Updated squid assessment results

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Summary

Glazer & Butterworth (2013) reports progress on refinements to the squid stock assessment model focusing particularly on replacing the discrete Pope catch equations with differentiable Baranov catch equations as recommended by the Panel of the International Stock Assessment Workshop held at UCT in December 2012. A comparison of key parameter estimates as per the Pope and Baranov models (utilizing data to 2011) indicated that although initial recruitment, and hence biomass, is estimated to be somewhat higher for the Baranov model (driven mainly by the lower estimate of *h* in that model), the ratio of current stock status relative to pristine ($\frac{B^*_{2012}}{B^*_{1971}}$) was at a similar level for both models.

This paper reports further results to those in Glazer & Butterworth (2013):

- A comparison of risk statistics for the Pope and Baranov models where each model was projected 5000 times into the future from their joint posterior mode values
- Updated joint posterior mode parameter estimates for the Baranov model including data to 2012

Data

Since the previous assessment conducted in 2012 the only abundance index that has been updated is the Apr-Dec jig CPUE index (with the addition of the 2012 data point). The trawl indices currently only cover the period 1978-1999 (pending a complete revision of these indices) and no further surveys have taken place since the assessment that was conducted in 2012.

Tables 1-5 report the data included in the analyses.

Performance statistics

Performance statistics reported comprise the following:

- average annual catches
- average annual variation (AAV) in catch from one year to the next, where:

$$AAV = \frac{1}{20}\sum_{y=2012}^{y=2021} \left|C_y - C_{y-1}\right|/C_{y-1}$$

- $\frac{B^*_{2022}}{K}$
- $\frac{B^*_{lowest}}{K}$

Results

Figures 1a-d plot the performance statistics as defined above as functions of a fixed annual effort expressed in terms of man-days for the following models:

1. Pope catch equation
2. Baranov catch equation
3. Baranov catch equation, but fixing h and η at the joint posterior values as estimated by the Pope model

From the results it appears that a target effort level of 300 000 man-hours is reasonable given that median $\frac{B^*_{2022}}{K}$ is around 0.4 with a lower 5%-ile of ~0.18, and median $\frac{B^*_{lowest}}{K}$ is around 0.2 with a lower 5%-ile of ~0.13.

Table 6 reports the updated Baranov model results including data to 2012 and compares them with those from the Baranov model utilizing data to 2011. Figures 2 and 3 show trends in recruitment and recruitment residuals respectively, while Figure 4 shows trends in biomass. Figures 5a-e compare the model fits to the indices of abundance.

Reference

Glazer, J.P. and D.S. Butterworth. 2013. Progress with respect to refinements of the squid stock assessment model. Unpublished DAFF working group document: Fisheries/2013/Jun/SWG-SQ/35. 10pp.

Table 1: Jig catches (tons).

year	Jan-Mar	Apr-Dec
1985	117	2487
1986	248	3151
1987	170	2627
1988	213	4614
1889	2044	7534
1990	459	1728
1991	149	4330
1992	218	1752
1993	309	6402
1994	2493	4356
1995	1735	5578
1996	1828	4996
1997	945	2829
1998	1644	4919
1999	1662	4973
2000	1217	4844
2001	719	2228
2002	1819	7795
2003	2166	9654
2004	5028	8233
2005	2758	6389
2006	3583	5708
2007	2044	7394
2008	3034	5987
2009	3242	7099
2010	3665	7112
2011	3154	4642
2012	2032	4426

Table 2: Trawl catches (tons)

year	Jan-Mar	Apr-Dec
1971	26.64	46.36
1972	186.88	325.12
1973	342	595
1974	1322	2300
1975	1331.86	2317.14
1976	769.77	339.23
1977	1205.21	2096.79
1978	1021.2	3967.8
1979	2080.57	3035.43
1980	1006.84	2047.16
1981	1719.16	2036.84
1982	1536.75	2067.25
1983	2304.69	1810.31
1984	586.7	1528.3
1985	1633.12	2053.88
1986	222.88	715.12
1987	238.3	413.7
1988	169.36	651.64
1989	413.2	749.8
1990	290.36	454.64
1991	141.72	351.28
1992	90.22	196.78
1993	50.62	227.38
1994	220.1	266.9
1995	125.43	213.57
1996	155.23	205.77
1997	75.6	161.4
1998	128.37	187.62
1999	90.94	183.72
2000	81.66	272.3
2001	119.41	124.85
2002	62.73	142.43
2003	76.14	261.67
2004	123.38	267.91
2005	94.6	279.25
2006	134.22	223.97
2007	126.77	369.32
2008	169.43	353.76
2009	395.8	363.63
2010	221.55	339.02
2011	256.86	202.7
2012	71.55	155.78

Table 3: Survey indices of abundance (tons) from surveys utilizing the old gear only.

	Spring index		Autumn Index	
year	index	CV	index	CV
1986	8638	1880		
1987	12111	1733		
1988	0	0	9075	1336
1989	0	0	19025	4191
1990	13434	1849	9222	1832
1991	23595	4021	14695	3503
1992	10034	1448	13145	1476
1993	14409	2437	22361	3938
1994	15255	2383	22377	5331
1995	13616	1549	23511	3021
1996			27968	2673
1997			10026	1049
1998				
1999			19495	2230
2000				
2001	10558	1532		
2002				
2003			22448	2937
2004				
2005				
2006	12763	1295	20118	2187
2007				
2008				
2009				
2010			16938	2363

Table 4: Jig CPUE index (kg/manhour).

year	Jan-Mar	Apr-Dec
1995	30.48	31.24
1996	29.49	25.36
1997	15.88	16.24
1998	18.21	26.11
1999	29.66	25.83
2000	19.68	28.16
2001	21.36	19.42
2002	22.40	30.58
2003	28.44	37.03
2004	45.00	26.74
2005	22.85	21.97
2006	30.48	22.49
2007	21.66	27.23
2008	29.05	36.75
2009	37.59	32.32
2010	31.33	25.86
2011	25.53	17.88
2012	16.46	21.27

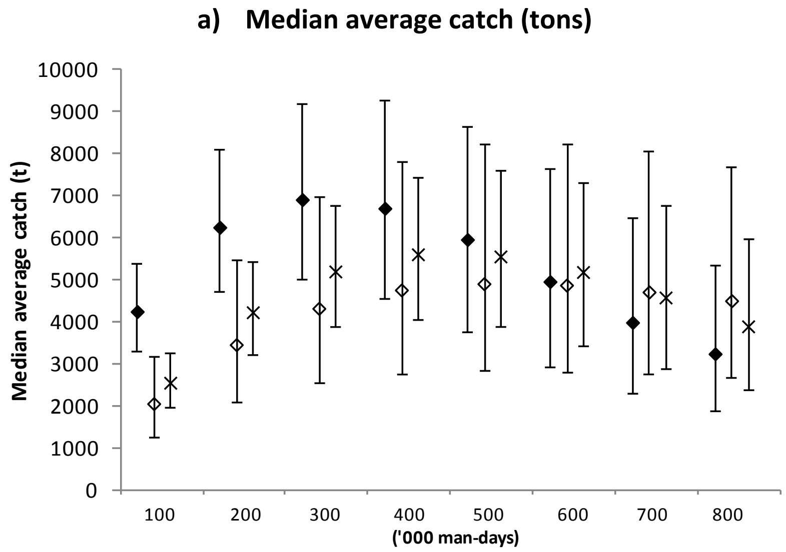
Table 5: Trawl CPUE index (kg/hour).

year	Jan-Mar	Apr-Dec
1978	13.77	7.46
1979	19.97	7.92
1980	14.52	4.31
1981	17.78	8.12
1982	16.50	4.94
1983	24.10	3.22
1984	8.90	4.02
1985	12.69	3.17
1986	6.20	2.80
1987	5.79	2.11
1988	5.60	3.15
1989	8.81	3.43
1990	6.25	2.07
1991	5.28	2.34
1992	3.84	1.72
1993	3.53	2.09
1994	6.58	2.14
1995	5.20	2.08
1996	5.25	2.10
1997	4.34	1.79
1998	4.83	2.21
1999	5.17	1.84

Table 6: Parameter estimates obtained from the Baranov model formulations including catch and abundance index data to 2011 (Baranov 2012) and 2012 (Baranov 2013) respectively.

	Models	
Parameter	**Baranov 2012**	**Baranov 2013**
ln*X*	10.75	10.74
R_0 (initial recruitment) = exp(ln*X*)	46590	46082
h	0.301	0.300
η	0.573	0.523
g	1.263	1.263
B*1971	64970	64258
B*2012	17520	17991
B*2012/B*1971	0.270	0.280
B*2013	n/a	18598
B*2013/B*1971	n/a	0.289
σ_R (input)	0.30	0.30
σ_R (estimated)	0.20	0.19
Jig Jan-March CPUE		
q	0.001370	0.001362
σ*	0.204	0.204
Jig Apr-Dec CPUE		
q	0.000642	0.000646
σ*	0.200	0.200
Trawl Jan-March CPUE		
q	0.000274	0.000276
σ*	0.200	0.200
Trawl Apr-Dec CPUE		
q	0.000055	0.000055
σ*	0.200	0.200
Autumn index		
q	0.273826	0.275546
σ*	0.346	0.346
Spring index		
q	0.369224	0.372097
σ*	0.262	0.262
-LnL contributions		
jig A-D	-9.291	-9.859
trawl J-M	-6.901	-6.897
Trawl A-D	-9.765	-9.762
autumn (old gear)	5.021	5.022
spring (old gear)	0.796	0.794
S/R residuals	-2.963	-3.209
penalty (g)	-1.187	-1.187
Jig JM catches	-80.813	-83.8063
jig AD catches	-80.812	-83.8052
Trawl JM catches	-122.716	-125.71
Trawl AD catches	-122.716	-125.71
Total -LnL	-431.349	-444.129
Total -lnL (excluding fits to catches)	-24.291	-25.098

Figure 1: Comparison of various risk statistics related to squid assessment projections for the following models: Pope (closed diamonds), Baranov (open diamonds) and Baranov, but with *h* and *η* fixed at the joint posterior estimate values from the Pope model, i.e. eta=0.313 & h=0.511 (crosses). The bars show medians and upper and lower 5%-iles.



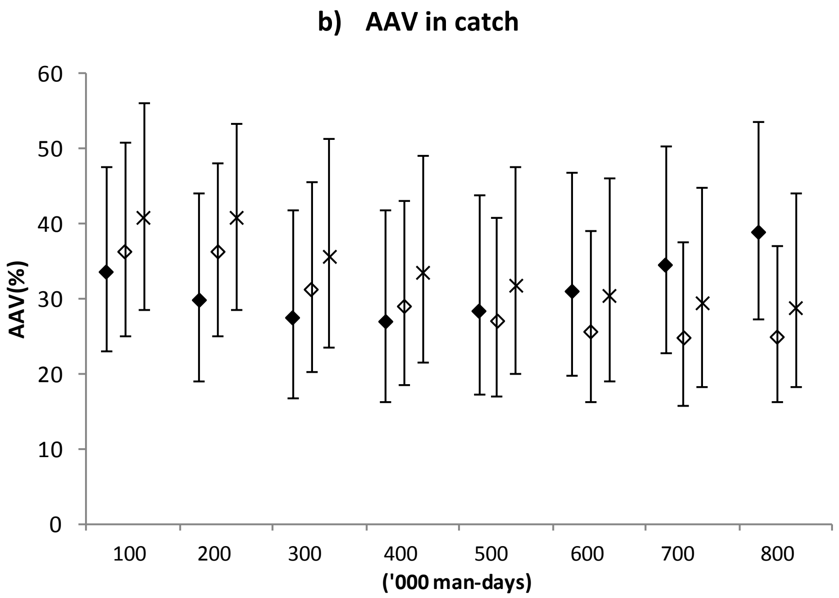
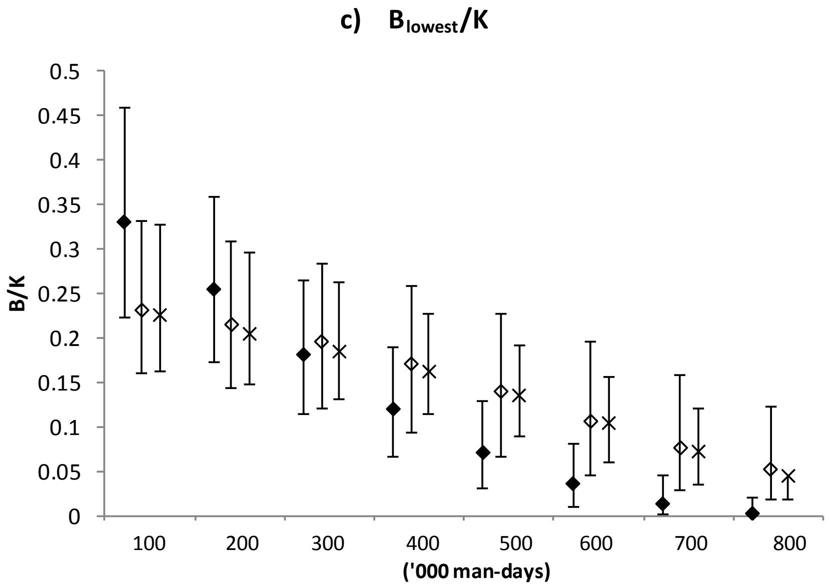


Figure 1 continued: Comparison of various risk statistics related to squid assessment projections for the following models: Pope (closed diamonds), Baranov (open diamonds) and Baranov, but with *h* and *η* fixed at the joint posterior estimate values from the Pope model, i.e. eta=0.313 & h=0.511 (crosses). The bars show medians and upper and lower 5%-iles.



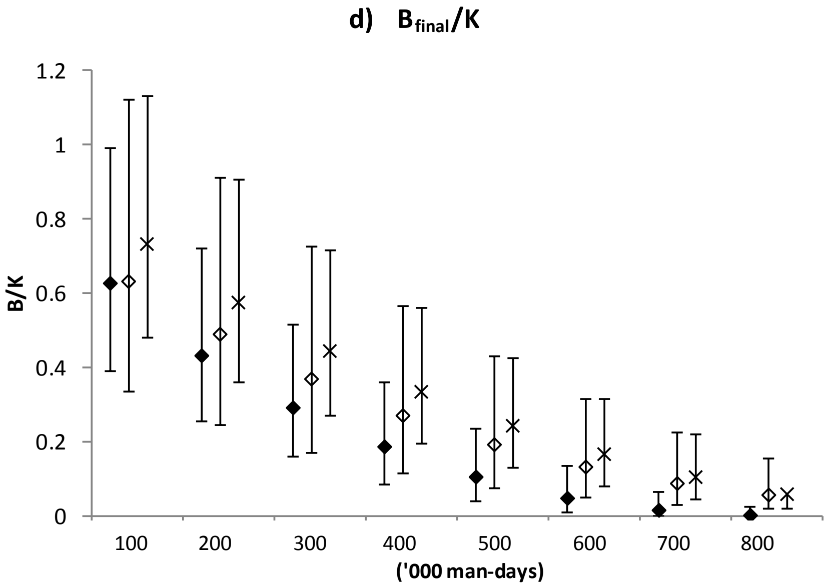


Figure 2: Recruitment series as per the Baranov model utilizing data to 2011 and 2012 respectively.

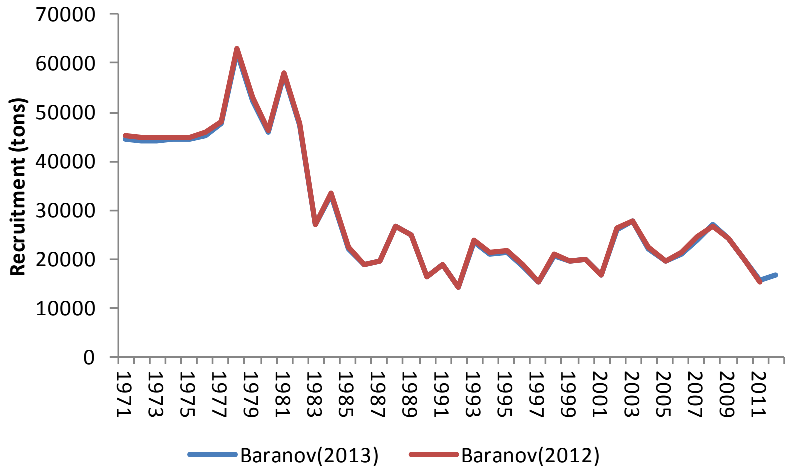


Figure 3: Recruitment residuals as per the Baranov model utilizing data to 2011 and 2012 respectively.

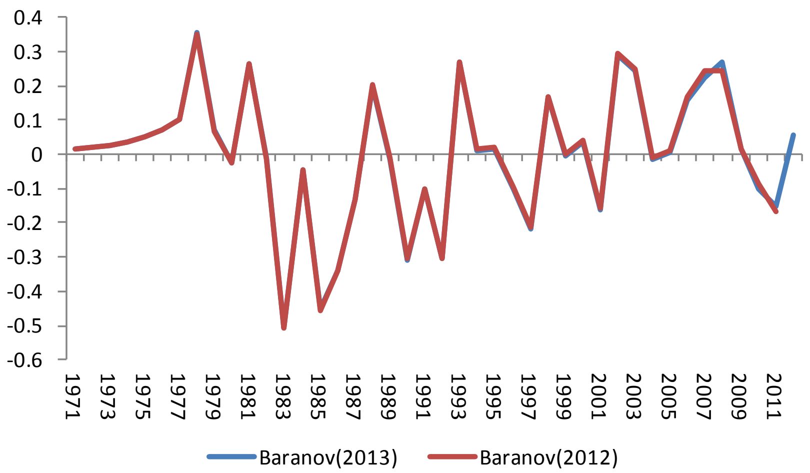


Figure 4: Begin-year biomass series as per the Baranov model utilizing data to 2011 and 2012 respectively.

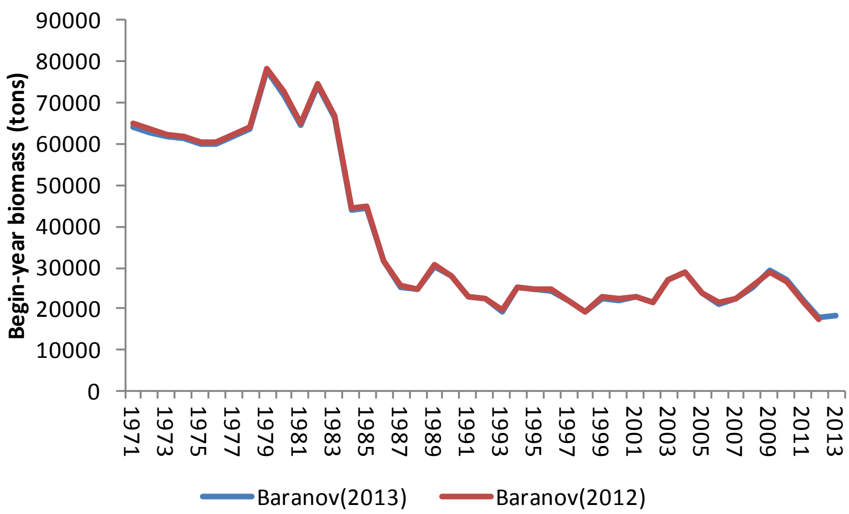


Figure 5: Fits to the abundance indices as per the Baranov model utilizing data to 2011 and 2012 respectively.