



MEMORANDUM

TO: Distribution
DATE: January 24, 2020

FROM: Nick DeCovich, Northern Cook Inlet Area
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SUBJECT: Outlook for the 2020
Deshka River king
salmon run, and
accuracy of the 2019
forecast

The point estimate of the preseason forecast for the 2020 Deshka River king salmon total run is 10,570 age 1.2-1.4 fish, which is below the sustainable escapement goal (SEG) of 13,000-28,000. The 80% prediction interval for the total run forecast is 1,860 to 19,280 fish (Table 1). This forecast estimate is 35% less than the ten-year (2010 – 2019) average run of 16,274 age 1.2-1.4 fish, 66% less than the long-term (1979 – 2019) average run of 30,865 fish, and 25% greater than the forecast for the 2019 run (8,466).

The forecast for 2020 is the sum of individual age class forecasts. We examined three classes of models: sibling relationships, Ricker spawner-recruit relationships, and recent year moving averages. The models chosen were those with statistically significant parameters that have the greatest past reliability (accuracy and precision). Specifically, the model estimates selected for each age class for inclusion in the 2020 forecast were those with the minimum recent five year's mean absolute deviation (MAD). We calculated the MAD as the mean of the absolute distance between hindcasted estimates for the previous five years and the actual returns for each age class. The hindcasts were produced for each return year as one step ahead predictions using the estimates from all prior years.

The univariate time series model was selected for age-1.2 fish; the five-year moving average was selected for age-1.3 fish; and the univariate time series model also selected for age-1.4 fish (Table 1). For a description of each model considered see Table 2.

Estimates of age-1.1 'jack' king salmon at the Deshka weir were very low in the previous 3 decades (1980's – early 2000's). In many years, zero to a few hundred fish of this age class were estimated through the weir. For this reason, past years forecasts have focused on age 1.2 – 1.4 fish. In recent years, there has been an increase in the number of jacks estimated at the weir, and efforts are underway to evaluate how this phenomenon could impact future production (Table 3).

The preliminary estimate of last year's (2019) Deshka River king salmon total run is 8,804 fish age-1.2, 1.3, and 1.4 (Table 3). The forecast estimate of total run for 2019 for these age classes was 8,466, a difference of only 4%. The average difference between the forecast total run and

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actual total run, for years 1999–2019 is -16% (Table 4). The 2019 actual total run was 62% less than the ten-year (2009 – 2018) average run of 16,647.

The age 2019 run completed the return of the 2013 brood year (BY). The 2013 BY produced a total return of 8,781 king salmon (return per spawner = 0.48). This was less productive than the 2012 brood year, which had a return-per-spawner of 1.62.

There is uncertainty in the total 2020 Deshka River king salmon forecast estimate. One pattern to this uncertainty is that the models used tend to over-forecast when runs are declining and under-forecast when they are rebounding. The Deshka king salmon forecast has differed by 12% to -51% from the actual run in the past ten years (-19% average).

The best way to consider this salmon forecast is in terms of 3 broad categories: approximately average run, below average run, or above average run. The 2020 forecast gives the expectation of a run in the below average category.

Table 1.— Forecast king salmon abundance of major age classes for the Deshka River in 2020 using various models, and the relative performance of each model to the previous 5 years of actual runs as measured by MAD (mean absolute deviation).

Model	Forecast 2020	Model chosen	5-year MAD
Age 1.2			
5-year moving average	3,198		3,469
Exponential smoothing	1,866		4,088
Univariate time series	3,083	*	3,147
Sibling	^a		
Ricker	3,460		3,533
Age 1.3			
5-year moving average	7,306	*	2,179
Exponential smoothing	6,138		2,970
Univariate time series	9,451		3,743
Sibling	2,395		3,147
Ricker	10,913		3,588
Age 1.4			
5-year moving average	678		1,194
Exponential smoothing	227		900
Univariate time series	181	*	858
Sibling	447		1,259
Ricker	^b		

Total forecast 10,570 (1,860 - 19,280, 80% PI)

^a There was no significant sibling relationship with 1.2 age fish.

^b The Ricker model was insignificant for 1.4 age fish.

Table 2. – Brief description of statistical models used in forecasting the Deshka River king salmon run for 2020. All calculations done using R software.

Model	Description
5-year moving average	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.
Univariate time series	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 for each age class.

Table 3. – Estimate of Deshka River king salmon by age class in the run for years 1979 – 2019.

Run Year	Number per Age Class					Total Run	Total Run
	1.1	1.2	1.3	1.4	1.5	age 1.2 - 1.4	all ages
1979	0	4,449	38,131	20,972	0	63,552	63,552
1980	0	3,900	19,891	15,211	0	39,002	39,002
1981	0	2,613	14,893	8,622	0	26,128	26,128
1982	0	5,442	18,838	18,001	0	42,282	42,282
1983	0	10,300	22,543	16,191	0	49,034	49,034
1984	0	7,651	21,154	16,203	0	45,008	45,008
1985	0	7,214	20,841	20,274	7	48,328	48,336
1986	10	18,330	22,105	14,970	27	55,405	55,443
1987	5	6,740	23,345	12,207	6	42,291	42,302
1988	493	6,069	12,611	30,149	995	48,829	50,317
1989	506	8,152	8,314	14,970	414	31,436	32,357
1990	445	8,212	21,165	18,930	147	48,307	48,899
1991	0	4,634	10,715	15,564	0	30,913	30,914
1992	3,032	5,639	8,696	10,331	6	24,666	27,703
1993	1	4,650	10,207	7,172	4	22,029	22,034
1994	3	1,698	4,533	4,260	99	10,490	10,592
1995	105	3,961	3,026	3,200	161	10,188	10,454
1996	6	7,022	5,486	1,962	0	14,470	14,475
1997	74	6,062	23,592	6,054	0	35,709	35,783
1998	0	10,593	15,572	10,306	115	36,470	36,585
1999	0	10,079	14,338	8,384	67	32,801	32,868
2000	1	4,468	32,678	4,210	0	41,356	41,357
2001	477	7,934	15,444	9,372	1	32,751	33,229
2002	533	8,791	18,776	5,221	0	32,788	33,321
2003	472	16,631	22,489	6,520	0	45,640	46,112
2004	660	11,877	43,550	9,898	0	65,325	65,985
2005	538	12,864	25,464	5,220	0	43,549	44,087
2006	0	8,660	20,987	8,426	0	38,074	38,074
2007	0	2,141	16,818	4,689	0	23,648	23,648
2008	0	1,520	3,686	4,502	0	9,708	9,708
2009	0	8,376	3,019	1,137	0	12,531	12,531
2010	195	4,542	15,182	1,882	0	21,605	21,800
2011	504	5,856	14,042	1,511	0	21,410	21,913
2012	654	8,611	4,087	2,398	0	15,096	15,750
2013	770	4,197	11,460	3,219	0	18,876	19,647
2014	1,526	6,960	6,982	2,127	0	16,068	17,594
2015	2,830	7,020	12,621	3,287	0	22,928	25,759
2016	4,024	10,828	8,639	1,743	0	21,209	25,233
2017	1,101	1,501	8,826	1,174	0	11,500	12,601
2018	3,352	2,148	3,008	86	0	5,242	8,594
2019	951	1,364	7,192	248	0	8,804	9,755

Table 4. – Accuracy of the Deshka River king salmon outlook for the three major age classes, 1999–2019.

Return year	Forecast run	Forecast category	Actual run	Forecast difference by major age class (forecast-actual)					Overall effect	Relative difference
				Actual run	Age 1.2	Age 1.3	Age 1.4			
1999	26,810	average	32,801	above	-4,142	-94	-1,755	underforecast	22%	
2000	33,337	above	41,356	above	3,694	-17,421	5,708	underforecast	24%	
2001	40,753	above	32,751	above	618	-5,632	13,017	overforecast	-20%	
2002	43,805	above	32,788	above	1,045	5,714	4,258	overforecast	-25%	
2003	41,041	above	45,640	above	-8,323	-696	4,420	underforecast	11%	
2004	60,833	above	65,325	above	-2,344	-228	-1,920	underforecast	7%	
2005	48,687	above	43,549	above	-4,519	3,267	6,391	overforecast	-11%	
2006	49,071	above	38,074	above	-542	12,264	-724	overforecast	-22%	
2007	37,007	above	23,648	average	6,626	4,391	2,342	overforecast	-36%	
2008	20,268	average	9,708	below	6,420	2,040	2,100	overforecast	-52%	
2009	20,593	average	12,531	below	1,151	4,194	2,716	overforecast	-39%	
2010	30,775	average	21,605	average	4,990	3,165	1,014	overforecast	-30%	
2011	21,080	average	21,410	average	445	-3,887	3,113	underforecast	2%	
2012	21,665	average	15,096	below	-3,983	9,514	1,038	overforecast	-30%	
2013	26,791	average	18,876	below	3,215	6,748	-2,048	overforecast	-30%	
2014	19,063	below	16,068	below	-463	1,580	1,876	overforecast	-16%	
2015	20,418	average	22,928	average	-793	-1,960	243	underforecast	12%	
2016	24,638	average	21,209	average	-4,002	4,194	3,236	overforecast	-14%	
2017	17,813	below	11,500	below	5,311	-427	1,428	overforecast	-35%	
2018	10,595	below	5,242	below	4,757	-1,744	2,340	overforecast	-51%	
2019	8,466	below	8,804	below	2,530	-3,668	800	underforecast	4%	
Average relative difference, 1999-2019									-16%	

^aAverage category is defined as +/- 25% of the the 1999-2019 actual run average of 25,755 age 1.2-1.4 fish.