

Can CPUE inform on sardine and anchovy recruitment strength?

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Abstract

A non-parametric approach is used to investigate whether CPUE for sardine and anchovy from Area A over the period April to June is able to inform on recruitment strength for these two species. There is no useful relationship for sardine, but there is some correlation for anchovy. Hence the anchovy CPUE for 2020 (near to the highest on record) is clearly indicative of anchovy recruitment that is hardly likely to be low.

This document summaries attempts to use sardine bycatch CPUE and anchovy CPUE from the autumn pelagic fishery on the west coast to inform on the annual (west) recruitment strength for each species. The CPUE index used for anchovy was the median catch per trip for the period April to June in Area A (north of Cape Columbine) for trips that returned at least 70% of anchovy in the catch landed. For sardine bycatch CPUE, the median sardine bycatch tonnage for all trips in Area A in which anchovy were landed was calculated³. The recruitment values used were taken from the most recent assessments (de Moor 2020a, b) for each species, with the west component used for sardine.

Because any relationship is weak, rather than attempting a standard parametric approach, a potentially more robust non-parametric method was used. This involved ordering the time series of (bycatch) CPUE and assessment estimates over the 1989-2019 period, dividing each into high (H), medium (M) and low (L) thirds, developing the associated 3x3 discrete correlation matrices, and using these to update uninformative priors for recruitment. Stock assessments provided the estimates of recruitment, as determined for November of the year prior to that to which the CPUE data corresponded.

Table 1 shows these correlation matrices. Uniform priors are updated using these matrices to provide the results shown in Table 2 and Figure 1. Finally, Figure 3 plots the annual (bycatch) CPUE against the recruitment values for each species.

For sardine, the near absence of any correlation is evident from the near even spread of entries in the discrete correlation matrix in Table 1. This is confirmed by the (hardly) updated uniform priors shown in Figure 1, which indicate (nonsensically) that a M bycatch CPUE would predict a higher recruitment than a H value for that CPUE. Clearly there is not sufficient information content in these sardine data to provide any predictive power.

In contrast, for anchovy the correlation matrix does indicate some reasonable, though noisy, relationship, and this is confirmed by the sensible results for the prior updates which are plotted in Figure 1.

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³Given COVID-19 restrictions on field station sampling and data capture, catch per trip information was collated and kindly provided by Johan de Goede from daily reports received from industry stakeholders, including rights holders and factory managers.

The data plots in Figure 3 are consistent with these inferences. Nothing can be concluded from the M sardine bycatch CPUE for 2020. However, the H anchovy CPUE for 2020 (near to the highest on record) is clearly indicative of anchovy recruitment that is hardly likely to be low.

References

- de Moor CL. 2020a. The South African anchovy assessment with annual maturity ogives. DEFF Branch Fisheries Document: FISHERIES/2020/JUL/SWG-PEL/51.
- de Moor CL. 2020b. Baseline assessment of the South African sardine resource using data from 1984-2019. DEFF Branch Fisheries Document: FISHERIES/2020/APR/SWG-PEL/30.

Table 1: Discrete form correlation matrix for (bycatch) CPUE and recruitment, for the period 1989-2019⁴ and three levels of each variable. Results are shown for (a) sardine and (b) anchovy. Note that for sardine, the split of the 31 juvenile bycatch CPUE data points between L, M, H is 10, 12, 9 as the 1989 and 2012 bycatch CPUE values are identical and have both been allocated an “M”, but if they had been slightly different one would have been an “M” and the other an “H”, resulting in the intended 10-11-10 split. Note that for 2020 the juvenile sardine bycatch CPUE is medium, whereas for anchovy the CPUE is high.

(a) Sardine		Bycatch CPUE		
		L	M	H
Recruitment	L	4	3	3
	M	4	5	2
	H	2	4	4

(b) Anchovy		CPUE		
		L	M	H
Recruitment	L	6	3	1
	M	2	6	3
	H	2	2	6

⁴ Data from 1987 and 1988 were excluded on the basis that extraordinarily high catches were taken by the anchovy fishery in those years.

Table 2: Recruitment values for (a) the last five years for **sardine** and (b) expressed relative to the average 1989-2019 value for **anchovy** are listed along with the rank they receive relative to the 1989-2019 series. The uniform prior is listed for each species. For each of CPUE L, M and H, the likelihood of each recruitment value is listed based on the corresponding CPUE-R tables above, and the resulting updated prior based on this likelihood is also listed. Plots of the original and updated priors are shown in Figure 1.

(a) Sardine				Bycatch CPUE L			Bycatch CPUE M			Bycatch CPUE H		
R(i) (absolute)	Rank	P(R,i)	P(R,i) normalized	L(i CPUE)	P*L	Pup(R,i)	L(i CPUE)	P*L	Pup(R,i)	L(i CPUE)	P*L	Pup(R,i)
14.1447	M	1.000	0.2000	4	0.800	0.200	5	1.000	0.294	2	0.400	0.143
11.5935	L	1.000	0.2000	4	0.800	0.200	3	0.600	0.176	3	0.600	0.214
8.10899	L	1.000	0.2000	4	0.800	0.200	3	0.600	0.176	3	0.600	0.214
6.98689	L	1.000	0.2000	4	0.800	0.200	3	0.600	0.176	3	0.600	0.214
3.47028	L	1.000	0.2000	4	0.800	0.200	3	0.600	0.176	3	0.600	0.214

(b) Anchovy				CPUE L			CPUE M			CPUE H		
R(i) (relative to mean)	Rank	P(R,i)	P(R,i) normalized	L(i CPUE)	P*L	Pup(R,i)	L(i CPUE)	P*L	Pup(R,i)	L(i CPUE)	P*L	Pup(R,i)
1.5	H	1.000	0.1250	2	0.250	0.071	2	0.250	0.065	6	0.750	0.250
1.3	H	1.000	0.1250	2	0.250	0.071	2	0.250	0.065	6	0.750	0.250
1.1	M	1.000	0.1250	2	0.250	0.071	6	0.750	0.194	3	0.375	0.125
0.9	M	1.000	0.1250	2	0.250	0.071	6	0.750	0.194	3	0.375	0.125
0.7	M	1.000	0.1250	2	0.250	0.071	6	0.750	0.194	3	0.375	0.125
0.5	L	1.000	0.1250	6	0.750	0.214	3	0.375	0.097	1	0.125	0.042
0.3	L	1.000	0.1250	6	0.750	0.214	3	0.375	0.097	1	0.125	0.042
0.1	L	1.000	0.1250	6	0.750	0.214	3	0.375	0.097	1	0.125	0.042

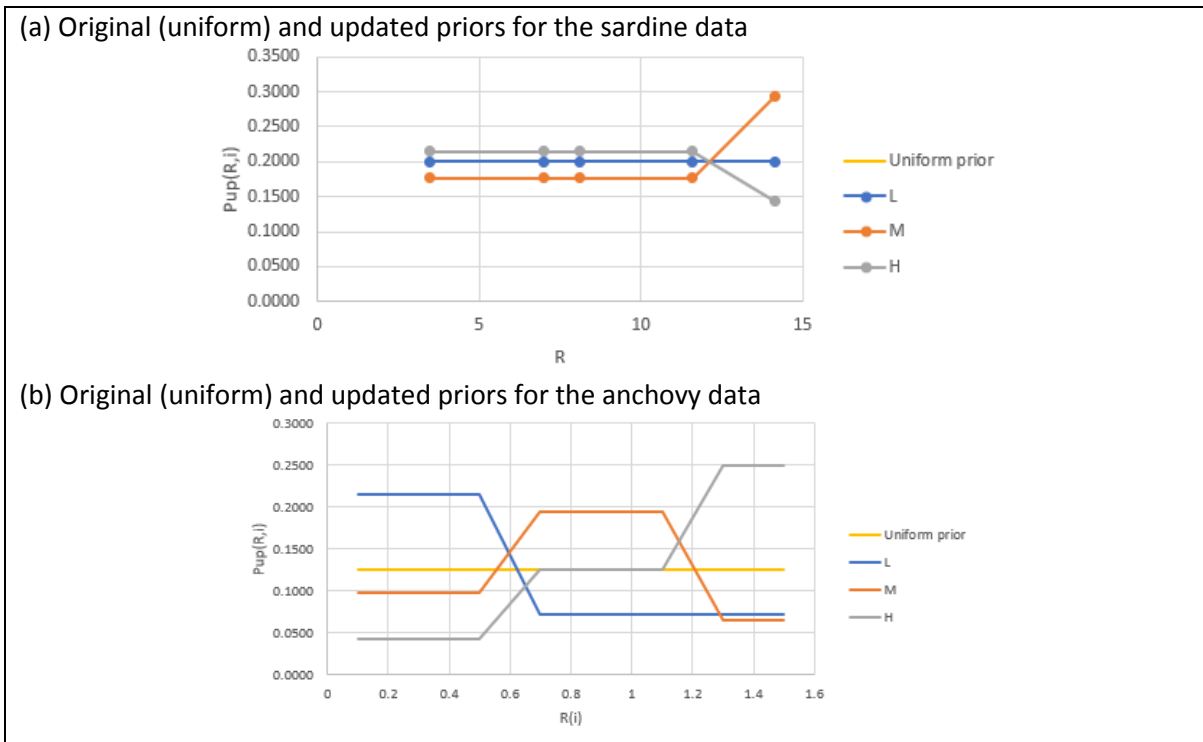


Figure 1: Plots of the original (uniform) and updated priors for (a) sardine and (b) anchovy. Note that for (a) the original uniform prior lies underneath the CPUE L updated prior.

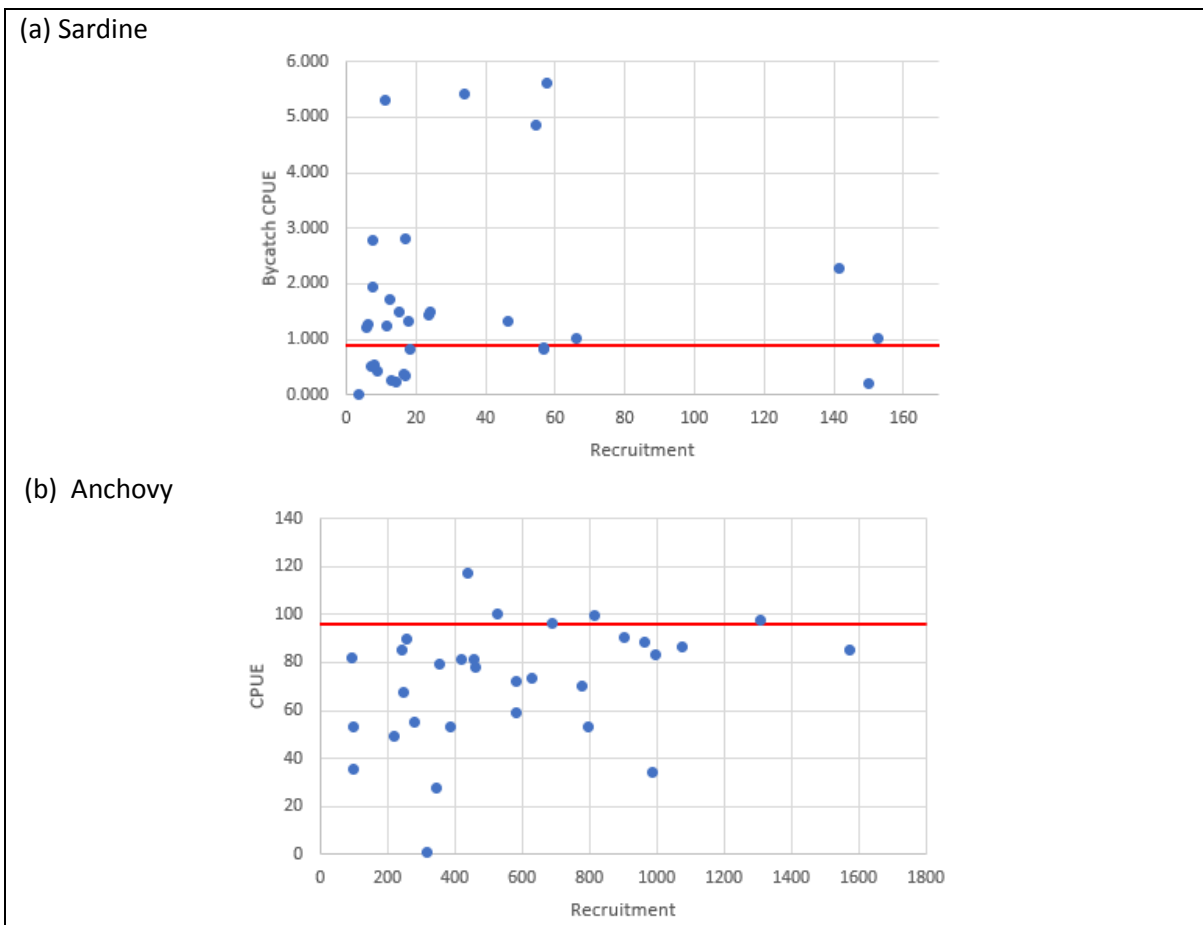


Figure 2: Plots of historical (bycatch) CPUE against Recruitment from 1989 to 2019 for sardine and anchovy. The red horizontal lines correspond to the 2020 values.