MEMORANDUM

Department of Fish and Wildlife
Intra Departmental

Date: December 11, 2009
To: Files, HQ
From: Chris Kern
Subject: 2010 Willamette Spring Chinook Forecast

The final 2009 Willamette spring Chinook return is estimated at 39,400 total fish to the Columbia River mouth, compared to the 2000-2008 average of 76,000. An estimated 8,900 of these were unmarked fish. The 2009 total return was 52% of the recent 2000-2008. Clackamas River returns performed more poorly than expected in 2009, with only 4,300 spring Chinook returning to the Clackamas River.

The 2009 total return was 105% of the projected value (Table 1). The total return of hatchery fish in 2009 is estimated at 30,500 fish at the Columbia River mouth, compared to the 27,500 fish expected. Ladder counts indicate that about 21,000 marked hatchery fish passed through the fishway at Willamette Falls. The total return of marked hatchery fish to the Clackamas River is estimated at 3,300. The full reconstruction of the 2009 return is shown in Table 2.

Table 1. 2009 Willamette River projected and actual return (to Columbia River mouth).

	Columbia River Mouth Returns				
	Age 3	Age 4	Age 5	Age 6	Total
2009 Forecast	1,413	16,220	19,880	101	37,614
Lower	*859*	*9,564*	*15,317*	*0*	*25,704*
Upper	*2,672*	*21,862*	*40,300*	*117*	*64,951*
2009 Actual Return	**3,978**	**27,547**	**7,725**	**160**	**39,410**

The projection for 2009 assumed 27% of the return would be comprised of unmarked fish, which was greater than past assumptions of 10% wild fish, due to the high percentage of unmarked fish seen in the 2007 and 2008 returns (average 27%). Historic estimates of total wild returns were limited by absence of large-scale hatchery fin-marking programs prior to the 2000s. The return year 2003 was the first year in which all returning age classes of hatchery-reared fish were part of mass-marking programs. Prior to that time, fewer fish were adipose fin-clipped, making it impossible to directly estimate returns of wild fish. Current hatchery programs mark about 98% or more of the hatchery fish released in the Willamette Basin annually. Up to 2% of current hatchery releases are comprised of double-index coded-wire tag groups (DIT), which receive a CWT, but no fin clip. These fish are encountered and treated as "wild" in fisheries and run reconstructions that rely on adipose fin-clips to identify hatchery fish.

As has been noted in past years, there is a strong tendency for models used in projecting Willamette returns to underestimate the total return in years in which the run is increasing, and to overestimate the return in years in which the run is decreasing. This can be seen in the lag between projected and actual returns in Figure 1, as well as in the relationship shown in Figure 2. Projection errors are magnified by increasing or declining run size effects. Sources of error include variability in cohort survival and

environmental conditions, as well as process error in estimating harvest and escapement. Several alternative models have been examined to attempt to improve the projection models, a process that is conducted annually.

Most forecast models utilize cohort regressions, and estimated abundance of cohorts is derived from run reconstructions. Abundance data from Willamette Falls is useful because it represents the most complete count, and little estimation is involved in estimating the total passage – the only estimation procedure is the assignment of ages to fish observed in the ladder. However, the Willamette Falls models are less able to account for the effects of Columbia and Lower Willamette River fisheries on variability in predicted returns. Models based on Columbia River abundance estimates of each age class require the addition of other estimation procedures to account for harvest and mortality to these points. Some models also use estimates of ocean abundance of each age class, requiring assumptions regarding ocean harvest and mortality to be applied to the point estimates. All of these procedures can introduce process error in the projection models in addition to natural variation in the population.

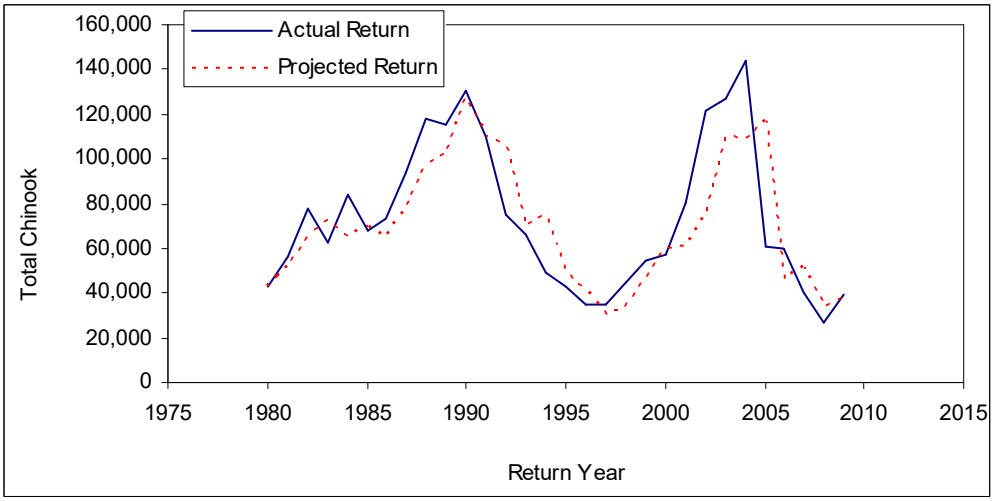

Figure 1. Actual and projected returns of Willamette River spring Chinook, 1975-2009.

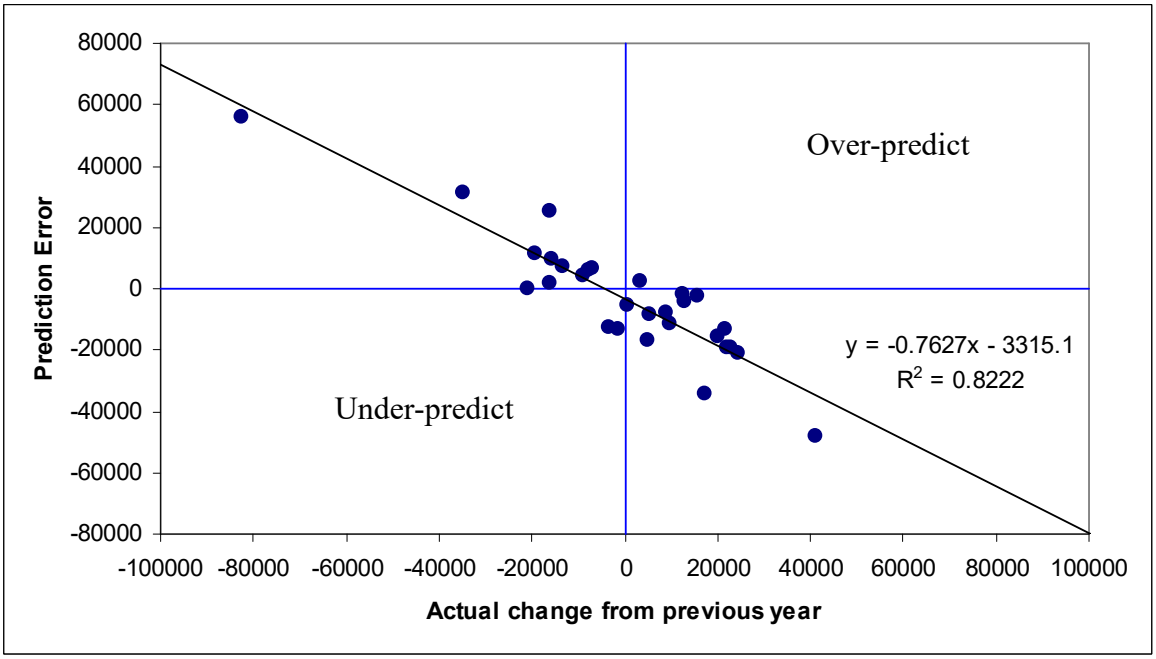

Figure 2. Errors in projections associated with declining or increasing run size effects.

Table 2. Preliminary summary of the 2009 Willamette River spring Chinook return.

Catch	Age 3	Age 4	Age 5	Age 6	Total
LCR Commercial	0	26	10	2	38
LCR Commercial (release mortality)	0	1	1	0	2
Select Area Commercial	0	243	40	0	283
LCR Sport (kept)	81	917	385	0	1,383
LCR Sport (release mortality)	2	17	8	0	27
L. Will. Sport Fishery (kept)	369	3,082	758	20	4,229
L. Will. Sport Fishery (release mortality)	11	93	23	1	128
L. Will. Sport Fishery (post-season hatchery rel. mortality)	12	102	25	1	140
L. Will. Sport Fishery (post-season wild rel. mortality)	1	4	1	0	6
Lower Clackamas Sport (kept)	122	157	27	0	306
Lower Clackamas Sport (release mortality)	5	6	1	0	12
Totals	603	4,648	1,279	24	6,554

Escapement	Age 3	Age 4	Age 5	Age 6	Total
Willamette Falls Count	2,719	20,596	5,064	135	28,514
Mortality Below Falls	0	78	56	0	134
Clackamas Hatchery swim-ins	254	968	603	0	1,825
Clackamas Hatchery transfers from N.F. Dam	197	500	311	0	1,008
Eagle Creek Hatchery Return	12	23	15	0	50
North Fork Dam, Passed Upstream	125	505	314	0	944
North Fork Dam, Recycled Downstream	32	38	23	0	93
Natural Spawn Bel. N.F. Dam	17	35	22	0	74
Sea Lion Predation	19	156	38	1	214
Totals	3,375	22,899	6,446	136	32,856
Run Entering Columbia	3,978	27,547	7,725	160	39,410
Run Entering Willamette	3,895	26,343	7,281	158	37,677
Run Entering Clackamas	764	2,232	1,316	0	4,312

Projections for Age 3 fish returning in 2010

In most years, either a simple cohort ratio of Age 2 (mini-jack) returns in year y versus Age 3 returns in year y+1 has been used to project Age 3 returns, or the recent 5-year average Age 3 return has been used. For the 2010 projection, the 5-yr average Age 3 return produces an estimate of 1,414 Age 3 fish, and will be used for the point estimate of the forecast.

Cohort regressions for projecting Age 3 returns from prior year Age 2 returns are problematic because the relationship between Age 2 and Age 3 returns is poor for Age 2 returns of less than 10,000 fish. For the 2009 return, the regression estimate of 1,260 Age 3 fish will be used for the lower bounds estimate. The 10-year average Age 3 return of 1,664 fish will be used for the upper bounds.

Projections for Age 4 fish returning in 2009

Age 4 returns are typically projected from the prior year's return of Age 3s. This relationship has worked well in most years, but did not accurately predict large Age 4 returns in the late 90s and early

2000s. In more recent years, the model has been relatively accurate compared with actual returns, although it substantially over-predicted the return of the Age 4s from the 2003 brood year (which was the poorest performing brood year on record). For 2010, this regression projects a return of 45,948 Age 4 fish, which will be used as the point estimate. This return would be the 7th largest returns of Age 4 fish since 1972.

The lower 95% CI of the linear regression of Age 3 to Age 4 (intercept forced to 0) will be used as the lower bounds (21,643 fish), and the upper 95% CI will be used for the upper bounds (74,297).

Although the point estimate for 2010 Age 4 returns may appear to be unreasonably high given recent returns, the point estimate for the Age 5 return appears to be somewhat lower than expected (see following paragraph), adding some conservation to the total estimate of adults returning.

Projections of Age 5 fish returning in 2009

Projections for Age 5 fish are estimated with methods similar to those for Age 4 fish. Similar issues exist regarding tendencies to over- or under-predict in decreasing or increasing run years, although in general, predictions of Age 5 fish from previous years' Age 4 fish have tended to be more accurate. For the last few return years, this accuracy has been reduced, and the cohort ratios of Age 4 versus Age 5 returns have differed markedly from historical averages. Because of this, the 2010 point estimate for Age 5 returns is based on a linear regression of Age 4 to Age 5 fish for more recent years, that incorporate the time period where the change in ratio has been observed. Using this model, the point estimate for the 2010 Age 5 return is 14,645 fish.

The lower bounds value is derived from Age 4 to Age 5 cohort ratios from the most recent 5 years, and produces an estimate of 12,176 fish. The upper bounds estimate of 19,449 is derived from a linear regression that includes only Age 4 returns of less than 30,000 fish as the predictor for Age 5s.

Projections for Age 6 fish returning in 2009

Age 6 comprise a very small portion of annual returns, and as a result are difficult to correlate with prior year returns of the same brood. Instead, the 10-year average return of 655 fish was used as the point estimate for the 2010 return. The lower bounds estimate of 308 fish was derived from a linear regression of Age 5 to Age 6 fish, and the upper bounds estimate of 671 fish was derived from the 5-year average return.

2010 Forecast Summary

Table 3. 2010 Projected Willamette spring Chinook return to Columbia River mouth.

	Columbia River Mouth Return				
	Age 3	Age 4	Age 5	Age 6	Total
2010 Forecast	**1,414**	**45,948**	**14,645**	**655**	**62,662**
Lower	1,260	21,643	12,176	308	35,386
Upper	1,664	74,297	19,449	671	96,081

The 2010 return contained an estimated 23% unmarked fish. For the period 2007-2009, the average mark rate was 75%. Assuming an unmarked return of 25% for 2010, the number of hatchery fish returning to the Columbia River mouth would be 47,000 fish (Table 4).

Table 4. 2010 Projected Willamette Basin (Clackamas included) spring Chinook hatchery fish return to Columbia River mouth.

	Columbia River Mouth Returns (hatchery fish only)				
	Age 3	Age 4	Age 5	Age 6	Total
2010 Forecast	**1,061**	**34,461**	**10,984**	**491**	**46,997**
Lower	945	16,232	9,132	231	26,540
Upper	1,248	55,723	14,587	503	72,061

Using a combination of regression models and cohort ratios similar to those used to estimate the total Willamette return, the 2010 Clackamas return is projected to be 6,800 Chinook. This estimate may underestimate the 2010 total return, because the Clackamas return data used to project the return is not reconstructed to the Columbia River mouth.

If the total Willamette Basin return shown in Table 3 is reduced by 6,800 fish to account for the Clackamas return, then further reduced by the 25% unmarked fish estimate discussed above, the final marked hatchery-fish return destined for areas above Willamette Falls (not including 2010 fishery removals) can be estimated (Table 5). This estimate ranges from a low of 21,500 total hatchery fish to a high of 67,000 total hatchery fish, with a point estimate of 41,900.

Table 5. 2010 Projected Columbia River mouth return of hatchery fish return destined for areas above Willamette Falls (not including fishery removals) after expected Clackamas turnoff.

	Columbia River Mouth Returns (hatchery fish only)				
	Age 3	Age 4	Age 5	Age 6	Total
2010 Forecast	**871**	**30,836**	**9,763**	**443**	**41,912**
Lower	755	12,607	7,911	182	21,455
Upper	1,059	52,098	13,366	454	66,977

Hatchery Surplus Estimates

The harvestable surplus of the 2010 return of hatchery fish is calculated by subtracting the Willamette FMEP hatchery fish escapement goals from the total estimated return. Based on the FMEP, at a total hatchery-fish run size of 47,000 fish, the escapement goals for Willamette Falls and the Clackamas River are 22,000 and 3,300 fish, respectively. This results in a harvestable surplus of 21,700 fish combined, with hatchery-fish surpluses of 19,900 and 1,800 for Willamette Falls and the Clackamas River, respectively. Of the total harvestable surplus, the FMEP specifies that 80% (17,360 fish) be allocated to recreational fisheries in the mainstem Columbia, lower Willamette, and lower Clackamas. The remaining 20% (4,340 fish) is to be allocated to commercial fisheries.

Appendix A. Estimates of wild Willamette River fish at the Columbia River mouth, 2000-2009 return years. The estimates include the effects of accounting for estimated returns of unmarked hatchery fish. Return years 2000-2001 included hatchery brood years that preceded mass-marking, and wild estimates for these years may be inaccurate due to lower proportions of marked hatchery fish in the returns.

Return Year	Age 3	Age 4	Age 5	Age 6	Sum	% Wild	3 yr avg % Wild
2000	946	3,698	0	129	4,773	8.28%	
2001	485	12,407	0	21	12,913	16.07%	
2002	297	17,013	5,365	0	22,676	18.63%	14.33%
2003	715	9,089	15,728	66	25,598	20.22%	18.31%
2004	170	14,097	10,405	232	24,903	17.24%	18.70%
2005	266	4,424	8,400	97	13,186	21.63%	19.70%
2006	72	8,154	2,845	282	11,353	19.03%	19.30%
2007	78	3,467	5,561	265	9,372	23.16%	21.27%
2008	198	4,531	923	27	5,679	21.00%	21.06%
2009	244	5,978	1,094	35	7,351	18.65%	20.94%