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MEMORANDUM

TO: Distribution

DATE: January 25, 2021

SUBJECT: Kenai River early run Chinook salmon 2021 outlook

FROM: Robert Begich
Division of Sport Fish, Region II

The 2021 forecast for the stock of large (≥75 cm mideye-to-tail-fork-length [METF] or approximately ≥34 inches in total length) early–run Chinook salmon in the Kenai River is 4,391 fish. Based upon the variability between the forecast and actual total runs from 2016–2020 there is an 80% chance the total run will be 1,573 to 7,354 fish. This prediction interval is fairly–wide and indicates a 20% chance the total run could be outside the prediction interval. The forecast is below the 1986 to 2020 average run of approximately 9,000 fish and the recent 5–year average run of approximately 4,700 fish (Table 1). If realized, this forecast would be the largest run since 2017, rank as the 3rd highest in the past ten years yet would rank as the 9th lowest run in the past 36 years. With no fishing mortality, the escapement from this forecast would be within the optimum escapement goal of 3,900 to 6,600 fish.

This forecast is the sum of individual age-specific (total age 5, 6 and 7) forecasts of abundance calculated from models based on historical adult returns by age class (mean, median, geometric mean), recent age-specific run size (5–year mean, 5–year geometric mean), or sibling ratios from previous years (mean sibling, 5–year mean sibling, median sibling, most recent sibling; Table 2). The variability among forecasted and actual total returns for each model was assessed by using the mean absolute deviation (MAD), mean absolute percent error (MAPE) and mean deviation (MD) (Tables 3 and 4). The choice of model used for each age class had minimum values of the 5–year MAPE in 2016 – 2020 hindcasts, as compared to the actual runs in those years (Tables 3 and 4). In recent years, we have evaluated models using the minimum MAPE because it has provided the best accuracy between observed and forecasted runs by age.

The age–5 large fish forecast of 2,624 fish from the 2016 brood year was selected by using the median return model from returns for the 1981–2015 brood years (Table 4). This forecast is larger than the estimated size of the 2020 run of 728 age-5 fish from the 2015 brood year (Table 1). In recent years, most of the early–run has been age-5 fish (60% or more); however, in 2020 about 29% of the run was estimated to be age-5 (Table

1). Although the median return forecast model out–performed the other models, the difference of the forecasted run sizes for the next two least variable models (geometric mean and 5–year geometric mean) is small, approximately 300 fish (Table 4).

The age–6 large fish forecast of 1,756 fish from the 2015 brood year was selected by using the year 5–year geometric mean model from returns for the 2010–2014 brood years (Table 4). This forecast of age–6 fish is close to the preliminary estimate (within 10 fish) of the 2020 run of 1,746 age–6 fish (Table 1). The 5–year mean model was the second least variable model and estimated a run of 1,812 age–6 fish (Table 4). The most recent sibling model generated a run forecast of just 509 age–6 fish (Table 4). The estimated age–6 to age–5 sibling ratio for Kenai River early–run Chinook salmon has been unusually low, less than 1, for the last five brood returns and explains the poor performance of the remaining sibling models for this age class (Table 4).

The age–7 large fish forecast of 11 fish from the 2014 brood year was selected by using the 5–year geometric mean model from the returns for the 2009–2013 brood years (Table 4). Early-run Chinook salmon of age–7 have been detected in just 2 of the past 5 years (Table 1).

The 2020 forecast was for a total run of approximately 4,794 large fish; however, preliminary estimates indicate the run was 2,474 fish, a difference of 2,320 fish or 48% less than forecasted. The error in the 2020 forecast was primarily due to over-forecasting production of age–5 fish from the 2015 brood year (729 observed versus 2,677 forecasted).

The 2021 early–run of large Kenai River Chinook salmon primarily originates from the 2015 and 2016 brood year escapements (Table 1). The best way to consider this forecast is in terms of 3 broad categories: approximately average run, below average run or above average run. The 2021 forecast gives the expectation of a run that will be below average and less than the recent 5–year average run of approximately 4,700 large fish (Table 1).

Table 1. Estimated number of early-run Kenai River Chinook salmon ≥ 75 cm METF by age class and year, 1986 - 2020.

Year	4	5	6	7	Total Run	Escapement
			Total Age in Years			
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		4,243	2,244	80	6,567	6,478
2017	123	4,898	2,380	0	7,401	6,725
2018		1,837	1,212	0	3,050	2,909
2019		2,498	1,479	233	4,210	4,128
2020		728	1,746	0	2,474	2,439
Average		3,053	5,566	380	9,004	5,154
Recent 5-Year Average		2,841	1,812	63	4,741	4,536

Table 2.–Description of models used in forecasting the 2021 large ($\geq$ 75 cm METF) early–run Kenai River Chinook salmon.

Model	Description
Mean	Mean return for the specified age class using all available return years.[a]
5-year mean	Mean of the 2016-2020 run for the specified age class.
Median	Median return for the specified age class using all available return years.
Mean sibling	Mean of sibling ratios (returns of age x/returns of age x-1) for all returns multiplied by the return of age x-1 siblings.
5-year mean sibling	Mean of sibling ratios (returns of age x /returns of age x-1) for previous 5 returns multiplied by the return of age x-1 siblings.
Median sibling	Median of sibling ratios (returns of age x/returns of age x-1) for all returns multiplied by return of age x-1 siblings.
Most recent sibling	Most recent sibling ratio (return age x/return age x-1), multiplied by the return of age x-1 siblings.
Geometric mean	Geometric mean of the return for the specified age class using all available return years.
5-year geometric mean	Geometric mean of the 2016–2020 return for the specified age class.

[a] 1981-2015 for age-5 fish, 1980-2014 age-6 fish, 1979-2013 for age-7 fish.

Table 3.–Description of statistics used to assess model fit for the 2021 Kenai River early-run Chinook salmon forecasts for large ($\geq$ 75 cm METF) fish.

Statistic	Description
Mean Absolute Deviation (MAD)	Sum of the absolute values of the deviations in the estimated total return from the sum of actual total returns for each model divided by the sample size (5 years).
Mean Deviation (MD)	Sum of the deviations in the estimated total return from the sum of actual total returns for each model divided by the sample size (5 years).
Mean Absolute Percent Error (MAPE)	Sum of the absolute values of the deviations of the estimated total return from the sum of actual returns for each model divided by the sample size (5 years) expressed as a percentage of the actual returns.

Table 4.–2021 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 2021	5-year MAD[a]	MAPE[b]	MD[c]
Age-5				
Mean	2,947	1,461	98%	290
5-year mean	2,841	1,865	105%	-300
Median	2,624	1,362	81%	-145
Geometric mean	2,577	1,386	84%	-91
5-year geometric mean	2,335	1,775	93%	-636
Forecast estimate	**2,624**			
Age-6				
Mean	5,566	4,126	248%	4,126
5-year mean	1,812	366	21%	-57
Median	4,956	3,813	228%	3,818
Mean sibling	1,399	4,684	290%	4,684
5-year mean sibling	477	1,196	79%	1,196
Median sibling	1,164	3,453	217%	3,455
Most recent sibling	509	928	58%	519
Geometric mean	4,404	3,032	183%	3,032
5-year geometric mean	1,756	380	19%	-208
Forecast estimate	**1,756**			
Age-7				
Mean	386	348	555%	349
5-year mean	63	80	90%	3
Median	229	181	318%	180
Mean sibling	98	108	165%	41
5-year mean sibling	82	107	149%	33
Median sibling	88	101	152%	33
Most recent sibling	0	147	114%	54
Geometric mean	173	177	302%	152
5-year geometric mean	11	67	58%	-25
Forecast estimate	**11**			
TOTAL RUN FORECAST	**4,391**			

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

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