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MEMORANDUM

TO: Distribution

DATE: March 2, 2023

SUBJECT: Kenai River late run Chinook salmon 2023 outlook

FROM: Robert Begich, Tony Eskelin
Division of Sport Fish, Region II

The 2023 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 13,630 fish. This total run forecast is less than the optimum escapement goal range of 15,000 to 30,000 fish. Based upon the difference between the forecasts and actual total runs from 2018–2022 there is an 80% chance the total run will be 4,700 to 22,500 fish. This prediction interval is wide and indicates a 20% chance the total run could be outside the prediction interval. The forecast is well below the 1986–2022 average run of approximately 40,900 fish and slightly below the recent 5-year 2018–2022 average total run of approximately 14,200 large fish (Table 1). If realized, this forecast would be the 2nd largest run in the past five years but rank as the 7th lowest in the past 38 years and near the 2022 preliminary estimated total run of 14,113 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 criterion has provided the best accuracy between observed and forecasted runs by age.

The age-5 large fish forecast of 4,750 is based on the recent 5-year (2013–2017) geometric mean model (Table 4). This forecast is approximately 2,400 fish lower than the 2022 run of this age class (7,100) and is less than the recent 5-year average of 5,025 age-5 fish (Table 1).

The selected age-6 large fish forecast of 8,674 fish from the 2017 brood year was generated using the 5-year geometric mean model from returns for the 2012–2016 brood years (Table 4). The 2022 age-6 large fish run forecast is larger than the 2022 estimated run of 6,966 age-6 fish (Table 4). The 5-year mean model was the second-best model and estimated a similar sized run of 8,818 age-6 fish. (Table 4).

The age-7 large fish forecast of 206 fish from the 2016 brood year was generated using the 5-year mean sibling model (Table 4). There were no age-7 fish sampled in 2022. (Table 1).

The 2022 forecast was for a total run of 16,004 fish, while the preliminary estimated observed total run was 14,113 large fish, which is 1,891 fish (13%) less than forecasted (Table 5). It's worth noting that in each of the last 6 years the run has been less than forecast (Table 5). The error in the 2022 forecast was primarily due to under-forecasting production of age-6 fish from the 2016 brood year and over-forecasting age-7 fish from the 2015 brood year.

The 2023 forecast gives the expectation of a total run that is below the historical average and near the recent 5-year average of approximately 14,200 large fish (Table 1).

Table 1.–Estimated number of large (≥75 cm MEFT) late-run Kenai River Chinook salmon by age class and year, 1986–2022.

	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
2022		7,132	6,966	0	14,113	13,974
Average	33	10,044	28,681	2,129	40,859	27,709
Recent 5-Year Average	8	5,025	8,818	302	14,156	13,391

Table 2.–Description of models used in forecasting the 2023 large (≥75 cm METF) Kenai River Chinook salmon late run.

Model	Description
Mean	Mean return for the specified age class using all available return years.[a]
5-year mean	Mean of the 2018–2022 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 2018–2022 return for the specified age class.

[a] 1981–2017 for age-5 fish, 1980–2016 for age-6 fish, 1979–2015 for age-7 fish.

Table 3.–Description of statistics used to assess model fit for the 2023 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.–2023 Kenai River late run Chinook salmon forecasts 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.

	Forecast	5-year		
Model	**2023**	**MAD[a]**	**MAPE[b]**	**MD[c]**
Age-5				
Mean	9,522	5,467	135%	5,467
5-year mean	5,025	3,141	86%	2,984
Median	8,815	4,474	113%	4,474
Geometric mean	8,778	4,255	108%	4,255
5-year geometric mean	4,750	2,593	70%	1,965
Forecast estimate	**4,750**			
Age-6				
Mean	28,681	21,739	257%	21,739
5-year mean	8,818	3,204	40%	3,204
Median	28,372	20,469	243%	20,469
Mean sibling	20,973	11,910	118%	11,910
5-year mean sibling	12,288	5,934	57%	4,234
Median sibling	19,375	10,027	100%	9,779
Most recent sibling	11,812	5,038	56%	1,382
Geometric mean	23,923	17,615	208%	17,615
5-year geometric mean	8,674	2,898	36%	2,898
Forecast estimate	**8,674**			
Age-7				
Mean	2,129	1,995	3,335%	1,995
5-year mean	302	364	756%	259
Median	1,610	1,426	2,496%	1,426
Mean sibling	459	415	790%	415
5-year mean sibling	206	355	540%	312
Median sibling	396	319	654%	319
Most recent sibling	13	283	596%	185
Geometric mean	1,408	1,443	2,427%	1,443
5-year geometric mean	194	299	655%	292
Forecast estimate	**206**			
TOTAL RUN FORECAST	**13,630**			

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

Table 5.–Accuracy of Kenai River late-run Chinook salmon forecasts for large (≥75 cm METF) fish, 2017–2022.

Year	Forecasted total run	Estimated total run	Difference	Relative difference	Overall effect
2017	33,613	31,262	2,351	-8%	overforecasted
2018	21,508	18,511	2,997	-16%	overforecasted
2019	21,746	13,271	8,475	-64%	overforecasted
2020	22,707	12,219	10,488	-86%	overforecasted
2021	18,406	12,665	5,741	-45%	overforecasted
2022	16,004	14,113	1,891	-13%	overforecasted
Average	22,331	17,007	5,324	39%[a]	

[a] Average absolute difference and relative difference.

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