Using the June 2020 survey estimate of anchovy recruitment to recommend a final anchovy TAC for 2020 based on the method of Butterworth (2020)

C.L. de Moor*

Correspondence email: *carryn.demoor@uct.ac.za*

This document uses a regression between the May/June survey estimate of recruitment and the corresponding proportion of historical November recruitment to implement a 'straightforward' method (Butterworth 2020a) to provide a final anchovy TAC for 2020.

Introduction

This document uses a regression between the May/June survey estimate of recruitment and the corresponding proportion of historical November recruitment to provide a 'straightforward' method to provide a final anchovy TAC for 2020 based on the method of Butterworth (2020a).

Methods

When regressing the log of the survey estimates of recruitment (R_y^{obs}) against the proportion of historical November recruitment (P_{y-1}) from de Moor (2020a), a trend in residuals can be seen if all years from 1985-2017,19 are used (Figure 1). However, there is no apparent trend in residuals if the regression is only applied to data from 2001-2017,19 (Figure 1), and thus the shorter time series is used for this analysis. The likelihood of a given proportion of historical recruitment, P_i, in November 2019 based on the survey observation in June 2020, R_{2020}^{obs}, is thus given by $e^{-0.5\left[\left(ln\left(R_{2020}^{obs}\right)-ln(P_i)-ln(k)\right)/(0.46)\right]^2} \Big/ 0.46\sqrt{2\pi}$.

Four alternative prior distributions are used for the range of proportions of historical recruitment:

i) An uninformative prior distribution over 0.1 to 1.5.

ii) An uninformative prior distribution over 0.5 to 1.5.

iii) An informative prior distribution with proportions 0.1, 0.3, 0.9, 1.1, 1.3 and 1.5 receiving 10% of the weight of 0.5 and 0.7.

iv) An informative prior distribution with proportions 0.9, 1.1, 1.3 and 1.5 receiving 10% of the weight of 0.5 and 0.7.

The range of P_{y-1} considered here is wider than that considered by the SWG-PEL in March (de Moor 2020). The motivation for (i) is that the prior views of which recruitment levels had greater/lesser weighting in March was subsumed in the decision finally reached (Butterworth 2020a). The motivation for (iii) is that the March recommendation for an initial anchovy TAC resulted from placing greatest weight on the 0.5 and 0.75 proportions (here the closest option is 0.7) (e.g. Bergh 2020, Butterworth 2020b, de Moor 2020c, DFFE 2020). Options (ii) and (iv) consider the sensitivity to the very low recruitment scenarios for which the "consequence" statistics in the tables of de Moor (2020d) do not accurately reflect the impact of the higher catch levels being taken.

* MARAM (Marine Resource Assessment and Management Group), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701, South Africa.

This method was applied to the statistics given in Tables 2, 3, 5 and 6 of de Moor (2020d); a sub-set of those considered by de Moor (2020b).

Results and discussion

Table 1 shows the implementation of this method to the "consequence" statistic of the 20%ile of the ratio of spawner biomass in 2020 to that in 2019 under alternative catch scenarios as a proportion of that ratio under the no catch scenario (i.e. Table 3 of de Moor 2020d) given the likelihood resulting from $R_{2020}^{obs} = 377$ (Coetzee *et al*. 2020). This analysis is carried out separately for each "consequence" statistic.

For this same consequence and the survey observation of 377 billion anchovy recruits, the resultant TAC ranges between 257 and 940 000t for prior (i), 222 and 579 000t for prior (ii), 237 and 834 000t for prior (iii) and 230 and 761 000t for prior (iv) (Table 1 and 2a). Extrapolation beyond the range for which results are available is not necessarily reliable, and given only 350 000t was considered feasible by the SWG-PEL TG, Table 2b shows this range capped at the 350 000t for which consequences were calculated.

Table 2c provides the median final TAC resulting from this method and 25-75%ile (i.e. the range of final TACs containing 50% of the answers). This is firstly provided for all the statistics of Tables 2, 3, 5 and 6 of de Moor (2020d). Initial testing of this method (results available upon request) showed that the exclusion of Table 2 statistics and the 50%ile statistics substantially reduced the range of resulting TACs, potentially allowing a more informative range to use for decision making purposes. The middle column of Table 2c thus gives the median and 25-75%ile excluding these statistics. The final column only considers the 20%iles of the "consequence" statistics. The medians range from 272 to 302 000t, while the 25-75%iles range from 248 to 350 000t.

Tables 3 and 4 show the TACs for alternative recruit survey observations of 340 billion and 400 billion anchovy, respectively.

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Table 1. Calculation example for the 20%ile of the ratio of spawner biomass in 2020 to that in 2019 under alternative catch scenarios as a proportion of that ratio under the no catch scenario. The "consequence" statistics come from Table 3b of de Moor (2020d).

		Fixed Catch																	
		0	150	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350
Proportion of average historical recruitment	0.1	1.00	0.84	0.78	0.77	0.76	0.75	0.74	0.73	0.72	0.71	0.69	0.68	0.67	0.66	0.65	0.64	0.63	0.62
	0.3	1.00	0.87	0.82	0.82	0.81	0.80	0.79	0.78	0.77	0.76	0.75	0.75	0.74	0.73	0.72	0.71	0.70	0.68
	0.5	1.00	0.89	0.86	0.85	0.84	0.83	0.83	0.82	0.81	0.81	0.80	0.79	0.78	0.77	0.76	0.76	0.75	0.74
	0.7	1.00	0.91	0.88	0.87	0.86	0.86	0.85	0.84	0.84	0.83	0.83	0.82	0.81	0.81	0.80	0.79	0.79	0.78
	0.9	1.00	0.92	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.85	0.85	0.84	0.84	0.83	0.82	0.82	0.82	0.81
	1.1	1.00	0.93	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.87	0.86	0.86	0.85	0.85	0.84	0.84	0.83
	1.3	1.00	0.93	0.91	0.91	0.90	0.90	0.89	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.86	0.86	0.85	0.85
	1.5	1.00	0.94	0.92	0.92	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.88	0.88	0.88	0.87	0.87	0.86	0.86
Prior (i)	C_{crit}	1.00	0.90	0.87	0.86	0.86	0.85	0.84	0.84	0.83	0.83	0.82	0.81	0.80	0.80	0.79	0.79	0.78	0.77
	C_{crit_updat}	1.00	0.93	0.91	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.86	0.85	0.85	0.85	0.84	0.84
	TAC_{rev}										278								
Prior (ii)	C_{crit}	1.00	0.92	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.86	0.85	0.84	0.84	0.83	0.83	0.82	0.82	0.81
	C_{crit_updat}	1.00	0.93	0.91	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.86	0.85	0.85	0.85	0.84	0.84
	TAC_{rev}					228													
Prior (iii)	C_{crit}	1.00	0.90	0.87	0.86	0.85	0.85	0.84	0.83	0.83	0.82	0.81	0.81	0.80	0.79	0.78	0.78	0.77	0.76
	C_{crit_updat}	1.00	0.92	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.86	0.85	0.84	0.84	0.83	0.83	0.82	0.82	0.81
	TAC_{rev}							246											
Prior (iv)	C_{crit}	1.00	0.91	0.87	0.87	0.86	0.85	0.85	0.84	0.83	0.83	0.82	0.81	0.81	0.80	0.79	0.79	0.78	0.77
	C_{crit_updat}	1.00	0.92	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.86	0.85	0.84	0.84	0.83	0.83	0.82	0.82	0.81
	TAC_{rev}							235											

Table 2a. The revised TACs recommended applying the method of Butterworth (2020) to a range of "consequence" statistics [Table numbers correspond to de Moor (2020d)] using $R_{2020}^{obs} = 377$ billion.

	(i)			(ii)			(iii)			(iv)		
	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile
Tables 2	486	674	940	352	446	579	425	590	834	399	545	761
Tables 3	257	278	296	222	228	235	237	246	259	230	235	246
Tables 5	312	360	423	249	267	287	276	307	343	263	288	313
Tables 6	450	514	593	263	263	263	316	330	348	278	277	277

Table 2b. As per Table 2a, but restricting the revised TAC to the max of 350 000t for which "consequences" were evaluated.

	(i)			(ii)			(iii)			(iv)		
	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile
Tables 2	350	350	350	350	350	350	350	350	350	350	350	350
Tables 3	257	278	296	222	228	235	237	246	259	230	235	246
Tables 5	312	350	350	249	267	287	276	307	343	263	288	313
Tables 6	350	350	350	263	263	263	316	330	348	278	277	277

Table 2c. The 25%ile, median and 50%ile of Table 2b.

	All	Excluding 50%ile and Table 2	Excluding 5%ile, 50%ile and Table 2
25%ile	263	248	259
50%ile	302	272	278
75%ile	350	308	313

Table 3a. The revised TACs recommended applying the method of Butterworth (2020) to a range of "consequence" statistics [Table numbers correspond to de Moor (2020d)] using $R_{2020}^{obs} = 340$ billion.

	(i)			(ii)			(iii)			(iv)	
	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile
Tables 2	463	637	885	330	410	522	386	523	729	361	478	655
Tables 3	253	272	289	220	225	230	231	238	249	224	228	237
Tables 5	304	349	409	242	258	275	263	288	319	251	270	291
Tables 6	434	496	570	255	255	254	298	311	328	262	262	262

Table 3b. As per Table 3a, but restricting the revised TAC to the max of 350 000t for which "consequences" were evaluated.

	(i)			(ii)			(iii)			(iv)	
	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile
Tables 2	350	350	350	330	350	350	350	350	350	350	350	350
Tables 3	253	272	289	220	225	230	231	238	249	224	228	237
Tables 5	304	349	350	242	258	275	263	288	319	251	270	291
Tables 6	350	350	350	255	255	254	298	311	328	262	262	262

Table 3c. The 25%ile, median and 50%ile of Table 3b.

	All	Excluding 50%ile and Table 2	Excluding 5%ile, 50%ile and Table 2
25%ile	254	241	251
50%ile	289	260	266
75%ile	350	291	294

Table 4a. The revised TACs recommended applying the method of Butterworth (2020) to a range of "consequence" statistics [Table numbers correspond to de Moor (2020d)] using $R_{2020}^{obs} = 400$ billion.

	(i)			(ii)			(iii)			(iv)	
	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile
Tables 2	498	694	970	364	466	609	448	629	894	422	583	821
Tables 3	258	280	299	224	231	238	241	251	265	233	240	252
Tables 5	315	366	431	252	273	294	284	319	357	271	299	326
Tables 6	458	523	606	268	268	268	328	342	360	287	287	287

Table 4b. As per Table 4a, but restricting the revised TAC to the max of 350 000t for which "consequences" were evaluated.

	(i)			(ii)			(iii)			(iv)	
	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile	5%ile	20%ile	50%ile
Tables 2	350	350	350	350	350	350	350	350	350	350	350	350
Tables 3	258	280	299	224	231	238	241	251	265	233	240	252
Tables 5	315	350	350	252	273	294	284	319	350	271	299	326
Tables 6	350	350	350	268	268	268	328	342	350	287	287	287

Table 4c. The 25%ile, median and 50%ile of Table 3b.

	All	Excluding 50%ile and Table 2	Excluding 5%ile, 50%ile and Table 2
25%ile	268	252	264
50%ile	307	277	284
75%ile	350	316	325

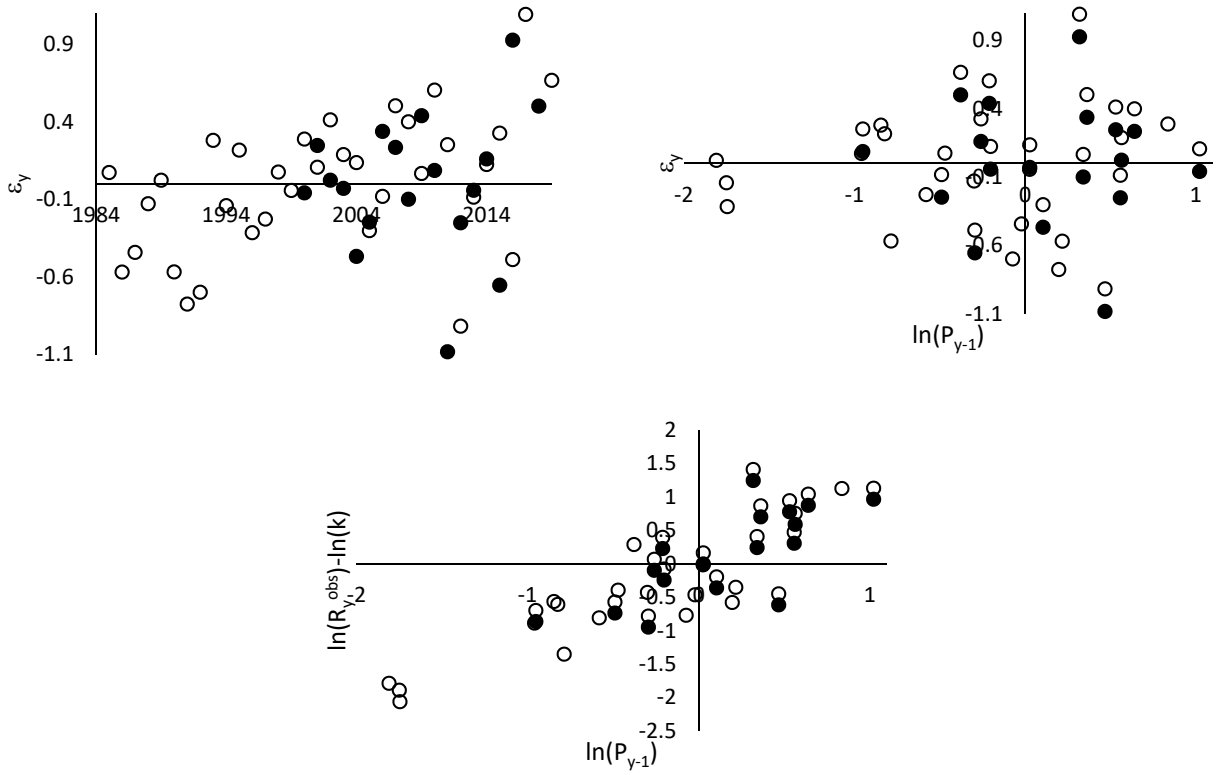

Figure 1. The annual residuals, $\varepsilon_y = ln\left(R_y^{obs}\right) - ln\left(P_{y-1}\right) - ln(k)$, obtained from minimising $\sum_y \left(\varepsilon_y\right)^2$, plotted against year and $ln\left(P_{y-1}\right)$. The open circles (with $k = 203$) result from fitting 1985-2017,19 while the closed circles (with $k = 239$) result from fitting 2001-2017,19. The standard deviation of the residuals is 0.44 and 0.46, respectively. The lower plot shows the resultant regressions.