MEMORANDUM

Department of Fish and Wildlife
Intra Departmental

Date: December 9, 2021
To: Files
From: Adam Storch
Subject: 2021 Willamette River Spring Chinook Run and 2022 Forecast

Summary of 2021 Willamette River Spring Chinook Return

The total Willamette River spring Chinook return to the Columbia River mouth during 2021 is estimated to be 43,148 fish (Table 1). An estimated 8,119 of these fish were unmarked (~19%). The 2021 reconstructed return was approximately 82% of forecast. The Clackamas River component was approximately 81% of forecast, with 3,733 spring Chinook returning to the Clackamas River compared to 4,640 (95% credible interval: 2,420–7,300) fish expected.

The total return of adipose-fin-marked hatchery fish to the Columbia River mouth in 2021 is estimated to be 35,029, compared to 38,260 fish expected. Counts at the Willamette Falls fishway indicate that 25,402 fin-marked hatchery fish and 4,623 unmarked fish passed the fish ladder. The full reconstruction of the 2021 return is shown in Table 2.

Table 1. 2021 forecasted and reconstructed return of Willamette River spring Chinook to Columbia River mouth.

	Columbia River Mouth Return					
	Age 3	Age 4	Age 5	Age 6	$Total_{adults}$	$Total_{jacks+adults}$
2021 Forcast	**2,350**	**32,820**	**17,140**	**90**	**50,050**	**52,400**
95% CrI	1,030–3,720	8,190–69,830	4,310–32,480	0–235		
2021 Reconstructed Return	**1,840**	**29,245**	**12,063**	**0**	**41,308**	**43,148**

The forecast for 2021 assumed 27% of the return would be comprised of unmarked fish based on the mean percentage of unmarked fish seen in the 2016–2020 returns. The actual unmarked rate for the full 2021 return is estimated to have been approximately 19%.

Table 2. Preliminary summary of the 2021 Willamette River spring Chinook return.

Catch	Age 3	Age 4	Age 5	Age 6	Total
SAF Commercial	0	148	114	0	262
LCR Sport (kept catch)	15	818	255	0	1,088
LCR Sport (release mortality)	0	10	4	0	14
L. Will. Sport Fishery (kept catch)	75	4,497	1,762	0	6,334
L. Will. Sport Fishery (release mortality)	2	98	39	0	139
Lower Clackamas Sport (kept catch)	1	2	2	0	5
Lower Clackamas Sport (rel. mortality)	0	1	0	0	1
Grand Ronde Will. Falls platform (kept catch)	0	0	0	0	0
Totals	93	5,574	2,176	0	7,843
Escapement					
Willamette Falls Count	1,379	20,581	8,065	0	30,025
Mortality Below Falls	2	135	53	0	190
Clackamas Hatchery swim-ins	144	196	137	0	477
Clackamas Hatchery transfers from N.F. Dam	15	97	68	0	180
Eagle Creek Hatchery Return	0	13	9	0	22
North Fork Dam, Passed Upstream	191	1,681	1,176	0	3,048
North Fork Dam, Recycled Downstream	0	0	0	0	0
Natural Spawn Bel. N.F. Dam	0	0	0	0	0
Sea Lion Predation	16	968	379	0	1,363
Totals	**1,747**	**23,671**	**9,887**	**0**	**35,305**
Run Entering Columbia	**1,840**	**29,245**	**12,063**	**0**	**43,148**
Run Entering Willamette	**1,825**	**28,269**	**11,690**	**0**	**41,784**
Run Entering Clackamas	**351**	**1,990**	**1,392**	**0**	**3,733**

Forecasted Willamette River Spring Chinook Return for 2022

Projections for Age-3 fish returning in 2022

The projected 2022 age-3 return was estimated as the product of the age-2 count at Willamette Falls in brood year 2018 and a cohort ratio predicted from a Bayesian implementation of a state-space model (i.e., Kalman Filter) where the process was a time-varying intercept for the linear regression of the logarithm of age-3 Columbia River return:age-2 Willamette Falls counts versus the logarithm of age-2 Willamette Falls counts. This approach produced an prediction of 1,740 (95% credible interval: 833–2,683) Age-3 fish returning to the Columbia River mouth.

Projections for Age-4 fish returning in 2022

Of the suite of models considered to predict the number age-4 Willamette River spring Chinook returning to the mouth of the Columbia River, the best was a state-space formulation of the linear regression of the logarithm of age-4 returns to the Columbia River mouth versus the logarithm of age-3 returns to the

Columbia River mouth and an ocean productivity metric (i.e., the ranking of NOAA ocean ecosystem indicators). In this application, the state or unobserved processes included a time-varying intercept and a time-varying slope for the age-3 predictor. The model predicts 34,962 (95% credible interval: 18,690–49,800) Age-4 fish returning to the Columbia River mouth in 2022.

Projections of Age-5 fish returning in 2022

The best model predicting age-5 returns of Willamette River spring Chinook to the Columbia River mouth in 2022 was again a state-space parameterization of the linear regression of the logarithm of age-5 returns versus the logarithm of age-4 returns, spring PDO (mean of May–August), spring transition date, and index of ichthyoplankton biomass and an index of copepod richness where the state process was a time-varying intercept. This model projects a 2021 age-5 return to the Columbia River mouth of 16,190 (95% credible interval: 4,659–29,420).

Projections for Age-6 fish returning in 2022

The projection for age-6 Willamette River spring Chinook returning to the Columbia River mouth in 2022 is 80 (95% credible interval: 0–230), estimated based on the running 5-year average age-6:age-5 cohort ratio.

2022 Clackamas River Forecasted Return

The best performing model predicting the total Clackamas River return applied the Kalman Filter method, where the state process was a time-varying intercept for the linear regression of the logarithm of the total return size versus of the sum of the prior two year's jack (age-3) returns. This produced a forecasted return of 4,247 (95% credible interval: 2,479–7,291) spring Chinook to the mouth of the Clackamas River.

2022 Forecast Summary

Table 3. 2022 projected Willamette basin (Clackamas included) spring Chinook return to Columbia River mouth and 95% credible intervals (95% CrI).

	Columbia River Mouth Return					
	Age 3	Age 4	Age 5	Age 6	$Total_{adults}$	$Total_{jacks+adults}$
2022 Forcast	**1,740**	**34,962**	**16,109**	**107**	**51,178**	**52,918**
95% CrI	833–2,683	18,690–49,800	4,659–29,420	0–312		

The 2021 return included an estimated 19% unmarked fish. Using the most recent five-year average of unmarked fish (~26%), the number of hatchery fish returning to the Columbia River mouth in 2022 is forecasted to be 39,090 (Table 4).

Table 4. 2022 projected Willamette basin (Clackamas included) spring Chinook **hatchery** fish return to Columbia River mouth and hatchery proportions of the 95% credible intervals (95% CrI) calculated for estimates of the total return (Table 3).

	Columbia River Mouth Return					
	Age 3	Age 4	Age 5	Age 6	$Total_{adults}$	$Total_{jacks+adults}$
2022 Forcast	**1,290**	**25,820**	**11,900**	**80**	**37,800**	**39,090**
Prop (95% CrI)	620–1,980	13,800–36,780	3,440–21,730	0–230		

Hatchery Surplus Estimates

The harvestable surplus of the 2022 return of hatchery fish is calculated by subtracting the hatchery fish escapement goals specified in the Willamette River Spring Chinook Fisheries Management and Evaluation Plan (FMEP) from the total forecasted hatchery component of the return. Based on the FMEP, at a total hatchery-fish run size of 39,090 fish, the escapement goals for Willamette Falls and the Clackamas River are 20,000 and 3,000 fish, respectively. This results in a harvestable surplus of 16,090 fish. Per the allocation schedule included in the FMEP 100% of this surplus is to be allocated to recreational fisheries with < 1% allocated as incidental for other fisheries.