

DEPARTMENT OF FISH AND GAME  
Sacramento North-Central Region

**Lower American River Chinook Salmon Escapement Survey  
October 2006 – January 2007**

By

Michael Healey  
Associate Fishery Biologist  
Department of Fish and Game  
1701 Nimbus Road  
Rancho Cordova, CA 95670

and

Shawn Fresz  
Fishery Biologist  
Pacific States Marine Fisheries Commission

May 2007

## 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 2006 - 2007 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 19, 2006 through January 15, 2007. The survey was terminated after Week 14 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.

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.

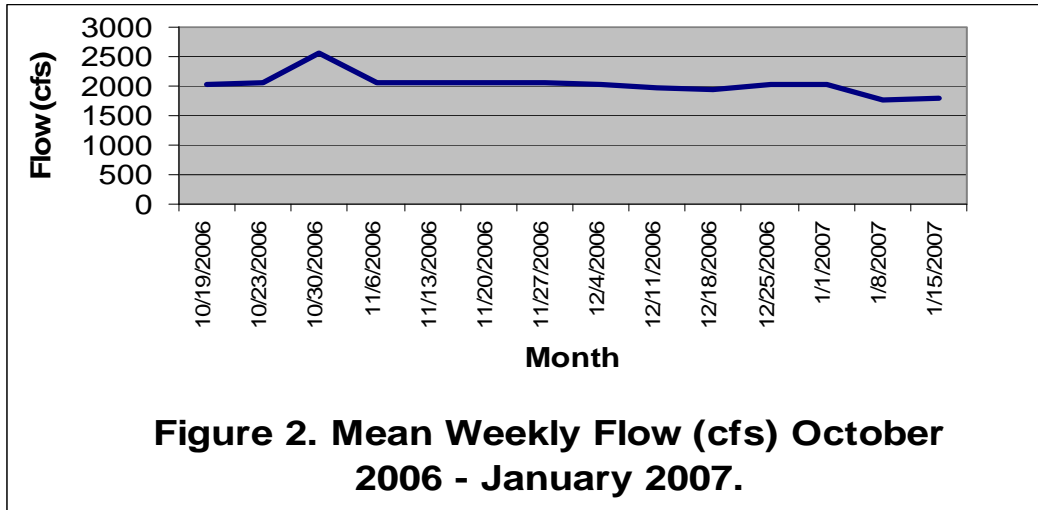
Nearly all (95%) fresh carcasses and all CWT carcasses were identified to sex and measured to the nearest centimeter (cm) Fork Length (FL). Fish  $\geq 68$  cm FL were considered adults, and those  $< 68$  cm FL were classified as a grilse, or young adult. All fresh female carcasses measured were checked 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 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 U.S. Bureau of Reclamation gaging stations located on the lower American River at Hazel Avenue, William Pond Park, and Watt Avenue. Water clarity was measured with a secchi disk to the nearest 0.25 meter.

## Results

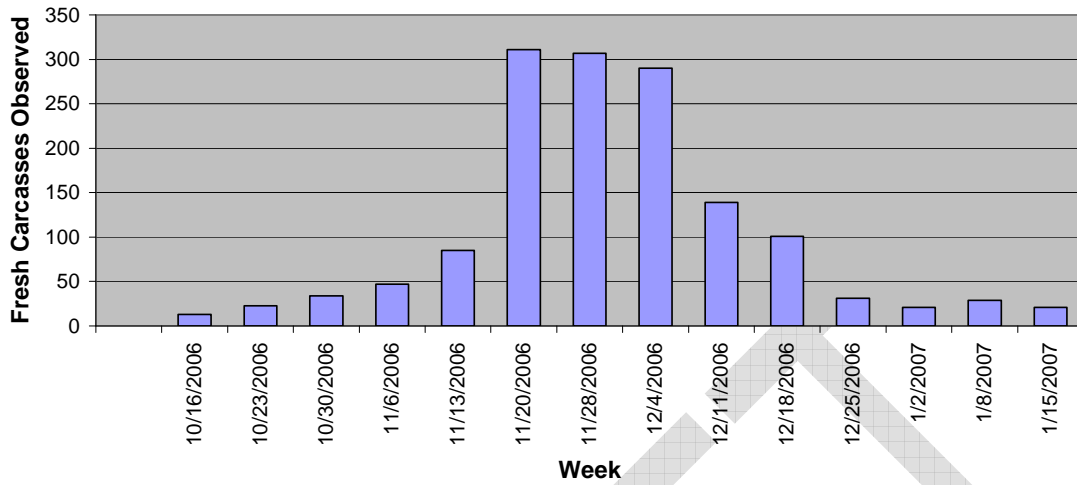
Mean daily flow ranged from 1,784 cubic feet per second (cfs) to 2,550 cfs during the fourteen week survey period (Figure 2). Flow was on a declining trend from 2,500 cfs during the first month of the survey and remained constant around 2,000 cfs through December 2006. After, flow was then steadily decreased to around 1,800 cfs through the week of January 15, 2007 (Week 14). Water temperature in the American River ranged from (68.5 °F) to (48.5 °F). Water clarity ranged from 1 to 3.5 meters during the survey.



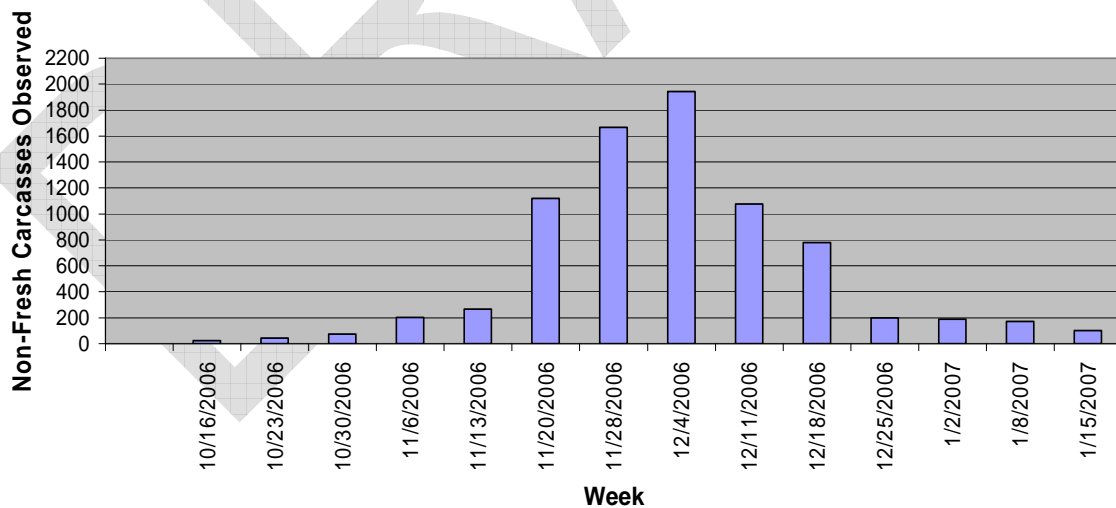
### Temporal Distribution

A total of 9,309 salmon carcasses was observed during the 2007 American River escapement survey, including 1,452 fresh and 7,857 non-fresh carcasses (Table 2). Fresh carcasses were first observed during the week of October 19 (Week 1) and were present throughout the survey period (Figure 3). The number of fresh carcasses observed increased through the week of November 27 and then decreased. The number of non-fresh carcasses observed exhibited a similar trend (Figure 4).

Week	Date	Carcasses Observed	
		Fresh	Non-fresh
1	Oct 19-Oct 20	13	23
2	Oct 24-Oct 26	23	45
3	Oct 31-Nov 2	34	75
4	Nov 6-Nov 8	47	201
5	Nov 13-Nov 15	85	267
6	Nov 20-Nov 22	311	1,121
7	Nov 27-Nov 29	307	1,667
8	Dec 4-Dec 7	290	1,942
9	Dec 11-Dec 14	139	1,076
10	Dec 18-Dec 20	101	779
11	Dec 25-Dec 27	31	200
12	Jan 1-Jan 4	21	188
13	Jan 8-Jan 11	29	171
14	Jan 15-Jan 16	21	102
Total		1,452	7,857



**Figure 3. Weekly Distribution of Fresh Carcasses, October 2006 - January 2007.**



**Figure 4. Weekly Distribution of Non-Fresh Carcasses, October 2006 - January 2007.**

## Age Composition

Grilse comprised approximately 4.5% (63) of the observed take of fresh carcasses measured (Table 3) and weekly percent composition ranged from 0% to 16%. The greatest number of grilse (13) was observed during the week of November 27, 2006. Adults comprised 95.5% (1,318) of the fresh carcasses. The greatest number of adults (284) also was observed during the week of November 27, 2006.

Date	Grilse		Adult	
	Number	%	Number	%
Oct 19-Oct 20	0	0	13	100
Oct 23-Oct 25	3	14	18	86
Oct 30-Nov 1	2	6	29	94
Nov 6-Nov 8	6	13	40	87
Nov 13-Nov 15	6	7	76	93
Nov 20-Nov 22	12	4	267	96
Nov 27-Nov 29	13	4	284	96
Dec 4-Dec 7	11	4	265	96
Dec 11-Dec 14	2	1	133	99
Dec 18-Dec 20	3	3	98	97
Dec 25-Dec 27	1	3	30	97
Jan 1-Jan 4	0	0	21	100
Jan 8-Jan 11	1	3	28	97
Jan 15-Jan 16	3	16	16	84
Total (Percent)	63 (4.5)		1,318 (95.5)	

## Sex Composition

Female Chinook salmon comprised 56% (773) of the 1,381 fresh carcasses (adult and grilse) examined for sex composition, while male Chinook salmon comprised 44% (608). The breakdown of adult Chinook salmon carcasses (1,318) was 42% male and 58% female with an overall ration of 1 to 1.4 male to female (Table 4).

Male grilse carcasses were more abundant (84%) than female grilse carcasses (16%) (Table 5). The overall ratio of male grilse to female grilse was 5.3 to 1.

Table 4. Sex composition of fresh Chinook salmon grilse and adult carcasses, October 19, 2006 - January 15, 2007.								
Date	Grilse				Adult			
	Male		Female		Male		Female	
	Number	%	Number	%	Number	%	Number	%
Oct 19-Oct 20	0	0	0	0	2	17	11	83
Oct 23-Oct 25	3	100	0	0	10	60	8	40
Oct 30-Nov 1	2	100	0	0	17	54	12	46
Nov 6-Nov 8	4	67	2	33	17	46	23	54
Nov 13-Nov 15	5	83	1	17	39	51	37	49
Nov 20-Nov 22	12	100	0	0	125	47	142	53
Nov 27-Nov 29	12	92	1	8	113	40	171	60
Dec 4-Dec 7	10	91	1	9	116	43	149	57
Dec 11-Dec 14	1	50	1	50	48	35	85	65
Dec 18-Dec 20	2	67	1	33	34	35	64	65
Dec 25-Dec 27	0	0	1	100	13	42	17	58
Jan 1-Jan 4	0	0	0	0	6	27	15	73
Jan 8-Jan 11	0	0	1	100	12	41	16	59
Jan 15-Jan 16	2	67	1	33	3	26	13	74
Total (Percent of age class)	53 (84)		10 (16)		555 (42)		763 (58)	

### Egg Retention

Of the 769 fresh adult and grilse female carcasses that were observed for egg retention, 538 (70%) were completely spawned, 146 (19%) were unspawned, and 85 (11%) were partially spawned (Table 5). Female salmon carcasses retaining eggs were observed each week during the survey. High egg retention in females was greatest



during the first three weeks of the survey (69%), but fell well below 50% as the season progressed.

Table 5. Egg retention summary for female Chinook salmon carcasses, October 19, 2006 - January 15, 2007.

Date	# females checked for egg retention	0 to 30% eggs retained		>30 to 70% eggs retained		>70% eggs retained	
		Number	%	Number	%	Number	%
Oct 19-Oct 20	11	3	27	1	9	7	64
Oct 23-Oct 25	6	2	33	0	0	4	67
Oct 30-Nov 1	12	1	8	2	17	9	75
Nov 6-Nov 8	25	5	42	4	16	16	64
Nov 13-Nov 16	37	22	58	1	3	14	37
Nov 20-Nov 23	142	91	64	25	18	26	18
Nov 27-Nov 29	172	125	73	18	10	29	17
Dec 4-Dec 7	149	112	75	21	14	16	11
Dec 11-Dec 14	86	62	72	9	10	15	17
Dec 18-Dec 21	65	57	88	2	3	6	9
Dec 25-Dec 27	18	17	94	0	0	1	6
Jan 1-Jan 4	15	13	87	0	0	2	13
Jan 8-Jan 11	17	15	88	1	6	1	6
Jan 15-Jan 16	14	13	93	1	7	0	0
Total (Percent of Total)	769	538 (70)		85 (11)		146 (19)	

#### Coded-wire tagged fish

Of the 1,452 fresh carcasses that were observed during the survey, 3 (0.2%) were observed with missing adipose fins and classified as CWT fish. Weekly percentage of CWT fish ranged from 0 to 4.8% (Table 6). All three CWT carcasses were adult female carcasses and did not exhibit any temporal distribution trend. The low number of CWT carcasses is due to the fact that there were no CWT tagging operations on the American River in the years representing the 2006 Chinook salmon cohort. Hatchery origin was determined for two of the three CWT carcasses that were collected as part of the 2006 -2007 American River carcass survey. One CWT carcass did not contain a CWT in the snout. One of the remaining two carcasses was identified as

originating from the Coleman National fish Hatchery (brood year 2002) and the other from the Feather River Hatchery (brood year 2003).

Table 6. Number and percentage of fresh CWT Chinook salmon carcasses observed, October 19, 2006 - January 15, 2007.			
Date	Number of fresh carcasses observed	Number of CWT fish observed	Weekly percent
Oct 19-Oct 20	13	0	0
Oct 23-Oct 25	23	0	0
Oct 30-Nov 1	34	0	0
Nov 6-Nov 8	47	0	0
Nov 13-Nov 16	85	1	1.2
Nov 20-Nov 23	311	0	0
Nov 27-Nov 29	307	1	0.3
Dec 4-Dec 7	290	0	0
Dec 11-Dec 14	139	0	0
Dec 18-Dec 21	101	0	0
Dec 25-Dec 27	31	0	0
Jan 1-Jan 4	21	1	4.8
Jan 8-Jan 11	29	0	0
Jan 15-Jan 16	21	0	0
Total (Percent of total)	1,452	3 (0.2)	

### Population Estimate

A total of 1,186 fresh adult carcasses was tagged from October 19, 2006 (Week 1) through January 14, 2007 (Week 12) of which 537 tags were subsequently recovered (Table 7). Overall tag recovery rate was 45.3% and weekly recovery rates ranged from 7 to 58%. The modified Schaefer model produced an adult in-river escapement estimate of 21,755 (Table 8). Since adults made up 95.5% of the escapement, a total escapement (adult and grilse) of 22,780 was calculated by dividing the adult estimate by 0.955. Grilse comprised 4.5% (1,025) of the total population.

Table 7. Weekly Summary of Tagging and Recovery of Adult Chinook Salmon Carcasses, October 19, 2006 - January 19, 2007.

Week of Recovery (j)	R(ij) by Week of Tagging(i)												Carcasses Recovered	CARCASSES COUNTED
	1	2	3	4	5	6	7	8	9	10	11	12		
2	6												6	103
3	0	1											1	105
4	0	0	6										6	235
5	0	0	0	5									5	335
6	0	0	0	0	38								38	1410
7	0	0	0	0	2	112							114	1992
8	0	0	0	0	1	20	112						133	2282
9	0	0	0	0	0	0	23	57					80	1257
10	0	0	0	0	0	0	7	22	38				67	916
11	0	0	0	0	0	0	1	4	5	19			29	253
12	0	0	0	0	0	1	0	2	8	6	4		21	220
13	0	0	0	0	0	0	0	0	2	16	8	11	37	343
Recovery R(i)	6	1	6	5	41	133	143	85	53	41	12	11	537	9451
Tagged M(j)	12	15	24	35	71	255	280	223	129	92	30	20	1186	
M(i)/R(i)	2.00	15.00	4.00	7.00	1.73	1.92	1.96	2.62	2.43	2.24	2.50	1.82		
Recovery rate	50.0%	6.7%	25.0%	14.3%	57.7%	52.2%	51.1%	38.1%	41.1%	44.6%	40.0%	55.0%	45.3%	Overall recv.rate

Table 8. Lower American River Adult Chinook Salmon Population Estimate Using the Schaefer Model Based on Tagging Fresh Adult Carcasses with all Untagged Carcasses Removed, October 19, 2006 – January 19, 2007.

Week of Recovery	1	2	3	4	5	6	7	8	9	10	11	12	Schaefer weekly	
2	6												6	
3		1											1	
4			6										6	
5				5									5	
6				38	38								76	
7				114	114	114							342	
8				133	133	133	133						532	
9				80	80	80	80	80					400	
10				67	67	67	67	67	67				402	
11				29	29	29	29	29	29	29			203	
12				21	21	21	21	21	21	21	21		168	
13				0	0	0	0	0	0	0	0	0	0	
subtotals	6	1	6	487	482	444	330	197	117	50	21	0	2141	TOTAL ESTIMATE
tags		-15	-24	-35	-71	-255	-280	-223	-129	-92	-30	-20	-1174	TOTAL ADJUSTMENT
													21755	ADJUSTED ESTIMATE

In addition to the 22,780 salmon that returned to the lower American River downstream of Nimbus weir, there were 8,728 salmon (8,322 adult and 406 grilse) that entered Nimbus Hatchery. There were an additional 1,365 adult and 275 grilse carcasses removed from the upstream side of the Nimbus fish weir. By combining the in-river escapement (22,780) with the total number of Chinook salmon collected at the Nimbus Fish Hatchery (8,728) and at the Nimbus fish weir (1,640), the total 2006 fall-run Chinook salmon escapement for the lower American River was estimated to be 33,148.

## Conclusion

The American River fall-run Chinook salmon in-river escapement estimate of 22,900 is the eighth lowest in-river estimate since 1967 and is less than half the 39 year average (1967-2005) of 46,055 ( Table 9). The estimate is consistent with the low returns of fall-run Chinook salmon to all Central Valley rivers during 2006. Therefore, we cannot speculate that a decline in the 2006 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 2006 American River estimate (in-river estimate plus hatchery totals) makes up over 12% of the preliminary Central Valley 2006 escapement estimate of 270,200 fall-run Chinook salmon.

Table 9. In-river American River Chinook salmon escapement estimates, 1967-2005.

Year	Grilse	Adult	Total
1967 <sup>a</sup>	3,132	14,868	18,000
1968 <sup>a</sup>	2,777	23,423	26,200
1969 <sup>a</sup>	8,208	35,452	43,660
1970 <sup>a</sup>	2,753	25,927	28,680
1971 <sup>a</sup>	5,210	36,470	41,680
1972 <sup>a</sup>	3,352	14,107	17,459
1973 <sup>a</sup>	4,688	77,554	82,242
1974 <sup>b</sup>	1,769	51,827	53,596
1975 <sup>a</sup>	2,699	29,433	32,132
1976 <sup>b</sup>	1,181	21,978	23,159
1977 <sup>b</sup>	4,701	36,904	41,605
1978 <sup>b</sup>	595	12,334	12,929
1979 <sup>b</sup>	896	36,419	37,315
1980 <sup>b</sup>	8,805	25,454	34,259
1981 <sup>b</sup>	2,521	40,941	43,462
1982 <sup>a</sup>	4,323	28,677	33,000
1983 <sup>a</sup>	7,313	19,087	26,400
1984 <sup>c</sup>	2,196	25,251	27,447
1985 <sup>b</sup>	11,392	44,728	56,120
1986 <sup>b</sup>	4,443	44,929	49,372
1987 <sup>b</sup>	2,960	18,185	21,145
1988 <sup>d</sup>	1,905	13,974	15,879
1989 <sup>b</sup>	2,459	14,619	17,078
1990 <sup>b</sup>	1,167	5,541	6,708
1991 <sup>b</sup>	1,506	16,639	18,145
1992 <sup>b</sup>	1,297	3,175	4,472
1993 <sup>b</sup>	6,162	20,624	26,786
1994 <sup>b</sup>	2,927	28,405	31,332
1995 <sup>b</sup>	7,010	63,086	70,096
1996 <sup>b</sup>	6,592	59,323	65,915
1997 <sup>b</sup>	4,220	42,668	46,888
1998 <sup>b</sup>	10,760	32,282	43,042
1999 <sup>b</sup>	7,716	40,509	48,225
2000 <sup>b</sup>	5,922	92,783	98,705
2001 <sup>b</sup>	10,463	120,322	130,785
2002 <sup>b</sup>	11,811	106,303	118,114
2003 <sup>b</sup>	11,571	146,945	158,516
2004 <sup>b</sup>	13,756	74,991	88,747
2005 <sup>b</sup>	2,842	54,001	56,843
<b>Average</b>	<b>5,025</b>	<b>41,029</b>	<b>46,054</b>

<sup>a</sup> Expanded direct counts; <sup>b</sup> Schaefer method; <sup>c</sup> Petersen method; <sup>d</sup> Jolly-Seber method

### **Literature Cited**

Gerstung, E.R 1971. Fish and Wildlife Resources of The American River. Department of Fish and Game. Region 2 Anadromous Fisheries Branch.

Schaefer, M.B. 1951. Estimation of the size of animal populations by marking experiments. U.S. Fish and Wildlife Bulletin, 52: 189-203.

Taylor, S.N. (Editor). 1974. King (Chinook) salmon spawning stocks in California's Central Valley, 1973. California Department of Fish and Game, Anadromous Fisheries Administrative Report. No. 74-12. 32 pp.

DRAFT