

DEPARTMENT OF FISH AND GAME
Sacramento North-Central Region

**Lower American River Chinook Salmon Escapement Survey
October 2007 – January 2008**

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Introduction

Spawner escapement surveys have been conducted on the lower American River to estimate the number of returning adult Chinook salmon for nearly 60 years. This information is important in guiding development and evaluation of management decisions. The four goals of the 2007 - 2008 lower American River spawner escapement survey were (1) estimate the number of spawners; (2) determine the sex and age composition; (3) determine the egg retention of the females in the run; and (4) determine the percentage of coded-wire tagged (CWT) fish within the fresh samples.

Adult fall-run Chinook salmon ascend the American River for approximately 23 miles from the confluence of the Sacramento River near Discovery Park to the terminus of anadromous migration at the Nimbus fish weir, just below Nimbus Dam. Spawning occurs within the eighteen miles of river from about Paradise Beach to Nimbus fish weir. However, most spawning occurs in the uppermost three miles of the river near Sunrise Avenue Bridge upstream to the Nimbus fish weir.

Materials and Methods

The lower American River salmon escapement survey was conducted from the Nimbus weir downstream to the Watt Avenue Bridge; a distance of 12.9 river miles. The river was stratified into three reaches (Table 1). All reaches were surveyed once a week from October 17, 2007 through January 24, 2008. The survey was terminated after Week 15 (January 24, 2008) because the recovery rate of fresh carcasses had fallen to zero. Each weekly survey was conducted with a crew of six to ten crew members and took three to four days to complete.

Table 1. American River fall-run Chinook salmon escapement survey reaches.		
Reach	Location	Miles
1	Nimbus Fish Weir to Elmanto Access	3.4
2	Elmanto Access to Goethe Park Footbridge	3.5
3	Goethe Park Footbridge to Watt Avenue Bridge	6.0
Total		12.9

Each week all fresh adult-sized carcasses (either one clear eye or pink gills) were counted and tagged with a color-coded hog ring on the upper jaw. A unique color was used each week to identify the carcasses to a specific tagging week. Each tagged carcass was returned to flowing water for dispersal. In Reach 3, only fresh carcasses were tagged down to Gristmill Fishing Access (Figure 1). This was to prevent tagged

carcasses from floating out of the study area downstream of Watt Avenue Bridge. Instead, fresh carcasses below Gristmill Fishing Access to Watt Avenue Bridge were chopped in half and counted.

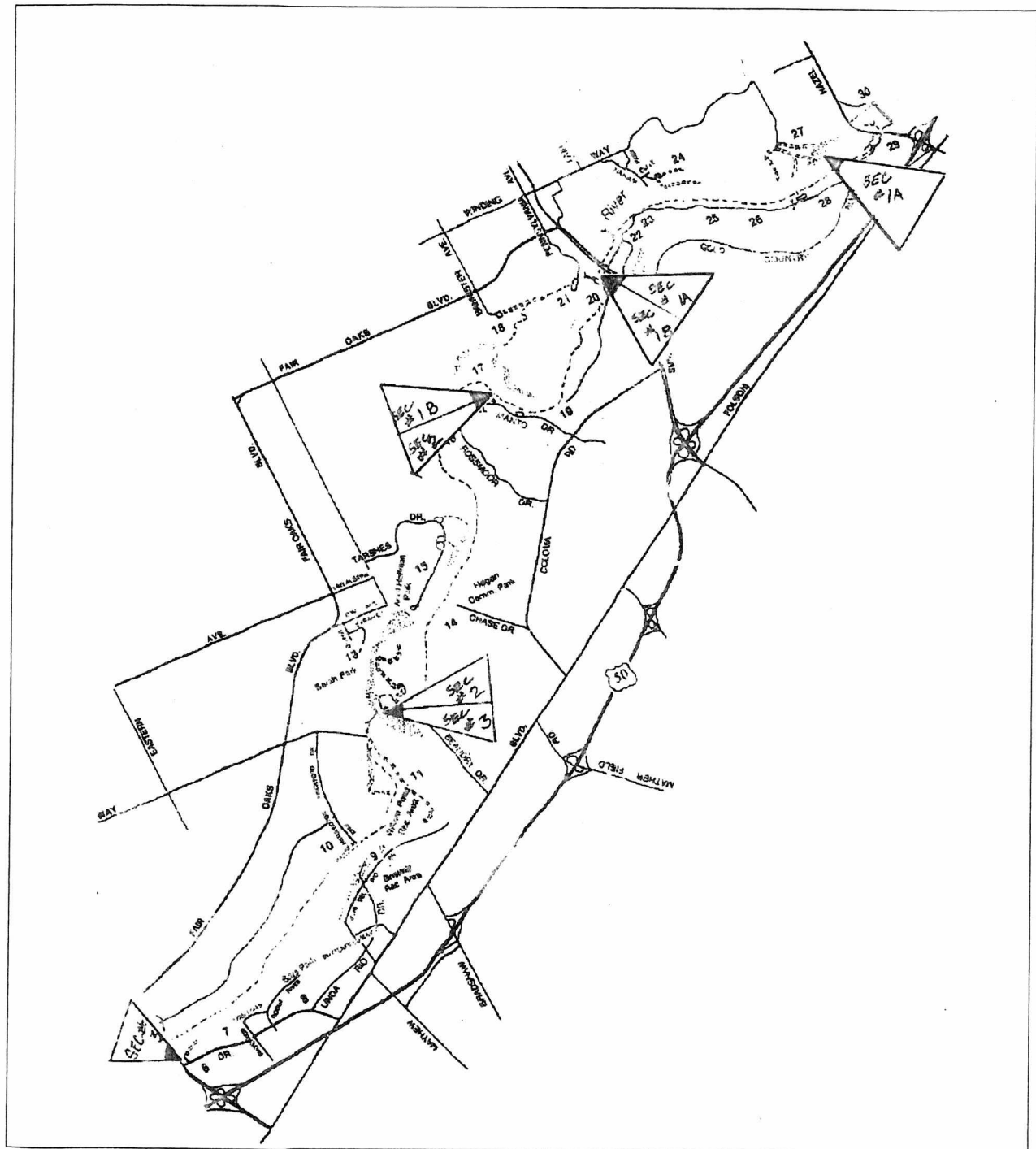


Figure 1. American River fall-run Chinook salmon escapement survey reaches.

Fresh carcasses with missing adipose fins were identified as carcasses with a CWT. Heads were removed from the CWT carcasses and affixed with a jaw tag for further analysis of any CWT's. In the course of this action, CWT carcasses were chopped in half and recorded as a fresh chopped carcass.

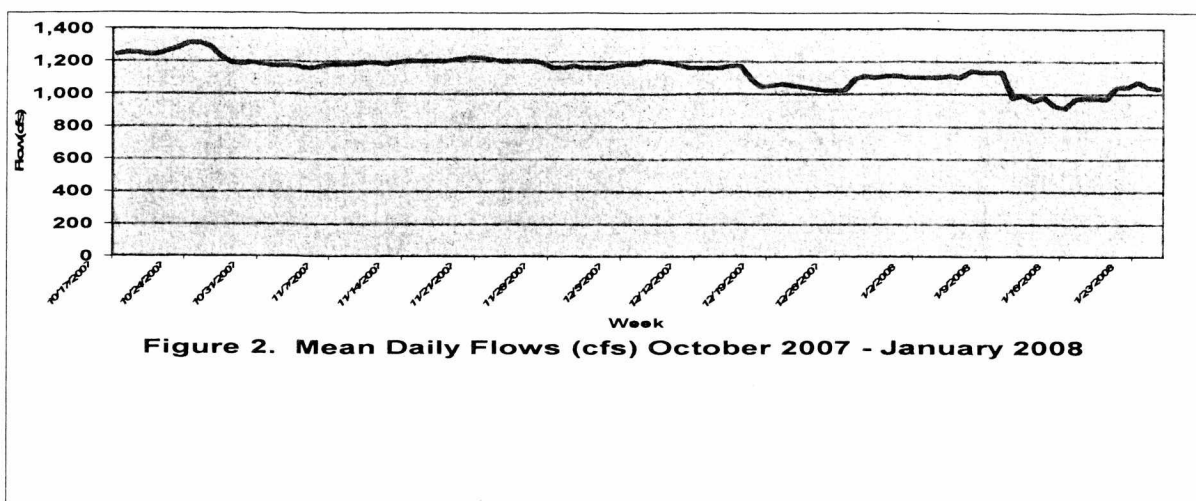
Nearly all (99%) fresh carcasses and all CWT carcasses were identified to sex and measured to the nearest centimeter (cm) Fork Length (FL). Fish ≥ 68 cm FL were considered adults, and those < 68 cm FL were classified as a grilse, or young adult. All fresh female carcasses measured were checked to determine the degree of egg retention. Each was identified as either completely spawned (0 to 30% eggs retained), partially spawned (>30 to 70% eggs retained), or un-spawned (> 70% retained).

All observed decomposing carcasses were counted but not tagged. Decomposing and recovered (previously tagged) carcasses were chopped in half to prevent recounting. Fresh adult carcass data was used in the Schaefer mark-recovery method (Schaefer, 1951) as modified by Taylor (1974) to produce an adult escapement estimate. The grilse population was determined by the proportion of grilse from the total number of fresh carcasses observed. The total lower American River fall-run Chinook salmon escapement was calculated by summing the in-river population estimate with the total number collected at Nimbus Fish Hatchery and the number of salmon carcasses that get impinged on the upstream side of the Nimbus fish weir. The Nimbus fish weir is not totally effective at blocking 100% of the salmon and some fish are able to move upstream of the weir. These fish that escape around the fish weir eventually die and are impinged on the upstream side of the weir.

Daily water temperature, flow, and clarity were collected throughout the sampling period. Mean daily water temperature and flow were obtained from a U.S. Geological Survey gauging station located on the lower American River at the Fair Oaks Bridge. Water clarity was measured with a secchi disk to the nearest 0.25 meter.

Results

Mean daily flow ranged from 1,310 cubic feet per second (cfs) to 914 cfs during the fifteen week survey period (Figure 2). Flow was on a declining trend from approximately 1,300 cfs during the first month of the survey down to around 900 cfs at the conclusion of the survey in mid January (Week 15). Water temperature in the American River ranged from (63.5 °F) to (46.5 °F). Water clarity ranged from 1 to 3.5 meters during the survey.



Temporal Distribution

A total of 3,021 salmon carcasses was observed during the 2007 American River escapement survey, including 714 fresh and 2,307 non-fresh carcasses (Table 2). Fresh carcasses were first observed during the week of October 22 (Week 2) and were present throughout the survey period (Figure 3). The number of fresh carcasses observed increased through Week 8. During Week 9 water visibility dropped to \leq one meter visibility resulting in a lower than expected number of carcasses observed during this period. The number of non-fresh carcasses observed during Week 9 exhibited a similar trend (Figure 4).

Table 2. General survey information for the Lower American River fall-run Chinook salmon escapement survey, October 17, 2007 - January 24, 2008.

Week	Date	Carcasses Observed	
		Fresh	Non-fresh
1	Oct 17-19	0	2
2	Oct 22-24	3	0
3	Oct 29-31	6	1
4	Nov 5-7	26	16
5	Nov 13-15	70	120
6	Nov 19-21	70	164
7	Nov 26-28	124	332
8	Dec 3-6	155	554
9	Dec 11-13	57	242
10	Dec 17-20	94	277
11	Dec 26-28	59	227
12	Jan 2-3	35	171
13	Jan 7-9	4	67
14	Jan 14-16	7	92
15	Jan 22-24	4	42
Total		714	2,307

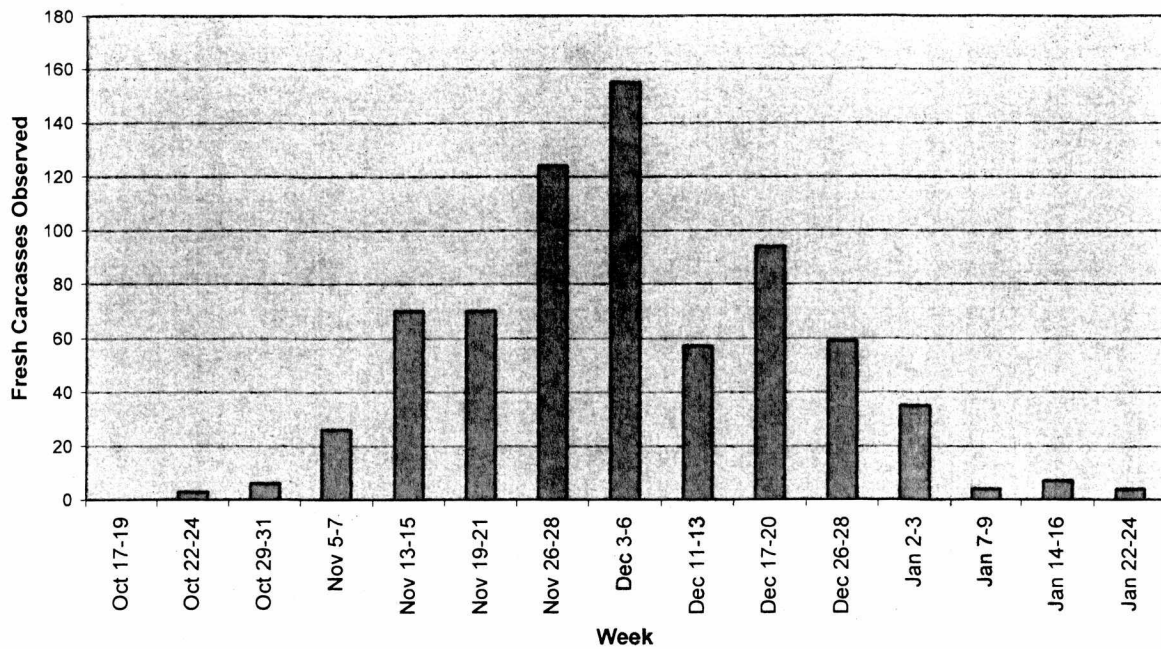


Figure 3. Weekly Distribution of Fresh Carcasses, October 2007 - January 2008

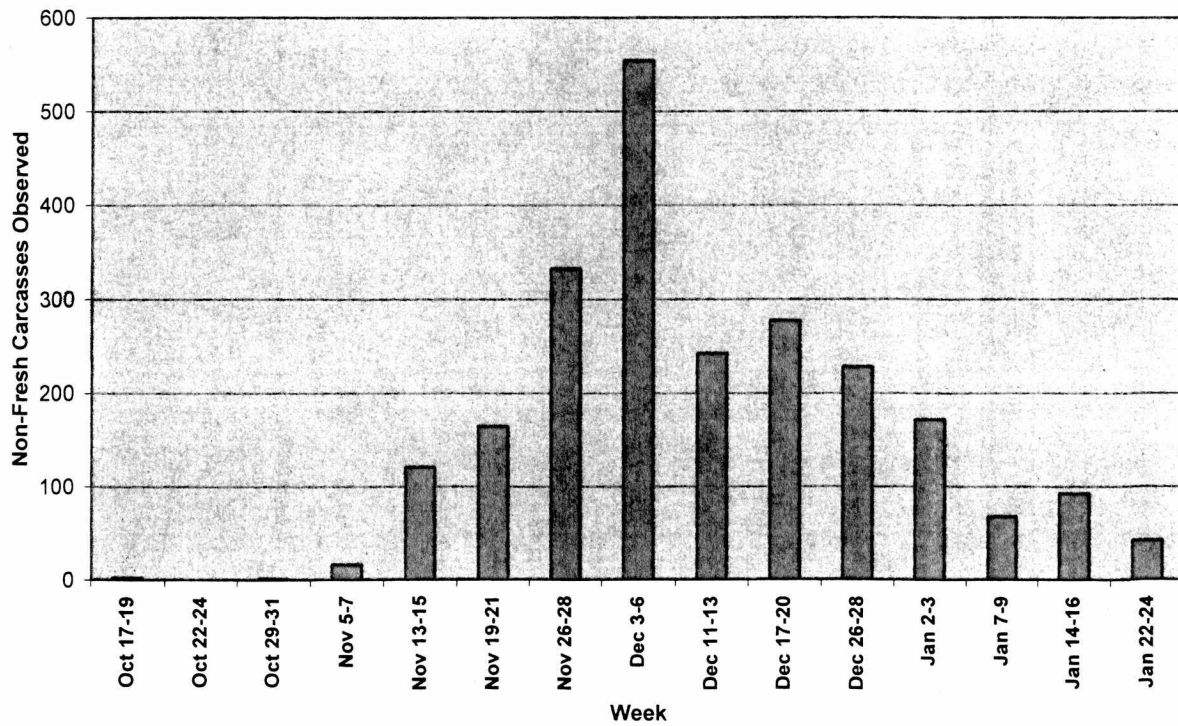


Figure 4. Weekly Distribution of Non-Fresh Carcasses, October 2007 - January 2008.

Age Composition

Grilse comprised approximately 1.3% (9) of the observed take of fresh carcasses (Table 3) and weekly percent composition ranged from 0% to 33%. The greatest number of grilse (3) was observed during the week of November 19, 2007. Adults comprised 98.7% (705) of all the fresh carcasses observed. The greatest number of adults (155) was observed during the week of December 3, 2007.

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Table 3. Age composition (grilse and adult) of fresh carcasses observed, October 17, 2007 - January 24, 2008.

Week	Grilse		Adult	
	Number	Percent	Number	Percent
Oct 17-19	0	0	0	0
Oct 22-24	1	33	2	67
Oct 29-31	0	0	6	100
Nov 5-7	0	0	26	100
Nov 13-15	1	1	69	99
Nov 19-21	3	4	67	96
Nov 26-28	1	<1	123	>99
Dec 3-6	0	0	155	100
Dec 11-13	1	2	56	98
Dec 17-20	0	0	94	100
Dec 26-28	0	0	59	100
Jan 2-3	1	3	34	97
Jan 7-9	1	25	3	75
Jan 14-16	0	0	7	100
Jan 22-24	0	0	4	100
Total (Percent)	9 (1.3)		705 (98.7)	

70
1.3
100

Sex Composition

Female Chinook salmon comprised 66% (473) from the sub-sample of 710 fresh carcasses that were measured and examined for sex composition, while male Chinook salmon comprised 34% (237). Adult Chinook salmon carcasses (701) was 34% male and 66% female with an overall ratio of 1:2 male to female (Table 4).

Male grilse carcasses comprised 55% (5) of the nine fresh grilse carcass measured, and female grilse carcasses comprised 45% (Table 4). The overall ratio of male grilse to female grilse was 1 to 1.

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Table 4. Sex composition of fresh Chinook salmon grilse and adult carcasses measured, October 17, 2007 - January 24, 2008.

Date	Grilse				Adult			
	Male		Female		Male		Female	
	Number	%	Number	%	Number	%	Number	%
Oct 17-19	0	0	0	0	0	0	0	0
Oct 22-24	1	100	0	0	0	0	2	100
Oct 29-31	0	0	0	0	4	67	2	33
Nov 5-7	0	0	0	0	9	35	17	65
Nov 13-15	1	100	0	0	26	38	43	62
Nov 19-21	1	25	2	75	24	36	43	64
Nov 26-28	0	0	1	100	36	29	87	71
Dec 3-6	0	0	0	0	53	34	102	66
Dec 11-13	1	100	0	0	18	30	38	70
Dec 17-20	0	0	0	0	35	39	56	61
Dec 26-28	0	0	0	0	13	22	45	78
Jan 2-3	0	0	1	100	8	23	26	77
Jan 7-9	1	100	0	0	3	100	0	0
Jan 14-16	0	0	0	0	1	14	6	86
Jan 22-24	0	0	0	0	2	50	2	50
Total (Percent of Age class)	5 (51)		4 (49)		232 (33)		469 (67)	

Egg Retention

Of the 473 fresh adult and grilse female carcasses that were observed for egg retention, 385 (82%) were completely spawned, 55 (11%) were unspawned, and 32 (7%) were partially spawned (Table 5). Female salmon carcasses observed with high egg retention were observed in weeks 2 – 11 during the survey. High egg retention in females was greatest during the first four weeks of the survey (52%) where 11 out of 21 carcasses were observed with eggs retained. Egg retention in females dropped substantially in the last eleven weeks of the survey (<10%) where 43 carcasses out of 450 were observed with eggs retained.

Table 5. Summary of fresh female Chinook salmon carcasses checked for egg retention, October 17, 2007 - January 24, 2008.

Date	# females checked for retention	0 to 30% retained		>30 to 70% retained		>70% retained	
		Number	%	Number	%	Number	%
Oct 17-19	0	0	0	0	0	0	0
Oct 22-24	2	1	50	0	0	1	50
Oct 29-31	2	0	0	0	0	2	100
Nov 5-7	17	7	41	2	12	8	47
Nov 13-15	43	23	52	10	24	10	24
Nov 19-21	45	28	62	4	9	13	29
Nov 26-28	88	72	82	6	7	10	11
Dec 3-6	101	90	89	6	6	5	5
Dec 11-13	38	35	92	2	5	1	3
Dec 17-20	55	52	95	2	4	2	2
Dec 26-28	45	42	93	0	0	3	7
Jan 2-3	27	27	100	0	0	0	0
Jan 7-9	0	0	0	0	0	0	0
Jan 14-16	6	6	100	0	0	0	0
Jan 22-24	2	2	100	0	0	0	0
Total (Percent of total)	472	385 (82)		32 (7)		55 (11)	

Coded-wire tagged fish

Of the 714 fresh carcasses observed during the survey, 6 (0.8%) were observed with missing adipose fins and classified as CWT fish. However, only one (0.14%) carcass contained a CWT (Table 6). This fish was found to be a late-fall run Chinook salmon from the brood year 2006 at Coleman National Fish Hatchery. The low number of CWT carcasses collected in the American River is due to the fact that there were no CWT tagging operations at Nimbus Hatchery in the years representing the returning 2007 cohort.

Table 6. Number and percentage of fresh CWT Chinook salmon carcasses observed, October 17, 2007 - January 24, 2008.

Date	Number of fresh carcasses observed	Number of CWT fish observed	Weekly percent
Oct 17-19	0	0	0
Oct 22-24	3	0	0
Oct 29-31	6	0	0
Nov 5-7	26	0	0
Nov 13-15	70	0	0
Nov 19-21	70	0	0
Nov 26-28	126	0	0
Dec 3-6	156	0	0
Dec 11-13	59	0	0
Dec 17-20	93	0	0
Dec 26-28	59	0	0
Jan 2-3	35	0	0
Jan 7-9	4	1	25
Jan 14-16	7	0	0
Jan 22-24	4	0	0
Total (Percent of total)	718	1 (.14)	

Population Estimate

A total of 675 fresh adult carcasses was tagged from October 29, 2007 (Week 3) through January 16, 2008 (Week 14) of which 223 tags were subsequently recovered. The modified Schaefer model produced an adult in-river escapement estimate of 9,827 (Table 7). An additional 28 fresh adult fish were removed during the survey and added to the Schaefer estimate leading to an adult escapement of 9,855. Overall tag recovery rate was 34.8% and weekly recovery rates ranged from 22.9 to 44.6%. Since adults made up 98.7% of the escapement, a total escapement (adult and grilse) of 9,985 was calculated by dividing the adult estimate by 0.987. Grilse comprised 1.3% (130) of the adult population.

Table 7. Lower American River Adult Chinook Salmon Population Estimate Using the Schaefer Model Based on Tagging Fresh Adult Carcasses with all Untagged Carcasses Removed, October 29, 2007 - January 16, 2008.

T(i)			E(i)		R(i)												
SURVEY PERIOD	NUMBER TAGGED	NUMBER CHOPPED	RATIO E(i) / R(i)	TOTAL EXAMINED	Sum of Rows	RECOVERED	RECAPTURES OF FISH MARKED IN SURVEY PERIOD										
PASTE FINAL SCHAEFER MATRIX HERE							1	2	3	4	5	6	7	8	9	10	11
1	6	3	0	9	0												
2	26	16	0	51	0												
3	67	118	62.66667	188	3		2	1									
4	65	164	16.26667	244	15				15								
5	116	329	24.42105	464	19				3	16							
6	153	550	16.97727	747	44				3	9	32						
7	51	241	9.588235	326	34				1	1	2	30					
8	91	276	8.978261	413	48				1		8	25	12				
9	58	227	16	304	19							2	5	12			
10	34	170	12.33333	222	18							1	1	9	7		
11	3	65	6.230769	81	13									1	6	5	
12	5	91	10.6	106	10										4	3	2
13	0	41	21.5	43	2										2		
Totals	675	2291		3198	223	R(i) Total											
					223	C(i) Total											
			C(i) RECOVERED Sum of Column				2	1	23	26	42	59	18	23	19	8	2
			T(i) / C(i) Ratio				3.00	26.00	2.91	2.50	2.76	2.59	2.83	3.96	3.05	4.25	1.50

SCHAEFER ESTIMATE CALCULATIONS:	
Total Population from Matrix =	10496
# Tagged from period 2 to last	-669
SCHAEFER ESTIMATE IS:	9,827

Matrix of Population Estimates											
Survey Period	1	2	3	4	5	6	7	8	9	10	11
1	-	-	-	-	-	-	-	-	-	-	-
2	0	0	0	0	0	0	0	0	0	0	0
3	376	1629	0	0	0	0	0	0	0	0	0
4	0	0	711	0	0	0	0	0	0	0	0
5	0	0	213	977	0	0	0	0	0	0	0
6	0	0	148	382	1500	0	0	0	0	0	0
7	0	0	28	24	53	746	0	0	0	0	0
8	0	0	26	0	198	582	305	0	0	0	0
9	0	0	0	0	0	83	227	760	0	0	0
10	0	0	0	0	0	32	35	439	264	0	0
11	0	0	0	0	0	16	0	25	114	132	0
12	0	0	0	0	0	0	0	42	129	135	32
13	0	0	0	0	0	0	0	0	131	0	0
Totals	376	1629	1127	1383	1752	1459	567	1265	638	268	32

In addition to the 9,985 salmon that returned to the lower American River downstream of Nimbus weir, there were 4,597 salmon (4,590 adult and 7 grilse) that entered Nimbus Hatchery. There were an additional 74 adult and 14 grilse carcasses removed from the upstream side of the Nimbus fish weir. By combining the in-river escapement (9,985) with the total number of Chinook salmon collected at the Nimbus Fish Hatchery (4,597) and at the Nimbus fish weir (88), the total 2007 fall-run Chinook salmon escapement for the lower American River was estimated to be 14,670.

Conclusion

The American River fall-run Chinook salmon in-river escapement estimate of 9,985 is the third lowest in-river estimate since 1967 and is < 25% of the 40 year average (1967-2006) of 45,473 (Table 8). The estimate is consistent with the low returns of fall-run Chinook salmon to all Central Valley Rivers during 2007. Therefore, we cannot speculate that a decline in the 2007 American River escapement is specific

only to the American River or its management operations, but rather to other variables that are beyond the scope of this report.

The American River appears to be making an important contribution to the Central Valley stocks based on historical annual estimates. Gerstung (1971) noted that salmon stocks returning to the American River (Nimbus hatchery plus in-river estimates) constituted about six percent of the estimated total Central Valley escapement between 1953-1959. During the period 1960-1970, the contribution of American River stocks to the Central Valley increased to 14%. Since 1970, the American River has contributed up to 37% and no less than 9% of the Central Valley escapement estimates. The total 2007 American River estimate (in-river estimate plus hatchery totals) makes up 16% of the preliminary Central Valley 2007 escapement estimate of 90,000 fall-run Chinook salmon.

Table 8. In-river American River Chinook salmon escapement estimates, 1967-2006.

Year	Grilse	Adult	Total
1967 ^a	3,132	14,868	18,000
1968 ^a	2,777	23,423	26,200
1969 ^a	8,208	35,452	43,660
1970 ^a	2,753	25,927	28,680
1971 ^a	5,210	36,470	41,680
1972 ^a	3,352	14,107	17,459
1973 ^a	4,688	77,554	82,242
1974 ^b	1,769	51,827	53,596
1975 ^a	2,699	29,433	32,132
1976 ^b	1,181	21,978	23,159
1977 ^b	4,701	36,904	41,605
1978 ^b	595	12,334	12,929
1979 ^b	896	36,419	37,315
1980 ^b	8,805	25,454	34,259
1981 ^b	2,521	40,941	43,462
1982 ^a	4,323	28,677	33,000
1983 ^a	7,313	19,087	26,400
1984 ^c	2,196	25,251	27,447
1985 ^b	11,392	44,728	56,120
1986 ^b	4,443	44,929	49,372
1987 ^b	2,960	18,185	21,145
1988 ^d	1,905	13,974	15,879
1989 ^b	2,459	14,619	17,078
1990 ^b	1,167	5,541	6,708
1991 ^b	1,506	16,639	18,145
1992 ^b	1,297	3,175	4,472
1993 ^b	6,162	20,624	26,786
1994 ^b	2,927	28,405	31,332
1995 ^b	7,010	63,086	70,096
1996 ^b	6,592	59,323	65,915
1997 ^b	4,220	42,668	46,888
1998 ^b	10,760	32,282	43,042
1999 ^b	7,716	40,509	48,225
2000 ^b	5,922	92,783	98,705
2001 ^b	10,463	120,322	130,785
2002 ^b	11,811	106,303	118,114
2003 ^b	11,571	146,945	158,516
2004 ^b	13,756	74,991	88,747
2005 ^b	2,842	54,001	56,843
2006 ^b	1,025	21,755	22,780
Average	4,926	40,547	45,473
^a Expanded direct counts; ^b Schaefer method; ^c Petersen method; ^d Jolly-Seber method			

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Appendix B. Total Chinook salmon escapement estimates for the lower American River, 1967 – 2007.

Year	Method of Estimate	Escapement Estimate		
		Grilse	Adult	Total
1967	Expanded Direct Counts	3,132	14,868	18,000
1968	Expanded Direct Counts	2,777	23,423	26,200
1969	Expanded Direct Counts	8,208	35,452	43,660
1970	Expanded Direct Counts	2,753	25,927	28,680
1971	Expanded Direct Counts	5,210	36,470	41,680
1972	Expanded Direct Counts	3,352	14,107	17,459
1973	Expanded Direct Counts	4,688	77,554	82,242
1974	Schaefer	1,769	51,827	53,596
1975	Expanded Direct Counts	2,699	29,433	32,132
1976	Schaefer	1,181	21,978	23,159
1977	Schaefer	4,701	36,904	41,605
1978	Schaefer	595	12,334	12,929
1979	Schaefer	896	36,419	37,315
1980	Schaefer	8,805	25,454	34,259
1981	Schaefer	2,521	40,941	43,462
1982	Expanded Direct Counts	4,323	28,677	33,000
1983	Expanded Direct Counts	7,313	19,087	26,400
1984	Petersen	2,196	25,251	27,447
1985	Schaefer	11,392	44,728	56,120
1986	Schaefer	4,443	44,929	49,372
1987	Schaefer	2,960	18,185	21,145
1988	Jolly-Seber	1,905	13,974	15,879
1989	Schaefer	2,459	14,619	17,078
1990	Schaefer	1,167	5,541	6,708
1991	Schaefer	1,506	16,639	18,145
1992	Schaefer	1,297	3,175	4,472
1993	Schaefer	6,162	20,624	26,786
1994	Schaefer	2,927	28,405	31,332
1995	Schaefer	7,010	63,086	70,096
1996	Schaefer	6,592	59,323	65,915
1997	Schaefer	4,220	42,668	46,888
1998	Schaefer	10,760	32,282	43,042
1999	Schaefer	7,716	40,509	48,225
2000	Schaefer	5,922	92,783	98,705
2001	Schaefer	10,463	120,322	130,785
2002	Schaefer	11,811	106,303	118,114
2003	Schaefer	11,571	146,945	158,516
2004	Schaefer	13,756	74,991	88,747
2005	Schaefer	2,842	54,001	56,843
2006	Schaefer	1,025	21,755	22,780
2007	Schaefer	151	14,519	14,670
Average		4,809	39,912	44,722