Extrapolation of recruit numbers to Cape Infanta in the years for which the survey only reached Cape Agulhas

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Introduction

The time series of sardine and anchovy recruits used in assessments and to set the final anchovy TAC and sardine TAB in June each year are based on the surveyed area west of Cape Infanta. In some years, the survey did not cover the full area eastwards to Cape Infanta. The first and urgent year for consideration is the survey in 2011 for which the area covered was west of Cape Agulhas only because of damage to the survey vessel. The second set of years for consideration are 1985-1990 when the survey was regularly terminated at Cape Agulhas. In this document we recommend an approach to deal with the survey estimate of recruit numbers and associated variance in such years.

Method

Table 1 lists the recruit numbers west of Cape Agulhas (strata A-E in recent years) and between Cape Agulhas and Cape Infanta (stratum F in recent years) for years for which these data can be extracted. The ratio of recruits between Cape Agulhas and Cape Infanta to that west of Cape Agulhas is computed as r_y. The recruits between Cape Agulhas and Cape Infanta can then be estimated using the average of these proportions, $\bar{r}$, i.e. $N_{stratumF} = \bar{r} N_{strataA-E}$.

The variance of the extrapolated estimate west of Cape Infanta is then estimated as follows:

$$\text{var}(N_{strataA-F}) = \text{var}((1+\bar{r})N_{strataA-E}) = \text{var}(1+\bar{r})(N_{strataA-E})^2 + (1+\bar{r})^2 \text{ var}(N_{strataA-E})$$

where

$$\text{var}(1+\bar{r}) = \text{var}(\bar{r}) = \frac{1}{n-1}\sum_y (r_y - \bar{r})^2$$

and

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$\text{var}(N_{strataA-E}) = \sqrt{\frac{N_{strataA-E}}{CV(N_{strataA-E})}}$. Although the CV is calculated from the biomass rather than the number of recruits west of Cape Agulhas, this is assumed to be an adequate assumption for these purposes.

Results and Discussion

The average proportion of recruits between Cape Agulhas and Cape Infanta to that west of Cape Agulhas is 0.03 for sardine and anchovy over the years 2002 to 2010. This average can be used to extrapolate the 2011 survey estimate of recruits from Cape Agulhas to Cape Infanta as demonstrated in Table 1.

The CVs of these estimates have decreased marginally, but to three decimal places they remain the same at 0.283 for anchovy and 0.475 for sardine.

The average proportion of recruits between Cape Agulhas and Cape Infanta to that west of Cape Agulhas over the years 1991 to 1995, 1998 and 1999 is 0.02 for anchovy and 0.06 for sardine. However, the proportion of sardine recruits between Cape Agulhas and Cape Infanta in 1999 is exceptionally high. Treating this point as an outlier results in an average of 0.00. Given these low proportions, the perception of a regime shift in the early 2000s and the previous held assumption of historically few recruits between Cape Agulhas and Cape Infanta, it is suggested that no extrapolation of recruit numbers for 1984 to 1990 is necessary.

Recommendations

1. The 2011 survey estimate of anchovy recruit numbers be increased for use in the setting of 2011 TACs. The estimate should be increased from 101.582 billion reflecting the area west of Cape Agulhas to 104.167 billion reflecting the area west of Cape Infanta.
2. The extrapolated estimates of recruit numbers in 2011 up to Cape Infanta (104.167 billion with a CV of 0.283 for anchovy and 5.470 billion with a CV of 0.475 for sardine) be used in future assessments of both resources.
3. No extrapolation of recruit numbers between 1985 and 1990 is undertaken.

Table 1. Recruit numbers, ratios and summary statistics estimated from surveys. The recruit numbers between Cape Agulhas and Cape Infanta, given in *italics*, have been extrapolated using the method described in the text. Note that numbers are quoted in billions (10^9).

	Anchovy			Sardine		
	Recruit numbers west of Cape Agulhas (strata A-E)	Recruit numbers between Cape Agulhas and Cape Infanta (stratum F)	Ratio F:A-E	Recruit numbers west of Cape Agulhas (strata A-E)	Recruit numbers between Cape Agulhas and Cape Infanta (stratum F)	Ratio F:A-E
2011	101.582	*2.585*		5.304	*0.165*	
2010	369.125	14.203	0.04	35.117	0.453	0.01
2009	324.147	39.241	0.12	9.068	0.139	0.02
2008	560.471	2.685	0.00	3.843	0.009	0.00
2007	506.461	0.242	0.00	2.927	0.010	0.00
2006	117.113	0.352	0.00	9.521	0.043	0.00
2005	176.302	0.616	0.00	2.677	0.197	0.07
2004	236.240	2.329	0.01	4.074	0.015	0.00
2003	430.247	0.062	0.00	33.406	3.042	0.09
2002	496.720	23.693	0.05	45.786	3.367	0.07
2001		627.200[1]	not available		60.065[1]	not available
2000		624.675[1]	not available		20.002[1]	not available
1999	194.750	4.477	0.02	7.298	3.080	0.42
1998	136.458	0.060	0.00	10.616	0.100	0.01
1997		90.206[1]	not available		40.372[1]	not available
1996		25.757[1]	not available		3.207[1]	not available
1995	110.380	0.020	0.00	26.036	0.006	0.00
1994	30.411	0.153	0.01	2.687	0.013	0.00
1993	109.035	6.037	0.06	15.396	0.038	0.00
1992	87.112	6.600	0.08	5.571	0.018	0.00
1991	112.830	0.750	0.01	1.898	0.006	0.00
Average 2002-2010			0.03			0.03
Variance 2002-2010			0.0016			0.0014
Average 1991-1995,98,99			0.02			0.06[2]

[1] Strata E and F were combined in these years.
[2] 0.00 if 1999 is excluded.