

INFORMATION SUMMARY TABLE ON WINTER-RUN CARCASS SURVEY DATA AND SOME RBDD (Red Bluff Diversion Dam) for 1996 to Present

Analysis by D.Killam, CDFG Red Bluff

Includes footnotes

Parameter		YEAR Winter-run Carcass and RBDD Data, (analysis by D.Killam)													
Category	Footnote	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Official total System estimate	1	1337	880	2992	3288	1352	8,224	7,464	8,218	7,869	15,839	17,304	2,541	2,830	4,537
In-river spawner estimate	2	1,012	836	2,893	3,264	1,263	8,120	7,360	8,133	7,784	15,730	17,205	2,487	2,725	4,416
Into Hatchery (CNFH or LSNFH)	3a	325	44	99	24	89	104	104	85	85	109	93	54	105	121
Winter-run surveyed in Battle Creek	3b	237	226	0	0	0	0	0	0	0	0	6	0	0	0
Peterson Standardized estimate	4	273	564	2,162	1,136	4,290	6,760	6,106	6,602	6,205	13,549	13,924	2,161	2,466	
Reported Peterson estimate	5	820	2,053	5,501	2,262	6,670	11,502	10,541	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Jolly-Seber in-river + expansions	6	n/a	n/a	n/a	n/a	6,023	8,120	7,360	8,133	7,784	15,730	17,205	2,487	2,725	4,416
RBDD estimate	7	1,337	880	2,992	3,288	1,352	5,523	9,169	9,757	7,192	5,299	7,436	6,144	3,635	n/a
Estimated Adult Females in-river-survey	8	193	395	1908	817	3,483	5,262	5,682	5,179	3,252	9,005	8,811	1,542	1,462	2,717
Carcasses Encountered on survey	9a	118	239	785	475	2,482	5,145	4,959	4,549	3,280	8,771	7,698	1,581	1,409	1,904
Date of peak carcasses encountered	9b	15-July	11-July	01-July	22-June	02-July	08-July	15-July	20-July	13-July	15-July	14-July	14-July	5-July	5-July
Carcasses Tagged (all)	10	86	191	575	313	1,954	4,364	3,770	3,457	2,072	4,758	4,121	1,063	841	1,146
Carcasses Chopped (all)	11	32	48	208	162	482	781	1,189	882	958	2,448	2,656	427	502	606
Carcasses Recaptured (all)	12	13	22	75	57	829	2,200	2,159	2,175	1,128	3,001	2,206	716	475	401
Carcasses with fin clip (CWT / Hatchery)	13	0	5	4	4	4	155	208	179	250	1,565	885	83	60	137
Number of CWT's found	14	0	5 (0)	2 (0)	2 (1)	1 (1)	124 (0)	148 (8)	134 (0)	168 (1)	1269 (1)	776 (0)	66 (1)	46 (1)	116(1)
Percent Hatchery Fish in Population	15	0	2.1%	0.5%	0.8%	0.2%	5.2%	5.3%	5.3%	10.2%	20.0%	13.3%	5.7%	6.0%	10.3%
Number of Hatchery Fish in Population	16	0	12	11	10	7	428	396	434	804	3,165	2,307	144	171	467
Percent Recapture of Tagged (all)	17	15%	12%	13%	18%	42%	50%	57%	63%	54%	63%	54%	67%	56%	35%
Percent males in carcass survey	18	29%	25%	12%	25%	18%	35%	22%	36%	58%	43%	48%	38%	46%	
Percent adult males to all adults: survey	19	13%	24%	10%	11%	17%	29%	18%	32%	43%	38%	48%	35%	42%	
Percent adult males to all fish: survey	20	11%	22%	10%	9%	16%	26.20%	17%	30%	32%	35%	47%	33%	39%	
Percent jacks to all fish: survey	21	18%	4%	2%	17%	2%	9%	5%	6.1%	25.9%	7.3%	1.9%	5.2%	7.3%	
Number of Jacks: survey: in-river	22	50	21	40	189	90	738	360	504	2041	1156	327	131	207	
Percent jacks to all fish: RBDD	23	42%	37%	18%	58%	46%	65%	13%	34%	64%	30%	35%	51%	58.6%	
Number of jacks from RBDD-system	24	564	328	522	1,907	620	3,566	1,152	3,282	4,570	1,604	2,630	3,140	2,131	n/a
Forklength cutoff for jacks (mm): survey	25	< 645	< 645	< 595	< 635	< 605	< 665	< 685	< 610	< 710	< 670	< 660	< 670	< 670	
Forklength cutoff for jacks (mm): RBDD	26	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	< 610	n/a
Percent females in carcass survey	27	71%	75%	88%	75%	82%	65%	78%	64%	42%	57%	52%	62%	53.5%	
Percent adult females to all adults: survey	28	87%	76%	90%	89%	83%	71%	82%	68%	57%	62%	52%	65%	57.8%	
Percent adult females to all fish: survey	29	71%	70%	88%	72%	81%	64.30%	77%	64%	42%	57%	51%	62%	53.5%	
Percent jills to all fish: survey	30	0%	4.7%	0%	2.9%	0.6%	0.4%	0.7%	0.5%	0.5%	0.3%	0.3%	0.3%	0.0%	
Forklength cutoff for jills (mm): survey	31	< 645	< 645	none	< 595	< 585	< 605	< 545	< 610	< 610	< 600	< 590	< 600	< 600	
Number of Jills: survey: in-river	32	0	27	0	32	25	33	51	39	41	42	51	8	0	
Percent Adults vs Percent Grilse- survey	33	82%-18%	92%-8%	98%-2%	80%-20%	97%-3%	90%-10%	94%-6%	93%-7%	74%-26%	93%-7%	98%- 2%	95%-5%	92%-8%	
Number Adults vs Number Grilse (survey)	34	223 - 50	516 - 48	2122 - 40	915 - 221	4175 - 115	7349 - 771	6949 - 411	7675 - 543	5786 - 2083	14683 - 1156	16926 - 378	2402 - 139	2622 - 207	
Percent female spawn success	35	95%	96%	95%	97%	100%	99%	99%	99%	99%	98%	98%	98%	98%	

Category		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Percent of redds within survey	36	100%	100%	94%	92.5%	72.1%	89.5%	95.9%	99.3%	100%	100%	99.7%	96.2%	100.0%	
Total number of winter redds observed	37	70	30	141	1,144	588	1,396	610	878	621	1,968	717	288	441	
Survey Date Start	38	4-Apr	30-Apr	5-May	5-May	3-May	2-May	1-May	30-Apr	30-Apr	28-Apr	1-May	1-May	1-May	
Survey Date End	39	5-Sep	29-Aug	28-Aug	27-Aug	29-Aug	29-Aug	27-Aug	4-Sep	3-Sep	2-Sep	25-Aug	24-Aug	22-Aug	
Number of Survey Periods	40	19	41	39	38	40	40	40	41	43	43	39	39	38	
Survey River Mile Range	41	271 -301	288 -301	288 -301	288 -301	288 -301	288 -301	288 -301	286.5 -301	273.5-301	273.5-301	276 -301	276 -301	276 -301	
Flow range (cfs x 1000)	42	7 - 16	8 - 15	10 - 23	9 - 13	8 - 16	8 - 15	7 - 15	8 - 29	8 - 16	4 - 37	6 - 15	8 - 15	8 - 13	
Water temp (°F) range	43	52 - 59	49 - 52	50 - 54	50 - 54	51 - 54	50 - 55	50 - 56	50 - 54	50 - 57	51 - 59	50 - 56	50 - 58	50 - 58	
Visibility range (ft)	44	n/a	3 - 10	4.5 - 11	6 - 11	9 - 21	14 - 21	17 - 22	8 - 15+	8.5 - 16	2 - 16+	5 - 13	2.5 - 20+	10.5 - 16+	

**Winter Run Carcass Survey Summary Table Notes**  
**Numbers correspond to those in the table's Footnote column**  
**Analysis by Douglas Killam, CDFG Red Bluff Office**

1 - Official total System estimate: This is the official number used by the Department and other agencies when reporting winter-run spawning populations (both hatchery and in-river). This data is also available in the Department's "GrandTab", an electronic summary of Central Valley salmon escapements. This number may include winter-run observed in Battle Creek (i.e. the six seen in Battle Creek in 2006). The RBDD number was used from 1996 to 2000. From 2001 to present, the Jolly-Seber estimate from the carcass survey was used. It is important to note that this number includes some winter-run that were estimated to have entered Battle Creek (1996 = 325, 1997 = 44, 2006 = 6).

2 - In river spawner estimate: This number is the number of winter-run salmon thought to have spawned naturally in the Sacramento River. It includes both natural origin and hatchery fish which spawned in the river. It also includes adults and grilse and fish assumed to have spawned downstream determined by aerial redds.

3a - Removed for hatchery use: This number is the number of fish removed for hatchery brood stock including fish which died before being spawned. It includes mostly natural origin fish as well as some hatchery origin fish used for brood stock or sacrificed to determine hatchery origin. In 1996 and 1997 this number represents the number of fish that were observed in Battle Creek at Coleman National Fish Hatchery. In 2006, five coded-wire-tagged winter-run were sacrificed at the Coleman Barrier Weir to determine hatchery origin. These five fish (along with a one natural winter-run) are not listed here, but are included in the total System estimate row above.

3b - In years 96, 97 and 06 winter-run salmon were surveyed in Battle Creek based on timing and passage dates. In 2006 5 of the six were sacrificed at CNFH and the other passed upstream.

4 - Peterson Standardized estimate: This number represents an expanded and corrected Peterson estimate from earlier carcass surveys that allows for comparison of numbers for all years using identical data parameters to generate an estimate. In this estimate both fresh and non-fresh adult carcasses are used in calculations. In addition grilse numbers and salmon spawning outside of carcass survey area (determined by aerial redd counts) are included. A correction to the Peterson estimate was applied to the 1996-2002 survey results. The correction eliminated the inclusion of tagged fish in the "examined fish" variable of the Peterson formula. A discussion of the details surrounding this correction is available in the 2004 CDFG Winter-run carcass survey report: Appendix 6.

5 - Reported Peterson estimate: This number represents the Peterson estimate reported in the Department reports from 1996-2002. In years 1998-2000 it does not include spawners outside of the carcass area (in 1996-1997 this number was zero, and in 2001-2002 aerial redd data was included). It also includes (except 1996-1997) the data from

only fresh adult carcasses. Estimates produced using only fresh carcasses must account for the non-fresh tagged carcasses as fish examined or the Peterson estimate will be incorrect (WR carcass survey annual report, 2004: Appendix 6). This problem is corrected for by using both fresh and non-fresh data in the Peterson Standardized estimate in the row above.

6 – Jolly-Seber in-river + expansions: This number represents the number of in-river spawners estimated through the use of the Jolly-Seber model and other expansions (including hatchery in-river spawners, downstream spawners, adult males, and grilse). The Jolly-Seber number has been the official Department estimate since 2001. Due to insufficient recaptures in earlier years the Jolly-Seber model was unable to be used, because during the calculations in the Jolly-Seber model if recaptures are zero for any recovery period an error is generated as a result of dividing by zero. This problem was prevalent in earlier years when populations were low and sometimes currently in the beginning and end of the survey or at other times when carcass numbers are low.

7 – RBDD estimate: This number results from calculations at the Red Bluff Diversion Dam fish trap and fish ladders. The RBDD numbers go back to 1967 and represent a long term database for winter-run populations. Since 1986 the RBDD number has been calculated using an average number which recently has resulted in significantly different numbers from the carcass survey. Beginning in 2001 the Department recognized that the carcass survey provided an improved method of counting winter-run salmon. The RBDD number is still developed to provide a continuation of data trends since 1967 but is no longer recognized as the most accurate number but it's use continues to provide some information to determine trends and to different groups analyzing data.

8 – Estimated adult females in-river: This number (from carcass survey) provides an estimate of the number of adult females that can be useful in comparing the number of juveniles produced by the winter-run spawners. The calculation of this number has been “standardized” for the survey years. The numbers in Table 1 years 1996-2000 are based on the standardized Peterson estimates for those years, but these numbers are not the official ones (RBDD was official). From 2001 to Present the number is based on the Jolly-Seber estimates (official). The adult female numbers for years 1996 to 2000 from the RBDD “official” reporting are as follows: 1996 = 421, 1997 = 308, 1998 = 1,183, 1999 = 427, and 2000 = 394. This number is useful in calculating the JPE number used by NMFS to determine the number of juveniles produced each year and the subsequent expectations of “take” numbers to be set for the pumping plants in the South Delta

9a – Total carcasses encountered: This number is the total number of individual carcasses encountered during the survey. It does not include the fish recaptured after they were initially tagged. It can be compared to the total population to determine what proportion of the population was sampled.

9b- Date of peak carcasses encountered: This is the date, during each yearly survey, that the most carcasses were found. It does not include recaptured carcasses. It includes all sizes, sexes and hatchery fish. This date can be used to estimate the timing of peak

spawning activity. It can be assumed that the peak carcass date precedes peak spawning by a two-week (14 day) period. Thus if peak carcasses occurs on 15 July then peak spawning likely occurred on 01 July. Caution in interpreting this data should be used, as often there are two or more peaks or many days of similar but slightly lower counts either earlier or later in survey.

10 – Carcasses tagged (all): This number is the total of all carcasses tagged during the surveys. It includes males and females, hatchery fish and grilse. In all surveys the grilse and adults were recorded as separate categories. Starting in 2003 hatchery fish were not survey tagged (because head removed) so they were not part of the tagged numbers. Population estimates were based on adult (large fish (defined as greater than 609mm for years 2003-present, similar-years 96-2002) and expanded for grilse after a large (adult) estimate was made. Subsequent expansions utilize other data to calculate the final population estimate.

11 – Carcasses chopped (all): In Table 1 this number includes the carcasses (including grilse) that were not tagged and did not have a survey jaw tag in them (recaptures). A chopped carcass is typically non-fresh; meaning it is not suitable for tagging or collecting biological data from. They are checked for survey tags placed in prior periods and then chopped in half to avoid re-counting. In some cases, fresh carcasses were chopped if they had been partially eaten by scavengers. It is also important to note that a recaptured previously tagged carcass is also chopped after the tag color and location is recorded, but these are not labeled as Chopped in the database. For purposes of the Peterson estimate calculation the category labeled “Examined” includes both recaptured and chopped carcasses, but not tagged fish.

12 – Carcasses recaptured (all): This number represents the number of previously tagged carcasses (including grilse) that are recaptured in the subsequent survey periods. It does not include hatchery tags or other types of tags applied when the fish was alive. The survey protocols dictate that all recaptures be chopped upon recapture. This was done to ensure that the surveys were conducted as “sampling without replacement” surveys. Starting in 2004, individually numbered “disc” tags were also applied to fresh carcasses to determine carcass decay times and movements over time. These carcasses were not chopped upon recapture but their first recapture date was used as if they were chopped for purposes of the population estimate protocols, (all subsequent recaptures were ignored for mark-recapture purposes). This type of sampling was still “sampling without replacement” but the data on these disc tagged fish can be used in the future as “sampling with replacement” if desired.

13 – Carcasses with a fin-clip (CWT (Hatchery): This number represents the number of adipose fin clipped or coded-wire-tagged (CWT) hatchery fish that were collected during the surveys. A carcass is identified as a hatchery fish by the absence of the adipose fin that is clipped off during hatchery tagging when the fish was a juvenile. In some cases the carcass is too decayed (or eaten) to tell if the fin has rotted off or was clipped off. In these “unknown clipped” cases the carcass head was removed and the fish was classified as a hatchery fish if a tag was found or as a natural fish if no tag was found. Because

some adipose fin clip fish shed their CWT there are often fish that are obviously clipped, but when dissected have no tag detected. If crews were positive that it was an adipose fin clip, the fish (with no tag detected) was labeled as a hatchery fish even if no CWT was found. Not all hatchery fish found on the surveys were winter-run as some late-fall-run and spring-run fish were encountered. In recent years (2001-present) the vast majority of hatchery fish were winter-run salmon raised at the Livingston Stone National Fish Hatchery. More specific details of hatchery evaluation are located in the Service's Annual winter run carcass survey reports.

14 – Number of CWT's found: This number represents the total number of coded-wire-tags actually recovered by crews dissecting heads. The tag codes 200000 and 400000 are included here (lost and illegible) as these were actual tags present in the fish. The number given is the total number of cwt(s). The number in the parentheses is the number of cwt's (included in the total) that were from other runs (i.e. CNFH late fall, or Feather River spring-run).

15 – Percent of hatchery fish in population: This value is the percent of hatchery fish present in the overall total population. It is calculated by survey data and the fresh fish ratios of clipped to natural origin carcasses. The value given here is based upon the database used by the CDFG in generating the population estimate. Values in the USFWS final reports are different but generally similar. The differences occur in the methodologies used by the two agencies. From 2003 to present the value given is based on the "final ad-clip" status in the CDFG database. The final ad-clip data attempts to account for all fish sampled in the survey. Fish are listed as natural if they had no fin clip or had an unknown fin clip that no CWT was detected. Fish that were listed as ad-fin clipped by crews receive a hatchery label. Unknown and partial clipped fish are listed according to the dissection results. Unknowns with CWT are hatchery, those without are natural, this is similar for partials. Another category during dissection is "head lost" or 300000 tag code. In the rare cases of unknown clip and head lost carcasses the final database status is proportioned to the ratio of the rest of the population. In short all sampled carcasses are assigned one origin or the other (natural or hatchery).

16 – Number of hatchery fish in population: This number is the percent of hatchery fish multiplied by the overall population. It is useful in a general sense in comparing year to year numbers. This number may differ from the numbers calculated by the USFWS in their annual reports, but are generally similar (differences due to methodology and category values). For in-depth analysis of hatchery fish populations the USFWS reports provide a more detailed evaluation of hatchery-origin fish.

17 – Percent recapture of tagged (all): This number is the total recaptured divided by the total tagged. It is a useful way to see if there was consistency over the yearly surveys. A high percent recapture indicates that many of the tagged fish released are recovered in future survey periods. A high recapture rate generally means that the survey periods were spaced close in time and that a lot of effort by crews was applied to the survey. Water visibility and number of fish both can lead to varying recapture rates. Turbid

water makes the decaying tagged fish harder to see and lowers recapture percentages. Fewer fish makes finding any fish difficult and increases the likelihood of scavengers eating the released tagged fish (often observed at the start and end of the surveys). Recapture rates can vary widely throughout the winter-run survey (more common in fall and late-fall surveys) due to flooding and muddy water for brief periods. This can have a large effect on the final population estimate, especially if such an episode occurs in the busy part of the survey. A flood immediately following the tagging of many new fish will make recapture of these fish difficult and effectively increase the overall population artificially by making it seem as if many fish were tagged but few recaptured. This is one of many possible bias of carcass surveys, but rarely occurs during the winter-run survey.

18- Percent males in carcass survey: This value is the percent (of both jacks and adults and hatchery fish) calculated from the fresh fish ratios determined by the survey for years 96-02. Beginning in year 2003 and continuing to the present this percentage is calculated using the number of males determined in the population methodology. This methodology attempts to correct for a known bias that some proportion of male fish leave the carcass survey area after spawning and are not available to crews sampling fresh carcasses. This is “corrected” for by using the ratios of winter-run male adults to female adults observed (alive) at the Keswick Dam Fish Trap (Keswick). This ratio is incorporated into the methodology and generates a large male (>609mm) population estimate. This large male number is used to generate a small male (<610mm) based on the ratio of these categories in the fresh carcasses sampled database of the survey. Additionally all fresh survey males are plotted by length and frequency to visually determine a fork length cut-off (see categories below for this value each year). After plotting, a cut-off length is selected and the jacks vs. adult male numbers are generated. The percent males from years 2003 to present include all fish including those taken into LSNFH. Years 1996 to 2002 include estimates for in-river fish only.

19 - Percent adult males to all adults in survey: This number compares male to female adults (greater than 2 year old fish). It incorporates fresh fish survey data for years 96-02 and for years 03-present is based on data from Keswick and survey results (includes LSNFH fish).

20 - Percent adult males to all fish in survey: This number is similar to above only it compares the percentage of the adult male category to all the other categories (jacks, jills and adult females). It is useful in comparing year to year trends and gives some indication of the proportions of other categories (includes LSNFH fish).

21 – Percent jacks to all fish in survey: This number compares 2-year old males (jacks) (based on length frequency analysis) to all other fish in the survey (includes adult males and adult females and jills (includes LSNFH fish)).

22 – Number of jacks from survey that were in-river: This number is the estimated number of jacks present in the river during the year (includes LSNFH fish).

23 – Percent jacks to all fish from RBDD: This number compares the number of jacks (based on fork length cut-off of <610 mm) to all other winter-run encountered at annually at the RBDD.

24 – Number of jacks from the RBDD expanded for the entire system: This number is the estimated number of jacks present in the river for each year based on RBDD data. It would include jacks entering into LSNFH. It does not include the few jacks downstream of RBDD winter-run fish.

25 – Fork length cut-off for jacks (mm) from survey: This number is the fork length cut-off determined by biologists after viewing a length frequency graph of male fish lengths. For years 96-02 it was chosen post-survey but may have conflicted with the mark-recapture efforts since mark-recapture requires a pre-season cut-off to determine adult size during data collection efforts. For years 03 to present a 610 mm cut-off is used to collect mark-recapture data on **small** and **large** carcasses. This eliminates the conflict between mark-recapture data and biological grilse vs. adult data, because the mark recapture generates an estimate, and the number of jacks is derived from within the confines of this estimate after it is complete. Afterwards, the length frequency histogram of all males is observed by biologists and a fork length cut-off is chosen specific to biological data of fresh carcasses independent of mark-recapture data.

26 – Fork length cut-off for jacks from RBDD data: The traditional cut-off for jacks and jills has been 610 mm. Of note is that Coleman National Fish Hatchery (CNFH) uses 650 as their cut-off for jacks. These two numbers may not be that different since fish at RBDD are not typically mature. As the male reaches maturity it's upper snout lengthens and fork lengths may increase on some jacks to be comparable with either site's cut-off.

27 – Percent females in carcass survey: Similar to footnote 18- for females. Exception is that females are calculated for years 03 to present by the mark recapture estimate. The assumption made is that large females are truly represented by the mark-recapture survey alone and that no bias is associated with this data. (Unlike males which use Keswick fish trap data).

28 – Percent adult females to all adults from survey: Similar to footnote 19 except for females.

29 - Percent adult females to all fish from survey: Similar to footnote 20 except for females.

30 – Percent jills to all fish from survey: Similar to footnote 21 except for females.

31 – Fork length cut-off for jills from survey: Similar to footnote 25 except for females.

32- Number of jills from survey that were in-river: Similar to footnote 22 except for females.



33 – Percent adults vs. percent grilse from survey: This number summarizes the proportion of adults and grilse for all winter-run from each year. It includes all adults vs. all grilse (jack and jills). For years 96 to 00 it is based on the standardized Peterson estimate (footnote 4) for 01-02 it was based on Jolly-Seber in-river estimate (footnote 6). For years 03 to present it is based on all fish, including LSNFH fish.

34 – Number of adults vs. number of grilse from survey: These numbers added together equal the standardized Peterson (footnote 4) for years 96-00. For years 01-02 they equal the Jolly-Seber estimate in river estimate (footnote 6) and for years 2003-to-present equals the overall official estimate including the LSNFH fish.

35 – Percent female spawn success: This number is the ratio of completely spawned to unspawned fresh female fish primarily based on crew's judgment of carcass appearance, (e.g. shrunken abdomen, worn tail). Unsuccessful spawners are those with without tail damage or those with more than a small (handful) of eggs remaining in their body cavity. Unspawned winter-run female fish are uncommon. Otters and incidental hooking by trout anglers are thought to be primary causes. Habitat or water quality limitations have not affected winter-run in recent years.

36 - Percent of redds within the survey area: This number represents the percentage of new redds observed within the boundaries of the carcass survey by the Department's aerial redd flights. These flights are to count new redds and determine the spawning distributions of all salmon runs on the mainstem Sacramento River. The winter-run flights are typically done in helicopters (planes if no helicopter available) and begin downstream of RBDD in Corning, California. If winter-run redds are observed outside of the survey area the population estimate is expanded by the percent of redds noted outside the boundaries.

37 – Total number of winter-run redds observed: This is the total number of new redds counted by observer on helicopter or fixed wing plane. Typically the flights are flown from mid-April to late-August. Only new redds are counted and counting starts at Woodson Bridge in Corning and goes up to Keswick Dam.

38 – Survey start date: The date in which new fresh fish are tallied as winter-run salmon. Typically carcass surveys are ongoing year round on the Sacramento River. After the winter-run survey commences any older recaptures from the late-fall survey (few) are removed from winter-run databases. After two weeks from the start date all fish (decayed, skeletons, etc) encountered are tallied as winter-run.

39 – Survey end date: The end of the intensive seven days per week sampling for winter-run carcasses.

40 – Number of survey periods: This is the number of survey periods typically characterized by a single pass through the entire survey area marking fish with a single color tag. A new period starts the next day (2003 to present; periods are 3 days long). A

survey period starts at the downstream end of the river distance being surveyed and continues until the crews reach the Keswick Dam.

41 – Survey river mile range: This category lists the range of river miles surveyed by crews from 1996 to present. Surveys have shortened or lengthened based on opinions of biologists to ensure that the majority of winter-run spawning is encompassed by the carcass survey.

42 – Flow range in cfs: This number is determined post season by analysis of Keswick outflow data on the CDEC website.

43 – Water temperature: This number is determined by crews taking a single water temperature using a low-cost thermometer at the end of each day in the section just completed. It should not be used for rigorous in depth analysis of temperature relationships for winter-run.

44 - Visibility range: This number is the visibility in feet observed by the crews after finishing a section each day. It is usually taken with the water temperature measurement above. Due to the large variability in techniques and crews over the years it should not be used for in-depth analysis of data. It is designed to provide a general sense of the daily visibility conditions (e.g. wind, glare, turbidity) that crews encounter on the river. For years 96-02 a Secchi disc was lowered on a flexible measuring tape into a deep hole on the river and the resulting depth at which it was no longer visible recorded. For years 03 to present a Secchi disc was attached to a rigid measuring pole and the depth at which the disc was no longer visible was recorded. A (+) after a number in this category represents that the Secchi was visible past the depth available for crews to reach (i.e. either to the river bottom or the length of the pole).