MEMORANDUM

State of Alaska

Department of Fish and Game
Division of Sport Fish

TO: Distribution

DATE: April 17, 2013

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SUBJECT: Outlook for the 2013 Kenai River Chinook
salmon Early Run

The outlook for the early run of Kenai River Chinook salmon in 2013 is well below average, with a forecast total run of 5,329 fish. If realized, this run would rank the lowest measured (28th out of 28 years), be similar in abundance to the run of 2012, and would be less than one-half the 1986–2012 average run of approximately 14,000 fish. Using the same methodology to forecast the 2013 total run, forecasts were made for previous years (2009–2012). Errors in the hindcasts (i.e., forecasts made for previous years) of the total run forecasts were relatively small, ranging from 3% to 25% (Figure 1). If the 2013 forecast is realized, the 2013 run will approximate the lower end of the optimum escapement goal (OEG) of 5,300 to 9,000 fish.

The forecast of total run is calculated from the sum of selected individual forecasts of abundance for fish ages 3 to 7. Forecast abundance for each age class (Table 1) was calculated from several models based on relationships between adult returns, spawners, or siblings from previous years (Table 2). The model estimates selected for each age class for inclusion in the 2013 forecast were those that performed best for the previous year. Percent error in previous year best model estimates averaged 14.5% annually, while minimum error estimates averaged 19.1% annually. Accuracy and precision were estimated by mean absolute deviation (MAD), mean absolute percent error (MAPE), mean percent error (MPE), and percent error (PE) between hindcasts of previous years' forecasts and actual runs.

For age-3 fish, the 5-year mean model forecast estimate was selected (a run of 249 fish). Fewer models can be used to forecast abundance for this age class because there are no prior sibling returns to provide insights. The number of fish at this age has only ranged up to ~600 fish, and hence has a small contribution to the run and run forecast. The forecast for this age class is similar to the actual run in 2012 (286).

For age-4 fish, the median was selected (a run of 1,013 fish). This is approximately twice the number that returned in 2012, and less than one-half of the number that returned in 2011.

The mean sibling model was used to forecast the number of age-5 fish, for a forecast of 1,805 fish. This represents approximately the same number of fish that returned of this age class in 2012, and approximately one-half of the historical mean.

Age-6 fish are generally the predominant age class for early run Kenai River Chinook salmon. The recent 5-year mean sibling model (using age-5's) and the recent 5-year mean sibling model (using age-5's and age-4's) produced the best estimate for this age class in 2012. Those models were averaged to forecast a run of 2,185 age-6 fish. This is similar to the number of fish of this age that returned in 2012, but approximately one-third of the historical mean. Fewer fish of this age returned only in 2010; in all other years the run was higher.

For age-7 fish, the recent 5-year mean sibling model was selected, and forecast a run of 78 fish in 2013. If realized, only 1999, 2000, 2010, and 2012 had a run of fish of this age that was lower.

In addition to the forecasting methods used above, a modified version of the state-space model used in the escapement goal analysis for 2013 (McKinley and Fleischman 2013) was constructed to provide a forecast of run size and age composition. The forecast using this method is very similar to the selected forecast of 5,329. According to this forecast, the 2013 total run is equally likely to be above or below 5,518, and there is a 95% probability that the run will be between 3,330 and 9,894 Chinook salmon. Hindcasts of run forecasts tracked

well with actual run size for most years (2008–2011; 2% to 18%), except for 2012 when the run was approximately one-half of the hindcast (Figure 1).

Whereas the base model of McKinley and Fleischman (2013) assumed constant age at maturity, the modified model allowed age at maturity to vary across brood years. Age at maturity for a given brood year was allowed to vary randomly from the proportions predicted by the trend. The forecast for 2013 was generated by running the modified model forward an additional year beyond the last year of data (2012). The forecast synthesizes information about the Ricker relationship, time-specific productivity, and varying age at maturity. The total run forecast is the sum of individual forecasts for the five age classes (ages 3, 4, 5, 6, and 7). Prediction intervals and probability statements can be constructed using percentiles from Table 3.

Table 1.–Chinook salmon forecasts for the 2103 Kenai River Early Run using several models, and the fit of each model to the previous 5 years of actual runs. Thin boxes around values indicate those with the lowest associated 5-year error. Thick boxes indicate those with the lowest error in 2012 and hence were selected to compose the total run forecast. Shaded boxes indicate the selected forecast for each age class. See Table 2 for a description of each model.

| Model | Forecast 2013 | 5-Year | | | 2012 |
		MAD[a]	MAPE[b]	MPE[c]	PE[d]
Age-3					
5-year mean	249	166	44	-36	**-33**
Mean	84	208	75	-75	-73
Forecast estimate	249				
Age-4					
5-year mean	1,521	1,575	384	-57	-328
Mean	1,676	668	74	54	244
Median	1,013	789	57	-12	**110**
Mean sibling	4,057	3,267	282	202	800
Median sibling	4,326	3,351	283	203	787
Most recent sibling	877	1,541	111	**-9**	160
Recent 5-year mean sibling	1,563	3,186	246	166	598
Forecast estimate	1,013				
Age-5					
5-year mean	2,985	1,217	59	23	-77
Mean	3,768	1,074	52	48	101
Median	3,384	986	44	31	80
Mean sibling	1,805	3,590	109	108	**-2**
Median sibling	1,723	3,322	101	98	-8
Most recent sibling	372	1,996	65	**-13**	-60
Recent 5-year mean sibling	823	1,112	36	-20	-57
Forecast estimate	1,805				

Model	Forecast 2013	MAD[a]	MAPE[b]	MPE[c]	2012 PE[d]
		5-Year			
	Age-6				
5-year mean	3,341	3,257	122	90	-58
Mean	6,464	3,557	138	138	161
Median	6,224	3,008	120	120	148
Mean sibling	3,567	2,114	69	64	44
Median sibling	3,141	1,734	54	46	24
Most recent sibling (5's and 4's)	2,235	1,053	55	-14	64
Most recent sibling	1,584	1,053	27	7	-21
Recent 5-year mean sibling	**1,863**	3,257	122	90	**-14**
Recent 5-year mean sibling (5's and 4's)	**2,507**	1,215	55	37	**14**
Forecast estimate	**2,185**				
	Age-7				
5-year mean	105	308	397	177	-135
Mean	463	407	552	552	568
Median	388	346	472	472	465
Mean sibling	149	133	192	188	114
Median sibling	150	131	187	182	112
Most recent sibling	45	74	97	62	140
Recent 5-year mean sibling	**78**	116	150	130	**28**
Forecast estimate	**78**				
TOTAL RUN FORECAST	**5,329**				

[a]mean absolute deviation

[b]mean absolute percent error

[c]mean percent error

[d]percent error

Table 2.–Description of models used in forecasting the Kenai River Chinook salmon early run, 2013.

Model	Description
5-year mean	Mean of the 2008-2012 run for the specified age class.
Mean	Mean using all brood years (1983-2006).
Median	Median return of all brood years (1983-2006).
Mean sibling	Mean of sibling ratios (age/age minus 1) for all returns (1983-2006 brood years) multiplied by the return of age minus 1 siblings.
Median sibling	Median of sibling ratios (age age minus 1) for all returns (1983-2006 brood years) multiplied by return of age minus 1 siblings.
Most recent sibling(5's and 4's) (to forecast age-6 fish)	Most recent ratio of (age-6)/(age-5+ age-4), multiplied by the return of age-5 and age-4 siblings.
Most recent sibling	Most recent sibling ratio (age/age minus 1), multiplied by the return of age minus 1 siblings.
Recent 5-year mean sibling	Mean of sibling ratios (age/age minus 1) for previous 5 brood years multiplied by the return of age minus 1 siblings.
Recent 5-year mean sibling (5's and 4's) (To forecast age-6 fish)	Mean of sibling ratios (age/ age minus 1+ age minus 2) for previous 5 brood years multiplied by return of age-5 and age-4 siblings.

Table 3. Posterior percentiles of forecasted total run for early-run Kenai River Chinook salmon in 2013 using a state-space model analysis.

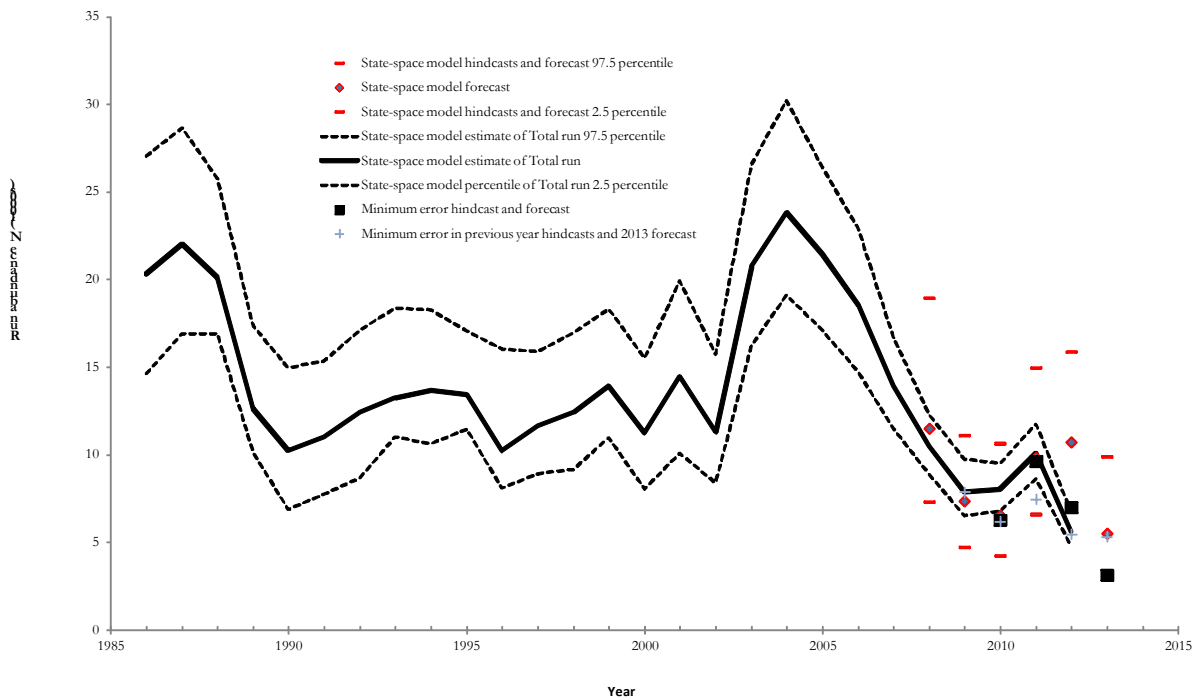| Posterior mean	Posterior SD	Posterior Percentiles				
		0.025	0.05	0.50	0.95	0.975
5,788	1,712	3,330	3,602	5,518	8,856	9,894

Figure 1.–Hindcasts and forecasts (2013) of total run compared to estimated total run for Kenai River early-run Chinook salmon.