

State of California  
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BUTTE AND BIG CHICO CREEKS  
SPRING-RUN CHINOOK SALMON, *ONCORYHNCHUS TSHAWYTSCHA*  
LIFE HISTORY INVESTIGATION  
2006-2007

By

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NCR – North Central Region

Inland Fisheries

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**ABSTRACT**

This report covers the spring-run Chinook salmon (*Oncorhynchus tshawytscha*) monitoring and life history evaluation in Butte and Big Chico creeks from September 2006 through December 2007.

For Butte Creek, there were 680,796 juvenile Chinook salmon captured near Chico of which 279,936 were coded-wire tagged. The adult spring-run Chinook salmon escapement estimate using the snorkel survey methodology was 4,943. An alternate estimate based upon the modified Schaefer model carcass survey methodology was 6,214. A Schaefer model carcass survey was also conducted to evaluate pre-spawning mortality with an estimated 628 fish that died prior to spawning. Combined, the carcass surveys recovered 64 Butte Creek coded-wire tagged adults from BY 03 (20) and BY 04 (44). Based upon tag recoveries and an adjustment for release group size, the year 2007 population contained an estimated 53% age-3, and 47% age-4 fish. Comparing the expanded recovery rate of ocean catch and inland escapement of BY 03 catch during 2006-2007 suggests an ocean catch rate of approximately 46%.

A simple Peterson model carcass survey of Butte Creek fall-run Chinook salmon estimated the population to be 1,225. There were 0 coded-wire tagged recoveries during the fall-run survey.

For Big Chico Creek, the adult spring-run Chinook salmon escapement was 0 based upon the snorkel methodology.

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## LIST OF ACRONYMS

Baldwin Construction Yard	BCY
Brood Year	BY
Centerville Covered Bridge	CCB
Coded-Wire-Tag	CWT
Fall-run Chinook Salmon	FRCS
Fork Length	FL
Late Fall-run Chinook Salmon	LFRCs
Parrott-Phelan Diversion Dam	PPDD
Quality Control Device	QCD
Quartz Bowl Pool	QBP
Spring-run Chinook Salmon	SRCS
Tricaine Methanesulfonate	MS-222
United States Fish and Wildlife Service	USFWS
Young-of-the-Year	YOY
Rotary Screw Trap	RST

## INTRODUCTION

This is the ninth 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 eight previous reports, Hill and Webber (1999), Ward and McReynolds (2004), Ward et al. (2004a,b,c), McReynolds et al. (2005), McReynolds et al. (2006), and McReynolds et al. (2007) summarized project results through December 2006. Butte Creek is one of several streams that form the basis for population trends for the threatened SRCS in the Central Valley of California. 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 Creek and SRCS escapement estimates for Big Chico Creek;
- 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) and released approximately two miles downstream at the Baldwin Construction Yard (BCY).

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 (Figures 1 and 2). The headwaters of Butte Creek originate in the Lassen National Forest, within the Jonesville Basin at an elevation of approximately 2,137 meters (m) (7,000 feet (ft)). The watershed is approximately 2,103 square kilometers (km<sup>2</sup>) (809 square miles (mi<sup>2</sup>)) and has an unimpaired average annual yield of approximately 300,000 cubic decameters (dam<sup>3</sup>) (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 and Sacramento rivers` (Figure 1). When flows in the Sacramento River are greater than approximately 595 cubic meters per second (m<sup>3</sup>/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<sup>3</sup>/s (45,000 cfs) and 1,841 m<sup>3</sup>/s

(65,000 cfs), respectively. The capacity of the Sacramento River channel downstream of the Tisdale Weir at Wilkins Slough is approximately  $850 \text{ m}^3/\text{s}$  (30,000 cfs). These weirs have a combined capacity to pass approximately  $3,766 \text{ m}^3/\text{s}$  (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 (Figure 1). 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  $116 \text{ km}^2$  ( $72 \text{ mi}^2$ ). 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  $66,600 \text{ dam}^3$  (54,000 acre-feet). The watershed also encompasses three smaller drainages to the north including Sycamore, Mud, and Rock creeks.



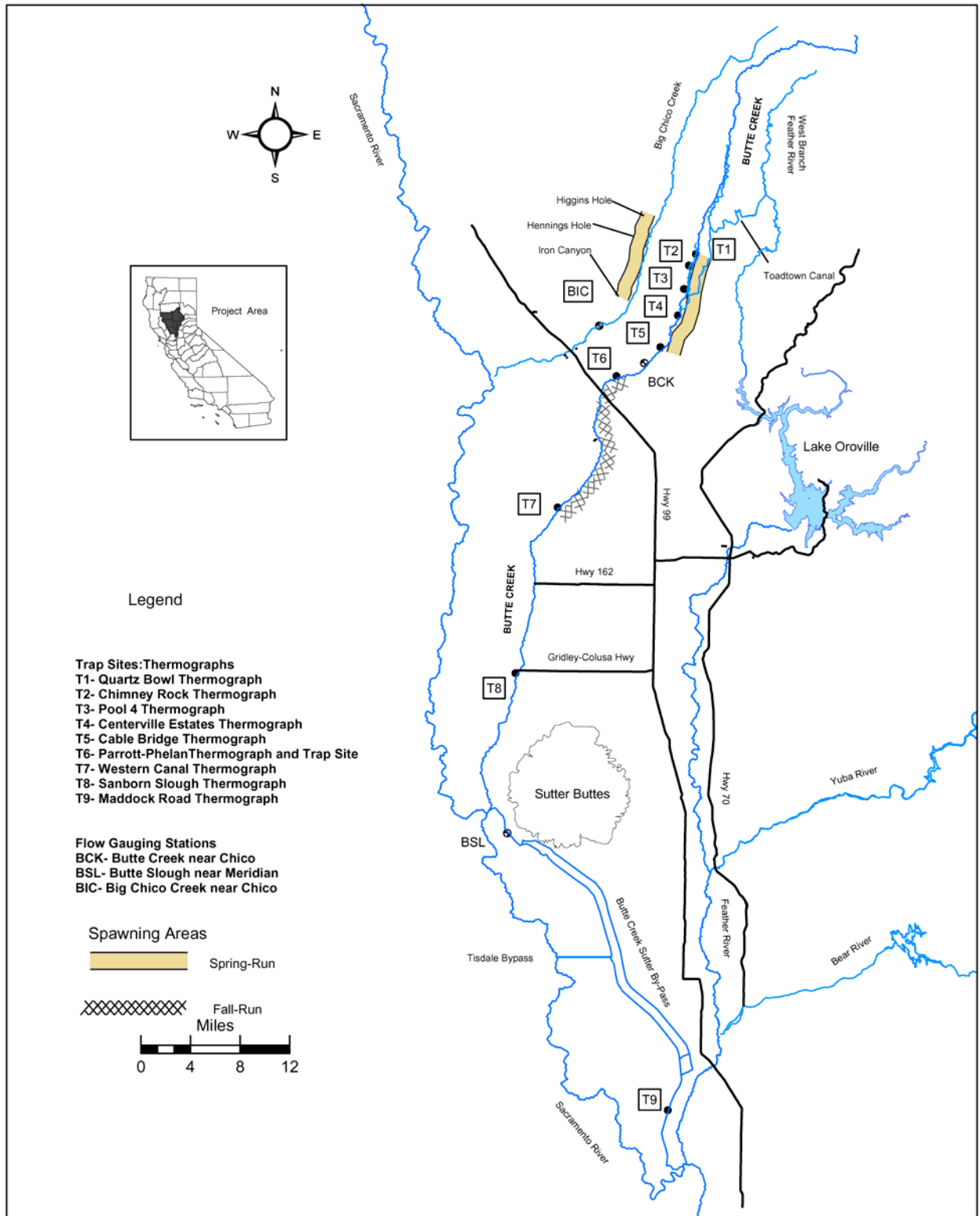


Figure 1. Butte Creek and Big Chico Creek watersheds with trap locations, gauging stations, and salmon spawning areas indicated.

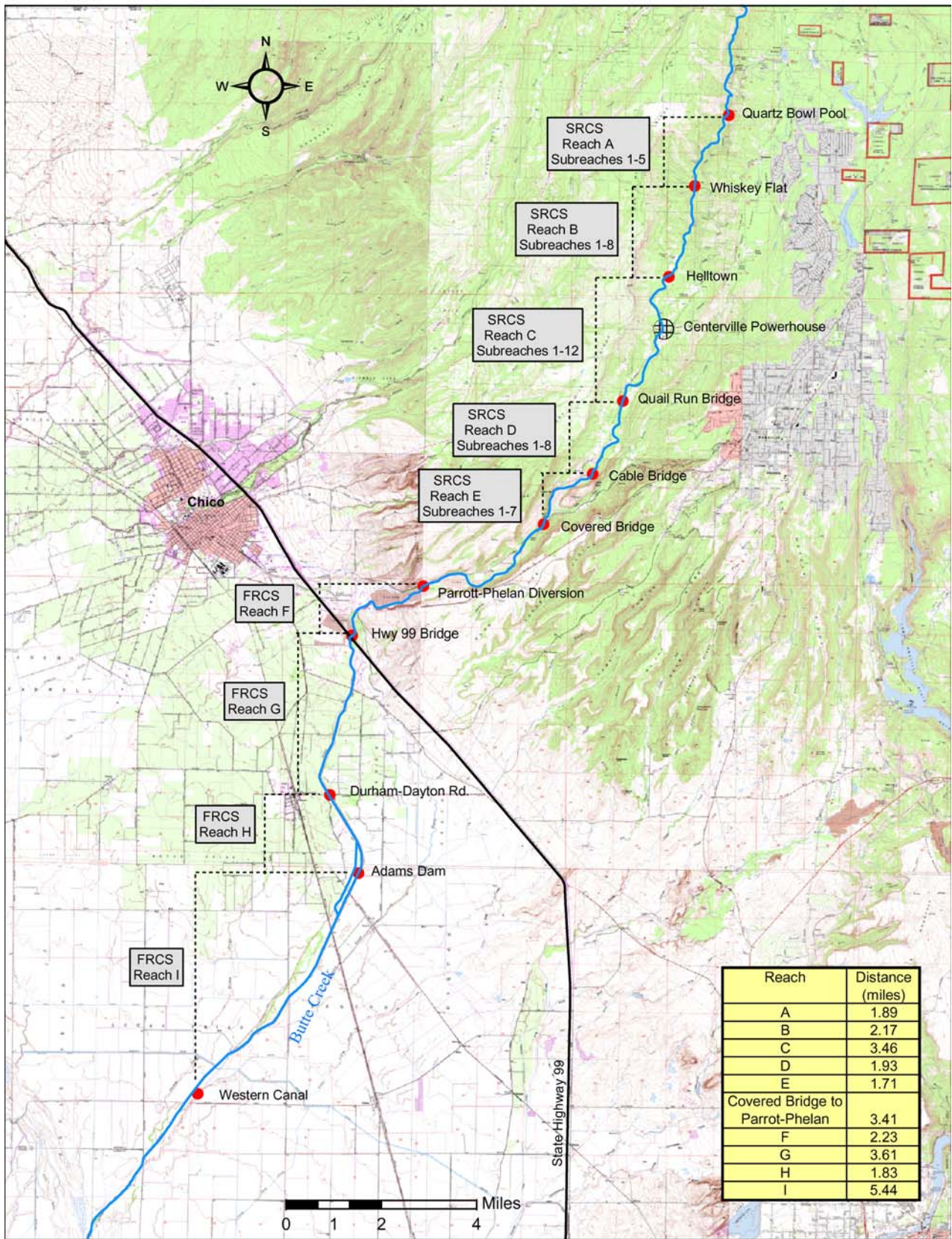


Figure 2. Butte Creek watershed showing spring-run spawning area by reach and sub-reach from Quartz Pool to Covered Bridge and fall-run spawning area by reach from Parrott-Phelan Diversion to Western Canal.



## **MATERIALS AND METHODS**

### **Butte Creek Trapping Sites**

During the 2006-2007 season fish were trapped only at the PPDD location along Butte Creek (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 site was sampled with a 2.4 m diameter (8 ft) rotary screw trap (RST) manufactured by EG Solutions (Eugene, Oregon). The RST was connected to an upstream stationary object, dam, weir, or fish ladder by use of steel cable 0.6 centimeter (cm) (0.25 inch (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 RST 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 flows or during periods of excessive debris.

The Sutter Bypass and Big Chico Creek traps were not operated this season.

### **Physical Measurements**

Four physical measurements were taken daily. Water velocity in meters per second (m/s) was measured at the mouth of the RST cone with a Marsh-McBirney Flo-Mate, Model 2000. The velocity sensor was attached to a graduated staff and submersed to a depth of 0.61 m (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 hour period. Additionally, RST cone revolutions were recorded through the use of a mechanical counter (Reddington Counters Inc., Model 1-2936). Total revolutions for the 24 hour 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 beside the rotary screw trap and the resultant measurement in Nephelometric Turbidity Units (NTU's) recorded on the daily data sheet.

### **Processing Captured Fish**

Daily, 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. Juvenile Chinook salmon were processed prior to any non-salmonid species. The first 10 of each non-salmonid species were identified to species, measured to the nearest mm fork length (FL), and released. The remainder were counted and released.

A random sub-sample of 50 salmon juveniles was placed into a bucket containing a weak, standardized solution of Tricaine methane sulfonate (MS-222) and anaesthetized (10 grams (g) of MS-222 powder dissolved in 1 liter (l) of fresh distilled water to create a stock solution, which was then used at a dilution of 40 milliliters (ml) stock solution added to 6 l of fresh river water). Upon immobilization, juveniles were individually placed onto a wetted Plexiglas measuring board and measured to the nearest mm FL. Salmon greater than 40 mm were transferred to a wetted container on an Ohaus electronic scale and individually weighed to the nearest 0.01 g.

Salmon not processed within the sub-sample were hand counted to determine the total catch for the 24 hour sample period. When numbers of fish were too high to hand count (>2000), five 25 g (0.88-ounce (oz)) sub-samples were weighed on an Ohaus electronic scale to the nearest 1.0 g (0.035 oz). The remaining fish were then added to a previously weighed bucket of fresh water and then weighed to the nearest 25 g on a Chatillon hanging scale. The average number of fish per gram from the five weighed sub-samples was then multiplied by the total grams from the hanging scale to provide an estimate for the total number of fish for the period. All juvenile SRCS were placed in holding pens for subsequent tagging with a CWT.

Salmon were transported in aerated buckets to the BCY, approximately two miles downstream of the PPDD site. Fish were tagged using a Northwest Marine Technology Tag Injector Model MKIV and Model MKIV Quality Control Device (QCD). Injectors were fitted with a 1,100-fish/pound (lb) head mold. 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**

By examining length-frequency distributions of fish captured at PPDD, young-of-the-year (YOY) and yearlings can generally be identified. 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 YOY emerge. Emigration of YOY SRCS is analyzed by examining catches of salmon trapped at PPDD and from tagged fish recovered by other projects in the lower Sacramento River and Delta.

### **Adult Escapement**

Each summer an adult SRCS escapement estimate is developed by conducting snorkel surveys. Adults are counted while in holding behavior, prior to spawning and before the possibility of pre-spawn mortality. On Butte Creek, the snorkel survey extended from the Quartz Bowl Pool (QBP) to PPDD (Figures 1 and 2). On Big Chico Creek, the survey was from Higgins Hole to Iron Canyon (Figure 1). On Butte Creek, the survey was conducted over three days (July 9-11, 2007) each covering a discrete reach, and on one day (July 18, 2007) with three discrete reaches on Big Chico Creek. Each pool was observed only once by each of up to four experienced surveyors, with each of the individual independent estimates recorded. There was subsequent analysis of the entire data set revealing any significant outliers. Such outliers were excluded from calculation of the population estimate. In such instances, the average for the pool only reflected the remaining recorded observations. Individual estimates were then averaged with the annual total escapement estimate calculated by summing the averages for all survey reaches.

### **Adult Pre-spawning Mortality Survey**

A modified Schaefer model (Schaefer, 1951; Taylor, 1974) mark/recapture survey, to identify pre-spawning mortalities, was conducted during the period June 12, through September 20, 2007 as follows:

$$E = N_{ij} = R_{ij}(T_i C_j / R_i R_j) - T_i$$

Where:

E = Total run size which is sum of  $N_{ij}$

$N_{ij}$  = Population size in tagging period i recovery period j,

$R_{ij}$  = number of carcasses tagged in the ith tagging period and recaptured in the jth recovery period,

$T_i$  = number of carcasses tagged in the ith tagging period,

$C_j$  = number of carcasses recovered and examined in the jth recovery period,

$R_i$  = total recaptures of carcasses tagged in the ith tagging period, and

$R_j$  = total recaptures of tagged carcasses in the jth recovery period.

The survey extended from QBP to the Centerville Covered Bridge (CCB) (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<sup>2</sup>) 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 and stored at -20° C. 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 enumerated and 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 a “recovery”.

### **Adult Spawning Carcass Survey**

Adult spawning surveys using the modified Schaefer model were completed for both SRCS and FRCS populations. This was the seventh year an intensive mark-recapture 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 and an estimate of the proportion taken in the ocean sport /commercial harvest.

The 2007 SRCS spawning survey was conducted from September 25, through November 8, 2007. The survey extended from the QBP to the CCB. 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. 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. All other carcasses were examined for an adipose fin-clip, and then chopped in half to avoid counting during subsequent trips. Tissue samples were taken from the first 10 fresh carcasses encountered in each reach each week. Clean scissors were used to cut a small piece (10 mm<sup>2</sup>) 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 plastic coin bag and recorded onto a data sheet. Between each sample, scissors were rinsed in fresh water to prevent cross contamination. Each sample was then air dried and placed into a small manila envelope. Heads were removed from adipose fin-clipped carcasses and kept for recovery of the CWT. While removing the CWT's from the heads, otoliths were extracted and archived with the previously taken tissue. There was a significant number of fish observed spawning below the previous lowermost limit at the CCB in the reach downstream to the PPDD. Since the project was not funded for an extensive mark/recapture effort in that reach, a survey to only count and chop carcasses was conducted during three weeks in October. All carcasses were recorded and chopped in half. An expansion factor to account for fish that were not observed was calculated as follows:

$$F = E / (C + T)$$

Where:

F = Expansion Factor

E = Total population estimate for surveyed reaches

C = Total untagged carcasses chopped for surveyed reaches

T = Total tagged carcasses for surveyed reaches

Estimation of the proportion taken in the ocean sport/commercial harvest was calculated as follows:

$$H = (O_s + O_c) / (O_s + O_c + I_{te})$$

Where:

H = Total ocean sport and commercial harvest

O<sub>s</sub> = Total ocean sport harvest cwt recoveries

O<sub>c</sub> = Total ocean commercial harvest cwt recoveries

I<sub>te</sub> = Total inland escapement cwt recoveries to include pre-spawn mortalities and fish surviving to spawn

The 2007 FRCS carcass survey was conducted from November 13, 2007 through December 18, 2007. The survey extended from PPDD to the Gorrill Ranch Dam, also covering a 0.8 km (0.5 mi) section near the Western Canal Siphon (Figure 1 and 2). The approximately 15.3 km (9.5 mi) creek section was divided into four reaches. The FRCS survey used the same modified Schaefer model as was used for the SRCS survey.

### **Water Temperature**

Onset, HOBO Water Temp Pro, model H20-001, temperature data loggers accurate to ± 0.2° C were deployed in pools at five sites within the SRCS spawning habitat (Figure 1). Each data logger was placed in a galvanized steel pipe and suspended by 0.6 cm (0.25 in) steel cable. Data loggers were set for 1h interval readings and recorded in degrees Celsius.

## RESULTS

### Butte Creek

#### Trapping Season 2006-2007

The 2006-2007 trapping season began at the PPDD when the diversion trap was installed on November 2, 2006. The diversion trap was operated until May 3, 2007. A rotary screw trap was installed on November 1, 2007 and removed on May 3, 2007. An additional rotary screw trap was installed on January 4, 2007 and was operated until March 3, 2007 to catch additional juvenile salmon for coded-wire tagging. During the trapping season, there were occasions when one or more of the traps were removed due to high stream flows or excessive debris. A total of 680,796 juvenile salmon, including yearlings, was captured in all traps; 359,567 in the diversion trap and 321,229 in the RST(s) (Tables 1 and 2). Of the total captured, 279,936 were tagged and released at the BCY (Table 3). Trapping was suspended periodically for both the diversion trap and RST during this survey period. Between mid-February and March the diversion trap was suspended for 19 days and the RST was suspended for a total of 46 days. (Tables 1, 2, and Appendix A, Figure 1).

**Table 1.** Semi-monthly catch summary of juvenile Butte Creek spring-run Chinook salmon caught in the diversion trap at Parrott-Phelan Diversion Dam from November 1, 2006 to May 3, 2007; yearling captures are included.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
11/1/06	11/15/06	-	-	-	-	0	15
11/16/06	11/30/06	33	1.7	30	36	29	15
12/1/06	12/15/06	35	4.3	30	100	1,034	15
12/16/06	12/31/06	36	3.3	30	101	8,252	12
1/1/07	1/15/07	36	1.4	32	39	14,811	15
1/16/07	1/31/07	36	1.6	33	56	21,219	16
2/1/07	2/15/07	37	1.5	33	40	284,325	9
2/16/07	2/28/07	-	-	-	-	0	0
3/1/07	3/15/07	38	3.3	33	56	17,704	15
3/16/07	3/31/07	39	6.0	32	69	6,451	16
4/1/07	4/15/07	47	12.7	33	97	1,567	15
4/16/07	4/30/07	54	11.5	32	84	3,652	15
5/1/07	5/15/07	66	7.8	43	94	523	3
Total						359,567	161

**Table 2.** Semi-monthly catch summary of juvenile Butte Creek spring-run Chinook salmon caught in the RST(s) at Parrott-Phelan Diversion Dam from November 1, 2006 to May 3, 2007; yearling captures are included.

Trapping period		Trap	Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
11/1/06	11/15/06	1	122	10.5	112	136	4	15
11/16/06	11/30/06	1	34	2.1	31	36	6	15
12/1/06	12/15/06	1	40	19.4	31	136	130	14
12/16/06	12/31/06	1	36	4.4	31	122	3,892	12
1/1/07	1/15/07	1	36	1.3	32	40	25,590	15
1/1/07	1/15/07	2	36	1.4	32	40	3,122	12
1/16/07	1/31/07	1	36	1.4	33	41	31,676	16
1/16/07	1/31/07	2	37	1.4	33	40	5,661	16
2/1/07	2/15/07	1	37	1.5	33	41	205,572	9
2/1/07	2/15/07	2	37	1.6	33	40	21,544	8
2/16/07	2/28/07	1	38	2.7	34	46	242	2
3/1/07	3/15/07	1	37	2.2	32	60	15,689	14
3/1/07	3/15/07	2	37	2.4	34	50	1,485	5
3/16/07	3/31/07	1	-	-	-	-	-	0
4/1/07	4/15/07	1	51	11.9	31	76	693	3
4/16/07	4/30/07	1	57	11.5	32	138	5,586	15
5/1/07	5/15/07	1	64	9.9	41	98	337	3
Total Trap 1							289,417	133
Total Trap 2							31,812	41

Sampling by the U.S. Fish and Wildlife Service (USFWS) at Chipps Island in the lower Sacramento River, and at Knights Landing, recovered two juvenile tagged Butte Creek SRCS on March 8 and April 20, 2007 (Table 4). Both fish were from BY( Brood Year) 2006, captured at PPDD and tagged at the BCY between January 2, and March 15, 2007. No marked juvenile SRCS were salvaged at the State Fish Facility in the central Delta for the 2007 sampling season



**Table 3.** Summary of coded-wire tagged juvenile Butte Creek spring-run Chinook salmon released at Baldwin Construction site from January 2, to March 15, 2007.

Tag Code	Release Date		Mean FL (mm)	Range FL (mm)		Total No. Released
06-02-01-02-00	1/2/2007	1/9/2007	36	32	40	11,258
06-02-01-02-01	1/2/2007	1/9/2007	36	32	56	10,895
06-02-01-02-02	1/9/2007	1/26/2007	37	32	45	10,855
06-02-01-02-03	1/9/2007	1/22/2007	36	33	56	10,279
06-02-01-02-04	1/9/2007	1/22/2007	37	33	56	11,395
06-02-01-02-05	1/22/2007	1/30/2007	37	33	56	10,536
06-02-01-02-06	1/26/2007	1/31/2007	37	33	56	11,181
06-02-01-02-07	1/30/2007	2/1/2007	36	33	56	10,883
06-02-01-02-08	1/30/2007	2/5/2007	37	33	56	10,786
06-02-01-02-09	1/31/2007	2/7/2007	37	33	41	10,965
06-02-01-03-00	1/31/2007	2/6/2007	37	33	41	11,184
06-02-01-03-01	2/5/2007	2/7/2007	37	33	40	10,503
06-02-01-03-02	2/6/2007	2/9/2007	37	33	41	11,187
06-02-01-03-03	2/7/2007	2/12/2007	37	33	41	10,269
06-02-01-03-04	2/7/2007	2/9/2007	37	33	41	10,506
06-02-01-03-05	2/7/2007	2/12/2007	37	33	41	10,168
06-02-01-03-06	2/9/2007	2/13/2007	37	33	41	11,229
06-02-01-03-07	2/9/2007	2/14/2007	37	33	41	10,505
06-02-01-03-08	2/12/2007	2/14/2007	37	33	41	10,633
06-02-01-03-09	2/12/2007	2/15/2007	37	33	46	11,069
06-02-01-04-00	2/13/2007	2/16/2007	37	33	46	11,116
06-02-01-04-01	2/14/2007	2/16/2007	37	33	46	10,585
06-02-01-04-02	2/14/2007	2/17/2007	37	33	46	10,568
06-02-01-04-03	2/15/2007	2/17/2007	37	33	46	10,749
06-02-01-04-04	2/16/2007	2/27/2007	37	34	46	5,007
06-02-01-04-05	2/16/2007	3/15/2007	38	34	69	5,708
06-02-01-04-06	2/17/2007	3/15/2007	38	34	69	9,917
					Total	279,936

**Table 4.** Recaptures of juvenile Butte Creek spring-run Chinook salmon bearing coded-wire tags by other research projects during 2007.

Recovery Date	Tag Code*	Recovery FL (mm)	Recapture Location	Days at Large
3/08/07	06-02-01-02-04	58	Knights Landing	52
4/20/07	06-02-01-03-04	80	Chippis Island	71

\* All fish were from BY 2006 and tagged at Baldwin Construction Yard.

## Juvenile Emigration 2006-2007

As discussed in previous reports (McReynolds et al., 2006), 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. 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 14 yearling SRCS were captured. The first yearling SRCS was captured on November 6, 2006 and the last on April 19, 2007 (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 YOY and yearling SRCS and also late fall-run Chinook salmon (LFRCS).

## Adult Escapement 2007

### Pre-spawning Mortality Carcass Survey

This was the fifth year that an intensive mark recapture survey was conducted during the adult SRCS holding period to assess pre-spawn mortalities (Ward et al., 2004d; Ward et al., 2006a,b,c). From June 12, 2007 through September 20, 2007, a total of 502 carcasses were examined of which 210 were measured, identified by sex ((72% female, 28% male) and marked for possible recovery. Ten were recovered. Since recoveries of marked salmon were too low to calculate an estimate using the modified Schaefer model, an expansion factor developed from the subsequent spawning carcass survey of  $F = 1.25$  (Appendix C) was applied to generate an estimated total pre-spawning mortality of 628. Mortalities appeared to be due to natural attrition. During this survey period, nine CWT carcasses were collected (Appendix D, Table 2). Four were BY 03 and five were BY 04. Carcasses were identified as pre-spawning mortalities due to immature gametes and lack of any visible spawning activity. During the SRCS pre-spawn mortality carcass survey, two CWT's were recovered by non –survey related methods. One fish was a BY 03 fish and the other a BY 04 fish.

### Spawning Carcass Survey

During this study period, the sixth intensive survey directed at recovering CWT's from previous release groups was conducted. A spawning carcass survey was begun on September 25, and continued through November 8, 2007 covering the 17.7 km (11 mi.) SRCS spawning area (Figures 1 and 2). Additionally, significant spawning activity was noted in the reach below the CCB and below the normal survey area. To provide some assessment of this activity, 484 carcasses were counted and chopped during three surveys that covered that reach. Based upon the spawning carcass survey there were an estimated 6,214 adult SRCS that spawned during 2007. There were a total of 4,885 carcasses examined, including those from below the CCB, with a total of 53 CWT's recovered: BY 03 (15) and BY 04 (38) (Appendix D, Table 2). For SRCS carcasses and CWT recoveries below the CCB, an expansion factor of  $F = 1.25$  was calculated as previously described for the pre-spawn mortality estimate. In addition to the Butte Creek carcass recoveries, 6 CWT's were recovered in the ocean fishery (Appendix D, Table 1).

Subsequent to the SRCS spawning carcass survey, a survey of the FRCS spawning area (Figure 1 and 2) was conducted from November 13 through December 18, 2007. No CWT's were recovered from the 273 carcasses that were examined. Due to low recoveries of marked carcasses, a simple mark-recapture Peterson model was utilized (Appendix C, Table 2).

### Snorkel Escapement Survey

The 2007 SRCS adult escapement estimate based upon the snorkel survey method was 4,943 (Table 5).

**Table 5.** Estimates of adult spring-run Chinook salmon escapement in Butte Creek from snorkel surveys.

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
2004	7,390	July 12 - July 16, 2004
2005	10,625	July 26 – July 28, 2005
2006	4,579	July 24 – July 26, 2006
2007	4,943	July 9 – July 11, 2007

### Water Temperatures 2006-2007

Thermal recording data loggers were installed at the five sites within the SRCS holding and spawning reach of Butte Creek (Figure 1). Recorded mean daily temperatures during the period June through October ranged as high as 21.2° C on July 6, at the Pool 4 location (Table 6; Appendix E, Figures 1 - 5). Average daily temperatures at all sites were above 15.0° C until early-September 2007. Initial data loggers and back-up loggers deployed at Centerville Estates and Cable Bridge sites failed to record any temperature data during the June to October period.

**Table 6.** Butte Creek spring-run Chinook salmon holding reach average daily temperature exceedance.

Location	Period of Record	Number of Days Equal to or Exceeding		
		15.0 C	17.5 C	20.0 C
Quartz Bowl Pool	6/1/06 to 10/31/06	66	29	0
Chimney Rock	6/1/06 to 10/31/06	102	56	3
Pool 4	6/1/06 to 10/31/06	107	94	15
Centerville Estates	6/1/06 to 10/31/06	-	-	-
Cable Bridge	6/1/06 to 10/31/06	-	-	-

### Big Chico Creek

#### Adult Escapement 2007

The Big Chico Creek spawning escapement survey was conducted July 18, 2007. The estimate was 0 based upon the snorkel survey method (Table 7).

**Table 7.** 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
2004	0	August 11 & 13, 2004
2005	37	August 10, 2005
2006	299*	July 17, 2006
2007	0*	July 18, 2007

\* Survey was conducted in July to avoid any potential pre-spawn mortalities.

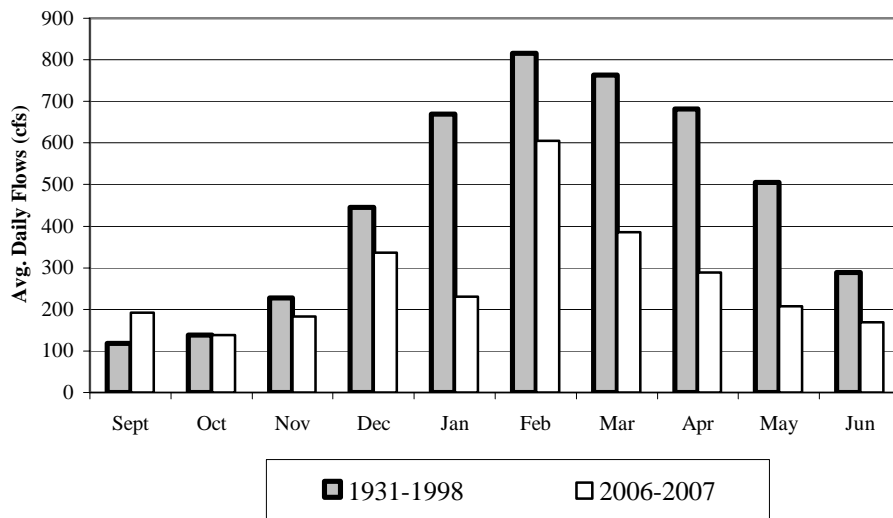
### DISCUSSION

During this study period, emphasis was focused on trapping and tagging juvenile SRCS on Butte Creek at the PPDD, as well as recovering tags from returning adults. As with previous studies, short periods of elevated uncontrolled flows and heavy debris required cessation of trapping (Appendix A, Figure 1) to protect personnel and gear. The juvenile trapping effort at PPDD for the RST and diversion trap was suspended a total of 46 and 19 trap days, respectively, of the 247 day trapping season.

### 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% of the total catch had occurred by the end of January (Hill and Webber, 1999; Ward and McReynolds, 2004). During the 2006-2007 study period, low average creek flows (January daily avg. flow 230cfs) during the peak of Chinook salmon emigration delayed the movement timing of juveniles (Figure 3). However, on February 9, 2007 heavy rain in the upper watershed in a 24 hour period (~4 in.) increased Butte Creek flows to 1,310 cfs, peaking at 4,360cfs on February 10, 2007. Due to storm induced flows and turbidity, there were an estimated 397,000 fish captured in one day. However, of the total catch, 92% had occurred by the end of February, similar to 2000-2001, 2001-2002 and 2004-2005 study periods. The total season catch for 2006-2007 was 680,000, significantly higher than last seasons catch of 25,454. During periods of high flows, traps are pulled for personnel safety, protection of trapping equipment and to decrease potential mortality of juvenile salmon. Past study reports (McReynolds, et al. 2006) have shown that increased flows in Butte Creek during peak juvenile emigration (January-February), result in increased juvenile salmon numbers passing PPDD. It is likely that large numbers of salmon emigrated past PPDD this season when traps were pulled.

Figure 3. Comparison of Butte Creek average flows as measured at Butte Creek near Chico Gage (USGS #11390000) during 2006-07 with average flows during the period 1931-1998 (CDWR, 2002).



Emerged fry were captured at PPDD from November 2006 through May 2007 (Appendix B, Figure 1). As with previous years (McReynolds et al., 2005), recently emerged fry captured at PPDD beginning in early April (Appendix B, Figure 1) were assumed to be LFRCS. Again, FRCS were observed spawning above PPDD after mid-October 2006, although numbers were

generally small. Fry captured at the site from November through March were assumed to be SRCS.

In contrast to previous study periods, many yearling salmon were observed upstream of PPDD during the summer adult escapement surveys. However, during this survey period only 14 yearling salmon were captured at PPDD compared to 83 yearling salmon the previous study year. These results continue to support the conclusion that the majority of Butte Creek SRCS migrate as YOY.

### Adult Escapement

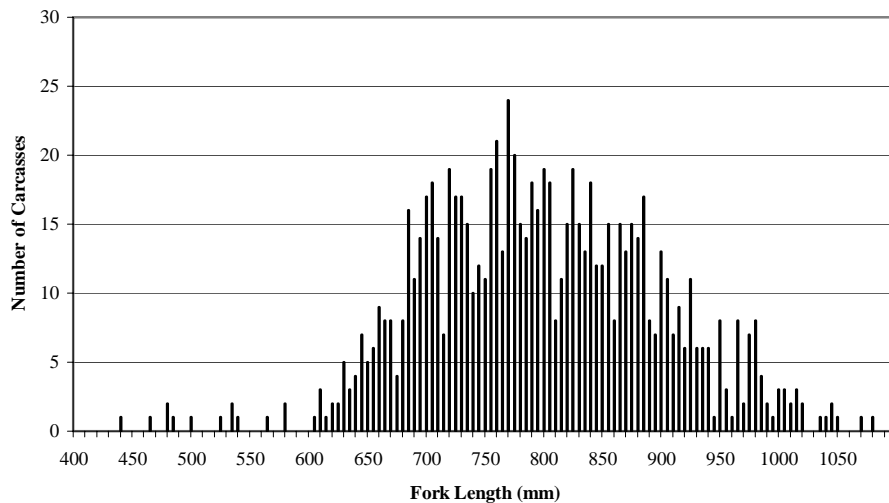
During this study period, three discrete surveys were completed to develop an estimate of adult SRCS escapement. A standard swimming snorkel survey was conducted July 9-11, 2007. The snorkel survey has been performed consistently since 1991 and serves as a population index. The 2007 snorkel survey was conducted during July in an attempt to develop a better estimate prior to any significant pre-spawn mortality. There were an estimated 17 pre-spawn mortalities prior to the snorkel survey. However, previous project findings have shown that snorkel surveys significantly underestimate salmon abundance (McReynolds et al., 2006). As an alternative, a standard modified Schaefer model spawning carcass survey was initiated beginning in 2001. Based upon significant pre-spawn mortalities observed during 2002, an additional modified Schaefer model survey was completed during 2003-2006 to account for those adults that died prior to spawning. The 2007 escapement estimate based upon the snorkel survey was 4,943 with a range of 4,255 to 5,702. The combined pre-spawn and spawning Schaefer model carcass survey results for 2007 suggest a larger population of 6,842 SRCS; 628 that died prior to spawning and 6,214 which survived to spawn (Appendix C, Table 1). During previous surveys (2001-2004) SRCS spawning was almost exclusively confined to reaches above the CCB, with only a small number observed below. However, as in 2005 and 2006, significant spawning in the reach below the CCB was noted in early October. Since the project was not funded to develop a modified Schaefer model estimate in that reach, four single day surveys to record and chop spawned carcasses were completed during September and October. There were 346 carcasses counted and chopped. Among those that survived to spawn, there were 4,885 carcasses examined including those from the reach below CCB, of which 858 fresh carcasses (55% female, 45% male) were marked, with a subsequent recovery of 557, a recovery rate of 65%.

Approximately 150-200 adult Chinook salmon were visually observed downstream of State Highway 99 in mid June. Low flows and high water temperatures precluded their ability to volitionally migrate upstream. Systematic and frequent monitoring of these fish occurred until no fish were observed by the second week of July. A single carcass was transported to the Department of Fish and Game Fish Health Lab in Rancho Cordova and determined to be infected with the two pathogens, *Flavobacterium columnare* (columnaris) and *Ichthyophthirius multifiliis* (Ich). It is assumed that the majority of these fish perished due to lethal water temperatures and did not contribute to the spawning population holding in the upper watershed.

Based upon snorkel surveys and adults returning as three year olds, the 2007 escapement estimate represents a 0.66 cohort replacement rate (4943/7390). However, Butte Creek CWT recoveries continue to demonstrate that a proportion of Butte Creek SRCS return to spawn at age-4. Of the 64 total CWT's recovered for all methods, 44 were age-3 and 20 were age-4

(Figure 4). Based upon tag recoveries adjusted for release group size the population contained approximately 53% age-3, and 47% age-4 fish.

**Figure 4.** Length frequency distribution of 858 spawned adult Butte Creek spring-run Chinook salmon carcasses measured and marked for abundance estimate between September 25, and November 8, 2007.



This was the fifth season a fully funded pre-spawning mortality survey was completed starting on June 12 and ending on September 20, 2007 at the onset of spawning. Mortalities were low throughout the study period. There were a total of 502 carcasses examined of which 210 were measured (72% female, 28% male) and identified by sex and marked for possible recovery. Ten were recovered during the 13 week survey. Due to the low number of marks and recoveries it was not possible to generate a modified Schaefer model estimate of total pre-spawn mortality. Instead, an expansion factor ( $F = 1.25$ ) generated from the subsequent modified Schaefer Model estimate of spawning was applied (Appendix C). Based upon that expansion factor, the estimate for pre-spawn mortality was 628 ( $502 \times 1.25$ ).

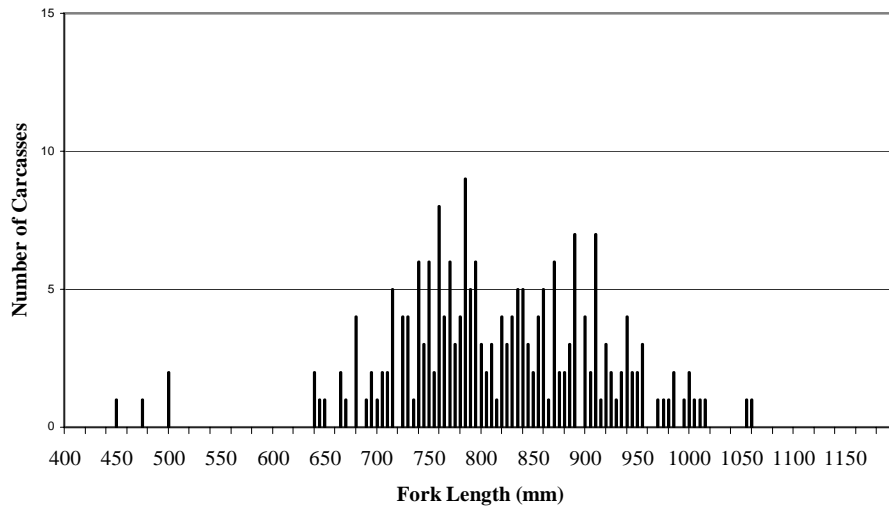
For the measured sub-sample of adult Butte Creek SRCS that died prior to spawning compares to those that survived to spawn, the average size of both males and females was similar to 2003 and 2006, and significantly larger than observed during 2001, 2002, 2004 and 2005. (Table 8, Figure 4, 5). In 2006 and 2003 age-4 fish dominated the age composition (75% and 69% respectively) which would result in the larger average size. The larger average size of measured carcasses for 2007 would suggest a larger proportion of age 4 fish. However, based upon this years' CWT analysis and adjusting for CWT release size groups, 2007 age-4 fish comprise 47% of the age composition.

Due to paucity of CWT recoveries it is difficult to assess age composition by adjusting for CWT release groups.

**Table 8.** Fork lengths of adult Butte Creek spring-run Chinook salmon that spawned during 2001- 2007 which were measured and marked for abundance estimate.

Year	Female					Male				
	Carcasses		FL (MM)			Carcasses		FL (MM)		
	Total	Percent	Max	Min	Mean	Total	Percent	Max	Min	Mean
2007	470	55%	992	581	762	388	45%	1081	440	839
2006	458	57%	972	562	762	342	43%	1065	478	817
2005	609	55%	895	518	706	495	45%	1090	435	771
2004	376	54%	962	490	723	324	46%	973	429	765
2003	378	60%	979	494	802	252	40%	1110	423	844
2002	416	49%	910	574	708	440	51%	1091	349	754
2001	784	52%	910	340	709	711	48%	1020	402	760

**Figure 5.** Length frequency distribution of 210 adult Butte Creek spring-run Chinook salmon pre-spawn mortalities measured between June 12, and September 20, 2007.



Ocean recoveries during 2007 (Appendix D, Table 1) occurred from June through mid-July, and were taken from south of Monterey, California to California/Oregon border. For the 2007 recovery year, no Butte Creek fish were recovered and/or reported in the Oregon ocean fisheries. Based upon the current ocean-aging convention that increments SRCS to the next age class on May 1 (Viele et al., 2004), there were 0 age-3, and 6 age-4 recoveries. Comparing the expanded BY 03 ocean and inland recoveries (Table 9; Appendix D, Table 1) it suggests a 46% ocean sport/commercial catch rate, lower than the 59% ocean sport/commercial catch rate for BY02 and slightly higher than BY01 (40%).

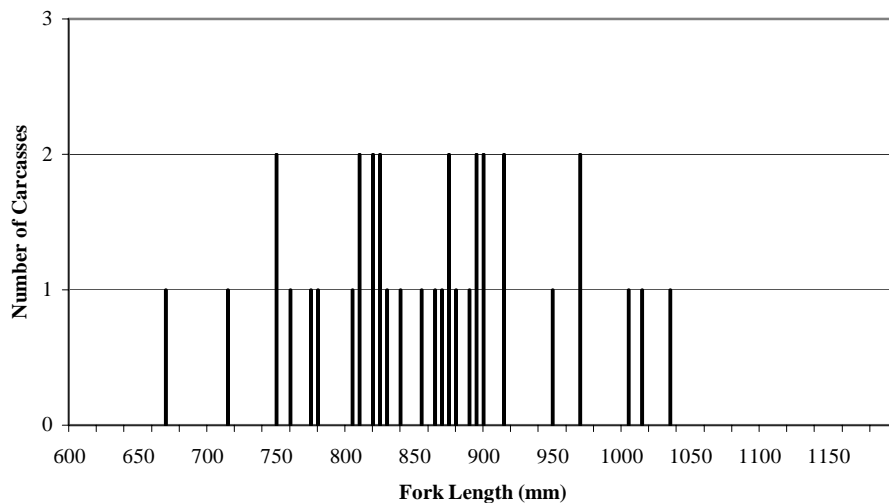


**Table 9.** Brood Year 2003 ocean and inland recoveries of CWT adult Butte Creek spring-run Chinook salmon.

Source	Inland Age	Ocean Age	Number Recovered		Expanded Number Recovered	
			Ocean	Inland	Ocean	Inland
Sport	3	3	1		5	
Sport	3	4	7		28	
Commercial	2	3	3		12	
Commercial	3	4	8		21	
Spawn	3			40		54
Spawn	4			20		25
Total			19	60	66	79

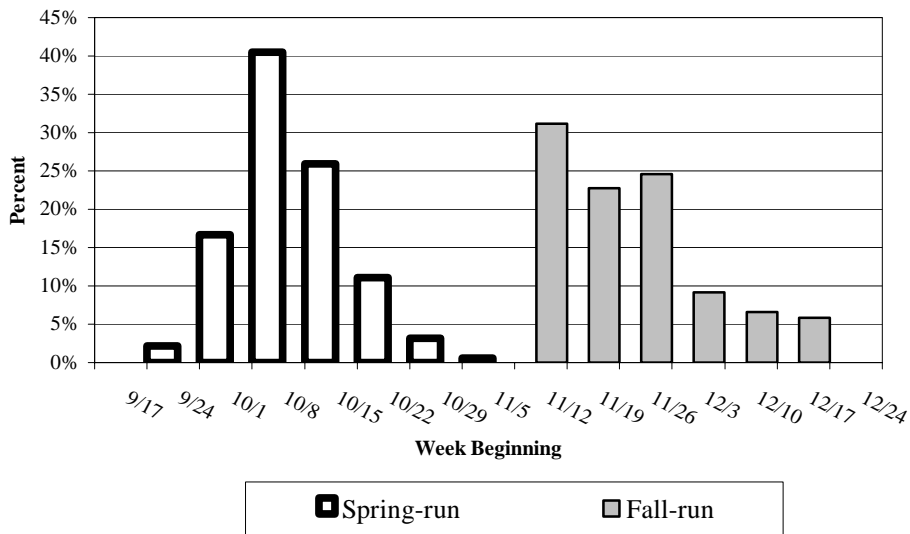
Subsequent to the SRCS spawning carcass survey, a FRCS spawning carcass survey was initiated on November 13, and continued through December 18, 2007. The FRCS survey covered the reaches of Butte Creek downstream of the PPDD (Figure 1 and 2). For the fifth consecutive year, a bar rack was placed in the 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. A survey utilizing a modified Schaefer model was initiated. However, only 273 carcasses were examined, with 35 of the fresh carcasses marked of which 7 were subsequently recovered. Additionally a Peterson model estimated 1225 FRCS which spawned in the reach downstream of the PPDD (Appendix C, Table 2). The mean FL of the measured sub-sample of 35 Butte Creek FRCS was 859 mm (Figure 6). There were no CWT marked carcasses recovered during the FRCS carcass surveys.

**Figure 6.** Length frequency distribution of 35 adult fall-run Chinook salmon carcasses measured and marked for abundance estimate between November 13, and December 18, 2007.



Comparison of Butte Creek SRCS and FRCS spawning timing (Figure 7) continues to show little overlap, with peak SRCS spawning occurring during the week beginning on October 9. For FRCS the peak occurred during the week beginning on November 13, 2007. All of the Butte Creek SRCS spawned above PPDD (Figure 1), while the vast majority of FRCS spawned downstream of that site.

**Figure 7.** Percent of carcasses of spawned Butte Creek spring- and fall-run Chinook salmon recovered for period September 25, through December 18, 2007.



### Adult Straying

During this reporting period, two Feather River adult CWT Chinook salmon were recovered on surveys conducted on Butte Creek. A female (BY04) at 732 mm with tag code 06244 was recovered during the pre-spawn mortality survey on August 2, 2007. Tag information from the Regional Mark Information System (RMIS) lists this tag group as SRCS released at Wickland Oil Field from 5/2/2005 thru 5/25/2005 at an average FL of 91 mm. A male (BY03) at 868 mm with tag code 0601080709 was recovered on October 3, 2007. Tag information from the Regional RMIS lists this tag group as FRCS released at Live Oak (Feather River) from 1/31/04 thru 2/1/2004 at an average FL of 35 mm. However, based upon the location, recovery date, average release FL, and time of tagging, it was concluded that the fish was a SRCS. 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. The results from the 2006-2007 study period continue to support Butte Creek SRCS as a distinct and sustaining population with little evidence to date of significant introgression from other watersheds. To date, there have been 252 (expanded to 386 for sampling effort) CWT Butte Creek SRCS recovered in Butte Creek and six (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. Average daily temperatures exceeded 17.5°C by July 5<sup>th</sup> and exceeded 20°C one day during the holding period at QBP.

## **ACKNOWLEDGMENTS**

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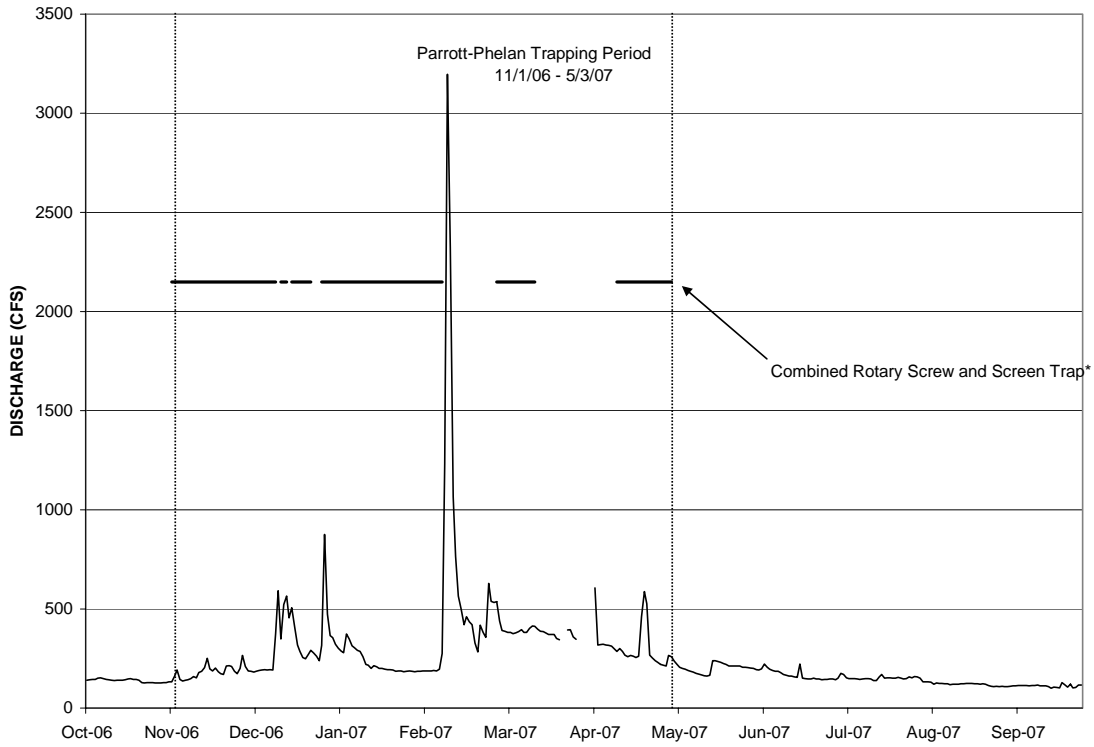
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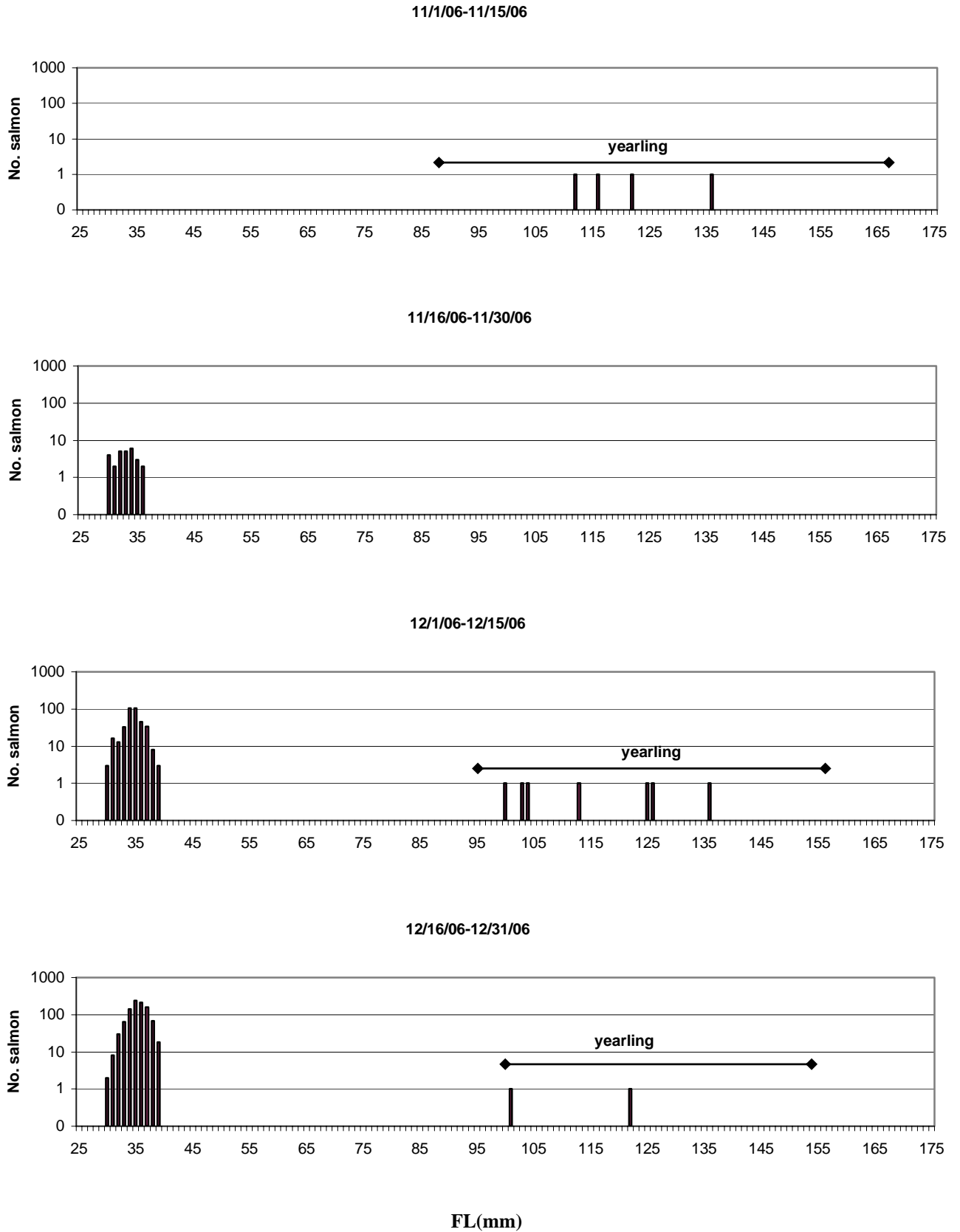
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APPENDIX A, Figure 1. Butte Creek flow at Butte Creek near Chico Gage (USGS - #11390000), water year 2006-07, with trapping period shown. Flow data are provisional and subject to revision.

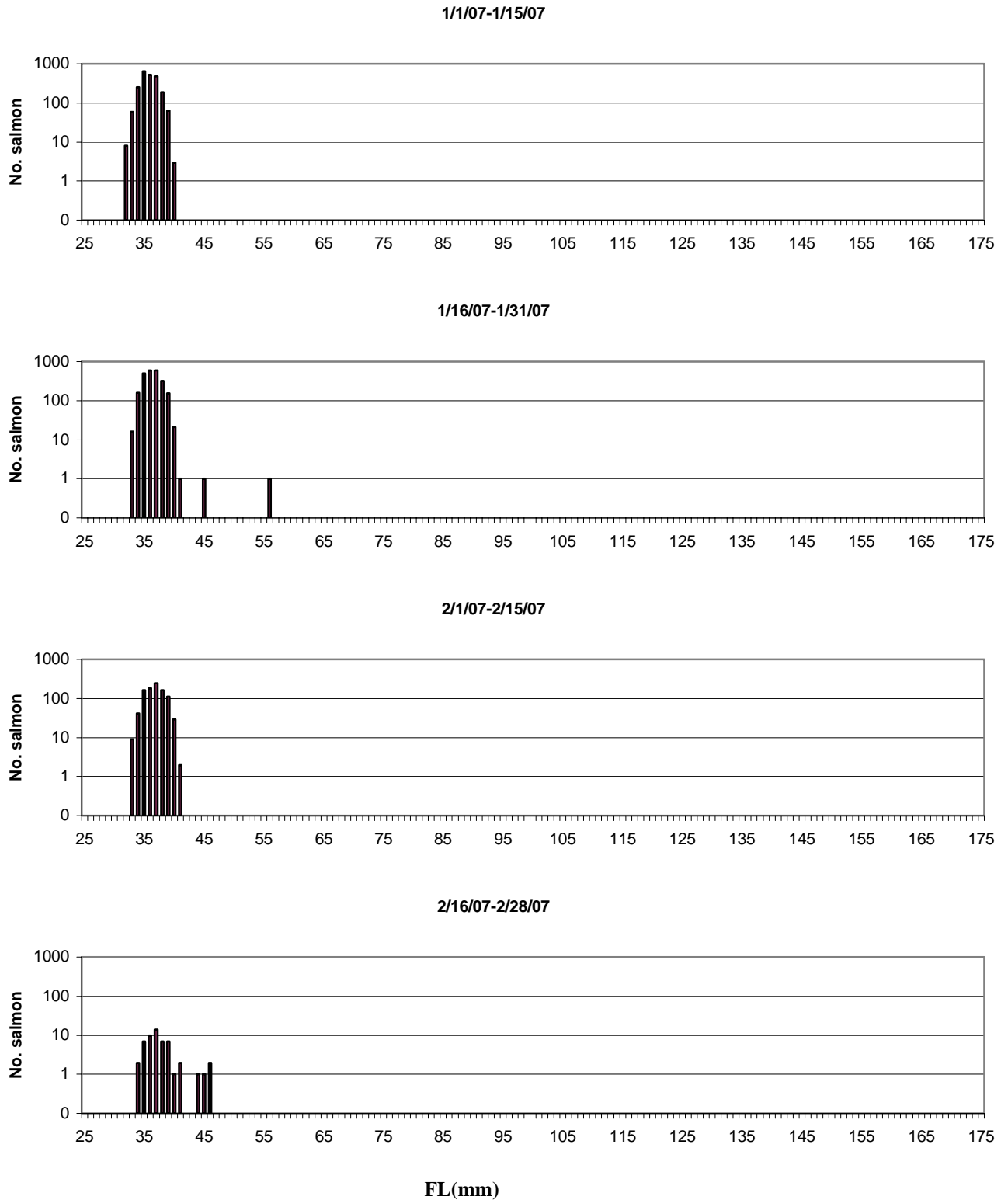
\*Breaks in horizontal line indicate periods of time when the trap(s) were not fishing.



APPENDIX B, Figure 1. Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from November 1, 2006 through May 3, 2007. All fish are assumed to be spring-run Chinook salmon except where indicated.

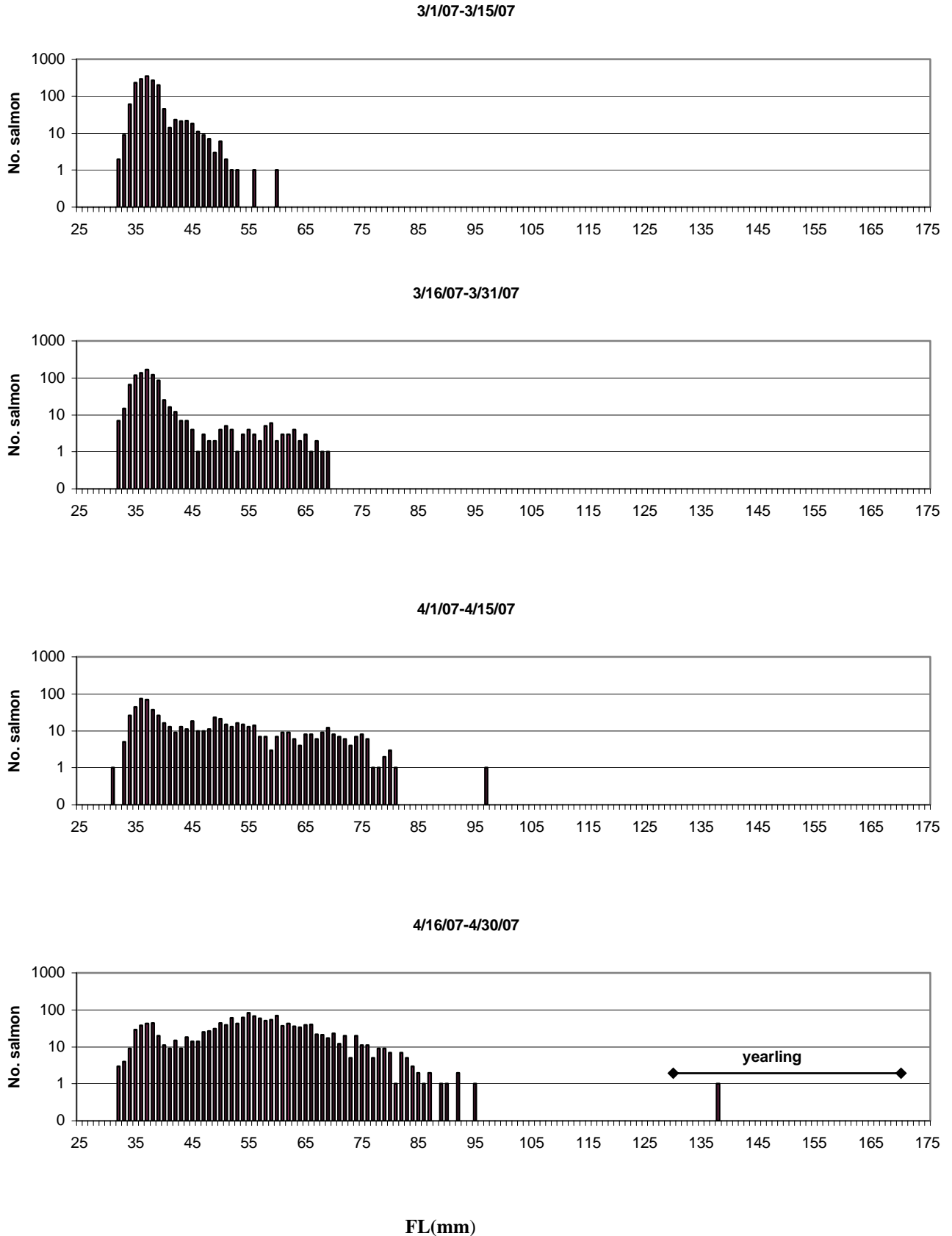


APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from November 1, 2006 through May 3, 2007. All fish are assumed to be spring-run Chinook salmon except where indicated.

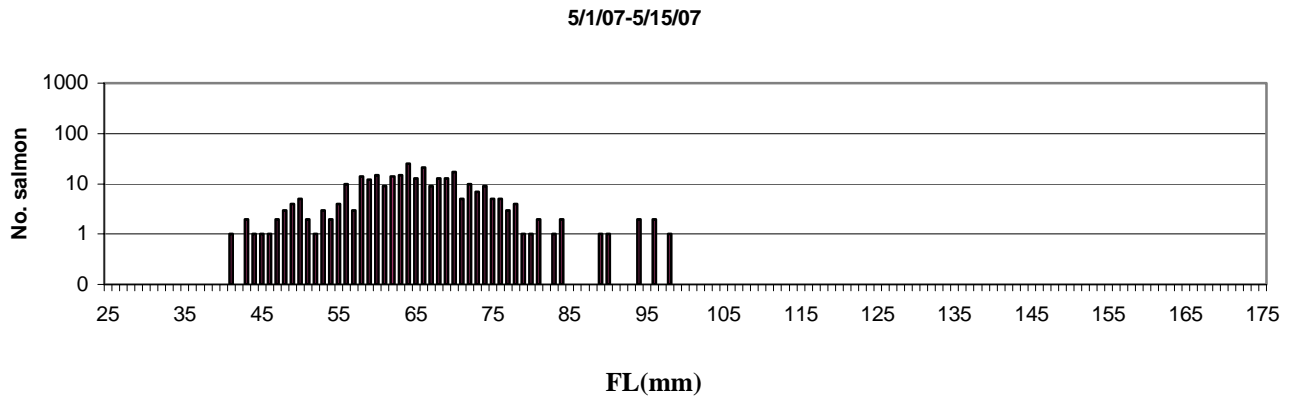




APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from November 1, 2006 through May 3, 2007. All fish are assumed to be spring-run Chinook salmon except where indicated.



APPENDIX B, Figure 1. (continued) Frequency distribution of lengths of juvenile Chinook salmon caught and released at Parrott-Phelan Diversion Dam from November 1, 2006 through May 3, 2007. All fish are assumed to be spring-run Chinook salmon except where indicated.



APPENDIX C, Table 1. Butte Creek spring-run Chinook spawning escapement estimate for 2007 using modified Schaefer Model.

Week of Recovery R <sub>(i)</sub>	R <sub>(i)</sub> Week of Tagging T <sub>(i)</sub>					Tags Recovered R <sub>(i)</sub>	Carcasses Counted C <sub>(i)</sub>	Population Estimate E <sub>(i)</sub>
	1 Sept. 25-27	2 Oct. 2-4	3 Oct. 9-11	4 Oct. 16-18	5 Oct. 23-25			
1 Oct. 2-4	13	-	-	-	-	13	438	1004
2 Oct. 9-11	5	175	-	-	-	180	1697	2484
3 Oct. 16-18	2	37	191	-	-	230	1283	1478
4 Oct. 23-25	1	17	37	47	-	102	566	551
5 Oct. 30-Nov.1	0	1	6	14	10	31	175	181
6 Nov. 6-8	0	0	0	1	0	1		
Tag Recovery R <sub>(i)</sub>	21	230	234	62	10	Total		5698
Tagged M <sub>(i)</sub>	42	331	323	123	39	Carcasses chopped first period (Sept. 19-21, Reaches A-E)		83
Total Population Estimate Surveyed Reaches A-E = E								5781
*Plus Chops from Covered Bridge to Parrott Diversion (346) adjusted by F = 1.25								433
<b>Total Population Estimate</b>								<b>6214</b>

\* Expansion factor for reaches with incomplete survey and for CWT recoveries F = 1.25

\* Calculation of expansion factor for reaches with incomplete survey and for expansion of CWT recoveries.

$$F = E / (C + T)$$

Where:

- F = Expansion Factor
- E = Total population estimate for surveyed reaches
- C = Total untagged carcasses chopped for surveyed reaches
- T = Total tagged carcasses for surveyed reaches

Where:

$$C = (\sum C_{(j)} - \sum R_{(i)}) + C_{(i)}$$

$$T = \sum M_{(i)}$$

And Where:

- C<sub>(j)</sub> = Carcasses Counted
- R<sub>(i)</sub> = Tag Recovery
- C<sub>(i)</sub> = Carcasses chopped first period
- M<sub>(i)</sub> = Tagged

Appendix C, Table 2. Butte Creek fall run Chinook spawning estimate using a Peterson mark- recapture model.

# of fish examined	# of fresh fish marked	# of marked fish recovered
238	35	7

$$N = C * ( T / R )$$

Where N = population

T = number marked

C = number examined (including those marked during the examination period)

R = number recaptured that were marked

$$245 * ( 35 / 7 ) = 1225$$

APPENDIX D, Table 1. Recoveries of Butte Creek adult spring-run Chinook salmon carcasses bearing coded-wire tags during 2007. All fish were tagged at Baldwin Construction Yard.

Release Date	Brood Year	Tag Code	Recovery				
			Date	FL (mm)	Expansion	Site	Method
12/31/03-1/6/2004	2003	06-01-00-03-04	6/18/2007	750	1	Butte Cr.-Reach CO	Inland Pre-Spawn
1/28/04-1/29/2004	2003	06-01-00-04-07	7/17/2007	770	1.25	Butte Cr.-Reach A	Inland Pre-Spawn
12/31/03-1/6/2004	2003	06-01-00-05-00	8/21/2007	966	1.25	Butte Cr.-Reach B	Inland Pre-Spawn
1/29/04-2/1/2004	2003	06-01-00-08-01	9/13/2007	850	1.25	Butte Cr.-Reach E	Inland Pre-Spawn
1/29/04-2/1/2004	2003	06-01-00-08-02	9/27/2007	805	1.25	Butte Cr.-Reach D	Inland Spawn
1/13/04-1/16/2004	2003	06-01-00-05-06	10/2/2007	792	1.25	Butte Cr.-Reach B	Inland Spawn
1/26/04-1/28/2004	2003	06-01-00-04-05	10/4/2007	929	1.25	Butte Cr.-Reach C	Inland Spawn
1/28/04-1/29/2004	2003	06-01-00-04-08	10/4/2007	790	1.25	Butte Cr.-Reach D	Inland Spawn
1/16/04-1/20/2004	2003	06-01-00-05-07	10/4/2007	833	1.25	Butte Cr.-Reach D	Inland Spawn
2/03/04-2/5/2004	2003	06-01-00-05-03	10/9/2007	877	1.25	Butte Cr.-Reach B	Inland Spawn
1/23/04-1/27/2004	2003	06-01-00-06-01	10/9/2007	897	1.25	Butte Cr.-Reach B	Inland Spawn
1/31/04-2/2/2004	2003	06-01-00-08-03	10/9/2007	916	1.25	Butte Cr.-Reach B	Inland Spawn
1/20/05-1/23/2005	2003	06-01-00-05-09	10/11/2007	1106	1.25	Butte Cr.-Reach C	Inland Spawn
2/01/04-2/2/2004	2003	06-01-00-04-09	10/11/2007	879	1.25	Butte Cr.-Reach C	Inland Spawn
1/12/04-1/16/2004	2003	06-01-00-04-03	10/23/2007	762	1.25	Butte Cr.-Reach A	Inland Spawn
1/31/04-2/2/2004	2003	06-01-00-08-03	10/23/2007	732	1.25	Butte Cr.-Reach A	Inland Spawn
12/31/03-1/6/2004	2003	06-01-00-03-04	10/25/2007	869	1.25	Butte Cr.-Reach C	Inland Spawn
1/12/04-1/16/2004	2003	06-01-00-04-03	10/30/2007	870	1.25	Butte Cr.-Reach B	Inland Spawn

APPENDIX D, Table 1. (continued) Recoveries of Butte Creek adult spring-run Chinook salmon carcasses bearing coded-wire tags during 2006 and 2007. All fish were tagged at Baldwin Construction Yard.

Release Date	Brood Year	Tag Code	Recovery				
			Date	FL (mm)	Expansion	Site	Method
12/31/03-1/6/2004	2003	06-01-00-03-04	ND	ND	1.25	Butte Cr.-Reach ND	Inland Spawn
1/12/05-1/13/2005	2004	06-01-00-07-00	6/2/2007	762	4.92	Eureka	Ocean Sport
1/10/05-1/12/2005	2004	06-01-00-07-01	7/2/2007	811	1.25	Butte Cr.-Below Hwy 99	Inland Pre-Spawn
1/13/05-1/16/2005	2004	06-01-00-08-06	7/11/2007	753	2.68	Bodega Bay	Ocean Troll
1/26/05-1/28/2005	2004	06-02-01-00-02	7/12/2007	714	2.68	San Francisco	Ocean Troll
1/26/05-1/28/2005	2004	06-02-01-00-02	7/12/2007	688	2.68	Bodega Bay	Ocean Troll
1/25/05-1/27/2005	2004	06-02-01-00-00	7/12/2007	782	2.68	Bodega Bay	Ocean Troll
1/15/05-1/18/2005	2004	06-01-00-08-05	7/12/2007	711	2.68	San Francisco	Ocean Troll
1/31/05-2/2/2005	2004	06-02-01-01-00	7/26/2007	833	1.25	Butte Cr.-Reach E	Inland Pre-Spawn
1/21/05-1/23/2005	2004	06-01-00-09-05	8/9/2007	734	1.25	Butte Cr.-Reach C	Inland Pre-Spawn
1/16/05-1/18/2005	2004	06-01-00-08-09	9/13/2007	771	1.25	Butte Cr.-Reach C	Inland Pre-Spawn
1/25/05-1/27/2005	2004	06-01-00-09-09	9/13/2007	641	1.25	Butte Cr.-Reach C	Inland Pre-Spawn
1/10/05-1/11/2005	2004	06-01-00-06-03	9/20/2007	694	1.25	Butte Cr.-Reach C	Inland Pre-Spawn
1/12/05-1/14/2005	2004	06-01-00-07-03	10/2/2007	654	1.25	Butte Cr.-Reach B	Inland Spawn
1/12/05-1/13/2005	2004	06-01-00-07-04	10/2/2007	814	1.25	Butte Cr.-Reach B	Inland Spawn
1/15/05-1/17/2005	2004	06-01-00-08-08	10/2/2007	700	1.25	Butte Cr.-Reach A	Inland Spawn
1/30/05-2/1/2005	2004	06-02-01-00-07	10/3/2007	771	1.25	Butte Cr.-Reach CO	Inland Spawn

APPENDIX D, Table 1. (continued) Recoveries of Butte Creek adult spring-run Chinook salmon carcasses bearing coded-wire tags during 2006 and 2007. All fish were tagged at Baldwin Construction Yard.

Release Date	Brood Year	Tag Code	Recovery				
			Date	FL (mm)	Expansion	Site	Method
1/07/05-1/7/2005	2004	06-01-00-05-05	10/4/2007	665	1.25	Butte Cr.-Reach E	Inland Spawn
1/07/05-1/7/2005	2004	06-01-00-05-05	10/4/2007	641	1.25	Butte Cr.-Reach D	Inland Spawn
1/07/05-1/11/2005	2004	06-01-00-06-02	10/4/2007	631	1.25	Butte Cr.-Reach C	Inland Spawn
1/12/05-1/14/2005	2004	06-01-00-07-03	10/4/2007	775	1.25	Butte Cr.-Reach E	Inland Spawn
1/12/05-1/14/2005	2004	06-01-00-07-03	10/4/2007	760	1.25	Butte Cr.-Reach D	Inland Spawn
1/13/05-1/16/2005	2004	06-01-00-08-06	10/4/2007	760	1.25	Butte Cr.-Reach C	Inland Spawn
1/13/05-1/16/2005	2004	06-01-00-08-06	10/4/2007	674	1.25	Butte Cr.-Reach C	Inland Spawn
1/22/05-1/26/2005	2004	06-01-00-09-07	10/4/2007	859	1.25	Butte Cr.-Reach D	Inland Spawn
1/27/05-1/29/2005	2004	06-02-01-00-03	10/4/2007	861	1.25	Butte Cr.-Reach D	Inland Spawn
1/29/05-1/30/2005	2004	06-02-01-00-05	10/4/2007	837	1.25	Butte Cr.-Reach E	Inland Spawn
1/29/05-1/31/2005	2004	06-02-01-00-06	10/4/2007	651	1.25	Butte Cr.-Reach C	Inland Spawn
1/31/05-2/2/2005	2004	06-02-01-01-00	10/4/2007	815	1.25	Butte Cr.-Reach E	Inland Spawn
2/02/05-2/4/2005	2004	06-02-01-01-04	10/4/2007	804	1.25	Butte Cr.-Reach C	Inland Spawn
1/07/05-1/7/2005	2004	06-01-00-05-05	10/9/2007	857	1.25	Butte Cr.-Reach B	Inland Spawn
1/07/05-1/11/2005	2004	06-01-00-06-02	10/9/2007	735	1.25	Butte Cr.-Reach B	Inland Spawn
1/10/05-1/11/2005	2004	06-01-00-06-03	10/9/2007	743	1.25	Butte Cr.-Reach B	Inland Spawn
1/15/05-1/18/2005	2004	06-01-00-08-05	10/9/2007	806	1.25	Butte Cr.-Reach B	Inland Spawn

APPENDIX D, Table 1. (continued) Recoveries of Butte Creek adult spring-run Chinook salmon carcasses bearing coded-wire tags during 2006 and 2007. All fish were tagged at Baldwin Construction Yard.

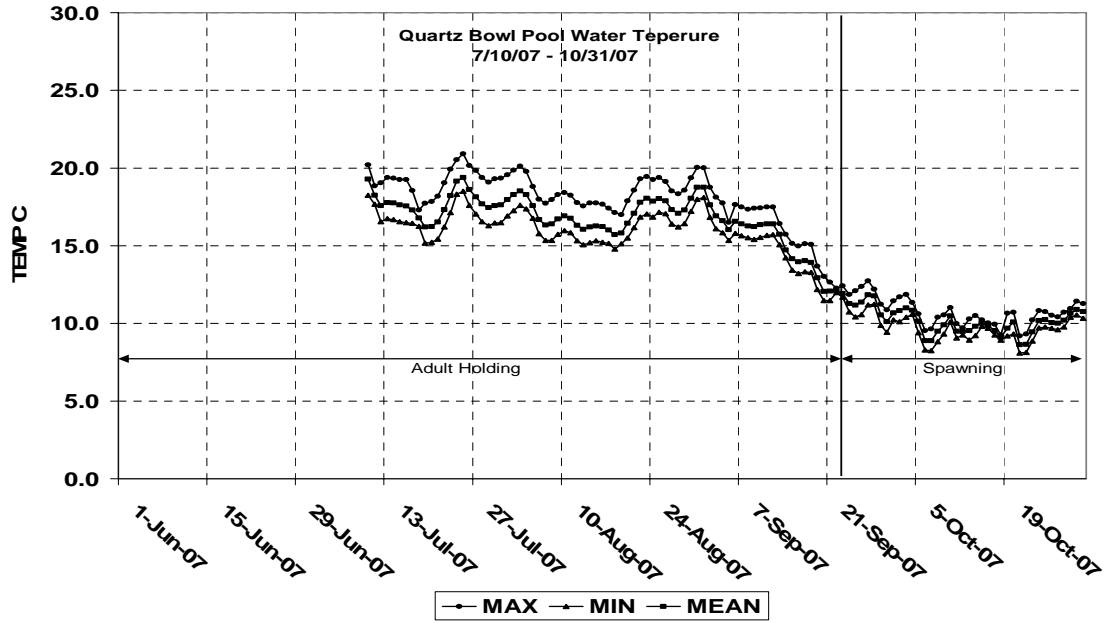
Release Date	Brood Year	Tag Code	Recovery				
			Date	FL (mm)	Expansion	Site	Method
1/25/05-1/27/2005	2004	06-02-01-00-00	10/9/2007	808	1.25	Butte Cr.-Reach B	Inland Spawn
1/07/05-1/11/2005	2004	06-01-00-06-02	10/11/2007	711	1.25	Butte Cr.-Reach C	Inland Spawn
1/12/05-1/13/2005	2004	06-01-00-07-04	10/11/2007	719	1.25	Butte Cr.-Reach D	Inland Spawn
1/13/05-1/16/2005	2004	06-01-00-08-06	10/11/2007	755	1.25	Butte Cr.-Reach E	Inland Spawn
1/13/05-1/16/2005	2004	06-01-00-08-06	10/11/2007	709	1.25	Butte Cr.-Reach C	Inland Spawn
1/18/05-1/21/2005	2004	06-01-00-09-02	10/11/2007	755	1.25	Butte Cr.-Reach C	Inland Spawn
1/29/05-1/31/2005	2004	06-02-01-00-06	10/11/2007	712	1.25	Butte Cr.-Reach D	Inland Spawn
1/22/05-1/26/2005	2004	06-01-00-09-07	10/16/2007	785	1.25	Butte Cr.-Reach B	Inland Spawn
1/28/05-1/30/2005	2004	06-02-01-00-04	10/16/2007	755	1.25	Butte Cr.-Reach B	Inland Spawn
1/29/05-1/31/2005	2004	06-02-01-00-06	10/16/2007	701	1.25	Butte Cr.-Reach B	Inland Spawn
1/30/05-2/1/2005	2004	06-02-01-00-08	10/17/2007	803	1.25	Butte Cr.-Reach CO	Inland Spawn
1/13/05-1/15/2005	2004	06-01-00-08-04	10/18/2007	762	1.25	Butte Cr.-Reach D	Inland Spawn
1/07/05-1/7/2005	2004	06-01-00-05-05	10/18/2007	724	1.25	Butte Cr.-Reach D	Inland Spawn
2/07/05-2/9/2005	2004	06-02-01-01-08	10/23/2007	713	1.25	Butte Cr.-Reach B	Inland Spawn
1/19/05-1/22/2005	2004	06-01-00-09-03	10/25/2007	655	1.25	Butte Cr.-Reach C	Inland Spawn
1/29/05-1/30/2005	2004	06-02-01-00-05	10/25/2007	894	1.25	Butte Cr.-Reach C	Inland Spawn



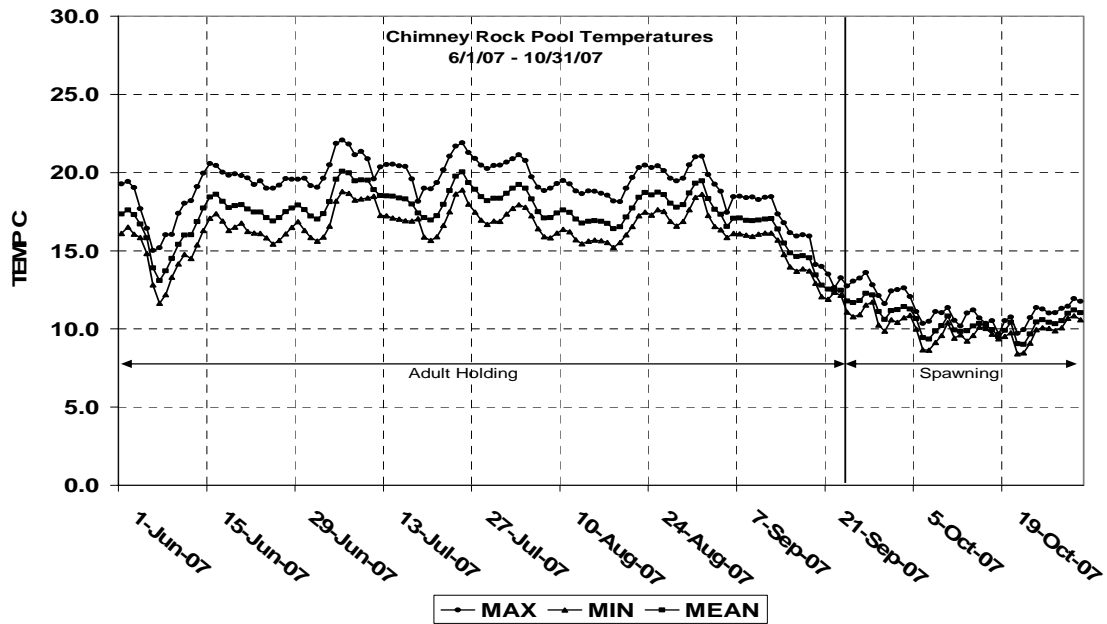
APPENDIX D, Table 2. Recoveries of coded-wire tags from out-of-basin Chinook salmon carcasses collected during spring-run surveys in Butte Creek during 2007.

Release				Recovery			
Stock	Brood Year	Tag Code	Site	Date	FL (mm)	Expansion	Butte Creek Reach
Feather River (FRCS)	2003	06-01-08-07-09	Liveoak	10/3/2007	868	1.25	COV-OKIE
Feather River (SRCS)	2004	62444	Wickland	8/2/2007	732	1.25	C

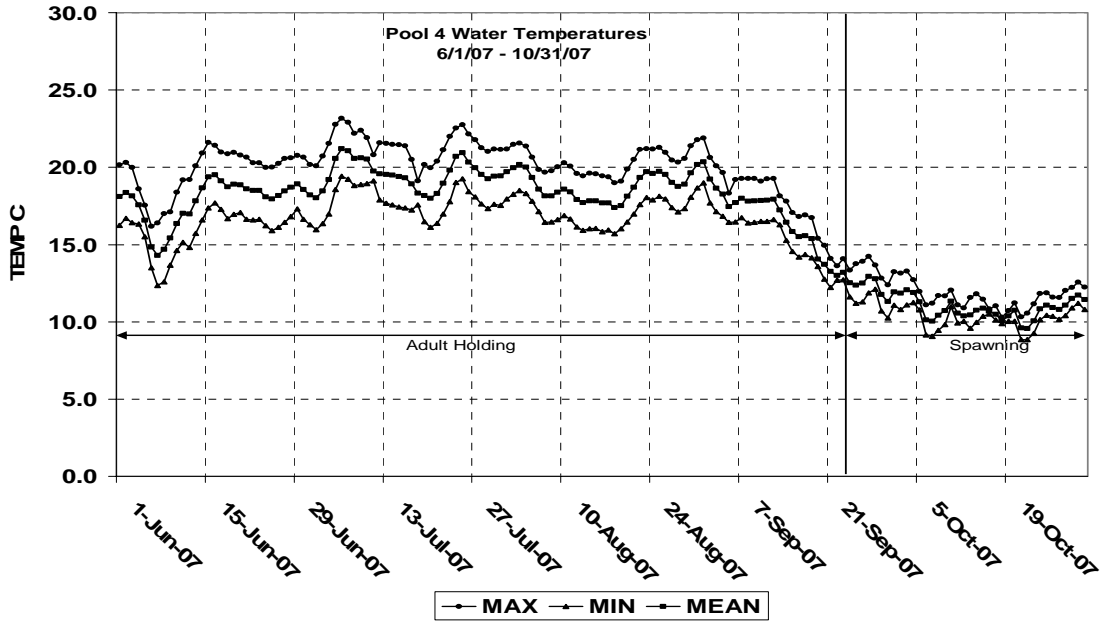
APPENDIX E, Figure 1. Butte Creek water temperature at Quartz Bowl pool.



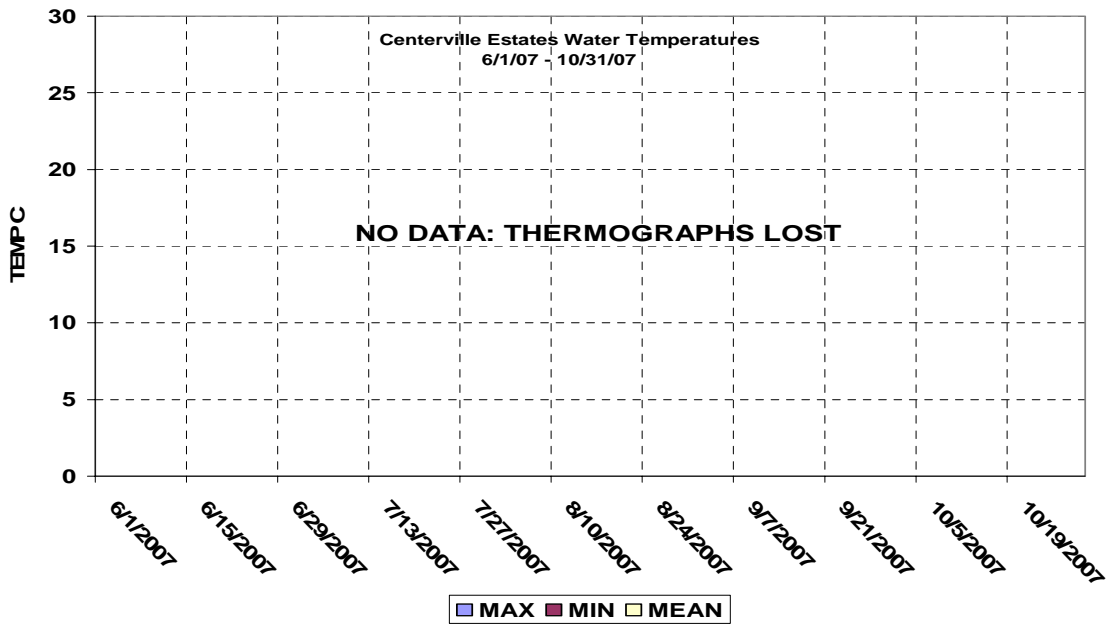
APPENDIX E, Figure 2. Butte Creek water temperature at Chimney Rock pool.



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.

