Pelagic Assessment Data and Key Problems Encountered in Compiling these Data, Including Sardine Ageing

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The sardine and anchovy assessments are tuned using the daily egg production method (DEPM), acoustic survey data and commercial catch data. The acoustic survey data are described in Coetzee (2007). In addition to the acoustic survey estimates of November spawner (1+) biomass and May recruitment, the anchovy model is fit to DEPM estimates of November spawner biomass together with the proportion-at-age 1 in the November survey. The sardine model is also fit to the proportion-at-age or length in the November survey and the proportion-at-length in the commercial catch. Other data used without error in the assessments include weights-at-age in the November survey, average recruitment weight at the time of the recruit survey and recruit catch taken prior to the start of the survey.

In the absence of commercial ALKs for anchovy, the split of catch between recruits and 1-year-olds was determined by a cut-off length varying by month (Cunningham and Butterworth 2007). The proportion of recruits in the November survey was determined on the basis of an 'average' ALK from those available for the period 1992 to 1995 developed by Prosch (De Oliveria 2003). Although the assessment models are age-structured production models (ASPM), the sardine model needed to be adapted to account for the proportion-at-length (not age) in the November survey and commercial catch. This was as a result of age-length keys (ALKs) only being available for 8 of the surveys and the limited availability of commercial ALKs (see Table 1 below).

Routine sardine age determination at MCM was conducted by Michael Kerstan (MK) for the period 1990 – 1999. There was then a 4 year hiatus until the appointment of Deon Durholtz (DD) in 2004. Sardine age determination activities were subsequently directed at:

1. Comparing DD with MK to ensure data continuity. Otoliths collected during three November surveys conducted during the 1990s (1993, 1994 and 1996) that had been read by both MK and DD were used for this purpose.
2. Generating sardine ALKs from November surveys for the period 2000 – present.

Sardine age determination at MCM currently employs the approach developed by Michael Kerstan during the 1990s. Annual growth zones are identified and their radii measured. A precise age for each fish (± 0.1 years) is computed using a multiple regression approach. The proportion of a year represented by the outermost, incomplete annual growth zone on each otolith is calculated from models describing the radius of complete annual growth zones. Each fish is then assigned to an age group and year class using the winter-to-winter

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convention appropriate for the Southern Hemisphere (each year class considered to contain fish hatched between 1 July and 30 June of the following year). For example, a fish caught in November displaying a precise age fraction greater than 0.4 will be assigned to an age group 1 year older than the number of complete annual growth zones identified in the otolith.

ALKs generated by DD are listed in Table 1. Apparent in Table 1 is that no ALKs are available for the 2000 and 2005 November surveys. An attempt was made to redress these gaps in the series by using ALKs generated from commercial catches landed in November of these years. To test the validity of this approach, the November 2002 survey ALK was compared to a commercial ALK generated from November 2002 landings. Applying these two ALKs to the November 2002 survey raised length frequency (RLF) data resulted in substantial differences, particularly in the relative proportions of 1 year olds in the resulting age structure (Fig. 1). Application of the survey ALK resulted in considerably fewer 1 year olds than two year olds, whereas the commercial ALK generated slightly more 1 year olds than 2 year olds (a more likely scenario). This result indicates that ALKs generated from survey and commercial samples collected during the same period may not be comparable. Comparisons of mean fish lengths at age generated from the two ALKs supported this conclusion. According to the two ALKs, sardine sampled by the commercial fishery during November 2002 were larger than those of the same age sampled during the November 2002 survey, particularly in age groups 1 to 4 (Fig. 2), suggesting that the fishery samples faster growing fish than the survey. Further work is being done to establish whether or not this is a “once-off” occurrence or a consistent feature of survey versus commercial sampling, or an artefact of the otolith reading process.

An additional problem encountered in the sardine age data is that relatively low proportions of 1 year olds are apparent in several of the years for which survey ALKs have been produced. Proportions-at-age displaying this feature were apparent in the 1993, 1994, 1996 and 2002 data, whereas data for 2001, 2003, 2004 and 2006 displayed more realistic proportions-at-age distributions, where 1 year olds dominated the population (in terms of numbers). A commercial ALK applied to the survey RLF from 2000 also yielded a low proportion of 1 year olds, whereas commercial ALKs applied to the 2002 and 2005 survey RLFs generated more realistic age distributions. It should be noted that the relatively low proportions of 1 year olds are also a feature of Michael Kerstan’s data for 1993, 1994 and 1996. While it is possible that fewer 1 year olds than 2 year olds may occur as a result of variations in recruitment, it is unlikely to occur as frequently as the results described above suggest. Two possible explanations for these results:

- There is a fundamental problem with the interpretation of age from otolith structure (specifically the identification of the first annulus). A comprehensive validation study will be required to address this possibility.
- Biased sampling (i.e. the November survey under-samples the smaller, younger fish). Note that this does not suggest that acoustic sampling incorporates a substantial bias, but rather it could be argued that trawl samples (the source of the length frequency data) may contain disproportionately fewer younger fish because of the preference of these fish for shallow water where trawling is frequently not practical.

Until this issue is resolved, the approach in the stock assessment will be to assume an age-dependent, multiplicative bias for the proportion-at-age in the November survey. The under-representation of 1 year olds in the survey will therefore be included in the estimated bias factor for proportion-at-age 1.

Although Table 1 shows that commercial ALKs are available for November 2000, 2002 and 2005 (the years lacking November survey ALKs), these commercial ALKs were not used in the stock assessment because of the apparent discrepancies between survey and commercial ALKs described above. For those years where no survey ALKs are available, model predicted proportions-at-length will be fitted to observed proportions-at-length from survey RLFs.

References:

Coetzee, J. 2007. Acoustic survey methodology and associated background information on anchovy and sardine off South Africa. ASWS/JUL07/PEL/DAT/2

Cunningham, C.L., and Butterworth, D.S. 2007. Proposed Cut-Off Lengths to Split Recruits and Adults for Anchovy Commercial Landings. Unpublished MCM Document MCM/2007/FEB/SWG-PEL/08. 15pp.

De Oliveira, J.A.A. 2003. The Development and Implementation of a Joint Management Procedure for the South African Pilchard and Anchovy Resources. PhD Thesis, University of Cape Town, South Africa.

Table 1: Sardine age data generated by Deon Durholtz (values are the number of size-at-age data incorporated into each ALK). Values in bold italics indicate those ALKs that have been spatially disaggregated.

YEAR	NOVEMBER SURVEY	NOVEMBER COMMERCIAL
1993	587	
1994	620	
1996	335	
2000	No samples or data	736
2001	***526***	To be processed
2002	***570***	526
2003	***145***	To be processed
2004	***322***	To be processed
2005	No samples	241
2006	***442***	Being Processed

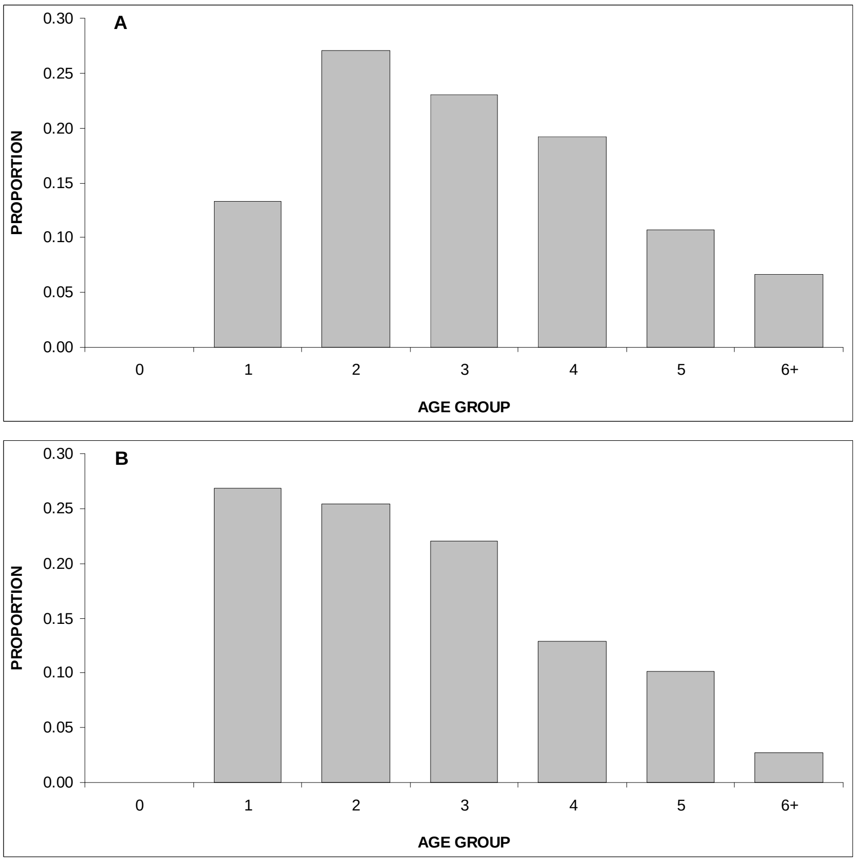

Figure 1: November 2002 sardine proportions at age obtained from applying (A) the November 2002 survey ALK and (B) the November 2002 commercial ALK to the survey raised length frequency distribution.

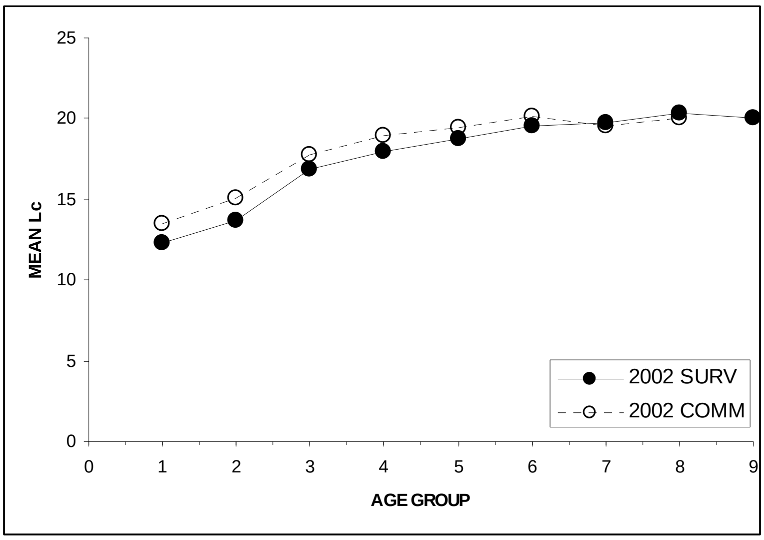

Figure 2: Comparison of estimates of the mean lengths at age of sardine in November 2002 generated by the survey (solid line, dots) and commercial (dashed line, circles) ALKs.