Stanislaus River Fall Chinook Salmon Escapement Survey 2003

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Introduction

San Joaquin River fall-run chinook salmon are currently a candidate species under the Federal Endangered Species Act. Population levels in the Stanislaus River, a tributary to the San Joaquin River, have declined in the past 50 years from approximately 35,000 returning adults in 1953 to a low of 160 in 1996 (Heyne, 2000). Escapement estimates for the past 5 years have ranged from a low of approximately 3,150 in 1998 to a high of approximately 8,500 in 2000 (Marston et al., 2002). The decline of the species can be attributed to many factors. In general, reduction of spawning and rearing habitat and stream flow management practices, are thought to be major factors limiting overall population numbers. Numerous additional factors including but not limited to predation, streambed alteration, pump diversions, gravel mining, land use practices, and ocean angler harvest contribute to a web of complex population dynamics which effect population numbers within the habitat currently available to Stanislaus River chinook salmon.

The California Department of Fish and Game (CDFG) has conducted escapement surveys on the Stanislaus River since 1953. The Schaefer mark recapture escapement estimation model (1951) has been utilized since 1971. Philip Law (1994) determined the Jolly-Seber model (1973) yielded a more accurate population estimate over all variable ranges when compared with the Schaefer model. The 2003 escapement survey was analyzed using both the Jolly-Seber and Schaefer models.

The current objectives of the Stanislaus River escapement surveys are:

- Estimate the escapement of fall-run chinook salmon on the Stanislaus River.
- Evaluate the distribution of salmon redds throughout the study area.
- Collect fork-length and sex data.
- Collect scale and otolith samples with which to conduct age determination and subsequent cohort analysis.
- Collect DNA samples for storage at the CDFG Salmonid Tissue Archive for subsequent genetic analysis.
- Collect and analyze coded wire tag data from marked hatchery fish to determine escapement contribution of hatchery produced salmon, and evaluate smolt survival.

Study Area

The 2003 Stanislaus River escapement survey covered a 25-mile reach beginning at river mile (RM) 58, and continuing downstream to Riverbank (RM 33). The survey is divided up into four sections, with section 1 being the upstream most reach. Section 1 begins below Goodwin Dam (RM 58) and extends downstream to Knight's Ferry (RM 55) and includes riffles A1 thru C1. Section 2 begins at Knight's Ferry (RM 55) and continues downstream to Horseshoe Road Recreation Area (RM 50.5) and includes riffles E1 thru J2. Section 3 begins at Horseshoe Road Recreation Area (RM 50.5) and continues

downstream to the Oakdale Recreation Area (RM 39.5) and includes riffles J3 thru T4. Section 4 begins at the Oakdale Recreation Area (RM 39.5) and continues downstream to Jacob Myers Park (RM 33) and includes riffles U1 thru Z2.

All riffles in the study area have been geo-referenced using a Trimble GPS TDC1 and mapped with the GIS computer program Arc View. In 2001, each riffle within the entire four section spawning reach was systematically re-named using sequential letter/number designations for river mile and riffle respectively. For example, the first riffle immediately below Goodwin Dam is named A1. Each letter designates a different river mile length (riffle A= RM 58, riffle B= RM 57 etc.). This numbering system is a departure from the historical riffle numbering system. However, the new riffle identification system is more logical and is more conducive to editing as river morphology changes.

In 2003, each riffle within the study reach was mapped prior to the spawning season. These updated riffle numbers, and river mile, are located in Table 1 and are cross-referenced with the 2002 riffle numbers. Riffle cross-reference for the historical cross-referencing system can be found in the 2001 and 2002 Stanislaus River escapement reports

Methods

Population Estimation

The Jolly-Seber (1973) mark-recapture method was used to estimate fall-run escapement on the Stanislaus River. Under this scheme, carcasses are marked and subsequently recovered during weekly surveys of the spawning reach. A ratio of recoveries to total fish counted (handled) is used to calculate weekly population estimates, which are then summed to estimate the total spawning population. Total fish counted (handled) includes total fish tagged, skeletons, and fresh recoveries by week. The CDFG survey began on September 22, 2003 (Week 1) and concluded on January 13, 2004 (Week 17). Carcasses were tagged for the first 15 weeks and weeks 16 and 17 were limited to the recovery of carcasses. During the two recovery weeks (weeks 16 and 17), carcasses were collected, examined for jaw tags and chopped in half. During this period, all untagged fish were chopped and counted as skeletons.

Weekly drift boat surveys were conducted in sections 2, 3, and 4 using a three person crew. All visible carcasses were collected from each riffle and pool immediately below. Multiple passes were made through each pool to ensure that the entire area of that pool was examined. Every carcass handled was designated as fresh, decayed, skeleton, or recovery depending on the degree of decomposition or the presence of an aluminum jaw tag in the case of recoveries. The fresh carcass designation criteria during 2003 were at least one clear eye and the presence of blood remaining in the gills (Figures 1 and 2). Decayed fish had cloudy eyes and no blood in the gills. Skeletons were fish judged to be in an advanced state of decay and unlikely to have the same probability of recapture as fresh and decayed specimens. Criteria for skeleton designation during the 2003 survey included the presence of fungus covering the entire body at the freshest end of the

skeleton designation (approximately one week) to actual skeleton at the most decayed end (Figure 3 and 4).

All fresh and decayed carcasses were given a unique number by attaching an aluminum head tag to the lower jaw. These newly tagged carcasses were redistributed to river current near the lower end of the riffle for recovery in subsequent weeks. For tagged recoveries, the unique tag number was noted and the carcass was chopped and returned to the river. All skeletons were enumerated, chopped and returned to the river to avoid double counting.

Section 1 is too dangerous to float by drift boat, therefore this section was surveyed by foot and consisted of a 2 person crew walking to accessible pool and riffle combination areas where carcasses are known to aggregate based upon previous carcass surveys. Retrieved carcasses were enumerated, chopped, and released back into the water to avoid duplicate counting. No effort to conduct a tagged capture/recapture (i.e., Schaefer etc.) survey was initiated. The escapement population estimate for Section 1 consisted of a calculating a divisor comprised of the ratio of retrieved tagged carcasses to the total number of carcasses tagged in Sections 2, 3, and 4 (i.e., to determine visible fraction of total carcasses present), then dividing the actual number of fish handled in Section 1 by this divisor.

Weekly Fish Distribution and Redd Counts

Weekly live fish observations and redd counts were conducted during the survey. These counts were conducted for each riffle and pool using the riffle identification system noted earlier. Counts were made using tally counters as the field crews drifted through riffles and pools. Live and redd counts were conducted through the entire seventeen week escapement survey period.

Individual Fish Data Collection

Fork length (to the nearest 0.5 centimeter) and sex data are collected for all tagged carcasses. Scale and genetic samples are collected from a percentage of specimens to determine the size, age, and genetic composition of annual spawning runs. Coded wire tag's (CWT) were collected from hatchery produced (adipose fin clipped) carcasses returning to the Stanislaus River as part of long term survival testing releases of marked outmigrating smolts and to determine incidence of straying from other river systems. CWT specimens are also used to validate scale and otolith age determination work.

Genetic samples; caudal, dorsal, or pectoral fin clips were sun-dried and delivered to the CDFG Salmonid Tissue Archive at the end of the survey. These samples are being used in an evaluation of the genetic structure of chinook in the Central Valley. Scale samples were collected from both wild and CWT carcasses and are catalogued at the CDFG La Grange Field Office. Coded wire tags and otoliths are collected via removal of the head minus the lower tagged jaw. Extraction and analysis of otoliths and CWT's is conducted by CDFG staff after the spawning season. All fish samples are catalogued by the fish's unique jaw tag number, which allows the samples to be tracked to the specific date and riffle number of collection.

Results

Escapement Estimate

A total of 1738 carcasses (1070 fresh) were tagged during the 2003 Stanislaus River escapement survey. An additional 1,825 skeletons were tallied and chopped giving a total of 3,563 individual chinook salmon handled during the escapement survey. Four hundred and thirty-seven tagged carcasses (244 fresh) were recovered for an overall 25.1 % tagged carcass recovery rate, and a fresh tagged carcass recovery rate of 22.8 %. Based on the Schaefer model, the 2003 escapement estimate for sections 2 through 4 is 6,919 salmon. The Jolly-Seber model yielded an estimate of 5,081 for sections 2 through 4. Both models utilize the number of recoveries of tagged carcasses that were fresh when tagged, the total number of fresh tagged fish and the total number of carcasses handled each week (Table 2) to generate weekly escapement estimates. A third estimate was generated with the Jolly-Seber model using all tagged fish, and is considered to be the most accurate estimate (Law, 1994). This estimate yielded a count of 5,141 chinook salmon for sections 2 through 4. The total numbers of fresh carcasses tagged each week and the number of recoveries made in subsequent weeks in relation to tag week are shown in Table 3. Table 4 shows the weekly Schaefer and Jolly-Seber estimates. Weekly cumulative Schaefer and Jolly-Seber estimates are graphed in Figure 5.

In Section 1, carcasses were not recovered so the Schaefer and Jolly-Seber models could not be used to generate an estimate. For an expansion estimate was made based on the number of fish handled (191 fish) and the recovery rate for the lower sections (25.1%). The resulting estimate was 761 fish in Section 1. Combining the Jolly-Seber estimate for Sections 2 through 4, using all tagged fish, with the Section 1 estimate yields a grand total of **5,902** fall-run chinook salmon returning to the Stanislaus River in 2003.

Live Salmon, Redd, and Carcass Counts

Weekly live fish observations increased steadily and peaked in week 7, with 1,580 live fish being observed, then sharply declined. Redd counts peaked in week 9 with a high of 1,237 redds counted. One week after redd counts peaked, total carcass counts peaked in week 10, at 566, and steadily declined thereafter (Table 5 and Figure 6). The number of live fish, redds, and tagged carcasses observed by week are graphed in Figure 7. The maximum number of redds counted for individual riffles is presented in Table 6. The highest concentration of spawning (172 redds per river mile) occurred within Section 2. Sections 1 and 3 had spawning of approximately 61 and 45 redds per river mile respectively, and Section 4 had 18 redds per mile (Figure 8).

Population Composition

Coded wire tagged fish comprised 11.7 % of the total tagged carcasses based on the ratio of adipose clipped fish to total tagged carcasses (Table 2). Skeletons were not checked for adipose fin clips due to their advanced state of decomposition. However, it is likely that ratios calculated for tagged fish are representative for skeletons as well. The total contributions (tagged fish only) to the spawning population were 36 % for natural males,

4 % for CWT males, 53 % for natural females, and 7% for CWT females (Figure 9). CWT verification and tag reading will be conducted at a later date therefore all CWT data presented here are preliminary.

Length frequency histograms of male and female (both natural and CWT) display bimodal peaks (Figures 10, 11, 12, and 13). The first peaks are likely grilse (age 1 and 2) and the second peaks are likely adults (age 3, 4, and 5). Because the histograms display overlap between age groups, separation of cohorts will be determined upon completion of age determination studies (CWT, scale, and otolith analysis).

Based on the San Joaquin River Basin length frequency histograms, the 2003 breakpoint between grilse and adults were as follows; natural males 71 cm, CWT males 66 cm, natural females 65 cm, and CWT females 67 cm. Grilse accounted for 13.9% of the total tagged fish. This is down from 2002, when 20.6% of the tagged fish were grilse. The grilse and adult compositions for all handled fish are provided in Table 7.

Sample Collection

Scales, otolith, and DNA samples were collected from both natural and adipose fin clipped fish throughout the survey period and survey area (Tables 8, 9, and 10). Distribution of sampling is intended to best represent the spawning population over time, space, and origin. One hundred DNA samples were collected by CDFG staff and delivered to the CDFG Salmonid Tissue Archive. Scale and otolith samples will be utilized in the CDFG age determination program and for subsequent cohort analysis of the San Joaquin River Basin chinook salmon populations.

Egg Production Estimation

An estimate for the number of eggs produced by the 2003 fall run was generated using a standard regression equation (158.45 * fork length cm – 6138.91= number of eggs). This fork length-fecundity relationship was determined for 48 San Joaquin fall-run chinook salmon females ranging from 62.5 to 94.0 cm fork length (Loudermilk et al. 1990). In the 2003 Stanislaus River escapement survey, the number of eggs was calculated for the expanded natural (n=3,128) and CWT (n=413) female population, based on the Jolly-Seber estimate. The number of natural female carcasses collected was 1,002 with an average egg production of 6,388 eggs per female. The number of CWT female carcasses collected was 141 with an average egg production of 6,033 eggs per female. Expanding the total egg production for the Stanislaus River in 2003 using the egg production regression equation yields a total of 22,475,071 eggs based on the Jolly-Seber population estimate, with 19,982,507 produced by natural females and 2,495,564 produced by CWT females.

Stanislaus River Flows

Stanislaus River flows for the period of October 1, 2003 through January 15, 2004 are shown in Figure 14 (preliminary data obtained from the California Data Exchange Center). River flows recorded at Orange Blossom Bridge (OBB) and Goodwin Dam (GDW) are reported, because the OBB gauge does not accurately record high flow events. A pulse flow (attraction flow) was initiated on October 20, for ten days with a maximum flow of approximately 980 cubic feet per second (cfs) released over Goodwin

Dam. The purpose of fall pulse flows, occurring in the Stanislaus and other San Joaquin River tributaries is threefold: 1) attract salmon into the Stanislaus River from the San Joaquin River; 2) cool water temperatures in the lower reaches of both the Stanislaus and San Joaquin River; and 3) improve oxygen conditions in the Stockton Deep Water Ship Channel. Spawning period flows in the Stanislaus River, OBB gauge, ranged from 220 cfs to 360 cfs from October 31, 2003 through January 15, 2004.

Stanislaus River Temperature

Water temperature in the Stanislaus River was recorded at several locations in 2003. Water temperatures are monitored at various locations within the New Melones Reservoir Complex (i.e., Melones, Tulloch, and Goodwin), as well as in seven locations within the lower Stanislaus River between Goodwin Dam and the confluence with the San Joaquin River. In-river water temperature data is recorded on a bi-hourly basis and the average daily water temperature for three stations (Knights Ferry, Orange Blossom Bridge, and Oakdale Recreation Area) are presented in Figure 15.

Discussion

Population Estimate

The 2003 Stanislaus River escapement Jolly-Seber estimate using all tagged fish was 5,902. For the purpose of comparison with previous years, the Schaefer estimate of 7,680 is very similar to the 2002 estimate of 7,735 (Guignard, 2003). One difference between the 2002 and 2003 spawning seasons was that in 2002, the majority of the fish arrived to the spawning grounds 3 weeks earlier than in 2003 (Figure 17). River conditions and water clarity were ideal for carcass recovery, live counts, and redd counts throughout most of the spawning season.

The Section 1 expansion estimate is most likely a very conservative estimate. The reason for this is threefold: 1) This section has a much higher gradient than the rest of the river, with a series of runs and deep pools, causing the carcasses to drift further and most likely fall out in the deep pools. 2) Only carcasses that "fall-out" near the shore are accessible, carcasses away from the edges are often unrecoverable due to the dangerous currents. 3) The steep canyon topography makes much of this section inaccessible, thus some spawning areas are not surveyed. In order to obtain a more accurate estimate for this section a much more thorough survey would be required.

Spawning Distribution

Redd counts are strongly affected by time of day, visibility, sunlight, wind rippling the water surface, redd superimposition, and other physical factors as well as the natural variability between observers. Furthermore, redd counts are conducted with a single pass as opposed to an intensive systematic approach beyond the scope of this study. In the primary spawning riffles of Section 1 and 2 the problem of redd superimposition is acute and leads to undercounting. On the other hand, redds further down the river are easily delineated as clean patches of freshly worked gravel among patches of darker undisturbed gravel. In these sections redd counts are accurate indicators of spawning density. For these reasons, the disparity between spawning density is likely greater than displayed in

Figure 8. River miles 57 and 55 show no spawning activity because these sections of the Goodwin Canyon reach were no surveyed.

Population Composition

Peak fork lengths for males and females, both natural and CWT, were similar indicating that returning hatchery fish were similar in age structure to returning natural females. The CWT contribution to the spawning population was estimated to be 4% (n= 85) male and 7% (n= 141) female. This is the same as the 2003 estimate of 4% male CWT and 7% female CWT. Scale and otolith samples collected during the 2003 survey will be used for further cohort analysis.

Stanislaus River Temperatures

Stanislaus River water temperatures remained above 14 C for most of October in the lower areas of the spawning reach (e.g., sections 3 and 4) as shown in Figure 15. With the fall pulse flow event, temperatures in the lower reach dropped to a suitable temperature. Spawning activity began to proliferate concurrent with water temperature cooling. Figure 16 shows the weekly live and redd counts in relation to water temperature and flow.

Table 1. Riffle Identification cross-reference for 2003 (New ID) and 2002 (Old ID). The corresponding river mile is noted next to the new riffle ID.

Section 1[a]		Section 2[b]		Section 3[c]		Section 4[d]	
New ID (RM)	Old ID	New ID (RM)	Old ID	New ID (RM)	Old ID	New ID (RM)	Old ID
A1N (58.3)	A1	E1 (54.5)	aE1*	J3 (50.5)	J3	U1 (39.1)	U1
A1S** (58.3)	A1a	E2 (54.3)	E1	J4 (50.2)	J4	V1* (38.7)	
A2 (58.2)	A2	E3 (54.2)	E2	K1 (49.7)	K1	V2 (38.4)	V1
A3 (58.1)	A3	F1 (53.9)	F1	K1s** (49.6)	K1s	V3* (38.2)	
A4 (58.1)	A4	F2 (53.4)	F2	K2 (49.6)	KIa	W1 (37.6)	W1
B1 (57.9)	B1	F3S (53.2)	F3	K3 (49.5)	K1b*	W2 (37.5)	W1a
C1 (56.9)	C1	F3N** (53.2)	F3a	K4 (49.3)	K1c*	W3 (37.3)	W1b
C2 (56.8)	C2	F4 (53.1)	F4	K5 (49.2)	K2	W4 (37.1)	W2
		G1* (52.9)		L1 (48.9)	L1	X1 (36.1)	X1
		G2 (52.8)	G1	L2 (48.6)	L2	Y1 (35.9)	X2
		G3 (52.6)	G2	L3 (48.1)	L3	Y2 (35.5)	X3
		G4 (52.5)	G2a	M1 (47.8)	M1	Z1 (34.6)	Z1
		G5 (52.4)	G3	M2 (47.4)	M2	Z2 (34.1)	Z2
		G6 (52.3)	G3	M3 (47.3)	M3		
		G7 (52.1)	G4	M4 (47.1)	M4		
		H1 (51.9)	H1	N1 (46.9)	N1		
			H1a	N2 (46.6)	N2		
		H2** (51.8)	H1b	N3 (46.5)	N3		
		H3 (51.6)	H2	N4 (46.3)	N4		
		H4 (51.5)	H2a	N5 (46.1)	N5		
		H5** (51.5)	H2s	O1 (45.9)	O1		
		H6 (51.4)	H2b	O2 (45.8)	O1a		
		H7 (51.2)	H3	O3 (45.6)	O2		
		J1 (50.9)	J1	O4* (45.5)			
		J2 (50.8)	J2	O5 (45.1)	O3		
				P1 (44.8)	P1		
				P2 (44.6)	P2		
				P3 (44.5)	P3		
				P4 (44.1)	P4		
				Q1 (43.9)	P5		
				Q2 (43.6)	Q1		
				Q3 (43.5)	Q2		
				Q4 (43.3)	Q3		
				Q5 (43.1)	Q4		
				R1 (43.0)	R1		
				R2 (42.1)	R2		
				S1 (41.7)	S1		
				T1 (40.6)	T1		
				T2 (40.5)	T2		
				T3 (40.4)	T3		
				T4 (40.2)	T4		

[a] Includes reach from Goodwin Dam to Knight's Ferry

[b] Includes reach from Knight's Ferry to Horseshoe Road Recreation Area

[c] Includes reach from Horseshoe Road Recreation Area to Oakdale Recreation Area

[d] Includes reach from Oakdale Recreation Area to Jacob Meyers Park

* New riffles identified during 2003 survey

** Side channels surveyed during 2003 survey

Table 2. Weekly totals (does not include Section I).

Week	Total Tagged	Skeletons	Fresh Recoveries*	Total Counted**	Tagged Fresh	CWT's
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	1	0	0	1	1	0
4	0	0	0	0	0	0
5	1	1	0	2	0	1
6	15	0	0	15	15	2
7	20	8	5	33	14	1
8	228	130	3	361	146	34
9	435	317	71	823	273	69
10	543	351	105	999	349	69
11	323	541	197	1061	173	40
12	111	183	84	378	66	8
13	34	188	63	285	21	2
14	24	98	27	149	11	0
15	3	8	2	13	1	0
16	0	0	0	0	0	0
17	0	0	1	1	0	0
Grand Total	**1738**	**1825**	**558**	**4121**	**1070**	**226**

*Includes only fish that were deemed fresh when tagged

**Includes total tagged, skeletons, and recoveries

Table 3. Distribution of mark versus recovery week of fresh fish, results using all fish are noted in parenthesis.

Recovery Week	Tag Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2	0													
3	0	0												
4	0	0	0											
5	0	0	0	0										
6	0	0	0	0	0									
7	0	0	0	0	0	5								
8	0	0	0	0	0	0	3(5)							
9	0	0	0	0	0	0	1(1)	70(108)						
10	0	0	0	0	0	0	1(1)	21(33)	83(151)					
11	0	0	0	0	0	0	0	5(6)	34(51)	158(238)				
12	0	0	0	0	0	0	0	1(2)	8(10)	27(40)	48(95)			
13	0	0	0	0	0	0	0	0	1(2)	10(18)	31(49)	21(45)		
14	0	0	0	0	0	0	0	0	0	1(1)	7(11)	14(16)	5(8)	
15	0	0	0	0	0	0	0	0	0	0	0	1(1)	1(1)	0(1)
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0(4)
17	0	0	0	0	0	0	0	0	0	0	0	1(1)	0	0(1)
Recoveries Per Tag Week	0	0	0	0	0	5	5 (8)	97 (149)	126 (214)	196 (297)	86 (155)	37 (63)	6 (9)	0 (6)
Fresh(All) Tagged Carcasses	0	0	1	0	0	15 (15)	14 (20)	146 (228)	273 (435)	349 (543)	173 (323)	66 (111)	21 (34)	11 (24)
Recovery Percentage Per Tag Week	0	0	0	0	0	33 (0)	36 (40)	66 (65)	46 (49)	56 (55)	50 (48)	56 (57)	29 (26)	0 (25)

Table 4. Recovery rate and weekly estimates

Week	Number Of Tags Recovered	Total Carcasses Handled	Jolly-Seber Weekly Estimate Fresh Tagged	Schaefer Weekly Estimates Fresh Tagged	Jolly-Seber Weekly Estimates All Tagged
2	0	0	0	0	0
3	0	1	0	0	0
4	0	0	0	0	0
5	0	2	0	0	0
6	0	15	482	84	52
7	5	33	382	1056	39
8	3(5)	361(363)	404	1420	163
9	71(109)	823(861)	1014	1923	833
10	105(185)	999(1079)	1222	1473	1095
11	197(295)	1061(1159)	891	622	1663
12	84(147)	378(441)	448	255	490
13	63(114)	285(336)	208	98	381
14	27(36)	149(158)	119	-11	419
15	2(3)	13(14)	-16	-1	5
16	0(4)	0(4)	0	0	1
17	1(2)	1(2)	0	0	0
Recovery Rate **22.8 (25.1)**			**Total Escapement Estimate Using Fresh Tagged Carcasses Only** **5,081**	**Total Escapement Estimate Using Fresh Tagged Carcasses Only** **6,919**	**Total Escapement Estimates Using All Tagged Carcasses** **5,141**

Table 5. Total live fish, redds and carcass counts by survey week.

Week	Live	Redds	Carcasses [a]
1	3	0	0
2	10	0	0
3	169	0	1
4	56	8	0
5	330	61	2
6	415	142	15
7	1794	579	28
8	1711	1041	358
9	1580	1237	752
10	932	997	894
11	478	865	864
12	197	635	294
13	107	995	222
14	51	907	122
15	18	589	11
16	7	260	0
17	3	105	0
Total	**7861**	**8421**	**3563**

[a] Carcasses includes all tagged carcasses and skeletons but does not include recoveries

Table 6. Maximum redd count for each riffle over the course of the escapement survey by section.

Section 1		Section 2		Section 3		Section 4	
Riffle	**Maximum # of Redds**	**Riffle**	**Maximum # of Redds**	**Riffle**	**Maximum # of Redds**	**Riffle**	**Maximum # of Redds**
A1	21	aE1	29	J3	15	U1	11
A1a	27	E1	109	J4	14	V1	3
A2	18	E1A	46	K1	22	W1	14
A3	22	E2	64	K1A	22	W1A	3
A4	95	F1	59	K1B	63	W1B	15
B1	11	F2	35	K1C	45	W2	12
C1	55	F3	13	K1S	39	X1	1
C2	71	F3A	11	K2	78	X2	2
		F4	30	L1	42	X3	3
		G1	75	L2	30	Z1	3
		G2	97	L3	31	Z2	4
		G2A	38	M1	16		
		G3	43	M2	52		
		G4	57	M3	37		
		H1	50	M4	20		
		H1A	10	N1	20		
		H1B	6	N2	13		
		H1S	11	N3	19		
		H2	25	N4	6		
		H2A	22	N5	7		
		H2B	22	O1	9		
		H2S	24	O1A	3		
		H3	21	O2	21		
		J1	12	O3	9		
		J2	8	P1	3		
				P2	17		
				P3	17		
				P4	7		
				P5	14		
				Q1	3		
				Q2	10		
				Q3	10		
				Q4	14		
				R1	7		
				R2	16		
				S1	12		
				T1	6		
				T2	11		
				T3	12		
				T4	2		
Subtotals Total Redds	**252**		**720**	**1695**	**610**		**113**

Table 7. Handled fish composition of natural and CWT grilse and adult.

	Total Handled (n=1922)		**Male** (n=779)		**Female** (n=1143)	
	Male (n=679)	**Female** (n=1143)	**CWT** (n=85)	**Natural** (n=694)	**CWT** (n=141)	**Natural** (n=1002)
Grilse	23.4% (n=159)	9.4% (n=108)	21.2% (n=18)	20.3% (n=141)	15.6% (n=22)	8.6% (n=86)
Adult	76.6% (n=520)	90.6% (n=1035)	78.8% (n=67)	79.7% (n=553)	84.4% (n=119)	91.4% (n=916)

Table 8. Distribution of scale samples collected by section and week for natural salmon. Adipose fin clipped salmon (cwt's) are noted in parenthesis.

Week	**Section**				**Weekly Totals**
	1	**2**	**3**	**4**	
1	0	0	0	0	**0**
2	0	0	0	0	**0**
3	0	0	0	0	**0**
4	0	0	0	0	**0**
5	0	0	0	0	**0**
6	2	1	8 (4)	0	**11 (4)**
7	2	7	0	0	**9**
8	10 (1)	48 (6)	18 (1)	0	**76 (8)**
9	10 (3)	53 (6)	39 (4)	0	**102 (13)**
10	5 (2)	42 (5)	16 (2)	0	**63 (9)**
11	13 (1)	45 (9)	21 (4)	1	**80 (14)**
12	3	48 (2)	15	2	**68 (2)**
13	0	5 (1)	4	0	**9 (1)**
14	0	4	3	0	**7**
15	0	0	0	0	**0**
Section Totals	**45 (7)**	**253 (29)**	**124 (15)**	**3**	**425 (51)**

Table 9. Distribution of heads collected from adipose fin clipped salmon (cwt's).

Week	**Section**				**Weekly Totals**
	1	**2**	**3**	**4**	
1	0	0	0	0	**0**
2	0	0	0	0	**0**
3	0	0	0	0	**0**
4	0	0	0	0	**0**
5	1	0	0	0	**1**
6	0	0	4	0	**4**
7	1	0	0	0	**1**
8	11	18	5	0	**34**
9	12	35	22	0	**69**
10	4	53	12	0	**69**
11	1	32	7	0	**40**
12	1	6	1	0	**8**
13	0	2	0	0	**2**
14	0	0	0	0	**0**
15	0	0	0	0	**0**
Section Totals	**31**	**146**	**51**	**0**	**228**

Table 10. Distribution of DNA samples collected from salmon.

Week	Section				Weekly Totals
	1	2	3	4	
1	0	0	0	0	**0**
2	0	0	0	0	**0**
3	0	0	0	0	**0**
4	0	0	0	0	**0**
5	0	0	0	0	**0**
6	0	1	6	0	**7**
7	2	4	0	0	**6**
8	0	16	9	0	**25**
9	0	34	0	0	**34**
10	0	2	0	0	**2**
11	0	19	6	0	**25**
12	0	0	3	0	**3**
13	0	0	0	0	**0**
14	0	0	0	0	**0**
15	0	0	0	0	**0**
Section Totals	**2**	**76**	**24**	**0**	**102**

Figure 1. Fresh carcass indicated by clear eye.

Figure 2. Fresh carcass indicated by presence of blood remaining in gill.

Figure 3. Fungus covered skeleton.

Figure 4. Two skeletons showing varied degrees of decomposition and a fresh carcass.

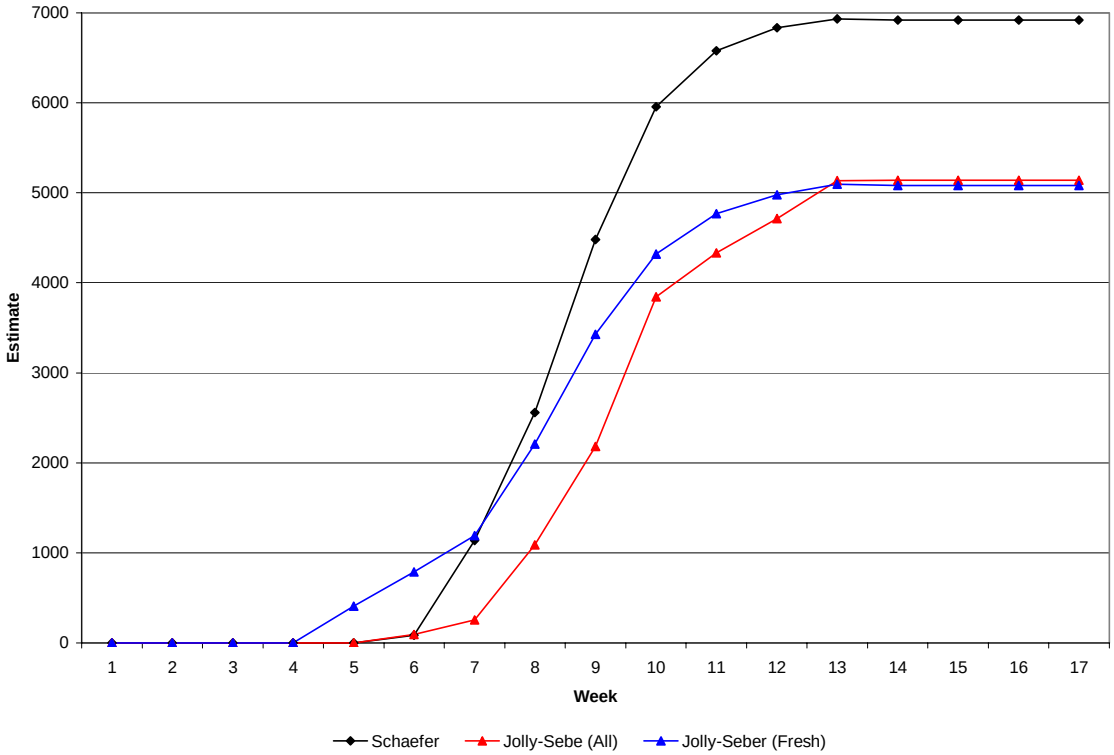

Figure 5. Weekly cumulative Schaefer and Jolly-Seber estimates (does not include Goodwin Canyon reach).

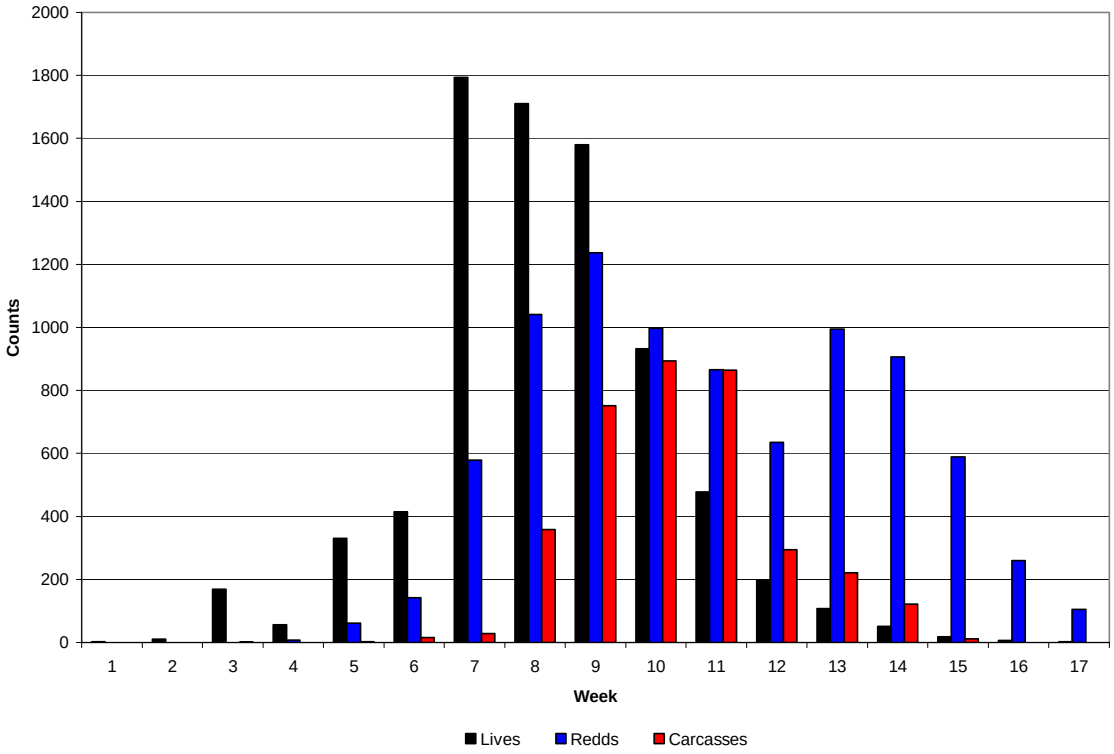

Figure 6. Live fish observation, redd, and total carcass weekly counts. Total carcasses includes all tagged carcasses and skeletons.

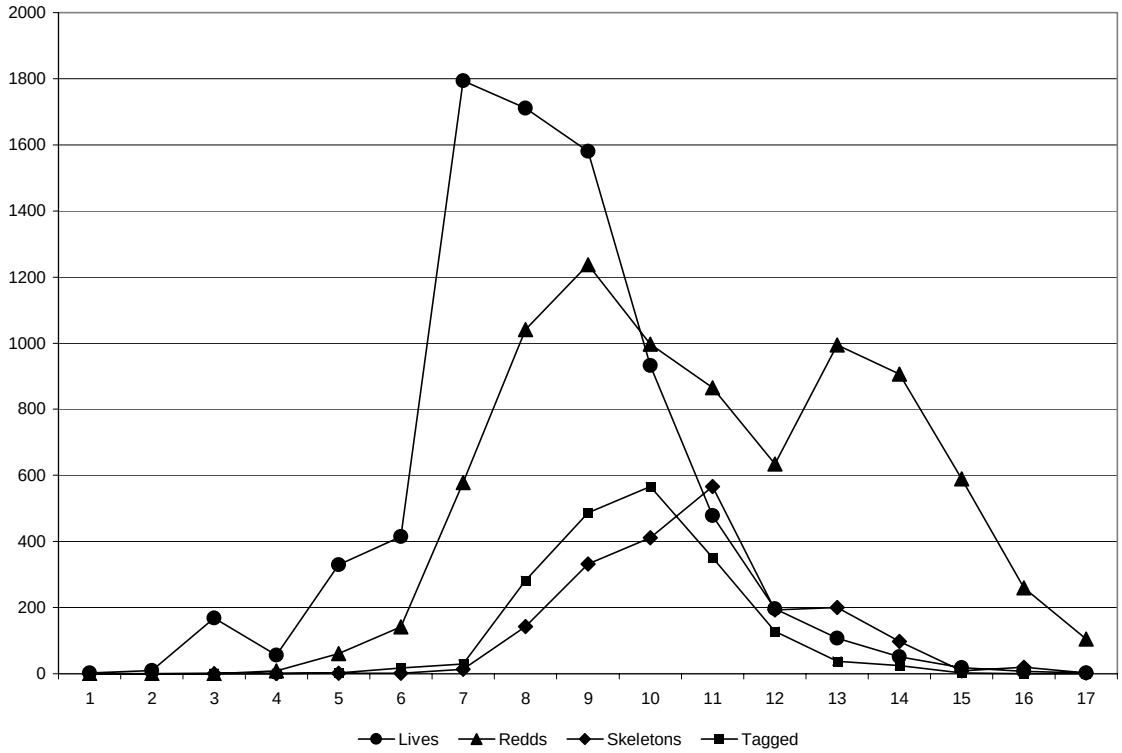

Figure 7. Maximum number of live fish, redds, skeletons, and total tagged carcasses by survey week.

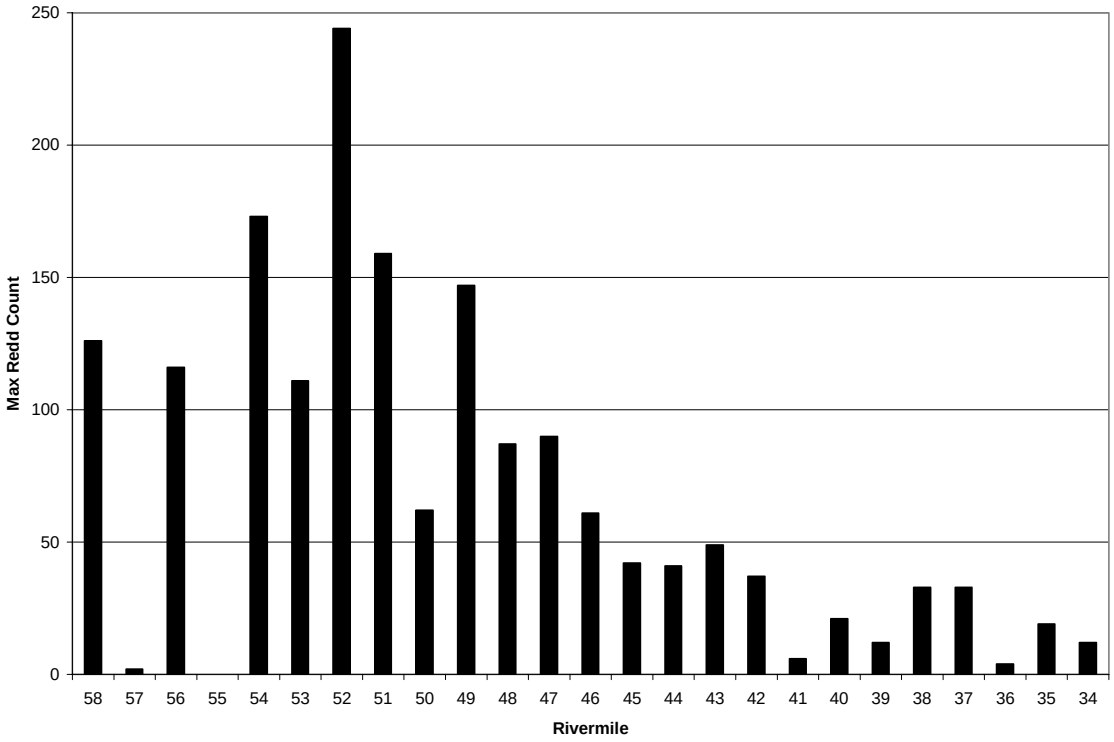

Figure 8. Maximum number of redds observed by river mile.

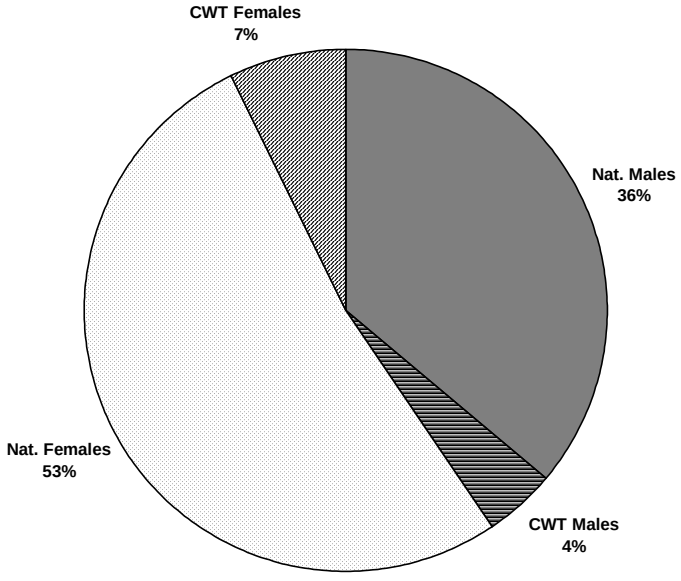

Figure 9. Contribution of male natural, male CWT, female natural, female CWT to the 2003 Stanislaus River escapement.

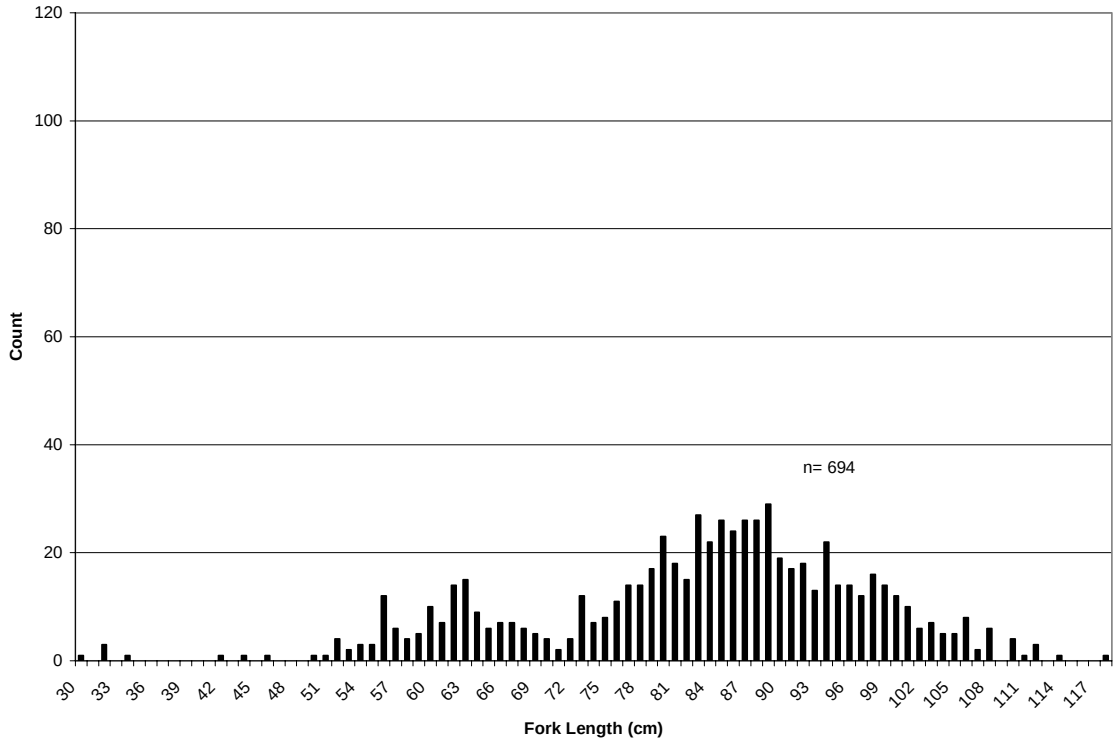

Figure 10. Length frequency histogram of natural male chinook salmon.

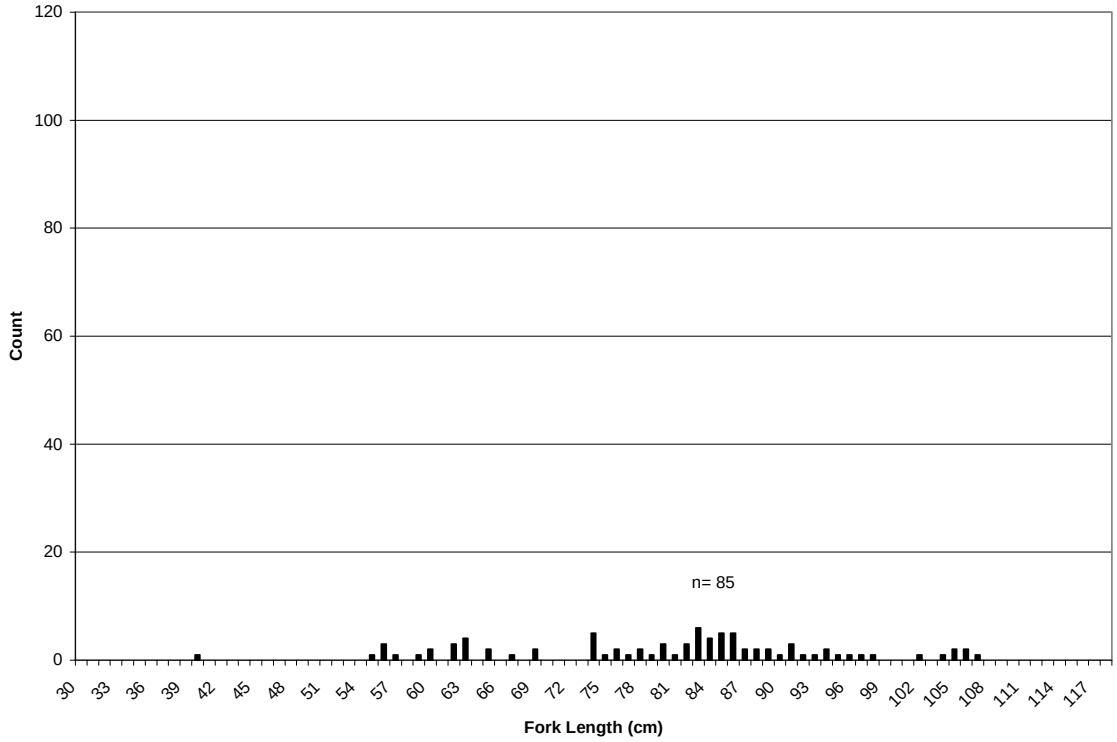

Figure 11. Length frequency histogram of CWT male chinook salmon.

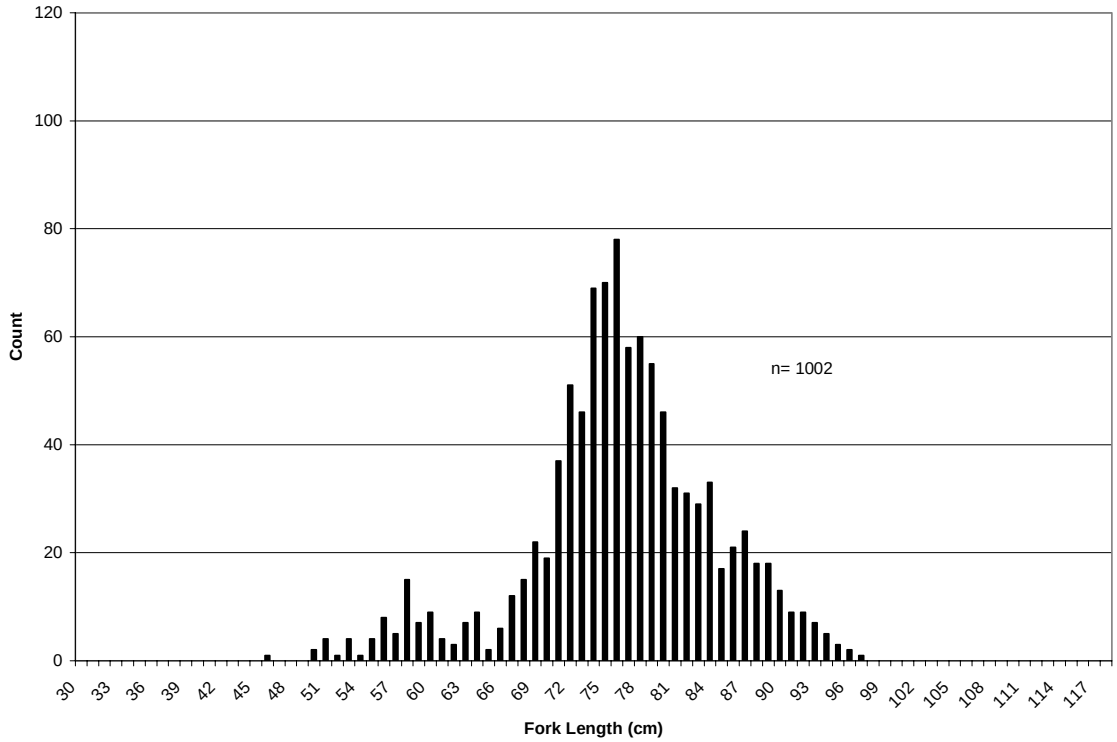

Figure 12. Length frequency histogram of natural female chinook salmon.

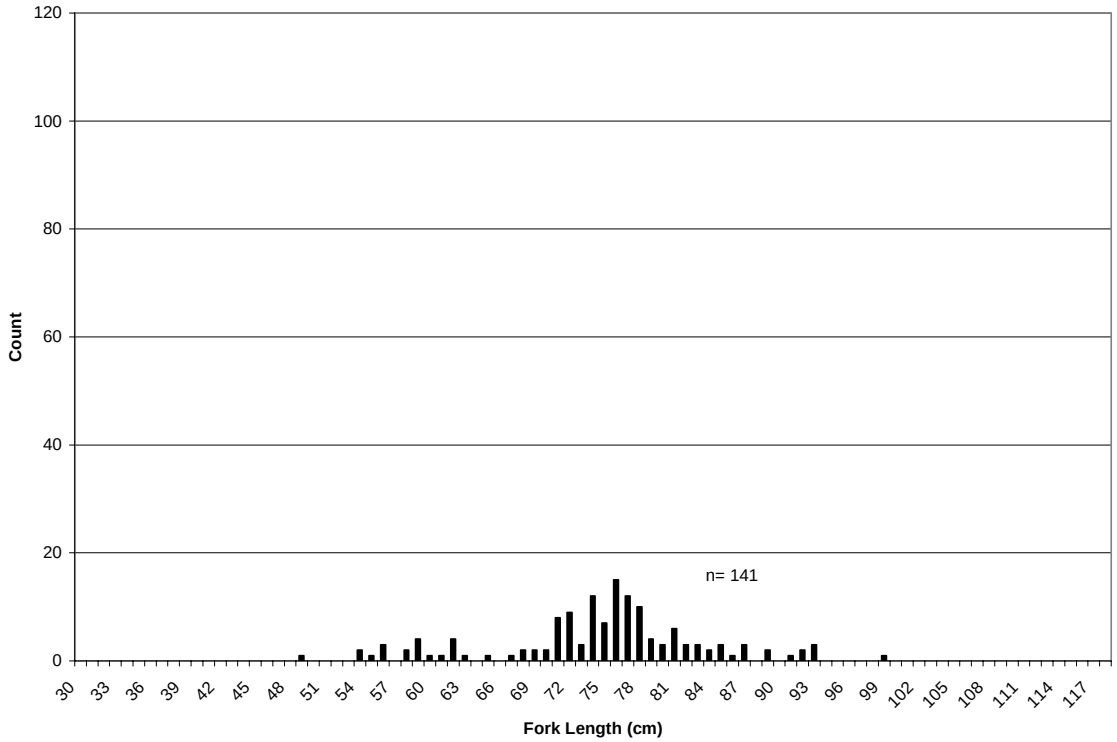

Figure 13. Length frequency histogram of CWT female chinook salmon.

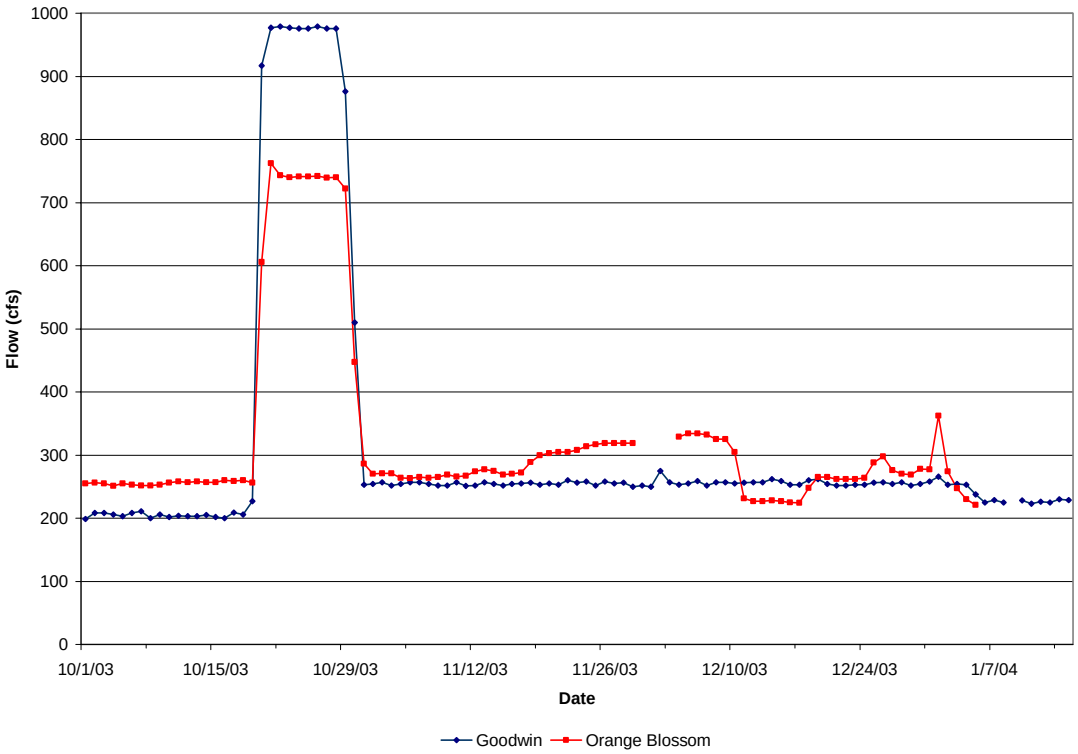

Figure 14. Average daily Stanislaus River flow (cubic feet per second) during the 2002 escapement survey. Preliminary data obtained from the California Data Exchange Center.

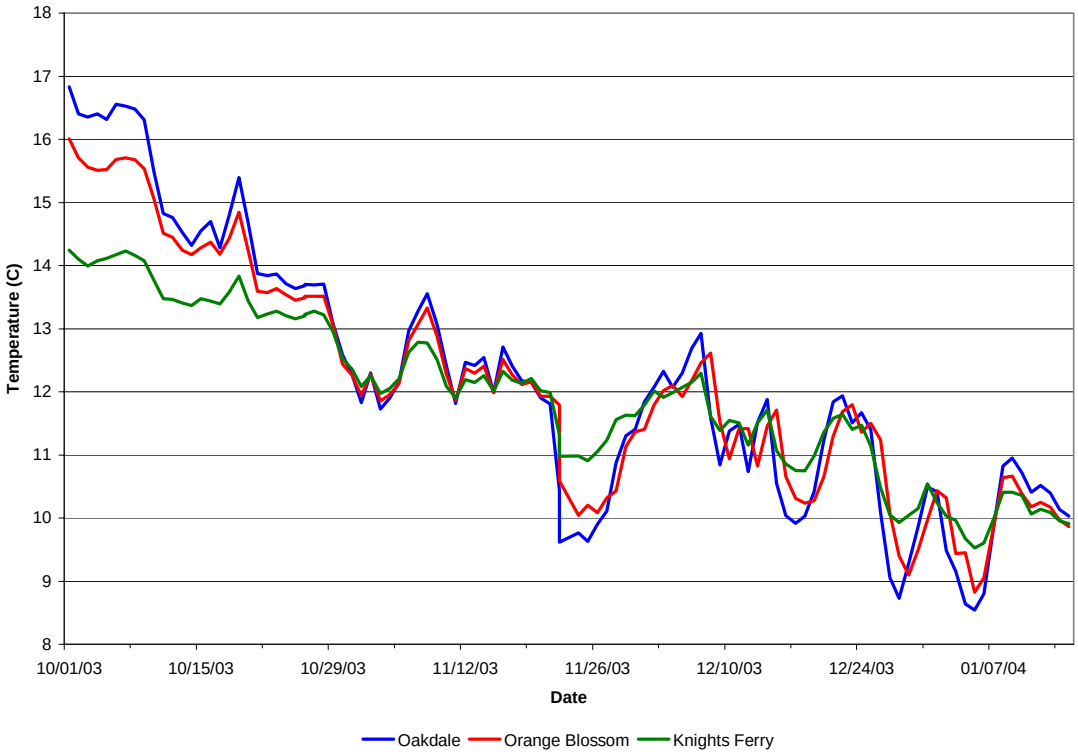

Figure 15. Average daily water temperature in the Stanislaus River.

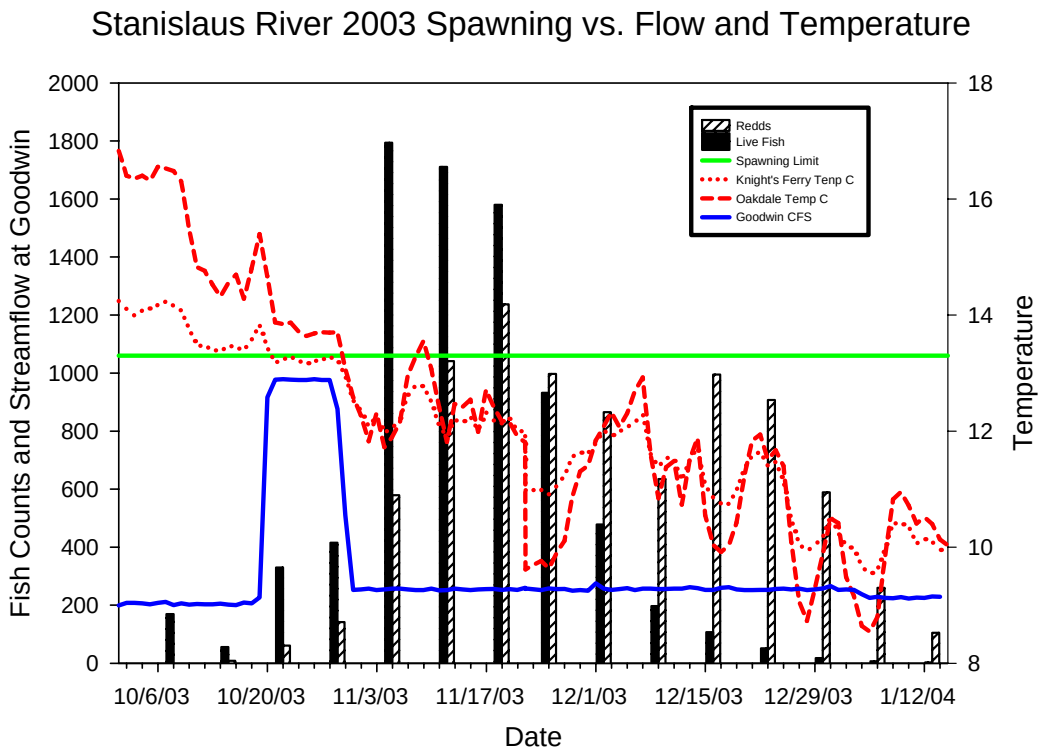

Figure 16. Weekly live and redd counts in relation to water temperature and flow.

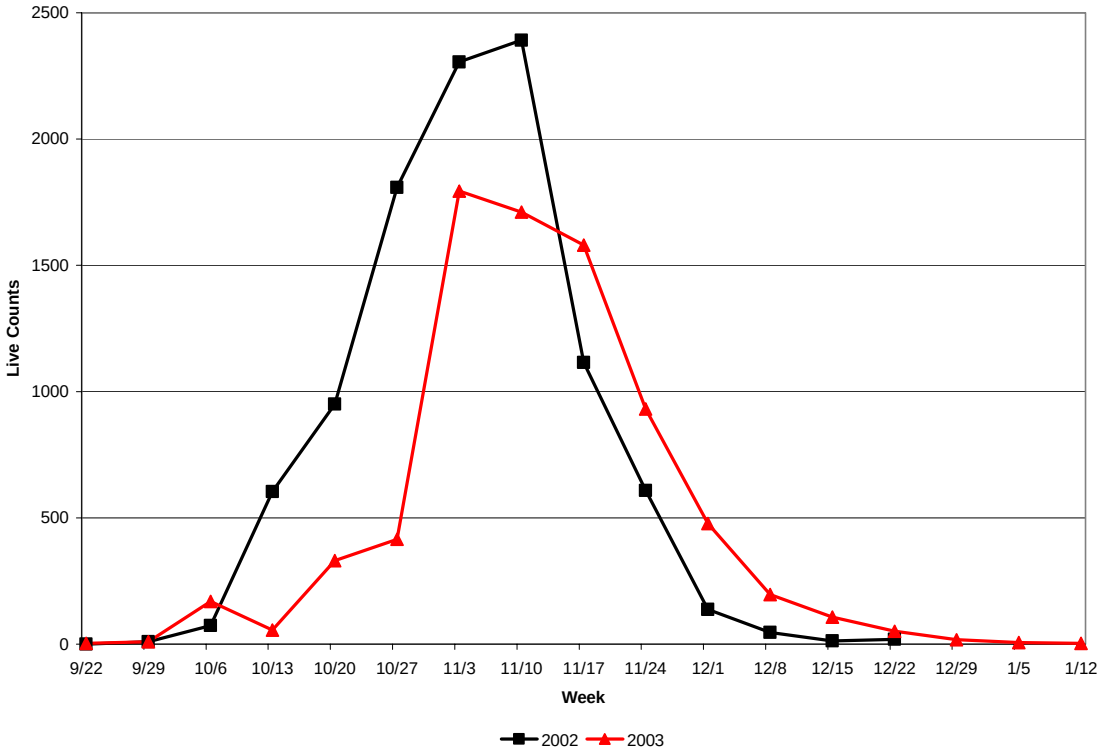

Figure 17. 2002 and 2003 live salmon counts.

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