Department of Fish and Game

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MEMORANDUM

TO: Distribution

DATE: February 12, 2019

SUBJECT: Kenai River late run Chinook salmon 2018 outlook

FROM: Robert Begich
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The outlook for the late run of Kenai River Chinook salmon in 2019 is well below average, with a large fish ($\geq$ 75 cm METF) forecast of approximately 21,746 fish. The 2019 forecasted total run of large fish approximates the mid-point of the large fish sustainable escapement goal (SEG) of 13,500 to 27,000 fish. If realized, this run will: rank the 4th lowest (31st out of 34 years); be approximately 20% (4,000 fish) larger than the 2018 preliminary estimated run of 17,571 large fish; and, be about half (49%) of the 1986–2018 average of approximately 44,000 large fish (Table 1). The 2019 large fish forecast is nearly the same as the 2018 forecasted total run of 21,503 large fish. The probability that the 2019 total run will fall within the difference of forecasted and actual total runs was set at 80%. The 80% prediction interval for the 2019 run of large fish is 14,972 to 27,267 fish.

The forecast of large fish is the sum of individual age-specific forecasts of abundance which are ages 5, 6 and 7. Forecast abundance for each age class was calculated from models based on historical adult returns by age class (Mean, Median), recent age-specific run size (5-year mean) or sibling ratios from previous years (Mean sibling, 5-year mean sibling, median sibling, most recent sibling) (Table 2). The model estimates selected for each of the age classes for inclusion in the 2019 large fish forecast had two or more minimum values of the follow statistics: mean absolute deviation (MAD), mean absolute percentage error (MAPE) and mean deviation (MD) in 2014 – 2018 hindcasts, as compared to the actual runs in those years (Table 3). In recent forecasts of Kenai River Chinook salmon run size, forecast estimates with the smallest estimates of each statistic have provided the best forecast accuracy.

For age-5 fish $\geq$ 75 MEFT, the recent 5-year mean model was selected (a run of 8,847 fish). The forecast is larger than the preliminary estimate of the 2018 run of this age class (6,016) and is less than the long-term average of age-5 fish (10,724). All model estimates for age-5 fish were similar.

For age-6 fish the 5-year mean model estimate of 12,093 fish was also selected. The 2019 age-6 large fish run forecast is about 61% less than the historical mean run of 30,600 age-6 fish. Of interest: in 2018 the 5-year mean model was also used to forecast a total run of 11,914 fish of this age class and compared closely to the 2018 preliminary estimated total run of 11,206 age-6 fish. The most recent sibling model performed 2nd best (MAD of 6,505, MAPE 56%, MD 3,059) and forecasts a much smaller total run of just 4,460 age-6 fish in 2019 (Table 3).

For age-7 fish, the mean sibling model was selected (a run of 806). If realized, this would be considerably larger (230%) than the preliminary estimated 2018 run of this age class of 349 age-7 fish.

The 2018 forecast was for a total run of approximately 21,503 fish, while the preliminary estimated total run was approximately 17,571 large fish which is approximately -21% or 3,784 fish less than forecasted. The error in the

2018 forecast was primarily due to over-forecasting production of age-5 fish from the 2013 brood year. The 2019 late run of large Kenai River Chinook salmon primarily originates from the two lowest brood year escapements on record which occurred consecutively during 2013 and 2014 (Table 1). The best way to consider this large fish 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, that may be similar to the 2018 run of large fish.

Table 1. Estimated number of late-run Kenai River Chinook salmon ≥ 75 cm MEFT by age class and year, 1986 - 2018.

Year	Total Age in Years				Total Run	Escapement
	4	5	6	7		
1986		28,843	28,643	2,881	60,367	42,101
1987		20,049	53,373	1,315	74,737	48,393
1988		5,929	55,173	9,289	70,391	42,815
1989		6,559	29,895	5,161	41,615	26,253
1990		4,818	26,277	1,884	32,979	25,139
1991		8,331	26,933	2,381	37,645	27,133
1992		9,550	39,956	1,610	51,116	37,469
1993		9,510	46,669	3,341	59,520	33,432
1994		7,332	42,680	3,149	53,161	26,145
1995		10,074	30,070	3,353	43,497	24,874
1996		14,613	28,372	968	43,953	29,056
1997		9,872	34,222	1,251	45,345	25,221
1998		8,100	33,132	1,898	43,130	33,385
1999		10,198	33,151	2,308	45,657	29,100
2000		12,019	28,189	1,511	41,719	25,502
2001		9,976	34,200	1,578	45,754	29,531
2002		13,123	40,530	2,257	55,910	40,514
2003		17,229	49,350	1,405	67,984	48,461
2004		24,465	64,462	2,385	91,312	65,112
2005		15,010	65,599	3,580	84,189	55,688
2006		10,299	40,112	6,711	57,122	39,305
2007		12,498	27,552	4,371	44,421	29,664
2008		8,869	30,653	3,158	42,680	28,094
2009		4,703	21,594	1,747	28,044	18,251
2010		8,760	11,719	1,701	22,180	13,037
2011		6,843	18,636	902	26,381	15,731
2012		8,470	13,681	1,055	23,206	22,453
2013		3,622	9,994	766	14,382	12,305
2014		4,684	8,225	494	13,403	11,980
2015		6,302	15,302	1,192	22,796	16,825
2016		12,114	12,091	1,213	25,418	14,754
2017	102	15,116	13,643	1,053	29,914	19,948
2018		6,016	11,206	349	17,571	16,813

Table 2.–Description of models used in forecasting the 2019 large ($\geq$ 75 cm METF) Kenai River Chinook salmon late run.

Model	Description
Mean	Mean return for the specified age class using all brood years[a]
5-year mean	Mean of the 2014-2018 run for the specified age class.
Median	Median return for the specified age class of all brood years
Mean sibling	Mean of sibling ratios (age/age minus 1) for all returns multiplied by the return of age minus 1 siblings.
5-year mean sibling	Mean of sibling ratios (age/age minus 1) for previous 5 brood years multiplied by the return of age minus 1 siblings.
Median sibling	Median of sibling ratios (age/age minus 1) for all returns multiplied by return of age minus 1 siblings.
Most recent sibling	Most recent sibling ratio (age/age minus 1), multiplied by the return of age minus 1 siblings.

[a]-1981-2013 for age-5 fish, 1980-2012 for age-6 fish, 1979-2011 for age-7 fish.

Table 3.– Kenai River late run Chinook salmon forecasts in 2019 for large ($\geq$ 75 cm METF) fish using several models, and the relative fit of hindcasts-of-forecasts of each model to the previous 5 years of actual runs. Transparent boxes indicate the lowest MAD, MAPE, and MD for each age class forecast. Shaded boxes indicate forecasts that were selected to be part of the total run forecast for each age class. See Table 2 for a description of each model.

Model	Forecast 2019	MAD[a]	5-year MAPE[a]	MD[b]
Age-5				
Mean	10,724	4,343	72%	1,965
5-year mean	8,847	3,733	62%	-2,005
Median	9,550	4,051	67%	736
Forecast estimate	**8,847**			
Age-6				
Mean	31,069	20,890	186%	20,890
5-year mean	12,093	2,651	26%	797
Median	29,895	18,499	165%	18,499
Mean sibling	18,299	14,564	123%	14,484
5-year mean sibling	11,219	7,738	63%	5,066
Median sibling	16,593	12,121	101%	11,228
Most recent sibling	4,460	6,506	54%	3,059
Forecast estimate	**12,093**			
Age-7				
Mean	2,370	1,667	278%	1,667
5-year mean	860	397	75%	137
Median	1,747	1,053	187%	1,053
Mean sibling	806	351	61%	-4
5-year mean sibling	866	354	66%	24
Median sibling	723	379	58%	-104
Most recent sibling	287	558	82%	206
Forecast estimate	**806**			
TOTAL RUN FORECAST	**21,746**			

[a]mean absolute deviation

[b]mean absolute percent error

[c]mean deviation

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