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MEMORANDUM

TO: Distribution

DATE: January 30, 2025

FROM: Nick DeCovich, Research Biologist
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SUBJECT: Forecast for the 2025 Deshka River king salmon run, and synopsis of 2024 run

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The point estimate of the preseason forecast for the 2025 Deshka River king salmon total run is 5,208 fish (ages 1.1–1.4). The 80% prediction interval, based upon the variability between forecast and actual total runs, is 1,837 to 14,767 fish (Table 1). The escapement, without harvest, is forecast to fall below the biological escapement goal of 9,000–18,000 fish. The preseason forecast estimate is 59% less than the recent ten-year (2015–2024) average run of 12,674 age-1.1–1.4 fish, and 82% less than the long-term (1979–2024) average of 29,263 fish.

The forecast for 2025 is the sum of individual age class forecasts. We examined estimates for three classes of models: sibling relationships, Ricker spawner-recruit relationships, and moving averages (Table 2). This forecast is the sum of individual age-specific (total age 3, 4, 5, and 6) model averaged forecasts of abundance. The sibling relationship and Ricker models were first tested for model significance ($p \leq 0.05$) and excluded if there was no significant relationship. Hindcasts by age were produced for each return year as one-step-ahead predictions (forecasts) using the estimates from prior years. The variability among forecasted and estimated total runs for each model was assessed using the mean deviation (MD), mean absolute deviation (MAD), and mean absolute arctangent percent error (MAAPE). The 5-year MAAPEs were model averaged to produce each age-specific forecast. The MAAPE model average for each age class is the average of the forecast from each model weighted by the normalized inverse MAAPE from each model. Note that only the 5-year geometric mean was used for age-1.1 fish, as it is the only applicable model as this age class has no returns from the prior year to inform other types of models.

The preliminary 2024 escapement estimate, which is simply the Deshka River weir count as no inriver harvest was allowed, was 3,440, which is far below the lower end of the escapement goal (9,000–18,000) and is also the lowest escapement on record. The second lowest escapement was 3,741, observed in 2023 (Table 3). The forecasted total run for 2024 for all age classes was 6,671, and the estimated actual total run (escapement plus marine harvest) was 3,581, a difference of -46%. When considering missed escapements estimates as an indicator of stock health, it is important to remember that the department establishes escapement goals to produce the maximize yield and a management reference point designed to ensure sustainability would be lower than the lower bound of the yield-based escapement goals.

The 2018 brood year return was completed with the 2024 run of age-1.4 fish. The 2018 brood year produced a total return of 5,125 king salmon (return per spawner = 0.60). This was less productive than the 2017 brood year, which had a return-per-spawner of 0.75.

There is considerable uncertainty in the 2025 Deshka River king salmon total run forecast estimate. The models used for Deshka River king salmon tend to over-forecast the total run (Table 4). Total run was over-forecasted in 7 of the last 10 years. The forecast was within 5% of the estimated run only once in the last 10 years. The Deshka king salmon forecast has differed by -66% to +45% from the estimated run in the past 10 years (Table 4). Note that table 4 excludes age-1.1 fish for both forecasts and estimated run size because adding age-1.1 fish to the forecast has only been done in recent years. Therefore, the age range for this table was condensed to allow historical comparisons of forecast performance.

The best way to consider this salmon forecast is in terms of 3 broad categories: approximately average run (within 25% of the historical average), below average run, or above average run. The 2025 forecast gives the expectation of a run in the below average run category (see footnote Table 4).

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Table 1. – Forecast king salmon 2025 total run with 80% prediction interval (PI) for the Deshka River, and the relative fit of each model to the previous 5 years of estimated runs by age. Note that the sibling model was not used for age-1.2 (total age 4) fish and the Ricker model not used for age-1.3 (total age5)fish because these models were insignificant ($p > .05$).

Age	Model	2025 Forecast	5-year Average			MAAPE weight
			MD[a]	MAD[b]	MAAPE[c]	
3	5-yr geometric mean	1,878	-45	451	0.24	1.00
	MAAPE model average	**1,878**				
4	Exponential Smooth	1,471	814	2,960	0.82	0.23
	5-yr geometric mean	2,112	-72	1,530	0.56	0.33
	ARIMA	2,247	1,213	2,871	0.89	0.21
	Ricker	1,282	1,573	2,153	0.79	0.24
	MAAPE model average	**1,800**				
5	Exponential Smooth	1,169	555	4,715	1.05	0.22
	5-yr geometric mean	2,075	1,103	4,529	1.03	0.23
	ARIMA	1,135	515	4,706	1.04	0.22
	Sibling	1,620	1,623	1,623	0.71	0.33
	MAAPE model average	**1,515**				
6	Exponential Smooth	11	45	75	0.60	0.33
	5-yr geometric mean	42	193	193	1.04	0.19
	ARIMA	5	36	86	0.63	0.32
	Sibling	8	1,235	1,261	1.23	0.16
	MAAPE model average	**14**				
2025 Total Forecast (80% PI)		**5,208 (1,837-14,767)**				

[a] mean deviation

[b] mean absolute deviation

[c] mean absolute arctangent percent error

Table 2. – Brief description of statistical models used to forecast the 2025 Deshka River king salmon run.

Model	Description
5-year geometric mean	A moving average on the natural log of abundance in each age class.
Exponential smoothing	A weighted moving average on the natural log of abundance in each class.
ARIMA	AutoRegressive Integrated Moving Average analysis on the natural log of abundance in each age class.
Sibling model	Regression between the natural logs of annual abundance in an age class and the most recent return of siblings from the same brood year.
Ricker Model	Ricker-style regression on the natural log of abundance for each age class.

Table 3. – Estimates of Deshka River king salmon by age class for years 1979–2024.

Run year	1.1	1.2	1.3	1.4	1.5	Total run age-1.2 - 1.4	Total run all ages	Escapement all ages
1979	0	4,455	38,185	21,002	0	63,642	63,642	60,607
1980	0	3,915	19,967	15,269	0	39,151	39,151	35,096
1981	0	2,626	14,969	8,666	0	26,261	26,261	23,162
1982	0	5,472	18,940	18,098	0	42,510	42,510	37,222
1983	0	10,341	22,620	16,258	0	49,219	49,219	43,871
1984	0	7,681	21,235	16,265	0	45,180	45,180	39,054
1985	0	7,219	20,962	20,337	12	48,518	48,530	41,640
1986	17	18,532	22,480	15,206	46	56,218	56,281	47,657
1987	8	6,877	23,659	12,448	10	42,984	43,002	35,226
1988	494	6,175	12,809	30,545	1,002	49,529	51,025	43,795
1989	510	8,287	8,559	15,311	419	32,157	33,086	23,246
1990	451	8,320	21,394	19,134	155	48,848	49,454	41,671
1991	0	4,753	10,866	15,713	1	31,332	31,333	21,020
1992	3,036	5,733	8,811	10,437	10	24,980	28,026	20,248
1993	3	4,688	10,309	7,294	8	22,292	22,302	16,207
1994	5	1,753	4,620	4,338	102	10,711	10,817	9,832
1995	109	4,070	3,106	3,295	168	10,472	10,749	10,048
1996	11	7,098	5,562	2,007	0	14,667	14,678	14,349
1997	77	6,094	23,652	6,080	0	35,825	35,902	35,587
1998	0	10,682	15,639	10,351	116	36,672	36,788	36,310
1999	0	10,358	14,707	8,560	69	33,625	33,695	29,649
2000	2	4,514	32,807	4,261	0	41,581	41,583	33,965
2001	479	8,038	15,505	9,413	2	32,955	33,436	27,966
2002	534	8,853	18,865	5,272	0	32,991	33,525	28,535
2003	474	16,694	22,575	6,545	0	45,813	46,288	39,257
2004	662	11,916	43,691	9,930	0	65,536	66,198	56,659
2005	541	12,932	25,598	5,247	0	43,778	44,318	36,433
2006	0	8,729	21,153	8,493	0	38,375	38,375	29,922
2007	0	2,166	17,021	4,745	0	23,932	23,932	17,594
2008	0	1,565	3,796	4,635	0	9,996	9,996	7,284
2009	0	8,468	3,052	1,149	0	12,668	12,668	11,641
2010	196	4,573	15,288	1,895	0	21,756	21,952	18,223
2011	508	5,900	14,147	1,523	0	21,569	22,077	18,553
2012	659	8,674	4,117	2,416	0	15,207	15,866	13,952
2013	776	4,229	11,549	3,244	0	19,023	19,799	18,378
2014	1,536	6,996	7,035	2,157	0	16,188	17,724	16,099
2015	2,855	7,089	12,673	3,304	0	23,065	25,920	23,627
2016	4,029	10,858	8,701	1,750	0	21,310	25,339	22,099
2017	1,111	1,564	8,959	1,229	0	11,752	12,863	11,034
2018	3,401	2,180	3,052	87	0	5,319	8,720	8,549
2019	961	1,378	7,266	251	0	8,894	9,855	9,705
2020	2,209	7,253	1,510	295	0	9,057	11,266	10,638
2021	2,912	3,049	13,387	176	0	16,612	19,524	18,652
2022	1,281	1,247	3,003	189	0	4,438	5,720	5,440
2023	1,513	1,489	952	0	0	2,442	3,955	3,741
2024	1,876	1,024	666	14	0	1,705	3,581	3,440

Table 4. – Accuracy of the Deshka River king salmon forecast for the three major age classes, 1999–2024. Note that this table excludes age-1.1 fish for both forecasted runs and estimated actual runs because forecasts for this age class have not been consistently produced.

Return year	Forecast run	Forecast category[a]	Estimated run	Estimated run category[a]	Age-1.2	Age-1.3	Age-1.4	Overall effect	Relative difference
					Forecast difference by major age class (forecast-estimated)				
1999	26,810	average	33,625	above	-4,421	-463	-1,931	underforecast	25%
2000	33,337	above	41,581	above	3,648	-17,550	5,657	underforecast	25%
2001	40,753	above	32,955	above	514	-5,693	12,976	overforecast	-19%
2002	43,805	above	32,991	above	983	5,625	4,207	overforecast	-25%
2003	41,041	above	45,813	above	-8,386	-782	4,395	underforecast	12%
2004	60,833	above	65,536	above	-2,383	-369	-1,952	underforecast	8%
2005	48,687	above	43,778	above	-4,587	3,133	6,364	overforecast	-10%
2006	49,071	above	38,375	above	-611	12,098	-791	overforecast	-22%
2007	37,007	above	23,932	average	6,601	4,188	2,286	overforecast	-35%
2008	20,268	average	9,996	below	6,375	1,931	1,967	overforecast	-51%
2009	20,593	average	12,668	below	1,059	4,161	2,704	overforecast	-38%
2010	30,775	average	21,756	average	4,959	3,059	1,001	overforecast	-29%
2011	21,080	average	21,569	average	401	-3,992	3,101	underforecast	2%
2012	21,665	average	15,207	below	-4,046	9,484	1,020	overforecast	-30%
2013	26,791	average	19,023	average	3,183	6,659	-2,073	overforecast	-29%
2014	19,063	average	16,188	below	-499	1,527	1,846	overforecast	-15%
2015	20,418	average	23,065	average	-862	-2,012	226	underforecast	13%
2016	24,638	average	21,310	average	-4,032	4,132	3,229	overforecast	-14%
2017	17,813	average	11,752	below	5,248	-560	1,373	overforecast	-34%
2018	10,595	below	5,319	below	4,725	-1,788	2,339	overforecast	-50%
2019	8,466	below	8,894	below	2,516	-3,742	797	underforecast	5%
2020	10,570	below	9,057	below	-4,170	5,796	-114	overforecast	-14%
2021	11,464	below	16,612	below	3,283	-8,535	104	underforecast	45%
2022	9,332	below	4,438	below	1,269	3,622	9	overforecast	-52%
2023	5,324	below	2,442	below	938	1,801	185	overforecast	-54%
2024	5,034	below	1,705	below	1,209	2,132	-11	overforecast	-66%
							Average relative difference, 1999-2024		-15%

[a] Average category is defined as within +/- 25% of the the 1999-2024 estimated run average of 22,292 age-1.2-1.4 fish.