MEMORANDUM

Department of Fish and Wildlife
Intra Departmental

Date: December 7, 2011
To: Files, HQ
From: Chris Kern
Subject: 2012 Willamette Spring Chinook Forecast

The final 2011 Willamette spring Chinook return is estimated at 80,254 total fish to the Columbia River mouth (Table 1). An estimated 16,600 of these were unmarked fish (21%). The 2011 total return was 77% of forecast. Clackamas River returns returned at much less than forecasted; with 6,775 spring Chinook returning to the Clackamas River compared to an expected 12,000.

The total return of hatchery fish in 2011 is estimated at 63,700 fish at the Columbia River mouth, compared to 83,250 fish expected. Ladder counts indicate that about 31,600 marked hatchery fish and 13,500 unmarked fish passed through the fishway at Willamette Falls. The full reconstruction of the 2011 return is shown in Table 2.

Table 1. 2011 Willamette River projected and actual return (to Columbia River mouth).

	Columbia River Mouth Returns				
	Age 3	Age 4	Age 5	Age 6	Total
2011 Forecast	***1,309***	***39,764***	***62,375***	***618***	***104,067***
Lower	779	35,000	47,917	437	84,134
Upper	1,685	51,582	78,302	637	132,207
2011 Actual Return	**3,705**	**55,533**	**20,632**	**384**	**80,254**

The projection for 2011 assumed 20% of the return would be comprised of unmarked fish, based on the average percentage of unmarked fish seen in the 2009-2010 returns. The actual estimated unmarked rate for the full return in 2011 was 21%. 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 difficult to estimate returns of wild 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.

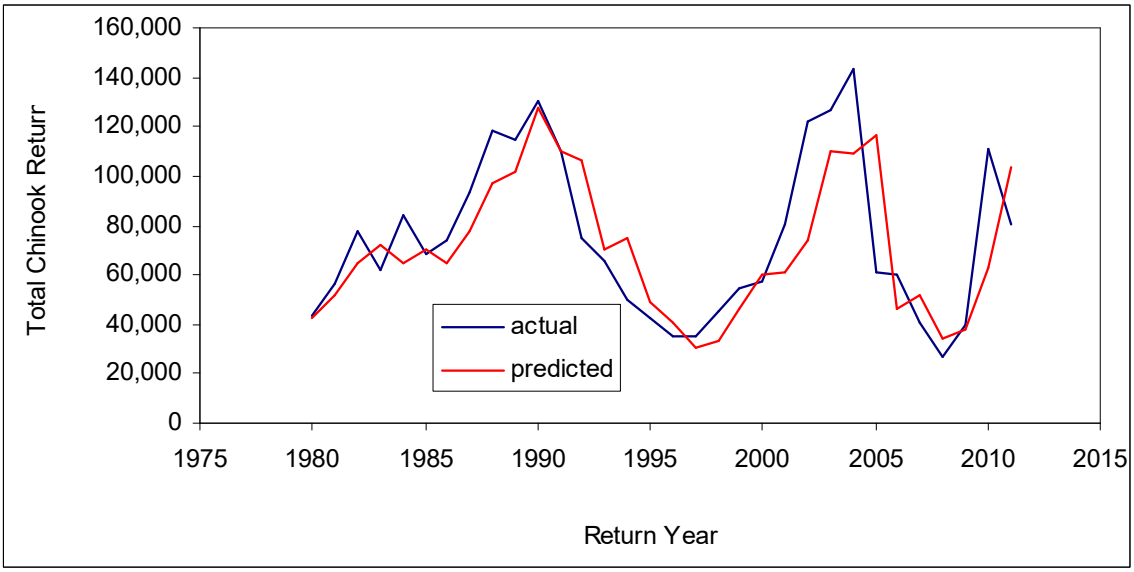

Figure 1. Actual and projected returns of Willamette River spring Chinook, 1975-2011.

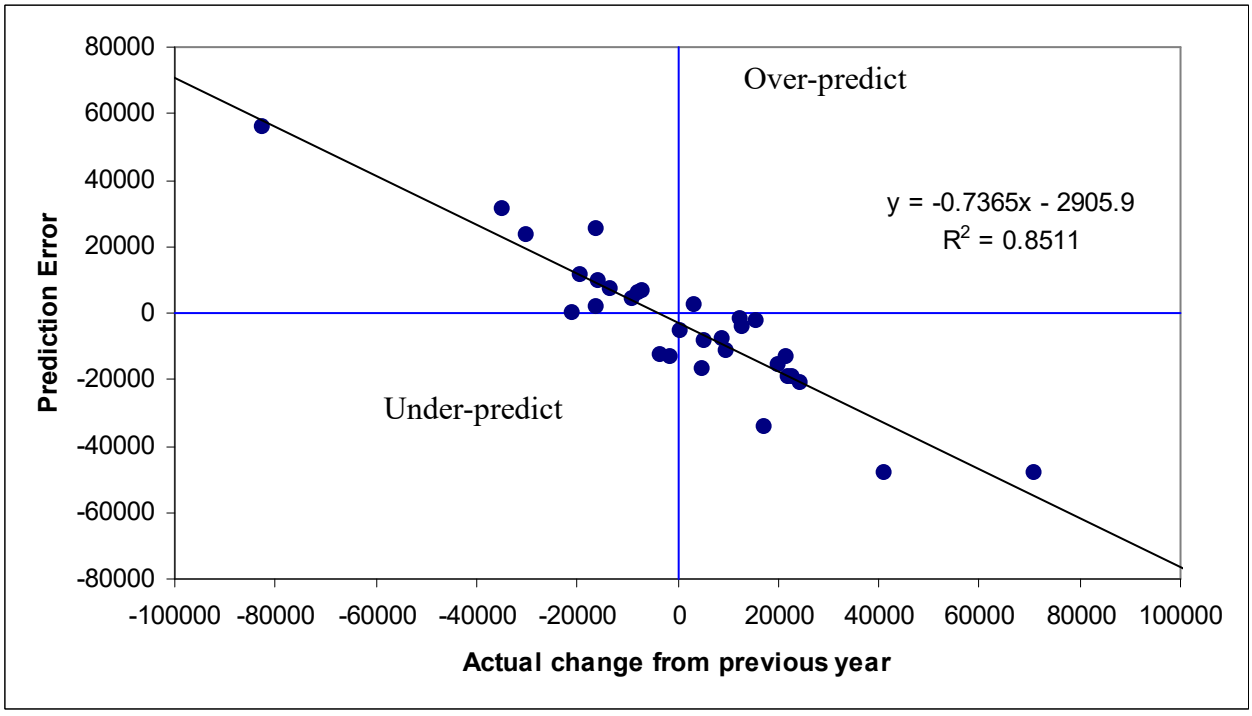

Figure 2. Errors in projections associated with declining or increasing run size effects.

Table 2. Preliminary summary of the 2011 Willamette River spring Chinook return.

Catch	Age 3	Age 4	Age 5	Age 6	Total
LCR Commercial (Gillnet)	36	644	432	17	1,129
LCR Commercial (Gillnet-rel. mortality)	3	72	45	1	121
Select Area Commercial	16	667	274	84	1,041
LCR Sport (kept catch)	83	1,174	788	13	2,058
LCR Sport (release mortality)	2	26	18	0	46
L. Will. Sport Fishery kept catch	1,782	15,175	5,335	72	22,364
L. Will. Sport Fishery release mortality [1]	38	319	113	2	472
Lower Clackamas Sport (kept catch)	38	442	46	0	526
Lower Clackamas Sport (rel. mortality) [1]	1	14	1	0	16
Totals	**1,999**	**18,533**	**7,052**	**189**	**27,773**
Escapement					
Willamette Falls Count [2]	1,399	32,256	11,340	152	45,147
Mortality Below Falls	7	65	22	0	94
Clackamas Hatchery swim-ins [2]	60	1,141	565	11	1,777
Clackamas Hatchery transfers from N.F. Dam [2]	72	1,368	677	14	2,131
Eagle Creek Hatchery Return [3]	1	7	4	0	12
North Fork Dam, Passed Upstream [2]	68	1,169	579	12	1,828
North Fork Dam, Recycled Downstream [2]	15	273	135	3	426
Natural Spawn Bel. N.F. Dam	4	37	18	0	59
Sea Lion Predation [4]	80	684	240	3	1,007
Totals	**1,706**	**37,000**	**13,580**	**195**	**52,481**
Run Entering Columbia	**3,705**	**55,533**	**20,632**	**384**	**80,254**
Run Entering Willamette	**3,565**	**52,950**	**19,075**	**269**	**75,859**
Run Entering Clackamas	**259**	**4,451**	**2,025**	**40**	**6,775**

Projections for Age 3 fish returning in 2011

In recent years, a regression of Age 2/3 cohort ratio versus Age 2 return has been used to predict the cohort ratio and project Age 3 returns. This method produces an estimate of 2,100 Age 3 fish, and will be used for the point estimate of the forecast. Alternative methodologies do not appear to be useful in explaining variation in projected returns, so no lower or upper bounds are provided.

Projections for Age 4 fish returning in 2011

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), and underestimated the 2010 return.

The relationship between Age 3 and Age 4 returns is problematic in that most models fail to adequately account for variability in the relationship at very high actual Age 4 returns, although many are able to account for variability at low actual returns.

For 2012, a linear regression of Age 3 versus Age 4, including a trend function of recent returns, yields a forecast of 60,700 Age 4 fish and will be used to project the 2012 abundance of Age 4 fish. The trend function is included in an attempt to address issues with missed forecasts on increasing/decreasing returns.

The lower and upper bound projections for Age 4 will be 43,000 (sibling regression with a PDO covariate) and 63,000 (sibling regression with NOAA ocean conditions ranking covariate), respectively.

Projections of Age 5 fish returning in 2011

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. In some recent return years, cohort ratios of Age 4 versus Age 5 returns have differed markedly from historical averages. Performance of Age 5 forecasts has been poor in recent years; this appears to be a result of a shift in the proportion of Age 5s returning in each brood year over the recent past.

Standard regressions have been unable to account for the observed recent shift in Age 5 proportions. As a result, this years Age 5 forecast is based on a 5 –year running average of the Age 4-to-Age 5 cohort ratio. This timeframe includes years in which Age 5 proportions have been particularly low, compared to historical averages. The projection for Age 5 returns for 2012 is 20,000 fish. If the Age 5 proportion in 2012 returns to the historic average, the actual return should substantially exceed this forecast. A model that includes recent year return trends is available, but produces a substantially higher Age 5 forecast that seems likely, given recent return performance. This model will be tracked into the future to see if the trend covariate is useful.

The lower and upper bounds will be 12,800 (last cohort ratio) and 43,000 (linear regression of Age 4 versus Age 5), respectively.

Projections for Age 6 fish returning in 2011

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, but also contribute few fish to total returns and forecast errors.

The 2012 projection of 500 fish is based on the 10-year average Age 5 to Age 6 cohort ratio.

2012 Clackamas Return

In 2011, a combination of sibling regressions for Age 4 and Age 5 returns, and 5 year average returns for Age 3 and Age 6 returns yielded a projection of about 12,000 fish. The actual return was substantially below the forecast. Using a regression of the sum of the last two year's jack returns versus the total return size for current year produces a projection that has been fairly accurate in past years; this method would have forecasted around 8,000 fish for 2011, far closer to the actual return of 6,775. This model has been used historically, with the addition of a covariate for hatchery smolt releases in the Clackamas basin. The addition of this covariate appears to provide little explanatory power, and it was dropped as a result. This model projects a total return of 8,000 fish for 2012. Age-specific forecasts are not shown here, but were calculated based on the average proportions of each age in Clackamas returns.

2012 Forecast Summary

Table 3. 2012 Projected Willamette spring Chinook return to Columbia River mouth.

	Columbia River Mouth Return				
	Age 3	Age 4	Age 5	Age 6	Total
2012 Forecast	2,097	60,692	20,101	512	83,402
Lower	2,097	42,968	12,797	512	53,384
Upper	2,097	63,040	43,050	512	108,699

The 2011 return contained an estimated 21% unmarked fish, which is similar to the average of the 2009 and 2010 returns combined. Assuming an unmarked return of 21% for 2012, the number of hatchery fish returning to the Columbia River mouth would be 65,900 fish (Table 4).

Table 4. 2012 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
2012 Forecast	1,657	47,946	15,880	405	65,888
Lower	1,657	33,944	15,122	405	51,127
Upper	1,657	49,801	34,010	405	85,872

Hatchery Surplus Estimates

The harvestable surplus of the 2012 return of hatchery fish is calculated by subtracting the Willamette FMEP hatchery fish escapement goals from the total estimated hatchery return. Based on the FMEP, at a total hatchery-fish run size of 65,900 fish, the escapement goals for Willamette Falls and the Clackamas River are 26,500 and 4,000 fish, respectively. This results in a harvestable surplus of 35,400 fish. Of the total harvestable surplus, the FMEP specifies that 73% (25,800 fish) be allocated to recreational fisheries in the mainstem Columbia, lower Willamette, and lower Clackamas. The remaining 27% (9,600 fish) is to be allocated to commercial fisheries.