MEMORANDUM

DEPARTMENT OF FISH AND WILDLIFE
INTRA DEPARTMENTAL

FROM: Adam Storch

TO: Files

SUBJECT: 2022 Willamette River spring Chinook Run and 2023 forecast

DATE GENERATED: 07 September 2023

Summary of 2022 Willamette River spring Chinook return

The total Willamette River spring Chinook return to the Columbia River mouth during 2022 is estimated to be 57,317 fish (Table 1). An estimated 10,728 of these fish were unmarked (~19%). The 2022 total reconstructed return was approximately 109% of forecast. The Clackamas River component was approximately 137% of forecast, with 6,432 spring Chinook returning to the Clackamas River compared to 4,700 (95% credible interval: 2,405–7,299) fish expected.

The total return of adipose-fin-marked hatchery fish to the Columbia River mouth in 2022 is estimated to be 46,589, compared to 37,008 (95% credible interval: 21,647–53,506) fish expected. Counts at the Willamette Falls fishway indicate that 31,937 fin-marked hatchery fish and 6,692 unmarked fish passed the fish ladder. The full reconstruction of the 2022 return is shown in Table 2.

Table 1. 2022 forecast and reconstructed return of Willamette River spring Chinook Salmon to Columbia River mouth.

	Age 3	Age 4	Age 5	Age 6	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$
2022 Forecast	1,731	34,728	16,107	107	50,941	52,673
95% CrI	774–2,714	18,568–50,183	4,548–29,472	0–319	30,712–72,448	32,806–74,606
2022 Reconstructed Return	1,926	37,907	17,435	49	55,391	57,317

To project hatchery returns in 2022, we assumed 30% of the total return would be comprised of unmarked fish based on a prediction from a Bayesian implementation of a univariate time-series model fit to non-clipped rates from 2008 through 2021. The actual (reconstructed) rate for the full 2022 return is estimated to have been approximately 19%.

Table 2. Preliminary summary of 2022 Willamette River spring Chinook Salmon return.

Catch	Age 3	Age 4	Age 5	Age 6	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$
SAF Commercial	0	462	387	0	849	849
LCR Sport (kept catch)	6	1,264	527	0	1,791	1,797
LCR Sport (release mortality)	0	14	5	0	19	19
L. Will. Sport Fishery kept catch	53	5,738	3,055	9	8,802	8,855
L. Will. Sport Fishery release mortality	1	112	60	0	172	173
Lower Clackamas Sport (kept catch)	0	12	1	0	13	13
Lower Clackamas Sport (rel. mortality)	0	2	0	0	2	2
Grand Ronde Will. Falls platform (kept catch)	0	9	5	0	14	14
Totals	60	7,613	4,040	9	11,662	11,722
Escapement						
Willamette Falls Count	1,572	24,156	12,861	40	37,057	38,629
Mortality Below Falls	1	72	38	0	110	111
Clackamas Hatchery swim-ins	43	2,062	106	0	2,168	2,211
PGE transfers to Clack Hatchery from N.F. Dam	0	538	28	0	566	566
Eagle Creek Hatchery Return	0	0	0	0	0	0
North Fork Dam, Passed Upstream	247	3,174	211	0	3,385	3,632
North Fork Dam, Recycled Downstream	0	0	0	0	0	0
Natural Spawn Bel. N.F. Dam	0	8	0	0	8	8
California Sea Lion Predation	3	284	151	0	435	438
Totals	1,866	30,294	13,395	40	43,729	45,595
Run Entering Columbia	1,926	37,907	17,435	49	55,391	57,317
Run Entering Willamette	1,920	36,167	16,516	49	52,732	54,652
Run Entering Clackamas	290	5,796	346	0	6,142	6,432

Projected Willamette River spring Chinook Salmon return in 2023

Age-3

The projected 2023 age-3 return was estimated as the product of the age-2 count at Willamette Falls in brood year 2021 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 1,974 (95% credible interval: 957–3,107) Age-3 fish returning to the Columbia River mouth.

Age-4

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 supported 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 52,106 (95% credible interval: 25,042–80,439) Age-4 fish returning to the Columbia River mouth in 2023.

Age-5

The best supported model predicting age-5 returns of Willamette River spring Chinook to the Columbia River mouth in 2023 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 2023 age-5 return to the Columbia River mouth of 19,082 (95% credible interval: 5,732–34,973).

Age-6

The projection for age-6 Willamette River spring Chinook returning to the Columbia River mouth in 2023 is 109 (95% credible interval: 0–385), estimated based on the running 5-year average age-6:age-5 cohort ratio.

Clackamas River forecast

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 forecast return of 6,590 (95% credible interval: 3,406– 3,107.0000, 80,439.0000, 34,973.0000, 385.0000, 104,362.0000, 106,454.0000, 2,472.0000, 64,069.0000, 27,725.0000, 305.0000, 84,297.0000, 85,160.0000, 0.3528, 10,327.0000, 100,573.0000, 98,128.0000) spring Chinook to the mouth of the Clackamas River.

Summary

Table 3. 2023 projected Willamette Basin (Clackamas included) spring Chinook return to Columbia River mouth and 95% credible intervals (95% CrI).

	Age 3	Age 4	Age 5	Age 6	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$
2023 Forecast	1,974	52,106	19,082	109	71,297	73,270
95% CrI	957–3,107	25,042–80,439	5,732–34,973	0–385	39,971–104,362	41,996–106,454

The 2022 return included an estimated 19% unmarked fish. Applying a prediction from a Bayesian implementation of a univariate time-series model fit to non-clipped rates from 2008 through 2022 (~22%), the total number of hatchery fish returning to the Columbia River mouth in 2023 is forecast to be 57,321 (95% credible interval: 31,317–85,160) (Table 4).

Table 4. 2023 projected Willamette Basin (Clackamas included) spring Chinook hatchery fish return to Columbia River mouth and 95% credible intervals (95% CrI).

	Age 3	Age 4	Age 5	Age 6	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$
2023 Forecast	1,544	40,763	14,929	85	55,777	57,321
95% CrI	724–2,472	18,768–64,069	4,402–27,725	0–305	30,681–84,297	31,317–85,160

	Age 3	Age 4	Age 5	Age 6	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$

Hatchery surplus estimates

The harvestable surplus of the 2023 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 forecast hatchery component of the return. Based on the FMEP, at a total hatchery-fish run size of 57,321 fish, the escapement goals for Willamette Falls and the Clackamas River are 24,000 and 3,600 fish, respectively. This results in a harvestable surplus of 29,721 fish. Per the allocation schedule included in the FMEP, 76% of this surplus is to be allocated to recreational fisheries and 24% to commercial fisheries.