The Relationship Between Pelagic Acoustic Survey CV and Pelagic Abundance and Survey Effort

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The NRF/SA Pelagic and Rock Lobster Industries International Stock Assessment Workshop, held in July 2007 recommended that a relationship between the survey CV and abundance, and possibly also survey effort, be included in the operating models for anchovy and sardine. This recommendation was reiterated at the MARAM International Stock Assessment Workshop in December 2008. Initial results (de Moor *et al*. 2008) suggested that only a relationship with biomass could be found. Further investigations have now been carried out.

Data

The data used are from the spawner biomass acoustic surveys from November 1984 to November 2006 and from the recruit acoustic surveys from May 1985 to 2006. These correspond to the data used in the latest full assessments.

Method

Letting B denote the model predicted November spawner biomass or May recruitment, T the total number of survey transects and L the total transect length, the estimated survey CV was modelled in the following ways, where a, p, b and c are estimable parameters with the last three constrained to be positive:

i) $\hat{CV}^2 = a + \frac{b}{B}$

ii) $\hat{CV}^2 = a + \frac{b}{B^p}$

iii) $\hat{CV}^2 = a + \frac{b}{B} + \frac{c}{T}$

iv) $\hat{CV}^2 = a + \frac{b}{B} + \frac{c}{L}$

These four sets of regressions were carried, separately for the November and May surveys and for sardine and anchovy. The negative log-likelihood minimised to estimate parameters was given by:

$$-\ln L = \frac{(2006-1984+1)}{\ln(\sigma)} + \frac{1}{2\sigma^2}\sum_{y=1984}^{2006}\left(CV_y - \hat{CV}_y\right)^2 \quad \text{for November and}$$

$$-\ln L = \frac{(2006-1985+1)}{\ln(\sigma)} + \frac{1}{2\sigma^2}\sum_{y=1985}^{2006}\left(CV_y - \hat{CV}_y\right)^2 \quad \text{for May.}$$

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Results

Table 1 lists the negative log likelihood and corresponding AIC for each model and survey. Using the AIC, the simplest model (i) of a relationship between survey CV and model predicted biomass/recruitment is the best selection for the anchovy surveys and the sardine November survey, while for the sardine May survey AIC suggests model ii.

The model fit to the data is shown in Figure 1 for anchovy and Figure 2 for sardine. The standardised residuals from these fits are shown in Figure 3 for anchovy and Figure 4 for sardine.

Discussion

These results indicate that relationships between survey CV and model predicted spawner biomass/recruitment do exist. Although relationships between survey CV and survey abundance together with effort were also tested, model selection criteria suggest using survey abundance only. Pragmatically, the AIC preference for estimation of p for the sardine recruitment survey is so slight that on consistency grounds it seems best to use p=1 for all four cases. Plots of the residuals suggest greater variance at smaller biomass, so the estimation procedure adopted may be overweighting these points somewhat, but this seems acceptable given that that is where the curvature of the relationship becomes important, and the fits to data at high biomass is in any case, generally good.

It is suggested that such relationships be incorporated in the development of the next pelagic OMP, although these regressions will need to be updated at that time with data subsequently becoming available for use in the next assessments.

References

de Moor, C.L., Butterworth, D.S., Durholtz, D., and van der Lingen, C. 2008. Progress on Recommendations from Previous Workshop: Sardine and Anchovy. MARAM International Stock Assessment Workshop, December 2008. MARAM IWS/DEC08/S/4.

Table 1. The negative log likelihood and corresponding AIC resulting from the four models tested against the different surveys.

Model	Sardine November	Anchovy November	Sardine May	Anchovy May
	-lnL			
i) $CV^2 = a + b/B$	-26.39	-71.22	-28.56	-80.71
ii) $CV^2 = a + b/(B^p)$	-27.07	-71.26	-29.63	-81.62
iii) $CV^2 = a + b/B + c/Tnum$	-26.74	-71.26	-28.56	-80.71
iv) $CV^2 = a + b/B + c/Tlen$	-26.39	-71.22	-29.11	-80.71
	AIC			
i) $CV^2 = a + b/B$	**-46.78**	**-136.45**	-51.13	**-155.42**
ii) $CV^2 = a + b/(B^p)$	-46.14	-134.52	**-51.27**	-155.24
iii) $CV^2 = a + b/B + c/Tnum$	-45.47	-134.51	-49.13	-153.42
iv) $CV^2 = a + b/B + c/Tlen$	-44.77	-134.45	-50.21	-153.42

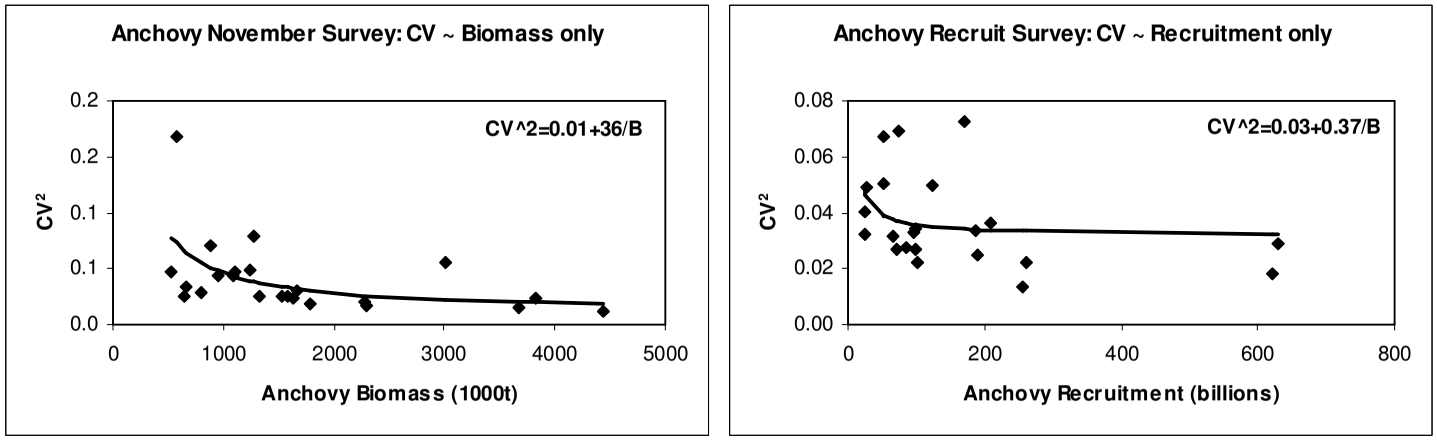

Figure 1. The observed (solid diamonds) and model predicted (line) relationship between the square of the anchovy survey CV and the survey estimate of abundance.

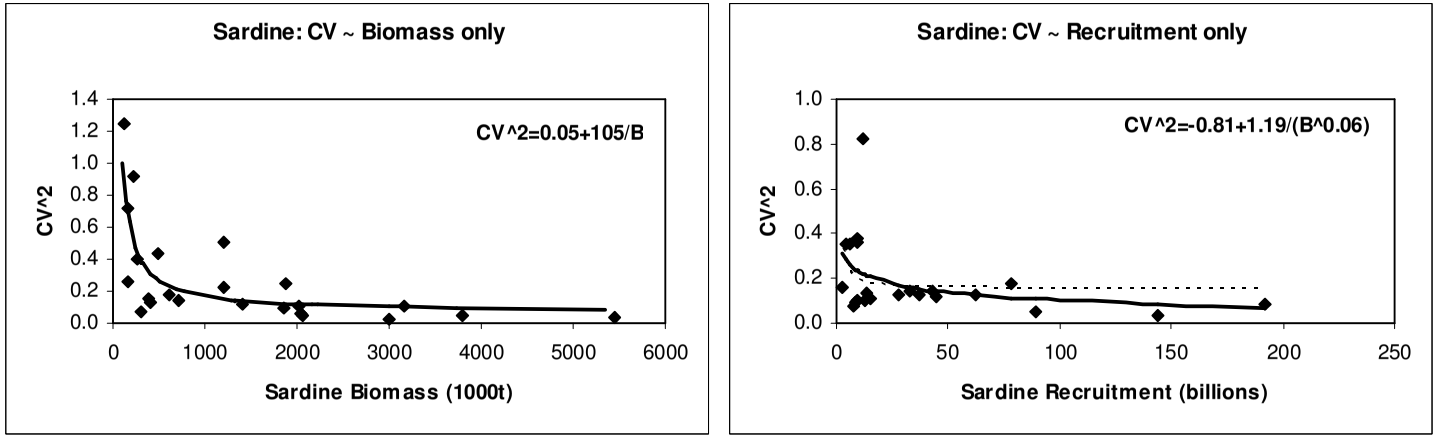

Figure 2. The observed (solid diamonds) and model predicted (lines) relationship between the square of the sardine November survey CV and the survey estimate of abundance. The dotted line in the right hand plot shows the fit when p=1, i.e. $CV^2=0.15+0.49/B$.

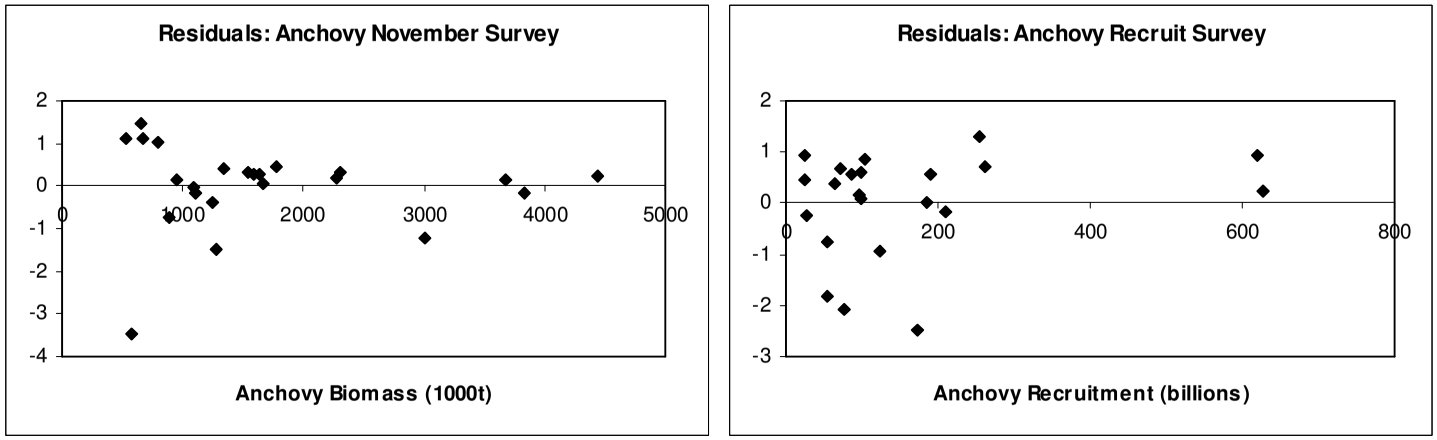

Figure 3. Standardised residuals from the fit of model predicted anchovy survey CV^2 to the observed survey squared CV^2 shown in Figure 1.

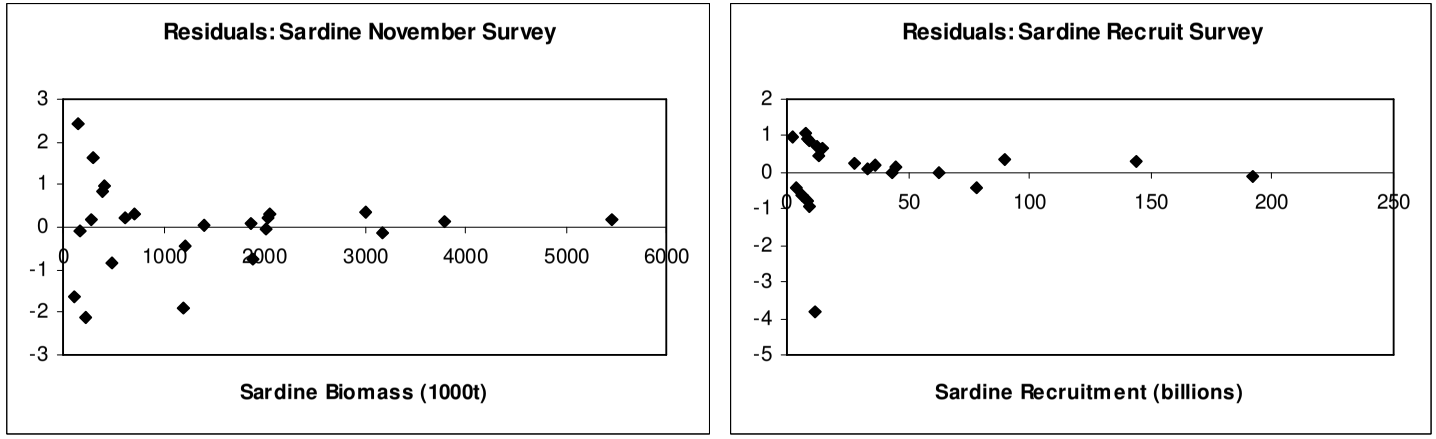

Figure 4. Standardised residuals from the fit of model predicted sardine survey CV^2 to the observed survey CV^2 shown in Figure 2.