CALIFORNIA DEPARTMENT OF FISH AND GAME
WATER AND AQUATIC HABITAT CONSERVATION BRANCH
STREAM EVALUATION PROGRAM

CENTRAL VALLEY ANADROMOUS FISH-HABITAT EVALUATIONS

October 1997 through September 1998

Annual Progress Report
Prepared for
U.S. Fish and Wildlife Service
Central Valley Anadromous Fish Restoration Program

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Funded by the U.S. Fish and Wildlife Service pursuant to the CENTRAL VALLEY PROJECT IMPROVEMENT ACT to improve anadromous fish habitat in California's Central Valley streams

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EXECUTIVE SUMMARY

The Department of Fish and Game is conducting various investigations in Central Valley streams to acquire information on anadromous salmonid populations. Results of the investigations will be used to identify flow requirements for Central Valley anadromous salmonid populations. The work is being conducted pursuant to a cooperative agreement with the US Fish and Wildlife Service to satisfy requirements of the Central Valley Project Improvement Act, Section 3406(b)(1)(B).

The investigations have been ongoing since fall 1995 and have included the Sacramento, Yuba, American, Cosumnes, Calaveras, Stanislaus, Tuolumne and Merced rivers. Data acquired on these streams varies from typing and mapping habitats using aerial photography to comprehensive evaluations and monitoring of spawner populations, spawning distribution, spawning habitat conditions, juvenile rearing, juvenile migration, and juvenile habitat conditions. The comprehensive evaluations have been primarily focused on the reaches of the Sacramento and American rivers that are dependent upon Central Valley Project operations.

To date, results of the investigations on the American River have provided substantial input to the identification of flows in the Anadromous Fishery Restoration Program portion of the CVPIA. The American River data is continually being used by water management and fishery management agencies to identify optimum allocation of flow required for conserving and restoring salmon and steelhead populations in the lower American River. These data along with data collected on the Sacramento River are also being used to globally identify status and needs of salmon and steelhead as they relate to basin-wide management of water and other habitat needs. The National Marine Fisheries Service has and continues to use data collected on winter-run chinook salmon and steelhead in identification of conservation management actions on a real-time basis. Data collected on steelhead is some of the most recent available for the Central Valley and was used by NMFS in their deliberation of listing steelhead as threatened in the Central Valley evolutionary significant unit (ESU). It is presently being used to help identify critical habitat for steelhead in the Central Valley ESU, and in the deliberation of the listing of spring-run, fall-run and late-fall run chinook salmon in the Central Valley ESU.

Data collected to date on the American and Sacramento rivers is also being used to refine methods used to identify habitat needs, including flow, on these rivers as well as on other stream systems within the Central Valley. One of the primary objectives of these investigations is to develop and validate scientifically credible methods for determining habitat requirements for all life stages of salmon and steelhead that depend upon Central Valley streams.

During the reporting period summarized in this report (October 1997 through September 1998) the majority of work was conducted in the Sacramento River. Spawner surveys were conducted on all four races of salmon: juvenile emigration monitoring was conducted on salmon and steelhead; spawning habitat condition investigations were initiated as well as investigation of the response of salmon and steelhead to fluctuating flows. Reconnaissance surveys, primarily aerial photograph based habitat surveys were initiated on the Yuba, Cosumnes and Calaveras rivers.

INTRODUCTION

In July 1995, the California Department of Fish and Game(DFG) entered into an agreement with the U.S. Fish and Wildlife Service (FWS) to evaluate anadromous salmonid habitat requirements in Central Valley streams. Various studies have been developed and are being implemented by the Stream Flow and Habitat Evaluation Program to provide the FWS Central Valley Anadromous Fish Restoration Program with reliable scientific information. The information is to be used by DFG and FWS to develop flow recommendations to satisfy requirements of the Central Valley Project Improvement Act, Section 3406(b)(1)(B).

The basic approach to the evaluations is outlined in "*Proposal to define instream flow and habitat requirements for anadromous resources in Central Valley Streams, September 1994.* The approach includes developing a better understanding of the life history of chinook salmon and steelhead trout emphasizing the relationships between life stage requirements and manageable habitat attributes (e.g., flow, water temperature, channel conditions, etc.). Initially, the evaluations are to be conducted in the Sacramento and American rivers and will include individual investigations of spawning, rearing and migration.

One of the requirements of the agreement is to provide the FWS with annual progress reports (based upon the federal fiscal year, October 1 - September 30). This report covers the investigations conducted in the Sacramento River during the period October 1997 through the last week of September 1998. During that period, DFG conducted seven general investigations (Table 1).

TABLE 1. Investigations conducted by the Department of Fish and Game to determine anadromous salmonid habitat requirements in Central Valley streams - October 1997 through the last week of September 1998.

Investigation	Sacramento River	Yuba, Cosumnes, Calaveras rivers
Habitat mapping	Completed	Initiated
Fall-run chinook salmon spawning	X	NA
Late fall-run chinook salmon spawning	X	NA
Winter-run chinook salmon spawning	X	NA
Spring-run chinook salmon spawning	X	NA
Juvenile salmonid rearing	X	NA
Juvenile salmonid emigration	X	NA

The results of three investigations conducted during the reporting period are presented as Appendices II, III, and IV. These reports cover fall-run, late-fall run and winter-run chinook salmon spawning evaluations in the Sacramento River.

The purpose of this annual progress report is only to generally describe ongoing investigations and to summarize data being collected to evaluate anadromous fish habitat needs in California's Central Valley. No attempt is made herein to analyze data that generally represents less than a complete year's investigation.

UPPER SACRAMENTO RIVER REARING HABITAT EVALUATION

Rearing habitat investigations are intended to determine temporal and spatial distributions of the various juvenile life stages of anadromous salmonids in the upper Sacramento River. These investigations compliment juvenile emigration evaluations and should be conducted year around to fully understand behavior of juvenile salmonids relative to habitat conditions. Some of the information to be gained from our studies include: relative importance of upper river habitat to different life stages under varying conditions; temporal and physical significance of various habitat conditions; and significance of stream conditions downstream of the study area - basically an overall understanding of the relationship between fish and habitat in the upper river as it is influenced by potentially manageable biotic and abiotic, habitat attributes. The results presented here represent the third year of a 5-year study. Sampling with seines and rotary screw traps (RST) was suspended after 16 September 1997 to comply with National Marine Fisheries Service's (NMFS) Section 10 permit conditions. The Department had exceeded the winter-run take limit for 1997-98, therefore halted sampling until March 1998 when NMFS permitted sampling to restart.

Evaluation of anadromous salmonid rearing habitat in the upper Sacramento River using seine and snorkel surveys was initiated in August 1996. The study area is located between river mile 271 (just below the mouth of Battle Creek) and river mile 302 (Keswick Dam) (Figure 1). Most sample sites are located above Battle Creek, hence upstream of the influence of Coleman National Fish Hatchery. Sample sites were selected from 143 habitat units located in the study area; these units had been previously mapped by the Department (DFG 1997, Appendix I). Habitat mapping was based on channel morphology using a stratified classification system similar to that used on the American River (Snider et al. 199?). Habitat types (e.g., pool, riffle, run, and glide) were stratified by habitat zone (flatwater, bar complex, side channel, and off channel). Our goal was to sample 3 replicates of 11 randomly selected habitats twice per month. For this report, all the data from habitats distinguished by zone (i.e. flatwater pool and bar complex pool) were combined to represent 4, instead of 11 habitats: riffle, pool, glide, and run (no off-channel sites are present in study area).

Snorkel surveys consisted of two swimmers simultaneously surveying a 150-ft long section randomly selected along each bank of the habitat unit. Data collected included: species, size in 25-mm size classes, and general habitat attributes (mean depth, mean velocity, cover, etc.). During the seining surveys, habitat units were sampled with a 50 x 4-ft beach seine. Up to two seine hauls were made per unit. Data acquired included number of salmonids (by species), size of up to 50 salmon and trout, per haul, (i.e., fork length [FL] to the nearest 0.5 mm, and weight, to the nearest 0.1 g), and general habitat attributes of the site seined.

UPPER SACRAMENTO RIVER EMIGRATION SURVEY

Emigrating juvenile salmonids were monitored at sites near the Balls Ferry Bridge (RM 278) and the Deschutes Road Bridge (RM 281). The purpose of the monitoring is to determine the timing and relative abundance of salmon and rainbow trout (potentially steelhead) emigration relative to precedent conditions of spawning and rearing in the upper natal stream. The results provided in this report are for the period from 10 March (week 11) through 30 September 1998 (week 40). Sampling is normally conducted with two rotary screws traps at RM 278 and one at RM 281.

Sampling had to be delayed until 10 March 1998 (week 11) because we had exceeded the Section 10 take limit for winter-run salmon for the 1 July 1997 through 30 June 1998 period and needed to get special authorization from NMFS to restart sampling prior to 1 July 1998. From 9 June (week 24) to 26 July (week 31) one of the Balls Ferry traps was not operated because it was broken. After repairing this trap, it was operated 4 days during week 31 (26 July) and then it was raised. Beginning on 10 August (week 33), the winter-run catch began to drastically increase so we curtailed our sampling efforts to avoid exceeding our take limit for 1998-99 season.

Data recorded when the screw traps were checked included number of hours fished and juvenile salmonids collected by species. Race for chinook salmon was determined using the length-at-time criteria developed by Frank Fisher (Department of Fish and Game - Red Bluff). All salmon identified as winter run, spring run, and late-fall run were measured and weighted (FL in mm and weight in g). Up to 300 fall-run-sized salmon were randomly selected per trap up to twice daily, then measured and weighted. All juvenile rainbow trout were counted and measured.

Trap efficiency was evaluated by marking a portion of salmon captured (winter run were never marked). Fish were marked with dyes either by injecting them with Alcian blue or, rarely, by bathing them in Bismark brown. Fish captured and marked at Balls Ferry were transported upstream about 2,500 feet then released. Those marked at Deschutes Road Bridge were released at that site. All salmon captured in the Balls Ferry traps were checked for marks as they were measured. The Deschutes Road trap was normally operated only 2 days/week to capture, mark, and then release fish for later recapture at the downstream traps.

Emigration Results

Chinook Salmon

Juvenile salmon were collected every week sampled (Table 10; Figure 30). Mean weekly size ranged from 37.6 mm FL (week 36) to 64.7 mm FL (week 24) (Figure 31). Both recently emerged-sized fish ($\leq$ 35 mm FL) and larger smolt-sized fish ($\geq$ 70 mm FL) were captured every week that samples were collected (Appendix II; Figures 1-12).

Catch rates ranged from 0.69 fish/h (week 22) to 42.68 fish/h (week 40) (Table 10; Figure 30). Due to Section 10 permit restrictions, we did not fish the screw traps during February the month that we could expect to get the greatest number of fall-run juveniles. The greatest catches were observed during weeks 12, 15, 16, and 17 (Table 10; Figure 31). A total of 49,257 chinook salmon was counted. Of this total, there were 571 spring-run sized salmon; 29,292 fall-run sized salmon; 10,620 late-fall-run sized salmon; and 8,774 winter-run sized salmon. When sampling starting in week 12 (10 March), the number of fall run emigrating had likely already peaked (Figure 32). Late-fall salmon catch peaked during weeks 16-20 (12 April through 9 May 1998). Spring run peaked in weeks 15-16 (5-18 April 1998). Winter-run first appeared in week 28 (5 July) and we greatly reduced our sampling efforts starting in week 33 (10 August 1998) to avoid exceeding the Section 10 take limit.

Spring-run sized salmon ranged from 65 to 119 mm FL (Figure 33). Fall run ranged from 27 to 140 mm FL; late-fall run ranged from 27 to 105 mm FL; and winter run ranged from 28 to 205 mm FL.

Trapping efficiency, as measured by the recovery of dye-marked fish, showed that efficiency was highest during March and April (Table 11). This may be biased by the lack of enough fish to mark to monitor trap efficiency throughout the year.

Rainbow Trout (Steelhead)

Rainbow trout (potentially steelhead) were collected throughout the survey (Table 12; Figure 34). Mean week size ranged from 29.0 mm FL (week 14) to 103.8 mm FL (week 11). Total catch ranged from 1 (week 40) to 202 (week 32). Catch rate ranged from 0.03 fish/h (week 11) to 0.69 fish/h (week 20) (Figure 35). Rainbow trout ranged from 21 to 200 mm FL.

TABLE 10. Summary of chinook salmon catch statistics, upper Sacramento River emigration survey using rotary screw traps including the Deschutes Road trap, October 1997 - September 1998.

Week	Start Date	Weekly Catch	Catch/h	Size Statistics			
				Mean	Minimum	Maximum	SD
No sampling weeks 40 - 10							
11	08 Mar	2,719	13.82	38.0	29	145	7.22
12	15 Mar	9,356	28.61	37.7	27	138	7.22
13	22 Mar			No sampling week 13			
14	29 Mar	1,010	4.07	37.7	31	87	7.12
15	05 Apr	4,024	11.55	41.1	28	143	12.29
16	12 Apr	7,793	23.90	45.5	27	205	17.29
17	19 Apr	4,971	15.10	41.8	29	195	13.79
18	26 Apr	2,163	5.09	45.7	31	121	17.35
19	03 May	1,438	3.38	51.2	30	111	19.60
20	10 May	1,210	3.11	52.2	27	112	18.65
21	17 May	531	1.78	54.3	28	110	17.24
22	24 May	95	0.69	55.6	31	92	18.11
23	31 May	462	1.56	62.9	29	98	15.07
24	07 Jun	490	2.07	64.7	30	119	14.50
25	14 Jun	663	2.98	57.4	30	99	18.67
26	21 Jun	603	1.95	55.2	30	111	20.73
27	28 Jun	328	1.56	58.0	33	99	20.83
28	05 Jul	370	2.47	55.7	28	98	21.09
29	12 Jul	1,096	6.67	50.1	31	101	18.81
30	19 Jul	826	5.04	47.0	31	99	17.96
31	26 Jul	947	5.07	46.7	30	110	18.64
32	02 Aug	1,399	7.69	44.3	31	104	17.34
33	09 Aug	876	11.68	46.0	29	111	17.39
34	16 Aug	538	10.35	40.3	34	93	10.35

TABLE 10 (cont.). Summary of chinook salmon catch statistics, upper Sacramento River emigration survey using rotary screw traps including the Deschutes Road trap, October 1997 - September 1998.

Week	Start Date	Weekly Catch	Catch/h	Size Statistics			
				Mean	Minimum	Maximum	SD
35	23 Aug	772	29.96	41.6	33	115	14.21
36	30 Aug	708	14.83	37.6	28	95	10.47
37	06 Sep	888	19.73	40.0	30	103	13.84
38	13 Sep	710	31.91	43.3	32	109	19.10
39	20 Sep	1,332	28.65	37.8	31	120	9.49
40	27 Sep	939	42.68	37.9	32	140	12.20
Total		49,257	8.26	45.5	27	205	16.81

TABLE 11. Results of Balls Ferry trap rotary screw trap efficiency evaluations conducted with marked chinook salmon during the upper Sacramento River emigration survey, October 1997 - September 1998.

Week	Number marked	Number recaptured	Efficiency (%)
		No sampling weeks 40-10	
11	1,701	27	1.59
12	5,455	95	1.74
13		No sampling week 13	
14	792	28	3.54
15	2,011	48	2.39
16	3,876	51	1.32
17	1,529	21	1.37
18	861	7	0.81
19	508	8	1.57
20	493	6	1.22
21	259	2	0.77
22	8	0	-
23	206	0	-
24	338	0	-
25	282	0	-
26	183	1	0.55
27	222	1	0.45
28	166	1	0.60
29	784	4	0.51
30	384	1	0.26
31	271	1	0.37
32	247	1	0.40
33	191	0	-
34	0	0	-
35	52	0	-
36	83	0	-

TABLE 11 (cont.). Results of Balls Ferry trap rotary screw trap efficiency evaluations conducted with marked chinook salmon during the upper Sacramento River emigration survey, October 1997 - September 1998.

Week	Number marked	Number recaptured	Efficiency (%)
37	0	0	-
38	0	0	-
39	0	0	-
40	0	0	-
Total	20,902	303	1.45

TABLE 12. Summary of rainbow trout catch statistics, upper Sacramento River emigration survey using rotary screw traps including the Deschutes Road trap, October 1997 - September, 1998.

Week	Start Date	Weekly Catch	Catch/h	Size Statistics			
				Mean	Minimum	Maximum	SD
			No sampling weeks 40 - 10				
11	08 Mar	6	0.03	103.8	56	180	40.63
12	15 Mar	14	0.04	85.3	25	160	40.34
13	22 Mar			No sampling Week 13			
14	29 Mar	2	0.01	29.0	26	32	3.00
15	05 Apr	10	0.03	65.0	26	140	38.42
16	12 Apr	36	0.11	61.6	26	86	13.46
17	19 Apr	91	0.28	63.0	31	111	12.09
18	26 Apr	113	0.27	57.5	27	90	12.89
19	03 May	201	0.47	57.5	29	195	16.18
20	10 May	246	0.63	53.6	32	200	13.70
21	17 May	76	0.26	57.8	25	90	12.12
22	24 May	23	0.17	52.8	37	71	7.92
23	31 May	65	0.22	62.9	45	98	11.57
24	07 Jun	110	0.46	57.7	27	98	11.75
25	14 Jun	79	0.35	57.4	24	82	13.11
26	21 Jun	34	0.11	52.6	23	115	21.74
27	28 Jun	25	0.12	49.3	27	94	20.44
28	05 Jul	19	0.13	49.3	21	90	19.94
29	12 Jul	74	0.45	38.1	22	93	18.10
30	19 Jul	85	0.52	39.2	21	99	20.21
31	26 Jul	109	0.58	39.3	21	111	20.52
32	02 Aug	37	0.20	44.7	22	99	20.44
33	09 Aug	27	0.36	52.8	25	99	18.62
34	16 Aug	14	0.27	45.4	31	84	13.20

TABLE 12 (cont.). Summary of rainbow trout catch statistics, upper Sacramento River emigration survey using rotary screw traps including the Deschutes Road trap, October 1997 - September, 1998.

Week	Start Date	Weekly Catch	Catch/h	Size Statistics			
				Mean	Minimum	Maximum	SD
35	23 Aug	28	0.36	52.4	33	79	11.59
36	30 Aug	20	0.42	51.0	33	175	31.42
37	06 Sep	14	0.31	52.2	35	76	12.43
38	13 Sep	2	0.09	54.5	48	61	6.50
39	20 Sep	4	0.09	66.3	42	125	34.16
40	27 Sep	1	0.05	45.0	45	45	-
Total		1,565	0.26	53.7	21	200	18.77

UPPER SACRAMENTO RIVER SALMON SPAWNING EVALUATION

Spawner surveys were conducted continuously throughout the reporting period. Survey effort and reach changed seasonally to accommodate the attributes of the particular salmon run being investigated. A detailed discussion of the methods and results associated with the fall-run, late-fall run and winter-run surveys are presented in appendices III, IV and V. These reports account for the period extending from late-September 1997 through late-August 1998.

Spawning occurred during every month (Figure). Spawning activity was relatively light during the traditional spring-run chinook salmon spawning period (early September through early October). A clear break in spawning distribution before and after this period indicates that spring run spawn in the survey reach but that abundance is low.

RECONNAISSANCE HABITAT SURVEYS

In preparation for future investigations, aerial photographs were taken of the Yuba, Cosumnes and Calaveras rivers. The Cosumnes and Calaveras river surveys were made during fall 1997 to include spawning activity. The Yuba River was surveyed in late-September 1998 to determine the presence and distribution of spring-run chinook salmon spawning activity. These photographs are being evaluated to determine habitat type distribution and abundance at the flows present during the photograph survey, and to identify spawning distribution.

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CDFG. 1997. Central Valley anadromous fish-habitat evaluations, October 1995 - September 1997. CA. Dept. of Fish and Game, Stream Evaluation Program, Env. Serv. Div.

Snider, W.M., D.B. Christophel, B.L. Jackson, and P.M. Bratovich. 1992. Habitat characterization of the Lower American River. Beak Consultants, Inc.

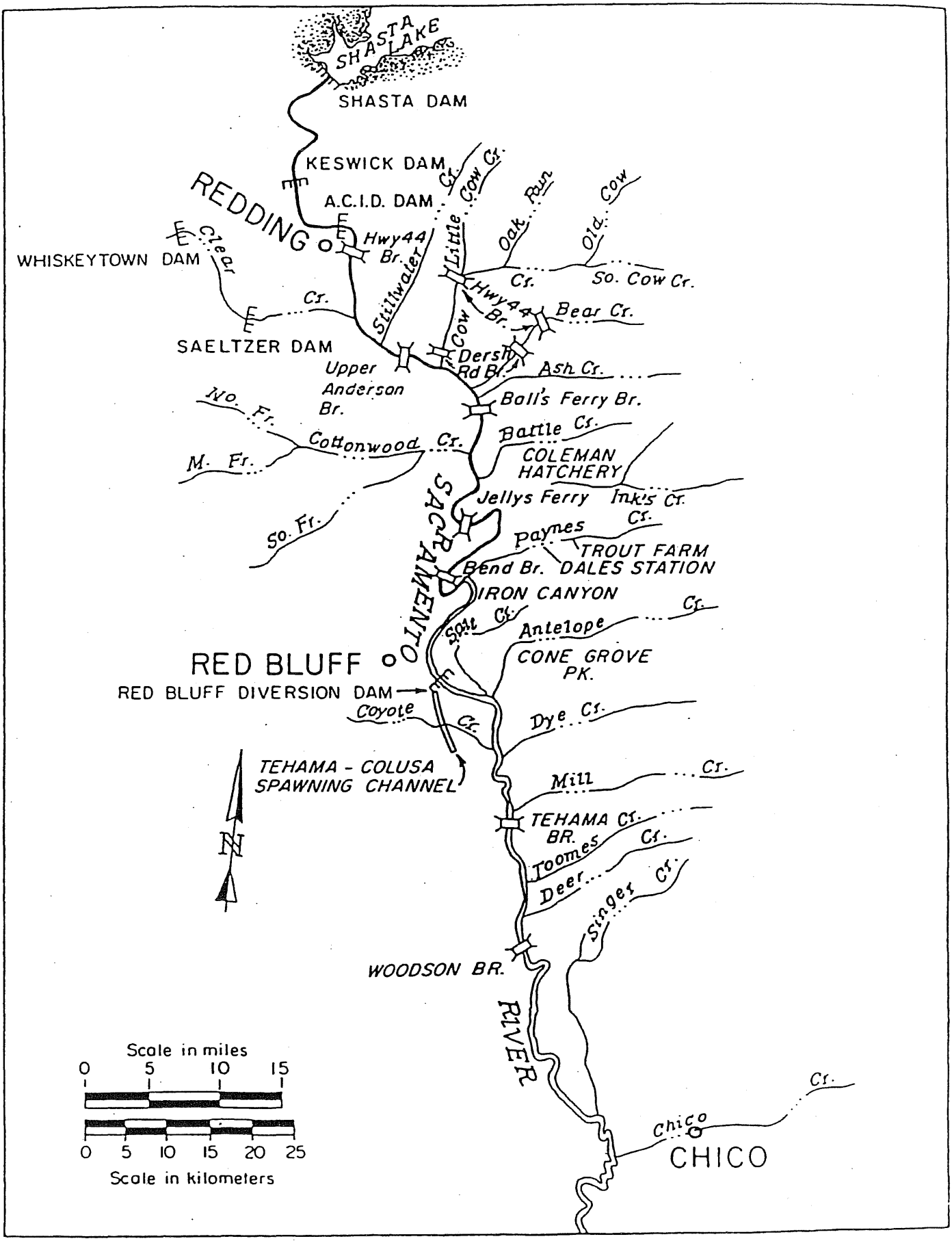


Figure 1. Upper Sacramento River.

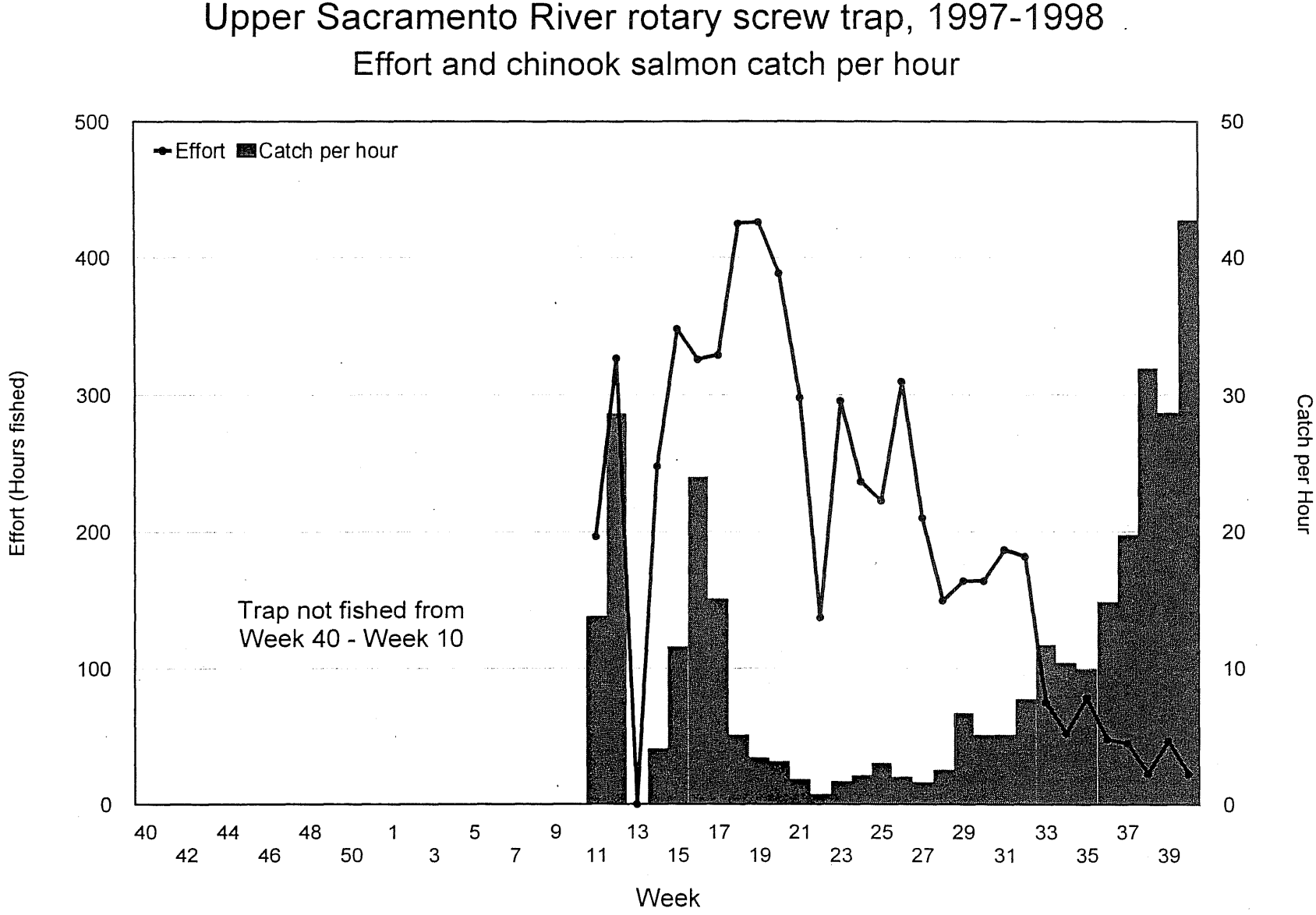


Figure 30. Weekly catch per hour of chinook salmon and hours fished by rotary screw trap in the upper Sacramento River, 01 October, 1997 - September 30, 1998.

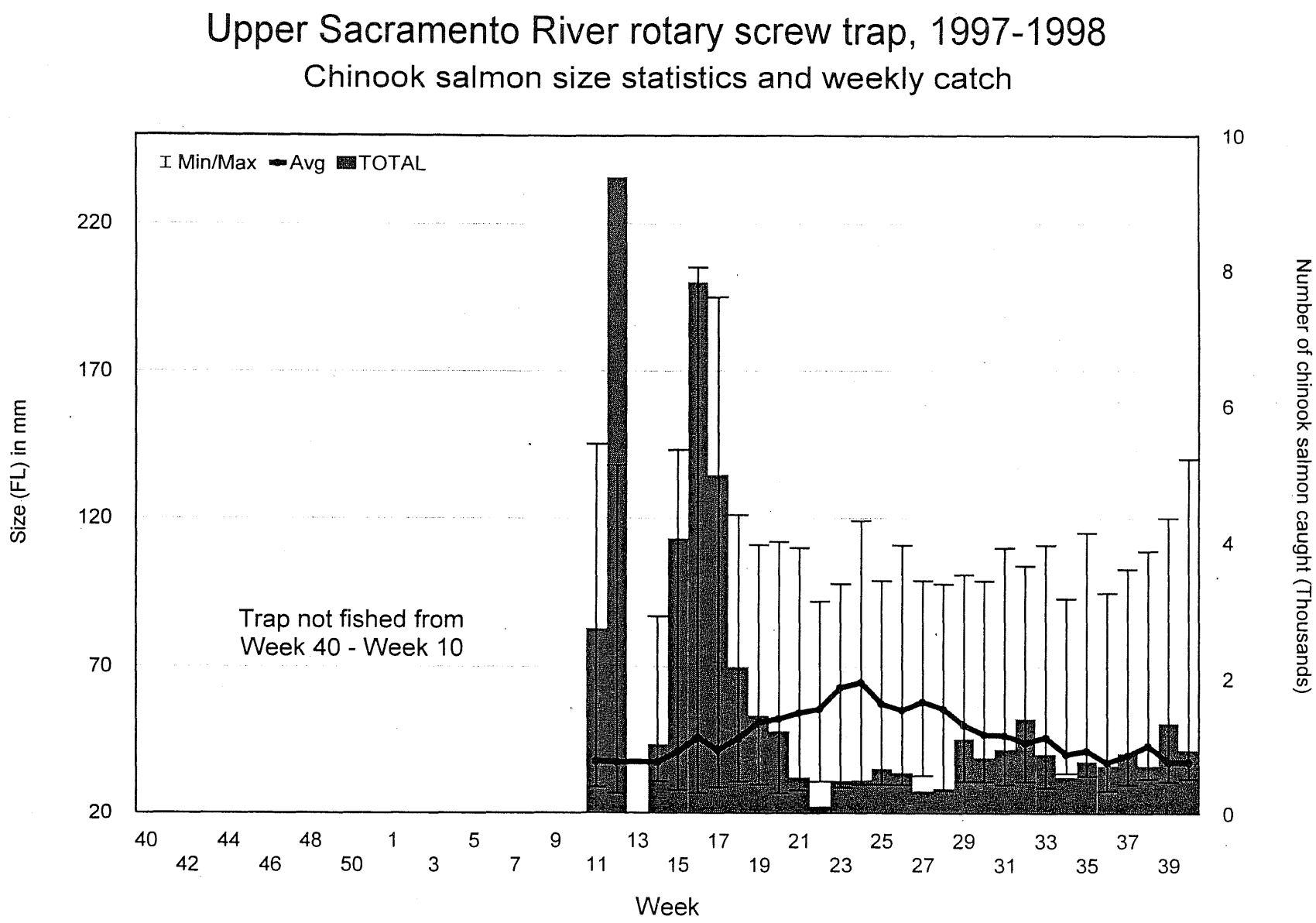


Figure 31. Chinook salmon mean fork length (minimum and maximum) and total caught by rotary screw trap in the upper Sacramento River, October 1997 - September 1998.

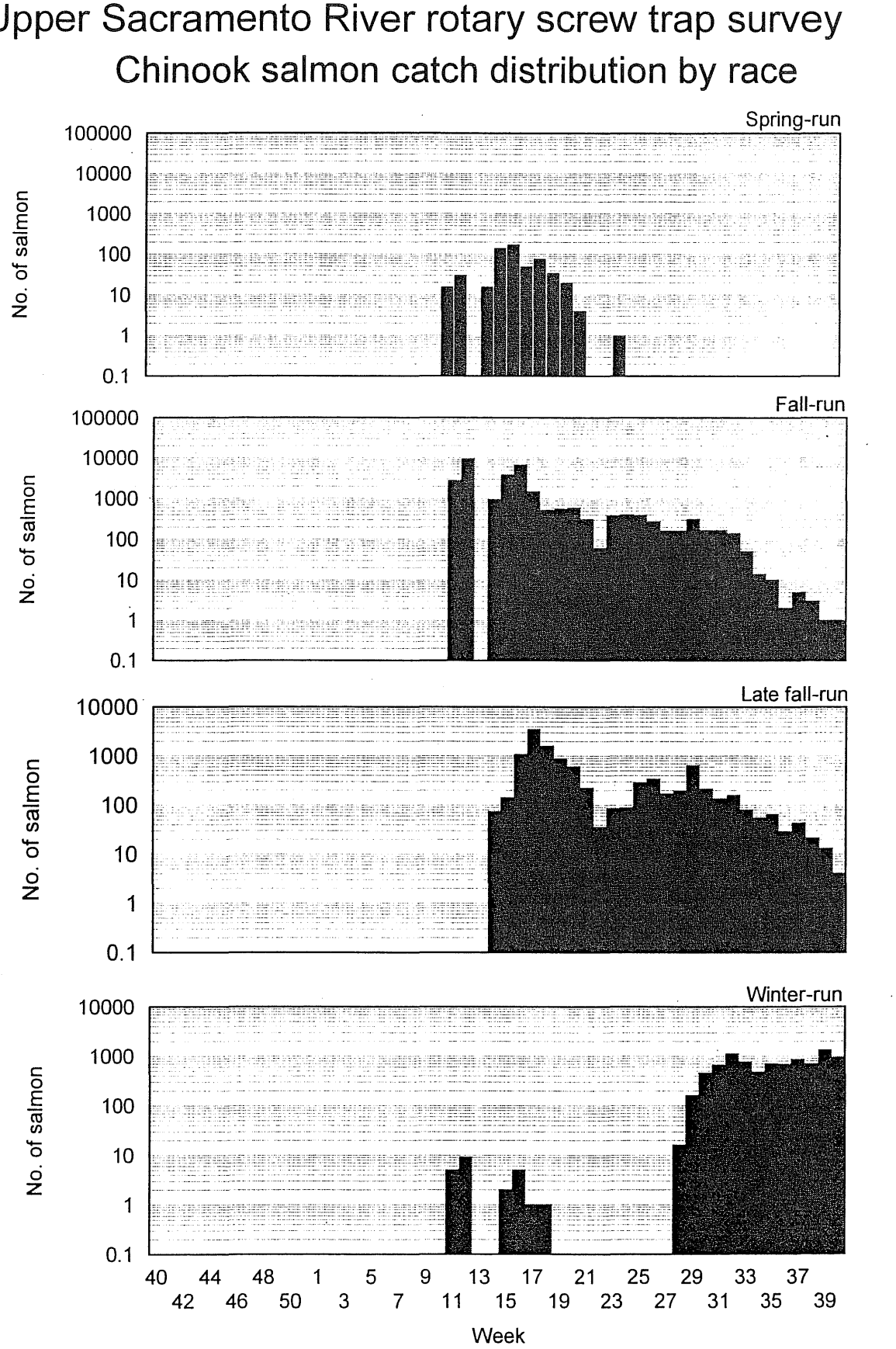


Figure 32. Catch distribution of chinook salmon races collected by rotary screw trap in the upper Sacramento River, 01 October, 1997 - 30 September, 1998.

Upper Sacramento River rotary screw trap survey

Chinook salmon size distribution by race

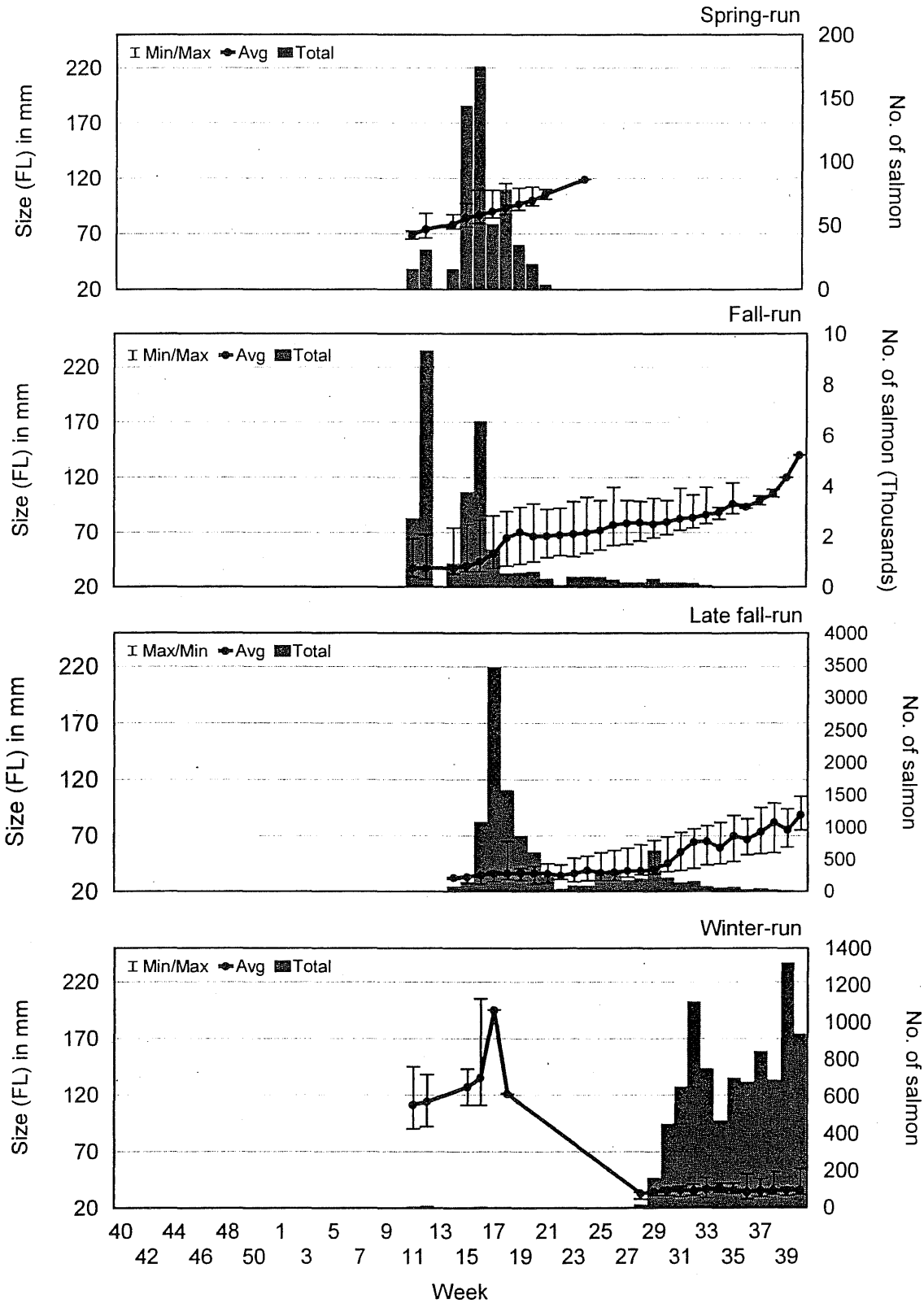


Figure 33. Weekly catch and size statistics for the four races of chinook salmon collected by rotary screw trap in the upper Sacramento River, 01 October, 1997 - 30 September, 1998.

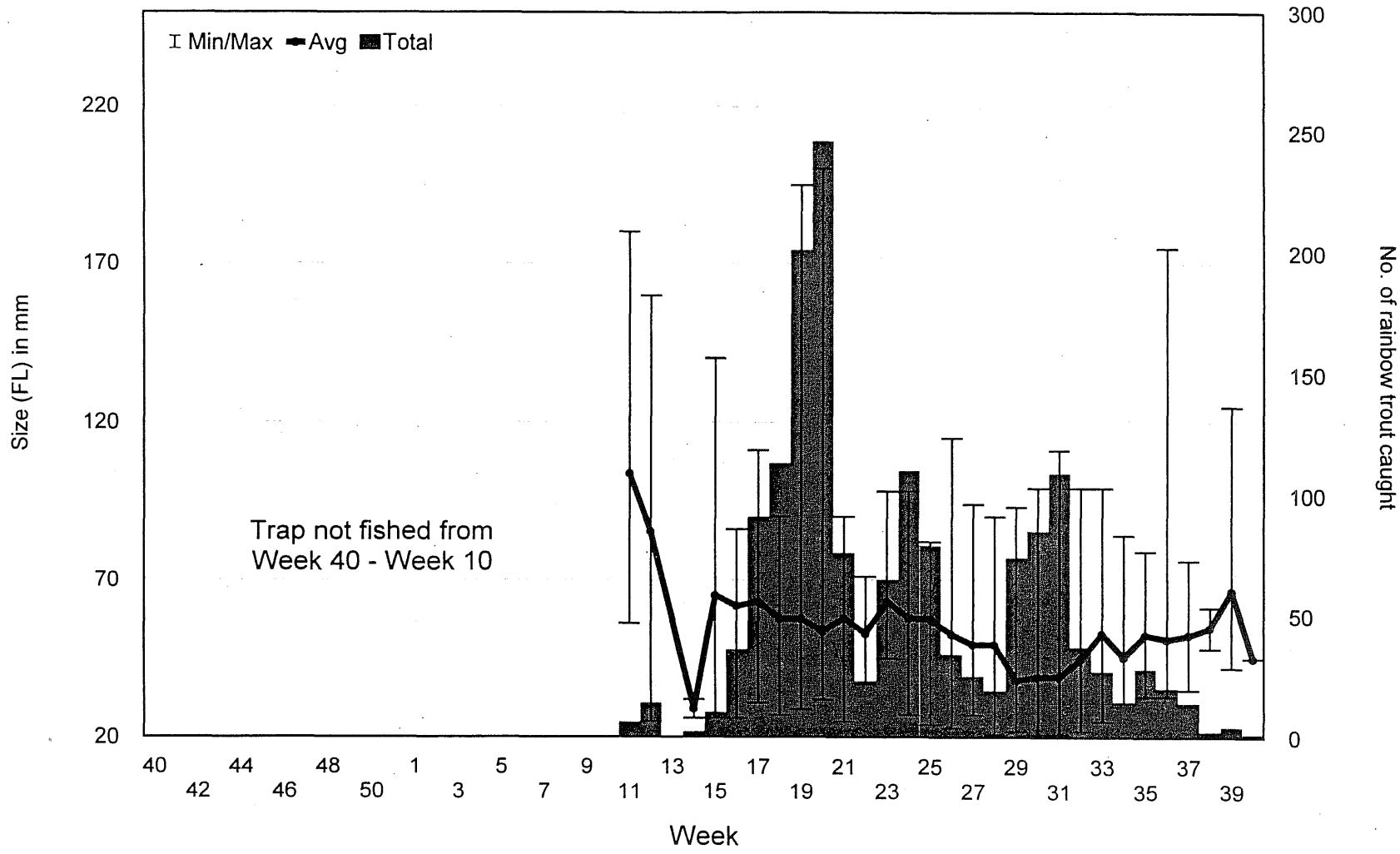


Figure 34. Rainbow trout mean fork length (minimum and maximum) and total caught by rotary screw trap in the upper Sacramento River, October 1997 - September 1998.

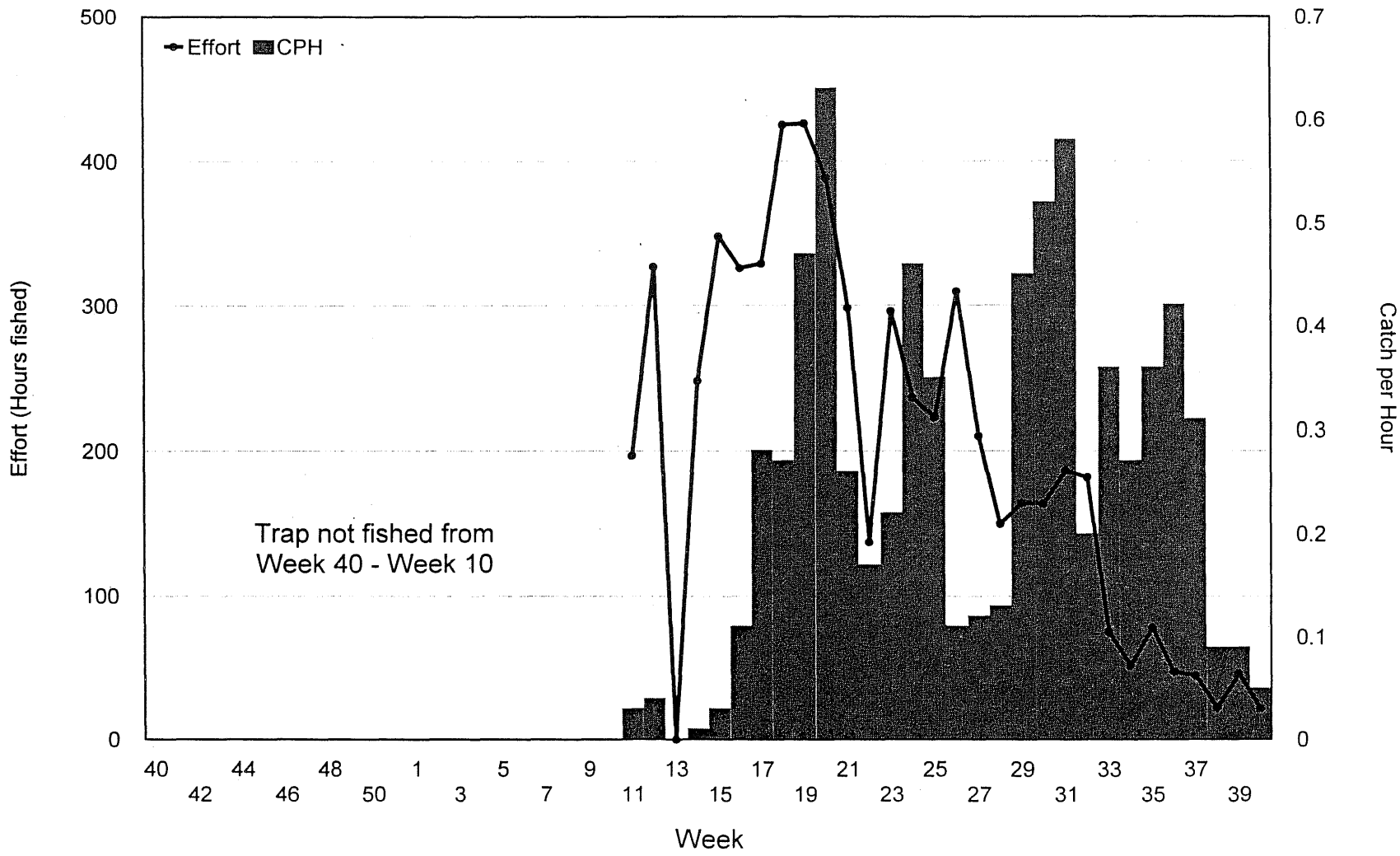


Figure 35. Weekly catch per hour of rainbow trout and hours fished by rotary screw trap in the upper Sacramento River, 01 October, 1997 - September 30, 1998.

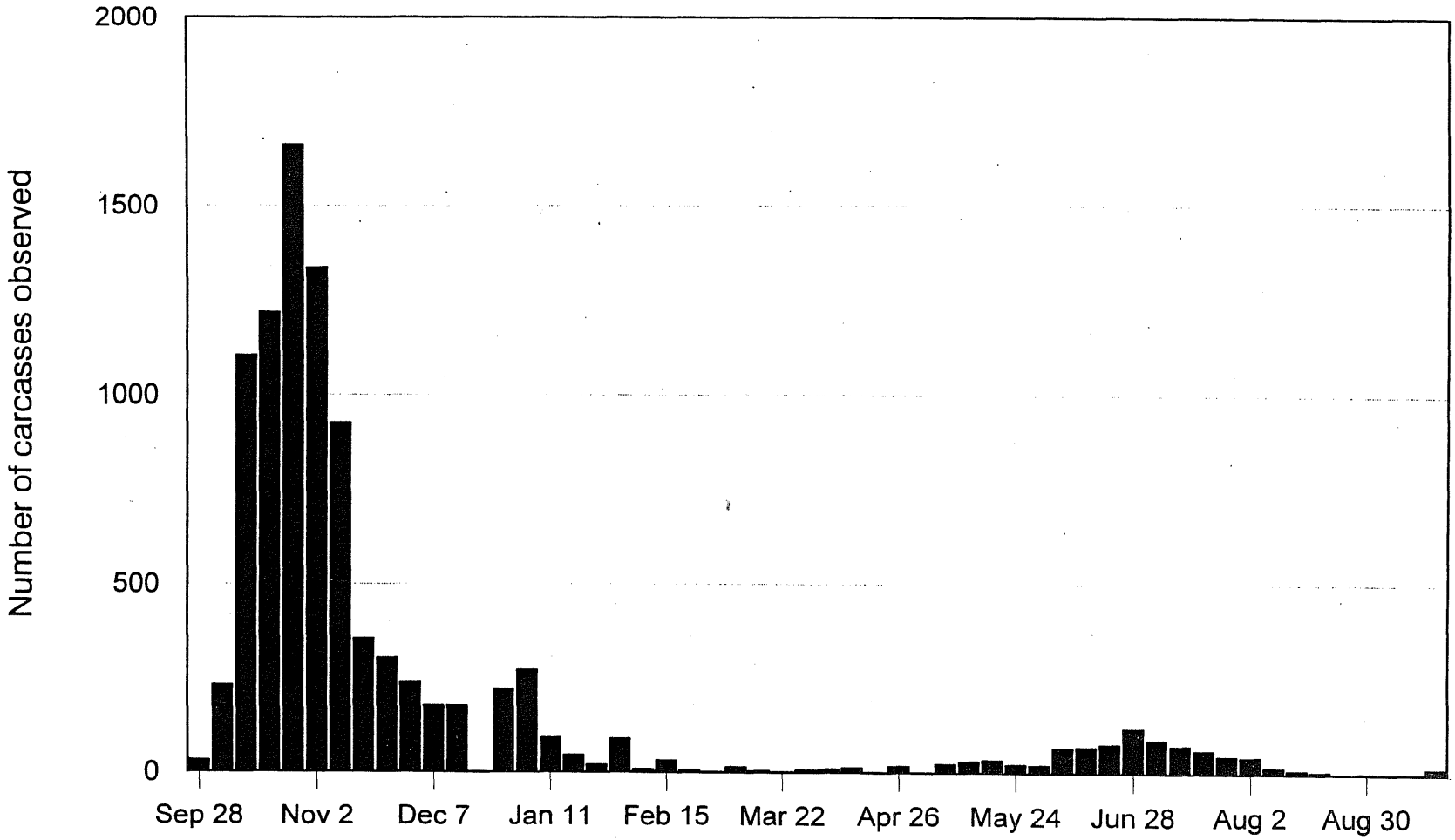
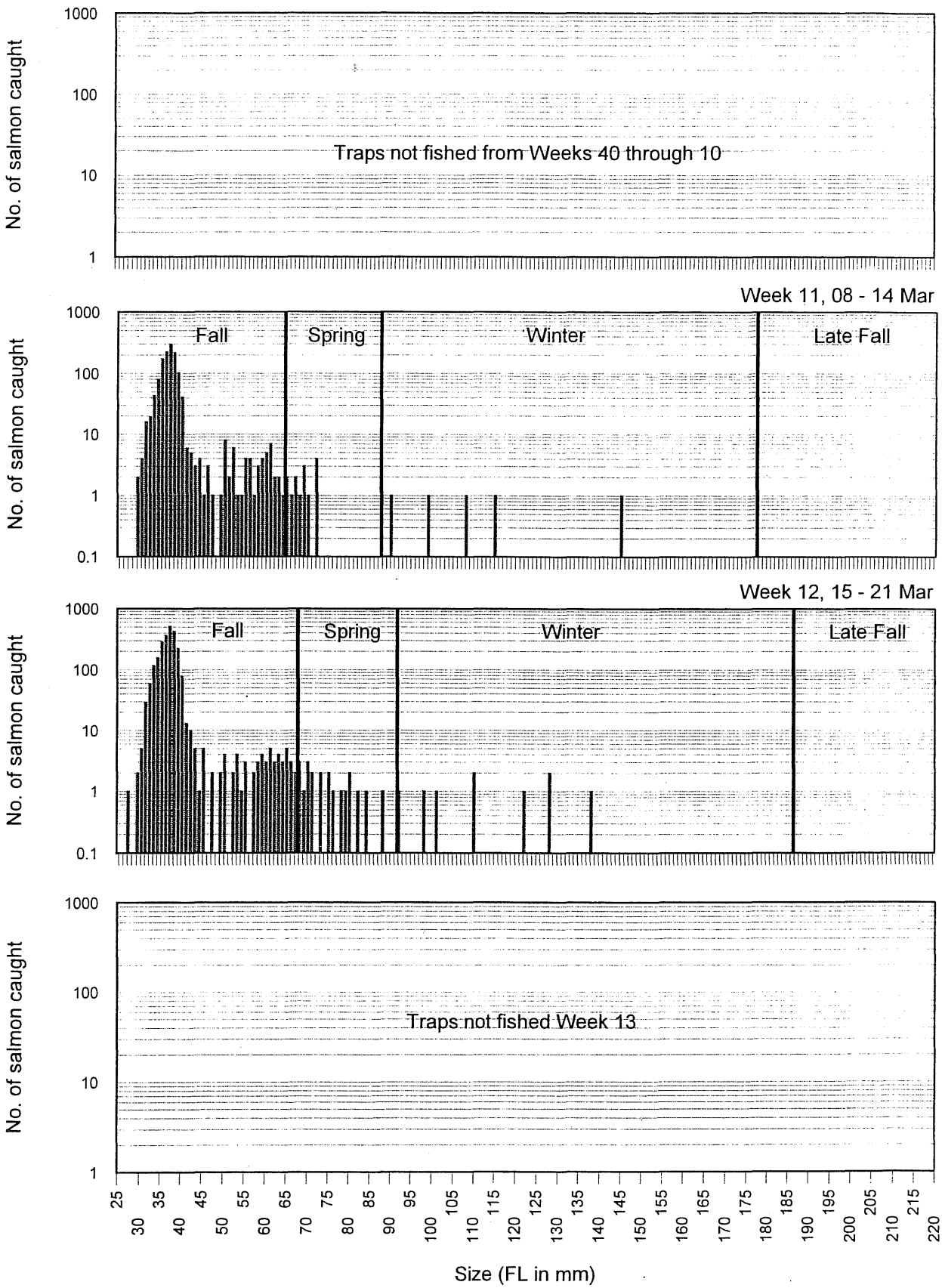


Figure 36. Weekly summary of chinook salmon carcasses observed during upper Sacramento River escapement surveys, September 28, 1997 through Spetember 30, 1998.

APPENDIX II

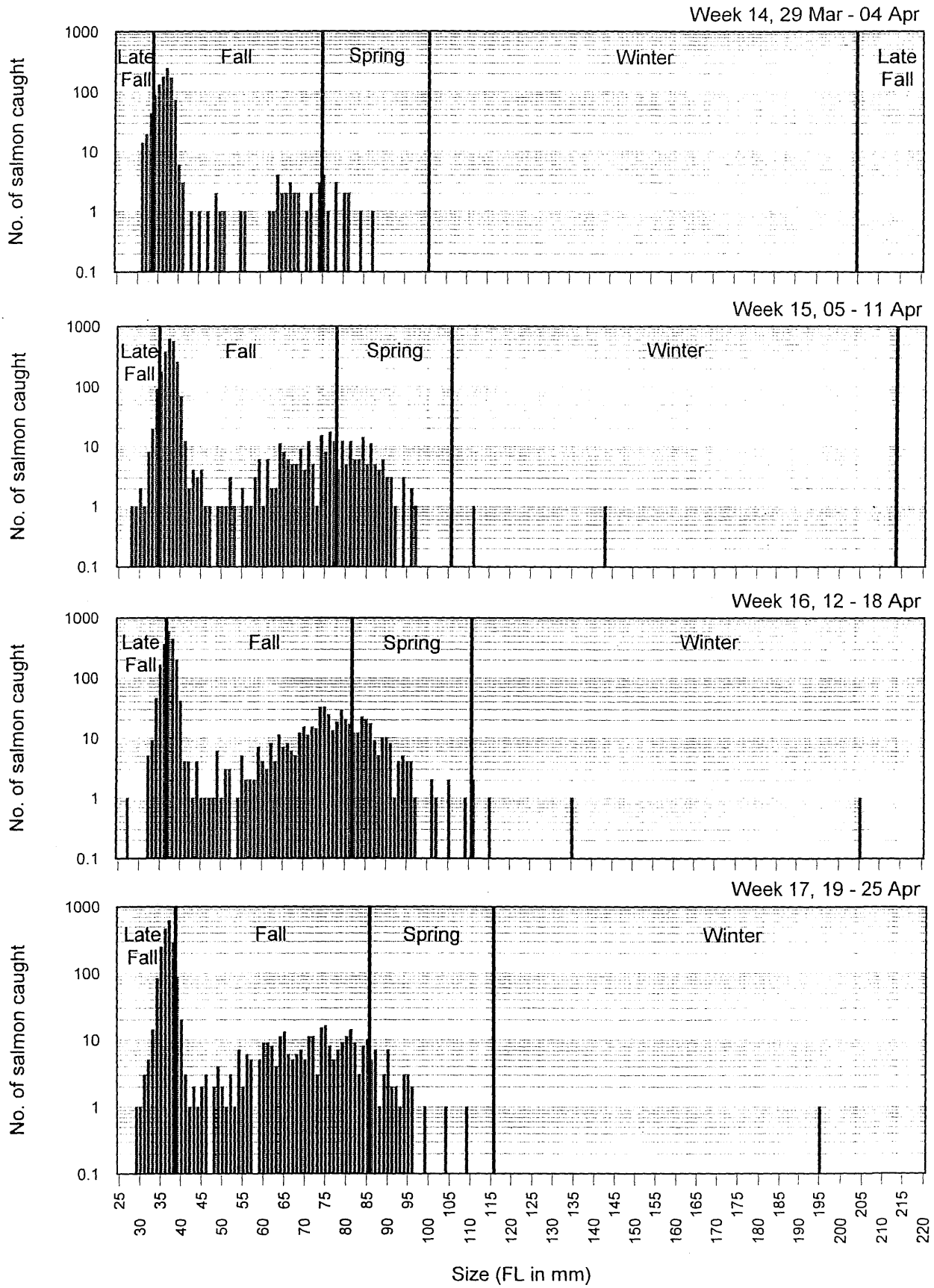
Rotary screw trap catch weekly length distribution

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



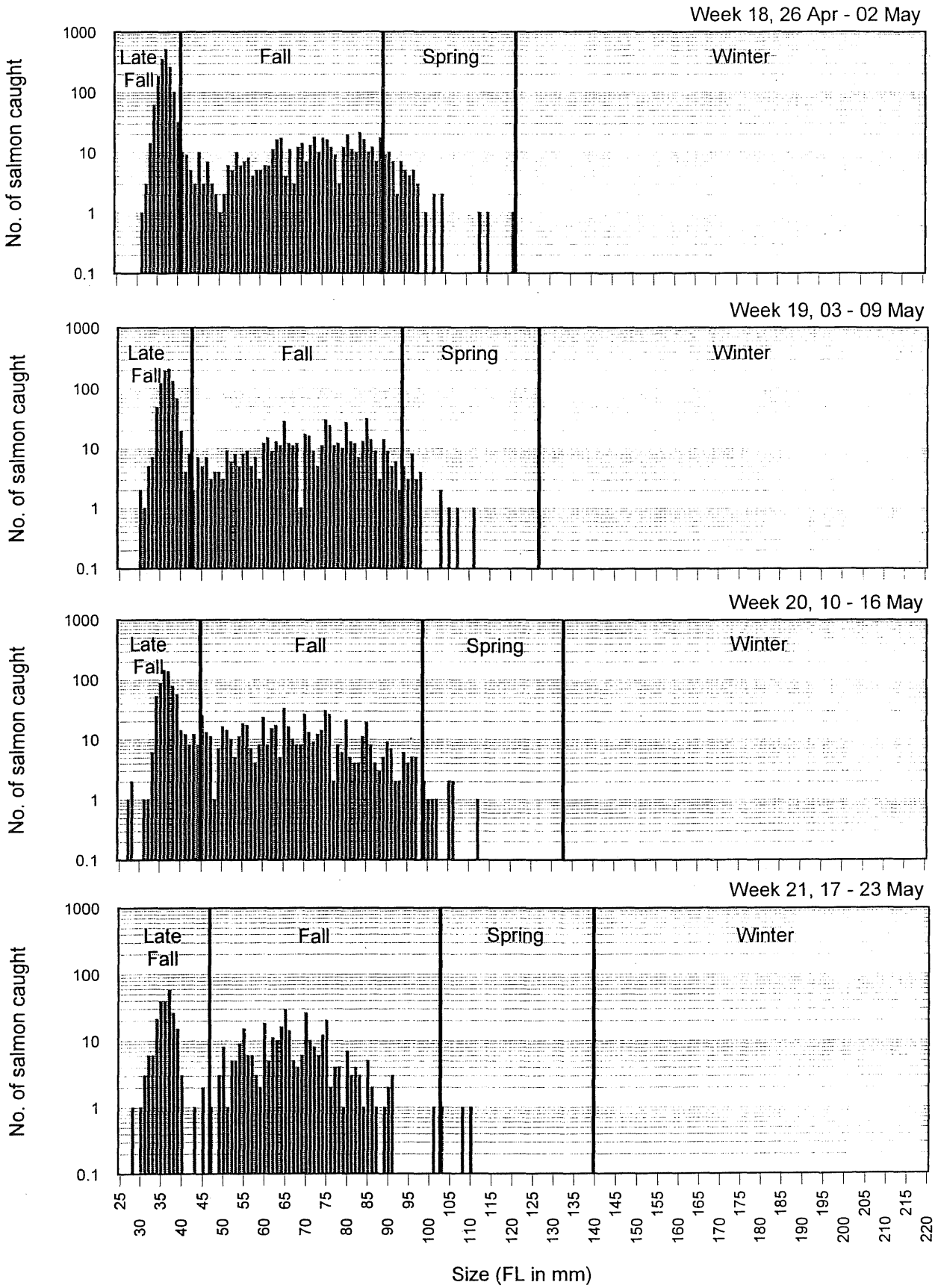
II-1. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 01 October, 1997 - 28 March, 1998.

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



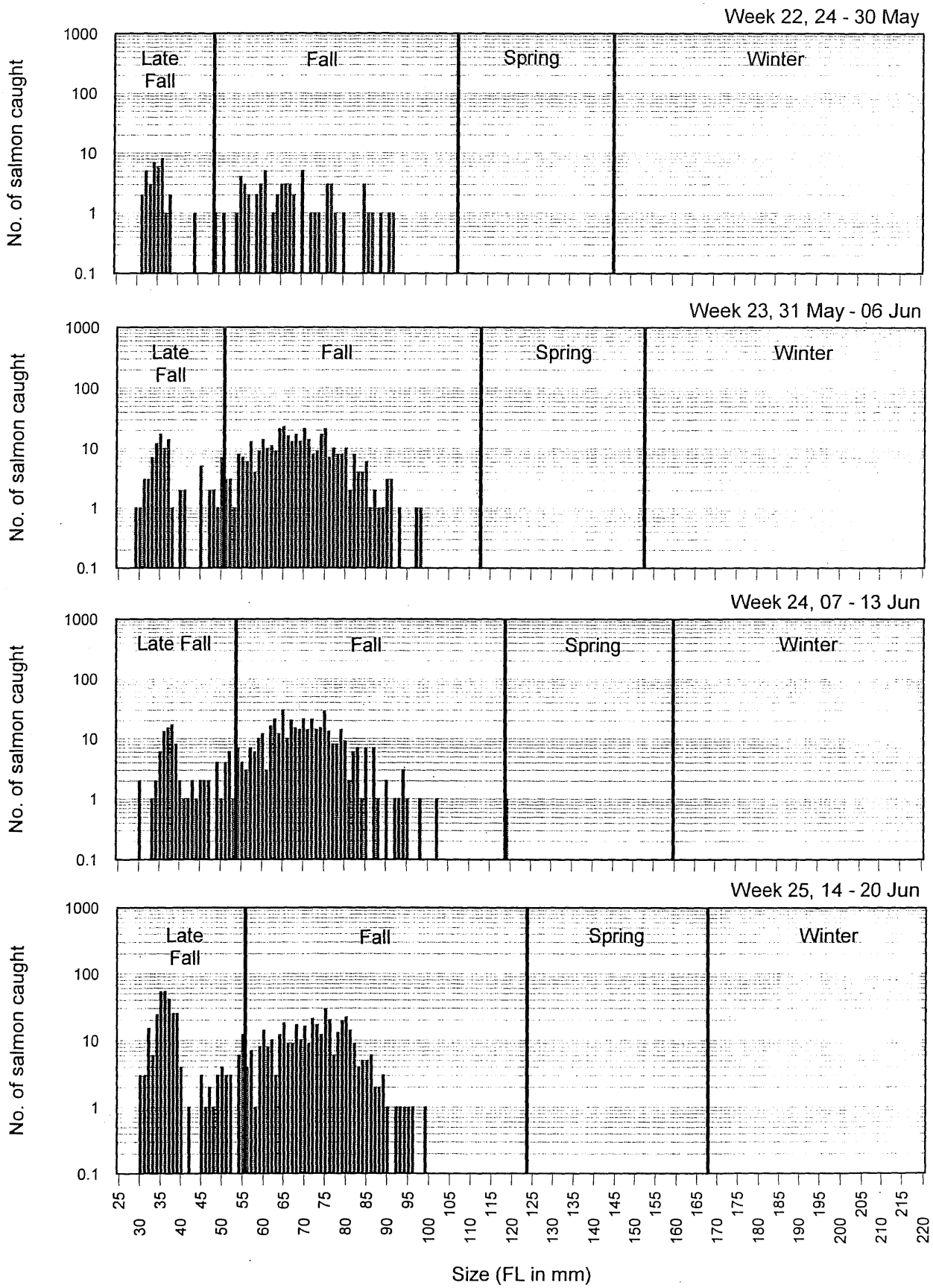
II-2. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 29 March - 25 April, 1998.

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



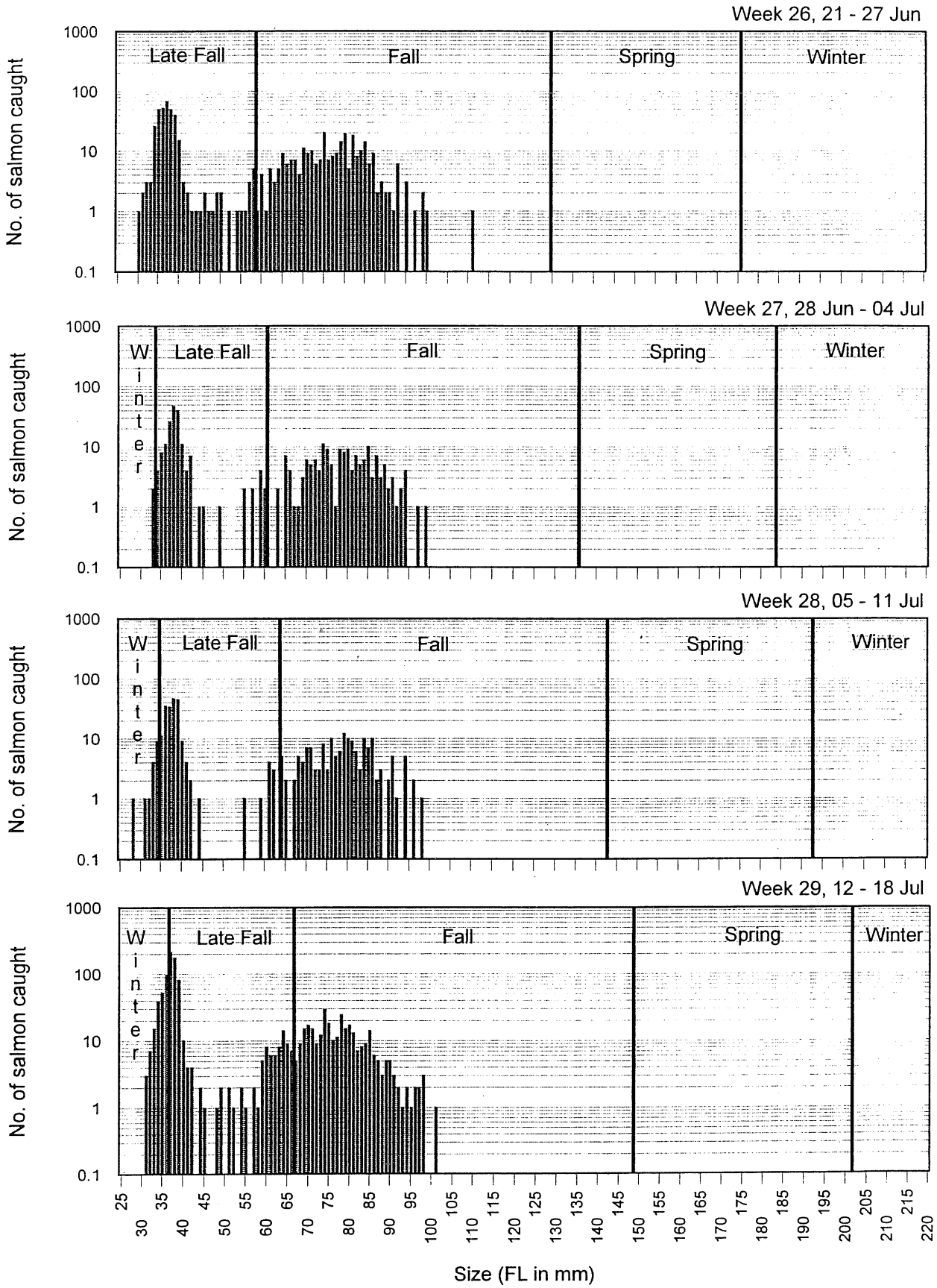
II-3. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 26 April - 23 May, 1998.

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



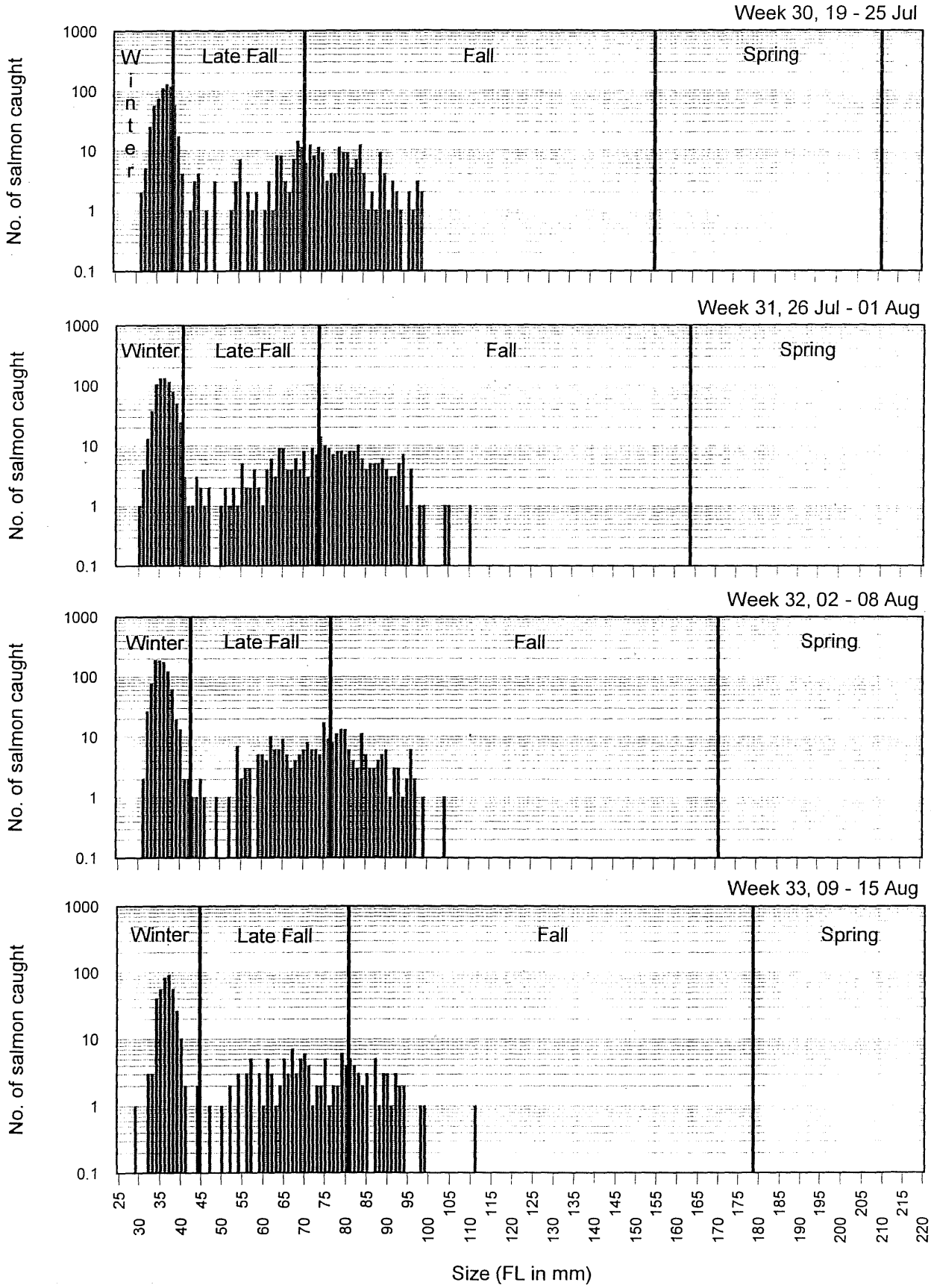
II-4. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 24 May - 20 June, 1998.

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



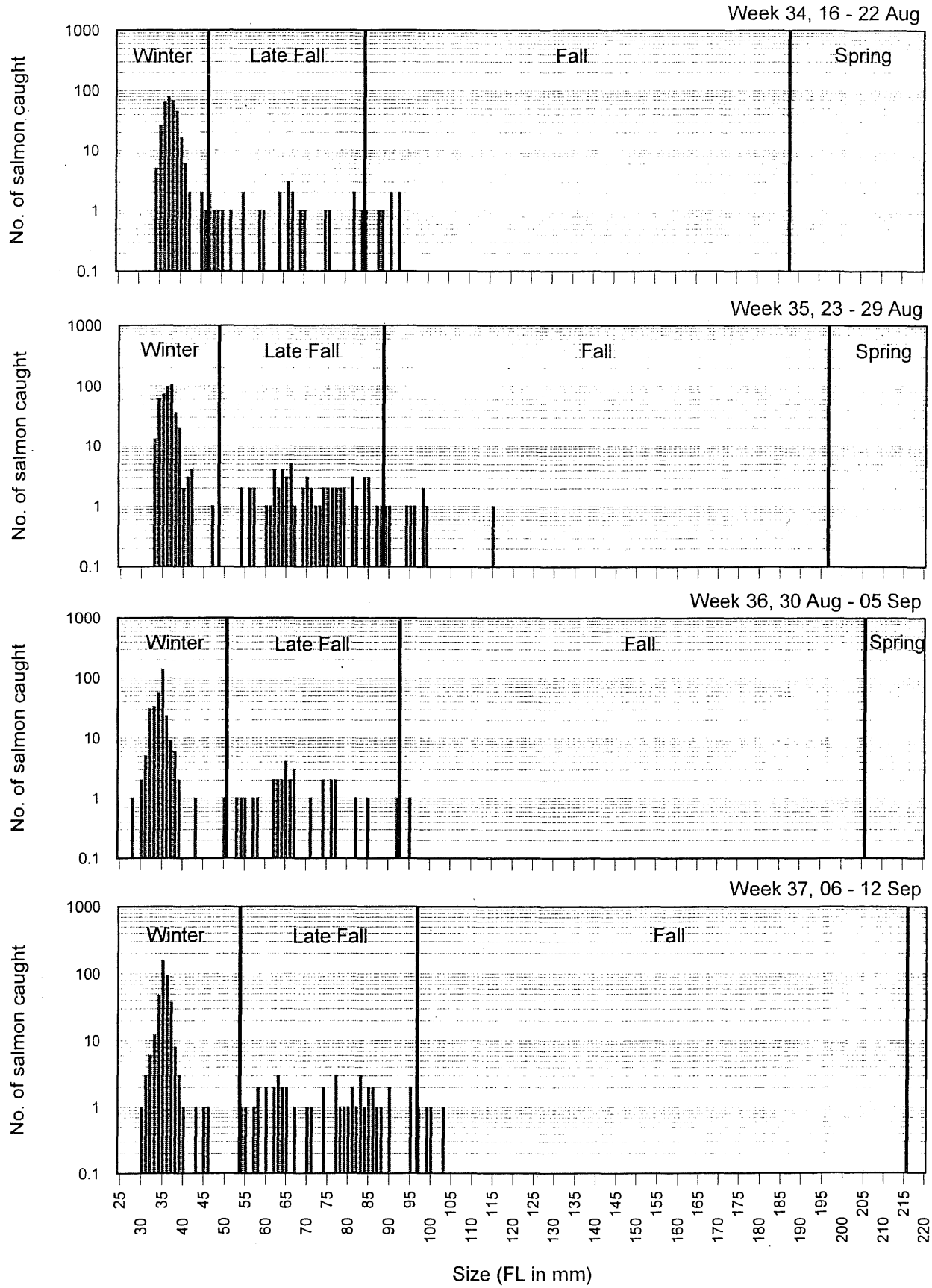
II-5. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 21 June - 18 July, 1998.

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



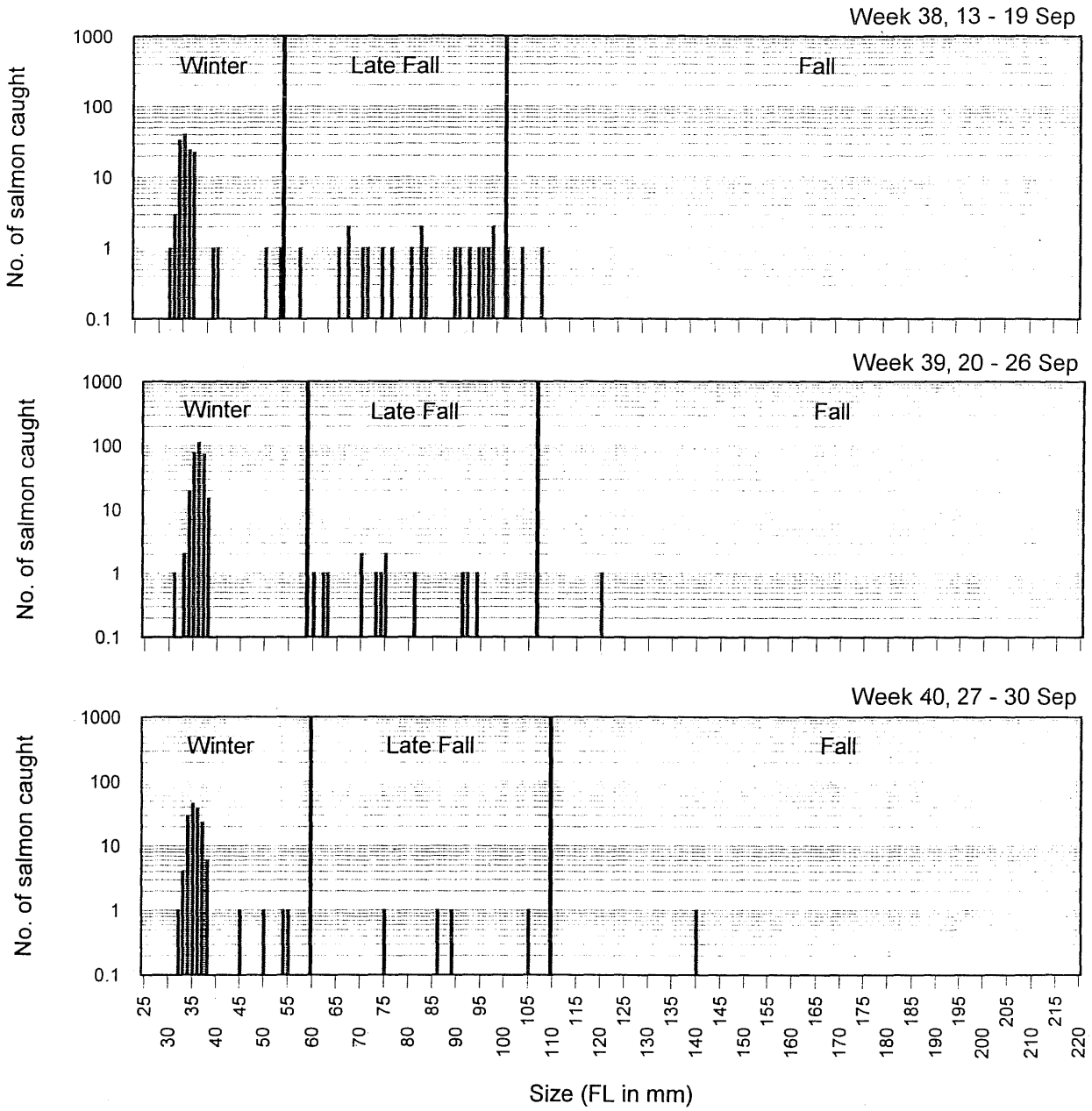
II-6. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 19 July - 15 August, 1998.

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



II-7. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 16 August - 12 September, 1998.

Chinook salmon Size Distribution
Upper Sacramento River rotary screw trap



II-8. Size distribution of chinook salmon caught by rotary screw traps in the upper Sacramento River, 13 - 30 September, 1998.