



## MEMORANDUM

TO: Distribution DATE: December 18, 2018

FROM: Nick DeCovich, Northern Cook Inlet Area  
Research Biologist  
Division of Sport Fish, Region II SUBJECT: Outlook for the 2019  
Deshka River king  
salmon run, and  
accuracy of the 2018  
forecast

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The point estimate of the preseason forecast for the 2019 Deshka River king salmon total run is 8,466 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 6,833-17,243 fish (Table 1). This forecast estimate is 49% less than the ten-year (2009 - 2018) average run of 16,647 age 1.2-1.4 fish, 73% less than the long-term (1979 - 2018) average of 31,416 fish, and 20% less than the forecast for the 2018 run of 10,595 fish.

The forecast for 2019 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 2019 forecast were those with the minimum recent five year's mean absolute deviation (MAD).

A univariate time series model was selected for age-1.2 fish; a sibling model incorporating the relationship between age-1.2 and 1.3 fish was selected for age-1.3 fish; and the 5-year moving average was selected for age-1.4 fish (Table 1). For a description of each model considered see Table 2.

Counts 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 only a few hundred fish of this age class were counted 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 counted at the weir, and efforts are underway to evaluate how this phenomenon could impact future production (Table 3).

The preliminary estimate of last years (2018) Deshka River king salmon total run is 5,245 fish age-1.2, 1.3, and 1.4 (Table 3). The forecast estimate of total run for 2018 for these age classes was 10,595, a difference of -50%. The long term (1999 - 2018) average difference between the forecast total run and actual total run is -17% (Table 4). The 2018 actual total run was 69% less than the ten-year (2008 - 2017) average run of 17,093.

The 2018 run completed the return of the 2011 brood year, a total return of 18,358 king salmon (return per spawner = .99). This was less than the 2010 brood year, which had a return-per-spawner of 1.21.

There is uncertainty in the total 2019 Deshka River king salmon forecast estimate. One pattern to this uncertainty is the models 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 -50% from the actual run in the past ten years (-23% average). Subtracting this average over-forecast percentage reduces the 2019 forecast to 6,519 fish. 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 2019 forecast gives the expectation of a run in the below average category.

Distribution:

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Table 1. – Forecast king salmon abundance of major age classes for the Deshka River in 2019 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) and MD (mean deviation).

Model	Forecast 2019	Model chosen	5-year MAD	5-year MD
<u>Age 1.2</u>				
5-year moving average	4,974		3,364	-113
Exponential smoothing	2,491		3,637	454
Univariate time series	3,894	*	2,678	584
Sibling	<sup>a</sup>			
Ricker	3,913		2,768	1,369
<u>Age 1.3</u>				
5-year moving average	7,325		2,553	589
Exponential smoothing	5,084		3,089	1,029
Univariate time series	5,961		5,469	5,226
Sibling	3,524	*	1,829	845
Ricker	6,568		5,215	4,872
<u>Age 1.4</u>				
5-year moving average	1,048	*	1,167	623
Exponential smoothing	127		1,391	936
Univariate time series	97		1,391	936
Sibling	246		1,539	1,487
Ricker	156		1,641	1,535
Total forecast	8,466 (6,833 - 17,243, 80% CI)			

<sup>a</sup> There was no significant sibling relationship with 1.2 age fish.

Table 2 – Brief description of statistical models used in forecasting the Deshka River king salmon run for 2019. 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. – Empirical estimate of Deshka River king salmon by age class in the run for years 1979 – 2018.

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	3,303	2,137	3,011	97	0	5,245	8,548

Table 4. – Accuracy of the Deshka River king salmon outlook for the three major age classes, 1999–2018. Forecasts were not done in the past for age 1.1 fish.

Return year	Forecast run	Forecast category <sup>a</sup>	Actual run	Forecast difference by major age class (forecast-actual)					Relative difference
				Actual run category <sup>a</sup>	Age 1.2	Age 1.3	Age 1.4	Overall effect	
1999	26,810	average	32,801	average	-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	average	618	-5,632	13,017	overforecast	-20%
2002	43,805	above	32,788	average	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	5,245	below	4,768	-1,747	2,329	overforecast	-50%
Average relative difference, 1999-2018									-17%

<sup>a</sup>Average category is defined as +/- 25% of the the 1999-2018 actual run average of 26,605 age 1.2-1.4 fish.