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BUTTE AND BIG CHICO CREEKS SPRING-RUN CHINOOK SALMON, ONCORYHNCHUS TSHAWYTSCHA LIFE HISTORY INVESTIGATION 2001-2002

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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 2001 through December 2002.

For Butte Creek, there were 375,274 juvenile Chinook salmon captured near Chico, and 14,732 in the Sutter Bypass. There were 155,413 fish captured near Chico that were coded-wire-tagged, and 37 of the tagged fish recaptured in the Sutter Bypass traps. Average calculated growth rate for the Sutter Bypass recaptures was 0.38 mm/day, and the average time to recapture was 53 days. Juvenile Butte Creek spring-run were first captured in the Sutter Bypass trap on November 29, 2001. The adult spring-run Chinook salmon escapement estimate based upon the snorkel survey methodology used since 1991, was 8,785. An alternate estimate based upon the Schaefer model carcass survey methodology was 12,597. There were an estimated 3,431 pre-spawning mortalities that were not included in the escapement estimates. The pre-spawn and spawning carcass surveys recovered 19 Butte Creek coded-wire-tagged adults from BY 1998 (2) and BY 1999 (17). Based upon the 19 tag recoveries, the year 2001 population contained a minimum of 11% age-4 fish. Comparing the expanded recovery rate of ocean catch and inland escapement of BY 1998 taken during year 2001-2002 suggests an ocean catch rate of approximately 48%. There was one additional ocean recovery classified as age-5, from the small coded-wire-tag release group (393 fish) of BY 1998 fish tagged as yearlings; bringing the total recovered to 3 (expanded to 9.34). 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 Schaeffer model carcass survey of Butte Creek fall-run Chinook salmon estimated the population to be 3,415. There were 41 recoveries of coded-wire-tagged fish during the fall-run survey, all of which were from outside of the Butte Creek watershed, substantiating significant straying. The carcass surveys continue to demonstrate that Butte Creek spring- and fall-run spawning is separated in time and space.

For Big Chico Creek, there were 1,752 juvenile salmon captured near Chico, and the adult spring-run Chinook salmon escapement estimate based upon the snorkel methodology was zero.

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LIST OF ACRONYMS

Baldwin Construction Yard	BCY
Brood Year	BY
Coded-Wire-Tag	CWT
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 fourth 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 three previous reports, Hill and Webber (1999), Ward and McReynolds (2001), and Ward et al. (2002) summarized project results through October 2001. 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 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 the 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 of juvenile salmon collected at the 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 km^2 (809 mi^2) and has an unimpaired average annual yield of approximately 300,000 cubic decameters (dam^3) (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 (m^3/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 m^3/s (45,000 cfs) and 1,841 m^3/s (65,000 cfs), respectively. The capacity of the Sacramento River channel downstream of the Tisdale Weir at Wilkins Slough is approximately 850 m^3/s (30,000 cfs). These weirs have a combined capacity to pass approximately 3,766 m^3/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 km^2 (72 mi^2). 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 dam^3 (54,000 acre-feet). The watershed also encompasses three smaller drainages to the north including Sycamore, Mud, and Rock creeks.

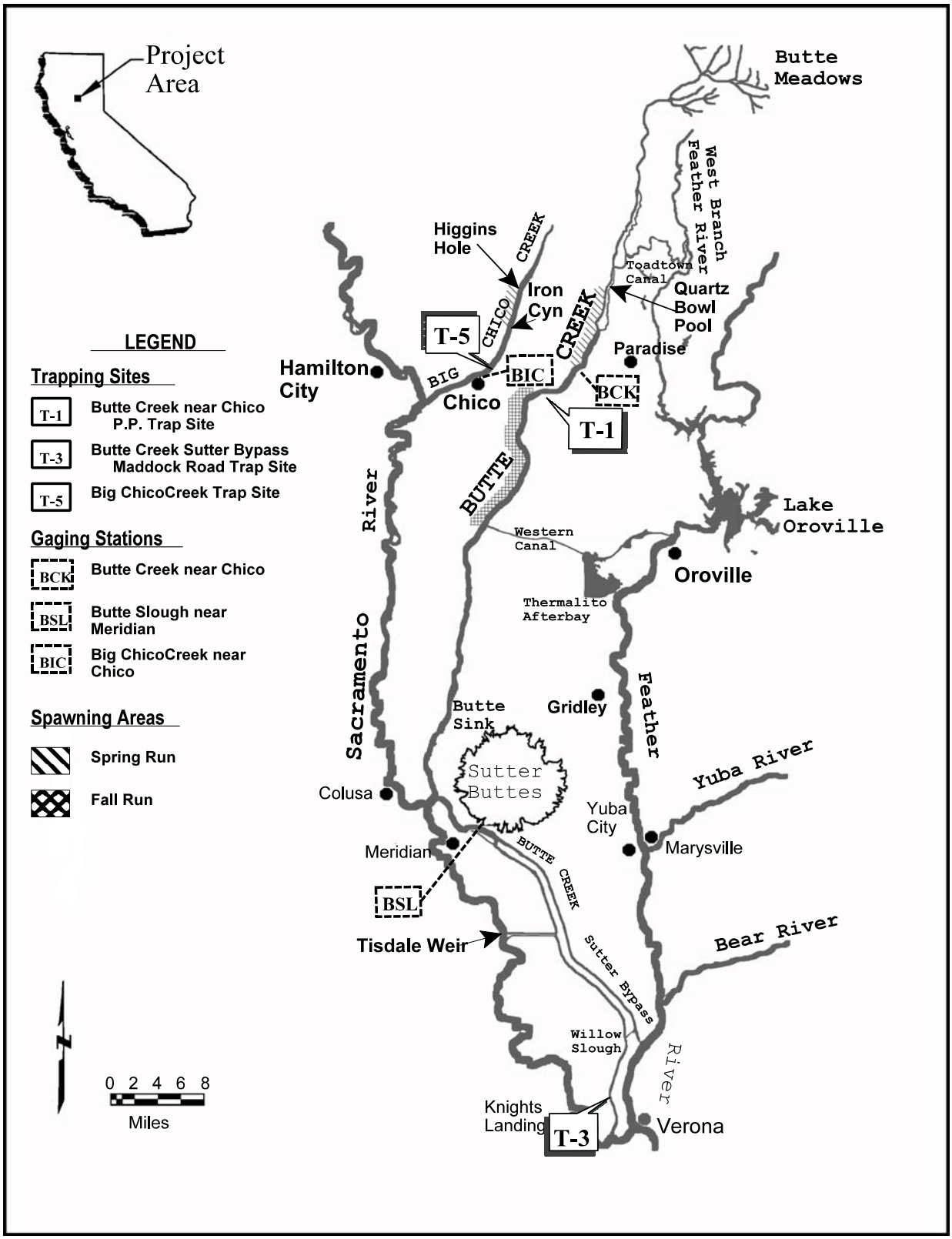

Figure 1. Butte Creek and Big Chico Creek watersheds with trap locations, gaging stations, and chinook spawning areas indicated.

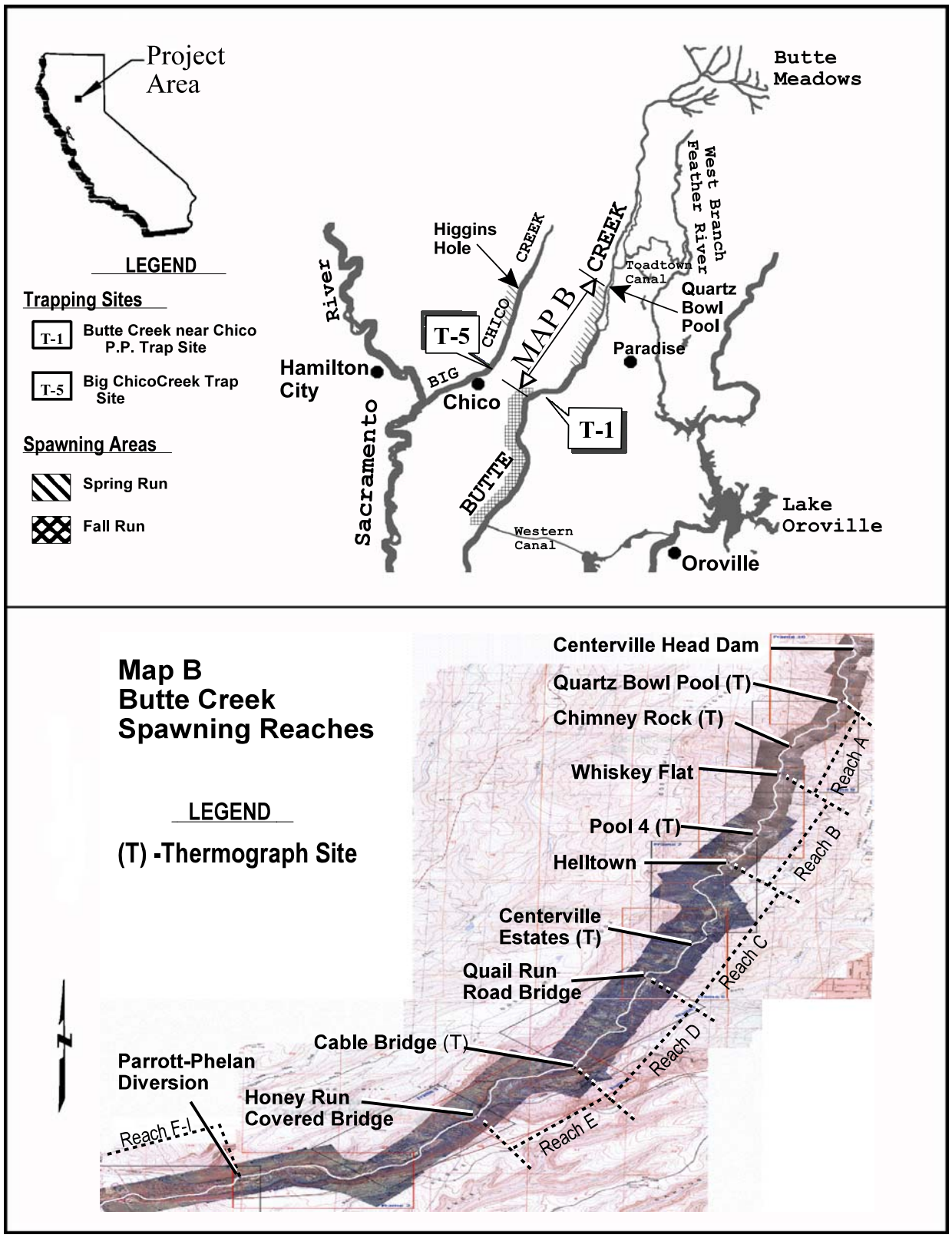

Figure 2. Butte Creek watershed showing fall-run and spring-run spawning areas. Map B shows the reach of Butte Creek from the Centerville Head Dam to the Parrott-Phelan Diversion Dam, indicating landmarks and stream sub-reach sampling areas.

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 T-1). 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 T-3). 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 (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 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 study does not include the coded-wire-tagging 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 ten of each non-salmonid fish species were 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 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 at the trapping site.

Salmon were transported via aerated buckets to the 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 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. No yearling SRCS were included in the sample tagged. Generally, tag codes were changed every five days or after use of an entire 10,000 coded-wire-tag spool.

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.

Growth

An estimate of relative growth was calculated using FL measurements from CWT recoveries at the Sutter Bypass site. Data collected were 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. 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 (($FL_{Recovery}$-$FL_{Release}$)/($d_{Recovery-Release}$)).

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 (Figure 2). On Big Chico Creek, the survey was from Higgins Hole to Iron Canyon (Figure 1). The survey was conducted over four days (August 12 – 16, 2002) each covering a discrete reach on Butte Creek, and on one day (August 8, 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 survey to identify pre-spawning mortalities was conducted during the period June 26, 2002 through September 19, 2002. 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. Due to budget and personnel constraints, each reach was covered only once during a two-week period. Two to four crew members walked downstream covering both sides of the creek. All carcasses were examined for an adipose fin-clip, and then chopped in half to avoid counting during subsequent trips. Carcasses classified as fresh (clear eye, firm flesh, red gills) were sexed and measured to the nearest mm FL. Heads were removed from adipose fin-clipped carcasses and returned to the office for recovery of the CWT.

Adult Spawning Carcass Survey

Adult spawning surveys using the Schaefer model (Schaefer, 1951) were completed for both SRCS and FRCS populations. This was the second 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 2002 SRCS spawning survey was conducted from September 17, 2001 through October 31, 2001. The survey extended from the 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. 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 numbered aluminum tag 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 and scale samples were taken from the first 20 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. Scale samples were collected using a knife, rubbing the skin directly behind and below the dorsal fin. If no scales were available, a second location was used. All scale samples were archived with the tissue samples for further genetic and age structure analysis. Adipose fin-clipped carcasses were measured to the nearest mm FL, tissue and scale samples collected, heads removed and a head tag number assigned with each head placed into a zip-lock bag. Heads were returned to the 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 and scale samples. 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".

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The 2002 FRCS carcass survey was conducted from October 21, 2002 through December 12, 2002. The survey extended from PPDD to the Gorrill Ranch Dam, also covering a ½-mi section near the Western Canal Siphon. The approximately 15.3 km (9.5-mi.) long stream section was divided into four reaches. Sampling techniques for the FRCS survey were the same as those used for the SRCS survey, except colored ribbons were used instead of the individually numbered tags.

Water Temperature

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

RESULTS

Butte Creek

Trapping Season 2001-2002

The 2001-2002 trapping season began at the PPDD when the diversion and rotary screw traps were installed on September 17, 2001. Both traps were operated until June 28, 2002. 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 375,274 juvenile salmon, including yearlings, was captured in both traps; 126,132 in the diversion screen trap and 249,142 in the screw trap (Tables 1 and 2). Of the total captured, 155,413 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 296,000 (79%) juvenile SRCS (Table 1 and 2) of the entire PPDD salmon catch occurred between December 1, 2001 and February 28, 2002. Trapping was suspended for various periods during December due to equipment damage, and in 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 17, 2001 to June 28, 2002.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)*		Total No. Captured	No. Trapping Days
9/15/01	9/30/01	102	-	102	102	2	14
10/1/01	10/15/01	-	-	-	-	0	15
10/16/01	10/31/01	107	8.9	94	118	9	16
11/1/01	11/15/01	68	36.9	30	127	35	15
11/16/01	11/30/01	36	16.0	27	113	628	14
12/1/01	12/15/01	37	15.9	29	132	1,943	6
12/16/01	12/31/01	-	-	-	-	0	**
1/1/02	1/15/02	35	3.6	31	112	11,323	13
1/16/02	1/31/02	36	4.5	31	114	3,390	16
2/1/02	2/15/02	35	1.5	31	46	41,346	15
2/16/02	2/28/02	35	3.1	31	100	35,965	13
3/1/02	3/15/02	36	1.9	30	43	5,941	15
3/16/02	3/31/02	38	8.8	32	70	2,812	16
4/1/02	4/15/02	41	8.1	32	77	3,052	15
4/16/30	4/30/02	54	11.7	30	97	3,790	15
5/1/02	5/15/02	63	8.9	31	101	6,044	15
5/16/02	5/31/02	66	6.4	43	100	8,974	16
6/1/02	6/15/02	70	6.5	48	91	850	15
6/16/02	6/28/02	72	6.0	61	82	28	13
					Total	126,132	257

* Yearling captures are included
** Trap was not operated due to equipment damage.

Table 2. Semi-monthly catch summary of spring-run Chinook salmon caught in the screw trap at Parrott-Phelan Diversion Dam from September 17, 2001 to June 28, 2002.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm) *		Total No. Captured	No. Trapping Days
9/15/01	9/30/01	-	-	-	-	0	14
10/1/01	10/15/01	108	1.4	107	109	2	15
10/16/01	10/31/01	117	9.8	104	132	8	16
11/1/01	11/15/01	95	26.4	29	131	101	15
11/16/01	11/30/01	42	24.5	28	121	303	14
12/1/01	12/15/01	39	18.4	29	128	1,594	9
12/16/01	12/31/01	35	7.5	30	114	12,627	14
1/1/02	1/15/02	35	5.8	30	124	4,430	12
1/16/02	1/31/02	36	4.7	32	120	6,735	16
2/1/02	2/15/02	35	3.5	30	93	98,733	15
2/16/02	2/28/02	36	5.8	32	116	79,605	13
3/1/02	3/15/02	36	4.0	31	106	7,789	15
3/16/02	3/31/02	37	5.7	31	116	6,859	16
4/1/02	4/15/02	42	9.2	30	124	4,848	15
4/16/02	4/30/02	56	11.4	34	93	7,535	14
5/1/02	5/15/02	61	7.6	36	93	7,324	15
5/16/02	5/31/02	65	6.7	46	100	9,663	16
6/1/02	6/15/02	70	6.3	48	84	951	15
6/16/02	6/28/02	72	5.1	59	82	35	12
					Total	249,142	271

* Yearling captures are included.

Sampling in the Sutter Bypass began on November 20, 2001 at the Maddock Rd. site (Figure 1). The trap fished until June 27, 2002. A total of 14,732 juvenile Chinook salmon was captured (Table 4). There was a total of 37 Butte Creek CWT recaptures in the Maddock Rd. trap, the first on January 23, 2002 and the last on May 18, 2002 (Table 5; Appendix C, Table 1). Additionally, there were 89 recaptures of CWT LFRCS fish released at CNFH between December 12, 2001 and January 30, 2002, and three WRCS released in the upper Sacramento River at the Redding Caldwell Park on January 30, 2002 (Appendix D, Table 1). The first CNFH CWT recapture was on January 18, 2002 and the last on March 2, 2002. Sampling by the USFWS at Chipps Island and Sherwood Harbor recovered six additional tagged Butte Creek fish from April 26, 2002 to May 5, 2002 (Table 6). Sampling by Hanson Environmental at Antioch recovered two tagged Butte Creek fish on April 23, 2002 and April 26, 2002 (Table 6). All fish were from BY 2001, captured at PPDD and tagged at the BCY between January 7, and May 29, 2002.

Table 3. Summary of coded-wire tagged spring-run Chinook salmon released at Baldwin Construction Yard from January 7, 2002 to May 29, 2002.

Tag code	Release Date Range		Mean FL (mm)	Range FL (mm)		Total Released
06-01-00-00-07	01/07/02	01/11/02	35	32	52	8,670
06-01-00-00-08	01/11/02	01/17/02	35	32	38	6,296
06-01-00-00-09	02/11/02	02/13/02	35	32	39	9,486
06-01-00-01-00	02/11/02	02/13/02	35	32	39	10,184
06-01-00-01-01	02/12/02	02/15/02	35	32	39	9,391
06-01-00-01-02	02/13/02	02/15/02	35	32	39	9,472
06-01-00-01-03	02/13/02	02/18/02	35	32	39	9,089
06-01-00-01-04	02/15/02	02/19/02	35	32	39	10,238
06-01-00-01-05	02/15/02	02/19/02	35	32	39	10,642
06-01-00-01-06	02/18/02	02/27/02	35	33	38	9,755
06-01-00-01-07	02/27/02	03/27/02	36	32	45	9,645
06-01-00-01-08	02/27/02	05/14/02	36	32	49	5,111
06-01-00-01-09	03/04/02	05/15/02	45	32	76	9,750
06-01-00-02-06	01/29/02	01/31/02	35	33	45	5,899
06-01-00-02-07	01/29/02	01/31/02	36	32	45	3,422
06-01-00-02-08	02/05/02	02/07/02	36	32	41	5,658
06-01-00-02-09	02/07/02	02/12/02	35	32	41	5,556
06-01-00-03-00	02/19/02	02/26/02	35	33	38	5,507
06-01-00-03-01	02/19/02	02/27/02	35	32	38	5,588
06-01-00-03-08	03/27/02	05/13/02	51	35	78	3,883
06-01-00-03-09	05/13/02	05/29/02	64	54	73	2,171
						155,413

Table 4. Semi-monthly catch summary of juvenile Chinook salmon caught in the screw trap in the Sutter Bypass at Maddock Road from November 20, 2001 to June 27, 2002.

Trapping Period *		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
11/20/01	11/30/01	74	-	74	74	1	8
12/01/01	12/15/01	73	29.0	34	132	11	7
12/16/00	12/31/01	55	23.6	30	116	28	11
1/1/02	1/15/02	37	7.8	31	161	529	11
1/16/02	1/31/02	58	35.0	34	169	4,507	16
2/1/02	2/15/02	50	13.7	34	180	3,316	15
2/16/02	2/28/02	54	13.8	34	180	1,337	13
3/1/02	3/15/02	60	14.3	33	176	694	15
3/16/02	3/31/02	81	12.1	37	131	560	16
4/1/02	4/15/02	80	10.4	42	111	1,041	15
4/16/02	4/30/02	78	8.7	42	114	1,201	15
5/1/02	5/15/002	72	6.3	55	110	1,138	13
5/16/02	5/31/02	67	4.7	55	87	368	16
6/1/02	6/15/02	70	-	70	70	1	11
6/16/02	6/28/02	-	-	-	-	-	11
					Totals	14,732	193

* 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 upper Sacramento River.

Table 5. Recaptures of BY 2001 Butte Creek spring-run Chinook salmon bearing coded-wire tags in the Sutter Bypass at Maddock Rd.

Tag Code	Total no. Captured**	Average FL (mm)	Average Days at Large	Average mm/d
06-01-00-00-07	3	37	16	0.12
06-01-00-00-08	6	54	48	0.40
06-01-00-00-09	1	69	71	0.43
06-01-00-01-00	3	57	51	0.38
06-01-00-01-01	4	73	71	0.54
06-01-00-01-03	1	75	67	0.60
06-01-00-01-04	2	77	73	0.58
06-01-00-01-05	1	75	74	0.54
06-01-00-01-06*	3	58	-	-
06-01-00-01-07*	2	68	-	-
06-01-00-01-08*	1	65	-	-
06-01-00-01-09*	2	72	-	-
06-01-00-02-06	2	37	11	0.18
06-01-00-02-08	3	76	82	0.49
06-01-00-03-00*	1	63	85	0.33
06-01-00-03-08*	2	70	-	-
Total	37			

* Days-at-large and average mm/d were not calculated because release period exceeded seven days.
** All fish were from BY 2001 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 2002.

Recovery Date	Tag Code*	Recovery FL (mm)	mm/day	Recapture Location	Days at Large
4/23/02	06-01-00-02-08	83	0.61	Antioch	77
4/26/02	06-01-00-00-08	80	0.44	Chipps Island	103
4/26/02	06-01-00-01-02	88	0.74	Antioch	72
4/26/02	06-01-00-01-04	70	0.51	Sherwood Harbor	69
4/26/02	06-01-00-02-08	79	0.54	Sherwood Harbor	80
4/27/02	06-01-00-02-06	77	0.75	Chipps Island	87
5/1/02	06-01-00-03-01	84	0.48	Chipps Island	68
5/5/02	06-01-00-03-01	76	0.57	Chipps Island	72

* All fish were from BY 2001 and tagged at Baldwin Construction Yard.

Juvenile Emigration 2001-2002

As discussed in previous reports (Hill and Webber, 1999; Ward and McReynolds, 2001; Ward, et al., 2002), YOY and yearling juvenile SRCS outmigrants were documented based upon the FL of juvenile salmon captured at PPDD. During this study trapping period (September 2001 through June 2002), the majority of Butte Creek SRCS that were captured migrated as fry during high flows in December and 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, 257 yearling SRCS were captured. Yearling SRCS were seen as early as September 27, 2001 and the last on May 30, 2002 at a length of 100 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.

Growth 2001-2002

Fish tagged at PPDD and recovered in the Sutter Bypass continue to provide a basis for estimating mean growth. Growth calculations were based upon recoveries from 11 tag groups released between January 29, 2002 and February 15, 2002 (Table 5; Appendix C, Table 1). Fish recovered varied in length from 36 mm FL to 81 mm FL and averaged 60 mm FL. Fish recovered from all tag groups for the period were at large an average of 59 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 study period (Ward and McReynolds, 2001), the interval for which a specific tag code was used was reduced and varied from 4 to 39 days. During the 2000-2001 study period (Ward et al., 2002), intervals for each specific tag code release varied from 1 to 17 days; however, growth calculations were based only upon tag release groups with a duration of four days or less. During this study period, growth calculations were based only on release groups with duration of seven days or less. The growth calculation was based upon the mean FL of a measured sub-sample (30 fish) for each tag group.

Adult Escapement 2002

Pre-spawning Mortality Carcass Survey

From June 26, 2002 through September 19, 2002 a total of 1,699 carcasses was examined (65% female, 35% male). Additionally, three adipose fin-clipped carcasses were collected with one age- 4 fish (BY98) and two age-3 fish (BY99). 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 second intensive survey directed at recovering CWTs from previous release groups was conducted. A spawning carcass survey was begun on September 17, and continued through October 24, 2001 and covered the 17.7 km (11 mi.) SRCS spawning area (Figures 1 and 2). During the SRCS spawning carcass survey, 6,226 carcasses were examined. A total of 16 CWT's was recovered: 1 from BY 1998 and 15 from BY 1999 (Appendix E, Table 1). Additionally, three CWT's were recovered during the pre-spawning mortality carcass survey within the SRCS spawning area during the period June through September 2002. For those carcasses recovered during the SRCS spawning period, an expansion factor of 2.02 was calculated based upon the Schaefer model population estimation methodology. In addition to the Butte Creek carcass recoveries, 16 tags were recovered in the ocean fishery, one of which was 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 21 through December 12, 2001. A total of 41 coded-wire tags was recovered (Appendix E, Table 2) from 1,455 carcasses that were examined. An expansion factor of 2.35 was calculated based upon the Schaefer model population estimation methodology.

Snorkel Escapement Survey

The 2002 SRCS adult escapement estimate based upon the snorkel survey method was 8,785 (Table 7). Of the 1,699 pre-spawning mortalities, 1,102 occurred prior to the snorkel survey. Subsequently, these carcasses are in addition to the snorkel estimate. Due to the long sampling interval for pre-spawning mortalities and no systematic basis for calculating a sample expansion factor, the count of 1,102 is likely significantly understating the actual number.

Table 7. Estimates of adult spring-run Chinook salmon escapement in Butte Creek from snorkel surveys conducted annually from 1994 through 2002.

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

Water Temperatures 2001-2002

Thermal recording data loggers installed at the five sites within the SRCS holding and spawning reach of Butte Creek (Figure 2, Map B) recorded average daily temperatures which ranged as high as 23.5° C on July 14, at the Cable Bridge location (Table 8; Appendix F, Figures 1 - 5). Summer temperatures at all sites were above 15.0° C until the first 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	6/01/02 to 10/22/02	105	57	8
Chimney Rock	6/01/02 to 10/22/02	113	68	18
Pool 4	6/01/02 to 10/29/02	121	81	41
Centerville Estates	6/01/02 to 10/29/02	122	81	44
Cable Bridge	6/01/02 to 10/29/02	127	99	54

Big Chico Creek

Trapping Season 2001-2002

The 2001-2002 trapping season began November 14, 2001. The 1.5 m (5 ft.) rotary screw trap was installed near the Bidwell Park Municipal Golf Course. The trap fished until May 30, 2002. A total of 1,752 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 14, 2001 to May 30, 2002.

Trapping period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
11/14/01	11/30/01	-	-	-	-	-	16
12/01/01	12/15/01	36	-			1	7
12/16/00	12/31/01	34	1.6	31	37	11	14
1/1/02	1/15/02	36	3.2	34	42	5	12
1/16/02	1/31/02	42	1.4	41	43	2	16
2/1/02	2/15/02	33	-	33	33	1	15
2/16/02	2/28/02	36	-	36	36	1	12
3/1/02	3/15/02	35	1.5	31	38	279	15
3/16/02	3/31/02	36	2.8	31	87	803	16
4/1/02	4/15/02	39	5.8	30	88	224	15
4/16/02	4/30/02	55	9.6	34	92	186	15
5/1/02	5/15/002	55	13.2	31	84	185	15
5/16/02	5/31/02	66	7.9	41	82	54	13
					Total:	1,752	181

Adult Escapement 2002

The 2002 Big Chico Creek adult escapement estimate based upon the snorkel survey method is zero (Table 10). Prior to the survey, project personnel observed approximately 40 adult SRCS, which apparently perished during the summer.

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

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 eight days out of the 271-day trapping season.

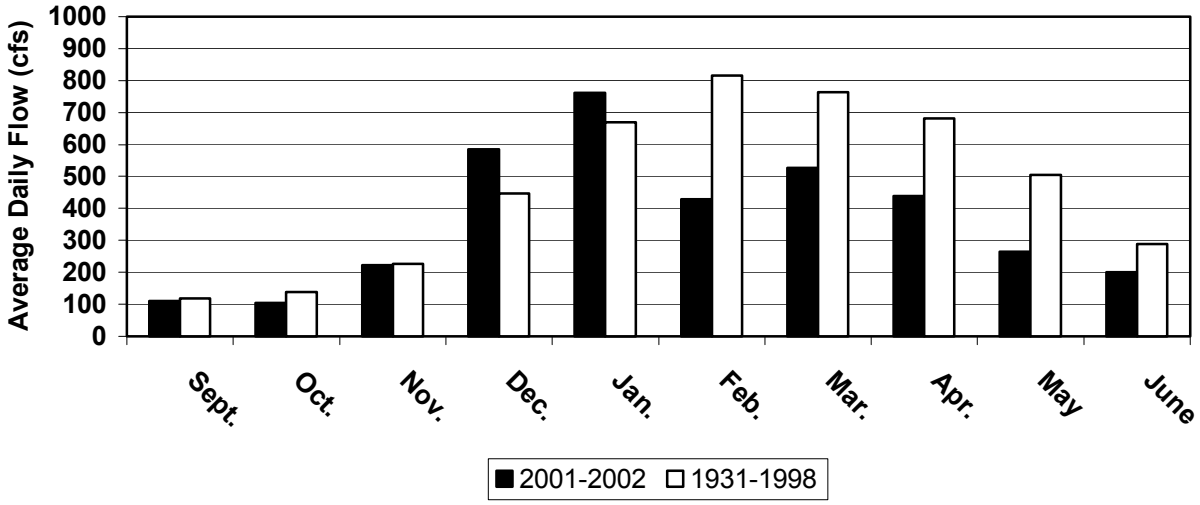
Juvenile Emigration

Results from this study continue 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 (Ward et al. 2002); this is further demonstrated by the recovery of an additional age-5 fish in the ocean sport fishery during 2002.

During this study period, juvenile emigration was more protracted and was similar to the 2000-2001 trapping season (Ward et al., 2002). Earlier project observations found that >95% had emigrated by the end of January (Hill and Webber, 1999; Ward and McReynolds, 2001). During this study, 320,159 juvenile SRCS, at an average size of 36 mm FL, were captured between December 1, 2001 and March 31, 2002. This represented 85% of the total for the year. An additional 55,115 juveniles (15% of the total) were captured between April 1 and June 30, 2002, at an average size for each semi-monthly period that varied between 41 and 72 mm FL. This more protracted emigration pattern is likely the result of lower more stable flows (Figure 3). Butte Creek did not exceed 1,000 cfs after mid-January 2002 (Appendix A, Figure 1, CDWR, 2002). Recently emerged fry were captured at PPDD from November through May 2002 (Appendix B, Figure 1). As with previous years (Hill and Webber, 1999; Ward and

McReynolds, 2001), 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 the numbers were generally small. Fry captured at the site from November through March were assumed to be SRCS.

Figure 3. Comparison of Butte Creek average flows during 2001-02 with average flows during the period 1931-1998 (CDWR, 2002).



There were 257 SRCS captured at PPDD during the entire trapping period identified as yearlings. The first yearling was captured on September 27, 2001, and the last on May 30, 2002. Unlike previous years, few yearling salmon were observed upstream of PPDD during the summer adult escapement survey. Of the 257 fish captured, that were classified as yearling SRCS, 9 % (24 fish) were within the Fisher length criteria for WRCS. However, there are no recorded observations of WRCS spawning in Butte Creek, and if WRCS did spawn water temperatures are too high for incubation.

A total of 37 Butte Creek SRCS juveniles were CWT marked at the BCY site and subsequently recaptured at the Maddock Rd. site, within the Sutter Bypass (Table 5). The earliest recaptures occurred on January 23, 2002, when two SRCS, 35 and 36 mm FL, released between January 7-11, 2002, were captured. The latest recaptures were on May 18, 2002, when two SRCS, 63 and 64mm FL, released between February 19 and May 13, 2002, were captured. The average days at large calculated for all fish marked at BCY and recaptured in the Sutter Bypass trap was 59 days. This study period continues to support the apparent value of the Sutter Bypass as a major nursery area.

During this evaluation period, the Sacramento River overflowed into the Sutter Bypass at either or both the Colusa and Tisdale Weirs a total of 21 days (Appendix A, Figure 2). The Sacramento River first overflowed into the Sutter Bypass via the Colusa/Tisdale Weirs on December 21, 2001, and for the last time on February 22, 2002. There were 22 juvenile Butte Creek SRCS captured prior to overflows from the Sacramento River. The first was on November 29, at 74

mm FL, with the size range for the entire group 30-132 mm FL. These early captures prior to overflows from the Sacramento River demonstrate that juvenile Butte Creek SRCS of all age classifications (fry, YOY, yearling) are migrating into the Sutter Bypass during the fall. This early migration appears to be the result of storm induced flow increases, as first occurred on October 30, 2002 (Appendix A, Figure 1). There were 92 recaptures of CWT fish from the upper Sacramento River marked by the USFWS (Appendix D, Table 1). Eighty-nine were CNFH LFRCS released in Battle Creek and three were LSNFH WRCS released at Caldwell Park. Average time at large for the group from date of release to date of recapture was 20 days. All fish were released during the high flow events of December and early-January. The fish entered the Sutter Bypass during spills at the Colusa and Tisdale Weirs. All USFWS marked salmon exited the Sutter Bypass by the end of February (Appendix D, Table 1). Unlike during previous years (Hill and Webber, 1999; Ward and McReynolds, 2001; and Ward, et al., 2002), flows in the Bypass diminished and were relatively stable after January leading to an earlier exit of rearing salmon.

Eight Butte Creek origin CWT recaptures were from other sampling efforts downstream of the Sutter Bypass (Table 6). Four were captured by the USFWS at Sherwood Harbor near Sacramento and two at Chipps Island. Two were captured by a private consultant (Hanson Environmental at Antioch). All recaptures occurred from late April to early May. Average time at large from release at BCY to recapture was 79 days at all three sites. As previously observed, the number of days at large is only slightly longer than the average time at large from BCY to the Sutter Bypass trap. This suggests that fish that exit the Sutter Bypass move rapidly downstream and do not use the mainstem Sacramento River for rearing.

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

During this study period, fish tagged at BCY at an average size of 38 mm FL were recovered in the Sutter Bypass at an average of 64 mm FL. The average number of days at large for all BCY recoveries was 59 days. There were 37 recaptures in the Sutter Bypass of fish tagged at BCY; however, only 26 of the fish recovered that were from groups with tagging duration of less than seven days were used for growth calculations. Average calculated growth rate was 0.38 mm/d. Fish tended to exit the Bypass earlier than previously observed, apparently due to lower more stable spring flows. This growth rate is slightly lower than found during 2000 and 2001 (Ward and McReynolds, 2001; Ward, et al., 2002); and is significantly less than found in 1996-1998 (Hill and Webber, 1999).

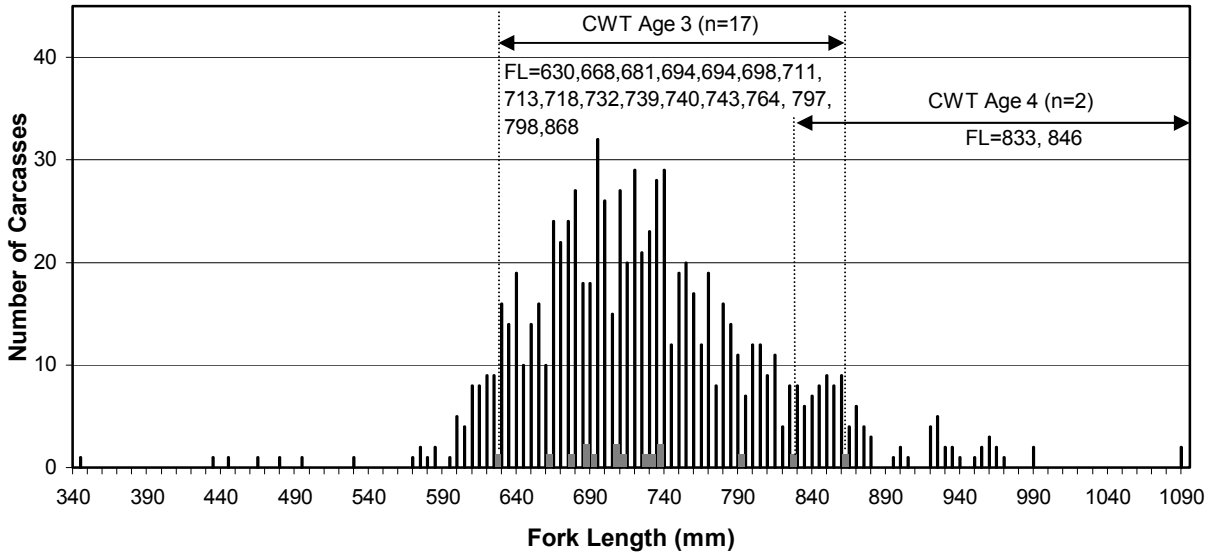
Adult Escapement

Once again, the adult escapement estimate was based upon a snorkel survey of the entire summer holding area (Table 7). 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 study period, for the second time an intensive carcass survey was conducted with the primary objective of recovering CWT's from returning adults. A secondary benefit of the effort was an alternate population estimate based upon a standardized carcass survey methodology utilizing the Schaefer model (Schaefer, 1951). The year 2002 escapement estimate based upon the snorkel survey was 8,785 with a range from 6,763 to 10,721. This estimate is lower than the year 2001 estimate of 9,605. However, based upon adults returning as three year olds, this represents a cohort replacement rate of 2.39 from the parent 1999 generation, which was 3,679. However, the carcass survey results for 2002 would suggest a larger population. There were 6,226 carcasses examined of which 855 fresh carcasses (52% female, 48% male) were marked with individually numbered tags and returned to the water, with a subsequent recovery of 431, or a recovery rate of approximately 50%. Therefore, a simple Petersen estimate (Ricker, 1975) would suggest that the total population was approximately 11,511, while the Schaefer model estimate was 12,597. The carcass survey estimates did not include 1,699 pre-spawning mortalities which occurred prior to the survey. Due to the long sampling interval for pre-spawning mortalities, and no basis for calculating a sample expansion factor, the count of 1,699 is likely significantly understating the actual number.

Pre-spawning mortality surveys of the entire SRCS holding and spawning area were conducted beginning on June 26, 2002, and the last on September 19, 2002. There were 1,699 pre-spawning mortalities observed. Of the 604 carcasses that were measured and sexed, 65% were female and 35% male. Higher than normal water temperatures (Table 8; Appendix F) in conjunction with the large number of SRCS resulted in an outbreak of Columnaris (*Flavobacterium columnare*) as confirmed by a Department of Fish and Game pathologist (Maret, 2002). Due to a lack of funding, the pre-spawning mortality survey was conducted only every other week, and no attempts were made to establish an expansion factor. A conservative estimate of the total number of pre-spawning mortalities was generated by expanding the actual number of pre-spawn mortality carcasses counted by the expansion factor generated from the later Schaeffer model spawning survey. That expansion factor was calculated as 2.02, resulting in an estimate of 3,431 (1,699 x 2.02) pre-spawning mortalities. Pre-spawning mortalities in Butte Creek have been reported in the past (Salo, 1960), and have been sporadically recorded during the current investigation, but have never been systematically assessed.

There were 37 recoveries of Butte Creek tagged SRCS adults during this evaluation period, (BY 1998 - 3, BY 1999 - 32, BY 2000 - 2), with 18 from the ocean sport/commercial catch and 19 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 two brood years: 1998 (2), and 1999 (17). This would suggest an age composition of 11% age-4, and 89% age-3.

Figure 4. Length frequency distribution of 855 adult spring-run Chinook salmon carcasses measured and marked for abundance estimate between September 17, 2002 and October 24, 2002.



Ocean recoveries during 2002 (Appendix E, Table 1) extended from March through September, and all were taken from Monterey, California, 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 were two age-3, 13 age-4, and one age-5. This evaluation supports the conclusion that some proportion of Butte Creek SRCS return at age-4 (Ward and McReynolds, 2001; Ward et al., 2002). Comparing the expanded BY 1998 ocean and inland recoveries (Appendix E, Table 1) suggests a 48% ocean sport/commercial catch rate. Comparing expanded BY-1999 ocean and inland recoveries through age-3 would suggest a 58% ocean sport/commercial catch rate. Cramer and Demko (1997) estimated that 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. As reported during 2001 (Ward et al., 2002), two of the seven 2001 ocean recoveries were from a small release group of 393 BY 1998 yearling Butte Creek SRCS (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. During 2002, there was one additional recovery from the same tag group (Appendix E, Table 1) taken in the Monterey fishery and classified as ocean age-5. None of the yearling releases was seen in the Butte Creek carcass survey. Re-examining the 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 (9.34 recoveries from 393 marked) shows a contribution rate that is approximately 109 times higher for yearlings. However, the overall contribution of fry is approximately 2.5 times that of yearlings based upon the significantly larger number of fry.

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

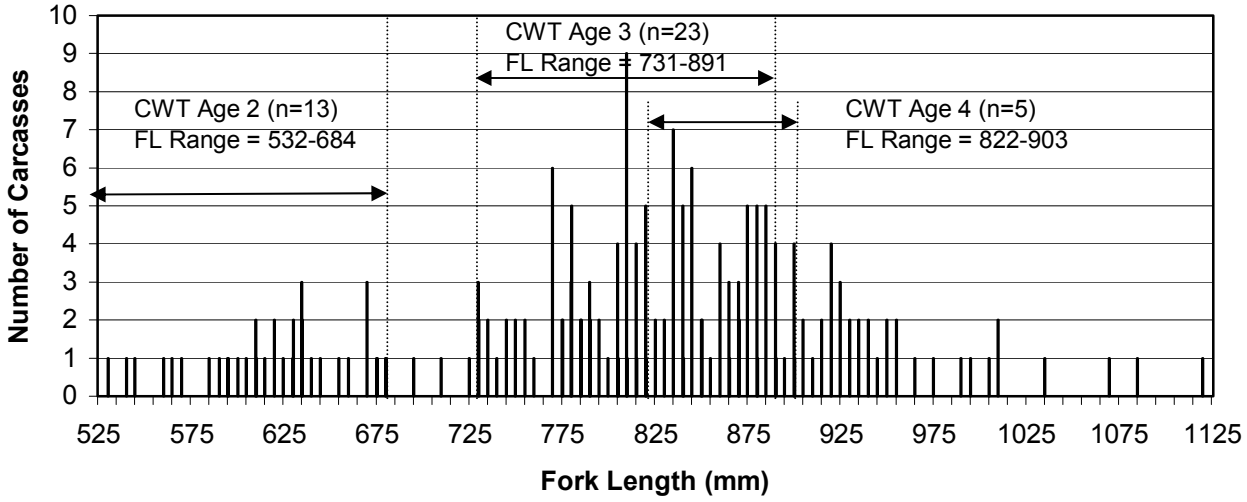
Source	Inland Age	Ocean Age	Number Recovered		Expanded Number Recovered	
			Ocean	Inland	Ocean	Inland
Sport	2	3	1		3	
Sport	3	4	3		14	
Sport	4	5	1		3	
Commercial	3	3	1		4	
Commercial	3	4	3		8	
Spawn	3			13		29
Pre-Spawn	3			1		2
Spawn	4			1		2
Pre-Spawn	4			1		2
Total			9	16	32	35

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		7	
Commercial	3	3	1		3	
Commercial	3	4	11		36	
Spawn	2			1		2
Spawn	3			15		30
Pre-Spawn	3			2		4
Total			15	18	50	36

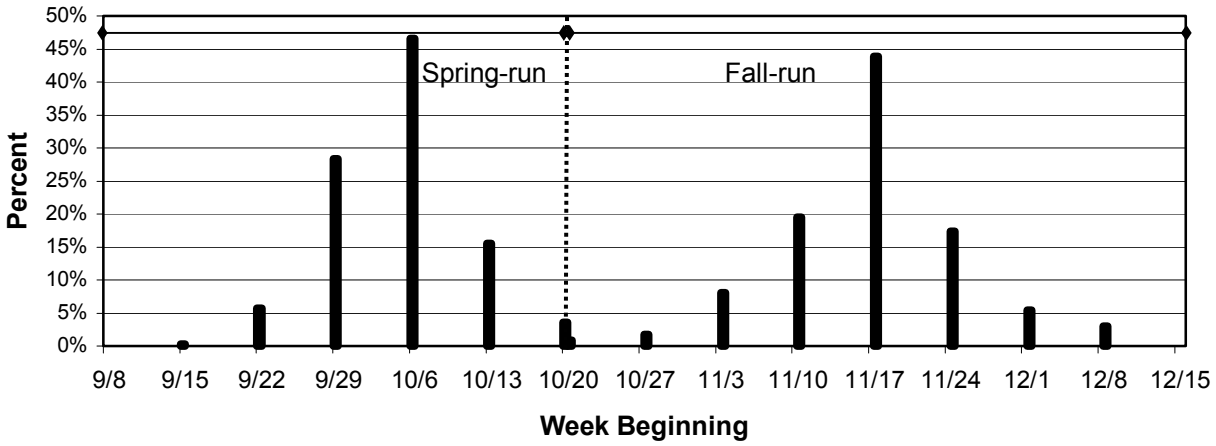
Subsequent to the SRCS carcass survey, a FRCS carcass survey was initiated on October 21 and continued through December 12, 2002. The FRCS survey covered the reaches of Butte Creek downstream of the PPDD (Figure 2, Map B). A bar rack was placed in the fish ladder at the PPDD on September 25, 2002, to reduce the number of FRCS moving upstream of the site, although some small number of FRCS ascended and spawned above. The bar rack was removed on December 6, 2002. Using the technique of the Schaefer model, 1,455 carcasses were examined, with 176 of the fresh carcasses marked with colored ribbons of which 84 were subsequently recovered. For 2002 the Schaefer model estimate for FRCS was 3,415 fish which spawned in the reach downstream of the PPDD. Limited visual observations of spawning adults estimated that approximately 250 FRCS spawned upstream of the PPDD. There were 41 CWT marked carcasses recovered during the FRCS carcass survey (Appendix E, Table 2). All CWT recoveries were from fish natal to other watersheds with a majority from the Merced River.

Figure 5. Length frequency distribution of 176 adult fall-run Chinook salmon carcasses measured and marked for abundance estimate between October 21, 2002 and December 12, 2002.



Comparison of Butte Creek SRCS and FRCS spawning timing (Figure 6) 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 17, 2001. Additionally, all Butte Creek SRCS spawned above PPDD (Figure 2, Map B), while the large majority of FRCS spawned downstream of that site.

Figure 6. Percent of carcasses of spawned spring- and fall-run Chinook salmon recovered for period September 17, 2002 through December 12, 2002.



The results from the 2001-02 study period continue 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 (Appendix F, Figures 1-5). In general, temperatures for holding adult SRCS should not exceed 15° C (59° F) (Hinze, 1959; Boles, 1988; CDFG, 1998). Continuously recording data loggers 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 the last week of September. Similar temperatures were previously recorded by P.G. & E (1993). Temperatures exceeded 17.5°C as early as June 23rd and exceeded 20°C for eight days during the holding period at Quartz Bowl Pool.

ACKNOWLEDGMENTS

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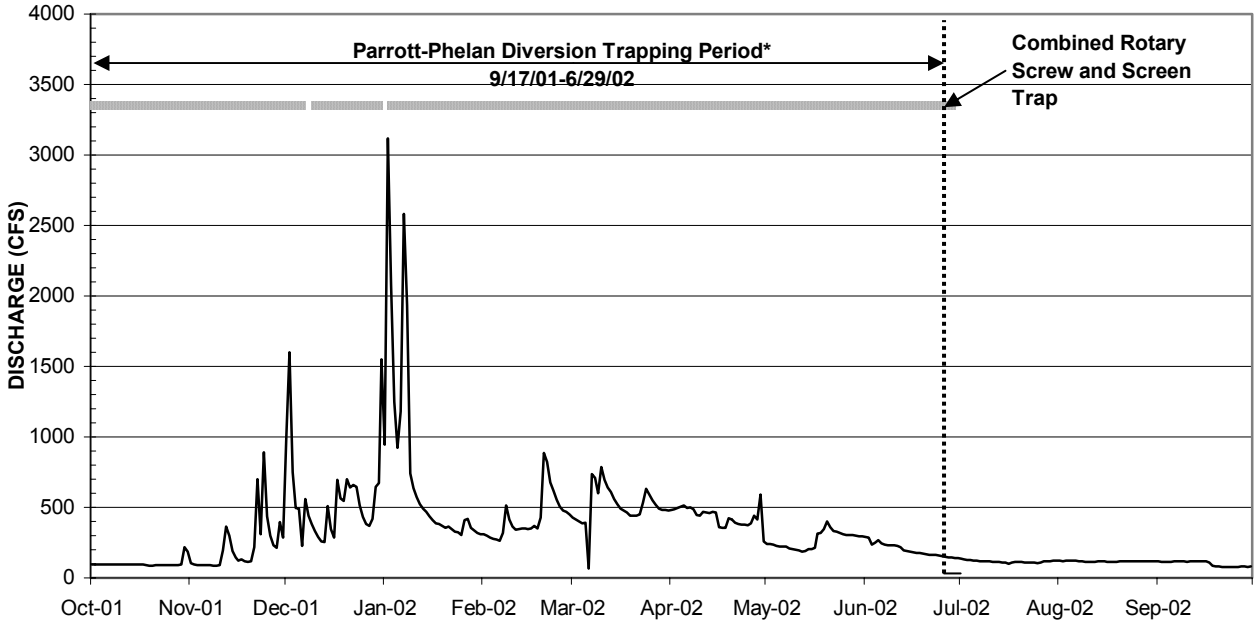
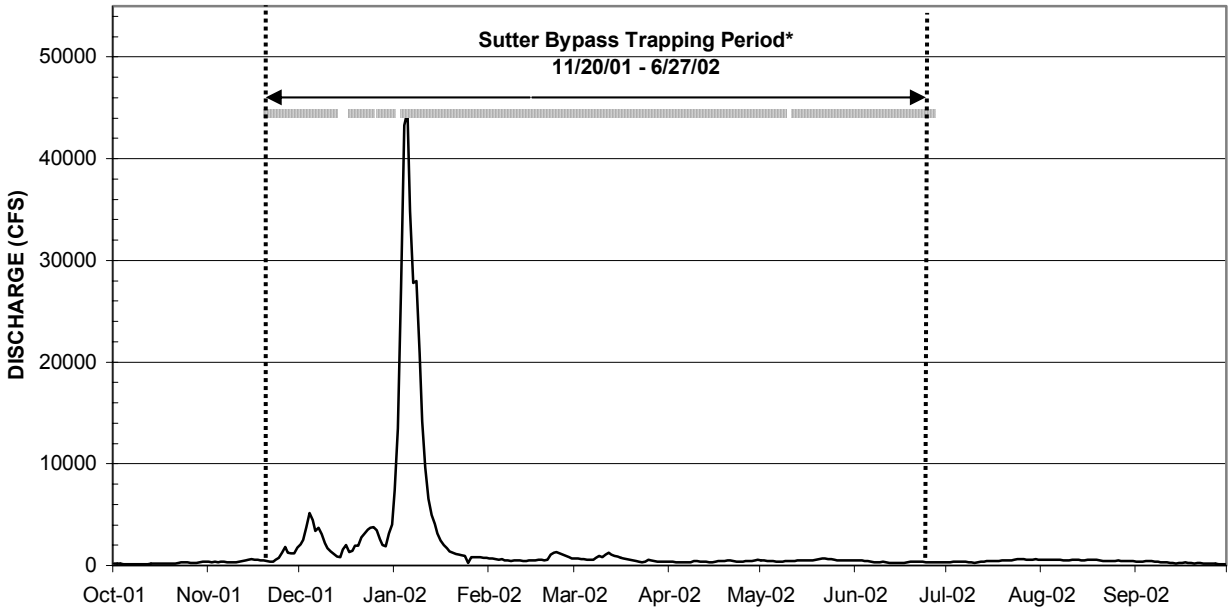
APPENDIX A, Figure 1. Butte Creek flow at Butte Creek near Chico Gage (USGS - #11390000), water year 2001-02, with trapping period shown. Flow data are provisional and subject to revision

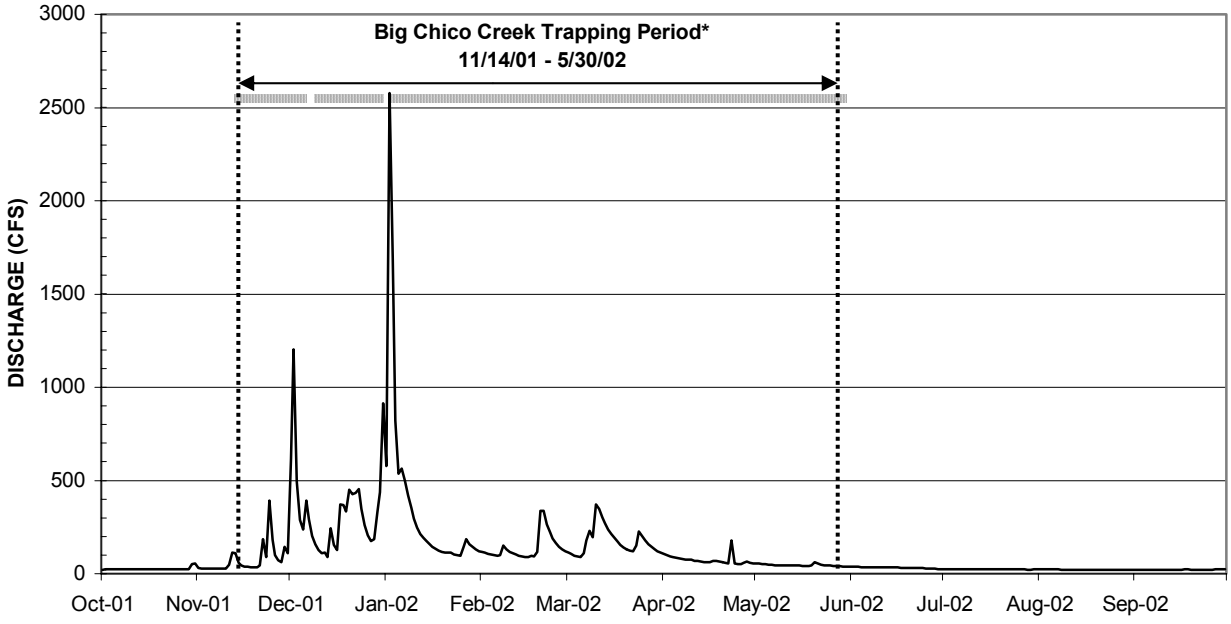


APPENDIX A, Figure 2. Butte Creek flow at Sutter Bypass Butte Slough near Meridian Gage (DWR A20972), water year 2001-02, with trapping period shown Flow data are provisional and subject to revision



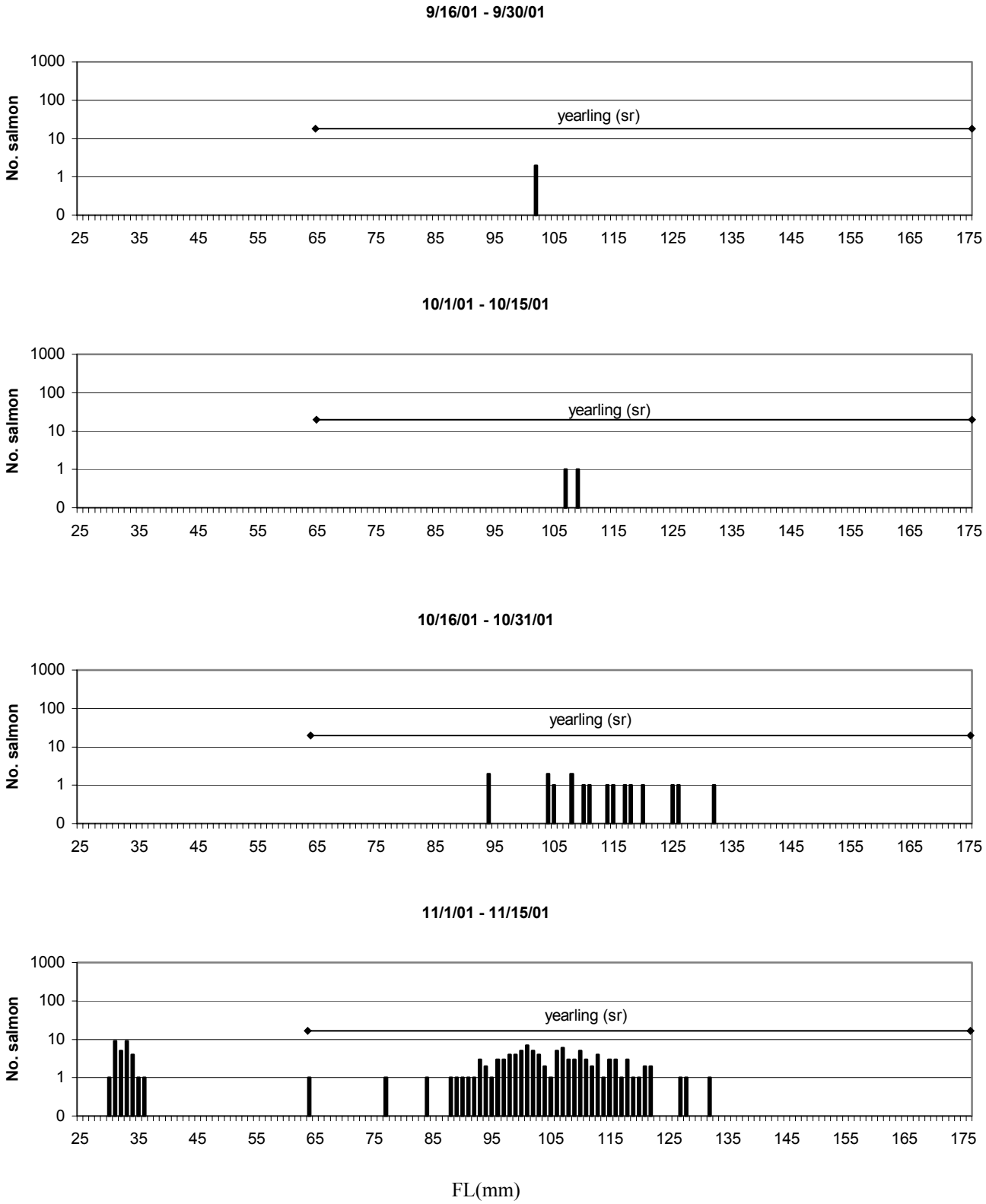
*Breaks in horizontal line indicate periods of time when the trap(s) were not fishing

APPENDIX A, Figure 3. Big Chico Creek flow at Big Chico Creek near Chico Gage (DWR #42105), water year 2001-02, with trapping period shown. Flow data are provisional and subject to revision

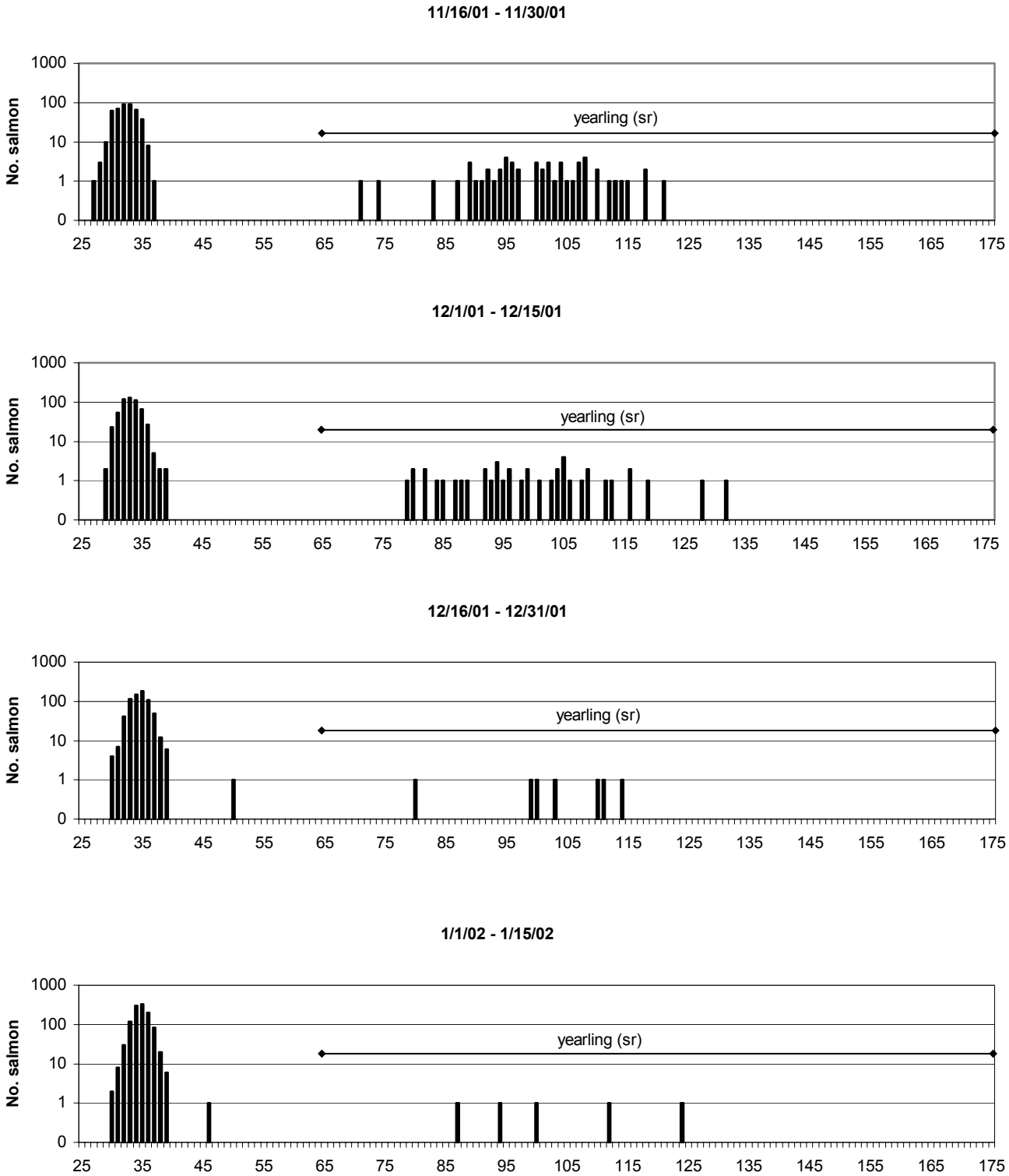


*Breaks in horizontal line indicate periods of time when the trap(s) were not fishing

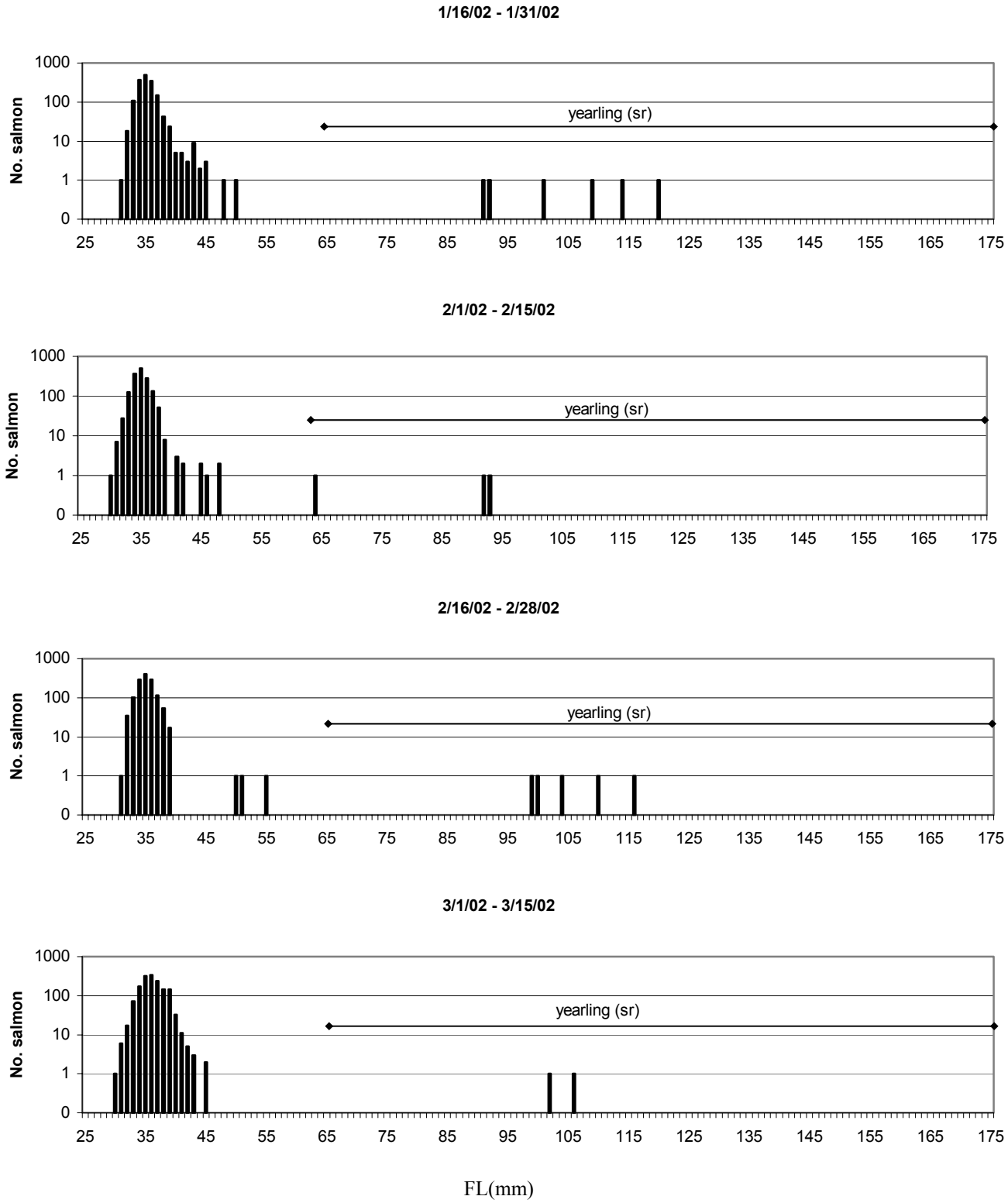
APPENDIX B, Figure 1. Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2001 through June 28, 2002. All fish are assumed to be spring-run Chinook salmon except where indicated.



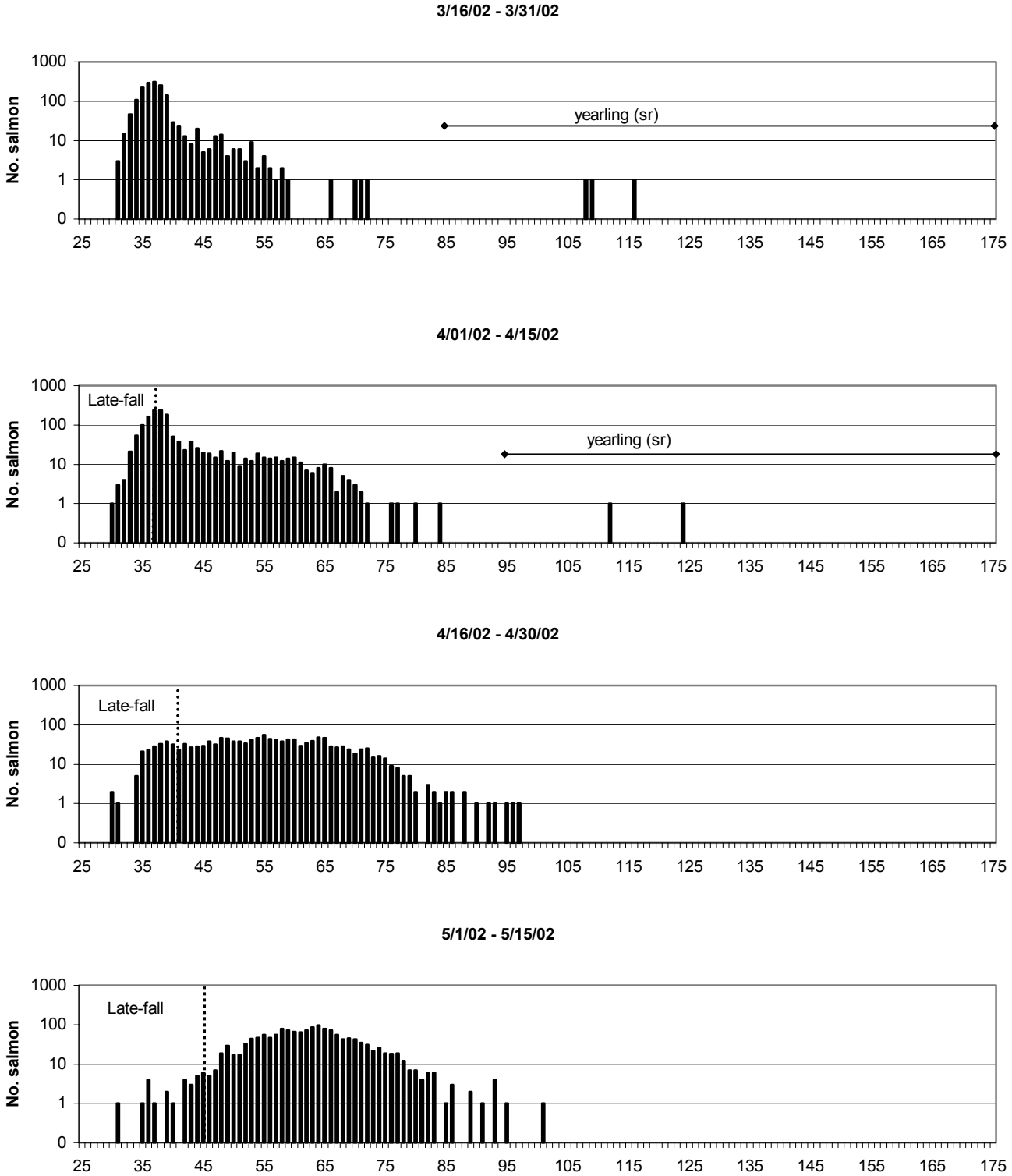
APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2001 through June 28, 2002. All fish are assumed to be spring-run Chinook salmon except where indicated.



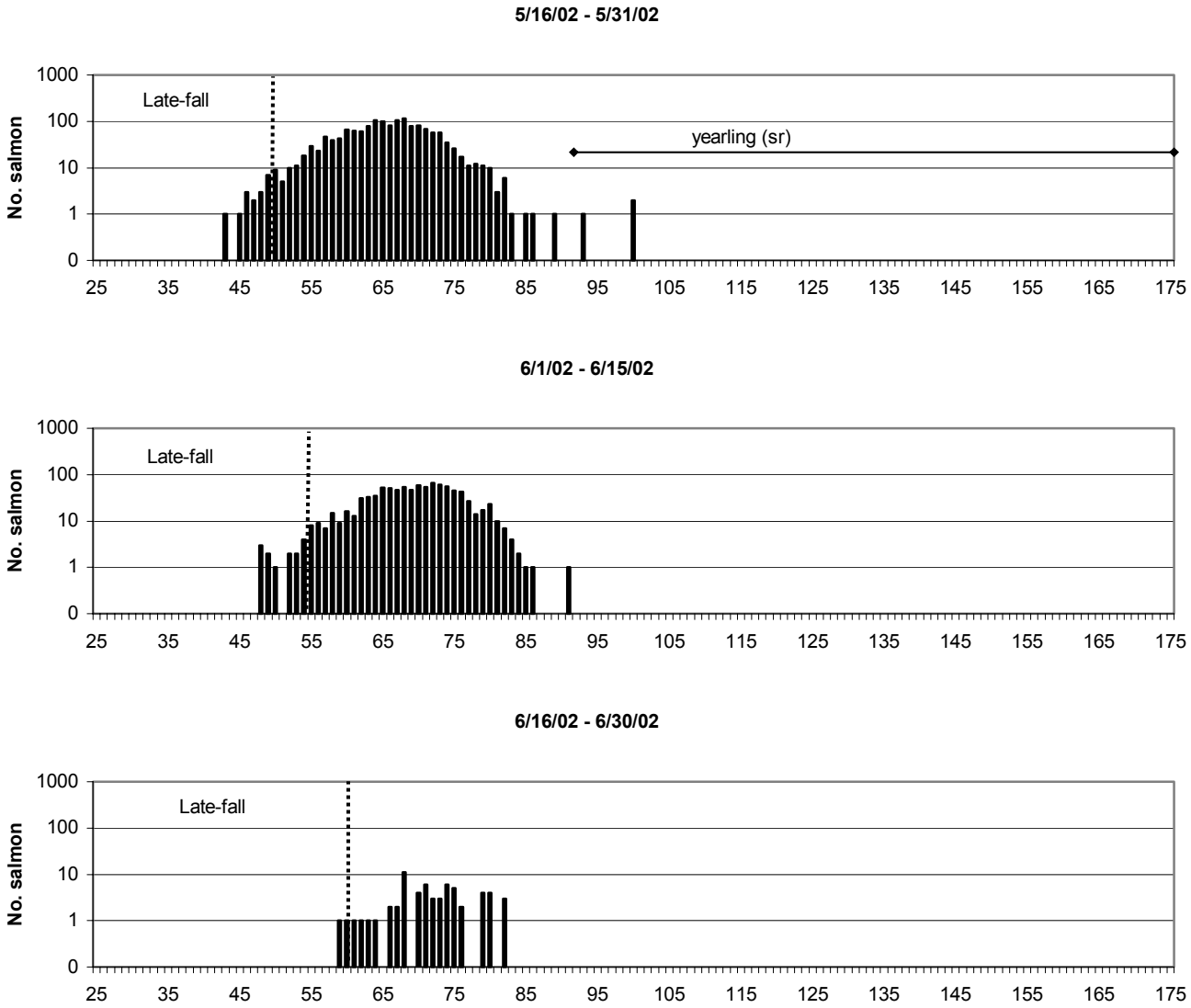
APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2001 through June 28, 2002. All fish are assumed to be spring-run Chinook salmon except where indicated.



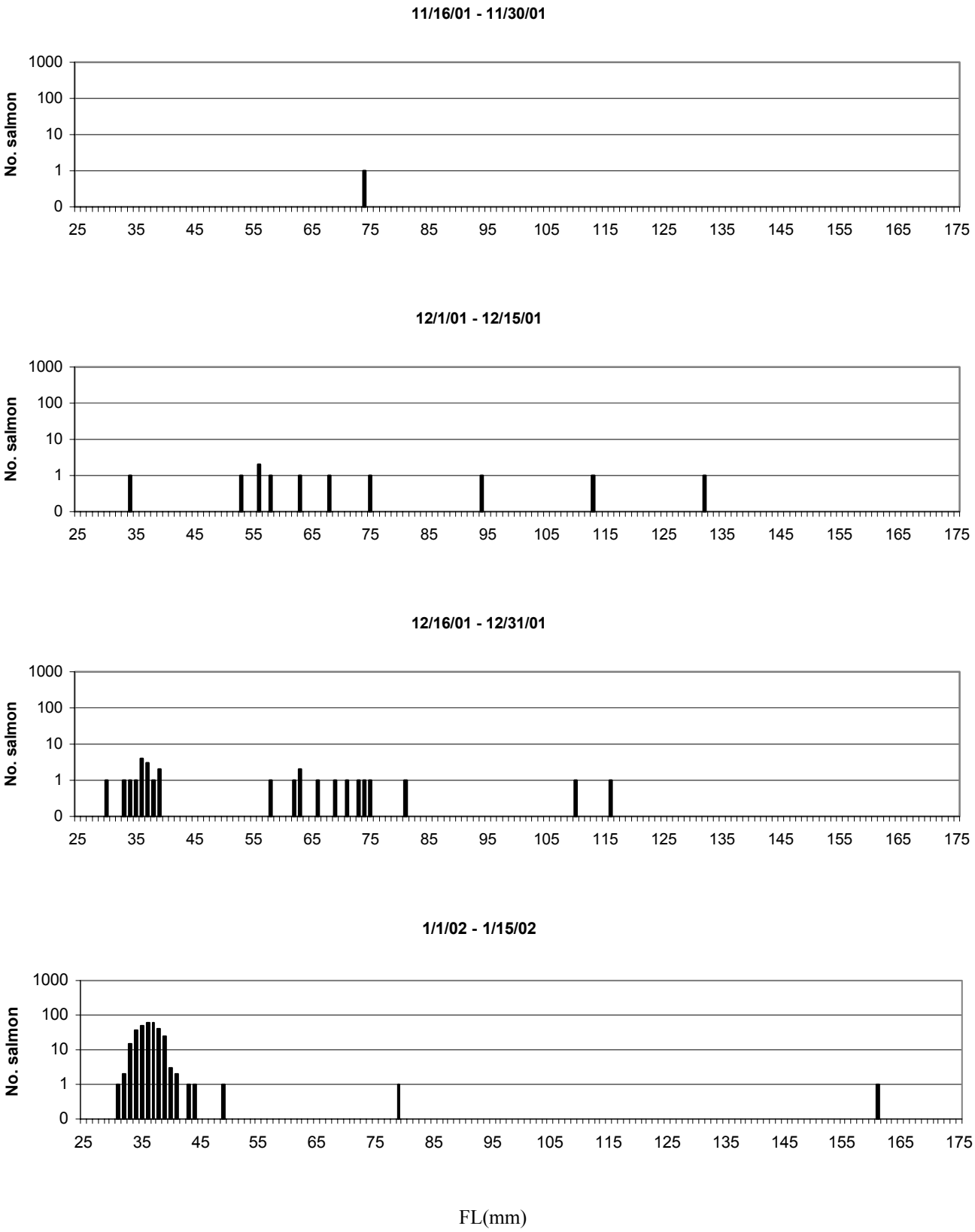
APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2001 through June 28, 2002. All fish are assumed to be spring-run Chinook salmon except where indicated.



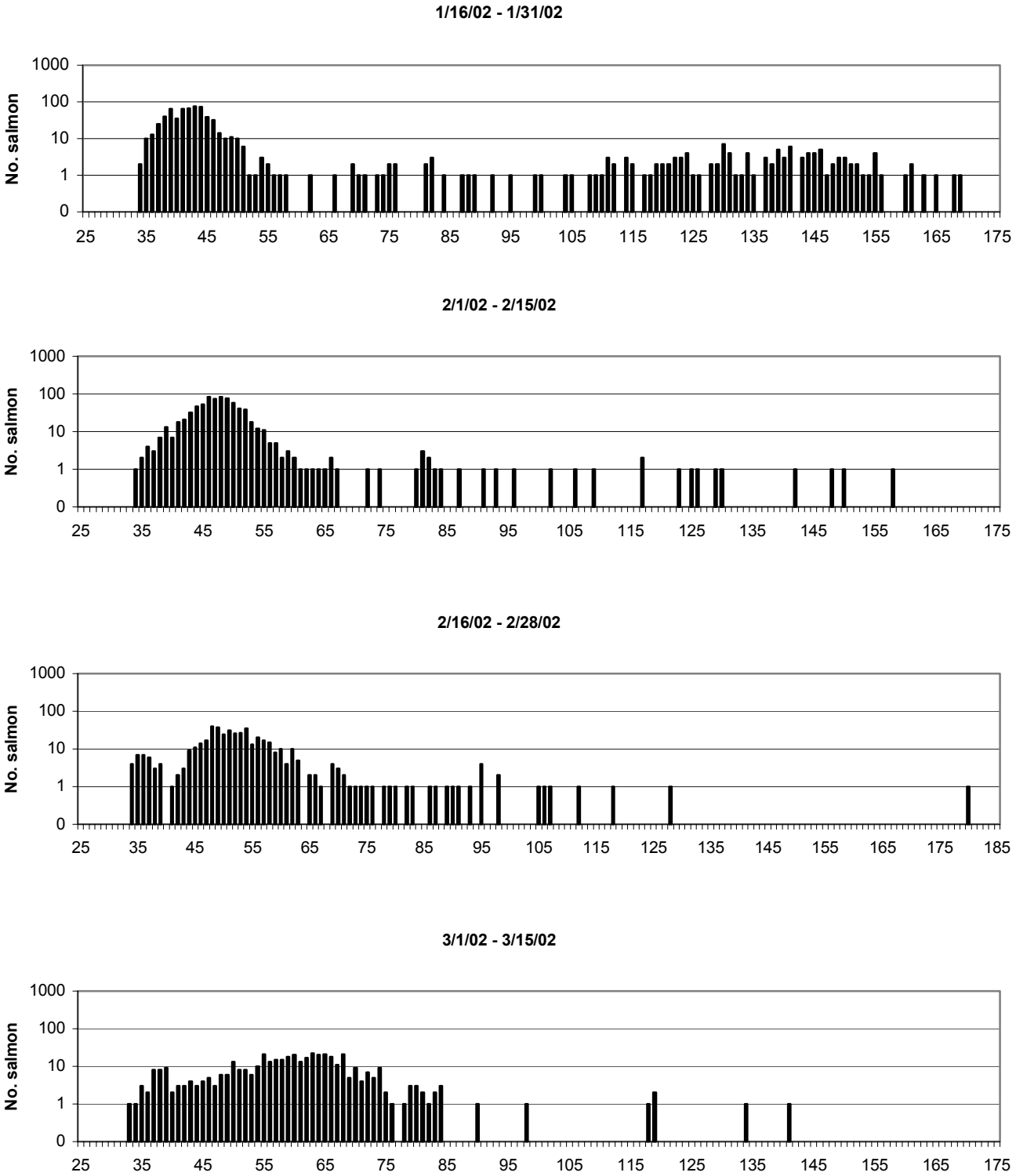
APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from September 17, 2001 through June 28, 2002. All fish are assumed to be spring-run Chinook salmon except where indicated.



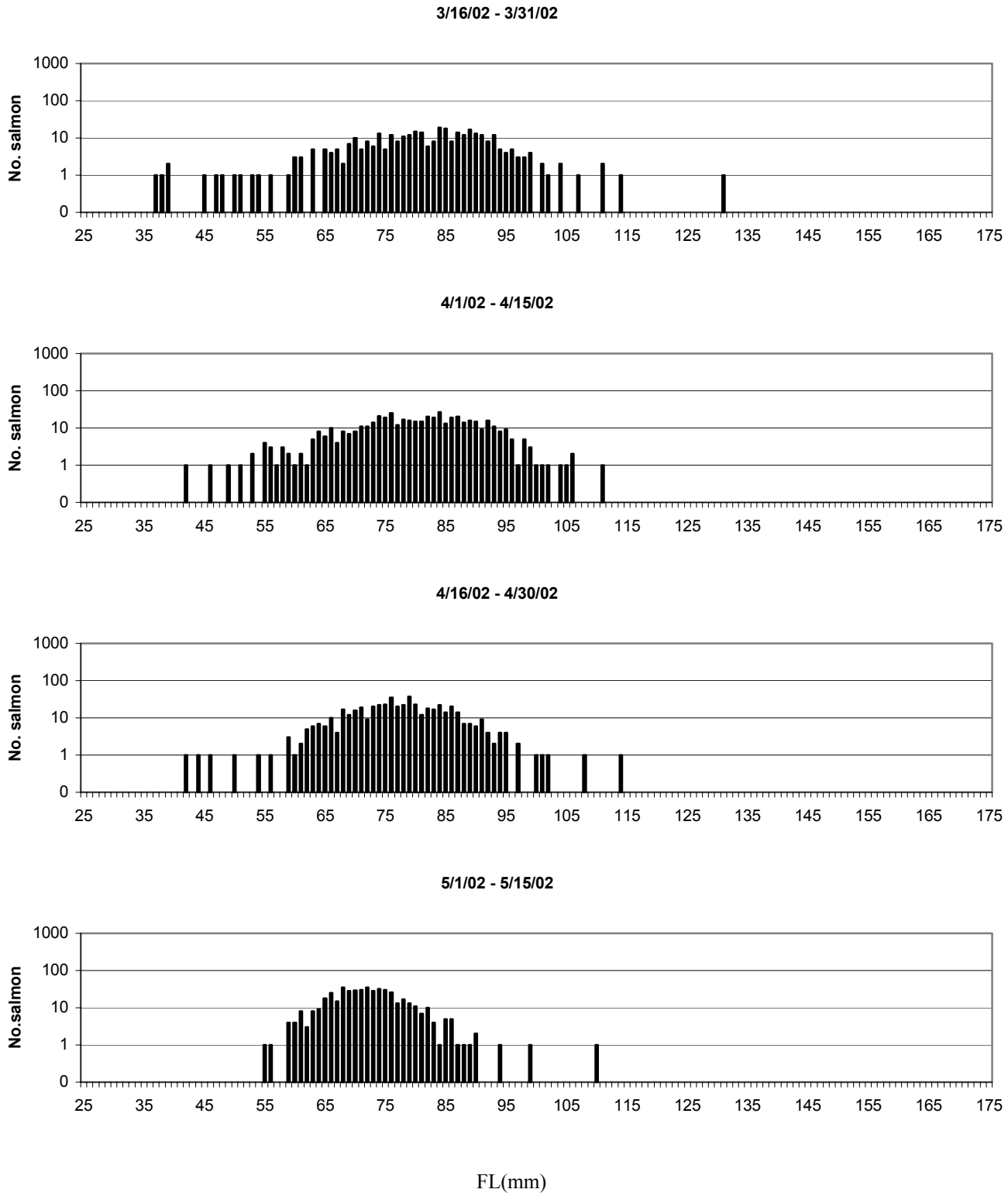
APPENDIX B, Figure 2. Frequency distribution of lengths of juvenile Chinook salmon caught and released at Maddock Road in the Sutter Bypass from November 20, 2001 through June 27, 2002.



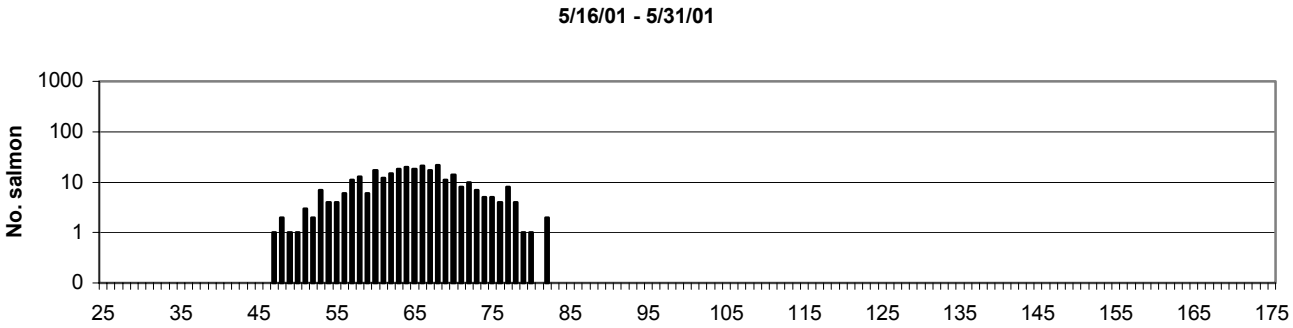
APPENDIX B, Figure 2. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Maddock Road in the Sutter Bypass from November 20, 2001 through June 27, 2002.



APPENDIX B, Figure 2. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Maddock Road in the Sutter Bypass from November 20, 2001 through June 27, 2002

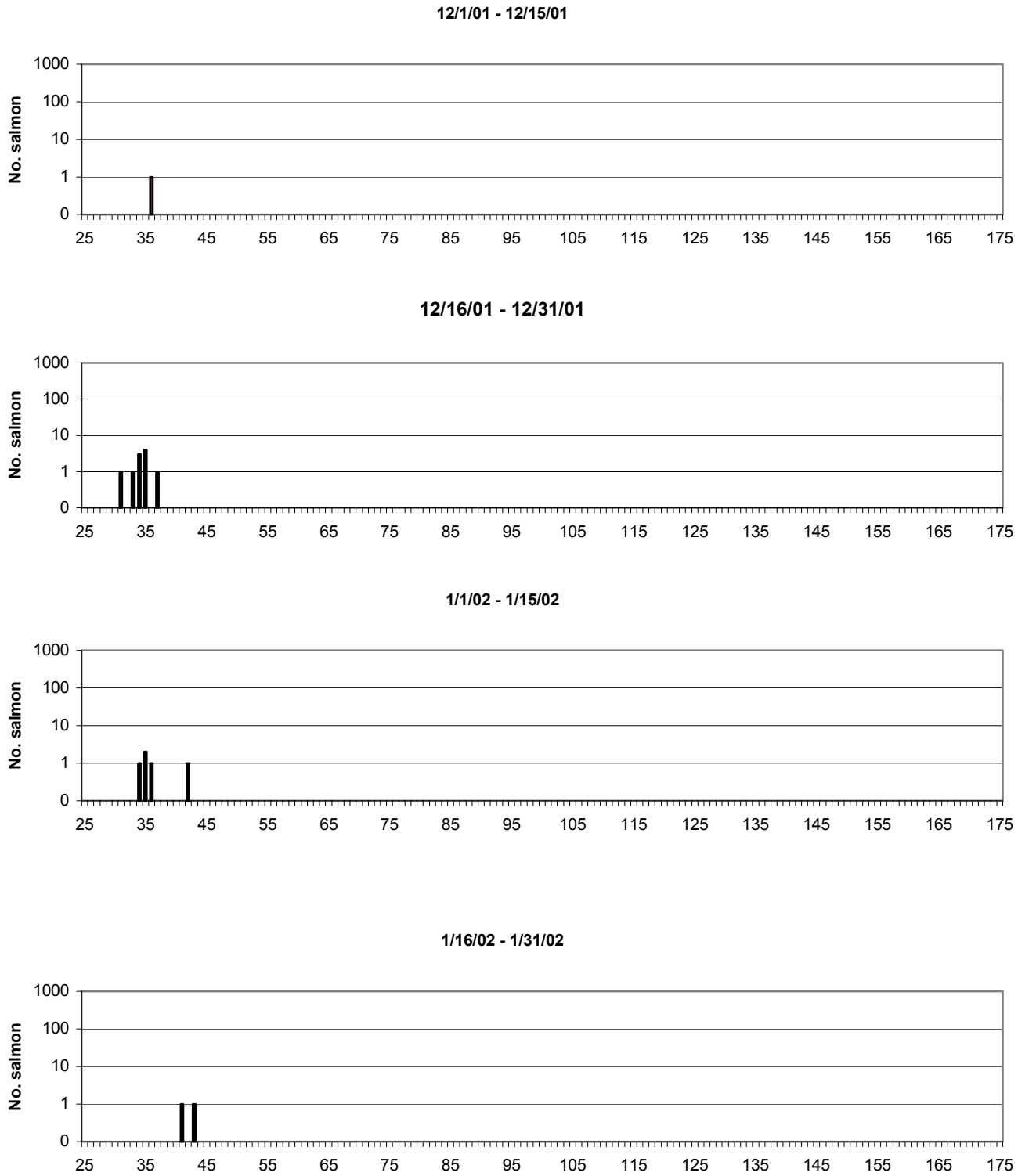


APPENDIX B, Figure 2. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Maddock Road in the Sutter Bypass from November 20, 2001 through June 27, 2002

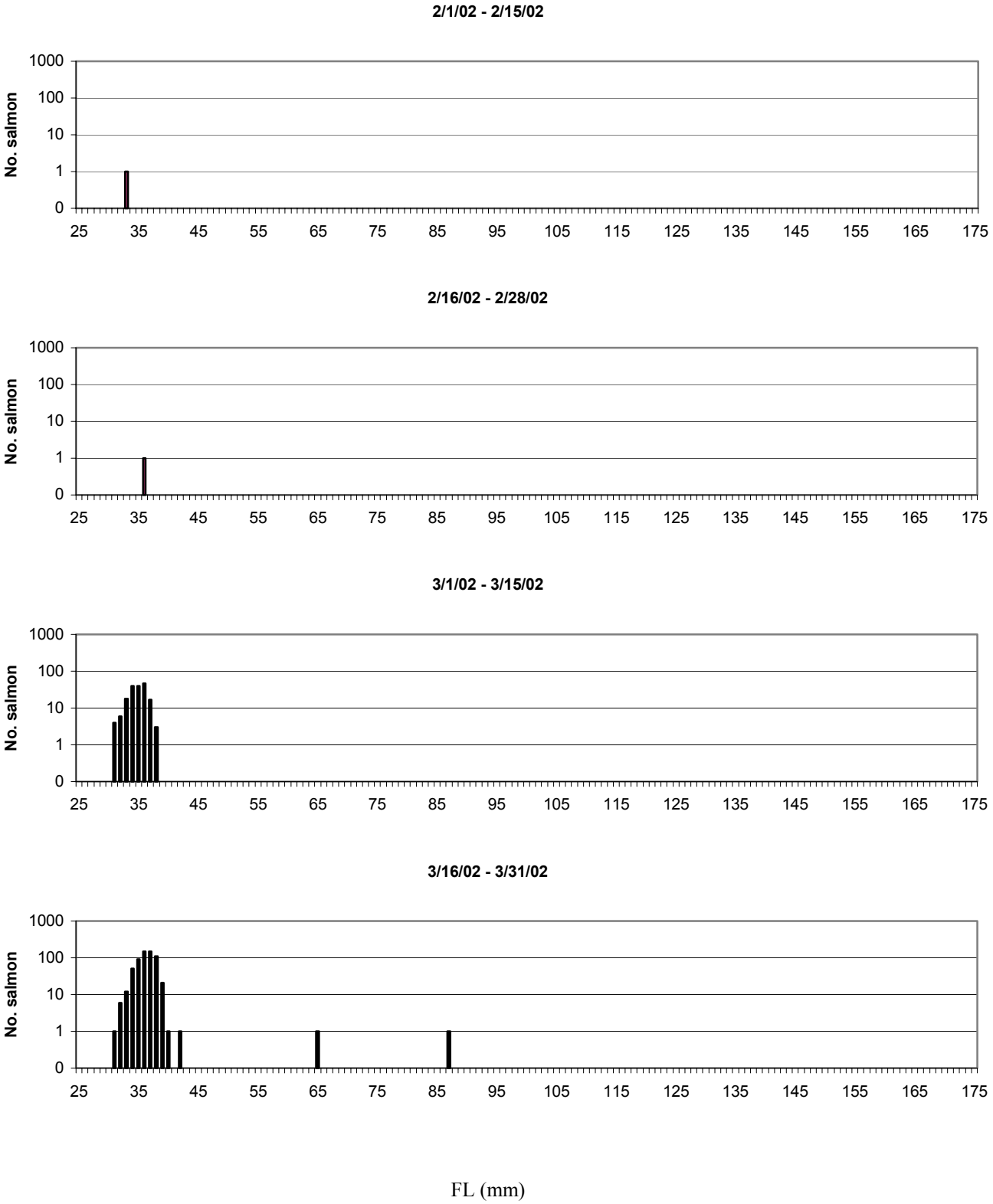


FL(mm)

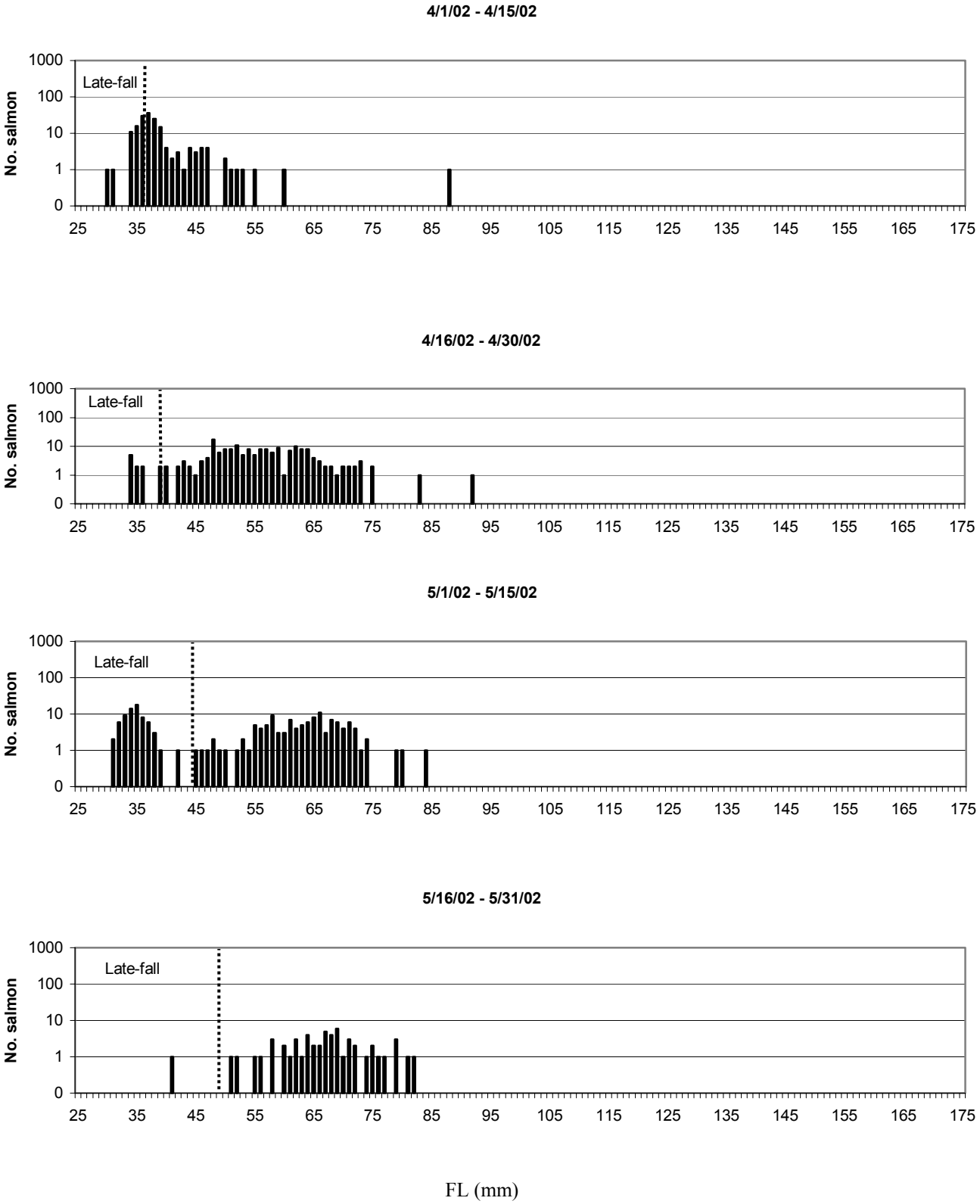
APPENDIX B, Figure 3. Frequency distribution of lengths of juvenile Chinook salmon caught and released in Big Chico Creek from November 14, 2001 through May 30, 2002. All fish are assumed to be spring-run Chinook salmon except where indicated.



APPENDIX B, Figure 3. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released in Big Chico Creek from November 14, 2001 through May 30, 2002. 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 November 14, 2001 through May 30, 2002. All fish are assumed to be spring-run Chinook salmon except where indicated



APPENDIX C, Table 1. Recaptures of spring-run Chinook salmon bearing coded-wire tags in the Sutter Bypass at Maddock Rd. All fish were from BY 2001 and tagged at Baldwin Construction Yard.

Tag code 06-01-00-00-07							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
1/23/2002	35	14	0.0	1/23/2002	36	14	0.07
1/30/2002	41	21	0.29				

Tag code 06-01-00-00-08							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
2/1/2002	40	18	0.28	2/9/2002	42	26	0.27
2/10/2002	41	27	0.22	2/14/2002	39	31	0.13
4/13/2002	81	89	0.52	4/23/2002	79	99	0.44

Tag code 06-01-00-00-09							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/24/2002	69	71	0.48				

Tag code 06-01-00-01-00							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
3/6/2002	41	22	0.27	4/15/2002	57	62	0.35
4/23/2002	72	70	0.53				

Tag code 06-01-00-01-01							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/24/2002	73	69	0.55	4/22/2002	76	67	0.61
4/24/2002	71	69	0.52	5/2/2002	71	77	0.47

Tag code 06-01-00-01-03							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/23/2002	75	66	0.60				

APPENDIX C, Table 1. (continued) Recaptures of spring-run Chinook salmon bearing coded-wire tags in the Sutter Bypass at Maddock Rd.. All fish were from BY 2001 and tagged at Baldwin Construction Yard.

Tag code 06-01-00-01-04							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/17/2002	76	59	0.69	5/15/2002	77	87	0.48

Tag code 06-01-00-01-05							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/2/2002	75	74	0.54				

Tag code 06-01-00-01-06							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
3/4/2002	38	10	0.30	4/25/2002	68	62	0.53
5/4/2002	68	71	0.46				

Tag code 06-01-00-01-07							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/25/02	62	*	*	5/15/02	73	*	*

Tag code 06-01-00-01-08							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/30/02	65	*	*				

Tag code 06-01-00-01-09							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/2/02	71	*	*	5/9/02	73	*	*

Tag code 06-01-00-02-06							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
2/6/02	37	34	0.06	2/11/2002	36	39	0.03

APPENDIX C, Table 1. (continued) Recaptures of spring-run Chinook salmon bearing coded-wire tags in the Sutter Bypass at Maddock Rd. All fish were from BY 2001 and tagged at Baldwin Construction Yard.

Tag code 06-01-00-02-08							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
4/23/2002	79	76	0.57	4/24/2001	78	77	0.55
5/9/2002	71	92	0.38				

Tag code 06-01-00-03-00							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/18/2002	63	85	0.33				

Tag code 06-01-00-03-08							
Recovery Date	Recovery FL (mm)	Days at Large	mm/day	Recovery Date	Recovery FL (mm)	Days at Large	mm/day
5/9/2002	76	*	*	5/18/2002	64	*	*

* Days-at-large and average mm/day were not calculated due to release period exceeding seven days.

APPENDIX D, Table 1. Recoveries of juvenile Chinook salmon in the Sutter Bypass at Maddock Rd., tagged and released by United States Fish and Wildlife Service in the upper Sacramento River.

Tag Code	Race	Source	Release Site	Release Date	Avg. FL at Release	Recovery Date	FL at Recovery	Days at Large
050764	LFRCS	CNFH	CNFH	12/12/01	104	1/22/02	115	41
050764	LFRCS	CNFH	CNFH	12/12/01	104	1/27/02	111	46
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	146	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	134	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	131	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	138	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	134	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/18/02	163	14
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/18/02	139	14
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/18/02	123	14
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/18/02	161	14
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/18/02	130	14
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/19/02	143	15
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/19/02	152	15
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	119	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	150	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	131	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	148	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/21/02	130	17
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/22/02	146	18
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/23/02	130	19
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/23/02	141	19
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/24/02	152	20
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/24/02	119	20
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/24/02	131	20
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/24/02	112	20
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/25/02	124	21
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/25/02	134	21
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/25/02	124	21
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/25/02	149	21
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/26/02	146	22
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/26/02	130	22
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/27/02	139	23
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/27/02	130	23
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/28/02	161	24
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/28/02	151	24
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/28/02	139	24
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/29/02	155	25
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/29/02	148	25
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/30/02	126	26
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/30/02	120	26
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/31/02	135	27
050766	LFRCS	CNFH	CNFH	1/4/02	127	1/31/02	111	27
050766	LFRCS	CNFH	CNFH	1/4/02	127	2/3/02	150	30

APPENDIX D, Table 1. (continued) Recoveries of juvenile Chinook salmon in the Sutter Bypass at Maddock Rd., tagged and released by United States Fish and Wildlife Service in the upper Sacramento River.

Tag Code	Race	Source	Release Site	Release Date	Avg. FL at Release	Recovery Date	FL at Recovery	Days at Large
050766	LFRCS	CNFH	CNFH	1/4/02	127	2/4/02	130	31
050766	LFRCS	CNFH	CNFH	1/4/02	127	2/5/02	158	32
050766	LFRCS	CNFH	CNFH	1/4/02	127	2/7/02	125	34
050766	LFRCS	CNFH	CNFH	1/4/02	127	2/10/02	180	37
050766	LFRCS	CNFH	CNFH	1/4/02	127	3/2/02	119	57
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/18/02	122	10
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/18/02	146	10
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/21/02	140	13
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/23/02	128	15
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/24/02	141	16
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/24/02	100	16
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/25/02	129	17
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/27/02	145	19
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/27/02	129	19
050769	LFRCS	CNFH	CNFH	1/8/02	132	1/29/02	123	21
050769	LFRCS	CNFH	CNFH	1/8/02	132	2/1/02	142	24
050769	LFRCS	CNFH	CNFH	1/8/02	132	2/5/02	126	28
050769	LFRCS	CNFH	CNFH	1/8/02	132	2/19/02	128	42
050770	LFRCS	CNFH	CNFH	1/8/02	120	1/21/02	150	13
050770	LFRCS	CNFH	CNFH	1/8/02	120	1/18/02	120	10
050770	LFRCS	CNFH	CNFH	1/8/02	120	1/19/02	154	11
050770	LFRCS	CNFH	CNFH	1/8/02	120	1/25/02	153	17
050770	LFRCS	CNFH	CNFH	1/8/02	120	2/2/02	148	25
050771	LFRCS	CNFH	CNFH	1/8/02	125	1/21/02	140	13
050771	LFRCS	CNFH	CNFH	1/8/02	125	1/23/02	123	15
050771	LFRCS	CNFH	CNFH	1/8/02	125	1/25/02	137	17
050772	LFRCS	CNFH	CNFH	1/8/02	127	1/21/02	150	13
050772	LFRCS	CNFH	CNFH	1/8/02	127	1/24/02	141	16
050772	LFRCS	CNFH	CNFH	1/8/02	127	1/26/02	133	18
050773	LFRCS	CNFH	CNFH	1/8/02	125	1/25/02	125	17
050773	LFRCS	CNFH	CNFH	1/8/02	125	1/29/02	155	21
050773	LFRCS	CNFH	CNFH	1/8/02	125	2/2/02	117	25
050773	LFRCS	CNFH	CNFH	1/8/02	125	2/9/02	123	32
050774	LFRCS	CNFH	CNFH	1/8/02	118	1/21/02	124	13
050774	LFRCS	CNFH	CNFH	1/8/02	118	1/21/02	141	13
050774	LFRCS	CNFH	CNFH	1/8/02	118	1/21/02	144	13
050774	LFRCS	CNFH	CNFH	1/8/02	118	1/19/02	137	11
050774	LFRCS	CNFH	CNFH	1/8/02	118	1/27/02	149	19
050774	LFRCS	CNFH	CNFH	1/8/02	118	1/27/02	121	19
050775	LFRCS	CNFH	CNFH	1/8/02	116	1/21/02	130	13
055135	LFRCS	CNFH	CNFH	1/8/02	123	1/21/02	155	13
055135	LFRCS	CNFH	CNFH	1/8/02	123	1/21/02	144	13
055135	LFRCS	CNFH	CNFH	1/8/02	123	1/19/02	144	11
055135	LFRCS	CNFH	CNFH	1/8/02	123	1/26/02	118	18
055135	LFRCS	CNFH	CNFH	1/8/02	123	1/31/02	130	26

APPENDIX D, Table 1. (continued) Recoveries of juvenile Chinook salmon in the Sutter Bypass at Maddock Rd., tagged and released by United States Fish and Wildlife Service in the upper Sacramento River.

Tag Code	Race	Source	Release Site	Release Date	Avg. FL at Release	Recovery Date	FL at Recovery	Days at Large
05-01-03-07-05	WRCS	LSNFH	CALDWELL PARK	1/30/02	75	2/27/02	86	28
05-01-03-07-05	WRCS	LSNFH	CALDWELL PARK	1/30/02	75	2/26/02	78	27
05-01-03-07-05	WRCS	LSNFH	CALDWELL PARK	1/30/02	75	2/16/02	69	17

APPENDIX E, Table 1. Recoveries during 2001 and 2002 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
1/19/99 - 1/26/99	1998	06-01-12-02-11	6/13/00	521	3.27	Fort Ross – Pigeon Pt.	Ocean sport
2/1/99 - 2/27/99	1998	06-01-12-02-15	4/23/01	636	3.57	Newport OR – Area 4	Ocean Commercial
1/19/99 - 1/22/99	1998	06-01-12-02-12	6/11/01	-	2.22*	Butte Cr. – Reach C	Inland Pre-spawn
2/1/99 - 2/27/99	1998	06-01-12-02-15	7/1/01	801	4.66	Fort Bragg	Ocean sport
1/25/99 - 2/1/99	1998	06-01-12-02-14	7/1/01	716	4.36	Crescent City	Ocean sport
12/29/98 - 1/15/99	1998	06-01-12-02-09	7/11/01	681	2.80	Bodega	Ocean Commercial
1/19/99 - 1/22/99	1998	06-01-12-02-12	7/30/01	686	4.88	Eureka	Ocean sport
10/15/99 - 10/26/99	1998	06-01-12-03-07	8/1/01	645	2.75	Newport OR – Area 4	Ocean Commercial
10/15/99 - 10/26/99	1998	06-01-12-03-07	9/01/01	665	2.54	Newport OR – Area 4	Ocean Commercial
2/1/99 - 2/27/99	1998	06-01-12-02-15	9/25/01	630	2.22	Butte Cr. – Reach B	Inland spawn
12/29/99- 1/10/00	1999	06-01-12-03-09	9/25/01	460	2.22	Butte Cr. – Reach B	Inland spawn
1/20/99 - 1/29/99	1998	06-01-12-02-13	9/27/01	700	2.22	Butte Cr. – Reach C	Inland spawn
1/13/99 - 1/20/99	1998	06-01-12-02-10	10/2/01	710	2.22	Butte Cr. – Reach B	Inland spawn
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/2/01	720	2.22	Butte Cr. – Reach B	Inland spawn
1/25/99 - 2/1/99	1998	06-01-12-02-14	10/2/01	562	2.22	Butte Cr. – Reach B	Inland spawn
1/19/99 - 1/26/99	1998	06-01-12-02-11	10/3/01	740	2.22	Butte Cr. – Reach C	Inland spawn
1/13/99 - 1/20/99	1998	06-01-12-02-10	10/4/01	608	2.22	Butte Cr. – Reach D	Inland spawn
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/4/01	670	2.22	Butte Cr. Reach D	Inland spawn
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/04/01	760	2.22	Butte Cr. – Reach B	Inland spawn
1/20/99 - 1/29/99	1998	06-01-12-02-13	10/9/01	690	2.22	Butte Cr. – Reach A	Inland spawn
3/2/99 - 3/20/99	1998	06-01-12-03-03	10/4/01	615	2.22	Butte Cr. – Reach D	Inland spawn

APPENDIX E, Table 1. (continued) Recoveries during 2001 and 2002 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
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/11/01	750	2.22	Butte Cr. – Reach C	Inland spawn
1/19/99 - 1/22/99	1998	06-01-12-02-12	10/11/01	770	2.22	Butte Cr. – Reach C	Inland spawn
10/15/99- 10/26/99	1998	06-01-12-03-07	7/5/02	850	3.34	Monterey	Ocean Sport
1/13/99- 1/20/99	1998	06-01-12-02-10	8/13/02	846	2.02*	Butte Cr. – Reach B	Inland Pre-spawn
1/20/99- 1/29/99	1998	06-01-12-02-13	10/10/02	833	2.02	Butte Cr. – Reach D	Inland Spawn
1/19/00- 1/28/00	1999	06-01-12-03-11	3/31/02	713	4.38	Monterey	Ocean Sport
1/19/00- 1/28/00	1999	06-01-12-03-11	4/23/02	592	3.24	Coos Bay OR	Ocean Commercial
1/10/00- 1/19/00	1999	06-01-12-03-10	5/22/02	672	5.45	Monterey	Ocean Commercial
1/10/00- 1/19/00	1999	06-01-12-03-10	5/28/02	686	5.45	Monterey	Ocean Commercial
1/10/00- 1/19/00	1999	06-01-12-03-10	6/5/02	770	4.54	Monterey	Ocean Commercial
1/19/00- 1/28/00	1999	06-01-12-03-11	6/13/02	691	4.54	Monterey	Ocean Commercial
1/10/00- 1/19/00	1999	06-01-12-03-10	6/25/02	724	3.60	Bodega	Ocean Sport
1/10/00- 1/19/00	1999	06-01-12-03-10	6/28/02	701	3.22	San Francisco	Ocean Commercial
12/29/99- 1/10/99	1999	06-01-12-03-09	6/29/02	683	3.60	San Francisco	Ocean Sport
2/7/00- 2/25/00	1999	06-01-12-03-13	7/12/02	747	3.26	San Francisco	Ocean Commercial
2/7/00- 2/25/00	1999	06-01-12-03-13	7/14/02	692	3.26	San Francisco	Ocean Commercial
1/19/00- 1/28/00	1999	06-01-12-03-11	7/24/02	740	1.37	Fort Bragg	Ocean Commercial
1/19/00- 1/28/00	1999	06-01-12-03-11	7/24/02	735	1.37	Fort Bragg	Ocean Commercial
1/19/00- 1/28/00	1999	06-01-12-03-11	7/25/02	704	3.41	Monterey	Ocean Commercial
1/10/00- 1/19/00	1999	06-01-12-03-10	7/31/02	797	2.02*	Butte Cr. – Reach C	Inland Pre-spawn
1/19/00- 1/28/00	1999	06-01-12-03-11	8/21/02	764	2.02*	Butte Cr. – Reach A	Inland Pre-spawn
1/27/00- 2/07/00	1999	06-01-12-03-12	9/25/02	743	1.59	Garabaldi N. OR	Ocean Commercial

APPENDIX E, Table 1. (continued) Recoveries during 2001 and 2002 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
1/10/00-1/19/00	1999	06-01-12-03-10	9/24/02	743	2.02	Butte Cr. – Reach B	Inland Spawn
12/29/99-1/10/00	1999	06-01-12-03-09	9/26/02	739	2.02	Butte Cr. – Reach C	Inland Spawn
12/29/99-1/10/00	1999	06-01-12-03-09	10/1/02	740	2.02	Butte Cr. – Reach B	Inland Spawn
1/19/00-1/28/00	1999	06-01-12-03-11	10/3/02	694	2.02	Butte Cr. – Reach D	Inland Spawn
1/10/00-1/19/00	1999	06-01-12-03-10	10/3/02	732	2.02	Butte Cr. – Reach C	Inland Spawn
12/29/99-1/10/00	1999	06-01-12-03-09	10/3/02	868	2.02	Butte Cr. – Reach C	Inland Spawn
1/10/00-1/19/00	1999	06-01-12-03-10	10/3/02	711	2.02	Butte Cr. – Reach C	Inland Spawn
1/19/00-1/28/00	1999	06-01-12-03-11	10/3/02	694	2.02	Butte Cr. – Reach C	Inland Spawn
1/27/00-2/7/00	1999	06-01-12-03-12	10/10/02	713	2.02	Butte Cr. – Reach D	Inland Spawn
1/19/00-1/28/00	1999	06-01-12-03-11	10/10/02	698	2.02	Butte Cr. – Reach C	Inland Spawn
1/27/00-2/7/00	1999	06-01-12-03-12	10/10/02	681	2.02	Butte Cr. – Reach C	Inland Spawn
1/10/00-1/19/00	1999	06-01-12-03-10	10/10/02	630	2.02	Butte Cr. – Reach C	Inland Spawn
1/10/00-1/19/00	1999	06-01-12-03-10	10/01/02	718	2.02	Butte Cr. – Reach B	Inland Spawn
1/10/00-1/19/00	1999	06-01-12-03-10	10/10/02	798	2.02	Butte Cr. – Reach D	Inland Spawn
2/7/00-2/25/00	1999	06-01-12-03-13	10/17/02	668	2.02	Butte Cr. – Reach C	Inland Spawn
1/16/01-1/18/01	2000	06-01-12-04-04	7/3/02	600	4.31	San Francisco	Ocean Sport
2/1/01**	2000	06-01-00-02-01	7/11/02	485	4.31	San Francisco	Ocean Sport

* Spawning carcass survey expansion factor applied to pre-spawn mortalities.
** Release data sheet lost, release information reconstructed from other incomplete records.

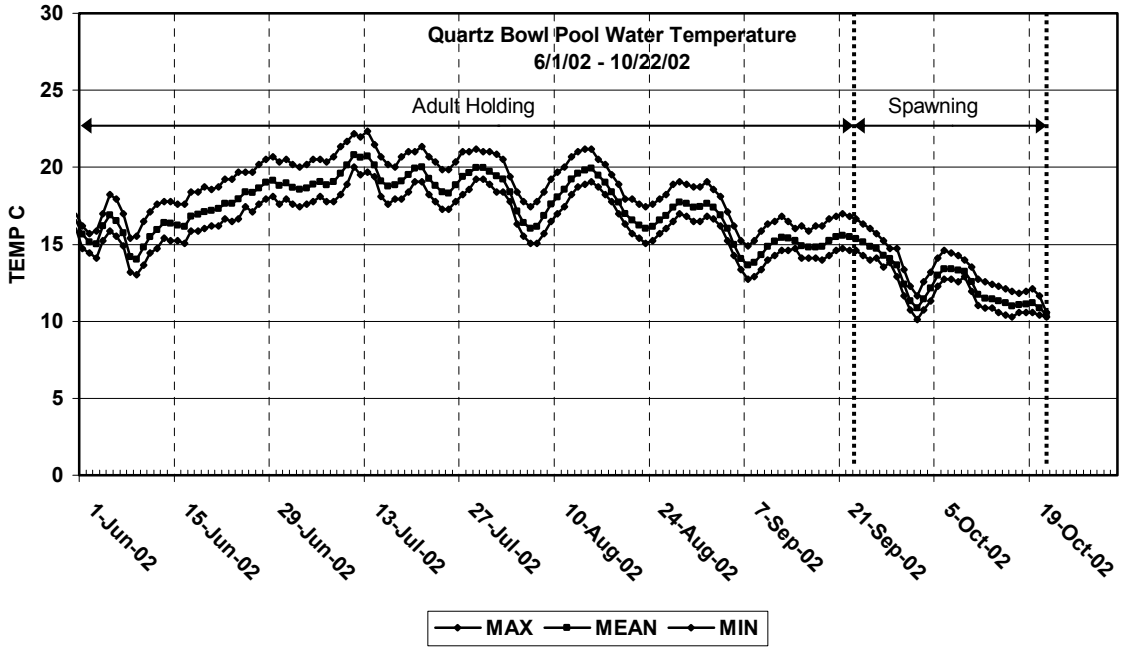
APPENDIX E, Table 2. Recoveries of adult fall-run Chinook salmon carcasses bearing coded-wire tags in Butte Creek during 2002.

Release				Recovery			
Stock	Brood Year	Tag Code	Site	Date	FL (mm)	Expansion	Butte Creek Reach
American River	1998	062939	Tiburon	11/21/02	867	2.35	I
Feather River	2000	062665	Wickland	10/31/02	633	2.35	H
Feather River	2000	062673	Rodeo	11/7/02	637	2.35	I
Feather River	1998	062638	Crockett	11/14/02	903	2.35	H
Feather River	2000	062665	Wickland	11/14/02	561	2.35	H
Feather River	2000	062675	Rodeo	11/14/02	541	2.35	H
Feather River	2000	062664	Wickland	11/14/02	640	2.35	I
Feather River	2000	062665	Wickland	11/14/02	596	2.35	H
Feather River	2000	062664	Wickland	11/14/02	591	2.35	I
Feather River	2000	062673	Rodeo	11/21/02	631	2.35	I
Feather River	2000	062664	Wickland	11/27/02	678	2.35	I
Merced River	1999	064403	S.J. River Jersey Pt.	11/7/02	788	2.35	I
Merced River	1999	064543	Hatfield	11/12/02	882	2.35	F
Merced River	1999	064403	S.J. River Jersey Pt	11/12/02	794	2.35	F
Merced River	1999	064403	S.J. River Jersey Pt	11/14/02	810	2.35	H
Merced River	1999	06-01-06-10-02	S.J. River Jersey Pt	11/14/02	789	2.35	I
Merced River	1999	064403	S.J. River Jersey Pt	11/14/02	809	2.35	I
Merced River	1999	064404	S.J. River Jersey Pt	11/14/02	826	2.35	H
Merced River	1999	064403	S.J. River Jersey Pt	11/14/02	776	2.35	H
Merced River	2000	064433	S.J. River Jersey Pt	11/14/02	611	2.35	I
Merced River	2000	064441	S.J. River Jersey Pt	11/14/02	532	2.35	H
Merced River	1998	062647	S.J. River Jersey Pt	11/19/02	873	2.35	F
Merced River	1999	064404	S.J. River Jersey Pt	11/21/02	782	2.35	I
Merced River	1999	064404	S.J. River Jersey Pt	11/21/02	731	2.35	I
Merced River	1999	064404	S.J. River Jersey Pt	11/21/02	850	2.35	I
Merced River	1999	064404	S.J. River Jersey Pt	11/21/02	819	2.35	I

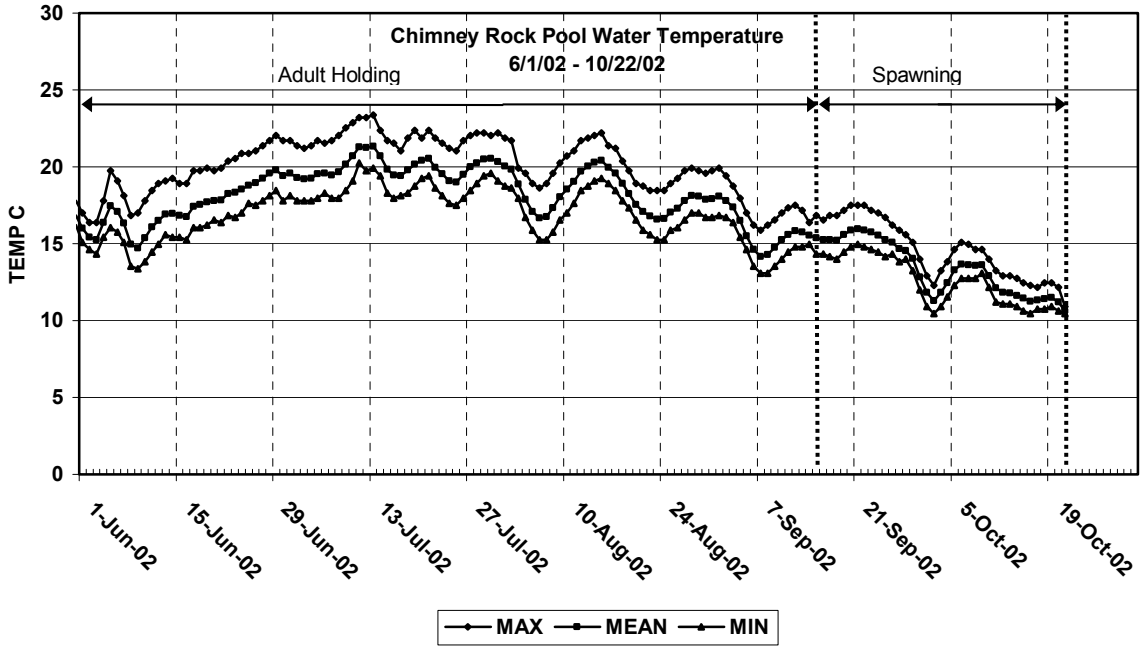
APPENDIX E, Table 2. (continued) Recoveries of adult fall-run Chinook salmon carcasses bearing coded-wire tags in Butte Creek during 2002.

Release				Recovery			
Stock	Brood Year	Tag Code	Site	Date	FL (mm)	Expansion	Butte Creek Reach
Merced River	1999	064553	Hatfield	11/21/02	783	2.35	I
Merced River	1999	064404	S.J. River Jersey Pt	11/21/02	782	2.35	I
Merced River	1999	064403	S.J. River Jersey Pt	11/21/02	791	2.35	I
Merced River	1999	064404	S.J. River Jersey Pt	11/21/02	780	2.35	I
Merced River	2000	064442	S.J. River Jersey Pt	11/21/02	604	2.35	I
Merced River	2000	064435	S.J. River Jersey Pt	11/21/02	684	2.35	I
Merced River	1999	064403	S.J. River Jersey Pt	11/27/02	829	2.35	I
Merced River	1999	064402	Mossdale	12/5/02	842	2.35	I
Mokelumne River	1998	060248	Sherman Island	11/21/02	822	2.35	I
Mokelumne River	1998	060215	Crockett	11/21/02	873	2.35	H
Mokelumne River	1999	060258	New Hope Landing	11/21/02	734	2.35	I
Mokelumne River	1999	062663	Mokelumne River Mouth	11/21/02	778	2.35	I
Mokelumne River	1999	060252	New Hope Landing	11/27/02	854	2.35	H
Mokelumne River	1999	060250	Wickland	11/27/02	782	2.35	I
Mokelumne River	1999	060255	Sherman Island	11/12/02	891	2.35	F

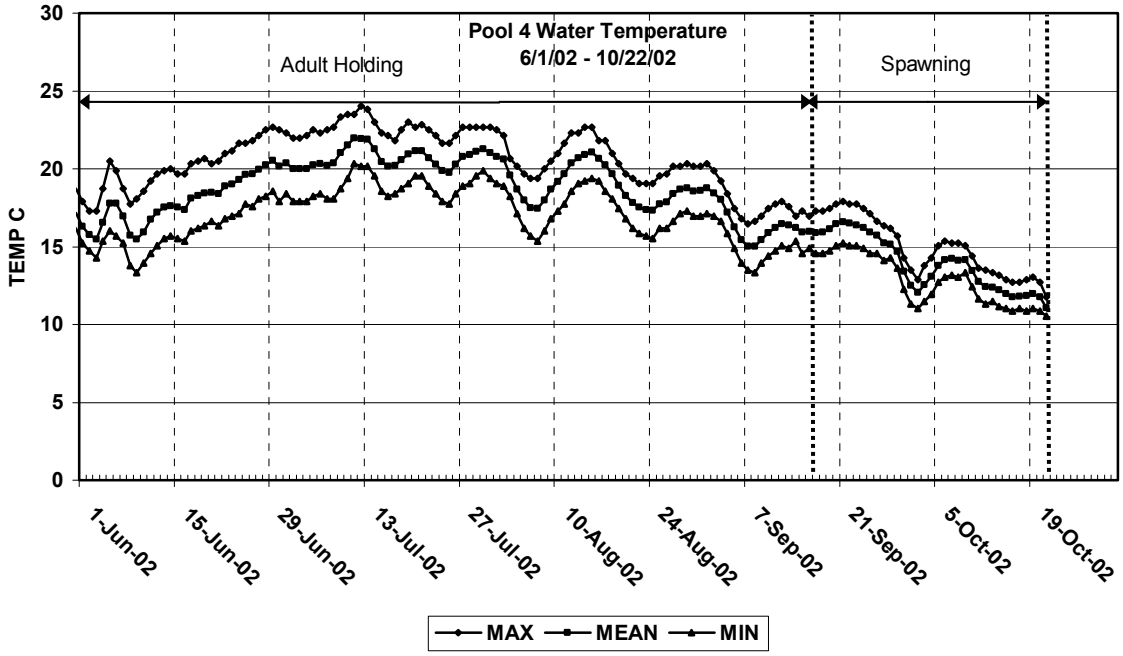
APPENDIX F, Figure 1. Butte Creek water temperature at Quartz Bowl pool.



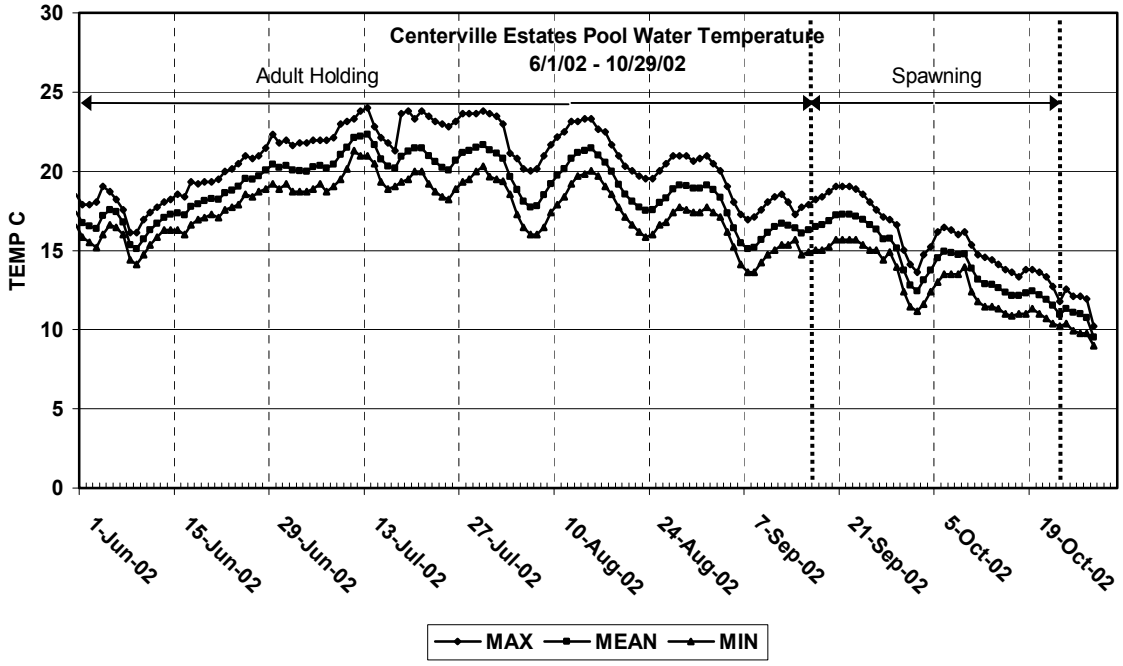
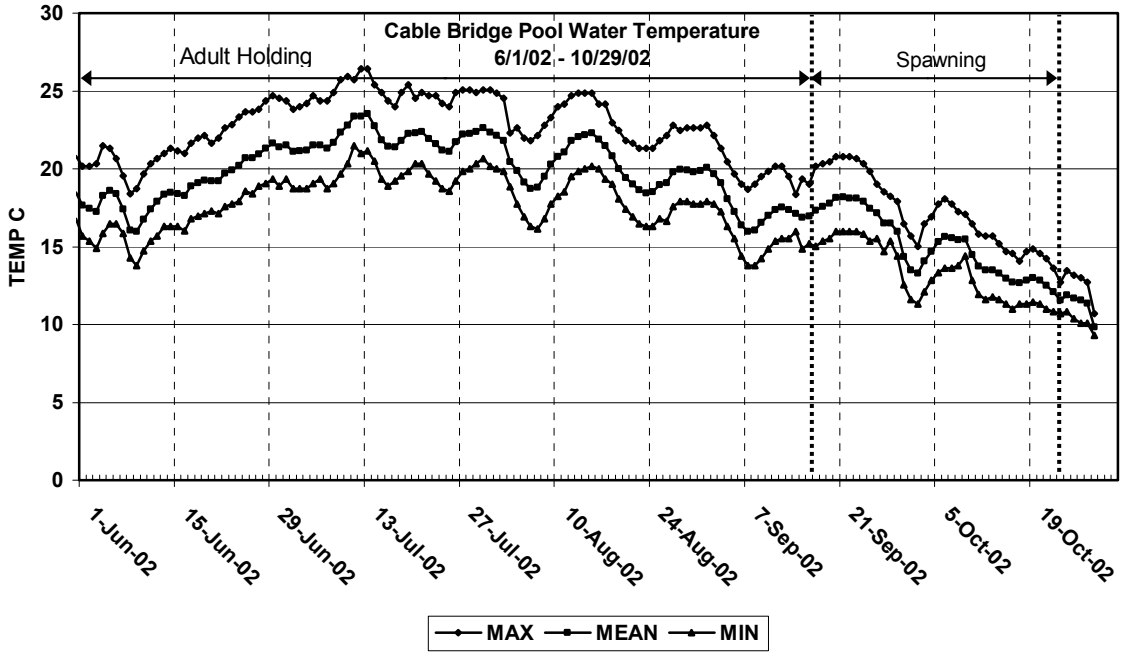
APPENDIX F, Figure 2. Butte Creek water temperature at Chimney Rock pool.



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.