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The Resources Agency
DEPARTMENT OF FISH AND GAME

BUTTE AND BIG CHICO CREEKS
SPRING-RUN CHINOOK SALMON, *ONCORYHNCHUS TSHAWYTSCHA*
LIFE HISTORY INVESTIGATION
2000-2001

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Paul D. Ward
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Sacramento Valley – Central Sierra Region

Inland Fisheries

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ABSTRACT

This report covers the spring-run chinook salmon (*Oncorhynchus tshawytscha*) monitoring and life history evaluation in Butte and Big Chico Creeks from September 2000 through December 2001.

For Butte Creek, there were 697,317 juvenile chinook salmon captured near Chico, and 13,241 in the Sutter Bypass. There were 166,570 fish captured near Chico that were coded-wire-tagged, and 110 of the tagged fish recaptured in Sutter Bypass traps. Average calculated growth rate for the Sutter Bypass recaptures was 0.57 mm/day, and the average time to recapture was 65 days. The adult spring-run chinook salmon escapement based upon the snorkel survey methodology used since 1991, was 9,605. An alternate estimate based upon the Schaefer model carcass survey methodology was 22,744. The carcass survey recovered 16 Butte Creek coded-wire-tagged adults from BY 1997 (2), BY 1998 (13) and BY 1999 (1). Based upon the 16 tag recoveries, the year 2001 population contained a minimum of 12.5% age-4 fish. However, adjusting for release group size (BY 1997–3,408, BY 1998–105,828, BY 1999–55,854), would suggest a significantly higher proportion of age-4 fish. There were seven, year 2001 ocean sport/commercial recoveries of BY 1998 Butte Creek coded-wire-tagged adults. Comparing the expanded recovery rate of ocean catch and inland escapement of BY 1998 taken during year 2001 suggests an ocean catch rate of approximately 44%. Two (expanded to six) of the seven ocean recoveries were from a small coded-wire-tag release group (393 fish) of BY 1998 fish tagged as yearlings. The limited sample suggests that yearling Butte Creek spring-run survive at a rate significantly higher than YOY emigrants, and that ocean harvest of yearlings is significantly higher. A Peterson model carcass survey of Butte Creek fall-run chinook salmon estimated the population to be 4,103. There were ten recoveries of coded-wire-tagged fish during the fall-run survey, all of which were from out of the Butte Creek watershed, suggesting significant straying. The carcass surveys showed that Butte Creek spring- and fall-run spawning is separated in time and space.

For Big Chico Creek, there were 1,057 juvenile salmon captured near Chico, and the adult escapement estimate based upon the snorkel methodology was 39.

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² California Department of Fish and Game, Sacramento Valley-Central Sierra Region, 2545 Zanella Way, Suite F, Chico, California 95928.

INTRODUCTION

This is the third report summarizing a study begun during 1995 to define life history characteristics of spring-run chinook salmon (SRCS), *Oncorhynchus tshawytscha*, in Butte and Big Chico Creeks. The two previous reports, Hill and Webber (1999) and Ward and McReynolds (2004), summarized project results through September 2000. Butte Creek is one of three remaining streams that form the basis for population trends for the threatened SRCS in the Central Valley of California. The other two are nearby Deer and Mill Creeks, located to the north in Tehama County. Big Chico Creek currently exhibits only a remnant non-sustaining population of SRCS and is not used as a population trend indicator at this time.

This project has 1) developed adult escapement estimates for Butte and Big Chico Creeks; 2) monitored outmigration timing and relative abundance of age-0+ juvenile SRCS within Butte and Big Chico creeks, including the Sutter Bypass; 3) documented the outmigration of yearling SRCS; and 4) documented relative growth of juvenile SRCS in the Butte Creek system, including the Sutter Bypass, through coded-wire-tagging of juvenile salmon collected at the Parrott-Phelan Diversion Dam (PPDD). Other research projects are assisting in tracking coded-wire-tagged Butte Creek SRCS juveniles as they emigrate downstream through the mainstem Sacramento River and Delta. Tagged salmon have been, and will be recovered in the ocean fishery to determine how and where Butte Creek SRCS contribute to the ocean harvest. Additionally, recovery of returning tagged adults to Butte Creek is providing information on survival, age structure, and straying.

Butte Creek Watershed and Hydrology

Butte Creek is located in Butte and Sutter Counties. The headwaters of Butte Creek originate in the Lassen National Forest, within the Jonesville Basin at an elevation of approximately 2,137 m (7,000- ft). The watershed is approximately 2,103 km² (809 mi²) and has an unimpaired average annual yield of approximately 300,000 cubic decameters (dam³) (243,000 acre-feet) (Hillaire, 1993). Butte Creek enters the mainstem Sacramento River at two locations, the Butte Slough Outfall gates and the downstream end of the Sutter Bypass near the confluence of the Feather River with the Sacramento River (Figure 1). When flows in the Sacramento River are greater than approximately 595 cubic meters per second (m³/s) (21,000 cubic feet per second (cfs)) at Wilkins Slough, part of the Sacramento River flows into lower Butte Creek and the Sutter Bypass through the Tisdale Weir (Figure 1). Moulton and Colusa weirs are upstream of Tisdale Weir and are staged to spill when the flow in the Sacramento River reaches approximately 1,274 m³/s (45,000 cfs) and 1,841 m³/s (65,000 cfs), respectively. The capacity of the Sacramento River channel downstream of the Tisdale Weir at Wilkins Slough is approximately 850 m³/s (30,000 cfs). These weirs have a combined capacity to pass approximately 3,766 m³/s (133,000 cfs) into the Sutter Bypass (Dept. of the Army, 1975). When water is bypassed, outmigrating salmonids from the upper Sacramento River mix with SRCS from Butte Creek.

Big Chico Creek Watershed and Hydrology

Big Chico Creek is located within Butte and Tehama Counties. The headwaters of Big Chico Creek originate from the southwest slope of Colby Mountain at an elevation of approximately 1,646 m (5,400 ft), and encompass a watershed area of approximately 116 km² (72 mi²). The creek is approximately 72 km (45 mi) in length entering the Sacramento River, west of the City of Chico. The unimpaired average annual yield is approximately 66,600 dam³ (54,000 acre-feet). The watershed also encompasses three smaller drainages to the north including Sycamore, Mud, and Rock creeks.

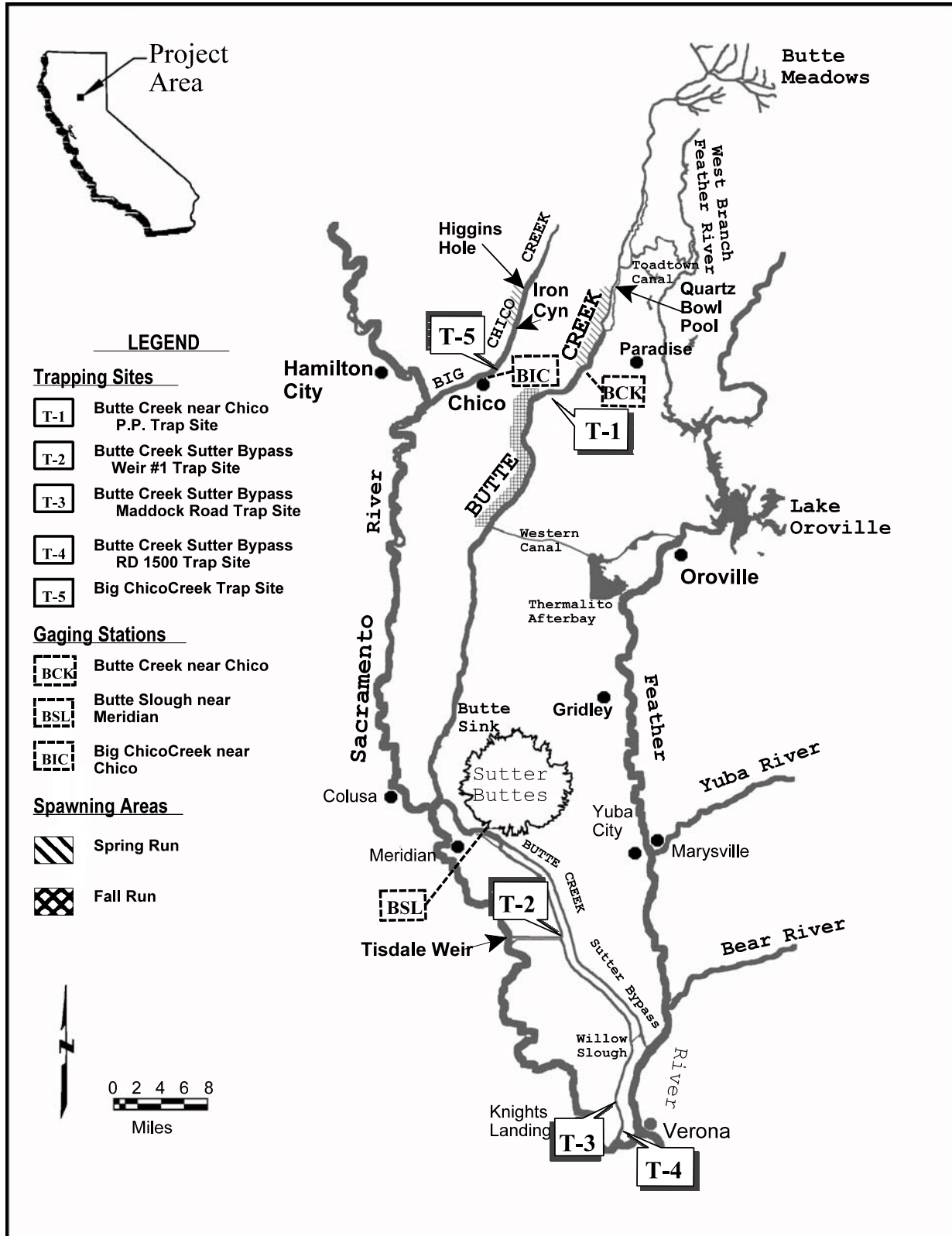


FIGURE 1. Butte Creek and Big Chico Creek watersheds.

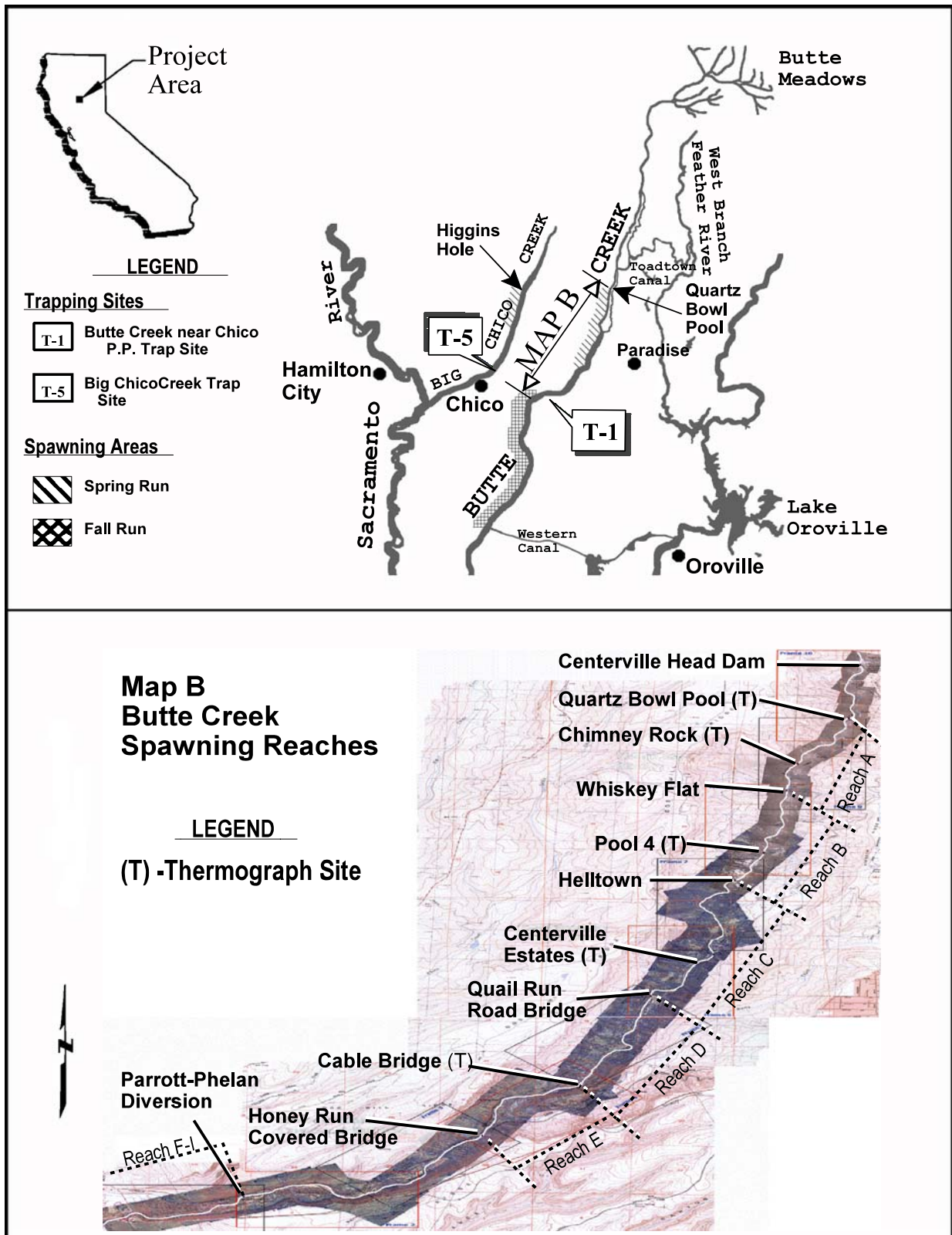


FIGURE 2. Butte Creek watershed showing fall and spring run spawning areas.

MATERIALS AND METHODS

Butte Creek Trapping Sites

Fish were trapped at four locations along Butte Creek (Figure 1). The PPDD is the uppermost site (Figure 1, site T-1). This site is directly downstream of the SRCS spawning habitat and upstream of the fall-run chinook salmon (FRCS) spawning habitat, although periodically some FRCS spawn above this site. The second trapping site is located at the Sutter Bypass West Borrow Weir 1, approximately 98 km (61 mi.) downstream of PPDD (Figure 1, Site T-2). The third trapping site is located within the Sutter Bypass at Maddock Road, approximately 118 km (73 mi.) downstream of PPDD (Figure 1, Site T-3). The fourth trapping site is located within the Sutter Bypass at Reclamation District 1500 (RD 1500), approximately 125 km (78 mi) downstream of PPDD (Figure 1, Site T-4). All Sutter Bypass traps are located southwest of Yuba City, California. Each site was sampled with a 2.4-m diameter (8 ft) rotary screw trap manufactured by EG Solutions (Eugene, Oregon). During the peak SRCS emigration period of the 2000/2001 trapping season, two 2.4-m diameter (8 ft) rotary screw traps were fished in tandem at the Sutter Bypass RD1500 and Maddock Road sites to maximize coded-wire-tag recoveries. Each rotary screw trap was connected to an upstream stationary object, dam, weir, or bridge by use of steel cable 0.6 cm (1/4 in.) in diameter. Placement was adjusted regularly to allow for safe operation and access as well as to maximize the efficiency of sampling. In addition to the rotary screw trap at PPDD, the diversion canal has an off-stream fish screen fitted with a trap box 1.2 m x 0.9 m x 2.1 m (4 ft x 3 ft x 7 ft). All traps were fished 24 hours a day, seven days a week, except during extraordinarily high water flows or during periods of excessive debris.

Big Chico Creek Trapping Site

Fish were trapped at the Bidwell Park Municipal Golf Course (Figure 1, Site T-5). The site was sampled using a 1.5-m diameter (5 ft) rotary screw trap manufactured by EG Solutions (Eugene, Oregon). Steel cable 0.6-cm (1/4 in.) in diameter connected the screw trap to the crossing bridge over Big Chico Creek. The trap was adjusted periodically to assure maximum trapping efficiency without jeopardizing safety. The trap was fished 24 hours per day, seven days a week, except during extraordinarily high water flows or during periods of excessive debris.

Physical Measurements

Four physical measurements were taken daily at each trapping site. Water velocity in meters per second (m/s) was measured at the mouth of the screw trap cone with a Marsh-McBirney Flo-Mate, Model 2000. The velocity sensor was attached to a graduated staff and submersed to a depth of 0.61m (2 ft) directly below the shaft of the screw trap cone. Each velocity reading was based upon a preset 45-second averaging period and recorded as the velocity reading for the entire 24-hr period. Additionally, screw-trap cone revolutions were recorded through the use of a mechanical counter (Reddington Counters Inc., Model 1-2936). Total revolutions for the 24-hr period were recorded and the counter reset each day. Water temperature (Celsius) was measured in the live box of each trap using a hand held Enviro-Safe Thermometer. Turbidity was recorded daily using a Hach Model 2100P Portable Turbidimeter. A representative sample of water was

collected directly besides the rotary screw trap and the resultant measurement in Nephelometric Turbidity Units (NTU's) recorded on the daily data sheet.

Processing Captured Fish

The methods used for processing fish were the same for both Butte and Big Chico creeks. The Big Chico Creek study does not include the procedures for the coded-wire-tagging elements. Similar methods for processing fish were used for the 2000-2001 trapping season as in the previous reports for 1998 through 2000 (Ward and McReynolds, 2004) and for 1995 through 1998 (Hill and Webber, 1999). All fish were netted from the live-boxes and immediately placed into a shallow tub of fresh river water. Juvenile chinook salmon were sorted from other species and transferred swiftly with small aquarium nets into buckets equipped with portable aerators to be transported to shore for processing. The first ten of each non-salmonid fish species were measured to the nearest mm fork length (FL) and released. The remainder were counted and released.

A random sub-sample of 50 salmon juveniles was placed into a bucket containing a weak, standardized solution of tricaine methanesulfonate (MS-222) and anaesthetized (10 g of MS-222 powder dissolved in 1 liter of fresh distilled water to create a stock solution, which was then used at a dilution of 40 ml stock solution/ 6 liter of fresh river water). Upon immobilization, juveniles were individually placed onto a wetted Plexiglas measuring board and measured to the nearest mm FL. Thirty salmon of this group that measured greater than 40mm were then transferred to a wetted container on an Ohaus electronic scale and individually weighed to the nearest 0.01 g. All salmon caught in the Sutter Bypass traps were examined for an adipose fin clip. Salmon with a clipped adipose fin were sacrificed and preserved for future coded-wire-tag (CWT) recovery and decoding. Each fish was individually bagged and given a tag having a unique numeric code identifying the date of capture, fork length, and capture location. Unclipped fish were placed into a bucket of fresh aerated river water for recovery. After full recovery, all unmarked salmon were released downstream of the trap.

Juvenile SRCS captured at the PPDD trapping site were measured as above. Instead of releasing these salmon at the site, they were held in holding pens for subsequent coded-wire-tagging. All fish were saved for tagging, unless daily trap numbers were extremely high making processing time extremely long (> 10 days). On days with large numbers of salmon, a sub-sample was held for the tagging process. The rest were released at the trapping site.

Salmon were transported via aerated buckets to the Baldwin Construction Yard (BCY), approximately one mile downstream of the PPDD site. Fish were tagged using a Northwest Marine Technology Tag Injector Model MKIV and Model MKIV Quality Control Device (QCD). Initially, injectors were fitted with a 1,100-fish/lb head mold. Head molds were changed periodically to accommodate for growth. Fish were anaesthetized in MS-222, adipose-fin clipped, then tagged with a half-length (0.5 mm) tag in the rostrum and placed through the QCD. Any miss-tagged or rejected fish were retagged. All but a group of 100 tagged fish were recovered in fresh water and released. The remaining fish were held for 24 hours and re-run through the QCD to obtain a 24-hour tag shedding rate and then released. Yearling SRCS were not included in the sample tagged. Tag codes were changed every fourteen days or after use of an entire 10,000 coded-wire-tag spool throughout the outmigration period.

Juvenile Outmigration

Yearling SRCS are fish that emigrate in the fall, approximately one year after egg deposition. These fish are the only salmon to emigrate before salmon from the newly spawned young-of-the-year (YOY) emerge. When both year classes are in the stream, yearlings are much larger than YOY. By examining length-frequency distributions of fish captured at PPDD, yearlings can generally be identified (Appendix B, Figure 1). Outmigration of YOY SRCS is described by examining catches of salmon trapped at PPDD and from tagged fish recovered in the Sutter Bypass, as well as catches by other projects in the lower Sacramento River and Delta.

Growth

An estimate of relative growth was calculated using information from tagged salmon recoveries at the Sutter Bypass sites. Data collected was used to determine how long juvenile salmon remained in the system and growth was expressed in millimeters per day. The mean FL was calculated for each tag group, except for one tag code group, where data were missing or incomplete. The release of a tag code extended over a number of days. A median release date was used for calculating mean growth. Growth was determined by subtracting the mean release size from the individual capture size. Growth rate was calculated by dividing the difference between mean size at release (FL_{Release}) and size at recovery (FL_{Recovery}) by the difference in the number of days (d) between median release date and recovery date ($(FL_{\text{Recovery}} - FL_{\text{Release}})/(d_{\text{Recovery-Release}})$).

Adult Escapement

Each summer an adult SRCS escapement estimate is developed by conducting a snorkel survey. Adults are counted while they are holding in deep pools, prior to spawning. On Butte Creek, the snorkel survey extended from the Centerville Head Dam to PPDD (Figure 2). On Big Chico Creek, the survey was from Higgins Hole to Iron Canyon (Figure 1). The survey was conducted over four days, each covering a discrete reach on Butte Creek, and on one day with three distinct reaches on Big Chico Creek. The 2001 escapement survey varied from the surveys conducted in previous years. In past years, three to five experienced personnel swam abreast downstream through each pool. At the end of each pool, survey personnel compared numbers of adults counted; if greater than a 20% discrepancy between individual counts, the survey was repeated. If less than a 20% discrepancy, all counts were recorded with the lowest and highest values for all pools summed for reporting a minimum and maximum range of total escapement. Counts were used for most pools; however, estimates were used when large numbers of salmon in a pool precluded an actual count. Numbers were reported by reach. The total escapement for the year was a summation of the reaches surveyed for each creek. In the 2001 survey, each pool was observed only once, with each of the four individual independent estimates recorded. The four individual estimates were then averaged. The annual escapement estimate was then calculated by summing the averages for the entire survey reach. Additionally, subsequent analysis of the entire data set revealed several significant outliers, which were also excluded from the calculation of the population estimate. In such instances, the average for the pool only reflected the remaining recorded observations.

Adult Carcass Survey

Adult mark-recapture surveys using the Schaefer model (Schaefer, 1951) were completed for both SRCS and FRCS populations. This was the first year an intensive carcass survey was conducted. The primary goal of the survey was to recover CWT's from adults tagged and released in Butte Creek during previous years. However, the survey provided an alternative adult escapement estimate using standard mark-recapture techniques.

The 2001 SRCS carcass survey was conducted from September 11, 2001 through October 25, 2001. The survey extended from Quartz Bowl Pool to the Covered Bridge (Figure 2, Map B). The approximately 17.7 km (11 mi.) long stream section was divided into five reaches. Each reach was then subdivided into 0.4 km (0.25 mi.) segments. Each reach was surveyed once per week. Department personnel spread out and walked downstream, covering both sides of the creek and any side channels. Collected carcasses were checked for "freshness". At least one clear eye and firm flesh constituted a fresh carcass. Each fresh carcass was tagged with a colored ribbon attached to the lower jaw using a hog ring and returned to flowing water near the location where collected. Carcasses that were not tagged were chopped in half, removing them from future surveys. On each subsequent survey, carcasses were checked for jaw tags and adipose-fin clips. Jaw-tagged carcasses were recorded as "recovered". Adipose-fin clipped carcasses were measured to the nearest fork-length (mm), heads removed, a head tag number assigned and each head placed into a zip-lock bag. Heads were frozen for later recovery of the CWT's. While removing the CWT's from the heads, otoliths were extracted and archived with the previously taken tissue samples.

Data collected from the fresh carcasses included gender, FL in mm, and the reach of the stream in which each carcass was observed. Data collected to determine population size included number of fish tagged, number chopped, and number recovered. In addition, tissue samples were taken from the first ten fresh carcasses encountered. Clean scissors were used to cut a small piece (10 mm sq.) of tissue from the caudal fin. If all fins were eroded or decayed, a small piece of skin was taken. Each sample was placed in a pre-labeled vial containing tris-buffer and placed into a container. All collected tissue samples were archived for future analysis. Between each sample, the scissors were rinsed in fresh water to prevent cross contamination.

The 2001 FRCS carcass survey was conducted from October 22, 2001 through December 4, 2001. The survey extended from PPDD to Gorrill Ranch Dam, also covering a ½-mi section near the Western Canal Siphon site. The approximately 15.3 km (9.5 mi.) long stream section was divided into four reaches. The sampling techniques for the FRCS survey were the same as those used for the SRCS survey.

Thermographs

Onset, model WTA032, temperature data loggers were deployed at five sites within the SRCS spawning habitat (Figure 2, Map B). For the pools selected, each logger was placed within a 2" x 6" long galvanized steel pipe and suspended by ¼" steel cable. Data loggers were set for 1-hour interval readings.

RESULTS

Butte Creek 2000-2001 Trapping Season

The 2000-2001 trapping season began at the PPDD when the diversion and rotary screw traps were installed on September 11, 2000. Both traps were operated until June 29, 2001. During the trapping season, there were occasions when one or both of the traps were removed due to high stream flows or excessive debris. A total of 697,317 juvenile salmon, including yearlings, was captured in both traps; 200,183 in the diversion screen trap and 497,134 in the screw trap (Tables 1 and 2). Of the total captured, 166,570 were tagged and released at the BCY (Table 3). Since the diversion screen trap was located off-stream in the diversion canal, the trapping data continue to demonstrate the benefit of the PPDD fish screen; any fish captured in the trap would have been lost into the canal if the structure did not exist.

Approximately 475,000 (68%) juvenile SRCS (Table 1 and 2) of the entire PPDD salmon catch occurred during January and February 2001. Trapping was suspended for various periods of time in February (Tables 1 and 2) because of high flows (Appendix A, Figure 1).

Table 1. Semi-monthly catch summary of juvenile SRCS caught in the screen trap at PPDD from September 11, 2000 to June 29, 2001; yearling captures are included.

Trapping Period		Mean FL(mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No.Trapping Days
9/1/00	9/15/00	-	-	-	-	-	4
9/16/00	9/30/00	103	15.1	82	135	10	15
10/1/00	10/15/00	0	0	0	0	0	15
10/16/00	10/31/00	110	7.6	98	120	7	16
11/1/00	11/15/00	-	-	-	-	0	15
11/16/00	11/30/00	48	30.4	30	117	26	15
12/1/00	12/15/00	35	5.7	29	88	110	15
12/16/00	12/31/00	35	6.3	31	105	258	16
1/1/01	1/15/01	36	8.1	31	114	14,618	15
1/16/01	1/31/01	36	7.4	32	114	43,526	16
2/1/01	2/15/01	35	1.6	32	52	28,421	14
2/16/01	2/29/01	35	1.3	31	39	52,688	9
3/1/01	3/15/01	36	1.9	31	51	5,513	15
3/16/01	3/31/01	36	2.7	31	65	10,093	16
4/1/01	4/15/01	39	5.6	31	77	1,900	15
4/16/01	4/30/01	43	11.9	30	102	10,179	15
5/1/01	5/15/01	62	9.5	35	95	12,700	14
5/16/01	5/31/01	62	9.3	28	170	18,636	13
6/1/01	6/15/01	63	7.3	44	91	1,423	15
6/16/01	6/30/01	66	6.4	51	81	75	14
					Total:	200,183	282

Table 2. Semi-monthly catch summary of juvenile SRCS caught in the screw trap at PPDD from September 11, 2000 to June 29, 2001; yearling captures are included.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
9/1/00	9/15/00	-	-	-	-	0	4
9/16/00	9/30/00	113	12.4	105	127	3	15
10/1/00	10/15/00	108	10.2	92	134	11	15
10/16/00	10/31/00	109	10.2	87	127	21	16
11/1/00	11/15/00	109	11.6	92	128	19	15
11/16/00	11/30/00	98	30.5	32	124	20	15
12/1/00	12/15/00	39	17.6	30	121	522	15
12/16/00	12/31/00	36	8.3	31	116	2,014	16
1/1/01	1/15/01	36	8.3	32	116	27,247	15
1/16/01	1/31/01	36	5.5	32	113	58,075	16
2/1/01	2/15/01	36	7.4	31	129	47,687	14
2/16/01	2/29/01	36	9.1	32	123	201,997	9
3/1/01	3/15/01	36	5.5	30	115	27,152	14
3/16/01	3/31/01	36	2.4	30	62	51,021	16
4/1/01	4/15/01	41	8.7	27	77	19,674	15
4/16/01	4/30/01	44	19.2	31	88	18,863	15
5/1/01	5/15/01	63	8.9	33	89	17,531	14
5/16/01	5/31/01	61	7.0	37	84	22,352	16
6/1/01	6/15/01	65	6.9	44	86	2,801	15
6/16/01	6/30/01	65	7.3	49	89	124	14
					Total:	497,134	284

Sampling in the Sutter Bypass began on January 9, 2001 at RD 1500. The RD 1500 traps fished until April 3, 2001. A total of 902 juvenile chinook salmon was captured at that site (Table 4). Excessive debris at the site impaired our ability to trap effectively. On April 4, 2001, both rotary screw traps were moved upstream to Maddock Rd. Trapping at that site continued from April 4, 2001 through May 17, 2001. A total of 9,624 juvenile chinook salmon was captured at that site (Table 5). Again, debris became a problem, and one trap was moved upstream to the West Borrow Weir 1. The Weir 1 trap fished from May 16, 2001 through June 22, 2001 (Table 6). A total of 2,715 juvenile chinook salmon was captured at that site (Table 6). The first CWT recapture from all sites was on February 15, 2001; the last was on May 20, 2001 (Table 7, 8 and 9; Appendix C, Table 1, 2 and 3). There were a total of 4, 92, and 14 Butte Creek CWT recaptures in the RD 1500, Maddock Rd. and Weir 1 traps, respectively. Additionally, there were three CWT recaptures of fish released at Coleman National Fish Hatchery between

February 23, 2001 and March 5, 2001; all were FRCS (Appendix D, Tables 1 and 2). Sampling by the U.S. Fish and Wildlife Service at Chipps Island and Sherwood Harbor recovered six additional tagged Butte Creek fish from March 28, 2001 to May 11, 2001 (Table 10). All fish were from brood year 2000, captured at PPDD and tagged at the BCY between January 16, and March 2, 2001.

Table 3. Summary of coded-wire-tagged juvenile SRCS released at BCY from December 18, 2000 to May 11, 2001.

Tag Code	Release Date Range		Mean FL (mm)	Range FL (mm)		Total Released
06-01-12-03-15	12/18/00	12/20/00	35	32	39	1,266
06-01-12-04-01	-	-	-	-	-	*
06-01-12-04-02	01/16/01	01/19/01	35	32	39	12,990
06-01-12-04-03	01/16/01	01/19/01	35	32	39	12,383
06-01-12-04-04	01/16/01	01/18/01	35	32	39	11,114
06-01-12-04-05	01/26/01	01/28/01	35	32	38	10,568
06-01-12-04-06	01/26/01	01/28/01	35	32	38	10,646
06-01-12-04-07	01/26/01	01/27/01	35	32	38	8,957
06-01-12-04-08	01/29/01	02/02/01	35	32	38	12,343
06-01-00-02-00	01/29/01	02/02/01	36	32	38	8,365
06-01-00-02-02	01/29/01	02/02/01	35	32	38	13,505
06-01-00-02-03	02/07/01	02/09/01	35	32	39	2,457
06-01-00-02-04	02/07/01	02/09/01	35	32	39	1,452
06-01-00-02-05	02/21/01	03/01/01	35	31	39	5,962
06-01-00-00-00	02/22/01	03/02/01	36	31	39	5,092
06-01-00-00-01	03/08/01	03/16/01	35	31	39	7,871
06-01-00-00-02	03/16/01	04/02/01	36	31	52	8,042
06-01-00-00-03	04/02/01	04/11/01	36	31	68	8,708
06-01-00-00-04	04/10/01	04/23/01	36	32	71	9,052
06-01-00-00-05	04/20/01	04/27/01	38	32	74	8,432
06-01-00-00-06	04/30/01	05/11/01	59	36	86	7,365
Total:						166,570

* Records were lost for this tag group.

Table 4. Semi-monthly catch summary of juvenile chinook salmon caught in screw trap(s) in the Sutter Bypass at RD 1500 from January 9, 2001 to April 3, 2001. Fish captured at this location cannot be identified as SRCS because of the mixing of juvenile salmon of other races from the Sacramento River

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No Captured	No. Trapping Days
1/1/01	1/15/01	-	-	-	-	0	7
1/16/01	1/31/01	64	29.5	33	103	17	14
2/1/01	2/15/01	43	17.6	33	110	37	15
2/16/01	2/29/01	38	3.5	33	50	66	13
3/1/01	3/15/01	48	16.8	34	135	302	7
3/16/01	3/31/01	49	7.7	33	103	480	13
4/1/01	4/15/01	-	-	-	-	0	3
					Total:	902	72

Table 5. Semi-monthly catch summary of juvenile chinook salmon caught in the screw trap(s) in the Sutter Bypass at Maddock Rd. from April 4, 2001 to May 15, 2001. Fish captured at this location cannot be identified as SRCS because of the mixing of juvenile salmon of other races from the Sacramento River.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
4/1/01	4/15/01	76	7.7	37	97	4,697	12
4/16/01	4/30/01	74	8.3	41	98	2,839	14
5/1/01	5/15/01	66	9.1	32	91	2,088	15
					Total	9,624	41

Table 6. Semi-monthly catch summary of juvenile chinook salmon caught in the screw trap in the Sutter Bypass at West Borrow Weir 1 from May 16, 2001 to June 22, 2001. Fish captured at this location cannot be identified as SRCS because of the mixing of juvenile salmon of other races from the Sacramento River.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
5/16/01	5/31/01	65	8.9	47	82	2,715	15
6/1/01	6/15/01	-	-	-	-	-	15
6/16/01	6/30/01	-	-	-	-	-	7
					Total:	2,715	37

Table 7. Recaptures of juvenile SRCS bearing coded-wire-tags in the Sutter Bypass at RD 1500 (See Appendix C, Table 1 for detail). All fish were from brood year 2000 and tagged at BCY.

Tag Code	Total No. Captured	Average FL (mm)	Average Days at Large	Average mm/day
06-01-12-04-05	3	41	20	0.29
06-01-00-00-00	1	44	16	0.5
Total	4			

Table 8. Recaptures of juvenile SRCS bearing coded-wire-tags in the Sutter Bypass at Maddock Rd. (See Appendix C, Table 2 for detail). All fish were from brood year 2000 and tagged at BCY.

Tag Code	Total No. Captured	Average FL (mm)	Average Days at Large	Average mm/day
06-01-12-04-01	1	80	-	-
06-01-12-04-02	10	81	85	0.55
06-01-12-04-03	4	80	85	0.53
06-01-12-04-04	2	83	88	0.54
06-01-12-04-05	20	74	65	0.55
06-01-12-04-06	16	80	76	0.59
06-01-12-04-07	14	80	76	0.59
06-01-12-04-08	8	80	71	0.62
06-01-00-02-00	3	75	68	0.57
06-01-00-02-02	10	79	69	0.64
06-01-00-02-04	1	81	70	0.66
06-01-00-02-05	2	78	48	0.91
06-01-00-00-00	1	68	39	0.82
Total	92			

Table 9. Recaptures of juvenile SRCS bearing coded-wire-tags in the Sutter Bypass West Borrow Weir 1 (See Appendix C, Table 3 for detail). All fish were from brood year 2000 and tagged at BCY.

Tag Code	Total No. Captured	Average FL (mm)	Average Days at Large	Average mm/day
06-01-00-00-00	1	63	53	0.51
06-01-00-00-02	1	78	54	0.78
06-01-00-00-03	3	61	41	0.59
06-01-00-00-04	1	67	31	1.00
06-01-00-00-05	2	58	24	0.82
06-01-00-00-06	6	60	12	1.00
Total	14			

Table 10. Recaptures of juvenile SRCS bearing coded-wire-tags from other research projects.
All fish were from brood year 2000 and tagged at BCY.

Recovery Date	Tag Code	Recovery FL (mm)	mm/day	Recapture Location	Days at Large
3/28/01	06-01-12-04-04	77	0.60	Sherwood Harbor	70
4/4/01	06-01-12-04-05	78	0.64	Sherwood Harbor	67
4/20/01	06-01-12-04-08	87	0.66	Sherwood Harbor	79
4/22/01	06-01-12-04-04	86	0.54	Chipps Island	95
4/25/01	06-01-00-00-00	75	0.67	Sherwood Harbor	58
5/11/01	06-01-12-04-05	78	0.41	Chipps Island	104

Butte Creek
Juvenile Outmigration 2000-2001

As in the previous evaluations (Hill and Webber, 1999; Ward and McReynolds, 2004), YOY and yearling juvenile SRCS outmigrants were documented based upon the FL of juvenile salmon captured at PPDD. During this evaluation trapping period (September 2000 through June 2001), the majority of Butte Creek SRCS that were captured migrated as fry during high flows in January and February (Tables 1 and 2). As in the previous years' evaluations, some YOY remain to rear in Butte Creek above PPDD, outmigrating later in the spring and early summer. During this evaluation trapping period, 169 yearling SRCS were captured. Yearling SRCS were seen as early as September 17, 2000 and the last on May 20, 2001 at a length of 170 mm FL (Table 1 and 2; Appendix B, Figure 1). Length-frequency distributions for the entire period (Appendix B, Figure 1) continue to show a bimodal, and sometimes trimodal distribution that generally appear to delineate yearling SRCS.

Butte Creek
Growth 2000-2001

Fish tagged at PPDD and recovered in the Sutter Bypass continue to provide a basis for determining mean growth. Growth calculations were based upon recoveries from 17 tag groups released between January 16, 2001 and May 11, 2001 (Table 3; Appendix C, Table 1, 2, and 3). Fish recovered varied in length from 40 mm FL to 88 mm FL and averaged 76 mm FL. Fish recovered from all tag groups for the period were at large an average of 65 days.

Growth calculations for this project as previously reported by Hill and Webber (1999) were based upon tag groups released over a large and varying number of days (22 – 52 days), which affected the precision of growth rate calculations. During the 1998-2000 evaluation period (Ward and McReynolds, 2004), the interval in which a specific tag code was used was reduced and varied from 4 to 39 days. During this evaluation period, intervals for each specific tag code release varied from 1 to 17 days; however, growth calculations were based only upon tag release

groups with duration of four days or less. The growth calculation was based upon the mean FL of a measured sub-sample (30 fish) for each tag group.

Butte Creek Adult Escapement

During this evaluation period, significant effort was directed at recovering tags from previous release groups. A carcass survey was begun on September 11, and continued through October 25, 2001 and covered the 17.7 km (11 mi.) SRCS spawning area (Figure 1 and 2). During the SRCS carcass survey, 10,266 carcasses were examined. A total of 16 tags was recovered: 2 from BY 1997, 13 from BY 1998 and 1 from BY 1999 (Appendix E, Table 1). Additionally, one tag was recovered from a BY 1998 carcass found by a local landowner within the SRCS spawning area during June, 2001. For those carcasses recovered during the SRCS spawning period, an expansion factor of 2.22 was developed based upon the Schaeffer model population estimation methodology. In addition to the Butte Creek carcass recoveries, seven BY 1998 tags were recovered in the ocean fishery, two of which were from a group of 393 yearlings tagged during October 15-26, 1999.

Subsequent to the SRCS carcass survey, a survey of the FRCS spawning area (Figure 2, Map B) was conducted from October 22 through December 4, 2001. A total of ten tags was recovered (Appendix E, Table 2) from 1701 carcasses that were examined. An expansion factor of 2.78 was developed based upon the Peterson model population estimation methodology.

Table 11. Estimates of adult SRCS escapement in Butte Creek from snorkel surveys taken annually from 1994 through 2001.

Year	Estimate	Survey Dates
1994	474	June 29 – July 1, 1994
1995	7,480	July 24 – July 27, 1995
1996	1,400	August 19 – August 23, 1996
1997	635	August 18 – August 21, 1997
1998	20,259	August 18 – August 24, 1998
1999	3,679	August 23 – August 31, 1999
2000	4,118	August 25 – September 1, 2000
2001	9,605	August 13 – August 16, 2001

Butte Creek Water Temperatures

Thermographs installed at five sites within the SRCS holding and spawning reach of Butte Creek (Figure 2, Map B) recorded average daily temperatures that varied as high as 21.8° C on July 23 at the Cable Bridge location (Table 12; Appendix F, Tables 1 - 5). Summer temperatures at all sites were above 15.0° C until late September.

Table 12. Butte Creek SRCS holding reach average daily temperature exceedance

Location	Period of Record	Number Days Equal to or Exceeding		
		15.0 C	17.5 C	20.0 C
Quartz Bowl Pool	6/19/01 to 11/09/01	92	45	0
Chimney Rock	6/20/01 to 11/08/01	100	61	0
Pool 4	6/20/01 to 11/09/01	107	79	19
Centerville Estates	6/25/01 to 11/09/01	102	73	13
Cable Bridge	7/23/01 to 11/09/01	78	60	27

Big Chico Creek
2000-2001 Trapping Season

The 2000-2001 trapping season began December 14, 2000. The 1.5 m (5 ft.) rotary screw trap was installed near the Bidwell Park Municipal Golf Course. The trap fished until May 31, 2001. A total of 1,057 juvenile salmon was captured (Table 13).

Table 13. Semi-monthly catch summary of juvenile chinook salmon caught in the screw trap at Bidwell Municipal Golf Course from December 14, 2000 to May 31, 2001.

Trapping Period		Mean FL(mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
12/1/00	12/15/00	-	-	-	-	-	1
12/16/00	12/31/00	91	-	91	91	1	16
1/1/01	1/15/01	-	-	-	-	0	15
1/16/01	1/31/01	-	-	-	-	0	16
2/1/01	2/15/01	34	0.8	32	36	54	14
2/16/01	2/29/01	34	1.1	33	37	23	10
3/1/01	3/15/01	35	2.0	33	43	25	14
3/16/01	3/31/01	37	6.3	31	68	384	16
4/1/01	4/15/01	62	8.4	41	111	152	15
4/16/01	4/30/01	63	8.8	44	86	228	15
5/1/01	5/15/01	69	6.2	40	92	189	15
5/16/01	5/31/01	78	-	78	78	1	16
					Total:	1,057	163

Big Chico
Adult Escapement

Table 14. Estimates of adult SRCS escapement in Big Chico Creek from snorkel surveys

Year	Estimate	Survey date
1998	369	August 1998
1999	27	September 10, 1999
2000	27	August 8, 2000
2001	39	August 8, 2001

DISCUSSION

During this evaluation period, emphasis continued to be focused on trapping and tagging juvenile SRCS at the PPDD, as well as recovering tags from returning adults. As with previous evaluations, short periods of elevated uncontrolled flows and high debris load required the cessation of sampling (Appendix A, Figure 1) to protect personnel and gear. The juvenile trapping effort at the PPDD was suspended a total of four days out of the 292-day trapping season.

Juvenile Emigration

During this evaluation period, juvenile emigration was more protracted than previously observed (Hill and Webber, 1999; Ward and McReynolds, 2004). During the period January 1, through March 31, 2001, 568,038 juvenile SRCS, at an average size of 36 mm FL, were captured. This represented 81.5% of the total for the year, in contrast to previous observations where >95% had migrated by the end of January. Additionally, 126,259 juveniles (18.1% of the total) were captured between April 1, and June 30, 2001, at an average size for each semi-monthly period that varied between 40 and 65 mm FL. This more protracted emigration pattern is likely the result of more stable flow conditions; Butte Creek did not exceed 1000 cfs until February 20 and never exceeded 1600 cfs (Appendix A, Figure 1). Recently emerged fry were captured at the site from November through May 2001 (Appendix B, Figure 1). As with the previous years' evaluations (Hill and Webber, 1999; Ward and McReynolds, 2004), recently emerged fry captured at PPDD beginning in early April (Appendix B, Figure 1) were assumed to be LFRCS using Fisher's length criteria (Johnson et al., 1992). Again, FRCS were observed spawning above PPDD after mid-October 2000, although the numbers were generally small. Fry captured at the site from November through March were assumed to be SRCS.

There were 169 SRCS captured at PPDD during the entire evaluation trapping period identified as yearlings. The first yearling was captured on September 17, 2000, and the last on May 20, 2001. As with previous years' evaluations, large numbers of yearling salmon were observed upstream of PPDD during the summer adult escapement survey. Of the 169 fish captured, that were classified as yearling SRCS, 32% (54 fish) were within the Fisher length criteria for winter run chinook salmon (WRCS). However, there were no recorded observations of WRCS spawning in Butte Creek, as water temperatures are too high for incubation.

A total of 110 fish captured at PPDD and CWT marked at BCY was subsequently recaptured in traps fished within the Sutter Bypass (Tables 7, 8 and 9). The earliest recapture occurred at the RD 1500 trap on February 15, 2001 when a 40 mm FL SRCS (tag code 06-01-12-04-05) released between January 26-28, 2001 was captured. The latest recapture was on May 20, 2001, when a 63 mm FL SRCS (tag code 06-01-00-00-00) released between February 22, and March 2, 2001, was captured in the Weir 1 trap. The average number of days at large calculated for all fish marked at BCY and recaptured in the Sutter Bypass traps was 65 days.

This evaluation continues to support the apparent value of the Sutter Bypass as a major nursery area. During this evaluation period, an attempt was made to locate traps as close as possible to the confluence of the Sutter Bypass reach of Butte Creek with the Sacramento River near Verona. The initial location was at the RD 1500 pumping plant located approximately 1.5 km (1 mi.) from the Sacramento River. The backwater effect from the pumping plant and heavy debris made that site very ineffective, and the trapping was then moved upstream approximately 7 km (4.6 mi) to the Maddock Road Bridge (Figure 1). The Maddock Road site was used until flows diminished to the point that the rotary screw trap ceased to function. One trap was then moved back upstream to Weir #1.

During this evaluation period, the Sacramento River overflowed into the Sutter Bypass at either or both the Colusa and Tisdale Weirs a total of eight days (Appendix A, Figure 2). The Sacramento River first overflowed into the Sutter Bypass via the Colusa/Tisdale Weirs on February 24, 2001, and for the last time on March 9, 2001. There were three recaptures of CWT fish from the upper Sacramento River marked by the USFWS (Appendix D, Tables 1 and 2). All were Coleman National Fish Hatchery FRCS released at Red Bluff Diversion Dam (RBDD). Average time at large for the group from date of release to date of recapture was 37 days. Based upon the days at large for the various release groups, it appears that upper Sacramento River fish that are entrained into the Sutter Bypass tend to reside and rear until the bypass drains, which occurred during mid-March, 2001. This evaluation continues to support the previous conclusion that most fish exit the Sutter Bypass by mid-May as was reported in the previous years' evaluations (Hill and Webber, 1999; Ward and McReynolds, 2004).

Six CWT recaptures were from other sampling efforts below the Sutter Bypass (Table 10). Four were captured by the USFWS at Sherwood Harbor near Sacramento and two at Chipps Island. All recaptures occurred from late March to early May. Average time at large from release at BCY to recapture was 68 days at Sherwood Harbor, and 100 days at Chipps Island. As with the previous evaluations, the number of days at large is only slightly longer than the average time at large from BCY to the Sutter Bypass trap, suggesting that fish that exit the Sutter Bypass move rapidly downstream and do not use the mainstem Sacramento River for rearing. However, time at large to recapture at Chipps Island was significantly longer, suggesting some rearing in the lower river.

Although no estimates were made, a small proportion of the fish tagged as SRCS may have actually been FRCS as the result of some FRCS adults spawning above the PPDD.

Growth

This evaluation continues to confirm that the majority of Butte Creek SRCS migrate as fry and rear below the PPDD (Tables 1 and 2). However, limited returns from the ocean fishery show that the relative contribution rate of yearlings rearing above the PPDD is significantly higher than for fry rearing below PPDD.

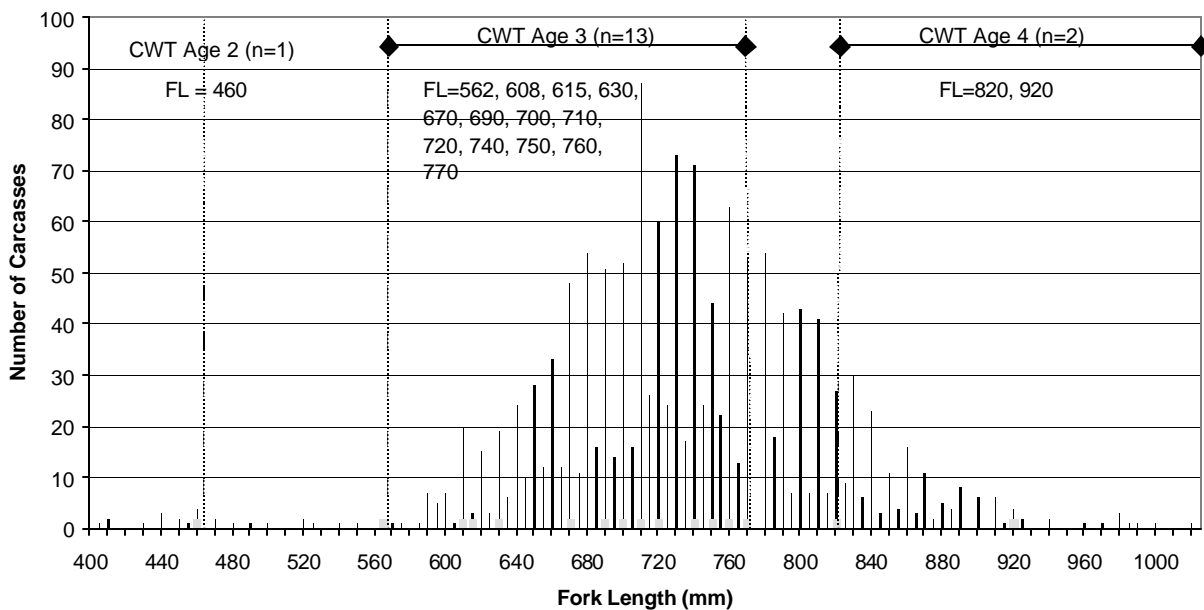
During this evaluation, fish tagged at BCY at an average size of 36 mm FL were recovered in the Sutter Bypass at an average of 75 mm FL. There were 110 recaptures in the Sutter Bypass of fish tagged at BCY; however only 91 of the fish recovered that were from groups with tagging duration of less than four days were used for growth calculations. Average growth rate of those fish was 0.57 mm/d, and ranged from 0.25 mm/d to 0.76 mm/d. This growth rate is comparable to that found during 1999 and 2000 (Ward and McReynolds, 2004); however, is less than found in 1996 and 1998 (Hill and Webber, 1999). These growth rates are comparable to those found by Kjelson et al. (1982) for fish that reared in the Delta which averaged 0.86 mm/d (range 0.57 to 1.23) in 1980 and 0.53 mm/d (range 0.40 to 0.69) in 1981. During 1981, they found growth rates that averaged 0.33 mm/d for fish that reared in the upper Sacramento River. A growth model (Johnson et al., 1992) developed for the upper Sacramento River predicted a growth rate of approximately 0.33 mm/d for fish rearing in the mainstem during the period March 24, 1996 to March 30, 1996.

Adult Escapement

The adult escapement estimate was once again based upon a snorkel survey of the entire summer holding area (Table 11). Generally, snorkel surveys significantly underestimate salmon abundance (Shardlow, et al. 1987; Campbell and Moyle, 1992). In Butte Creek, as with the other SRCS tributaries, snorkel surveys continue to be the preferred methodology primarily based upon cost. Other alternatives such as counting weirs, carcass surveys, or redd surveys are equipment and labor intensive and, therefore, very costly. During this evaluation period, an intensive carcass survey was conducted with the primary objective of recovering tags from returning adults. A secondary benefit of this effort was to develop a population estimate based upon a standardized carcass survey methodology utilizing the Schaefer model (Schaefer, 1951). The year 2001 escapement estimate based upon the snorkel survey was 9,605 with a range from 7,435 to 11,066. This estimate is higher than the year 2000 estimate of 4,118. However, based upon adults returning as three year olds, this represents a cohort replacement rate of 0.47 from the parent 1998 generation, which was 20,212. However, the carcass survey results for 2001 would suggest a much larger population, as the number of carcasses physically examined was 10,266, which was very close to the maximum snorkel survey estimate of 11,066. There were 1,468 fresh carcasses (52% female, 48% male) that were marked with colored ribbons and returned to the water, with a subsequent recovery of 775, or a recovery rate of approximately 53%. Therefore, a simple Petersen estimate (Ricker, 1975) would suggest that the total population was approximately 19,445, or nearly double the snorkel survey estimate, while the Schaefer model estimate was 22,744. Pre-spawning surveys of the entire SRCS holding and spawning area were conducted on ten days beginning on June 19, 2001, and the last on September 5, 2001. There were 141 pre-spawning mortalities observed, measured, and sexed of which 70% were female and 30% male.

There were 24 recoveries of Butte Creek tagged SRCS adults during this evaluation period, (BY 1997 – 2, BY 1998 – 22, BY 1999 – 1), with seven from the ocean sport/commercial catch and 17 recovered in Butte Creek (Appendix E, Table 1). For the Butte Creek carcass recoveries, all were from previous Butte Creek SRCS CWT releases and were from three brood years: 1997 (2), 1998 (13), and 1999 (1). This would suggest an age composition of 12.5% age-4, 81.25% age-3, and 6.25% age-2. However, tag release group size varied significantly with 3,408 releases for the BY1997, 105,828 for BY 1998 and 58,854 for BY 1999. If recoveries are standardized for release group size, age composition changes significantly with an estimated 80.8% age-4, 16.9% age-3 and 2.3% age-2. Evaluation of carcass length frequencies (Figure 3), would suggest an age composition intermediate to the two estimates.

Figure 3. Length frequency distribution of 1492 adult SRCS salmon carcasses measured and marked for abundance estimate between September 11, 2001 and October 25, 2001.



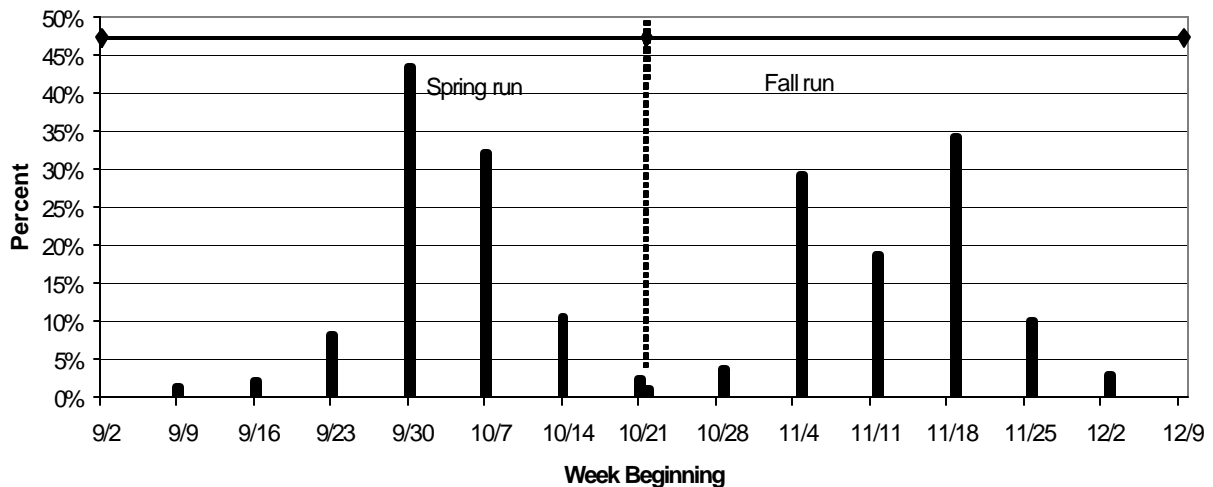
Ocean recoveries (Appendix E, Table 1) extended from April through September, and all were taken from Bodega Bay north to Newport Oregon. Recovery dates and locations would suggest that none would have entered fresh water until year 2002 at age-4. This evaluation continues to support the conclusion that some proportion of Butte Creek SRCS return at age-4 (Ward and McReynolds, 2001). Comparing the expanded BY 1998 age-3 ocean and inland recoveries (Appendix E, Table 1) suggests a 44% ocean sport/commercial catch rate (ocean sport-commercial catch / (ocean sport-commercial catch + inland escapement)). As reported by Cramer and Demko (1997), 80% to 90% of Feather River Hatchery SRCS released as smolts matured at age-4, and up to 85% of those fish were taken in the ocean harvest by the time they reached age-4. Two of the seven year 2001 ocean recoveries were from a small release group of 393 BY 1998 yearling Butte Creek SRCS (Appendix E, Table 1, Tag # 06-01-12-03-07), captured and released during the period October 15-26, 1999. The two, expanded to six for sampling effort, were taken in Oregon's Newport Area 4 fishery. None of the yearling releases was seen in the Butte Creek carcass survey. Comparison of the limited BY 1998 expanded ocean recoveries of fish marked as fry (23.04 recoveries from 105,828 marked) versus those marked as yearlings (6.00 recoveries from 393 marked) shows a contribution rate that is approximately 70 times

higher for yearlings. However, the overall contribution of fry is approximately four times that of yearlings based upon the significantly larger number of fry.

Subsequent to the SRCS carcass survey, a FRCS carcass survey was initiated on October 22 and continued until December 4, 2001 when the survey was terminated due to an accident. The fall run survey covered the reaches of Butte Creek below the PPDD (Figure 2, Map B), although some small number of fall run ascended and spawned above the site. Using the technique of the Schaeffer model, 1,476 carcasses were examined. There were 225 fresh carcasses marked with colored ribbons of which 81 were subsequently recovered. Due to the interruption of the survey by the accident on December 6, the Schaeffer model could not be applied to the results to generate a population estimate. Based upon a mark to recovery ratio ($225/81$) of 2.78, using the Peterson model it was estimated that 4,103 FRCS spawned in Butte Creek in the reach below the PPDD during the period October 22, through December 4, 2001. Limited visual observations of spawning adults estimated that approximately 330 FRCS spawned above the PPDD. There were ten CWT marked carcasses recovered during the FRCS carcass survey (Appendix E, Table 2). All of the CWT recoveries were from fish natal to other watersheds.

Comparison of Butte Creek SRCS and FRCS spawning timing (Figure 4) shows little overlap, with peak SRCS spawning occurring during the week of September 23; for FRCS the peak occurred during the week of November 18, 2001. Additionally, all Butte Creek SRCS spawned above PPDD (Figure 2, Map B), while the large majority of FRCS spawned below that site.

Figure 4. Percent of carcasses of spawned SRCS and FRCS recovered for period September 2, 2001 through December 4, 2001.



This evaluation continues to support Butte Creek SRCS as a distinct and sustaining population with little evidence to date of introgression from other watersheds.

Water Temperature

Butte Creek water temperatures have historically exceeded ideal temperatures as reported for holding and spawning SRCS. In general, temperatures for holding adult SRCS should not exceed 15° C (59° F) (Hinze, 1959; Boles, 1988; CDFG, 1998). Recording thermographs were installed at five locations within the summer holding reach of Butte Creek (Figure 2, Map B). Average daily temperatures exceeded 15° C at all sites from mid-June until late September. Similar temperatures were previously recorded by P.G. & E (1993).

ACKNOWLEDGMENTS

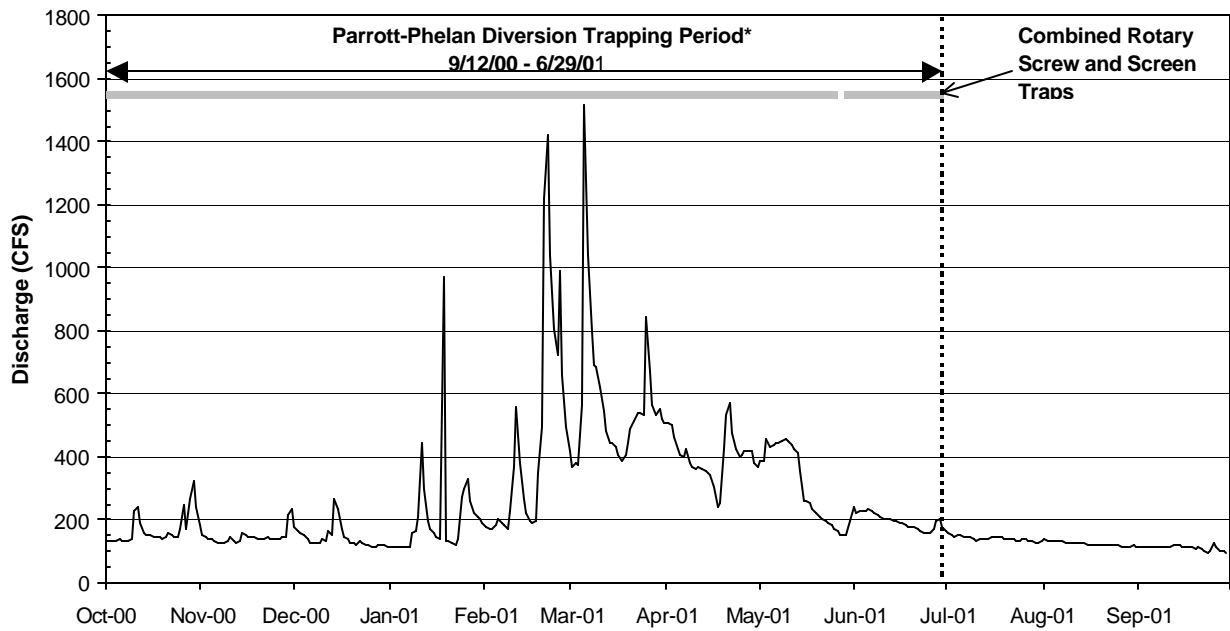
This project was supported by funding provided by the U.S. Fish and Wildlife Service, Central Valley Anadromous Fish Restoration Program and by the Federal Aid in Sport Fish Restoration Act, in partnership with the California Department of Fish and Game.

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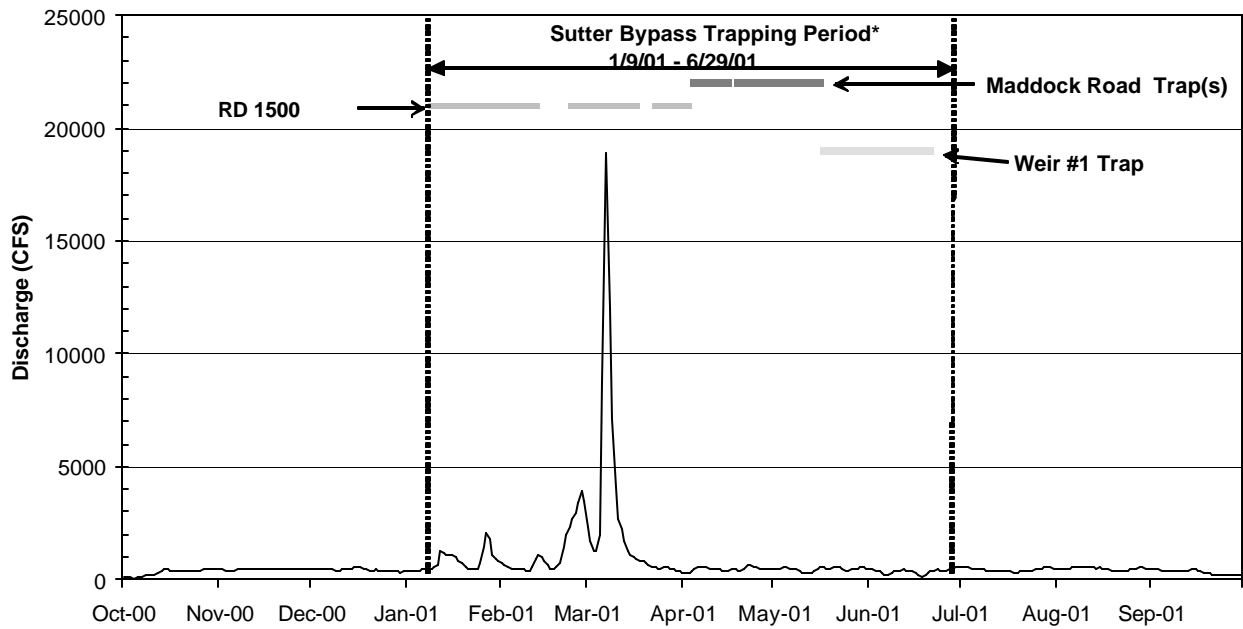
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APPENDIX A, FIGURE 1. Butte Creek flow at Butte Creek near Chico Gage (USGS - #11390000), water year 2000-01, with trapping period shown. Flow data are provisional and subject to revision

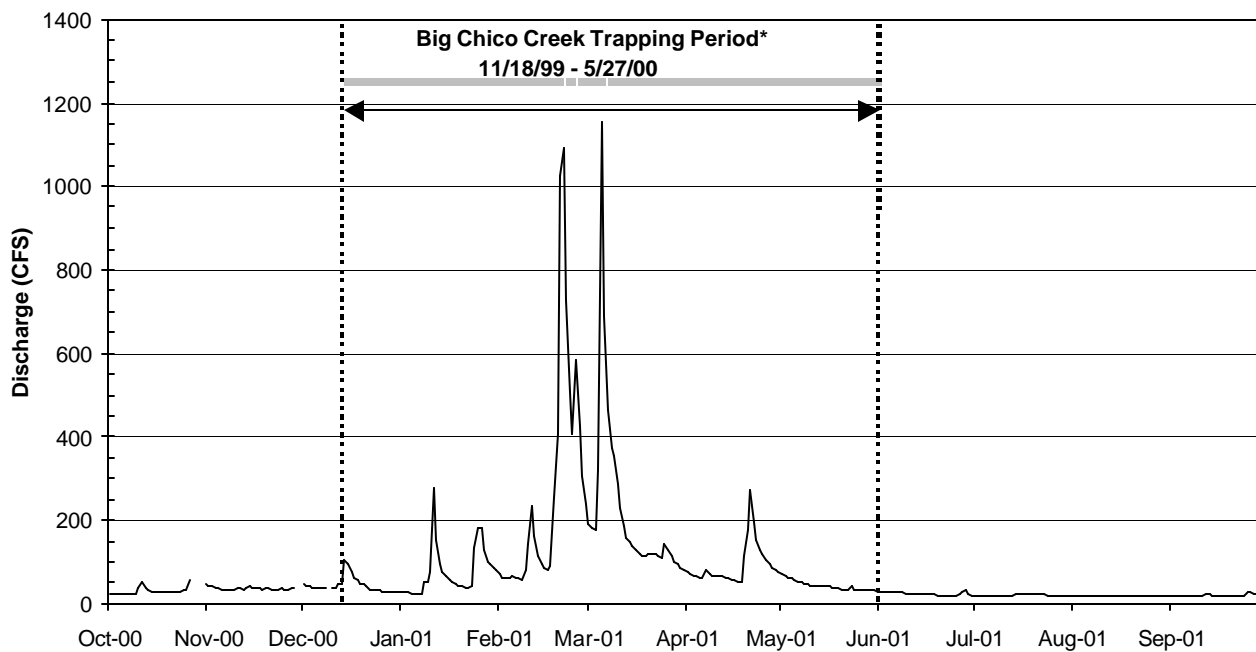


APPENDIX A, FIGURE 2. Butte Creek flow at Sutter Bypass Butte Slough near Meridian Gage (DWR A20972), water year 2000-01, with trapping period shown. Flow data are provisional and subject to revision



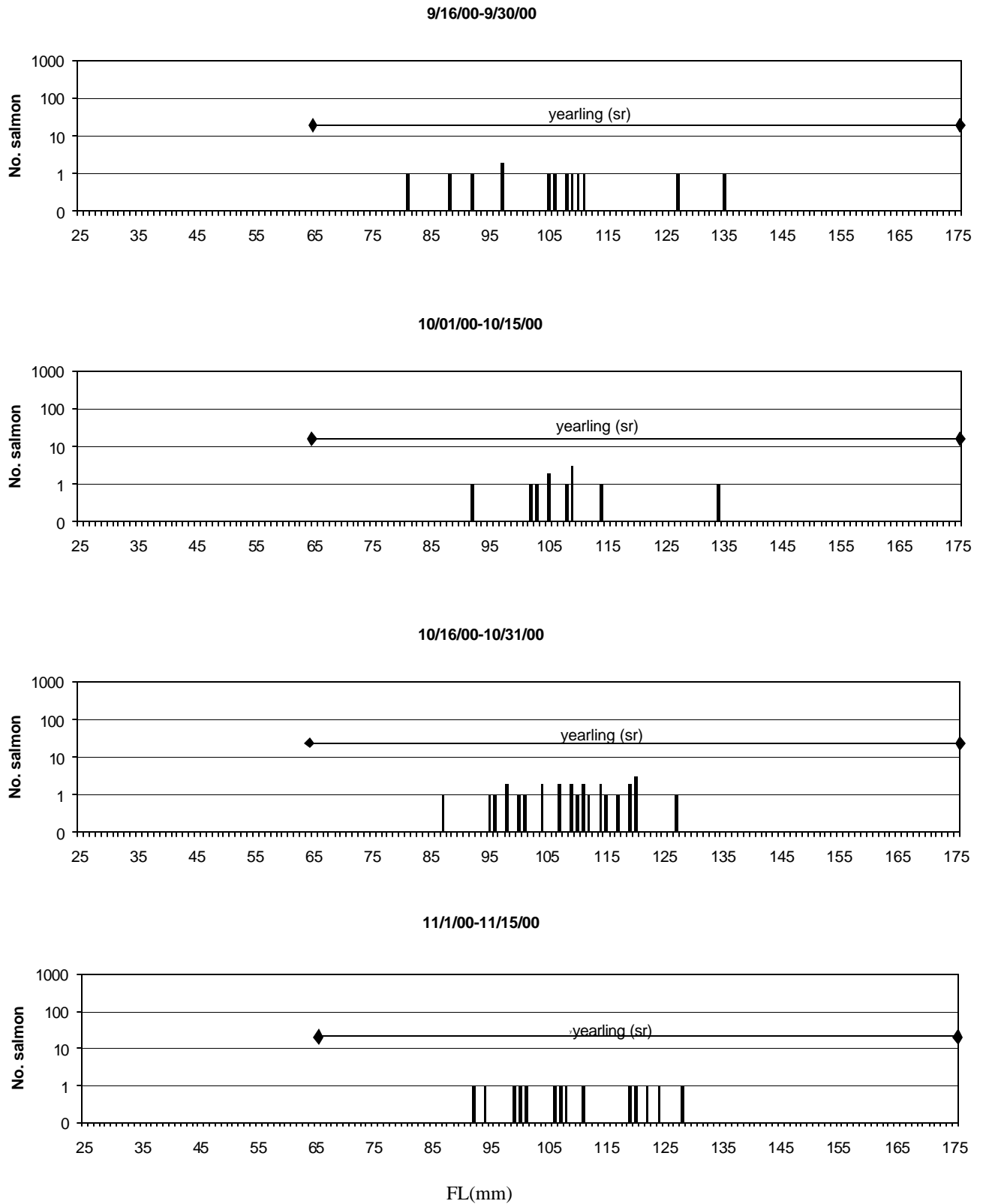
*Breaks in horizontal line indicate periods of time when the trap(s) were not fishing

APPENDIX A, FIGURE 3. Big Chico Creek flow at Big Chico Creek near Chico Gage (DWR #42105), water year 2000-01, with trapping period shown. Flow data are provisional and subject to revision

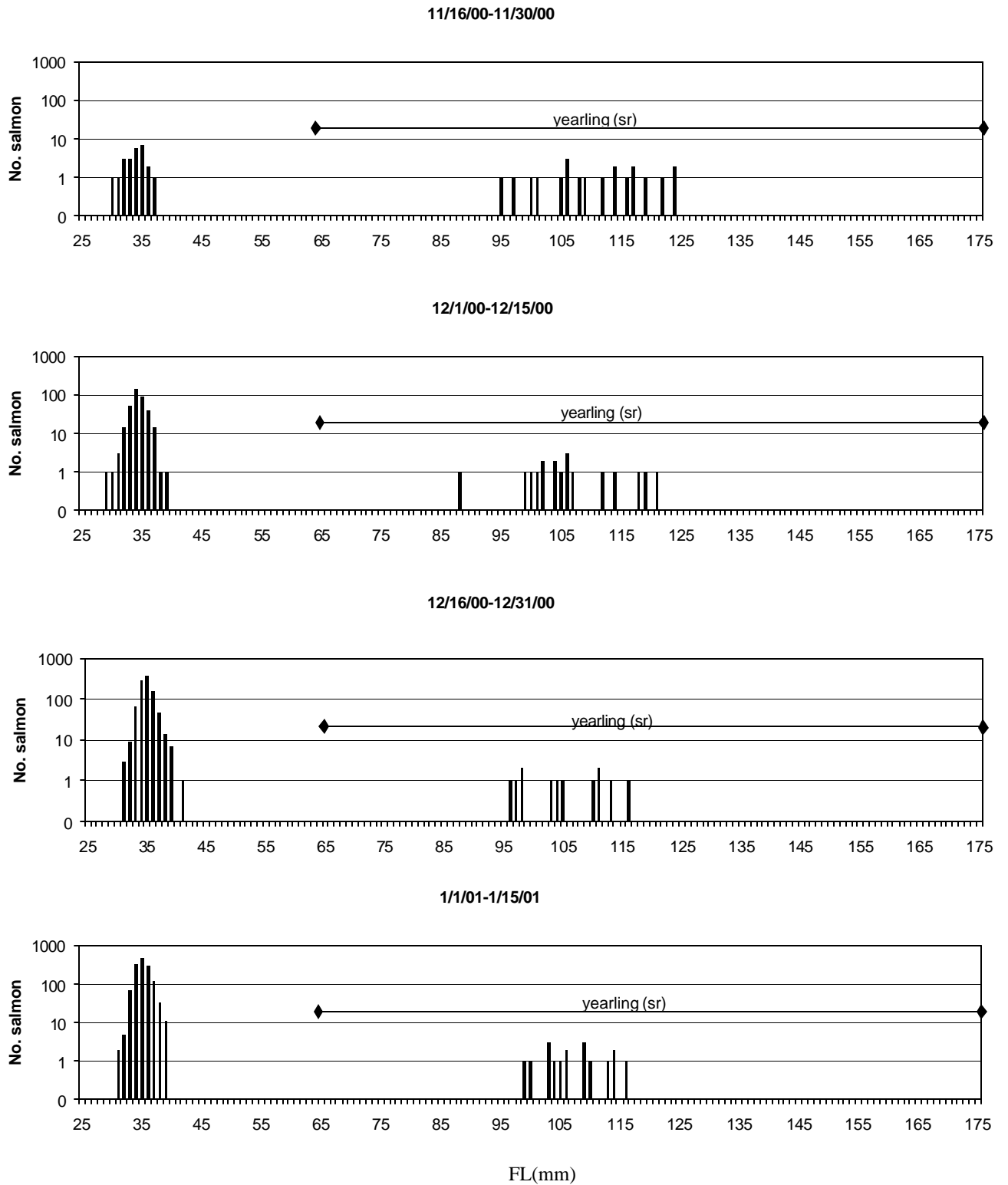


*Breaks in horizontal line indicate periods of time when the trap(s) were not fishing

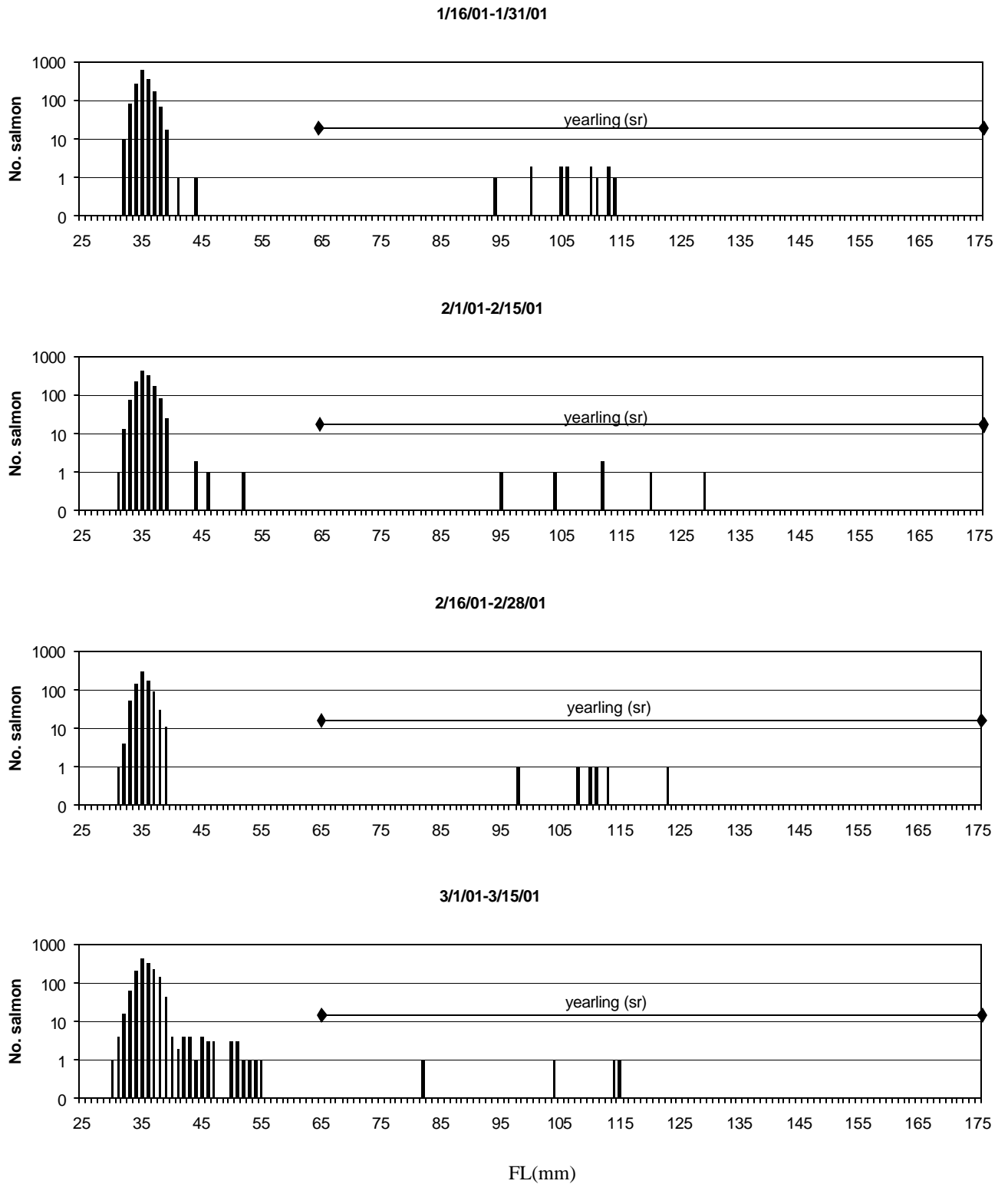
APPENDIX B, FIGURE 1. Frequency distribution of lengths of juvenile chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2000 through June 28, 2001. All fish are assumed to be spring-run chinook salmon except where indicated.



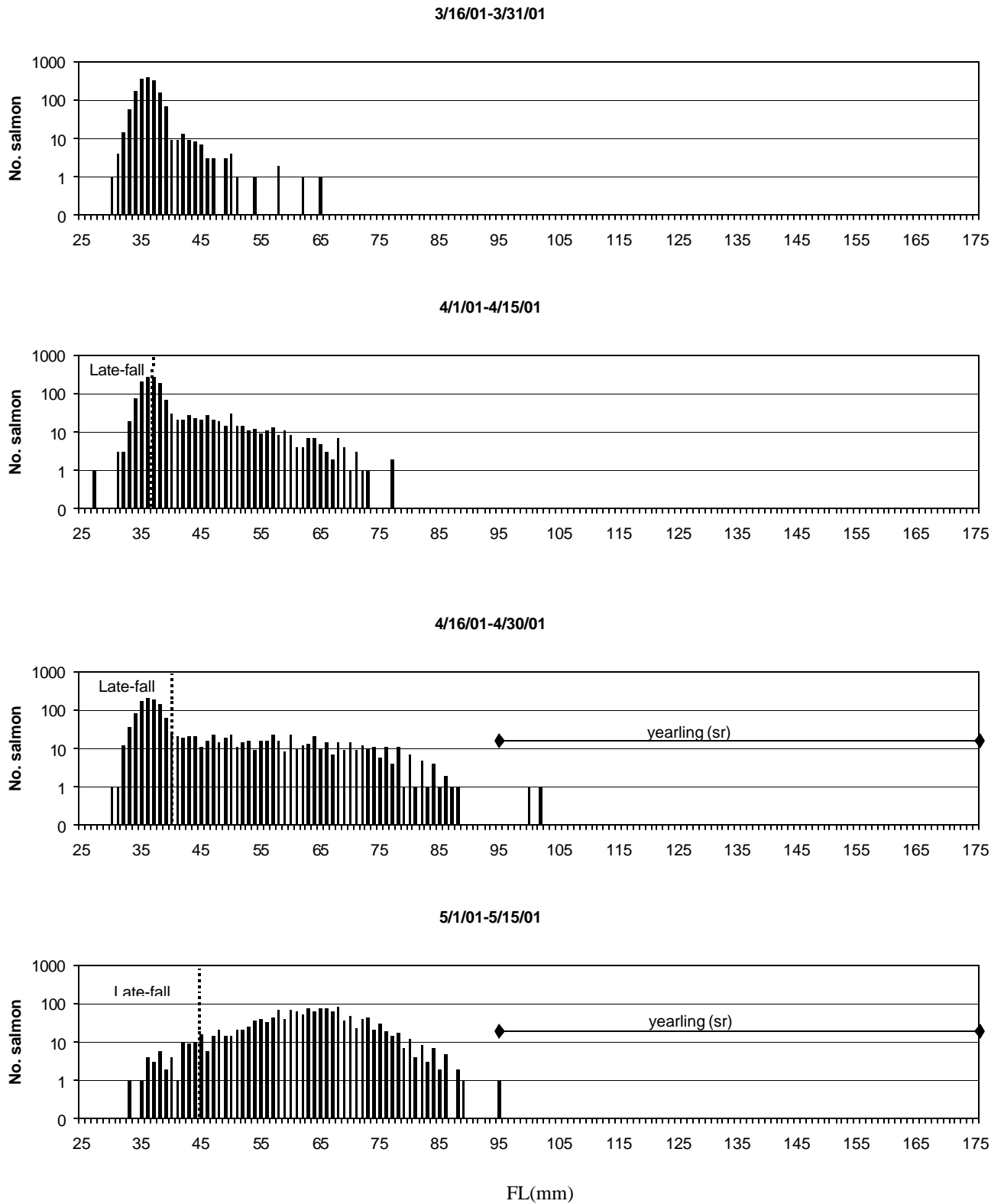
APPENDIX B, FIGURE 1. (continued) Frequency distribution of lengths of juvenile chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2000 through June 28, 2001. All fish are assumed to be spring-run chinook salmon except where indicated.



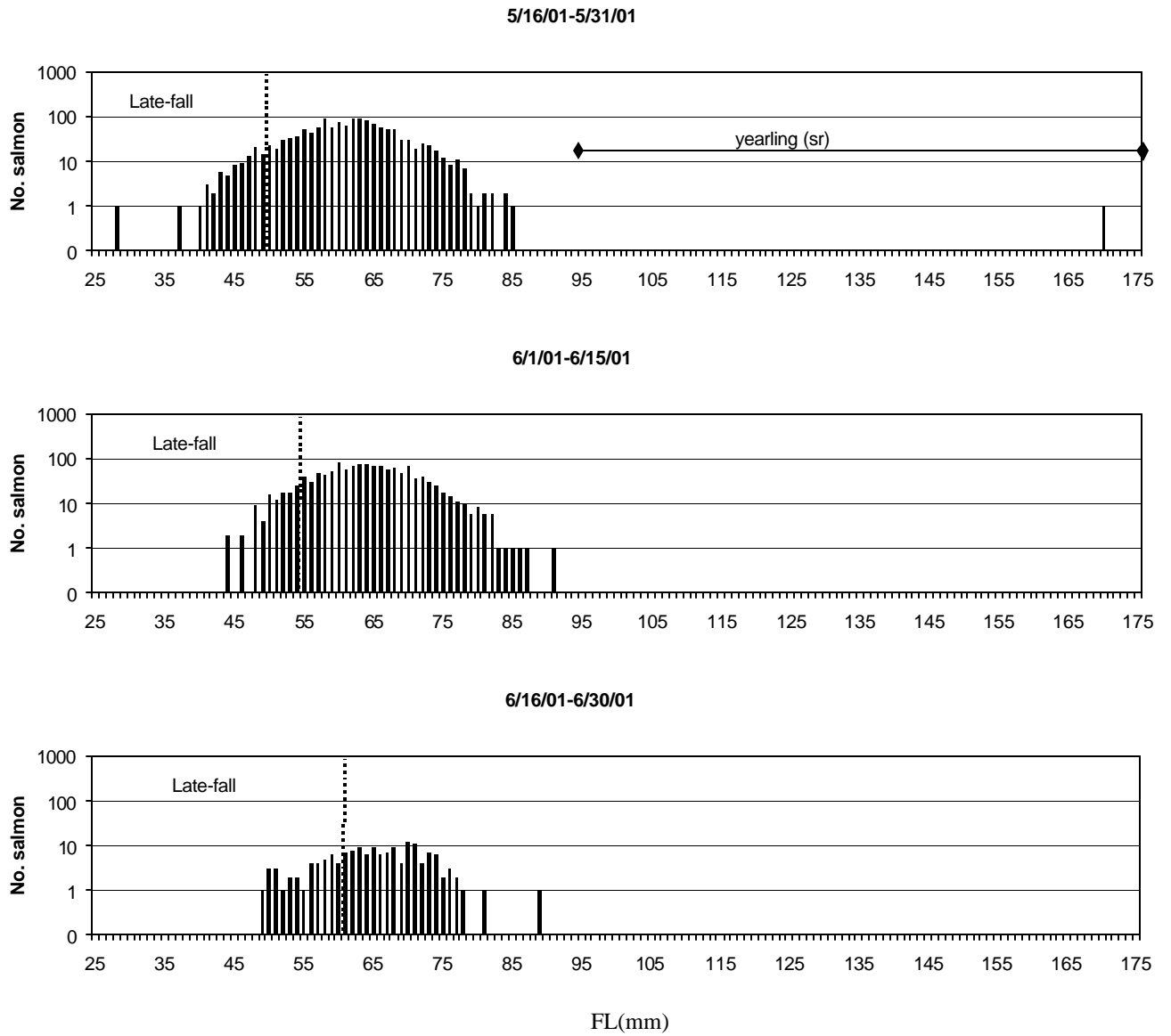
APPENDIX B, FIGURE 1. (continued) Frequency distribution of lengths of juvenile chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2000 through June 28, 2001. All fish are assumed to be spring-run chinook salmon except where indicated.



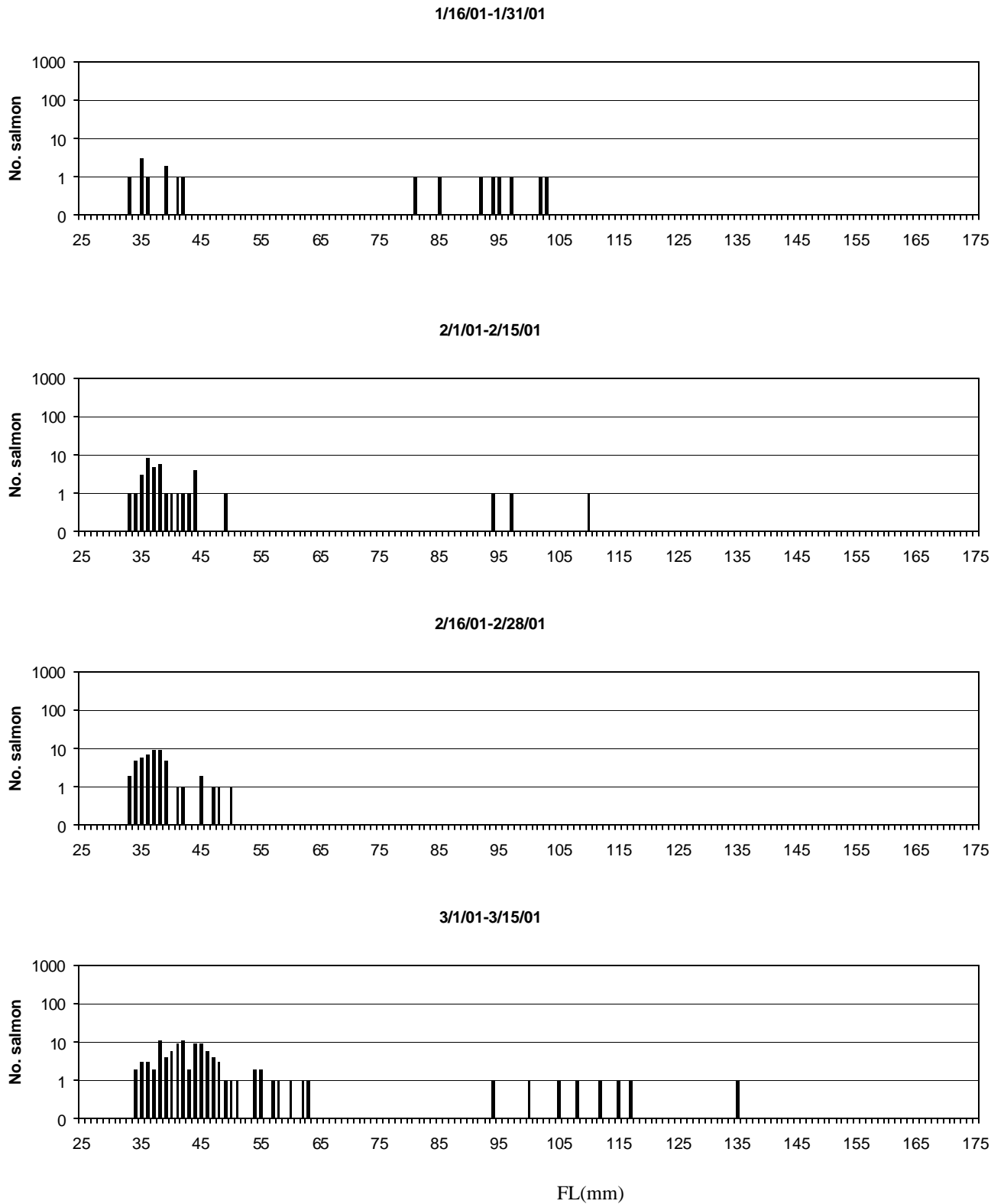
APPENDIX B, FIGURE 1. (continued) Frequency distribution of lengths of juvenile chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2000 through June 28, 2001. All fish are assumed to be spring-run chinook salmon except where indicated.



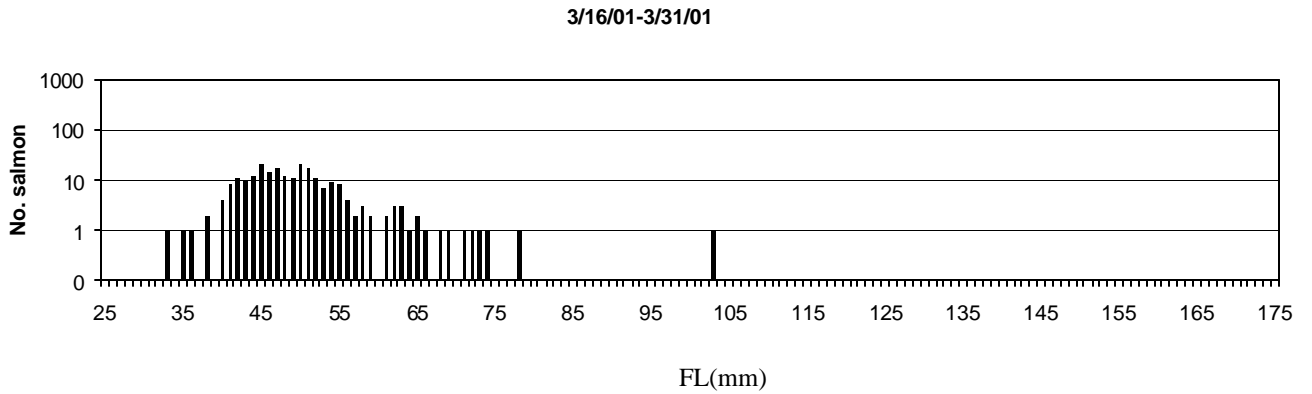
APPENDIX B, FIGURE 1. (continued) Frequency distribution of lengths of juvenile chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2000 through June 28, 2001. All fish are assumed to be spring-run chinook salmon except where indicated.



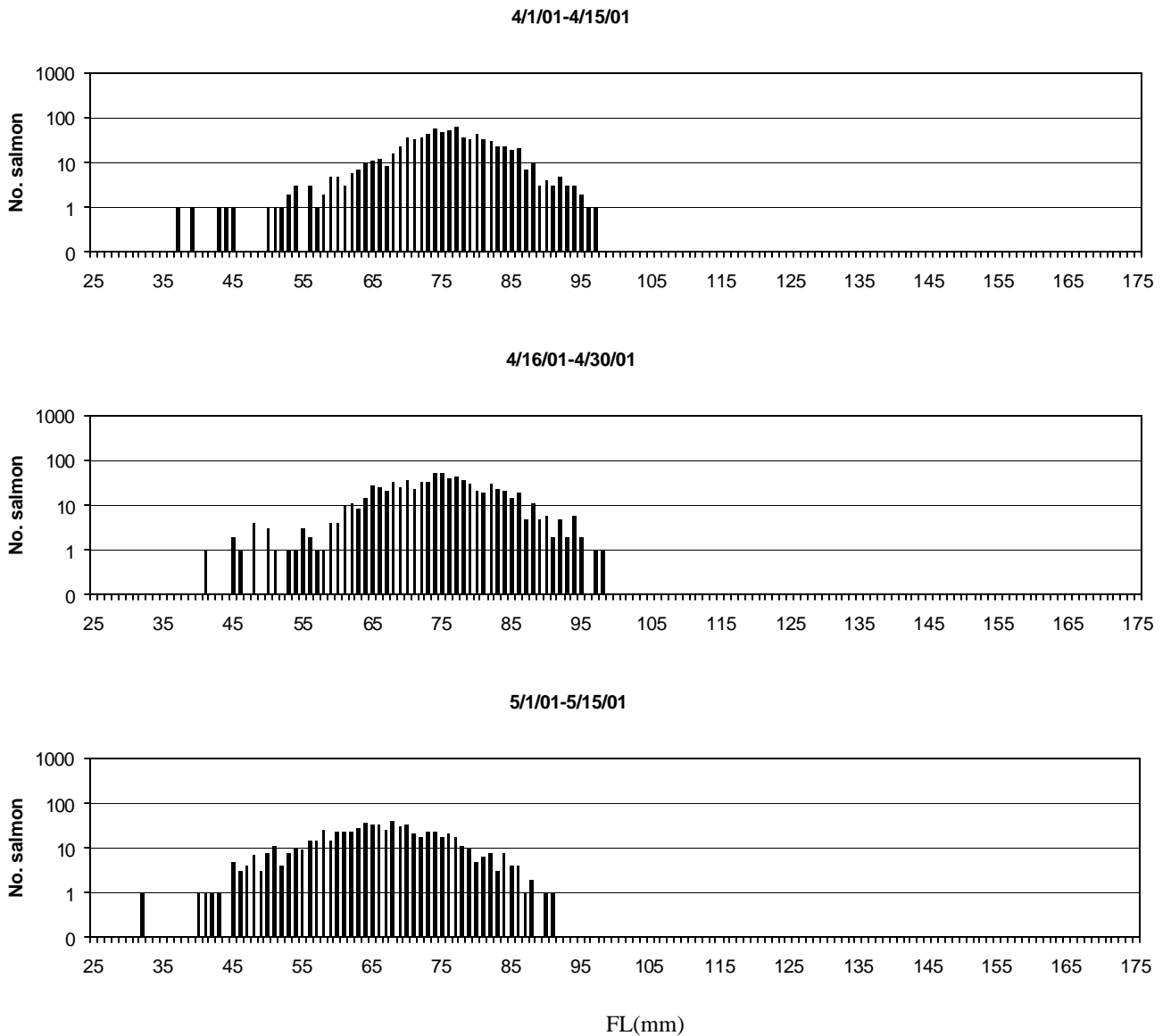
APPENDIX B, FIGURE 2. Frequency distribution of lengths of juvenile chinook salmon caught and released at Sutter Bypass RD 1500 bridge from January 17, 2001 through March 29, 2001.



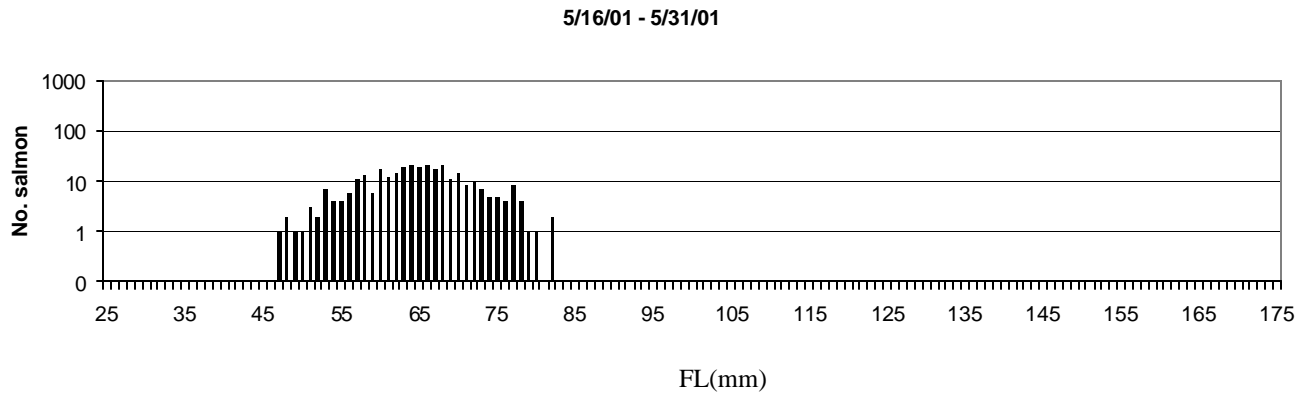
APPENDIX B, FIGURE 2. (continued) Frequency distribution of lengths of juvenile chinook salmon caught and released at Sutter Bypass RD 1500 from January 17, 2001 through March 29, 2001.



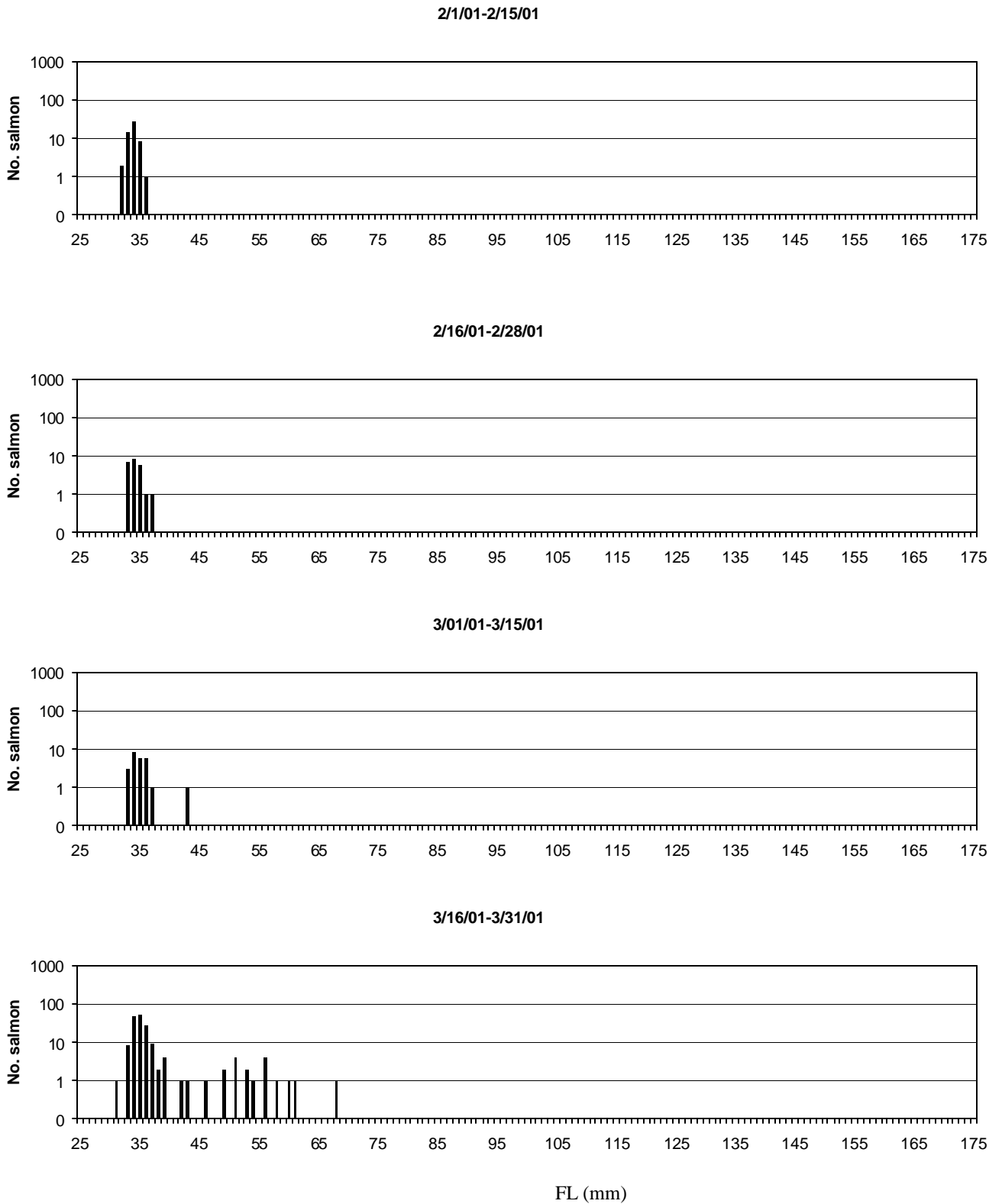
APPENDIX B, FIGURE 3. Frequency distribution of lengths of juvenile chinook salmon caught and released at Sutter Bypass Maddock Road from April 5, 2001 through May 9, 2001.



APPENDIX B, FIGURE 4. Frequency distribution of lengths of juvenile chinook salmon caught and released at Sutter Bypass Weir #1 from May 17, 2001 through May 23, 2001.

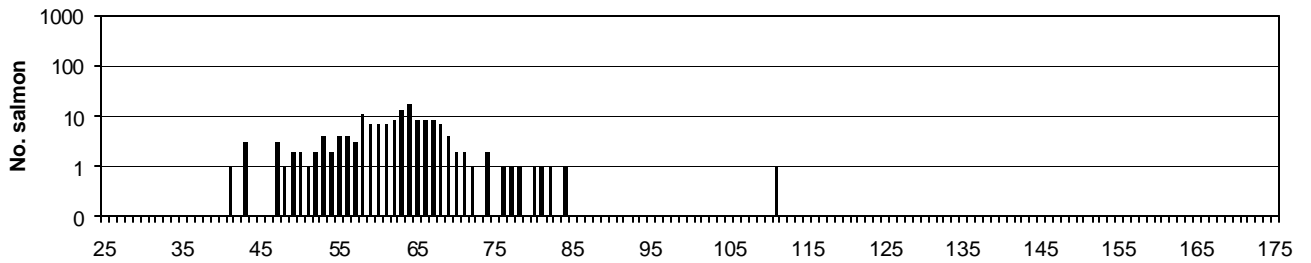


APPENDIX B, FIGURE 5. Frequency distribution of lengths of juvenile chinook salmon caught and released in Big Chico Creek from February 12, 2001 through March 17, 2001. All fish are assumed to be spring-run chinook salmon except where indicated.

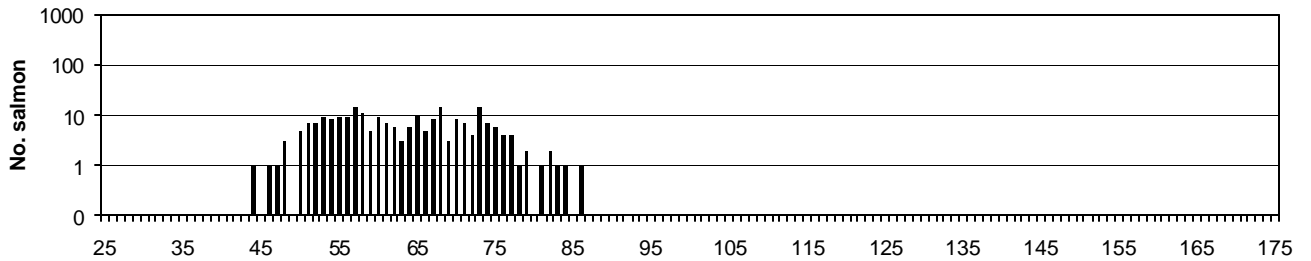


APPENDIX B, FIGURE 5. (continued) Frequency distribution of lengths of juvenile chinook salmon caught and released in Big Chico Creek from February 16, 1999 through May 31, 1999. All fish are assumed to be spring-run chinook salmon except where indicated.

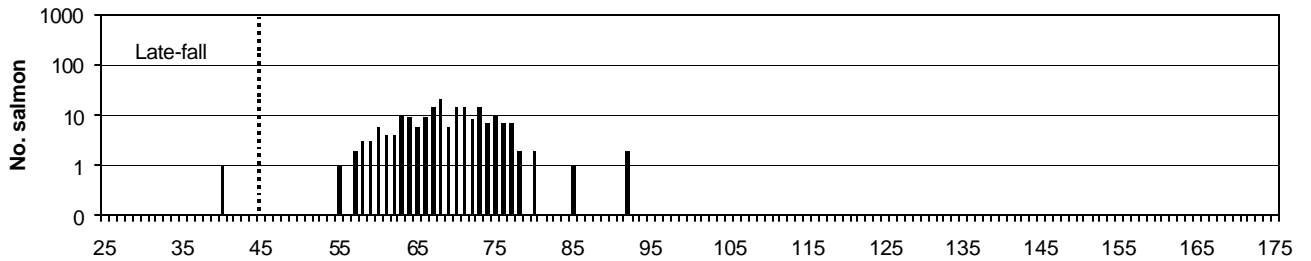
4/01/01-4/15/01



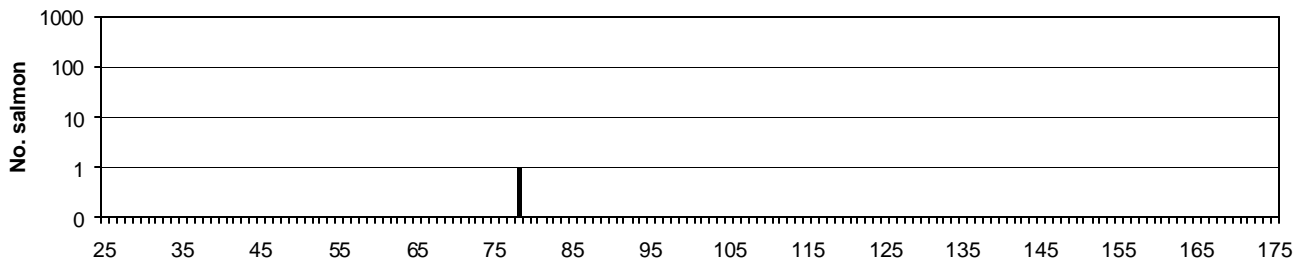
4/16/01-4/30/01



5/01/01-5/15/01



5/16/01-5/31/01



FL(mm)

APPENDIX C, TABLE 1. Recaptures of spring-run chinook salmon bearing coded-wire-tags in the Sutter Bypass at RD 1500. All fish were tagged at Baldwin Construction Yard. All fish were from brood year 2000.

Tag Code 06-01-12-04-05							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
2/15/2001	40	19	0.26	2/18/2001	43	22	0.36
2/16/2001	40	20	0.25				

Tag Code 06-01-00-00-00							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
3/14/2001	44	16	0.5				

APPENDIX C, TABLE 2. Recaptures of spring-run chinook salmon bearing coded-wire-tags in the Sutter Bypass at Maddock Rd.. All fish were tagged at Baldwin Construction Yard. All fish were from brood year 2000.

Tag code 06-01-12-04-01							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/10/2001	80						

Tag Code 06-01-12-04-02							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/8/2001	76	81	0.51	4/12/2001	87	85	0.61
4/10/2001	82	83	0.57	4/13/2001	78	86	0.50
4/10/2001	74	83	0.47	4/14/2001	81	87	0.53
4/10/2001	85	83	0.62	4/14/2001	85	87	0.57
4/11/2001	81	84	0.55	4/15/2001	81	88	0.52

Tag Code 06-01-12-04-03							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/8/2001	78	81	0.53	4/14/2001	86	87	0.59
4/8/2001	70	81	0.43	4/16/2001	85	89	0.56

Tag Code 06-01-12-04-04							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/14/2001	85	87	0.57	4/16/2001	80	89	0.51

APPENDIX C, TABLE 2 (continued). Recaptures of spring-run chinook salmon bearing coded-wire tags in the Sutter Bypass at Maddock Rd.. All fish were tagged at Baldwin Construction Yard. All fish were from brood year 2000.

Tag Code 06-01-12-04-05							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/5/2001	77	68	0.62	4/12/2001	87	75	0.69
4/5/2001	77	68	0.62	4/12/2001	84	75	0.65
4/6/2001	72	69	0.54	4/14/2001	79	77	0.57
4/9/2001	83	72	0.67	4/14/2001	83	77	0.62
4/9/2001	82	72	0.65	4/15/2001	88	78	0.68
4/9/2001	75	72	0.56	4/15/2001	77	78	0.54
4/10/2001	79	73	0.60	4/21/2001	81	54	0.55
4/10/2001	76	73	0.56	4/28/2001	70	91	0.38
4/11/2001	82	74	0.64				

Tag Code 06-01-12-04-06							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/8/2001	77	71	0.59	4/11/2001	77	74	0.57
4/8/2001	78	71	0.61	4/13/2001	81	76	0.61
4/9/2001	81	72	0.64	4/14/2001	77	77	0.55
4/9/2001	76	72	0.57	4/14/2001	80	77	0.58
4/9/2001	80	72	0.63	4/14/2001	82	77	0.61
4/10/2001	83	73	0.66	4/15/2001	85	78	0.64
4/11/2001	78	74	0.58	4/23/2001	84	86	0.57
4/11/2001	82	74	0.64	4/26/2001	72	89	0.42

Tag Code 06-01-12-04-07							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/8/2001	66	71	0.44	4/12/2001	81	75	0.61
4/8/2001	87	71	0.73	4/15/2001	77	78	0.54
4/9/2001	83	72	0.67	4/15/2001	86	78	0.65
4/9/2001	79	72	0.61	4/16/2001	85	79	0.63
4/9/2001	78	72	0.60	4/16/2001	82	79	0.59
4/10/2001	76	73	0.56	4/16/2001	74	79	0.49
4/12/2001	79	75	0.59	4/21/2001	80	84	0.54

Tag Code 06-01-12-04-08							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/8/2001	80	67	0.67	4/13/2001	79	72	0.61
4/8/2001	86	67	0.76	4/14/2001	74	73	0.53
4/10/2001	78	69	0.62	4/14/2001	85	73	0.68
4/11/2001	78	70	0.61	4/21/2001	76	80	0.51

APPENDIX C, TABLE 2 (continued). Recaptures of spring-run chinook salmon bearing coded-wire tags in the Sutter Bypass at Maddock Rd.. All fish were tagged at Baldwin Construction Yard. All fish were from brood year 2000.

Tag Code 06-01-00-02-00							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/5/2001	76	64	0.63	4/14/2001	71	73	0.48
4/9/2001	77	68	0.6				

Tag Code 06-01-00-02-02							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/5/2001	81	64	0.72	4/9/2001	82	68	0.69
4/6/2001	75	65	0.62	4/10/2001	78	69	0.62
4/8/2001	75	67	0.60	4/12/2001	79	71	0.62
4/9/2001	80	68	0.66	4/15/2001	84	74	0.66
4/9/2001	72	68	0.54	4/16/2001	87	75	0.69

Tag Code 06-01-00-02-04							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/19/2001	81	70	0.66				

Tag Code 06-01-00-02-05							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/11/2001	81	45	1.02	4/16/2001	75	50	0.8

Tag Code 06-01-00-00-00							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/6/2001	68	39	0.82				

APPENDIX C, TABLE 3. Recaptures of spring-run chinook salmon bearing coded-wire tags in the Sutter Bypass West Borrow Weir 1. All fish were tagged at Baldwin Construction Yard. All fish were from brood year 2000.

Tag Code 06-01-00-00-00							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/20/2001	63	53	0.51				

Tag Code 06-01-00-00-02							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/17/2001	78	54	0.78				

APPENDIX C, TABLE 3 (continued). Recaptures of spring-run chinook salmon bearing coded-wire tags in the Sutter Bypass West Borrow Weir 1. All fish were tagged at Baldwin Construction Yard. All fish were from brood year 2000.

Tag Code 06-01-00-00-03							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/18/2001	53	41	0.41	5/19/2001	63	42	0.64
5/18/2001	66	41	0.73				

Tag Code 06-01-00-00-04							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/18/2001	67	31	1				

Tag Code 06-01-00-00-05							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/18/2001	62	24	1	5/18/2001	53	24	0.63

Tag Code 06-01-00-00-06							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/17/2001	54	11	-0.45	5/18/2001	57	12	-0.16
5/17/2001	59	11	1	5/19/2001	62	13	0.23
5/18/2001	57	12	-0.16	5/19/2001	72	13	1

APPENDIX D, TABLE 1. 2000-2001 Season. Recovery of juvenile chinook salmon tagged and released by USFWS. Salmon were recovered in the Sutter Bypass at Maddock Rd.

Tag Code	Race ¹	Source ²	Release Site ²	Release Date	Avg. FL at Release	Recovery Date	FL at Recovery	Days at Large
05-01-03-05-01	FR	CNFH	RBDD	3/5/2001	47	4/14/2001	84	40
05-01-03-05-01	FR	CNFH	RBDD	3/5/2001	47	4/14/2001	74	40

APPENDIX D, TABLE 2. 2000-2001 Season. Recovery of juvenile chinook salmon tagged and released by USFWS. Salmon were recovered in the Sutter Bypass at RD 1500.

Tag Code	Race ¹	Source ²	Release Site ²	Release Date	Avg. FL at release	Recovery Date	FL at recovery	Days at Large
05-01-03-05-02	FR	CNFH	RBDD	2/23/2001	43	3/23/2001	64	28

¹ Race designation, LFR = late-fall run chinook salmon, FR = fall run chinook salmon, WR = winter run chinook salmon.

² Represent various sources of fish and release sites including Coleman National Fish Hatchery on Battle Creek (CNFH), Livingston Stone National Fish Hatchery (LSNFH) on the Sacramento River near Shasta Dam, Red Bluff Diversion Dam (RBDD) on the Sacramento River at Red Bluff, and Lake Redding Park (LRP) on the Sacramento River at Redding.

APPENDIX E, TABLE 1. Recoveries of Butte Creek adult spring-run chinook salmon bearing coded-wire-tags. All fish were tagged at Parrott-Phelan Diversion Dam or Baldwin Construction Yard. Fish were from brood years 1995-1999.

Release Date	Brood Year	Tag Code	Recovery Date	Recovery FL (mm)	Recovery Expansion	Recapture Location	Recapture Method
1/4/96 - 1/25/96	1995	B6-12-01	05/98	678	3.00	Point Sur-CA/Mex. Bor	Ocean troll
1/4/96 - 1/25/96	1995	B6-12-01	10/13/99	-	-	Butte Cr.-Centerville PH	Inland carcass
1/25/96 - 3/16/96	1995	B6-12-02	04/98	594	2.5	Fort Ross-Pigeon Pt.	Ocean sport
1/25/96 - 3/16/96	1995	B6-12-02	04/98	555	2.5	Fort Ross-Pigeon Pt.	Ocean sport
1/14/98 - 1/25/98	1997	06-01-12-01-13	9/27/01	820	2.22	Butte Cr. - Reach C	Inland carcass
1/14/98 - 1/25/98	1997	06-01-12-01-13	9/18/01	920	2.22	Butte Cr. - Reach A	Inland carcass
3/9/98 - 3/17/98	1997	06-01-12-02-01	6/1/00	672	3.00	Fort Ross - Pigeon Pt.	Ocean sport
3/12/98 - 3/17/98	1997	06-01-12-02-05	5/1/00	617	5.00	Fort Ross - Pt. Sur	Ocean troll
12/29/98 - 1/15/99	1998	06-01-12-02-09	7/11/01	681	2.76	Bodega	Ocean troll
1/13/99 - 1/20/99	1998	06-01-12-02-10	10/4/01	608	2.22	Butte Cr. - Reach D	Inland carcass
1/19/99 - 1/26/99	1998	06-01-12-02-11	6/1/00	521	3.00	Fort Ross - Pigeon Pt.	Ocean sport
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/4/01	670	2.22	Butte Cr. Reach D	Inland carcass
1/13/99 - 1/20/99	1998	06-01-12-02-10	10/2/01	720	2.22	Butte Cr. - Reach B	Inland carcass
1/19/99 - 1/22/99	1998	06-01-12-02-12	8/13/01	686	4.28	Eureka	Ocean sport
1/19/99 - 1/22/99	1998	06-01-12-01-13	10/9/01	690	2.22	Butte Cr. - Reach A	Inland carcass
1/19/99 - 1/22/99	1998	06-01-12-02-13	9/27/01	700	2.22	Butte Cr. - Reach C	Inland carcass
1-19-99 - 1/22/99	1998	06-01-12-02-12	10/2/01	710	2.22	Butte Cr. - Reach B	Inland carcass
1/19/99 - 1/26/99	1998	06-01-12-02-11	10/3/01	740	2.22	Butte Cr. - Reach C	Inland carcass
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/11/01	750	2.22	Butte Cr. - Reach C	Inland carcass
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/04/01	760	2.22	Butte Cr. - Reach C	Inland carcass
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/11/01	770	2.22	Butte Cr. - Reach C	Inland carcass
1/19/99 - 1/22/99	1998	06-01-12-02-12	6/11/01	-	-	Butte Cr. - Reach C	Inland carcass ¹

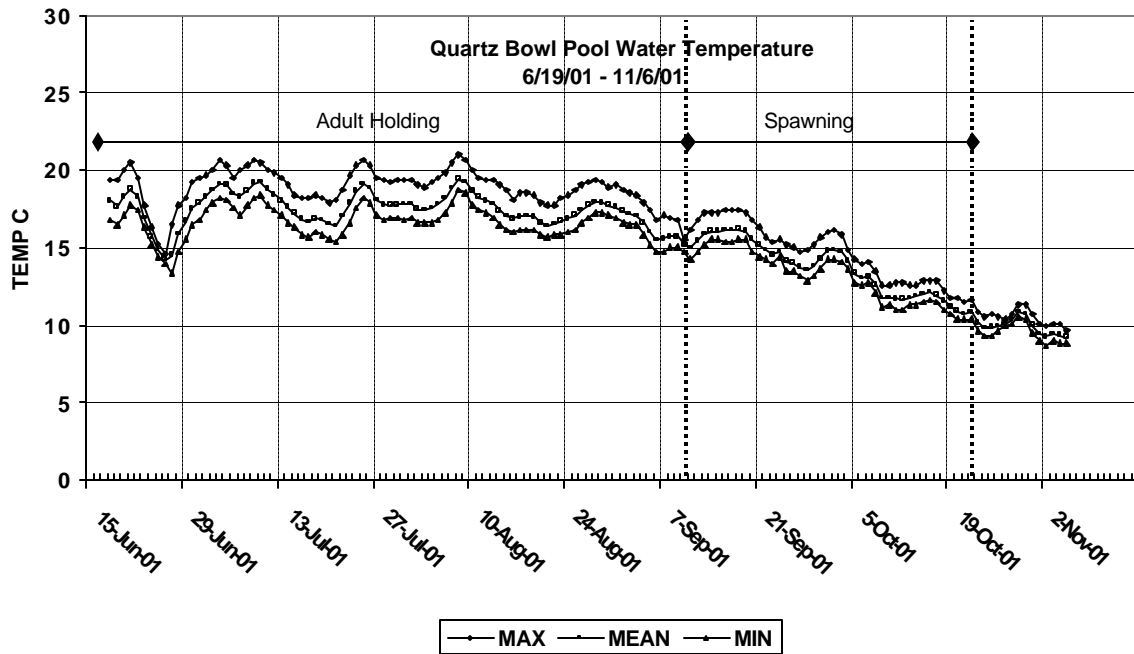
Release Date	Brood Year	Tag Code	Recovery Date	Recovery FL (mm)	Recovery Expansion	Recapture Location	Recapture Method
1/25/99 - 2/1/99	1998	06-01-12-02-14	10/2/01	562	2.22	Butte Cr. – Reach B	Inland carcass
1/25/99 - 2/1/99	1998	06-01-12-02-14	7/1/01	716	4.36	Crescent City	Ocean sport
2/1/99 - 2/27/99	1998	06-01-12-02-15	9/25/01	630	2.22	Butte Cr. – Reach B	Inland carcass
2/1/99 - 2/27/99	1998	06-01-12-02-15	4/1/01	636	4.00	Newport OR – Area 4	Ocean troll
2/1/99 - 2/27/99	1998	06-01-12-02-15	7/1/01	801	4.64	Fort Bragg	Ocean sport
3/2/99 - 3/20/99	1998	06-01-12-03-03	10/4/01	615	2.22	Butte Cr. – Reach D	Inland carcass
10/15/99 - 10/26/99	1998	06-01-12-03-07	8/1/01	645	3.00	Newport OR – Area 4	Ocean troll
10/15/99 - 10/26/99	1998	06-01-12-03-07	9/01/01	665	3.00	Newport OR – Area 4	Ocean troll
12/29/99- 1/10/00	1999	06-01-12-03-07	9/25/01	460	2.22	Butte Cr. – Reach B	Inland carcass

¹ Carcass recovered by local landowner.

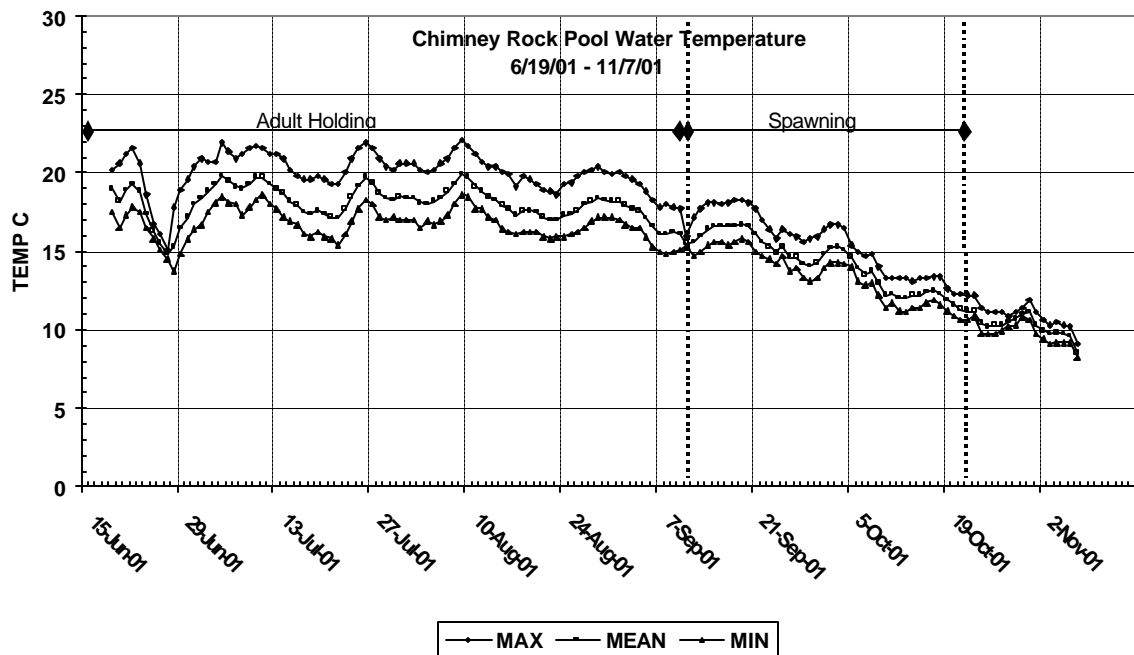
APPENDIX E, Table 2. Recoveries in Butte Creek of adult fall-run chinook salmon carcasses bearing coded-wire-tags.

Recovery Date	Tag Code	Stock	Release Site	Brood Year	Recovery Expansion	Recapture Location
11/8/01	06-0215	Mokelumne River	Crockett	1998	2.78	Reach H
11/13/01	06-4404	Merced River	S.J. River Jersey Pt.	1999	2.78	Reach F
11/15/01	06-0215	Mokelumne River	Crockett	1998	2.78	Reach I
11/15/01	06-4404	Merced River	S.J. River Jersey Pt.	1999	2.78	Reach I
11/19/01	06-2647	Merced River	Dos Reis Rd.	1998	2.78	Reach G
11/19/01	06-01-06-10-01	Merced River	S.J. River Jersey Pt.	1999	2.78	Reach G
11/19/01	06-01-06-10-01	Merced River	S.J. River Jersey Pt.	1999	2.78	Reach F
11/21/01	06-01-06-04-08	Feather River	Feather River	1997	2.78	Reach H
11/21/01	06-01-11-08-15	Merced River	S.J. River Jersey Pt.	1998	2.78	Reach H
11/27/01	06-0215	Mokelumne River	Crockett	1998	2.78	Reach G

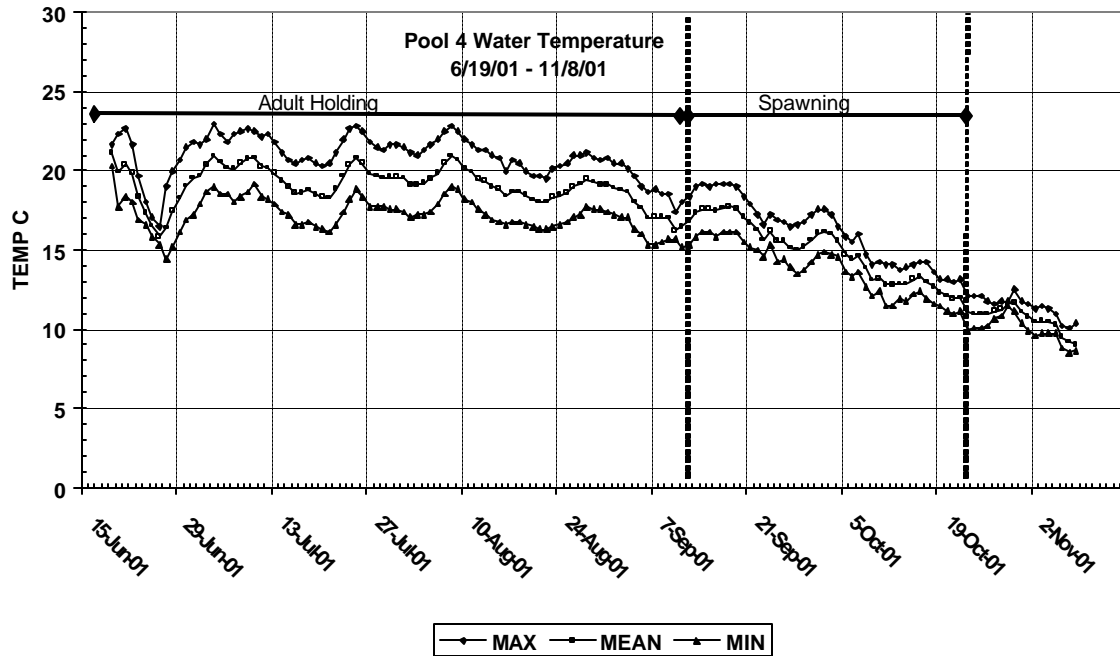
APPENDIX F, FIGURE 1. Butte Creek water temperature at Quartz Bowl pool.



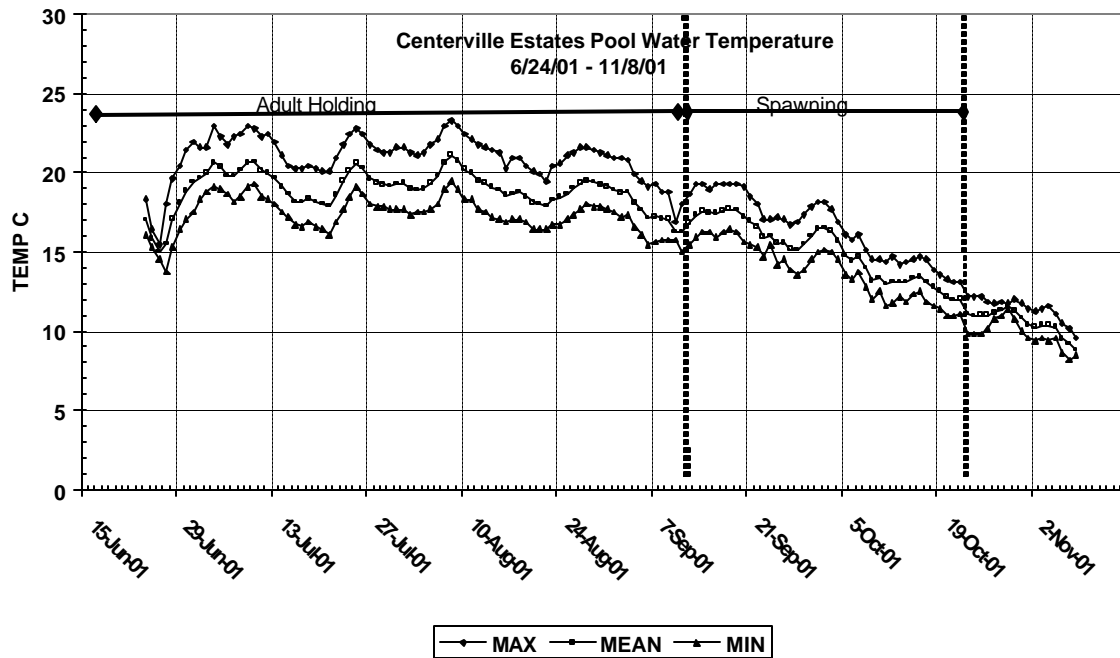
APPENDIX F, FIGURE 2. Butte Creek water temperature at Chimney Rock pool.



APPENDIX F, FIGURE 3. Butte Creek water temperature at Pool 4.



APPENDIX F, FIGURE 4. Butte Creek water temperature at Centerville Estates pool.



APPENDIX F, FIGURE 5. Butte Creek water temperature at Cable Bridge pool.

