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MEMORANDUM

TO: Distribution

FROM: Robert Begich
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DATE: February 12, 2019

SUBJECT: Kenai River early run
           Chinook salmon
           2019 outlook

The outlook for the early run of Kenai River Chinook salmon in 2019 is below average, with a large fish (≥ 75 cm mideye-to-tail-fork-length or approximately ≥ 34 inches in total length) forecast of 3,168 fish. The 2019 forecasted total run of large fish is less than the optimum escapement goal of 3,900 to 6,600 fish and far below the 1986-2018 average total run of approximately 9,300 large fish (Table 1). If realized, the 2019 run will rank as the 4th lowest (31st out of 34 years) and be similar to the preliminary estimate of the 2018 total run of 3,072 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 814 to 5,521 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, the median (for brood years 1981–2013) was selected (a run of 2,709 fish). The forecast of this age class is larger than the estimated size of the 2018 run of age-5 fish (1,836), which was approximately 60% of the 2018 total run of 3,072 fish. Since 2014 the age-5 fish have comprised an average of 63% of the total run of large fish.

For age-6 fish the most recent sibling model estimate of 458 fish was selected. This forecast of age-6 fish is less than half of the preliminary estimate of the actual run of age-6 fish in 2018 (1,222 fish) and would be the lowest return for age-6 fish on record. Historically age-6 fish are the predominant age class; however, since 2014 the large fish run has been comprised of an average of approximately 36% age-6 fish. Of interest: the 5-year mean model has performed nearly as well in recent years (MAPE of 62% vs MAPE of 54%, MD of 532 vs MD of 409 for the selected forecast model), and forecasts a run of approximately 1,690 or about 1,200 more fish in 2019.

For age-7 fish, most recent sibling model was selected (a run of 1 fish). If realized, this would be similar to runs of this age class since 2017.

The 2018 forecast was for a total run of approximately 5,499 large fish, while the preliminary estimated actual total run was approximately 3,072 large fish; about 44% percent (2,400 fish) less than forecasted. The error in the 2018 forecast was due to over-forecasting production of age-5 and age-6 fish from the 2013 and 2012 brood years, respectively. The 2019 early run of large Kenai River Chinook salmon primarily originates from the lowest and the 3rd lowest brood year escapements on record which occurred consecutively during 2013 and 2014 (Table 1).

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

Year	Total Age in Years 4	5	6	7	Total Run	Escapement
1986		6,648	6,108	1,387	14,143	6,562
1987		6,874	11,037	437	18,348	4,660
1988		2,226	13,367	1,944	17,537	2,668
1989		1,267	8,020	1,072	10,359	2,663
1990		1,901	5,354	570	7,825	5,523
1991		2,042	6,556	526	9,124	6,830
1992		2,624	7,243	647	10,514	7,902
1993		3,235	8,824	509	12,568	3,108
1994		1,873	9,349	555	11,777	3,448
1995		2,268	9,570	609	12,447	1,692
1996		2,099	6,157	229	8,485	1,940
1997		3,139	6,429	131	9,699	2,898
1998		3,188	4,214	317	7,719	5,918
1999		5,846	4,566	59	10,471	2,808
2000		3,791	4,956	65	8,812	6,580
2001		2,754	5,943	240	8,937	6,455
2002		4,108	4,902	432	9,442	8,489
2003		3,783	10,469	229	14,481	11,735
2004		6,249	11,092	994	18,335	15,319
2005		4,131	10,672	611	15,414	11,529
2006		2,709	7,331	565	10,605	6,072
2007		3,923	4,412	150	8,485	5,151
2008		3,457	4,012	135	7,604	4,138
2009		1,474	3,835	126	5,435	4,034
2010		2,534	1,648	73	4,255	3,012
2011		2,621	3,812	110	6,543	5,196
2012		1,138	2,168	70	3,376	2,977
2013		548	1,069	71	1,688	1,601
2014		1,881	754	55	2,690	2,621
2015		2,324	1,897	82	4,303	4,198
2016		4,183	2,188	64	6,436	6,346
2017	124	4,900	2,389	0	7,289	6,702
2018	18	1,831	1,222	2	3,072	2,909

Table 2.–Description of models used in forecasting the large (≥ 75 cm METF) Kenai River Chinook salmon early-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[a]
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 age-6 fish, 1979-2011 for age-7 fish.

Table 3.–2019 Kenai River early-run Chinook salmon forecasts for large ($\geq$ 75 cm METF) fish using several models, and the fit 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	5-year MAD[a]	MAPE[b]	MD[c]
Age-5				
Mean	3,139	1,257	48%	108
5-year mean	3,025	1,419	41%	-1,046
Median	2,709	1,168	38%	-315
Forecast estimate	**2,709**			
Age-6				
Mean	5,805	4,527	345%	4,527
5-year mean	1,690	644	62%	532
Median	5,354	4,281	324%	4,080
Mean sibling	3,660	4,132	259%	3,477
5-year mean sibling	1,522	1,251	84%	981
Median sibling	3,019	2,989	189%	2,445
Most recent sibling	458	842	54%	409
Forecast estimate	**458**			
Age-7				
Mean	396	393	288%	393
5-year mean	41	35	45%	33
Median	229	248	164%	248
Mean sibling	65	68	84%	52
5-year mean sibling	48	65	73%	36
Median sibling	62	63	78%	46
Most recent sibling	1	56	43%	30
Forecast estimate	**1**			
TOTAL RUN FORECAST	**3,168**			

[a] mean absolute deviation
[b] mean absolute percent error
[c] mean deviation

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