LOWER MOKELUMNE RIVER
Fall run Chinook Salmon Escapement Report
October through December 2005

September 2006

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Key words: lower Mokelumne River, fall-run Chinook salmon, escapement, carcass survey

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Abstract

A mark-recapture carcass survey was conducted from October through December 2005 to estimate fall-run Chinook salmon population on the lower Mokelumne River. The final estimate based on 5,945 tagged carcasses was 10,406 river spawners (+/- 290). The Mokelumne River Fish Hatchery's (MRFH) final count of hatchery spawners was 5,738. Total Mokelumne River escapement was estimated at 16,144 (+/- 290). The river spawning population was composed of 92% adults and 8% grilse. The grilse component was 79% male and 21% female. The adult component, as well as total escapement (adult and grilse), was 37% male and 63% female. Seventy-two percent of females were completely spawned out, while 21% were completely unspawned and 7% were partially spawned out. Most carcasses were observed in reach 6a and were decayed on initial contact.

Introduction

East Bay Municipal Utility District (EBMUD) has been monitoring adult fall-run Chinook salmon, *Oncorhynchus tshawytscha*, escapement in the lower Mokelumne River (LMR) using video monitoring and trapping at the Woodbridge Irrigation District (WID) Dam at Rkm 64 since fall 1990. In 1997 WID initiated a rebuild of the dam, fish ladders and fish screening facilities on the lower Mokelumne River. Construction time lines indicated that video monitoring may not be feasible during all construction phases so alternative methods of salmonid escapement estimation would be needed during the interim. Carcass surveys and video monitoring were conducted simultaneously in the fall of 2003 in order to determine the accuracy and precision of estimates generated by carcass survey versus video monitoring and trapping at WIDD (Workman 2004). During the 2004 fall Chinook salmon escapement, carcass surveys and video monitoring were again both completed successfully. Carcass estimates were deemed an appropriate surrogate for video monitoring based on these two years of comparative data (Workman 2004, 2005). In 2005 the lower Mokelumne River fall run chinook salmon escapement was estimated solely by conducting carcass surveys for in river escapement and adding

the salmon trapped at the Mokelumne River Fish Hatchery (MRFH) for a total Mokelumne River fall run Chinook salmon escapement.

Objectives

To develop an escapement estimate for fall run Chinook salmon for the lower Mokelumne River for 2005

To summarize sex and age composition, timing, spatial distribution, prespawn mortality rates, and CWT component of the river spawning portion of the 2005 fall run Chinook salmon population on the lower Mokelumne River.

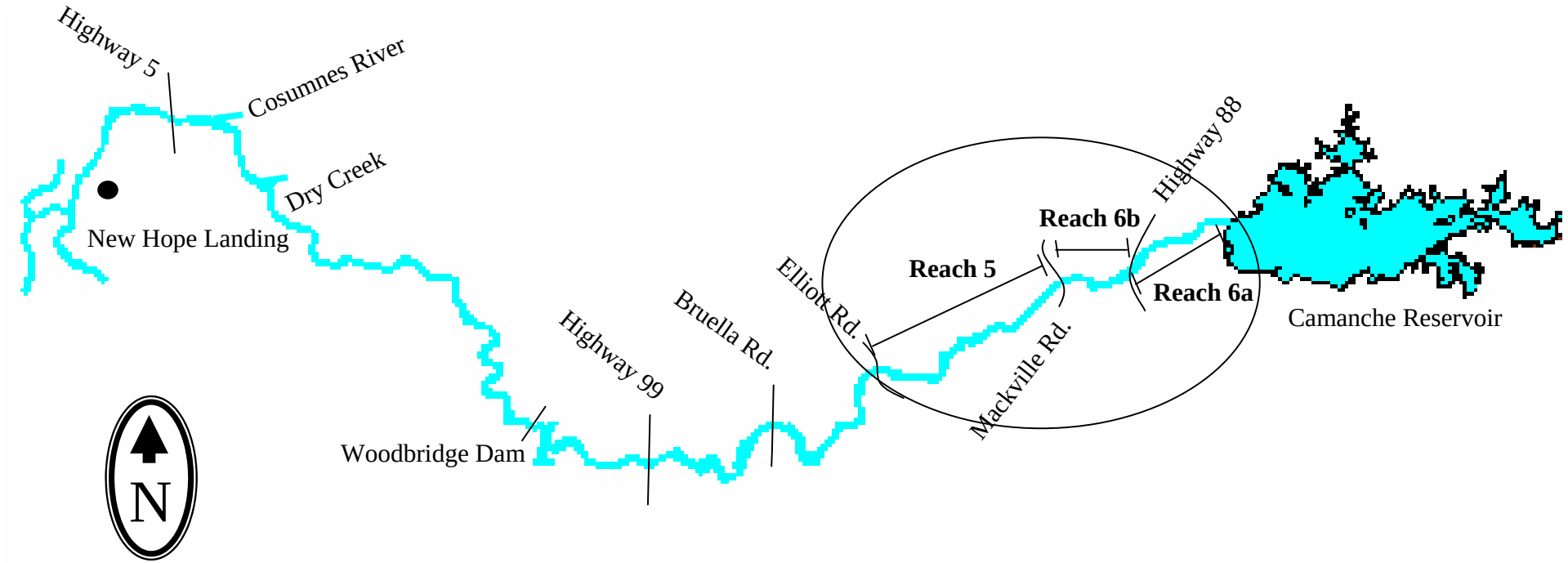
Methods

Survey Methods

Carcass surveys were conducted on a weekly basis from the first week in October through December. Each week two to three-person crew(s) in a drift boat or prop driven boat, surveyed from the base of Camanche Dam to Elliott Road. This distance encompasses three sections of river designated for this study as reach 6a, 6b, and reach 5 (Figure 1). In periods of low carcass abundance, one day, and one crew was sufficient to cover the entire survey area. During periods of higher carcass abundance the survey was conducted over two to five survey days and with two to three crews surveying different river sections. Split channels were surveyed with one person walking one channel and two surveyors in the boat drifting the other channel looking for carcasses. The river channel and banks were scanned for carcasses.

A fish guidance fence, installed on October 1st each year to block fish access to the powerhouse of Camanche Dam, marked the beginning of the survey area. The crew walked out on the fence to scan for carcasses above and below. Any carcasses encountered above the fence were marked and released below the fence. The remainder of the river was surveyed from boat or by foot. Surveys were conducted by drifting in the boat until a carcass was encountered. All observed carcasses were collected with a gaff, and then observed for condition (decayed, fresh, skeleton) sex (male, female, unknown), fork length (nearest 5 cm), and the presence of any clip, tag or mark. Females were checked for prespawn mortality (completely spawned out , partially spawned out, or unspawned)

Carcasses were given a condition classification of “fresh” (F), “decayed” (D), or “skeleton” (S). Fish with clear eyes and blood remaining in the gills were recorded as fresh, while fish with cloudy eyes and no blood in the gills were designated as decayed. Only fresh or decayed carcasses were tagged. Skeletons were fish that were in an advanced state of decay (i.e. covered entirely or nearly entirely with fungus, falling apart, lacking substantial flesh on the bones) (Marston et al 2002). Skeletons were enumerated, jaws were removed, and the entire skeleton was placed outside of the survey area, so as



Reach	Location	River Mile (distance in miles)
6a	Fish Guidance Fence at Camanche Dam to Hwy 88	64-61 (3 miles)
6b	Hwy 88 to Mackville Road	61-59 (2 miles)
5	Mackville Road to Elliott Road	59-53 (6 miles)

Figure 1. Reach designations for carcass surveys on the lower Mokelumne River, California. October – December 2005

not to be counted again in subsequent weeks. The jaws were removed in case scavengers brought the carcass back into the survey area. Any carcass without a lower jaw was not counted during surveys. Skeletons were not part of the calculated estimate since they were unavailable for recapture, they were simply counted as an addition of one fish to the estimate. Fresh and decayed carcasses were tagged with a uniquely numbered jaw tag applied to the lower jaw, and colored flagging to denote the week of survey, and then returned into the river current where they were initially captured. Each carcass encountered was assessed for the presence of a numbered jaw tag from previous surveys. If a previously tagged carcass was recaptured the jaw tag number was recorded and the carcass was released back to the water for subsequent recapture. Recaptured fish were not removed from the sample population as in other Central Valley carcass surveys (Seesholtz et al 2004, Marston et al 2002, Snider et al 1999). The Jolly-Dickson full model allows for multiple recaptures, so all fish were available for multiple recapture during the survey period (Appendix A). The 2005 carcass survey was truncated due to flood control releases on January 1st. In the two previous years, surveys were continued to the second week in January to encompass the entire run. For 2005, all fish tagged during the last week of surveying were simply counted since there was no opportunity to recapture them.

Length, Sex and Age Determination

Length of carcasses was estimated to the nearest 5 cm using a 110 cm measuring board with 1 cm increments. Sex was determined by secondary sexual characteristics visible on the carcass such as presence or absence of a developed kype, size of adipose fin, or as in severely decayed carcasses, internal anatomy was used. Carcasses were classified as adults (males $\geq$ 71 cm and females $\geq$63 cm), or grilse (males $\leq$ 70.5 cm and females $\leq$ 62.5 cm) based on length frequencies of known age coded wire tag returns to the Mokelumne River Fish Hatchery.

Coded Wire Tag Recoveries

All fish were checked for an adipose fin clip. If clipped, the fish was assessed with a Northwest Marine Technologies (NMT) handheld wand detector for the presence of a CWT. If no tag was detected the fish was left intact and tagged as usual. If a CWT was detected, the upper portion of the head was taken and data recorded on the head tag following the protocol supplied by the California Department of Fish and Game (CDFG) Ocean Salmon Project. By leaving the lower jaw the fish was still available for the mark-recapture portion of the survey and was tagged with a jaw tag for carcass sampling.

Prespawning Mortality

Egg retention rates were assessed for female carcasses. Fish were classified as exhibiting completely unspawned (all or nearly all eggs intact), partially spawned ($\geq$50% of eggs intact), or spawned out (few to no eggs retained).

Hatchery Carcasses

Forty carcasses per week for the first three weeks were taken from fish spawned at the hatchery and marked with unique number tags and added to the river to increase sample size and reduce the variability of recapture rates associated with low numbers of tagged fish. These fish are used in the calculation of the recapture probabilities and associated confidence intervals, but not added to the population.

Hatchery Returned Fish

The MRFH returned 2,452 unripe, live fish to the river this year, on an experimental basis, to encourage river spawning and reduce the need for disposing of fish and/or gametes which were above production goals for the hatchery. At each spawning event hatchery staff designated a portion of the fish that were not ready to be spawned and these fish were tagged with a disc or floy tag or pelvic fin clip and released alive back into the river. These fish were not included in the hatchery escapement total, but were included in the river escapement total.

Biological Sampling

The Mokelumne River was designated as a pilot scale collection site for the Ocean Salmon Project of California Department of Fish and Game. Scales were collected from a small percentage of fish encountered in the river and in the hatchery following a scale collection protocol provided by CDFG (Duran 2005). All scale samples collected were deposited with the Ocean Salmon Project of CDFG at the end of the survey season. No otolith or tissue samples were collected for the 2005 carcass survey period.

Environmental Variables

EBMUD collects and records flow and temperature information at permanent stations along the river. These data were used to analyze temporal patterns of spawning and subsequent recruitment to the carcass survey. Carcass locations were mapped in the river and entered into ArcGIS to facilitate analysis of spatial patterns of carcass collection.

Data Analysis

Temporal distribution of population attributes was represented graphically by number and percent for each survey week including sex and age composition, length frequency distribution, egg retention, and spatial distribution.

A generalized Jolly-Dickson full model (Schwarz et al 1993; Schwarz and Arnason 1996) mark recapture model was used to develop an escapement estimate utilizing the data collected in the field. This model allows for injections of hatchery fish, used to increase sample size, and enumeration of loss on captures (skeletons), and also facilitates an

estimate of precision (95% confidence interval) based on the variance of recapture probabilities from week to week. Unlike other commonly used mark-recapture estimators which are closed population models, namely the Peterson and Schaeffer methods, the Jolly-Dickson full model is an open population model and allows for losses and additions to the population between sample periods and is therefore a more robust tool to estimate population size than the Peterson and Schaeffer methods. A statistics program available for free download, POPAN 5(http://www.cs.umanitoba.ca/~popan/), was used to analyze the data.

Results

The 2005 river escapement estimate for the lower Mokelumne River was 10, 406 (+/- 290). This number is based on 5,945 tagged carcasses, of which there were 2,972 recaptures and an additional 558 skeletons (Appendix A). When added to the final count of fish entering and staying in the hatchery of 5,738, the final total escapement for fall run Chinook salmon on the lower Mokelumne River for 2005 was 16,144 (+/- 290).

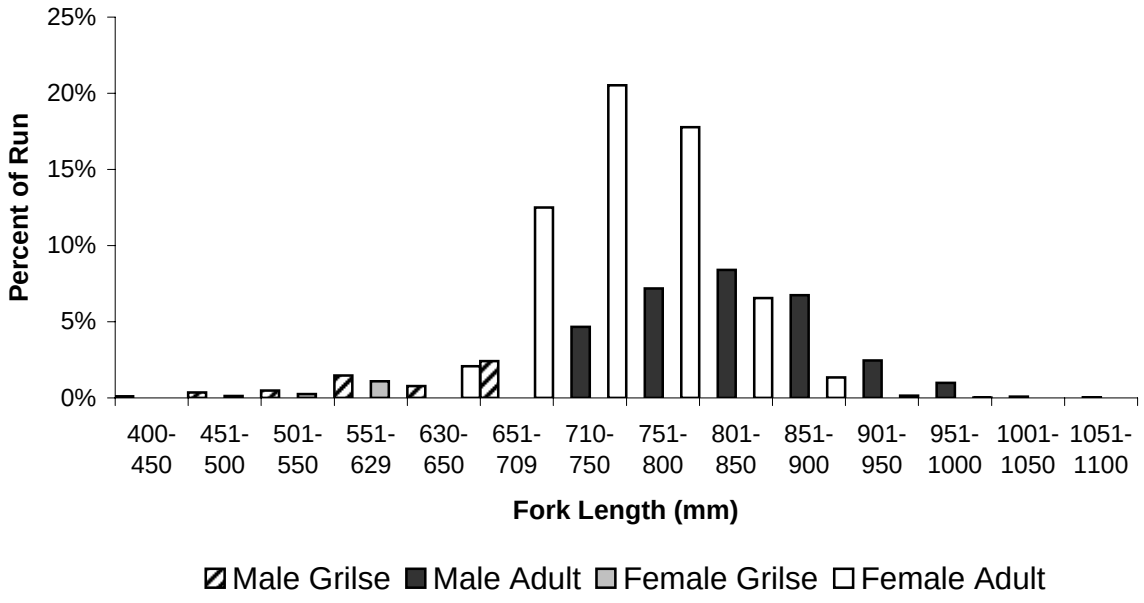
Sex and Age Composition

The 2005 run was composed of 92% adults and 8% grilse. The grilse sex composition was 79% males and 21% females. The sex composition of adults, as well as total escapement (adult and grilse, was 37% males and 63% females (Figure 2). The first two weeks of the run were composed of slightly more males than females, but all subsequent weeks were dominated by adult females (Table 1, Figure 3). Grilse made up a very small portion of the run in any given week (Figure 3). Coded-wire tag recoveries at the MRFH in 2005 showed age composition of females as 1.3% 2-year olds, 89.3% 3-year olds and 9.4% 4-year olds (n=159). Male proportions in the MRFH were 3.0% 2-year olds, 79.4% 3-year olds and 17.6% 4-year olds (n=102). CWT returns in the river for 2005 showed age composition of females as 22.2% 2-year olds, 77.8% 3-year olds, and no 4-year olds (n=18). Male proportions in the river based on CWT returns was 4.5% 2-year olds, 59.1% 3-year olds, and 36.4% 4-year olds (n=22).

Length Frequency

Measured adult females ranged in size from 63-100 cm ($\overline{X}$ =75.6), female grilse ranged in size from 49-62 cm ($\overline{X}$ =58.4). Males in the adult size range were 71-110 cm ($\overline{X}$ =84.0) and male grilse were 45-70 ($\overline{X}$ =63.2) (Table1). Over 20% of the entire population was made up of adult females in the 71-75 cm size range (Figure 4). Peaks of size distribution of males and females show the most abundant size class of males is about 10 cm larger than the most abundant size class of females (Figure 4).

Also, when compared by survey week, the largest average size for males and females was observed during week 7 (Table 1).



	Female		Male	
	Adult	**Grilse**	**Adult**	**Grilse**
Number	3536	87	1763	377
Mean FL	74.8	58.4	83.9	62.5
Range FL	63-100	49-62	71-110	45-70

Figure 2 . Sex and age composition of fall run chinook salmon on the lower Mokelumne River October - December 2005

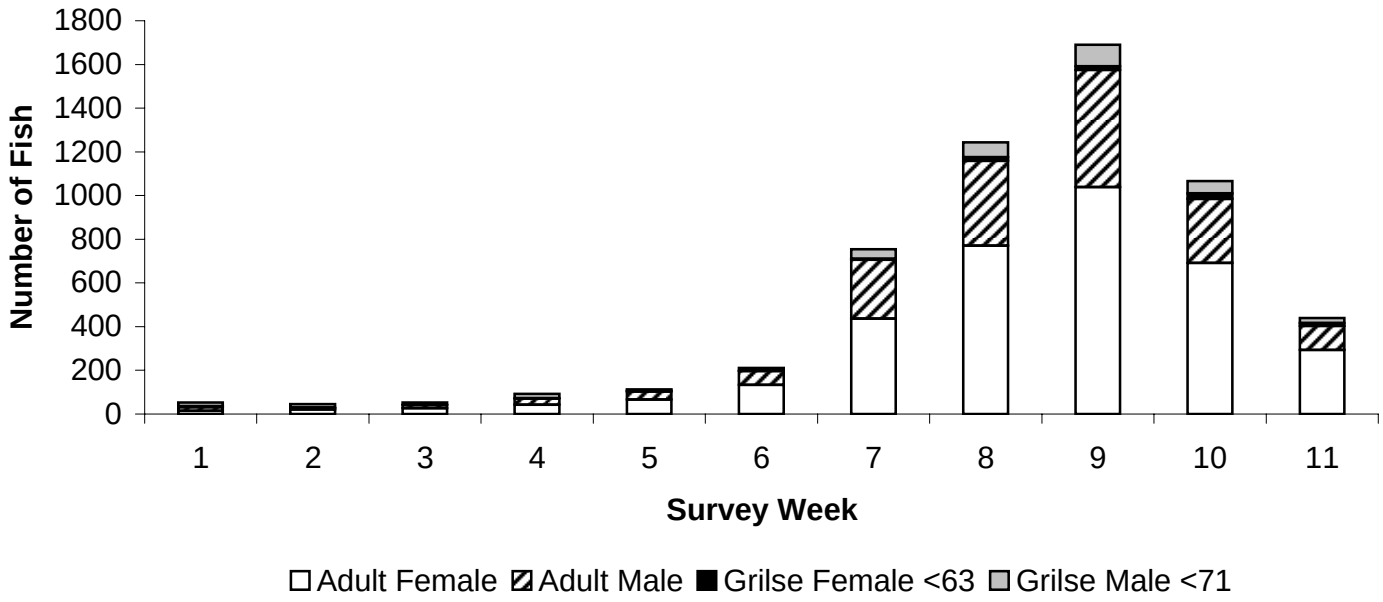


Figure 3. Sex and Age composition of the 2005 fall run Chinook Salmon population on the lower Mokelumne River, October - December 2005.

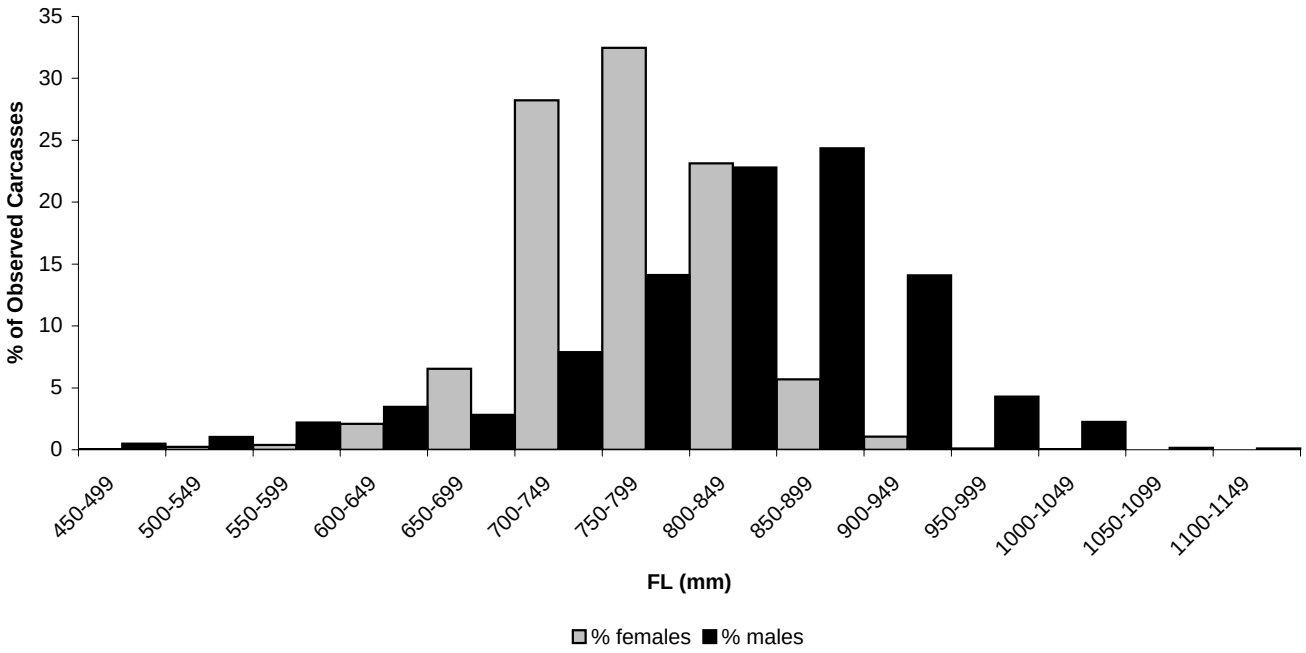


Figure 4. Length frequency distribution of male and female carcasses encountered on the lower Mokelumne River, October - December 2005.

Table 1. Length distribution of measured,tagged carcasses, listed by sex, observed on the lower Mokelumne River. October - December 2005.

	Females			Males			All		
Week	Number	mean	range	Number	mean	range	Number	mean	range
1	19	68.9	55-85	33	68.1	50-90	52	68.4	50-90
2	22	77.1	62-91	24	65.9	53.5-90	46	71.3	53.5-91
3	28	77.6	57-86	24	74	45-97	52	76	45-97
4	44	75.3	61-85	49	73.7	49-100	93	74.4	49-100
5	70	75.1	51-85	43	82	52-100	113	77.7	51-100
6	134	76.4	60-91	77	80.1	50-100	211	77.8	50-100
7	442	76.9	55-100	312	82.8	45-110	754	79.3	45-110
8	786	76.1	49-95	458	80.7	45-100	1244	77.7	45-100
9	1055	75	50-95	637	80.6	45-110	1692	77.1	45-110
10	717	74	50-93	349	79.7	55-100	1066	75.9	50-100
11	306	73.2	55-85	134	78.5	50-95	440	74.8	50-95
Total (mean)	3623		49-100	2140		45-110	5763		45-110

Coded Wire Tag Recoveries

We observed 49 fish that appeared to have adipose fin clips. Forty-two of these fish had a positive detection for a CWT. Heads were collected for these 42 carcasses and were taken and sent to the Santa Rosa head lab of CDFG for tag reading and determination of age and origin of fish. CWT recoveries included one American River fall run Chinook released at the Wickland Net Pens in San Pablo Bay, and one Coleman National Fish Hatchery late fall run. The rest of the CWT recoveries were Mokelumne origin hatchery fall run Chinook (CDFG Santa Rosa office DRAFT findings).

Hatchery fish returned to the river

The MRFH tagged and released 2,452 fall-run Chinook back to the river between October 13, 2005 and January 17, 2006. The carcass crews recovered 391 of these fish between November 9 and December 29, 2005. Carcass tags were applied to 376 of these for the carcass survey and 15 were counted as skeletons. Nine of the tagged fish were subsequently recaptured. Sex was recorded for 372 of the tagged fish. Sex composition of these was 329 (88%) females, 43 (12%) males. Sex composition of the released fish was 77% female and 23% male.

Prespawning Mortality

Of 3,643 total female carcasses sampled 21% were prespawn mortalities, 7% retained ≥50% of their eggs (partially spawned), and 72% spawned successfully. Prespawn mortality rates were higher in hatchery released female carcasses than in non disc-tagged female carcasses. Overall, for non disc-tagged fish, 19% were prespawn mortalities and 7% partially spawned while hatchery returns showed 40% prespawn mortalities and 8% partially spawned (Table 2a and 2b). The highest proportion of prespawn mortality in non disc-tagged fish occurred during week 5 of the survey. Disc tagged fish showed the highest retention rates as late as week 9. Retention rates were consistently higher in disc tagged fish (>30%) than in non disc tagged fish ≤20%), with the exception of week 5 (Figure 5).

Spatial Distribution of Carcasses

Carcass abundance in reach 6a was much greater than in reaches 6b and 5. Eighty-three percent of all carcasses observed (tagged and skeletons) were observed in reach 6a. Each reach had an equivalent proportion of observed carcasses that were skeletons (approx 8-12%) (Table 3). Female carcasses were more abundant than male carcasses in both reaches 6a and 6b, but in reach 5 more male carcasses were observed than females (Table 4). Reaches 6a and 6b contain most of the spawning habitat and males may move farther from spawning habitat before dying than females which stay to guard their nests.

For all reaches, the majority of tagged fish were decayed, with very few fresh carcasses observed overall. 800 fish were tagged fresh, and the balance, 5,145 were tagged as decayed carcasses (Table 5). Weekly distribution of fresh, decayed and skeletons show that in the first four weeks composition is dominated by fresh carcasses. By week 5 and through the rest of the survey is dominated by decayed carcasses. Abundance of skeletons is also greater in the last five weeks of the survey than in weeks one through four (Table 5, Figure 6).

Environmental Variables

Water temperature range for the survey period was 13.4^{o} C to 16.4^{o} C with an average of 15.4^{o} C. Temperatures during the first six weeks of the survey were approximately 16^{o} C and began to drop around week seven of the survey. By the end of the spawning season temperatures were in the mid 13^{o} C range (Table 5).

Releases from Camanche Dam were constant throughout the survey period at approximately 330 cfs until week ten of the survey (Table 5). Due to large amounts of rainfall in the area, flood flow releases were slowly raised in late December and flood flow releases in January precluded further monitoring. Since this occurred with little warning, during week eleven of the survey we tagged fish for recapture in subsequent weeks. Since there was no opportunity to recapture these fish at a later date, they were treated as skeletons and added to the spawner estimate.

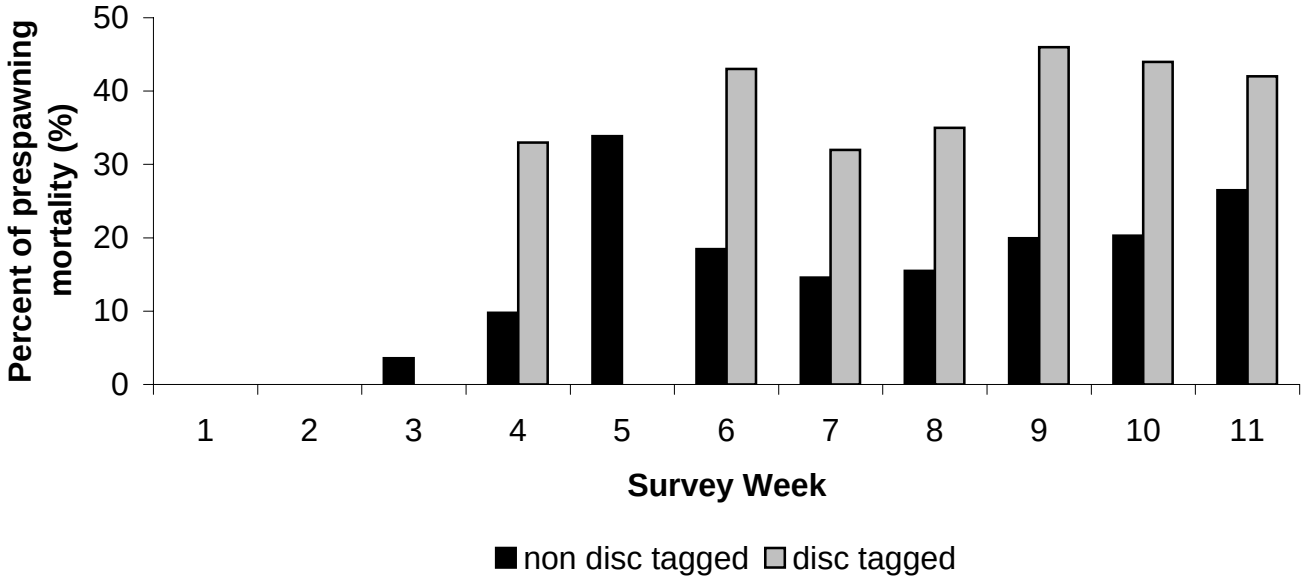


Figure 5. Percent of female carcasses exhibiting complete egg retention, by survey week, on the lower Mokelumne River, October - December 2005.

Table 2a. **Egg retention summary for female chinook salmon carcasses captured with no disc tag present on the lower Mokelumne River. October - December 2005**

Week	Number Checked	No eggs retained (%)	50% of eggs retained (%)	All eggs retained (%)
1	19	19 (100)	0(0)	0(0)
2	22	22(100)	0(0)	0(0)
3	28	27(96)	0(0)	1(4)
4	41	37(90)	0(0)	4(10)
5	62	36(58)	5(8)	21(34)
6	103	74(72)	10(10)	19(18)
7	391	301(77)	33(8)	57(15)
8	729	542(74)	74(10)	113(16)
9	989	711(72)	81(8)	197(20)
10	665	506(76)	24(4)	135(20)
11	272	193(71)	7(3)	72(26)
Total (mean%)	3321	2468(74)	234(7)	619(19)

Table 2b. **Egg retention summary for female chinook salmon carcasses captured with disc tag present on the lower Mokelumne River. October -December 2005**

Week	Number Checked	No eggs retained (%)	50% of eggs retained (%)	All eggs retained (%)
1	0	n/a	n/a	n/a
2	0	n/a	n/a	n/a
3	0	n/a	n/a	n/a
4	3	1(33)	1(33)	1(33)
5	6	5(83)	1(17)	0(0)
6	28	15(54)	1(4)	12(43)
7	65	38(58)	6(9)	21(32)
8	52	29(56)	5(10)	18(35)
9	90	40(44)	9(10)	41(46)
10	43	21(48)	3(7)	19(44)
11	33	18(54)	1(3)	14(42)
Total (mean%)	320	167(52)	27(8)	126(40)

Table 3. Spatial distribution of all carcasses observed on the lower Mokelumne River. October - December 2005.

	Reach 6a (Fish Guidance Fence to Hwy 88)		Reach 6b (Hwy 88-Mackville Rd.)		Reach 5 (Mackville Rd. to Elliott Rd.)	
Week	Tagged	Skeletons	Tagged	Skeletons	Tagged	Skeletons
1	18		7		27	
2	11	3	8		27	
3	25		5		22	
4	60	11	5		28	
5	102	24	8	2	3	
6	173	20	16	6	23	3
7	612	64	133	14	39	3
8	1062	87	161	20	52	8
9	1558	117	165	14	50	16
10	961	54	107	16	23	6
11	405	58	34	12	15	
Totals	4987	438	649	84	309	36

Table 4. Spatial distribution of tagged carcasses, listed by sex, observed on the lower Mokelumne River. October - December 2005.

	Reach 6a (Fish Guidance Fence To Hwy 88)			Reach 6b (Hwy 88-Mackville Rd.)			Reach 5 (Mackville Rd. to Elliott Rd.)		
Week	Female	Male	Unknown	Female	Male	Unknown	Female	Male	Unknown
1	10	8		1	6		8	19	
2	7	4		3	5		12	15	
3	14	11		2	3		12	10	
4	29	31		3	2		12	16	
5	66	36		3	5		1	2	
6	113	60		10	6		11	12	
7	380	230	2	72	61		13	26	
8	709	351	2	80	81		21	31	
9	1025	532	1	85	79	1	19	31	
10	674	285	2	54	52	1	9	14	
11	284	119	2	22	12		12	3	
Totals	3311	1667	9	335	312	2	130	179	0

Table 5. Weekly Carcass Abundance and related flow and temperature on the lower Mokelumne River. October-December 2005.

						Camanche Release Data	
Week	Dates	Fresh	Decayed	Skeletons	Total	Average Flow (cfs)	Average Temperature (^{o}C)
1*	Oct.10-Oct. 21	47	5	0	52	332	15.9
2	Oct. 24-Oct. 28	42	4	3	49	331	16.0
3	Oct. 31-Nov . 4	44	8	0	52	330	16.1
4	Nov. 7-Nov. 11	57	36	11	104	329	16.2
5	Nov. 14-Nov. 18	27	86	26	139	330	16.3
6	Nov. 21-Nov. 25	47	165	29	241	331	16.3
7	Nov. 28-Dec. 2	106	678	81	865	332	15.5
8	Dec. 5-Dec. 9	150	1125	115	1390	330	14.6
9	Dec. 12-Dec 16	169	1604	147	1920	331	13.9
10	Dec. 19-Dec. 23	95	996	76	1167	457	13.6
11	Dec. 26-Dec. 30	16	438	70	524	652	13.5
	Totals	800	5945	558	6503		

* Two weeks combined due to small numbers of captures.

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Appendix A. Tag and recapture matrix for Jolly-Seber methodology using POPAN-5 statistical software for the 2005 fall run chinook salmon estimate on the lower Mokelumne

	Tagged	Skeletons	Recaptures	2	3	4	5	6	7	8	9	10	11	Totals*
Week 1	52	0	7	X										
			1	X	X		X							
			2		X									
			3							X				
			1								X			
			1										X	
														17(15)
Week 2	46	3	3		X									
			1		X		X							
			1			X								
			1							X				
			1								X			
														8(7)
Week 3	52	0	2			X								
			3			X	X							
			1				X							
			1					X						
			3			X				X				
			4							X				
			1			X					X			
			1										X	
														23(16)
Week 4	93	11	16				X							
			4				X	X						
			1				X	X		X				
			2				X			X				
			1				X					X		
			8					X						
			1					X		X				
			1						X					
			5							X				
			1								X			
														50(40)
Week 5	113	26	19					X						
			8						X					
			15							X				
			1								X			
			1									X		
			1					X	X	X	X			
			1					X	X	X				
			1					X	X		X			
			12					X	X					
			7					X		X				
			1						X	X				
			1						X			X		
														96(68)
Week 6	212	29	45						X					
			24						X	X				
			6						X	X	X			
			6						X		X			
			12							X				
			1							X	X			
			4								X			
			1									X		
														142(99)

Appendix A. (cont.) Tag and recapture matrix for Jolly-Seber methodology using POPAN-5 statistical software for the 2005 fall run chinook salmon estimate on the lower Mokelumne

	Tagged	Skeletons	Recaptures*	2	3	4	5	6	7	8	9	10	11	Totals*
Week 7	784	81	236							X				
			111							X	X			
			16							X	X	X		
			2							X	X		X	
			10							X		X		
			3							X			X	
			50								X			
			4								X	X		
			10									X		
			5										X	
											X			**611(447)**
Week 8	1275	115	403								X	X		
			151								X	X	X	
			15								X		X	
			24									X		
			67									X	X	
			7										X	
			13											
												X		**892(680)**
Week 9	1773	147	581									X	X	
			225										X	
			102											
														1133(908)
Week 10	1091	76	357										X	**(357)**
Week 11**	454	70												**0**
Total	5945	558	2637											**2972(2637)**

* First number represents total number recaptured, ( ) represent unique codes recaptured. Eg, for totals: 2972 total recaptures and 2637 unique tag codes represented.

** No fish tagged in week 11 were recaptured due to high flows which ended the survey.

```
This result file generated on 06 Jan 25 at 11:26:40
 from C:\POPAN5\FINCARC.POP

 **********************
 *                    *
 *  CREATE            *     2005 FINAL CARCASS ESTIMATE
 *  PARAGRAPH #   1   *
 *                    *
 **********************


     *** C R E A T E    S U M M A R Y ***
     NUMBER OF HISTORIES READ       =            100 EQUALING           6507 ANIMALS
     NUMBER OF HISTORIES WRITTEN    =            100 EQUALING           6507 ANIMALS
     NUMBER OF HIST. FAILING TCHECK =              0 EQUALING              0 ANIMALS
     NUMBER OF HIST. FAILING ACHECK =              0 EQUALING              0 ANIMALS
     NUMBER OF HISTORIES REORDERED  =              0
     MIN(X(1)) ON HISTORIES WRITTEN =              1
     MAX(X(T)) ON HISTORIES WRITTEN =             11
 POP317W -# HISTORIES READ NOT = NUMBER SPECIFIED IN CREATE -- HEADER ADJUSTED.
 POP319W -DS UNORDERED ON IDENTIFIER -- MODIFY AND ADD CANNOT BE USED.
     *** E N D   O F   C R E A T E ***
     NEW DATASET STORED IN FILE C:\POPAN5\FINCARC.BIN

     TITLE OF NEW DATASET:            FINAL CARCASS
     MIN (X(1)) =          1            BEGIN =          1
     MAX (X(T)) =         11              END =         11
     NUMBER OF HISTORIES ON NEW FILE =                 100
     HISTORIES WERE STORED USING FORMAT (A8,A2,2A1,(200A2,200A2,112A2))

     HISTORIES WERE READ USING FREE FORMAT
```

```
**********************
*                    *
*  SELECT            *     FINAL CARCASS
*  PARAGRAPH #   1   *     SELECT ALL
*                    *
**********************
```

SELECTED DATASET FILE = C:\POPAN5\FINCARC.BIN

FILE IS STORED UNDER FORMAT (A8,A2,2A1,(200A2,200A2,112A2))
ORIGINAL FILE CREATED USING FREE FORMAT

IDENTIFIER TYPE	# ATTRIBUTES	BEGIN	END	LSEL	# HISTORIES	ACHECKS DONE	TCHECKS DONE	FILE ORDERED
GROUPED	0	1	11	11	100	NO	ORDER & RANGE	NO

MAP OF NEW NUMBERING FOR SAMPLE TIMES

	OLD NUMBER				NEW NUMBER			
I	OX(I)	SDES(I)	ABS. TIMES	WEIGHTS	NX(I)	NEW SDES(I)	ABS. TIMES	WEIGHTS
1	1		10/17/05	1	1		1.0000	1
2	2		10/25/05	1	2		2.0000	1
3	3		11/01/05	1	3		3.0000	1
4	4		11/10/05	1	4		4.0000	1
5	5		11/16/05	1	5		5.0000	1
6	6		11/22/05	1	6		6.0000	1
7	7		12/02/05	1	7		7.0000	1
8	8		12/09/05	1	8		8.0000	1
9	9		12/16/05	1	9		9.0000	1
10	10		12/22/05	1	10		10.0000	1
11	11		12/29/05	1	11		11.0000	1

OLD LSEL (ORIGINAL DATA) = 11

NEW LSEL (REDUCED DATA) = 11

ATTRIBUTE SELECTION CONDITION WAS:
AT =ALL

```
**********************
*                    *
*  UFIT              *     FINAL CARCASS
*  PARAGRAPH #   1   *     SELECT ALL
*                    *     ESCAPEMENT ESTIMATE: TOTAL POPULATION
**********************

 REPORT ON USER-SPECIFIED CONSTRAINTS
 ====================================

 NOTATION:
 =========
       Pt  =  parameter value at sample time t
       Lt  =  logit of parameter value at sample time t
      P^t  =  parameter value at sample time t ADJUSTed for time
                 between sample time t and t+1
      L^t  =  logit of parameter value at sample time t
                 ADJUSTed for time between sample time t and t+1
 where:
        t  =  1,..k ( = NLSEL = number of sample times)
        g  =  1,..n ( = NGROUPS = number of cohort groups)
 and    *     indicates Gross births (P*) or logit Gross births (L*)
 note
     Any group prefix on the above notation (e.g. GgPt) implies
     Group g=1 (e.g. G1Pt) as no cohort groups were specified

 Capture Probability Constraints (CPCONST)
 =========================================

   No constraints specified but AUTOmatic = YES
   POPAN adds the following AUTOmatic constraints:
        GgP1  =  1.0       for g=1,...n
        GgPk  =  1.0       for g=1,...n
   Number of constraints added to model =   2

 Survival Probability Constraints (SPCONST)
 ==========================================

   No constraints specified...none added
   Number of constraints added to model =   0
```

```
 Birth Probability Constraints (BPCONST)
 =======================================
   For ALL models, POPAN adds the following automatic constraints:

        Sum (GgPi)  =  1.0    (sum over i=0,...k-1) for each g=1,...n

   No additional user constraints specified
   Number of constraints added to model =   1

============================================
   Total constraints specified by user  =   3
   (POPAN may add further constraints to fix out-of-range estimates)


END OF REPORT ON USER-SPECIFIED CONSTRAINTS
============================================



***** BEGIN CHECKS OF MODELS AND CONSTRAINTS  *****

***** GETTING STATISTICS FOR ITERATIVE MODEL FIT  *****
**********************
*                    *
*  UFIT              *     FINAL CARCASS
*  PARAGRAPH #   1   *     SELECT ALL
*                    *     ESCAPEMENT ESTIMATE: TOTAL POPULATION
**********************     USER-DEFINED MODEL FIT: ADMISSIBLE MLE'S
```

STATISTICS TABLE DEFINITION

NAME	DESCRIPTION (AND DEFINING PHRASE)
N(I)	SAMPLE SIZE AT TIME I, EXCLUDING INJECTED ANIMALS SEEN AT (I) AND NOT INJECTED AT (I)
M(I)	SIZE OF MARKED SUBSET OF N(I) SEEN AT (I) AND SEEN BEFORE (I)
L(I)	LOSSES ON CAPTURE LOST AT (I)
S(I)	NUMBER RETURNED TO POPULATION (EXCLUDING LOSSES, INCLUDING INJECTIONS) SEEN AT (I) AND NOT LOST AT (I)
SM(I)	NUMBER RETURNED TO THE POPULATION EXCLUDING THOSE FIRST MARKED AT I SEEN BEFORE (I) AND SEEN AT (I) AND NOT LOST AT (I)
R(I)	NUMBER OF RECAPTURES OUT OF S(I) SEEN AT (I) AND SEEN AFTER (I)
Z(I)	NUMBER SEEN BEFORE I, AFTER I, AND NOT AT I SEEN BEFORE (I) AND SEEN AFTER (I) AND NOT SEEN AT (I)

```
 **********************
 *                    *
 *  UFIT              *     FINAL CARCASS
 *  PARAGRAPH #   1   *     SELECT ALL
 *                    *     ESCAPEMENT ESTIMATE: TOTAL POPULATION
 **********************     USER-DEFINED MODEL FIT: ADMISSIBLE MLE'S

     STATISTICS TABLE
     ================
   I  |N(I)    |M(I)    |L(I)    |S(I)    |SM(I)   |R(I)    |Z(I)    |
 ==========================================================================
    1 |     12 |      0 |      0 |     52 |      0 |     15 |      0 |
    2 |     17 |      8 |      3 |     54 |      8 |      8 |      7 |
    3 |     19 |      7 |      0 |     59 |      7 |     18 |      8 |
    4 |     74 |     10 |     11 |    103 |     10 |     47 |     16 |
    5 |    169 |     30 |     26 |    143 |     30 |     76 |     33 |
    6 |    297 |     56 |     29 |    268 |     56 |    124 |     53 |
    7 |    972 |    107 |     81 |    891 |    107 |    490 |     70 |
    8 |   1858 |    468 |    115 |   1743 |    468 |    829 |     92 |
    9 |   2721 |    800 |    148 |   2573 |    800 |   1127 |    121 |
   10 |   2264 |   1097 |     76 |   2188 |   1097 |    603 |    151 |
   11 |   1281 |    754 |     70 |   1211 |    754 |      0 |      0 |
    # HISTORIES SCANNED USING EFFICIENT  SCAN           =         100 EQUALING        6507 ANIMALS

    # HISTORIES REJECTED ON ATTRIBUTES                 =           0 EQUALING           0 ANIMALS

    # HISTORIES REJECTED FOR NO CAPTURES IN (BEGIN,END) =           0 EQUALING           0 ANIMALS
   STATISTICS TABLE NOT SAVED...EXECUTION CONTINUING
 **********************
 *                    *
 *  UFIT              *     FINAL CARCASS
 *  PARAGRAPH #   1   *     SELECT ALL
 *                    *     ESCAPEMENT ESTIMATE: TOTAL POPULATION
 **********************     INITIAL ESTIMATES OBTAINED USING: JOLLY-DICKSON FULL MODEL (BIRTH & DEATH) -- UNADJUSTED
ESTIMATES
*****    ITERATIVE MODEL FIT NOW BEING CALLED    *****
 *****    ITERATIVE FIT CONVERGED SUCCESSFULLY    *****
         Final conditional log-likelihood: -11294.314
         Number of  restrictions  applied:      3
         Number of  singular values found:      1
     Actual number of restrictions(nr-ns):      2
```

```
 **********************
 *                    *
 *  UFIT              *     FINAL CARCASS
 *  PARAGRAPH #   1   *     SELECT ALL
 *                    *     ESCAPEMENT ESTIMATE: TOTAL POPULATION
 **********************     INITIAL ESTIMATES OBTAINED USING: JOLLY-DICKSON FULL MODEL (BIRTH & DEATH) -- UNADJUSTED
ESTIMATES
    ESTIMATE TABLE
    ==============
    ESTIMATE DEFINITIONS
    ====================

 NAME          |   DESCRIPTION
_______________|_____________________________________________________________________________
               |
 PH(I)         | ESTIMATE OF CAPTURE PROBABILITY AT TIME I
 S(PH(I))      | STANDARD ERROR OF ESTIMATE OF CAPTURE PROBABILITY
 PHI(I)        | ESTIMATE OF SURVIVAL RATE BETWEEN I,I+1
 S(PHI(I))     | STANDARD ERROR OF ESTIMATE OF SURVIVAL RATE
 BH(I)         | ESTIMATE OF BIRTHS ENTERING BETWEEN I AND I+1
 S(BH(I))      | STANDARD ERROR OF THE ESTIMATE OF BIRTHS
 NH(I)         | ESTIMATED POPULATION SIZE AT TIME I
 S(NH(I)!N)    | CONDITIONAL STANDARD ERROR OF ESTIMATE OF POPULATION SIZE
 BHG(I)        | ESTIMATE OF GROSS BIRTHS BETWEEN I AND I+1
 S(BHG(I)!N)   | CONDITIONAL STANDARD ERROR OF ESTIMATE OF GROSS BIRTHS
 C_PC(I)       | COEFFICIENTS OF COVARIATE MODEL FOR CAPTURE PROBABILITY
 S(C_PC(I))    | STANDARD ERROR OF COEFFICIENTS OF COVARIATE MODEL FOR CAPTURE PROBABILITY
 C_PHI(I)      | COEFFICIENTS OF COVARIATE MODEL FOR SURVIVAL PROBABILITY
 S(C_PHI(I))   | STANDARD ERROR OF COEFFICIENTS OF COVARIATE MODEL FOR SURVIVAL PROBABILITY
 C_PENT(I)     | COEFFICIENTS OF COVARIATE MODEL FOR ENTRY PROBABILITY
 S(C_PENT(I))  | STANDARD ERROR OF COEFFICIENTS OF COVARIATE MODEL FOR ENTRY PROBABILITY
```

VALIDITY FLAGS
(LOCATED TO THE IMMEDIATE RIGHT OF ANY ESTIMATE)

CHAR.	MEANING
' '	ESTIMATE AS CALCULATED IS VALID
'G'	ESTIMATE OF A PROPORTION IS > 1 -- ESTIMATE WAS RESET TO 1
'L'	ESTIMATE OF A POSITIVE QTY < 0 -- ESTIMATE WAS RESET TO 0
'Z'	ESTIMATE NOT FORMED DUE TO 0 IN DENOMINATOR
'U'	ESTIMATE UNAVAILABLE FOR ESTIMATES NEAR BEGINNING/END OF SAMPLE CHAIN
'R'	NO UNMARKED ANIMALS -- ESTIMATE MAY BE INVALID IF SAMPLE IS 'RECAPTURES ONLY'
'N'	SAMPLE SIZE = 0 -- ESTIMATE SET TO 0 -- OTHERS IN THIS ROW MAY BE INVALID
'I'	INVALID DUE TO 0 SAMPLE SIZE AT NEXT SAMPLE TIME
'F'	GENERAL FAILURE -- E.G. CONVERGENCE FAILURE OR MATRIX INVERSION ERROR
'X'	COEFFICIENT WAS NOT DEFINED BY A COVARIATE CONSTRAINT

```
**********************
*                    *
*  UFIT              *     FINAL CARCASS
*  PARAGRAPH #   1   *     SELECT ALL
*                    *     ESCAPEMENT ESTIMATE: TOTAL POPULATION
**********************     INITIAL ESTIMATES OBTAINED USING: JOLLY-DICKSON FULL MODEL (BIRTH & DEATH) -- UNADJUSTED
```

ESTIMATES

ESTIMATE TABLE
==============

I	PH(I)	S(PH(I))	PHI(I)	S(PHI(I))	BH(I)	S(BH(I))	NH(I)	S(NH(I)!N)
1	1.0000 G	0.0000	0.9999	0.0000	58.4965	27.2341	12.0000	3.4615
2	0.1539	0.0500	0.3390	0.1062	40.1724	28.9908	110.4934	27.4498
3	0.2107	0.0921	0.5288	0.1181	264.6386	99.4163	90.1746	35.9932
4	0.2219	0.0720	0.6670	0.0839	277.0072	99.9060	333.4723	104.2052
5	0.3258	0.0580	0.8316	0.0805	494.7300	118.8621	518.7855	89.0955
6	0.3284	0.0447	0.6124	0.0438	1592.0820	176.4732	904.5156	118.8024
7	0.4567	0.0389	0.6496	0.0224	1296.1254	129.7694	2128.2776	178.5028
8	0.7076	0.0242	0.5558	0.0159	2265.0356	90.0163	2625.9458	93.4153
9	0.7433	0.0191	0.5773	0.0180	1366.9127	77.5110	3660.5930	97.6069
10	0.6669	0.0208	0.2756	0.0096	366.3646	26.9594	3394.7764	106.6665
11	1.0000 G	0.0000	0.0000 U	0.0000 U	8033.5649	104.7197	1281.0000	32.6792

ESTIMATE TABLE CONTINUED
========================

I	BHG(I)	S(BHG(I)!N)	C_PC(I)	S(C_PC(I))	C_PHI(I)	S(C_PHI(I))	C_PENT(I)	S(C_PENT(I))
1	58.4983	27.2350	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
2	65.7429	45.5432	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
3	357.8437	126.5857	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
4	336.8657	117.8329	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
5	541.7557	123.5956	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
6	2014.1605	212.5272	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
7	1595.7886	156.7284	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
8	2994.9854	112.8426	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
9	1776.5914	93.3652	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
10	651.8173	48.7898	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X
11	10406.0498	147.6254	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X	0.0000 X

*** ESTIMATE TABLE NOT SAVED...EXECUTION CONTINUING