27 March and 14 May 1991, from the confluence with Hayfork Creek to the confluence of the North Fork of the East Fork of Hayfork Creek, observing 17 redds.

Goods Creek. Goods Creek, a tributary to Hayfork Creek (RKM 45.6), is located in Wildwood. Steelhead habitat was poor due to the low flow conditions. Spawning areas were limited, and creek sedimentation was heavy. A beaver dam, which caused a barrier to anadromous fish migration in 1990, had been removed. We surveyed 1.6 km on 24 April and 15 May 1991, and observed one redd.

Hayfork Creek. Hayfork Creek is the major tributary to the SFTR (RKM 30.1). Most of the creek above the Hayfork Valley is composed of boulders and large rubble unsuitable for spawning. Some upper reaches of Hayfork Creek contain a few areas of suitable spawning habitat, but beaver dams are creating a serious siltation and sedimentation problem resulting in cemented gravels. The section flowing through the Hayfork Valley contains a fair amount of spawning gravel, but the habitat is poor, with little or no cover, very few pools, and warm water temperatures in the summer. We surveyed sections from the upper Hayfork Valley at the Dubakella Creek confluence to the lower Hayfork Valley in those areas that were accessible and where we knew spawning habitat existed. We surveyed 23.0 km of the creek between 8 May and 24 May 1991, and counted 48 redds.

Little Creek. Little Creek, a tributary to Hayfork Creek (RKM 29.0), is located west of the town of Hayfork. The USFS has constructed habitat improvement structures in the stream, and there are areas of suitable spawning habitat. A complete barrier exists 1.6 km from the confluence. We surveyed 1.6 km of the creek between 8 May and 20 May 1991, and counted three redds.

Philpot Creek. Philpot Creek, a tributary to Salt Creek (RKM 11.1) [see below], is located in the Hayfork Valley. It is composed of long stretches of bedrock substrate and contains some areas of suitable spawning gravels. A dense canopy of riparian vegetation makes walking the stream in its lower section impossible. We surveyed 2.6 km of the creek on 23 April 1991 and counted no redds.

Potato Creek. Potato Creek, a tributary to East Fork Hayfork Creek (RKM 3.1), lies in an extremely steep-sided basin. We surveyed the lower 2.4 km on 22 April and 5 May 1991, found good steelhead habitat, but counted no redds.

Rusch Creek. Rusch Creek, a tributary to Hayfork Creek (RKM 28.5), is located west of the town of Hayfork. This is a perennial stream running through mountainous terrain with fairly dense shade canopy provided by Douglas fir, yew, bigleaf maple, and alder trees. The creek contains numerous habitat improvement structures for bank stabilization, pool scouring and spawning gravel recruitment, but spawning habitat is very limited. The upper 3.2 km are very steep, with many cascades and no spawning habitat present. Steelhead rearing habitat was fair throughout the creek. Pools were primarily boulder- and log-formed, with pool cover provided mostly by rock and woody debris. Several complete and low flow barriers were noted 6.0 km from the confluence. We surveyed 6.4 km of the creek between 24 April and 28 May 1991, and counted 13 redds.

Salt Creek. Salt Creek, a major tributary to Hayfork Creek (RKM 37.0), runs through the Hayfork Valley. The lower section flows through pasture land where the creek is very open and exposed, and steelhead habitat is poor. Some pools are present but are lacking in cover, with the riparian vegetation consisting of alders and willows. The upper and middle sections contain better habitat with deeper pools and a denser canopy. Spawning habitat exists, but many of these areas are located within pastures and contain numerous cattle crossings, disturbing available spawning areas. Riparian vegetation is also heavily grazed, reducing cover and increasing sun exposure. We surveyed Salt Creek for 17.7 km between 28 March and 16 May 1991, counted 15 redds, and observed one adult steelhead.

Tule Creek. Tule Creek, a tributary to Hayfork Creek (RKM 35.9), flows through the Hayfork Valley. Spawning habitat in the lower section is poor, due to a clay hardpan substrate. The upper section contains many large deep pools, and spawning habitat is more readily available. Primary riparian cover is alders and oaks. Personnel from CDFG removed a beaver dam located in the lower 4.0 km, which was a low flow barrier during spring 1990. We surveyed 3.7 km of the creek on 4 April and 8 May 1991, and observed two redds.

Upper South Fork Trinity River Basin Near Forest Glen

We surveyed five tributaries to the SFTR in the upper SFTR basin area between 3 and 29 May 1991. These surveys covered a total of 23.7 km, and we observed 94 redds (Table 7).

East Fork of the South Fork Trinity River. The East Fork of the SFTR (beginning at SFTR RKM 118.0) is located in the Yolla Bolla region south of Highway 36. The upper 3.2-km section flows through a rugged, steep-sided canyon and is composed mostly of riffles and runs, while the lower section levels out into a low-gradient stream that is composed predominantly of cascades and large deep pools. Spawning gravels were found throughout the surveyed section. We surveyed 4.8 km on 3 May and 6 May 1991, counted 52 redds, and observed one adult steelhead.

Plummer Creek. Plummer Creek, a tributary to the upper SFTR (RKM 70.3), flows through a steep-sided canyon. Firs and alders dominate the canopy, while aquatic and riparian vegetation provide plentiful stream cover. Spawning gravels were plentiful and located mainly at the ends of pools. Few runs were observed, due to the fairly steep gradient of this section. Many of the firs growing on the canyon slopes were burned during the Friendly Fire of 1987. A slide which dammed the stream and was then blown-out with high flows is located approximately 1.21 km above the confluence with the SFTR. The quality of habitat below the slide is poorer than above; pools are filled in, riparian vegetation removed and spawning gravels show signs of sedimentation. Our survey crew was of the opinion that the slide occurred after the fire. We surveyed 3.2 km of Plummer Creek on 23 May 1991 and counted 21 redds.

Rattlesnake Creek. Rattlesnake Creek, a tributary to the SFTR (RKM 91.7), is located in the Forest Glen area. The upper and middle sections contain spawning habitat, but the lower section is composed mainly of cascades and very large pools. We surveyed 10.9 km of the creek on 7 May and 29 May 1991, and counted nine redds.

Silver Creek. Silver Creek, a tributary to the SFTR (RKM 102.7), is located south of Forest Glen in a very steep-sloped mountainous region. Spawning habitat is not abundant, but juvenile steelhead habitat is good throughout the survey reach. High gradient cascades are prevalent in the lower section. We surveyed 2.4 km of the creek on 4 May 1991 and observed no steelhead redds.

Smokey Creek. Smokey Creek, a tributary to the SFTR (RKM 104.1), is located south of Forest Glen. Smokey Creek is characterized by a wide floodplain, with abundant spawning habitat and large pools. We surveyed 2.4 km of the creek on 5 May 1991 and observed 12 redds.

Steelhead Redd and Spawning Habitat Evaluations

We studied 153 steelhead redds throughout the SFTR basin, to assess their associated habitat and substrate components and to measure the physical and hydraulic characteristics of each individual redd. We found redds in three basic habitat types: runs, riffles, and pools (Figure 5). The average redd area was 6.9 m^2 (Figure 6), and the average redd depth was 0.24 m (Figure 7).

The composition of the substrate provides information on the stream's suitability for spawning, insect production, and in-stream cover (Hunter 1991). Of the steelhead redds evaluated, the combination of dominant and subdominant substrate components in about 87% of the redds were of medium and large gravels, and small cobbles, in various combinations, with an average embeddedness of about 40% [mean embeddedness code of 3.6] (Tables 8-9). Embeddedness is the extent to which the larger substrate particles, such as boulders, cobbles, or gravels, are surrounded or covered by fine sediments. Current research indicates that when the substrate becomes more than 30-40% embedded, there is an accompanying loss of spawning habitat (Hunter 1991). More study of SFTR steelhead redds is needed to determine what spawning habitat components and criteria the fish are selecting. This information is needed to help us begin to address the question of the basin's capacity to support steelhead spawning and production.

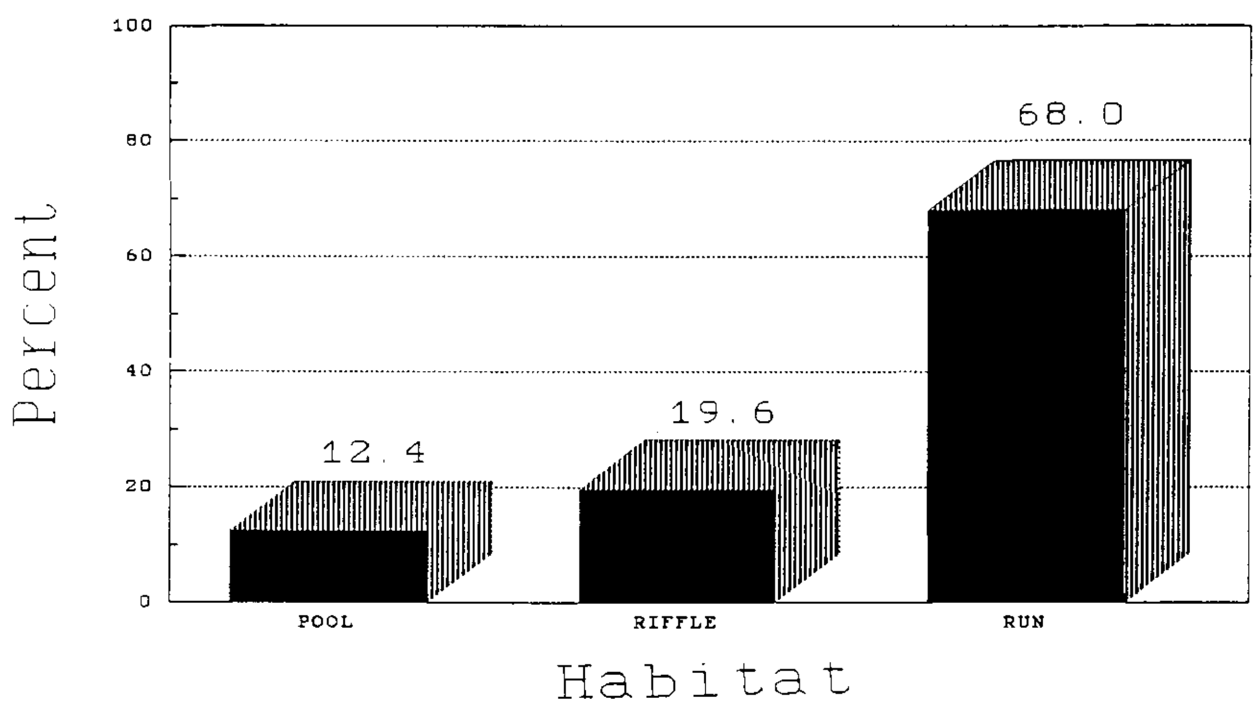

Figure 5. Relative frequency distribution of steelhead redds observed within three habitat types in the South Fork Trinity River basin during the 1990-91 season.

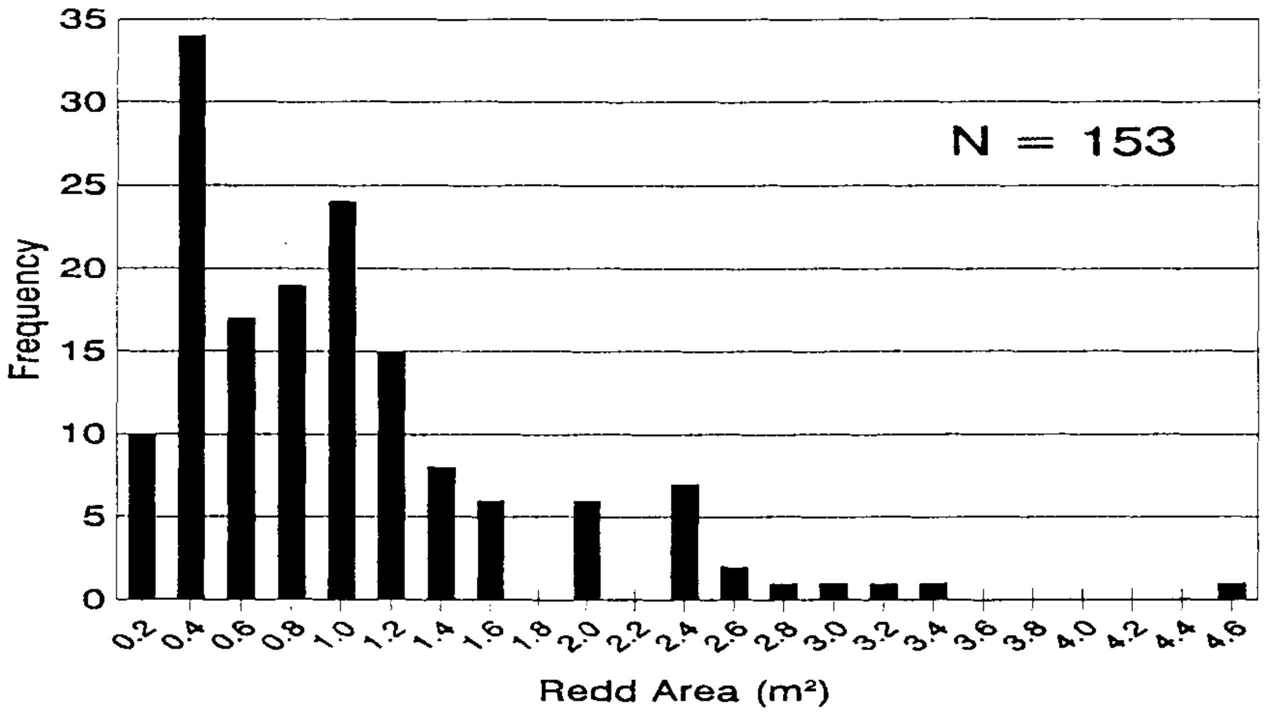

Figure 6. Size frequency distribution (m^2 of surface area) of steelhead redds examined within the South Fork Trinity River basin during the 1990-91 season.

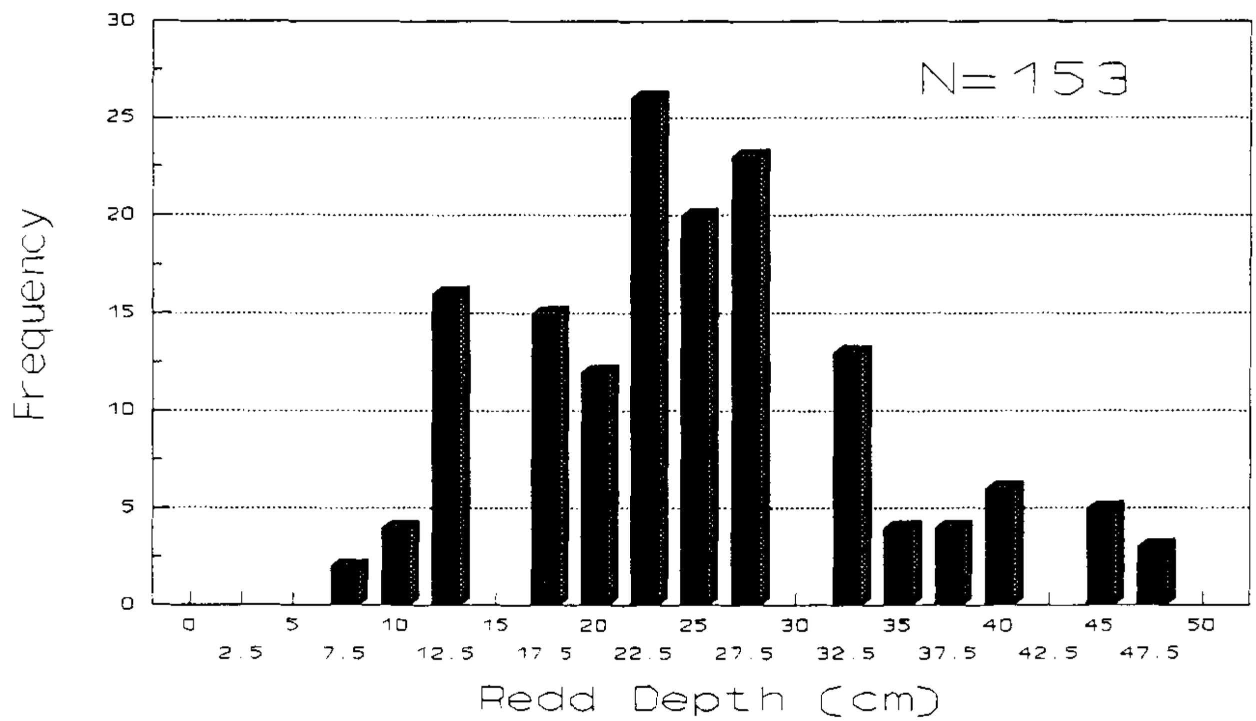

Figure 7. Redd-depth frequency distribution of steelhead redds examined within the South Fork Trinity River basin during the 1990-91 season.

Table 8. Dominant and subdominant substrate composition of steelhead redds observed in the South Fork Trinity River basin during the 1990-91 season.

		Dominant		Subdominant	
Code	Substrate	Observed	Percent	Observed	Percent
0	Fines	0	0.0%	2	1.3%
1	Small gravel	6	3.9%	8	5.2%
2	Medium gravel	41	26.8%	36	23.5%
3	Large gravel	59	38.6%	50	32.7%
4	Small cobble	36	23.5%	45	29.4%
5	Medium cobble	11	7.2%	12	7.8%
6	Large cobble	0	0.0%	0	0.0%
7	Small boulder	0	0.0%	0	0.0%
8	Large boulder	0	0.0%	0	0.0%
9	Bedrock	0	0.0%	0	0.0%
	TOTAL:	153	100.0%	153	100.0%

Table 9. Embeddedness of substrate components from steelhead redds observed in the South Fork Trinity River basin during the 1990-91 season.

		Embeddedness	
Code	Percent category	Number observed	Percent observed
0	0% - 9%	0	0.0%
1	10% - 19%	8	5.2%
2	20% - 29%	33	21.6%
3	30% - 39%	31	20.3%
4	40% - 49%	31	20.3%
5	50% - 59%	36	23.5%
6	60% - 69%	14	9.2%
7	70% - 79%	0	0.0%
8	80% - 89%	0	0.0%
9	90% - 100%	0	0.0%
	TOTAL:	153	100.0%

Adult Steelhead Recoveries at Emigrant Weirs

Project personnel operated two Alaskan-style weirs during the season, to recover post-spawning, emigrant adult steelhead. The Hayfork Creek Weir was operated for 83 d, from 18 April through 6 July 1991. The Forest Glen Weir operated for 131 d, from 17 March through 25 July 1991. In addition to our two weirs, CDFG's Trinity Fisheries Investigations Project personnel operated the Gates Road Weir below our two weirs on the SFTR at river km 31.7, for 80 d, from 30 April through 18 July 1991.

We captured 88 emigrant winter-run steelhead in the three weirs: 15 in the Hayfork Creek Weir (Figure 8), 26 in the Forest Glen Weir (Figure 9), and 47 in the Gates Road Weir (Figure 10). Three of the 88 were fish tagged at the Sandy Bar Weir and the remaining 85 were unmarked.

Of the 88 fish trapped at the three emigrant weirs, 45 were males, 35 were females, and 8 were of unknown sex. Mean FL was 63.4 cm (range: 43-79 cm) for males and 62.7 cm for females (range: 49-76). Mean FL for all fish was 62.4 cm (range: 34-79 cm) (Figure 11).

Twenty-five immigrant spring-run steelhead were captured in the upstream traps: 3 in the Hayfork Creek Weir, 4 in the Forest Glen Weir, and 18 in the Gates Road Weir (Figure 12). Seven fish were males, 15 were females, and 3 were of unknown sex. Mean FL was 62.7 cm (range: 50-77 cm) for males and 59.7 cm for females (range: 47-71 cm). Mean FL for all fish was 59.8 cm (range: 47-77 cm) (Figure 13).

Adult Steelhead Escapement Estimate

Of the 176 steelhead tagged, fin-clipped, and released at the Sandy Bar Weir between 13 September 1990 and 1 March 1991, only six were recovered: three in the creel surveys, one at the Hayfork Creek Weir, one at the Forest Glen Weir, and one at the Gates Road Weir. Eighty-eight unmarked steelhead were also recovered: through creel surveys (3), at the Hayfork Creek Weir (14), at the Forest Glen Weir (25), and at the Gates Road Weir (46). Based upon these numbers, an estimated 2,402 adult steelhead (95% Poisson C.I.: 1193 to 5255) immigrated into the SFTR basin during the 1990-1991 season.

Although the tagging weirs were an effective method of assessing steelhead run-size and run-timing this year, we need to determine whether weirs are our only means of gathering this information. This was another dry water-year, but unpredictable weather and high river flows make weir operations in the winter impossible during most normal water-years. Since our weirs cannot be operated under high flow conditions, we may not be able to monitor the entire run during normal water-years.

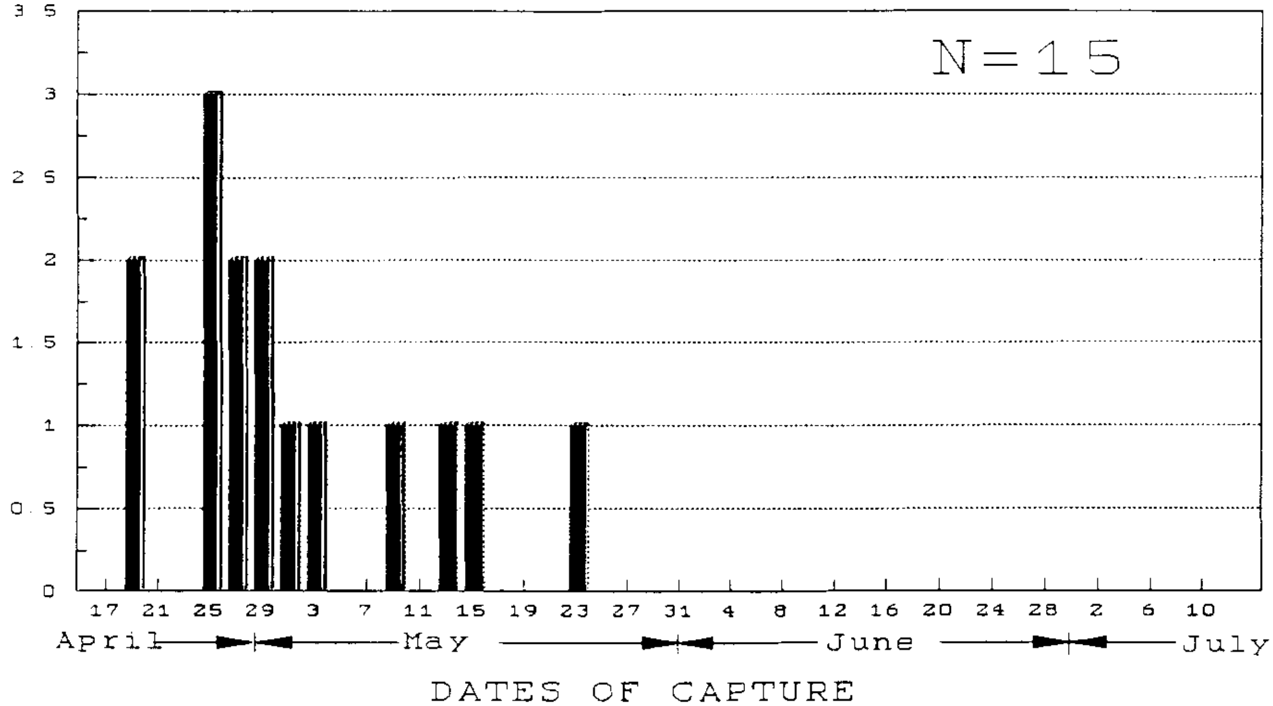

Figure 8. Daily catches of post-spawning, emigrant, winter-run adult steelhead at the Hayfork Creek Weir in the South Fork Trinity River basin from 18 April through 6 July 1991.

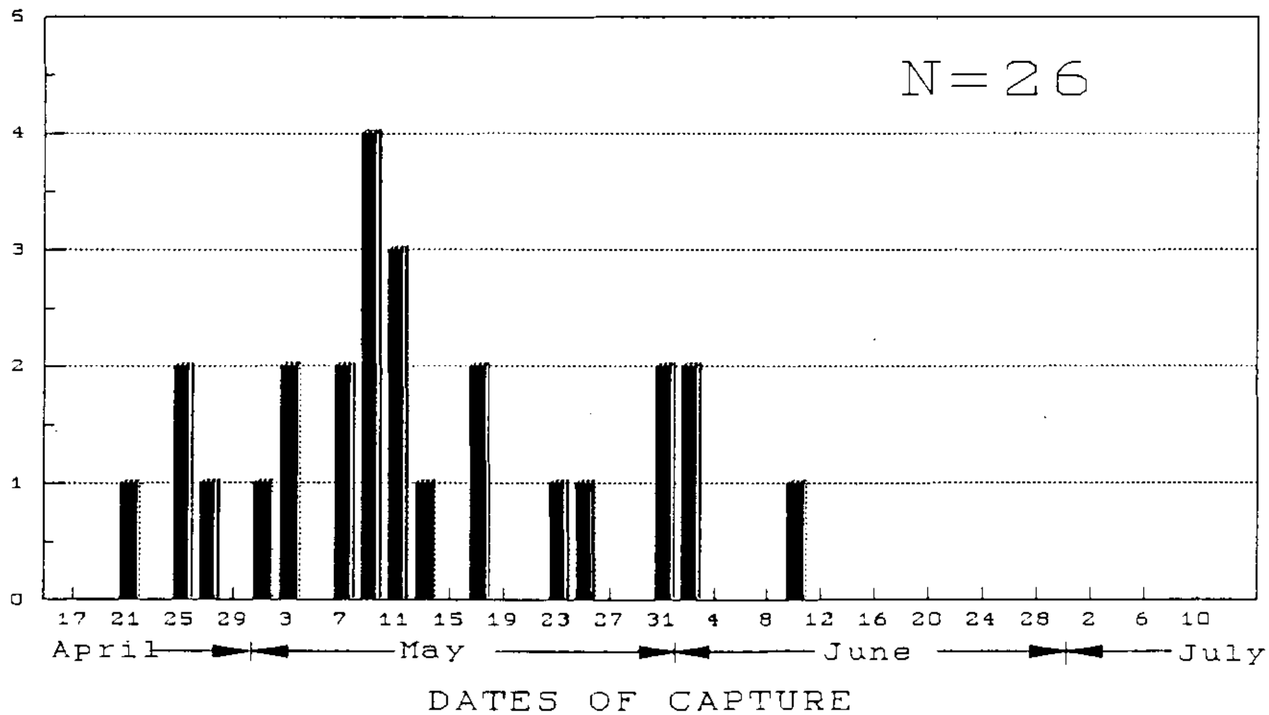

Figure 9. Daily catches of post-spawning, emigrant, winter-run adult steelhead at the Forest Glen Weir in the South Fork Trinity River basin from 17 March through 25 July 1991.

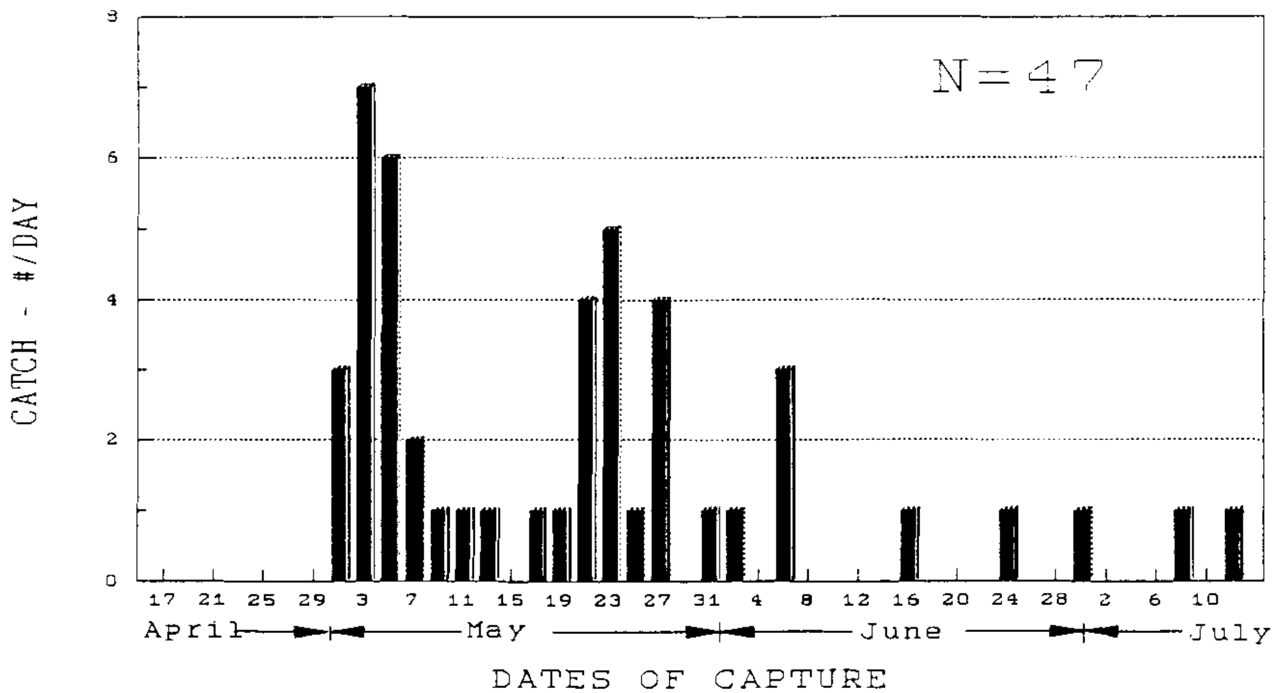

Figure 10. Daily catches of post-spawning, emigrant, winter-run adult steelhead at the Gates Road Weir in the South Fork Trinity River basin from 30 April through 18 July 1991.

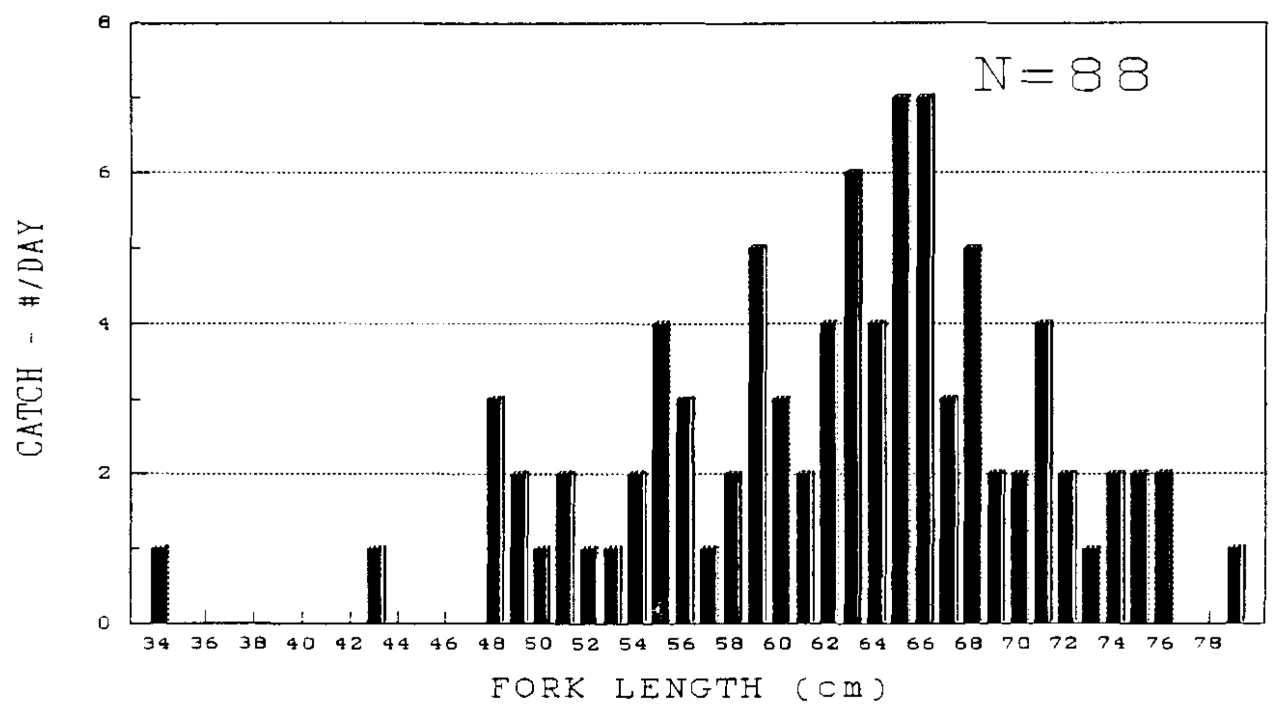

Figure 11. Combined length frequency distribution of post-spawning, emigrant, winter-run adult steelhead trapped at the Hayfork Creek, Forest Glen, and Gates Road weirs in the South Fork Trinity River basin from 17 March through 25 July 1991.

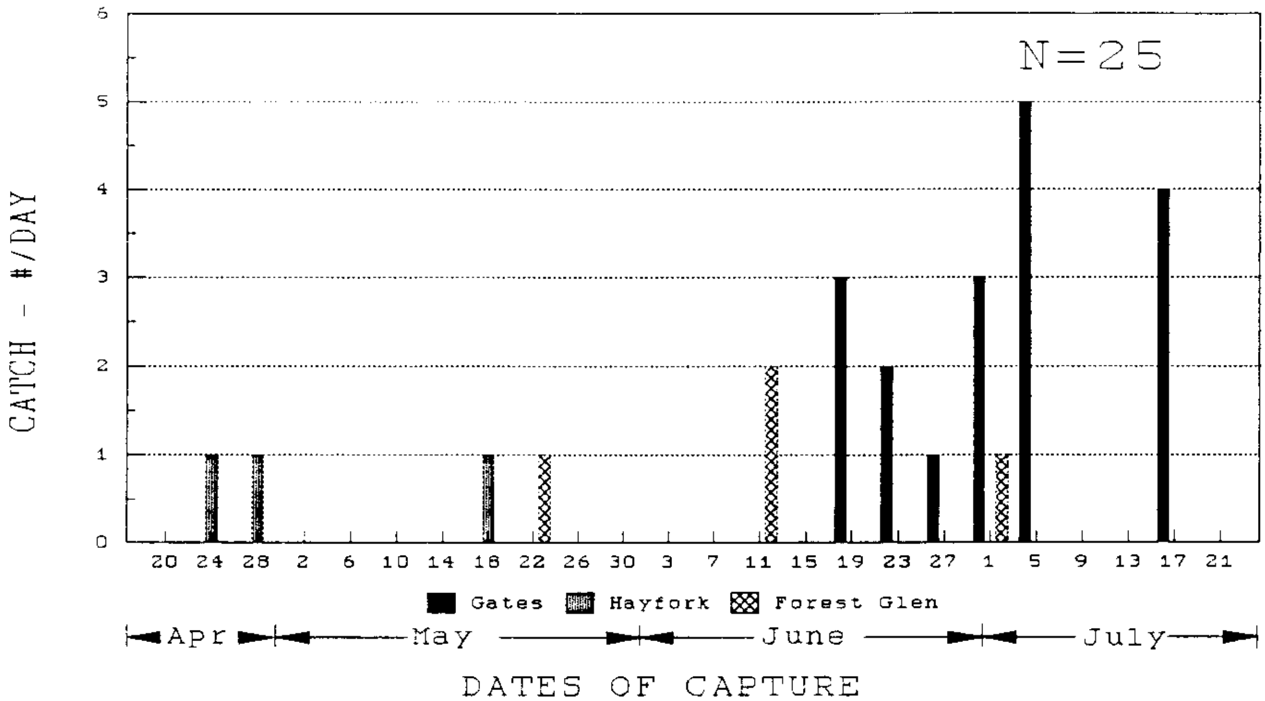

Figure 12. Daily catches of immigrant, spring-run adult steelhead at the Hayfork Creek, Forest Glen, and Gates Road weirs in the South Fork Trinity River basin from 17 March through 25 July 1991.

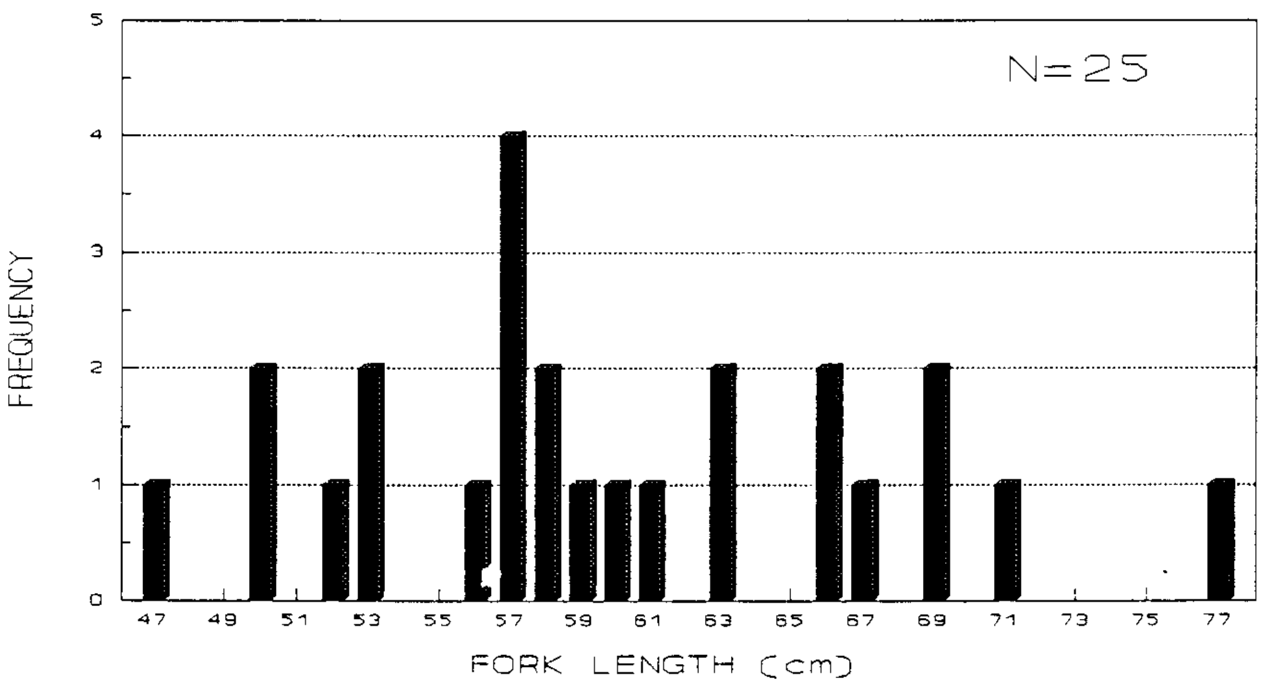

Figure 13. Combined length frequency distribution of immigrant, spring-run adult steelhead at the Hayfork Creek, Forest Glen, and Gates Road weirs in the South Fork Trinity River basin from 17 March through 25 July 1991.

Juvenile Steelhead Emigration Studies

From 1 July 1990 through 30 June 1991, we captured 2,000 Age 0+, 792 Age 1+, and 21 Age 2+ steelhead, and 892 juvenile chinook salmon at the Hayfork Creek and SFTR juvenile out-migrant trapping sites (Figure 1, Table 10). The peak emigration of Age 0+ steelhead occurred during May and June 1991 while peak emigration of Age 0+ chinook salmon occurred during May 1991. We suspect peak emigration of Age 1+ and older steelhead occurred during March 1991, but cannot confirm this, due to high water conditions which prevented any trapping during the entire month of March 1991. Age 0+ steelhead were more abundant in Hayfork Creek and chinook salmon were more abundant in the SFTR (Table 10). The mean FL of Age 0+ steelhead from the 1990 brood year (BY) ranged from 55 mm to 84 mm, and mean FL of 1991-BY, Age-0+ steelhead increased from 24 mm during mid-May 1991 to 55 mm by June 1991 (Table 11). Mean FL's of Age 1+ steelhead ranged from 95 to 119 mm, and Age 2+ steelhead ranged from 153 to 185 mm (Table 11). Mean FL's of chinook salmon from the 1990 BY ranged from 62 to 102 mm (Table 11).

Habitat Use by Juvenile Steelhead

We intended to use either the two-step or the Zippin method to estimate abundance (Hankin 1986; Price 1982), however, the two-step method proved unsatisfactory because, in several cases, more fish were caught on the second pass than the first, leading to negative abundance estimates. In addition, several other cases yielded equal numbers of fish on both passes, which leads to division by zero in the formula. Abundance estimates calculated using the Zippin method were identical to the total number of fish caught in most of the units sampled. A large difference (>40%) occurred in only 3 of 48 cases. Therefore, density estimates calculated for this report are based on the total number of fish caught. The three cases mentioned above were deleted from analysis.

We evaluated juvenile steelhead utilization of the five basic habitat types in Eltapom Creek during Fall 1990 (29 August through 4 September) and in Spring 1991 (3-6 June). We sampled 24 (33.3%) of the 72 identified habitat units: 1 cascade, 9 pools, 6 riffles, 4 runs and 4 step-runs. Pools and riffles were the predominant habitat types (about 30% each), followed by step-runs (23%) and runs (15%). Cascades were the least abundant habitat type (2%).

During the fall 1990 survey, densities of Age 0+ and Age 1+ steelhead were similar in pools and riffles, while densities of Age 0+ were higher than those of Age 1+ steelhead in runs and step-runs. In the single cascade unit sampled, almost all of the fish found were Age 1+ (Figure 14). Absolute fish densities were similar in all habitat types ranging from about 25 to 38 fish per

Table 10. South Fork Trinity River basin juvenile salmonid trapping summary for the 1990–91 season.

			NUMBERS TRAPPED							
			Hayfork Creek				South Fork Trinity River			
			Steelhead			Chinook	Steelhead			Chinook
Year	Dates	Julian week	Age 0+	Age 1+	Age 2+	Age 0+	Age 0+	Age 1+	Age 2+	Age 0+
1990	07/02 – 07/08	27	2	0	0	0	26	0	0	15
	07/09 – 07/15	28	2	0	0	0	85	0	0	5
	07/1[illegible] – 07/22	29	0	0	0	0	40	0	0	0
	07/23 – 07/29	30	0	–	–	–	–	–	–	–
	07/30 – 08/05	31	–	–	–	–	–	–	–	–
	08/06 – 08/12	32	–	–	–	–	–	–	–	–
	08/13 – 08/19	33	–	–	–	–	–	–	–	–
	08/20 – 08/26	34	–	–	–	–	–	–	–	–
	08/27 – 09/02	35	–	–	–	–	–	–	–	–
	09/03 – 09/09	36	–	–	–	–	–	–	–	–
	09/10 – 09/16	37	–	–	–	–	–	–	–	–
	09/17 – 09/23	38	–	–	–	–	–	–	–	–
	09/24 – 09/30	39	–	–	–	–	–	–	–	–
	10/01 – 10/07	40	–	–	–	–	–	–	–	–
	10/08 – 10/14	41	–	–	–	–	–	–	–	–
	10/15 – 10/21	42	–	–	–	–	–	–	–	–
	10/22 – 10/28	43	–	–	–	–	–	–	–	–
	10/29 – 11/04	44	1	4	0	1	0	1	0	0
	11/05 – 11/11	45	0	7	0	0	0	1	4	0
	11/12 – 11/18	46	1	8	1	2	3	3	2	0
	11/19 – 11/25	47	4	18	17	0	2	1	0	0
	11/26 – 12/02	48	4	31	0	0	2	4	0	0
	12/03 – 12/09	49	0	3	0	0	1	0	0	0
	12/10 – 12/16	50	9	3	1	0	26	7	0	0
	12/17 – 12/23	51	1	8	0	0	5	2	0	1
	12/24 – 12/31	52	–	–	–	–	–	–	–	–

(continued)

Table 10. South Fork Trinity River basin juvenile salmonid trapping summary for the 1990–91 season (continued).

			NUMBERS TRAPPED							
			Hayfork Creek				South Fork Trinity River			
			Steelhead			Chinook	Steelhead			Chinook
Year	Dates	Julian week	Age 0+	Age 1+	Age 2+	Age 0+	Age 0+	Age 1+	Age 2+	Age 0+
1991	01/01 – 01/07	1	–	–	–	–	–	–	–	–
	01/08 – 01/14	2	–	–	–	–	–	–	–	–
	01/15 – 01/21	3	1	10	1	0	19	13	0	1
	01/22 – 01/28	4	4	2	0	0	3	0	0	0
	01/29 – 02/04	5	–	–	–	–	–	–	–	–
	02/05 – 02/11	6	8	20	0	0	14	31	0	2
	02/12 – 02/18	7	13	40	1	0	14	46	0	1
	02/19 – 02/25	8	9	20	0	0	9	18	0	0
	02/26 – 03/04	9	–	–	–	–	–	–	–	–
	03/05 – 03/11	10	–	–	–	–	–	–	–	–
	03/12 – 03/18	11	–	–	–	–	–	–	–	–
	03/19 – 03/25	12	–	–	–	–	–	–	–	–
	03/26 – 04/01	13	–	–	–	–	–	–	–	–
	04/02 – 04/08	14	–	–	–	–	–	–	–	–
	04/09 – 04/15	15	–	–	–	–	–	–	–	–
	04/16 – 04/22	16	6	40	0	0	0	0	0	0
	04/23 – 04/29	17	0	10	0	0	0	0	0	0
	04/30 – 05/06	18	0	0	0	0	25	229	0	20
	05/07 – 05/13	19	0	11	0	29	48	110	0	142
	05/14 – 05/20	20	244	5	0	167	17	80	0	122
	05/21 – 05/27	21	268	0	0	74	11	3	0	67
	05/28 – 06/03	22	157	0	0	53	15	2	0	82
	06/04 – 06/10	23	267	0	0	13	15	0	0	35
	06/11 – 06/17	24	279	0	0	2	41	0	0	21
	06/18 – 06/24	25	204	0	0	1	26	0	0	30
	06/25 – 07/01	26	62	0	0	2	7	1	0	4
		Totals	1,546	240	21	344	454	552	0	548

Table 11. Fork lengths of juvenile steelhead and chinook salmon captured within the South Fork Trinity River basin during the 1990–91 season.

			Steelhead												Chinook Salmon			
		Julian	Age 0+				Age 1+				Age 2+							
		week		Fork length (mm)				Fork length (mm)				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
1990	07/02 – 07/15	27–28	110	59	45	76	0	––	––	––	0	––	––	––	7	88	83	95
	07/16 – 07/29	29–30	40	55	43	78	0	––	––	––	0	––	––	––	0	––	––	––
	07/30 – 08/12	31–32	ns a/	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	08/13 – 08/26	33–34	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	08/27 – 09/09	35–36	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	09/10 – 09/23	37–38	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	09/24 – 10/07	39–40	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	10/08 – 10/21	41–42	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	10/22 – 11/04	43–44	1	84	84	84	4	114	98	129	0	––	––	––	1	86	86	86
	11/05 – 11/18	45–46	5	74	56	82	20	111	87	142	6	185	159	230	2	94	93	94
	11/19 – 12/02	47–48	12	71	51	83	55	111	81	150	17	179	156	200	0	––	––	––
	12/03 – 12/16	49–50	29	58	39	84	21	96	86	118	1	153	153	153	0	––	––	––
	12/17 – 12/31	51–52	6	69	49	84	7	112	95	132	0	––	––	––	1	93	93	93
1991	01/01 – 01/14	01–02	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	01/15 – 01/28	03–04	27	65	44	85	24	102	88	124	1	161	161	161	1	101	101	101
	01/29 – 02/11	05–06	22	74	54	85	52	98	85	137	3	166	152	173	2	102	95	109
	02/12 – 02/25	07–08	45	74	55	85	122	100	85	143	0	––	––	––	0	––	––	––
	02/26 – 03/11	09–10	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	03/12 – 03/25	11–12	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	03/26 – 04/08	13–14	ns	––	––	––	––	––	––	––	––	––	––	––	––	––	––	––
	04/09 – 04/[illegible]	15–16	0	––	––	––	48	97	70	133	0	––	––	––	0	––	––	––
	04/23 – 05/06	17–18	0	––	––	––	114	95	74	135	0	––	––	––	35	65	48	77
	05/07 – 05/20	19–20	121	24	20	46	135	98	73	139	0	––	––	––	205	62	47	89
	05/21 – 06/03	21–22	241	42	27	68	5	105	82	95	0	––	––	––	215	65	33	90
	06/04 – 06/17	23–24	294	49	27	69	1	119	119	119	0	––	––	––	67	72	58	89
	06/18 – 07/01	25–26	195	55	40	71	1	106	106	106	0	––	––	––	36	71	59	89

a/. ns = Not sampled

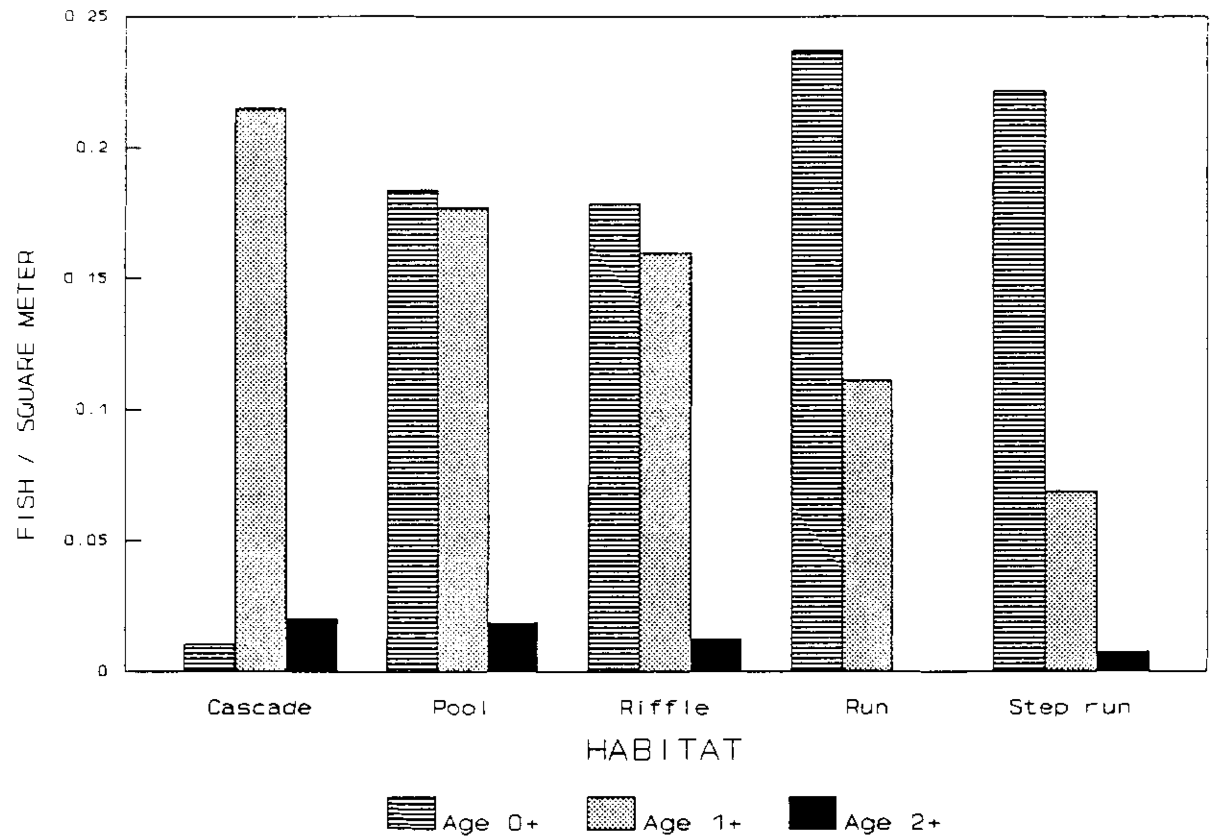

Figure 14. Estimated densities of different age groups of juvenile steelhead observed in habitat types sampled in Eltapom Creek within the South Fork Trinity River basin during fall 1990 (29 August - 3 September).

100 m^2, with the highest densities observed in pools, riffles, and runs (Table 12).

During the spring 1991 survey, the highest densities of Age 0+ fish were found in step-runs, runs, and riffles, while the highest densities of Age 1+ and older fish were found in the cascade, runs, and pools (Figure 15). Absolute fish densities were fairly similar in all habitat types, but were much lower than during the fall 1990 survey. Densities ranged from about 4-to-8 fish per 100 square meters. The highest densities were found in step-runs, runs, and cascades, while somewhat lower densities were found in pools and riffles (Table 13). Young-of-the-year steelhead were underrepresented during the spring 1991 survey.

Table 12. Juvenile steelhead habitat utilization in Eltapom Creek between 29 August and 3 September 1990 (fall 1990).

Habitat type	Number of habitat units	Total available habitat (m^2)	Area of habitat sampled (m^2)	Number of fish observed	Sampled fish density (#/m^2)	Estimated fish per available area
Cascades	3	140.55	97.66	24	0.25	35
Pools	27	1,818.26	489.88	164	0.38	690
Riffles	18	1,863.90	520.63	194	0.35	655
Run	11	951.28	234.80	72	0.35	331
Step-run	13	1,309.14	220.24	68	0.30	390
Totals:	72	6,083.13	1,563.20			
Grand-mean:					0.33	

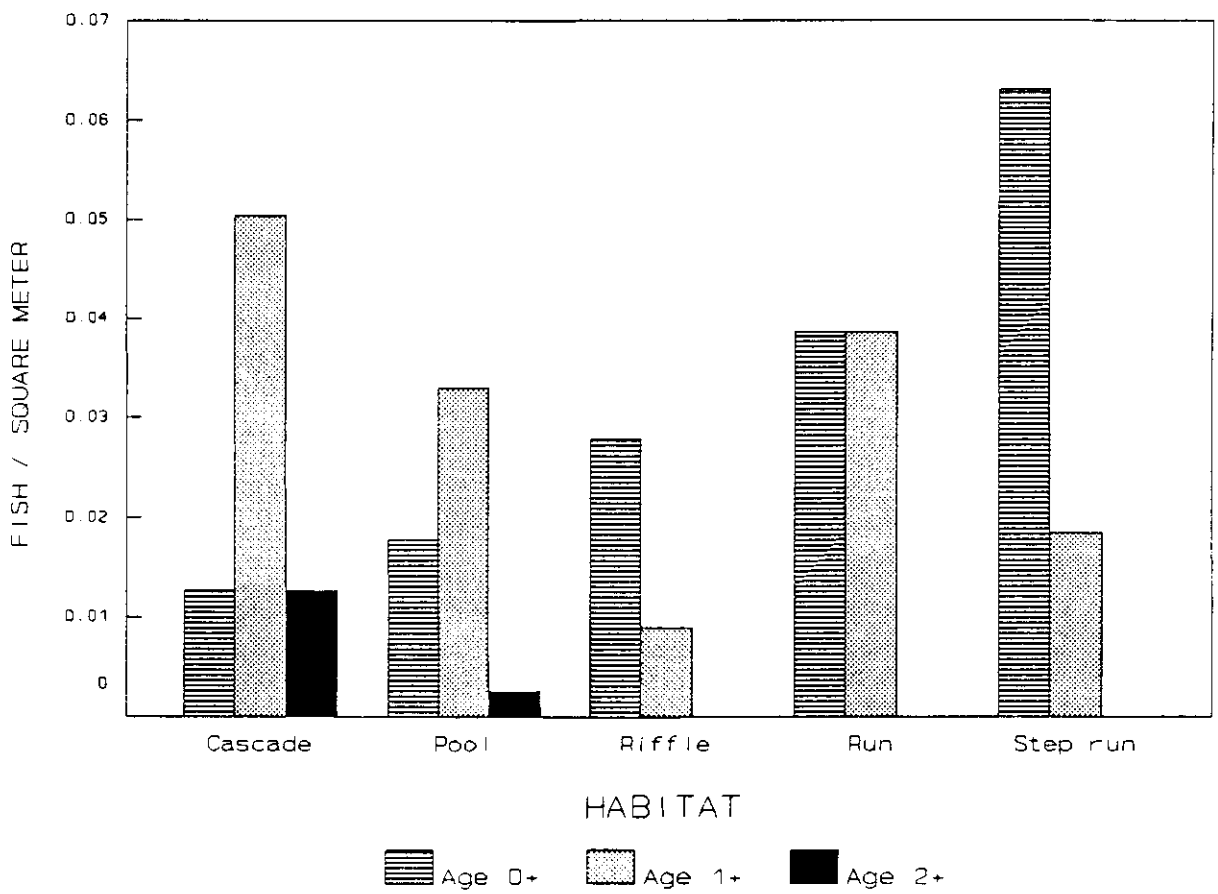

Figure 15. Estimated densities of different age groups of juvenile steelhead observed in habitat types sampled in Eltapom Creek within the South Fork Trinity River basin during spring 1991 (3 - 6 June).

Table 13. Juvenile steelhead habitat utilization in Eltapom Creek between 3 and 6 June 1991 (spring 1991).

Habitat type	Number of habitat units	Total available habitat (m^2)	Area of habitat sampled (m^2)	Number of fish observed	Sampled fish density (#/m^2)	Estimated fish per available area
Cascades	3	163.88	79.35	6	0.08	12
Pools	27	1,932.42	570.64	21	0.05	103
Riffles	17	1,970.02	548.00	10	0.04	72
Run	11	990.17	259.60	16	0.08	76
Step-run	14	1,632.49	468.38	36	0.08	133
Totals:	72	6,688.99	1,925.96			397
Grand-mean:					0.05	

Steelhead Life History Patterns

Juvenile steelhead scale analysis was conducted using the OPRS system. We concentrated primarily on scale samples of juvenile 1+ fish, to help clarify the location of the first annulus in adult scales. We have also read scales from Age 0+ through Age 2+ fish to further describe juvenile life history patterns. We collected 640 sets of juvenile scales this year, and read and interpreted 280 of them. One hundred five were from Age 0+, 164 were Age 1+ and 11 were Age 2+ steelhead (Table 14).

The analysis of juvenile steelhead scales will help us to better clarify the juvenile life history portions of our adult scales in future adult steelhead scale studies.

RECOMMENDATIONS

1. Creel surveys in the SFTR basin should continue during the 1991-92 Fiscal Year (FY) to document angler use. Additional information is needed on harvest rates, especially during low flow conditions.

2. Adult steelhead spawner surveys should begin by 1 March, weather permitting. Habitat types should be quantified during these surveys to document spawning area available to steelhead.

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

Table 14. Fork lengths and circuli counts of juvenile steelhead collected in the South Fork Trinity River basin during the 1990-91 season, stratified by age and collection location.

			Circuli count		Fork length (mm)	
Collection Location	Age	Sample size	Mean	Range	Mean	Range
SFTR a/	0+	54	12	6-20	78	57-104
	1+	48	21	16-32	127	89-164
	2+	8	32	24-35	182	165-230
HFC b/	0+	51	13	7-21	87	67-115
	1+	116	20	16-33	118	81-183
	2+	3	31	24-34	199	145-200
Both sites	0+	105	12	7-21	68	57-115
	1+	164	21	16-33	120	81-183
	2+	11	31	24-35	186	145-230

a/ South Fork Trinity River above the mouth of Hayfork Creek.

b/ Mouth of Hayfork Creek in the Hyampom Valley.

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

5. Juvenile steelhead habitat utilization studies should continue, with like studies conducted during other seasons for comparison of seasonal habitat use by the various age groups.

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

ACKNOWLEDGEMENTS

The authors would like to thank Judith Jackson for assistance in preparing the tables for this report, Kevin Shaffer for OPRS scale analysis work, and all Natural Stocks Assessment Project personnel working in the SFTR basin for their assistance in fieldwork and data collection.

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

Julian week	Calander dates		Julian week	Calander dates	
	Start	Finish		Start	Finish
01	Jan. 01	Jan. 07	27	Jul. 02	Jul. 08
02	Jan. 08	Jan. 14	28	Jul. 09	Jul. 15
03	Jan. 15	Jan. 21	29	Jul. 16	Jul. 22
04	Jan. 22	Jan. 28	30	Jul. 23	Jul. 29
05	Jan. 29	Feb. 04	31	Jul. 30	Aug. 05
06	Feb. 05	Feb. 11	32	Aug. 06	Aug. 12
07	Feb. 12	Feb. 18	33	Aug. 13	Aug. 19
08	Feb. 19	Feb 25	34	Aug. 20	Aug. 26
09	Feb. 26	Mar. 04 [a]	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. 29	Nov. 04
19	May 07	May 13	45	Nov. 05	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 [b]

[a] Eight-day week in each year which is divisible by 4.

[b] Eight-day week every year.

Appendix 2. Travel times to Sandy Bar Weir in the South Fork Trinity River of steelhead previously tagged and released at the Willow Creek Weir in the mainstem Trinity River, between 18 September and 16 November 1990.

Date tagged at Willow Creek Weir	Date recaptured at Sandy Bar Weir	Travel days between weirs
18 September 1990	11 December 1990	84
16 October 1990	12 December 1990	57
19 October 1990	26 November 1990	38
24 October 1990	29 October 1990	5
26 October 1990	12 January 1991	78
31 October 1990	2 November 1990	2
1 November 1990	11 December 1990	40
2 November 1990	9 November 1990	7
9 November 1990	26 November 1990	38
16 November 1990	27 December 1990	41
	Mean Days:	37

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1990-91 SEASON

CHAPTER IV

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

by

Bill Heubach, Michael Lau and Ed Miller

ABSTRACT

The California Department of Fish and Game's Trinity River Project conducted tag and recapture operations from May through December 1990 to obtain chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), and fall-run steelhead (O. mykiss) run-size, in-river harvest, and spawner escapement estimates in the Trinity River basin. We placed weirs in the Trinity River near the towns of Junction City and Willow Creek, and trapped 1,160 spring-run and 1,144 fall-run chinook salmon, 431 coho salmon, and 463 fall-run steelhead.

Based on tagged fish recovered at Trinity River Hatchery and on the return of reward tags by anglers, we estimate 6,388 spring-run chinook salmon migrated into the Trinity River basin upstream of Junction City Weir and that 845 (13.2%) were caught by anglers, leaving 5,543 fish as potential spawners. We estimate 9,992 fall-run chinook salmon migrated past Willow Creek Weir and that 4,787 of these fish continued up the Trinity River past Junction City Weir. Anglers harvested an estimated 350 (3.5%) of the fall-run chinook salmon that passed Willow Creek Weir, leaving 9,642 fish as potential spawners.

The coho salmon run in the Trinity River basin upstream of Willow Creek Weir was 3,897 fish, of which 2,177 continued their migration past Junction City Weir. Anglers harvested an estimated 47 (1.2%) of the coho salmon that migrated past Willow Creek Weir, leaving 3,850 fish as potential spawners.

An estimated 5,348 adult fall-run steelhead entered the Trinity River basin upstream of Willow Creek Weir, and 3,296 continued their migration upstream of Junction City Weir. Anglers harvested 1,230 (23.0%) of the adult fall-run steelhead that migrated past Willow Creek Weir, leaving 4,118 fish as potential spawners.

JOB OBJECTIVES

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

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

INTRODUCTION

The California Department of Fish and Game's (CDFG) Trinity River Project (TRP) conducts annual tagging and recapture operations for adult chinook and coho salmon, and fall-run steelhead in the mainstem Trinity River. This effort determines the composition (species, race, and proportion of hatchery-marked[1/] or Project-tagged[2/] fish), distribution, and timing of the chinook and coho salmon, and fall steelhead runs in the Trinity River basin. Recaptures of hatchery-marked and 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 this year (fall 1990).

The earlier studies were funded by the U.S. Bureau of Reclamation (U.S.B.R.) and Anadromous Fish Act funds administered by the U.S. Fish and Wildlife Service and National Marine Fisheries Service. The U.S.B.R. (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 main stem Trinity River and certain of its tributaries, or the South Fork Trinity River and some of its tributaries (Gibbs 1956; La Faunce 1965a, 1965b, 1967; Miller 1975; Moffett and Smith 1950; Rogers 1970, 1972,

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

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

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

METHODS

Trapping and Tagging

Trapping Locations and Periods

Trapping and tagging operations were conducted by TRP personnel from May through December 1990 at the same temporary weir sites near the towns of Willow Creek and Junction City in the mainstem Trinity River that were used in 1989 (Heubach et al. 1992). The downstream site, Willow Creek Weir (WCW), was located 6.7 km upstream of the town of Willow Creek, 46.8 km upstream of the Trinity River's confluence with the Klamath River, and 131.9 km downstream from Trinity River Hatchery (TRH). The upstream site, Junction City Weir (JCW) was located 6.4 km upstream of the town of Junction City, 133.2 km upstream from the Klamath River confluence, and 45.5 km downstream of TRH (Figure 1).

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

We trapped at the JCW from 21 May through 13 December 1990, except from 28 May through 6 June when high flows prevented operation. We trapped at WCW from 24 August through 13 December 1990.

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

Weir and Trap Design

As in the 1989-90 season, we used the Bertoni (Alaskan) weir design at both weir sites (Figure 2). The weir was supported by wooden tripods set 2.5 m apart. The weir panels were composed of

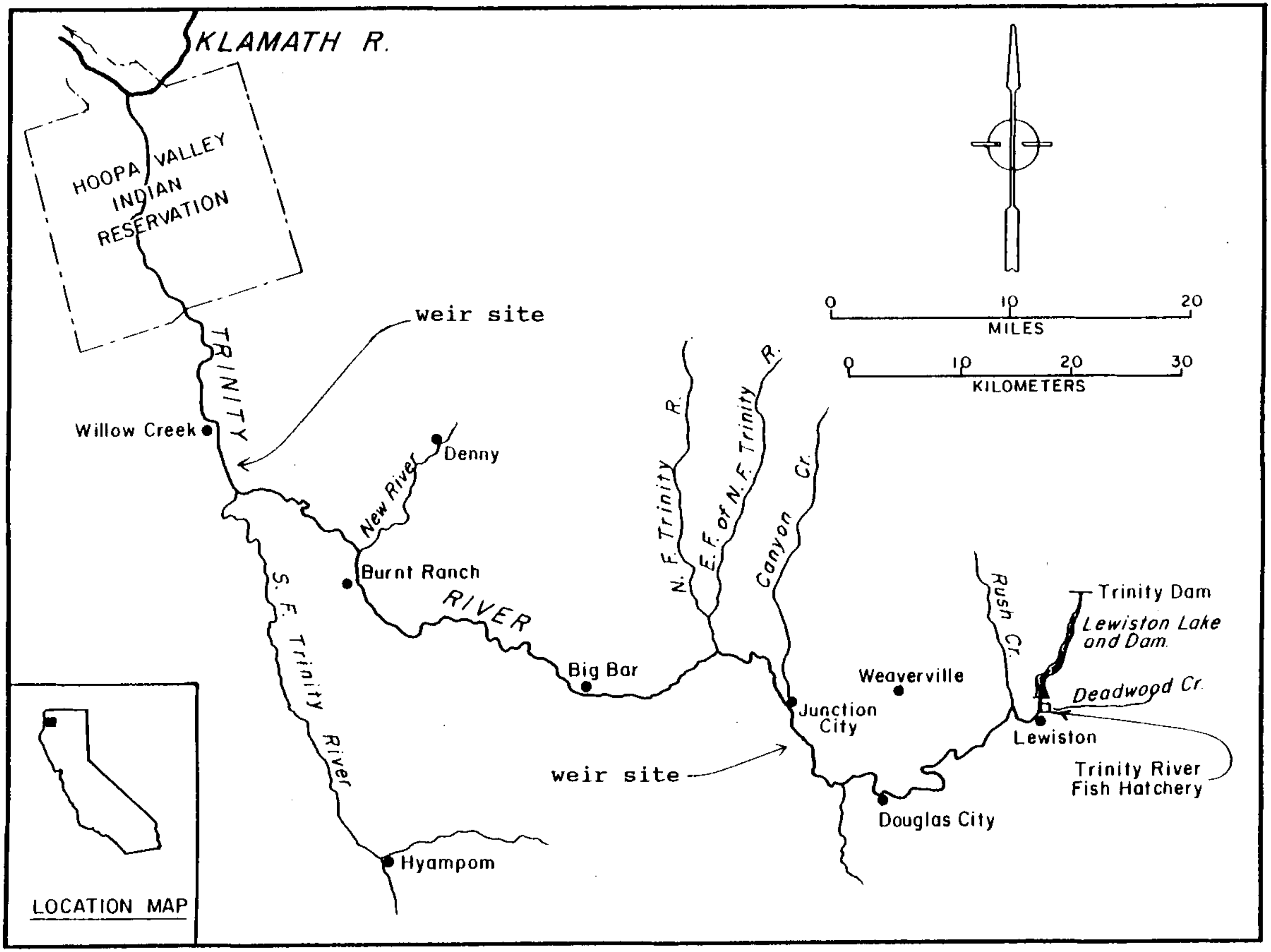

Figure 1. Locations of trapping and tagging weirs for anadromous salmonids near Willow Creek and Junction City on the main stem Trinity River, 1990-91 season.

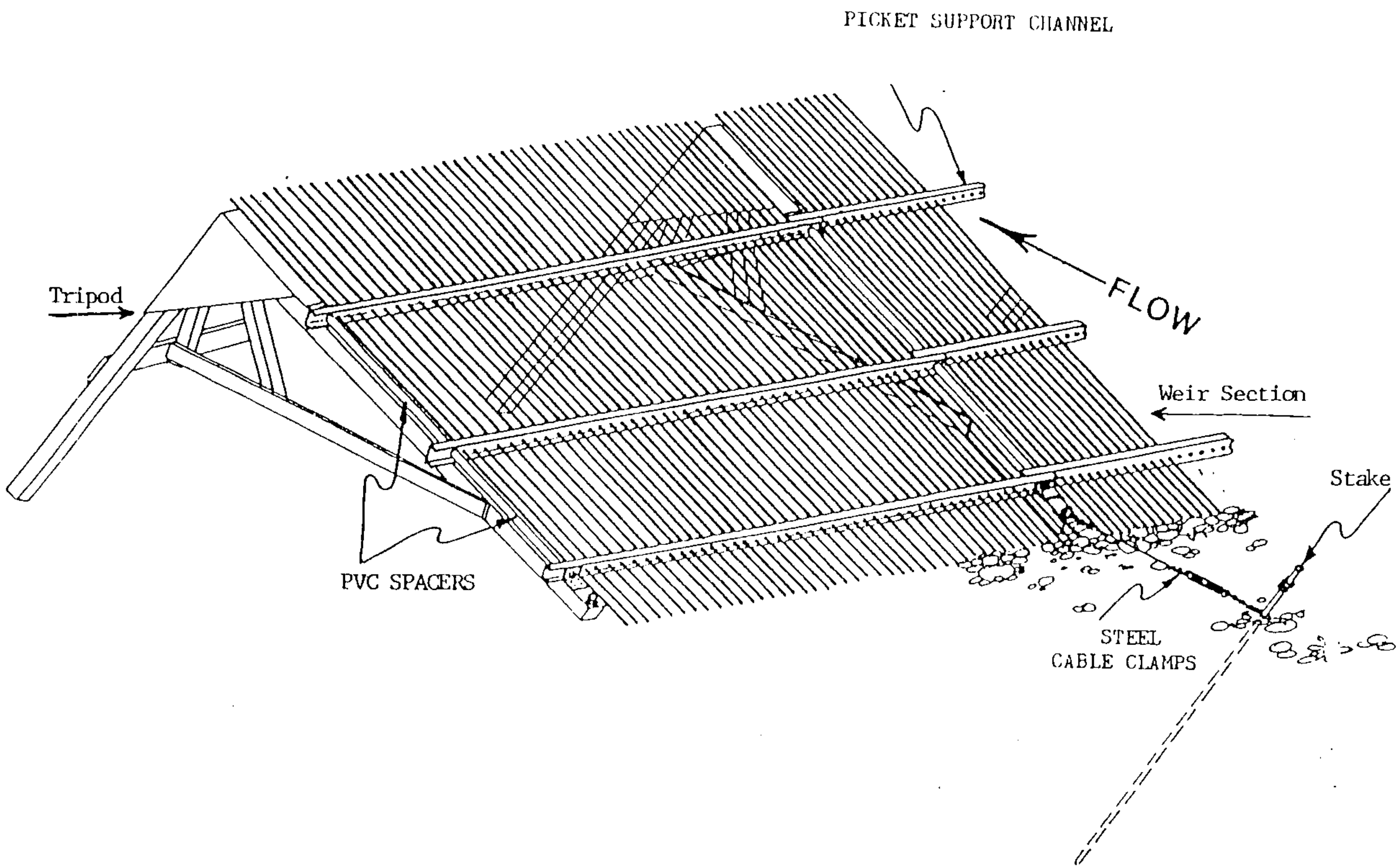

Figure 2. Schematic diagram of an Alaskan weir section, showing the arrangement of the tripod and weir paneling, as used on the Trinity River.

2.4-m X 2.54-cm (8-ft. X 1-in.) electrical conduit with the centers spaced 5.4 cm apart. The conduit was supported by three pieces of aluminum channel arranged 0.92 m apart, that connected to the supporting tripods. We anchored the tripods with 1.8-m stakes driven into the stream bottom. The weir conduits were angled, with the top of the weir standing 1.8 m above the river bottom (Figure 2).

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

Processing of Fish

At both weirs, we identified all trapped salmonids to species, measured them to the nearest cm of fork length (FL), and examined them for hook and gill-net scars, hatchery marks (fin clips) and tags. All untagged salmonids judged not to be moribund and not to have spawned were tagged with a serially numbered FT-4[3/] spaghetti tag (Project-tagged). To determine angler harvest rates, 55% (606/1,109) of the taggable spring chinook salmon at JCW received a $10-reward version of the spaghetti tags, and 54% (265/487) of the fall chinook, 65% (169/261) of coho, and 65% (174/269) of the steelhead tagged at WCW received $10- or $20-reward tags. All remaining fish received non-reward tags. All tags (both reward and non-reward) applied at Willow Creek were brown, while all tags applied at Junction City were blue.

This year we began a three-year experiment to determine the relative return rates, by anglers, of the non-reward and the $10- and $20-reward tags. We attempted to tag equal, one-third proportions of the fall chinook, coho and steelhead at WCW with each of the three spaghetti tag types (non-reward, $10-, and $20-reward tags). However, the $20 reward tags arrived after the trapping season began and, therefore, only 16% of the fall chinook received $20 reward tags. Our objective was to recover a sufficient number of tags to statistically compare the return rates of the three tag denominations.

To determine tag shedding rates, we removed one-half of the left ventral fin from all spring chinook tagged at JCW. We gave all fall chinook and coho tagged at WCW a single 6.4 mm (0.25 in.)

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

diameter puncture on the left operculum, while those tagged at JCW received two such punctures of the left operculum. The tagged steelhead did not receive a secondary mark at either weir. We released all fish at the respective capture sites immediately after processing.

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

Each year there is a temporal overlap in the annual spring and fall chinook runs in the Trinity River. Since the timing of each run varies between years, we assign a specific date each season separating the two runs so that numbers of spring and fall chinook can be determined for the run-size and angler harvest estimates. In 1990, we selected the date separating the runs based on changes in the ratio of hatchery-marked (adipose fin-clipped and coded-wire tagged [Ad+CWT]) spring to fall chinook which were spaghetti tagged at the weirs, and later recovered dead during upriver salmon spawner surveys or at TRH. Only double-tagged fish (Project-applied spaghetti tag and hatchery-applied coded-wire tag) were used for this evaluation. The race of these fish and the specific date that they were caught at the weirs could be identified because they were both coded-wire tagged (CWT) and Project-tagged fish, respectively. We also used the fish's coloration as a subjective indicator of the length of time it had been in the river. During the transition period of the run from spring to fall chinook, dark-colored fish were considered to be migrating spring chinook while light-colored fish were considered to be recently migrating fall chinook. We determined that the spring run was over at both weirs when light-colored fish clearly outnumbered dark-colored fish and carcass recoveries of double-tagged fish (Project-tagged and CWT) indicated that fall chinook dominated the run.

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

As at the weirs, there is an overlap in the migration of spring and fall chinook into TRH. To estimate the respective numbers of spring and fall chinook entering TRH, we expanded the numbers of coded-wire tags recovered from each returning coded-wire tag group by the ratio of CWT to untagged chinook salmon that occurred when they were originally released (same strain, brood year, release site and date). For example, 101,030 CWT spring chinook of code group 6-61-46, plus 385,018 unmarked spring chinook were released directly from TRH in September 1987. Since there were 3.8 unmarked chinook salmon released for every CWT chinook salmon released (385,018 unmarked/ 101,030 marked = 3.8), we multiplied the total number of CWT chinook salmon of code group 6-61-46 by 3.8 to estimate the number of unmarked fish of that release group that returned to TRH. In doing so, we assumed that return rates to TRH of both CWT and unmarked salmon were the same.

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

Separation of Adult and Grilse Salmon

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

The length data collected at the weirs and TRH were smoothed with a moving average of five, 1-cm FL increments to determine the nadir separating grilse and adults. In the 1990-91 season, only one coho grilse was trapped at the weirs, so we based the coho grilse:adult separation on length frequency data taken from coho entering TRH.

Adult Steelhead

All steelhead >41 cm FL were adults, and steelhead ≤41 cm were considered half-pounders.

Recovery of Tagged Fish

River Surveys

River surveys for dead, tagged fish were not conducted in the 1990-91 season, because only one dead tagged fish was recovered during the river surveys in the 1989-90 season. 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 (hatchery-marked) fish were removed for the recovery of the coded-wire tag. After examination, the carcasses were cut in half t› prevent recounting.

Tagging Mortalities

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

Angler Tag Returns

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

Salmon Spawner Surveys

The Trinity River Fisheries Investigation Project (TFIP), another element of CDFG's Klamath-Trinity Program, conducted salmon spawner (carcass) surveys in the mainstem Trinity River and its spawning tributaries from Lewiston Dam to the confluence of, and including the North Fork Trinity River, from 17 September through 20 December 1990 (Figure 1). Staff of the TFIP routinely provided us records of the species, tag number, date, and recovery location of Project-tagged fish.

Trinity River Hatchery

The TRH fish ladder was opened from 1 September 1990 through 27 March 1991. Hatchery personnel conducted fish sorting and spawning operations two-to-four days per week, depending on the numbers of fish entering TRH per day. 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 the secondary tagging mark. We measured all salmon and steelhead to the nearest cm FL, except those that were Project-tagged fish from the weirs. Project-tagged salmon and steelhead recovered at TRH were assigned the original FL recorded for them at the weir where they were originally tagged.

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

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

Statistical Analyses

Effectively Tagged Fish

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

Run-size Estimates

We determined the run-size estimates for salmon migrating into the Trinity River basin above WCW and JCW in 1990-91 by using Chapman's[4/] version of the Petersen Single Census Method (Ricker 1975):

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

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

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

Each year, we examine the grilse and adult composition of the effectively tagged salmon, the sample of Project-tagged salmon recovered at TRH, and the untagged sample of salmon at TRH to determine if the run-size estimate should be stratified by grilse and adults. Run-size estimates are stratified by grilse and

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

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

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

All steelhead run-size estimates are for adults only.

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

Angler Harvest Rates

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

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

The confidence limits surrounding the point harvest rate estimate were determined by tables for the binomial distribution. We attempted to effectively reward tag enough fish to obtain 95% confidence limits of $\leq$+10.0% of the harvest rate.

Angler Harvest Estimates

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

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

Other Analyses

The mean FLs of samples were compared statistically using a Student's t-test. We 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 the Project 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 added to 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.

RESULTS AND DISCUSSION

Trapping and Tagging

Spring-run Chinook Salmon

Run Timing. A few spring chinook salmon were mixed with fall-run fish but did not occur in significant numbers when we began trapping operations at WCW on 24 August 1990. Therefore, in this report we assume that no spring chinook were trapped at WCW during the 1990-91 season.

We captured two spring chinook the first week (21-27 May 1990, JW 21) of trapping at JCW, suggesting the run was just getting underway there. The weir was temporarily removed 28 May through 3 June, because of storms, and we did not resume trapping until 7 June 1990 (JW 23). From that week, the spring run increased rapidly and peaked 18-24 June and 9-15 July 1990 (JWs 25 and 28). Catches then generally declined through 13-19 August (JW 33), and then increased slightly through 10-16 September 1990 (JW 37), which we believe was the last week of the spring run (Figure 3). We trapped 1,160 spring chinook at JCW during the 1990-91 season (Table 1).

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

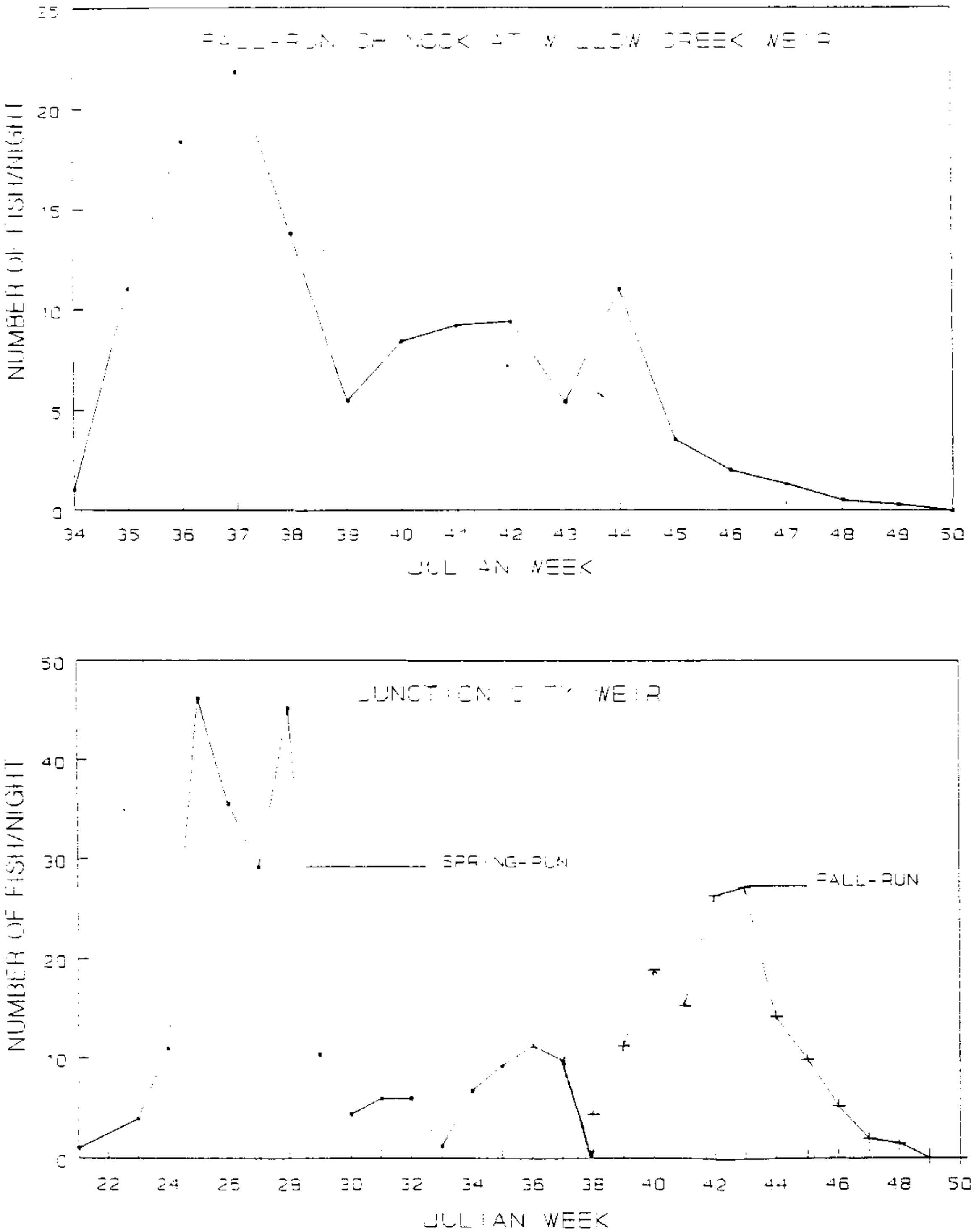

Figure 3. Average number of fall-run chinook salmon trapped per night each Julian week at Willow Creek Weir, and average number of spring- and fall-run chinook salmon trapped per night each Julian week at Junction City Weir in the Trinity River during the 1990-91 season.

Table 1. Weekly summary of spring-run and fall-run chinook salmon trapped in the Trinity River at Willow Creek and Juntion City weirs during the 1990-91 season.

	Willow Creek Weir a/					Junction City Weir b/				
		Number trapped					Number trapped			
Julian week	Nights trapped	Grilse	Adults	Total	Fish/ night	Nights trapped	Grilse	Adults	Totals	Fish/ night
					Spring-run chinook c/					
21 5/21-5/27						2	0	2	2	1.0
22 5/28-6/3 d/						0	-	-	-	-
23 6/4-6/10						2	0	8	8	4.0
24 6/11-6/17						5	1	54	55	11.0
25 6/18-6/24						5	2	229	231	46.2
26 6/25-7/1						5	1	177	178	35.6
27 7/2-7/8						5	5	141	146	29.2
28 7/9-7/15						5	9	217	226	45.2
29 7/16-7/22						5	1	51	52	10.4
30 7/23-7/29						5	1	21	22	4.4
31 7/30-8/5						5	2	28	30	6.0
32 8/6-8/12						5	6	24	30	6.0
33 8/13-8/19						5	1	5	6	1.2
34 8/20-8/26	-	-	-	-	-	5	1	33	34	6.8
35 8/27-9/2	-	-	-	-	-	6	7	49	56	9.3
36 9/3-9/9	-	-	-	-	-	4	6	39	45	11.3
37 9/10-9/16	-	-	-	-	-	4	5	34	39	9.8
Sub-total	-	-	-	-	-	73	48	1,112	1,160	
Sub-mean										15.9
					Fall-run chinook e/					
34 8/20-8/26	1	0	1	1	1.0	-	-	-	-	-
35 8/27-9/2	4	0	44	44	11.0	-	-	-	-	-
36 9/3-9/9	4	2	71	73	18.3	-	-	-	-	-
37 9/10-9/16	4	5	82	87	21.8	-	-	-	-	
38 9/17-9/23	4	1	54	55	13.8	4	1	17	18	4.5
39 9/24-9/30	4	2	20	22	5.5	3	0	34	34	11.3
40 10/1-10/7	5	2	40	42	8.4	5	6	89	95	19.0
41 10/8-10/14	6	5	50	55	9.2	5	5	72	77	15.4
42 10/15-10/21	5	7	40	47	9.4	5	9	123	132	26.4
43 10/22-10/28	5	1	25	26	5.2	5	24	112	136	27.2
44 10/29-11/4	5	4	51	55	11.0	3	5	38	43	14.3
45 11/5-11/11	4	2	12	14	3.5	4	3	37	40	10.0
46 11/12-11/18	4	0	8	8	2.0	4	4	17	21	5.3
47 11/19-11/25	3	2	2	4	1.3	3	0	6	6	2.0
48 11/26-12/2	4	1	1	2	0.5	4	1	5	6	1.5
49 12/3-12/9	4	0	1	1	0.3	4	0	0	0	0.0
50 12/10-12/16	3	0	0	0	0.0	3	0	0	0	0.0
Sub-total f/	69	34	502	536		52	58	550	608	
Sub-mean f/					7.8					11.7
GRAND TOTALS	69	34	502	536		125	106	1,662	1,768	
COMBINED MEAN					7.8					14.1

a/ Trapping at Willow Creek Weir took place from Julian week 34 (24 August) through Julian week 50 (13 December) of 1990.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1990.
c/ Spring-run chinook salmon grilse are ≤54 cm FL; adults are >54 cm FL.
d/ There was no trapping because of high water caused by storms.
e/ Fall-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.
f/ Based on computations beginning the first Julian week that fall-run chinook salmon were trapped and continuing through the end of the sampling period.

<u>Size of Trapped Fish</u>. Spring chinook trapped at JCW averaged 68.7 cm FL, similar to that in 1989 (Heubach et al. 1992) (Table 2). The nadir in the fork lengths separating grilse and adult spring chinook at JCW was 54 cm, the same as for spring chinook that entered TRH (Figure 4). Therefore, during the 1990-91 season we considered spring chinook in the Trinity River basin ≤54 cm FL to be grilse, while adults were >54 cm FL. During the 1990-91 season, only 48 (4.1%) of the spring chinook trapped at JCW were grilse (Table 2), which was similar to the proportion of spring chinook grilse (4.1%, 66/1,606) in the TRH sample. The low proportion of grilse is typical of the upper Trinity River basin spring run (Heubach 1984a, 1984b; Heubach et al. 1992).

<u>Incidence of Tags and Hatchery Marks</u>. None of the fish tagged in the lower Klamath River were recaptured at the JCW during the spring run. However, two chinook tagged at WCW were recaptured during the spring run. For this report, we allocate these fish to totals for fall-run chinook at WCW but consider them spring-run chinook at JCW. The reason for classifying these fish differently at the two weirs is simply to maintain a date separating spring and fall chinook runs at the weirs. Except for hatchery-marked (Ad+CWT) fish that are tagged at a weir and subsequently recaptured so the tag can be recovered and decoded, as occurred with these two fish, it is impractical, if not impossible to distinguish every chinook as either a spring-run or fall-run chinook.

We trapped 146 hatchery-marked (Ad+CWT) spring chinook (12.6% of those trapped) at JCW (Table 2). The mean FL of the hatchery-marked spring chinook was not significantly different than that of the unmarked spring chinook (Table 3).

Forty-nine of the 146 hatchery-marked (Ad+CWT) spring chinook which were spaghetti tagged at JCW were subsequently recovered either dead as tagging mortalities, in the spawner survey, or at TRH. Seventy-five percent of the double-marked fish (Hatchery- and Project-marked) we recovered were from the 1986 brood year (BY) and had been released at TRH as yearlings (Table 4).

<u>Incidence of Gill-net and Hook Scars</u>. We observed 156 (13.4%) of the spring chinook at JCW with gill-net scars. The FL of gill-net scarred spring chinook was not significantly different than the non-gill-net scarred fish (Table 3).

Five of 23 (21.7%) of the Project-tagged spring chinook recovered dead had gill-net scars compared to 151 of 1,132 (13.3%) fish that we originally tagged. Although the difference was not statistically significant ($X^2 = 0.92$, $p > 0.60$), it follows the observation in 1989 when the tagging mortality rate was higher for gill-net scarred than non-gill-net scarred spring chinook (Heubach et al. 1992). After correcting for tagging mortality,

Table 2. Fork lengths of spring-run chinook salmon trapped and tagged in the Trinity River at Junction City Weir and recovered at Trinity River Hatchery during the 1990-91 season. a/

Fork length (cm)	Total trapped	Ad+CWT c/	Effectively tagged d/	TRH b/ recovery
42	1	1	1	
43	1	0	1	1
44	0	0	0	0
45	3	1	3	0
46	3	1	3	2
47	4	0	4	0
48	4	0	3	0
49	5	0	5	2
50	5	0	5	2
51	6	1	6	0
52	7	1	7	4
53	6	2	5	2
54	3	0	3	1
55	4	1	4	2
56	6	0	6	1
57	9	0	9	3
58	14	0	13	4
59	29	2	29	10
60	35	4	34	7
61	40	3	35	9
62	44	2	44	17
63	43	4	42	9
64	53	4	48	23
65	60	5	58	23
66	62	5	58	27
67	63	9	62	30
68	62	6	61	32
69	60	13	54	25

Fork length (cm)	Total trapped	Ad+CWT c/	Effectively tagged d/	TRH b/ recovery
70	55	8	53	21
71	56	5	53	20
72	52	6	50	15
73	49	10	48	26
74	50	10	50	21
75	49	9	46	22
76	43	7	41	15
77	29	4	27	13
78	27	4	26	8
79	33	6	31	13
80	20	6	19	9
81	12	2	11	3
82	12	1	12	5
83	13	1	12	3
84	11	1	10	2
85	4	0	4	2
86	3	1	3	1
87	3		3	1
88	2		2	2
89	1		1	0
90	0		0	0
91	2		2	1
92	2		2	1
TOTALS	1,160	146	1,109	440
Mean FL	68.7	70.1	68.7	69.3
Grilse e/	48	7	46	14
Adults	1,112	139	1,063	426

a/ Trapping at Junction City Weir took place from Julian week 21 (21 May) 1990 through Julian week 50 (13 December) of 1990. Only chinook trapped through 15 September are considered spring-run chinook salmon. See Table 5 for fork length of chinook trapped after 15 September.

b/ TRH=Trinity River Hatchery.

c/ Adipose fin clipped and coded-wire tagged and released from Trinity River Hatchery during previous years.

d/ Corrected for fish not tagged and tagging mortalities.

e/ Spring-run chinook salmon grilse are ≤54 cm FL; adults are >54 cm FL.

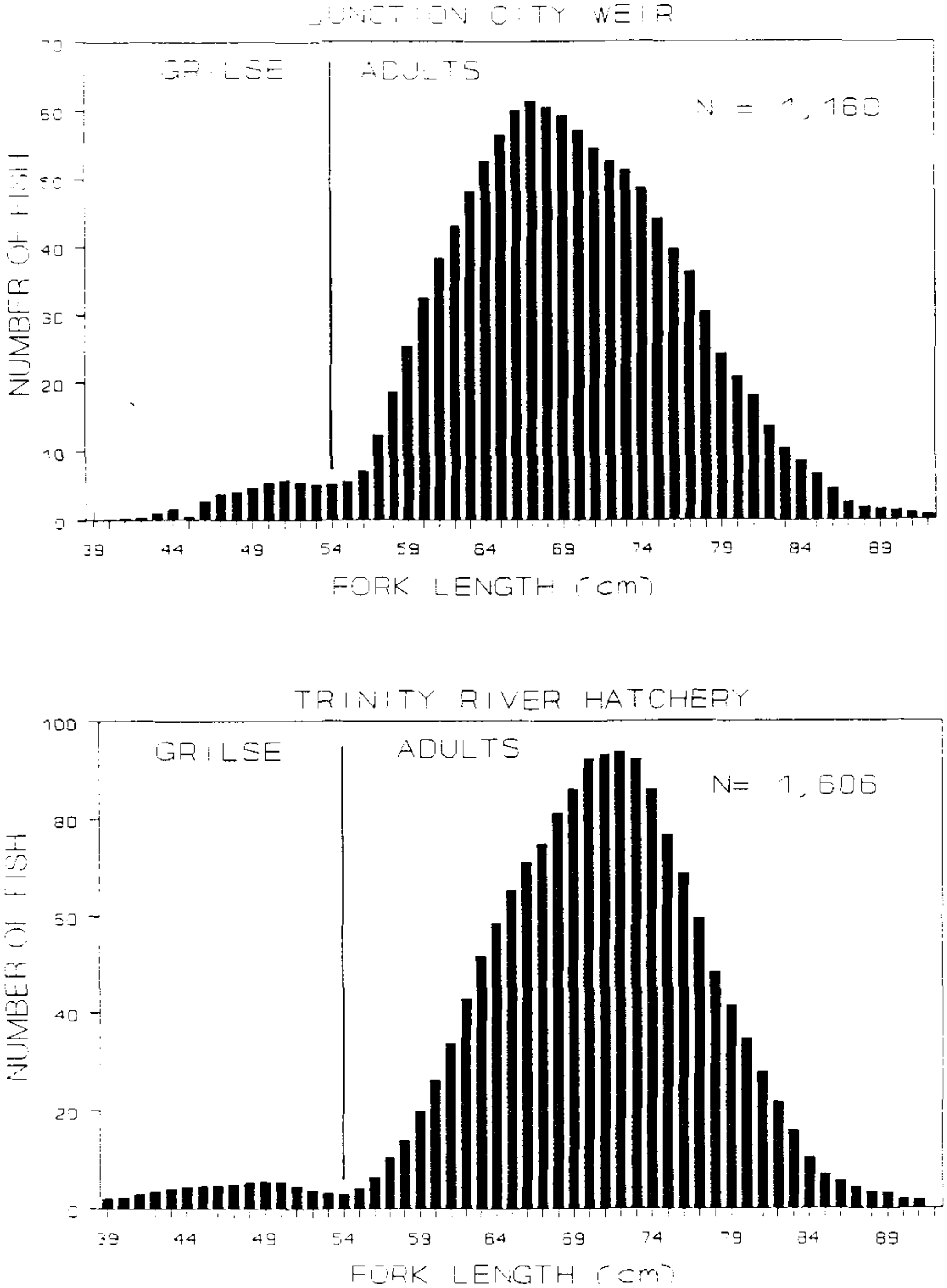

Figure 4. Fork lengths of spring-run chinook salmon trapped in the Trinity River at Junction City Weir, and that entered Trinity River Hatchery during the 1990-91 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line points to the nadir at 54 cm FL separating grilse and adult spring-run chinook salmon.

Table 3. Size difference between marked or scarred vs. unmarked or unscarred groups of spring- and fall-run chinook and coho salmon, and fall-run steelhead trapped in the Trinity River at Willow Creek and Junction City weirs during the 1990-91 season.

	Willow Creek Weir					Junction City Weir				
		Fork length (cm)					Fork length (cm)			
Species/ race	Comments	Range	Mean	Sample size	t-value a/	Comments	Range	Mean	Sample size	t-value a/
Spring-run chinook	With Ad b/	-	-	-		With Ad	42-86	70.1	146	
	Without Ad	-	-	-	-	Without Ad	42-92	68.5	1,014	0.24
	With gill-net scars	-	-	-		With gill-net scars	59-85	70.1	156	
	Without gill-net scars	-	-	-	-	Without gill-net scars	42-92	68.5	1,004	1.08
	With hook scars	-	-	-		With hook scars	46-84	69.0	81	
	Without hook scars	-	-	-	-	Without hook scars	42-92	68.7	1,079	1.10
Fall-run chinook	With Ad	48-7	64.9	32		With Ad	45-79	63.4	40	
	Without Ad	35-9	67.7	504	0.24	Without Ad	39-86	65.7	568	0.21
	With gill-net scars	57-8	71.6	105		With gill-net scars	59-83	71.4	46	
	Without gill-net scars	35-9	66.5	431	1.18	Without gill-net scars	39-86	65.1	562	0.31
	With hook scars	48-8	66.9	73		With hook scars	48-84	65.9	58	
	Without hook scars	35-9	67.2	443	0.08	Without hook scars	39-86	65.5	550	0.37
Coho c/	With gill-net scars	60-7	66.4	18		With gill-net scars	60-73	64.7	3	
	Without gill-net scars	36-7	64.4	253	0.13	Without gill-net scars	48-72	62.1	157	- d/
	With hook scars	55-6	63.6	10		With hook scars	59-69	64.3	4	
	Without hook scars	36-7	64.6	261	0.05	Without hook scars	48-73	62.1	156	-
Fall-run Steelhead	With gill-net scars	59-8	66.9	24		With gill-net scars e/		-	-	
	Without gill-net scars	47-8	63.6	301	0.24	Without gill-net scars	50-76	59.4	138	-
	With hook scars	59-7	66.5	6		With hook scars	55-60	57.7	3	
	Without hook scars	47-8	63.7	319	_	Without hook scars	50-76	59.4	135	-

a/ None of the t values were statistically significant, ($p < 0.05$).
b/ Ad=adipose fin clip.
c/ None of the coho salmon had adipose fin clips and coded-wire tags.
d/ A t-test was not conducted with sample sizes less than 10.
e/ None of the fall-run steelhead trapped at Junction City Weir had gill-net scars.

TABLE 4. Release and recovery data for Trinity River Hatchery-produced, coded-wire-tagged chinook salmon that were trapped in the Trinity River at Willow Creek and Junction City weirs, and recovered on spawning surveys or at Trinity River Hatchery during the 1990-91 season.

Release data						Tagging site	
CWT a/ code	Brood year	Race	Date	Age b/	Number	Willow Creek Weir	Junction City Weir
6-61-44	1985	Spring-run chinook	10/03/86	Y	101,090	-	2
6-61-48	1986	Spring-run chinook	05/28/87	F	197,113	-	4
6-61-46	1986	Spring-run chinook	9/24/87	Y	101,030	-	34
6-61-47	1987	Spring-run chinook	5/23/88	F	185,718	-	5
Shed tag c/						0	4
6-56-26	1986	Fall-run chinook	6/11/87	F	202,486	0	1
6-56-27	1986	Fall-run chinook	9/21/87	Y	100,320	1	7
6-56-28	1986	Fall-run chinook	9/24/87	Y	26,730	1	1
6-56-31	1987	Fall-run chinook	10/28/88	Y	92,300	3	1
6-56-33	1987	Fall-run chinook	6/02/88	F	172,980	0	2
Shed tag c/						0	2
TOTALS						5	63

a/ CWT=coded-wire tag.
b/ Y=yearling, S=smolt
c/ No coded-wire tag was recovered from the fish.

49 of 146 (33.5%) of the gill-net scarred spring chinook were recovered at TRH while, 391 of 963 (40.6%) of the non-gill-net scarred chinook were recovered at TRH. Again, while not statistically significant (X^2 =2.3, p=0.12), it suggests that a slightly greater mortality of gill-net scarred spring chinook than the non-gill-net scarred fish, among those fish that were Project-tagged at the weirs and recovered at TRH.

Eighty-one (7.0%) of the spring chinook trapped at JCW were hook scarred, 39 were healed scars indicating they were from the ocean fishery, and 42 were fresh scars probably acquired in the freshwater fishery. The mean FL of the combined ocean and freshwater hook-scarred chinook was essentially the same as the non-hook-scarred fish (Table 3).

Fall-run Chinook Salmon

Run Timing. All chinook salmon trapped at WCW during the 1990-91 season were considered fall chinook, although there were a few dark-colored fish caught during the first full week of trapping that were probably spring-run fish. From the first full week of trapping, 27 August - 2 September 1990 (JW 35), fall chinook salmon catches increased and peaked 10-16 September (JW 37) (Figure 3). The run then decreased and fluctuated sporadically to a second, smaller peak 29 October - 4 November (JW 44). Thereafter the run decreased each week and the last fall chinook was trapped 4 December (JW 49), suggesting the fall run was over in the lower Trinity River when we removed the weir. We trapped 536 fall chinook at WCW during the 1990-91 season (Table 1).

The fall run began at JCW 17-23 September 1990 (JW 38), three weeks after it began at WCW. The numbers of fall chinook trapped at JCW increased each week through 1-7 October (JW 40), decreased slightly the next week, and peaked 22-28 October (JW 43), six weeks after the peak at WCW (Figure 3). The numbers trapped each week decreased substantially thereafter and we trapped the last fall chinook 30 November (JW 48), two weeks before the weir was removed for the season. We trapped 608 fall chinook at JCW in 1990 (Table 1).

Size of Fish Trapped. The ranges and mean FL of fall chinook trapped at WCW and JCW were essentially the same (t=0.47, p>0.5) (Table 5).

The size separating grilse and adult fall chinook was 53 cm FL at both weirs and TRH (Figure 5). Therefore, this season, we consider all fall chinook ≤53 cm FL to be grilse and those >53 cm FL are considered adults. Grilse composed 6.3% (34/536) and 9.5% (58/608) of the fall chinook trapped at WCW and JCW, respectively, while they were 21.6% (250/1,158) of the sample at TRH (Figure 5). The difference in the proportions of grilse and

Table 5. Fork lengths of fall-run chinook salmon trapped and tagged in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1990-91 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad+CWT d/	Effectively tagged e/	TRH c/ recovery	Total trapped	Ad+CWT d/	Effectively tagged e/	TRH c/ recovery
35	1		1					
36	0		0					
37	0		0					
38	0		0					
39	0		0		1		1	1
40	0		0		0		0	0
41	0		0		0		0	0
42	0		0		0		0	0
43	0		0		0		0	0
44	0		0		1		1	1
45	2		2		2	1	2	1
46	2		2		4	0	4	3
47	0		0		6	0	4	0
48	4	1	1		9	0	7	3
49	6	0	6		8	0	7	2
50	6	0	3		8	0	7	2
51	5	1	5		6	0	4	2
52	5	2	4	2	6	0	6	4
53	3	1	3	1	7	1	7	3
54	5	1	5	1	7	1	7	3
55	5	0	5	1	7	1	6	1
56	7	0	7	0	12	2	10	3
57	7	1	6	1	19	7	19	3
58	10	1	9	0	20	0	16	4
59	12	0	10	1	22	0	10	1
60	10	2	10	3	22	4	20	2
61	15	1	15	3	24	0	18	5
62	33	1	31	3	25	2	22	10
63	27	1	27	4	25	4	20	6
64	16	0	15	0	25	0	23	6
65	23	1	22	5	25	3	13	4
66	28	3	25	2	25	0	12	1
67	17	0	17	1	25	1	19	7
68	27	1	27	6	25	3	20	9
69	31	4	28	5	26	1	22	13
70	18	1	15	2	27	1	21	10
71	34	1	34	6	31	2	27	12
72	23	0	19	3	27	0	20	7
73	26	1	23	4	22	1	17	8
74	33	3	27	6	20	1	20	12
75	23	2	21	2	17	1	16	5
76	17	1	14	5	13	0	11	4
77	8	1	7	3	9	1	7	1
78	12		10	4	16	1	14	7
79	9		8	3	10	1	7	2
80	3		3	1	4		4	0
81	8		7	2	7		3	0
82	3		3	0	6		6	3
83	1		1	1	3		3	1
84	2		2	0	1		1	1
85	1		1	0	0		0	0
86	2		2	1	3		2	1
87	2		1	0				
88	0		0	0				
89	1		0	0				
90	1		1	0				
91	0		0	0				
92	0		0	0				
93	0		0	0				
94	0		0	0				
95	1		1	1				
96	0		0					
97	0		0					
98	1		1					

(continued on next page)

Table 5. Fork lengths of fall-run chinook salmon trapped and tagged in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1990-91 season (continued).

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad-CWT d/	Effectively tagged e/	TRH c/ recovery	Total trapped	Ad-CWT d/	Effectively tagged e/	TRH c/ recovery
TOTALS	536	32	487	83	608	40	486	174
Mean FL	67.5	64.9	66.4	69.8	65.6	63.4	65.5	66.2
Grilse f/	34	5	27	3	58	2	50	22
Adults	502	27	460	80	550	38	436	152

a/ Trapping at Willow Creek Weir took place from Julian week 34 (24 August) through Julian week 50 (13 December) of 1990. All chinook salmon trapped were considered fall-run chinook.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1990. Only chinook salmon trapped after 15 September are considered fall-run chinook. See Table 2 for fork lengths of chinook trapped through 15 September.
c/ TRH=Trinity River Hatchery.
d/ Adipose fin clipped and coded-wire tagged and released from Trinity River Hatchery during previous years.
e/ Corrected for fish not tagged and tagging mortalities.
f/ Fall-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.

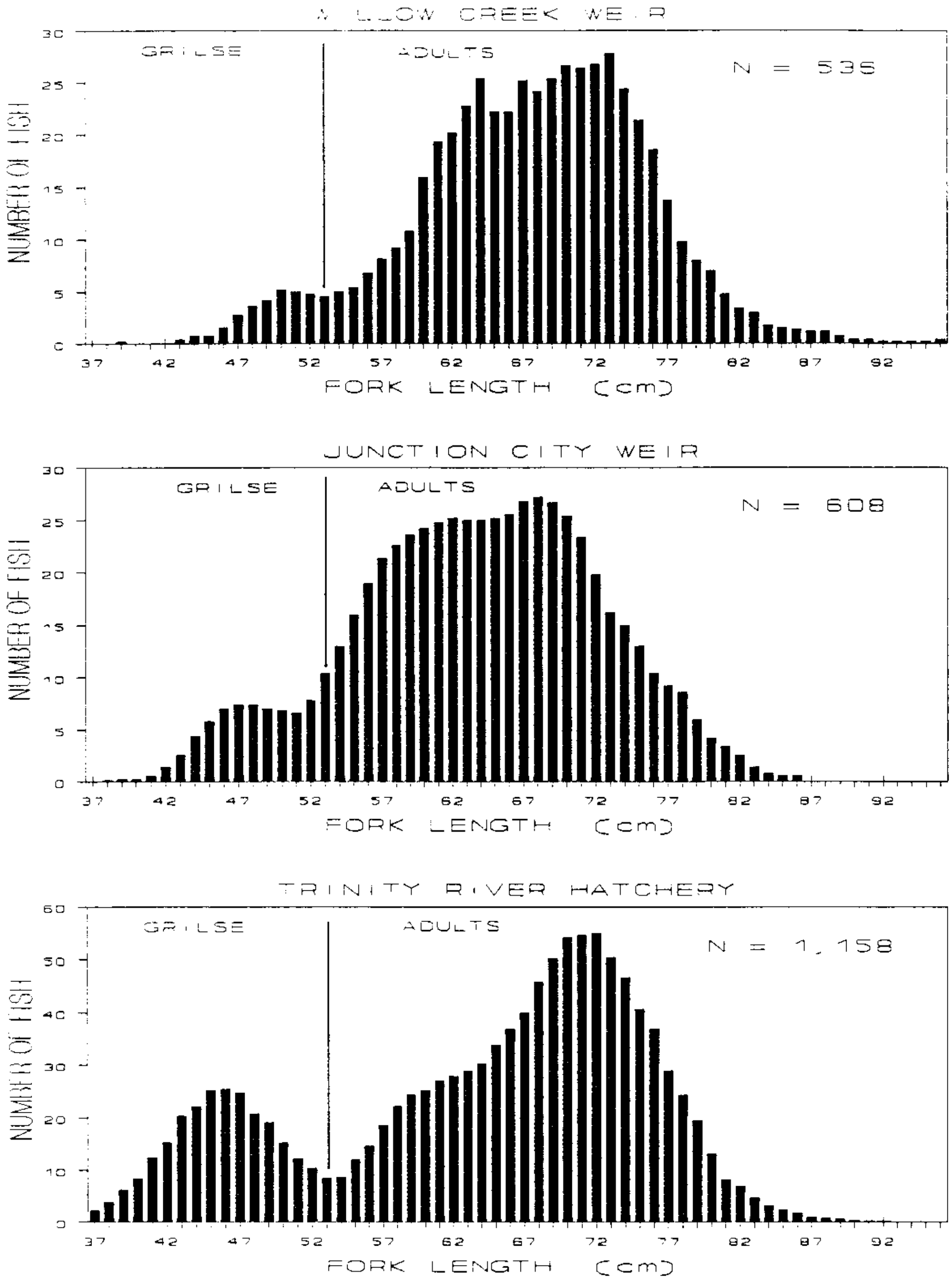

Figure 5. Fork lengths of fall-run chinook salmon trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1990-91 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line points to the nadir at 53 cm FL separating grilse and adult fall-run chinook salmon.

adult fall chinook trapped at the two weirs was not statistically significant ($X^2 = 3.5$, $p>0.05$). However, the proportions of grilse and adult fall chinook in both the WCW and JCW samples were significantly different than in the TRH sample ($p<0.01$).

Incidence of Tags and Hatchery Marks. We recaptured two fall chinook salmon tagged in the lower Klamath River at WCW. However, only one tag number was legible. The one identifiable fall chinook was recaptured at WCW 58 d after it was tagged in the lower Klamath River, for a mean migration rate of 2.0 km/d. No Klamath River-tagged fish were recaptured at JCW.

Thirty-nine fall chinook tagged at WCW were recaptured at JCW during the fall run (after 15 September 1990). These fish took from 15 to 48 d to migrate to JCW, with a mean of 29 d, for a mean migration rate of 3.0 km/d. The mean number of days it took for fall chinook tagged at WCW to migrate to JCW suggests the fall run began at JCW four weeks after it began at WCW. However data on average catch/night/wk suggests the peak of the fall run at JCW (JW 43) was six weeks after the peak at Willow Creek (JW 37). In 1989 the mean migration rate of fall chinook tagged at WCW and recaptured at JCW was three weeks (Heubach et al. 1992). The reason for the apparent difference in the migration rate in the two years is not known, although in 1990 there were no storm events, as there were in 1989.

Thirty-two (6.0%) and 40 (6.6%) of the fall chinook trapped at WCW and JCW, respectively, were hatchery-marked (Ad+CWT) fish (Table 5). At both weirs the mean FL of the hatchery-marked fall chinook were slightly smaller than the unmarked chinook although the differences were not statistically significant ($p>0.30$) (Table 3).

Five of the 32 hatchery-marked (Ad+CWT) fall chinook which were spaghetti-tagged at WCW were subsequently recovered either dead as tagging mortalities, in the spawner survey, or at TRH. These fish were from the 1986 and 1987 BY's and had been released at TRH as yearlings (Table 4).

Fourteen of the 40 hatchery-marked (Ad+CWT) fall chinook which were spaghetti-tagged at JCW were similarly recovered. All of them were from the 1986 and 1987 BY's, nine had been released as yearlings and three as smolts, all at TRH (Table 4).

Incidence of Gill-net and Hook Scars. Gill-net scars were observed on 19.6% and 7.5% of the fall chinook trapped at WCW and JCW, respectively. At both weirs, the mean FL of the gill-net scarred fall chinook was larger than the non-gill-net scarred fish, although the differences were not statistically significant (Table 3).

Seventy-three (13.6%) of the fall chinook trapped at WCW had hook scars. Fifty-five were fish that were hook scarred in the freshwater fishery, while the remainder were of ocean origin. Hook scars were observed on 58 (9.5%) of the fall chinook trapped at WCW. Twenty-four were of freshwater origin, and 34 of ocean origin. At both weirs, the mean FLs of all hook scarred and non-hook scarred fish were statistically similar (Table 3).

Coho Salmon

Run Timing. The first two coho were trapped at WCW 18 September 1990 (JW 38). The catches increased sporadically through 15-21 October (JW 42), decreased the next week and then peaked 29 October-4 November (JW 44) (Figure 6). The numbers of coho trapped decreased dramatically 5-11 November (JW 45), and more slowly thereafter. We trapped the last coho at WCW 7 December 1990 (JW 49). We trapped 271 coho at WCW during the 1990-91 season (Table 6).

The first coho was trapped at JCW 4 October 1990 (JW 40), approximately two weeks after coho initially appeared at WCW. The number of coho trapped per week increased rapidly and peaked 5-11 November (JW 45), one week after the peak at WCW (Figure 6). We continued to trap coho through the last week of operations at JCW (13 December 1990), indicating the coho run had not ended there when we removed the weir. We trapped 160 coho at JCW during the 1990-91 season (Table 6).

Size of Fish Trapped. The mean FLs of coho trapped at the WCW and JCW were statistically similar ($t=0.37$, $p>0.50$) (Table 7). The size separating grilse and adult coho is based entirely on the coho that entered TRH this year, because only one coho grilse was trapped at the two weirs. The nadir separating grilse and adult coho that entered TRH was 45 cm FL (Figure 7). Therefore, in this report, all coho $\leq$45 cm FL are considered grilse, whereas larger coho are considered adults.

Only one coho grilse was trapped at the weirs this year, and last year, no grilse were trapped (Heubach et al. 1992). It appears the weir panel spacing (5.4 cm) is effective for salmon and steelhead $\geq$50 cm, but efficiency decreases rapidly for smaller fish. Apparently, salmon and steelhead <45.0 cm FL can pass through the weir.

Incidence of Tags and Hatchery Marks. None of the coho tagged in the lower Klamath River were recaptured at either weir. Twelve coho tagged at WCW were recaptured at JCW. Their mean migration time was 27 d, for a mean migration rate of 3.2 km/d, which appears to be slower than the pace observed in 1990 (Heubach et al. 1992).

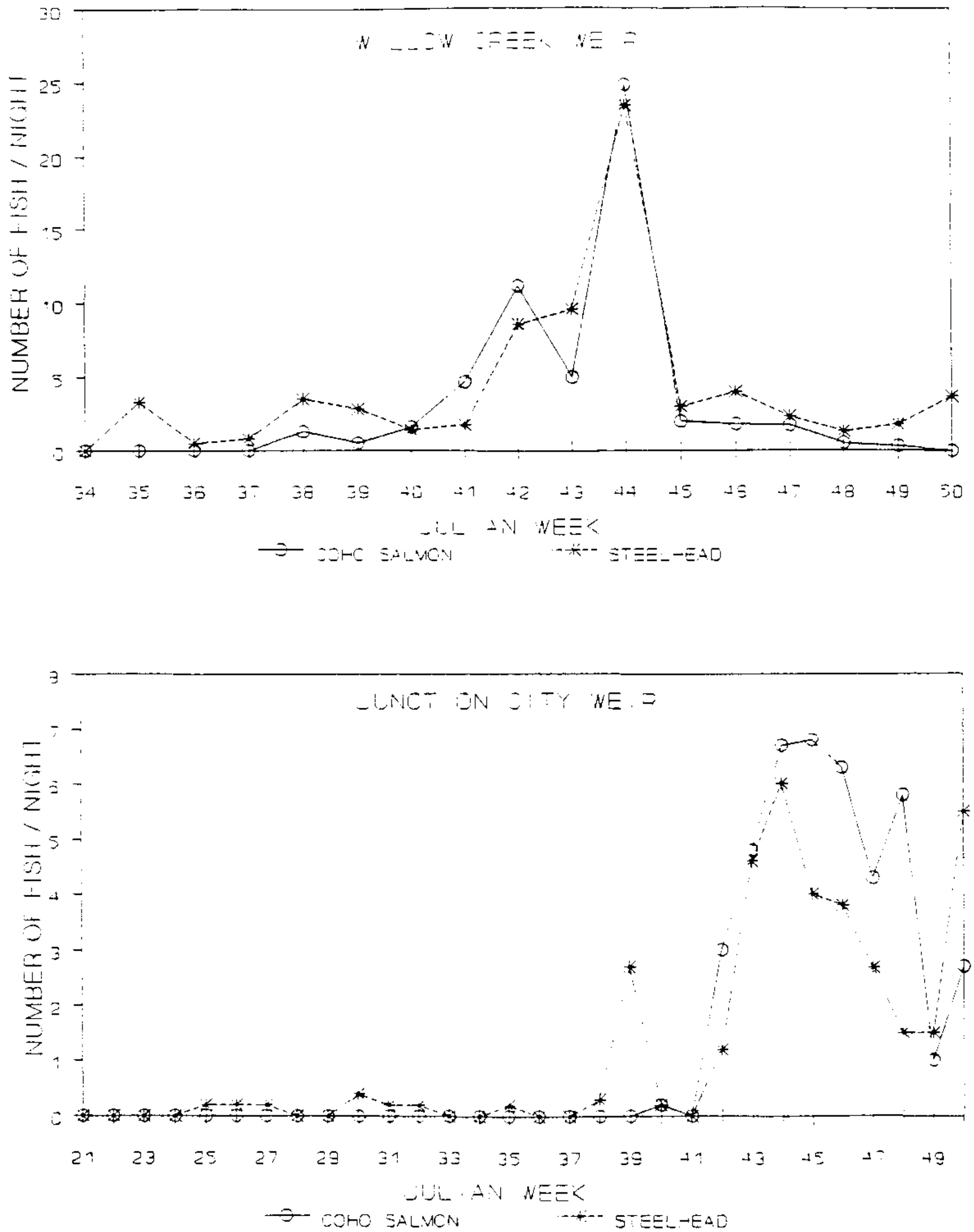

Figure 6. Average numbers of coho salmon and steelhead trapped per night each Julian week in the Trinity River at the Willow Creek and Junction City weirs during the 1990-91 season.

Table 6. Weekly summary of coho salmon trapped and tagged in the Trinity River at Willow Creek and Junction City weirs during the 1990-91 season.

	Willow Creek Weir a/					Junction City Weir b/				
		Number trapped					Number trapped			
Julian week	Nights trapped	Grilse c/	Adults	Totals	Fish/ night	Nights trapped	Grilse c/	Adults	Totals	Fish/ night
21-37 5/21-9/16	13	0	0	0	0.0	80	0	0	0	0.0
38 9/17-9/23	4	0	5	5	1.3	5	0	0	0	0.0
39 9/24-9/30	4	0	2	2	0.5	5	0	0	0	0.0
40 10/1-10/7	5	1	7	8	1.6	5	0	1	1	0.2
41 10/8-10/14	6	0	28	28	4.7	5	0	0	0	0.0
42 10/15-10/21	5	0	56	56	11.2	5	0	15	15	3.0
43 10/22-10/28	5	0	25	25	5.0	5	0	24	24	4.8
44 10/29-11/4	5	0	124	124	24.8	3	0	20	20	6.7
45 11/5-11/11	4	0	8	8	2.0	4	0	27	27	6.8
46 11/12-11/18	4	0	7	7	1.8	4	0	25	25	6.3
47 11/19-11/25	3	0	5	5	1.7	3	0	13	13	4.3
48 11/26-12/2	4	0	2	2	0.5	4	0	23	23	5.8
49 12/3-12/9	4	0	1	1	0.3	4	0	4	4	1.0
50 12/10-12/16	3	0	0	0	0.0	3	0	8	8	2.7
TOTALS d/	56	1	270	271		45	0	160	160	
MEAN d/					4.8					3.6

a/ Trapping at Willow Creek took place from Julian week 34 (24 August) through Julian week 50 (13 December) of 1990.
b/ Trapping at Junction City took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1990.
c/ Coho salmon grilse are ≤45 cm FL; adults are >45 cm FL.
d/ Based on computations beginning the first Julian week that coho salmon were trapped and continuing through the end of the sampling period.

Table 7. Fork lengths of coho salmon trapped in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1990-91 season.

	Willow Creek Weir a/				Junction City Weir b/			
Fork length (cm)	Total trapped	Ad d/	Effectively tagged e/	TRH c/ recovery	Total trapped	Ad d/	Effectively tagged e/	TRH c/ recovery
36	1		1	1				
37	0		0	0				
38	0		0	0				
39	0		0	0				
40	0		0	0				
41	0		0	0				
42	0		0	0				
43	0		0	0				
44	0		0	0				
45	0		0	0				
46	0		0	0				
47	0		0	0				
48	0		0	0	1		1	
49	0		0	0	0		0	
50	0		0	0	0		0	
51	0		0	0	2		2	2
52	1		1	1	3		3	1
53	1		1	0	0		0	0
54	0		0	0	4		3	2
55	1		1	0	5		5	4
56	1		0	0	4		4	2
57	5		5	3	6		6	6
58	5		5	3	7		6	4
59	8		8	2	9		9	6
60	15		15	2	14		14	12
61	20		19	8	14		14	12
62	18		17	4	14		13	9
63	22		22	10	12		12	10
64	28		27	11	11		11	6
65	22		21	7	12		12	8
66	35		32	16	12		12	11
67	24		23	13	10		9	7
68	31		31	14	9		9	6
69	12	1	11	5	5		5	4
70	13	0	13	4	3		3	3
71	4	0	4	4	1		1	0
72	0	0	0	0	1		1	1
73	0	0	0	0	1		1	1
74	1	0	1	0				
75	1	0	1	1				
76	1	0	1					
77	0	0	0					
78	1	1	1					
TOTALS	271	2	261	109	160	0	156	117
Mean FL	64.6	73.5	64.6	64.8	62.2	-	62.2	62.4
Grilse f/	1	0	1	1	0	0	0	0
Adults	270	2	260	108	160	0	156	117

a/ Trapping at Willow Creek Weir took place from Julian week 34 (24 August) through Julian week 50 (13 December) of 1990.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1990.
c/ TRH=Trinity River Hatchery.
d/ Assumed to be naturally absent adipose fin.
e/ Corrected for fish not tagged and tagging mortalities.
f/ Coho salmon grilse are ≤45 cm FL; adults are >45 cm FL.

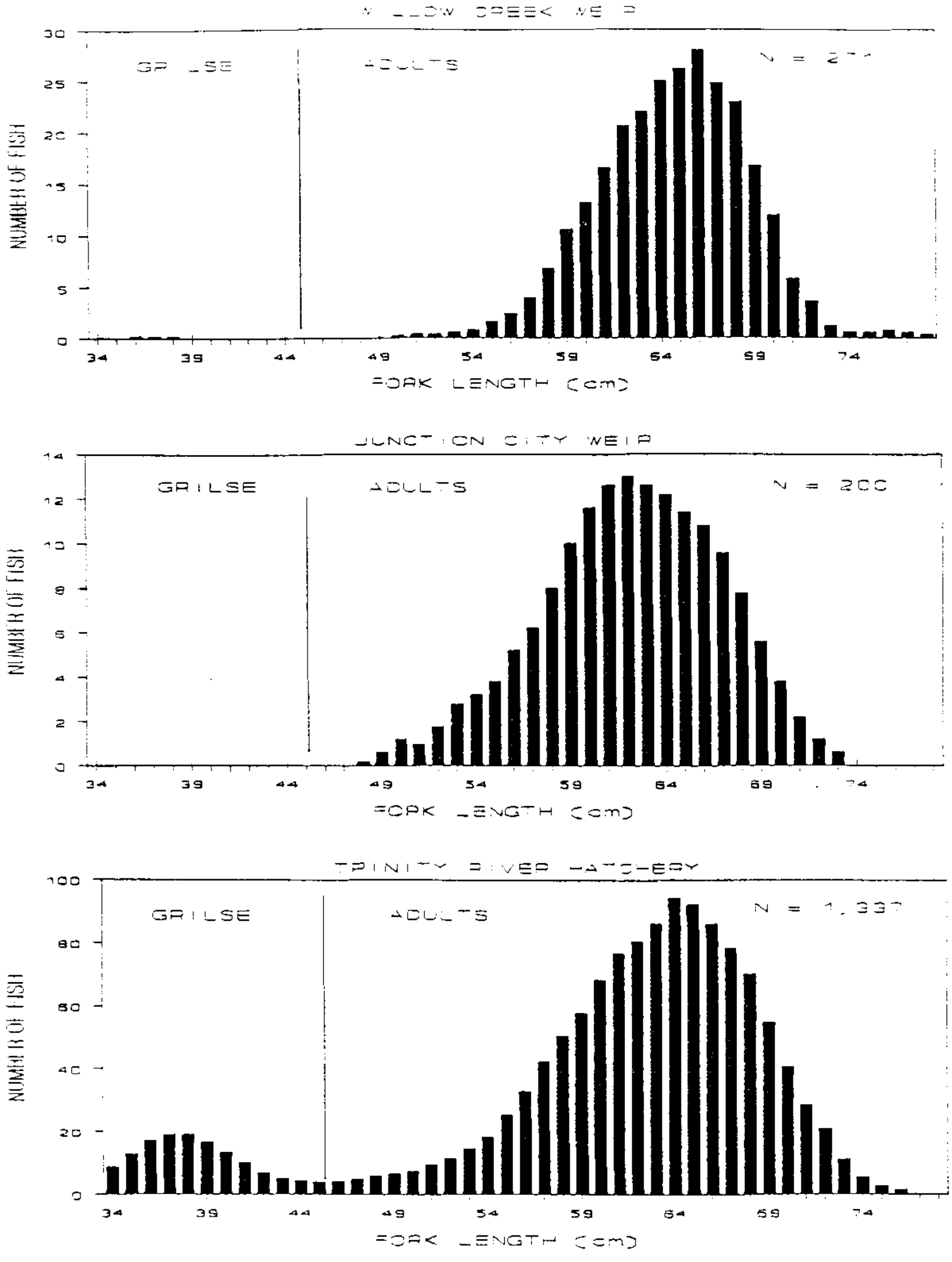

Figure 7. Fork lengths of coho salmon trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1990-91 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line points to the nadir at 45 cm FL separating grilse and adult coho salmon.

Only two coho that appeared to have adipose fin clips were trapped at WCW and none at JCW (Table 7). No coded-wire tags were found in these fish or in the three coho entering TRH that appeared to have adipose fin clips. Therefore, we conclude that no hatchery-marked coho (Ad+CWT) produced at TRH were returning this year. The fish that appeared to be marked (Ad) probably had a natural deformity, because no hatchery-marked coho were expected to return to TRH this year (no 1987 or 1988 BY coho were marked and released at TRH).

Incidence of Gill-net and Hook Scars. Gill-net scars were observed on 6.6% and 2% of the coho trapped at WCW and JCW, respectively. At both weirs, the gill-net scarred fish were slightly larger than the non-gill-net scarred coho, but the differences were not statistically significant (Table 3).

We observed hook scars on 3.7% and 2% of the coho trapped at WCW and JCW, respectively (Table 3). Collectively, ten of the hook scars appeared fresh. The mean FLs of the hook-scarred coho trapped at WCW and JCW were not statistically different from the non-hook-scarred coho observed at their respective weirs (Table 3).

Fall-run Steelhead

Run Timing. Steelhead were trapped the first full week of operations at WCW and every week thereafter. The largest steelhead catches occurred 15-21 October (JW 42) through 29 October - 4 November (JW 44) (Figure 6). The steelhead catch increased slightly during the last week of trapping at WCW, suggesting that the run was not over when we removed the weir. We trapped 325 steelhead at WCW during the 1990-91 season (Table 8).

We trapped the first steelhead at JCW 18 June 1990 (JW 23) and continued to trap an occasional steelhead throughout the summer and early fall (Figure 6). The largest steelhead catches occurred from 24-30 September (JW 39) through 19-25 November (JW 47). As at WCW, we also trapped a relatively large number of steelhead during the last week of operations, indicating the steelhead run was not over at JCW when the weir was removed. We trapped 138 steelhead at JCW during the 1990-91 season (Table 8).

With the exception of the nine steelhead trapped from 18 June through 20 September at Junction City, which we believe were spring-run steelhead, the seasonal catch patterns for fall-run steelhead and coho were strikingly similar at both weirs (Figure 5).

Size of Fish Trapped. The mean FL of steelhead trapped at WCW was slightly larger than that at JCW, but the difference was not statistically significant ($t=0.69$, $p=0.50$) (Table 9). The

Table 8. Weekly summary of fall-run steelhead trapped in the Trinity River at Willow Creek and Junction City weirs during the 1990-91 season.

	Willow Creek Weir a/					Junction City Weir b/				
		Number trapped					Number trapped			
Julian week	Nights trapped	Half-pounders c/	Adults	Totals	Fish/ night	Nights trapped	Half-pounders c/	Adults	Totals	Fish/ night
21-24 5/21-6/17	-	-	-	-	-	10	0	0	0	0.0
25 6/18-6/24	-	-	-	-	-	5	0	1	1	0.2
26 6/25-7/1	-	-	-	-	-	5	0	1	1	0.2
27 7/2-7/8	-	-	-	-	-	5	0	1	1	0.2
28 7/9-7/15	-	-	-	-	-	5	0	0	0	0.0
29 7/16-7/22	-	-	-	-	-	5	0	0	0	0.0
30 7/23-7/29	-	-	-	-	-	5	0	2	2	0.4
31 7/30-8/5	-	-	-	-	-	5	0	1	1	0.2
32 8/6-8/12	-	-	-	-	-	5	0	1	1	0.2
33 8/13-1/19	-	-	-	-	-	5	0	0	0	0.0
34 8/20-8/26	1	0	0	0	0.0	5	0	0	0	0.0
35 8/27-9/2	4	0	13	13	3.3	5	0	1	1	0.2
36 9/3-9/9	4	0	2	2	0.5	4	0	0	0	0.0
37 9/10-9/16	4	0	3	3	0.8	4	0	0	0	0.0
38 9/17-9/23	4	0	14	14	3.5	4	0	1	1	0.3
39 9/24-9/30	4	0	11	11	2.8	3	0	8	8	2.7
40 10/1-10/7	5	0	7	7	1.4	5	0	1	1	0.2
41 10/8-10/14	5	0	9	9	1.8	5	0	0	0	0.0
42 10/15-10/21	5	0	43	43	8.6	5	0	6	6	1.2
43 10/22-10/28	5	0	48	48	9.6	5	0	23	23	4.6
44 10/29-11/4	5	0	117	117	23.4	3	0	18	18	6.0
45 11/5-11/11	4	0	12	12	3.0	4	0	16	16	4.0
46 11/12-11/18	4	0	16	16	4.0	4	0	15	15	3.8
47 11/19-11/25	3	0	7	7	2.3	3	0	8	8	2.7
48 11/26-12/2	4	0	5	5	1.3	4	0	6	6	1.5
49 12/3-12/9	4	0	7	7	1.8	4	0	6	6	1.5
50 12/10-12/16	3	0	11	11	3.7	4	0	22	22	5.5
TOTALS d/	67	0	325	325		116	0	138	138	
MEAN d/					4.9					1.2

a/ Trapping at Willow Creek Weir took place from Julian week 34 (24 August) through Julian week 50 (13 December) of 1990.
b/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 50 (13 December) of 1990
c/ Half-pounder fall-run steelhead are ≤41 cm FL; adults are >41 cm FL.
d/ Based on computations beginning the first Julian week that steelhead were trapped and continuing through the end of the sampling period.

Table 9. Fork lengths of fall-run steelhead trapped and tagged in the Trinity River at Willow Creek and Junction City weirs, and recovered at Trinity River Hatchery during the 1990-91 season. a/

	Willow Creek Weir b/			Junction City Weir c/		
Fork length (cm)	Total trapped	Effectively tagged e/	TRH d/ recovery	Total trapped	Effectively tagged e/	TRH d/ recovery
47	1	1				
48	0	0				
49	0	0				
50	0	0		1	1	
51	0	0		1	1	
52	1	1		3	3	
53	2	2		3	3	
54	3	3	1	8	8	1
55	2	0	0	9	8	3
56	6	5	0	10	8	1
57	10	7	1	13	9	2
58	17	14	2	12	11	6
59	22	19	6	13	13	4
60	12	8	1	12	12	3
61	31	28	9	12	12	5
62	29	21	4	11	11	3
63	24	19	7	11	11	5
64	37	34	3	7	7	2
65	21	21	2	3	3	0
66	14	13	2	3	3	0
67	22	14	1	2	2	0
68	21	17	0	1	1	0
69	9	7	0	0	0	0
70	7	5	1	0	0	0
71	15	14	4	2	2	0
72	3	3	0	0	0	0
73	6	5	0	0	0	0
74	3	2	0	0	0	0
75	2	2	0	0	0	0
76	2	2	1	1	1	1
77	1	1	0			
78	1	1	1			
79	0					
80	0					
81	1					
TOTALS	325	269	46	138	130	36
Mean FL	63.8	63.8	63.2	59.4	59.6	60.1

a/ Only adult fall-run steelhead (>41 cm FL) were trapped.
b/ Trapping at Willow Creek Weir took place from Julian week 34 (24 August) through Julian week 51 (13 December) of 1990.
c/ Trapping at Junction City Weir took place from Julian week 21 (21 May) through Julian week 51 (13 December) of 1990.
d/ TRH=Trinity River Hatchery.
e/ Corrected for fish not tagged and tagging mortalities.

combined mean FL of all steelhead trapped was 62.4 cm. No half-pounder steelhead ($\leq$ 41 cm FL) were trapped at either weir during the 1990-91 season, and only three half-pounder steelhead were seen at TRH (Figure 8). Apparently, steelhead <50 cm FL, are passing through the weir, as is the case for salmon.

Incidence of Tags and Hatchery Marks. None of the steelhead trapped at either weir were fin-clipped. One steelhead tagged at the mouth of the Klamath River was recaptured at WCW. The fish had been at liberty for 34 d. We recaptured three steelhead at JCW that had been tagged at WCW. They had been at liberty for 12 to 42 d, for a mean of 28 d.

Incidence of Gill-net and Hook Scars. Twenty-four (7.4%) steelhead trapped at WCW had gill-net scars. We did not see any scars on steelhead trapped at JCW. The mean FL of the gill-net-scarred steelhead at WCW was moderately larger than the non-gill-net-scarred steelhead, but the difference was not statistically different (Table 3).

We observed hook scars on 2% of the steelhead trapped at WCW and JCW (Table 3).

Recovery of Tagged Fish

Tagging Mortalities

Spring-run Chinook Salmon. We trapped 1,160 spring chinook at JCW, 26 of which were released untagged. Two were found dead in the trap. Of the 1,132 fish tagged, 23 (2.0%) were recovered dead, and classified as tagging mortalities (See "Tagging Mortalities", page). Therefore, 1,109 spring chinook (46 grilse and 1063 adults) were effectively tagged at JCW during the 1990-91 season, including two recaptured fish from the WCW (Table 2). The mean FLs of those originally tagged (68.7 cm FL) and those recovered dead (68.9 cm FL), were essentially the same. Reward tags were placed on 606 (45 grilse and 561 adults) (54.6%) of the effectively-tagged spring chinook. After correcting for tag loss, 605 spring chinook were effectively reward-tagged.

Fall-run Chinook Salmon. We trapped 536 fall chinook at WCW, of which 494 were tagged. We recovered seven tagged fish dead at the weir. Therefore we effectively tagged 487 (27 grilse and 460 adult) fall chinook at WCW, including two fish that were tagged in the lower Klamath River and recaptured at WCW. The mean FL of the tagged fish recovered dead was 73.5 cm FL, considerably larger than that of those effectively tagged (66.4 cm FL), although there were too few dead fish to compare statistically. Reward tags were placed on 265 (20 grilse and 245 adults) (54.4%) of the effectively-tagged fall chinook. After correcting for tag loss, 259 fall chinook were effectively reward-tagged at WCW.

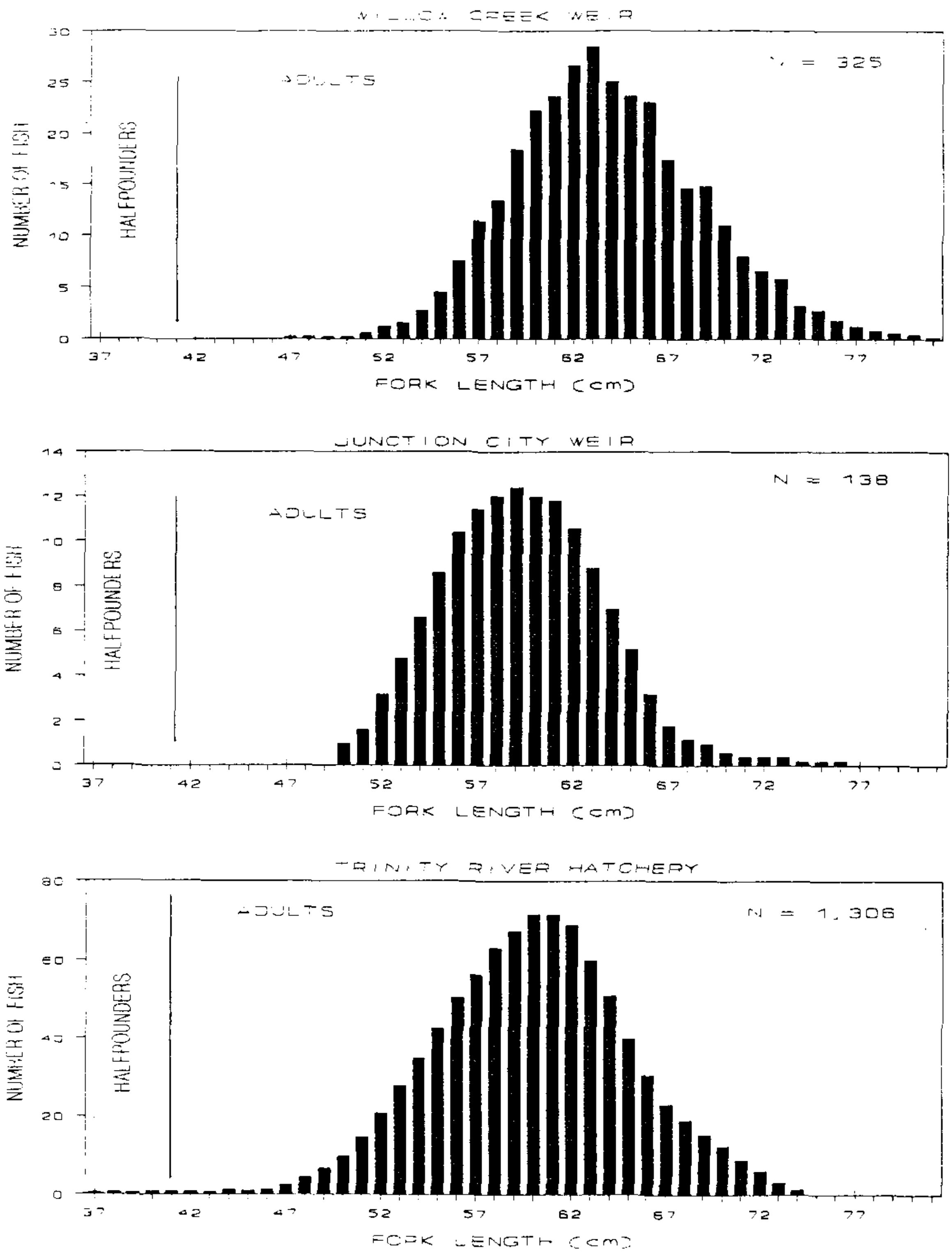

Figure 8. Fork lengths of steelhead trapped in the Trinity River at Willow Creek and Junction City weirs, and that entered Trinity River Hatchery during the 1990-91 season. Fork lengths are presented as a moving average of five, 1-cm size increments. The line points to the nadir at 41 cm FL separating halfpounder and adult steelhead.

We trapped 608 fall chinook at JCW, 122 of which were released untagged. None of the tagged fish were recovered dead. Therefore, 486 fall chinook (50 grilse and 436 adults) were effectively tagged at JCW, including the 39 recaptured chinook that were originally tagged at WCW.

Coho Salmon. We trapped 271 coho at WCW and released eight fish untagged. Two tagged coho (<1.0%) were recovered dead (tagging mortalities). One grilse and 260 adult coho were effectively tagged at WCW, including 169 with reward tags. After correcting for tag shedding, 167 coho, including one grilse, were effectively reward-tagged at WCW.

We trapped 160 adult coho at JCW, three of which were released untagged, and one tagged coho was recovered dead. Therefore, 156 adult coho were effectively tagged at JCW, including the eight coho originally tagged at WCW that were recaptured at JCW.

Steelhead. We trapped 325 adult steelhead at WCW, 269 of which were tagged, including 174 with a reward tag. There were no tagging mortalities or evidence of tag shedding, thus 269 steelhead were effectively tagged at WCW, 174 with reward-tags.

We trapped 138 adult steelhead at JCW, 130 of which received tags, including three steelhead originally tagged at WCW. There were no tagging mortalities, therefore 130 steelhead were effectively tagged at JCW.

Reward Tag Returns by Anglers

Spring-run Chinook Salmon. Anglers reported catching 80 (6 grilse and 74 adults) of the 605 (45 grilse and 560 adult) effectively reward-tagged spring chinook, for an overall harvest rate of 13.2%. In past years, the harvest rate of spring chinook in the Trinity River basin upstream of Junction City has typically ranged from 13 to 16%, but has been as high as 26% (Heubach 1984a, 1984b; Heubach and Hubbell 1980; Heubach et al. 1992; Zuspan et al. 1985). Grilse and adults were harvested in essentially equal proportions. The mean FL of spring chinook caught by anglers was 67.1 cm FL, essentially the same as that for those effectively reward-tagged ($t=0.11$, $p>0.50$). The number of days between tagging and reported capture by anglers ranged from 2 to 144 d, with a mean of 38 d.

Fall-run Chinook Salmon. Anglers reported catching nine (all adults) of the 259 effectively reward-tagged fall chinook from WCW, for a harvest rate of 3.5%. This is a very low harvest rate for Trinity River basin fall chinook upstream of WCW. In past years, harvest rates have typically been greater than 10% (Heubach 1984a, 1984b; Heubach and Hubbell 1980; Zuspan et al. 1985), with the exception of a low of 6.5% in 1989 (Heubach et al. 1992). The mean FL of the fall chinook harvested was 66.8 cm

FL, essentially the same as for all the effectively reward-tagged fall chinook (66.9 cm FL), which included grilse. However, the mean size of the harvested adults (66.9 cm FL) appeared slightly smaller then the reward-tagged adults (68.2 cm FL). The number of days between tagging and reported capture by anglers of all fall chinook (reward and non-reward tagged) ranged from 13 to 39 d, with a mean of 24 d.

Anglers reported the catch location for 13 reward and non-reward-tagged fish from WCW. Two (15%) reported they caught their fish upstream of JCW. Therefore, we conclude that 15% of the fall chinook harvested were caught upstream of JCW. The estimated harvest rate of fall chinook upstream of JCW is 1.1%.

Coho Salmon. Only two of the 167 effectively reward-tagged coho were reported caught by anglers, for a harvest rate of 1.2%. In past years, the coho harvest rate in the Trinity River has ranged from 0% to 9.0%, but generally has been less than 6.0% (Heubach 1984a, 1984b; Heubach and Hubbell 1980; Heubach et al. 1992; Zuspan et al. 1985).

All of the coho salmon were reported caught downstream of JCW, and none of the tags applied to coho at JCW were returned by anglers. Therefore, we conclude that there were no coho caught by anglers upstream of JCW.

Fall-run Steelhead. Anglers reported catching 40 of the 174 effectively reward-tagged adult steelhead from WCW, for a harvest rate of 23%. The mean FL of the harvested steelhead was 63.4 cm FL, similar to that for those effectively tagged (63.6 cm FL) (Table 9). The steelhead were reported to have been caught from 2 to 117 d after being tagged, with a mean of 42 d. Seventeen (33%) of the 51 steelhead reported caught by anglers, were caught upstream of JCW. Therefore, we conclude that 33% of the steelhead were caught upstream of JCW, for an estimated harvest rate above JCW of 12.4%.

Angler Returns of Reward vs. Non-reward Tags

There were insufficient fall chinook and coho non-reward, and $10 and $20 reward tags returned by anglers to compare return rates statistically. However, there were enough steelhead tags returned for analysis. Anglers returned 11.7% of the non-reward tags, 20.2% of the $10 reward tags, and 26.2% of the $20 reward tags with the variation in return rates being statistically significant ($p<0.05$) (Table 10). Specifically, the return rates of non-reward and $10 reward tags were not significantly different ($p=0.20$), nor were the return rates of the $10 and $20 reward tags ($p>0.50$). However, return rates of the non reward and $20 reward tags were significantly different ($p=0.02$).

Table 10. Angler-return rates of non-reward and reward tags applied to fall-run chinook and coho salmon, and fall-run steelhead in the Trinity River at Willow Creek Weir during the 1990-91 season.

Species	Effective number of tags applied and returned by anglers a/									Chi square value	p
	Non-reward tag			$ 10 Reward tag			$ 20 Reward tag				
	Applied	Returned	(%)	Applied	Returned	(%)	Applied	Returned	(%)		
Fall chinook	215	4	(1.9)	180	7	(3.9)	79	2	(2.5)	1.5	< .50
Coho	90	1	(1.1)	83	1	(1.2)	83	1	(1.2)	<0.1	< .99
Steelhead	94	11	(11.7)	94	19	(20.2)	80	21	(26.2)	6.1	< .05

a/ Corrected for tagging mortalities and tag shedding.

Salmon Spawner Survey

Spring-run Chinook Salmon. Personnel from the TFIP recovered 31 Project-tagged spring chinook in their spawner (carcass) survey. The fish ranged from 53 cm to 82 cm FL. They averaged 68.6 cm FL, which was essentially the same as the mean for all effectively tagged spring chinook from JCW (Table 2). The spring chinook were recovered on the survey from 20 to 127 d after tagging, with a mean of 90 d.

Fall-run Chinook Salmon. Personnel from the TFIP recovered 40 Project-tagged fall chinook in their spawner (carcass) survey, 10 from WCW and 30 from JCW.

Project-tagged fall chinook recovered from WCW averaged 68.0 cm FL, while those from JCW averaged 69.2 cm FL. Only two Project-tagged fall chinook grilse from JCW were recovered in the spawner survey. While the mean FL of the fall chinook recovered in the spawner survey from JCW was nearly 4 cm greater than that for all the effectively tagged fish (65.5 cm FL), the difference was not statistically significant ($t=0.29$, $p>0.50$).

Fall chinook tagged at WCW were recovered in the spawner survey from 34 to 68 d after tagging, with a mean of 50 d. Those from JCW were recovered 13 to 34 d after tagging, with a mean of 20 d.

Coho Salmon. Only one coho, tagged at JCW, was recovered in the spawner survey. It had been tagged 19 d before it was recovered.

Fall-run Steelhead. No steelhead were recovered in the spawner survey.

Trinity River Hatchery

Spring-run Chinook Salmon. All but 75 of the 1,469 chinook salmon entering TRH from 4 through 24 September 1990 were considered spring chinook. The entry of spring chinook into the hatchery peaked on 17 and 27 September, and decreased rapidly thereafter (Figure 9). The last spring chinook entered the hatchery 15 October 1990. The median entry date of spring chinook at TRH was 24 September (Table 11). An estimated 2,537 (104 grilse and 2,433 adults) spring chinook entered TRH during the 1990-91 season.

We recaptured 440 spring chinook (14 grilse and 426 adults) at TRH that had been tagged at JCW, including one fish that had shed its tag (Table 11). The median entry date of the Project-tagged spring chinook was also 24 September 1990. The mean FL of the Project-tagged spring chinook that entered TRH was essentially the same as that for those effectively tagged at JCW (Table 2). They had been at liberty from 10 to 115 d, with a mean of 77 d before entering TRH.

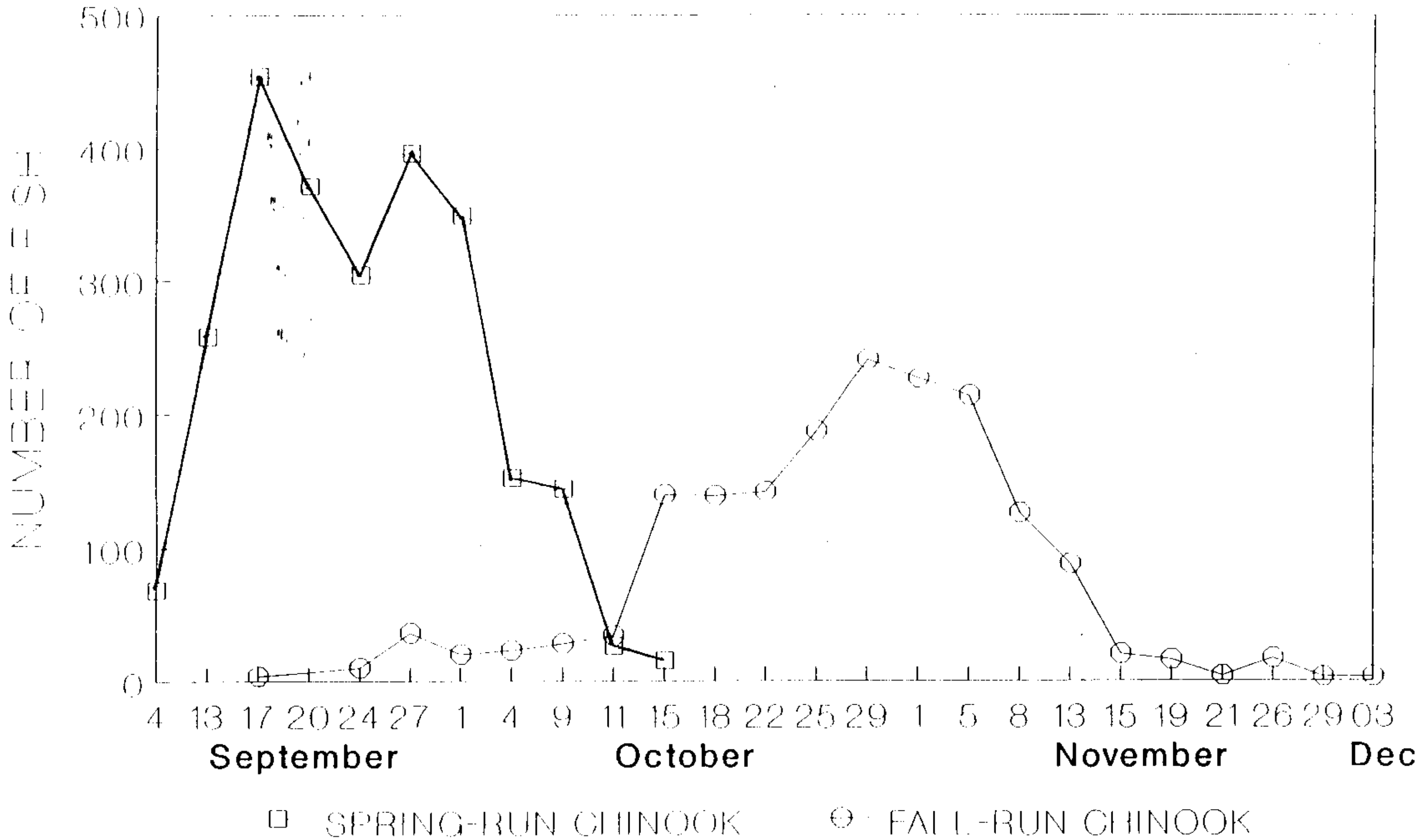

Figure 9. Estimated numbers per Julian week of spring- and fall-run chinook salmon that entered Trinity River Hatchery during the 1990-91 season. The dates shown are the first day of each Julian week. The fish ladder was open from 1 September 1990 through 27 March

Table 11. Total numbers and numbers of Project-tagged chinook and coho salmon that entered Trinity River Hatchery during the 1990-91 season. a/

	Chinook salmon					Coho salmon		
		Spring-run	Fall-run					
		Tagged at	Tagged at				Tagged at	
Entry date b/	Number entering TRH c/	Junction City Weir	Junction City Weir	Willow Creek Weir	Lower Klamath d/	Number entering TRH c/	Junction City Weir	Willow Creek Weir
09/04	68	9						
09/13	258	34						
09/17	458	71						
09/20	371	67						
09/24	314 *	58 *						
09/27	432	97						
10/01	368	48						
10/04	175	25						
10/09	172	17	2	2				
10/11	60	7	6 (1) e/	4				
10/15	155	3	17 (2)	7		2		
10/18	139	2	19 (2)	4		1		
10/22	142	1	17 (1)	11		10	1	
10/25	187	1	37 *(3)	18 *		36	5	1
10/29	241 *		29 (1)	6	1	34	4	0
11/01	226		25	8	0	180	15	6
11/05	213		9	5	1	181	11	3
11/08	126		3	8	0	152	6 (1) e/	11
11/13	88		6	3	0	253 *	10 *	17
11/15	20		0	2	1	99	8	6
11/19	16		2	0		125	12 (2)	13 *
11/21	4		0	0		104	5	13
11/26	17		2 (2)	4		137	12	16
11/29	3			1		123	3	13
12/03	3					45	13 (3)	4
12/06						31	2	2
12/10						30	5 (1)	2
12/13						17	3 (1)	1
12/17						10	1	0
12/20						31	1	1
12/24						25		
12/27						1		
12/31						0		
01/07						2		
01/11						2		
01/14						1		
01/16						1		
01/28						2		
TOTALS:	4,256	440	174 (12)	83	3	1,635	117 (8)	109

a/ The fish ladder was open 1 September 1990 through 27 March 1991.
b/ Entry date is considered the day the fish were initially sorted, although they may have entered the hatchery any time after the previous sorting period.
c/ Numbers shown include tagged fish that were recovered the same day.
d/ Tagged and released in the Klamath River near the Highway 101 bridge (river km 5.1).
e/ Figures in parentheses are fish tagged and released at Willow Creek Weir that were recaptured and rereleased at Junction City Weir, and that subsequently entered Trinity River Hatchery. They are included in totals shown.

* Median entry date. The first and second asterisks on the numbers shown for chinook salmon are the estimated median entry dates of spring- or fall-run chinook salmon into Trinity River Hatchery, respectively.

Three-hundred seventy-nine hatchery-marked (Ad+CWT) spring chinook entered TRH during the 1990-91 season, but only 345 coded-wire tags were recovered from them. The median entry date of the hatchery-marked spring chinook was 20 September 1990 (Table 12). Most (76.5%) of the CWT spring chinook we recaptured at TRH were from the 1986 BY and had been released at TRH as yearlings.

Fall-run Chinook Salmon. The first fall chinook entered TRH 17 September 1990, but appreciable numbers did not enter until 15 October (Figure 9). The numbers of fall chinook entering TRH increased through 29 October, then decreased rapidly through 15 November, and more gradually until the last entry date, 3 December 1990. The median entry date of all fall chinook occurred 29 October 1990 (Table 11). We estimate that 1,719 (371 grilse and 1,348 adults) fall chinook entered TRH during the 1990-91 season.

We recaptured 83 fall chinook (3 grilse and 80 adults) at TRH that had been tagged at WCW. Two of these fish had shed their spaghetti tag. The median entry date into TRH of the fall chinook tagged at WCW was 25 October 1990 (Table 11).

The mean FL of the Project-tagged fall chinook from WCW was over 2 cm larger than that for those effectively tagged at JCW, but the difference was not statistically significant ($t=0.29$, $p>0.5$) (Table 5). Project-tagged fall chinook from WCW were at liberty from 13 to 39 d before entering TRH, with a mean of 37 d. The mean migration rate of the fall chinook upstream of Willow Creek was 3.6 km/d, similar to the migration rate in 1989 (Heubach et al. 1992).

We recaptured 174 fall chinook (22 grilse and 152 adults) at TRH that had been tagged at JCW, including 12 fish that had originally been tagged at WCW. One fall chinook from JCW had lost its spaghetti tag (Table 11). The median entry date into TRH of fish tagged at JCW was 25 October 1990. Three fall chinook tagged in the lower Klamath River were also recovered at the hatchery. The mean FL of fall chinook tagged at JCW and recovered at TRH was comparable to that of the fish effectively tagged at JCW (Table 5). Fall chinook tagged at JCW were at liberty from 3 to 30 d, with a mean of 10 d, before they entered TRH. Their mean migration rate was 4.6 km/d, which appears to be somewhat faster than the migration rate of 3.2 km/d measured in 1989 (Heubach et al. 1992).

Two hundred twenty hatchery-marked (Ad+CWT) fall chinook entered TRH. Coded-wire tags were recovered from 211 of them (Table 13). Their median entry date into TRH was 25 October 1990. Yearling-release groups of the 1986 and 1987 BYs composed 75% of the CWT fall chinook recovered.

Table 12. Entry dates of coded-wire-tagged, Trinity River-strain, spring-run chinook salmon recovered at Trinity River Hatchery during the 1990-91 season. a/

	1985 BY b/		1986 BY b/		1987 BY b/	1988 BY b/		
	Tag code							
	06-61-42	06-61-44	06-61-45	06-61-46	06-61-47	06-61-49		
	Release date							
Entry date c/	06/02/85	10/03/86	05/28/87	09/24/87	05/23/88	05/26/89	Shed tag d/	Totals
09/04				23	1		4	28
09/13	1	3	4	37	3		5	53
09/17	0	3	1	60	8		7	79
09/20	1	2	1	49	10		4	67 *
09/24	0	0	2	26	7	1	6	42
09/27	0	1	1	33	8	0	2	45
10/01	0	0	0	24	11	0	4	39
10/04	0	1	1	6	4	0	1	13
10/09	1		1	3	2	0	1	8
10/11				1	1	1		3
10/15				2				2
TOTALS	3	10	11	264	55	2	34	379

a/ The fish ladder was open from 1 September 1990 through 27 March 1991.
b/ BY=brood year.
c/ Entry date is considered the date the fish were initially sorted, although they may have entered the hatchery any time after the previous sorting period.
d/ No tag was recovered from the marked fish. All chinook salmon with a shed tag recovered from 1 September through 9 October are considered spring-run chinook; chinook salmon with a shed tag recovered after 9 October are considered fall-run chinook.

* Median entry date into Trinity River Hatchery.

Table 13. Entry dates of coded-wire-tagged, Trinity River-strain, fall-run chinook salmon recovered at Trinity River Hatchery during the 1990-91 season. a/

	1985 BY b/	1986 BY b/						1987 BY b/		1988 BY b/			
	Tag code												
	06-56-25	06-56-26	06-56-29	06-56-30	06-56-27	06-56-28	06-63-10	06-56-33	06-56-31	06-56-35	06-56-32		
	Release date												
Entry date c/	10/24/86	06/11/87	06/11/87	06/27/87	09/21/87	09/24/87	02/29/88	06/02/88	10/28/88	06/12/89	10/01/89	Shed tag d/	Totals
09/17					1								1
09/20					0								0
09/24					1								1
09/27					3								3
10/01			1		0				1				2
10/04			0		0				0				0
10/09			0		2				1				3
10/11		1	0		6				2			1	10
10/15	1	0	0	1	3			1	3			0	9
10/18	1	0	0	1	7	1		1	8			2	21
10/22	0	1	1	0	8	0		3	1	1		0	15
10/25	0	1	0	0	19	1		2	5	1	2	1	32 *
10/29	0		2	1	10	1		2	15	2	0	1	34
11/01	0		1	0	10	0		2	11	2	2	1	29
11/05	0			1	6	0	2	1	8	1	1	1	21
11/08	1				9	0		4	9	1	1	2	27
11/13					2	0			2	1	1		6
11/15					0	0			0				0
11/19					1	0			2				3
11/21						0			0				0
11/26						1			2				3
TOTALS:	3	3	5	4	88	4	2	16	70	9	7	9	220

a/ The fish ladder was open from 1 September 1990 through 27 March 1991.

b/ BY = brood year.

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

d/ No tag was recovered from the marked fish. All chinook salmon with a shed tag recovered from 11 October through 26 November are considered fall-run chinook; chinook salmon with a shed tag recovered before 11 October are considered spring-run chinook.

* Median entry date into Trinity River Hatchery.

<u>Coho Salmon</u>. The first coho entered TRH on 15 October 1990, and the numbers entering the hatchery increased nearly every sorting day through the median-entry date of 13 November. Relatively large numbers of coho continued to enter the hatchery through 29 November, then decreased sharply, thereafter (Table 11). The last coho entered TRH 28 January 1991. We counted 1,635 coho (173 grilse and 1,462 adults) entering TRH during the 1990-91 season.

We recovered 109 coho (1 grilse and 108 adults) at TRH that had been tagged at WCW, including one coho that had shed its spaghetti tag. The median entry date into TRH of coho tagged at WCW was 13 November 1990 (Table 11). Their mean FL was 64.8 cm FL, essentially the same as that for fish effectively tagged at WCW (Table 7). Coho tagged at WCW had been at liberty from 13 to 53 d before entering TRH, with a mean of 28 d. The mean migration rate from the WCW to TRH was 4.7 km/d, which appears to be slightly faster than the 3.6 km/d seen in 1989 (Heubach et al. 1992).

We recovered 117 adult coho at TRH that had been tagged at JCW. One had shed its spaghetti tag. Included in the total were eight coho originally tagged at WCW. The median entry date of these 117 fish into TRH was 19 November 1990 (Table 11). Coho tagged at JCW and recovered at TRH averaged 62.4 cm FL, similar to those effectively tagged there (Table 7).

The tagged coho took from 2 to 32 d to travel from JCW to TRH, with a mean of 8 d. Their mean migration rate was 5.4 km/d, which appears to be moderately faster than the 3.5 km/d observed in 1989 (Heubach et al. 1992).

We recovered three coho at TRH without an adipose fin that did not have a coded-wire-tag. These fish were probably naturally marked fish, because no hatchery-marked coho were expected to return to TRH this year (no 1987 or 1988 BY coho were marked and released at TRH).

<u>Steelhead</u>. The first steelhead entered TRH 8 November 1990 (JW 45). Steelhead entered the hatchery sporadically through the first week of January 1991. The number entering TRH increased sharply from mid-January through February 1991 (JW 3-9) (Table 14). Thereafter, the number of steelhead entering the hatchery decreased gradually, and we caught only one steelhead on the last sorting day (27 March 1991, JW 13), suggesting the run was essentially over. The median entry week[6/] of steelhead into TRH was 5-11 February 1991 (JW 6). We counted 930 adult steelhead entering TRH during the 1990-91 season.

<u>6</u>/ The median entry week is used for steelhead instead of the median entry day, as for salmon, because steelhead have a protracted immigration period into TRH.

Table 14. Total number and number of Project-tagged fall-run steelhead recovered at Trinity River Hatchery during the 1990-91 season. a/

		Source of tag recoveries		
Julian week b/	Number entering TRH c/	Junction City Weir	Willow Creek Weir	Lower Klamath d/
45 11/5-11/11	3			
46 11/12-11/18	10			
47 11/19-11/25	10	1		
48 11/26-12/2	7	0		
49 12/3-12/9	6	0		
50 12/10-12/16	6	0		
51 12/17-12/23	12	1		
52 12/24-12/31	10	2	1	
01 1/1-1/7	1	0	0	
02 1/8-1/14	14	1	0	
03 1/15-1/21	84	6	3	
04 1/22-1/28	54	5	0	
05 1/29-2/4	44	2 *	3	
06 2/5-2/11	196 *	8	10	1
07 2/12-2/18	116	2 (1) e/	10 *	
08 2/19-2/25	192	5	11	
09 2/26-3/4	98	2	5	
10 3/5-3/11	44	1	1	
11 3/12-3/18	15		1	
12 3/19-3/25	7		1	
13 3/26-4/1	1			
TOTALS	930	36 (1) e/	46	1

a/ The fish ladder was open from 1 September 1990 through 27 March 1991.

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

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

d/ Tagged and released in the Klamath River near the Highway 101 bridge (river km 5.1).

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

* Median entry week into Trinity River Hatchery.

Forty-six Project-tagged steelhead from WCW were recovered at TRH. Their median entry week was 12-18 February 1991 (JW 7). The size of the recaptured steelhead from WCW was similar to those effectively tagged (Table 9). The steelhead had been tagged at WCW from 50 to 160 d before entering the hatchery, with a mean of 113 d. Their mean migration rate was 1.2 km/d.

Thirty-six Project-tagged steelhead from JCW were recaptured at TRH, including one fish that had been tagged at WCW. Their median entry week was 29 January - 4 February 1991 (JW 5). The mean FL of the recovered JCW-tagged steelhead was similar to that for those effectively tagged (Table 9). The steelhead tagged at JCW were at liberty from 12 to 140 d before entering TRH, with a mean of 75 d, and migrated only 0.6 km/d.

None of the nine steelhead tagged and released at JCW before 23 September 1990 were recovered at TRH. This observation supports our assumption that steelhead trapped at JCW during June through mid-September are probably spring-run steelhead.

Run-size, Angler Harvest, and Spawner Escapement Estimates

Run-size estimates of fall chinook and coho upstream of WCW and JCW were not stratified by grilse and adults this year, because too few tagged grilse were recaptured at TRH to provide grilse estimates with 95% confidence limits within $\pm$10% of the grilse run-size estimate. The spring chinook run-size estimate was not stratified by grilse and adults because the proportions of grilse and adults in the effectively tagged sample, the recaptured tagged sample at TRH, and the untagged sample at TRH was not statistically different (x^2 =0.90, p=0.45).

Therefore, for the spring chinook run-size estimate upstream of JCW and fall chinook run-size estimates upstream of WCW and JCW, we used the proportions of grilse and adults trapped at the respective weirs. Since only one grilse coho was trapped at the two weirs, we assumed the proportions of grilse and adult coho at the weirs were similar to that of the coho that entered TRH.

Spring-run Chinook Salmon

We estimate 6,388 spring chinook (265 grilse and 6,123 adults), including those eventually harvested, migrated into the Trinity River basin upstream of JCW during the 1990-91 season (Table 15). We also estimate 845 (13.2%) of them were caught by anglers (35 grilse and 810 adults). Thus, the spawner escapement above JCW was 5,543 fish (230 grilse and 5,313 adults), including the 2,537 spring chinook that entered TRH (Table 16).

Table 15. Data used to generate Trinity River basin chinook and coho salmon, and fall-run steelhead run-size estimates, 1990-91 season.

Species/ race	Area of estimate	Size class	Number effectively tagged a/	Number examined for tags	Number of tags in sample	Run-size estimate	Confidence limits 1-P = 0.95
Spring-run chinook	Trinity River basin above Junction City Weir	Grilse b/	46	104	14	265	
		Adults	1,063	2,433	426	6,123	
		Total	1,109	2,537	440	6,388	5,873 - 6,959 c/
Fall-run chinook	Trinity River basin above Willow Creek Weir	Grilse d/	27	371	3	634	
		Adults	460	1,348	80	9,358	
		Total	487	1,719	83	9,992	7,995 - 12,190 e/
Fall-run chinook	Trinity River basin above Junction City Weir	Grilse d/	50	371	22	457	
		Adults	436	1,348	152	4,330	
		Total	486	1,719	174	4,787	4,165 - 5,513 c/
Coho	Trinity River basin above Willow Creek Weir	Grilse f/	1	173	1	412	
		Adults	260	1,462	108	3,485	
		Total	261	1,635	109	3,897	3,258 - 4,671 c/
Coho	Trinity River basin above Junction City Weir	Grilse f/	0	173	0	230	
		Adults	156	1,462	117	1,947	
		Total	156	1,635	117	2,177	1,832 - 2,592 c/
Fall-run steelhead	Trinity River basin above Willow Creek Weir	Adults g/	269	930	46	5,348	3,995 - 6,915 e/
Fall-run steelhead	Trinity River basin above Junction City Weir	Adults g/	130	930	36	3,296	2,345 - 4,380 e/

a/ Corrected for tagging mortalities.
b/ Spring-run chinook salmon grilse are ≤54 cm FL; adults are >54 cm FL.
c/ Confidence limits were estimated by normal approximation.
d/ Fall-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.
e/ Confidence limits were estimated by Poisson approximation.
f/ Coho salmon grilse are ≤45 cm FL; adults are >45 cm FL.
g/ Fall-run steelhead adults are >41 cm FL.

Table 16. Trinity River basin salmon and steelhead run-size, angler harvest, and spawner escapement estimates, 1990-91 season.

Species/ race	Area of estimate	Size class	Run-size	Angler harvest (%)		Spawner escapement: Natural	Spawner escapement: Trinity River Hatchery	Spawner escapement: Total
Spring-run chinook	Trinity River basin above Junction City Weir	Grilse a/	265	35		126	104	230
		Adults	6,123	810		2,880	2,433	5,313
		Total	6,388	845	(13.2)	3,006	2,537	5,543
Fall-run chinook	Trinity River basin above Willow Creek Weir	Grilse b/	634	22		241	371	612
		Adults	9,358	328		7,682	1,348	9,030
		Total	9,992	350	(3.5)	7,923	1,719	9,642
Fall-run chinook	Trinity River basin above Junction City Weir	Grilse b/	457	3		83	371	454
		Adults	4,330	51		2,931	1,348	4,279
		Total	4,787	54	(1.1)	3,014	1,719	4,733
Coho	Trinity River basin above Willow Creek Weir	Grilse c/	412	5		234	173	407
		Adults	3,485	42		1,981	1,462	3,443
		Total	3,897	47	(1.2)	2,215	1,635	3,850
Coho	Trinity River basin above Junction City Weir	Grilse c/	230	0		57	173	230
		Adults	1,947	0		485	1,462	1,947
		Total	2,177	0	(0.0)	542	1,635	2,177
Fall-run steelhead	Trinity River basin above Willow Creek Weir	Adults d/	5,348	1,230	(23.0)	3,188	930	4,118
Fall-run steelhead	Trinity River basin above Junction City Weir	Adults d/	3,296	411	(12.5)	1,955	930	2,885

a/ Spring-run chinook salmon grilse are ≤54 cm FL; adults are >54 cm FL.
b/ Fall-run chinook salmon grilse are ≤53 cm FL; adults are >53 cm FL.
c/ Coho salmon grilse are ≤45 cm FL; adults are >45 cm FL.
d/ Steelhead adults are >41 cm FL.

Fall-run Chinook Salmon

An estimated 9,992 fall chinook (634 grilse and 9,358 adults), including those eventually harvested, migrated into the Trinity River basin upstream of WCW during the 1990-91 season (Table 15). An estimated 4,787 of them (457 grilse and 4,330 adults) continued their migration upstream of JCW.

We estimate that 350 (3.5%) of the fall chinook (22 grilse and 328 adults) passing upstream of WCW, were harvested by anglers (Table 16). Of that total, 54 (three grilse and 51 adults) were caught upstream of JCW. Thus, an estimated 9,642 fall chinook (612 grilse and 9,030 adults) spawned in the Trinity River basin upstream of WCW, 3,850 (407 grilse and 3,443 adults) of which spawned upstream of JCW, including the 1,719 fall chinook that entered TRH (Table 16).

Coho Salmon

We estimate 3,897 coho (412 grilse and 3,485 adults), including those eventually harvested by anglers, migrated into the Trinity River basin upstream of WCW during the 1990-91 season (Table 15). Of that total, 2,177 coho (230 grilse and 1,947 adults) migrated upstream of JCW.

An estimated 1.2% or 47 coho (5 grilse and 42 adults) were harvested by anglers upstream of WCW, all of which were caught downstream of JCW (Table 16). Thus, we estimate that 3,850 coho (407 grilse and 3,443 adults) composed the spawner escapement upstream of WCW, 2,177 (230 grilse and 1,947 adults) of which spawned in the Trinity River basin upstream of JCW, including the 1,635 (173 grilse and 1,462 adults) coho that entered TRH.

Fall-run Steelhead

An estimated 5,348 adult steelhead entered the Trinity River basin upstream of WCW, 3,296 of which continued their migration upstream of JCW (Table 15). We estimate 1,230 (23.0%) of the adult steelhead were harvested by anglers upstream of WCW, 410 of which were taken above JCW. Thus, 4,118 steelhead escaped to spawn above WCW, 2,886 of which spawned upstream of JCW, including the 930 adult steelhead that entered TRH (Table 16).

RECOMMENDATIONS

1. Tag and recapture operations for adult spring- and fall-run chinook and coho salmon, and fall-run steelhead being conducted in the Trinity River basin should be continued during the 1991-92 migration season, using the capture sites near Willow Creek and Junction City.

2. The experiment to estimate the non-response rate for non-reward and $10-reward tags should be continued by tagging samples of chinook and coho salmon, and steelhead with $20 reward tags.

3. We should apply $10-reward tags to fall-run chinook and coho salmon, and steelhead at the JCW to estimate angler harvest rates of those species upstream of JCW.

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

Julian week	Calander dates		Julian week	Calander dates	
	Start	Finish		Start	Finish
01	Jan. 01	Jan. 07	27	Jul. 02	Jul. 08
02	Jan. 08	Jan. 14	28	Jul. 09	Jul. 15
03	Jan. 15	Jan. 21	29	Jul. 16	Jul. 22
04	Jan. 22	Jan. 28	30	Jul. 23	Jul. 29
05	Jan. 29	Feb. 04	31	Jul. 30	Aug. 05
06	Feb. 05	Feb. 11	32	Aug. 06	Aug. 12
07	Feb. 12	Feb. 18	33	Aug. 13	Aug. 19
08	Feb. 19	Feb 25	34	Aug. 20	Aug. 26
09	Feb. 26	Mar. 04 [a]	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. 29	Nov. 04
19	May 07	May 13	45	Nov. 05	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 [b]

[a] Eight-day week in each year which is divisible by 4.

[b] Eight-day week every year.

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1990-91 SEASON

CHAPTER V

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

by

Bill Heubach, Michael Lau, and Ed Miller

ABSTRACT

Between 1 July 1990 and 30 June 1991, the California Department of Fish and Game's Trinity River Project marked (adipose fin-clipped and binary coded-wire tagged) three 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 at the hatchery. We marked 299,463 spring-run and 97,810 fall-run chinook salmon, and 51,088 coho salmon. In addition, Trinity River Hatchery personnel marked and released two lots of fall-run chinook salmon, totaling 46,168 fish, as part of a hatchery feed experiment.

Recovery operations at Trinity River Hatchery captured 602 adipose fin-clipped chinook and coho salmon. Coded-wire tags were recovered from 345 spring-run and 211 fall-run chinook salmon. None were recovered from coho salmon.

Run-size, angler harvest, and spawner escapements of marked spring- and fall-run chinook salmon of the 1985 through 1989 brood years are presented. Complete returns were only available for fish from the 1985 brood year, returning as two- through five-year-olds. Based on coded-wire tags collected from 1987 through 1990, we estimate that 7,929 spring-run and 7,239 fall-run chinook salmon from the 1985 brood year produced at Trinity River Hatchery returned to the Trinity River basin upstream of the Willow Creek Weir.

JOB OBJECTIVES

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

INTRODUCTION

During the period of 1 July 1990 through 30 June 1991, the California Department of Fish and Game's (CDFG) Trinity River Project marked (adipose fin-clipped and coded-wire tagged [Ad+CWT]) and released chinook salmon smolts and yearlings, and yearling+ coho salmon produced at Trinity River Hatchery (TRH), and recaptured fish from previously marked brood years (BY) returning to TRH. Similar marking studies began at TRH in 1977, with the marking and release of fall-run chinook salmon (fall chinook) from the 1976 BY. Beginning with the 1977 BY, representative, marked subsets of TRH-produced fish have been included in all releases of smolt, yearling, and yearling+ spring-run (spring chinook) and fall chinook released from TRH and its associated off-site rearing locations. Beginning in 1978, representative samples of coho salmon (coho) were marked and released from TRH in most years, except BY's 1987 and 1988.

These earlier studies were funded 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 spawning escapements in the Trinity basin, in order to properly manage hatchery production and fishery harvest.

METHODS

Fish Marking and Release

Salmon selected for marking at TRH were crowded into a small area beneath a marking shed situated over their rearing pond. After crowding, fish were dip-netted into a 152.4 x 61.0 x 76.2-cm wooden holding tank in the tagging shed through which water from the pond was circulated. We dip-netted approximately 25 fish at a time from the holding tank into pans containing an anesthetic solution of tricaine methanesulfonate (MS 222[1/]). Once anesthetized, we marked the fish by removing their adipose (Ad) fin and injecting a coded-wire tag (CWT) into their rostrum. A NMT MK 4[1/] tagging unit was used to tag smolt spring chinook with half-length CWTs, and yearling chinook and coho with full-length tags.

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

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

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

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

Coded-wire Tag Recovery

The TRH fish ladder was open from 1 September 1990 through 27 March 1991. Hatchery personnel conducted fish sorting and spawning operations two days per week.

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

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

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

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

The information needed to estimate the numbers of 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 used to determine the run-size and harvest estimates are presented as a part of Task IV (p x - x). To estimate the numbers of the salmon above a specific weir site with a CWT, we used the equation:

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

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_{AD+CWT} = 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:

$$F_{CWT\ group} = \frac{NH_{CWT\ group}}{NH_{AD+CWT}}$$

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

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

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

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

CWT code group.

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

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

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

We estimated the total number of fish 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 tag group available to the spawner escapement.

The estimated number of salmon available to natural spawner escapement is:

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

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

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

RESULTS AND DISCUSSION

Fish Marking and Release

Three groups of chinook salmon reared at TRH, totaling 397,273 fish, were marked (Ad+CWT), and released into the Trinity River below the hatchery during October 1990 and May 1991 (Table 1). The spring and fall chinook yearlings were released in October 1990. Both releases were from the 1989 BY. Spring chinook smolts of the 1990 BY were released in May 1991. We marked (Ad+CWT) 51,088 coho from the 1989 BY at TRH. The coho were released into the Trinity River below TRH in March 1991.

Fingerling spring and fall chinook from the 1989 BY reared at TRH showed symptoms of Enteric Redmouth Disease (Pseudomonas hydrophila) so all were treated. The 1989 BY spring and fall chinook released as yearlings appeared free of the disease. The fall chinook suffered virtually no mortality, and the spring

Table 1. Code-wire-tagged (CWT) and unmarked chinook and coho salmon releases from Trinity River Hatchery from 1 July 1990 through 30 June 1991. a/

CWT code	Brood year	Species/race	Total number tagged	Mortality b/	Extrapolated tag shed/poor fin clip (%) c/	Number of tagged fish released d/	Release date	Release size No/kg &	Release size FL (mm)	Unmarked fish released
06-56-39	1989	Spring-run chinook	109,386	39 (0.04)	6,792 (6.2)	102,555	10/01/90	25.3	146.4	246,359
06-56-34	1989	Fall-run chinook	101,621	0 (0.0)	3,811 (3.8)	97,810	10/15/90	21.3	120.8	380,710
06-56-37 e/	1989	Fall-run chinook	25,076	0 (0.0)	1,448 (5.8)	23,628	10/16/90	17.6	158.4	f/
06-56-41 e/	1989	Fall-run chinook	23,632	0 (0.0)	1,092 (4.6)	22,540	10/16/90	18.2	162.2	f/
Yearling release subtototals:			259,715			246,533				627,069
6-1-4-1-3	1990	Spring-run chinook	230,400	25,776 (11.1)	7,716 (3.8)	196,908	05/28/91	158.4	79.5	1,642,633
Smolt release subtototals:			230,400			196,908				1,642,633
TOTAL CHINOOK RELEASED:			490,115			443,441				2,269,702
06-56-60	1989	Coho	54,151	2,512 (4.6)	551 (1.1)	51,088	03/18/91	26.4	149.1	576,651
TOTAL COHO RELEASED:			54,151			51,088				576,651
TOTAL SALMON RELEASED:			544,266			494,529				2,846,353

a/ All relesases were into the Trinity River directly below the hatchery.
b/ Absolute number followed by percent in parenthesis.
c/ Absolute number followed by percent in parenthesis. The percent mortality is based on the total number of fish marked minus mortality.
d/ The number of tagged fish released = the total number of fish marked minus the mortality and the extrapolated number of fish with a shed tag or poor fin clip.
e/ Marked and released by Trinity River Hatchery personnel as part of a feed experiment.
f/ Unmarked fish released are included with fish of tag code 06-56-34.

chinook had insignificant mortality between marking and release (Table 1). Hatchery personnel considered the fish to be in excellent condition when released.

Fall chinook smolts from the 1990 BY were not marked in the spring of 1991 because of a pandemic of Infectious HematopoieticNecrosis (IHN). All survivors will be released during fall 1991, as yearlings. The outbreak of IHN also infected the spring chinook, and 11% of the smolts that were marked died during and after marking, due to a combination of the disease and handling stress (Table 1). The fish were still infected when released and were considered by hatchery personnel to be in fair condition.

The 1989 BY coho released in March 1991 were infected with Bacterial Kidney Disease (Corynebacterium sp.) and were considered to be in poor-to-fair condition when released. The mortality during and following marking was moderately high (Table 1).

In addition to the salmon marked by Project Personnel, TRH personnel marked (Ad+CWT) and released two groups (46,168 fish) of fall chinook yearlings from the 1989 BY as part of a feed experiment (Table 1). The experiment's results will be reported in a forthcoming TRH annual report.

All chinook and coho mark groups were released concurrently with unmarked fish of the same BY, strain, and size.

Coded-wire Tag Recovery

We recaptured 602 marked (Ad+CWT) chinook and coho at TRH during the 1990-91 season. Tags were recovered from 345 spring chinook and 211 fall chinook. None were recovered from coho (Table 2). Spring chinook from the 1986 BY, released as yearlings, comprised 77% of the CWTed spring chinook we recovered, while 75% of the CWTed fall chinook recovered were from the 1986 and 1987 BYs that had been released as yearlings.

The three marked coho that entered TRH probably had natural marks, as no tags were recovered from them. No marked coho from TRH should have been returning during the 1990-91 season, because none of the 1987 or 1988 BY coho produced at TRH were marked. No chinook or coho salmon were recovered at TRH during the 1990-91 season that were released from other facilities.

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

In this report period, complete returns were only available for spring and fall chinook from the 1985 BY, and they were the only groups used for the following analyses. We estimate that 5.7% of

Table 2. Release and 1987-88 through 1990-91 season recovery data of coded-wire-tagged chinook salmon produced at Trinity River Hatchery during the 1985-86 through 1988-89 seasons. a/

Release data							Trinity River Hatchery Recovery data			
									Mean fork length (cm)	
CWT b/ code	Race	Brood year	Date	Number	Size (#/kg)	Site	Season recovered	CWT b/ recoveries	Male	Female
06-61-42	Spring-run	1985	06/02/86	192,487	154.0	TRH c/	87-88	68	49 (67) d/	67 (1)
							88-89	382	69 (177)	66 (205)
							89-90	53	78 (25)	75 (28)
							90-91	3	86 (1)	74 (2)
06-61-44	Spring-run	1985	10/03/86	101,091	27.2	TRH	87-88	51	44 (51)	(0)
							88-89	1,026	66 (650)	63 (376)
							89-90	308	77 (170)	71 (138)
							90-91	10	76 (6)	78 (4)
06-61-45	Spring-run	1986	05/28/87	197,113	191.0	TRH	88-89	7	50 (7)	(0)
							89-90	15	69 (10)	66 (5)
							90-91	11	74 (4)	71 (7)
06-61-46	Spring-run	1986	09/24/87	101,030	39.6	TRH	88-89	48	45 (47)	44 (1)
							89-90	285	65 (210)	64 (75)
							90-91	264	73 (106)	71 (158)
06-61-47	Spring-run	1987	05/23/88	185,718	187.0	Sawmill Pond	89-90	6	50 (6)	(0)
							90-91	55	64 (23)	64 (32)
06-61-49	Spring-run	1988	05/26/89	186,698	182.6	TRH	90-91	2	52 (2)	(0)
100000 e/	Spring-run f/						89-90	160	65 (100)	65 (60)
							89-90	50	75 (24)	71 (26)
							90-91	34	64 (15)	68 (19)
06-56-25	Fall-run	1985	10/24/86	97,368	29.7	TRH	87-88	93	46 (92)	66 (1)
							88-89	812	65 (563)	65 (249)
							89-90	202	75 (79)	75 (123)
							90-91	3	72 (2)	82 (1)
06-56-26	Fall-run	1986	06/11,17/87	202,486	195.8	TRH	88-89	20	49 (20)	(0)
							89-90	19	65 (13)	68 (6)
							90-91	3	71 (1)	73 (2)
06-56-29 g/	Fall-run	1986	06/11/87	99,118	182.6	Sawmill Pond	88-89	3	52 (3)	(0)
							89-90	9	62 (2)	64 (7)
							90-91	5	70 (2)	71 (3)
06-56-30 g/	Fall-run	1986	06/27/87	92,351	151.8	Ambrose Pond	88-89	7	51 (7)	(0)
							89-90	14	65 (9)	67 (5)
							90-91	4	73 (2)	71 (2)
06-56-27	Fall-run	1986	09/21/87	100,320	41.8	TRH	88-89	424	49 (415)	49 (9)
							89-90	738	65 (422)	65 (316)
							90-91	88	72 (29)	73 (59)
06-56-28	Fall-run	1986	09/24/87	26,730	24.2	TRH	88-89	45	50 (40)	51 (5)
							89-90	55	64 (26)	64 (29)
							90-91	4	64 (1)	72 (3)
06-63-10	Fall-run	1986	02/29/88	26,650	19.8	TRH	89-90	14	60 (7)	60 (7)
							90-91	2	- (0)	64 (2)
06-56-33	Fall-run	1987	06/22/88	172,980	257.4	Ambrose Pond	89-90	10	51 (10)	- (0)
							90-91	16	60 (12)	62 (4)
06-56-31	Fall-run	1987	10/28/88	93,300	19.6	Ambrose Pond	89-90	11	47 (11)	(0)
							90-91	70	56 (56)	61 (14)
06-56-35	Fall-run	1988	06/12/89	194,197	161.0	TRH	90-91	9	48 (9)	- (0)

(continued on next page)

Table 2. Release and 1987-88 through 1990-91 season recovery data of coded-wire-tagged chinook salmon produced at Trinity River Hatchery during the 1985-86 through 1988-89 seasons (continued). a/

Release data							Trinity River Hatchery Recovery data					
									Mean fork length (cm)			
CWT b/ code	Race	Brood year	Date	Number	Size (#/kg)	Site	Season recovered	CWT b/ recoveries	Male		Female	
06-56-32	Fall-run	1988	10/27/89	97,569	34.1	TRH	90-91	7	42	(7)	-	(0)
100000	Fall-run h/						88-89	152	65	(85)	68	(67)
							89-90	47	73	(22)	68	(25)
							90-91	9	60	(4)	71	(5)

a/ Only coded-wire-tagged groups that entered Trinity River Hatchery during the 1990-91 season are listed.
b/ CWT=coded-wire tag.
c/ TRH=Trinity River Hatchery.
d/ Sample size is in parenthesis.
e/ 100000=no coded-wire tag was found or it was lost during recovery.
f/ Assumed to be spring-run chinook salmon by entry date into Trinity River Hatchery.
g/ Tagged and Released by U.S. Fish and Wildlife Service personnel.
h/ Assumed to be fall-run chinook salmon by entry date into Trinity River Hatchery.

the 1985 BY spring chinook released from TRH in October 1986 as yearlings (CWT code 066144) returned to the Trinity River basin upstream of JCW as two- through five-year-olds. An estimated 771 of the 5,808 returning fish were caught by anglers, thus 5,037 were available for spawner escapement. The total return rate of spring chinook released as yearlings was approximately five times the return rate of spring chinook from the 1985 BY released as smolts (CWT code 066142) (Table 3).

We estimate that 4,164 1985 BY fall chinook released as yearlings (CWT code 065625) returned to the Trinity River basin above WCW and that 489 were caught by anglers, thus the remaining 3,675 were available for spawner escapement. The total return rates of fall chinook of the 1985 BY released as yearlings was approximately three times the return rate of fall chinook from the same BY released as smolts (CWT code 065623) (Table 3).

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 1991-92.

Table 3. Run-size, sport catch, and spawner escapement estimates for the 1985 through 1988 brood year, Trinity River Hatchery-produced, coded-wire-tagged chinook salmon in the Trinity River upstream of Willow Creek and Junction City weirs during the 1987-88 through 1990-91 seasons. a/

	Release data					Return data					
									Spawner escapement		
Race	CWT b/ code	Brood year	Date c/	Number	Site	Age	Run-size	River harvest	Hatchery	Natural	Total
Spring-run	066142	1985	6/2/86	192,487	TRH d/	2	347	64	68	215	283
						3	1,518	214	382	922	1,304
						4	250	25	53	172	225
						5	6	1	3	2	5
Spring-run	066144	1985	10/2,3/86	101,091	TRH	2	260	48	51	161	212
						3	4,076	575	1,026	2,475	3,501
						4	1,452	145	308	999	1,307
						5	20	3	10	7	17
Spring-run	066145	1986	5/28/87	197,113	TRH	2	10	1	7	2	9
						3	71	7	15	49	64
						4	22	3	11	8	19
Spring-run	066146	1986	9/24/87	101,030	TRH	2	66	9	48	9	57
						3	1,344	134	285	925	1,210
						4	540	71	264	205	469
Spring-run	066147	1987	5/23/88	185,718	Sawmill Pond	2	61	6	6	49	55
						3	112	15	55	42	97
Spring-run	066149	1988	5/26/89	181,698	TRH	2	30	4	2	24	26
Spring-run	066148	1988	10/24/89	98,820	TRH	2	0	0	0	0	0
Fall-run	065623	1985	6/19/86	196,249	TRH	2	1,073	106	272	695	967
						3	1,859	243	492	1,124	1,616
						4	143	10	40	93	[illegible]
						5	0	0	0	0	
Fall-run	065625	1985	10/24/86	97,368	TRH	2	366	36	93	237	330
						3	3,068	402	812	1,854	2,666
						4	723	51	202	470	672
						5	7	0	3	4	7
Fall-run	065626	1986	6/11,17/87	202,486	TRH	2	76	11	20	45	65
						3	68	5	19	44	63
						4	7	0	3	4	7
Fall-run	065629 e/	1986	6/11/87	99,118	Sawmill Pond	2	11	2	3	6	9
						3	32	2	9	21	30
						4	12	0	5	7	12
Fall-run	065630 e/	1986	6/27/87	92,351	Ambrose pond	2	26	4	7	15	22
						3	51	4	14	33	47
						4	9	0	4	5	9
Fall-run	065627	1986	9/21/87	100,320	TRH	2	1,602	242	424	936	1,360
						3	2,645	185	738	1,722	2,460
						4	219	8	88	123	211
Fall-run	065628	1986	9/24/87	26,730	TRH	2	170	26	45	99	144
						3	197	14	55	128	183
						4	10	0	4	6	10
Fall-run	066310	1986	2/29/88	26,650	TRH	2	0	0	0	0	0
						3	51	4	14	33	47
						4	5	0	2	3	5
Fall-run	065633	1987	6/2/88	172,980	Ambrose pond	2	60	4	10	46	56
						3	39	1	16	22	38

(continued on next page)

Table 3. Run-size, sport catch, and spawner escapement estimates for the 1985 through 1988 brood year. Trinity River Hatchery-produced, coded-wire-tagged chinook salmon in the Trinity River upstream of Willow Creek and Junction City weirs during the 1987-88 through 1990-91 seasons (continued). a/

	Release data					Return data					
									Spawner escapement		
Race	CWT b/ code	Brood year	Date c/	Number	Site	Age	Run-size	River harvest	Hatchery	Natural	Total
Fall-run	065631	1987	10/28/88	92,300	Ambrose pond	2	63	4	11	48	59
						3	174	6	70	98	168
Fall-run	065635	1988	6/12/89	194,197	TRH	2	50	2	9	39	48
Fall-run	065632	1988	10/27/89	97,569	TRH	2	39	1	7	31	38
Fall-run	065522 f/	1988	11/1/89	22,234	TRH	2	0	0	0	0	0
Fall-run	065523 f/	1988	11/1/89	24,131	TRH	2	0	0	0	0	0

a/ All spring-run chinook salmon estimates are for the Trinity River basin upstream of Junction City Weir while fall-run chinook salmon estimates are upstream of the Willow Creek Weir.

b/ CWT=coded-wire tag.

c/ All chinook salmon released during May or June are considered smolts , those released in September or October are yearlings, and those relseased in February of their second year are yearling+.

d/ TRH=Trinity River Hatchery.

e/ Tagged and released by U.S Fish and Wildlife Service personnel.

f/ Tagged and released by Trinity River Hatchery personnel.

ANNUAL REPORT
TRINITY RIVER BASIN AND STEELHEAD MONITORING PROJECT
1990-1991 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 October to 31 December 1990. Unique combinations of fin clips were given to each group of fish to permit identification of brood year upon recapture. This season, we marked 970,617 fish from brood year 1990 with an adipose and left ventral fin clip, to be released as yearlings, and 102,316 fish from brood year 1989 with an adipose and right ventral fin clip, to be released as two-year-olds.

We checked 1,500 steelhead from brood year 1990 and 1,000 from brood year 1989 for fin clip accuracy prior to release. We found that 2.1% of the fish from brood year 1989 and 0.7% of those from brood year 1990 were poorly fin-clipped. We monitored adult steelhead returning to Trinity River Hatchery from 5 September 1990 through 27 March 1991, when migration was determined to have been complete. During that time, six steelhead from brood year 1988 returned to Trinity River Hatchery.

JOB OBJECTIVE

To determine relative return rates and contributions to spawning escapements and the fisheries made by steelhead produced at Trinity River Hatchery, and to evaluate experimental hatchery management practices aimed at increasing adult returns.

INTRODUCTION

The completion of the Trinity River Division of the Central Valley Project (15 May 1963) blocked access to a significant part of the historic steelhead spawning and rearing habitat in the Trinity River basin, and resulted in significant downstream flow reductions. This project-induced reduction in fishery habitat is the major factor contributing to the decline of annual runs of steelhead in the Trinity River system.

In October 1984, U.S. Public Law 98-541 was signed into law 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 a program to restore fish and wildlife populations to pre-dam conditions.

One of the major goals of the California Department of Fish and Game's (CDFG) Klamath-Trinity Program is to develop fishery harvest management recommendations which are compatible with the goal of restoring full, natural salmon and steelhead production in the Trinity River and its tributaries downstream from Lewiston Dam. Knowledge of hatchery- and naturally produced steelhead escapements into the Trinity River is needed to develop management recommendations and determine 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 CDFG's Trinity Fisheries Investigations Project (TFIP) continued to mark steelhead produced at Trinity River Hatchery (TRH) as part of the first half of our Project's efforts to meet the Job Objectives. The second half, which began this season, includes the monitoring of adults returning to TRH.

METHODS

In-hatchery Fish Growth

The amount of feed given to fish reared at TRH is determined by taking weekly standard weight counts (number of fish per pound), and then fish are fed according to suggested manufacturers requirements (Gary Ramsden, Manager, Trinity River Hatchery, CDFG, pers. comm.). The average weight of fish was determined by dividing one lb by the number of fish per pound, based on data from TRH feeding schedules which record the number of fish per pound.

Marking Operations

Staff of CDFG's TFIP marked steelhead at TRH inside two wooden sheds measuring 3 m X 3 m, and positioned directly over the hatchery ponds. Positioning the sheds over the ponds allowed access for two crews of four markers, each, to effectively net fish into each shed. Each shed contained a four-station marking table and was equipped with a circulating, holding tank (approximately 284 liters) through which fresh hatchery pond water was pumped. Fish were netted directly from the hatchery ponds and placed into the holding tank located inside the shed. Another smaller holding sink, also with circulating fresh, pond water, was located in the center of each marking table. One shed was equipped with a recirculating tricaine methanesulfonate (MS-222[1]) system (approximately 76 liters), which was changed once per day with fresh aqueous MS-222 solution. This system used 1.5 cups of MS-222 per week. The recirculating MS-222 system was installed to minimize fish mortality caused by overdoses of anaesthetic. The other shed had a separate, non-circulating MS-222 sink at each of the four work stations, with each marker responsible for controlling their own MS-222 concentrations. Comparisons of MS-222 usage between the two sheds are not conclusive at this time. The temperatures of the fresh water and MS-222 solutions from both sheds were monitored regularly throughout the day.

Marking steelhead involved anaesthetizing them with MS-222, removing one or more of their fins by clipping, and releasing them into a pond reserved for marked fish. To keep count of fish marked, each marking station was equipped with a manual counter. A combination of right ventral (RV) or left ventral (LV) and adipose (Ad) fin clips was used to differentiate each fish's brood year (BY) and age at release. Fish marked during this season were from the 1989 BY, given a Ad+RV fin clip to be released as two year-olds, and from the 1990 BY, given a Ad+LV

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

fin clip to be released as yearlings.

We had previously marked 144,800 steelhead from the 1989 BY with an Ad+RV fin clip during the spring of 1990 (Aguilar 1992). These fish were moved off-site to the Old Sawmill Site at Lewiston (river km 175.4) for rearing because of lack of space at TRH. As of 3 April 1990, an estimated 110,000 fish from this BY remained to be marked, but operations were halted because of rising water temperatures which could have lead to increased mortalities. The remaining fish from this BY were reared at TRH, and marked this season when water temperatures cooled.

Numbers of fish released from TRH were estimated by TRH personnel, using the standard weight count method on a subsample of marked fish at time of release. Numbers of fish released from the Old Sawmill Site were estimated by TRH personnel, using a Peterson estimate on marked fish only.

Hatchery Mark Evaluations

To determine fin clip accuracy, we examined a sample of the marked steelhead just prior to release. These fish were anaesthetized with MS-222, measured to nearest cm fork length (FL), and checked for how well the fin was removed during the marking process. Fin clipping is considered a permanent mark if the rays are removed to the point of attachment to the bone (Stuart 1958, Eipper and Forney 1965, Jones 1979). Fins which were less than 1/2 removed are likely to regenerate. In this situation, fin rays appear distorted at the location of the clip. Unless those persons checking for fin clips on returning adults specifically look for distorted rays, fish that were actually marked, may be unrecognizable. We determined the number of effectively marked fish by multiplying the percent of fish with poor fin clips by the total number of fish released, and subtracting this product from the total.

Prior to release, a sample of marked fish was autopsied for signs of health and general condition by a CDFG pathologist. Project personnel also checked the fish for general condition, by sight examination during the hatchery mark-evaluation procedure.

Recovery Operations

Project personnel monitored steelhead returning to TRH from 13 September 1990 through 27 March 1991. We examined the fish for fin clips, measured them to the nearest cm FL, and recorded their sex. Steelhead were also checked for fin clips by Trinity River Project (TRP) personnel during their operation of the Willow Creek Weir, located 132.0 km downstream of TRH, and at the Junction City Weir, located 42.4 km downstream of TRH.

RESULTS AND DISCUSSION

In-hatchery Fish Growth

Brood Year 1989 (2-year-olds)

These fish were not marked and released in 1990 as yearlings, because TRH management determined they would not reach the minimum release size of 15.2 cm (6 in.) by March 1991. At the beginning of TRH's 1990-91 feeding schedule, the average weight of these fish was 36 gm (12 - 13 fish per pound). Hatchery records show there was progressive growth from 23 May to 19 September 1990. From 19 September 1990 to 9 January 1991 there was no recorded growth. This frequently occurs because of water temperatures, and culling and grading of the fish (Gary Ramsden, Manager, Trinity River Hatchery, CDFG pers. comm.). From 9 January to 6 February 1991, average weight increased from 65 gm to 110 gm. At release in March 1991, average weight was 115 gm (Figure 1).

Brood Year 1990 (yearlings)

According to hatchery feeding schedules, there was progressive growth throughout the time these fish were reared at TRH. On 23 May, the average fish weighed 3 gm. At release, average weight was 65 gm (Figure 1).

Marking Operations

This season we marked 102,316 fish held over from the 1989 BY to be released as two-year-olds, and 970,617 fish from the 1990 BY to be released as yearlings. Both groups were released in March 1991 (Table 1). There were no experimental hatchery management practices to evaluate this season.

Brood Year 1989 (2-year-olds)

We previously marked 144,800 steelhead from this BY with an Ad+RV fin clip during the spring of 1990 (Aguilar 1992). These fish were moved off-site to the Old Sawmill Site for rearing because of lack of space at TRH. On 18 March 1991, pond screens at the Old Sawmill Site were pulled and fish were allowed to enter the mainstem Trinity River of their own volition. At release, the mean size of fish from these ponds was 2.0 fish/kg (Table 1).

We completed marking the remaining fish from the 1989 BY from 5 through 17 October 1990. We marked a total of 102,316 fish. These fish were reared at TRH until 18 March 1991, when pond screens were removed and fish were allowed to leave of their own volition. Mean fish size at release was 1.6 fish/kg (Table 1).

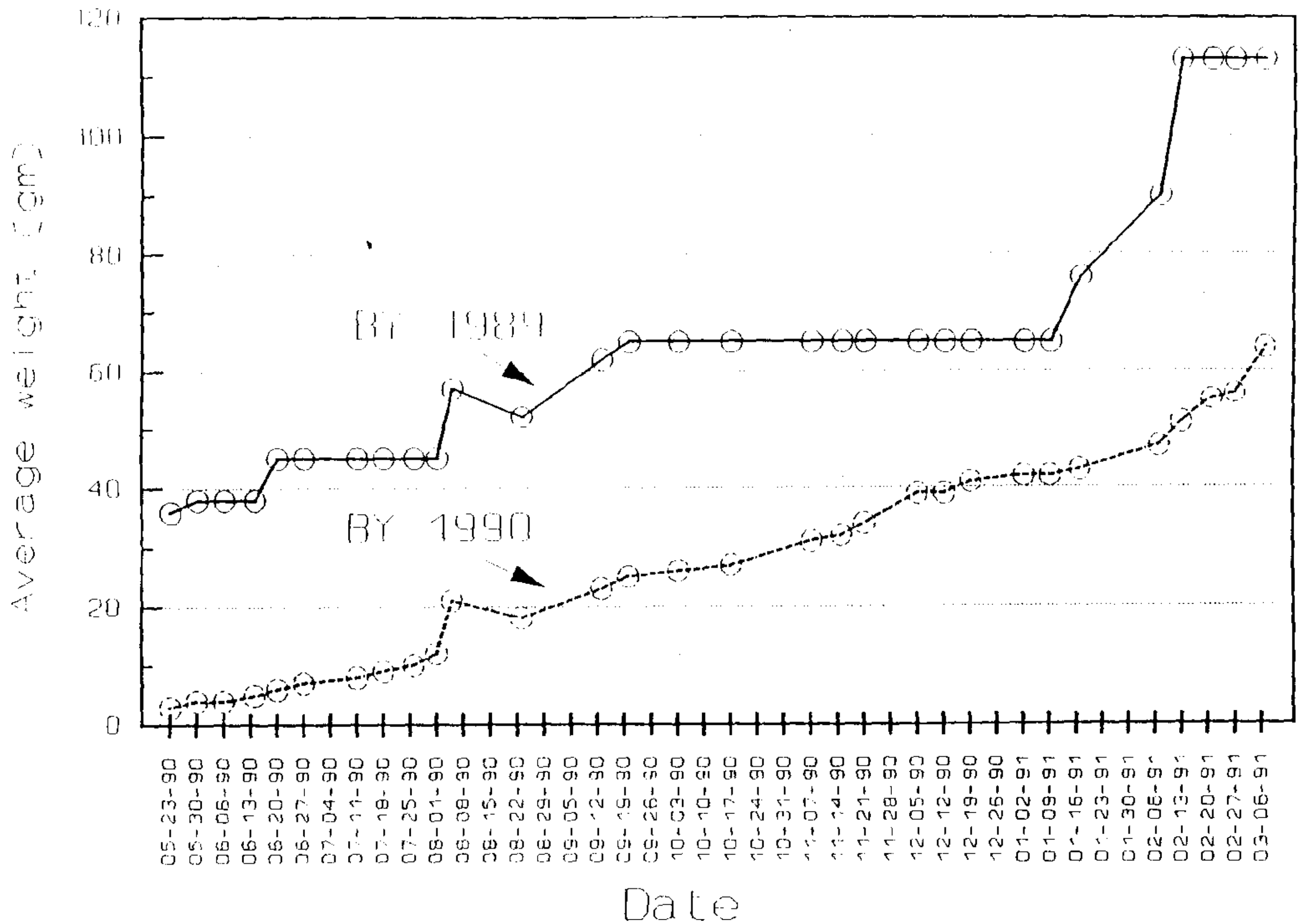

FIGURE 1. Average weight of steelhead from the 1989 and 1990 brood years reared at Trinity River Hatchery from 23 May 1990 through 6 March 1991.

TABLE 1. Summary of steelhead fin-clipping operations at Trinity River Hatchery from 5 October through 31 December 1990.

Release group					
Brood year	Age	Number clipped	Fin[a] clip type	Release date	Size (#/kg)
1989	2 yr-old	144,800[b]	Ad+RV	3/18/91	2.0
1989	2 yr-old	102,316	Ad+RV	3/18/91	1.6
1990	yearling	970,617	Ad+LV	3/18/91	3.2

a/ Fin clips are right ventral (RV), left ventral (LV), adipose plus right ventral (Ad+RV), and adipose plus left ventral (Ad+LV).
b/ These fish were marked and then moved to the Old Sawmill Site at Lewiston, for rearing.

Brood Year 1990 (yearlings)

We marked 970,617 yearlings from the 1990 BY from 17 October through 31 December 1990 with a Ad+LV fin clip. These fish were reared at TRH until 18 March 1991, when pond screens were removed and fish were allowed to leave of their own volition. Mean fish size at release was 3.2 fish/kg (Table 1).

Hatchery Mark Evaluations

Brood Year 1989 (2-year-olds)

On 15 March 1991, we examined a subsample of 1,000 steelhead reared and released from the Old Sawmill Site. It appeared that 2.8% of them (28/1000) were unmarked fish, indicating a large number with poor fin clips. We later discovered that naturally produced (unmarked) steelhead were able to enter ponds at this site and mix with the marked fish. Because of this, we were unable to determine the number of fish with poor fin clips and make an adjustment for the number of effectively marked fish released from this location. The number of effectively marked fish was determined from fish of the same BY reared at TRH. TRH personnel estimated that 83,551 marked steelhead were released from the Old Sawmill Site. Based on their estimate, there were approximately 61,249 holding mortalities. Adjusting for the proportion of poor fin-clips seen at TRH, we estimate 81,796 effectively-marked, two-year-old fish were released from this location in 1991 (Table 2).

On 14 and 15 March 1991, we examined a sub-sample of 1,000 of the steelhead which were reared at TRH. Lengths ranged from 11.0 to 32.0 cm FL, and averaged 21.7 cm FL with a sample standard deviation (SD) of 3.52 (Figure 2). We found 2.1% (21/1000) of these fish had poor fin clips. TRH personnel determined 101,299

TABLE 2. Summary of steelhead hatchery mark evaluations from 5 October 1990 through 18 March 1991.

Release group						
Brood year	Age	Number[a] released	Fin[b] clip type	Number evaluated	% poor clips	Number[c] effectively marked
1989	2 yr-old	101,299	AD+RV	1,000	2.1%	99,171
1989	2 yr-old	83,551[d]	AD+RV	1,000	2.1%[e]	81,796
1990	yearling	969,600	AD+LV	1,500	0.7%	962,812

a/ Number released = total number of fish marked adjusted for holding mortalities.
b/ Fin clips are: RV=right ventral, LV=left ventral, AD+RV=adipose plus right ventral, and AD+LV=adipose plus left ventral.
c/ Number of effectively marked fish = number with accurate fin clips = number released X ((100 - % poor clips)/100).
d/ Number released estimated by Peterson sampling method on marked fish only.
e/ Percent poor fin clips was based on fish of the same brood year reared at Trinity River Hatchery.

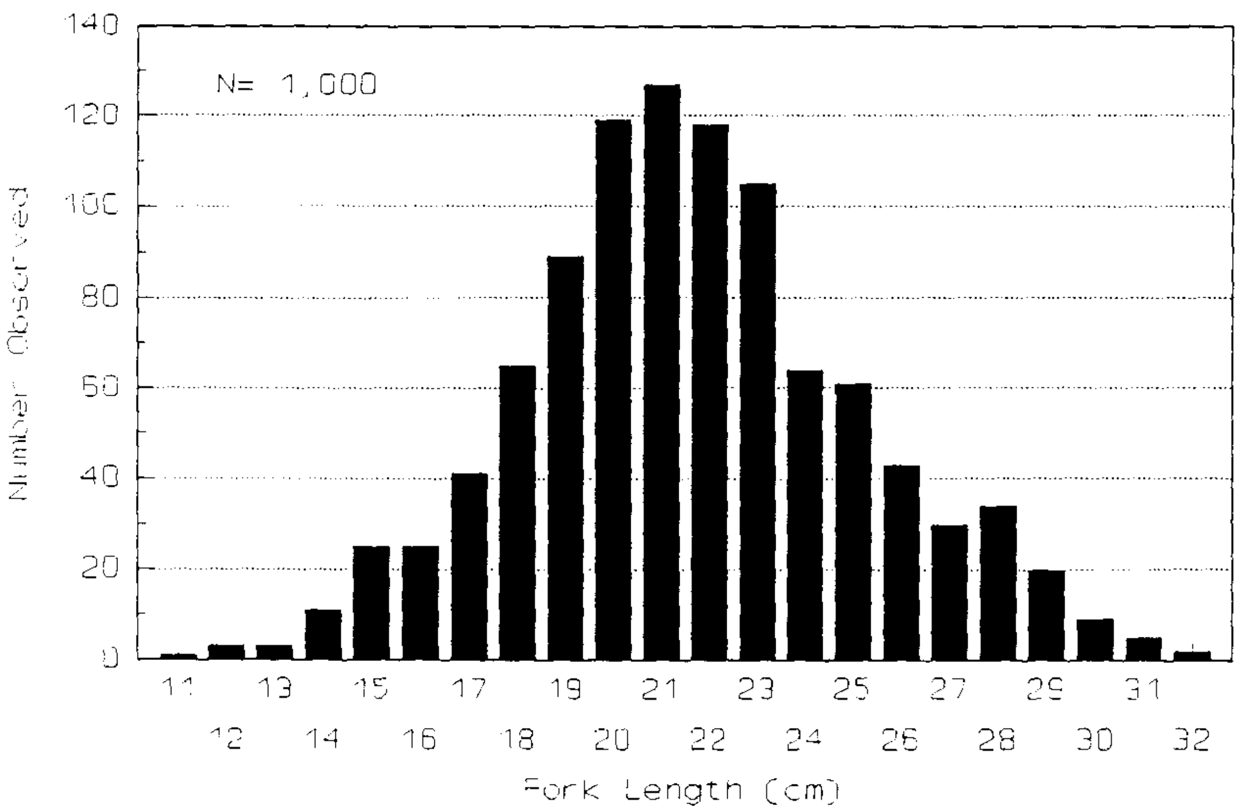

FIGURE 2. Length frequency of two-year-old steelhead from the 1989 brood year released from Trinity River Hatchery on 18 March 1991.

steelhead were released, with approximately 1,017 holding mortalities. Based on their estimate, we determined 99,171 two-year-old steelhead were effectively marked and released from TRH (Table 2).

Based only on the rate of poor fin clips observed for 1989 BY fish reared and released from TRH (2.1%), we estimate 180,967 two-year-old fish from the 1989 BY were effectively marked and released from the two sites combined (Table 2). Overall condition and health of fish from both locations at time of release were good, with the exception of some fin erosion.

Brood Year 1990 (yearlings)

On 18 March 1991, we examined a subsample of 1,500 fish from the 1990 BY which we marked with Ad+LV fin clips. We found 0.7% (11/1500) of the fish had poor fin clips. Personnel from TRH counted 1,017 mortalities, thus we estimate 962,812 yearling steelhead were effectively marked and released from the 1990 BY. Lengths ranged from 10.0 to 24.0 cm FL, averaged 18.0 cm FL, with a sample SD of 1.99 (Figure 3). Overall, general condition and health were good, with the exception of some fin erosion.

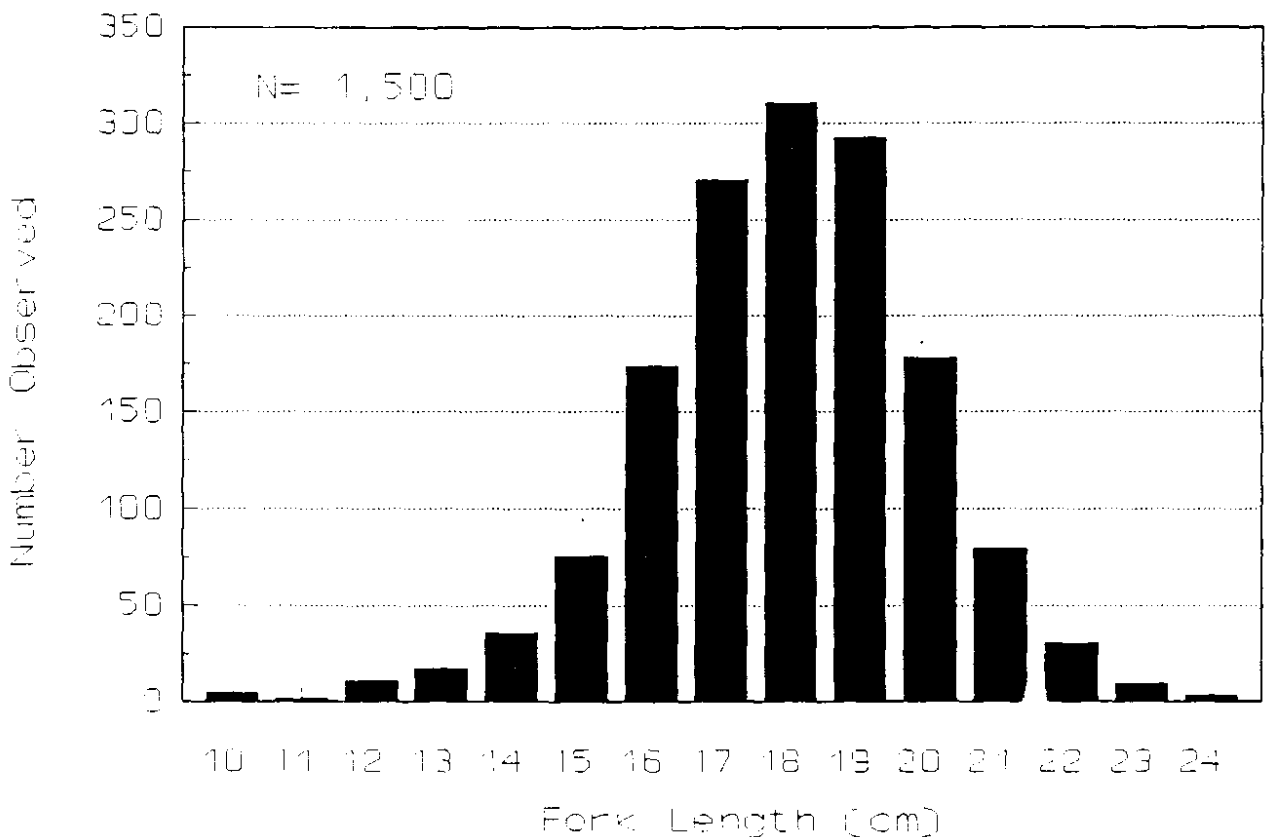

FIGURE 3. Length frequency of yearling steelhead from the 1990 brood year released from Trinity River Hatchery on 18 March 1991.

Recovery Operations

Juvenile steelhead migrate to sea after spending one to three years in fresh water. They usually stay one to two years in salt water, then return to freshwater to spawn when they are 38 to 69 cm in total length. Life history patterns of steelhead are variable, however, and growth rates may vary (Moyle 1976).

A fraction of the Trinity River steelhead run 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 (Hopelain 1987). These fish are referred to as half-pounders.

Project personnel monitored steelhead returning to TRH from 13 September 1990 through 27 March 1991, when migration was complete. During that time, 927 steelhead returned to TRH, 22 of which were marked. Fifteen were marked with a RV fin clip, indicating they were from the 1988 BY released as two-year-olds. One was marked with a LV fin clip, indicating it was from the 1989 BY released as a yearling. One was marked with a Ad+RV fin clip indicating it was from the 1989 BY released as a two-year-old. Five were marked with an Ad fin clip of unknown origin.

Personnel from the TRP caught 138 steelhead at the Junction City Weir during the 1990-91 season. One was marked with a right pectoral fin clip of unknown origin. Three hundred twenty five unmarked steelhead were recovered at the Willow Creek Weir.

Although Project and TRH personnel were monitored adult returns this season, we did not expect to see many fin-clipped fish until next year, when most fish released in 1990 (1988 and 1989 BY's) are expected to return. Because of the small number of returns this season, we were unable to determine relative return rates and contributions to the spawner escapement and the fisheries made by steelhead produced at TRH.

RECOMMENDATIONS

1. To minimize possibilities of an overdose of anaesthetic, both marking sheds should be equipped with a recirculating MS-222 system.

2. To minimize the number of poor fin clips, fin clip accuracy should be checked on a daily basis.

3. To increase measurement accuracy, all fish taken during the hatchery mark-evaluation process should be measured to the nearest mm of fork length.

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ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1990-1991 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's, Trinity Fisheries Investigations Project conducted an adult spring-run chinook salmon (Oncorhynchus tshawytscha) tagging operation in the South Fork Trinity River below the Hyampom valley from 28 April through 18 July 1991. We marked and released 34 adult and 9 grilse spring-run chinook salmon, 22 of which were tagged with anchor tags and marked with a left ventral fin clip, and 21 were marked with a right ventral fin clip only. As of 18 July 1991, no tags had been returned. Coincident with this operation, 47 fall- or winter-run and 18 spring-run steelhead (O. mykiss) were captured, marked, and released. We will observe and recover adult spring-run chinook salmon during snorkel, spawning, and carcass surveys scheduled for summer and fall 1991 to generate an escapement estimate. We will determine instream life history patterns from analyses of adult and yearling scales, juvenile trapping, and direct observations.

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 (Oncorhynchus tshawytscha) within the South Fork Trinity River (SFTR) basin. This is the first major study of spring-run chinook salmon (spring chinook) in the basin. The only other study was conducted in the summer and fall of 1964 prior to the devastating flood that occurred later that year (LaFaunce 1964). The California Department of Fish and Game (CDFG) and the U.S. Forest Service (USFS) have made numerous attempts to count adult salmonids in the SFTR in an effort to track population trends and to evaluate habitat recovery (Healy 1969; Rogers 1970, 1971; Fox 1972; Miller 1974, 1975; Ross and Hawks 1975; Lee 1976; Freese 1979, 1982; LaFaunce 1980; Strate and Underwood 1982; Mitchell 1985; Zustak 1986; Wood 1989; Gerstung 1990). These efforts have been sporadic and made no attempt to determine the complete life history of spring chinook. Reliable, statistically valid, population estimates were not determined.

The current size of the population of spring chinook in the SFTR is not known. Estimates of annual spawner escapements from various sources (see above) range from multiples of ten to a few hundred fish. It is certain that the population has experienced serious decline since 1964, when the run was estimated to be 11,604 fish (LaFaunce 1964). A current, valid population estimate and understanding of life history patterns is crucial to any management or restoration effort.

This is the first year of a five year study of SFTR spring chinook by the CDFG's, Trinity Fisheries Investigations Project (TFIP). As of 18 July 1991, only two and one-half months of work had been completed. Consequently, the results presented here are incomplete. Other elements of our study not covered in this report include a spring chinook spawner survey, carcass recovery effort, angler harvest estimate, and a determination of instream life history patterns.

METHODS

The study area includes the lower 125 km of the SFTR, the lower 7 km of the East Fork of the SFTR, and the lower 16 km of Hayfork Creek, totaling 148 km of river. Lafaunce (1964) and USFS surveys 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).

This study is composed of several distinct elements, each generating an escapement estimate or providing information on instream life history. However, due to the timing of the reporting schedule, only the adult trapping and tagging portion of the study designed to monitor the first half of the apparent bimodal immigration of spring chinook will be covered here in any detail.

An adult spring chinook capture and tagging operation was conducted during the spring and early summer of 1991. The weir (Gates Weir) was located at river kilometer (RKM) 31.7, 16 km downstream of the township of Hyampom (Figure 1). The weir functions as a fence across the river designed to guide adult fish into a trap. The weir was constructed of 1.5 m wide by 1.2 m high panels, which reached completely across the river. Each panel was constructed of 1.9-cm (diameter) galvanized conduit welded horizontally on 5.7 cm centers to 2.5-cm by 2.5-cm steel angle iron uprights. Panels were wired together with steel tie-wire, and supported with conventional steel fence posts driven into the river bottom. Netting was placed atop the panels to prevent fish from jumping over the weir.

The trap was 2.13 m long by 2.13 m wide and 1.2 m high and was constructed with the weir panels described above. Two 1.1-m panels were placed inside to form a fyke which lead fish into the trap and deterred their escape. The conduit of the "head" or upstream panel was sleeved with clear vinyl tubing and oriented vertically in an effort to minimize potential abrasion to fish. In an effort to make fish more at ease in the trap and less likely to try to jump out, a piece of dark blue nylon fabric was floated on the surface of the water. It was attached inside the trap at the upstream end only. If a fish were to jump and land atop the fabric, the fabric would simply sink allowing the fish to settle back into the water. This device also provided cover and made fish difficult to see from above. Great care was taken to insure that there were no sharp projection inside the trap which might injure trapped fish.

Once trapped, fish were placed in a closed tagging box to allow the use of an anesthetic. However, anesthesia was never necessary, as fish were not difficult to handle. The box was constructed of 1.27 cm thick plywood and measured 48.3 cm wide by

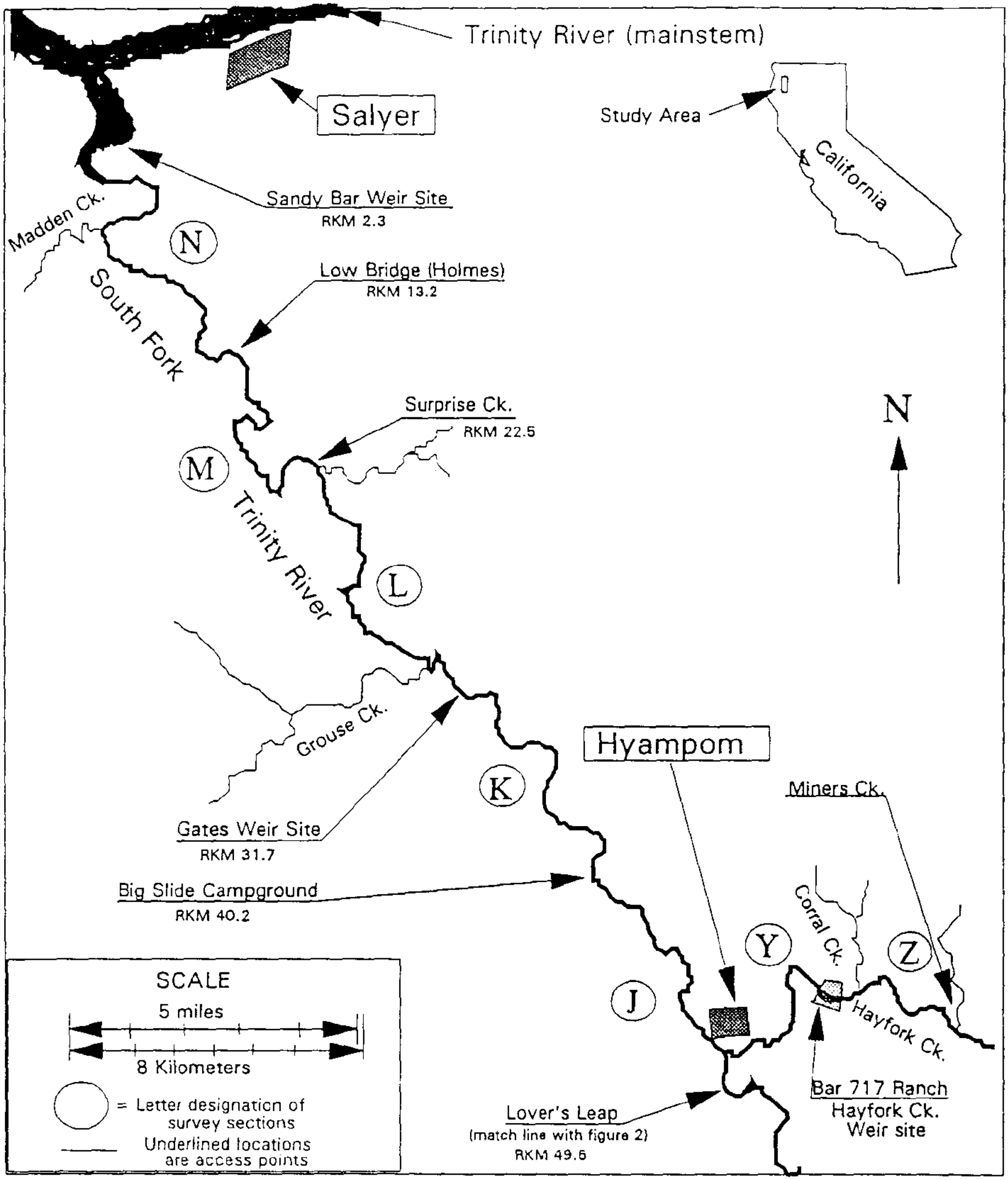

FIGURE 1. Map of the South Fork Trinity River, Hyampom and below, depicting survey sections and major tributaries. (RKM = river kilometer, from the mouth of the South Fork Trinity River)

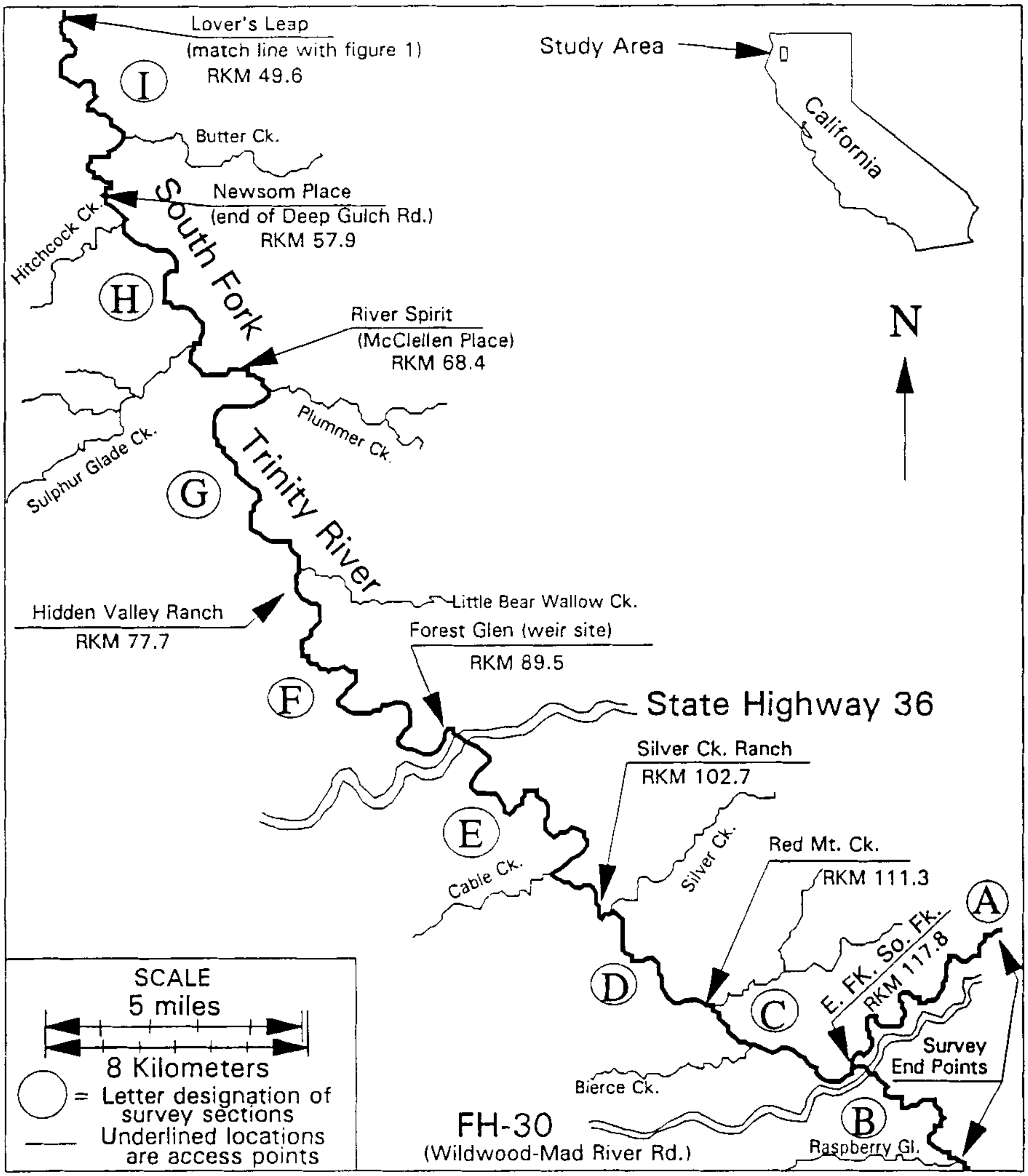

FIGURE 2. Map of the South Fork Trinity River above Hyampom depicting survey sections and major tributaries. (RKM = river kilometer from the mouth of the South Fork Trinity River)

48.3 cm tall, and 91.4 cm long. It was fitted with a nylon tagging cradle and a metric ruler for measuring fork lengths (FL).

Once in the tagging box, fish were examined for marks, scars, and general condition, their FL was measured to the nearest cm, and a scale sample was taken. Fish were then marked in one of two ways. Out of concern for potential tagging mortality, only half the fish were tagged. These fish received a 1/2 left ventral (LV) fin clip and a Floy[1/] anchor tag placed on the left side just below the dorsal fin, posterior to the midline. The other half of the fish received a 1/2 right ventral (RV) fin clip. The fish were then sprayed with a 10-20% aqueous solution of Propolyaqua[1/] (artificial slime) to help prevent infection caused by the removal of mucus during handling. Spraying was focused on areas such as the caudal peduncle, scale sample site, and the tag location. Care was taken to insure that the head, operculum, and gills were not sprayed with the solution. Fish were then placed into a recovery box for 45 to 60 minutes. The recovery box was constructed of plywood and measured 0.61 m wide by 0.61 m tall by 0.91 m long. It was lined with 0.95-cm thick, high density foam padding, and had a closable lid to provide cover. Both the upstream and the downstream ends were constructed of perforated plate (0.32-cm holes) which allowed ample water to flow through the box. Once the recovery time was met, the sliding upstream gate was opened and fish were allowed to leave of their own accord.

All equipment used in the tagging operation, such as the tagging gun, fin clippers, and scale sample knife, were disinfected with 70% isopropyl alcohol prior to each use to minimize the potential of infection.

A digitally recording thermograph was used to continually monitor temperature at the Gates Weir site. The thermograph was protected inside a steel casing and chained to the weir. Prior to the deployment of the thermograph on 23 May 1991, hand held thermometers were used.

Two Alaskan-style weirs were operated in the basin as recovery stations. These weirs were located in Hayfork Creek at Bar 717 Ranch, 8 km upstream from its confluence with the SFTR, and in the mainstem SFTR at Forest Glen Campground (RKM 89.5) (Figure 1). The Alaskan weir also utilizes 1.9-cm galvanized conduit as the "fence", but the support and orientation of the pipe is markedly different than the Gates Weir. The conduit slides

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

through holes in 7.6 cm wide by 3.3 m long aluminum channel and contacts the natural river bottom. The aluminum channel is supported on tripods constructed of 10.2- x 15.2-cm (4- x 6-in.) and 5.1- x 15.2-cm (2- x 6-in.) Douglas fir beams. The aluminum channel is oriented horizontally and the conduit is oriented vertically. The spacing between the conduit pieces is 5.7 cm. The trap construction is also the same as that noted above, except that vinyl tubing (as pipe sleeve) is not used. 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 three weirs were operated 7 days per week, 24 hours per day. Each was serviced every morning and usually staffed 24 hours per day during busy holiday weekends.

The snorkel survey is another element of this project which is already underway. We use a team of two to three individuals, equipped with mask, snorkel, wetsuit, anti-slip footwear or fins, and appropriate safety gear (i.e. rescue rope and first aid kit). We enter the river at approximately 9:00 AM and cover 7.0 to 9.7 km of river per day, depending on the length and difficulty of the river section. The team floats or swims down the river, and records the numbers of adult salmonids and the relative abundance of juvenile salmonids. We also note habitat type and condition, water temperature, presence of tributaries and their respective temperature, presence or absence of summer holding habitat, and other noteworthy features. The most difficult task is finding adult fish. We spend a great deal of effort searching beneath undercut rocks, ledges, vegetation, overhangs, etc., where adult fish hide during daylight hours. Some areas require a good deal of walking and investigation of pools, step-runs, glides, and other habitat types which afford good cover.

Other aspects of the project are spawner and carcass surveys, estimation of angler harvest, and determination of in-stream life history patterns. To accomplish the spawner survey, we will use an aerial survey conducted by helicopter to select sections of the river to be covered in detail by two-person crews, on-foot or in kayaks. The carcass recovery effort will focus on those areas covered in the spawner survey. We will also attempt to determine a tag shedding rate during the carcass survey. An angler harvest estimate will be generated, based upon tag returns and an on-going creel survey. In-stream life history patterns will be determined from analysis of adult and yearling scales, and a juvenile trapping and observation program to be performed during late winter and spring.

Use of Standard Julian Week

All 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 included in the 9th week, and the last day of the year is included in the 52nd week. This procedure allows inter-annual comparisons of identical weekly time periods (Appendix 1).

RESULTS AND DISCUSSION

Obviously, those portions of this project which are yet-to-be performed will not be discussed. Preliminary results and discussion are presented for those portions of the project which are still in progress. All results must be considered preliminary, since spring chinook are believed to have a bimodal entry pattern into the SFTR, and we may only have seen the early entering portion of the run as of 18 July 1991.

Trapping and Tagging

We operated the Gates Weir for 80 days, from 28 April through 18 July 1991. During this period, immigrant and emigrant traps were maintained. On 2 and 3 June we were not able to fish because of vandalism to the weir. We captured, marked, and released 34 adult and 9 grilse spring chinook, 8 unspawned adult winter-run and 18 adult spring-run steelhead from the immigrant trap. We captured, examined, and released 39 out-migrant (spawned) adult fall- or winter-run steelhead from the emigrant trap (Table 1).

Spring chinook captured at the Gates Weir averaged 60.4 cm FL (Figure 3). We established 55 cm FL as the length separating adults and grilse in the mainstem Trinity River. Until we obtain additional length data and analyze our scale collection, we will continue to use this value. However, current data are inadequate to make a final determination at this time. Length data for steelhead captured at the Gates Weir are reported in Chapter III of this annual report, and will not be discussed here.

Operation of the weir was largely successful, but we had some difficulty maintaining its effectiveness. Approximately one-third of the substrate covered by the weir was gravel and course sand. Early in the operation of the weir, as water levels began to drop, the current shifted such that it began to erode and undermine the gravel-based portion of the weir. Consequently, holes continuously formed beneath the weir, and for a few hours on some days fish could pass undetected. As soon as field staff arrived at the site, they would plug the holes with sand bags or large rocks. By late June, these efforts solved the erosion problems. Next season, weir panels will be arranged in a manner that will minimize the undercutting problem. In addition, a more aggressive maintenance schedule should prevent holes from reaching a size that will allow fish to escape past the weir.

TABLE 1. Trapping summary for Gates Weir in the South Fork Trinity River by Julian week from 28 April through 18 July 1991.

		Immigrant trap				Emigrant trap
		Spring-run chinook salmon		Steelhead		
Julian week	Start date	Adults	Grilse a/	Winter-run b/	Spring-run c/	Spawned winter-run steelhead
17	4/28/91	0	0	0	0	0
18	4/30/91	0	0	3	0	14
19	5/07/91	1	0	1	0	3
20	5/14/91	3	1	0	0	4
21	5/21/91	2	1	4	0	8
22	5/28/91	1	0	0	0	2
23	6/04/91	4	0	0	0	3
24	6/11/91	4	0	0	1	1
25	6/18/91	10	0	0	4	1
26	6/25/91	2	3	0	4	1
27	7/02/91	2	4	0	5	1
28	7/09/91	4	0	0	1	1
29	7/16/91	1	0	0	3	0
	TOTALS:	34	9	8	18	39

a/ Grilse are chinook salmon measuring ≤ 55 cm, adults are > 55 cm. This length cut-off is subject to revision.
b/ Fall- and winter-run steelhead are upstream-migrating, sexually mature fish.
c/ Spring-run steelhead are upstream-migrating, sexually immature fish.

The trap design was adequate, but could be improved. Because of the natural cobble bottom, we had some difficulty netting suckers and some steelhead. Our next trap will be constructed with a plywood bottom. The use of vinyl tubing on trap panels as abrasion prevention appears to work well, and will be utilized to a greater extent on our new trap. The nylon fabric, floating cover was very effective and will continue to be used unchanged.

The Floy Anchor tags were quick and easy to apply, and appeared to cause little discomfort to the fish. Depending on the results of our tag effects and tag-shedding study, their use may be continued next season. We hope to develop a tag-shedding rate during the carcass recovery portion of the project. Observations

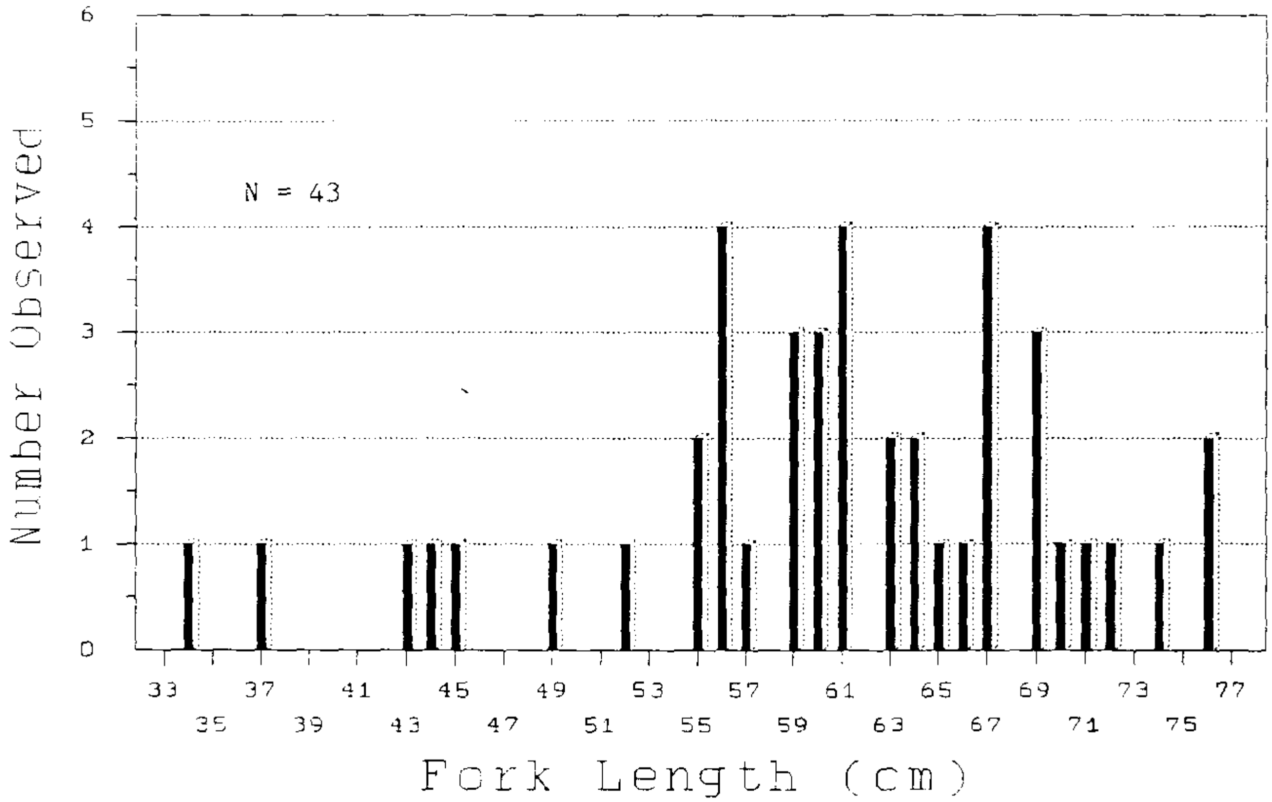

FIGURE 3. Fork length distribution of spring-run chinook salmon captured at the Gates Weir in the South Fork Trinity River from 28 April through 18 July 1991.

made during the snorkel surveys, spawner survey, and carcass recovery survey will be used to evaluate other possible tagging effects based on signs of fungus, bruising, necrosis, and differential mortality between tagged and untagged fish. If no fungus or other problems associated with tagging are apparent at the end of this season, all spring chinook trapped next season will be tagged as described. If application of Propolyaqua as a prophylaxis to fungus growth is effective, we will continue to use it. No tags had been returned as of 18 July 1991.

Since it has been unnecessary to anesthetize fish before tagging, next season we will utilize a tagging cradle which allows water to flow through it. The cradle will also be designed with a sliding door at the upstream end, so that fish can be released directly from it, thus eliminating one handling operation.

Recovery

As of 18 July 1991, no spring chinook had been captured at the Hayfork Creek Weir, while 14 had been captured at the Forest Glen Weir. Of these 14 fish, two were RV-clipped, indicating that they were processed through the Gates Weir. Since no tagged fish were recovered, no conclusions or discussion will be attempted at this point regarding our data (Table 2).

The thermographs worked very well and will continue to be used to monitor river temperatures. Data collections are incomplete at this time and, therefore, will not be reported.

As of 18 July 1991, only a small portion of the river had been examined via snorkel survey. The snorkel survey methodology appears adequate and will remain unchanged. Prior to the removal of the Gates Weir, a snorkel survey was completed for that

TABLE 2. Summary of spring-run chinook salmon recaptured at the Forest Glen Weir in the South Fork Trinity River by Julian week, through 18 July 1991.

Julian week	Date of capture	Fork length (cm)	Sex	Marks a/
24	6/11/91	67	F	None
	6/13/91	74	F	None
25	6/18/91	59	M	None
	6/22/91	72	F	None
	"	71	F	None
	"	50	b/	None
26	6/28/91	65	M	None
	6/29/91	60	M	None
	7/01/91	62	F	None
27	7/02/91	79	M	None
	7/04/91	63	F	RV c/
	"	40	M	None
	7/07/91	72	M	None
28	7/13/91	67	F	RV c/
	Size Range:	40 to 79		Total Fish = 14
	Average Size:	64.4		Total marks = 2

a/ Marks applied at Gates Weir.
b/ Sex was not determined for this fish.
c/ RV = right ventral fin clip.

portion of the river below the Gates Weir. Water temperatures ranged from morning lows of 15.5 to afternoon highs of 25°C. We observed 13 adult and one grilse spring chinook, including one dead, 76-cm female. The cause of death was not obvious but did not appear to be predation. However, thermal stress may have been a factor, as water temperatures reached 25°C.

Gill Net, Hook, and Predator Scars

As noted above, we captured and released 43 spring chinook and 65 steelhead at the Gates Weir. Only 15 percent of the steelhead captured showed scars compared to 67 percent of the spring chinook (Table 3).

TABLE 3. Summary of marks and scars observed on steelhead and spring-run chinook salmon captured at the Gates Weir in the South Fork Trinity River from 28 April through 18 July 1991.

Scar types	Number of steelhead captured	Percent of steelhead captured	Number of spring-run chinook captured	Percent of spring-run chinook captured
Gill net a/	4	6	11	25.6
Fresh hook b/	3	5	5	11.6
Ocean hook c/	0	-	1	2.3
Predator d/	2	3	8	18.6
Unknown e/	1	1	4	9.3

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.
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. Trapping efficiency at the Gates Weir should be improved through a different arrangement of weir panels and a more rigorous maintenance schedule.

2. A new, slightly larger trap with a plywood bottom should be used to improve dip-netting efficiency. It should also be fitted with a plywood lid and padlocked to prevent entry by

unauthorized persons. The use of vinyl tubing as a sleeve over the conduit of trap panels should be expanded in an effort to minimize abrasion to trapped fish.

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

Julian week	Calander dates		Julian week	Calander dates	
	Start	Finish		Start	Finish
01	Jan. 01	Jan. 07	27	Jul. 02	Jul. 08
02	Jan. 08	Jan. 14	28	Jul. 09	Jul. 15
03	Jan. 15	Jan. 21	29	Jul. 16	Jul. 22
04	Jan. 22	Jan. 28	30	Jul. 23	Jul. 29
05	Jan. 29	Feb. 04	31	Jul. 30	Aug. 05
06	Feb. 05	Feb. 11	32	Aug. 06	Aug. 12
07	Feb. 12	Feb. 18	33	Aug. 13	Aug. 19
08	Feb. 19	Feb 25	34	Aug. 20	Aug. 26
09	Feb. 26	Mar. 04 [a]	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. 29	Nov. 04
19	May 07	May 13	45	Nov. 05	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 [b]

[a] Eight-day week in each year which is divisible by 4.

[b] Eight-day week every year.

ANNUAL REPORT
TRINITY RIVER BASIN SALMON AND STEELHEAD MONITORING PROJECT
1990-1991 SEASON

CHAPTER VIII

JOB VIII
SPECIAL PROJECTS: TECHNICAL ANALYSES AND REPORT PREPARATION

by

Robert L. Reavis

ABSTRACT

I began my assignment on 1 April 1991 to compile, analyze and write-up or edit back-year accumulations of file data pertaining to studies conducted to determine survival and harvest rates of salmon and steelhead reared at Trinity River Hatchery. Preliminary analyses have been completed for the first of four high priority tasks developed to meet Job VIII's contract objectives.

JOB OBJECTIVES

1. To provide for the compilation, analysis, write-up or editing of multi-year accumulations of previously collected file data pertaining to 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

Klamath-Trinity Program management defined the following four high priority tasks as the first to be completed in fulfilling the Job Objectives mentioned above.

1. Survival and contribution to the fisheries and spawner escapements made by chinook salmon of the 1977-1979 and 1982-1984 brood years released at Trinity River Hatchery (TRH) and at locations downstream of the hatchery.

2. Survival and contribution to the fisheries and spawner escapements made by chinook salmon of the 1977-1979, 1983-1984 and 1986 brood years reared and released at TRH as fingerlings, yearlings and 1.5 year old fish.

3. Survival and contribution to the fisheries and spawner escapements made by coho salmon of the 1979-1982 brood years reared and released at TRH at various phases of the lunar cycle.

4. Survival and contribution to the fisheries and spawner escapements made by coho salmon of the 1976-1978 brood years reared and released at TRH, based on size of release.

RESULTS

I was appointed to fill this position on 1 April 1991 and began collecting tagging records and recovery data for the coded-wire tag groups used in the first study listed above. As of 30 June 1991, preliminary analysis was completed on the first study. The results of this analysis showed that survival was increased from three to ten fold by trucking and releasing fingerlings in the lower Trinity River. Although survival was increased, straying of fish returning to spawn was also increased. The survival of yearlings was increased by about 10 percent for groups planted 38 miles downstream of Trinity River Hatchery.