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DEPARTMENT OF FISH AND GAME

BUTTE AND BIG CHICO CREEKS
SPRING-RUN CHINOOK SALMON, *ONCORYHNCHUS TSHAWYTSCHA*
LIFE HISTORY INVESTIGATION
2002-2003

By

Paul D. Ward
Tracy R. McReynolds
And
Clint E. Garman
Sacramento Valley – Central Sierra Region

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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 2002 through December 2003.

For Butte Creek, there were 50,936 juvenile Chinook salmon captured near Chico, and 7,448 in the Sutter Bypass. There were 36,415 fish captured near Chico that were coded-wire-tagged, and two of the tagged fish recaptured in the Sutter Bypass trap. The adult spring-run Chinook salmon escapement estimate based upon the snorkel survey methodology used since 1991, was 4,398. An alternate estimate based upon the Schaefer model carcass survey methodology was 6,063. A mark/recapture survey was conducted to evaluate pre-spawning mortality. Based upon the Schaefer model, there were an estimated 11,231 pre-spawn mortalities. The pre-spawn and spawning carcass surveys recovered 38 Butte Creek coded-wire-tagged adults from BY 99 (17) and BY 00 (21). Based upon the tag recoveries, the year 2003 population contained a minimum of 44% age-4 fish, and if adjusted for release group size, 69% were age-4 fish. Comparing the expanded recovery rate of ocean catch and inland escapement of BY 99 catch during 2002-2003 suggest an ocean catch rate of approximately 43%. Additionally, there was one Butte Creek coded-wire tag recovery from Clear Creek (BY 00), and one recovered at the Feather River Hatchery (BY 98). The FRH recovery was from the small release group (393 fish) of BY 98 fish tagged as yearlings, bringing the total recovered to 4 (expanded to 10.34). The limited sample suggests that yearling Butte Creek spring-run survive at a rate significantly higher than YOY emigrants.

A Schaefer model carcass survey of Butte Creek fall-run Chinook salmon estimated the population to be 3,310. There were 85 CWT recoveries during the fall-run survey, with 84 from fish natal to other watersheds while one was tagged and released as a Butte Creek SRCS during January 2001. The number of out-of-basin CWT recoveries substantiates significant straying.

For Big Chico Creek, there were 173 juvenile salmon captured near Chico, and the adult spring-run Chinook salmon escapement was 81 based upon the snorkel methodology.

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

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LIST OF ACRONYMS

Baldwin Construction Yard	BCY
Brood Year	BY
Coded-Wire-Tag	CWT
Caldwell Park	CP
Coleman National Fish Hatchery	CNFH
Fall-run Chinook Salmon	FRCS
Fork Length	FL
Late Fall-run Chinook Salmon	LFRCS
Livingston Stone National Fish Hatchery	LSNFH
Parrott-Phelan Diversion Dam	PPDD
Quality Control Device	QCD
Spring-run Chinook Salmon	SRCS
Tricaine Methanesulfonate	MS-222
United States Fish and Wildlife Service	USFWS
Winter-run Chinook Salmon	WRCS
Young-of-the-Year	YOY

INTRODUCTION

This is the fifth 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 four previous reports, Hill and Webber (1999), Ward and McReynolds (2004), Ward et al. (2004 & 2004a), summarized project results through December 2002. 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 SRCS and fall-run Chinook salmon (FRCS) 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 outmigration of yearling SRCS; and 4) documented relative growth and residence time of juvenile SRCS in the Butte Creek system, including the Sutter Bypass, through coded-wire tagging (CWT) of juvenile salmon collected at the Parrott-Phelan Diversion Dam (PPDD). Other research projects are assisting in tracking CWT 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.

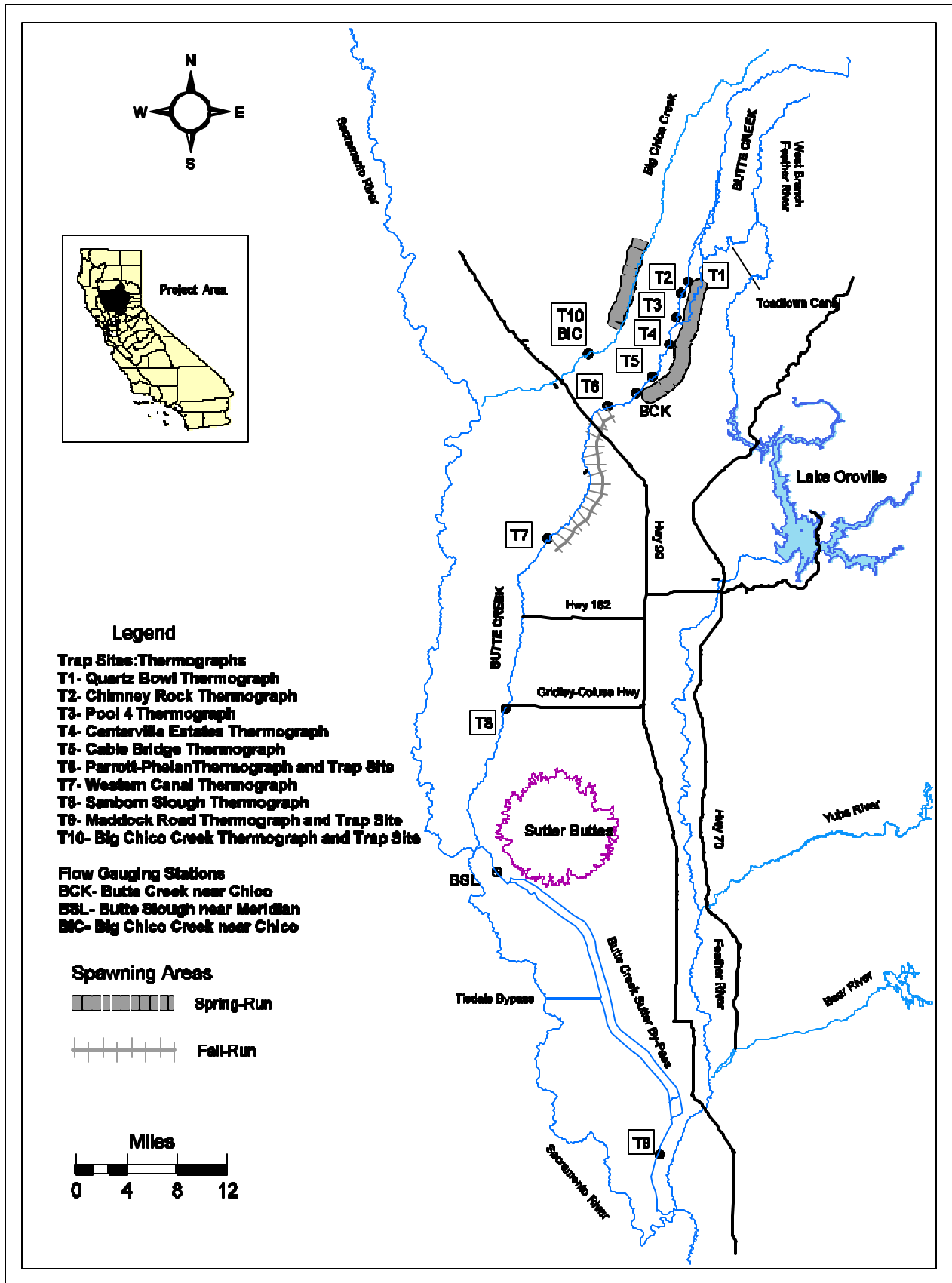


Figure 1. Butte Creek and Big Chico Creek watersheds with trap locations, gaging stations, and salmon spawning areas indicated.

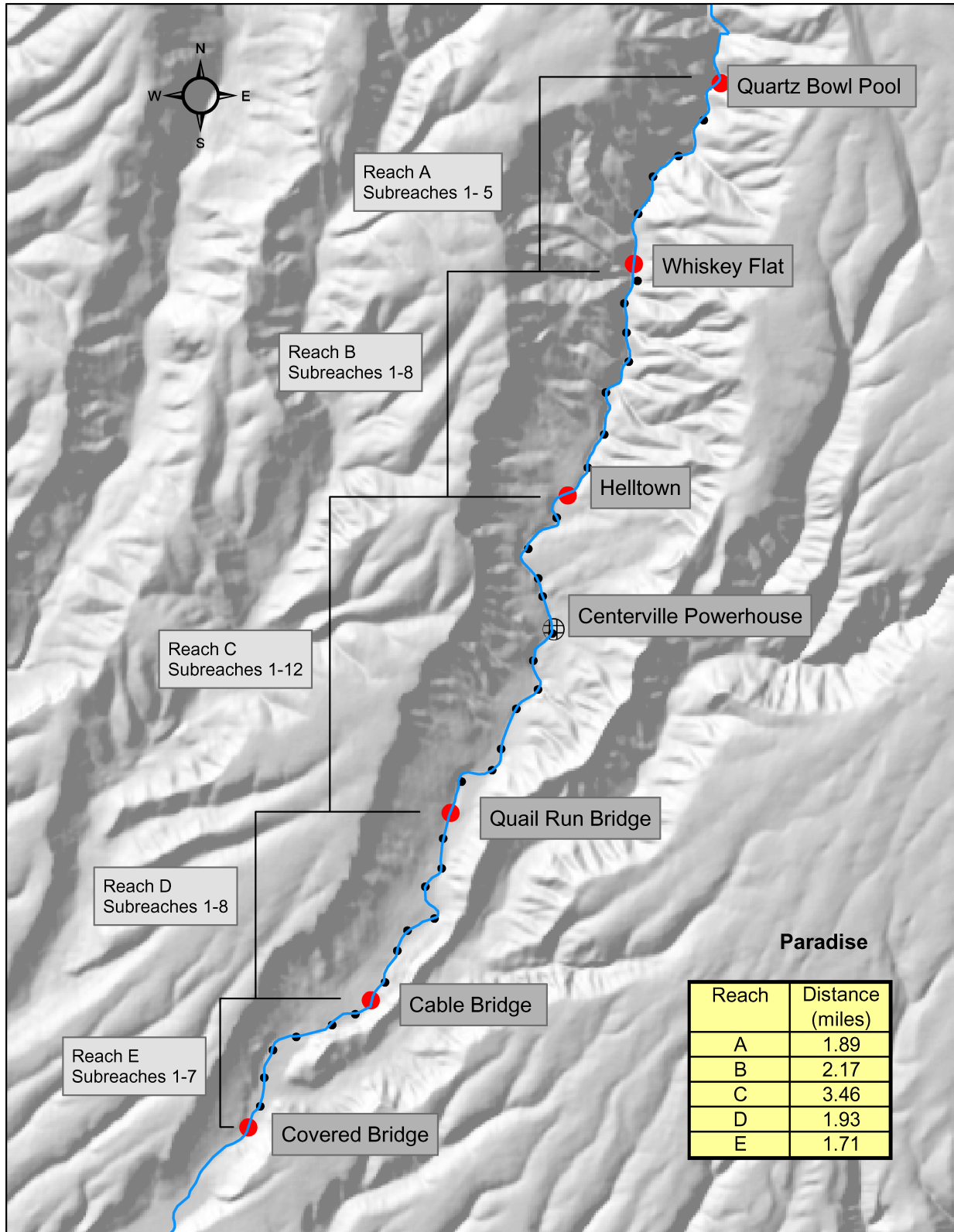


Figure 2. Butte Creek watershed showing spring-run spawning area by reach and sub-reach from Quartz Pool to Covered Bridge.

MATERIALS AND METHODS

Butte Creek Trapping Sites

Fish were trapped at two locations along Butte Creek (Figure 1). The PPDD is the uppermost site (Figure 1, site T6). This site is directly downstream of the SRCS spawning habitat and upstream of the FRCS spawning habitat, although periodically some FRCS spawn above this site. The second trapping site is located within the Sutter Bypass reach of Butte Creek at Maddock Road, approximately 118 km (73 mi.) downstream of PPDD (Figure 1, Site T9). Each site was sampled with a 2.4-m diameter (8-ft) rotary screw trap manufactured by EG Solutions (Eugene, Oregon). Each rotary screw trap was connected to an upstream stationary object, dam, weir, or bridge by use of steel cable 0.6 cm (0.25 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). The PPDD traps were fished 24 hours a day, seven days a week, except during extraordinarily high water flows or during periods of excessive debris. The Sutter Bypass trap was fished a limited number of days due to budget constraints. Typically, it was fished three or four days per week.

Big Chico Creek Trapping Site

Fish were trapped at the Bidwell Park Municipal Golf Course (Figure 1, Site T10). 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 (0.25 in.) in diameter connected the screw trap to the bridge over Big Chico Creek. The trap was adjusted periodically to assure maximum trapping efficiency without jeopardizing safety. The trap was fished 24 hours a 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, except the Big Chico Creek component of the study does not include the CWT elements. All fish were netted from the trap live-boxes and immediately placed into a shallow tub of fresh river water. Juvenile Chinook salmon were sorted from other species and swiftly transferred with small

aquarium nets into buckets equipped with portable aerators to be transported to shore for processing. The first 10 of each non-salmonid species were identified to species, measured to the nearest mm 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 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 fork length (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 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, weight, 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 placed in holding pens for subsequent tagging with a CWT. 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 tagging while the rest were released below 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 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, tagged with a half-length (0.5 mm) tag in the rostrum and placed through the QCD. Any miss-tagged or rejected fish were re-tagged. 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. No yearling SRCS were included in the sample tagged.

Juvenile Emigration

Yearling SRCS begin emigrating 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. By examining length-frequency distributions of fish captured at PPDD, yearlings can generally be identified (Appendix B, Figure 1). Emigration of YOY SRCS is analyzed 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.

Adult Escapement

Each summer an adult SRCS escapement estimate is developed by conducting a snorkel survey. Adults are counted while holding prior to spawning. On Butte Creek, the snorkel survey extended from the Quartz Bowl Pool to PPDD (Figures 1 and 2). On Big Chico Creek, the survey was from Higgins Hole to Iron Canyon (Figure 1). The survey was conducted over four

days (August 18 – 27, 2002) each covering a discrete reach on Butte Creek, and on one day (August 11, 2002) with three discrete reaches on Big Chico Creek. Each pool was observed only once by each of four surveyors, with each of the four individual independent estimates recorded. Additionally, subsequent analysis of the entire data set revealed several significant outliers, which were excluded from the calculation of the population estimate. In such instances, the average for the pool only reflected the remaining recorded observations. The individual estimates were then averaged. The annual total escapement estimate was then calculated by summing the averages for all survey reaches.

Adult Pre-spawning Mortality Survey

A Schaefer model (Schaefer, 1951) mark/recapture survey, to identify pre-spawning mortalities, was conducted during the period June 19, 2003 through September 18, 2003. The survey extended from Quartz Bowl Pool to the Covered Bridge (Figures 1 and 2). The approximately 17.7-km (11-mi.) stream section was divided into five reaches. Each reach was covered once per week. Two to four crew members walked downstream covering both sides of the creek. Carcasses were checked for “freshness” and presence/absence of the adipose fin. At least one clear eye and firm flesh constituted a fresh carcass. Each fresh carcass was measured to the nearest mm FL, sexed, tagged with a colored ribbon attached to the lower jaw using a hog ring, and returned to the water near the location where collected. In addition, tissue samples were taken from the first 10 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. Between each sample, scissors were rinsed in fresh water to prevent cross contamination. Adipose fin-clipped carcasses were measured to the nearest mm FL, tissue sample collected, heads removed and a head tag number assigned with each head placed into a zip-lock bag. Heads were returned to the Chico office and 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 sample. Carcasses that were not tagged were chopped in half, removing them from being counted during future surveys. On each subsequent survey, carcasses were checked for jaw tags, with jaw-tagged carcasses recorded as “recovered”.

Adult Spawning Carcass Survey

Adult spawning surveys using the Schaefer model (Schaefer, 1951) were completed for both SRCS and FRCS populations. This was the third year an intensive spawning carcass survey was conducted. The primary goal of the survey was to recover CWT's from adults tagged and released as juveniles in Butte Creek during previous years; also, the survey provided an alternative adult escapement estimate.

The 2003 SRCS spawning survey was conducted from September 23, 2003 through October 30, 2003. The survey extended from the Quartz Bowl Pool to the Covered Bridge (Figures 1 and 2). The approximately 17.7-km (11-mi.) stream section was divided into five reaches. Each reach was then subdivided into approximately 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. All carcasses were examined for an adipose fin-clip, and then chopped in half to avoid counting during subsequent trips. Each fresh carcass (clear eye and firm flesh) was measured to the nearest mm FL, sexed, tagged with a colored ribbon attached to the lower jaw using a hog ring, and returned to the water near the location where

collected. In addition, tissue samples were taken from the first 10 fresh carcasses encountered in each reach. 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. Between each sample, scissors were rinsed in fresh water to prevent cross contamination. Heads were removed from adipose fin-clipped carcasses and returned to the Chico office for recovery of the CWT. While removing the CWT's from the heads, otoliths were extracted and archived with the previously taken tissue.

The 2003 FRCS carcass survey was conducted from October 20, 2003 through December 9, 2003. The survey extended from PPDD to the Gorrill Ranch Dam, also covering a ½-mi section near the Western Canal Siphon (Figure 1). The approximately 15.3-km (9.5-mi.) stream section was divided into four reaches. Sampling techniques for the FRCS survey were the same as those used for the SRCS survey.

Water Temperature

Onset, model WTA032, temperature data loggers calibrated to $\pm 0.2^{\circ}$ Celsius (C) were deployed in pools at five sites within the SRCS spawning habitat (Figure 1). Each data logger was placed in a 5 cm x 15.2 cm (2 in x 6 in) long galvanized steel pipe and suspended by 0.6 cm (0.25 in) steel cable. Data loggers were set for 1-hour interval readings and recorded in degrees Celsius (C).

RESULTS

Butte Creek

Trapping Season 2002-2003

The 2002-2003 trapping season began at the PPDD when the diversion trap was installed on September 23, 2002. The rotary screw trap was installed on October 31, 2002. Both traps were operated until May 30, 2003. 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 50,936 juvenile salmon, including yearlings, was captured in both traps; 21,150 in the diversion screen trap and 29,786 in the screw trap (Tables 1 and 2). Of the total captured, 36,415 were tagged and released at the BCY (Table 3). Since the diversion screen trap is located off-stream in the diversion canal, 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 43,701 (84%) juvenile SRCS (Table 1 and 2) of the entire PPDD salmon catch occurred between December 1, 2002 and February 28, 2003. Trapping was suspended for 14 days during December and January due to high flows (Tables 1, 2, and Appendix A, Figure 1).

Table 1. Semi-monthly catch summary of spring-run Chinook salmon caught in the screen trap at Parrott-Phelan Diversion Dam from September 23, 2002 to May 30, 2003; yearling captures are included.

Trapping period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Caputred	No. Trapping Days
9/15/02	9/30/02	-	-	-	-	0	7
10/1/02	10/15/02	-	-	-	-	0	15
10/16/02	10/31/02	113	1.4	112	114	2	16
11/1/02	11/15/02	70	35.5	29	91	3	15
11/16/02	11/30/02	-	-	-	-	0	15
12/1/02	12/15/02	35	1.0	34	36	4	11
12/16/02	12/31/02	34	1.7	30	39	1,848	6
1/1/03	1/15/03	35	1.4	30	39	2,415	12
1/16/03	1/31/03	35	1.3	30	39	7,326	16
2/1/03	2/15/03	35	2.0	30	52	3,388	15
2/16/03	2/28/03	35	2.0	31	53	3,483	13
3/1/03	3/15/03	37	4.0	31	71	1,318	15
3/16/03	3/31/03	40	6.7	31	75	604	16
4/1/03	4/15/03	51	13.0	31	90	189	15
4/16/03	4/30/03	63	14.2	37	100	64	15
5/1/03	5/15/03	83	12.0	49	101	54	15
5/16/03	5/31/03	75	8.7	48	110	452	15
					Total	21,150	232

Table 2. Semi-monthly catch summary of spring-run Chinook salmon caught in the screw trap at Parrott-Phelan Diversion Dam from October 31, 2002 to May 30, 2003; yearling captures are included.

Trapping period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Caputred	No. Trapping Days
10/16/02	10/31/02	-	-	-	-	0	1
11/1/02	11/15/02	103	7.5	94	112	5	15
11/16/02	11/30/02	103	8.1	94	110	4	15
12/1/02	12/15/02	35	10.6	31	95	35	14
12/16/02	12/31/02	35	5.2	30	117	908	7
1/1/03	1/15/03	35	1.4	31	39	4,694	15
1/16/03	1/31/03	35	1.3	31	39	9,923	16
2/1/03	2/15/03	35	2.4	31	60	4,480	15
2/16/03	2/28/03	36	2.4	31	59	5,188	13
3/1/03	3/15/03	37	5.7	30	125	1,141	15
3/16/03	3/31/03	41	8.0	31	75	894	14
4/1/03	4/15/03	52	10.6	34	85	470	15
4/16/03	4/30/03	60	9.0	35	91	509	14
5/1/03	5/15/03	65	9.7	35	97	476	15
5/16/03	5/31/03	71	7.8	46	121	1,059	15
					Total	29,786	199

Sampling in the Sutter Bypass began on February 11, 2003 at the Maddock Rd. site (Figure 1, T9). The trap fished until May 9, 2002. A total of 7,448 juvenile Chinook salmon was captured (Table 4). There were only two Butte Creek CWT recaptures in the Maddock Rd. trap on March 12, and April 3, 2003, respectively (Table 5). Additionally, there were five recaptures of CWT late fall-run Chinook Salmon (LFRCS) released at CNFH on January 2, 2003, and one WRCS released in the upper Sacramento River at the Redding Caldwell Park on January 30, 2003 (Appendix C, Table 1). The first CNFH CWT recapture was on January 12, 2002 and the last on March 18, 2002. Sampling by the U.S. Fish and Wildlife Service (USFWS) at Chipps Island and Sherwood Harbor recovered six additional tagged Butte Creek fish from April 14, 2003 to May 25, 2003 (Table 6). Sampling by Hanson Environmental at Antioch recovered one tagged Butte Creek fish on May 18, 2003 (Table 6). All fish were from BY 2002, captured at PPDD and tagged at the BCY between January 17, and March 27, 2003.

Table 3. Summary of coded-wire tagged spring-run Chinook salmon released at Baldwin Construction Yard from January 11, 2003 to March 27, 2003.

Tag Code	Release Date Range		Mean FL (mm)	Range FL (mm)		Total No. Released
06-01-00-03-02	01/17/03	01/22/03	35	33	38	4,527
06-01-00-03-03	01/22/03	01/27/03	35	34	38	5,505
06-01-00-04-00	01/30/03	02/13/03	35	32	38	10,762
06-01-00-04-01	02/13/03	02/24/03	36	33	39	10,526
06-01-00-04-02	03/05/03	03/27/03	38	38	48	5,095
						36,415

Table 4. Semi-monthly catch summary of juvenile Chinook salmon caught in the screw trap in the Sutter Bypass at Maddock Road from February 11, 2003 to April 30, 2003.

Trapping Period*		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
2/1/03	2/15/03	59	14.6	35	149	4,606	4
2/16/03	2/28/03	61	9.2	40	105	1,565	6
3/1/03	3/15/03	64	11.5	42	106	608	5
3/16/03	3/31/03	74	13.2	34	109	172	6
4/1/03	4/15/03	94	9.7	55	120	470	8
4/16/03	4/30/03	85	12.8	38	112	27	7
					Totals	7,448	36

* Fish captured at this location cannot be identified as spring-run Chinook salmon because of the mixing of juvenile salmon of other races from the Sacramento River.

Table 5. Recaptures of BY 2002 Butte Creek spring-run Chinook salmon bearing coded-wire tags in the Sutter Bypass at Maddock Rd.

Tag Code	Total no. Captured*	Average FL at Release (mm)	Recovery FL (mm)	Days at Large
06-01-00-03-02	1	35	89	74
06-01-00-04-00	1	35	49	33
Total	2			

* Both fish were from BY 2002 tagged at Baldwin Construction Yard (See Appendix C, Table 1 for detail)

Table 6. Recaptures of Butte Creek juvenile spring-run Chinook salmon bearing coded-wire tags by other research projects during 2003.

Recovery Date	Tag Code*	Recovery FL (mm)	Recapture Location	Days at Large
4/14/03	06-01-00-03-02	92	Chippis Island	84
4/27/03	06-01-00-04-00	83	Chippis Island	79
5/13/03	06-01-00-04-00	96	Chippis Island	92
5/15/03	06-01-00-04-01	85	Sherwood Harbor	85
5/18/03	06-01-00-04-01	90	Antioch	88
5/19/03	06-01-00-04-00	88	Chippis Island	101
5/25/03	06-01-00-04-02	84	Chippis Island	70

* All fish were from BY 2002 and tagged at Baldwin Construction Yard

Juvenile Emigration 2002-2003

As discussed in previous reports (Hill and Webber, 1999; Ward and McReynolds, 2004; Ward, et al., 2004 and 2004a), YOY and yearling juvenile SRCS outmigrants were documented based upon the FL of juvenile salmon captured at PPDD. During this study trapping period, the majority of Butte Creek SRCS that were captured migrated as fry. Emigration appears to have been hastened by high flows during the period December through February (Tables 1 and 2). As observed in previous years, some YOY remained to rear in Butte Creek above PPDD, emigrating later in the spring. During this study trapping period only 14 yearling SRCS were captured. Yearling SRCS were seen as early as October 18, 2002 and the last on May 22, 2003 at a length of 121 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 bi-modal, and sometimes tri-modal distribution that generally appear to delineate yearling SRCS.

Adult Escapement 2003

Pre-spawning Mortality Carcass Survey

This was the first year that an intensive mark/recapture survey was conducted during the adult SRCS holding period to assess pre-spawn mortalities (Ward et al., 2004b). From June 19, 2003

through September 18, 2003, a total of 5,556 carcasses was examined (62% female, 38% male), with an estimated total pre-spawning mortality of 11,231. For those carcasses recovered during the SRCS pre-spawn mortality period, an expansion factor of 2.17 was calculated based upon the Schaefer model population estimation methodology. Mortalities were due to high water temperatures and high density of fish which resulted in an outbreak of two pathogens, *Flavobacterium columnare* (columnaris) and the protozoan *Ichthyophthirius multifiliis* (Ich) (Veek, 2003). Additionally, 24 adipose fin-clipped carcasses were collected with 10 age- 4 fish (BY99) and 14 age-3 fish (BY00). Carcasses were identified as pre-spawning mortalities due to immature gametes and lack of any visible spawning activity.

Spawning Carcass Survey

During this study period, the third intensive survey directed at recovering CWTs from previous release groups was conducted. A spawning carcass survey was begun on September 23, and continued through October 30, 2003 and covered the 17.7 km (11 mi.) SRCS spawning area (Figures 1 and 2). During the SRCS spawning carcass survey, 3,721 carcasses were examined. A total of 14 CWT's were recovered: 7 from BY 99 and 7 from BY 00 (Appendix D, Table 1). For those carcasses recovered during the SRCS spawning period, an expansion factor of 1.56 was calculated based upon the Schaefer model population estimation methodology. In addition to the Butte Creek carcass recoveries, eight CWT's were recovered in the ocean fishery, three from California and five from Oregon.

Subsequent to the SRCS carcass survey, a survey of the FRCS spawning area (Figure 1) was conducted from October 20 through December 9, 2003. A total of 85 CWT's was recovered (Appendix D, Table 2) from 1,893 carcasses that were examined. An expansion factor of 1.77 was calculated based upon the Schaefer model population estimation methodology.

Snorkel Escapement Survey

The 2003 SRCS adult escapement estimate based upon the snorkel survey method was 4,398 (Table 7).

Table 7. Estimates of adult spring-run Chinook salmon escapement in Butte Creek from snorkel surveys conducted annually from 1994 through 2003.

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
2002	8,785	August 12 – August 16, 2002
2003	4,398	August 18 – August 20, 2003

Water Temperatures 2002-2003

Thermal recording data loggers installed at the five sites within the SRCS holding and spawning reach of Butte Creek (Figure 1) recorded average daily temperatures which ranged as high as 22.9° C on July 23, at the Cable Bridge location (Table 8; Appendix E, Figures 1 - 5). Summer temperatures at all sites were above 15.0° C until the second week of September.

Table 8. Butte Creek spring-run Chinook salmon 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	6/25/03 to 10/28/03	85	26	7
Chimney Rock	6/25/03 to 10/28/03	91	40	12
Pool 4	6/01/03 to 10/31/03	124	65	16
Centerville Estates	6/01/03 to 10/31/03*	104	62	13
Cable Bridge	6/20/03 to 10/31/03	121	72	17
*Centerville thermograph data lost from 9/11/03 to 10/2/03 due to software error.				

Big Chico Creek

Trapping Season 2002-2003

The 2002-2003 trapping season began November 12, 2002. The 1.5-m rotary screw trap was installed near the Bidwell Park Municipal Golf Course. The trap fished until May 15, 2003. A total of 86 juvenile salmon was captured (Table 9).

Table 9. Semi-monthly catch summary of spring-run Chinook salmon caught in the screw trap at Bidwell Park Municipal Golf Course from November 12, 2002 to May 15, 2003.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
11/1/02	11/15/02	-	-	-	-	0	4
11/16/02	11/30/02	-	-	-	-	0	15
12/1/02	12/15/02	-	-	-	-	0	14
12/16/02	12/31/02	-	-	-	-	0	7
1/1/03	1/15/03	-	-	-	-	0	15
1/16/03	1/31/03	-	-	-	-	0	16
2/1/03	2/15/03	32	0	32	32	1	15
2/16/03	2/28/03	34	1.6	32	37-	8	13
3/1/03	3/15/03	-	-	-	-	0	15
3/16/03	3/31/03	38	0.6	38	39	3	15
4/1/03	4/15/03	53	3.5	47	56	6	15
4/16/03	4/30/03	46	12.4	34	68	49	14
5/1/03	5/15/03	62	15.2	31	79	19	15
					Total:	86	173

Adult Escapement 2003

The 2003 Big Chico Creek adult escapement estimate is 81 based upon the snorkel survey method (Table 10).

Table 10. Estimates of adult spring-run Chinook salmon 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
2002	0	August 8, 2002
2003	81	August 11, 2003

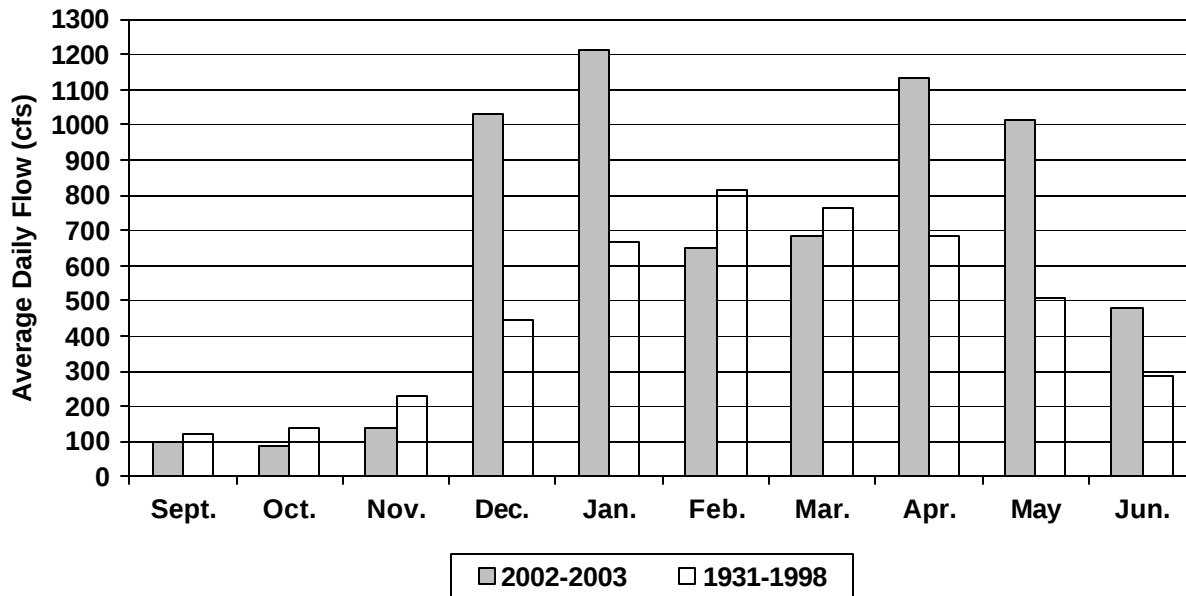
DISCUSSION

During this study period, emphasis was focused on trapping and tagging juvenile SRCS at the PPDD, as well as recovering tags from returning adults. As with previous studies, short periods of elevated uncontrolled flows and heavy 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 19 days out of the 249-day trapping season. Fourteen of those days were in December.

Juvenile Emigration

During this study period, trapping data continued to support previous project conclusions that Butte Creek SRCS primarily emigrate as fry. Earlier project observations found that >95% had emigrated by the end of January (Hill and Webber, 1999; Ward and McReynolds, 2004). The previous two study years (2000-01 and 2001-02) exhibited a more protracted emigration pattern, due to low stable spring flows (Ward, et al. 2004, 2004a). During this study period 86% of the total catch occurred by the end of February, at an average size of 35 mm (Tables 1 and 2). During this season, only 50,953 total juvenile salmon were captured at PPDD. This total is significantly lower than during previous study periods (Ward, et al. 2002, 2003a). There are two possible factors contributing to the lower season trapping totals. The first was the inability to trap effectively in December 2002 when traps were removed for 14 of the 31 days (Tables 1 and 2) due to high flows and debris. Flows exceeded 85 m³/s during two separate storm events. On December 16 and 28, flows peaked at 93.2 m³/s and 148.8 m³/s respectively (Appendix A, Figure 1). December 2002, flows were higher than the historical average for that month (Figure 3). The second contributing factor may have been reduced egg viability. Adult Butte Creek SRCS held in water temperatures exceeding 20°C for up to 16 days (Table 8). Mature SRCS exposed to sub-lethal elevated temperatures (17.5 -19°C) may produce eggs of decreased viability, including pre-hatch mortality and developmental abnormalities (Berman, 1990; Campbell and Moyle, 1992).

Figure 3. Comparison of Butte Creek average flows during 2002-03 with average flows during the period 1931-1998 (CDWR, 2002).



Recently emerged fry were captured at PPDD from November 2002 through May 2003 (Appendix B, Figure 1). As with previous years (Ward et al., 2004a), 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 2002, although numbers were generally small. Fry captured at the site from November through March were assumed to be SRCS.

There were 14 SRCS captured at PPDD during the entire trapping period identified as yearlings. The first yearling was captured on October 18, 2002, and the last on May 22, 2002. Similar to the previous study period, few yearling salmon were observed upstream of PPDD during the summer adult escapement surveys.

Only two Butte Creek SRCS juveniles CWT marked at the BCY site were subsequently recaptured at the Maddock Rd. site, within the Sutter Bypass (Table 5). The dates of recapture occurred on March 12 and April 3, 2002 measuring 49 and 89 mm, respectively. The days at large calculated for the salmon marked at BCY and recaptured in the Sutter Bypass trap were 33 and 74 days, respectively.

During this evaluation period, the Sacramento River overflowed into the Sutter Bypass at either or both the Colusa and Tisdale Weirs a total of 63 days (Appendix A, Figure 2). The Sacramento River first overflowed into the Sutter Bypass via the Colusa/Tisdale Weirs on December 15, 2002, and for the last time on May 11, 2003. There were 6 recaptures of CWT fish from the upper Sacramento River marked by the USFWS (Appendix C, Table 1). Five were CNFH LFRCS released in Battle Creek and one was LSNFH WRCS released at Caldwell Park. Average time at large for the group from date of release to date of recapture was 43 days. Seven CWT recaptures originating from Butte Creek were from other sampling projects downstream of the Sutter Bypass (Table 6). Five were captured by the USFWS at Chipps Island

and one at Sherwood Harbor near Sacramento. One was captured by a private consultant (Hanson Environmental) at Antioch. All recaptures occurred from late April to late May.

Adult Escapement

During this study period, three surveys were completed to estimate adult escapement. A standard swimming snorkel survey was conducted during the third week in August 2003. The annual snorkel survey has been performed consistently since 1991 and serves as a population index. However, previous project findings support the conclusion that snorkel surveys significantly underestimate salmon abundance (Ward et al. 2004, 2004a). As an alternative population estimate, a standardized carcass mark/recapture survey was initiated. For the third consecutive year, a spawning survey utilizing the Schaefer model was performed. The 2003 escapement estimate based upon the snorkel survey was 4,398 with a range of 4,109 to 4,717. The carcass survey results from 2003 suggest a larger population. There were 3,962 carcasses examined of which 631 fresh carcasses (60% female, 40% male) were marked with colored ribbons and returned to the water, with a subsequent recovery of 381, or a recovery rate of 60%. Therefore, a simple Peterson estimate (Ricker, 1975) would suggest that the total population was approximately 6,147 while the Schaefer model estimate was 6,063. Based upon adults returning as three year olds, the population estimate for the parent 2000 generation, as determined by snorkel survey, was 4,118. The 2003 estimate represents a 1.07 cohort replacement rate. However, Butte Creek CWT recoveries continue to demonstrate that a significant proportion of returning adult SRCS spawn at age-4. Of the 14 CWT's recovered on the spawning survey, 7 were age-3 and 7 were age-4 (Figure 5). Both the snorkel survey and the spawning survey did not include pre-spawning mortalities. A third survey was performed to estimate pre-spawning mortality during summer 2003.

Due to the pre-spawning mortality during the summer holding period of 2002, a fully funded pre-spawning mortality survey was conducted starting on June 19, 2003 and ending on September 18, 2003. Mortalities were low through mid-July. During the last two weeks of July, warm air temperatures significantly affected water temperatures throughout the system and specifically impacted the SRCS holding reach between the Quartz Bowl and the Centerville Powerhouse. The peak average daily water temperature as measured at the Quartz Bowl occurred on July 23, at 20.9°C (Appendix E, Figure 1). The warmer water temperatures and high density of salmon in the Quartz Bowl to Centerville Powerhouse reach resulted in an outbreak of two pathogens, *Flavobacterium columnare* (columnaris) and the protozoan *Ichthyophthirius multifiliis* (Ich.) (Veek, 2003). Pre-spawning mortalities significantly increased during the last week of July and peaked during the second week of August. There was a total of 5,556 carcasses examined, of which 965 were measured (62% female and 38% male), tagged with a colored ribbon and returned to the water for subsequent recovery. Of the 965 tagged fish, 351 were recovered during the survey, representing a 36% recovery rate. The Schaffer estimate for pre-spawn mortality was 11,231, with an expansion rate of 2.17. Average length of both females and males during this survey were significantly larger (99mm and 122mm respectively) than observed during 2002 (Figure 4). During the survey, there were 24 CWT's recovered (14 age-3 and 10 age-4). All 24 CWT's were from previous Butte Creek CWT releases. If CWT recoveries are standardized for release group size, age composition is estimated to be 31% age-3 and 69% age-4. This estimate is supported by the significantly larger average lengths. The average FL of all fish measured during 2002 was 732 mm (n = 1440), while the average FL during 2003 was 834 mm (n = 1595). A t-Test comparison confirms that the 2003 populations was significantly larger ($p=5.52E-189$, $df = 3032$, $t \text{ Stat} = -31.53$).

Figure 4. Length frequency distribution of 965 adult spring-run Chinook salmon pre-spawn mortalities measured and marked for abundance estimate between June 19, 2003 and September 18, 2003.

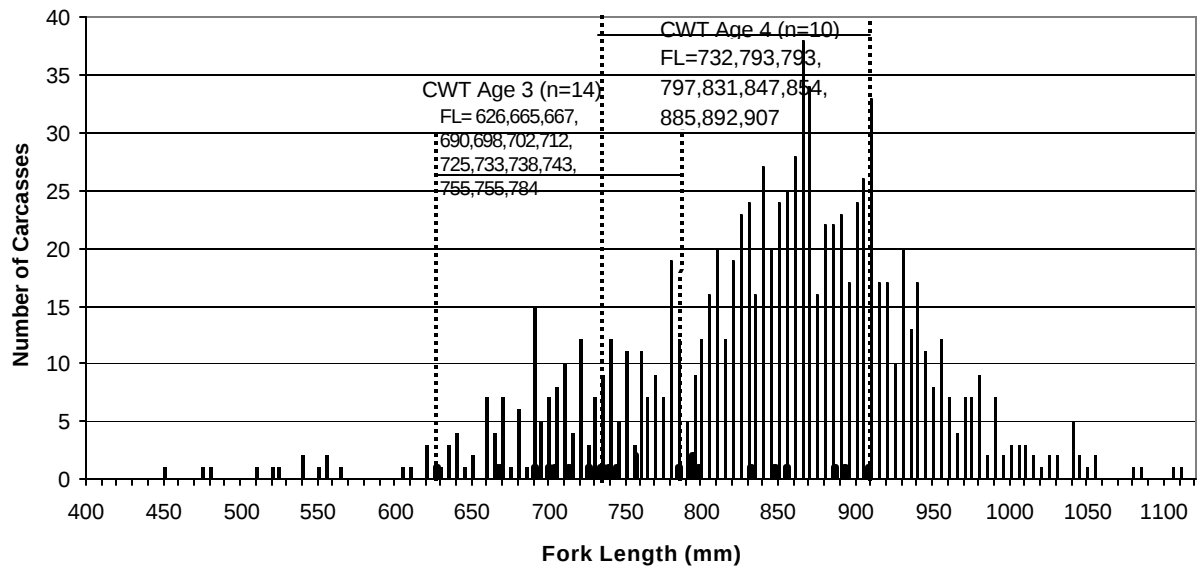
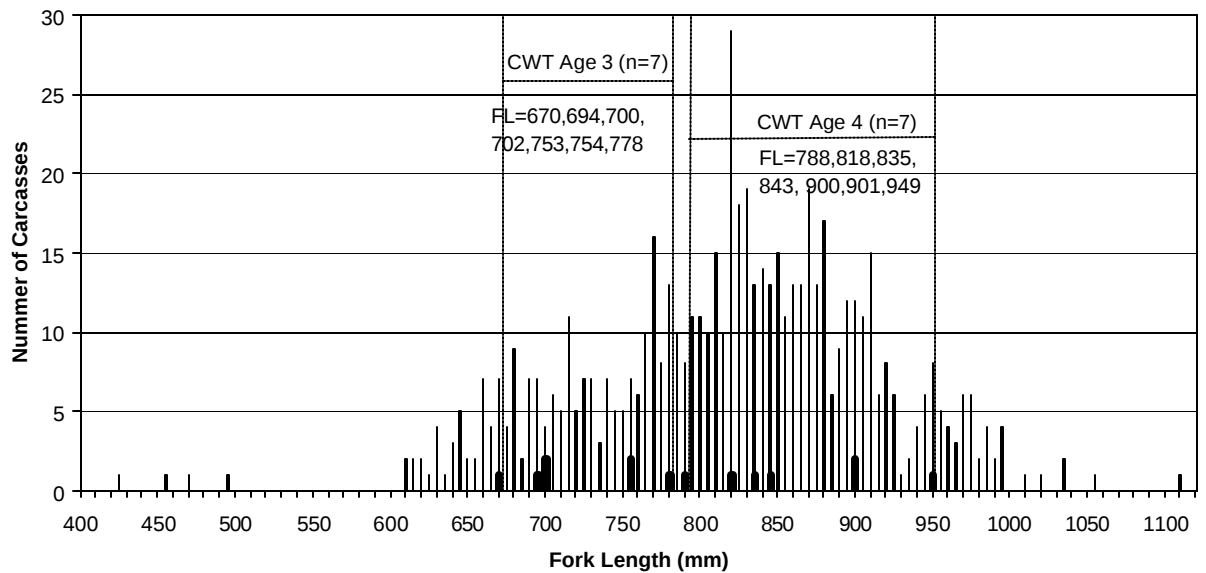


Figure 5. Length frequency distribution of 630 spawned adult spring-run Chinook salmon carcasses measured and marked for abundance estimate between September 23, 2003 and October 30, 2003.



The combined Schaefer estimates for the pre-spawn mortality survey and the spawning carcass survey was 17,294.

Ocean recoveries during 2003 (Appendix D, Table 1) extended from April through October, and all were taken from south of Monterey to Coos Bay, Oregon. Based upon the current ocean-aging convention that increments spring-run salmon to the next age class on May 1, there was one age-3 and seven age-4. Comparing the expanded BY 99 ocean and inland recoveries (Appendix D, Table 1) suggests a 43% ocean/commercial catch rate, slightly lower than the 48% ocean/commercial catch rate for BY 98.

Table 11. Brood Year 1998 ocean and inland recoveries of Butte Creek spring-run Chinook salmon tagged and released at Baldwin Construction Yard.

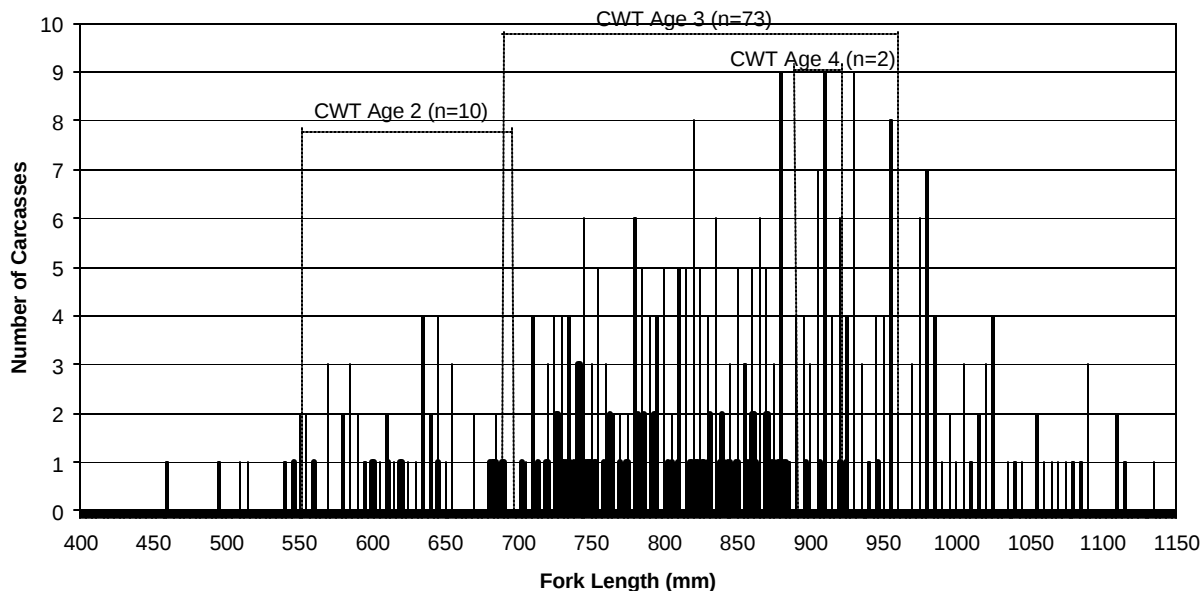
Source	Inland Age	Ocean Age	Number Recovered		Expanded Number Recovered	
			Ocean	Inland	Ocean	Inland
Sport	2	3	1		3	
Sport	3	4	3		14	
Sport	4	5	1		3	
Commercial	3	3	1		4	
Commercial	3	4	3		8	
Spawn	3			13		29
Pre-Spawn	3			1		2
Spawn	4			1		2
Pre-Spawn	4			1		2
Inland FRH	4					1
Total			9	16	32	36

Table 12. Brood Year 1999 ocean and inland recoveries of Butte Creek spring-run Chinook salmon tagged and released at Baldwin Construction Yard.

Source	Inland Age	Ocean Age	Number Recovered		Expanded Number Recovered	
			Ocean	Inland	Ocean	Inland
Sport	3	3	1		4	
Sport	3	4	2		9	
Commercial	3	3	1		3	
Commercial	3	4	11		37	
Spawn	2			1		2
Spawn	3			15		30
Spawn	4			7		11
Pre-Spawn	3			2		4
Pre-Spawn	4			10		22
Total			15	35	53	69

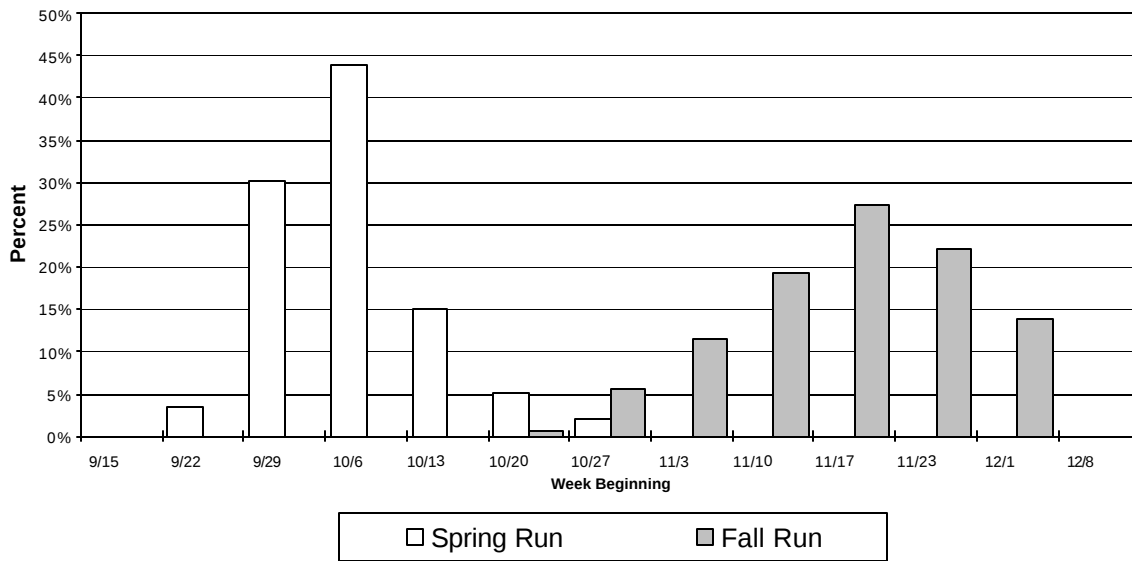
Subsequent to the SRCS carcass survey, a FRCS carcass survey was initiated on October 20 and continued through December 9, 2003. The FRCS survey covered the reaches of Butte Creek downstream of the PPDD (Figure 1). For a second consecutive year, a bar rack was placed in the fish ladder at the PPDD during the last week of September, to reduce the number of FRCS that spawn upstream of this site, although a small number of FRCS ascended and spawned above. The bar rack was removed during the first week of December. Using the technique of the Schaefer model, 1,893 carcasses were examined, with 278 of the fresh carcasses marked with colored ribbons of which 135 were subsequently recovered. For 2003, the Schaefer model estimate for FRCS was 3,310 fish which spawned in the reach downstream of the PPDD. Two kayak surveys were conducted to assess the spawning upstream of the PPDD. It was estimated that a minimum of 182 FRCS spawned upstream. There was a total of 85 CWT marked carcasses recovered during the FRCS carcass survey (Figure 6; Appendix D, Table 2). Eighty-four of the recovered CWT's were from salmon natal to other watersheds, with a majority from the FRH. One recovered CWT was released from Butte Creek as an SRCS, during January 26-28, 2001. Due to the very small proportion of FRCS that spawn upstream of PPDD, it is possible that our CWT project occasionally marks some number of emigrating FRCS.

Figure 6. Length frequency distribution of 176 adult fall-run Chinook salmon carcasses measured and marked for abundance estimate between October 20, 2003 and December 9, 2003.



Comparison of Butte Creek SRCS and FRCS spawning timing (Figure 7) continues to show little overlap, with peak SRCS spawning occurring during the week of October 6; for FRCS the peak occurred during the week of November 23, 2003. The SRCS onset of spawning was a week later than observed during 2002. Additionally, all Butte Creek SRCS spawned above PPDD (Figure 1), while the large majority of FRCS spawned downstream of that site. The results from the 2002-2003 study period continue to support Butte Creek SRCS as a distinct and sustaining population with little evidence to date of introgression from other watersheds.

Figure 7. Percent of carcasses of spawned spring- and fall-run Chinook salmon recovered for period September 22, 2003 through December 1, 2003.



Adult Spring-run Straying

During this reporting period, there were two recoveries of Butte Creek adult CWT SRCS in other watersheds. One was from BY 98 spawned at the Feather River Hatchery (FRH) on Tuesday, October 29, 2002. This spawning date is within the last week of the SRCS spawning period seen on Butte Creek (Figure 7). Of particular importance, is that the fish was from the small group of 393 BY 98 yearling Butte Creek SRCS (Tag # 06-01-12-03-07), captured and released during the period October 15-26, 1999. The second recovery was a BY 00 SRCS in Clear Creek on October 1, 2003. The Clear Creek picket weir was installed from September 7 to October 31, 2003 to spatially isolate SRCS from the FRCS. This Butte Creek stray (Tag # 06-01-12-04-06) was found upstream of the picket weir (Appendix D, Table 1). Since there was no systematic SRCS spawning survey in Clear Creek, no expansion factor for sampling effort was determined. Thus it is difficult to assess the magnitude of Butte Creek SRCS straying into other Central Valley watersheds due to the lack of uniform effort to recover CWT fish, particularly among SRCS. To date, there have been 76 (expanded to 150 for sampling effort) CWT Butte Creek SRCS recovered in Butte Creek and two (no expansion) in other watersheds.

Water Temperature

Butte Creek water temperatures have historically exceeded ideal temperatures as reported for holding and spawning SRCS (Appendix E, Figures 1-5). In general, temperatures for holding adult SRCS should not exceed 15°C (59°F) (Hinze, 1959; Boles, 1988; CDFG, 1998). There are five locations within the summer holding habitat of Butte Creek that have continuously recording data loggers (Figure 1). Average daily temperatures exceeded 15°C at all sites from late-June until the first week of September. Temperatures exceeded 17.5°C by July 12th and exceeded 20°C for seven days during the holding period at Quartz Bowl Pool.

ACKNOWLEDGMENTS

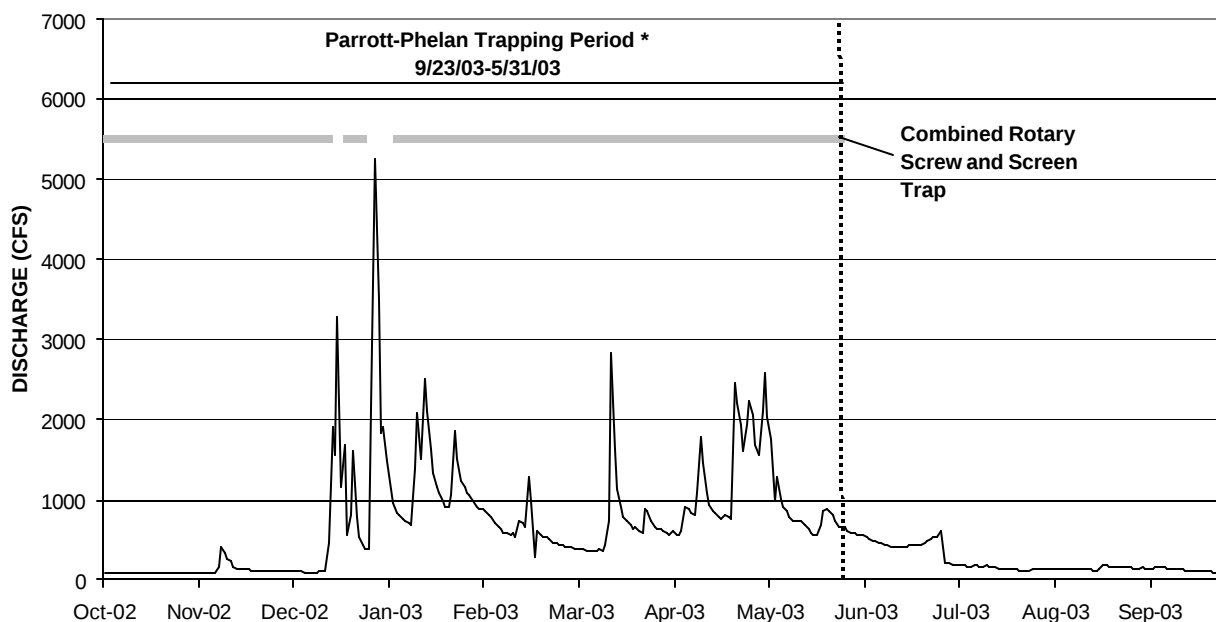
This project was supported by funding provided by the CALFED Bay-Delta Program through State Proposition 204, and by the Federal Aid in Sport Fish Restoration Act, in partnership with the California Department of Fish and Game.

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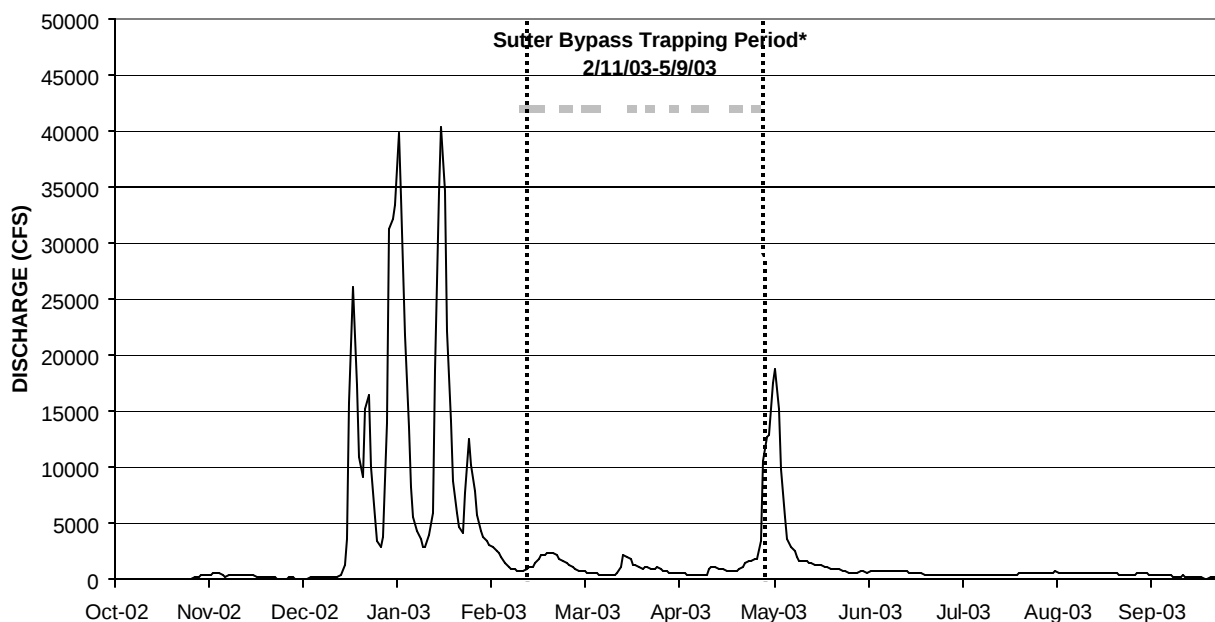
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APPENDIX A, Figure 1. Butte Creek flow at Butte Creek near Chico Gage (USGS - #11390000), water year 2002-03, with trapping period shown. Flow data are provisional and subject to revision.

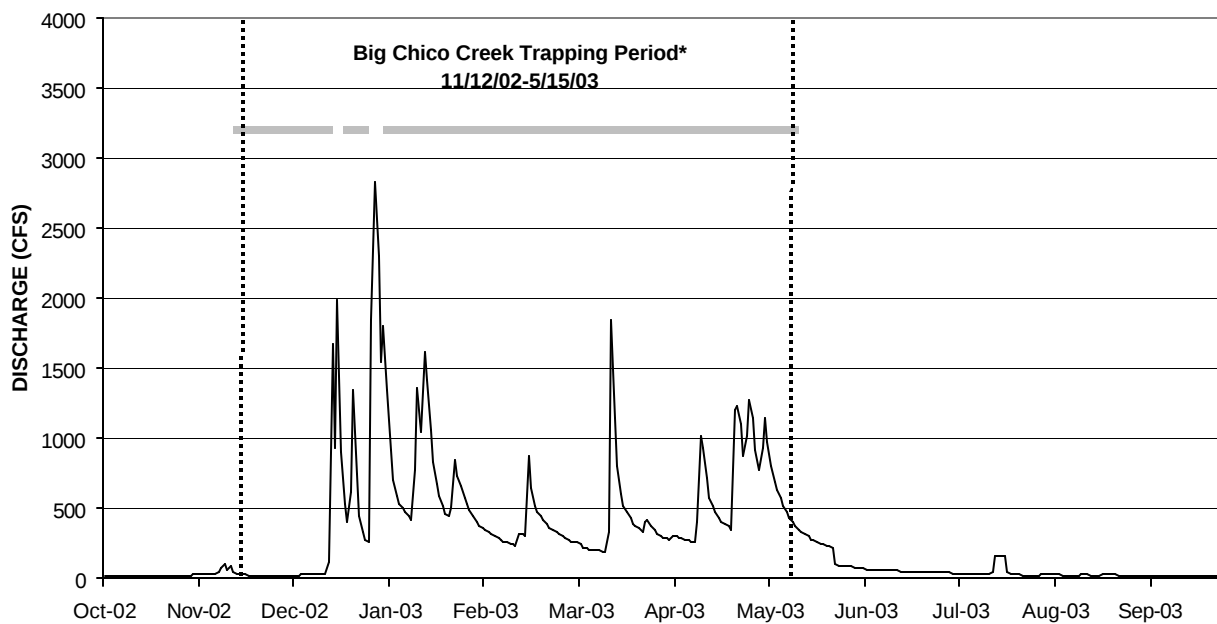


APPENDIX A, Figure 2. Butte Creek flow at Sutter Bypass Butte Slough near Meridian Gage (DWR A20972), water year 2002-03, with trapping period shown. Flow data are provisional and subject to revision.



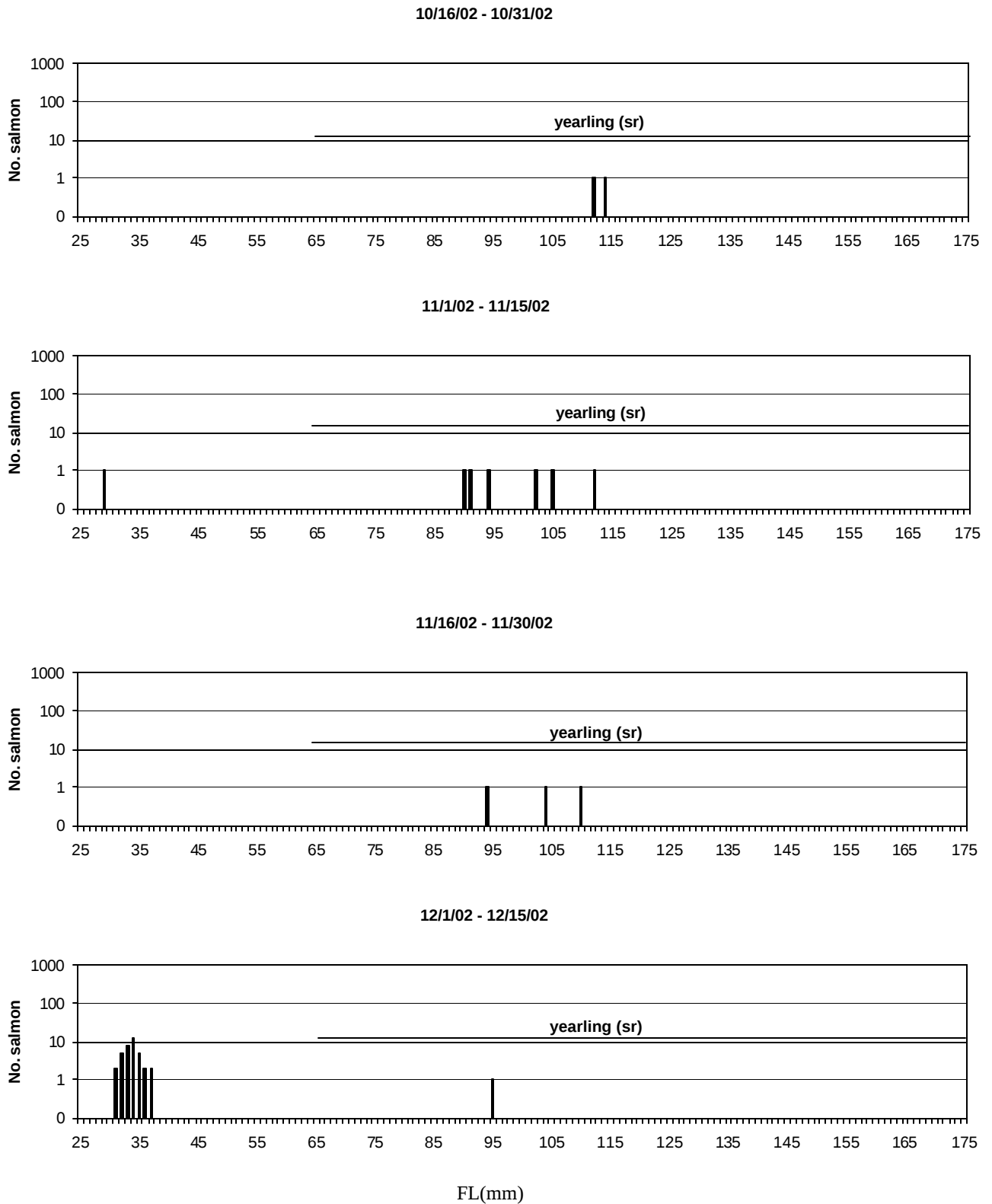
*Breaks in horizontal line indicate periods of time when the trap(s) were not fishing.

APPENDIX A, Figure 3. Big Chico Creek flow at Big Chico Creek near Chico Gage (DWR #42105), water year 2002-03, with trapping period shown. Flow data are provisional and subject to revision.

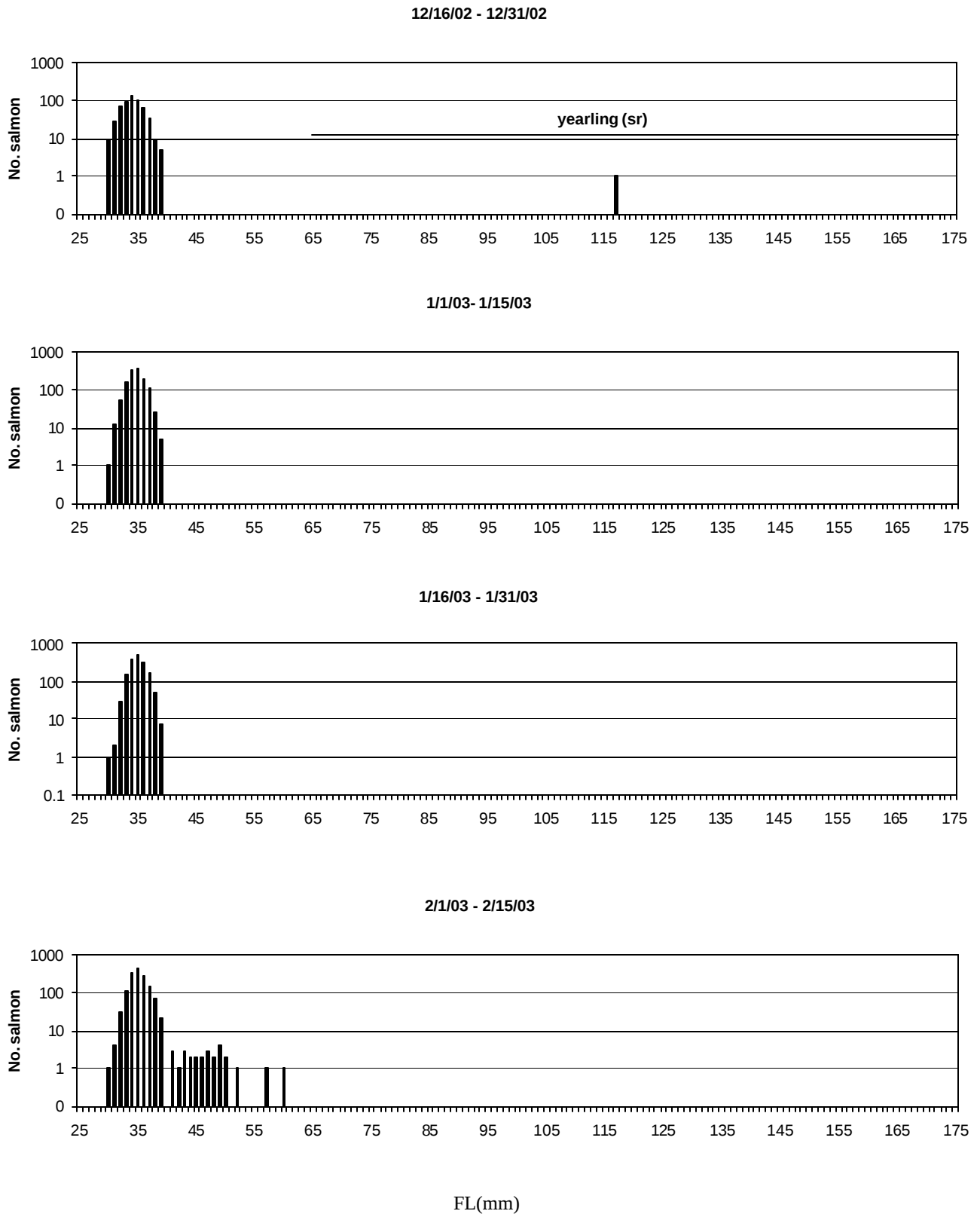


*Breaks in horizontal line indicate periods of time when the trap(s) were not fishing.

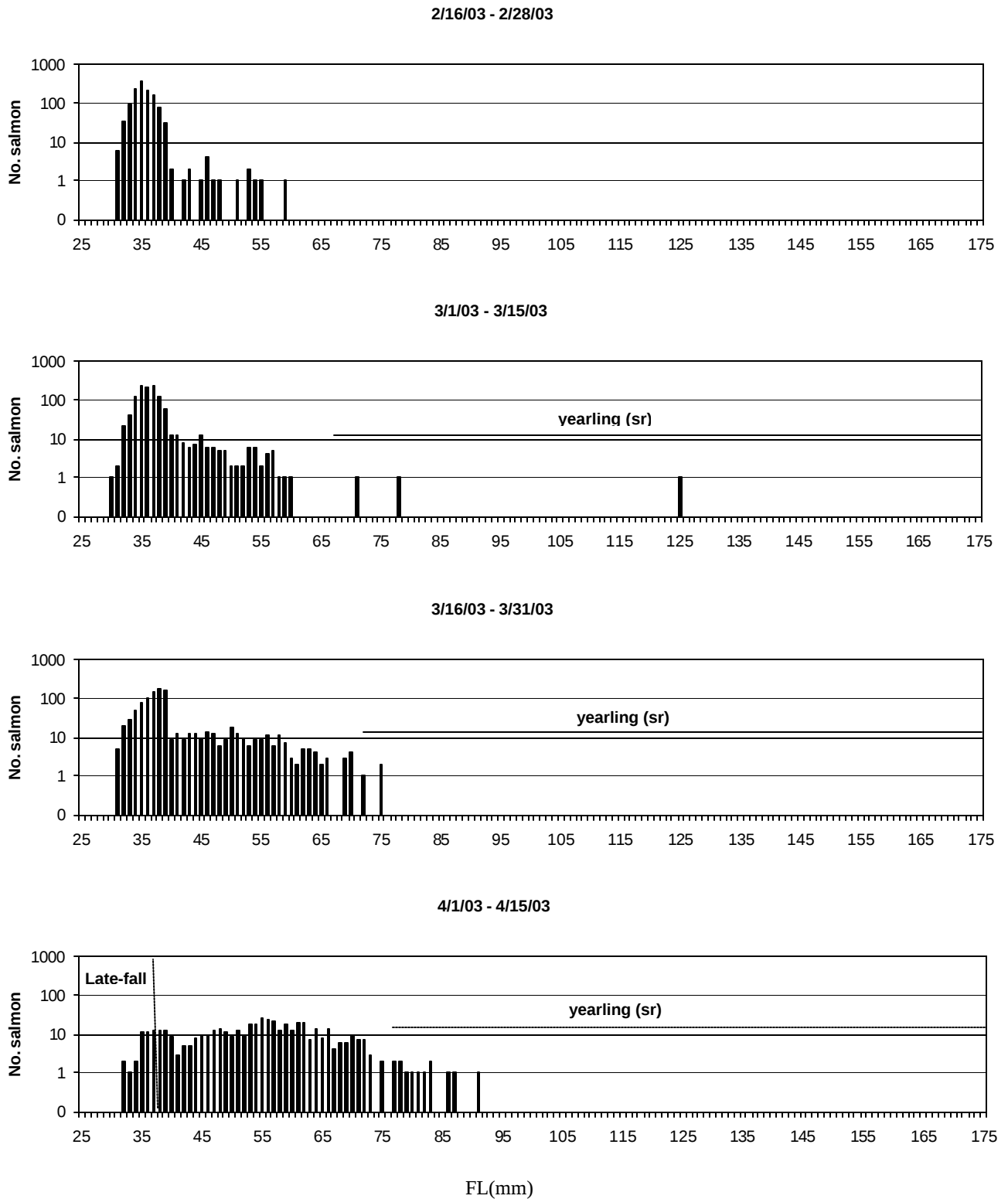
APPENDIX B, Figure 1. Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from October 18, 2002 through May 30, 2003. All fish are assumed to be spring-run Chinook salmon except where indicated.



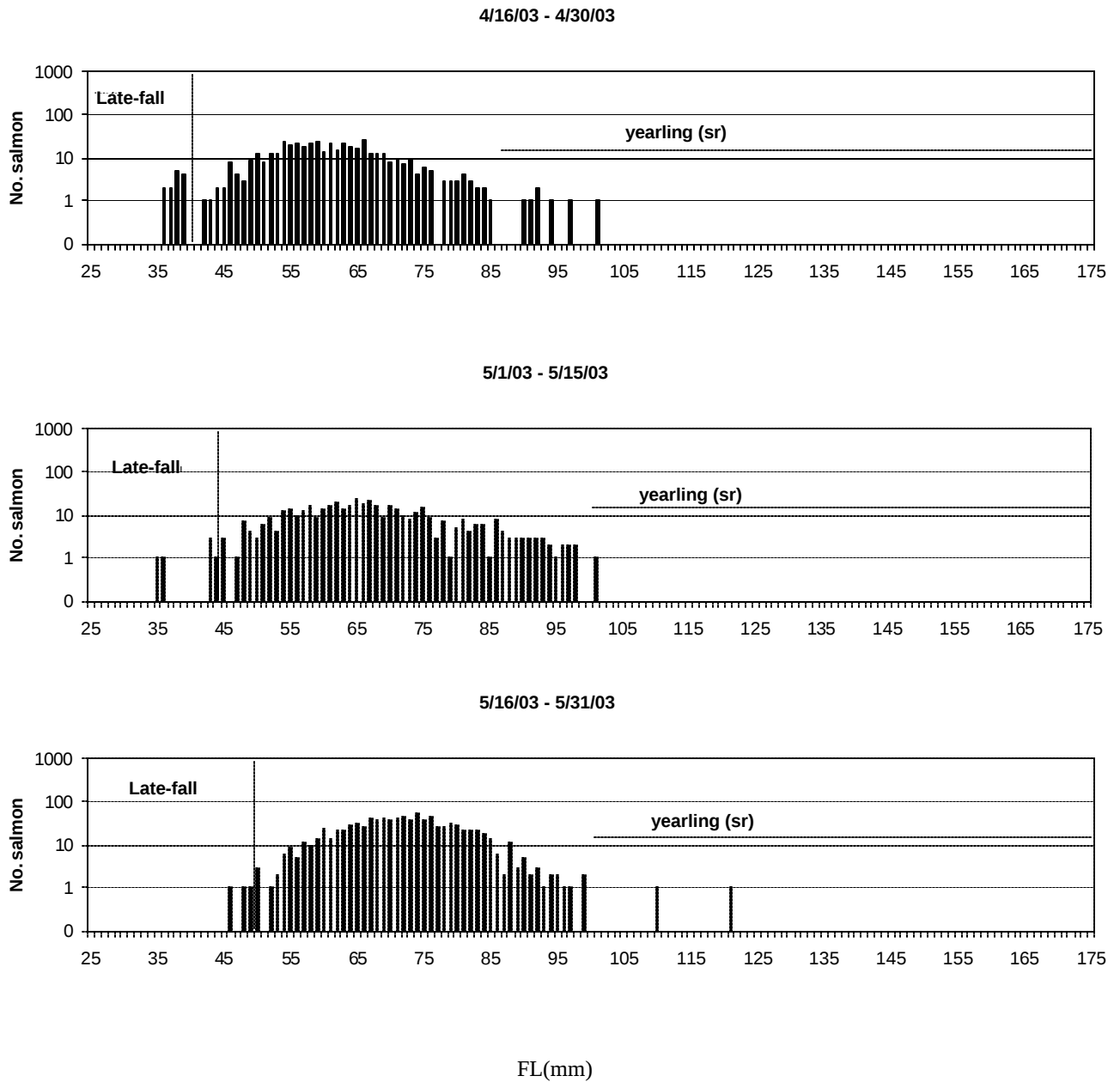
APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from October 18, 2002 through May 30, 2003. All fish are assumed to be spring-run Chinook salmon except where indicated.



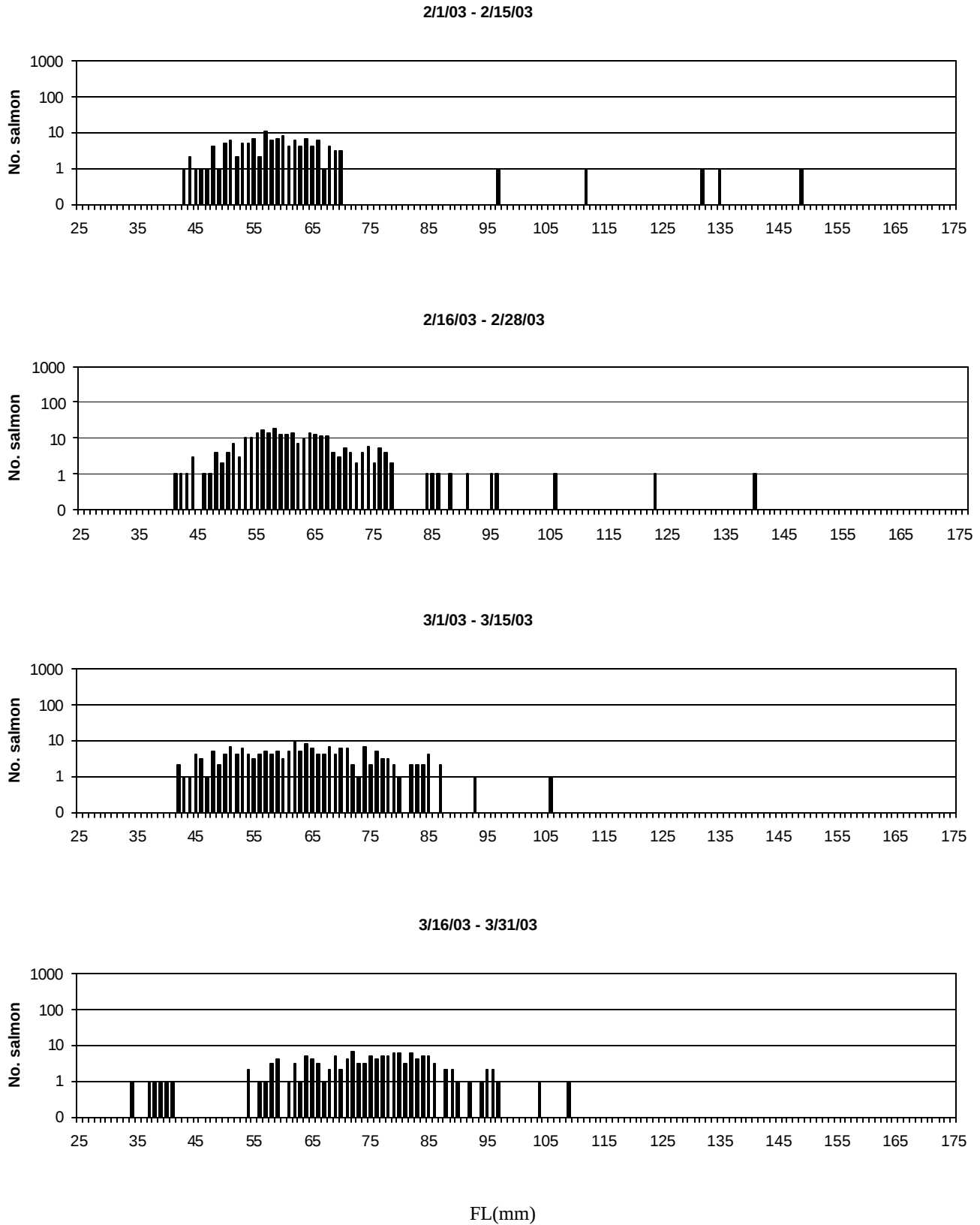
APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from October 18, 2002 through May 30, 2003. All fish are assumed to be spring-run Chinook salmon except where indicated.



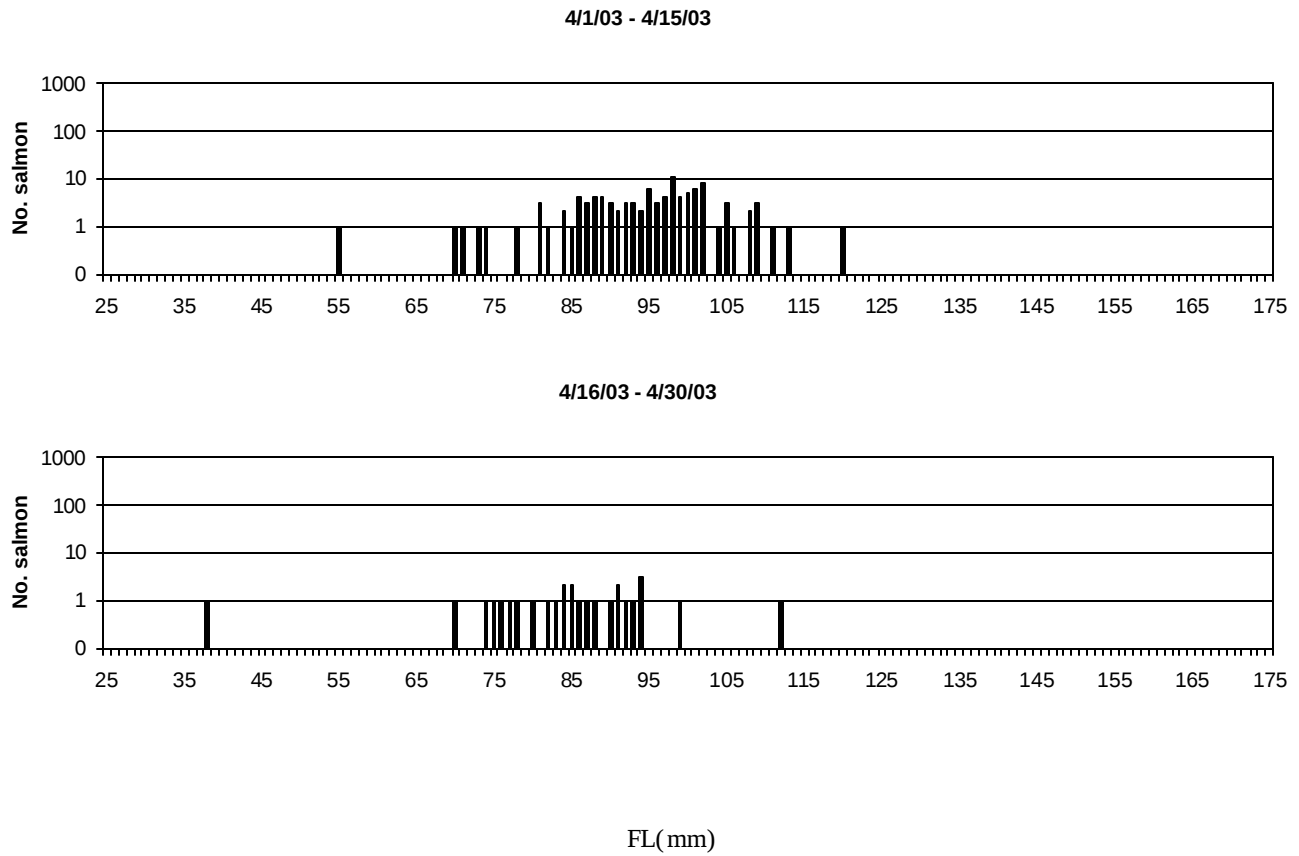
APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from October 18, 2002 through May 30, 2003. All fish are assumed to be spring-run Chinook salmon except where indicated.



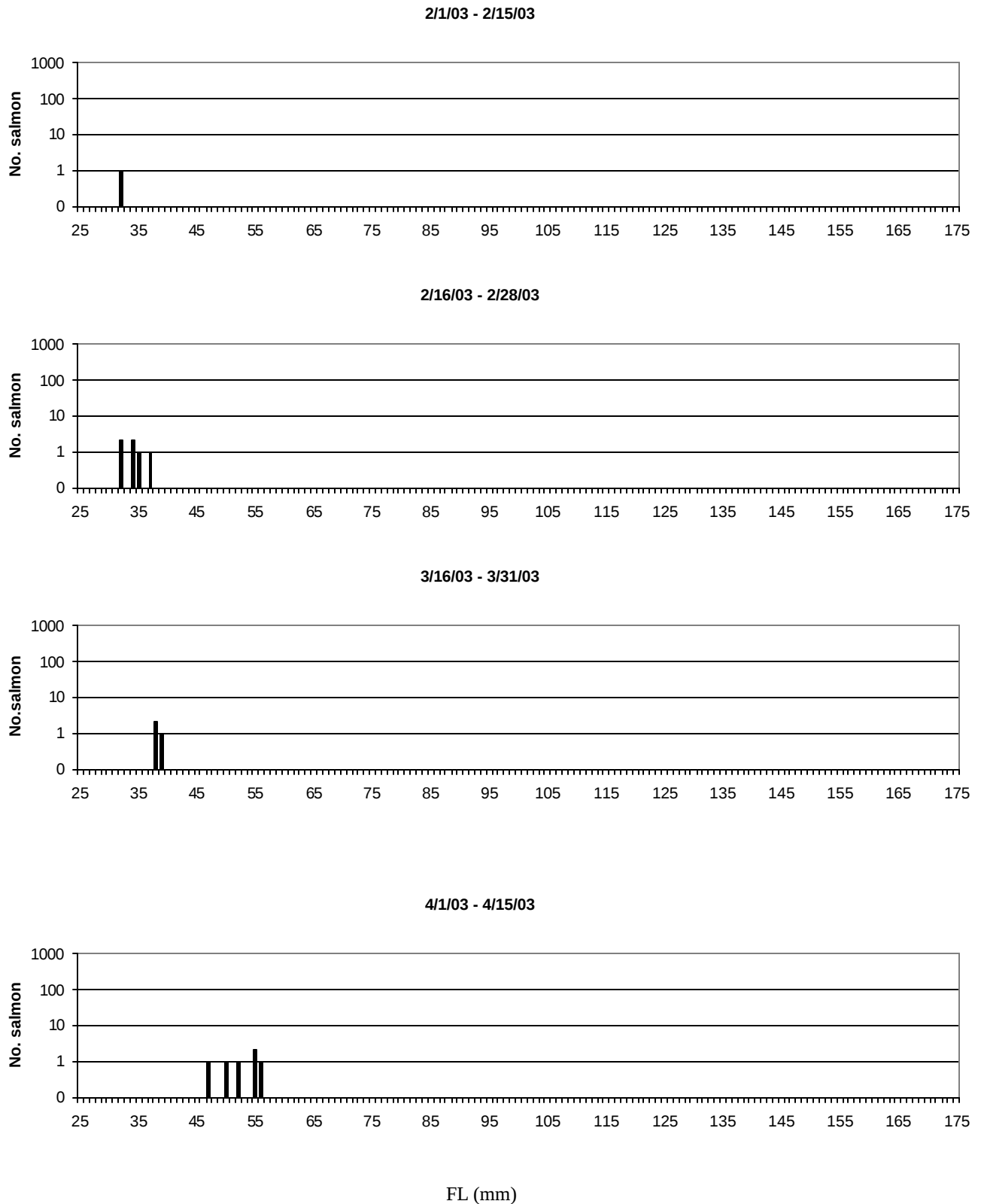
APPENDIX B, Figure 2. Frequency distribution of lengths of juvenile Chinook salmon caught and released at Maddock Road in the Sutter Bypass from February 12, 2003 through April 30, 2003.



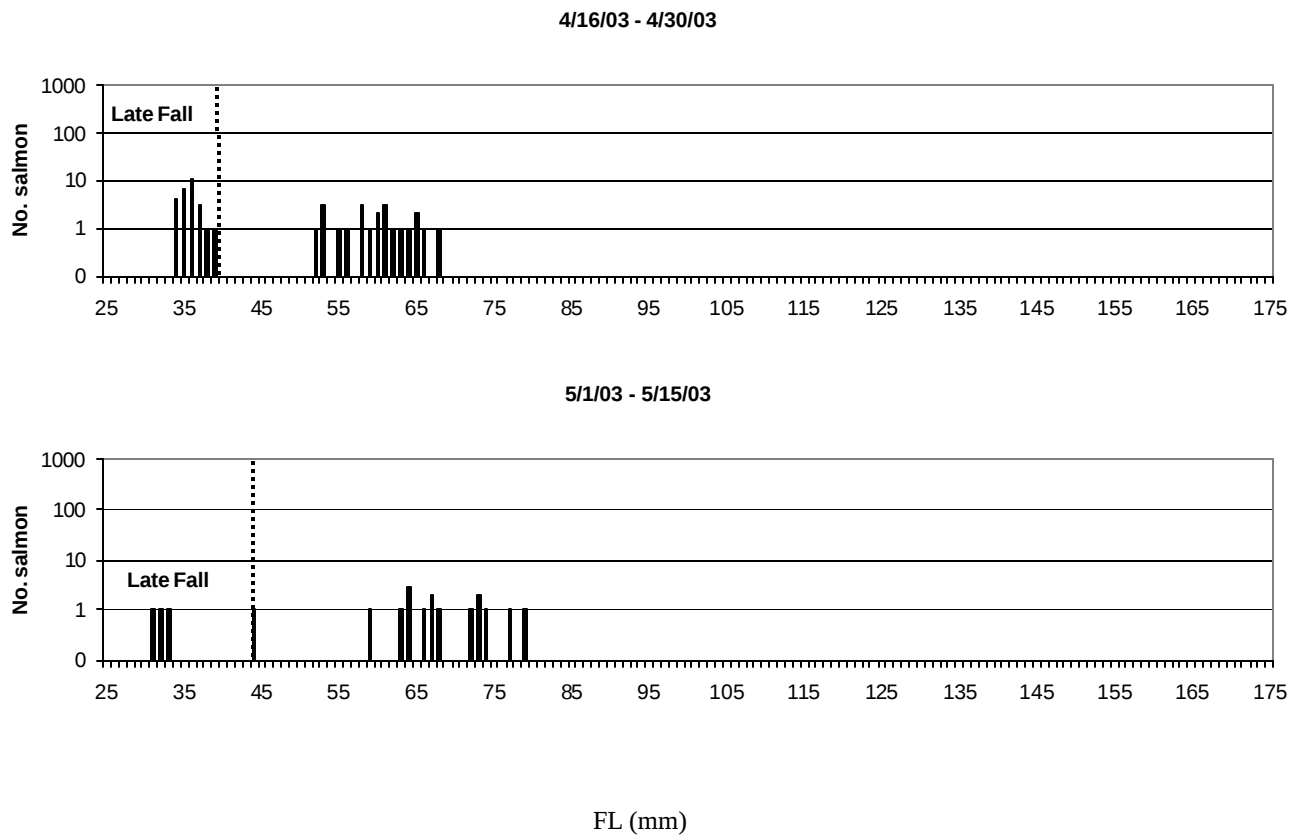
APPENDIX B, Figure 2. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Maddock Road in the Sutter Bypass from February 12, 2003 through April 30, 2003.



APPENDIX B, Figure 3. Frequency distribution of lengths of juvenile Chinook salmon caught and released in Big Chico Creek from February 14, 2003 through May 14, 2003. All fish are assumed to be spring-run Chinook salmon except where indicated.



APPENDIX B, Figure 3. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released in Big Chico Creek from February 14, 2003 through May 14, 2003. All fish are assumed to be spring-run Chinook salmon except where indicated



APPENDIX C, Table 1. 2002-2003 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
051095	LFR	CNFH	CNFH	01/02/03	131	02/12/03	149	42
051095	LFR	CNFH	CNFH	01/02/03	131	02/14/03	135	44
051164	LFR	CNFH	CNFH	01/02/03	130	02/13/03	132	43
051164	LFR	CNFH	CNFH	01/02/03	130	02/15/03	139	45
051164	LFR	CNFH	CNFH	01/02/03	130	02/15/03	122	45
051281	WR	LSNFH	CP	01/30/03	80	03/18/03	104	48

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, and Caldwell Park (CP) on the Sacramento River near Redding.

APPENDIX D, Table 1. Recoveries during 2002 and 2003 of Butte Creek adult spring-run Chinook salmon carcasses bearing coded-wire tags. All fish were tagged at Baldwin Construction Yard.

Release Date	Brood Year	Tag Code	Recovery				
			Date	FL (mm)	Expansion	Site	Method
10/15/99-10/26/99	1998	06-01-12-03-07	10/29/02	885	1.0	Feather River Hatchery	Hatchery
12/6/99 – 12/29/99	1999	06-01-12-03-08	7/15/02	690	1.74	Marine Area 2	Ocean Sport
1/10/00 - 1/19/00	1999	06-01-12-03-10	7/31/03	793	2.17	Butte Cr. – Reach C	Inland Pre-spawn
02/07/00 - 02/25/00	1999	06-01-12-03-13	8/12/03	797	2.17	Butte Cr. – Reach B	Inland Pre-spawn
12/29/99 - 1/10/00	1999	06-01-12-03-09	8/12/03	831	2.17	Butte Cr. – Reach B	Inland Pre-spawn
1/10/00 - 1/19/00	1999	06-01-12-03-10	8/12/03	892	2.17	Butte Cr. – Reach B	Inland Pre-spawn
12/29/99 - 1/10/00	1999	06-01-12-03-09	8/13/03	854	2.17	Butte Cr. – Reach A	Inland Pre-spawn
12/29/99 - 1/10/00	1999	06-01-12-03-09	8/13/03	885	2.17	Butte Cr. – Reach A	Inland Pre-spawn
1/27/00 - 2/07/00	1999	06-01-12-03-12	8/18/03	732	2.17	Butte Cr. – Reach B	Inland Pre-spawn
1/27/00 - 2/07/00	1999	06-01-12-03-12	8/18/03	907	2.17	Butte Cr. – Reach B	Inland Pre-spawn
12/29/99 - 1/10/00	1999	06-01-12-03-09	8/28/03	793	2.17	Butte Cr. – Reach C	Inland Pre-spawn
1/10/00 - 1/19/00	1999	06-01-12-03-10	9/2/03	847	2.17	Butte Cr. – Reach A	Inland Pre-spawn
12/29/99 - 1/10/00	1999	06-01-12-03-09	9/25/03	788	1.56	Butte Cr. – Reach C	Inland spawn
1/27/00 - 2/07/00	1999	06-01-12-03-12	10/2/03	843	1.56	Butte Cr. – Reach C	Inland spawn
1/10/00 - 1/19/00	1999	06-01-12-03-10	10/2/03	901	1.56	Butte Cr. – Reach D	Inland spawn
1/10/00 - 1/19/00	1999	06-01-12-03-10	10/9/03	949	1.56	Butte Cr. – Reach C	Inland spawn
02/07/00 - 02/25/00	1999	06-01-12-03-13	10/9/03	818	1.56	Butte Cr. – Reach C	Inland spawn
02/07/00 - 02/25/00	1999	06-01-12-03-13	10/9/03	900	1.56	Butte Cr. – Reach C	Inland spawn
1/19/00 - 1/28/00	1999	06-01-12-03-11	10/23/03	835	1.56	Butte Cr. – Reach C	Inland spawn
1/29/01-2/2/01	2000	06-01-00-02-02	4/18/03	630	3.51	Newport Troll 5	Ocean Commercial
1/26/01 - 1/28/01	2000	06-01-12-04-06	5/23/03	648	1.00	Butte Cr. Reach C	Inland landowner ^{1/}

APPENDIX D, Table 1. (continued) Recoveries during 2002 and 2003 of Butte Creek adult spring-run Chinook salmon carcasses bearing coded-wire tags. All fish were tagged at Baldwin Construction Yard.

Release Date	Brood Year	Tag Code	Recovery				
			Date	FL (mm)	Expansion	Site	Method
1/26/01 - 1/28/01	2000	06-01-12-04-06	6/5/03	711	3.12	Pt. Arena - Pigeon Pt.	Ocean Commercial
1/16/01 - 1/19/01	2000	06-01-12-04-02	7/1/03	703	3.98	Pt. Reyes - Pigeon Pt.	Ocean Commercial
1/29/01 - 2/2/01	2000	06-01-12-04-08	7/21/03	713	4.25	Spanish Flat - C. Vizcaino	Ocean Sport
1/16/01 - 1/19/01	2000	06-01-12-04-02	7/31/03	720	2.7	Coos Bay Troll 5	Ocean Commercial
01/29/01 - 2/02/01	2000	06-01-00-02-02	8/5/03	743	2.17	Butte Cr. - Reach A	Inland Pre-spawn
1/16/01 - 1/19/01	2000	06-01-12-04-02	8/6/03	712	3.69	Winchester B Sport 5	Ocean Sport
1/16/01 - 1/19/01	2000	06-01-12-04-02	8/7/03	784	2.17	Butte Cr. - Reach C	Inland Pre-spawn
1/26/01 - 1/27/01	2000	06-01-12-04-07	8/12/03	702	2.17	Butte Cr. - Reach A	Inland Pre-spawn
1/26/01 - 1/28/01	2000	06-01-12-04-05	8/12/03	733	2.17	Butte Cr. - Reach B	Inland Pre-spawn
1/26/01 - 1/28/01	2000	06-01-12-04-06	8/12/03	667	2.17	Butte Cr. - Reach A	Inland Pre-Spawn
1/29/01 - 2/02/01	2000	06-01-00-02-02	8/13/03	725	2.17	Butte Cr. - Reach A	Inland Pre-Spawn
1/26/01 - 1/28/00	2000	06-01-12-04-05	8/13/03	690	2.17	Butte Cr. - Reach A	Inland Pre-Spawn
1/26/01 - 1/28/01	2000	06-01-12-04-06	8/13/03	755	2.17	Butte Cr. - Reach A	Inland Pre-Spawn
1/29/01 - 2/02/01	2000	06-01-12-04-08	8/13/03	738	2.17	Butte Cr. - Reach A	Inland Pre-Spawn
1/26/01 - 1/28/01	2000	06-01-12-04-06	8/18/03	665	2.17	Butte Cr. - Reach B	Inland Pre-Spawn
1/16/01 - 1/18/01	2000	06-01-12-04-04	8/21/03	626	2.17	Butte Cr. - Reach C	Inland Pre-Spawn
1/16/01 - 1/19/01	2000	06-01-12-04-03	8/26/03	712	2.17	Butte Cr. - Reach A	Inland Pre-Spawn
2/01/01 - 2/01/01	2000	06-01-00-02-01	8/28/03	755	2.17	Butte Cr. - Reach C	Inland Pre-Spawn
1/26/01 - 1/28/01	2000	06-01-12-04-06	8/28/03	698	2.17	Butte Cr. - Reach C	Inland Pre-Spawn

APPENDIX D, Table 1. (continued) Recoveries during 2002 and 2003 of Butte Creek adult spring-run Chinook salmon carcasses bearing coded-wire tags. All fish were tagged at Baldwin Construction Yard.

Release Date	Brood Year	Tag Code	Recovery				
			Date	FL (mm)	Expansion	Site	Method
2/22/01-3/2/01	2000	06-01-00-00-00	9/08/03	740	1.96	Newport Troll 4	Ocean Commercial
1/26/01-1/28/01	2000	06-01-12-04-05	9/30/03	753	1.56	Butte Cr.– Reach B	Inland Spawn
1/26/01 - 1/28/01	2000	06-01-12-04-06	9/30/03	670	1.56	Butte Cr. – Reach B	Inland Spawn
1/26/01-1/28/01	2000	06-01-12-04-06	10/1/03	675	1.00	Clear Creek	Inland Recovery
2/21/01-3/1/01	2000	06-01-00-02-05	10/1/03	750	2.78	Newport Troll 4	Ocean Commercial
1/26/01-1/27/01	2000	06-01-12-04-07	10/2/03	754	1.56	Butte Cr. – Reach D	Inland Spawn
1/16/01 - 1/19/01	2000	06-01-12-04-02	10/7/03	702	1.56	Butte Cr. – Reach B	Inland Spawn
1/26/01-1/28/01	2000	06-01-12-04-05	10/7/03	700	1.56	Butte Cr. – Reach B	Inland Spawn
2/21/01-3/01/01	2000	06-01-00-02-05	10/9/03	778	1.56	Butte Cr. – Reach C	Inland Spawn
1/26/01-1/28/01	2000	06-01-12-04-05	10/9/03	694	1.56	Butte Cr. – Reach C	Inland Spawn
1/26/01 - 1/28/01	2000	06-01-12-04-06	11/11/03	861	1.56	Butte Cr. – Reach F	Inland Spawn

^{1/} Fish was found dead by local landowner who contacted Department personnel.

APPENDIX D, Table 2. Recoveries of adult fall-run Chinook salmon carcasses bearing coded-wire tags in Butte Creek during 2003.

Release				Recovery			
Stock	Brood Year	Tag Code	Site	Date	FL (mm)	Expansion	Butte Creek Reach
American River	2000	065459	Wickland	11/20/03	748	1.77	H
American River	2000	065455	Wickland	11/26/03	809	1.77	I
American River	2000	065455	Wickland	12/5/03	770	1.0*	C
Feather River	2000	062679	Rodeo Minor	10/22/03	735	1.77	I
Feather River	2000	062664	Wickland	10/29/03	741	1.77	H
Feather River	2000	062664	Wickland	10/29/03	861	1.77	H
Feather River	2000	062664	Wickland	11/04/03	883	1.77	F
Feather River	2000	062664	Wickland	11/04/03	764	1.77	F
Feather River	2000	062671	Rodeo Minor	11/04/03	780	1.77	G
Feather River	2000	062664	Wickland	11/04/03	738	1.77	G
Feather River	2000	062676	Rodeo Minor	11/06/03	862	1.77	H
Feather River	2000	062665	Wickland	11/06/03	873	1.77	I
Feather River	2000	062672	Rodeo Minor	11/11/03	785	1.77	F
Feather River	2000	062665	Wickland	11/11/03	839	1.77	F
Feather River	2000	062664	Wickland	11/11/03	924	1.77	F
Feather River	2000	062665	Wickland	11/11/03	838	1.77	F
Feather River	2000	062664	Wickland	11/11/03	845	1.77	G
Feather River	2000	062665	Wickland	11/13/03	860	1.77	H
Feather River	2000	062664	Wickland	11/13/03	774	1.77	H
Feather River	2000	062664	Wickland	11/13/03	818	1.77	H
Feather River	2000	062941	Tiburon	11/13/03	734	1.77	I
Feather River	2000	062664	Wickland	11/13/03	762	1.77	I
Feather River	2000	062665	Wickland	11/13/03	740	1.77	I
Feather River	2000	062665	Wickland	11/13/03	741	1.77	I
Feather River	2000	062664	Wickland	11/18/03	870	1.77	F
Feather River	2000	062665	Wickland	11/18/03	702	1.77	F
Feather River	2000	062665	Wickland	11/18/03	897	1.77	F
Feather River	2000	062664	Wickland	11/18/03	726	1.77	F
Feather River	2000	062664	Wickland	11/18/03	786	1.77	G
Feather River	2000	062665	Wickland	11/18/03	794	1.77	G
Feather River	2000	062664	Wickland	11/20/03	850	1.77	H
Feather River	2000	062665	Wickland	11/20/03	730	1.77	I
Feather River	2000	062941	Tiburon	11/20/03	752	1.77	I
Feather River	2000	062665	Wickland	11/20/03	713	1.77	I
Feather River	2000	062664	Wickland	11/20/03	793	1.77	I
Feather River	2000	062665	Wickland	11/20/03	826	1.77	I
Feather River	2000	062673	Rodeo Minor	11/20/03	879	1.77	I
Feather River	2000	062673	Rodeo Minor	11/20/03	781	1.77	I
Feather River	2000	062665	Wickland	11/21/03	804	1.0*	E-F
Feather River	2000	062665	Wickland	11/24/03	744	1.77	F
Feather River	2000	062664	Wickland	11/24/03	831	1.77	G

APPENDIX D, Table 2. (continued) Recoveries of adult fall-run Chinook salmon carcasses bearing coded-wire tags in Butte Creek during 2003.

Release				Recovery			
Stock	Brood Year	Tag Code	Site	Date	FL (mm)	Expansion	Butte Creek Reach
Feather River	2000	062676	Rodeo Minor	11/26/03	849	1.77	H
Feather River	2000	062665	Wickland	11/26/03	821	1.77	H
Feather River	2000	062664	Wickland	11/26/03	781	1.77	I
Feather River	2000	062664	Wickland	11/26/03	802	1.77	I
Feather River	2000	062675	Rodeo Minor	11/26/03	857	1.77	I
Feather River	2000	062664	Wickland	11/26/03	763	1.77	I
Feather River	2000	062665	Wickland	11/26/03	881	1.77	I
Feather River	2000	062664	Wickland	11/26/03	829	1.77	I
Feather River	2000	062941	Tiburon	11/26/03	680	1.77	I
Feather River	2000	062664	Wickland	11/26/03	782	1.77	I
Feather River	2000	062665	Wickland	12/02/03	747	1.77	F
Feather River	2000	062665	Wickland	12/02/03	741	1.77	G
Feather River	2000	062665	Wickland	12/02/03	769	1.77	G
Feather River	2000	062941	Tiburon	12/04/03	726	1.77	H
Feather River	2000	062664	Wickland	12/04/03	684	1.77	I
Feather River	2000	062664	Wickland	-	-	1.77	-
Feather River	2001	062090	Wickland	11/04/03	560	1.77	F
Feather River	2001	062090	Wickland	11/06/03	619	1.77	H
Feather River	2001	062091	Wickland	11/11/03	682	1.77	F
Feather River	2001	062090	Wickland	11/11/03	610	1.77	G
Feather River	2001	062090	Wickland	11/13/03	600	1.77	I
Feather River	2001	062090	Wickland	11/13/03	645	1.77	I
Feather River	2001	062091	Wickland	11/18/03		1.77	F
Merced River	1999	064404	S.J. River Jersey Pt	11/24/03	906	1.77	F
Merced River	2000	064435	S.J. River Jersey Pt	11/18/03	786	1.77	F
Merced River	2000	064434	S.J. River Jersey Pt.	11/18/03	874	1.77	F
Merced River	2000	064435	S.J. River Jersey Pt	11/20/03	758	1.77	H
Merced River	2000	064442	S.J. River Jersey Pt	11/19/03	862	1.0*	F
Merced River	2000	064434	S.J. River Jersey Pt	11/20/03	822	1.77	H
Merced River	2000	064434	S.J. River Jersey Pt	11/20/03	839	1.77	I
Merced River	2000	064441	S.J. River Jersey Pt	11/20/03	793	1.77	I
Merced River	2000	064434	S.J. River Jersey Pt	11/20/03	831	1.77	I

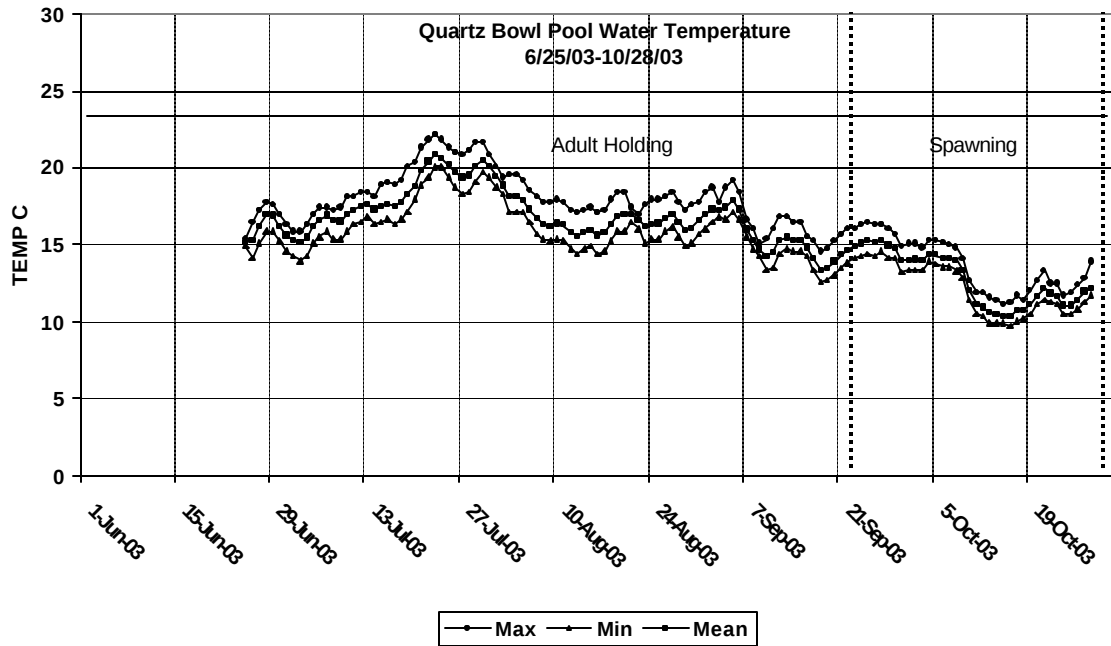
APPENDIX D, Table 2. (continued) Recoveries of adult fall-run Chinook salmon carcasses bearing coded-wire tags in Butte Creek during 2003.

Release				Recovery			
Stock	Brood Year	Tag Code	Site	Date	FL (mm)	Expansion	Butte Creek Reach
Merced River	2000	064434	S.J. River Jersey Pt	11/21/03	764	1.0*	D
Merced River	2000	064435	S.J. River Jersey Pt	11/24/03	762	1.77	F
Merced River	2000	064434	S.J. River Jersey Pt	11/24/03	805	1.77	F
Merced River	2000	064434	S.J. River Jersey Pt	11/24/03	920	1.77	G
Merced River	2000	064443	Old Fisherman's Club	11/26/03	860	1.77	I
Merced River	2001	064459	S.J. River Jersey Pt	12/02/03	689	1.77	F
Merced River	2000	064442	S.J. River Jersey Pt	12/04/03	719	1.77	I
Merced River	2001	064480	S.J. River Jersey Pt	11/13/03	546	1.77	H
Mokelumne River	1999	060254	Sherman Isle	11/26/03	878	1.77	I
Mokelumne River	2000	062714	West Sacramento	11/20/03	870	1.77	H
Mokelumne River	2000	062707	Benicia	11/20/03	946	1.77	H
Mokelumne River	2000	062714	West Sacramento	11/20/03	843	1.77	I
Mokelumne River	2000	060264	New Hope Landing	11/26/03	732	1.77	I
Mokelumne River	2000	062714	West Sacramento	11/26/03	746	1.77	I
Mokelumne River	2000	060269	North Fork Mokelumne	11/26/03	742	1.77	I
Mokelumne River	2000	062706	Benicia	11/26/03	840	1.77	I
Mokelumne River	2001	065863	S.J. River Jersey Pt	12/04/03	**	1.77	I

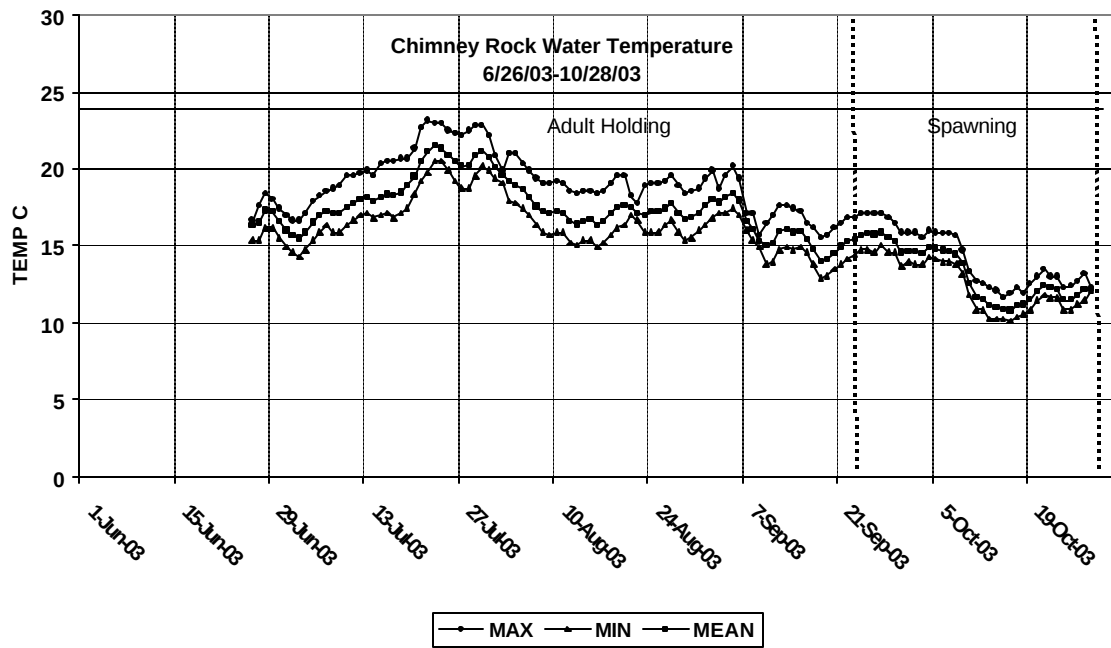
* Fish were found during surveys of SRCS spawning reaches.

** Field records were lost.

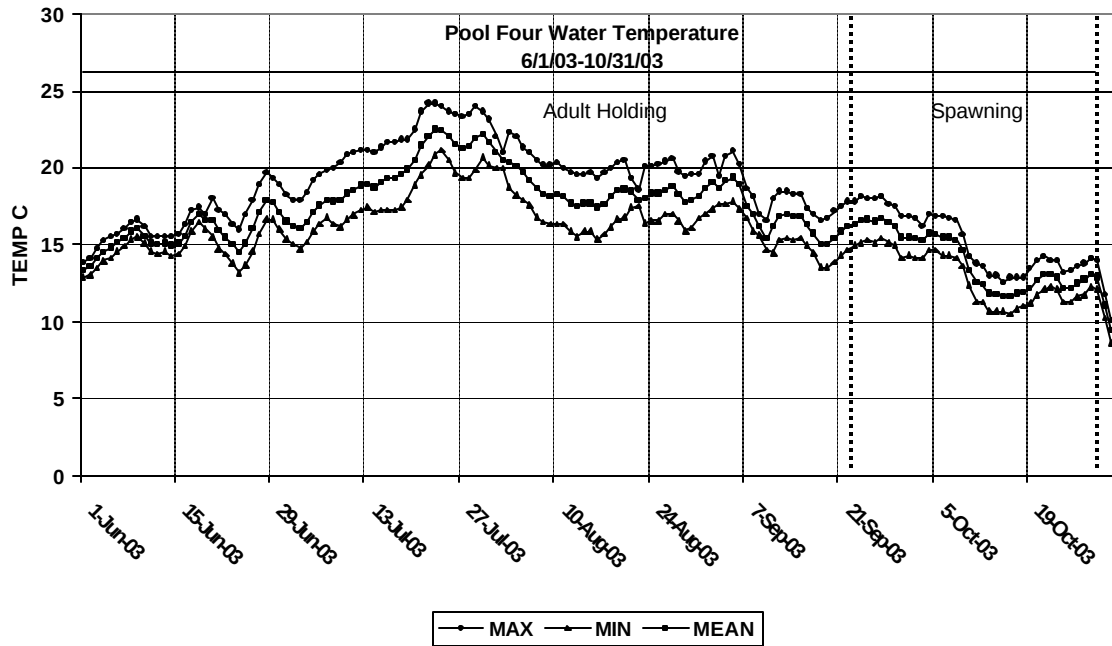
APPENDIX E, Figure 1. Butte Creek water temperature at Quartz Bowl pool.



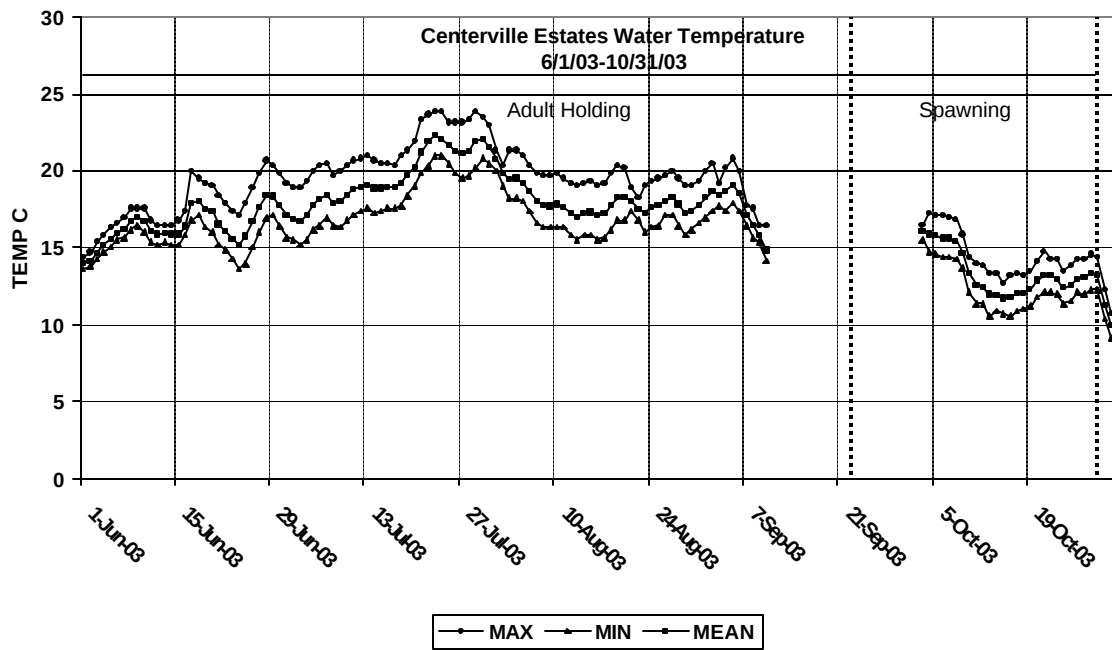
APPENDIX E, Figure 2. Butte Creek water temperature at Chimney Rock pool.



APPENDIX E, Figure 3. Butte Creek water temperature at Pool 4.



APPENDIX E, Figure 4. Butte Creek water temperature at Centerville Estates pool.



APPENDIX E, Figure 5. Butte Creek water temperature at Cable Bridge pool.

