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MEMORANDUM

TO: Distribution

DATE: January 12, 2022

SUBJECT: Kenai River early run Chinook salmon 2022 outlook

FROM: Robert Begich
Division of Sport Fish, Region II

The 2022 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 4,272 fish. This total run forecast is within the optimum escapement goal range of 3,900 to 6,600 fish. Based upon the differences between the forecast and actual total runs from 2017–2021 there is an 80% chance the total run will be 1,944 to 6,983 fish. This prediction interval is wide and indicates a 20% chance the total run could be outside the prediction interval. The forecast is below the 1986–2021 average run of approximately 8,900 fish; however, is nearly the same as the recent 5-year average run of approximately 4,300 fish (Table 1). If realized, this forecast would be the largest run in the past four years but rank as the 9th lowest run in the past 37 years. With no fishing mortality, the escapement from this forecasted run would be within the optimum escapement goal.

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 difference between forecasted and estimated total returns for each model was assessed by calculating the mean absolute deviation (MAD), mean absolute percent error (MAPE) and mean deviation (MD) (Tables 3 and 4). The model used had minimum values of the 5-year MAPE (Table 4). In recent years, we have selected models based on the minimum MAPE because this criteria has provided the best accuracy between observed and forecasted runs by age.

The age-5 large fish forecast of 2,623 fish is based on the median return model from returns for the 1981–2016 brood years (Table 4). This forecast is similar to the 2021 run of 2,451 age-5 fish from the 2016 brood year (Table 1). Although the median return forecast model was selected because it out–performed the other models, the difference of the forecasted run size for the next best model (geometric mean) is small (difference of approximately 19 fish; Table 4).

The 5-year geometric mean model from returns for the 2011–2015 brood years of age-6 large fish was selected for a forecast of 1,645 fish (Table 4). This forecast of age–6 fish is slightly more than the preliminary estimate of the 2021 run of 1,617 age-6 fish (Table 1). The 5-year mean model was the second–best model and estimated a similar sized run of 1,686 age-6 fish (Table 4). The most recent sibling model was the third best model and estimated a much larger run of 5,467 age-6 fish (Table 4). The reason the most recent sibling model estimated a much larger run was due to the observed sibling ratio increase from less than 1.0 for the five brood returns from 2010 through 2014 (mean=0.66), to 2.23 for the 2015 brood return (Table 1 and 4).

The 5–year geometric mean model from the returns for the 2010–2014 brood years was selected to forecast the return of age–7 large fish (4 fish) (Table 4). Early-run Chinook salmon of age–7 have been detected in samples in 2 of the past 5 years (Table 1).

The 2021 forecast was for a total run of 4,391 large fish while preliminary estimated total run was 4,159, a difference of 232 fish or approximately 5% less than forecasted. The error in the 2021 forecast was due to small differences in observed versus forecasted returns for all three of the large fish age classes.

The 2022 forecast gives the expectation of a run that will be below the historical average; however, it is projected to be similar to the recent 5-year total run average of approximately 4,300 large fish (Table 1).

Table 1. Estimated number of early-run Kenai River Chinook salmon ≥ 75 cm METF by age class and year, 1986 - 2021.

	Total Age in Years					
Year	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		4,243	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		2,497	1,478	233	4,208	4,128
2020		725	1,744	0	2,469	2,439
2021		2,451	1,617	91	4,159	4,036
Average		3,036	5,457	372	8,869	5,123
Recent 5-Year Average		2,482	1,686	65	4,257	4,047

Table 2.–Description of models used in forecasting the 2022 large (≥ 75 cm METF) early–run Kenai River Chinook salmon run.

Model	Description
Mean	Mean return for the specified age class using all available return years.[a]
5-year mean	Mean of the 2017-2021 return 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 2017–2021 return for the specified age class.

[a]1981-2016 for age-5 fish, 1980-2015 age-6 fish, 1979-2014 for age-7 fish.

Table 3.–Description of statistics used to assess model fit for the 2022 Kenai River early-run Chinook salmon forecasts for large (≥ 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.–2022 Kenai River early-run Chinook salmon forecasts for large (≥ 75 cm METF) fish using several models, and the fit of each model to the previous 5 years of actual returns. Transparent boxes indicate the lowest MAPE 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 2022	5-year MAD[a]	5-year MAPE[b]	5-year MD[c]
		Age-5		
Mean	3,036	1,352	98%	643
5-year mean	2,482	1,435	97%	287
Median	2,623	1,082	75%	206
Geometric mean	2,642	1,105	78%	243
5-year geometric mean	2,091	1,248	82%	-106
Forecast estimate	**2,623**			
		Age-6		
Mean	5,457	4,127	262%	4,127
5-year mean	1,686	344	20%	43
Median	4,929	3,725	236%	3,725
Mean sibling	4,730	4,183	269%	4,094
5-year mean sibling	2,226	1,348	90%	891
Median sibling	3,992	3,202	207%	3,019
Most recent sibling	5,467	1,130	70%	276
Geometric mean	4,283	3,012	192%	3,012
5-year geometric mean	1,645	292	16%	-63
Forecast estimate	**1,645**			
		Age-7		
Mean	372	335	689%	335
5-year mean	65	85	117%	-2
Median	229	169	397%	168
Mean sibling	90	104	194%	36
5-year mean sibling	79	105	184%	27
Median sibling	83	98	178%	28
Most recent sibling	84	140	210%	11
Geometric mean	143	150	361%	126
5-year geometric mean	**4**	82	62%	-40
Forecast estimate	**4**			
TOTAL RUN FORECAST	**4,272**			

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

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