APPENDIX I

Summer Chinook Spawning Ground Surveys in the Methow and Okanogan Basin, 2006

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January 31, 2007

To: HCP Hatchery Committee

From: Mark Miller

Re: 2006 Draft Spawning Ground Surveys in the Okanogan and Methow Basins

The purpose of this memo is to provide information on the hatchery-supplemented, natural-spawning population of summer/fall Chinook in the Methow and Okanogan basins. This work is part of a larger effort focused on monitoring and evaluating Chelan PUD's hatchery supplementation program. The tasks and objectives associated with implementing Chelan PUD's hatchery M&E plan for 2006 are outlined in several documents (Murdoch and Peven 2005; Peven 2006; Hays et al. 2006). Figures and tables are presented at the end of this memo.

METHODS

Spawning ground surveys were conducted by foot, raft, and aircraft beginning the last week of September and ending mid-November. During aerial surveys an observer recorded the location and number of redds on topographic maps. We did not use aerial surveys on the Methow River because past work has demonstrated that ground counts were more accurate there than aerial surveys (Miller and Hillman 1997). Ground surveys were used to provide more accurate counts and a complete census of Chinook redds within their spawning distribution. Observers floated through sampling reaches and recorded the location and numbers of redds each week. Observers recorded the date, water temperature, rivermile, and constructed a drawing of the area where redds were located. A different symbol was used each week to record the number of new and incomplete redds.

To maintain consistency, at least one observer surveyed the same stream reach on successive dates. In areas where numerous salmon spawn, we constructed detailed maps of the river and used the cell-area method (Hamilton and Bergersen 1984) to identify the number of redds within each cell. Cells were bound by noticeable landmarks along the banks (e.g., bridges or trees) or at stream habitat boundaries (e.g., transitions between pools and riffles). The number of redds were then recorded in the corresponding grid on the map. When possible, observers estimated the number of redds in a large disturbed area by counting females that defended their redds. We assumed that the area or territory defended by a female was one redd.

During redd surveys we sampled carcasses of summer/fall Chinook to describe the spawning population. Biological data included collection of scale samples for age analysis, length measurements (POH and FKL), gender, egg voidance, and a check for tags or marks. DNA samples (five-hole punches from operculum) were collected as needed to address different objectives. These data will be used to assess length-at-age, size-at-age, egg voidance, origin (hatchery or naturally produced), stray rates, and genetics.

RESULTS

Methow

There were 1,353 summer/fall Chinook redds counted within seven reaches on the Methow River (Table 1). This was the third highest redd count observed in the Methow River (Appendix A). Spawning began the last week of September, peaked in the middle of October, and ended after the first week of November because of high water (Table 1; Figure 1). Stream temperatures in the Methow River, when spawning began, varied from 10-13°C. Peak spawning occurred in the upper reaches (M3-M5) of the Methow River during the second week of October and in the lower reaches (M1 and M2) the following week. Most redds (64%) were located in reaches (M1-M3) downstream from the town of Twisp and in reach M5 between Methow Valley Irrigation Diversion (MVID) and Winthrop Bridge (Table 1). Few summer Chinook spawned upstream from the Winthrop Bridge in reaches M6 and M7. Estimated spawning escapement in the Methow River, based on redd counts and the sex-ratio observed at Wells Dam during broodstock collection, was 2,733 (1,353 redds x 2.02 fish/redd) summer/fall Chinook spawners.

There were 587 summer/fall Chinook salmon carcasses sampled within the different reaches on the Methow River (Table 2). Twenty-one percent of the spawning escapement was sampled based on the estimated escapement of 2,733 summer/fall Chinook. Females made up 62% and males 38% of the carcasses examined. Mean percent egg voidance assessed from 365 female carcasses was 98%. Seven females (2%) died before they spawned (i.e., they retained all their eggs). Ad-clipped hatchery fish made up 25% and naturally produced fish 75% of the sample collected (Table 2). The distribution of ad-clipped hatchery and naturally produced fish showed that more than half (66%) of the ad-clipped hatchery fish were located in the lower two reaches, while most naturally produced fish were collected in reaches M5 and M2 (Figure 2).

Okanogan

There were 2,592 summer/fall Chinook redds counted within six reaches on the Okanogan River (Table 1). This was the second highest redd count observed in the Okanogan River (Appendix A). Peak aerial redd counts (1,857 redds) were about 72% of the redds counted from the ground. Spawning began the first week of October and peaked the following two weeks (Figure 1). Spawning was initiated in the Okanogan River when the stream temperature varied from 10-14°C. High water and poor visibility ended redd counts after the first week of November (Table 1; Figure 1). Peak spawning occurred in the upper reach of the Okanogan River during the second and third week of October and in the lowermost reaches at the end of October. Most redds (85%) were located in the upper reaches (O5 and O6) between Zosel Dam and the town of

Riverside (Table 1). Estimated spawning escapement (2,592 redds x 2.02 fish/redd) in the Okanogan River was 5,236 summer/fall Chinook.

There were 465 summer/fall Chinook salmon carcasses sampled within 6 reaches on the Okanogan River (Table 2). Nine percent of the spawning escapement was sampled based on the estimated escapement of 5,236 summer/fall Chinook. Females made up 65% and males 35% of the carcasses examined. Mean percent egg voidance from 302 female carcasses was 94%. Eighteen females (6%) died before spawning. Ad-clipped hatchery fish made up 10% and naturally produced fish 90% of the sample collected (Table 2). Most naturally produced and ad-clipped hatchery fish were collected in the upper reaches (O5 and O6) of the Okanogan River, closely following the distribution of redds (Figure 2).

Similkameen

There were 1,666 summer/fall Chinook redds counted within the two reaches on the Similkameen River (Table 1). This was the second highest redd count recorded in the Similkameen River (Appendix A). The peak aerial count (1,337 redds) was about 80% of the redds counted on the ground. Spawning began the last week of September and peaked two weeks later in the middle of October (Figure 5). Spawning was initiated in the Similkameen River when the temperature varied from 14-17°C. High water and poor visibility ended redd counts after the first week of November, although spawning activity appeared to be complete (Table 1). Most (83%) spawning occurred in the lower reach from the Oroville Bridge downstream to the Driscoll channel on the Similkameen River. Estimated spawning escapement (1,666 redds x 2.02 fish/redd) in the Similkameen River was 3,365 summer/fall Chinook.

There were 613 summer/fall Chinook salmon carcasses sampled within the two reaches on the Similkameen River (Table 2). Eighteen percent of the spawning escapement was sampled based on the estimated escapement of 3,365 summer/fall Chinook. Females made up 57% and males 43% of the carcasses examined. Mean percent egg voidance from 349 female carcasses was 81%. Sixty-five females (19%) died before they spawned. Ad-clipped hatchery fish made up 15% and naturally produced fish 85% of the sample collected (Table 2).

Chelan and Columbia Rivers

There were 208 and 48 summer/fall Chinook redds counted in the Chelan River and in the Columbia River downstream from Wells Dam, respectively (Table 1). No redds were observed in the Columbia River upstream from Wells Dam during aerial surveys. Spawning began the second week of October in the Chelan River and the following week in the Columbia River. Peak spawning in both rivers occurred the last week of October. Estimated spawning escapement (208 redds x 2.02 fish/redd) to the Chelan River was about 420 summer/fall Chinook.

There were 107 summer/fall Chinook salmon carcasses sampled within the Chelan River (Table 2). Twenty-five percent of the spawning escapement was sampled based on the estimated escapement of 402 summer/fall Chinook. Females made up 81% and males 19% of the carcasses examined. Ad-clipped hatchery fish made up 32% and naturally produced fish 68% of the sample collected (Table 2).

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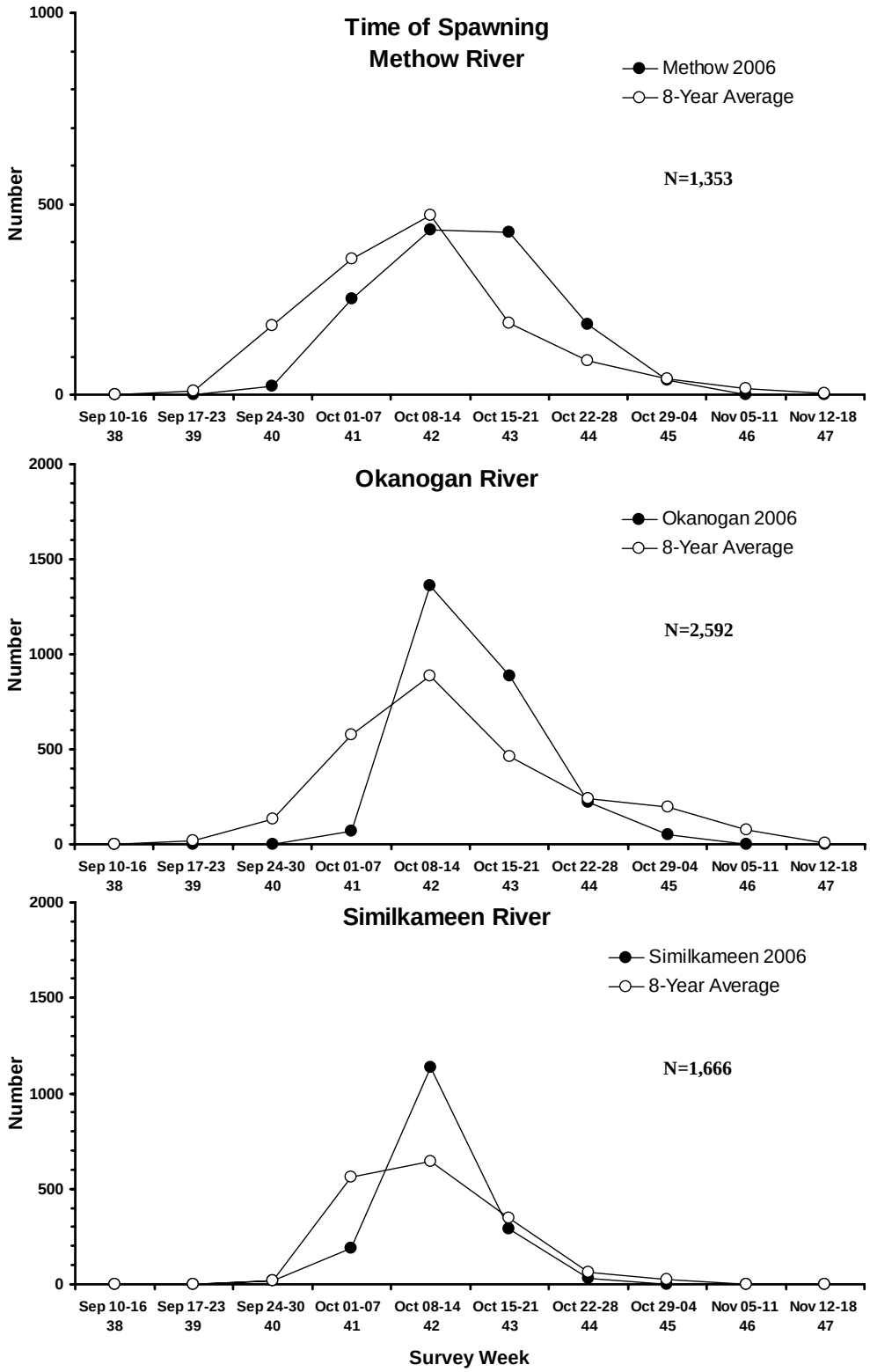

Figure 1. Number of new redds counted each week from September to mid-November. The figures display the beginning, peak, and end of spawning for summer/fall Chinook in the Methow, Okanogan, and Similkameen rivers in 2006 and 8-year average (1998-2005).

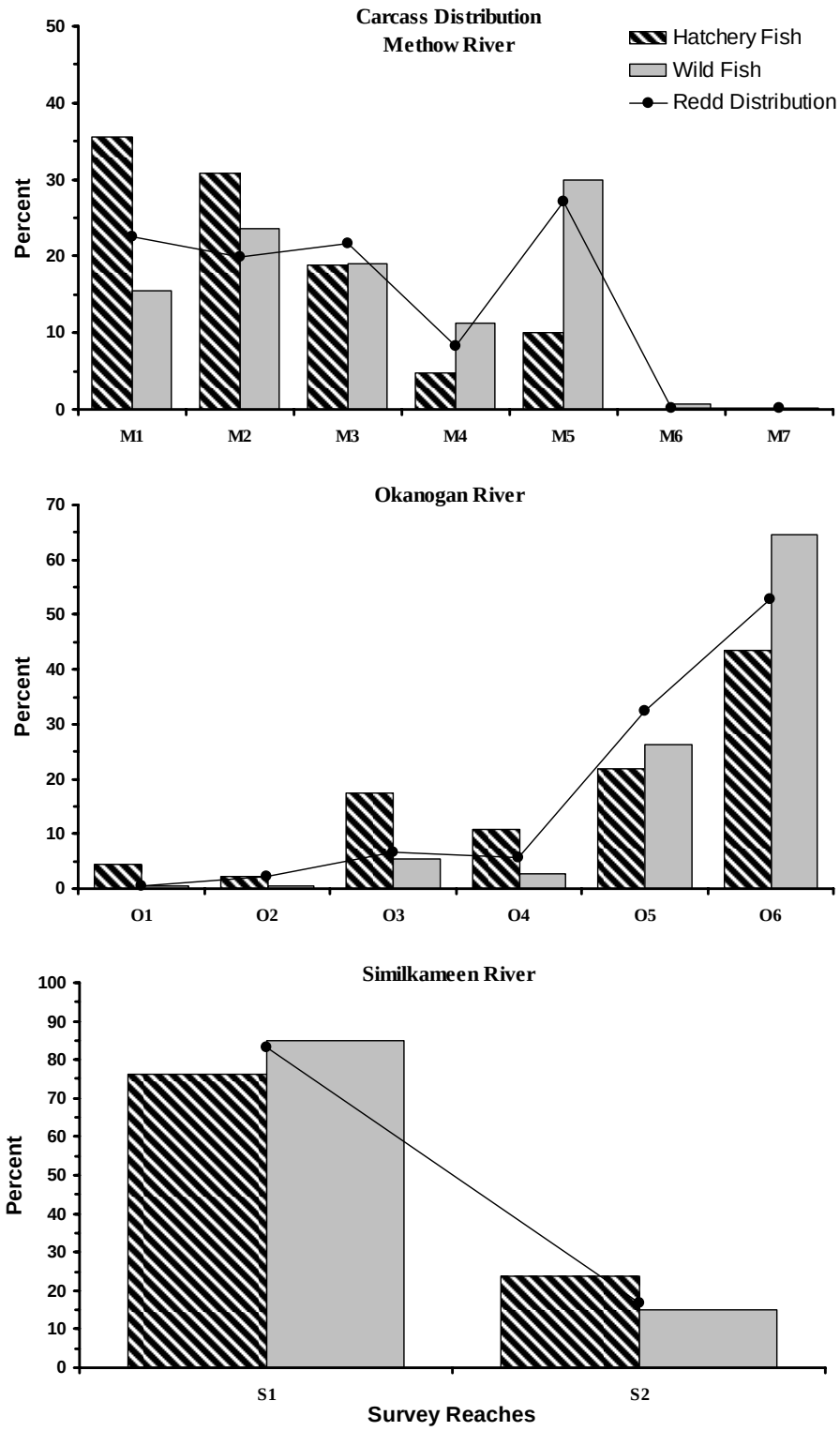

Figure 2. Percent distribution of ad-clipped hatchery and naturally produced fish plotted against the percent distribution of redds observed in reaches of the Methow, Okanogan, and Similkameen rivers.

Table 1. Number of summer/fall Chinook redds observed each week within reaches of the Methow River. Flooding during the beginning of November (Nov. 6) ended redd survey counts.

Reach	Location (Rkm)	Sep	Oct					Nov		Total	Percent
		24-30	1-7	7-14	15-21	22-28	29-4	5-11	12-18		
		1	2	3	4	5	6	7	8		
Methow River											
M1	0.0-25.0	2	16	80	128	62	18	--	--	**306**	**22.6**
M2	25.0-45.9	11	61	57	76	56	9	--	--	**270**	**20.0**
M3	45.9-63.6	6	71	119	68	26	4	--	--	**294**	**21.7**
M4	63.6-75.8	1	18	52	35	7	0	--	--	**113**	**8.4**
M5	75.8-84.2	2	86	123	114	34	7	--	--	**366**	**27.1**
M6	84.2-87.2	0	0	0	2	0	0	--	--	**2**	**0.1**
M7	87.2-90.2	0	0	0	2	0	0	--	--	**2**	**0.1**
	Total	**22**	**252**	**431**	**425**	**185**	**38**	--	--	**1,353**	**100.0**
Okanogan River											
O1	0.0-27.2	0	0	0	0	8	2	--	--	**10**	**0.4**
O2	27.2-41.9	0	0	5	0	46	5	--	--	**56**	**2.2**
O3	41.9-49.4	0	4	82	48	0	41	--	--	**175**	**6.8**
O4	49.4-65.4	0	0	15	0	127	3	--	--	**145**	**5.6**
O5	65.4-91.4	0	17	384	421	18	0	--	--	**840**	**32.4**
O6	91.4-129.6	0	49	876	417	24	0	--	--	**1,366**	**52.7**
	Total	**0**	**70**	**1,362**	**886**	**223**	**51**	--	--	**2,592**	**100.0**
Similkameen River											
S1	0.0-2.9	19	168	926	250	25	0	--	--	**1,388**	**83.3**
S2	2.9-9.1	1	23	207	40	7	0	--	--	**278**	**16.7**
		20	**191**	**1,133**	**290**	**32**	**0**	--	--	**1,666**	**100.0**
Chelan River											
	0.0-1.0	---	**0**	**2**	**41**	**84**	**49**	---	**32**	**208**	
Columbia River											
	953.3-954.3	---	**0**	**0**	**2**	**46**	---	---	---	**48**	

Table 2. Number and percent of hatchery (ad-clipped) and naturally produced (not ad-clipped) summer/fall Chinook collected in six reaches of the Similkameen River.

Reach	Location (Rkm)	Ad-Clipped Hatchery				Naturally Produced				Reach Total
		Male	Female	Total	Percent	Male	Female	Total	Percent	
Methow River										
M1	0.0-25.0	11	42	53	35.6	29	39	68	15.5	**121**
M2	25.0-45.9	23	23	46	30.9	40	63	103	23.5	**149**
M3	45.9-63.6	9	19	28	18.8	33	50	83	18.9	**111**
M4	63.6-75.8	1	6	7	4.7	21	28	49	11.2	**56**
M5	75.8-84.2	2	13	15	10.1	52	79	131	29.9	**146**
M6	84.2-87.2	0	0	0	0.0	0	3	3	0.7	**3**
M7	87.2-90.2	0	0	0	0.0	1	0	1	0.2	**1**
	Total	**46**	**103**	**149**	**100.0**	**176**	**262**	**438**	**100.0**	**587**
Okanogan River										
O1	0.0-27.2	1	1	2	4.3	1	1	2	0.5	**4**
O2	27.2-41.9	0	1	1	2.2	2	0	2	0.5	**3**
O3	41.9-49.4	2	6	8	17.4	5	18	23	5.5	**31**
O4	49.4-65.4	3	2	5	10.9	9	2	11	2.6	**16**
O5	65.4-91.4	5	5	10	21.7	31	79	110	26.3	**120**
O6	91.4-129.6	6	14	20	43.5	98	173	271	64.7	**291**
	Total	**17**	**29**	**46**	**100.0**	**146**	**273**	**419**	**100.0**	**465**
Similkameen River										
S1	0.0-2.9	35	35	70	76.1	199	244	443	85.0	**513**
S2	2.9-9.1	8	14	22	23.9	22	56	78	15.0	**100**
	Total	**43**	**49**	**92**	**100**	**221**	**300**	**521**	**100**	**613**
Chelan River										
	0.0-1.0	5	29	34	---	15	58	73	---	**107**

Appendix A. Historical aerial and ground redd counts of summer/fall Chinook in the Methow, Okanogan, and Similkameen rivers.

	Methow		Okanogan		Similkameen	
Year	**Aerial**	**Ground**	**Aerial**	**Ground**	**Aerial**	**Ground**
1956	109	--	37	--	30	--
1957	451	--	53	--	30	--
1958	335	--	94	--	31	--
1959	130	--	50	--	23	--
1960	194	--	29	--	--	--
1961	120	--	--	--	--	--
1962	678	--	--	--	17	--
1963	298	--	9	--	51	--
1964	795	--	112	--	67	--
1965	562	--	109	--	154	--
1966	1,275	--	389	--	77	--
1967	733	--	149	--	107	--
1968	659	--	232	--	83	--
1969	329	--	103	--	357	--
1970	705	--	656	--	210	--
1971	562	--	310	--	55	--
1972	325	--	182	--	64	--
1973	366	--	138	--	130	--
1974	223	--	112	--	201	--
1975	432	--	273	--	184	--
1976	191	--	107	--	139	--
1977	365	--	276	--	268	--
1978	507	--	195	--	268	--
1979	622	--	173	--	138	--
1980	345	--	118	--	172	--
1981	195	--	55	--	121	--
1982	142	--	23	--	56	--
1983	65	--	36	--	57	--
1984	162	--	235	--	301	--
1985	164	--	138	--	309	--
1986	169	--	197	--	300	--
1987	211	--	201	--	164	--
1988	123	--	113	--	191	--
1989	126	--	134	--	221	370

Appendix A. Concluded.

	Methow		Okanogan		Similkameen	
Year	**Aerial**	**Ground**	**Aerial**	**Ground**	**Aerial**	**Ground**
1990	229	--	88	47	94	147
1991	--	153	55	64	68	91
1992	--	107	35	53	48	57
1993	--	154	144	162	152	288
1994	--	310	372	375	463	777
1995	--	357	260	267	337	616
1996	--	181	100	116	252	419
1997	--	205	149	158	297	486
1998	--	225	75	88	238	276
1999	--	448	222	369	903	1,275
2000	--	500	384	549	549	993
2001	--	675	883	1,108	865	1,540
2002	--	2,013	1,958	2,667	2,000[a]	3,358
2003	--	1,624	1,099	1,035	103	378
2004	--	973	1,310	1,327	2,127	1,660
2005	--	874	1,084	1,611	1,111	1,423
2006	--	1,353	1,857	2,592	1,337	1,666