MEMORANDUM STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

Division of Sport Fish

TO: Distribution DATE: 1/9/2014

FROM: Suzanne Hayes- Fisheries Biologist II
Anton Antonovich – Biometrician III

PHONE: 746-6329

SUBJECT: Outlook for the 2014 Deshka Chinook salmon run and accuracy of the 2013 outlook

The outlook for the Chinook salmon run at the Deshka River in 2014 is below average, with a forecast total run of 19,000 fish. If realized, it would rank 29th out of 36 years and be below the 1979-2013 average run of 35,000 fish. The anticipated 2014 harvest of Deshka River Chinook salmon in marine and sport fisheries is approximately 3,000 fish (2008 – 2012 average), and if realized, would result in a 2014 escapement of approximately 16,000 fish, within the sustainable escapement goal (SEG) range of 13,000 to 28,000 fish. The 80% prediction interval for the total run forecast is 14,000 to 24,000 fish. If the run falls near the lower prediction interval, and a recent average harvest occurs in marine and sport fisheries, the Deshka Chinook salmon escapement will fall below the SEG.

The total run forecast is the sum of individual forecasts for the three major age classes (1.2, 1.3, and 1.4; Table 1, Table 5). Forecast abundance for each age class was calculated from models based on the relationship between adult returns and spawners or siblings from previous years. Models included simple linear regression, recent year averages, time series, and combinations thereof (Table 2). The models chosen were those with statistically significant parameters having the greatest past reliability (accuracy and precision) based on mean absolute deviation (MAD), mean absolute percent error (MAPE), and mean percent error (MPE) between forecasts and actual returns for the years 2009 through 2013. We used results from the last 5 years to look at the performance of forecast models thus limiting the influence of longer term trends in Chinook salmon returns on model selection. The 5-year average model had the lowest error for each criterion for age-1.2 fish, and was selected for the forecast. The log sibling 1979 on model was selected as the forecast for age-1.3 fish, as it had the smallest errors for every criterion except 5-year MAD, which was the second smallest. The log sibling AR1,2 model was selected as the forecast for age-1.4 fish, as it had the smallest error for the 5-year MAPE and MPE, second smallest for the 5-year MAD, and fourth smallest for the 3-year MAPE.

The preliminary total run observed in 2013 was 20,953 fish, comprising 18,448 fish in the escapement, 2,000 assumed in the sport harvest, and 505 fish assumed in the marine harvest. Sport harvest was assumed to be similar to the 2012 harvest because of a similar below average run and generally restrictive regulations (Table 3). While the Chinook salmon sport fishery did occur in 2013 it was initially managed with a reduced annual limit (restricted to 2 Chinook salmon from the Susitna drainage), no bait, and only

single hook gear allowed. On June 29 bait and multiple hooks were allowed until the end of the Chinook salmon season. Generally, the sport fishery was liberalized from 2000 to 2007 and restricted from 2008 to 2010 and in 2012 and 2013 (Table 3).

The 2013 harvest of Deshka Chinook salmon in marine fisheries is an estimated 505 fish. To estimate the marine harvest, the aerial count of Chinook salmon in Deshka River in 2013 (8,686) was divided by the sum of all northern Cook Inlet aerial survey counts plus the Anchorage-area foot survey counts of Chinook salmon in 2013 (34,973). This value (≈0.25) was multiplied by the combined harvests of Chinook salmon in the Tyonek subsistence and the Kustatan Subdistrict and Northern District commercial fisheries in 2013 for the entire salmon season (2,032 x 0.25 ≈ 505). The estimated average annual marine harvest of Deshka Chinook salmon was 727 fish from 1993 to 2012.

As for the accuracy of the 2013 forecast, the preliminary total run for the three major age classes was 33% lower than forecast (Table 4). Ages 1.2 and 1.3 returned in lower abundance than forecast. For age-1.2 fish, the preliminary abundance is 66% less than the univariate log AR1 model estimate. For age-1.3 fish, the preliminary abundance is 49% less than the standard log sibling 1979 forecast. Five of the twelve models for age-1.3 fish over forecasted the preliminary run in 2013. For age-1.4 fish, the Log Sibling AR1,2 estimate used for the 2013 forecast was 66% less than the observed preliminary abundance. For age-1.4 fish, 12 of the 16 models examined had smaller differences in 2013 than did the selected model for the 2013 forecast. During the past 15 years the forecast has been larger run than the actual run for most years, including 2013 (Table 5).

The 2013 preliminary total run ranks 29th out of 35 years, assuming a below average sport harvest in 2013. The preliminary total exploitation rate for 2013 stands at 12%, and would rank 26th out of 35 years. However, the exploitation rate is heavily influenced by the sport harvest, which historically is the majority of the harvest. It will be late 2014 before a final estimate of the 2013 sport harvest is finalized using the statewide harvest survey.

The weir count of 18,531 in 2013 was within the SEG range. The weir was operational by June 7 which was two weeks later than average due to an extremely late ice break up; however, the weir count was considered a complete count. The preliminary 2013 escapement is 18,448 fish, which is the weir count minus the 83 fish reported harvested above the weir, and ranks 29th out of 40 years of data. The 1995-1997, 1999-2012 average escapement was 25,232 fish. The final escapement will be estimated when the harvest above the weir is reported in the statewide harvest survey for 2013 and subtracted from the weir count. During 1999-2012 the sport harvest above the weir averaged 789 fish.

The 2013 run completes the 2006 brood year, which generated a total return of 21,583 Chinook salmon from 29,922 spawners, for a return per spawner of 0.72, and is below average but better than the three previous brood years.

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Table 1.-Forecast Chinook salmon abundance for the Deshka River in 2014 using various models, and the fit of each model to the previous 3 or 5 years of actual runs. Boxes around values indicate those selected to compose the total run forecast. See Table 2 for a description of each model.

Model	Forecast 2014	5-Year MAD[a]	5-Year MAPE[b]	5-Year MPE[c]	3-Year MAPE
	Age 1.2				
5-year average	6,497	1,938	30%	-1%	32%
Univariate Log MA1 (better fit)	5,091	2,891	49%	-12%	32%
Univariate Log AR1	5,573	2,564	41%	-4%	32%
Standard Sibling 1992 on	12,110	2,636	49%	-39%	62%
Standard Log Sibling 1992 on	10,098	2,533	44%	-25%	57%
Standard Ricker	7,510	2,342	38%	-13%	37%
Ricker w/MA1	5,085	3,525	61%	-18%	49%
Ricker w/AR1	6,692	2,965	48%	-11%	42%
	Age 1.3				
5-year average	9,907	6,748	169%	-146%	69%
Univariate log MA1	21,692	5,861	76%	-43%	81%
Univariate AR1	15,149	5,549	121%	-107%	103%
Standard Sibling	12,600	5,562	102%	-98%	110%
Standard Sibling 1991 on	9,739	4,709	65%	-53%	101%
Standard Log Sibling	10,359	4,571	69%	-59%	100%
Standard Log Sibling 1991 on	8,967	4,195	58%	-42%	92%
Log Sibling AR1	9,094	3,527	66%	-49%	101%
Standard Log Sibling 1979 on	8,562	3,832	54%	-36%	86%
Standard Ricker	12,522	5,027	118%	-108%	101%
Ricker w/MA1	24,238	5,782	77%	-38%	90%
Ricker w/AR1	14,753	6,020	92%	-48%	107%
	Age 1.4				
5-year average	2,106	2,485	168%	-154%	71%
Univariate AR1,2	4,225	1,838	128%	-128%	45%
Univatiate AR1	5,606	2,768	176%	-176%	107%
Univatiate MA1	7,899	5,434	318%	-318%	238%
Univariate Log AR1	4,100	1,118	86%	-76%	29%
Standard Sibling	8,402	5,230	298%	-298%	282%
Standard Sibling 1990 on	4,661	1,928	117%	-116%	115%
Standard Log Sibling	6,582	2,755	157%	-154%	205%
Standard Log Sibling 1990 on	4,338	1,582	88%	-76%	115%
Sibling AR1,2	4,346	1,859	106%	-84%	106%
Log Sibling AR1,2	4,003	1,154	65%	-39%	64%
Log Sibling AR1	5,581	1,277	80%	-57%	75%
Log Sibling AR1 1978 on	5,505	1,274	79%	-55%	74%
Standard Log Sibling 1978 on	6,284	2,599	149%	-144%	192%
Standard Ricker	3,054	5,801	346%	-346%	246%
Ricker w/AR1	2,104	1,378	100%	-81%	39%
TOTAL RUN FORECAST	**19,063**	**(80% prediction interval 14,143-23,982)**			

[a] mean absolute deviation

[b] mean absolute percent error

[c] mean percent error

Table 2. - Brief description of statistical models used in forecasting the Deshka River Chinook salmon run for 2013.

Model	Description
5-year average	Arithmetic average of the the 2007-2011 total run for specified age class.
Univariate MA1	Moving average of order one time series model using all years of runs (1974-2007 brood years). Done in SAS software.
Univariate log MA1	Moving average of order one time series model using natural log of all years of runs (1974-2007 brood years). Done in SAS software.
Univariate AR1	Autoregressive of order 1 (or order 1 and 2) time series model using all years of runs (1974-2007 brood years). Done in SAS software.
Univariate AR1,2	Autoregressive of order 2 time series model using all years of runs (1974-2007 brood years). Done is SAS software.
Univariate Log AR1	Autoregressive of order 1 time series model using natural log of all years of runs (1974-2007 brood year). Done in SAS software.
Sibling	Sibling regression using all years of runs (1974-2007 brood years). Done in Excel software.
Sibling 19XX on	Sibling regression using runs with the escapement counted by weir. Exact year (XX) to begin data set depends upon age class being modeled, through 2007 brood year. Runs from 1990 are the first counted by weir, runs prior to those years had the escapement estimated by expanding the aerial index. Done in Excel software.
Log Sibling	Sibling regression using natural log of all years of runs (1974-2007 brood years). Done in Excel software.
Log Sibling 19XX on	Sibling regression using natural log of runs. XX is exact year to begin data set, through 2007 brood year. Runs from 1990 are the first counted by weir, runs prior to those years had the escapement estimated by expanding the aerial index. Done in Excel software.
Sibling AR1,2	Sibling regression using all runs (1974-2007 brood years) and a lag 1 and lag 2 autoregressive term. Done in SAS software.
Log Sibling AR1	Sibling regression using natural log of all runs (1974-2007 brood years) and a lag 1 (or lag 1 and lag 2) autoregressive term. Done in SAS software.
Log Sibling AR1,2	Sibling regression using natural log of all runs (1974-2007 brood years) and a lag 1 and lag 2 autoregressive terms. Done in SAS software.
Log Sibling AR1 1978 on	Sibling regression using natural log of 1978-2007 brood years and a lag 1 autoregressive term. Done in SAS software.
Ricker	Ricker-style regression using all brood years (1974-2007). Done in SAS software.
Ricker MA1	Ricker-style regression using all year brood years (1974-2007) and a moving average lag 1 term. Done in SAS software.
Ricker AR1	Ricker-style regression using all brood years (1974-2007) and an autoregressive lag 1 term. Done in SAS software.

Table 3.-Summary of Northern District commercial and Deshka sport Chinook salmon fishery regulations during 1999 to 2013, either by regulation or emergency order.

	Northern District Commercial [a]			Deshka Sport Chinook Salmon [b]					
Year	Periods Fished/ Periods Allowed	Hours per Period	Season Harvest (mixed stock)	Dates	Bait	Hours per Day	Retention Days per Week	Bag/ Posession	Season Harvest
1999	2/3	6	2,259	January 1 - July 13	No	17	7	1/1	3,489
2000	3/3	6	2,046	prior to June 8	No	17	7	1/1	7,076
				June 8 - July 13	Yes	17	7	1/1	
2001	3/3	6	1,616	prior to June 12	No	17	7	1/1	5,006
				June 12 - July 13	Yes	17	7	1/1	
2002	3/3	6	1,747	prior to June 8	No	17	7	1/2	4,508
				June 8 - July 13	Yes	17	7	1/2	
2003	3/3	6	1,172	prior to June 18	No	17	7	1/2	6,605
				June 18 - July 13	Yes	17	7	2/4	
2004	3/3	6	1,819	prior to May 28	No	17	7	1/2	9,050
				May 28 - June 11	Yes	17	7	1/2	
				June 12 - July 13	Yes	17	7	2/4	
2005	3/3	12	3,144	May 15 - May 26	Yes	17	7	1/2	7,332
				May 27 - July 13	Yes	24	7	2/4	
				July 14 - July 31	Yes	17	7	1/2	
2006	3/3	12	3,849	May 15 - May 25	Yes	17	7	1/2	7,753
				May 26 - July 13	Yes	24	7	2/4	
2007	3/3	12	3,132	May 15 - May 24	Yes	17	7	1/2	5,696
				May 25 - July 13	Yes	24	7	2/4	
2008	4/5	12	3,855	May 15 - June 13	Yes	17	7	1/2	2,036
				June 14 - June 19	No	17	7	1/2	
				June 20 - July 13		---Closed ---			
2009	2/2	6	1,266	May 15 - June 12	No	17	3	1/2	723
	1/3	12		June 13 - July 13		---Closed ---			
2010	3/3[c]	12	1,674	May 15 - June 11	Yes	17	7	1/2	3,381
	1/1[c]	6		June 12 - June 18	No	17	7	1/2	
				June 19 - July 13	Yes	17	7	1/2	
2011	4/4[c]	12	2,187	May 15 - July 13	Yes	17	7	1/2	3,139
2012	4/4[c]	6	1,030	May 15 - June 19	Yes	17	7	1/2	1,650
				June 20 - June 24[d]	No	17	7	1/2	
				June 25 - July 13		---Closed ---			
2013	4/5[c]	6	1,142	May 15 - June 28	No	17	7	1/2	
				June 29 - July 13	Yes	17	7	1/2	

[a] Directed Chinook salmon fishery only. During 1999-2007 opened first Monday in June, only open each Monday thereafter until regular season or 12,500 season quota achieved. Starting in 2008, opened first Monday on or after May 25, only open each Monday thereafter until June 24 or until 12,500 season quota achieved.

[b] Season closes July 13 each year, lower 17 miles of river open, 1999 was first year.

[c] Portion of area closed all season

[d] Deshka river closed to Chinook salmon fishing upstream of river mile 7.

Table 4.-The preliminary 2013 Chinook salmon run for the Deshka River compared to the various models used to forecast the 2013 run. Boxes around values indicate those used in the total run forecast. See Table 2 for a description of each model. The sustainable escapement goal is 13,000-28,000 fish.

Model	Forecast 2013	Preliminary Run 2013	Difference	Fish Difference
	Age 1.2	**4,476**		
5-year average	5,978		34%	1,503
Univariate Log MA1 (better fit)	7,209		61%	2,733
Univariate Log AR1	7,412		66%	2,937
Sibling 1992 on	13,064		192%	8,588
Log Sibling 1992 on	11,118		148%	6,643
Ricker	6,521		46%	2,045
Ricker MA1	8,478		89%	4,003
Ricker AR1	8,113		81%	3,638
	Age 1.3	**12,222**		
5-year average	8,231		-33%	(3,991)
Univariate log MA1	7,439		-39%	(4,783)
Univariate AR1	11,523		-6%	(699)
Sibling	20,240		66%	8,017
Sibling 1991 on	20,588		68%	8,366
Log Sibling	19,687		61%	7,465
Log Sibling 1991 on	19,449		59%	7,227
Log Sibling AR1	11,118		-9%	(1,104)
Log Sibling 1979 on	18,208		49%	5,986
Ricker	8,928		-27%	(3,294)
Ricker MA1	3,964		-68%	(8,258)
Ricker AR1	4,175		-66%	(8,048)
	Age 1.4	**3,433**		
5-year average	2,335		-32%	(1,098)
Univariate AR1,2	3,536		3%	103
Univariate AR1	5,138		50%	1,705
Univariate MA1	7,961		132%	4,528
Univariate Log AR1	3,266		-5%	(167)
Sibling	6,586		92%	3,153
Sibling 1990 on	3,327		-3%	(106)
Log Sibling	3,146		-8%	(287)
Log Sibling 1990 on	2,284		-33%	(1,149)
Sibling AR1,2	1,476		-57%	(1,957)
Log Sibling AR1,2	1,171		-66%	(2,262)
Log Sibling AR1	2,024		-41%	(1,409)
Log Sibling AR1 1978 on	1,990		-42%	(1,443)
Log Sibling 1978 on	3,066		-11%	(367)
Ricker	6,202		81%	2,769
Ricker AR1	2,560		-25%	(873)
	TOTAL RUN			
Ages 1.2, 1.3, 1.4 Total	26,791	**20,131**	33%	6,660
Age 1.1		822		
All Ages Total		20,953		

Table 5.-Accuracy of the Deshka River Chinook salmon outlook 1999 - 2013.

Return year	Forecast Total Run	Actual Total Run [a]	Forecast difference by major age class (forecast-actual) Age 1.2	Age 1.3	Age 1.4	overall effect
1999	26,810	33,371	-4,374	-363	-1,824	underforecast
2000	33,337	42,273	3,508	-17,945	5,502	underforecast
2001	40,753	33,210	385	-5,768	12,926	overforecast
2002	43,805	32,955	994	5,640	4,216	overforecast
2003	41,041	46,193	-8,524	-969	4,341	underforecast
2004	60,833	66,383	-2,537	-933	-2,080	underforecast
2005	48,687	44,134	-4,692	2,924	6,321	overforecast
2006	49,071	38,451	-628	12,056	-808	overforecast
2007	37,007	24,032	6,592	4,117	2,266	overforecast
2008	20,268	9,656	6,428	2,060	2,124	overforecast
2009	20,593	12,721	1,024	4,148	2,699	overforecast
2010	30,775	22,207	4,864	2,742	962	overforecast
2011	21,080	22,049	270	-4,306	3,068	underforecast
2012	21,665	16,113	-4,181	9,419	983	overforecast
2013	26,791	20,953	2,936	5,986	-2,262	overforecast

a Total run includes a small number of Age 1.1 Chinook salmon.