July 10, 2009

To: Kristine Petersen
NOAA Fisheries
1201 NE Lloyd Blvd, Suite 1100
Portland, Oregon 97232

Dear Ms. Petersen,

Public Utility District No.1 of Chelan County (Chelan) respectfully submits the 2008 Wenatchee River Spawning Ground Memo. The memo is submitted in compliance with the reporting conditions set forth in Section D(5) of Incidental Take Permit No. 1347. Please contact me with any questions or concerns that you might have.

Respectfully yours,

Barry Keesee
Chelan County PUD # 1
Fisheries Studies Coordinator
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e-mail barry.keesee@chelanpud.org

APPENDIX G

Wenatchee Sockeye and Summer Chinook Spawning Ground Surveys, 2008

PUBLIC UTILITY DISTRICT NUMBER 1 OF CHELAN COUNTY
Fish and Wildlife Department
327 N. Wenatchee Ave., Wenatchee WA 98801 (509) 663-8121

January 8, 2009

To: HCP Hatchery Committee

From: Joe Miller

Subject: 2008 Wenatchee River Basin Summer Chinook and Sockeye Salmon Spawning Ground Surveys

Introduction

The Chelan County Public Utility District (District) has conducted or funded others to conduct intensive spawning ground surveys of spring and summer/fall (late run)[1] Chinook salmon (*Oncorhyncus tshawytscha*) and sockeye salmon (*O. nerka*) in river basins of the Columbia River upstream of Rock Island Dam. Summer/fall Chinook spawn in the entire mainstem of the Wenatchee River, from the mouth to the lake (Figure 1; Table 1). Sockeye spawn in the White and Little Wenatchee River basins (Figure 2).

The spawning surveys are performed yearly to assist in evaluating the effectiveness of the District's hatchery program. The purpose of this document is to report the results of the 2008 Chinook and sockeye salmon spawning ground surveys in the Wenatchee River basin. Information included in this document describes abundance, distribution, and timing of spawning activity.

[1] The majority of Chinook that ascend the mid-Columbia River as adults after July spawn between October and November in the mainstem of the Columbia, Wenatchee, Methow, Similkameen and Okanogan rivers. These fish have been called "summer" and "fall" Chinook based on their migration timing past the dams. Their life histories are identical (Mullan 1987), and should be termed "late-run" to separate them from earlier running "spring" Chinook that have a different life history. For consistency with previous year's reports, only the earlier segment of the late-run (those that ascend Rock Island Dam between June 24 and September 1; "summers") will be focused on in this report.

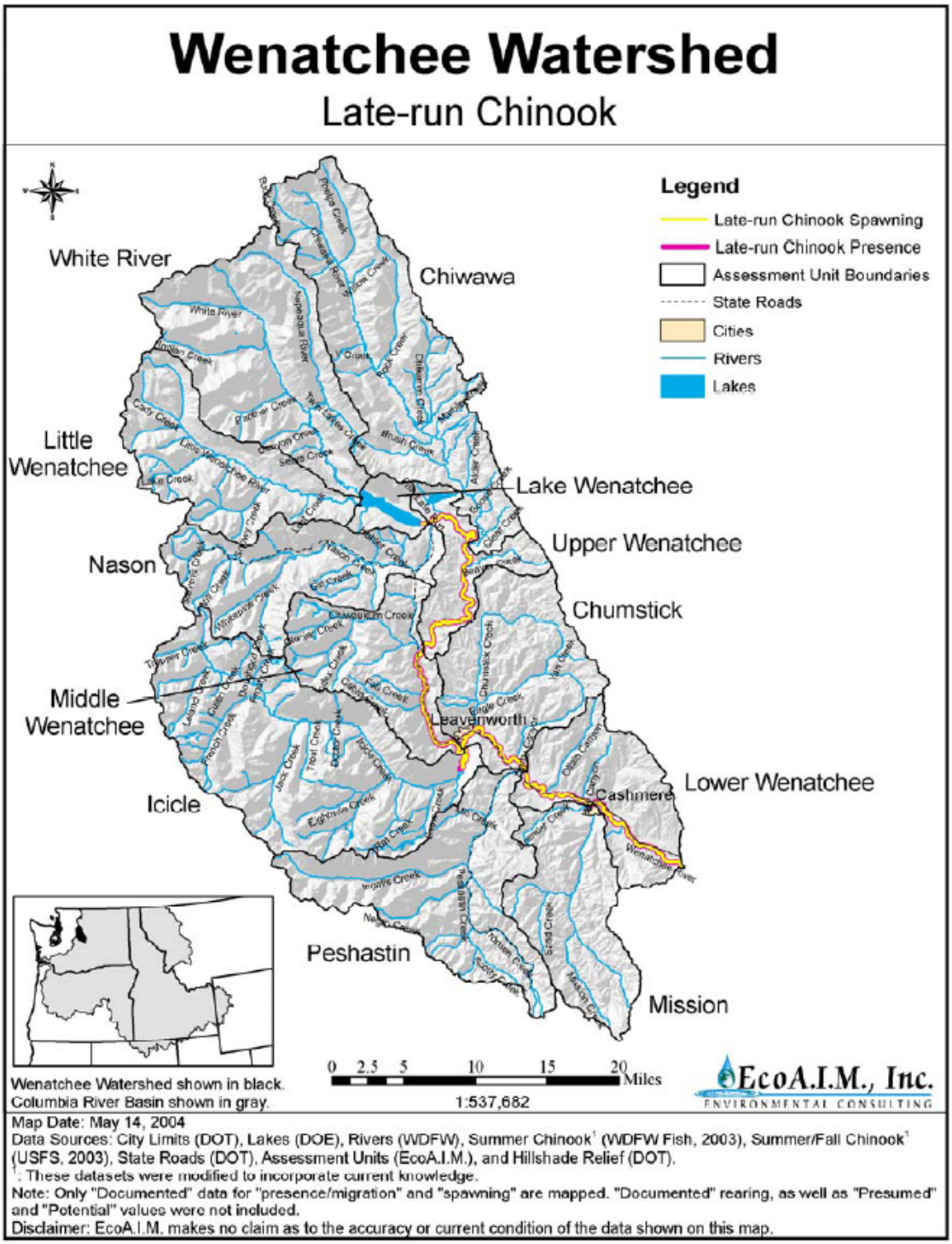

Figure 1. Map of the Wenatchee River Basin with spawning and migrational areas of late-run (summer/fall Chinook) areas highlighted (copied from the Wenatchee Subbasin Plan, NWPCC 2004).

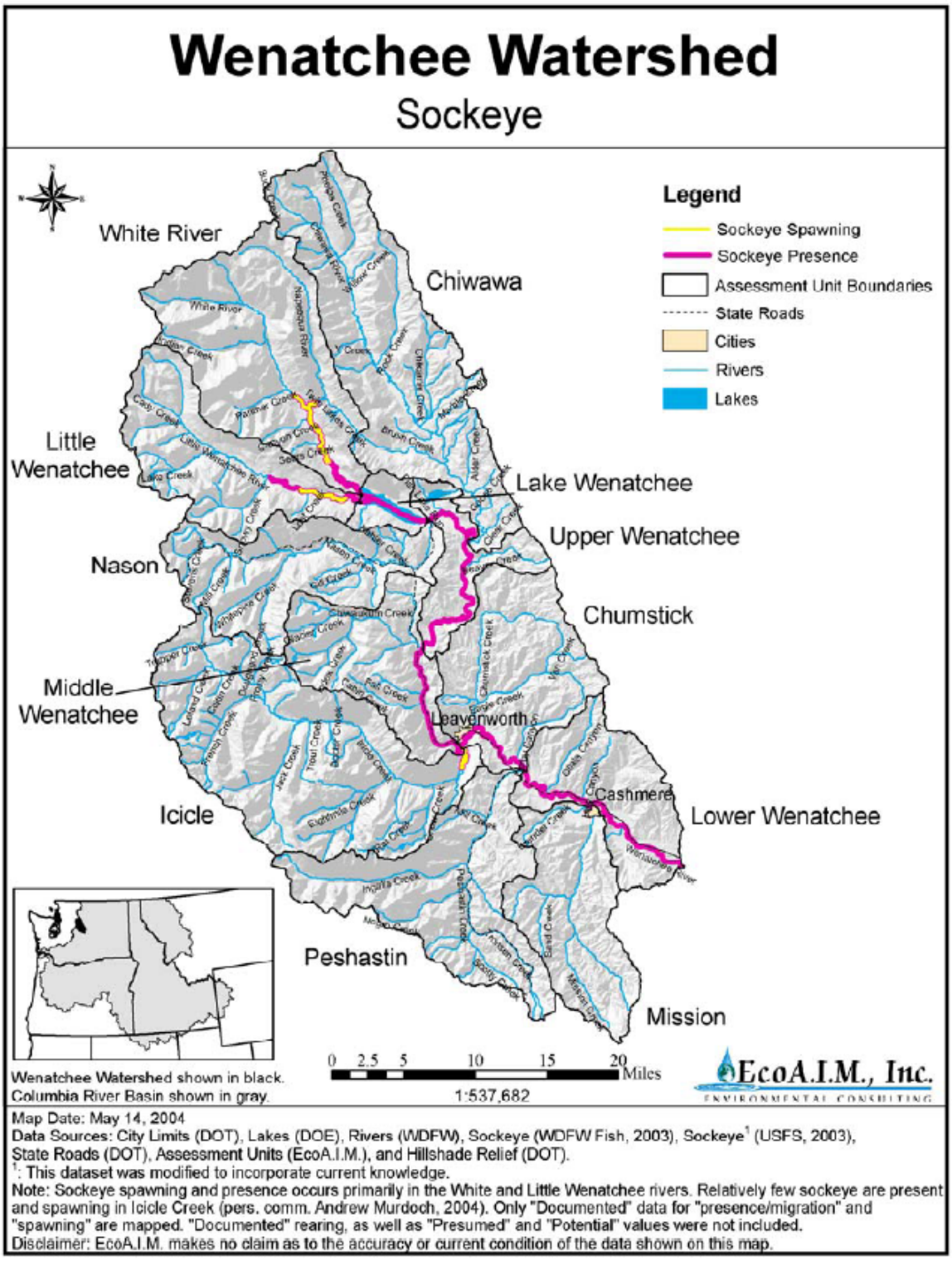

Figure 2. Map of the Wenatchee River Basin with spawning and migrational areas for sockeye highlighted (copied from the Wenatchee Subbasin Plan, NWPCC 2004).

Methods

In 2008, there were several notable differences in study methodology. First, the summer Chinook spawning surveys were modified to incorporate additional mapping index areas in all ten river reach strata. Additionally, summer Chinook naïve counts were also performed in all river reach strata by the Washington State Department of Fish and Wildlife (WDFW) and the District. Previously, mapping index counts focused on six of the ten reaches and naïve counts were conducted solely by WDFW.

Chinook Spawning Ground Surveys

Chinook spawning ground surveys are conducted by foot, raft, or canoe. The most appropriate survey method is chosen for a given stream reach based on stream size, flow, and density of spawners. Because of the broad stream width and high spawner densities, individual summer Chinook redds are not flagged. Each reach is surveyed approximately once per week.

In 2008, summer Chinook spawning ground surveys occurred from September 22 to November 10.

Table 1: Designated survey reaches for spawning ground areas on the Wenatchee, Little Wenatchee, White, and Nepeequa rivers for all species.

Survey Section	River Mile
Wenatchee River-Summer Chinook	
Mouth to Sleepy Hollow Bridge	0 – 3.5
Sleepy Hollow Bridge to Lower Cashmere Bridge	3.5 – 9.5
Lower Cashmere Bridge to Dryden Dam	9.5 - 17.5
Dryden Dam to Peshastin Bridge	17.5 – 20.0
Peshastin Bridge to Leavenworth Bridge	20.0 – 23.9
Leavenworth Bridge to Icicle Road Bridge	23.9 – 26.4
Icicle Road Bridge to Tumwater Dam	26.4 – 30.9
Tumwater Dam to Tumwater Bridge	30.9 – 35.6
Tumwater Bridge to Chiwawa River	35.6 – 48.4
Chiwawa River to Lake Wenatchee	48.4 – 54.2
Little Wenatchee River-Sockeye	
Mouth to Old Fish Weir	0 – 2.7
Old Fish Weir to Lost Creek	2.7 – 5.2
Lost Creek to Rainey Creek	5.2 – 9.2
Rainey Creek to End	9.2 – End
White River-Sockeye	
Mouth to Sears Creek Bridge	0 – 6.4
Sears Creek Bridge to Napeequa River	6.4 – 11.0
Napeequa River to Grasshopper Meadows	11.0 – 12.9
Grasshopper Meadows to Falls	12.9 – 14.3
Napeequa River-Sockeye	
Mouth to End	0 - End

Peak and total redd count methodologies were used during the summer Chinook surveys in 2008 (see Appendix F of Murdoch and Peven (2005) for more detail). A peak count is conducted by counting all visible redds (new and old) observed within a reach on each survey. The objective of the peak redd count methodology is to capture the apex of spawning activity over an entire spawning season. This apex occurs at different times between reaches during the season, i.e. spawning begins sooner in the upstream reaches compared to the downstream reaches. The sum of all of the apex counts for the entire river is the peak redd count for the year. Peak counts provide an index of spawning and have been used historically (Attachment 1).

Two different approaches were used to estimate the total number of redds within the Wenatchee River. The first method used map counts to expand peak counts. Under this approach, a total redd count is conducted by counting or mapping only new or recently constructed redds within an area. Each new redd is mapped on aerial photos and enumerated. The objective of the total redd count methodology is to capture 1) "early" redds that may fade over time due to siltation or algae growth, and 2) redds that become disfigured by superimposition (when new redds are constructed on top of previously existing redds).

Since it is not feasible to map all new redds within the entire river, an expansion is used to estimate total count for the entire Wenatchee River. To account for the different spawning substrate types in the main stem Wenatchee River, the river was delineated into ten distinct reaches in consultation with WDFW (Table 2). Within each of these reaches, index areas have been identified as being representative areas of spawning activity. Peak counts are performed within each total reach (referred to as non-index areas), while mapping new redds only occurs within the index areas. An expansion is developed based on the ratio of mapped to peak counts for each reach (i.e., each reach has its own expansion factor), and the sum of the expanded counts is the estimate of the total redd counts. Additional details of how total redd counts are calculated are provided below.

a. Calculate an index peak expansion factor (*IP*) by dividing the peak number of redds in the index by the total number of redds (map count) in the index area.

$$IP = n_{peak} / n_{total}$$

b. Expand the non-index area peak redd counts by the *IP* to estimate the total number of redds in the entire reach (reach total; *RT*).

$$RT_{peak} = n_{peak} / IP$$

c. Estimate the total number of redds (total redds; *TR*) by summing the reach totals.

$$TR_{peak} = \sum RT$$

The second approach relied on a "naïve" count to expand redd numbers in reaches that did not have map counts. As noted above, the reaches with map counts are referred to as index reaches and those that were not mapped are called non-index reaches. Near the end of the spawning period (early November), one team of observers counts all visible redds within all non-index reaches. A separate, independent team counts all visible redds within the index reaches (these are the naïve counts). Surveys within the index and non-index areas should occur within one day of each other near the end of the spawning period. The naïve counts are divided by the total map count to estimate an index expansion factor. This factor is then applied to the total visible count in the non-index areas to estimate the total number of redds within each reach. The sum of the expanded counts is the estimate of the total redd count for the river. Additional details of how total numbers of redds are estimated using this approach are provided below.

a. Calculate an index expansion factor (*IF*) by dividing the number of visible redds in the index by the total number of redds (map counts) in the index area.

$$IF = n_{visible} / n_{total}$$

b. Expand the non-index area redd counts by the proportion of visible redds in the index to estimate the total number of redds in the entire reach (reach total; *RT*).

$$RT_{visible} = n_{non-index} / IF$$

c. Estimate the total number of redds (total redds; *TR*) by summing the reach totals.

$$TR_{visible} = \sum RT$$

The total redd count methods are believed to provide a more accurate indication of total spawning than the peak redd count methodology, because the peak count methodology only accounts for visible redds each week during the survey season. For example, summer Chinook redds that were visible during the first week of spawning may not be visible during the third week; those redds would be missed in the third and subsequent weeks' redd counts. Using the total count methodology, the redds in the first week would be mapped and accounted for in subsequent weeks, even though they may fade at some point during the future surveys.

Table 2: Index (Mapping) Areas on the Wenatchee River for 2008.

Reach	Reach description	Distance (miles)	Mapping index area within reach
1	Sleepy Hollow Br to River Mouth	3.5	Sleepy Hollow Br to River Bend
2	Cashmere Br to Sleepy Hollow Br	6	Cashmere Br 2 to Old Monitor Br.
3	Dryden Dam to Cashmere Br	8	Dryden Dam to Williams Canyon
4	Peshastin Br to Dryden Dam	2.5	Peshastin Br to Dryden Dam
5	Leavenworth Br to Peshastin Br	3.9	Leavenworth Br to Irrigation Flume
6	Icicle Rd Br to Leavenworth Br	2.5	Icicle Mouth to Boat Takeout
7	Tumwater Dam to Icicle Rd Br	4.5	Penstock Br to Icicle Rd Br
8	Tumwater Br to Tumwater Dam	4.7	Tumwater Br to Swiftwater Campground
9	Old Plain Br to Tumwater Br	12.8	RR Tunnel to Swing Pool
10	Lake Wenatchee to Old Plain Br	5.8	Bridge to Swamp

Sockeye Spawning Ground Surveys

In 2008, we employed one survey method, area-under-the-curve (AUC). Sockeye spawning ground surveys began August 25 and ended October 9. Spawning areas in the Little Wenatchee, Napeequa, and White rivers (Table 1) were surveyed at least once per week. Both the Little Wenatchee and White rivers have blocking falls, and spawning is known to occur only within the first few miles of the Napeequa River, a tributary to the White River.

Area-under-the-curve

The AUC method is based on the number of live spawners counted. Using AUC, the number of fish observed in a survey is plotted against the day of the year and the number of fish-days is estimated using an algorithm. The number of fish spawning is then estimated by dividing the cumulative fish-days by the estimated mean number of days that the average spawner is alive in the survey area (survey- or stream-life). This is then multiplied by a correction factor for fish visibility (observer efficiency; Hillborn et al. 1999).

Hillborn et al. (1999) outlined what they termed as the most commonly used form of AUC, *trapezoidal approximation*:

$$AUC = \sum_{i=2}^{n} (t_i - t_{i-1}) \frac{(x_i + x_{i-1})}{2}$$

where t_i is the day of the year and x_i is the number of salmon observed for the ith survey. Attempts are often made to initiate surveys prior to the presence of fish; however, when the first or last survey is not zero, then the above algorithm is not valid and Hillborn et al. (1999) recommend using the "rules" that the Alaska Department of Fish and Game use:

$$AUC_{first} = \frac{x_i s}{2}$$

where *s* is the survey life. Attempts should also be made until all salmon die, but when this is not possible, then the final survey should be calculated:

$$AUC_{last} = \frac{x_{last} s}{2}$$

Then total escapement (*E*) is estimated:

$$\hat{E} = \frac{AUC}{s} v$$

where v is a correction for observer efficiency. Since survey life has not been empirically estimated for the Wenatchee system, we used 11 days based on Perrin and Irvine (1990) and Hyatt et al. (2006).

Results

Summer Chinook

Peak Counts

The cumulative peak summer Chinook redd count was 1,135 in 2008, based on District ground surveys along the Wenatchee River (Table 3). Spawning activity began the last week of September and peaked during middle of October.

Table 3. Summary of summer Chinook redd peak counts, total redd estimates (TR) and spawner densities by reach in the Wenatchee River, 2008. Expansion factors were rounded to two decimal places (0.00) prior to calculating reach totals.

Reach	Peak Count	CCPUD Estimates				WDFW Estimates	
		RT_{Peak}	$Density_{Peak}$ (redds/mile)	$RT_{Visible}$	$Density_{Visible}$ (redds/mile)	$RT_{Visible}$	$Density_{Visible}$ (redds/mile)
1	9	15	4	18	5	16	5
2	37	137	23	82	14	80	13
3	67	227	28	215	27	113	14
4	22	22	9	22	9	22	9
5	10	56	14	59	15	63	16
6	536	1,125	450	1,299	520	1,157	463
7	144	215	48	222	49	241	54
8	92	139	30	125	27	134	29
9	87	491	38	437	34	378	30
10	131	350	60	396	68	431	74
Total	***1,135***	***2,777***	***51***	***2,875***	***53***	***2,635***	***49***

Total Counts

The total number of redds in the Wenatchee River was 2,777 (TR_{peak}), using data from District surveys and the peak expansion factor, and 2,875 (TR_{visble}) using District naïve suveys and the naïve expansion factor (Table 3). Similarly, WDFW estimated 2,635 redds (TR_{visble}) based on their concurrent naïve surveys (Table 3). Although District and WDFW *RT* estimates differed at individual reaches, there was strong concordance in RT_{visble} among all reaches (Figure 3) and similarity in the total estimated number of redds for the Wenatchee (8% difference; Table 3). All survey methods (peak and visible) indicated that redd densities were highest in Reach 6 and lowest in Reach 1 (Table 3), consistent with the previous two years. The historical summer Chinook peak counts (1996-2008) for the Wenatchee River basin are summarized in Attachment 1.

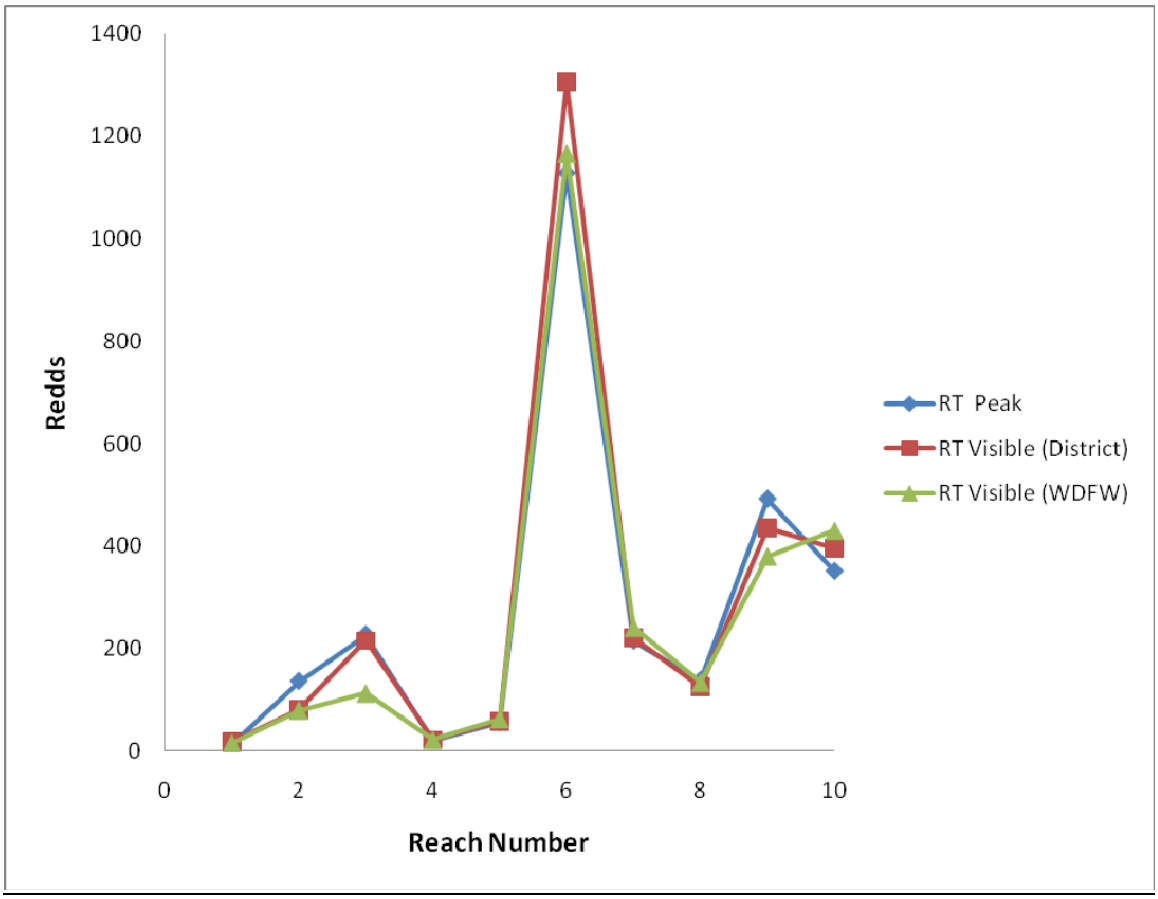

Figure 3. Alternative estimates of reach totals (RT) for summer Chinook redds in the the Wenatchee River in 2008 [RT_{peak}=District peak counts expanded by peak expansion method, RT_{visble}(District)=District naïve counts expanded by naïve expansion method, and RT_{visble} (WDFW)=WDFW naïve counts expanded by naïve expansion factor].

Sockeye

Live fish counts

Fish counts were conducted for sockeye from August 26 through October 9. Peak spawning occurred in the Little Wenatchee (2,130); Napeequa River (483); and White River (9,557) during the middle of September (Figure 4; Table 4).

Escapement

The total estimated spawning escapement of sockeye to the Wenatchee tributaries was 20,248 in 2008 (Table 4). The escapement estimate is based solely on tributary observations and does not include fish harvested in the Lake Wenatchee sockeye fishery.

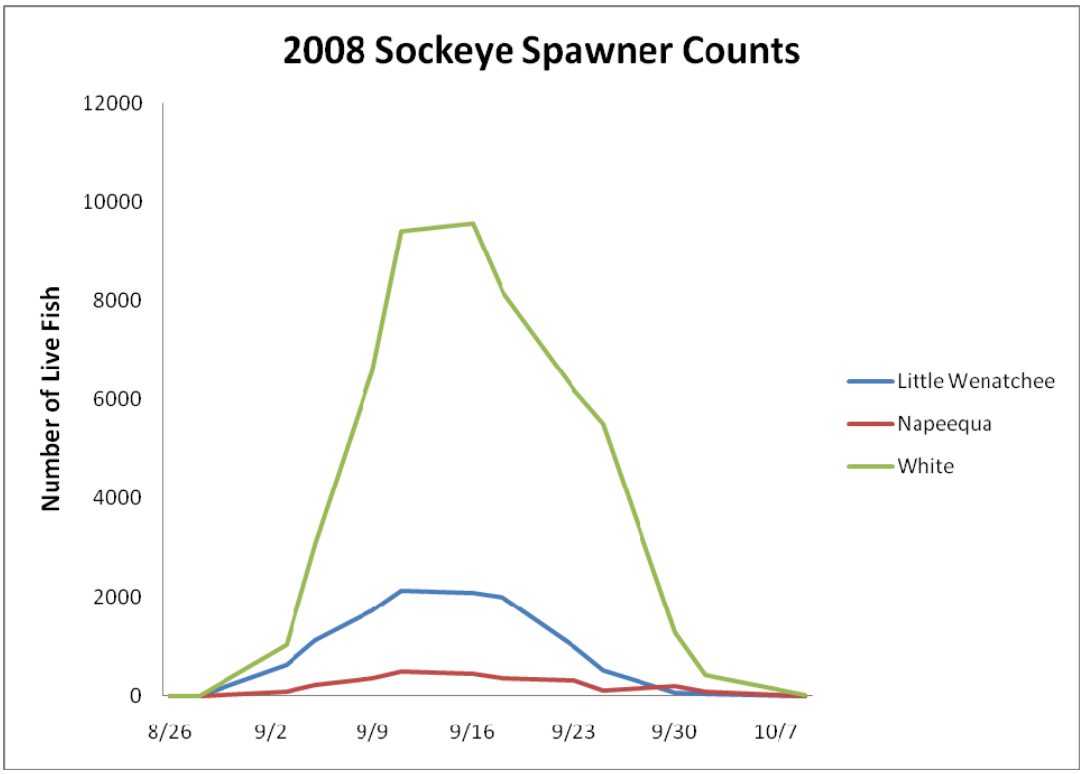

Figure 4. Approximate live counts and survey dates for sockeye salmon in the Wenatchee River Basin, 2008.

Table 4. Number of live fish and total spawning escapement estimates for sockeye salmon in the Wenatchee Basin, August through October, 2008.

River	Peak number of live fish	Escapement
Little Wenatchee	2,130	3,491
Napeequa	483	820
White	9,557	15,937
Total	***12,170***	***20,248***

Recommendations

In 2009, sockeye escapements to the Wenatchee basin tributaries will be augmented with PIT-tag arrays on the White and Little Wenatchee Rivers. The District will continue to evaluate spawner enumeration techniques to ensure accuracy.

References

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Hyatt, K.D., M.M. Stockwell, H. Wright, K. Long, J. Tamblyn, and M. Walsh. 2006. Fish and Water Management Tool Project Assessments: Okanogan Adult Sockeye Salmon (*Oncorhynchus nerka*) Abundance and Biological Traits in 2005. DRAFT Report to file: JSID-SRe 3-05. Salmon and Freshwater Ecolsystems Division, Fisheries and Oceans Canada, Nanaimo, B.C. V9T 6N7.

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Murdoch, A. and C. Peven. 2005. Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Hatchery Programs. *Prepared for:* Chelan PUD Habitat Conservation Plan's Hatchery Committee. Chelan PUD, Wenatchee, WA

Perrin, C.J. and J.R. Irvine. 1990. A review of survey life estimates as they apply to the area-under-the-curve method for estimating the spawning escapement of Pacific salmon. Canadian Tech. Rep. of Fisheries and Aquatic Sciences No. 1733. Departmet of Fisheries and Oceans, Nanaimo, B.C. V9R 5K6.

Peven, C. M. 1990. The life history of naturally produced steelhead trout from the Mid-Columbia River Basin. MS Thesis, University of Washington, Seattle.

Attachment 1.

Historic peak redd counts in the Wenatchee River for summer/fall Chinook salmon. Prior to 1995, all counts based on highest count of multiple agencies surveys, which were usually aerial counts from fixed-wing aircraft. Since 1995, counts are ground counts based on Chelan PUD surveys.

Year	Highest Count	Year	Highest Count	Year	Highest Count
1960	502	1970	1333	1980	2024
1961	872	1971	1419	1981	1469
1962	1035	1972	1364	1982	1140
1963	1223	1973	1119	1983	723
1964	1300	1974	1155	1984	1332
1965	706	1975	925	1985	1058
1966	1260	1976	1106	1986	1322
1967	1593	1977	1365	1987	2955
1968	1776	1978	1956	1988	2102
1969	1354	1979	1698	1989	3331
1990	2479	2000	2022		
1991	2180	2001	2857		
1992	2328	2002	5419		
1993	2334	2003	4281		
1994	2426	2004	3764		
1995	1872	2005	3327		
1996	1435	2006	7165		
1997	1388	2007	1857		
1998	1660	2008	1135		
1999	2188				