AGE, GROWTH, AND LIFE HISTORY OF KLAMATH RIVER BASIN STEELHEAD TROUT (*Oncorhynchus mykiss irideus*) AS DETERMINED FROM SCALE ANALYSIS

by

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ABSTRACT

Adult steelhead (*Oncorhynchus mykiss irideus*) scales were analyzed from eight fall-run, two spring-run, and one winter-run stocks within the Klamath-Trinity River system, from 1981 through 1983, to provide basic information on age, growth, and life history. The higher degree of half-pounder occurrence of upper Klamath River steelhead stocks (86.7 to 100%) compared to Trinity River steelhead stocks (32.0 to 80.0%) was the major life history difference noted in scale analysis. Early life history was similar for all areas sampled with most juveniles (86.4%) remaining in freshwater during the first two years of life before migrating to sea. Repeat spawning ranged from 17.6 to 47.9% for fall-run, 40.0 to 63.6% for spring-run, and 31.1% for winter-run steelhead. Mean length of adults at first spawning was inversely related to percent half-pounder occurrence in each stock. Ages of returning spawners, back calculated lengths at various life stages, and growth information are presented.

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PREFACE

This report represents the final form of a preliminary draft that was first completed in 1985. A subsequent draft, completed in 1987, was distributed widely and was cited as an unpublished document by many authors. The information contained in this final document is essentially the same as that contained in the earlier drafts, however, there are some minor revisions. The most substantial revision was standardizing the age notation to conform more closely with earlier published reports. It is hoped that the information in this report will provide current steelhead managers with background for initiating further investigations concerning steelhead stocks in the Klamath-Trinity River system.

INTRODUCTION

The Klamath-Trinity River basin, located in northern California and southern Oregon (Figure 1), is an important producer of anadromous salmonids and the number-one producer of steelhead trout (*Oncorhynchus mykiss irideus*) in California. The system supports spring and fall runs of chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and three distinct runs of steelhead: i) a winter run, entering the river from November through March, ii) a spring run entering the river from March through June, and iii) a fall run, entering the river from July through October.

Very little information has been published concerning the winter-run steelhead in the Klamath-Trinity River system. It generally receives little attention by sports persons, primarily because of relatively poor winter angling conditions. The size of the winter steelhead run is unknown but, based on limited angler and Indian gill net harvest data, I believe the magnitude was about 5,000 to 25,000 adults during the years 1980-82. Annual counts (1980-82) of spring-run steelhead in holding areas throughout the system have ranged from 500 to 3,000 adult-size fish (Roeloffs 1983). The fall run is by far the largest of the three runs and supports the most popular steelhead sport fishery in California. Fall steelhead run size during the years 1980-82 was estimated to include 55,000 to 75,000 adults and 150,000 to 225,000 non-spawning fish called half-pounders (D.P. Lee, CDFG, pers. comm.). Half-pounders are immature steelhead, 25 to 41 centimeters (cm) fork length (FL), that return to fresh water 3 to 4 months after initial entry into salt water. This phenomenon is unique to streams located in extreme northern California and southern Oregon (Kesner and Barnhart, 1972; and Everest 1972).

Limited information regarding Klamath-Trinity River system steelhead life history, or age and growth based on scale analysis is available. Kesner and Barnhart (1972) provide life history and growth information in their description of angler-caught half-pounders from the lower Klamath River. Freese (1982) presented age and life history information of adult spring steelhead from North Fork Trinity and New rivers. Winter (1983) analyzed Wooley Creek and Elk Creek spring steelhead otolith and scale morphology in an attempt at racial separation. More recently, steelhead life history and age during freshwater and ocean periods have been described based on scale interpretations from steelhead in the South Fork Trinity River (Mills and Wilson 1991, Wilson and Mills 1992, and Collins and Wilson 1994).

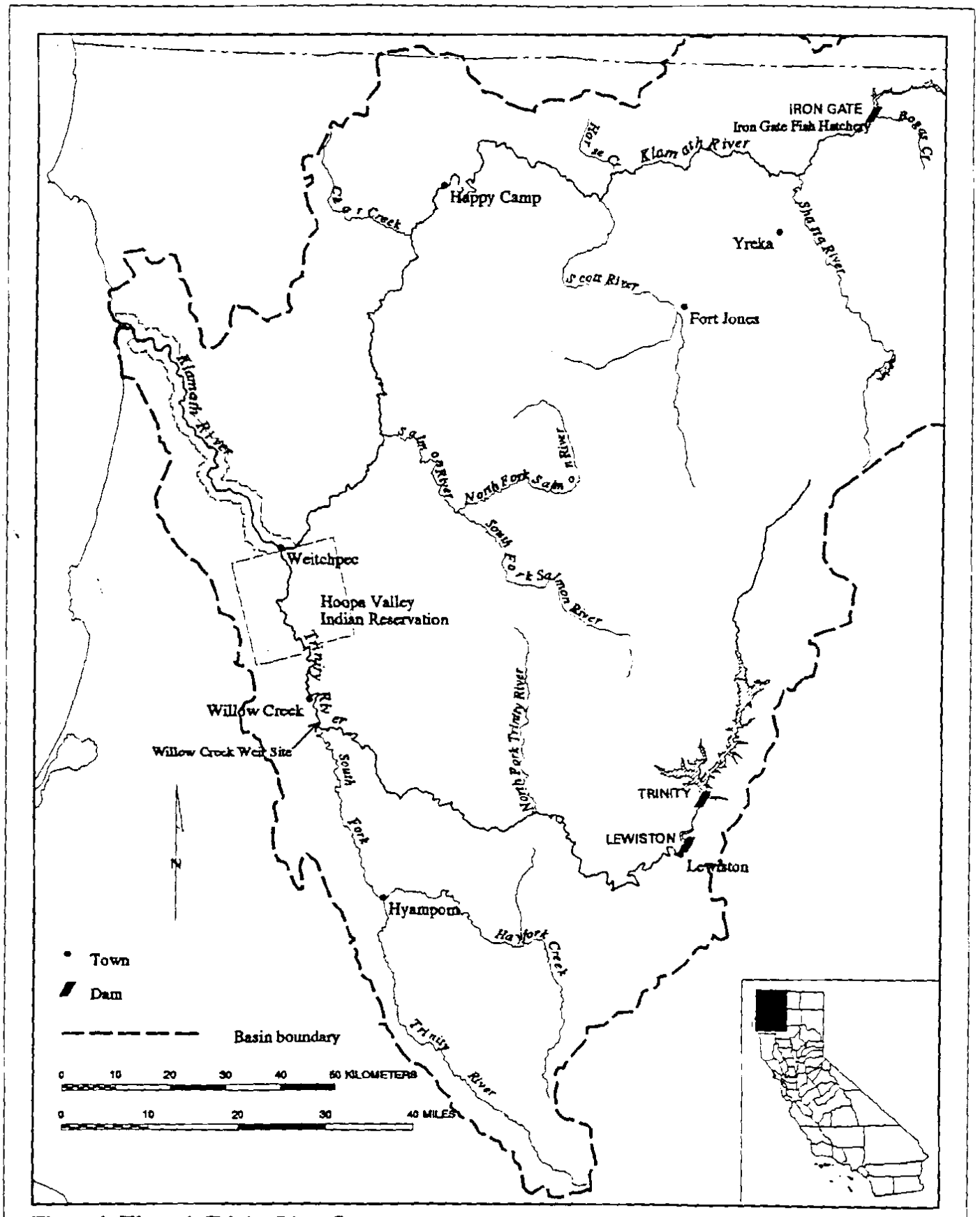

Figure 1. Klamath-Trinity River System

Understanding basic life history characteristics of the individual steelhead runs and relationships between the runs is of fundamental importance for proper management of the Klamath-Trinity River basin steelhead resource. The purpose of this report is to provide additional information on steelhead life history in terms of age, occurrence of half-pounder phenomenon, spawning frequency, growth, and a general comparison of life history and growth characteristics among the three steelhead runs of the Klamath-Trinity River system.

METHODS

The sampling objective was to obtain scale samples from a minimum of 25 adult steelhead during each annual upstream spawning migration in major Klamath-Trinity River steelhead spawning tributaries and Iron Gate Hatchery (IGH). Electrofishing and angling were used to capture steelhead in most tributaries. All Shasta River, 1982 Bogus Creek, and IGH samples were obtained from California Department of Fish and Game (CDFG) trapping facilities. Hatchery samples include unmarked (assumed to be wild) steelhead only. Winter-run steelhead scales were collected by U.S. Fish and Wildlife Service (USFWS) biologists in 1980 from Indian gill-net-caught steelhead.

The race of each steelhead stock sampled was assumed based on river location and time of capture. For example, steelhead captured in the North Fork Trinity River in July and August were assumed to be spring run because it is unlikely that fall-run individuals would have entered freshwater and traveled over 140 miles in about a month. Similarly, steelhead captured in the lower Klamath River below Weitchpec in February and March were assumed to be winter run because of their close proximity to the river mouth and their bright appearance, suggesting they recently entered freshwater. In addition, race was assumed in specific tributaries based on CDFG file information. For example, CDFG file information indicates no known spring-run steelhead in the Scott or Shasta rivers, Bogus Creek or IGH, therefore, all steelhead in these areas were assumed to be fall run. Although the Salmon River system is known to contain spring-run steelhead, fish were captured in areas not in close proximity to known spring-run steelhead holding areas. I assumed steelhead captured in the Salmon River for this study were fall-run.

Scale samples were taken from an area below the posterior margin of the dorsal fin and two scale rows above the lateral line. Scale-sampled steelhead were measured to the nearest cm FL, and the gender, and location and date of capture noted.

Scales were mounted dry on a standard microscope slide and held in place with a cover slip and transparent tape. Scale images were projected using a Bell and Howell microfiche reader. Interpretation of scale patterns was performed by the author using standard techniques of annuli and spawning check identification (Lagler 1956). Measurements of scales to the nearest millimeter (mm) were taken along a line about 15 degrees on either side of the longitudinal axis. Annulus or check areas were measured from the scale center to the anterior or outer margin of the annulus or check.

Scales that were difficult to interpret were read and analyzed a second time approximately two weeks later. Scales that could not be interpreted with confidence at the second reading were read

and analyzed by a another trained individual. If agreement could not be reached, the scale was discarded.

An important aspect of scale reading is the development of references that verify or support interpretations from circuli patterns on the scales. I developed a reference collection of scales from known steelhead life stages that ranged from Age 1 and 2 wild juveniles, hatchery smolts, smolts in the Klamath River estuary, upstream migrating half-pounders, to spawning adults. Circuli patterns at these various known life stages were used as training aids and as verification ("ground truthing") during interpretation of scale information from subsequently sampled adults.

Life history stages were categorized into six general periods: 1) freshwater years, 2) plus growth (growth after freshwater annulus formation and before ocean entry), 3) ocean entry, 4) ocean or salt water years, 5) half-pounder occurrence, and 6) spawning.

Age notation used in this report is similar to that used by Shapovalov and Taft (1954), except an additional character 'h' was included to represent half-pounder occurrence. The following is an example of notation:

2/h.1s

Where: freshwater years are left of slash
saltwater years are right of slash
h = half-pounder run occurred
s = number of spawning runs

In the above example, the fish spent two years in freshwater, returned from the ocean as a half-pounder during its first ocean year, and returned to spawn during its second ocean year. Total age is four years.

In another example: 2/1.1s represents an age four-year fish that spent two years in freshwater and two years in the ocean, returning during the second ocean winter to spawn.

Fish lengths at various life stages were back-calculated using the Lee method (Carlander 1981):

$$Li = \underline{c} + \frac{Si(L-\underline{c})}{S}$$

where: Li = fish length at point (i) in cm
Si = scale length at point (i) in mm
$\underline{c}$ = body scale constant = 3.0 cm
S = total scale radius in mm
L = fish length at capture (cm FL)

The body scale constant is the fish length at which scale formation first begins. A scale radius-body length regression of steelhead in my sample yielded an intercept of 3.0 cm (1.2 in.) for all

three runs. This agrees with a C value of 3.01 cm (1.2 in.) for Klamath River fall-run steelhead determined by Kesner and Barnhart (1972)

Only scales exhibiting less than two spawning checks were used for back calculations. Scale margin erosion and regeneration of scale material from fish with two or more spawning checks was generally too severe for reliable back calculation results.

RESULTS

Sample Sites

Shasta River

Scale samples were taken from 119 adult fall-run steelhead between December and March, 1981 through 1983. Mean length of fish sampled was 55.2 cm (21.7 in.) FL, and ranged from 43 to 70 cm (16.9 to 27.6 in.) FL. The most common age categories represented on the scales were 2/h.1s (47.9%), 2/h.2s (23.5%), and 2/h.3s (16.0%) (Table 1). Based on scale interpretation, during the juvenile rearing period 94.1 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 94.1 percent (Table 2), and repeat spawners comprised 47.9 percent of the sample (Table 3).

Scott River

Scale samples were taken from 78 adult fall-run steelhead between December and March, 1981 through 1983. Mean length of fish sampled was 52.1 cm (20.6 in.) FL, and ranged from 42 to 69 cm (16.5 to 27.2 in.) FL. The most common age categories represented on the scales were 2/h.1s (62.8%) and 2/h.2s (19.2%)(Table 1). Based on scale interpretation, during the juvenile rearing period 89.7 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 96.1 percent (Table 2), and repeat spawners comprised 26.9 percent of the sample (Table 3).

Salmon River

Scale samples were taken from 15 adult fall-run steelhead captured by angling between January and March, 1981 through 1983. Mean length of fish sampled was 51.1 cm (20.1 in.) FL, and ranged from 40 to 63 cm (15.7 to 22.4 in.) FL. The most common age category represented on the scales was 2/h.1s (66.7%)(Table 1). Based on scale interpretation, during the juvenile rearing period 93.3 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 86.7 percent (Table 2), and repeat spawners comprised 26.7 percent of the sample (Table 3).

Table 1. Steelhead age category summary as determined by scale analysis from adult steelhead from selected areas of the Klamath-Trinity River system.

Sample location	First-time spawners												
	2/1s[1]	3/1s	1/1.1s	2/1.1s	3/1.1s	1/h.1.1s	2/h.1.1s	2/2.1s	3/2.1s	1/h.1s	2/h.1s	3/h.1s	n[2]
Shasta River				3							57	2	62
Scott River			1	1						3	49	3	57
Salmon River				1							10		11
Bogus Creek										10	44	2	56
Horse Creek											4		4
Clear Creek											4		4
Iron Gate Hatchery	1			2		1	1			9	56	1	71
Trinity River (Willow Cr. Weir)	1									3	27		31
N. Fork Trinity R.			1	9			1	1			2		14
S. Fork Trinity R.	4	1		7			1	3	1	1	5		23
Lower Klamath R.	1			18	2		3	5			1		30

1/ Age notation: numbers to left of slash represent years in freshwater, numbers to right of slash represent years in saltwater. "h" indicates half-pounder run, "s" indicates a spawning run. Example: 2/h.1s indicates a four-year old fish that spent two years in freshwater, and two ocean years with a half-pounder run and a spawning run.

2/ "n" represents number of fish sampled

Table 1 (continued). Steelhead age category summary as determined by scale analysis from adult steelhead from selected areas of the Klamath-Trinity River system.

Sample location	Second-time spawners									
	1/2s[1]	2/2s	3/2s	1/h.2s	2/h.2s	3/h.2s	1/1.2s	2/1.2s	2/h.1.2s	n[2]
Shasta River		1	1		28	1		2	2	35
Scott River		1		1	15					17
Salmon River			1		3					4
Bogus Creek	1	4	1		6					12
Horse Creek					2					2
Clear Creek					7					7
Iron Gate Hatchery				16	25	1		1		43
Trinity River (Willow Cr. Weir)		7		2	4			1		14
N. Fork Trinity R.		3		1	4			2		10
S. Fork Trinity R.				1	2			4		7
Lower Klamath R.		2	1		3		1	6	1	14

1/ Age notation: numbers to left of slash represent years in freshwater, numbers to right of slash represent years in saltwater. "h" indicates half-pounder run, "s" indicates a spawning run. Example: 2/h.1s indicates a four-year old fish that spent two years in freshwater, and two ocean years with a half-pounder run and a spawning run.

2/ "n" represents number of fish sampled

Table 1 (continued). Steelhead age category summary as determined by scale analysis from adult steelhead from selected areas of the Klamath-Trinity River system.

Sample location	Third-time spawners							Fourth-time spawners		
	1/3s[1]	2/3s	3/3s	1/h.3s	2/h.3s	3/h.3s	n[2]	2/h.4s		n
Shasta River				3	19		22			
Scott River					2		2	2		2
Salmon River										
Bogus Creek										
Horse Creek						1	1			
Clear Creek										
Iron Gate Hatchery			1	1	3		5			
Trinity River (Willow Cr. Weir)										
N. Fork Trinity R.		1					1			
S. Fork Trinity R.		1	1		2		4			
Lower Klamath R.		1					1			

1/ Age notation: numbers to left of slash represent years in freshwater, numbers to right of slash represent years in saltwater. "h" indicates half-pounder run, "s" indicates a spawning run. Example: 2/h.1s indicates a four-year old fish that spent two years in freshwater, and two ocean years with a half-pounder run and a spawning run.

2/ "n" represents number of fish sampled

Table 2. Comparison of half-pounder occurrence as determined from adult steelhead scales in the Klamath-Trinity River System.

Stream	Percent of sample with half-pounder check	Sample size
Shasta River	94.1	119
Scott River	96.1	78
Salmon River	86.7	15
Bogus Creek	91.2	68
Iron Gate Hatchery	95.8	119
Trinity River (Willow Creek weir)	80.0	45
N.F. Trinity River	32.0	25
S.F. Trinity River	35.3	34
Lower Klamath River (winter run)	17.8	45
Clear Creek	100.0	11
Horse Creek	100.0	7

Table 3. Comparison of adult steelhead spawning frequency in selected tributaries of the Klamath-Trinity River System as determined from scales.

Stream	Spawning migration				Sample Size
	First	Second	Third	Fourth	
	Percent of sample				
Shasta River	52.1	29.4	18.5		119
Scott River	73.1	21.8	2.6	2.6	78
Salmon River	73.3	26.7			15
Bogus Creek	82.3	17.6			68
Iron Gate Hatchery	59.7	36.1	4.2		119
Horse Creek	57.1	28.6	14.3		7
Clear Creek	36.4	63.6			11
Trinity River (Willow Cr. weir)	68.9	31.1			45
S.Fork Trinity River	67.6	20.6	11.8		34
N.Fork Trinity River	56.0	40.0	4.0		25
Lower Klamath River	66.7	31.1	2.2		45

Bogus Creek

In 1982 and 1983 adult fall-run steelhead were collected in Bogus Creek between January and March by electrofishing and trapping at the CDFG temporary weir. Scale samples were taken from 68 fish for analysis. Mean length of fish sampled was 50.2 cm (19.7 in.) FL, and ranged from 41 to 66 cm (16.1 to 26.0 in.) FL. The most common age categories represented on the scales were 2/h.1s (64.7%)(Table 1). Based on scale interpretation, during the juvenile rearing period 79.4 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 91.2 percent (Table 2), and repeat spawners comprised 17.6 percent of the sample (Table 3).

Horse Creek

Scale samples were taken from seven adult fall-run steelhead captured by electrofishing during February 1981. Mean length of fish sampled was 56.9 cm (22.4 in.) FL, and ranged from 39 to 58 cm (15.4 to 22.8 in.) FL. The most common age category represented on the scales was 2/h.1s (57.1%)(Table 1). Based on scale interpretation, during the juvenile rearing period 85.7 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 100 percent (Table 2), and repeat spawners comprised 42.8 percent of the sample (Table 3).

Iron Gate Hatchery
Scale samples were taken from 119 adult fall-run steelhead captured during February and March, 1980 through 1983. Mean length of fish sampled was 51.2 cm (20.2 in.) FL, and ranged from 46 to 64 cm (18.1 to 25.2 in.) FL. The most common age categories represented on the scales were 2/h.1s (47.0%), 2/h.2s (21.0%), and 1/h.2s (13.4%) (Table 1). Based on scale interpretation, during the juvenile rearing period 74.8 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 95.8 percent (Table 2), and repeat spawners comprised 40.3 percent of the sample (Table 3).

Trinity River (between Willow Creek and Burnt Ranch)
Scale samples were taken from 45 adult fall-run steelhead captured between August and October 1982. Mean length of fish sampled was 54.7 cm (21.5 in.) FL, and ranged from 44 to 61 cm (17.2 to 24.0 in.) FL. The most common age categories represented on the scales were 2/h.1s (60.0%), and 2/2s (15.5%) (Table 1). Based on scale interpretation, during the juvenile rearing period 88.9 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 80 percent (Table 2), and repeat spawners comprised 31.1 percent of the sample (Table 3).

South Fork Trinity River
Scale samples were taken from 34 adult steelhead captured during November and December 1981, and during February and March 1982. Mean length of fish sampled was 61.0 cm (24.0 in.) FL, and ranged from 41 to 76 cm (16.1 to 29.9 in.) FL. The most common age categories represented on the scales were 2/1.1s (20.6%), 2/h.1s (14.7%), 2/1s (11.8%), and 2/1.2s (11.8%) (Table 1). Based on scale interpretation, during the juvenile rearing period 85.3 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 35.3 percent (Table 2), and repeat spawners comprised 32.3 percent of the sample (Table 3).

North Fork Trinity River
Scale samples were taken from 25 adult spring-run steelhead captured during July and August 1983. Mean length of fish sampled was 57.6 cm (22.7 in.) FL, and ranged from 50 to 66 cm (19.7 to 26.0 in.) FL. The most common age categories represented on the scales were 2/1.1s (36.0%), 2/h.2s (16.0%), and 2/2s (12.0%) (Table 1). Based on scale interpretation, during the juvenile rearing period 92.0 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1), a half-pounder cycle occurred in 32.0 percent (Table 2), and repeat spawners comprised 44.0 percent of the sample (Table 3).

Clear Creek
Scale samples were taken from 11 adult spring-run steelhead captured during August 1980 and October 1981. Mean length of fish sampled was 48.6 cm (19.1 in.) FL, and ranged from 38 to 56 cm (15.0 to 22.0 in.) FL. Only two age categories were represented on the scales, 2/h.2s (63.6%) and 2/h.1s (36.4%) (Table 1). Based on scale interpretation, during the juvenile rearing period 100 percent remained in freshwater for two years prior to emigrating to the ocean as smolts (Table 1). A half-pounder run was observed in all fish sampled (Table 2). Repeat spawners comprised 63.6 percent of the sample (Table 3).

Lower Klamath River

Scale samples were taken from 45 adult winter-run steelhead captured in gill nets during February and March 1980. Mean length of fish sampled was 66.4 cm FL, and ranged from 55 to 83 cm FL. The most common age categories were 2/1.1s (40.0 %), and 2/1.2s (13.3%) (Table 1). Most juveniles, 91.1 percent, remained in freshwater for two years before emigrating to the ocean. A half-pounder cycle was observed in 17.8 percent of the fish sampled (Table 2). Repeat spawners comprised 33.3 percent of the sample (Table 3).

Growth

Steelhead juvenile mean growth in freshwater was similar for all tributaries and runs sampled. For all tributaries, back-calculated mean lengths at the end of the first freshwater annulus ranged from 8.6 to 10.3 cm (3.4 to 4.1 in.) (Table 4). Mean freshwater growth between the first and second annuli ranged 5.3 to 7.4 cm (2.1 to 2.9 in.) (Table 5). Mean plus growth, from the end of the last freshwater annulus to ocean entry, a period of 2 to 4 months, ranged from 4.8 to 8.0 cm (1.9 to 3.1 in.) (Table 5).

DISCUSSION

Fall Run

Areas known to have fall runs of steelhead that were sampled included IGH, Shasta, Scott, and Salmon rivers, and Bogus and Horse creeks. In general, steelhead from these areas exhibited the following characteristics: a) juveniles remained in freshwater for two years prior to emigrating to the ocean, b) mean lengths of smolts at ocean entry range from 21 to 23 cm FL, c) 86 to 100 percent return as half-pounders, d) most return to spawn for the first time the year following their half-pounder run, e) 15 to 30 percent return to spawn a second time, and f) up to 20 percent return to spawn a third time.

It is assumed steelhead captured from the Trinity River near Willow Creek, Burnt Ranch Falls and Greys Falls during the month of October were fall run. However, they differ significantly (Chi-square, $P<0.05$) from the other fall run listed above by showing a lower half-pounder rate of 64.4 percent. Other life history characteristics appear to be similar for fall-run steelhead from the Klamath and Trinity rivers.

Steelhead sampled from the South Fork Trinity River were thought to be fall run. However, the diversity of life history stages (unlike all other fall-run steelhead samples) raises the question of this sample being strictly fall run. Mean length of adults sampled from the South Fork Trinity River was significantly larger than fall-run steelhead sampled from all other areas (T-test, $P<0.05$). Interestingly, mean lengths of South Fork Trinity River adult steelhead (assumed to be fall-run) were comparable to mean lengths from North Fork Trinity River spring-run and lower Klamath

TABLE 4. Mean lengths (cm FL) of Klamath-Trinity River Steelhead at Various Life History Stages as Determined from Scale Calculations from First-time Spawners that Emigrated to the Ocean after Two Years in Freshwater.

Stream	Sample years	Sample size	Years in Freshwater 1	Years in Freshwater 2	Ocean entry	First ocean check 1/	First spawning
			----------Centimeters fork length----------				
Shasta River	81-83	62	9.3	14.8	22.6	36.2	50.1
Scott River	81-83	55	9.5	15.3	22.1	35.8	48.8
Bogus Creek	82-83	57	9.5	14.8	22.8	36.2	48.7
Salmon River	83	14	9.2	14.9	20.8	37.1	50.4
Iron Gate Hatchery	83	29	10.3	17.2	23.7	36.9	49.3
Trinity River (Willow Creek)	82	31	8.8	14.4	19.2	37.3	51.7
N.Fork Trinity River (spring run)	83	17	8.8	15.2	20.1	47.5	58.9
S.Fork Trinity River	82	24	9.6	17.0	22.0	43.7	58.2
Lower Klamath River (winter run)	80	30	9.9	16.7	21.6	48.7	64.8
Horse Creek	81	7	9.1	15.6	20.6	30.3	40.4
Clear Creek (spring run)	80	11	8.6	14.5	22.4	34.0	44.5

1/ The first ocean check is the half-pounder check for those individuals re-entering freshwater after a few months in the ocean.

Table 5. Growth of Klamath-Trinity River system steelhead between selected life history stages as determined from scale analysis.

Stream	Intervals between life history stages: 1 FW [1] to 2 FW	2 FW to Ocean entry	Ocean entry to 1 ocean [2]	1 ocean to 2 ocean [3]
	Mean lengths in centimeter fork length			
Fall Run				
Shasta River	5.5	7.8	13.6	13.9
Scott River	5.8	6.8	13.7	13.0
Salmon River	5.7	5.9	16.3	13.3
Bogus Creek	5.3	8.0	13.4	12.5
Iron Gate Hatchery	6.9	6.5	13.2	12.4
Horse Creek	6.5	5.0	9.7	10.1
Trinity River Willow Creek weir	5.6	4.8	18.1	14.4
S. Fork Trinity River	7.4	5.0	21.7	14.5
Spring Run				
N. Fork Trinity River	6.4	4.9	27.4	11.4
Clear Creek	5.9	7.9	11.6	10.5
Winter Run				
Lower Klamath River	6.8	4.9	27.1	16.1

1/ FW = Fresh water
2/ 1 Ocean = first ocean annulus or half-pounder check.
3/ 2 Ocean = second ocean annulus or first spawning check.

River winter-run adult steelhead. The half-pounder rate of 41.2 percent for South Fork Trinity River fall-run steelhead is significantly lower (Chi-square, $P<0.5$) than any other fall-run samples. Either this run is unique or the sample contained mixed runs.

Winter Run

Steelhead sampled from the lower Klamath River were assumed to be winter run, based on the time and location of capture. Based on a bright silvery appearance, these fish appeared to have recently entered the river. This conclusion is supported by the fact they were captured at approximately river-mile 12 during February and March. Their spawning destination is unknown.

Lower Klamath River winter-run steelhead life history characteristics were more similar to North Fork Trinity River spring-run steelhead than upper Klamath River stocks. Lower Klamath River winter-run steelhead had the lowest incidence of half-pounder occurrence of all areas sampled, 17.8 percent. North Fork Trinity River spring-run steelhead half-pounder occurrence of 32.0 percent was also relatively low compared to upper Klamath River locations. Incidence of repeat spawning (33.3%), and length at various life stages were also more similar to Trinity River stocks than to upper Klamath River stocks (Table 4). Approximately 91 percent of Klamath River winter-run steelhead juveniles enter the ocean at age two, compared with 68 percent of age-two juveniles entering the ocean from Waddell Creek as reported by Shapovalov and Taft (1954). Repeat spawners also made up a greater proportion of the winter steelhead run in the Klamath River than representative smaller coastal streams like Waddell Creek, 33.3 and 17.1 percent, respectively. However, mean lengths of similar age adults (same number of freshwater and ocean years) were comparable in both Klamath River and Waddell Creek winter steelhead runs, 64.8 and 68.0 cm FL, respectively.

Spring Run

Clear Creek spring-run steelhead exhibited scale characteristics more similar to upper Klamath River fall-run steelhead than the other spring-run stock sampled from the North Fork Trinity River. Clear Creek spring-run half-pounder incidence of 100% differed significantly with North Fork Trinity River spring-run half-pounder rate of 32.0% (Chi-square, $P < 0.05$). Mean lengths at various juvenile life stages were comparable with North Fork Trinity River spring-run steelhead, however, mean lengths at first and second ocean annuli were significantly different for the two spring-run stocks (T-test, $P <0.05$).

North Fork Trinity River spring-run steelhead differed significantly (Chi-square, $P <0.05$) in many scale characteristics compared to fall-run steelhead, but were similar in many respects to winter-run steelhead. Half-pounder incidence was only 32.0 percent in North Fork Trinity River spring-run steelhead compared to 93.5 percent for upper Klamath River fall-run steelhead, but nearly twice that of lower Klamath River winter run which had a half-pounder incidence of 17.8 percent. Freese (1982) reports a half-pounder incidence of 41.5 percent from North Fork Trinity River spring-run samples.

Fresh water growth of North Fork Trinity River spring-run steelhead was similar to all other sample locations (Table 5 and Figure 2). The majority (92%) of North Fork Trinity River spring-

run steelhead remained in freshwater for two years prior to emigration. Freese (1982) found 95.1 percent of North Fork Trinity River spring-run steelhead exhibited two years of stream growth prior to emigration.

Klamath River winter-run and North Fork Trinity River spring-run steelhead had similar mean lengths at all life history stages (differences not statistically significant, $P > 0.05$) except the 2-ocean stage.

Although freshwater characteristics of spring-run stocks are similar with all other fall-run and winter-run stocks, ocean life history is much more diverse compared to fall-run stocks. A similar broad spectrum of ocean age history occurred in lower Klamath River winter-run and South Fork Trinity River fall-run scale samples (Table 1).

This study was limited in scope, and some locations (Salmon River, Clear Creek and Horse Creek) were represented by relatively small samples. Conclusions of life history descriptions or growth rates of specific steelhead stocks should be viewed with caution because of the many variable environmental conditions (e.g. river and ocean temperature, stream flows, storms, and ocean upwelling) that were not identified or accounted for in this study. These data are intended to be viewed as trend or framework pieces that partly describe a complex Klamath-Trinity River system steelhead population.

It is generally accepted that the ocean environment produces better growth than the freshwater environments. First year ocean mean growth varies substantially among Klamath-Trinity River system steelhead stocks, depending upon the degree of half-pounder occurrence. In general, longer periods spent in the ocean produce greater absolute growth. There is a strong inverse

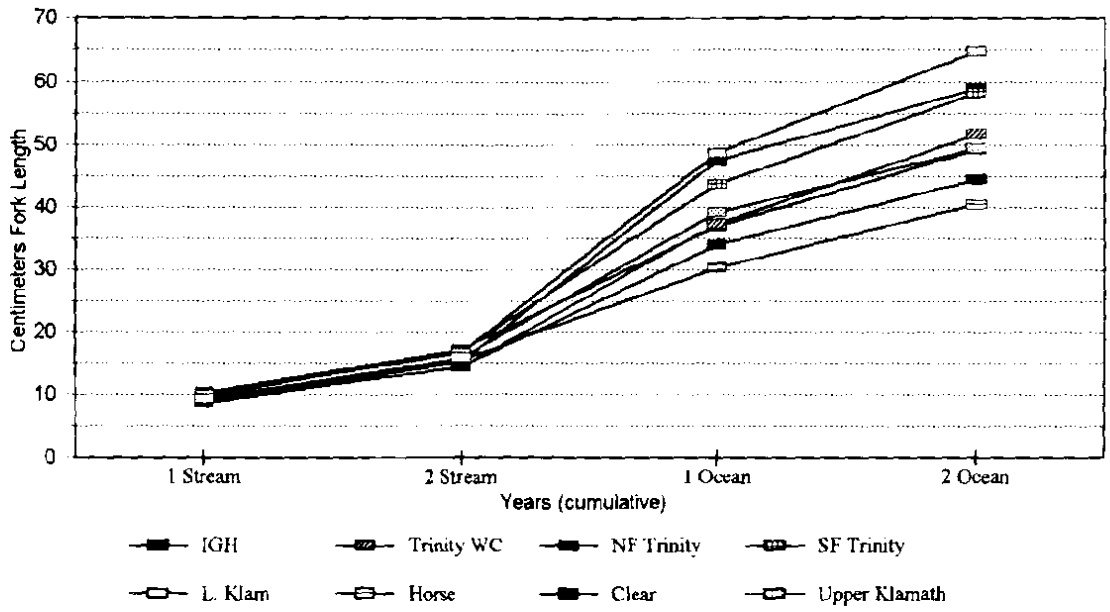

Figure 2. Mean lengths at four life history stages for selected Klamath-Trinity River system steelhead stocks.

linear relationship ($r^2 = 0.87$) between rate of occurrence of half-pounder migration and length at first-time spawning for individual stocks (Figure 3).

For steelhead stocks demonstrating a half-pounder phase, mean growth from ocean entry and return to freshwater as half-pounders (an average period of three months) is 10.2 cm (4.0 in.). Everest (1973) reported a similar growth of 11.9 cm (4.7 in.) during the same three-month period

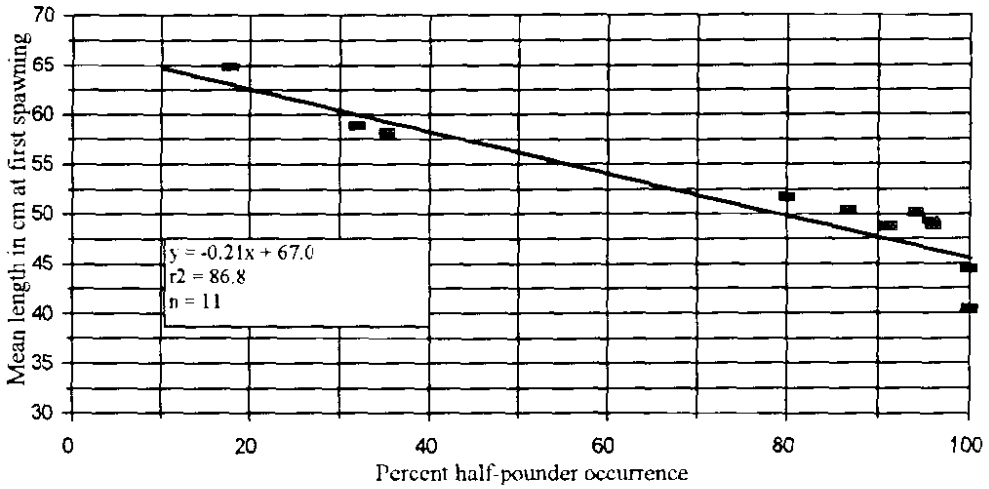

Figure 3. Relationship between percent half-pounder occurrence and mean length at maiden spawning for selected Klamath-Trinity River system steelhead stocks.

for Rogue River steelhead half-pounders. An additional average length of 2.4 cm (1.0 in.) is added during the half-pounder's stay in freshwater.

North Fork Trinity River spring-run and Klamath River winter-run steelhead stocks do not generally return as half-pounders and have first-year ocean growth ranging from 27.1 to 27.4 cm (10.7 to 10.8 in.). Stocks with intermediate degrees of half-pounder occurrence (Trinity River and South Fork Trinity River fall-runs) exhibit a corresponding intermediate growth of 18.1 to 21.7 cm (7.1 to 8.5 in.) during the first ocean growth period (Table 5).

Second year ocean growth is also directly related to amount of time spent in the ocean. Monthly growth rates are highest for spring-run fish and lowest for winter-run fish (Table 6). The amount of absolute growth, however, appears to be a function of ocean duration. Spring-run steelhead spend an estimated 2 to 4 months in the ocean after the end of the first ocean annulus and increase in length 10.5 to 11.4 cm (4.1 to 4.5 in.) before the first spawning . Fall-run steelhead spend an estimated 4 to 7 months in the ocean after the half-pounder check and increase in length 12.4 to 14.5 cm (4.9 to 5.7 in.) before making the first spawning run. Everest (1973) reported Rogue River steelhead averaged 5.2 inches of growth between the half-pounder event and first spawning. Winter-run steelhead spend an estimated 9 to 12 months in the ocean after the first ocean annulus and exhibit an increase in mean length of 16.1 cm (6.3 in.) before the first spawning.

Mean lengths obtained from the various stocks examined at the end of the first and second growing seasons in the ocean may be related to genetic differences or to ocean productivity. Klamath River winter-run and Clear Creek spring-run steelhead samples represent similar brood years but significantly different mean lengths at adult life stages (t_test, $P<0.05$). Trinity River adult steelhead stocks are typically larger than Klamath River adult steelhead stocks for similar brood years. Comparison of mean lengths of first-time spawners revealed that upper Klamath River steelhead were significantly smaller than Trinity River steelhead (t-test, $P<0.05$) (Figure 2 and Table 4). The mean size differences of adult first-time spawners among the stocks sampled appears to be related directly to the percent of half-pounder occurrence within each stock (Figure 3). The simple explanation for this phenomenon is that increased time spent in the ocean produces greater length of adults.

SUMMARY

Main stem Klamath River tributaries upstream of the confluence of the Trinity River have the highest incidence of half-pounder occurrence within the Klamath-Trinity River system. Fall-run steelhead sampled from five streams and IGH had a mean half-pounder incidence of 94.3 percent, ranging from 86.7 to 100 percent. Everest (1973) reported a 97 percent half-pounder incidence for fall-run steelhead (these fish are called summer-run in Oregon) in the Rogue River.

South Fork Trinity River fall-run steelhead and North Fork Trinity River spring-run steelhead had nearly identical rates of half-pounder occurrence, 35.3 and 32.0 percent, respectively. Both of these rates were significantly lower than half-pounder occurrence observed from steelhead sampled in the main stem Trinity River near Willow Creek (80.0 %) (Chi-square, $P<0.05$).

Half-pounder occurrence from winter-run steelhead in the lower Klamath River was the lowest of all stocks sampled at 17.8 percent.

All Klamath-Trinity River system wild steelhead exhibit similar freshwater age and growth characteristics. Age at smolt emigration occurred at the following mean percentages: Age 1 at 9.9, Age 2 at 86.4, and Age 3 at 3.7.

Incidence of repeat spawning for the steelhead stocks sampled ranged from 17.6 to 47.9 percent for fall run, 40.0 to 63.6 percent for spring run, and 31.1 percent for winter run.

Mean length of upper Klamath River and Trinity River fall-run first-time spawners is 49.5 and 51.7 cm FL (19.5 and 20.3 in.), respectively. North Fork Trinity River spring-run first-time spawners averaged 58.9 cm FL (23.2 in.). Lower Klamath River winter-run first-time spawners averaged 64.8 cm FL (25.5 in.). All of these differences are statistically significant (T-test,$P<0.05$).

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OBJECTIVES

From the fall of 1977 through the spring of 1983, personnel of the California Department of fish and Game (CDFG) conducted investigations of returning steelhead trout populations in the Klamath-Trinity basin.

the objectives of these investigations were to:

1. Determine the size composition, distribution, and timing size of the Klamath River system fall steelhead population.
2. Determine the harvest of Klamath River system fall steelhead populations.
3. Determine the rates at which steelhead produced at Trinity River and Iron Gate hatcheries (TRH and IGH) return to the Klamath River system, and the contributions these fish make to the fisheries of the Klamath River system.

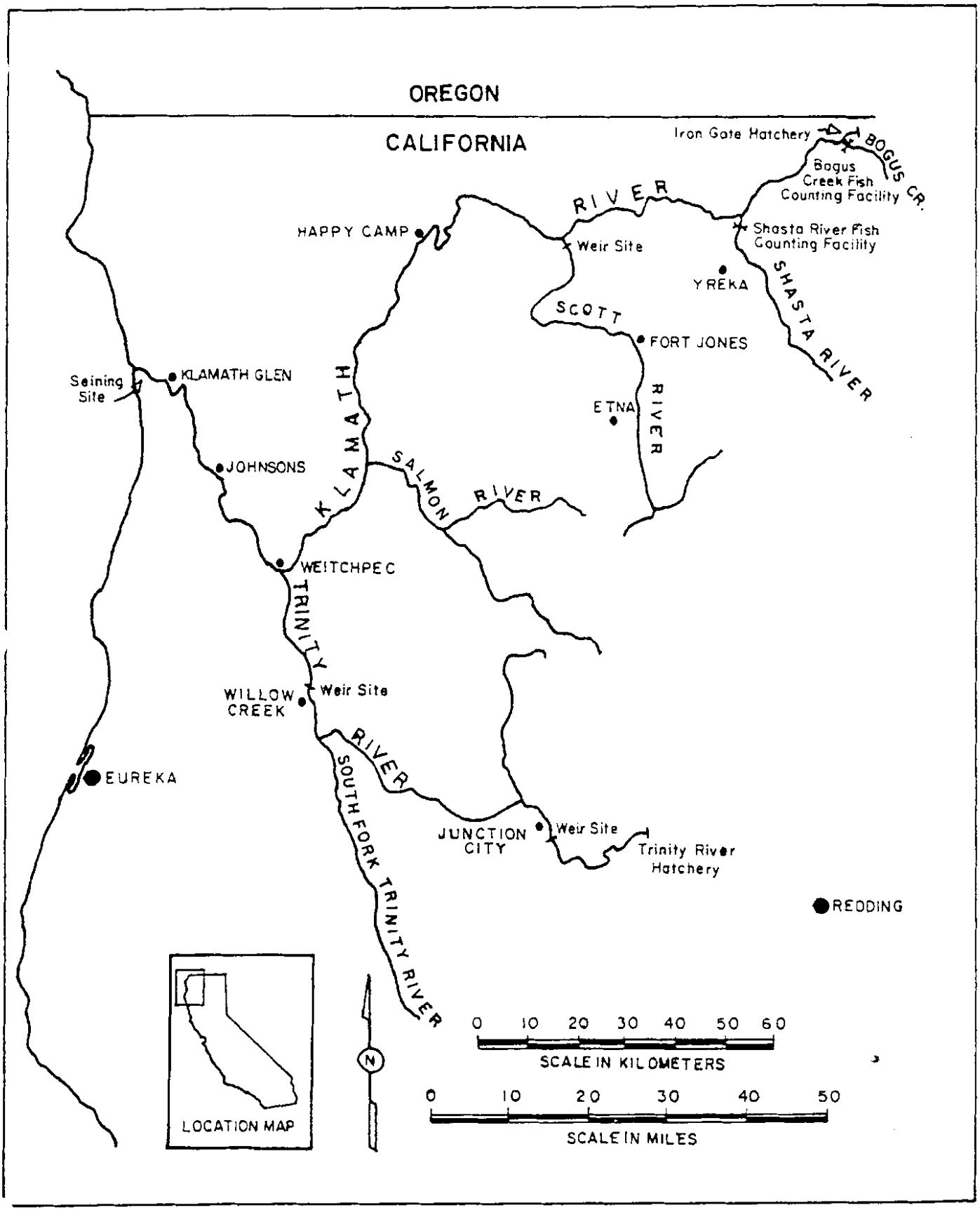

Figure 1. Study location map.

Mark-recovery sampling took place in creel census' on Klamath and Trinity rivers, at IGH and TRH, at the Bogus Creek Fish Counting Facility (BCFCF) during the 1981-82 and 1982-83 seasons, at the Shasta River Fish Counting Facility (SRFCF), at a temporary fish tagging weir on the Scott River during the 1982-83 season, and at Trinity River fish tagging weirs (Tish Tang Campground, Willow Creek and Junction City) during the 1979-80 through 1982-83 seasons.

Creel census areas and procedures have been previously described (Boydstun 1979, 1980; Lee 1984a, 1984b, 1984c).

All steelhead released at TRH during the period 1974 through 1981 and all steelhead released at IGH during the period 1977 through 1982 were marked by a fin clip and/or freeze brand. Fin-clipping materials and methods are described in the fiscal year (FY) 1979 report for Task II (Heubach 1980). Materials and methods for freeze branding are described in the FY 1980 Task II report (Boydstun 1981). A summary of releases made between 1977 and 1982 are presented in Appendix A.

Adult steelhead population estimates were made using the equation from Ricker (1975):

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

where: N = estimated run size,
M = number of fish tagged during our lower Klamath River seining operations,
C = number of fish examined for tags in the lower Klamath River creel census samples, and
R = number of tags in the creel census samples.

Factors influencing the validity of the run-size estimates (Ricker 1975) as described in this report are discussed as they apply to the 1977-79 through 1982-83 seasons.

Confidence limits were determined using the Poisson or normal approximations according to criteria described by Adams (1951).

The contribution of hatchery-origin steelhead to the run was estimated by multiplying the steelhead population estimates by the percent occurrence of marked fish observed during the lower Klamath River seining operations. Cumulative contribution for each mark group was determined by combining the number of fish estimated returning each year. Comparisons between groups were made by Chi-square analysis.

TABLE 5. Number of Days Sampled with Seine by Standard Week, Lower Klamath River (Waukel Creek), 1977 Through 1982

Week ending	Number of days sampled						
	1977a/	1978b/	1979c/	1980d/	1981e/	1982f/	Total
July 22	7	3	7	0	0	3	20
July 29	7	5	7	0	3	3	25
Aug 5	6	6	7	0	3	4	26
Aug 12	5	7	7	0	4	4	27
Aug 19	7	7	7	0	4	4	29
Aug 26	7	7	7	4	4	4	33
Sep 2	7	7	7	3	6	3	33
Sep 9	7	7	7	5	4	5	35
Sep 16	7	5	7	4	4	2	29
Sep 23	7	7	7	4	4	4	33
Sep 30	4	7	6	4	4	2	27
Oct 7	4	7	3	2	4	4	24
Oct 14	4	6	5	0	1	0	16
Oct 21	0	4	0	0	0	0	4
Oct 28	0	4	0	0	0	0	4
TOTALS	79	89	84	26	45	42	365

a/ Sampling began May 17, 1977 and ended October 13, 1977.
b/ Sampling began July 19, 1978 and ended October 27, 1978.
c/ Sampling began July 16, 1979 and ended October 12, 1979.
d/ Sampling began August 21, 1980 and ended October 2, 1980.
e/ Sampling began July 27, 1981 and ended October 8, 1981.
f/ Sampling began July 20, 1982 and ended October 7, 1982.

To compare the return of marked (hatchery-origin) steelhead in the sport fishery and at various sampling locations, a relative return rate was developed by dividing the number of steelhead observed in each mark group by the number of effectively-marked fish released; and expanding the resulting number by 10,000 to facilitate comparisons.

The annual rate of exploitation of adult steelhead was estimated from angler returns of reward and nonreward tags applied during the lower Klamath River seining operations where:

$$\text{exploitation rate} = \frac{\text{number of tags returned}}{\text{number of tags in the fishery}}$$

Angler nonresponse to nonreward tags was corrected by the formula described by Rawstron (1971).

Scale samples for steelhead life history studies were collected from adult steelhead by electrofishing, trapping, gill netting, creel sampling and angling. Scales were removed from an area below the posterior margin of the dorsal fin and two scale rows above the lateral line. Scales were dry mounted and images projected using a Bell and Howell microfische reader. Age notation used in this report generally follows Shapovalov and Taft (1954).

Weekly sampling data are presented in standard (Julian) week format.

RESULTS

Klamath River Estuary

Seining Effort

During the six seasons Project personnel sampled 365 days (d) at the Waukel Creek seining site (km 4.8, RM 3.0) (Table 5). The number of days sampled averaged 61 d and ranged from 26 to 89 d during the six seasons. Seining effort averaged 4.0 days per week (d/w) during the six seasons. Project personnel made a total of 3,361 hauls (H) throughout the study at the Waukel Creek seining site and averaged 224.1 H/w (Table 6).

During the 1980-81 season, Project personnel also measured and tagged steelhead caught by USFWS personnel seining near the river mouth for use in population estimates.

Run Timing

The earliest capture of steelhead at our Waukel Creek seining site (km 4.8, RM 3) was May 18, 1977, when six half-pounders were

caught. Seining activities were initiated on May 17, 1977 that season, and small catches of half-pounder steelhead (<seven fish/d) were made through the summer. We do not know if these were upstream or downstream migrating fish.

Substantial July catches of half-pounder steelhead (>1.0 fish/H) were recorded only during the 1979 season when catch per haul (c/H) rates were 1.93 fish/H the week ending July 22 (Table 7). Substantial July catches of adult steelhead (>1.0 fish/H) were also recorded in 1977 the week ending July 29, and in 1979 during the week ending July 22 (Table 7). In 1979, local anglers reported catching adult and half-pounder steelhead starting about July 10. We believe this was an unusual significant early migration of the late summer/fall-run steelhead population.

The half-pounder steelhead run peaked at the Waukel Creek seining site between August 20 and September 9 in four of the six seasons. In 1981, the run exhibited two peaks, an early peak occurring the week ending August 19, and a second peak occurring the week ending September 2. In 1982, the run also exhibited two peaks, the first the week ending August 12 and the second the week ending September 9 (Figure 2).

The adult steelhead run peaked at the Waukel Creek seining site between August 13 and September 23, and in general appeared to be more protracted in duration than the half-pounder run (Figure 2).

Run Size

During the 1977-78 through 1982-83 seasons we tagged and released 1,683 half-pounder and 5,814 adult steelhead during lower Klamath River seining operations (Table 8). During the same period, we recovered 136 tags (Table 9).

Adult steelhead population estimates were developed for the 1977 through 1982 runs and ranged from 87,010 to 181,410 fish annually (Table 10). Half-pounder steelhead population estimates were derived from the annual adult steelhead population estimates and the ratio of half-pounder steelhead to adult steelhead caught during our lower Klamath River seining operations and ranged from 105,218 to 251,459 fish (Table 11). Adult run sizes were estimated to be highest during the 1978-79 season while half-pounder runs were greatest during the 1981-82 seasons (Figure 3).

Size of Fish

The length frequency distribution of steelhead sampled during the 1977 through 1982 seasons at Waukel Creek was generally bimodal (Figure 4). The modal length of half-pounders occurred between 29 and 31 cm (11.4 and 12.2 in.) FL and between 42 and 52 cm (16.5 and 20.5 in.) FL for adult steelhead during the six seasons (Figure 5).

TABLE 6. Number of Seine Hauls by Standard Week, Lower Klamath River (Waukel Creek), 1977 Through 1982

Week ending	Number of seine hauls						
	1977	1978	1979	1980	1981	1982	Total
July 22	50	26	67	0	0	17	160
July 29	65	48	74	0	22	28	237
Aug 5	55	58	79	0	29	40	261
Aug 12	46	88	62	0	40	40	276
Aug 19	63	83	81	0	37	33	297
Aug 26	63	80	50	23	37	40	293
Sep 2	65	73	61	20	34	30	283
Sep 9	66	79	63	29	38	47	322
Sep 16	71	52	78	29	38	18	286
Sep 23	62	76	56	27	35	36	292
Sep 30	37	74	54	24	30	18	237
Oct 7	29	70	22	12	39	34	206
Oct 14	30	57	38	0	8	0	133
Oct 21	0	39	0	0	0	0	39
Oct 28	0	39	0	0	0	0	39
TOTALS	702	942	785	164	387	381	3,361

TABLE 7. Weekly Summaries of Half-pounder and Adult Steelhead Catches from Lower Klamath River (Waukell Creek) Seining Operations, 1977 Through 1982

Standard week ending	1977	1978	1979	1980	1981	1982	Mean catch/haul
			Half-pounders				
July 22 a/	9 (0.18)b/	1 (0.03)	129 (1.93)	--	--	0	0.52
July 29	5 (0.08)	0	50 (0.68)	--	0	0	0.15
Aug 5	56 (1.02)	1 (0.02)	1 (0.01)	--	1 (0.03)	7 (0.18)	0.25
Aug 12	122 (2.65)	17 (0.19)	34 (0.55)	--	6 (0.15)	258 (6.45)	2.00
Aug 19	629 (9.98)	93 (1.12)	201 (2.48)	--	554(14.97)	41 (1.24)	5.96
Aug 26	910 (14.44)	207 (2.59)	1,004 (20.04)	76 (3.30)	366 (9.89)	25 (0.62)	8.48
Sep 2	1,913 (29.43)	518 (7.10)	743 (12.18)	320 (16.00)	734 (21.59)	112 (3.73)	15.00
Sep 9	1,127 (17.08)	85 (1.08)	79 (1.25)	550 (18.97)	529 (13.92)	208 (4.43)	9.45
Sep 16	231 (3.25)	59 (1.13)	3 (0.04)	142 (4.90)	313 (8.24)	67 (3.72)	3.55
Sep 23	267 (4.31)	13 (0.17)	2 (0.04)	225 (8.33)	114 (3.26)	86 (2.39)	3.08
Sep 30	15 (0.41)	29 (0.39)	2 (0.04)	33 (1.38)	57 (1.90)	8 (0.44)	0.76
Oct 7	13 (0.45)	1 (0.01)	0	3 (0.25)	18 (0.46)	7 (0.21)	0.23
Oct 14	1 (0.03)	9 (0.16)	1 (0.03)	--	0	--	0.06
Oct 21	--	0	--	--	--	--	0.00
Oct 28	--	0	--	--	--	--	0.00
TOTALS	5,298 (7.55)	1,032 (1.10)	2,249 (2.86)	1,349 (8.22)	2,692 (6.96)	819 (2.14)	4.79
			Adults				
July 22 a/	26 (0.52)b/	2 (0.08)	138 (2.06)	--	--	0	0.89
July 29	155 (2.38)	1 (0.02)	60 (0.81)	--	0	1 (0.04)	0.65
Aug 5	277 (5.04)	22 (0.38)	14 (0.18)	--	5 (0.17)	7 (0.18)	1.19
Aug 12	437 (9.50)	15 (0.17)	26 (0.42)	--	9 (0.23)	87 (2.18)	2.50
Aug 19	488 (7.75)	324 (3.90)	170 (2.10)	--	198 (5.35)	23 (0.70)	3.96
Aug 26	426 (6.76)	211 (2.64)	583 (11.66)	29 (1.26)	84 (2.27)	47 (1.18)	4.30
Sep 2	652 (10.03)	421 (5.77)	378 (6.20)	55 (2.75)	87 (2.56)	69 (2.30)	4.94
Sep 9	342 (5.18)	82 (1.04)	126 (2.00)	122 (4.21)	107 (2.82)	241 (5.13)	3.40
Sep 16	33 (0.46)	84 (1.62)	4 (0.05)	99 (3.41)	83 (2.18)	113 (6.28)	2.33
Sep 23	51 (0.82)	102 (1.34)	1 (0.02)	177 (6.56)	184 (5.26)	190 (5.28)	3.21
Sep 30	5 (0.14)	180 (2.43)	5 (0.09)	141 (5.88)	141 (4.70)	36 (2.00)	2.54
Oct 7	2 (0.07)	106 (1.51)	3 (0.14)	18 (1.50)	32 (0.82)	32 (0.94)	0.83
Oct 14	0	186 (3.26)	0	--	0	--	0.81
Oct 21	--	18 (0.46)	--	--	--	--	0.46
Oct 28	--	16 (0.41)	--	--	--	--	0.41
TOTALS	2,894 (4.12)	1,770 (1.88)	1,508 (1.92)	641 (3.91)	930 (2.40)	846 (2.22)	2.74

a/ Includes all weeks prior to July 16-22.

b/ Numbers in parentheses represent catch per seine haul.

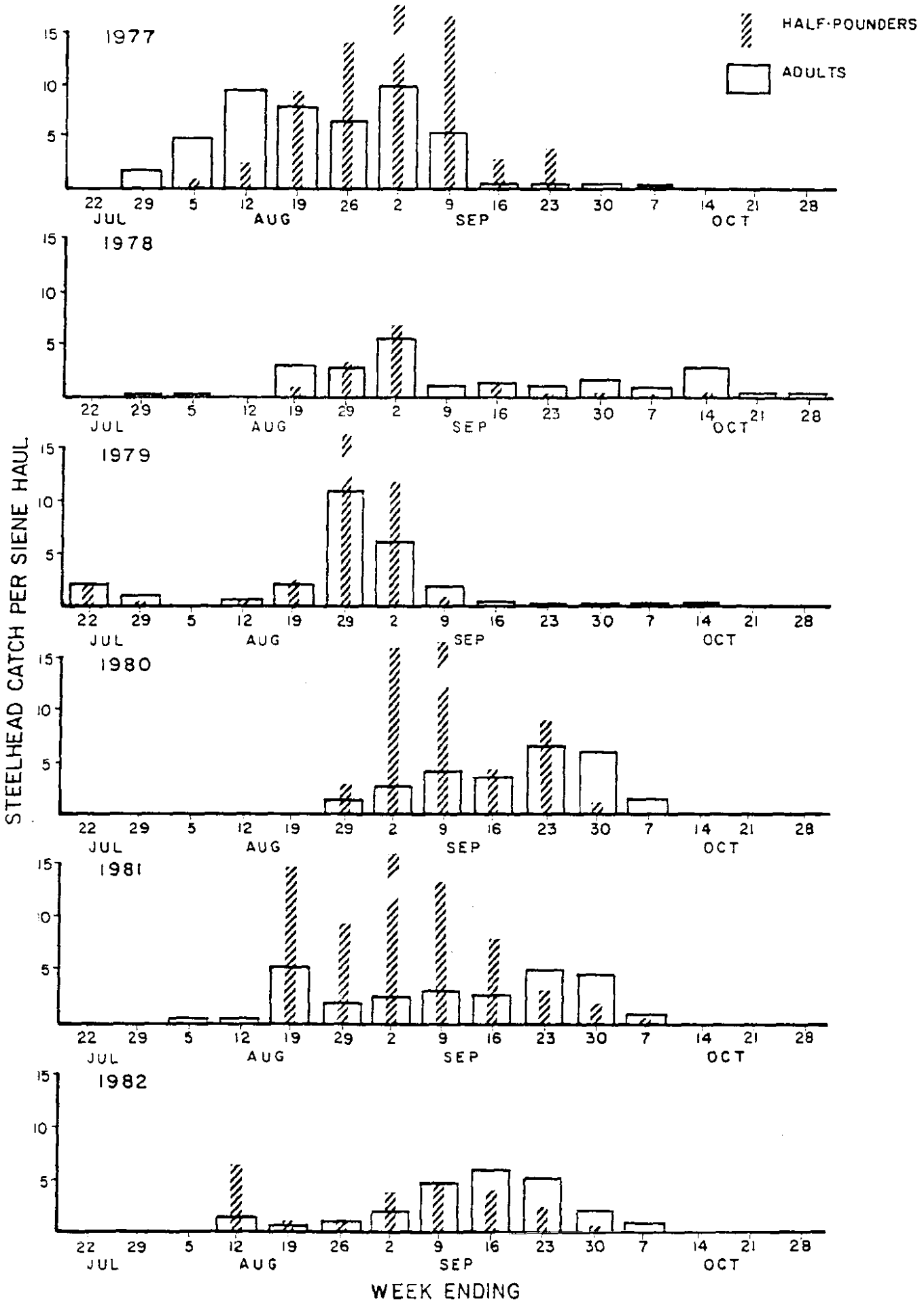

Figure 2. Catch per seine haul by standard week of half-pounder and adult steelhead captured by seining in the lower Klamath River and Waukel Creek, 1977 through 1982.

TABLE 8. Numbers of Half-pounders and Adult Steelhead Tagged and Released During Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982

Year	Half-pounders	Adults
1977	1,206 a/	588 a/
1978	0 a/	1,423 a/
1979	397 a/	1,418 a/
1980	50	805 b/c/
1981	22	859 c/
1982	8	721 e/
TOTALS	1,683	5,814

a/ Tagged with $5.00 reward tags.
b/ Of the 805, 593 were captured by CDFG and 212 by USFWS. All were tagged and released by Klamath River Project personnel.
c/ Total includes all non-reward tags.
d/ Total includes 96 $10.00 reward and 763 non-reward tagged steelhead.
e/ Total includes 292 tagged with $10.00 reward and 429 tagged with non-reward tags.

TABLE 9. Numbers and Locations of Adult Steelhead Sampled, and Numbers of Tagged Steelhead Observed, 1977-78 Through 1982-83 Seasons

Location	Season of tagging and recapture						
	1977-1978	1978-1979	1979-1980	1980-1981	1981-1982	1982-1983	Totals
Creel census a/	2,295(22)b/	4,475(15) b/	894(6)	1,417(8)	1,429(12)	2,185(9)	12,695(72)
IGH	4,411(5)	2,079(5)	1,651(2)	1,247(1)	2,261(1)	2,703(0)	14,352(14)
TRH	285(3)	683(1)	382(0)	2,019(7)	1,007(3)	715(1)	5,091(20)
Shasta River Fish Counting Facility	n/s c/	375(2)	1,866(4)	1,816(8)	218(1)	2,060(5)	6,335(20)
Willow Creek Weir, Trinity River	27(1)	68(0)	174(0)	247(8)	64(0)	296(1)	876(10)
Junction City Weir, Trinity River	n/s	n/s	n/s	10(0)	3(0)	6(0)	19(0)
North Fork Trinity River Weir	n/s	n/s	n/s	n/s	n/s	3(0)	3(0)
Bogus Creek Fish Counting Facility	n/s	n/s	n/s	n/s	6(0)	26(0)	32(0)
Scott River Weir	n/s	n/s	n/s	n/s	n/s	139(0)	139(0)
TOTALS	7,018(31)	7,680(23)	4,967(12)	6,756(32)	4,988(32)	8,133(16)	39,542(136)

a/ In 1977 and 1978 the creel census included the area from Waukel Creek (river km 4.8) upstream to Johnson's (river km 32) and from Weitchpec (river km 68) upstream to Happy Camp (river km 169).

b/ Number in parenthesis is number of project tagged steelhead in sample.

c/ n/s = no sampling.

TABLE 10. Klamath River Basin Adult Fall Steelhead Run-size Estimates, 1977-78 Through 1982-83 Seasons

Season	Number effectively tagged a/	Number sampled in creel census	Number of tags recaptured in creel census	Run-size estimate (95% C.I.)
1977-78	559	1,749	10	89,091 (50,515 - 171,930)
1978-79	1,110	2,285	13	181,410 (103,618 - 321,487)
1979-80	1,205	894	6	154,196 (76,551 - 337,303)
1980-81	741	1,417	8	116,906 (62,628 - 239,126)
1981-82	790	1,429	12	87,010 (51,415 - 157,101)
1982-83	663	2,185	9	145,150 (80,194 - 290,301)
TOTALS	5,068	9,959	58	

a/ Corrected for 5% mortality in 1977-78, 22% in 1978-79, 15% in 19798-80, and 8% in remaining years.

TABLE 11. Klamath River Basin Half-pounder Steelhead Run-size Estimates, 1977-78 Through 1982-83 Seasons

Season	Ratio of half-pounder to adult steelhead	Adult steelhead population estimate	Half-pounder steelhead population estimate	Total
1977-78	1.83:1	89,091	163,037	252,128
1978-79	0.58:1	181,410	105,218	286,628
1979-80	1.49:1	154,196	229,752	383,942
1980-81	2.09:1	116,906	244,334	361,240
1981-82	2.89:1	87,010	251,459	338,469
1982-83	0.97:1	145,150	140,518	285,668

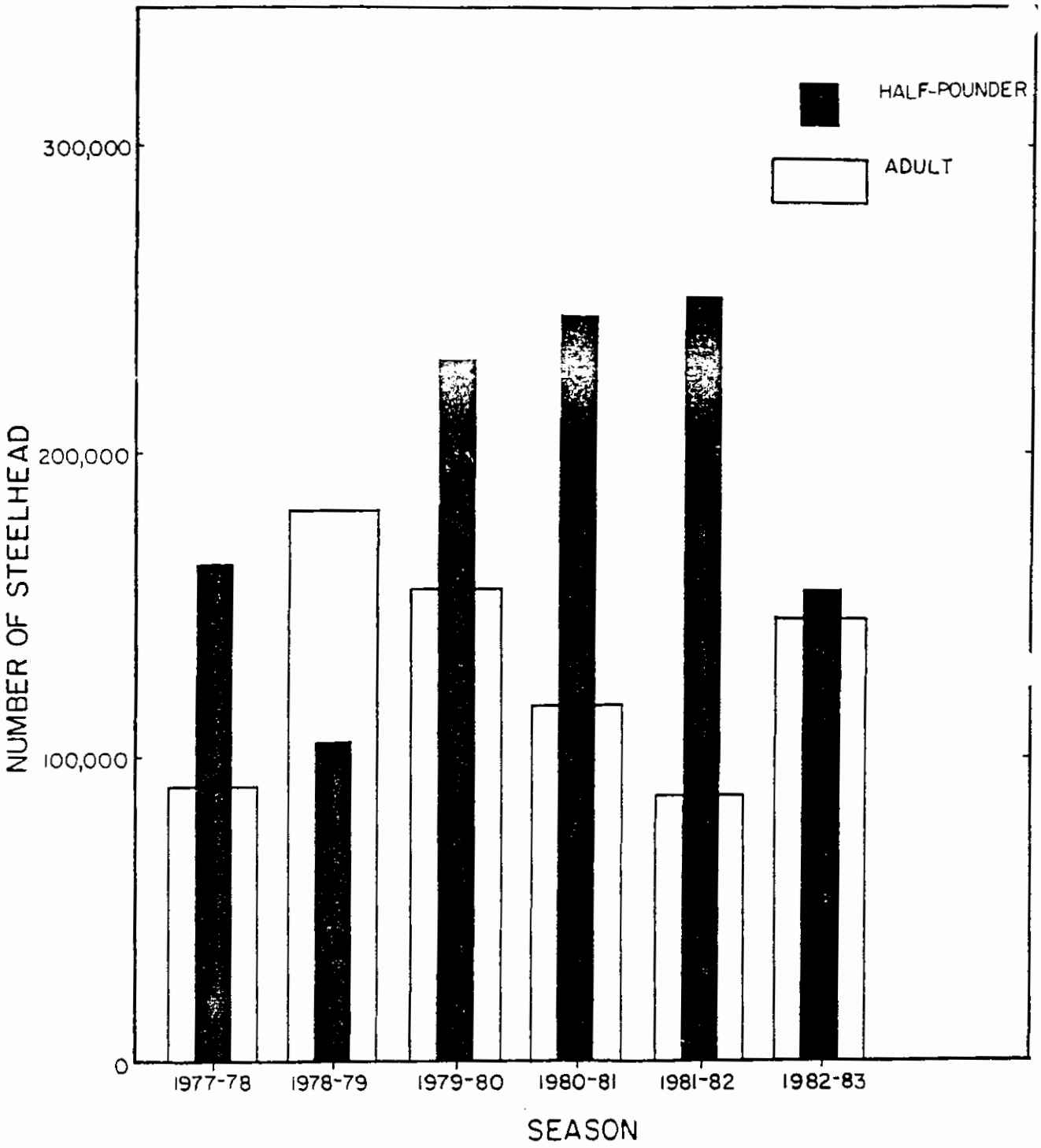

Figure 3. Estimated numbers of half-pounder and adult fall-run steelhead entering the Klamath River during the 1977/78 through 1982/83 seasons.

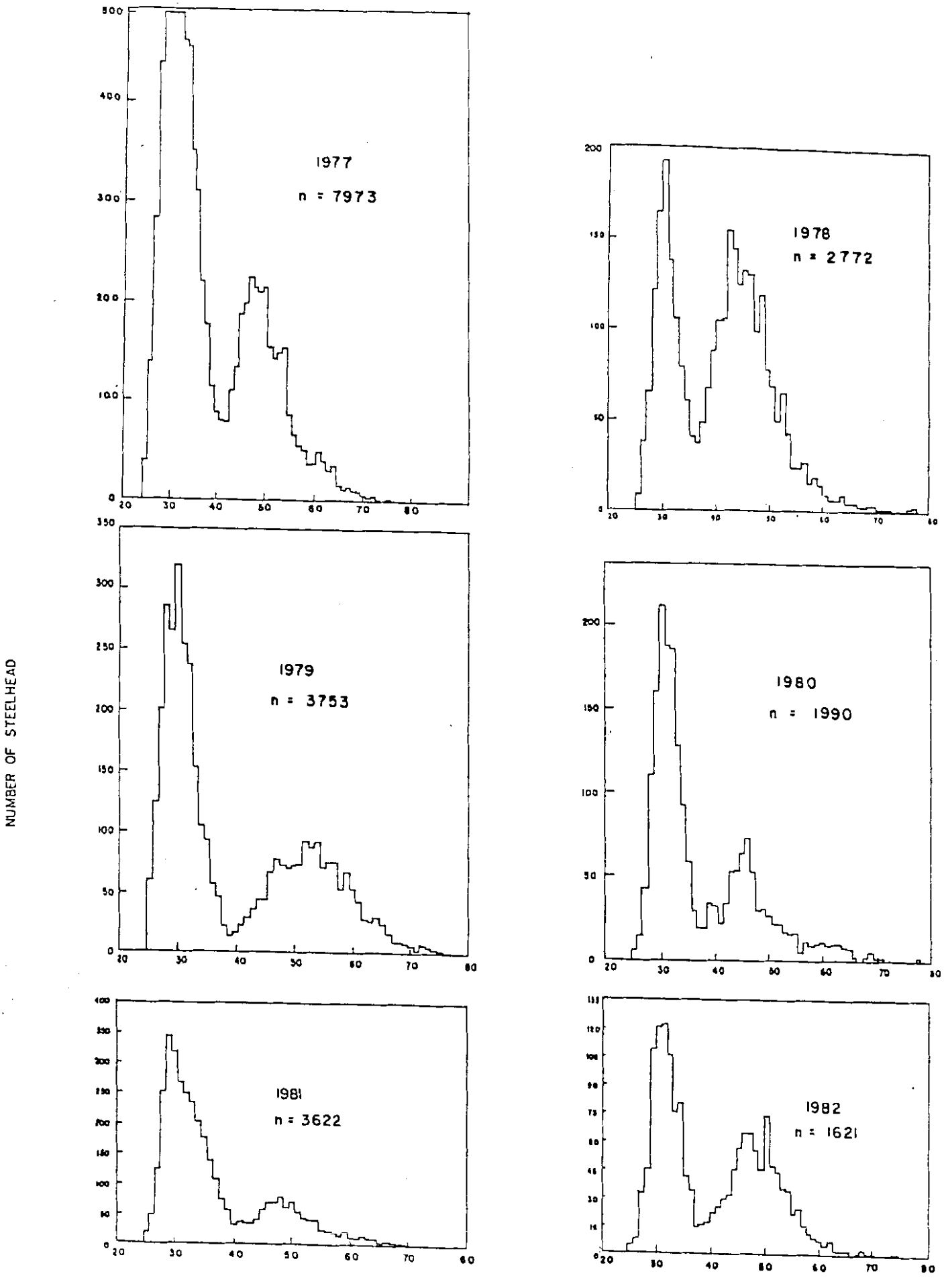

FIGURE 4. Length frequency of fall steelhead seined from the Klamath River at Waukel Creek, fall 1977-1982.

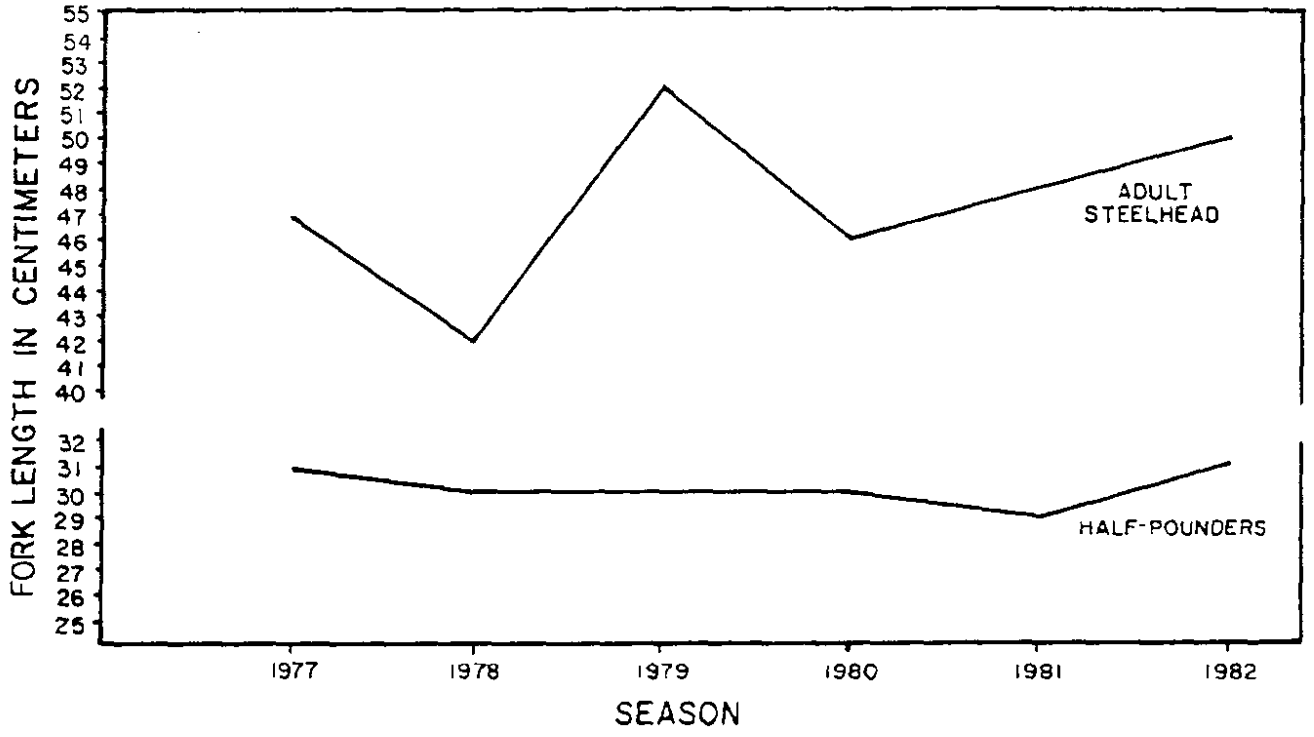

Figure 5. Modes in the length frequency of half-pounder and adult steelhead captured by seining in the lower Klamath River at Waukel Creek, 1977 through 1982.

The nadir in the length frequency (determine by a moving average of 5) separating half-pounder and adult steelhead ranged from 36 to 40 cm (14.1 to 15.7 in.) FL (Figure 6).

The mean length of half-pounder steelhead sampled at Waukel Creek averaged 31.3 cm (12.3 in.) FL, and ranged from 30.4 to 32.0 cm (12.0 to 12.6 in.) FL during the 1977 through 1982 season (Table 12). The mean length of adult steelhead was 49.8 cm (19.6 in.) FL and ranged from 45.9 to 53.4 cm (18.1 to 21.0 in.) FL during the same period (Table 12).

In most years, size of adult steelhead captured at Waukel Creek generally increased during our seining operations (Figure 7). This increase was most apparent during the 1978, 1979 and 1982 seasons. During these years, the increase in mean length was approximately 11 cm (4.3 in.) FL and ranged from 7.5 to 14.2 cm (3.0 to 5.6 in.) FL from the first week to the last week of seining.

The mean length of fin-marked adult steelhead was similar to unmarked adults in 1978, but was slightly larger in 1979 and slightly smaller the remaining seasons (Figure 8). Fin-marked and unmarked half-pounder steelhead were approximately the same length in all years (Figure 8).

Incidence of Fin-marked Steelhead

During 1977 through 1982, 5.1% of the adult (439 of 8,589) and 11.2% of the half-pounder (1,508 of 13,439) steelhead we sampled during our lower Klamath River seining operations were fin marked, indicating they were of hatchery origin (Table 13). We observed 42 different fin-marked groups released from the two basin hatcheries, IGH and TRH, 10 groups released from Cole Rivers Hatchery (CRH), located on the Rogue River in Oregon, and one group which bore a fin mark applied to steelhead released from both TRH and CRH (Table 14).

In order to identify hatchery-origin steelhead in the lower river sampling and at the hatcheries, all steelhead released from TRH in the Trinity River basin below Lewiston Dam from 1974 through 1981 were marked. Similarly, all steelhead released from IGH in the Klamath River basin below Iron Gate Dam from 1977 through 1981 were marked.

In 1977, an unknown number of unmarked hatchery-produced steelhead released in 1976 may have been classified as half-pounders, while all hatchery-produced steelhead released in 1982 were not marked. As such, only in the 1978 through 1981 seasons would all TRH- and IGH-produced steelhead in the half-pounder run have been marked. During those seasons, the contribution of TRH- and IGH-produced steelhead returning as half-pounders averaged 12.4% and ranged from 9.6 to 20.4% (Table 13).

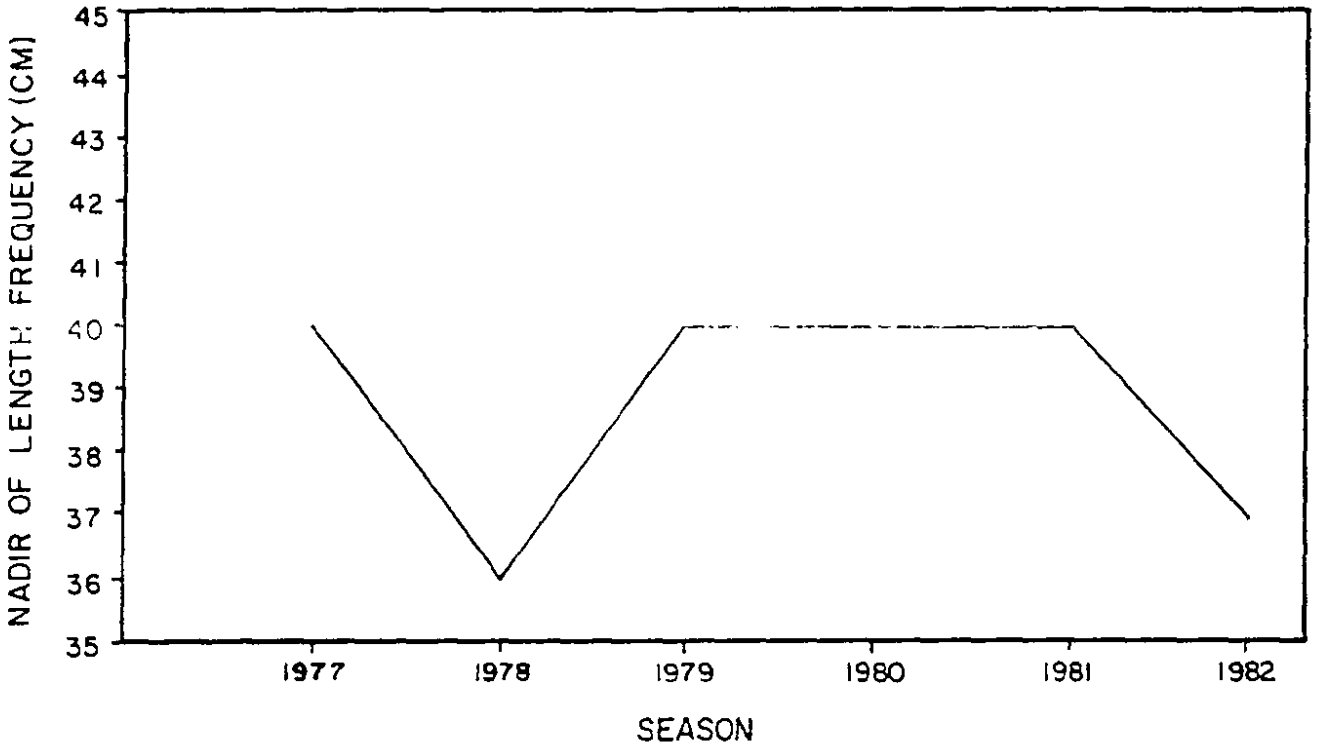

Figure 6. Nadir in length frequency of steelhead captured by seining in the lower Klamath River at Waukel Creek, 1977 through 1982.

TABLE 12. Fork Lengths of Fall Steelhead Captured by Seining in the Lower Klamath River at Waukel Creek, 1977 Through 1982

Year	Unmarked Mean (cm)	Fin-clipped Mean (cm)	All fish Mean (range)(cm)
		Half-pounders	
1977	31.9	32.5	32.0 (25-40)
1978	30.4	31.0	30.5 (25-36)
1979	30.4	30.6	30.4 (25-40)
1980	31.6	31.1	31.6 (25-40)
1981	31.9	30.7	31.8 (25-40)
1982	31.3	31.3	31.3 (25-37)
		Adults	
1977	50.3	51.6	50.3 (41-75)
1978	45.9	45.9	45.9 (37-77)
1979	53.7	50.4	53.4 (41-75)
1980	48.9	47.5	48.7 (41-71)
1981	50.4	49.0	50.3 (41-76)
1982	49.5	48.4	49.0 (38-74)

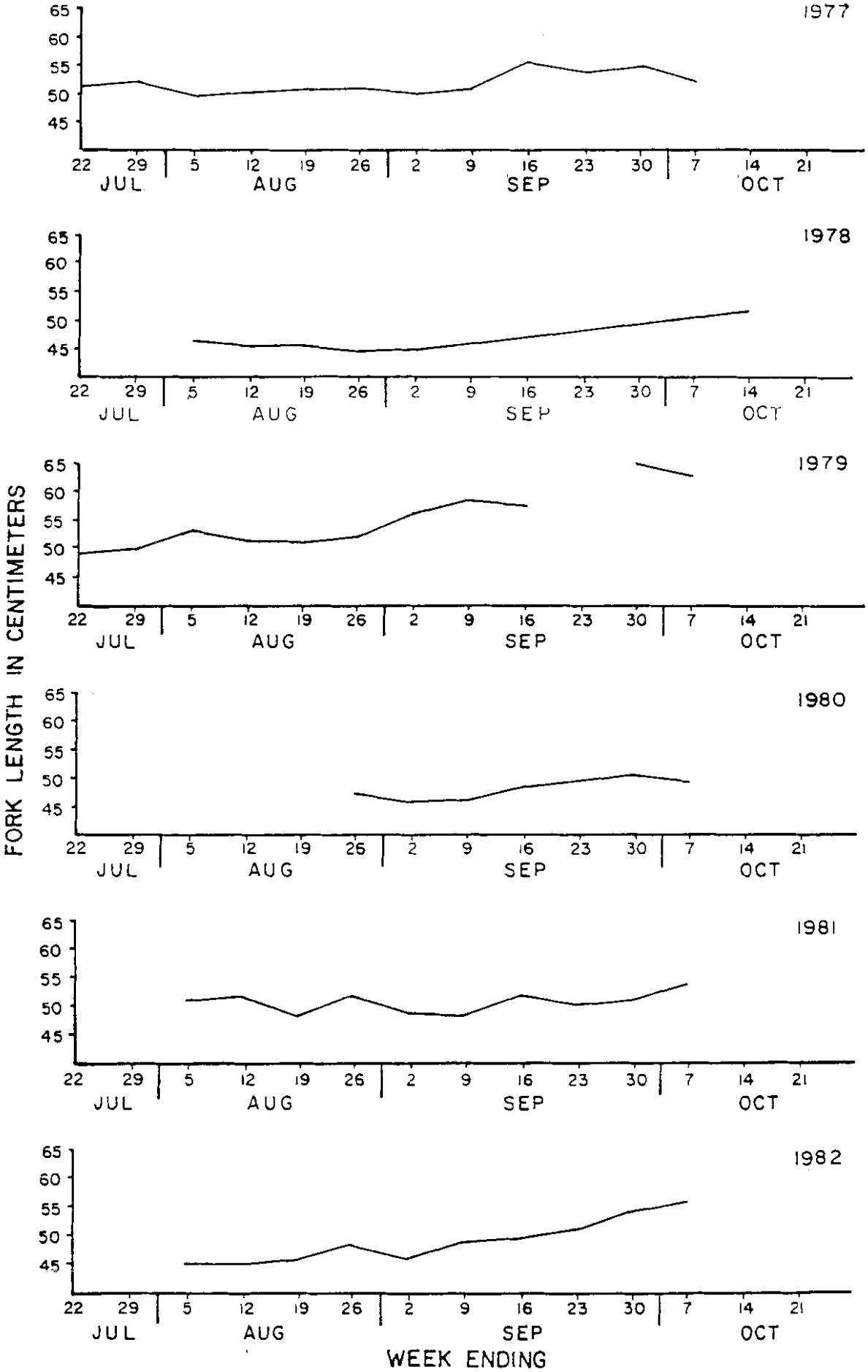

Figure 7. Mean fork length of adult steelhead by standard weeks captured by seining in the lower Klamath River at Waukel Creek, 1977 through 1982.

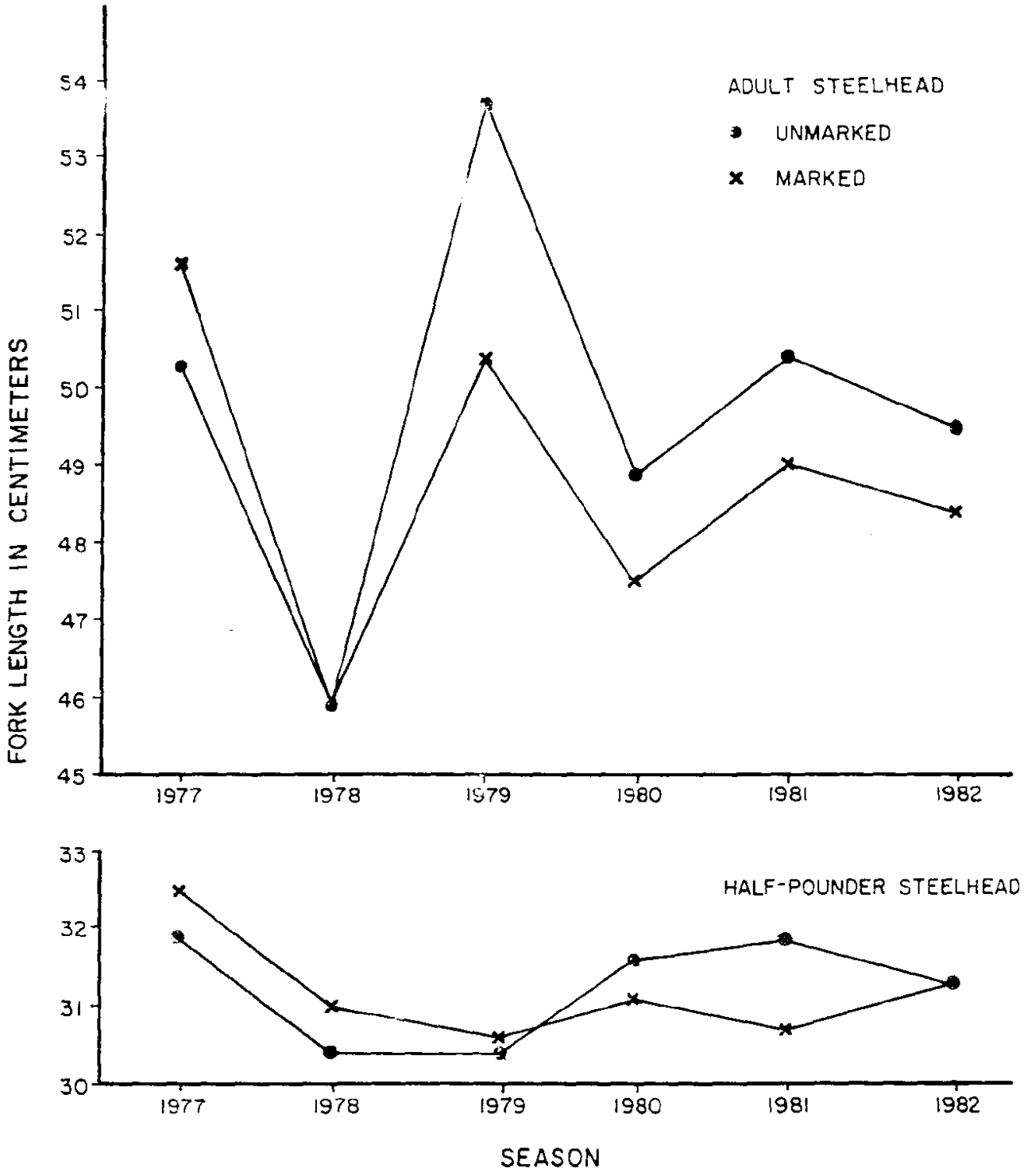

Figure 8. Mean fork length of marked and unmarked adult and half-pounder steelhead captured by seining in the lower Klamath River at Waukel Creek, 1977 through 1982.

TABLE 13. Number of Trinity River and Iron Gate Hatchery Origin Steelhead Captured by Seining in the Lower Klamath River at Waukel Creek, 1977 Through 1982

Year	Number of Steelhead					
	Fin-clipped				Unmarked	Total
	TRH a/	IGH a/	Other a/	Total		
			Adults			
1977	44(1.5)b/	0	35(1.2)	79(2.7)	2,815	2,894
1978	19(1.1)	18(1.0)	23(1.3)	60(3.4)	1,710	1,770
1979	52(3.4)	36(2.4)	23(1.5)	111(7.2)	1,397	1,508
1980	58(9.0)	9(1.4)	1(0.2)	68(10.6)	573	641
1981	21(2.3)	38(4.1)	4(0.4)	63(6.8)	867	930
1982	15(1.8)	39(4.6)	4(0.5)	58(6.9)	788	846
TOTALS	209(2.4)	140(1.6)	90(1.0)	439(5.1)	8,150	8,589
			Half-pounders			
1977	257(4.9)	76(1.4)	41(0.8)	374(7.1)	4,924	5,298
1978	47(4.6)	62(6.0)	34(3.3)	143(13.9)	889	1,032
1979	390(17.3)	58(2.6)	10(0.4)	458(20.4)	1,791	2,249
1980	88(6.5)	48(3.6)	13(1.0)	149(11.0)	1,200	1,349
1981	81(3.0)	157(5.8)	21(0.8)	259(9.6)	2,433	2,692
1982	46(5.6)	60(7.3)	19(2.3)	125(15.3)	694	819
TOTALS	909(6.8)	461(3.4)	138(1.0)	1,508(11.2)	11,931	13,439

a/ TRH = Trinity River Hatchery, IGH = Iron Gate Hatchery, Other = Cole River Hatchery and marks of unidentifiable origin.

b/ Numbers in parentheses are percentages of total annual catch.

TABLE 14. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982

Mark b/	Release data: Origin c/	Date	BYd/	Number	Recovery FL (cm) e/	Number returned (relative return rate) a/: 1977	1978	1979	1980	1981	1982	Total
D-Ad	IGH	4/77	1976	14,144	25-40	22 (15.6)	4 (2.8)	0				26 (18.4)
					> 40	0	2 (1.4)	5 (3.5)				7 (4.9)
					TOTALS	22 (15.6)	6 (4.2)	5 (3.5)				33 (23.3)
Ad-LP	IGH	4/77	1976	429,306	25-40	23 (0.5)	56 (1.3)	0				79 (1.8)
					> 40	0	4 (0.1)	24 (0.6)				28 (0.7)
					TOTALS	23	60 (1.4)	24 (0.6)				107 (2.5)
Ad-RP	IGH	4/77	1976	40,292	25-40	31 (7.7)	3 (0.7)	0				34 (8.4)
					> 40	0	3 (0.7)	3 (0.7)				6 (1.4)
					TOTALS	31 (7.7)	6 (1.5)	3 (0.7)				40 (9.9)
LV-RV	IGH	4/78	1977	200,000	25-40		8 (0.4)	21 (1.0)	0			29 (1.5)
					> 40		0	4 (0.2)	7 (0.4)			11 (0.6)
					TOTALS		8 (0.4)	25 (1.3)	7 (0.4)			40 (2.0)
D-Ad	IGH	4/79	1978	10,033	25-40			3 (3.0)	0	0		3 (3.0)
					> 40			0	0	2 (2.0)		2 (2.0)
					TOTALS			3 (3.0)	0	2 (2.0)		5 (5.0)
LV	IGH	4/79	1978	216,194	25-40			9 (0.4)	2 (0.1)	0		11 (0.5)
					> 40			0	1 (0.0)	0		1 (0.0)
					TOTALS			9 (0.4)	3 (0.1)	0		12 (0.5)
RV	IGH	4/79	1978	119,264	25-40			7 (0.6)	0			7 (0.6)
					> 40			0	1 (0.1)	1 (0.1)		2 (0.2)
					TOTALS			7 (0.6)	1 (0.1)	1 (0.1)		9 (0.7)
Ad-"T"	IGH	4/80	1979	58,047	25-40				20 (3.4)	6 (1.0)	0	26 (4.5)
					> 40				0	20 (3.4)	5 (0.9)	25 (4.3)
					TOTALS				20 (3.4)	26 (4.5)	5 (0.9)	51 (8.8)
Ad-"H"	IGH	5/80	1979	59,000	25-40				20 (3.4)	3 (0.5)	0	23 (3.9)
					> 40				0	10 (1.7)	0	10 (1.7)
					TOTALS				20 (3.4)	13 (2.2)	0	33 (5.6)
Ad-"O"	IGH	6/80	1979	53,070	25-40				6 (1.1)	7 (1.3)	0	13 (2.4)
					> 40				0	5 (0.9)	0	5 (0.9)
					TOTALS				6 (1.1)	12 (2.2)	0	18 (3.4)

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TABLE 14. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982 (continued)

Mark[b]	Release data: Origin[c]	Date	BY[d]	Number	Recovery FL(cm)[e]	Number returned (relative return rate) [a]: 1977	1978	1979	1980	1981	1982	Total
LV-"H"	IGH	4/81	1980	64,660	25-40					45 (7.0)	6 (0.9)	51 (7.9)
					) 40					0	14 (2.2)	14 (2.2)
					TOTALS					45 (7.0)	20 (3.1)	65(10.1)
LV-"O"	IGH	5/81	1980	66,250	25-40					55 (8.3)	1 (0.2)	56 (8.4)
					) 40					0	7 (1.1)	7 (1.1)
					TOTALS					55 (8.3)	8 (1.3)	63 (9.5)
LV-"T"	IGH	6/81	1980	66,240	25-40					6 (0.9)	0	6 (0.9)
					) 40					0	0	0
					TOTALS					6 (0.9)	0	6 (0.9)
LV-"X"	IGH	4/81	WILD	38,580	25-40					35 (9.1)	0	35 (9.1)
					) 40					0	7 (1.8)	7 (1.8)
					TOTALS					35 (9.1)	7 (1.8)	42(10.9)
RV-"T"	IGH	4/82	1981	57,552	25-40						24 (4.2)	24 (4.2)
					) 40						0	0
					TOTALS						24 (4.2)	24 (4.2)
RV-"O"	IGH	5/82	1981	59,474	25-40						21 (3.5)	21 (3.5)
					) 40						0	0
					TOTALS						21 (3.5)	21 (3.5)
RV-"H"	IGH	6/82	1981	58,474	25-40						7 (1.2)	7 (1.2)
					) 40						0	0
					TOTALS						7 (1.2)	7 (1.2)
Ad-LV	TRH	4/76	1974	46,221	25-40	0						0
	CRH	4/76	1974	102,947	) 40	7						7
					TOTAL	7						7
Ad-LP	TRH	4/76	1974	13,750	25-40	0						0
					) 40	2 (1.5)						2 (1.5)
					TOTAL	2 (1.5)						2 (1.5)

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TABLE 14. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982 (continued)

Release data					Recovery	Number returned (relative return rate) a/						
Mark b/	Origin c/	Date	BY d/	Number	FL (mm) e/	1977	1978	1979	1980	1981	1982	Total
LV	TRH	4/76	1974	38,509	25-40	0						0
					> 40	4 (1.0)						4 (1.0)
					TOTAL	4 (1.0)						4 (1.0)
LP	TRH	4/76	1974	29,630	25-40	0						0
					> 40	21 (7.1)						21 (7.1)
					TOTAL	21 (7.1)						21 (7.1)
Ad-RV	TRH	4/76	1975	118,966	25-40	0						0
					> 40	19 (1.6)						19 (1.6)
					TOTAL	19 (1.6)						19 (1.6)
Ad-LV-RP	TRH	3/77	1975	21,342	25-40	3 (1.4)	0					3 (1.4)
					> 40	0	2 (0.9)					2 (0.9)
					TOTALS	3 (1.4)	2 (0.9)					5 (2.3)
Ad-RV-LP	TRH	3/77	1975	43,658	25-40	52 (11.9)	3 (0.7)					55 (12.6)
					> 40	0	3 (0.7)					3 (0.7)
					TOTALS	52 (11.9)	6 (1.4)					58 (13.3)
RV	TRH	4/77	1975	115,607	25-40	0						0
					> 40	11 (1.0)						11 (1.0)
					TOTAL	11 (1.0)						11 (1.0)
LV-RP	TRH	4/77	1976	175,210	25-40	127 (7.2)	0	0				127 (7.2)
					> 40	0	3 (0.2)	9 (0.5)				12 (0.7)
					TOTALS	127 (7.2)	3 (0.2)	9 (0.5)				139 (7.9)
RV-LP	TRH	4/77	1976	129,585	25-40	75 (5.8)	2 (0.2)	0				77 (5.9)
					> 40	0	8 (0.6)	3 (0.2)				11 (0.8)
					TOTALS	75 (5.8)	10 (0.8)	3 (0.2)				88 (6.8)
Ad-LV-RV	TRH	4/78	1977	152,876	25-40		47 (3.1)	0				47 (3.1)
					> 40		0	37 (2.4)				37 (2.4)
					TOTALS		47 (3.1)	37 (2.4)				84 (5.5)
Ad-LV	TRH	4/79	1978	30,418	25-40			22 (7.2)	0	0		22 (7.2)
					> 40			0	2 (0.7)	1 (0.3)		3 (1.0)
					TOTALS			22 (7.2)	2 (0.7)	1 (0.3)		25 (8.2)
Ad-RV	TRH	2-3/79	1978	14,813	25-40			13 (8.8)	1 (0.7)	0		14 (9.5)
					> 40			0	1 (0.7)	1 (0.7)		2 (1.4)
					TOTALS			13 (8.8)	2 (1.4)	1 (0.7)		16 (10.8)

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TABLE 14. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982 (continued)

	Release data				Recovery	Number returned (relative return rate) a/					
Mark b/	Origin c/	Date	BYd/	Number	FL(cm)e/	1977	1978	1979	1980	1981	1982	Total
LP	TRH	3/79	1978	324,774	25-40			277 (8.5)	7 (0.2)	0		284 (8.7)
					) 40			0	43 (1.3)	4 (0.1)		47 (1.4)
					TOTALS			277 (8.5)	50 (1.5)	4 (0.1)		331 (10.2)
RP	TRH	4/79	1978	67,133	25-40			75 (11.2)	3 (0.4)	0		78 (11.6)
					) 40			0	10 (1.5)	1 (0.1)		11 (1.6)
					TOTALS			75 (11.2)	13 (1.9)	1 (0.1)		89 (13.3)
Ad-LP	TRH	4/80	1979	52,781	25-40				15 (2.8)	0		15 (2.8)
					) 40				1 (0.2)	3 (0.6)		4 (0.8)
					TOTALS				16 (3.0)	3 (0.6)		19 (3.6)
Ad-RP	TRH	1-4/80	1979	18,365	25-40				1 (0.5)	0		1 (0.5)
					) 40				0	1 (0.5)		1 (0.5)
					TOTALS				1 (0.5)	1 (0.5)		2 (1.1)
LV-RP	TRH	4/80	1979	113,625	25-40				24 (2.1)	0		24 (2.1)
					) 40				1 (0.1)	8 (0.7)		9 (0 °)
					TOTALS				25 (2.2)	8 (0.7)		33 (2
RV-LP	TRH	4/80	1979	139,211	25-40				37 (2.7)	0		37 (2.7)
					) 40				0	2 (0.1)	1 (0.1)	3 (0.2)
					TOTALS				37 (2.7)	2 (0.1)	1 (0.1)	40 (2.9)
Ad-LV	TRH	4/81	1980	81,136	25-40					26 (3.2)	0	26 (3.2)
					) 40					0	6 (0.7)	6 (0.7)
					TOTALS					26 (3.2)	6 (0.7)	32 (3.9)
Ad-LV-RP	TRH	3/81	1979	28,943	25-40					5 (1.7)	0	5 (1.7)
					) 40					0	0	0
					TOTALS					5 (1.7	0	5 (1.7)
Ad-RV	TRH	2-4/81	1980	1,815	25-40					1 (5.5)	0	1 (5.5)
					) 40					0	0	0
					TOTALS					1 (5.5)	0	1 (5.5)
LV-RV	TRH	4/81	1980	51,230	25-40					35 (6.8)	0	35 (6.8)
					) 40					0	5 (1.0)	5 (1.0)
					TOTALS					35 (6.8)	5 (1.0)	40 (7.8)
RV	TRH	4/81	1980	59,188	25-40					14 (2.4)	0	14 (2.4)
					) 40					0	1 (0.2)	1 (0.2)
					TOTAL					14 (2.4)	1 (0.2)	15 (2

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TABLE 14. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982 (continued)

Mark[b]	Release data: Origin[c]	Date	BY[d]	Number	Recovery FL(cm)[e]	Number returned (relative return rate) [a]: 1977	1978	1979	1980	1981	1982	Total
Ad	TRH	4/81	1981	137,403	25-40						45 (3.3)	45 (3.3)
					) 40						0	0
					TOTAL						45 (3.3)	45 (3.3)
Ad	CRH	4/76	1974	23,500	25-40	0						0
					) 40	2 (0.9)						2 (0.9)
					TOTAL	2 (0.9)						2 (0.9)
Ad-LV [f]	CRH	4/76	1974	102,947								
LV	CRH	4/77	1975	138,460	25-40	6 (0.4)						6 (0.4)
					) 40	0						0
					TOTAL	6 (0.4)						6 (0.4)
LP-LM	CRH	4/77	1975	179,004	25-40	22 (1.2)	0					22 (1.2)
					) 40	0	1 (0.1)					1 (0.1)
					TOTALS	22 (1.2)	1 (0.1)					23 (1.3)
LP	CRH	4/78	1976	176,600	25-40		24 (1.4)	0				24 (1.4)
					) 40		2 (0.1)	7 (0.4)				9 (0.5)
					TOTALS		26 (1.5)	7 (0.4)				33 (1.9)
Ad-RV-LM	CRH	4/81	1980	20,000	25-40							0
					) 40						1 (0.5)	1 (0.5)
					TOTAL						1 (0.5)	1 (0.5)
RV-RM	CRH	4/81	1979		25-40					6 (3.0)	0	6 (3.0)
					) 40						0	0
					TOTALS					6 (3.0)	0	6 (3.0)
Ad-LV	CRH	4/82	1981	18,879	25-40						9 (4.8)	9 (4.8)
Ad-RV	CRH	4/82	1981	20,139	25-40						3 (1.5)	3 (1.5)
Ad-RP-LM	CRH	5/82	1981	19,970	25-40						1 (0.5)	1 (0.5)
Ad-LP	CRH	4/82	1981	21,875	25-40						11 (5.0)	11 (5.0)

[a] Relative return rate = (Number recovered / Number released) x 10,000.
[b] Letters in quotation marks indicate freeze brands applied to marked (fin-clipped) fish.
[c] IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery; CRH = Cole Rivers Hatchery (Rogue River).
[d] BY = Brood year.
[e] FL = Fork length.
[f] Note: Ad-LV mark on 1974 BY steelhead was duplicated at CRH and TRH. See section of Table under TRH for number of these fish recovered.

In the fall of 1982 an unknown number of unmarked hatchery steelhead released in the spring of 1982 may have been classified as adults. However, the contribution of hatchery fish classified as adults during the same year as released was small throughout the study. Only during the 1979 through 1982 seasons would all TRH- and IGH-produced adult steelhead in the run have been marked. During those seasons, the contribution of hatchery steelhead to the adult run averaged 7.8% and ranged from 6.8 to 10.6% (Table 13).

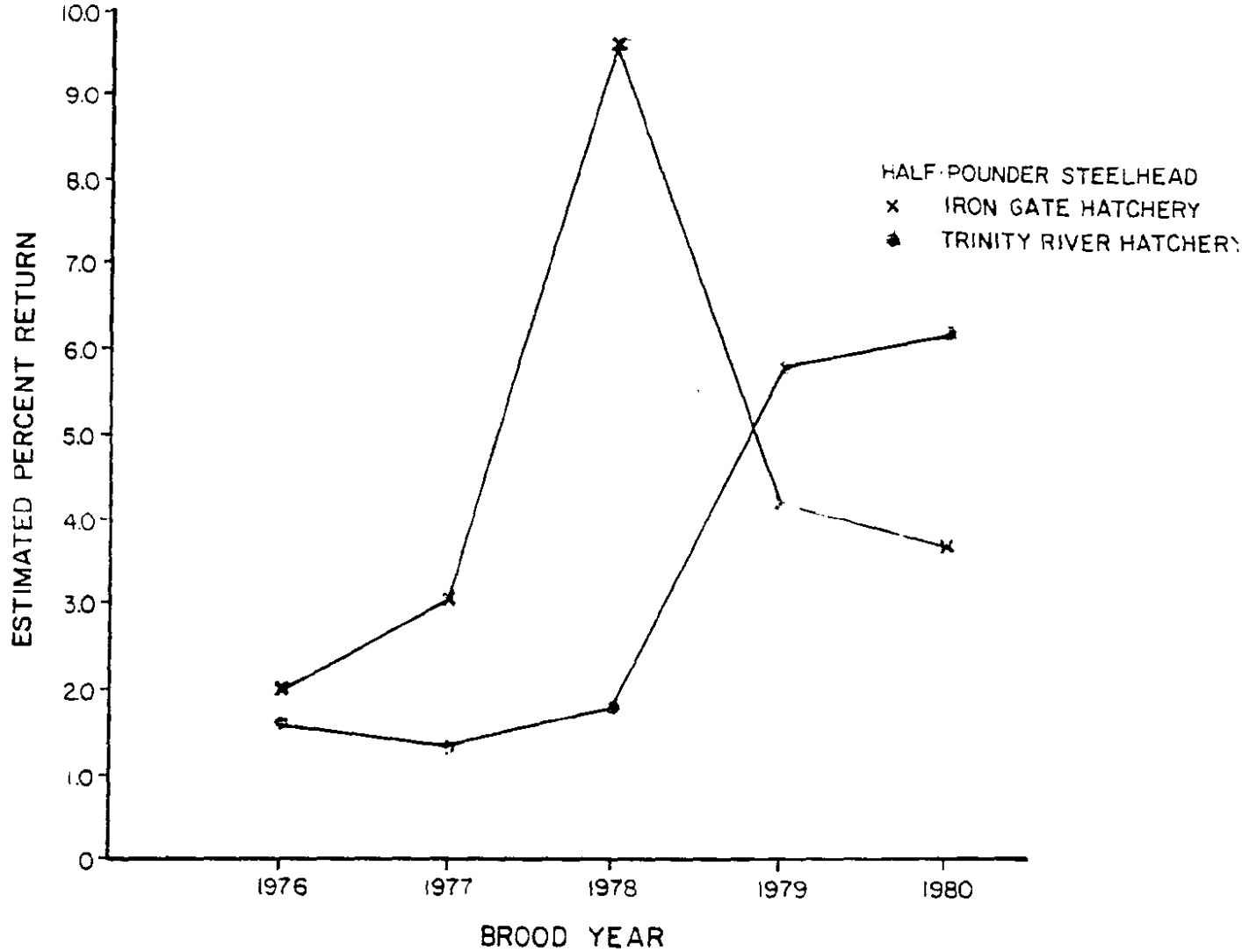
Total return by brood years (BY) of IGH and TRH adult steelhead ranged from a low of 0.3% for the 1978 BY IGH releases to a high of 2.5% for the 1977 BY TRH and 1979 BY IGH releases (Figure 9). Total return by BY's for hatchery-produced half-pounders ranged from a low of 1.4% for the 1977 BY IGH releases to a high of 9.6% for the 1978 BY TRH releases (Figure 9).

To evaluate the return rate of yearling steelhead releases based on size at release, two groups of 1976 BY steelhead were released from IGH in 1977. A third group of steelhead comprised of naturally produced fish collected from Klamath River tributaries in the spring and summer of 1976 and reared at the Bogus Creek Rearing Facility (BCFRF) were also released in 1977. The return percentage to the Klamath River of 1976 BY marked steelhead groups varied (Table 15). The adipose-left pectoral (Ad-LP) release group comprised principally of fish <150 mm total length (TL) at release had the poorest return with a large portion of the release group returning to the Klamath River as half-pounders the second year after release (Figure 10). The adipose-right pectoral (Ad-RP) release group of which 68.1% were $\geq$150 mm TL at release had a higher return of both half-pounders and adults (Figure 15). Greatest returns, however, were from the dorsal-adipose (D-Ad) marked BCFRF release group (Figure 10).

Two groups of 1976 BY yearling steelhead were released from TRH in 1977 to evaluate the success of rearing and releasing Klamath-strain steelhead at TRH. The 1976 By Trinity River-strain release group (left ventral-right pectoral [LV-RP]) had similar return rates as both half-pounders and adults to the Klamath River as the comparable 1976 By Klamath River-strain release group (Table 16, Figure 11).

Only one group of 1977 BY yearling steelhead were released from each hatchery in 1978. The 1977 BY marked steelhead released from TRH had a cumulative 5.6% return to the Klamath River as compared to 2.3% cumulative return for the group released from IGH (Table 17). The TRH release group produced more half-pounders but did not contribute as adults in 1980-81 (Figure 12). The average size of the TRH release group was greater than the IGH release group and a much larger percentage of the fish were $\geq$150 mm TL.

Two groups of Klamath-strain 1978 BY yearling steelhead were released from TRH in 1979. The 1978 BY Klamath-strain (F2



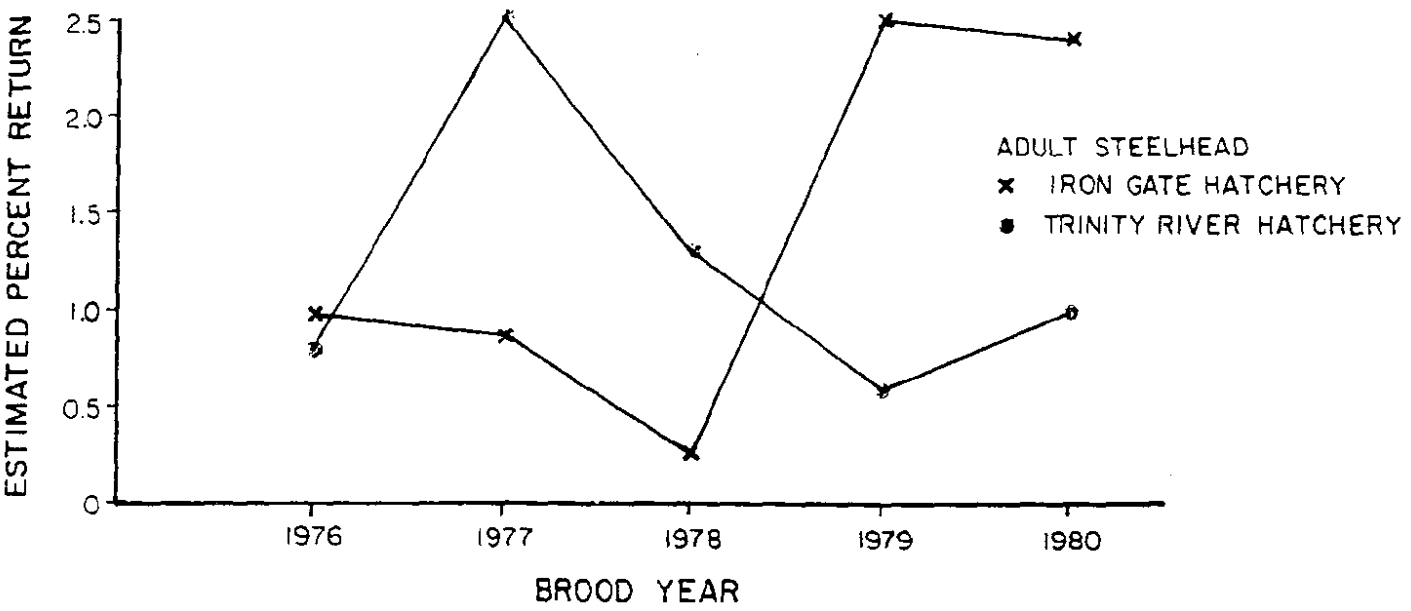


Figure 9. Estimated total return to the Klamath River of 1976 through 1980 BY marked steelhead released from Trinity River and Iron Gate hatcheries.

TABLE 15. Estimated Numbers of Iron Gate Hatchery 1976 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group	Release data: Origin a/	Date	TL(cm) b/	Number	Recovery FL (cm) b/	Number estimated in run: 1977-78	1978-79	1979-80	Total	Return percent c/
D-Ad	IGH	4/77	13.1	14,144	25-40	677	204	0	881	6.2
					> 40	0	410	511	921	6.5
					Subtotals	677	614	511	1,802	12.7
Ad-LP	IGH	4/77	10.6	429,306	25-40	708	5,302	0	6,010	1.4
					> 40	0	820	2,454	3,274	0.8
					Subtotals	708	6,122	2,454	9,284	2.2
Ad-RP	IGH	4/77	15.3	40,292	25-40	954	102	0	1,056	2.6
					> 40	0	512	307	819	2.0
					Subtotals	954	614	307	1,875	4.6
TOTALS	IGH			483,742	25-40	2,339	5,608	0	7,947	1.6
					> 40	0	1,742	3,270	5,012	1.0
					TOTALS	2,339	7,350	3,270	12,959	2.6

a/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
b/ TL = Total length; FL = Fork length.
c/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

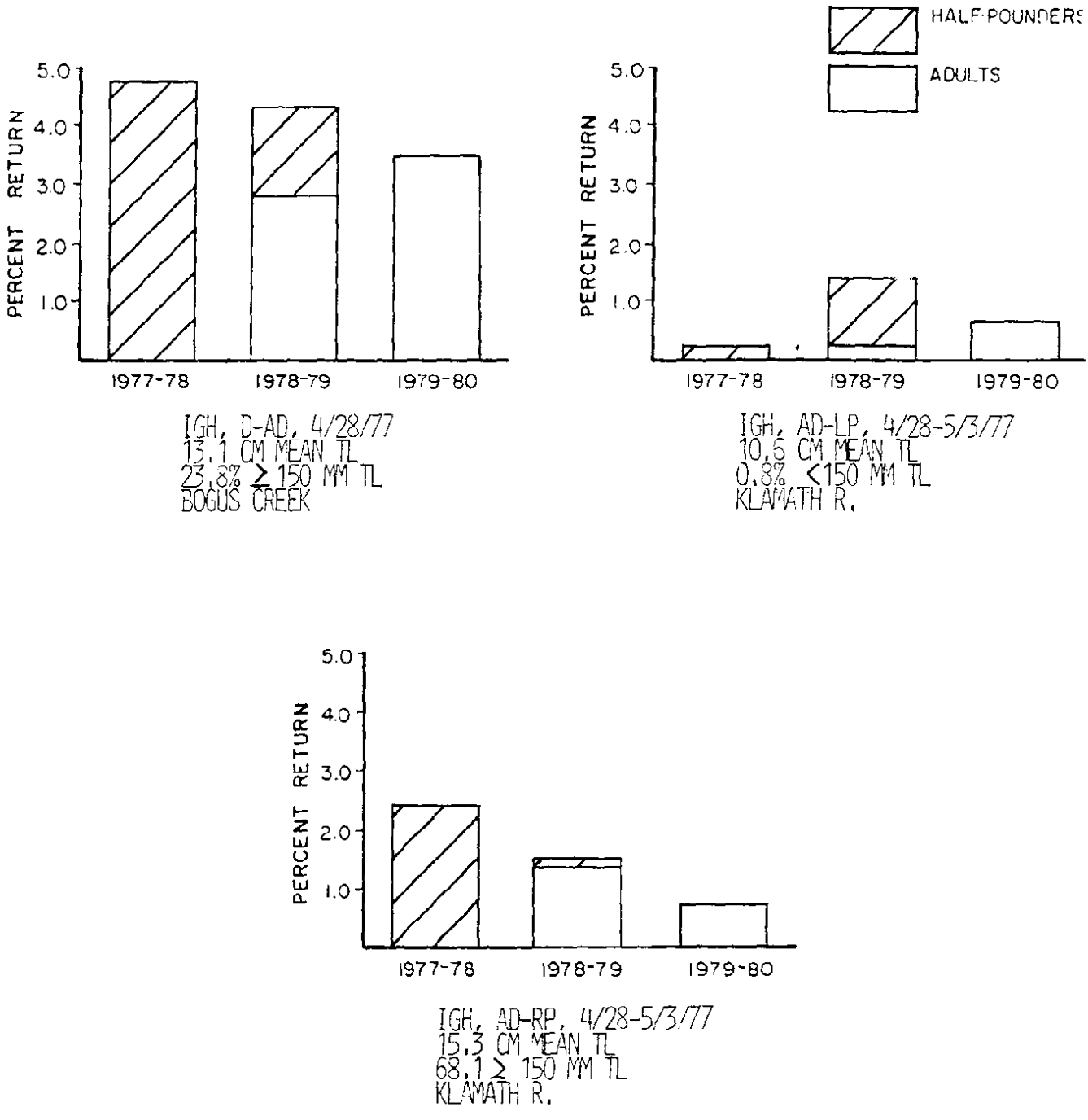


Figure 10. Percent return to the Klamath River of 1976 BY marked steelhead released from Iron Gate Hatchery.

TABLE 16. Estimated Numbers of Trinity River Hatchery 1976 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group	Release data: Origin a/	Date	TL(cm)b/	Number	Recovery FL (cm)b/	Number estimated in run: 1977-78	1978-79	1979-80	Total	Return percent c/
LV-RP	TRH	4/77	19.9	175,210	25-40	3,908	0	0	3,908	2.2
					>40	0	307	920	1,227	0.7
					Subtotals	3,908	307	920	5,135	2.9
RV-LP	TRH	4/77	17.1	129,585	25-40	2,308	0	0	2,308	1.8
					> 40	0	1,325	307	1,332	1.0
					Subtotals	2,308	1,025	307	3,640	2.8
TOTALS	TRH			304,795	25-40	6,216	0	0	6,216	2.1
					> 40	0	1,332	1,227	2,559	0.8
					TOTALS	6,216	1,332	1,227	8,775	2.8

a/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
b/ TL = Total length; FL = Fork length.
c/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

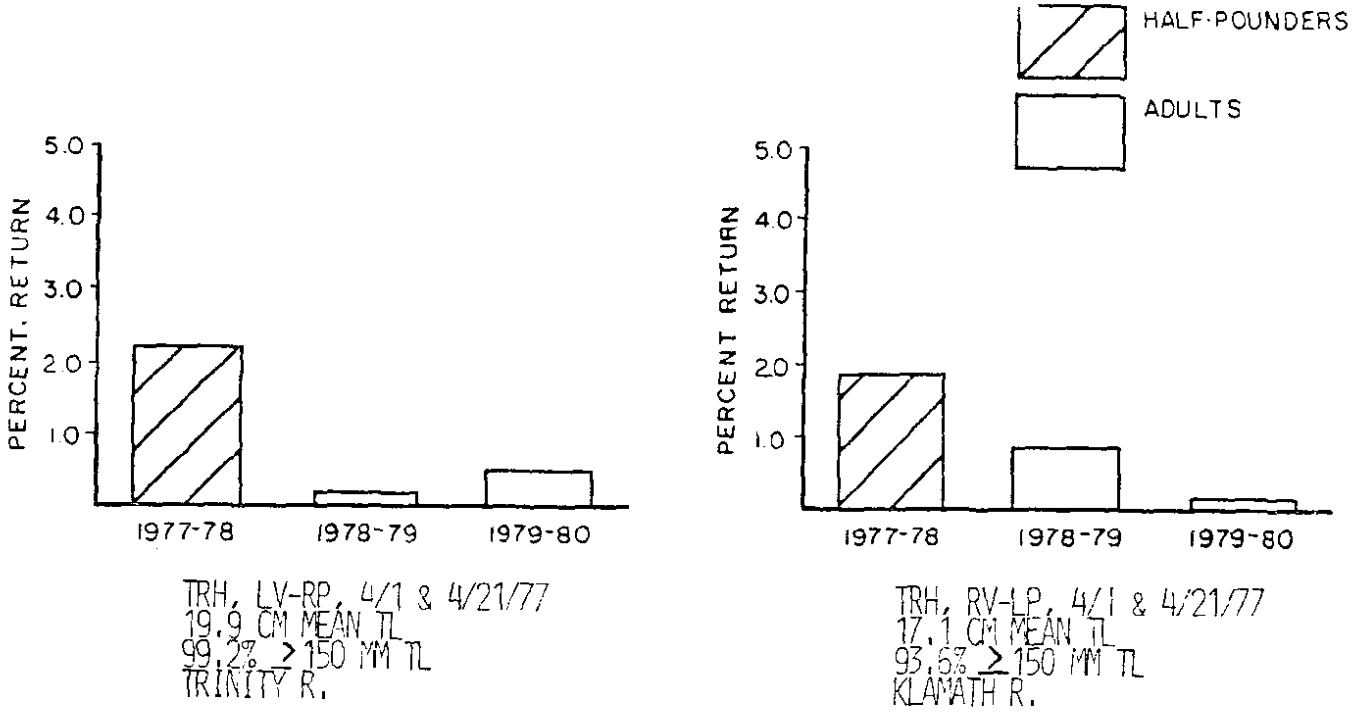


Figure 11. Percent return to the Klamath River of 1976 BY marked steelhead released from Trinity River Hatchery.

TABLE 17. Estimated Numbers of 1977 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group	Release data				Recovery FL (cm)b/	Number estimated in run				Return percent c/
	Origin a/	Date	TL(cm)b/	Number		1978-79	1979-80	1980-81	Total	
LV-RV	IGH	4/78	11.7	200,000	25-40	1,714	2,145	0	2,859	1.4
					) 40	102	409	1,277	1,788	0.9
					TOTALS	816	2,554	1,277	4,647	2.3
Ad-LV-RV	TRH	4/78	17.5	152,876	25-40	4,792	0	0	4,792	3.1
					) 40	102	3,783	0	3,885	2.5
					TOTALS	4,894	3,783	0	8,677	5.6

a/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
b/ TL = Total length; FL = Fork length.
c/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

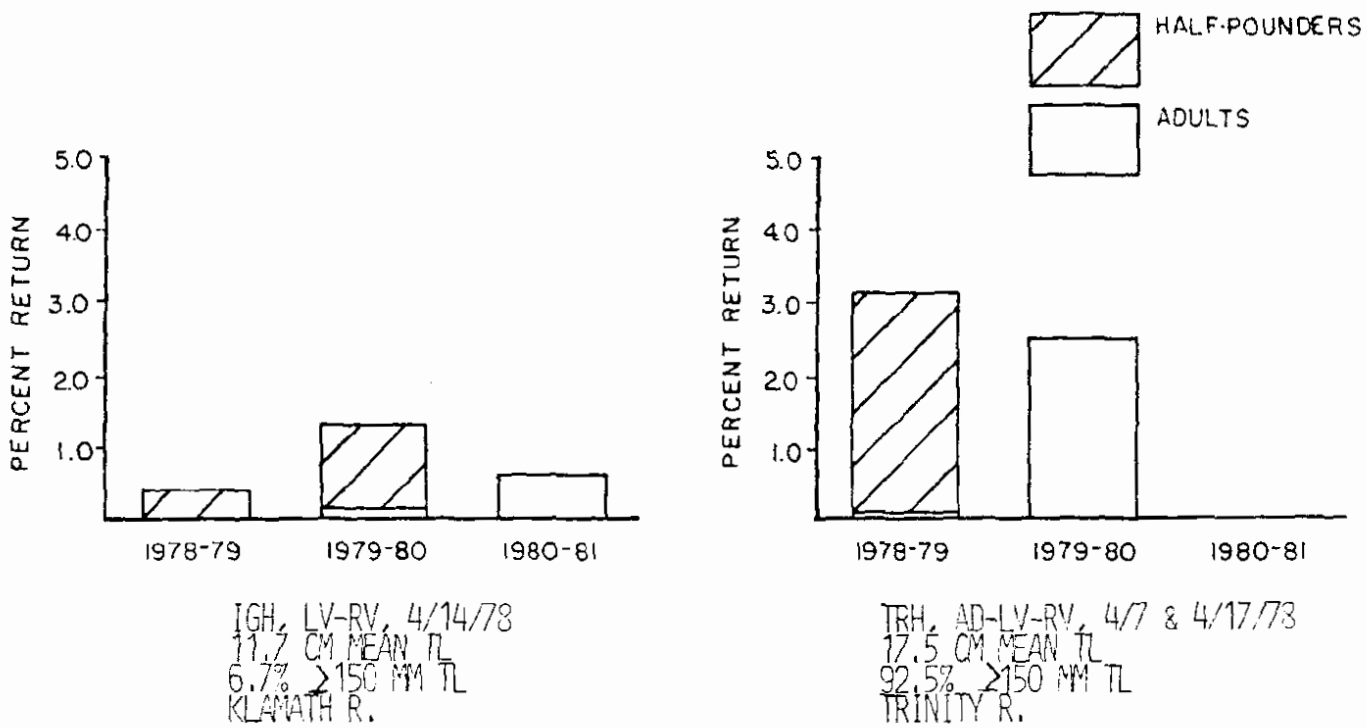


Figure 12. Percent return to the Klamath River of 1977 BY marked steelhead released from Iron Gate Hatchery and Trinity River Hatchery.

generation) mark group (right pectoral [RP], 3/79) had a slightly higher cumulative return (15.1%) to the Klamath River as compared to the Klamath-strain (F1 generation) mark group (left pectoral [LP], 3/79) which had a cumulative return of 11.7% (Table 18). Cumulative adult only returns were similar (Figure 13).

One group each of 1979 BY Trinity- and Klamath-strain yearling steelhead were released from TRH in 1980. The 1979 BY Klamath-strain mark group (left ventral [LV]-RP, 4/80) had the same cumulative return (5.2%) to the Klamath River as the comparable Trinity-strain mark group (RV-LP, 4/80) (Table 19). Cumulative return as adults was greater for the Klamath-strain mark group (Figure 14). Average size at release of both groups was similar.

Two additional groups of 1979 BY Trinity- and Klamath-strain steelhead were held at TRH an additional year before release in 1981 to determine if it is desirable to raise gradeout steelhead yearlings for an additional year. The 1979 By Trinity-strain mark group (Ad-LV-RV, 3/81) had a cumulative return of 1.6% to the Klamath River (Table 19). The comparable group of 1979 BY Klamath-strain (Ad-RV-LP, 3/81) steelhead which was treated similarly did not appear in any of our Lower Klamath River seining operation samples. The Trinity-strain mark group appeared in our samples only during 1981-82 as half-pounders (Figure 14).

Voluntary emigration studies were conducted at TRH with several release groups of 1978 through 1980 BY yearling steelhead.

The 1978 BY mark group (Ad-RV, 2/-3/79) which was allowed to voluntarily emigrate from TRH, had a higher cumulative return rate to the Klamath River of 12.1% as compared to 9.9% for a similar group (Ad-LV, 4/79) which were released as a single group from the hatchery ponds (Table 18). Returns were also greater when compared by season (Figure 13).

The two 1979 BY emigration study mark groups which had similar treatment had cumulative return rates of 6.0% for the involuntary emigrant group (Ad-LP, 4/80) as compared to 1.5% for the voluntary emigrant group (Ad-RP, 1-4/80) (Table 19). A large portion of the returns of the involuntary emigrant group were as half-pounders (Figure 14). A third 1979 BY group (RV-LP, 4/80) released from TRH as an additional control group had a cumulative return rate of 5.2% (Table 19). No adults were sampled in 1982-83 from the involuntary emigrant group while adults were sampled in 1982-83 from the additional control release group (Figure 14).

The 1980 BY mark group (Ad-RV, 2/4/81) which were allowed to voluntarily emigrate from TRH, had a higher cumulative return rate of 5.1% to the Klamath River, than the mark group (Ad-LV, 4/81) which were the nonmigrants released as part of the Voluntary Emigration Study (Table 20). The 1980 BY voluntary emigration

TABLE 18. Estimated Numbers of Trinity River Hatchery 1978 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group	Release data				Recovery FL (cm)	Number estimated in run				Return percent c/
	Origin a/	Date	FL(cm)b/	Number		1979-80	1980-81	1981-82	Total	
Ad-LV	TRH	4/79	19.8	30,418	25-40	2,247	0	0	2,247	7.4
					) 40	307	365	94	766	2.5
					Subtotals	2,554	365	94	3,013	9.9
Ad-RV	TRH	2/-3/79	20.6	14,813	25-40	1,328	181	0	1,509	10.2
					) 40	0	182	94	276	1.9
					Subtotals	1,328	362	94	1,785	12.1
LP	TRH	3/79	17.5	324,774	25-40	28,604	1,268	0	29,872	9.2
					) 40	0	7,842	374	8,216	2.5
					Subtotals	28,604	9,110	374	38,088	11.7
RP	TRH	4/79	18.2	67,133	25-40	7,662	543	0	8,205	12.2
					) 40	0	1,824	94	1,918	2.9
					Subtotals	7,662	2,367	94	10,123	15.1
TOTALS	TRH			437,138	25-40	39,841	1,992	0	41,833	9.6
					) 40	0	4,853	656	5,509	1.3
					TOTALS	39,841	6,845	656	47,342	10.9

a/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.

b/ FL = Fork length.

c/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

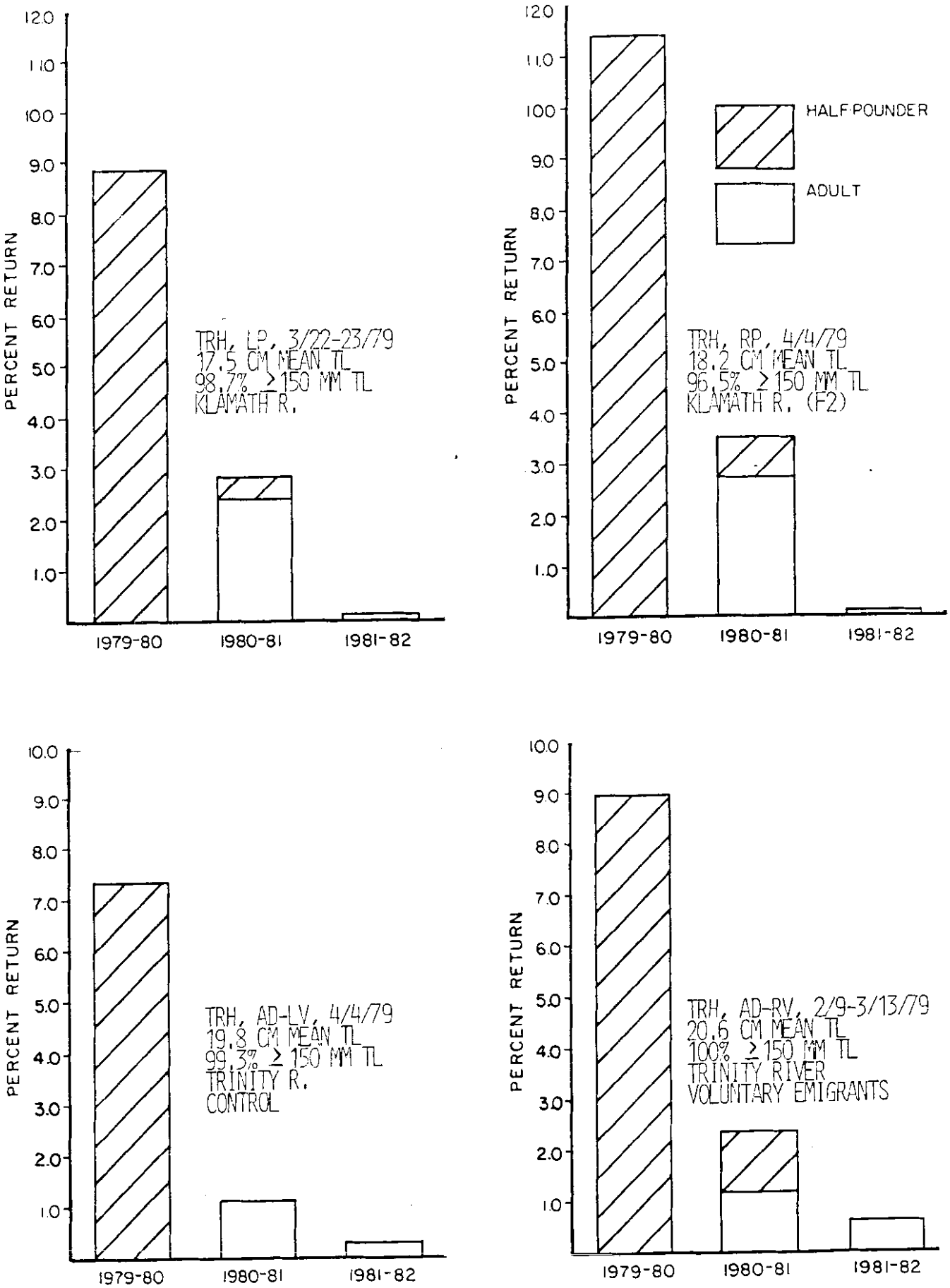


Figure 13. Percent return to the Klamath River of 1978 BY marked steelhead released from Trinity River Hatchery.

TABLE 19. Estimated Numbers of Trinity River Hatchery 1979 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group	Release data				Recovery FL (cm)	Number estimated in run				Return percent c/
	Origin a/	Date	FL(cm)b/	Number		1980-81	1981-82	1982-83	Total	
Ad-LP	TRH	4/80	19.2	52,781	25-40	2,717	0	0	2,717	5.1
					> 40	182	281	0	463	0.9
					Subtotals	2,899	281	0	3,180	6.0
Ad-RP	TRH	1/-4/80	17.8	18,365	25-40	181	0	0	181	1.0
					> 40	0	94	0	94	0.5
					Subtotals	181	94	0	275	1.5
LV-RP	TRH	4/80	17.0	109,761	25-40	4,347	0	0	4,347	4.0
					> 40	182	748	343	1,273	1.2
					Subtotals	4,529	748	343	5,620	5.2
RV-LP	TRH	4/80	17.4	133,782	25-40	6,702	0	0	6,702	5.0
					> 40	0	65	172	237	0.2
					Subtotals	6,702	65	172	6,939	5.2
Ad-LV-RP	TRH	3/81	19.9	28,943	25-40	0	467	0	467	1.6
					> 40	0	0	0	0	0
					Subtotals	0	467	0	467	1.6
TOTALS	TRH			343,632	25-40	13,947	467	0	14,414	4.2
					> 40	364	1,188	514	2,066	0.6
					TOTALS	14,311	1,655	514	16,480	4.8

a/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.

b/ FL = Fork length.

c/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

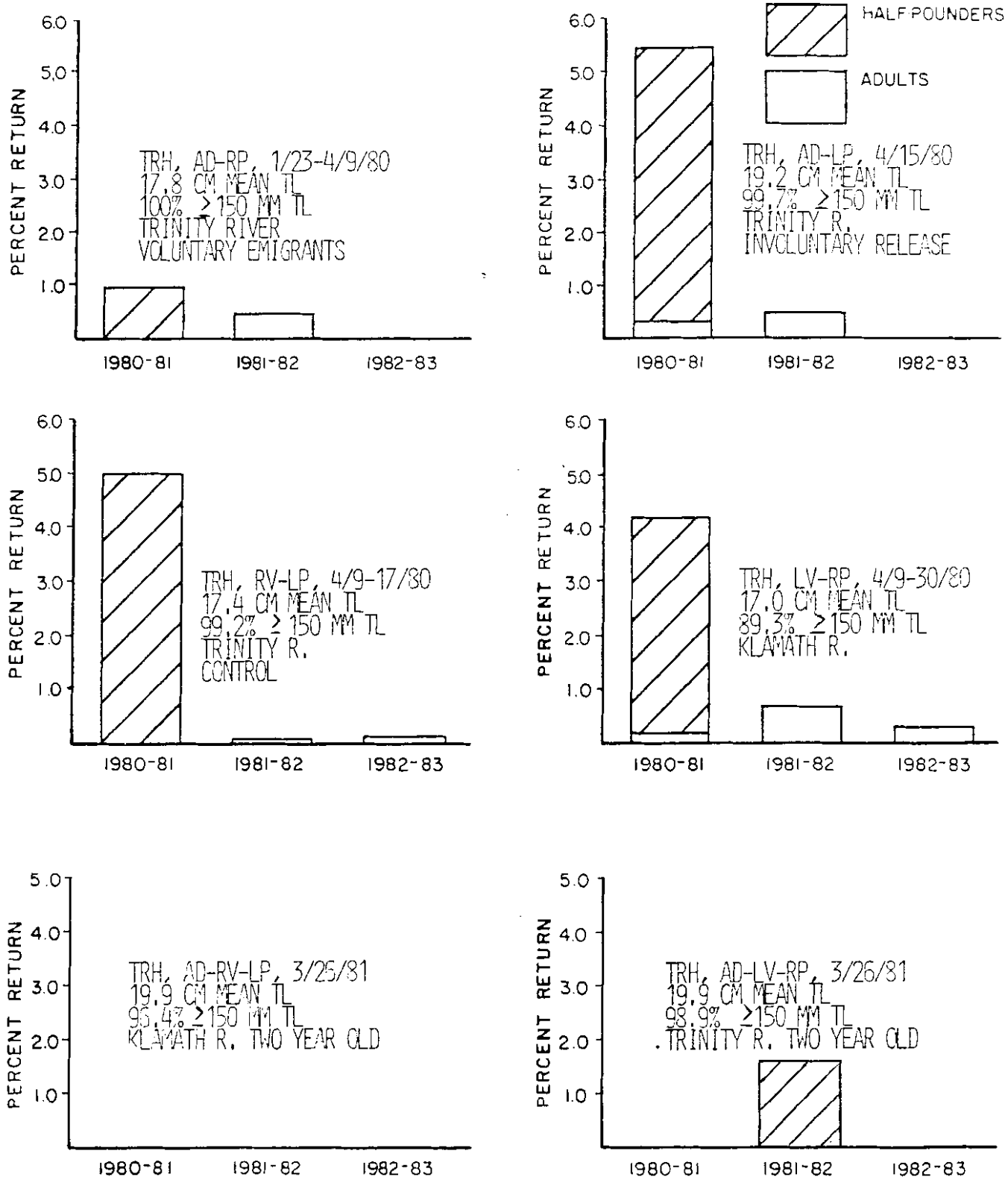


Figure 14. Percent return to the Klamath River of 1979 BY marked steelhead released from Trinity River Hatchery.

TABLE 20. Estimated Numbers of Trinity River Hatchery 1980 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group	Release data				Recovery FL (cm)	Number estimated in run			Return percent d/
	Origin a/	Date	FL(cm)b/	Number		1981-82	1982-83	Total c/	
Ad-LV	TRH	4/81	16.0	81,136	25-40	2,429	0	2,429	3.0
					) 40	0	1,029	1,029	1.3
					Subtotals	2,429	1,029	3,458	4.3
Ad-RV	TRH	2/-4/81	17.6	1,815	25-40	93	0	93	5.1
					) 40	0	0	0	0
					Subtotals	93	0	93	5.1
LV-RV	TRH	4/81	18.3	51,230	25-40	3,269	0	3,269	6.4
					) 40	0	858	858	1.7
					Subtotals	3,269	858	4,127	8.1
RV	TRH	4/81	15.9	59,188	25-40	1,308	0	1,308	2.2
					) 40	0	172	172	0.3
					Subtotals	1,308	172	1,480	2.5
TOTALS	TRH			193,369	25-40	7,099	0	7,099	3.7
					) 40	0	2,059	2,059	1.0
					TOTALS	7,099	2,059	9,158	4.7

a/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
b/ FL = Fork length.
c/ Additional returns of 1980 Brood Year fish expected to occur during 1983-84 season.
d/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

study control group (RV, 4/81) had the lowest cumulative return rate, 2.5%, for all groups (Table 20). Although the voluntary emigrant group had the highest cumulative return rate, all the fish were observed as half-pounders in the 1981 lower Klamath River seining operations and no fish from this group were sampled either as half-pounders or adults in the seining operations in 1982 (Figure 15). Adults were sampled from the other two groups during the 1982 season (Figure 15).

The 1978 By mark group (D-Ad, 4/79) released from IGH which was comprised of fish rescued from Klamath River tributaries and reared at the BCFRF had the highest cumulative return rate of fish released from IGH (Table 21). We did not sample any of these fish in 1980, however, adults were observed in 1981 (Figure 16). The 1978 BY mark group (RV, 4/79) released from IGH, which was comprised of 49.9% fish $\geq$150 mm TL at release, had a cumulative return rate of 2.3% as compared to the 1978 mark group (LV, 4/79) comprised of only 4.3% fish $\geq$150 mm TL at release which had a lower cumulative return rate of 0.5% (Table 21). Sixty-seven percent of the fish from the smaller sized group (LV, 4/79) returning the second year were classified as half-pounders (Figure 16). We did not sample any of these fish in the third year of return (Figure 16).

In 1980, three 1979 BY IGH mark groups were released in an extended rearing study to evaluate different release times at IGH. The average size fish in each group varied and more than 93% of the two later release groups were $\geq$150 mm TL at release. The earliest group released (Ad-"T", 4/80) averaged 15.4 cm (6.1 in.) FL at release and had a cumulative return rate of 12.1% (Table 22). This group also included a high number of returning Age 3+ adults (Figure 17). The 1979 BY mark group (Ad-"H", 5/80), which averaged 17.3 cm (6.8 in.) FL at release, had a cumulative return of 8.2% (Table 22). The third mark group (Ad-"O", 6/80) which had a mean length of 19.5 cm (7.7 in.) FL at release had a cumulative return of 4.2% (Table 22). Neither of the two later release groups included any returning adults in the third year (Figure 17).

In 1981, three 1980 BY IGH releases were again made on different dates to evaluate release times. This year the mean FL of the fish released was similar for all groups. A fourth group of fish reared at the BCFRF were also released in 1981. Returns of these groups are incomplete since they do not reflect returns of Age 3+ adults in 1983. However, as demonstrated by the 1979 BY releases, the earliest comparable release group (LV-"H", 4/81) had the highest cumulative return of 11.5% for the 1981-82 and 1982-83 seasons (Table 23). Slightly more than 30% of the returns of this group the second year were comprised of half-pounders (Figure 18). The BCFRF mark group (LV-"X", 4/81) and the mark group (LV-"O", 5/81) each had high cumulative return rates for the two seasons of 11.4 and 11.6%, respectively (Table 23). The mark group (LV-"T", 6/81)

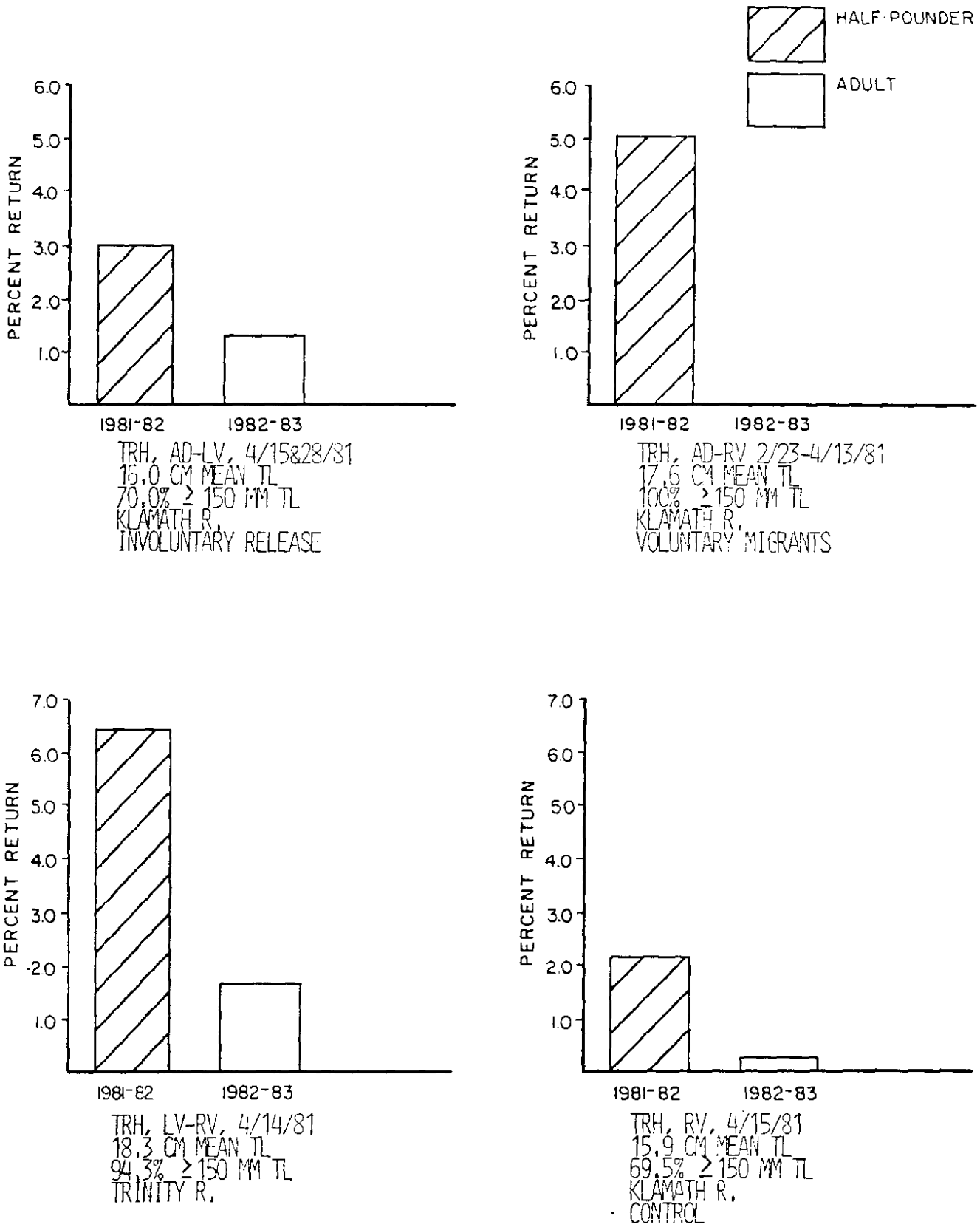


Figure 15. Percent return to the Klamath River of 1980 BY marked steelhead released from Trinity River Hatchery.

TABLE 21. Estimated Numbers of Iron Gate Hatchery 1978 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group	Release data				Recovery FL (cm)	Number estimated in run				Return percent c/
	Origin a/	Date	FL(cm)b/	Number		1979-80	1980-81	1981-82	Total	
D-Ad	IGH	4/79	12.7	10,033	25-40	306	0	0	306	30.
					) 40	0	0	187	187	1.9
					Subtotals	306	0	187	493	4.9
LV	IGH	4/79	11.9	216,194	25-40	919	362	0	919	0.4
					) 40	0	182	0	182	0.1
					Subtotals	919	544	0	1,101	0.5
RV	IGH	4/79	14.8	119,264	25-40	2,554	0	0	2,554	2.1
					) 40	0	182	94	276	0.2
					Subtotals	2,554	182	94	2,830	2.3
TOTALS	IGH			226,227	25-40	3,779	362	0	4,141	1.8
					) 40	0	364	281	645	0.3
					TOTALS	3,779	726	281	4,786	2.1

a/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
b/ FL = Fork length.
c/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

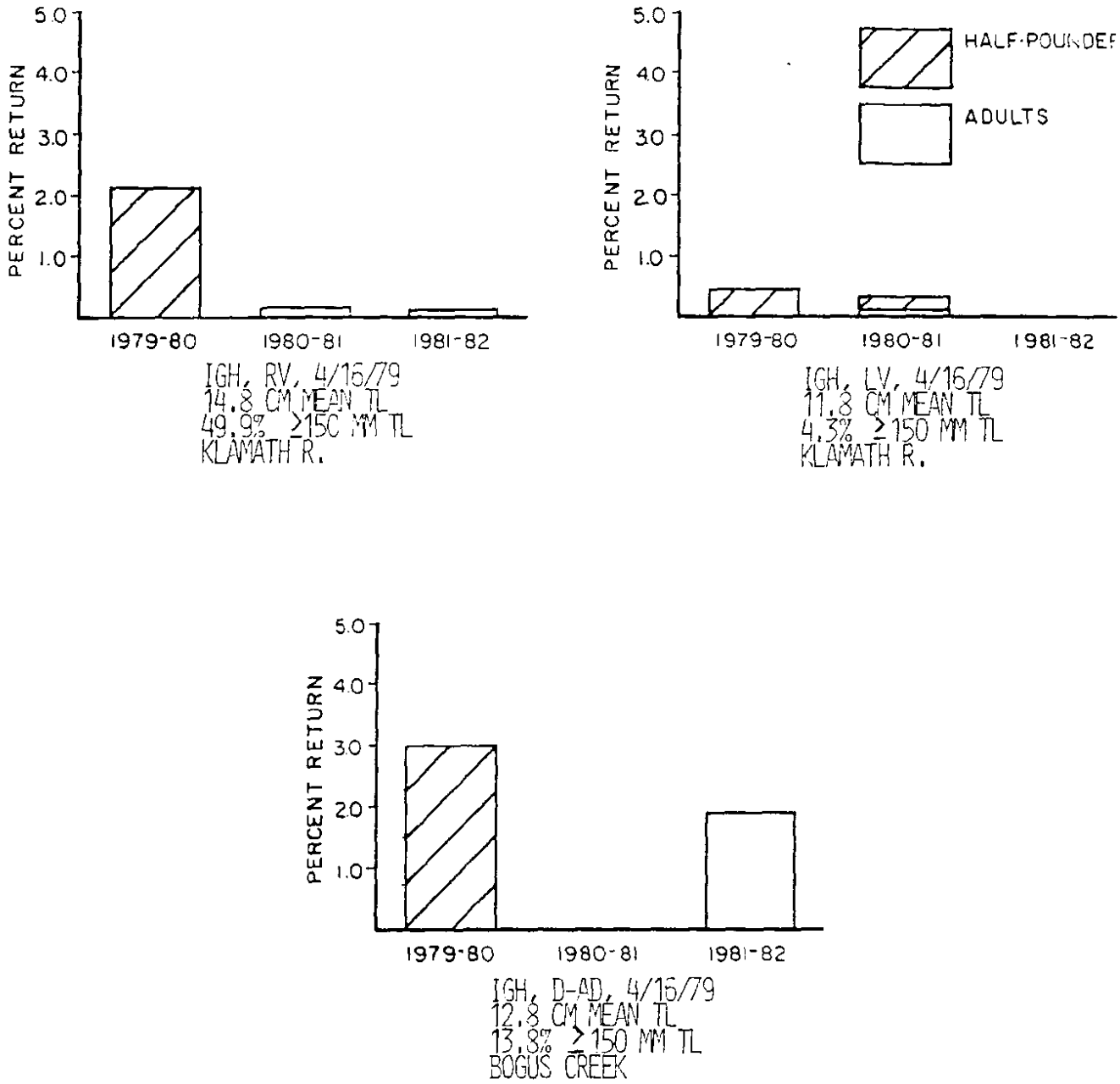


Figure 16. Percent return to the Klamath River of 1979 BY marked steelhead released from Iron Gate Hatchery.

TABLE 22. Estimated Numbers of Iron Gate Hatchery 1979 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group a/	Release data Origin b/	Date	TL(cm) c/	Number	Recovery FL (cm)	Number estimated in run 1980-81	1981-82	1982-83	Total	Return percent d/
Ad-"T"	IGH	4/80	15.4	58,047	25-40	3,622	560	0	4,183	7.2
					> 40	0	1,817	1,029	2,846	4.9
					Subtotals	3,622	2,377	1,029	7,029	12.1
Ad-"H"	IGH	5/80	17.3	59,000	25-40	3,622	280	0	3,902	6.6
					> 40	0	936	0	936	1.6
					Subtotals	3,622	1,216	0	4,838	8.2
Ad-"O"	IGH	6/80	19.5	53,070	25-40	1,087	654	0	1,741	3.3
					> 40	0	468	0	468	0.9
					Subtotals	1,087	1,122	0	2,209	4.2
TOTALS	IGH			170,117	25-40	8,331	1,494	0	9,825	5.8
					> 40	0	3,221	1,029	4,250	2.5
					TOTALS	8,331	4,715	1,029	14,075	8.3

a/ Letters in quotation marks indicate freeze brands applied to marked (fin-clipped) fish.
b/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
c/ FL = Fork length.
d/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

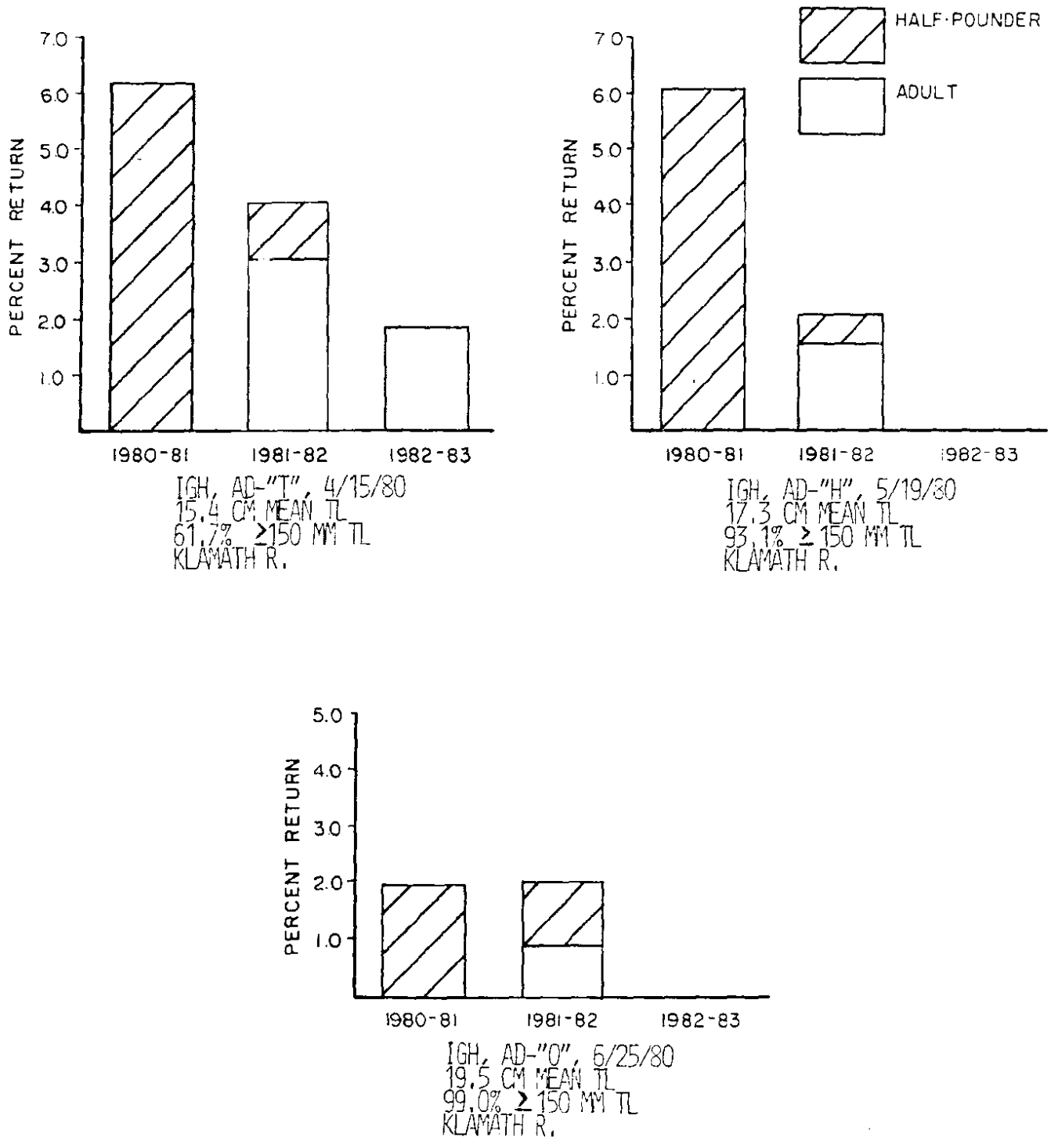


Figure 17. Percent return to the Klamath River of 1979 BY marked steelhead released from Iron Gate Hatchery.

TABLE 23. Estimated Numbers of Iron Gate Hatchery 1980 Brood Year Hatchery-produced Steelhead Returning to the K'amath River

Mark group a/	Release data: Origin b/	Date	FL(cm) c/	Number	Recovery FL (cm)	Number estimated in run: 1981-82	1982-83	Total d/	Return percent e/
LV-"H"	IGH	4/81	15.0	64,660	25-40	4,203	1,029	5,232	8.1
					> 40	0	2,230	2,230	3.4
					Subtotals	4,203	3,259	7,462	11.5
LV-"O"	IGH	5/81	14.9	66,250	25-40	5,138	343	5,481	8.3
					> 40	0	2,059	2,059	3.1
					Subtotals	5,138	2,402	7,540	11.4
LV-"T"	IGH	6/81	14.9	66,240	25-40	560	0	560	0.8
					> 40	0	172	172	0.3
					Subtotals	560	172	732	1.1
LV-"X"	IGH	4/81	14.5	38,580	25-40	3,269	0	3,269	8.5
					> 40	0	1,201	1,201	3.1
					Subtotals	3,083	1,201	4,470	11.6
TOTALS	IGH			235,730	25-40	13,170	1,372	14,542	6.2
					> 40	0	5,662	5,662	2.4
					TOTALS	13,170	7,034	20,204	8.6

a/ Letters in quotation marks indicate freeze brands applied to marked (fin-clipped) fish.
b/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
c/ FL = Fork length.
d/ Additional returns of 1980 Brood Year fish expected to occur during 1983-84 season.
e/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

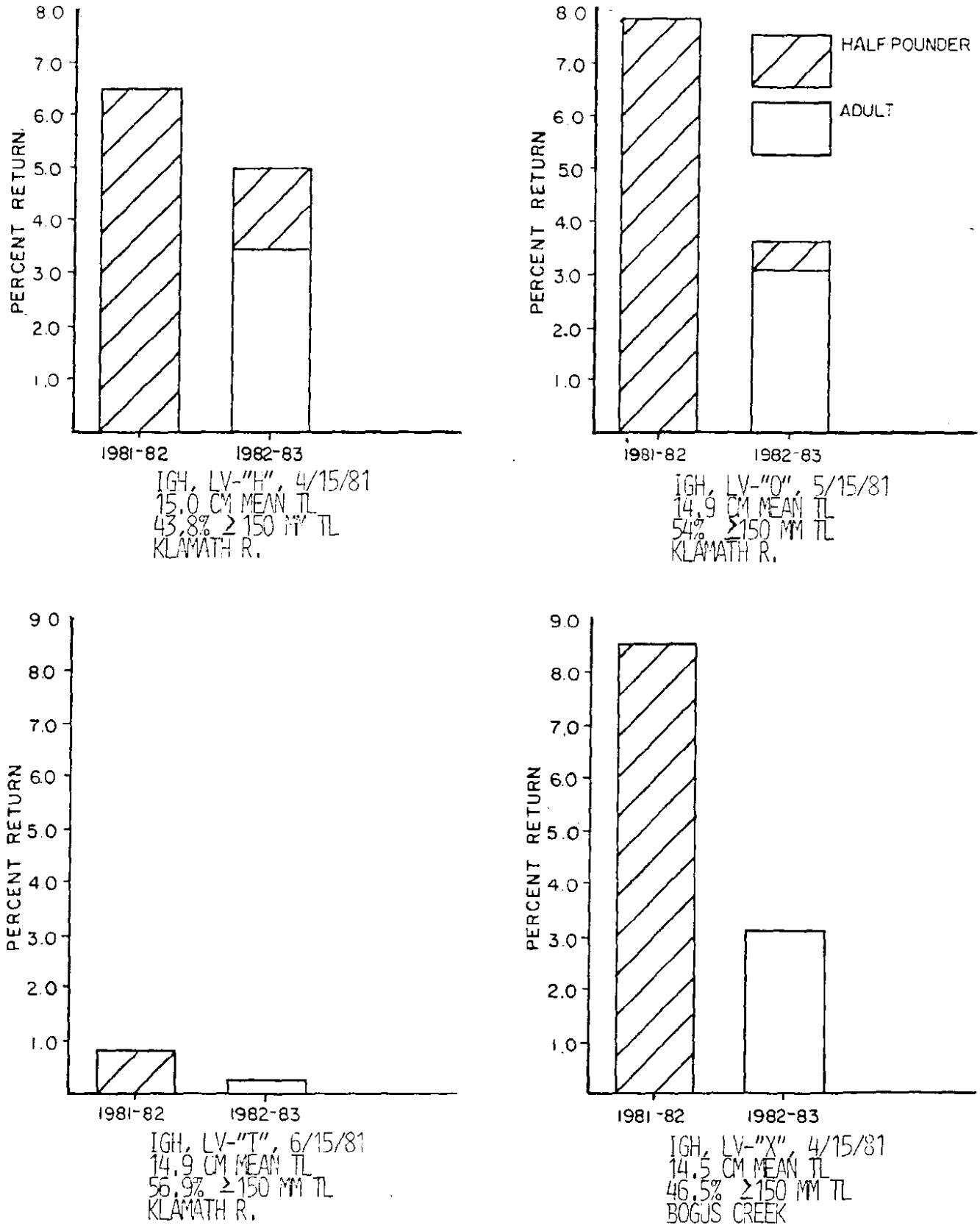


Figure 18. Percent return to the Klamath River of 1980 BY marked steelhead released from Iron Gate Hatchery.

released the latest from IGH had a very poor cumulative return rate of 1.1% (Table 23). both half-pounders and adults were sampled in the second year of return for the April and May release groups, while the BCFRF and June release groups samples included only adults in 1982 (Figure 18).

In 1982, three groups of 1981 BY steelhead were also made on three different dates with fish or approximately equal size. No fish were reared at the BCFCF and released in 1982. Although returns are incomplete, the earliest release group had the highest return as half-pounders in 1982 (Table 24 and Figure 19).

Incidence of Gill-net Marks and Hook Scars

We sampled six half-pounders (0.04% of 13,769) and 53 (0.7% of 8,116) adult steelhead with gill-net marks during the seasons 1977-1982 (Table 25). The mean length of the adult steelhead was 59.0 cm (23.2 in) FL and ranged from 45-74 cm (17.7-29.1 in.) FL. The mean length of the half-pounders was 31.7 cm (12.5 in.) FL and ranged from 27-38 cm (11.4-15.0 in.) FL.

Healed and/or healed hook scars were observed during the lower Klamath River seining operations on 40 half-pounders and 142 adult steelhead during the 1977 through 1982 seasons (Table 26). The majority of the scared half-pounders and adults, 70% (28 of 40) and 75% (106 of 142), respectively, were observed during the 1977 season.

Scott River

Run Timing

A temporary fish trapping weir was installed on the Scott River one km (1.6 miles) upstream from the mouth from September 14 through October 19, 1982. During that period 140 adults and no half-pounder steelhead were trapped, examined and measured.

The first steelhead was trapped the week ending September 16 and steelhead numbers peaked the week ending October 28 when 100 (71.4% of 140) fish were trapped. No steelhead were trapped on October 29 when the trap became inoperable due to high flows. The number of adult steelhead in the run appeared to be increasing when the weir was removed.

Run Size

Because of the small amount of sampling conducted on the Scott River, no information on run size is presented.

TABLE 24. Estimated Numbers of Iron Gate Hatchery 1981 Brood Year Hatchery-produced Steelhead Returning to the Klamath River

Mark group a/	Release data Origin b/	Date	FL(cm) c/	Number	Recovery FL (cm)	Number estimated in run 1982-83	Total d/	Return percent e/
RV-"T"	IGH	4/15/82	15.5	57,552	25-40	4,118	4,118	7.2
					) 40	0	0	0
					Subtotals	4,118	4,118	7.2
RV-"O"	IGH	5/15/82	15.2	59,474	25-40	3,603	3,603	6.1
					) 40	0	0	0
					Subtotals	3,603	3,603	6.1
RV-"H"	IGH	6/15/82	15.8	58,474	25-40	1,201	1,201	2.1
					) 40	0	0	0
					Subtotals	1,201	1,201	2.1
TOTALS	IGH			175,500	25-40	8,922	8,922	5.1

a/ Letters in quotation marks indicate freeze brands applied to marked (fin-clipped) fish.
b/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
c/ FL = Fork length.
d/ Additional returns of 1980 Brood Year fish expected to occur during 1983-84 season.
e/ Return Percentage = (Number estimated to have returned/Number effectively marked and released) x 100.

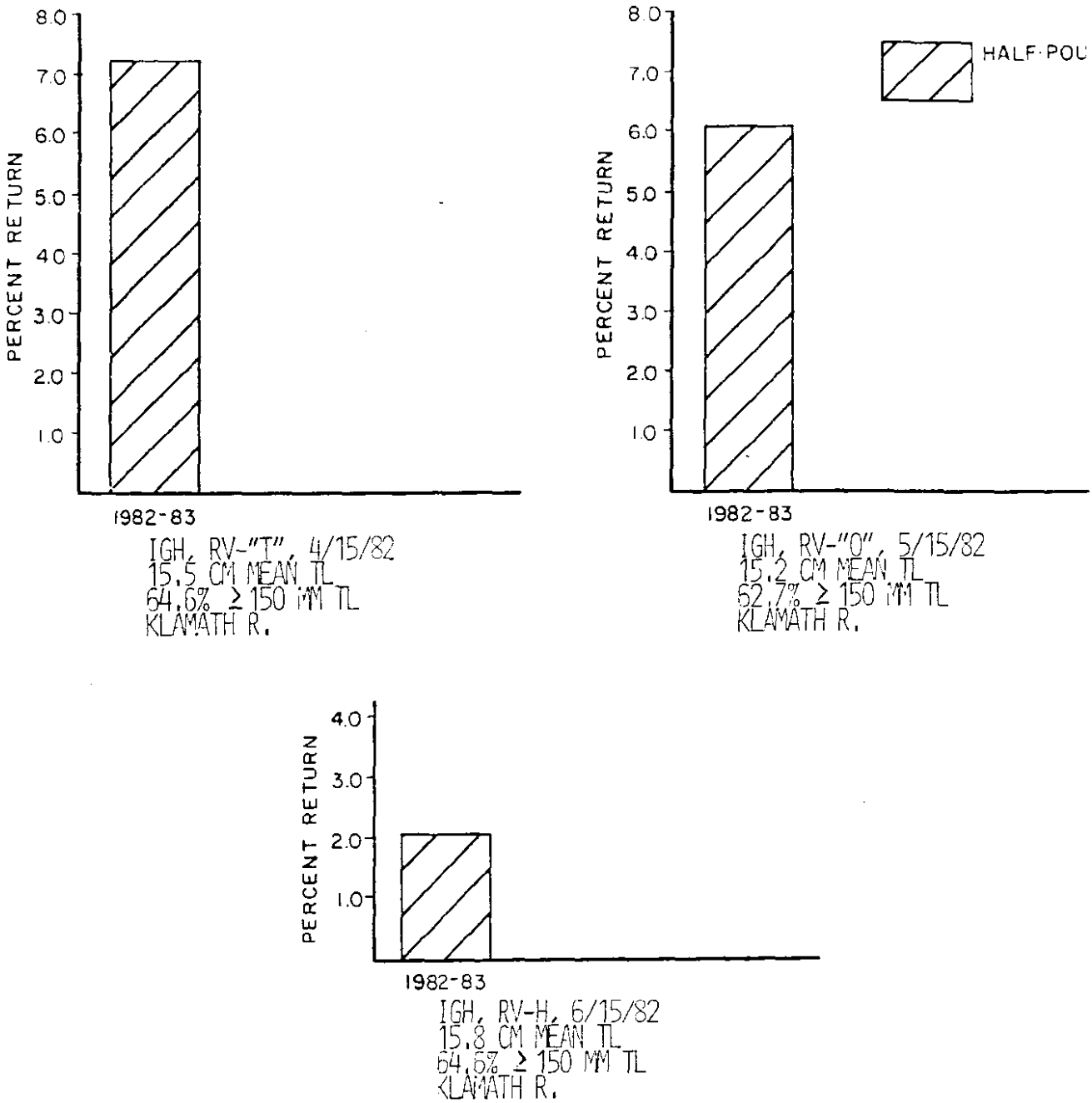


Figure 19. Percent return to the Klamath River of 1981 BY marked steelhead released from Iron Gate Hatchery.

TABLE 25. Fork Lengths of Gill-net-marked Steelhead Captured in Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982 a/

Year	Half-pounders		Adults	
	No.	Mean FL (range)(cm)	No.	Mean FL (range)(cm)
1977	2	34.0 (34-34)	22	58.9 (47-70)
1978	0		3	59.7 (49-67)
1979	2	27.5 (27-28)	11	62.6 (45-73)
1980	2	33.5 (29-38)	5	56.8 (47-63)
1981	0		9	59.7 (47-74)
1982	0		3	47.7 (45-49)
TOTALS	6		53	

a/ All half-pounders caught were not measured in most years; samples shown are limited to those half-pounders measured that were observed to have gill-net marks. Essentially 100% of the adult steelhead captured were mearsured, and numbers shown are totals captured that bore gill-net marks.

TABLE 26. Fork Lengths of Hook-scared Steelhead Captured in Lower Klamath River (Waukel Creek) Seining Operations, 1977 Through 1982 a/

Year	Scar type	Half-pounders No.	Half-pounders Mean FL (range)(cm)	Adults No.	Adults Mean FL (range)(cm)
1977	Healed	28	34.6 (29-40)	85	46.0 (41-51)
	Fresh	5	34.2 (28-40)	21	50.6 (42-64)
1978	Healed	1	40.0	6	46.0 (41-51)
	Fresh	2	39.0 (38-40)	2	48.0 (43-53)
1979	Healed	1	32.0	1	65.0
	Fresh	0		2	52.5 (52-53)
1980	Healed	0		3	52.0 (41-60)
	Fresh	0		0	
1981	Healed	2	32.5 (26-39)	7	52.1 (41-59)
	Fresh	1	n/a	6	52.3 (46-59)
1982	Healed	0		4	48.3 (44-54)
	Fresh	0		4	50.3 (45-57)
	Healed/Fresh	0		1	53.0
TOTALS		40		142	

a/ All half-pounders caught were not measured in most years; samples shown are limited to those thaat were observed to have hook scars. Essentially 100% of the adult steelhead captured were measured, and numbers shown are totals captured that bore hook scars.

Size of Fish

The mean length of the 140 adult steelhead captured in 1982 was 52.8 (20.8 in.) FL and ranged from 38-62 cm (15.0-24.4 in.) FL.

Incidence of Tags and Hatchery Marks

No tags or marks were observed on any of the steelhead trapped in the Scott River.

Shasta River

The SRFCF was operational prior to the beginning of the steelhead run in all years. During the 1978-79, 1979-80, 1980-81 and 1982-83 seasons the facility remained operational long enough to enumerate the majority of the steelhead run. During the 1981-82 season, the facility was inoperative one week in December due to high flows and trapping was terminated on January 6, 1982. High flows hampered counting during the 1982-83 season during the period December 16 through December 22, and again from January 28 to the end of the counting season. During these periods steelhead were observed to occasionally jump the weir at the facility and accurate counts and observations of tags and marks were not possible.

Run Timing

The entry of adult steelhead into the Shasta River appeared to be bimodal with fall (October-December) and spring (January-April) peaks (Figure 20). The fall peak occurred as early as the week ending October 7 and as late as the week ending December 31. In those years when counts were continued through the spring, the spring peak occurred as early as the week ending February 11 and as late as the week ending March 11 (Figure 20).

Half-pounder steelhead were not observed at the SRFCF in large numbers and no run-timing patterns were observed. During the 1980-81 season when 144 half-pounders were counted, 95 (66% of 1,344) were counted in the fall and 49 (34% of 1,434) were counted in the spring. The greatest numbers were counted the week ending November 4 in the fall and the week ending January 21 in the spring. During the 1982-83 season when 96 half-pounders were counted, all but two fish were counted prior to December 31. Highest counts were recorded the two-week period ending October 14 when 83 (86.5% of 96) fish were counted.

Run Size

Steelhead counts were made at the SRFCF during all six study seasons. During that period, 6,855 adult and half-pounder steelhead were counted (Table 27).

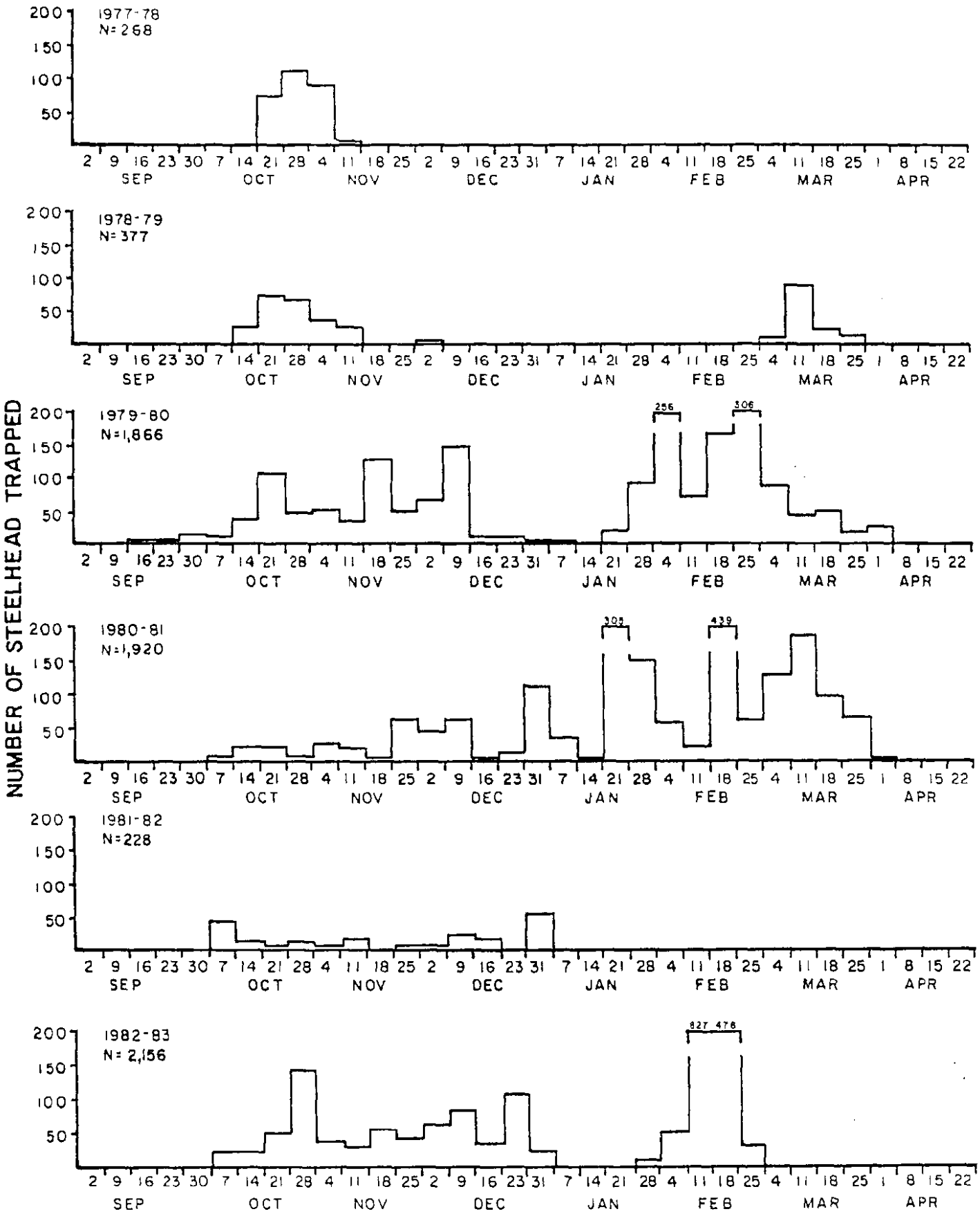


Figure 20. Number of steelhead trapped at the Shasta River Trapping Facility by standard week during the 1977/78 through 1982/83 seasons.

TABLE 27. Steelhead Counts, Shasta River Fish Counting Facility, 1977-78 Through 1982-83 Seasons

Season	Counting period	Numbers		
		Adults	Half-pounders	Total
1977/78a/	9/1/77 - 11/12/77	b/	b/	268
1978/79	9/24/78 - 4/11/79	375	2	377
1979/80	9/1/79 - 3/3/80	1,866	0	1,866
1980/81	9/7/80 - 4/5/81	1,816	144	1,960
1981/82a/	9/1/81 - 1/5/82	218	10	228
1982/83a/	9/3/82 - 2/24/83	2,060	96	2,156
TOTALS				6,855

a/ Season count incomplete.
b/ Adults and half-pounders were not seperated.

Due to the problem of making complete steelhead counts at the SRFCF in all years because of high stream flows, the average annual run size for the Shasta River for all six study years is not available. Accurate counts were believed to have been made only during the 1979-80, 1980-81 and 1982-83 seasons. During these three seasons, the run averaged 1,994 adult steelhead.

Half-pounder steelhead were recorded separately from adult steelhead during all seasons except 1977 and comprised 3.4% (252 of 6,587) of the steelhead counted during the 1978 through 1982 seasons.

Size of Fish

Steelhead length frequency data was collected at the SRFCF only during the 1982-83 season. Sixty-six fish were measured which averaged 55.4 cm (21.8 in.) FL and ranged from 43 to 69 cm (16.9 to 27.2 in.) FL.

Incidence of Tags and Hatchery Marks

During the 1977-78 through 1982-83 seasons 20 tags applied to steelhead during our lower Klamath River seining operations were observed (Table 28). Only one hatchery fin-clipped steelhead, a 1978 BY TRH release which had been tagged during the 1980-81 lower Klamath River seining operations was observed the same season as tagged.

Bogus Creek

The BCFCF on Bogus Creek (located 0.6 km [0.4 mile] upstream from the mouth) was operated during the 1981-82 and 1982-83 seasons. The facility was installed principally to enumerate the fall chinook salmon run, however, early entering steelhead were additionally trapped. During the 1981-82 season the BCFCF was operational from September 16 through November 5, 1981. The following season, 1982-83, the BCFCF was operational from September 16 through November 4, 1982.

Run Timing

During the 1981-82 and 1982-83 seasons, six and 26 adult steelhead, respectively, were trapped. All of the steelhead were trapped after October 4 and no peak entry periods were discernible.

Run Size

Run-size-estimates were not developed since the BCFCF was operational for only part of the annual steelhead run.

TABLE 28. Release and Recovery Data for Steelhead Tagged During the Lower Klamath River (Waukel Creek) Seining Operations and Recovered at the Shasta River Fish Counting Facility, 1977-78 Through 1982-83 Seasons

Season	Number of Tagged Steelhead Observed a/	Recovery FL Mean (range)(cm)	Days at liberty Mean (range)
1977-78	0		
1978-79	2	52 b/	143
1979-80	4	50.8 (45-56)	160 (165-184)
1980-81	8 c/	45.7 (45-47)	150.5 (121-180)
1981-80	1	58.0	16
1982-83	5 d/	48.3 (45-51)	100.3 (36-147)
TOTAL	20		

a/ All tags were recovered in the same season the fish were tagged.
b/ Tag number was observed for only one of the recovered fish.
c/ One fish was LP fin-marked (1978 BY TRH release).
d/ Tag numbers were obtained from three of the five fish.

Size of fish

No length measurements were taken from steelhead during the operation of the BCFCF.

Incidence of Tags and Hatchery Marks

No tag or marks were observed on any steelhead trapped at the BCFCF.

Iron Gate Hatchery

Run Timing

The steelhead run at IGH was generally bimodal with major peaks occurring in the fall (October-December) and spring (January-March) (Figure 21). However, during the 1977-78 and 1979-80 seasons two spring peaks were observed. The fall peak generally occurred during the period October 22 through November 18, while the major spring peak generally occurred during the period February 12 through March 11.

Stream flows measured 1.0 km (0.6 m) downstream from Iron Gate Dam during the study years were generally constant from September to early December in all study seasons except 1981-82. The number of steelhead entering IGH normally began to increase in early October and decrease in late November. With the exception of the 1982-83 season, there did not appear to be any relationship during the fall migration period between flows and steelhead entry into IGH. In 1982, increases in flow in October and early November appeared to be related to increased numbers of steelhead at IGH, however, the time period coincided with the expected entry timing as observed in previous years (Figure 22).

Water temperature measured at the same location during early October generally ranged about 13 degrees C during the periods of record (1977-78 through 1980-81 seasons). Maximum and minimum water temperatures were normally already declining in October and usually reached a low of approximately 3-5 degrees C in late December or early January. Water temperatures of approximately 8-10 degrees C appeared to coincide with the reduction in numbers of steelhead entering IGH in mid- to late November (Figure 22).

Water releases and spills from Iron Gate Dam resulted in variable stream flows after early December. In many years, the increased late winter and spring period stream flows coincided or preceded increased numbers of steelhead entering IGH during that period (Figure 22).

During the December through January period, water temperatures fluctuated slightly and generally began increasing in February or

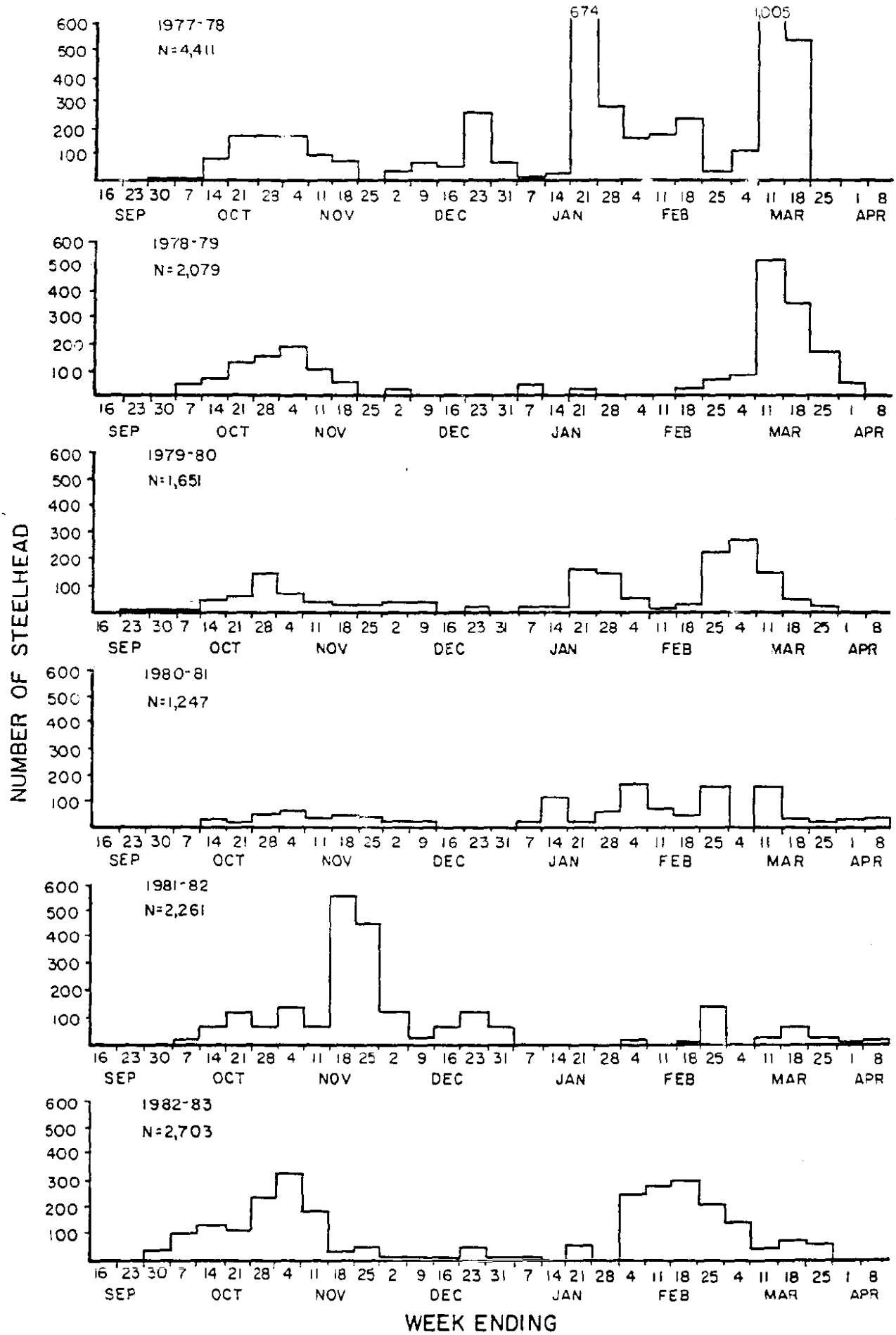


Figure 21. Number of steelhead trapped at Iron Gate Hatchery by standard week during the 1977/78 through 1982/83 seasons.

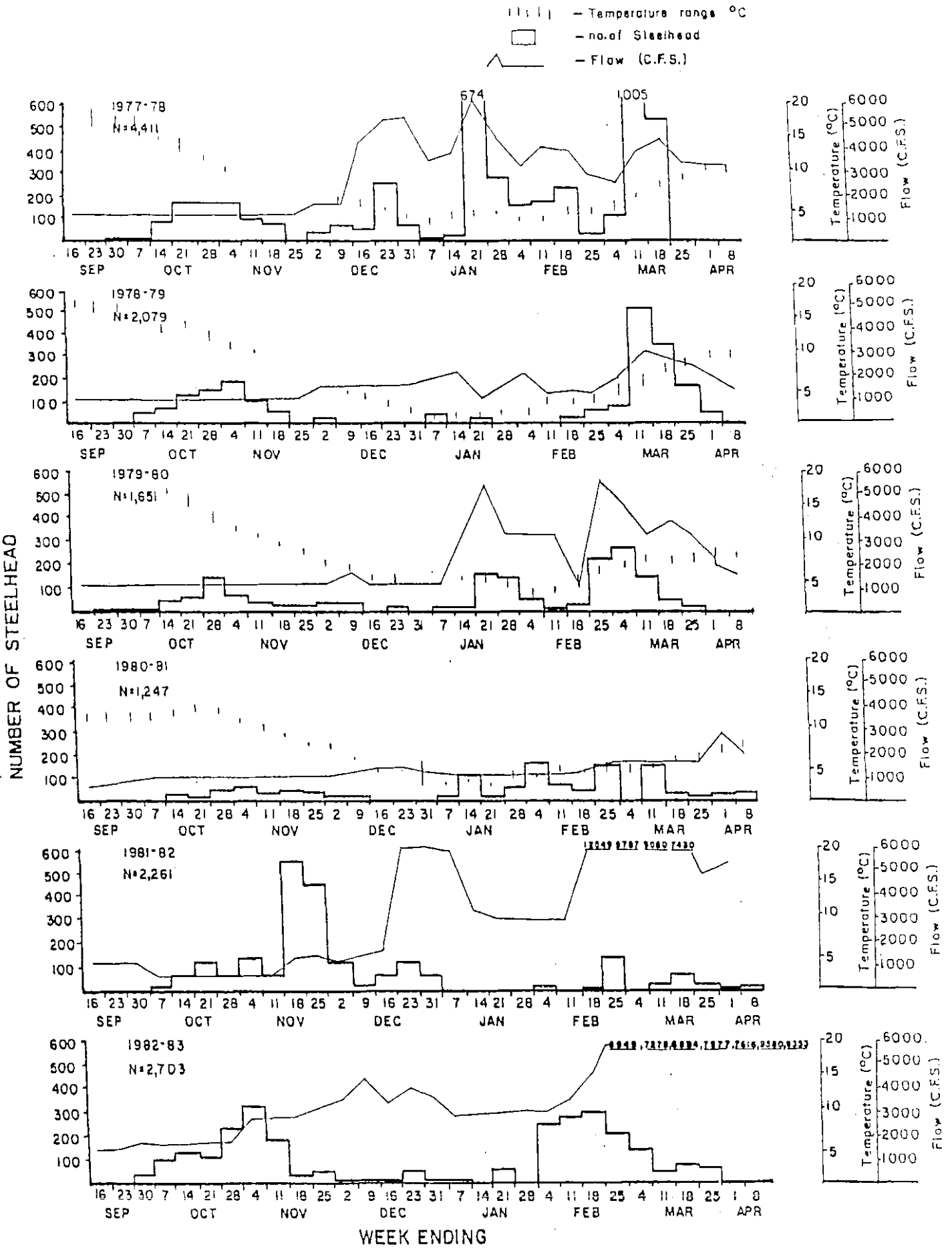


FIGURE 22. Number of steelhead trapped at Iron Gate Hatchery, and stream flows and water temperatures in the Klamath River near Iron Gate Hatchery.

March. In some years, increased stream flows coincided with slight increases in temperature. Because of this factor, it is difficult to assess the influence of temperatures in the late winter and spring period on entry of steelhead into IGH (Figure 22).

Run Size

During the 1977-78 through 1982-83 seasons, the steelhead run averaged 2,392 fish (Table 29). During that period, 65.9% of the run entered IGH in the spring excluding the 1981-82 season. During the 1981-82 season, only 15.8% of the run entered IGH in the spring.

Size of Fish

Length frequency data was collected from a sample of steelhead entering IGH during each season. Separation of data by mark groups was begun during the 1979-80 season.

During the six seasons, the mean length of steelhead entering IGH averaged 49.8 cm (19.6 in.) FL, and ranged from 46.5 to 51.1 cm (18.3 to 20.1 in.) FL (Table 30).

Average size and ranges of marked steelhead observed at IGH beginning during the 1979-80 season are presented in Table 83 with the exception of the 1981-82 season for which data are not available.

Incidence of Tags and Hatchery Marks

We recovered 20 steelhead (0.14% of 14,352) at IGH which had been tagged during our lower Klamath River seining operations during the 1977-78 through 1982-83 seasons (Table 32). Seventy percent (14 of 20) of the recoveries were made during the same season as tagged.

During the 1977-78 season, hatchery personnel reported trapping a 45 cm (17.7 in.) FL steelhead 153 d after it had been tagged in the lower Rogue River, Oregon, at km 8 (RM 5.0) on August 18, 1977.

A total of 4,534 (31.6% of 14.352) fin-marked, presumed hatchery-origin steelhead were trapped at IGH during the 1977-78 through 1982-83 seasons. During the last four seasons when all IGH- or TRH-origin steelhead entering IGH would have been fin marked, the contribution of IGH-origin steelhead was 51.7% (4,067 of 7,862) and the contribution of TRH-origin steelhead was 0.5% (36 of 7,862 (Table 33).

Twenty-eight groups of fin-clipped steelhead released from IGH and TRH were observed at IGH during the 1977-78 through 1982-83 seasons (Table 34).

TABLE 30. Fork Lengths of Steelhead Sampled at Iron Gate Hatchery, 1977-78 Through 1982-83 Seasons

Season	Mean FL (range)(cm)	Number Sampled
1977-78	49.8 (34-70)	2,591
1978-79	49.7 (n/a) a/	1,244
1979-80	50.6 (37-68)	941
1980-81	46.5 (35-62)	544
1981-82	51.1 (41-68)	n/a
1982-83	51.0 (40-70)	1,039
MEAN	49.8 (34-70)	

a/ Not available.

TABLE 29. Numbers of Steelhead Trapped at Iron Gate Hatchery, 1977-78 Through 1982-83 Seasons

Season	Numbers trapped		
	Fall a/	Spring b/	Total
1977-78	1,214	3,197	4,411
1978-79	771	1,308	2,079
1979-80	514	1,137	1,651
1980-81	359	888	1,247
1981-82	1,903	358	2,261
1982-83	1,267	1,436	2,703
TOTALS	6,028	8,324	14,352
AVERAGES	1,005	1,387	2,392

a/ Fall trapping period extends from September through December.
b/ Spring trapping period extends from January through April.

TABLE 31. Fork Lengths of Marked Steelhead Observed at Iron Gate Hatchery, 1979-80, 1980-81 and 1982-83 Seasons a/

	Season					
	1979-80		1980-81		1982-83	
Mark b/	Mean FL	(range)(cm)	Mean FL	(range)(cm)	Mean FL	(range)(cm)
D	47.7	(41-55)	54.2	(49-61)		
D-Ad	56.9	(51-60)				
Ad	49.7	(44-54)	49.0	(44-55	54.8	(47-70)
Ad-LP	47.7	(41-55)	54.2	(49-61)		
Ad-RP	52.9	(46-61)				
Ad-LV-RV	47.0					
LV	41.0		46.2	(39-53	49.7	(37-60)
LV-RV	44.4	(37-51)	48.7	(41-55)		
RV	51.7	(46-55)	45.6	(38-56)		
LP	48.0		46.0			
RP	53.0					
Ad-"T"					54.8	(49-68)
Ad-"H"					53.5	(45-65)
Ad-"O"					53.5	(43-62)
LV-"H"					47.9	(40-59)
LV-"O"					46.2	(40-53)
LV-"T"					47.0	(44-50)
LV-"X"					46.0	(42-59)

a/ Note: No data available for 1981-82 season.

b/ Letters in quotation marks denote freeze brands applied to marked (fin-clipped) fish.

TABLE 32. Numbers and Fork Lengths of Steelhead Tagged During Lower Klamath River (Waukel Creek) Seining Operations and Trapped at Iron Gate Hatchery, 1977-78 Through 1982-83 Seasons

Tagging data		Recovery data			
Season	Mean FL (range)(cm)	Season	Number	Mean FL (range)(cm)	Days at liberty mean (range)
1976-77	35.6 (29-40)	1977-78	5	51.4 (48-61)	510.0 (471-546)
1977-78	50.2 (47-53)	1977-78	5	50.2 (47-53)	115.2 (61-163)
1977-78	28.0	1978-79	1	44.0	n/a
1978-79	n/a	1978-79	5	n/a	n/a
1979-80	46.5 (44-49)	1979-80	2	46.5 (44-49)	110.5 (88-133)
1980-81	48.0	1980-81	1	48.0	167
1981-82	42.0	1981-82	1	42.0	78
1982-83	-	1982-83	0	-	-

TABLE 33. Occurrence of Fin-marked Steelhead at Iron Gate Hatchery, 1977-78 Through 1982-83 Seasons

Season	Number of steelhead trapped	Number of fin-marked steelhead trapped a/			
		IGH	TRH	Other	Total
1977-78	4,411	0	7(0.1)b/	24(0.5)	31(0.6)
1978-79	2,079	63(3.0)	0	17(0.8)	80(3.8)
1979-80	1,651	929(56.3)	1(0.1)	33(2.0)	963(58.3)
1980-81	1,247	384(30.8)	8(0.6)	28(2.2)	420(33.7)
1981-82	2,261	1,023(45.2)	18(0.8)	259(11.4)c/	1,300(51.5)
1982-83	2,703	1,731(64.0)	9(0.3)	0	1,740(64.3)

a/ Origin of fish: IGH = Iron Gate Hatchery, TRH = Trinity River Hatchery, Other = Cole Rivers Hatchery and marks of unidentifiable origin.
b/ Number in parentheses is percent of total steelhead trapped.
c/ All of these fish were classified as having dorsal fin clips but were probably misidentified by inexperienced workers.

TABLE 34. Numbers and Relative Return Rates of Marked, Hatchery-produced Fall Steelhead Returning to Iron Gate Hatchery, 1977-78 Through 1982-83 Seasons

Mark[b]	Release data: Origin[c]	Date	BY[d]	Number	Recovery FL(cm)[e]	Number returned (relative return rate)[a]: 1978-79	1979-80	1980-81	1981-82	1982-83	Total
D-Ad	IGH	4/77	1976	14,144	) 40		51 (36.1)				51 (36.1)
Ad-LP	IGH	4/77	1976	429,306	25-40	10 (0.2)	0	0			10 (0.2)
					) 40	29 (0.7)	589 (13.7)	14 (0.3)			632 (14.7)
					TOTALS	39 (0.9)	589 (13.7)	14 (0.3)			642 (14.9)
Ad-RP	IGH	4/77	1976	40,292	) 40	23 (5.7)	85 (21.1)				108 (26.8)
LV-RV	IGH	4/78	1977	200,000	25-40	0	4 (0.2)	0			4 (0.2)
					) 40	1 (0.1)	200 (10.0)	230 (11.5)			431 (21.6)
					TOTALS	1 (0.1)	204 (10.2)	230 (11.5)			435 (21.8)
D-Ad	IGH	4/79	1978	10,033	) 40					1 (1.0)	1 (1.0)
LV	IGH	4/79	1978	216,194	) 40			23 (1.1)	26 (1.2)		49 (2.3)
RV	IGH	4/79	1978	119,264	) 40			117 (9.8)	8 (0.7)	2 (0.2)	127(10.6)
Ad-"T"	IGH	4/80	1979	58,047	) 40				101(17.4)	138(23.8)	239(41.2)
Ad-"H"	IGH	5/80	1979	59,000	) 40				432(73.2)	271(45.9)	703(119.2)
Ad-"O"	IGH	6/80	1979	53,070	) 40				456(85.9)	226(42.6)	682(128.5)

(continued on next page)

TABLE 34. Numbers and Relative Return Rates of Marked, Hatchery-produced Fall Steelhead Returning to Iron Gate Hatchery, 1977-78 Through 1982-83 Seasons (continued)

Mark[b]	Origin[c]	Release data: Date	BY[d]	Number	Recovery: FL(cm)[e]	Number returned (relative return rate)[a]: 1978-79	1979-80	1980-81	1981-82	1982-83	Total
LV-"H"	IGH	4/81	1980	64,660	) 40					702(108.6)	702(108.6)
LV-"O"	IGH	5/81	1980	66,250	) 40					240(36.2)	240(36.2)
LV-"T"	IGH	6/81	1980	66,240	) 40					17(2.6)	17 (2.6)
LV-"X"	IGH	4/81	WILD	38,580	) 40					136(35.3)	136 (35.3)
Ad-LV-RV	TRH	4/78	1977	152,876	) 40		1 (0.1)	1 (0.1)			2 (0.2)
LP	TRH	3/79	1978	324,774	) 40			3 (0.1)	0	5 (0.2)	8 (0.2)
RP	TRH	4/79	1978	67,570	) 40			4 (0.6)	1(0.1)		5 (0.7)
Ad-RP	TRH	1-4/80	1979	18,365	) 40					1 (0.5)	1 (0.5)
Ad-LV	TRH	4/81	1980	81,136	) 40				5 (0.6)		5 (0.6)
LV-RV	TRH	4/81	1980	51,230	UNK				6 (1.2)	1 (0.2)	7 (1.4)
RV	TRH	4/81	1980	59,188						2 (0.3)	2 (0.3)

a/ Relative return rate = (Number returned / Number released) x 10,000.
b/ Letters in quotation marks indicate freeze brands applied to marked (fin-clipped) fish.
c/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery.
d/ BY = Brood year.
e/ FL = Fork length.

Trinity River Weirs

During the 1977-78 season, a temporary fish trapping and marking weir was operated at the U. S. Forest Service (USFS) Tish Tang Campground (km 94, RM 58). During the remaining years the weir site was moved upstream near Willow Creek (km 108, RM 67). Beginning with the 1978-79 season, a second weir was installed and operated each season near Junction City (km 128, RM 79.5).

Run Timing

Information on steelhead run timing at the Trinity River fish trapping and marking weirs is difficult to assess due to the low number of steelhead trapped each season. At Willow Creek (km 208, RM 67), the earliest steelhead were trapped during the week ending August 5 when trapping activities were initiated. Adult steelhead were usually trapped throughout the late summer and fall until high stream flows prevented operation of the weir. Only during 1980 was a peak in the run timing evident when 104 steelhead were trapped the week ending October 14.

At the Junction City weir site (km 218, RM 79.5) insufficient numbers of steelhead were trapped in most seasons to make any observations regarding steelhead run timing at that location (Table 35). In most years, the weir did not remain in place throughout the steelhead migration. During the 1978-79 season, however, the weir remained in place throughout the season and the majority (64% of 181) steelhead were trapped during November.

Size of Fish

The mean length of steelhead trapped at the Willow Creek weir ranged from 50.4 to 57.0 cm (19.8 to 22.4 in.) FL during the 1977-78 through 1982-83 seasons (Table 36).

At Junction City, mean length of steelhead trapped for the 1978-79 through 1982-83 seasons ranged from 46.6 to 60.2 cm (18.3 to 23.7 in.) FL (Table 36).

Incidence of Marks and Tags

Four (0.4% of 903) tagged steelhead were trapped at Willow Creek weir during the six seasons of trapping (Table 37). Three of the tagged steelhead had been tagged during lower Klamath River seining operations. All were recovered during the same season as tagged. The fourth tagged steelhead was trapped in 1979 and had been tagged at the Willow Creek weir site the previous season.

Three (1.4% of 211) tagged steelhead were trapped at the Junction City weir during the five years of trapping (Table 38). Two fish had been tagged in the lower Klamath River seining operations

TABLE 35. Numbers of Steelhead Trapped at Junction City Weir, 1977-78 Through 1982-83 Seasons

Month	Season 1977-78 a/	1978-79 b/	1979-80 c/	1980-81 d/	1981-82 e/	1982-83 f/
May	n/s	0	0	0	0	0
June	n/s	1	0	1	0	2
July	n/s	0	1	0	2	2
August	n/s	0	out 8/4	0	1	1
September	n/s	1	n/s g/	0	0	0
October	n/s	16	n/s	9	0	1
November	n/s	116	n/s	0	n/s	n/s
December	n/s	10	10	0	n/s	n/s
January	n/s	20	n/s	n/s	n/s	n/s
February	n/s	9	n/s	n/s	n/s	n/s
March	n/s	8	n/s	n/s	n/s	n/s
TOTALS		181	11	10	3	6

a/ Junction City Weir not operated during 1977-78 season.
b/ Weir operational May 9, 1978 through March 28, 1979.
c/ Weir operational May 12 through August 3, 1979, and December 12 through 22, 1979.
d/ Weir operational May 15 through November 6, 1980, and December 3-4, 1980.
e/ Weir operational May 19 through October 2, 1981.
f/ Weir operational May 14 through October 22, 1982.
g/ n/s = no sampling.

TABLE 36. Mean Fork Lengths of Steelhead Trapped at Trinity River Weirs, 1977-78 Through 1982-83 Seasons

Season	Willow Creek			Junction City		
	Unmarked	Fin-marked	Combined	Unmarked	Fin-marked	Combined
1977-78 a/	53.8 b/ (39-64) (22)	55.0 (48-66) (5)	54.0 (39-66) (27)	no sampling		
1978-79	56.1 (36-80) (52)	58.3 (50-71) (16)	56.6 (36-80) (68)	59.0 (48-72) (112)	59.5 (46-68) (69)	59.2 (46-72) (181)
1979-80	58.0 (39-74) (151)	53.0 (43-69) (24)	57.0 (39-74) (176)	65.8 (59-73) (5)	51.0 (48-53) (3)	60.2 (48-73) (8)
1980-81	51.3 (28-68) (167)	48.4 (29-62) (80)	50.4 (28-68) (247)	45.8 (42-51) (6)	47.8 (42-56) (4)	46.6 (42-56) (10)
1981-82	51.7 (28-76) (74)	51.8 (31-69) (11)	51.7 (28-76) (85)	60.0 (53-67) (2)	57.0 (59) (1)	59.0 (53-67) (3)
1982-83	54.1 (37-72) (244)	53.6 (39-70) (56)	54.1 (39-72) (300)	53.3 (48-61) (3)	53.6 (45-64) (3)	53.5 (45-64) (6)

a/ This season the weir location was Tish Tang Campground (river Km 22).

b/ The three figures shown for each category and season are: 1) Mean fork length; 2) Fork length range (cm); 3) Number of fish sampled.

TABLE 37. Numbers of Tagged Steelhead Recaptured at Willow Creek Weir, Trinity River, 1977-78 Through 1982-83 Seasons

Season	Total steelhead trapped	Tagged fish in total	Tagged fish size at recovery	Mean days at liberty (range)
1977-78 a/	27	1 b/		
1978-79	68	0		
1979-80	176	2 c/		
1980-81	247	0		
1981-82	85	0		
1982-83	300	1 d/	42	19
TOTALS	903	4		

a/ This season the weir location was at Tish Tang Campground (river km 22).
b/ Tagged during fall 1977 lower Klamath River (Waukel Creek) seining operations.
c/ One fish tagged during fall 1979 lower Klamath River (Waukel Creek) seining operations and one fish tagged during fall 1978 Willow Creek Weir trapping and tagging operations.
d/ Tagged during fall 1982 lower Klamath River (Waukel Creek) seining operations.

TABLE 38. Numbers of Tagged Steelhead Recaptured at Junction City Weir, Trinity River, 1977-78 Through 1982-83 Seasons

Season	Total steelhead trapped	Tagged fish in total	Tagged fish size at recovery	Mean days at liberty (range)
1977-78	n/s a/	0		
1978-79	181	2 b/ 1 c/		54 (31-77)
1979-80	11	0		
1980-81	10	0		
1981-82	3	0		
1982-83	6	0		
TOTALS	211	3		

a/ n/s = no sampling.
b/ Tagged during fall 1978 lower Klamath River (Waukel Creek) seining operations.
c/ Tagged by ODFW, September 1977, Rogue River, Oregon.

during the same season. One steelhead tagged and released in the Rogue River in September 1977, by the Oregon Department of Fish and Wildlife (ODFW), was trapped in 1978.

Twenty-one mark groups of steelhead released from TRH were observed during the six seasons at the Willow Creek and Junction City weirs, and in a creel census conducted by Trinity River Project personnel in the upper Trinity River (Table 39).

Trinity River Hatchery

Run Timing

The earliest steelhead trapped at TRH (km 246, RM 153) was during the week ending October 7 in 1977. During the 1977-78, 1979-80 and 1982-83 seasons, few steelhead were trapped prior to January 1. During the 1980-81 and 1981-82 seasons, 44.9 and 61.5%, respectively, of the total run was trapped prior to January 1 (Table 40).

The steelhead run at TRH generally appeared to peak from mid-December through March (Figure 23). When runs exceeded 1,000 fish during the 1980-81 and 1981-82 seasons the runs appeared to peak in late December.

Stream flows measured near Lewiston (0.6 km [0.4 RM] downstream TRH) were constant during the 1977-78 and 1978-79 seasons and as such, no correlation between entry of steelhead into TRH and flow releases was noted. Stream flows were less than 345 cfs in both years. Maximum and minimum water temperatures varied in the two seasons from approximately 7.5 to 12 degrees C during the period of steelhead entry into TRH. No significant correlations between steelhead entry into TRH and water temperatures was noted, however, a slight drop of approximately 0.5 to 2.0 degrees C occurred in both years coincidence with a reduction in numbers of steelhead entering TRH during early February (Figure 24).

During the 1979-80 season, peak entry and the first significant numbers of steelhead entering TRH coincided with a significant increase in stream flows. Stream flows increased from a weekly average of approximately 300 cfs to 1,250 cfs. Maximum daily stream flow recorded during the peak entry week was 2,060 cfs. Stream flows remained about 2,000 cfs during the following week, however, numbers of steelhead entering TRH decreased. Maximum and minimum water temperatures during the increased flow period varied less than 0.5 degrees C. Maximum water temperatures during the migration period did not exceed 8 degrees C and increased to 9 degrees C in early April when stream flows dropped to less than 300 cfs (Fugure 24).

During the 1980-81 migration period stream flows were constant at approximately 320 cfs until the week ending December 23 when they

TABLE 39. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed at the Willow Creek Weir, Junction City Weir and in the Trinity River Creel Census, 1977-78 Through 1982-83 Seasons

	Release data				Numbers recovered (relative return rate) a/						
Mark	Origin b/	Date	BY c/	Number	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	Total
LV	TRH	4/76	1974	38,509	1 (0.3)						1 (0.3)
LP	TRH	4/76	1974	29,630		1 (0.3)					1 (0.3)
Ad-RV	TRH	4-5/76	1975	118,394	1 (0.3)						1 (0.3)
RV	TRH	4-5/76	1975	115,607	3 (0.3)	3 (0.3)					6 (0.5)
Ad-LV-RP	TRH	3/77	1975	21,842		1 (0.5)					1 (0.5)
Ad-RV-LP	TRH	3/77	1975	43,658		3 (0.7)					3 (0.7)
LV-RP	TRH	4/77	1976	175,210		65 (3.7)	4 (0.2)				69 (3.9)
RV-LP	TRH	4/77	1976	129,595		12 (0.9)	3 (0.2)	3 (0.2)			18 (1.4)
Ad-LV-RV	TRH	4/78	1977	152,876			14 (0.9)				14 (0.9)
Ad-LV	TRH	4/79	1978	30,418			1 (0.3)	24 (7.9)			25 (8.2)
Ad-RV	TRH	2-3/79	1978	14,813			1 (0.7)	15 (10.1)		2 (1.4)	18 (12.2
LP	TRH	3/79	1978	324,774			1 (0.0)	55 (1.7)	2 (0.1)	1(0.0)	59 (1.8)
RP	TRH	4/79	1978	67,133				6 (0.9)	1 (0.1)		7 (1.0)
Ad-LP	TRH	4/80	1979	52,781				4 (0.8)	3 (0.6)		7 (1.4)
Ad-RP	TRH	1-4/80	1979	18,365				1 (0.5)	1 (0.5)	2(1.1)	4 (2.2)
LV-RP	TRH	4/80	1979	113,625					1 (0.1)	3 (0.3)	4 (0.4)
RV-LP	TRH	4/80	1979	139,211					1 (0.1)	3 (0.2)	4 (0.3)
Ad-LV-RP	TRH	3/81	1979	28,943						4 (1.4)	4 (1.4)
Ad-RV-LP	TRH	3/81	1979	4,206						2 (4.8)	2 (4.8)
Ad-RV	TRH	2-4/81	1980	1,815						3 (16.5)	3 (16.5
Ad-LV	TRH	4/81	1980	81,136						12 (1.5)	12 (1.5)
LV-RV	TRH	4/81	1980	51,230					2 (0.4)	28 (5.5)	30 (5.9)
RV	TRH	4/81	1980	59,188						10 (1.7)	10 (1.7)

a/ All fish recovered were adults, >40 cm fork length. Relative return rate = (Marks recovered/Marks released) x 10,000.

b/ TRH = Trinity River Hatchery.

c/ BY = Brood year.

Table 40. Numbers of Steelhead Entering Trinity River Hatchery, 1977-78 Through 1982-83 Seasons

Standard week	Numbers of steelhead trapped					
	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Oct. 1- 7	3					
8-14	0					
15-21	2	1		3		
22-28	1	0		4		
29- 4	3	1		3		
Nov. 5-11	2	0	1	5		
12-18	2	0	2	4		
19-25	0	2	1	10	24	1
26- 2	1	3	1	19	11	19
Dec. 3- 9	2	0	0	51	6	10
10-16	2	0	0	33	15	0
17-23	1	4	0	330	435	11
24-31	0	13	4	444	130*	27
Jan. 1- 7	44	9	0	96	21	2
8-14	45	12	0	169*	41	25
15-21	32	51	0	182	17	28
22-28	12*	34	1	199	18	75
29- 4	0	3	2	38	17	120
Feb. 5-11	1	1	0	46	24	51*
12-18	0	46	4	213	72	136
19-25	8	62	255*	89	77	44
26- 4	19	189	26	13	40	101
Mar. 5-11	72	116*	15	41	39	27
12-18	20	66	40	26	13	30
19-25	9	45	7	1	3	5
26- 1	4	19	10		3	3
Apr. 2- 8		4	4		1	
9-15		1	9			
16-22		1				
TOTALS	285	683	382	2,019	1,007	715

* Median entry week.

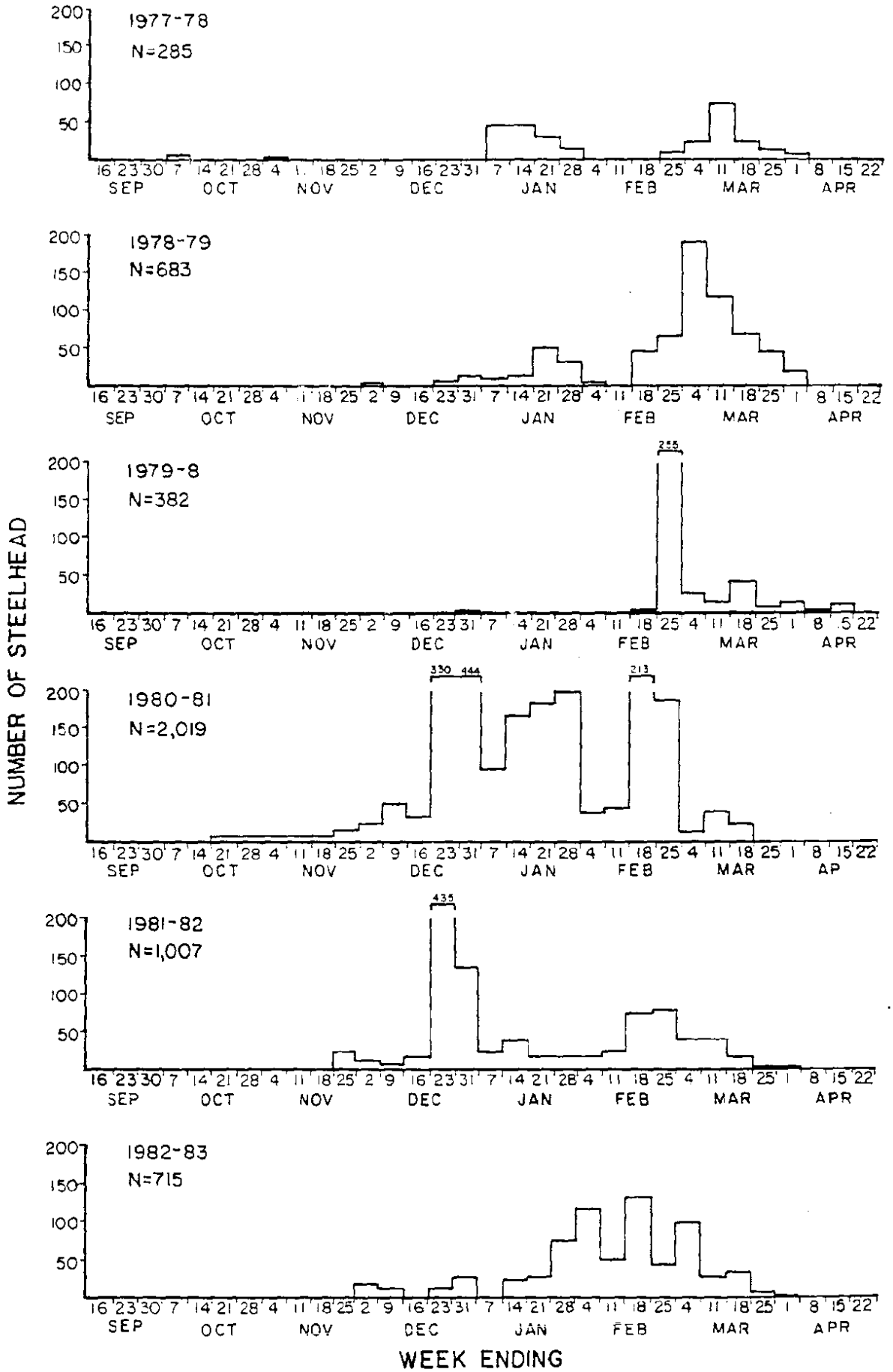


Figure 23. Number of steelhead trapped at Trinity River Hatchery by standard week during the 1977/78 through 1982/83 seasons.

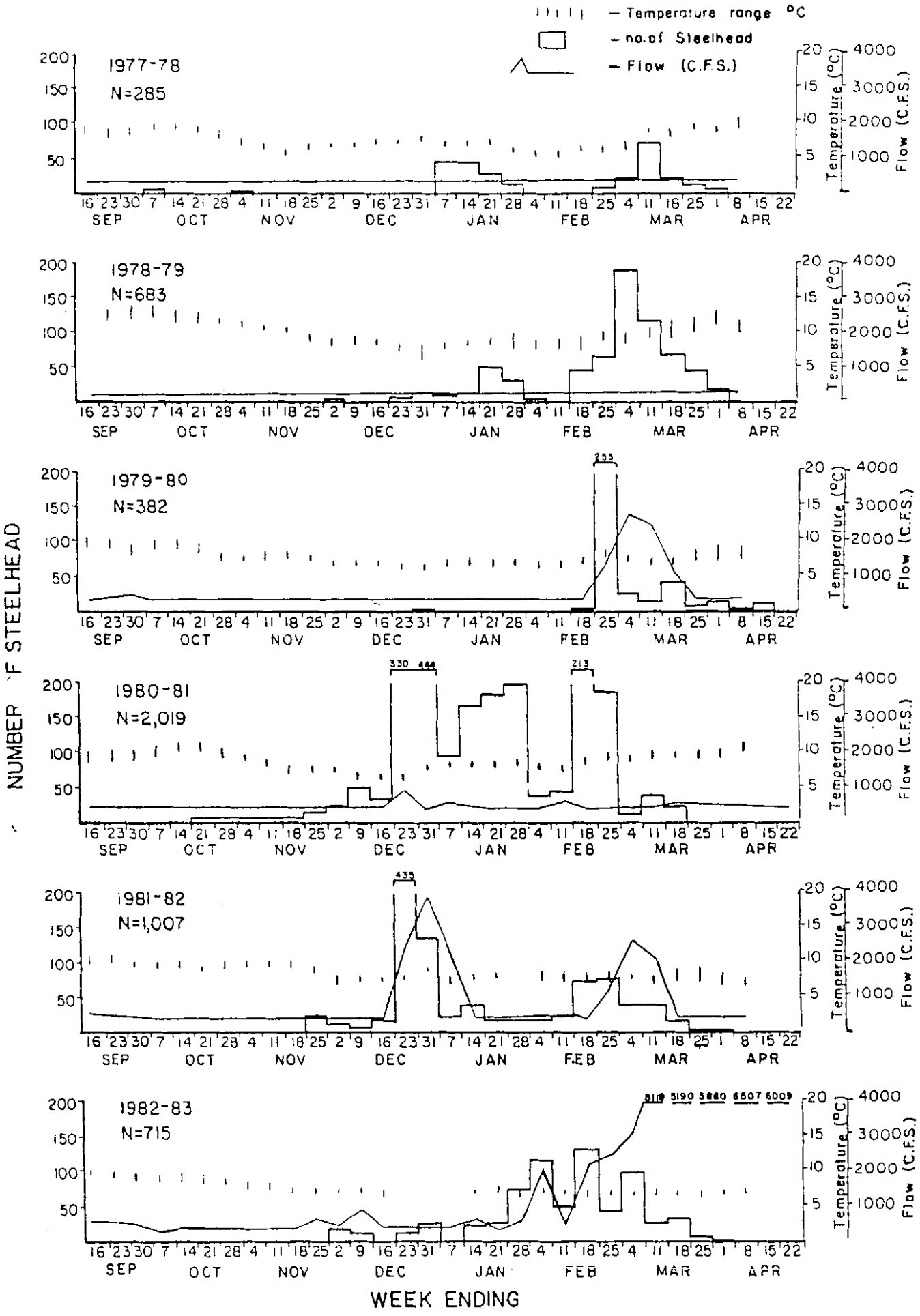


FIGURE 24. Number of steelhead trapped at Trinity River Hatchery, and streamflows and water temperatures in the Trinity River near Trinity River Hatchery.

increased to approximately 900 cfs. This increase coincided with a large increase in numbers of steelhead entering TRH. Numbers of steelhead continued to increase the following week in spite of a reduction in stream flow to approximately 300 cfs. Additional increased stream flows of approximately 900 cfs lasting less than a week also occurred later in the season. Number of steelhead entering TRH appeared to increase during the weeks following the increased streamflows. Maximum and minimum water temperatures varied between 6 and 7 degrees C prior to the first increase in stream flow and generally increased to approximately 9 to 11 degrees C in early April. There did not appear to be any relationship between water temperatures and number of steelhead entering TRH during the 1980-81 season (Figure 24).

The first peak entry of steelhead entering TRH during the 1981-82 season appeared to be strongly related to with an increase in streamflows. A second and smaller peak entry of steelhead which occurred the week ending February 18 and continued through the week ending March 18 did not appear to be initiated by increases in stream flow. Significant stream flow increases occurred on February 23, after steelhead numbers began increasing. However, the increased entry numbers may have been initiated by a storm event which occurred earlier and doubled streamflows in downstream reaches (Douglas City area) during the week ending February 18. Throughout this time period, maximum and minimum water temperatures varied less than 0.5 degrees C and ranged from 7 to 8.5 degrees C Figure 24).

During the 1982-83 season, a similar pattern of steelhead entry and stream flows as observed in 1981-82 was observed. Steelhead entry into TRH in late November and early December appeared to coincide with increased stream flows. Increased numbers of steelhead entering TRH in late January and again in mid-February also appeared to coincide with increased stream flows. Maximum and minimum water temperatures demonstrated very little variation this season and remained between 6.5 and 7.5 degrees C (Figure 24).

Run Size

The steelhead run at TRH averaged 849 steelhead during the 1977-78 through 1982-83 seasons and ranged from 285 to 2,019 fish (Table 40).

Size of Fish

Mean lengths of steelhead trapped at TRH are available for all seasons except 1978-79. During the five seasons, steelhead mean lengths averaged 53.0 cm (20.9 in.) FL and ranged from 50.4 to 54.7 cm (19.8 to 21.5 in.) FL (Table 41). The size of fish trapped during the five seasons ranged from 25 to 81 cm (9.8 to 31.9 in.) FL.

TABLE 41. Fork Lengths of Steelhead Entering Trinity River Hatchery, 1977-78 Through 1982-83 Seasons

Season	Number sampled	Mean FL (range)(cm) a/
1977-78	281	50.4 (30-74)
1978-79	n/a b/	n/a
1979-80	376	51.2 (25-78)
1980-81	1,979	54.6 (26-73)
1981-82	1,007	53.9 (37-75)
1982-83	715	54.7 (36-81)

a/ FL = Fork length.
b/ No data available.

Incidence of Tags and Marks

Twenty steelhead tagged during the lower Klamath River seining operations were trapped at TRH (Table 42). All but three were recovered during the same season as tagged. The mean number of days at liberty for fish recovered the same season as tagged was 112.7 d (range 70 to 194 d). The three steelhead recovered at TRH which had been tagged the previous season were at liberty an average of 466 d (range 423-491 d).

Twenty-four steelhead mark groups released from TRH were observed at TRH during the 1977-78 through 1982-83 seasons (Table 43). During the 1978-79 season, 284 various marked steelhead released from TRH were recovered at TRH. During the 1980-81 and 1981-82 seasons, six and two IGH-origin marked steelhead were observed.

The majority (92.3%) of steelhead observed at TRH during the 1977-78 through 1982-83 seasons have been TRH-origin. Hatchery-produced fish trapped during the same period contributed 92.7% (4,666 of 5,091) of the fish trapped (Table 44).

Fifty-two tags applied to steelhead at the Tish Tang Campground, Willow Creek and Junction City weirs were recovered at TRH during the 1977-78 through 1982-83 seasons (Table 45).

Sport Fishery

Angler Effort and Harvest

Lower Klamath River. During the 1977-78 and 1978-79 seasons, a creel census was conducted on the Klamath River immediately above the Waukel Creek seining site (river km 4.8, RM 3.0) upstream to Blakes Riffle (river km 11.3, RM 7.0) and from Johnson's (river km 32.2, RM 20) upstream to Happy Camp (river km 169, RM 105). The creel census emphasized the examination of sport-caught steelhead and salmon for Project marks and tags. Total angler effort or catch was not estimated.

During the 1979 season, a creel census was conducted in the area from the mouth upstream to Blakes Riffle and again emphasized examining sport-caught steelhead and salmon for Project marks and tags.

During the 1980-81 through 1982-83 seasons the creel census methodology was changed from a mark sampling program to a census designed to estimate complete angler effort and harvest in the area from the mouth upstream to Blakes Riffle and boat anglers landing steelhead in this area and fishing from the mouth upstream to Johnsons.

During the six seasons, we sampled 60,510 angler trips from river km 4.8 (RM 3.0) upstream to Blakes Riffle (km 11.3, RM 7.0) (Table

TABLE 42. Numbers of Steelhead Tagged During Lower Klamath River Seining Operations (Waukel Creek) and Trapped at Trinity River Hatchery, 1977-78 Through 1982-83 Seasons

Recapture season	Year tagged	Number	Tagging mean FL (range)(cm)	Recovery mean FL (range)(cm)	Mean days at liberty (range)
1977-78	1976	1	26	45	491
	1977	1	45	45	96
1978-79		0	--	--	--
1979-80		0	--	--	--
1980-81	1979	2	52.5(52-53)	62.0(61-63)	452.5(423-484)
	1980	7	48.0(42-57)	48.0(42-57)	100.0(70-140)
1981-82	1981	8	54.9(48-66)	54.9(48-66)	119.8(91-194)
1982-83	1982	1	46	46	161

TABLE 43. Numbers and Relative Return Rates of Trinity River and Iron Gate Hatchery Origin Fin-clipped Steelhead Returning to Trinity River Hatchery , 1977-78 Through 1982-83 Seasons

Mark	Release data: Origin[b]	Date	BY[c]	Number	Numbers recovered (relative return rate) [a]: 1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	Total
Ad-LV	TRH	5/74	1973	61,000	1 (0.2)						1 (0.2)
Ad-LP	TRH	4/76	1974	13,750	2 (1.5)						2 (1.5)
LV	TRH	4/76	1974	38,509	29 (7.5)	7 (1.8)	2 (0.5)				38 (9.9)
LP	TRH	4/76	1974	21,630	18 (8.3)						18 (8.3)
Ad-RV	TRH	4/76	1975	118,966	59 (5.0)	8 (0.7)	12 (1.0)				79 (6.7)
Ad-LV	TRH	5/76	1975	46,221	21 (4.5)	1 (0.2)					22 (4.7)
RV	TRH	4-5/76	1975	98,607	35 (3.5)	5 (0.5)					40 (4.0)
Ad-LV-RP	TRH	3/77	1975	21,842	7 (3.2)	30 (13.7)	1 (0.5)				38 (17.4)
Ad-RV-LP	TRH	3/77	1975	43,658	72 (16.5)	92 (21.1)	3 (0.7)				167 (38.3)
Ad-LP	TRH	4/76	1975	13,750	16 (11.6)	2 (1.5)					18 (13.1
LV-RP	TRH	4/77	1976	175,210	9 (0.5)	299 (17.1)	36 (2.1)	1 (0.1)			345 (19.7)
RV-LP	TRH	4/77	1976	129,585	2 (0.2)	181 (14.0)	28 (2.2)	2 (0.2)			213 (16.0)
Ad-LV-RV	TRH	4/78	1977	152,876			229 (15.0)	15 (1.0)	1 (0.1)		245 (16.1)
Ad-LV	TRH	4/79	1978	30,418			10 (3.3)[d]	103 (33.9)	27 (8.9)	16 (5.3)	156 (51.3)
Ad-RV	TRH	2-3/79	1978	14,813				46 (31.1)	4 (2.7)	2 (1.4)	52 (35.1)
LP	TRH	3/79	1978	323,240				1,277 (39.5)	251 (7.8)	6 (0.2)	1,534 (47.5)
RP	TRH	4/79	1978	67,133				499 (74.3)	59 (8.8)	2 (0.3)	560 (83.4)
Ad-LP	TRH	4/80	1979	52,781				6 (1.1)	85 (16.1)	13 (2.5)	104 (19.7)
Ad-RP	TRH	1-4/80	1979	18,365				4 (2.2)	26 (14.2)	9 (4.9)	39 (21.2)
LV-RP	TRH	4/80	1979	113,625					292 (25.7)	34 (3.0)	326 (28.7)
RV-LP	TRH	4/80	1979	139,211					141 (10.1)	28 (2.0)	169 (12.1)
Ad-LV-RP	TRH	3/81	1979	28,943					2 (0.7)	55 (19.0)	57 (19.7)
Ad-RV-LP	TRH	3/81	1979	4,206						8 (19.0)	8 (19.0)
Ad-LV	TRH	4/81	1980	81,136						198 (24.4)	198 (24.4)
Ad-RV	TRH	2-4/81	1980	1,815						7 (38.5)	7 (38.5)
LV-RV	TRH	4/81	1980	51,230					1 (0.2)	160 (31.2)	161 (31.4)
RV	TRH	4/81	1980	59,188					3 (0.5)	98 (16.6)	101 (17.1)
LV	IGH	4/79	1978	233,850				6 (0.3)	2 (0.1)		8 (0.3)
TOTALS					271	625	321	1,959	894	636	4,706

[a] All fish were adults, >40 cm fork length. Relative return rate = (Marks recovered/Marks released) x 10,000.
[b] TRH = Trinity River Hatchery.
[c] BY = Brood year.
[d] Returns included nonmigrant fish.

TABLE 44. Occurrence of Fin-marked Steelhead at Trinity River Hatchery, 1977-78 Through 1982-83 Seasons

Season	Number of steelhead trapped	Number of fin-marked steelhead trapped a/			
		IGH	TRH	Other	Total
1977-78	285	0	269(94.4)b/	0	269(94.4)
1978-79	683	0	625(91.5)	2(0.3)	627(91.8)
1979-80	382	0	321(84.0)	8(2.1)	329(86.1)
1980-81	2,019	6(0.3)	1,903(94.3)	2(0.1)	1,911(94.7)
1981-82	1,007	2(0.2)	892(88.6)	0	894(88.8)
1982-83	715	0	636(89.0)	0	636(89.0)

a/ Origin of fish: IGH = Iron Gate Hatchery, TRH = Trinity River Hatchery.
b/ Number in parentheses is percent of total steelhead trapped.

TABLE 45. Numbers of Steelhead Tagged at the Willow Creek and Junction City Weirs (Trinity River) Recovered at Trinity River Hatchery, 1977-78 Through 1982-83 Seasons

		Recovery data	
Season	Number	Mean FL (range)(cm)	Mean days at liberty (range)
1977-78 a/	1		
1978-79	11		
1979-80	2		
1980-81	17		
1981-82	1		
1982-83	20	55.2(46-70)	134.9(95-201)

a/ This season the Willow Creek Weir was located at Tish Tang Campground (river km 22); no trapping occurred at Junction City.

46). During those trips, anglers caught a total of 9,815 adult and 18,644 half-pounder steelhead.

During the seasons 1980-81 to 1982-83, we estimated an average of 41,524 angler trips were made and an average of 154,790 angler hours (h) were expended annually in the area from the mouth upstream to Blakes Riffle (km 11.3, RM 7.0) during that period (Table 47). Anglers caught an average of 3,235 adult and 6,265 half-pounder steelhead annually during the three seasons (Table 47).

We recovered 72 (1.4% of 5,168) steelhead in the creel census tagged during the same season in the lower Klamath River seining operations (Table 48).

In 1977, four steelhead tagged by the Oregon Department of Fish and Wildlife (ODFW) on the lower Rogue River were recovered during the lower Klamath River creel census. In 1978, we recovered two fish tagged by the ODFW in the fall of 1977 and released in the Rogue River. Both fish had been tagged as half-pounders and were recovered in the Klamath River sport fishery as adults during the 1978-79 season.

We observed 48 marked steelhead groups originating from the two basin hatcheries and CVH during creel census' conducted on the lower Klamath River from 1977-78 through 1982-83 (Table 49).

Trinity River. Creel census' were conducted on the Trinity River during all seasons and were designed to emphasize the examination of sport-caught salmon and steelhead. During most seasons, the census did not encompass the entire steelhead fishing season or area. As such, estimates of total angling effort are not available for the Trinity River.

During the six seasons, 1,033 adult steelhead were effectively tagged and released at Trinity River weir sites. Anglers returned 76 (8.9% of 857) of these tags and return rates varied from 7.5% (5 of 68) in 1978 for nonreward-tagged fish released at Willow Creek to 12.7% (23 of 181) for nonreward-tagged fish released at the Junction City weir the same season. During the last two seasons, 1981-82 and 1982-83, $10 reward tags were used and return rates for fish tagged and released at the Willow Creek weir site were 11.5 and 11.9%, respectively.

Angler Effort and Harvest

No attempt was made to estimate total angling effort for the Klamath River basin.

Table 46. Angler Effort and Steelhead Sampled in the Lower Klamath River Creel Census, 1977-78 Through 1982-83 Seasons a/

Season	Angler trips b/	Total hours fished	Steelhead observed (fish/hour) Adults	Half-pounders
1977-78	11,699	39,192	1,615 (0.041)	6,193 (0.158)
1978-79	7,748	25,956	2,285 (0.088)	1,396 (0.054)
1979-80	4,242	14,210	894 (0.063)	2,243 (0.158)
1980-81	9,639	31,288	1,417 (0.045)	2,628 (0.084)
1981-82	12,155	39,334	1,419 (0.036)	4,121 (0.105)
1982-83	15,027	52,847	2,185 (0.041)	2,063 (0.039)
TOTALS	60,510	202,827	9,815	18,644

a/ All sampling took place between the U.S. Highway 101 Bridge (river km 5) and Blakes Riffle (river km 11). In addition to anglers fishing this reach, creel samples included boat anglers landing within the sample area but fishing between Blakes Riffle and Johnson's (river km 39).

b/ Because some anglers make more than one trip during a single fishing day, data are stratified to reflect single trips/day.

Table 47. Estimated Total Angler Effort and Steelhead Catch from the Lower Klamath River, 1977-78 Through 1982-83 Seasons a/

Season	Angler trips	Total angler hours	Steelhead catch (fish/hour) Adults	Half-pounders
1977-78	b/	n/a		
1978-79	b/	n/a		
1979-80	b/	n/a		
1980-81	29,390	104,294	2,330 (0.022)	4,500 (0.043)
1981-82	43,220	157,813	3,410 (0.022)	9,859 (0.062)
1982-83	51,963	202,264	3,964 (0.020)	4,436 (0.022)
Average	41,524	154,790	3,235	6,265

a/ Includes all anglers fishing the area from the mouth upstream to Klamath Glen (km 8.0), and boat anglers landing fish between Klamath Glen and Johnson's (river km 39).

b/ Creel census not designed to provide total estimates of angler effort and harvest.

TABLE 48. Numbers and Sizes of Steelhead Tagged During the Lower Klamath River (Waukel Creek) Seining Operations Observed in Lower Klamath River Creel Census Samples, 1977-78 Through 1982-83 Seasons

Season	Number effectively tagged	Recovery Data		
		Number	Mean FL (range)(cm)	Mean days at liberty (range)
1977-78 a/	559	22	n/a b/	n/a
1978-79 a/	1,110	15	n/a	n/a
1979-80 c/	1,305	6	n/a	n/a
1980-81 c/	741	8	n/a	n/a
1981-82 c/	790	12	n/a	n/a
1982-83 c/	663	9	48.6 (47-57)	8 (2-16)
TOTALS	5,168	72		

a/ Includes area from U.S. Highway 101 Bridge (river km 5) upstream to Blakes Riffle (river km 11).
b/ n/a = not available.
c/ Includes area from the Klamath River mouth upstream to Blakes Riffle (river km 11).

TABLE 49. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River Creel Census During 1977-78 Through 1982-83 Seasons

Mark b/	Release data: Origin c/	Date	BY d/	Number	Recovery FL(cm) e/	Number returned (relative return rate) a/: 1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	Total
D-Ad	IGH	4/77	1976	14,144	25-40	14 (9.9)	1 (0.7)	0				15 (10.6)
					> 40	0	3 (2.1)	1 (0.7)				4 (2.8)
					TOTAL	14 (9.9)	4 (2.8)	1 (0.7)				19 (13.4)
Ad-LP	IGH	4/77	1976	429,306	25-40	10 (0.2)	45 (1.0)	5 (0.1)	0			60 (1.4)
					> 40	0	1 (0.0)	9 (0.2)	1 (0.0)			11 (0.3)
					TOTAL	10 (0.2)	46 (1.1)	14 (0.3)	1 (0.0)			71 (1.7)
Ad-RP	IGH	4/77	1976	40,292	25-40	20 (5.0)	1 (0.2)	0				21 (5.2)
					> 40	0	7 (1.7)	3 (0.7)				10 (2.5)
					TOTAL	20 (5.0)	8 (1.9)	3 (0.7)				31 (7.7)
LV-RV	IGH	4/78	1977	200,000	25-40		16 (0.8)	13 (0.7)	1 (0.1)			20 (1.0)
					> 40		0	6 (0.3)	4 (0.2)			10 (0.5)
					TOTAL		16 (0.8)	19 (1.0)	5 (0.3)			30 (1.5)
D-Ad	IGH	4/79	1978	10,033	25-40			1 (1.0)	1 (1.0)	1 (1.0)		3 (3.0)
					> 40					5 (5.0)	1 (1.0)	6 (6.0)
					TOTAL			1 (1.0)	1 (1.0)	6 (6.0)	1 (1.0)	9 (9.0)
LV	IGH	4/79	1978	216,194	25-40			9 (0.4)	6 (0.3)			15 (0.7)
					> 40			0	0	7 (0.3)		7 (0.3)
					TOTAL			9 (0.4)	6 (0.3)	7 (0.3)		22 (1.0)
RV	IGH	4/79	1978	119,264	25-40			5 (0.4)	6 (0.5)	0		11 (0.9)
					> 40			0	3 (0.3)	2 (0.2)		5 (0.4)
					TOTAL			5 (0.4)	9 (0.8)	2 (0.2)		16 (1.3)
Ad-"T"	IGH	4/80	1979	58,047	25-40				15 (2.6)	0	0	15 (2.6)
					> 40				0	10 (1.7)	3 (0.5)	13 (2.2)
					TOTAL				15 (2.6)	10 (1.7)	3 (0.5)	28 (4.8)
Ad-"H"	IGH	5/80	1979	59,000	25-40				10 (1.7)	0		10 (1.7)
					> 40				0	25 (4.2)		25 (4.2)
					TOTAL				10 (1.7)	25 (4.2)		35 (5.9)
Ad-"O"	IGH	6/80	1979	53,070	25-40				10 (1.9)	0		10 (1.9)
					> 40				0	2 (0.4)	7 (1.3)	9 (1.7)
					TOTAL				10 (1.9)	2 (0.4)	7 (1.3)	19 (3.6)

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TABLE 49. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River Creel Census During 1977-78 Through 1982-83 Seasons (continued)

Markb/	Release data: Origine/	Date	BY d/	Number	Recovery FL(cm) e/	Number returned (relative return rate) a/: 1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	Total
LV-"H"	IGH	4/81	1980	64,660	25-40					32 (4.9)	1 (0.2)	33 (5.1)
					> 40					0	20 (3.1)	20 (3.1)
					TOTAL					32 (4.9)	21 (3.3)	53 (8.2)
LV-"O"	IGH	5/81	1980	66,250	25-40					20 (3.0)	3 (0.5)	23 (3.5)
					> 40					0	11 (1.7)	11 (1.7)
					TOTAL					20 (3.0)	14 (2.2)	34 (5.2)
LV-"T"	IGH	6/81	1980	66,240	25-40					7 (1.1)	9 (1.4)	16 (2.5)
					> 40					0	4 (0.6)	4 (0.6)
					TOTAL					7 (1.1)	13 (2.0)	20 (3.1)
LV-"X"	IGH	4/81	WILD	38,580	25-40					18 (4.7)	8 (2.1)	26 (6.8)
					> 40					0	11 (2.9)	11 (2.9)
					TOTAL					18 (4.7)	29 (5.0)	37 (9.7)
RV-"T"	IGH	4/82	1981	57,552	25-40						1 (0.2)	1 (0.2)
					> 40						0	0
					TOTAL						1 (0.2)	1 (0.2)
RV-"O"	IGH	5/82	1981	59,474	25-40						4 (0.7)	4 (0.7)
					> 40						0	0
					TOTAL						4 (0.7)	4 (0.7)
RV-"H"	IGH	6/82	1981	58,474	25-40						4 (0.7)	4 (0.7)
					> 40						1 (0.2)	1 (0.2)
					TOTAL						5 (0.9)	5 (0.9)
Ad-LV	TRH	4/76	1974	46,221	25-40	0						0
	CRH	4/76	1974	102,947	> 40	4 (0.9)						4 (0.9)
					TOTAL	4 (0.9)						4 (0.9)
Ad-LP	TRH	4/76	1974	13,750	25-40	0						0
					> 40	2 (1.5)						2 (1.5)
					TOTAL	2 (1.5)						2 (1.5)

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TABLE 49. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River Creel Census During 1977-78 Through 1982-83 Seasons (continued)

Release data					Recovery	Number returned (relative return rate) a/						
Mark b/	Origin c/	Date	BY d/	Number	FL(cm) e/	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	Total
LV	TRH	4/76	1974	38,509	25-40	0						0
					) 40	7 (1.8)						7 (1.8)
					TOTAL	7 (1.8)						7 (1.8)
LP	TRH	4/76	1974	29,630	25-40	0						0
					) 40	11 (3.7)						11 (3.7)
					TOTAL	11 (3.7)						11 (3.7)
Ad-RV	TRH	4/76	1975	118,966	25-40	0						0
					) 40	8 (0.7)						8 (0.7)
					TOTAL	8 (0.7)						8 (0.7)
Ad-LV-RP	TRH	3/77	1975	21,842	25-40	3 (1.4)						3 (1.4)
					) 40	0						0
					TOTAL	3 (1.4)						3 (1.4)
Ad-RV-LP	TRH	3/77	1975	43,658	25-40	18 (4.1)	0					18 (4.1)
					) 40	0	3 (0.7)					3 (0.7)
					TOTAL	18 (4.1)	3 (0.7)					21 (4.8)
RV	TRH	4/76	1975	115,607	25-40	0						0
					) 40	13 (1.1)						11 (1.1)
					TOTAL	13 (1.1)						13 (1.1)
LV-RP	TRH	4/77	1976	175,210	25-40	147 (8.4)	0					147 (8.4)
					) 40	0	12 (0.7)					12 (0.7)
					TOTAL	147 (8.4)	12 (0.7)					159 (9.1)
RV-LP	TRH	4/77	1976	129,585	25-40	76 (5.9)	3 (0.2)	0				79 (6.1)
					) 40	0	12 (0.9)	1 (0.1)				13 (1.0)
					TOTAL	76 (5.9)	15 (1.1)	1 (0.1)				92 (7.1)
Ad-LV-RV	TRH	4/78	1977	152,876	25-40		19 (1.2)	2 (0.1)				21 (1.4)
					) 40		0	7 (0.5)				7 (0.5)
					TOTAL		19 (1.2)	9 (0.6)				28 (1.8)
Ad-LV	TRH	4/79	1978	30,418	25-40			8 (2.6)	0			8 (2.6)
					) 40			3 (1.0)	5 (1.6)			8 (2.6)
					TOTAL			11 (3.6)	5 (1.6)			16 (5.3)
Ad-RV	TRH	2/-3/79	1978	14,813	25-40			9 (6.1)	2 (1.4)			11 (7.4)
					) 40			4 (2.7)	2 (1.4)			6 (4.1)
					TOTAL			13 (8.8)	4 (2.7)			17 (11.5)

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TABLE 49. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River Creel Census During 1977-78 Through 1982-83 Seasons (continued)

Release data					Recovery	Number returned (relative return rate) a/						
Mark b/	Origin c/	Date	BY d/	Number	FL(cm) e/	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	Total
LP	TRH	3/79	1978	324,774	25-40			35 (1.1)	17 (0.5)	0		52 (1.6)
					> 40			0	74 (2.3)	2 (0.1)		76 (2.3)
					TOTAL			35 (1.1)	91 (2.8)	2 (0.1)		128 (3.9)
RP	TRH	4/79	1978	67,133	25-40			14 (2.1)	6 (0.9)			20 (3.0)
					> 40			0	9 (1.3)			9 (1.3)
					TOTAL			14 (2.1)	15 (2.2)			29 (4.3)
Ad-LP	TRH	4/80	1979	52,781	25-40				12 (2.3)	1 (0.2)		13 (2.5)
					> 40				0	0		0
					TOTAL				12 (2.3)	1 (0.2)		13 (2.3)
Ad-RP	TRH	1/-4/80	1979	18,365	25-40				3 (1.6)	0		3 (1.6)
					> 40				1 (0.5)	2 (1.1)		3 (1.6)
					TOTAL				4 (2.2)	2 (1.1)		6 (3.3)
LV-RP	TRH	4/80	1979	113,625	25-40				10 (0.9)	0		10 (0.9)
					> 40				0	3 (0.3)		3 (0.3)
					TOTAL				10 (0.9)	3 (0.3)		13 (1.1)
RV-LP	TRH	4/80	1979	139,211	25-40				12 (0.9)	2 (0.1)		14 (1.0)
					> 40				1 (0.1)	3 (0.2)		4 (0.3)
					TOTAL				13 (0.9)	5 (0.4)		18 (1.3)
Ad-LV	TRH	4/81	1980	81,136	25-40					7 (0.9)		7 (0.9)
					> 40					0	9 (1.1)	9 (1.1)
					TOTAL					7 (0.9)	9 (1.1)	16 (2.0)
Ad-LV-RP	TRH	3/81	1979	28,943	25-40					1 (0.3)	0	1 (0.3)
					> 40					0	0	0
					TOTAL					1 (0.3)	0	1 (0.3)
Ad-RV	TRH	2/-4/81	1980	1,815	25-40					1 (5.5)	0	1 (5.5)
					> 40					0	1 (5.5)	1 (5.5)
					TOTAL					1 (5.5)	1 (5.5)	2 (1.1)
LV-RV	TRH	4/81	1980	51,230	25-40					14 (2.7)	0	14 (2.7)
					> 40					0	2 (0.4)	2 (0.4)
					TOTAL					14 (2.7)	2 (0.4)	16 (3.1)

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TABLE 49. Numbers and Relative Return Rates of Fin-clipped Steelhead Observed in Lower Klamath River Creel Census During 1977-78 Through 1982-83 Seasons (continued)

Release data					Recovery	Number returned (relative return rate) a/						
Mark b/	Origin c/	Date	BY d/	Number	FL(cm) e/	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	Total
RV	TRH	4/81	1980	59,188	25-40					10 (1.7)	0	10 (1.7)
					) 40					0	3 (0.5)	3 (0.5)
					TOTAL					10 (1.7)	3 (0.5)	13 (2.2)
Ad	TRH	4/81	1981	137,403	25-40						21 (1.5)	21 (1.5)
					) 40						0	0
					TOTAL						21 (1.5)	212 (1.5)
Ad	CRH	4/76	1974	23,500	25-40	0						0
					) 40	2 (0.9)						2 (0.9)
					TOTAL	2 (0.9)						2 (0.9)
Ad-LV f/	CRH	4/76	1974	102,947								
LP-LM	CRH	4/77	1975	179,004	25-40	0	1 (0.1)					1 (0.1)
					) 40	0	0					0
					TOTAL	0	1 (0.1)					1 (0.1)
LP	CRH	4/78	1976	176,600	25-40		32 (1.8)					32 (1.8)
					) 40		0					0
					TOTAL		32 (1.8)					32 (1.8)
RV-RM	CRH	4/81	1979		25-40					2 (1.0)		2 (1.0)
					) 40					0		0
					TOTAL					2 (1.0)		2 (1.0)
Ad-LV	CRH	4/82	1981	18,879	25-40						3 (1.6)	3 (1.6)
Ad-RV	CRH	4/82	1981	20,139	25-40						1 (0.5)	1 (0.5)

a/ Relative return rate = (Number recovered / Number released) x 10,000.
b/ Letters in quotation marks indicate freeze brands applied to marked (fin-clipped) fish.
c/ IGH = Iron Gate Hatchery; TRH = Trinity River Hatchery; CRH = Cole Rivers Hatchery (Rogue River), Oregon.
d/ BY = Brood year.
e/ FL = Fork length.
f/ Note: Ad-LV mark on 1974 BY steelhead was duplicated at CRH and TRH. See section of Table under TRH for numbers of marked fish recovered.

Anglers returned 335 (5.8% of 5,822) reward and nonreward tags from steelhead tagged during lower Klamath River seining operations (Table 50).

Based on the number of steelhead effectively tagged and corrections for angler nonresponse to nonreward tags, the mean annual exploitation rate for adult steelhead was 12.1% during the 1977-78 through 1982-83 seasons. The rate varied from a low of 7.4% in 1979-80 to a high of 19.2% in 1981-82 (Table 51).

Based on the estimated adult steelhead run size and the estimated exploitation rate for adult steelhead, we estimated anglers annually harvested an average of 14,571 adult steelhead from the Klamath River during the 1977-78 through 1981-83 seasons. Annual harvest estimates ranged from a low or 11,808 fish in 1980-81 to a high of 21,588 fish in 1978-79 (Table 52).

Anglers returned 326 tags from steelhead tagged during the lower Klamath River seining operations with information on the location of the catch (Table 53). The majority (41% of 328) of the captures were from the area from Weitchpec (km 67.6, RM 42) upstream to IGH.

DISCUSSION

The steelhead run at the lower Klamath River seining site (Waukel Creek) generally commenced the second or third week of August. Earlier entering steelhead were occasionally sampled, especially in 1979 when an early adult steelhead run was already underway when sampling commenced the week ending July 22. The half-pounder run usually demonstrated one migrational peak which occurred between August 20 and September 9. The adult run generally peaked between August 13 and September 23, and in all years, demonstrated more than one peak entry time. The half-pounder run generally terminated the last part of September although small catches were made in early October. The majority of adult steelhead generally passed our seining site by October 7 but small catches were occasionally made until seining was terminated in mid-October.

During the 1977 to 1979 seasons, a greater portion of the adult steelhead run appeared to pass our seining site prior to September 2. During the 1980 to 1982 seasons, the majority of adult steelhead passed the seining site after September 2. Half-pounder steelhead did not demonstrate a similar patterns. No explanation for the difference in migrational patterns is offered.

Data on the timing of the steelhead run in the Klamath River basin upstream from the Waukel Creek seining site is not complete for all study years. In 1982, steelhead were first observed in the lower Scott River (km 227, RM 141) the week ending September 16. The entire run was not sampled due to problems maintaining our weir during high flows.

TABLE 50. Angler Returns of Tags Applied to Adult Steelhead Tagged in Lower Klamath River (WauKel Creek) Seining Operations, 1977-78 Through 1982-83 Seasons

Season	Number of tags applied			Number of (%) of tags returned		
	Reward	Nonreward	Total	Reward	Nonreward	Total
1977-78	588	0	588	42 (7.1)	0	42 (7.1)
1978-79	1,421	0	1,421	96 (6.8)	0	96 (6.8)
1979-80	1,418	0	1,418	56 (3.9)	0	56 (3.9)
1980-81	0	805	805 a/	0	36 (4.5)	36 (4.5)
1981-82	96	763	859	17 (17.7)	42 (5.5)	59 (6.9)
1982-83	292	429	721	28 (9.6)	18 (4.2)	46 (6.4)
TOTALS	3,815	1,997	5,822	239 (6.3)	96 (4.8)	335 (5.8)

a/ Includes 593 steelhead captured and tagged by Klamath River Project personnel at WauKel Creek (river km 4.8), and 212 captured by USFWS at the Klamath River mouth, also tagged by Klamath River Project personnel.

TABLE 51. Estimated Annual Exploitation Rates of Adult Steelhead in the Klamath River Basin Sport Fishery, 1977-78 Through 1982-83 Seasons

Season	Number of fish effectively tagged a/	Number of tags returned b/	Estimated exploitation rate (%)
1977-78	559	86	15.4
1978-79	1,110	132	11.9
1979-80	1,205	89	7.4
1980-81	741	75	10.1
1981-82	790	152	19.2
1982-83	663	56	8.4

a/ Corrected for 5.0% tagging mortality in 1977-78, 22% in 1978-79, 15% in 1979-80, and 8.0% mortality in remaining years.
b/ Corrected for angler nonresponse of 35% in 1977-78, 25% in 1978-79, 57% in 1979-80, 62% in 1980-81, 69% in 1981-82, and 56% in 1982-83; 26% tag shedding in 1977-78 and 4.2% in 1978-79 (Note: Tag shedding not a problem in subsequent years, due to use of a different tag).

TABLE 52. Estimated Annual In-river Sport Fishery Harvest of Adult Steelhead from the Klamath River Basin, 1977-78 Through 1982-83 Seasons

Season	Estimated in-river run size	Estimated exploitation rate	Estimated harvest
1977-78	89,091	15.4	13,720
1978-79	181,410	11.9	21,588
1979-80	154,196	7.4	11,411
1980-81	116,906	10.1	11,808
1981-82	87,010	19.2	16,706
1982-83	145,150	8.4	12,193

TABLE 53. Distribution of Angler Catch of Adult Steelhead in Klamath River Basin, 1977-78 Through 1982-83 Seasons a/

Season	Number tagged	Mouth-101 (km 0-5)	101-Johnson's (km 5-39)	Johnson's-Weitchpec (km 39-70)	Weitchpec-Iron Gate Dam (km 70-306)	Trinity River basin	Salmon River basin	Scott River basin	Shasta River basin	Other	Total
1977-78	598	0	17	3	12	7	3	0	0	0	42
1978-79	1,421	0	28	3	39	9	13	2	0	1	95
1979-80	1,418	0	8	4	32	4	4	1	0	0	53
1980-81	805	0	6	2	16	8	2	0	0	0	34
1981-82	859	0	23	0	27	6	4	3	0	0	63
1982-83	721	0	18	2	9	4	3	3	0	0	39
TOTALS		0	100(30.5)b/	14(4.3)	135(41.2)	38(11.6)	29(8.8)	9(2.7)	0	1(0.3)	326

a/ Based on returns by anglers of tags applied each fall to adult steelhead during seining operations in the Lower Klamath River at Waukel Creek (river km 4.8).

b/ Number in parenthesis is percentage of total catch.

The SRFCF was operational during the initiation of the steelhead run into the Shasta River (km 282, RM 175) in all years. The first adult steelhead were generally counted between the middle of September and the second week of October. During the five years when the SRFCF remained operational through January 1, adult steelhead counts did not indicate any peak in the run. During the four years when the SRFCF was operational through February or March, the adult steelhead run appeared to peak during the middle of February. During those same years the run appeared to terminate in late March or April.

Adult steelhead were generally first observed at IGH (km 303, RM 188) in late September or early October. The run tended to first peak in late October or early November. Entry of adult steelhead into IGH was generally slow during the month of December. Numbers of steelhead trapped increased in January and usually peaked a second time in late February or early March. In 1977, two major entry peaks after January 1 were observed the weeks ending January 21 and March 11, respectively. In all years the run appeared to terminate by the first of April.

Half-pounder steelhead were not observed in large numbers at the Scott River Weir, SRFCF, or IGH. Large sport angler catches of half-pounder steelhead have not been observed above km 161 (RM 100) which additionally suggests a shorter freshwater migration than observed for adult steelhead. The exact extent and duration of the freshwater migration period of half-pounder steelhead in the Klamath River is unknown. However, we speculate the majority of the run does not migrate past Happy Camp (km 167, RM 104).

Steelhead were first trapped in the Trinity River at the Willow Creek weir (km 108, RM 67) in early August. Only during the 1980-81 season were any migrational peaks observed at that site when the steelhead run appeared to peak the week ending October 14.

Very few steelhead were trapped at the Junction City Weir (km 128, RM 79.5) however, the steelhead run appeared to pass the weir during the period October through March.

The first steelhead were trapped at TRH (km 246, RM 153) generally in late November. The run appeared to peak during the period of late December through early March. Steelhead entry into TRH also appeared to be influenced by increased precipitation and/or an increase in discharge from Lewiston Dam.

Few half-pounder steelhead were trapped at any of the weirs in the Trinity River or at TRH. Half-pounder steelhead are known to enter the Trinity River in some years in numbers large enough to support a sport fishery. Entry of half-pounder steelhead into the Trinity River may be variable and significant migrations may not occur past Willow Creek (km 108, RM 67) during every year.

Population estimates of the Klamath River steelhead run averaged 318,013 fish annually during the study and ranged from 252,128 to 383,948 fish during the period 1977 through 1982. Confidence limits around these estimates are generally quite wide and reflect the small sample sizes.

The ratio of half-pounder to adult steelhead determined by catches during our lower Klamath River seining operations varied from 0.58 to 2.89:1 with a mean of 1.64:1. In two years, 1978 and 1982, more adults were sampled than half-pounders. The low ratio in 1978 may reflect a small 1976 naturally spawned steelhead BY, probably the result of the 1976-77 drought experienced in California. The reduced numbers of half-pounder steelhead in 1982 may have been the result of poor survival of 1982 outmigrants due to the "El Nino" ocean conditions. There did not appear to be any relationship between half-pounder run size and adult run size the following year. This is probably due to the variety of brood years which comprise the adult run. Based on our scale analysis, the adult run could be comprised of a minimum of five different BYs representing various years of stream residency, incidence of half-pounder life history and repeat spawning.

We compared our catch per haul (c/H) rates which accounted for 80% or more of the catch from our lower Klamath River seining operations to our population estimates. There was a poor negative linear relationship for adult steelhead c/H rates with the estimated population. Half-pounder c/H rates appeared to have a poor positive linear relationship with population estimates. Lack of any significant correlations may reflect the wide confidence limits around the population estimates for both half-pounders and adults and/or bias in the seining operation sampling.

Run-size estimates of adult steelhead are available from counts at SRFCF for the Shasta River for selected seasons. During the three years when operation of the SRFCF encompassed the majority of the steelhead migration period (September through February) the counts averaged 1,994 adult steelhead and ranged from 1,866 to 2,060 fish. There did not appear to be any relationship between SRFCF counts and adult population estimates for the entire run. The low numbers recorded at the SRFCF in 1978 may reflect low survival rates of half-pounders which entered fresh water in 1977 during the 1976-77 California drought. Counts recorded in 1979-80, 1980-81 and 1982-83 of approximately 2,000 fish are probably more indicative of the Shasta River adult steelhead run size during those years.

Run sizes at IGH averaged 2,392 adult steelhead and ranged from 1,247 to 4,411 fish during the period 1977 to 1982. As at the SRFCF, there did not appear to be any relationship between in-river adult steelhead population estimates and number of steelhead trapped at IGH.

The majority of all TRH- and IGH-origin steelhead entering the Klamath River from 1979 through 1982 were marked. The number of adult TRH- and IGH-origin steelhead in the run based on the percent of marked adult steelhead in our seine operation samples averaged 9,003 fish and ranged from 5,520 to 12,219 fish during the period 1979 through 1982. The total annual steelhead run for both TRH and IGH averaged 3,240 fish and ranged from 2,033 to 4,696 during the same period. IGH has accounted for 74% of all steelhead trapped by the two hatcheries during this period. There did not appear to be any relationship between the estimated number of TRH-origin steelhead entering the Klamath River and runs at TRH. However, greatest numbers of TRH-origin fish entering the Klamath River were estimated in 1980-81, the same season the highest number of steelhead were trapped at TRH. There was a significant ($P \leq 0.01$, $r = 0.90$, 3 d.f.) linear correlation between number of IGH-origin adult steelhead estimated entering the Klamath River and number of steelhead trapped at IGH. TRH-origin steelhead appeared to exhibit more straying than IGH-origin fish.

The length frequency distribution of steelhead sampled in the lower Klamath reflect the smaller sized half-pounders and the larger sized adults. Modal lengths of half-pounders varied only 4 cm (1.6 in.) during the period 1977 to 1982 while the adult modal lengths ranged from 42 cm (16.5 in.) to 52 cm (20.5 in.). The mean length of adult steelhead sampled during the period 1977 through 1982 averaged 49.8 cm (19.6 in.) FL and ranged from 45.9 to 54.4 cm (18.1 to 21.5 in.) FL. Variations in lengths of adult steelhead probably represent proportional differences in the number of steelhead from various BYs comprising the runs. This difference is not as notable in half-pounders. Our scale analysis indicates the majority of Klamath River steelhead spend two years in fresh water before migrating to the ocean. Since size at time of ocean entry did not vary greatly in our analysis of scales collected from 1980 to 1983, half-pounders returning to fresh water after less than six months in the ocean would not demonstrate disproportional growth. The average size of half-pounder steelhead sampled at Waukel Creek did not change greatly during the period 1977 to 1982. The half-pounder steelhead mean length averaged 31.3 cm (12.3 in.) FL and the average ranged from 30.4 to 32.0 cm (12.0 to 12.6 in.) FL.

The size of adult steelhead sampled during our lower Klamath River seining operations generally increased during the 12-week sampling period. There was a significant ($P < 0.05$) positive correlation of an increase in mean length during the seining period for the 1978, 1979, 1980 and 1982 seasons. The difference varied each season of sampling but averaged approximately 5 cm (2.0 in.) for all years. This increase may be due to summer/fall ocean growth for late entering adult steelhead which would be approximately 1.7 cm (0.7 in.)/month or later entry of repeat spawning steelhead which average slightly larger than maiden spawners.

A t-test analysis showed that unmarked half-pounders captured by seining were significantly larger ($P<0.05$) in 1980 and 1981 than marked half-pounders. Unmarked adults were significantly larger ($P<0.01$) only in 1979. In all other years there was no significant difference ($P>0.05$).

The nadir in the length frequency separating half-pounder and adult steelhead ranged from 37 to 40 cm (14.7 to 15.7 in.) FL. The smallest nadir occurred in 1978 and may have been due to a smaller average size of the 1978 outmigrants. This smaller size may have been the result of reduced freshwater growth of 1976 BY in 1977 as a result of poor instream habitat conditions created by the 1976-77 California drought.

TRH- and IGH-origin steelhead comprised an average of 5.4 and 11.4% of the half-pounder and adult runs, respectively, during the period 1977 to 1982. The greatest incidence of TRH- and IGH-origin half-pounders sampled was in 1979 when they comprised 17.9% of the run. TRH-origin half-pounders comprised 87% (390 of 448) of this group. The greatest percent of TRH- and IGH-origin adults sampled was in 1980 when they comprised 10.5% of the run. In those years when 100% of the hatchery fish were marked, hatchery origin half-pounders and adults comprised 7.3 and 12.4%, respectively, of the total run. There was a significant linear correlation ($P\leq0.01$, $r = 0.92$, 4 d.f.) in the percentage of TRH- and IGH-origin half-pounders in the run and the percentage of TRH- and IGH-origin adults the year following.

Returns of Trinity- and Klamath-strain steelhead release groups from TRH did not clearly indicate one strain returned in greater numbers to the Klamath River. Half-pounder returns from the 1980 BY Trinity-strain release group was the only group which had a significantly greater ($P<0.05$) return to the river than the comparative Klamath-strain group. Additionally, there were no significant differences ($P\geq0.05$) in returns to TRH of the two strains for the various BY releases.

Voluntary emigration appears to have produced slightly greater returns to the Klamath River, however, the returns were not statistically significant for all BYs when compared with involuntary release groups and control groups. The 1978 BY voluntary emigrant study group released from TRH demonstrated higher cumulative returns to the Klamath River than the involuntary release groups but were not significant ($P\geq0.05$). Cumulative returns of the 1979 BY voluntary release study release group were significantly lower ($P<0.05$) than the involuntary or control release group. The 1980 BY voluntary emigrant study release group had a higher cumulative return than the involuntary release group, but returns were comprised of half-pounders and no adults from this group were sampled in 1982. However, returns were not significant ($P\geq0.05$) at our sample level.

Relative return rates to TRH of voluntary emigration groups were not significantly greater ($P \geq 0.05$) than the nonmigrants from the voluntary migrant study groups or the control groups.

Results of these experiments indicated that voluntary release programs were not successful in significantly increasing returns of hatchery-reared yearling steelhead.

The size of release studies conducted with the 1976 and 1978 BY IGH release groups did not indicate cumulative returns to the Klamath River as half-pounders or adults were influenced by size of release. Only the 1976 BY release group, of which 68.1% of the fish were $\geq$150 mm TL at release returned as half-pounders at a significantly greater ($P \leq 0.05$) rate than a comparable release group of which only 0.8% of the fish were $\geq$150 mm TL. This difference was influenced by a large percentage (71% of 79) of the smaller length release group returning as half-pounders two seasons after release. Apparently, a large number of fish from this release group did not reach smolting size the first season and remained in fresh water an additional year before migrating to the ocean.

The size at release of yearling steelhead from IGH indicated that larger sized fish produced greater returns to IGH. A comparison of returns of the 1976 BY release groups to IGH indicated a significantly greater (≤ 0.05) number of fish of which 68.1% of the fish were $\geq$150 mm TL at release returned to IGH than the release group in which only 0.8% of the fish were $\geq$150 mm TL. The relative return rate was almost twice as large. The relative return rate of the 1978 BY release group which 49.9% of the fish were $\geq$150 mm FL at release, also returned to IGH in significantly greater ($P \leq 0.05$) numbers than the comparable group of which only 4.7% of the fish were $\geq$150 mm FL at release.

The delayed release studies conducted at IGH for the 1979 and 1980 BYs indicated that April release groups returned to the Klamath River at significantly greater ($P \leq 0.05$) numbers as adults than did the May or June release groups. The 1981 BY returns as adults are incomplete. Returns of the 1979 BY release groups as half-pounders were not significantly different ($P \geq 0.05$), while the 1980 BY April and May release groups returned at significantly greater ($P \leq 0.05$) numbers as half-pounders than did the June release groups. This was also observed for 1981 BY half-pounder returns to the Klamath River.

Returns to IGH of the 1979 BY release groups indicated that the May and June release groups had a significantly greater ($P \geq 0.05$) return rate than the April release group. Returns of the 1980 BY indicate that the April release group had a significantly greater ($P \geq 0.5$) return rate than the May or June release groups. Apparently, the 1979 BY release group of which only 61.7% of the fish were $\geq$150 mm

FL at release did not imprint and return to IGH as well as the larger sized May and June release groups, even though return to the Klamath River of the April release group was greater.

Results of these studies suggest that size of release influences the tendency of hatchery-released steelhead to migrate to the ocean. Release groups which have a large percentage of fish $\geq$150 mm FL show a greater tendency to migrate to the ocean the year of release. This migration pattern influences the number of fish returning to fresh water as half-pounders, surviving to adult size, and subsequently returning to the hatchery. Release groups which are comprised of large numbers of fish $\leq$150 mm FL will demonstrate a tendency to residualize in fresh water an additional year. Such residualization would intuitively suggest reduced survival and fewer fish returning as half-pounders and adults. Return rates to IGH appear to be reduced by this type of migrational pattern due to poor imprinting of fish which residualize in the river one year before migrating to the ocean.

The 1977 and 1979 release groups of naturally produced steelhead reared at the BCFRF demonstrated a significantly greater ($P \leq 0.05$) return rate to the Klamath River as half-pounders and adults when compared to comparable release groups of hatchery-origin steelhead. Return rate of the 1981 BCFRF release group was greatest, but did not demonstrate a significant difference ($P \leq .05$) when compared with a comparable hatchery-origin release group. The 1977 and 1981 releases were made at IGH while the 1979 release was made at Happy Camp (km 167, RM 104). Naturally spawned steelhead which were rescued from Klamath River tributaries and had already undergone an unknown amount of natural selection demonstrated higher survival than hatchery-spawned and reared steelhead.

Opportunities to increase survival of hatchery-spawned and reared steelhead may be available by incorporating some method of natural selection during the early life stages of the fish. This would be most advantageous in years when surplus steelhead eggs are available at IGH. Steelhead pond-rearing programs may also present management opportunities to increase steelhead runs in the Klamath River.

The estimated return percentages of marked steelhead from IGH and TRH varied for the 1976 through 1980 BYs and did not demonstrate any pattern or relationship with the estimated in-river run size.

Survival of IGH- and TRH-origin steelhead from half-pounders to adults was compared by regressing the estimated return percentage as half-pounders with the estimate as adults by brood years. There was a significant correlation ($P \leq 0.05$, $r = 0.94$, 4 d.f.) for IGH-origin release. Survival appeared to be high (63-64%) for the 1976 and 1977 BYs, low (17%) for the 1978 BY, and in-between (39-43%) for the 1979 and 1980 BYs IGH-origin release groups.

There was no significant correlation ($P \leq 0.05$, $r = 0.29$, 4 d.f.) for the TRH-origin half-pounder and adult return percentages and survival appeared to be highly variable ranging from 14% for the 1978 and 1979 BYs to 81% for the 1977 BY. The high survival for the 1977 BY is due to the large number of 1977 BY TRH-origin adults sampled in our seining operation in 1979 relative to the number of half-pounders of the same group sampled the previous year. Additional studies to determine factors which limit survival of half-pounder to adult would be desirable and may provide additional management opportunities for Klamath River steelhead.

Problems were apparent in our expansions of marked steelhead numbers observed in the lower Klamath River seining operations. In 1982, we estimated that no 1979 BY Ad-"H"- or Ad-"O"-marked adult steelhead occurred in the run. During our seining we observed two Ad-marked steelhead with "T" freeze brands and four Ad-marked steelhead with no visible freeze brands. The four fish with no visible brands were assigned to the Ad-"T" mark group. During the 1982-83 season, several hundred Ad-"H" and Ad-"O" steelhead were observed at IGH. Capture of only two each "H" and "O" freeze-branded steelhead in our seine operation would have accounted for the numbers observed at IGH based on our expansion methodology. Because of the small sample sizes, biases in our evaluation could easily occur.

The incidence of Indian gill-net marks on steelhead sampled during our lower Klamath River seining operations was much lower than observed for chinook salmon. In all years except 1982, the average size of adult steelhead observed with gill-net marks was significantly larger ($P \leq 0.01$) than the average size of all adult steelhead sampled during our lower river seining operations. In 1982, our sample size of gill-net-marked adult steelhead was insufficient to make a comparison. Indian gill-net fisheries which target chinook salmon most likely result in incidental harvest of larger adult steelhead. The magnitude of this harvest is unknown.

Very few steelhead were sampled during our lower Klamath River seining operations with hook scars after 1977. The larger number of steelhead observed with hook scars in 1977 was probably due to problems associated with proper identification during the early study years.

The Klamath River steelhead sport fishery in the lower river generally commences in late August and peaks in early September. The majority of steelhead caught in the lower Klamath River are caught above the Highway 101 bridge. Sport fishing occurs throughout the Klamath River basin as the steelhead migrate upstream. The majority of steelhead are harvested from the Klamath River basin with the area from Weitchpec to IGH accounting for an average of 39% of the total basin harvest during the period 1977 to 1982. Based on the return of tags applied during our lower Klamath River seining operations, sport anglers harvested 7.4 to 19.2% of

the adult steelhead run annually from 1977 to 1982. The unweighted mean exploitation rate during this period was 12.1%. We estimated that Klamath River basin anglers harvested an average of 14,571 adult steelhead annually during the period 1977 to 1982. Harvest rates of this magnitude are not felt to be detrimental to the run. Other factors such as survival of smolts and half-pounders are probably more limiting to the population than adult steelhead harvest. Unfortunately, we were unable to assess the sport harvest of half-pounders which is a factor in half-pounder to adult survival. Additional study to determine half-pounder harvest rates would be desirable.

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APPENDIX A

Summary of marked steelhead releases made in the Trinity and Klamath rivers,, 1977 through 1982.

TABLE 1. Summary of Marked Steelhead Released Made in The Trinity and Klamath River, 1977

Mark	Brood year	Strain	Number released	Release date	Release site	Mean TL (range) (mm)	Percent <150 mm TL	Percent precocious males
Trinity River Hatchery Releases								
Ad-LV-RP	1975	Trinity R.	21,842	3/21/77	TRH	234(173-342)	0.0	12.2
Ad-RV-LP	1975	Klamath R.	43,658	3/21/77	TRH	237(158-375)	0.0	17.4
LV-RP	1976	Trinity R.	175,210	4/1/77 & 4/21/77	TRH	199(147-288)	0.2	0.7
RV-LP	1976	Klamath R.	129,585	4/1/77 & 4/21/77	TRH	171(135-248)	4.4	0.9
Subtotal			370,295					
Iron Gate Hatchery Releases								
Ad-LP	1976	Klamath R.	429,306	4/28-5/3/77	IGH	106(60-153)	99.2	--
Ad-RP	1976	Klamath R.	40,292	4/28-5/3/77	IGH	153(108-186)	31.9	--
Ad-D 1/	1976	Klamath R.	14,144	4/28/77	IGH	131(65-182)	76.2	--
Subtotal			483,742					
Total			854,037					

1/ Fish in this mark group were naturally spawned fingerlings rescued by DFG personnel from drying streams in the Klamath River basin (excluding the Trinity River drainage) in the spring and summer of 1976 and reared in the Bogus Pond facility at Iron Gate Hatchery.

TABLE 2. Summary of Marked Steelhead Releases Made in The Trinity and Klamath Rivers 1978

Mark	Brood year	Strain	Number released	Release date	Mean TL (range)(mm)	Percent >150 mm TL	
			Trinity River Hatchery				
Ad-LV-RV	1977	Klamath R.	133,376	5/7/78	173(134-223)	95.5	92.5
Ad-LV-RV	1977	Klamath R.	19,500	4/17/78	155(133-191)	71.9	
Subtotal			152,876				
			Iron Gate Hatchery				
LV-RV	1977	Klamath R.	200,000	4/14/78	116(58-186)	6.7	
Subtotal			200,000				
TOTAL			352,876				

TABLE 3. Summary of Marked Steelhead Releases Made in The Tirnity and Klamath Rivers, 1979

Mark	Brood year	Strain	Test group	Total released	No. (%) properly marked	Release date	Release site	Release site Mean FL (range)(mm)	Release site No./kg	Percent >150 mm FL
					Trinity River Hatchery					
RP	1978	Klamath River	Progeny of returning adults (F2)	68,133	67,570 (99.2)	4/4/79	TRH	182(148-246)	14.5	96.3
LP	1978	Klamath River	Eggs from Iron Gate Hatchery(F1)	342,661	324,774 (94.8)	3/22&23/79	TRH	176(100-244)	17.6	98.7
Ad-RV	1978	Trinity River	Voluntary emigration emigrants	14,813	14,813 (100.0)	2/9-3/13/79	TRH	205(150-333)	8.4	100.0
Ad-LV	1978	Trinity River	Voluntary emigration controls	30,903	30,418 (98.4)	4/4/79	TRH	199(145-312)	8.8	99.2
Subtotals				456,510	437,575 (95.8)					
					Iron Gate Hatchery					
RV	1978	Klamath River	≥150 mm FL	128,282	119,264 (93.0)	4/16/79	IGH	148(92-182)	28.6	49.9
LV	1978	Klamath River	<150 mm FL	233,850	216,194 (92.4)	4/16/79	IGH	118(76-169)	52.8	4.3
D-Ad	1978	Klamath River	Bogus Pond	10,500	10,033 (95.6)	4/16/79	IGH	128(58-179)	37.4	13.8
Subtotals				372,632	345,491 (92.7)					
TOTALS				829,142	783,066 (94.4)					

TABLE 4. Summary of Marked Steelhead Releases Made in The Trinity and Klamath River, 1980

Mark	Brood year	Strain	Test group	Total released	No. (%) properly marked	Release date	Release site	Release site: Mean FL (range)(mm)	Release site: No./kg	Percent >150 mm FL
				Trinity River Hatchery						
AD-LP	1979	Trinity River	Voluntary Emigration Study (involuntary release)	56,390	52,781 2/ (93.6)	4/15/80	TRH	192(148-227)	15.4	99.7
Ad-RP	1979	Trinity River	Voluntary Emigration Study (voluntary release)	18,365	18,365 (100.0)	1/23-4/9/80	TRH	178(150-239)	16.5	100.0
LV-RP	1979	Klamath River	Stock Identification	113,625	109,761	4/9-4/30/80	TRH	170(132-237)	18.0	89.3
RV-LP	1979	Trinity River	Stock Identification and Voluntary Emigration Study Control Group	139,211	133,782 2/	4/9-4/17/80	TRH	174(139-224)	18.9	99.2
Subtotal				227,591	314,689					
				Iron Gate Hatchery						
Ad+C brand	1979	Klamath River	Extended Rearing Study	59,842	58,047 (97.0)	4/15/80	IGH	154(116-192)	22.0	61.7
Ad+H brand	1979	Klamath River	Extended Rearing Study	59,000	59,000 (100.0)	5/19/80	IGH	173(135-209)	16.5	93.1
Ad+O brand	1979	Klamath	Extended Rearing Study	61,000	53,070 (87.0)	6/25/80	IGH	195(143-230)	13.0	99.0
Subtotal				179,842	170,117					
Total				507,433	484,806					

1/ Corrected for incomplete marks and/or illegible brands.
2/ Based on numbers of properly fin-clipped steelhead. Figures differ from hatchery records; it is believed approximately 26,000 Ad-LP-marked steelhead inadvertantly released as RV-LP by hatchery personnel.

TABLE 5. Summary of Marked Steelhead Releases Made in the Trinity and Klamath Rivers, 1981 a/

Mark	Brood year	Strain	Test group	Total released	No. (%) properly marked	Release date	Release site: Mean FL (range)(mm)	Release site: No./kg	Percent >150 mm FL
				Trinity River Hatchery					
Ad-RV-LP	1979	Klamath River	Stock Identification	4,223	4,206 (99.6)	3/26/81	199(129-273)	12.8	96.4
Ad-LV-RP	1979	Trinity River	Stock Identification	29,104 b/	28,943 (99.4)	3/26/81	199(125-275)	12.8	98.9
LV-RV	1980	Trinity River	Hatchery Production	51,327 b/	51,230 (99.8)	4/14/81	183(116-249)	15.4	94.3
RV	1980	Klamath River	Voluntary Emigration Study (Control Group)	59,304 b/	59,188 (99.8)	4/15/81	159(118-230)	20.5	69.5
Ad-LV	1980	Klamath River	Voluntary Emigration Study (nonmigrants)	81,985 b/	81,136 (99.0)	4/15&28/81	160(112-212)	20.9	70.0
Ad-RV	1980	Klamath River	Voluntary Emigration Study (migrants)	1,815 b/	1,815 (100)	2/23-4/13/81	176(150-252)	20.8	100.0
Subtotals				227,758	226,518				
				Iron Gate Hatchery					
LV+H Brand	1980	Klamath River	Extended Rearing Study	64,660	64,660 (100)	4/15/81	150(110-192)	23.3	43.8
LV+O Brand	1980	Klamath River	Extended Rearing Study	66,250	66,250 (100)	5/15/81	149(108-183)	28.6	54.0
LV+T Brand	1980	Klamath River	Extended Rearing Study	66,240	66,240 (100)	6/15/81	149(105-193)	28.6	56.9
LV+X Brand	1980	Wild	Rescued Fish	38,580	38,580 (100)	4/22/81	145(101-195)	?	46.5
Subtotals				235,730	235,730				
Totals				563,488	462,248				

a/ All fish released at the hatcheries.
b/ Number released based on weight counts taken by Project personnel.

TABLE 6. Summary of Steelhead Marked and Released in the Klamath River, 1982 a/

Mark	Brood year	Strain	Test group	Total released	No. (%) properly marked	Release date	Release site Mean FL (range)(mm)	No./kg	Percent >150 mm FL
				Iron Gate Hatchery					
RV+T brand	1981	Klamath River	Extended Rearing Study	66,000	57,552 (87.2)	4/15/82	155(107-195)	23.1	64.6
RV+O brand	1981	Klamath	Extended Rearing Study	59,474	59,474 (89.1)	5/15/82	152(103-195)	22.0	62.7
RV+H brand	1981	Klamath	Extended Rearing Study	66,980 b/	58,474 c/ (87.3)	6/15/82	158(110-198)	17.6	64.6
				Trinity River Hatchery					
Ad	1981			137,403	137,403	4/1-9/82			
Subtotals				199,730	175,500				
Totals				337,133	312,903				

a/ All fish released at the hatchery.
b/ Number released based on weight counts by hatchery personnel.
c/ Based on numbers of properly marked and/or fin-clipped steelhead.