

Does the ratio of juvenile sardine : anchovy observed in the fishery and the recruit surveys correlate with that predicted by models?

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The ratios of juvenile sardine to anchovy observed in the fishery and in the recruit surveys are compared against those estimated by the anchovy assessment model. Assuming the model ratio of sardine:anchovy recruit numbers represents the 'true' ratio, it is found that almost no reliable inference can be made about the true ratio from that observed in the fishery, (possibly because the industry take steps to avoid areas with high juvenile sardine bycatch), but that some inference is possible from the ratio observed in the survey (though this has relatively high variance).

Background

While sardine are ideally targeted as adults, small sardine recruits are an unavoidable bycatch with directed anchovy recruit catches, particularly during the autumn and early winter months when recruits first become available to the South African small pelagic fishery. The Operational Management Procedure (OMP) Harvest Control Rule uses information from both the recruit survey and May commercial catches to inform (in part) the recommended TAB for small sardine bycatch with anchovy (de Moor 2018). However, the sardine resource abundance is currently very low, and the OMP is not being used to recommend sardine TAC and TABs due to Exceptional Circumstances having been declared since December 2018. The 2020 sardine TAC and TABs have thus been recommended based on short-term projections of the resource (de Moor 2020a, DFFE 2020).

For both the current Exceptional Circumstances scenario and for future OMP HCRs, it would be useful to re-examine whether the observations available in real time from the fishery or from the annual May/June recruit survey provide a good indication of the true underlying ratio of sardine : anchovy recruitment. For these analyses, "true" recruitment is assumed to be represented by the model predicted values (de Moor 2020b).

Comparisons

Figure 1 compares the ratio (in tons) of the small sardine bycatch with directed anchovy catches to the directed anchovy catches from April to June against the model predicted recruitment ratio (in numbers) at the time of the survey. The April commercial ratios do not provide a good indication of the underlying true ratio. The May and June commercial ratios may provide a reasonable indication of the underlying 'true' ratio at low values, although there is some 'flattening' in the commercial ratio as the 'true' ratio increases above 0.05, presumably due to the industry deliberately avoiding areas with substantial sardine bycatch in the immediate past.

Figure 2 compares the ratio of the survey estimated sardine recruit **biomass** : anchovy recruit **biomass** against the model predicted sardine recruit **numbers** : anchovy recruit **numbers** at the time of the survey. There is some correlation evident between these ratios, with the linear slope (regression through the origin) between the two suggesting the observation is 2.7 times that estimated by the model. This high factor will – in part – be due to the difference between the observed ratio in

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biomass (with sardine being heavier than anchovy at the same schooling size) to the model ratio in numbers. The observed ratio in biomass is what has historically been used to inform the small sardine TAB with anchovy. The linear slope between the two ratios in **numbers** suggests the observation is 0.9 of that estimated by the model (Figure 3).

Conclusion

When considering if the observed ratio of small sardine bycatch with anchovy directed catches to anchovy catch can give a reliable indication overall of the underlying 'true' ratio, the qualitative answer from data considered in Figure 1 is no. Although low true ratios tend to correspond with low observed ratios, low observed ratios have also been found to occur with high true ratios, so little inference can be drawn from observing low ratios in commercial catches. However, high ratios in commercial catches have been observed historically only during years of medium to high 'true' ratios, which might have some (though limited) predictive value.

When considering if the observed ratio of sardine to anchovy recruits in the survey (either in numbers or biomass) can give a reliable indication of the underlying 'true' ratio, the qualitative answer from data considered in Figures 2 and 3 is yes. There is a close to linear relationship in log space, with a slope of 0.69 when the survey ratio is based on recruit biomass and 0.99 when this is based on recruit numbers. If these relationships (in log space) are used for predictive purposes, the standard deviations of the residuals in that space (which correspond to relative errors in normal space) are 0.73 and 0.58 respectively.

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References

- de Moor CL. 2018. The 2018 Operational Management Procedure for the South African sardine and anchovy resources. DAFF: Branch Fisheries Document FISHERIES/2018/DEC/SWG-PEL/37.
- de Moor CL. 2020a. Sardine projections based on constant catch scenarios. DFFE: Branch Fisheries Document FISHERIES/2020/APR/SWG-PEL/33.
- de Moor CL. 2020b. The South African anchovy assessment with an informative prior distribution on the bias in hydro-acoustic survey estimates of abundance. DFFE: Branch Fisheries Document FISHERIES/2020/JUN/SWG-PEL/40.
- DFFE 2020. Additional recommendations of the small pelagic scientific working group for the sustainable management of sardine for the 2020 season. DFFE: Branch Fisheries Document FISHERIES/2020/APR/SWG-PEL/37.

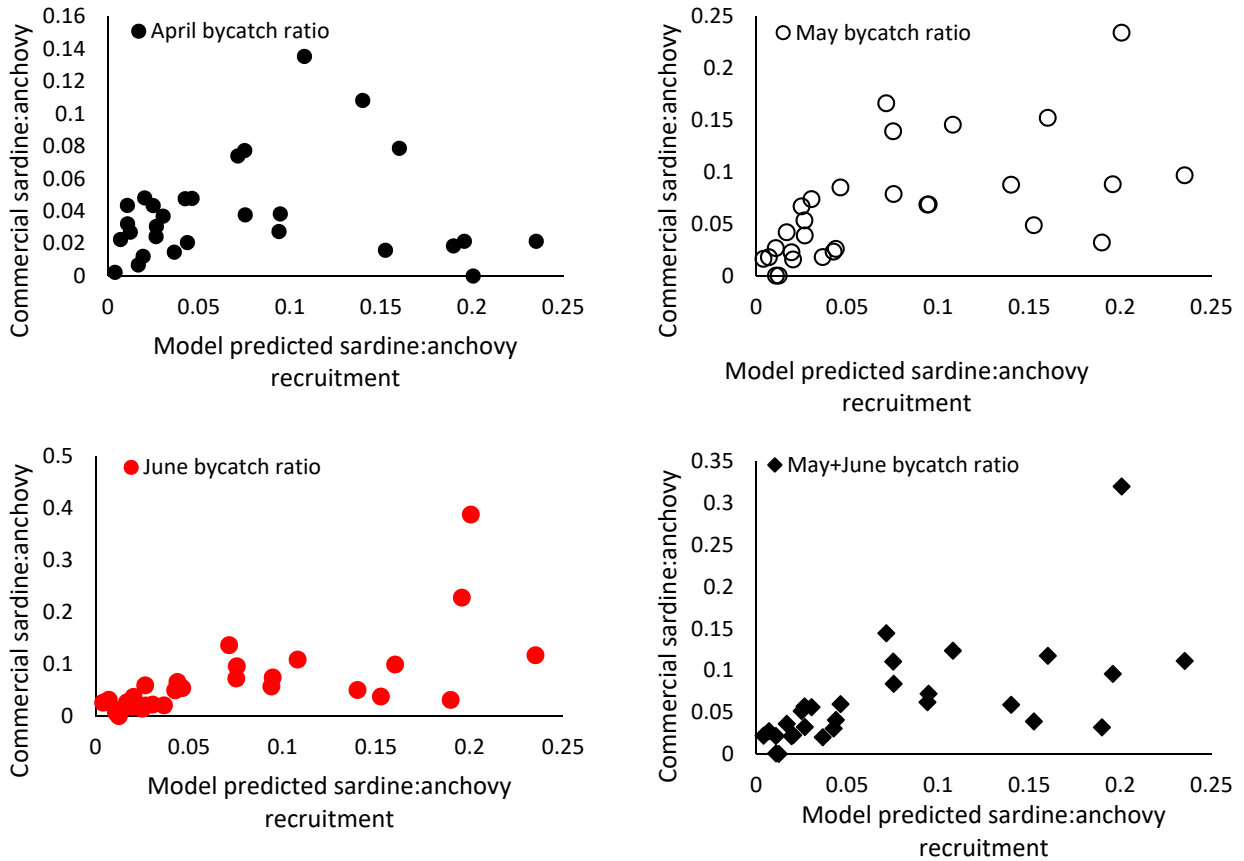


Figure 1. The ratio of small sardine bycatch with directed anchovy landings to directed anchovy landings in April, May, June and May+June from 1987-2015 plotted against the ratio of model predicted sardine to anchovy recruitment at the time of the survey. The model used is A_0 with an informative prior on $\ln(k_N^A)$ and assuming the DEPM indices are absolute. Similar patterned plots result if A_1 is used instead, again with the informative prior on $\ln(k_N^A)$ and assuming that the DEPM indices are absolute (de Moor 2020b).

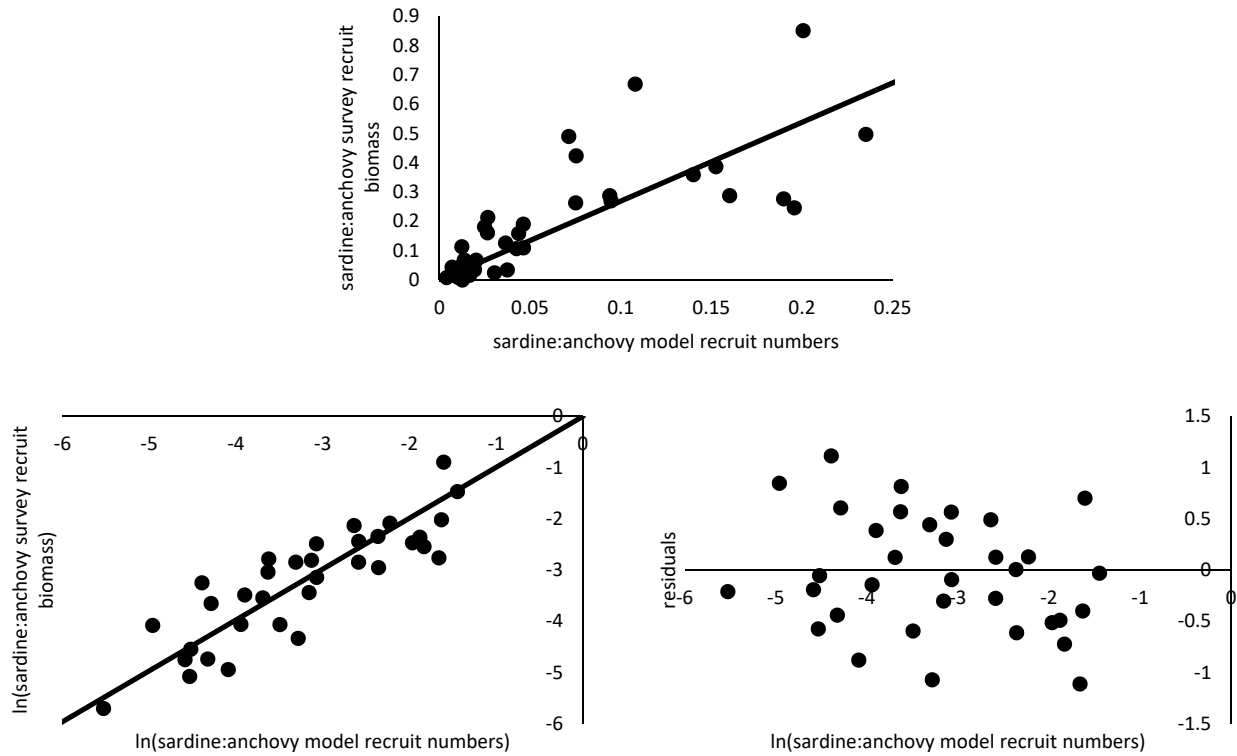


Figure 2. The ratio of sardine recruit **biomass** to anchovy recruit biomass as estimated by the May/June recruit survey plotted against the ratio of model predicted sardine numbers to anchovy numbers at the time of the survey from 1987-2019. The model used is A_0 with an informative prior on $\ln(k_N^A)$ and assuming the DEPM indices are absolute. Similar patterned plots result if A_1 is used instead, again with the informative prior on $\ln(k_N^A)$ and assuming that the DEPM indices are absolute (de Moor 2020b). In the lower plots, the ratios are plotted in log space and the residuals resulting from the linear fit are given. The regression lines plotted are forced through the origin.

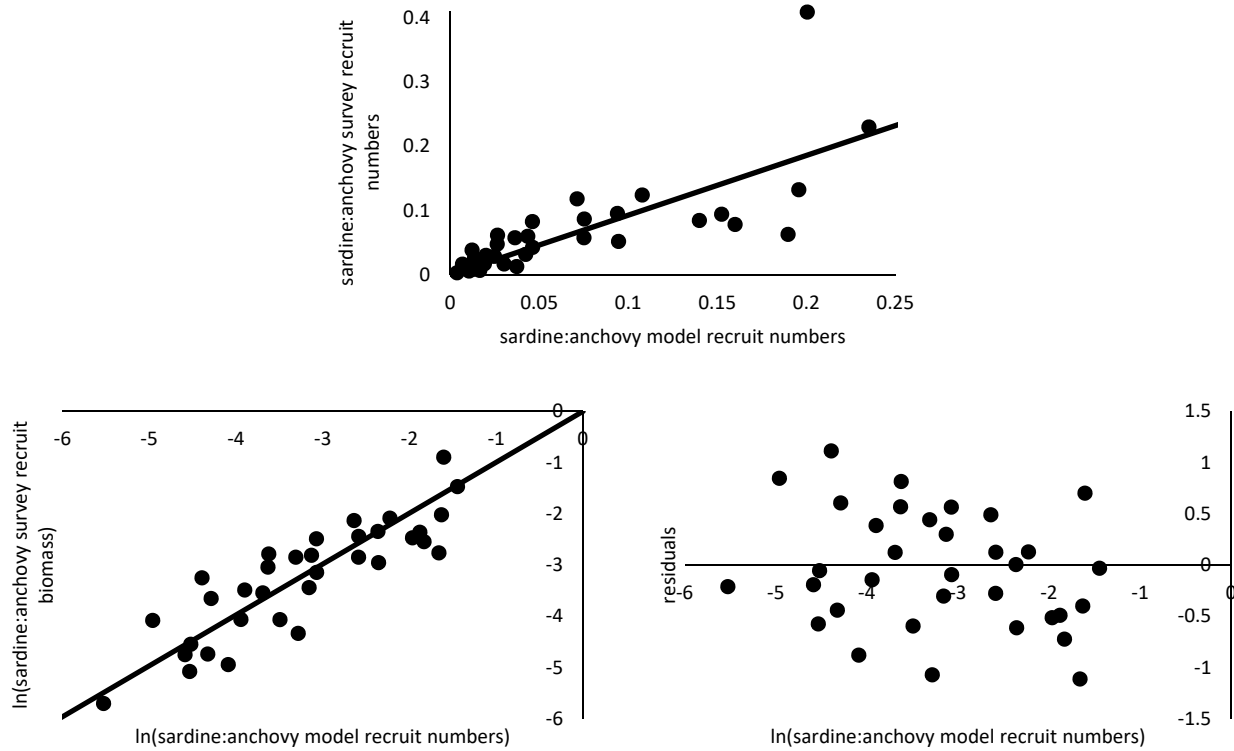


Figure 3. The ratio of sardine recruit numbers to anchovy recruit **numbers** as estimated by the May/June recruit survey plotted against the ratio of model predicted sardine numbers to anchovy numbers at the time of the survey from 1987-2019. The model used is A_0 with an informative prior on $\ln(k_N^A)$ and assuming the DEPM indices are absolute. Similar patterned plots result if A_1 is used instead with the informative prior on $\ln(k_N^A)$ and assuming that the DEPM indices are absolute (de Moor 2020b). In the lower plots the ratios are plotted in log space and the residuals resulting from the linear fit are given. The regression lines plotted are forced through the origin.