Comparing the 2018 survey estimated sardine biomass to carrying capacity

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This document details a calculation noted during the December 2018 Small Pelagic Scientific Working Group meeting which compared the recent survey estimate of sardine biomass to estimated carrying capacity, showing the survey biomass west of Cape Agulhas corresponded to approximately 3-4% of carrying capacity. A comparison between the alternative biomass "currencies" of total, spawner, effective spawner and survey estimated biomass is also given.

The sardine biomass estimated by the November 2018 pelagic hydroacoustic survey was (Coetzee *et al*. 2018):

Total survey area: 90 768t

West of Cape Agulhas: 34 845t

East of Cape Agulhas: 55 922t

In order to compare these survey estimates against the sardine carrying capacity, they need to be converted into the same biomass "currency" (see Appendix). Carrying capacity is based on 'effective' spawner biomass. The following method of approximation was used:

Survey estimated biomass X Conversion factor = Effective spawner biomass corresponding to survey biomass

Figure 1 shows the histogram of the ratio of the survey estimated biomass (y) / posterior median effective spawner biomass (y). The conversion factor was taken as the average or median over years 1984 to 2015. The west and south component effective spawner biomass was taken from the two component mixing hypothesis (de Moor 2016, 2018), while the total spawner biomass was taken from the single stock hypothesis (de Moor and Butterworth 2016).

This effective spawner biomass corresponding to the survey biomass in 2018 was then compared with the posterior median carrying capacity (from the two component mixing hypothesis for the west and south components, and from the single stock hypothesis for the total) to give the following:

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	Using Average of Figure 1		Using Median of Figure 1	
	EffSSB corresponding to 2018 survey biomass	Survey estimate : Carrying Capacity	EffSSB corresponding to 2018 survey biomass	Survey estimate : Carrying Capacity
West	11 155t	0.032	13 528t	0.038
South	14 927t	4.352	24 220t	7.043
Total	37 449t	0.087	45 854t	0.107

If we instead use the "effective" survey observations, transferring 8% of the survey biomass estimated on the south coast to that on the west coast in these calculations we get:

	Using Average of Figure 1		Using Median of Figure 1	
	EffSSB corresponding to 2018 survey biomass	Survey estimate : Carrying Capacity	EffSSB corresponding to 2018 survey biomass	Survey estimate : Carrying Capacity
West	12 587t	0.036	15 265t	0.043
South	13 733t	3.996	22 282t	6.488
Total	37 449t	0.087	45 854t	0.107

The hydroacoustic survey estimate of biomass in November 2018 therefore corresponds to approximately only 3-4% of carrying capacity on the west coast, but 4 times the carrying capacity on the south coast. Assuming a single stock hypothesis, the survey estimate in November 2018 corresponds to approximately 9-10% of carrying capacity.

References

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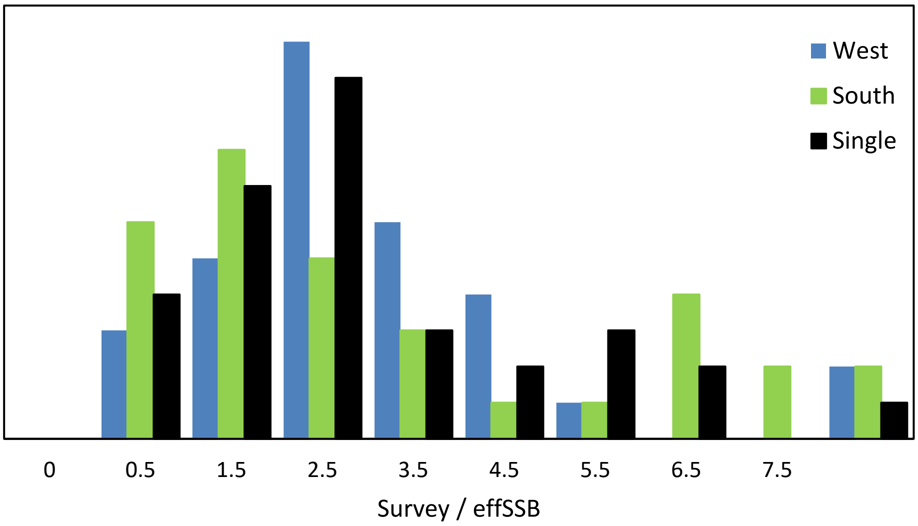

Figure 1. Histogram of the 32 historical years of the ratio of survey estimated biomass to effective spawning biomass for the west component, south component and single stock hypothesis. The medians are 2.58, 2.31 and 2.57, and the averages are 3.12, 3.74 and 3.03, respectively, for the west and south components and the single stock hypothesis.

Appendix

Four different levels of sardine biomass are regularly used when discussing sardine:

Total biomass – the total model estimated biomass of sardine, i.e. all ages/lengths of sardine; we also give this biomass by component.

Spawner biomass – the model estimated biomass contributing to spawning, this is a proportion of the total biomass based on a maturity ogive, i.e. the proportion mature-at-length (Figure A1); we also give this biomass by component.

Effective spawner biomass - the model estimated spawner biomass on which recruitment to the west/south component is assumed to be dependent; the baseline model assumes the west component effective spawner biomass consists of the west component spawner biomass and 8% of south coast spawner biomass.

Survey estimated (or "observed") biomass - the biomass estimated during the annual October/November hydroacoustic survey (e.g. Coetzee *et al*. 2018); this biomass is also recorded west and east of Cape Agulhas taken to correspond to the west and south components of sardine, respectively.

Figure A2 demonstrates the absolute historical difference between these estimated biomass levels.

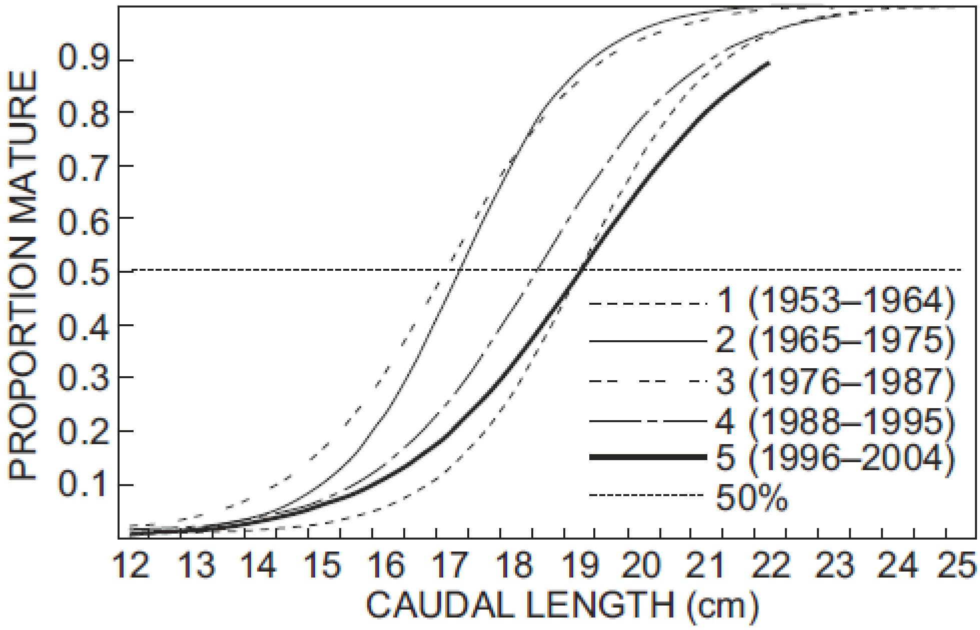

Figure A1. The proportion of sardine mature at length from van der Lingen *et al*. (2006). The maturity ogive from 1965-1975 is assumed to apply from 2003 onwards based on a density-dependent hypothesis as both these periods correspond to low biomass following a peak in abundance.

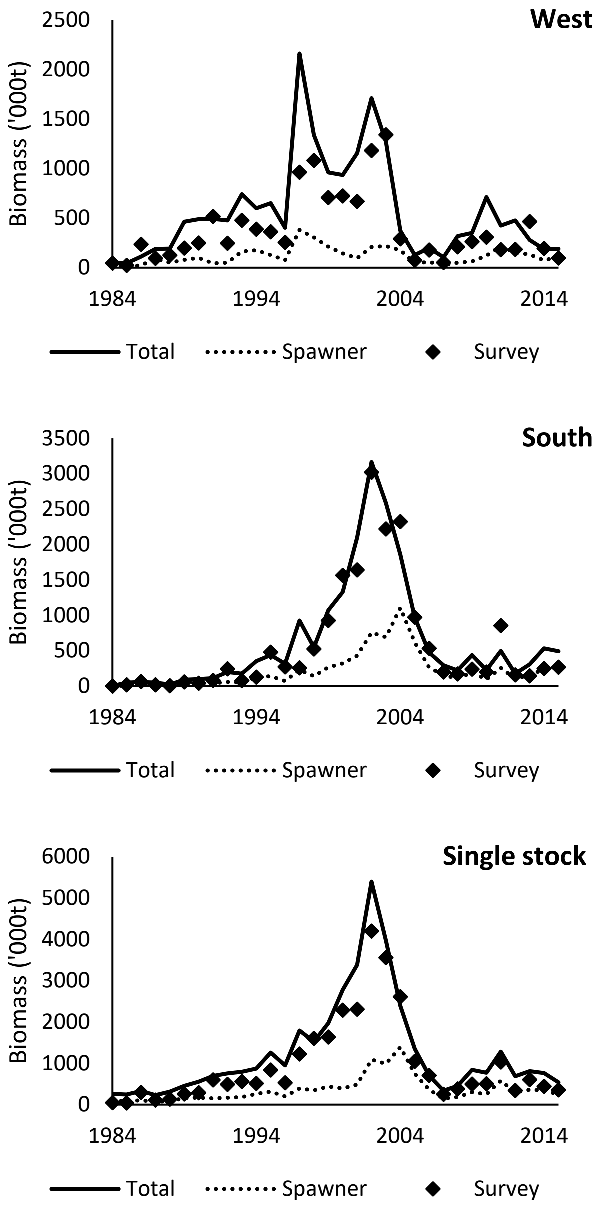

Figure A2. The historical median total and spawner biomass levels estimated by the baseline model (de Moor 2018) for the west and south components of South African sardine, and for the single stock hypothesis (de Moor and Butterworth 2016), as well the survey estimated biomass levels.