Department of Fish and Game
Fisheries Branch
North Central Region

Lower American River Fall-Run Chinook Salmon Escapement Survey October 2009 – January 2010

By

Robert Vincik
Environmental Scientist
Department of Fish and Game
1701 Nimbus Road
Rancho Cordova, CA 95670

and

Michael Mamola
Fishery Biologist
Pacific States Marine Fisheries Commission
1701 Nimbus Road
Rancho Cordova, CA 95670

INTRODUCTION

The Lower American River (LAR) is a 23 mile stretch of the American River extending from the base of Nimbus Dam downstream to the confluence of the Sacramento River near Discovery Park. The LAR system supports both wild and hatchery runs of fall-run Chinook salmon (Oncorhynchus tshawytscha) and historically has contributed an average of 14% of all returning Chinook stocks to the entire Central Valley. The 2009-2010 LAR escapement survey was conducted on the 12.9 river miles separating the Nimbus weir from the Watt Avenue Bridge (Appendix A). This stretch between the Nimbus weir and the Watt Avenue Bridge was further stratified into three reaches (Table 1) which were surveyed once a week from 20 October, 2009 through 27 January, 2010 with a crew of four to seven fisheries technicians, taking 3 to 4 days to complete each survey.

Table 1. Lower American River Chinook Salmon Escapement Survey Reaches, October 2009 – January 2010

Reach	Location	Miles
1	Nimbus Fish Weir to Elmanto Access	3.4
2	Elmanto Access to River Bend Park Footbridge	3.5
3	River Bend Park Footbridge to Watt Avenue Access	6
Total		**12.9**

Chinook salmon escapement surveys have been conducted on the lower American River for nearly 60 years, beginning in 1944 (Gerstung 1971). The purpose of these surveys is to estimate the size of the returning adult Chinook salmon population. Four goals were set for the 2009-2010 lower American River escapement survey. The four goals consisted of (1) estimate the size of the returning Chinook salmon population spawning in the American River system; (2) determine the age and sexual composition of Chinook salmon returning to the American River; (3) determine female egg retention; and (4) determine the percentage of coded-wire tagged (CWT) fish utilizing spawning habitat in the lower American River.

MATERIALS and METHODS

All Chinook salmon carcasses encountered while conducting the LAR escapement survey were collected and evaluated for their status of decomposition and the presence of a coded-wire tag (CWT). Levels of decomposition were determined by the coloration of the fish's eyes and gills. Carcasses containing either one clear eye or pink coloration of the gills were determined to be "fresh" fish. Carcasses failing to contain one of the above mentioned requirements were determined to be "non-fresh." Along with the determination of decomposition, both fresh and non-fresh carcasses were inspected for the presence of a CWT. CWT fish were identified by the lack of an adipose fin, presumably removed when the coded wire-tag was inserted.

All fresh and adipose-clipped fish were identified to sex and measured to the nearest millimeter (mm) at the fork length. Carcasses with a fork length ≥ 680mm were

classified as adult fish, while fork lengths < 680mm were classified as grilse, or young adult fish. Female carcasses found to be fresh were evaluated for egg retention. Female fish were identified as either completely spawned (0 to 30% eggs retained), partially spawned (>30% to 70% eggs retained), or un-spawned (>70% eggs retained). Fresh carcasses possessing an adipose fin were processed and tagged with a color-coded hog ring attached to the maxilla. A specific color hog ring was used weekly to identify individual carcasses to a specific week of the survey. Following the attachment of a hog ring, carcasses were returned to flowing water to simulate natural downstream dispersal. Fresh carcasses were tagged from the Nimbus weir on Reach 1 downstream to the Gristmill fishing access on Reach 3 (Appendix A). Fresh carcasses observed downstream of the Gristmill fishing access were processed, chopped and recorded as "fresh-chopped" to prevent dispersal of tagged carcasses out of the study area. CWT fish were processed by recording information such as date, location found, sex and fork length. The heads were removed and the information recorded on a tag affixed to the jaw to allow for further processing at a later date. Heads were eventually sent to a lab for CWT extraction and reading.

All non-fresh and recovered (previously tagged) carcasses encountered were tallied and chopped in half as to avoid any duplicate counting of fish.

Daily water temperature, flow and water clarity were collected throughout the course of the 2009-2010 sampling period. Daily water temperature was collected from the U. S. Geological Survey gauging station located at the Hazel Avenue Bridge; while flow was obtained from the U. S. Geological Survey gauging station located at the Fair Oaks Bridge (Figure 1). Water clarity was obtained by the use of a secchi disk, depth measured to the nearest centimeter (cm). Data was recorded on all three reaches, each week of the survey.

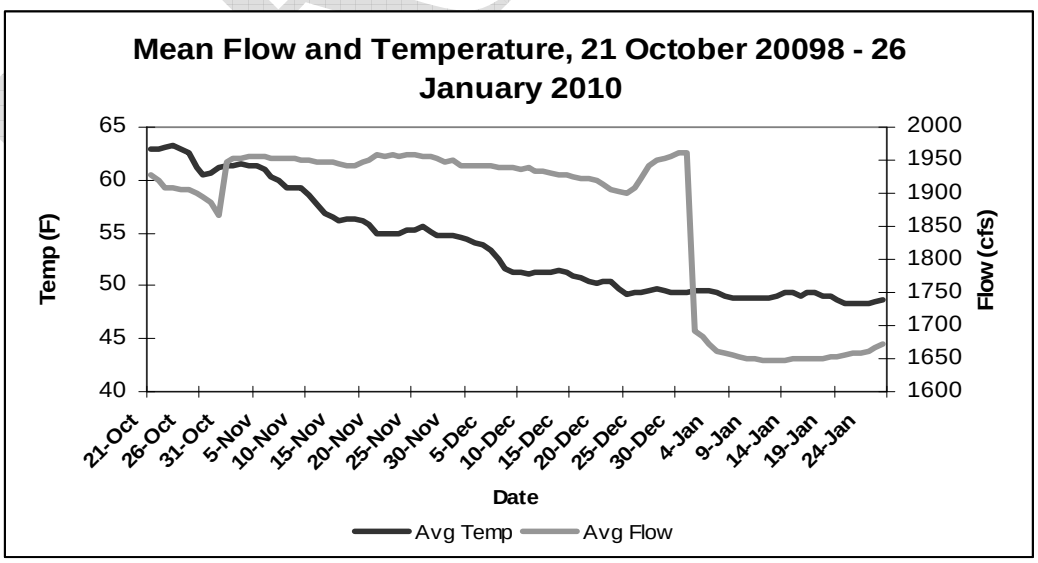

Figure 1. Mean Daily Flow (cfs) and Temperature (F), 20 October, 2009 – 27 January, 2010, California Data Exchange Center, Department of Water Resources.

A total of 723 Chinook salmon carcasses were observed during the 2009-2010 LAR escapement survey. Of the 723 carcasses observed, 223 were identified as fresh fish; while 500 were identified as non-fresh fish (Table 2). Fresh carcasses were first observed on 20 October, 2009 and were present in the survey through 19 January, 2010 with a peak of observed fresh carcasses collected during the week of 9 November. Non-fresh carcasses were first observed on 20 October, 2009 and were present through 27 January, 2010; with a peak of observed non-fresh carcasses collected during the week of 30 November (Figure 2).

Table 2. General Survey Information for the Lower American River Chinook Salmon Escapement Survey, 20 October 2009 – 27 January 2010

Week	Date	Carcasses Observed	
		Fresh	Non-Fresh
1	20-Oct-2009 - 22-Oct-2009	8	9
2	26-Oct-2009 - 28-Oct-2009	17	15
3	02-Nov-2009 - 04-Nov-2009	22	28
4	09-Nov-2009 - 11-Nov-2009	42	50
5	16-Nov-2009 - 18-Nov-2009	28	56
6	23-Nov-2009 - 25-Nov-2009	28	51
7	30-Nov-2009 - 02-Dec-2009	24	74
8	07-Dec-2009 - 09-Dec-2009	18	64
9	14-Dec-2009 - 16-Dec-2009	6	36
10	21-Dec-2009 - 23-Dec-2009	5	40
11	28-Dec-2009 - 30-Dec-2009	7	37
12	04-Jan-2010 - 06-Jan-2010	8	13
13	11-Jan-2010 - 13-Jan-2010	5	21
14	19-Jan-2010 - 21-Jan-2010	5	5
15	25-Jan-2010 - 27-Jan-2010	0	1
Total		**223**	**500**

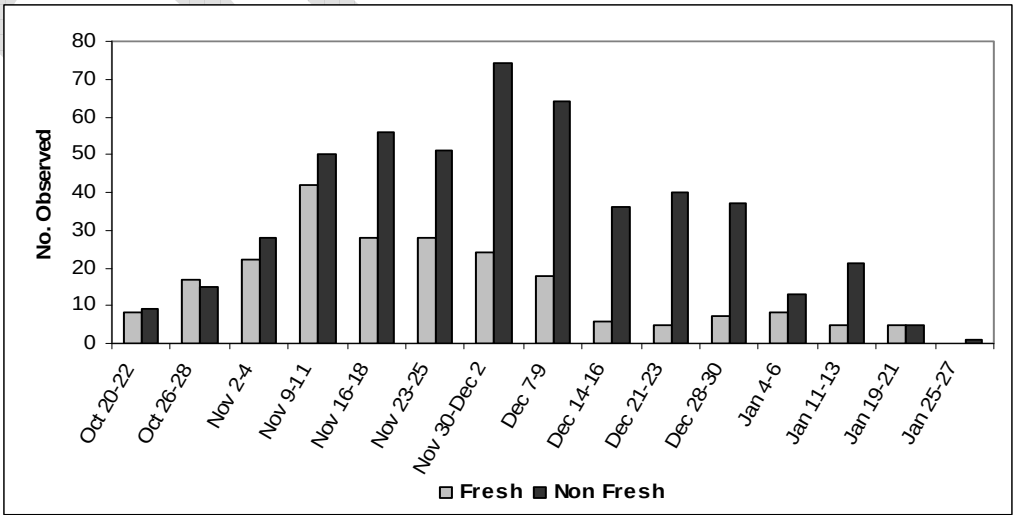

Figure 2. Weekly Distribution of Fresh and Non-Fresh Carcasses, 20 October – 27 January, 2010

SPATIAL DISTRIBUTION

During the 2009-2010 LAR escapement survey, the majority of fresh and non-fresh carcasses encountered, 80.64% (583), were observed on Reach 1. A total of 15.63% (113) of carcasses were observed in Reach 2; while 3.73% (27) of carcasses were observed on Reach 3 (Table 3).

Table 3. Spatial Distribution of Chinook Salmon Carcasses on the Lower American River, 20 October 2009 – 27 January 2010

Week	Date	Carcasses Observed		
		Reach 1	Reach 2	Reach 3
1	20-Oct-2009 - 22-Oct-2009	12	3	2
2	26-Oct-2009 - 28-Oct-2009	29	3	0
3	02-Nov-2009 - 04-Nov-2009	39	10	1
4	09-Nov-2009 - 11-Nov-2009	65	23	4
5	16-Nov-2009 - 18-Nov-2009	56	20	8
6	23-Nov-2009 - 25-Nov-2009	55	19	5
7	30-Nov-2009 - 02-Dec-2009	78	16	4
8	07-Dec-2009 - 09-Dec-2009	74	8	0
9	14-Dec-2009 - 16-Dec-2009	40	2	0
10	21-Dec-2009 - 23-Dec-2009	41	4	0
11	28-Dec-2009 - 30-Dec-2009	41	2	1
12	04-Jan-2010 - 06-Jan-2010	19	2	0
13	11-Jan-2010 - 13-Jan-2010	24	1	1
14	19-Jan-2010 - 21-Jan-2010	10	0	0
15	25-Jan-2010 - 27-Jan-2010	0	0	1
Total (%)		**583 (80.64)**	**113 (15.63)**	**27 (3.73)**

AGE COMPOSITION

Grilse Chinook salmon comprised 23% (48) of the total number of fresh fish observed during the 2009-2010 survey season comprising between 0-31% of the survey's weekly numbers. Adult fish comprised 77% (157) of the total number of fresh fish observed during the 2009-2010 survey season; comprising between 0-100% of the survey's weekly numbers (Table 4). Grilse were first observed during week 1 of the survey and were present through week 14. Numbers of observed Grilse were highest during week 4 of the survey. Adult fish were first observed during week 1 of the survey and were present

through week 15. Numbers of observed adult fish were highest during week 4 of the survey (Figure 3).

Table 4. Age Composition (Grilse and Adult) of Fresh Carcasses Observed, 20 October 2009 – 27 January 2010

Week	Date	Grilse		Adult	
		Number	%	Number	%
1	20-Oct-2009 - 22-Oct-2009	2	25	6	75
2	26-Oct-2009 - 28-Oct-2009	3	23	10	77
3	02-Nov-2009 - 04-Nov-2009	6	30	14	70
4	09-Nov-2009 - 11-Nov-2009	11	31	25	69
5	16-Nov-2009 - 18-Nov-2009	6	22	21	78
6	23-Nov-2009 - 25-Nov-2009	6	23	21	77
7	30-Nov-2009 - 02-Dec-2009	3	14	18	86
8	07-Dec-2009 - 09-Dec-2009	3	18	14	82
9	14-Dec-2009 - 16-Dec-2009	1	17	5	83
10	21-Dec-2009 - 23-Dec-2009	0	0	5	100
11	28-Dec-2009 - 30-Dec-2009	2	29	5	71
12	04-Jan-2010 - 06-Jan-2010	2	25	6	75
13	11-Jan-2010 - 13-Jan-2010	1	20	4	80
14	19-Jan-2010 - 21-Jan-2010	1	20	4	80
15	25-Jan-2010 - 27-Jan-2010	0	0	0	0
Total (%)		**47 (23)**		**158 (77)**	

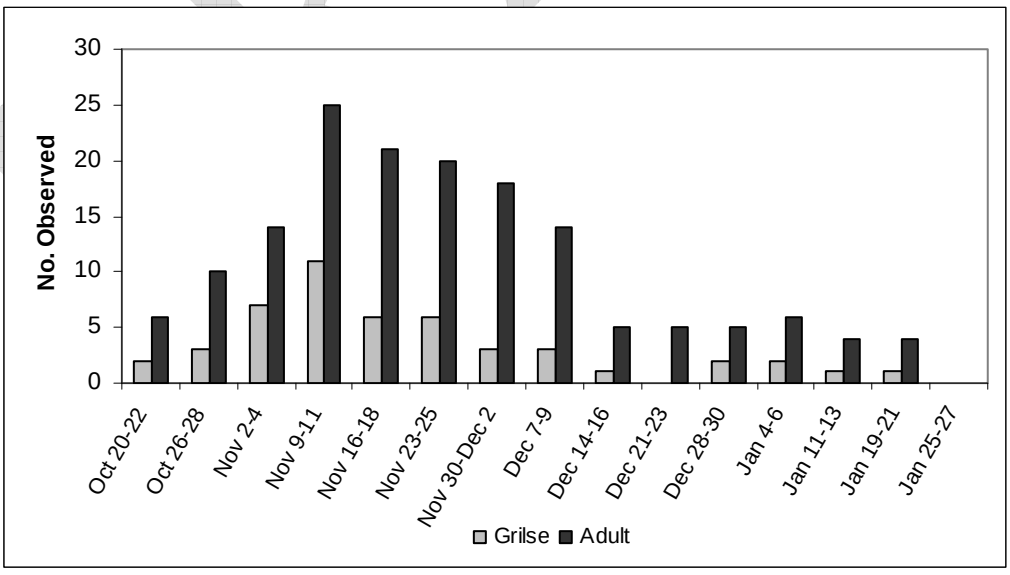

Figure 3. Weekly Distribution of Grilse and Adult Chinook Salmon, 20 October - 27 January

SEX COMPOSITION

Grilse female Chinook salmon observed in the 2009-2010 survey season represented 5% (11) of the total number of observed fish examined for sex composition. Grilse male Chinook salmon represented 19% (39) of the total number of observed fish examined for sex composition. Grilse carcasses surveyed were comprised of 22% female and 78% male, resulting in a ratio of 1 to 3.5 female to male. (Table 5)

Adult female Chinook salmon observed during the 2009-2010 survey season represented 36% (74) of the total number of observed fish examined for sex composition. Adult male Chinook salmon represented 40% (83) of the total number of observed fish examined for sex composition. Adult carcasses surveyed were comprised of 47% female and 53% male, resulting in a ratio of 1 to 1.1 female to male.

Table 5. Sex Composition of Fresh Grilse and Adult Chinook Salmon Carcasses, 20 October 2009 – 27 January 2010

		Grilse				Adult			
		Male		Female		Male		Female	
Week	Date	Number	%	Number	%	Number	%	Number	%
1	20-Oct-2009 - 22-Oct-2009	1	50	1	50	2	33	4	67
2	26-Oct-2009 - 28-Oct-2009	2	67	1	33	6	60	4	40
3	02-Nov-2009 - 04-Nov-2009	5	75	1	25	5	38	9	62
4	09-Nov-2009 - 11-Nov-2009	8	73	3	27	11	44	14	56
5	16-Nov-2009 - 18-Nov-2009	6	100	0	0	11	52	10	48
6	23-Nov-2009 - 25-Nov-2009	6	100	0	0	12	57	9	43
7	30-Nov-2009 - 02-Dec-2009	3	100	0	0	12	67	6	33
8	07-Dec-2009 - 09-Dec-2009	3	100	0	0	9	64	5	36
9	14-Dec-2009 - 16-Dec-2009	0	0	1	100	1	20	4	80
10	21-Dec-2009 - 23-Dec-2009	0	0	0	0	3	60	2	40
11	28-Dec-2009 - 30-Dec-2009	1	50	1	50	3	60	2	40
12	04-Jan-2010 - 06-Jan-2010	1	50	1	50	4	67	2	33
13	11-Jan-2010 - 13-Jan-2010	1	100	0	0	3	75	1	25
14	19-Jan-2010 - 21-Jan-2010	0	0	1	100	1	25	3	75
15	25-Jan-2010 - 27-Jan-2010	0	0	0	0	0	0	0	0
Total (%)		**37 (78)**		**10 (22)**		**83 (53)**		**75 (47)**	

EGG RETENTION

Between 20 October, 2009 and 19 January, 2010, 79 fresh adult and grilse female carcasses were inspected for egg retention. Of the 79 fish inspected, 4% (3) were un-spawned, 16% (13) were partially spawned and 80% (63) were completely spawned. (Table 6)

Carcasses displaying high egg retention were observed in weeks 3-5 of the 2009-2010 survey. High egg retention in carcasses was greatest during week 5 of the survey, where 1 out of 7 carcasses were observed displaying high egg retention. Egg retention dropped during weeks 8-15 of the survey, where 100% of carcasses checked for egg retention were considered spawned. (Table 6)

Table 6. Summary of Fresh Female Chinook Salmon Carcasses Checked for Egg Retention, 20 October 2009 – 27 January 2010

Week	Date	# of Females Checked for Egg Retention	0 to 30% Retained		>30 to 70% Retained		>70% Retained	
			Number	%	Number	%	Number	%
1	20-Oct-2009 - 22-Oct-2009	5	2	40	3	60	0	0
2	26-Oct-2009 - 28-Oct-2009	5	4	80	1	20	0	0
3	02-Nov-2009 - 04-Nov-2009	10	3	30	6	60	1	10
4	09-Nov-2009 - 11-Nov-2009	16*	13	81	2	13	1	6
5	16-Nov-2009 - 18-Nov-2009	8*	7	88	0	0	1	12
6	23-Nov-2009 - 25-Nov-2009	8*	8	100	0	0	0	0
7	30-Nov-2009 - 02-Dec-2009	6	5	83	1	17	0	0
8	07-Dec-2009 - 09-Dec-2009	5	5	100	0	0	0	0
9	14-Dec-2009 - 16-Dec-2009	4*	4	100	0	0	0	0
10	21-Dec-2009 - 23-Dec-2009	2	2	100	0	0	0	0
11	28-Dec-2009 - 30-Dec-2009	3	3	100	0	0	0	0
12	04-Jan-2010 - 06-Jan-2010	2*	2	100	0	0	0	0
13	11-Jan-2010 - 13-Jan-2010	1	1	100	0	0	0	0
14	19-Jan-2010 - 21-Jan-2010	4	4	100	0	0	0	0
15	25-Jan-2010 - 27-Jan-2010	0	0	0	0	0	0	0
Total (%)		**79**	**63 (80)**		**13 (16)**		**3 (4)**	

* one fish on week 4, two fish on week5, one fish on week 6, one fish on week 9 and one fish on week 12 were not checked for egg retention; and are not included in this table

CODED-WIRE TAGGED CARCASSES

In the course of the 2009–2010 sampling season, 109 carcasses were observed with missing adipose fins. Of the 109 carcasses missing adipose fins, 98 were found to contain CWTs (Table 7). Fresh and non-fresh carcasses containing CWTs were first observed in week 1 and were present through week 14. Carcasses observed missing adipose fins were highest in week 4 of the survey. Of the 109 carcasses observed missing adipose fins, 16.5% (18) were observed in week 4 of the survey. Of the 109 carcasses observed missing adipose fins, 85% (93) were observed on Reach 1. All carcasses observed missing adipose fins were identified to sex, measured to fork length and had heads removed. Males comprised 61% (66) of the 109 carcasses observed, while females made up 39% (43). Female CWT carcasses missing adipose fins were inspected for egg retention. Of the 43 females observed missing adipose fins 5% (2) were considered un-spawned, 16% (7) were partially spawned, and 65% (28) were completely spawned. An additional 14% (6) of the female CWT carcasses observed missing adipose fins were undetermined for retention. Analysis of the 98 CWTs retrieved revealed that 45% (44) of

CWT salmon originated at the Feather River Hatchery, 23% (22) originated at the Mokelumne River Hatchery, 21% (21) originated at Nimbus Fish Hatchery and 3% (3) originated at Coleman National Fish Hatchery (Appendix B). An additional 8 fish were determined to be late-fall run Chinook salmon from Coleman National Fish Hatchery comprising 8% of the CWT sample.

Table 7. Number and Percentage of Fresh CWT Chinook Salmon Carcasses Observed, 20 October 2009 – 27 January 2010

Week	Date	# of Carcasses Observed	# of CWT Fish Obtained	Weekly %
1	20-Oct-2009 - 22-Oct-2009	17	6	35
2	26-Oct-2009 - 28-Oct-2009	32	6	19
3	02-Nov-2009 - 04-Nov-2009	50	6	12
4	09-Nov-2009 - 11-Nov-2009	92	18	20
5	16-Nov-2009 - 18-Nov-2009	84	13	15
6	23-Nov-2009 - 25-Nov-2009	79	12	15
7	30-Nov-2009 - 02-Dec-2009	98	7	7
8	07-Dec-2009 - 09-Dec-2009	82	10	12
9	14-Dec-2009 - 16-Dec-2009	42	2	5
10	21-Dec-2009 - 23-Dec-2009	45	3	7
11	28-Dec-2009 - 30-Dec-2009	44	3	7
12	04-Jan-2010 - 06-Jan-2010	21	7	3
13	11-Jan-2010 - 13-Jan-2010	26	2	8
14	19-Jan-2010 - 21-Jan-2010	10	3	30
15	25-Jan-2010 - 27-Jan-2010	1	0	0
Total (%)		**723**	**98**	**(14)**

POPULATION ESTIMATE

A total of 92 fresh carcasses were tagged with a color specific hog ring between the week of 26 October, 2009 and 13 January, 2010 as part of a mark-release-recapture study. Of the 92 carcasses tagged, 15 were recovered; yielding a recovery rate of 16% (Table 8). A modified Schaefer model, using fresh tagged carcass data, tag recovery data, and non-fresh chopped carcass data, produced an in-river escapement estimate of 3,128 Chinook salmon (Table 9). In addition to the 3,128 in-river estimate, 2,083 Chinook salmon carcasses (1,611 adults and 472 grilse) were removed from the upstream side of the Nimbus Weir; while 7,657 Chinook salmon (6,725 adult and 932 grilse) were collected at the Nimbus Fish Hatchery. Combining the in-river estimate with carcasses collected upstream of the Nimbus Weir and Nimbus Fish Hatchery, resulted in a total fall-run Chinook salmon escapement of 12,868 for the lower American River.

Table 8. Mark-Release-Recapture Data, 20 October 2009 – 27 January 2010																	
Week	**Date**	**# of Fish Tagged**	**Recaptures of Tagged Fish in Survey Period**														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	20-Oct-2009 - 22-Oct-2009	2															
2	26-Oct-2009 - 28-Oct-2009	7															
3	02-Nov-2009 - 04-Nov-2009	15		1													
4	09-Nov-2009 - 11-Nov-2009	17			2												
5	16-Nov-2009 - 18-Nov-2009	14				1											
6	23-Nov-2009 - 25-Nov-2009	10					1										
7	30-Nov-2009 - 02-Dec-2009	12					1	2									
8	07-Dec-2009 - 09-Dec-2009	4					1		2								
9	14-Dec-2009 - 16-Dec-2009	4															
10	21-Dec-2009 - 23-Dec-2009	1									1						
11	28-Dec-2009 - 30-Dec-2009	4															
12	04-Jan-2010 - 06-Jan-2010	1											2				
13	11-Jan-2010 - 13-Jan-2010	3															
14	19-Jan-2010 - 21-Jan-2010	0													1		
15	25-Jan-2010 - 27-Jan-2010	0															

Table 9. Matrix of Population Estimates from the Modified Schaefer Method for In-River Chinook Salmon, 20 October 2009 – 27 January 2010																	**Total**
Week	**Date**	**Recaptures of Tagged Fish in Weekly Survey Period**															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	20-Oct-2009 - 22-Oct-2009																0
2	26-Oct-2009 - 28-Oct-2009	33															33
3	02-Nov-2009 - 04-Nov-2009		294														294
4	09-Nov-2009 - 11-Nov-2009			503													503
5	16-Nov-2009 - 18-Nov-2009				1122												1122
6	23-Nov-2009 - 25-Nov-2009					247											247
7	30-Nov-2009 - 02-Dec-2009					128	273										401
8	07-Dec-2009 - 09-Dec-2009					100		256									356
9	14-Dec-2009 - 16-Dec-2009								35								35
10	21-Dec-2009 - 23-Dec-2009									128							128
11	28-Dec-2009 - 30-Dec-2009										36						36
12	04-Jan-2010 - 06-Jan-2010											26					26
13	11-Jan-2010 - 13-Jan-2010												21				21
14	19-Jan-2010 - 21-Jan-2010													18			18
15	25-Jan-2010 - 27-Jan-2010														1		1
															Total		3220
															Number of Tagged Fish (Period 2 to 15)		-92
															Total Adult In-River Schaefer Estimate		3128

CONCLUSION

The 2009-2010 LAR fall-run Chinook salmon total escapement estimate of 12,868 is the fourth lowest estimate since 1967.

During the 2009-2010 LAR escapement survey, river flow, water clarity and other weather related conditions remained relatively constant, exhibiting conditions conducive to locating carcasses within the LAR system. As a result, environmental conditions are not believed to have substantially impacted 2009-2010 survey results.

The 2009-2010 fall-run Chinook salmon escapement survey yielded a distribution of fresh carcasses which reached a peak in week 4 of the survey (9 November, 2009 through 11 November, 2009); with non-fresh carcasses reaching a peak in week 7 of the survey (30 November, 2009 through 2 December, 2009). The peak of observed fresh and non-fresh carcasses for the 2009-2010 fall-run escapement survey occurred during week 7 of the survey (30 November, 2009 through 2 December, 2009); which roughly parallels the 2008-2009 fall-run escapement's peak during week 8 of the survey (8 December, 2008 – 10 December, 2008).

Egg retention in fresh, female carcasses was low (4%) compared to previous surveys (Healey and Redding, 2008; Vincik and Kirsch, 2009). At the onset of each year's survey, water temperatures ranged from 62.5 to 63.4 °F. By week 5 (~November 16) temperatures had dropped to 58 °F in 2007, 56.7 °F in 2008, and 54.6°F in 2009, the year of the lowest percent of egg retention. During each year's survey, egg retention dropped sharply after November 16th suggesting that temperature may be driving spawning timing in the American River. Based on scientific literature, the range of water temperatures for highest survival of incubation Chinook salmon eggs appears to be between 43 °F to 58 °F. Prolonged exposure of eggs to temperatures in excess of 58 °F results in high egg mortality (Williams, 2001).

During the 2008/09 carcass survey, a significant number of CWT Late-fall-run juvenile Chinook salmon (N=120) from the CNFH were collected in the American River. Most of these fish were released in 2006 into the Sacramento River at West Sacramento and Discovery Park; sites near the mouth of the American River. During the 2009/10 carcass survey only 8 CWT Late-fall-run Chinook were collected, all of which were released further downstream into Georgianna Slough in 2007. The occurrence of such a large number of CNFH salmon straying into the American River in 2009 was in all probability due to the close proximity of release in relation to the American River.

Fall-run Chinook salmon estimates for the LAR have been in steady decline since the record high fall-run escapement estimate of 158,516 Chinook salmon in 2003 (Appendix C). However the LAR does appear to be making an important contribution to the Central Valley Chinook stocks. Returning Chinook stocks to the LAR, 1967 to present, have contributed an average of 15% to the estimates of returning spawners in the Central Valley.

Literature Cited

[DFG] California Department of Fish and Game. 2009 Feb. 18. Fisheries Branch Anadromous Assessment – GrandTab. <http://www.dfg.ca.gov.>. Accessed 2010 Mar. 25.

[DWR] California Department of Water Resources. 2010 Apr. 22. California Data Exchange Center (CDEC). <http://cdec.water.ca.gov.>. Accessed 2010 Apr. 22.

Gerstung, E.R. 1971. Fish and wildlife resources of the American River. Department of Fish and Game, Technical Report.

Healey, M and J. Redding. 2008. Lower American River Chinook salmon escapement survey October 2007 – January 2008. Department of Fish and Game, Preliminary Technical Report.

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

Vincik, R and J. Kirsch. 2009. Lower American River Chinook salmon escapement survey October 2008 – January 2009. Department of Fish and Game, Preliminary Technical Report.

Williams, J.G. 2001 Chinook salmon in the Lower American River, California's largest urban stream. Contributions to the biology of Central Valley salmonids (volume 2). State of California, The Resources Agency Department of Fish and Game, Fish Bulletin 179 pps 1-38.

Appendix B. Coded-Wire Tag Analysis for the Lower American River Chinook Salmon Escapement Survey, 2009 - 2010						
Recovery Date	**Head Tag Number**	**CWT Code**	**Run**	**Brood Year**	**Hatchery of Origin**	**Release Location**
10/4/2009	73488	068009	Spring	2007	Feather R Hatchery	San Pablo Bay
10/20/2009	73478	067002	Fall	2006	Feather R Hatchery	San Pablo Bay
10/20/2009	73491	067000	Fall	2006	Feather R Hatchery	San Pablo Bay
10/20/2009	73476	067000	Fall	2006	Feather R Hatchery	San Pablo Bay
10/20/2009	73479	068609	Fall	2007	Feather R Hatchery	San Pablo Bay
10/21/2009	73492	067000	Fall	2006	Feather R Hatchery	San Pablo Bay
10/22/2009	73494	067000	Fall	2006	Feather R Hatchery	San Pablo Bay
10/26/2009	67503	067000	Fall	2006	Feather R Hatchery	San Pablo Bay
10/26/2009	67505	068608	Fall	2007	Feather R Hatchery	San Pablo Bay
10/26/2009	67502	0501040806	Fall	2006	Coleman Nfh	Clarksburg
10/26/2009	73446	068609	Fall	2007	Feather R Hatchery	San Pablo Bay
10/27/2009	73445	067000	Fall	2006	Feather R Hatchery	San Pablo Bay
11/2/2009	67542	067002	Fall	2006	Feather R Hatchery	San Pablo Bay
11/2/2009	67521	067003	Fall	2006	Feather R Hatchery	San Pablo Bay
11/2/2009	67506	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/2/2009	67504	067018	Fall	2006	Feather R Hatchery	San Pablo Bay
11/2/2009	67546	068604	Fall	2007	Feather R Hatchery	San Pablo Bay
11/3/2009	67508	068608	Fall	2007	Feather R Hatchery	San Pablo Bay
11/9/2009	67537	067007	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	67524	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/9/2009	67510	067007	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	67531	068610	Fall	2007	Feather R Hatchery	San Pablo Bay
11/9/2009	67525	067004	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	73448	067007	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	67519	067002	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	67520	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/9/2009	67516	068611	Fall	2007	Feather R Hatchery	San Pablo Bay
11/9/2009	67526	067004	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	67507	067005	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	73450	0501040805	Fall	2006	Coleman Nfh	Clarksburg
11/9/2009	67540	067006	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	73449	067005	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	67543	067003	Fall	2006	Feather R Hatchery	San Pablo Bay
11/9/2009	67539	068608	Fall	2007	Feather R Hatchery	San Pablo Bay
11/9/2009	67547	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/11/2009	73443	068611	Fall	2007	Feather R Hatchery	San Pablo Bay
11/16/2009	67518	068608	Fall	2007	Feather R Hatchery	San Pablo Bay
11/16/2009	73405	0501040802	Fall	2006	Coleman Nfh	Clarksburg
11/16/2009	73489	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/16/2009	67501	068611	Fall	2007	Feather R Hatchery	San Pablo Bay
11/16/2009	73437	067008	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
11/16/2009	67517	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/16/2009	73402	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/16/2009	73442	067004	Fall	2006	Feather R Hatchery	San Pablo Bay
11/17/2009	67532	068602	Fall	2007	Nimbus Fish Hatchery	San Pablo Bay
11/17/2009	73440	067008	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
11/17/2009	73435	067007	Fall	2006	Feather R Hatchery	San Pablo Bay
11/17/2009	67533	067008	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
11/23/2009	73490	067006	Fall	2006	Feather R Hatchery	San Pablo Bay
11/23/2009	73410	067014	Fall	2006	Mokelumne R Fish Ins	CA Ocean locations
11/23/2009	73401	067002	Fall	2006	Feather R Hatchery	San Pablo Bay
11/23/2009	73409	068608	Fall	2007	Feather R Hatchery	San Pablo Bay
11/23/2009	73406	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/23/2009	67549	067006	Fall	2006	Feather R Hatchery	San Pablo Bay
11/23/2009	73407	067004	Fall	2006	Feather R Hatchery	San Pablo Bay
11/23/2009	73441	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
11/23/2009	73408	067006	Fall	2006	Feather R Hatchery	San Pablo Bay
11/23/2009	73430	067014	Fall	2006	Mokelumne R Fish Ins	CA Ocean locations

11/23/2009	67541	068604	Fall	2007	Feather R Hatchery	San Pablo Bay
11/25/2009	67514	068612	Fall	2007	Feather R Hatchery	San Pablo Bay
11/30/2009	73416	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
11/30/2009	73431	067009	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
11/30/2009	67538	067022	Fall	2006	Mokelumne R Fish Ins	CA Ocean locations
12/1/2009	67523	067022	Fall	2006	Mokelumne R Fish Ins	CA Ocean locations
12/1/2009	67544	068609	Fall	2007	Feather R Hatchery	San Pablo Bay
12/1/2009	73425	068601	Fall	2007	Mokelumne R Fish Ins	San Pablo Bay
12/1/2009	73447	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/7/2009	91181	067009	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/7/2009	91180	068602	Fall	2007	Nimbus Fish Hatchery	San Pablo Bay
12/7/2009	73486	067008	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/7/2009	91188	067014	Fall	2006	Mokelumne R Fish Ins	CA Ocean locations
12/7/2009	91153	067008	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/7/2009	73418	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/7/2009	91179	067009	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/7/2009	73419	068604	Fall	2007	Feather R Hatchery	San Pablo Bay
12/7/2009	91198	067011	Fall	2006	Mokelumne R Fish Ins	Wickland oil termina
12/14/2009	73428	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/14/2009	91152	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/16/2009	73436	067008	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/21/2009	91175	067014	Fall	2006	Mokelumne R Fish Ins	CA Ocean locations
12/21/2009	91174	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/21/2009	91166	053687	Late Fall	2007	Coleman Nfh	Georgianna Slough
12/28/2009	91192	068601	Fall	2007	Mokelumne R Fish Ins	San Pablo Bay
12/28/2009	73413	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
12/28/2009	91193	067009	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
1/4/2010	91151	052798	Late Fall	2007	Coleman Nfh	Ryde-koket
1/4/2010	73427	052988	Late Fall	2006	Coleman Nfh	Ryde-koket
1/4/2010	91195	067022	Fall	2006	Mokelumne R Fish Ins	CA Ocean locations
1/4/2010	91162	068601	Fall	2007	Mokelumne R Fish Ins	San Pablo Bay
1/4/2010	91177	052995	Late Fall	2007	Coleman Nfh	Georgianna Slough
1/4/2010	91168	068601	Fall	2007	Mokelumne R Fish Ins	San Pablo Bay
1/5/2010	73412	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
1/9/2010	73484	053375	Late Fall	2006	Coleman Nfh	West Sacramento
1/11/2010	91100	052988	Late Fall	2006	Coleman Nfh	Ryde-koket
1/11/2010	91101	067010	Fall	2006	Nimbus Fish Hatchery	Wickland oil termina
1/19/2010	91157	053686	Late Fall	2007	Coleman Nfh	Georgianna Slough
1/19/2010	91106	068601	Fall	2007	Mokelumne R Fish Ins	San Pablo Bay
1/19/2010	91156	053376	Late Fall	2006	Coleman Nfh	West Sacramento

Appendix C. Total Chinook Salmon Estimates for the Lower American River, 1967 - 2008						
		Escapement Estimate			Total	American River Contribution
Year	Method of Estimate	Grilse	Adult	Total	(Central Valley)	(%)
1967	Expanded Direct Counts	3,132	14,868	18,000	180,428	9.97
1968	Expanded Direct Counts	2,777	23,423	26,200	210,314	12.45
1969	Expanded Direct Counts	8,208	35,452	43,660	320,390	13.62
1970	Expanded Direct Counts	2,753	25,927	28,680	235,493	12.17
1971	Expanded Direct Counts	5,210	36,470	41,680	238,619	17.46
1972	Expanded Direct Counts	3,352	14,107	17,459	153,063	11.4
1973	Expanded Direct Counts	4,688	77,554	82,242	271,320	30.31
1974	Schaefer	1,769	51,827	53,596	234,626	22.84
1975	Expanded Direct Counts	2,699	29,433	32,132	195,389	16.44
1976	Schaefer	1,181	21,978	23,159	195,208	11.86
1977	Schaefer	4,701	36,904	41,605	185,663	22.4
1978	Schaefer	595	12,334	12,929	156,962	8.23
1979	Schaefer	896	36,419	37,315	227,646	16.39
1980	Schaefer	8,805	25,454	34,259	172,137	19.9
1981	Schaefer	2,521	40,941	43,462	260,259	16.69
1982	Expanded Direct Counts	4,323	28,677	33,000	230,706	14.3
1983	Expanded Direct Counts	7,313	19,087	26,400	205,290	12.85
1984	Petersen	2,196	25,251	27,447	262,907	10.43
1985	Schaefer	11,392	44,728	56,120	356,304	15.75
1986	Schaefer	4,443	44,929	49,372	297,820	16.57
1987	Schaefer	2,960	18,185	21,145	301,583	7.01
1988	Jolly-Seber	1,905	13,974	15,879	268,436	5.91
1989	Schaefer	2,459	14,619	17,078	182,350	9.36
1990	Schaefer	1,167	5,541	6,708	87,903	7.63
1991	Schaefer	1,506	16,639	18,145	132,855	13.65
1992	Schaefer	1,297	3,175	4,472	109,313	4.09
1993	Schaefer	6,162	20,624	26,786	163,150	16.41
1994	Schaefer	2,927	28,405	31,332	218,589	14.33
1995	Schaefer	7,010	63,086	70,069	339,880	20.62
1996	Schaefer	6,592	59,323	65,915	356,551	18.48
1997	Schaefer	4,220	42,668	46,888	407,797	11.49
1998	Schaefer	10,760	32,289	43,042	250,361	17.19
1999	Schaefer	7,716	40,509	48,225	414,030	11.64
2000	Schaefer	5,922	92,783	98,705	483,428	20.41
2001	Schaefer	10,463	120,322	130,785	624,871	20.92
2002	Schaefer	11,811	106,303	118,114	871,542	13.55
2003	Schaefer	11,571	146,945	158,516	590,917	26.82
2004	Schaefer	13,756	74,991	88,747	384,700	23.06
2005	Schaefer	2,842	54,001	56,843	434,816	13.07
2006	Schaefer	1,025	21,755	22,780	290,722	7.83
2007	Schaefer	151	14,519	14,670	96,039	15.27
2008	Schaefer	607	5,118	5,725	74,370	7.69
Average		**4,709**	**39,084**	**43,793**	**277,970**	**15**