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MEMORANDUM

TO: Distribution

DATE: January 12, 2022

SUBJECT: Kenai River late 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) late-run Chinook salmon in the Kenai River is 16,004 fish. This total run forecast is within the optimum escapement goal range of 15,000 to 30,000 fish. Based upon the difference between the forecast and actual total run from 2017–2021 there is an 80% chance the total run will be 4,084 to 27,924 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 41,600 fish and less than the recent 5-year 2017–2021 average total run of approximately 17,600 large fish (Table 1). If realized, this run will rank the 6th lowest (32nd out of 37 years); though larger than the 2021 preliminary estimated total run of 12,665 large fish (Table 1).

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 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 (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 5,562 is based on the recent 5-year (2012–2016) geometric mean model (Table 4). This forecast is approximately 1,300 fish greater than

the 2021 run of this age class (4,200) and is less than the recent 5-year average of 6,738 age-5 fish (Table 1).

The selected age-6 large fish forecast of 10,021 fish from the 2016 brood year was generated using the 5-year geometric mean model from returns for the 2011–2015 brood years (Table 4). The 2022 age-6 large fish run forecast is larger than the 2021 estimated run of 7,962 age–6 fish and similar to the 5-year average run of 10,292 age-6 fish. The second–best forecast model was the 5-year mean model which forecasts a similar run of age-6 fish (Table 4).

The age-7 large fish forecast of 421 fish from the 2015 brood year was generated using the most recent sibling model (Table 4). If realized, a run of 421 would be slightly less than the 2021 estimated run of 486 age-7 fish (Table 1).

The 2021 forecast was for a total run of 18,406 fish, while the preliminary estimated observed total run was 12,665 large fish which is 5,741 fish (31%) less than forecasted. The error in the 2021 forecast was primarily due to over-forecasting production of both age-5 fish from the 2016 brood year and age-6 fish from the 2015 brood year.

The 2022 forecast gives the expectation of a total run that is below the historical average and is also less than the recent 5-year average of approximately 17,600 large fish (Table 1).

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

	Total Age in Years					
Year	4	5	6	7	Total Run	Escapement
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		10,149	14,430	550	25,129	14,676
2017	108	15,698	14,336	1,119	31,262	20,615
2018		6,312	11,825	374	18,511	17,289
2019	6	4,829	8,153	283	13,271	11,638
2020	7	2,644	9,184	353	12,219	11,909
2021	11	4,206	7,962	486	12,665	12,147
Average	26	10,125	29,284	2,188	41,601	28,090
Recent 5-Year Average	26	6,738	10,292	523	17,585	14,720

Table 2.–Description of models used in forecasting the 2022 large (≥ 75 cm METF) late–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 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 for age-6 fish, 1979-2014 for age-7 fish.

Table 3.–Description of statistics used to assess model fit for the 2022 Kenai River late-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.– Kenai River late run Chinook salmon forecasts in 2022 for large (≥ 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 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	MAD[a]	5-year MAPE[b]	MD[c]
Age-5				
Mean	10,125	5,868	133%	3,857
5-year mean	6,738	4,867	96%	1,246
Median	9,190	5,286	115%	2,827
Geometric mean	8,829	5,147	111%	2.673
5-year geometric mean	5,562	4,172	78%	375
Forecast estimate	**5,562**			
Age-6				
Mean	29,248	20,846	217%	20,846
5-year mean	10,292	2,908	32%	2,104
Median	28,508	19,276	202%	19,276
Mean sibling	12,523	14,420	128%	14,383
5-year mean sibling	7,042	7,552	68%	5,788
Median sibling	11,575	11,933	106%	11,662
Most recent sibling	12,666	5,710	52%	1,991
Geometric mean	24,757	16,886	176%	16,886
5-year geometric mean	10,021	2,723	30%	1,786
Forecast estimate	**10,021**			
Age-7				
Mean	2,188	1,828	461%	1,828
5-year mean	523	324	84%	201
Median	1,656	1,251	322%	1,251
Mean sibling	539	328	93%	293
5-year mean sibling	356	312	87%	218
Median sibling	454	278	74%	185
Most recent sibling	421	322	65%	-17
Geometric mean	1,597	1,293	333%	1,293
5-year geometric mean	459	281	70%	133
Forecast estimate	**421**			
TOTAL RUN FORECAST	**16,004**			

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

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