MEMORANDUM

DEPARTMENT OF FISH AND WILDLIFE
INTRA DEPARTMENTAL

FROM: Adam Storch

TO: Files

SUBJECT: 2023 Willamette River spring Chinook Run and 2024 forecast

DATE GENERATED: 13 June 2023

Summary of 2023 Willamette River spring Chinook return

The total Willamette River spring Chinook return to the Columbia River mouth during 2023 is estimated to be 43,148 fish (Table 1). An estimated 8,119 of these fish were unmarked (~19%). The 2023 total reconstructed return was approximately 59% of forecast. The Clackamas River component was approximately 57% of forecast, with 3,733 spring Chinook returning to the Clackamas River compared to 6,595 (95% credible interval: 3,361–10,262) fish expected.

The total return of adipose-fin-marked hatchery fish to the Columbia River mouth in 2023 is estimated to be 35,029, compared to 57,265 (95% credible interval: 31,504–85,245) 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 2022 return is shown in Table 2.

Table 1. 2023 forecast and reconstructed return of Willamette River spring Chinook Salmon to Columbia River mouth.

	Age 3	Age 4	Age 5	Age 6	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$
2023 Forecast	1,976	52,058	19,077	109	71,244	73,220
95% CrI	952–3,085	25,396–80,630	5,957–35,262	0–388	40,345–104,573	42,797–107,060
2023 Reconstructed Return	1,840	29,245	12,063	0	41,308	43,148

To project hatchery returns in 2023, I assumed 22% 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 2022. The actual (reconstructed) rate for the full 2023 return is estimated to have been approximately 19%.

Table 2. Preliminary summary of 2023 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	148	114	0	262	262
LCR Sport (kept catch)	15	818	255	0	1,073	1,088
LCR Sport (release mortality)	0	10	4	0	14	14
L. Will. Sport Fishery kept catch	75	4,497	1,762	0	6,259	6,334
L. Will. Sport Fishery release mortality	2	98	39	0	137	139
Lower Clackamas Sport (kept catch)	1	2	2	0	4	5
Lower Clackamas Sport (rel. mortality)	0	1	0	0	1	1
Grand Ronde Will. Falls platform (kept catch)	0	0	0	0	0	0
Totals	93	5,574	2,176	0	7,750	7,843
Escapement						
Willamette Falls Count	1,379	20,581	8,065	0	28,646	30,025
Mortality Below Falls	2	135	53	0	188	190
Clackamas Hatchery swim-ins	144	196	137	0	333	477
Clackamas Hatchery transfers from N.F. Dam	15	97	68	0	165	180
Eagle Creek Hatchery Return	0	13	9	0	22	22
North Fork Dam, Passed Upstream	191	1,681	1,176	0	2,857	3,048
North Fork Dam, Recycled Downstream	0	0	0	0	0	0
Natural Spawn Bel. N.F. Dam	0	0	0	0	0	0
Sea Lion Predation	16	968	379	0	1,347	1,363
Totals	1,747	23,671	9,887	0	33,558	35,305
Run Entering Columbia	1,840	29,245	12,063	0	41,308	43,148
Run Entering Willamette	1,825	28,269	11,690	0	39,959	41,784
Run Entering Clackamas	351	1,990	1,392	0	3,382	3,733

Projected Willamette River spring Chinook Salmon return in 2024

Age-3

The projected 2024 age-3 return was estimated as the product of the age-2 count at Willamette Falls in brood year 2022 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 1,956 (95% credible interval: 946–3,027) 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 32,972 (95% credible interval: 18,491–46,814) Age-4 fish returning to the Columbia River mouth in 2024.

Age-5

The best supported model predicting age-5 returns of Willamette River spring Chinook to the Columbia River mouth in 2024 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 2024 age-5 return to the Columbia River mouth of 13,526 (95% credible interval: 3,788–25,339).

Age-6

The projection for age-6 Willamette River spring Chinook returning to the Columbia River mouth in 2024 is 65 (95% credible interval: 0–268), 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 4,585 (95% credible interval: 2,325–7,074) spring Chinook to the mouth of the Clackamas River.

Summary

Table 3. 2024 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	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$
2024 Forecast	1,956	32,972	13,526	65	46,563	48,519
95% CrI	946–3,027	18,491–46,814	3,788–25,339	0–268	28,026–65,212	30,120–67,356

The 2023 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 2023 (~19%), the total number of hatchery fish returning to the Columbia River mouth in 2024 is forecast to be 39,126 (95% credible interval: 23,243–55,567) (Table 4).

Table 4. 2024 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	$\text{Total}_{\text{adults}}$	$\text{Total}_{\text{adults+jacks}}$
2024 Forecast	1,577	26,589	10,907	53	37,549	39,126
95% CrI	742–2,480	14,296–38,676	3,103–20,766	0–216	21,771–53,887	23,243–55,567

Hatchery surplus estimates

The harvestable surplus of the 2024 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 39,126 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 16,126 fish. Per the allocation schedule included in the FMEP, 100% of this surplus is to be allocated to recreational fisheries and <1% of the predicted return as incidental catch for other fisheries.