



MEMORANDUM

TO: Distribution

DATE: January 25, 2021

SUBJECT: Kenai River late
run Chinook
salmon 2021
outlook

FROM: Robert Begich
Division of Sport Fish, Region II

The 2021 forecast for the stock of large (≥ 75 cm mid-eye-to-tail-fork-length [METF] or approximately ≥ 34 inches in total length) late-run Chinook salmon in the Kenai River is 18,406 fish. Based upon the variability between the forecast and actual total run from 2016–2020 there is an 80% chance the total run will be 8,039 to 31,762 fish. This prediction interval is fairly-wide and indicates a 20% chance the total run could be outside the prediction interval. The 2021 forecasted total run of large fish is within the large fish optimal escapement goal range of 15,000 to 30,000 fish. If realized, this run will: rank the 5th lowest (32nd out of 36 years); be approximately 50% (6,100 fish) larger than the 2020 preliminary estimated total run of 12,219 large fish; be less than half of the 1986–2020 average of approximately 42,400 large fish and less than the recent 5-year 2016–2020 average total run of approximately 20,100 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 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 (Table 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 6,644 fish from the 2016 brood year was selected by using the recent 5-year geometric mean model from returns for the 2011–2015 brood

years (Table 4). The forecast is twice as large as the preliminary estimate of the 2020 run of this age class (2,659) and is less than the historical mean of 10,295 age-5 fish (Table 1).

The age-6 large fish forecast of 11,292 fish from the 2015 brood year was selected using the 5-year geometric mean model from returns for the 2010-2014 brood years (Table 4). The 2021 age-6 large fish run forecast is larger than the 2020 estimated run of 9,199 age-6 fish and about 61% less than the historical mean run of 29,894 age-6 fish. The second least variable forecast model was the 5-year mean model which forecasts a similar run of 11,590 age-6 fish (Table 4).

The age-7 large fish forecast of 470 fish from the 2014 brood year was selected using the 5-year geometric mean model from the returns for the 2009-2013 brood years (Table 4). If realized, a run of 470 would be the largest run of age-7 fish since 2017 (Table 1).

The 2020 forecast was for a total run of approximately 22,707 fish, while the preliminary estimated observed total run was approximately 12,219 large fish which is approximately 10,488 fish (46%) less than forecasted. The error in the 2020 forecast was primarily due to over-forecasting production of both age-5 fish from the 2015 brood year and age-6 fish from the 2014 brood year. The best way to consider this large fish 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 in the below average category and less than the recent 5-year average of approximately 20,000 large fish (Table 1).

Table 1. Estimated number of late-run Kenai River Chinook salmon \geq 75 cm MEFT by age class and year, 1986 - 2020.

Year	Total Age in Years				Total Run	Escapement
	4	5	6	7		
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	4,843	8,158	283	13,290	11,638
2020	8	2,659	9,199	353	12,219	11,909
Average	41	10,295	29,894	2,237	42,429	28,546
Recent 5-Year						
Average	41	7,932	11,590	536	20,082	15,225

Table 2.—Description of models used in forecasting the 2021 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 2016-2020 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 2016–2020 return for the specified age class.

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

Table 3.—Description of statistics used to assess model fit for the 2021 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 2021 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 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 2020	MAD ^a	5-year MAPE ^a	MD ^b
Age-5				
Mean	10,295	4,758	105%	2,748
5-year mean	7,932	4,957	86%	-330
Median	9,510	4,349	91%	1,642
Geometric mean	9,020	4,316	90%	1,579
5-year geometric mean	6,644	4,571	75%	-993
Forecast estimate	6,644			
Age-6				
Mean	29,894	20,162	187%	20,162
5-year mean	11,590	2,436	25%	1,127
Median	28,643	18,326	172%	18,236
Mean sibling	7,913	15,590	136%	5,590
5-year mean sibling	4,066	6,916	59%	6,424
Median sibling	7,222	12,449	109%	12,449
Most recent sibling	5,050	6,351	53%	3,813
Geometric mean	25,574	16,339	152%	16,339
5-year geometric mean	11,292	2,419	24%	761
Forecast estimate	11,292			
Age-7				
Mean	2,237	1871	461%	1,871
5-year mean	536	381	94%	259
Median	1,701	1,276	321%	1,276
Mean sibling	627	412	108%	377
5-year mean sibling	380	416	105%	364
Most recent sibling	398	638	122%	335
Geometric mean	1,652	1,357	339%	1,357
5-year geometric mean	470	337	80%	195
Forecast estimate	470			
TOTAL RUN FORECAST	18,406			

^amean absolute deviation, ^bmean absolute percent error, ^cmean deviation

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