

BUTTE CREEK
JUVENILE CHINOOK SALMON MONITORING
2012-2013^{1/}
by

Clint E. Garman^{2/}

North Central Region

ABSTRACT

This report covers the juvenile spring-run Chinook salmon (*Oncorhynchus tshawytscha*) emigration monitoring at Parrot-Phelan Diversion Dam in Butte Creek from November 11, 2012 through June 30, 2013. Of the available 230 trap days, the diversion trap and rotary screw trap fished a total of 215 and 194 days respectively. A total of 105,957 juvenile salmon, including yearlings were captured in a diversion and rotary screw trap; a total of 50,594 in the diversion trap and 55,363 in the rotary screw trap. Of the total catch, approximately 97% had emigrated past the trap site by the end of March.

¹ North Central Region, 1701 Nimbus Road, , Rancho Cordova, California 95670. This study was funded in part by the U.S. Fish and Wildlife Service, Grant No. F12AS00084

² California Department of Fish and Game, North Central Region, 629 Entler Ave. Suite 12, Chico, Calif. 95928

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INTRODUCTION

This is the eleventh report summarizing a study begun during 1995 to define life history characteristics of spring-run Chinook salmon (SRCS), *Oncorhynchus tshawytscha*, in Butte Creek. Butte Creek is one of several streams that form the basis for population trends for the threatened SRCS in the Central Valley of California. Additionally, the U.S. Fish and Wildlife Service (USFWS) are proposing to reintroduce Central Valley SRCS to the San Joaquin River (SJR) upstream of the mouth of the Merced River in the Central Valley of California. The overall objective of reintroducing SRCS into the SJR is to collect and reintroduce multiple life stages to develop a naturally reproducing, self-sustaining population. This project will provide additional baseline population information on juvenile out-migrant SRCS essential for the assessment of Butte Creek as a potential donor for the SJR as well as assessing restoration actions on Butte Creek.

The project objectives are:

- 1) Identify and monitor time of alevin emergence.
- 2) Monitor and document juvenile size at emigration.
- 3) Develop a measure of juvenile relative abundance.
- 4) Document rearing and emigration patterns.

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

Figure 1. Map of Butte Creek watershed with trap locations, gaging stations, and salmon spawning areas indicated.

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

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MATERIALS AND METHODS

Butte Creek Trapping Sites

During the 2012-2013 trapping period, fish were trapped at the Parrott-Phelan Diversion Dam (PPDD) location along Butte Creek (Figure 1, Site T6). This site is directly downstream of the SRCS spawning habitat and upstream of the fall-run Chinook salmon (FRCS) spawning habitat, although periodically some FRCS spawn above this site. The 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, periods of excessive debris or when migrating adults were present in large numbers near the RST.

Physical Measurements

Three 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.

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.

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.

RESULTS

Trapping Season 2012-2013

The 2012-2013 trapping season began at the PPDD when the RST was installed on November 12, 2012 and removed on July 1, 2013. The side diversion trap was set on November 13, 2012 and was operated and pulled on July 1, 2013. 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 105,957 juvenile salmon, including yearlings, was captured in all traps; 50,594 in the diversion trap and 55,363 in the RST (Tables 1 & 2).

Table 1. Semi-monthly catch summary of SRCS caught in the screen trap at Parrott-Phelan Diversion Dam from November 13, 2012 to June 30, 2013; yearling captures are included.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
11/01/12	11/15/12	110	-	110	110	1	2
11/16/12	11/30/12	44.4	31.0	26	163	74	11
12/01/12	12/15/12	35.3	10.9	30	113	655	9
12/16/12	12/31/12	34.1	1.6	30	40	1,023	11
1/01/13	1/15/13	34.8	2.9	30	106	2,300	15
1/16/13	1/31/13	35.0	1.3	32	39	12,801	16
2/01/13	2/15/13	35.1	1.3	31	42	14,813	15
2/16/13	2/28/13	35.4	1.6	32	45	9,934	13
3/01/13	3/15/13	35.8	2.4	32	53	7,085	15
3/16/13	3/31/13	38.4	7.5	31	132	724	16
4/01/13	4/15/13	50.2	13.4	25	83	233	15
4/16/13	4/30/13	64.0	7.7	34	96	650	15
5/01/13	5/15/13	65.4	8.4	42	91	168	15
5/16/13	5/31/13	70.0	6.5	51	87	127	16
6/01/13	6/15/13	73.7	14.5	46	85	6	15
6/16/13	6/30/13	-	-	-	-	0	15
Total						50,594	214

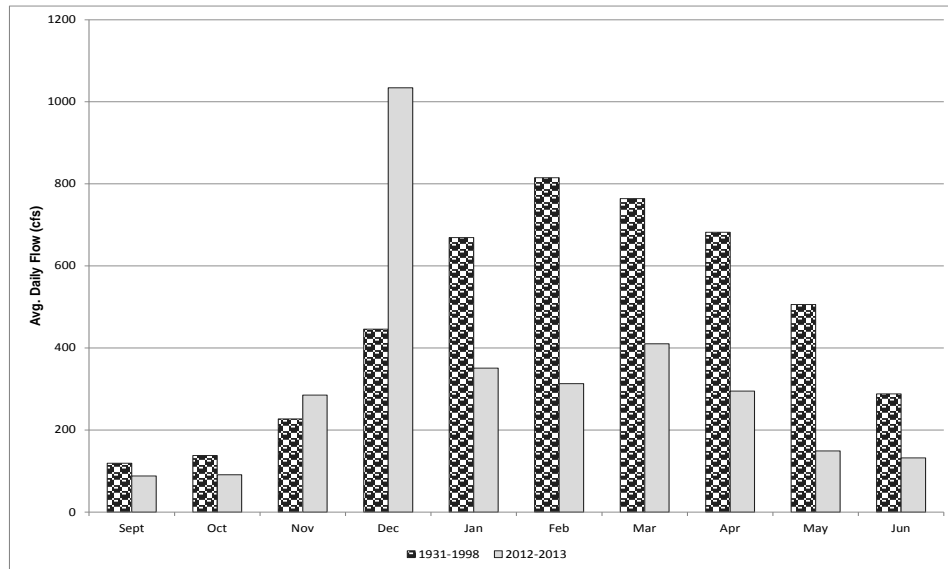
Average daily flows for the months of November and December were very high when compared to historical flows (1931-1998) and trapping was suspended periodically for both the diversion trap and RST during this survey period (Figure 3). Between November and June, the diversion trap was suspended for 15 days and the RST was suspended for a total of 36 days. (Tables 1 & 2, and Appendix A).

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 trapping period, 39 yearling SRCS were captured. The first yearling SRCS was captured on November 13, 2012 and the last on March 21, 2013 (Table 1 and 2; Appendix B). Length-frequency distributions for the entire period (Appendix B) 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).

Table 2. Semi-monthly catch summary of SRCS caught in the rotary-screw trap at Parrott-Phelan Diversion Dam from November 12, 2012 to June 30, 2013; yearling captures are included.

Trapping Period		Mean FL (mm)	Standard Deviation	Range FL (mm)		Total No. Captured	No. Trapping Days
11/01/12	11/15/12	109.3	12.0	89	130	9	3
11/16/12	11/30/12	46.3	30.3	31	108	6	4
12/01/12	12/15/12	35.0	9.5	28	105	187	8
12/16/12	12/31/12	34.4	6.8	30	109	482	8
1/01/13	1/15/13	34.8	3.1	31	109	1,478	15
1/16/13	1/31/13	35.0	1.3	31	39	15,446	16
2/01/13	2/15/13	35.1	1.3	31	40	14,203	15
2/16/13	2/28/13	35.3	1.6	32	51	15,297	13
3/01/13	3/15/13	35.8	2.5	32	51	6,394	15
3/16/13	3/31/13	40.4	6.9	32	64	554	16
4/01/13	4/15/13	44.8	10.9	31	76	245	15
4/16/13	4/30/13	61.2	7.6	36	85	402	5
5/01/13	5/15/13	66.9	6.9	47	89	405	10
5/16/13	5/31/13	69.6	5.9	53	85	207	16
6/01/13	6/15/13	73.8	5.8	63	96	40	15
6/16/13	6/30/13	77.0	2.8	65	84	8	15
Total						55,363	189

Figure 3. Comparison of Butte Creek average flows as measured at Butte Creek near Chico Gage (USGS #11390000) during 2012-2013 with average flows during the 1931-1998 (CDWR, 2013)

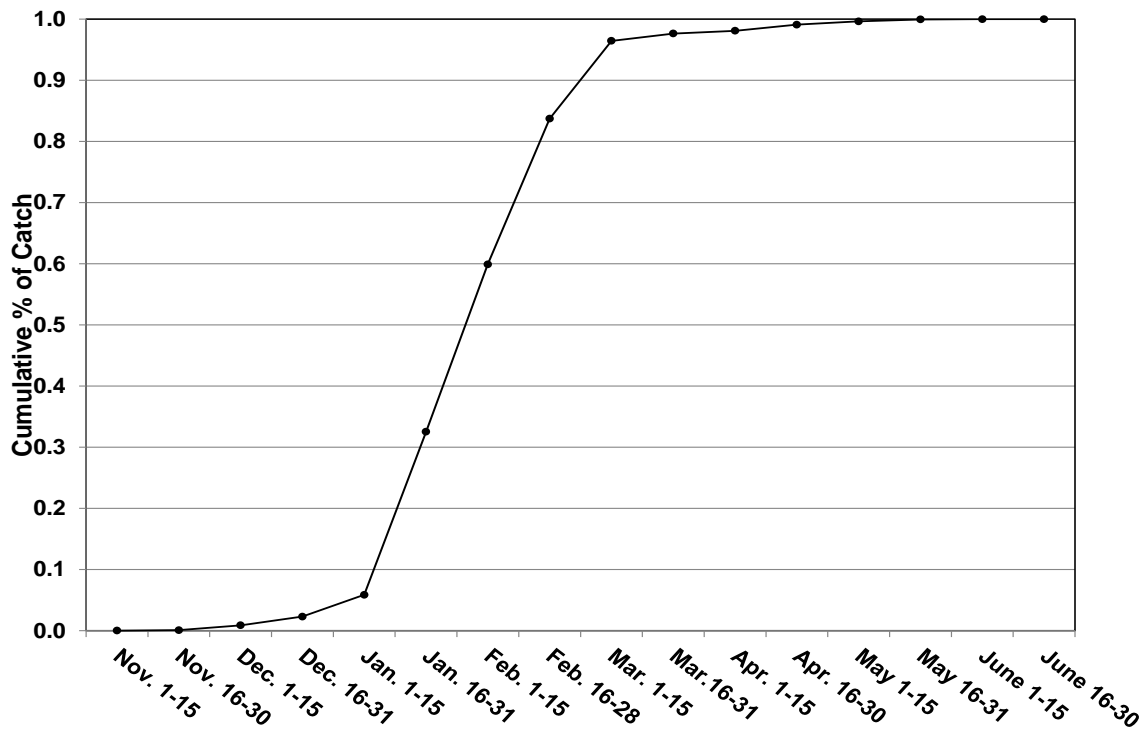


DISCUSSION

As with previous studies, short periods of elevated uncontrolled flows and heavy debris required cessation of trapping to protect personnel and gear. Additionally, a higher than expected number of migrating adult SRCS was observed in close proximity to the RST and the trap was pulled for a period of time to reduce potential capture and injury to entrained fish (Appendix A). Of the 230 available sampling days, the RST and diversion trap was suspended a total of 36 and 15 trap days, respectively.

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 2012-2013 study period, very high average December creek flows during the start of juvenile Chinook salmon emigration may have caused newly emerged fry to be swept downstream with the high flows (Appendix A). 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. Of the total catch, 97% had occurred by the end of March (Figure 4). This is in contrast to the 2000-2001, 2001-2002 and 2004-2005 study periods, where the majority of the catch ($\geq 90\%$) had occurred by the end of February. The total season catch for 2012-2013 was 105,957, substantially lower than the last season traps were fished in 2007-2008 with a catch of 391,363.

Figure 4. Cumulative total catch of juvenile salmon in both diversion and rotary screw traps at Parrott-Phelan Diversion Dam.



Newly emerged fry were captured at PPDD from mid-November 2012 through June 16, 2013 (Appendix B). Relatively small numbers of FRCS were observed spawning upstream of PPDD in mid-October. As with previous years (McReynolds et al., 2005), recently emerged fry captured at PPDD beginning in early April (Appendix B) were assumed to be FRCS. However, fry captured at the site from November through March were assumed to be SRCS.

ACKNOWLEDGMENTS

This project was supported by funding provided by the United States Fish and Wildlife Service through grant No. F12AS00084 administered by the CSU Chico Research Foundation, in partnership with the California Department of Fish and Game. Additionally, we wish to acknowledge the field crew members that participated during the 2012-2013 season to include Andrew Huneycutt, Andrew Anderson, Kyle Thompson, Lowren McAmis, Grant Henley, Tom Steele and Kevin Moncrief.

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APPENDIX A

Figure 1. Butte Creek flow at Butte Creek near Chico Gage (USGS - #11390000), water year 2012-2013, with trapping period shown.

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APPENDIX B

Figure 1. Frequency distribution of lengths of juvenile Butte Creek Chinook salmon caught and released at Parrott-Phelan Diversion from November 12, 2012 through June 30, 2013.

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