This is a Petition not a Record Copy (Kenai Sockeye)

Petition to the Alaska Board of Fisheries

I am petitioning the Alaska Board of Fisheries under 5 AAC 96.625 and AS 44.62.220 to reject the escapement goal recommendations for Kenai River Late Run Sockeye Escapement Goal as a nonsensical analysis of the data in what can only be assessed as yet another ridiculous attempt to raise the goal to unsustainable levels. For the last 20 years the Kenai River Sockeye Salmon escapement goal has been set using the Brood Year Interaction model with the multiplicative term that was rejected by Clark et.al. 2007 for the 2005 Board meeting. At that time the Board rejected their analysis and left the goal as set by this model. How ridiculous would it be to leave it for 10-12 years after that "thorough" analysis the department conducted that didn't even contact the original authors to see if the silly assumptions made by Clark et.al. were justified. The original Brood Year Model was extensively peer reviewed for over a year with numerous public and departmental meetings before publication. After 20 years and numerous reviews including this one, it remains the model with the lowest DIC score and best fit. While the authors try to downplay the DIC scores and differences of 5 as being no big deal you can see from Table 1 lifted from the 2012 escapement goal analysis at the bottom of the page that "Rule-of- thumb, DIC differences of 5-10 are "substantial". The real problem with each and every model is that they are all getting worse, much worse every 3 years. The DIC scores for each model are increasing by about 100 points each time they are run. From 1994 to 2012, every three years there has been a 100 point increase from 800 in 1994 to nearly 1,400 in 2012. If a difference of 5 to 10 is substantial a 600 point increase must be meaningful. ADF&G next uses a "Markov Table" to justify raising the goal by an inconsequential amount, however there could not of been any type of peer review of this report as the table they present is laughable when compared to any other Markov Table I ever seen, whether the Brood Year simulation, previous tables in escapement goal reviews like the Clark et.al. 2007b that they cite in this report or the one presented in the other report for Kasilof Sockeye. Also on Friday I contacted one of the co-authors of this 2019 report by Hasbrouck and he told me he just got a copy of the first draft, but by Monday it was published, not much time for a peer review. The Markov Table they present in this report has overlapping ranges of 500,000 to 1 million, the width of the entire escapement goal range or more constructed in the precise manner to raise the goal for no justifiable reason. The very text they cite on page 7 of this report (Hilborn and Walters 1992) displays a very different looking Markov Table on page 263 Table 7.1 (attached). Raising the goal to gain information, find Seq, MAXR or any other point on the curve is not only not authorized in regulation the very text they quote, Hilborn and Walters, 1992 repeatedly cautions the reader from this very exercise as the lost yield from the "experiment" will never be recovered.

Since none of the models perform well and are all getting worse it is time to abandon their use and employ a different Markov Table, Table 2 (attached). From this Markov Table mean yield is in the second column from the right marked by the arrow. From this table it is quite simple to see that at ranges of 600,000-800,000 spawners mean yields are maximized at 3.9 million. This range of escapements has the two largest returns and largest R/S ratio of 6.3 with over 40 years of data. You have to go to over 2 million spawners to exceed this average yield, however one of the two data points is 8.3 million and the other is 2.4 million. It is also a very risky yield profile if there are less than two million spawners in any given year. While the Biometricians in their arrogance will try and convince us all that this is "Fuzzy Math" lets see what Hilborn and Walters say. Quoting from page 263 "*This approach is **highly recommended** when many years of data are available, because it can accommodate any possible form of the stock-recruitment curve...You should not even try such an approach without 30-50 data points. Even if you only use five intervals for spawning stock size and recruitment, we are attempting to estimate 25 parameters. **This is quite a jump from the three parameters of the Beverton-Holt and Ricker models.***" There are 21 individual brood year escapements above this 600,000-800,000 range and only 2 of them produced yields above the average yield of 3.9 million within this range. If exploring this area of the S/R relationship was going to produce more yield it should have already happened. Also this Markov Table has appeared many times with the same area of the spawner table showing the same relative average high yields. So unlike all of the other six models that ADF&G has produced, which keep getting worse and over predicting yields, this Markov Table has stayed very stable and resilient over time.

Jeff Fox

Soldotna

How well have the 6 models performed historically?

Current Kenai SEG (700k-1,200k) was based on <6% chance of yield less than 1 million fish (Clark et al. 2007)

Models	DIC 2012	DIC 2009	DIC 2006	DIC 2003	DIC2000	DIC1997	DIC1994
Ricker	1,399.6	1,301.5	1,209.2	1,115.8	1,022.4	927.1	831.9
Ricker AR1	1,400.4	1,300.6	1,208.4	1,115.4	1,019.9	922.2	831.4
Ricker BYI	1,399.5	1,301.0	1,207.9	1,114.5	1,021.0	920.5	829.7
Beverton-Holt	1,399.9	1,301.4	1,209.1	1,115.8	1,022.5	923.6	832.1
Deriso-Schnute	1,399.5	1,301.4	1,208.9	1,115.6	1,022.4	923.5	831.9
BYI2 (Carlson)	1,396.9	1,299.2	1,206.2	1,111.2	1,017.9	921.7	826.9

delta DIC (max. diff)

Models	DIC 2012	DIC 2009	DIC 2006	DIC 2003	DIC2000	DIC1997	DIC1994
Ricker	2.7	2.3	3.0	4.6	4.5	6.6	5.0
Ricker AR1	3.5	1.4	2.2	4.2	2.0	1.7	4.5
Ricker BYI	2.6	1.8	1.7	3.3	3.1	-	2.8
Beverton-Holt	3.0	2.2	2.9	4.6	4.6	3.1	5.2
Deriso-Schnute	2.6	2.2	2.7	4.4	4.5	3.0	5.0
BYI2 (Carlson)	-	-	-	-	-	1.2	-

- A smaller DIC represents a better fit
- Rule-of-thumb, DIC differences of 5-10 are "substantial"

Table 2. Markov Table for Brood years 1969-2012 in 200,000 fish in overlapping intervals of escapement for Kenai Late Run Sockeye Salmon.

Escapement Interval	n	Mean Spawners	Mean Returns	Return per Spawner	Yield Mean	Yield Range
0-200	3	120	679	6	564	358-871
100-300	3	165	798	5	633	449-871
200-400	2	292	1,055	4	763	578-947
300-500	4	414	2,179	5	1,764	580-3413
400-600	9	497	2,448	5	1,950	580-3413
500-700	8	563	3,046	5	2,483	999-6361
600-800	**9**	**734**	**4,636**	**6**	**3,902**	**713-8832**
700-900	8	768	4,497	6	3,729	713-8832
800-1000	7	943	3,664	4	2,720	692-4806
900-1100	7	970	3,612	4	2,642	692-4806
1000-1200	2	1,082	3,628	3	2,546	2504-2588
1100-1300	5	1,209	3,291	3	2,082	277-3229
1200-1400	6	1,266	3,250	3	1,985	277-3229
1300-1500	3	1,359	2,867	2	1,508	520-2261
1400-1600	1	1,402	1,922	1	520	520
1500-1700	2	1,672	4,021	2	2,349	1550-3148
1600-1800	2	1,672	4,021	2	2,349	1550-3148
1700-1900	1	1,892	5,004	3	3,111	3,111
1800-2000	1	1,892	5,004	3	3,111	3,111
>2000	2	2,019	7,408	4	5,388	2,432-8,345

Table 3. Yield from the number of spawners from ADF&G brood tables , 1969-2012 sorted by size of escapements, for Kenai River Sockeye Salmon.

Brood Year	Spawners	Returns	Yield	Return per Spawner	Harvest Rate
1969	72.901	430.947	358.046	5.91	0.83
1970	101.794	550.923	449.129	5.41	0.82
1975	184.262	1,055.373	871.111	5.73	0.83
1974	209.836	788.067	578.231	3.76	0.73
1979	373.810	1,321.039	947.229	3.53	0.72
1971	406.714	986.397	579.683	2.43	0.59
1972	431.058	2,547.851	2,116.793	5.91	0.83
1984	446.397	3,859.109	3,412.712	8.65	0.88
1973	507.072	2,125.986	1,618.914	4.19	0.76
1976	507.440	1,506.012	998.572	2.97	0.66
1978	511.781	3,785.040	3,273.259	7.40	0.86
1981	535.523	2,464.323	1,928.800	4.60	0.78
1986	555.207	2,165.138	1,609.931	3.90	0.74
1985	573.836	2,587.921	2,014.085	4.51	0.78
1980	615.382	2,673.295	2,057.913	4.34	0.77
2000	696.899	7,058.348	6,361.449	10.13	0.90
2008	708.833	3,377.884	2,669.051	4.77	0.79
1991	727.159	4,436.074	3,708.915	6.10	0.84
2001	738.229	1,698.142	959.913	2.30	0.57
1982	755.672	9,587.700	8,832.028	12.69	0.92
1995	776.880	1,899.870	1,122.990	2.45	0.59
1983	792.765	9,486.794	8,694.029	11.97	0.92
1990	794.754	1,507.693	712.939	1.90	0.47
2009	848.117	3,983.872	3,135.755	4.70	0.79
1998	929.091	4,465.328	3,536.237	4.81	0.79
1999	949.276	5,755.063	4,805.787	6.06	0.84
1977	951.038	3,112.620	2,161.582	3.27	0.69
1996	963.125	2,261.757	1,298.632	2.35	0.57
2007	964.261	4,376.406	3,412.145	4.54	0.78
1993	997.730	1,689.779	692.049	1.69	0.41
2010	1,037.666	3,625.388	2,587.722	3.49	0.71
2002	1,126.642	3,630.740	2,504.098	3.22	0.69
1992	1,207.382	4,271.576	3,064.194	3.54	0.72
2012	1,212.837	1,490.134	277.297	1.23	0.19
1988	1,213.047	2,546.639	1,333.592	2.10	0.52
2011	1,284.486	4,513.815	3,229.329	3.51	0.72
1994	1,309.695	3,052.634	1,742.939	2.33	0.57
1997	1,365.746	3,626.402	2,260.656	2.66	0.62
2003	1,402.340	1,922.165	519.825	1.37	0.27
2005	1,654.003	4,802.362	3,148.359	2.90	0.66
2004	1,690.547	3,240.428	1,549.881	1.92	0.48
2006	1,892.090	5,003.585	3,111.495	2.64	0.62
1987	2,011.772	10,356.627	8,344.855	5.15	0.81
1989	2,026.637	4,458.679	2,432.042	2.20	0.55

Table 7.1. Probability of recruitment table for Skeena River sockeye salmon.

Recruitment	Spawning Stock							
From: To:	0–200	200–400	400–600	600–800	800–1000	1000–1200	1200–1400	1400–1600
3600–4000	0	0	0	0	0.333	0	0	0
3200–3600	0	0	0	0	0	0	0	0
2800–3200	0	0	0.091	0	0.167	0	0	0
2400–2800	0	0	0	0	0.167	0.200	0	0
2000–2400	0	0	0	0.429	0.167	0	0	0
1600–2000	0	0	0.182	0	0	0.200	0	1.000
1200–1600	0	0.333	0.364	0.143	0	0.400	0	0
800–1200	0	0.250	0.273	0.429	0	0.200	0	0
400–800	0.667	0.417	0.091	0	0.167	0	0	0
0–400	0.333	0	0	0	0	0	0	0
number of points	3	12	11	7	6	5	0	1
avg spawners	164	308	532	695	924	1077	0	1506
avg recruitment	487	917	1433	1585	2697	1535	0	1921
surplus yield	322	609	901	889	1773	458	0	415

where the power parameter m is greater than 1.0. In principle. m can be estimated from stock-recruitment data and should be much larger than 1.0 (e.g., 2.0 or larger) if depensatory effects are strong.

Tabular and Markovian approaches

A totally different approach to the description of stock-recruitment relationships is to not bother fitting any average curve, and instead simply describe the data tabularly by breaking the range of potential stocks and recruitments into intervals and computing the proportion of the times that a spawning stock within any specific interval produces a recruitment within each recruitment interval. This method has been used by Getz and Swartzman (1981) and Overholtz et al. (1986). Table 7.1 shows such an approach for the Skeena River sockeye data of Figure 7.1.

This type of approach is also called a Markov model in mathematical terms and the table is called a Markov transition probability matrix, but it is simpler to just think of it as a table. This approach is highly recommended when many years data are available, because it can accommodate any possible form of stock-recruitment curve and explicitly incorporates the type of variation seen in the data.

The major problem with the tabular approach is that it requires a lot of data. You should not even try such an approach without 30–50 data points. Even if we only use five intervals for spawning stock size and recruitment, we are attempting to estimate 25 parameters. This is quite a jump from the three parameters of the Beverton-Holt and Ricker models. Do not fool yourself by thinking that you have avoided a parametric approach by using a tabular representation of recruitment probabilities based directly on the data; when you attempt to make predictions about future recruitment patterns and variability using the tabular approach, all those tabled parameter estimates will come back to haunt you.

Structure of random variation around recruitment curves

The tabular approach explicitly incorporates random variation, but the average stock-recruitment curves, such as Beverton-Holt and Ricker, need an additional term to describe how the observed recruitment will vary around the average. There are two approaches to analyzing variation around recruitment curves. One is theoretical, where you propose models of how survival should vary and then see what this means in terms of the distribution of recruits for any specific spawning stock size. The second approach is to simply look at the distribution of variability around fitted curves.

Theory

If we think of the stock-recruitment process as a series of individual life history stages and the total survival from egg to recruit as the product of these survivals, we can write

$$s = s_1 s_2 s_3 \ldots s_n \tag{7.5.14}$$

where s is the total survival over life history stages 1 to n, and s_i is the survival rate in life history stage i. If we take logarithms of both sides, we obtain

$$\log(s) = \Sigma \log(s_i) \tag{7.5.15}$$

If we assume that the survival rate in each life history stage is an independent random variable, and that no single or few stages with peculiar patterns of variation dominate the sum, then we can use an important idea from basic statistics to predict the distribution of the sum (i.e., of overall survival rate). The Central Limit Theorem states that the sum of any long series of independent, identically distributed random variables [log (s_i) in this case] will have a distribution that approaches the normal distribution as the number of values summed increases. In practice, not many values (e.g., 10–20) need be added before the sum closely approaches a normal distribution. This means that the overall survival rate should be lognormally distributed, as in Equation 7.5.16

$$R = \bar{R}e^{w} \tag{7.5.16}$$