

Should Exceptional Circumstances be declared for anchovy?

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The survey estimates of anchovy November biomass have been appreciably outside the range that was projected during OMP-18 simulation testing. In addition, the updated assessment indicates anchovy is less productive than that assumed by the base case Operating Model used during OMP-18 simulation testing. Exceptional Circumstances should be declared for anchovy, and OMP-18 should not be automatically applied to recommend catch limits for 2020.

Introduction

When Operational Management Procedures (OMPs) are developed, a number of assumptions are made with regards to, among other things, the future dynamics of the resource. Within South Africa, an OMP is expected to be used for approximately four years prior to review. The review may then simply involve retesting the OMP under updated Operating Models (OMs) to ensure that performance statistics - including risk - remain satisfactory, or may entail substantial changes to the OMP (e.g. a change from an assessment-based MP to an empirical MP or changes to the shape or parameters of the Harvest Control Rule (HCR)). Within the context of the South African sardine and anchovy OMPs, all reviews of OMPs have resulted in changes to the HCRs. The approximately four years of OMP implementation should result in catch limits being recommended according to the pre-specified and pre-tested HCRs of the OMP.

However, it is possible that some situations may arise when the OMP should no longer be applied on 'auto-pilot'. These are circumstances that were not expected/projected during the development and simulation testing of the OMP, and are therefore considered 'exceptional'. Examples of what might constitute an Exceptional Circumstance in the case of sardine and anchovy include, but are not necessarily limited to (Appendix B, de Moor 2018):

- Survey estimates of abundance that are appreciably outside the bounds predicted in the OMP testing.
- Spatial distribution of directed sardine catches that are appreciably outside the bounds predicted in the OMP testing.
- New data or information to suggest a substantial revision of assumptions of stock structure

In addition to the above, an updated assessment can also be used to determine whether there is evidence for Exceptional Circumstances (Appendix B, de Moor 2018).

"The primary focus for concluding that Exceptional Circumstances exist is if the population assessment/indicator review process provides results appreciably outside the range of simulated population and/or other indicator trajectories considered in OMP evaluations. This includes the core (Reference case or set of) operating models used for these evaluations, and likely also (though subject to discussion) the operating models for the robustness tests for which the OMP was considered to have shown adequate performance."

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If Exceptional Circumstances are declared for a particular species/OMP, the 'auto-pilot' application of the OMP to recommend catch limits is then set aside and additional methods are considered (e.g. see below).

Recent survey estimates were appreciably outside the bounds predicted when OMP-18 was tested

The November survey estimates of anchovy biomass have been appreciably outside the range simulated when OMP-18 was developed. The realised estimates during November 2017, 2018 and 2019 were all less than not only the lower 5%ile, but the lower 2.5%ile of the distribution of survey estimates that was simulated to occur during the implementation of OMP-18 (Figure 1).

The realised survey estimates in Novembers 2017, 2018 and 2019 were also outside the range simulated when OMP-18 was tested against anchovy robustness tests (Table 1).

Updated anchovy assessment provides a revised understanding of resource productivity

The base case assessment for South African anchovy has recently been updated (de Moor 2020). These initial results indicate that the average anchovy recruitment is 716 billion, with 5 out of the most recent 6 years being below this average (Figure 2). The perception obtained from this updated timeseries of recruitments could also change the previous perception that anchovy recruitment was according to a 'lower regime' prior to 1999 and a 'higher regime' since 2000. The Beverton Holt stock recruitment relationship that is estimated from the updated assessment has a substantially lower asymptote to that estimated by de Moor (2016) which provided the baseline OM against which OMP-18 was simulation tested (Figure 10 of de Moor (2020)).

Given time constraints, the updated assessment has yet to be tested against alternative assumptions such as, alternative rates of natural mortality or stock recruitment relationships.

Of particular interest is that the updated baseline assessment suggests the May 2017 survey estimate of recruitment (the highest recorded historically) was a substantial over-estimate of recruitment (Figure 3 of de Moor (2020)). However, at the time that OMP-18 was simulation tested, this observation was assumed to be reflective of true recruitment, substantially influencing the projected biomass in the short term (e.g. Figure 1).

Why would Exceptional Circumstances be declared when the anchovy biomass is above the critical biomass threshold?

The OMP-18 anchovy HCR consists of a number of constraints and equations which differ depending on whether survey observations and/or TACs are above or below different thresholds. One such threshold is the critical biomass threshold of 600 000t. If the survey estimate of biomass (or predicted November survey estimate after the May/June survey) is below this threshold, then the form of the HCR (the equation) and some constraints are different (more conservative) from that which are applied above the threshold. The OMP HCR is, however, continuous over all possible survey estimates and all constraints and equations are automatically applied under OMP-18 based on realised survey estimates (and other data input), whether above or below the critical biomass threshold. The value of the critical biomass threshold was not chosen based on, for example, external analyses informing a quantitative 'critical' biomass level. The critical biomass threshold together with the anchovy control parameter and other constraints were chosen so that performance statistics (such as average catch and

average variability in catch) could be optimised subject to the risk criteria being satisfied. The value of the threshold can be changed like any other constraint of an OMP during OMP development to obtain preferred performance from the OMP.

This critical biomass threshold should not be confused with nor compared to the range over which OMP-18 was simulation tested (as, for example, shown in Figure 1). The former is part of the OMP's HCR. The latter is used to determine whether the OMP should be used to recommend catch limits. If the OMP can be used, then the form (equations and constraints) used to calculate the TAC will depend on (among other thresholds) whether the survey estimate is above or below the critical biomass threshold. However, if Exceptional Circumstances are declared because the OMP was not simulation tested for a realised situation, the automatic application of the OMP would be set-aside.

The range over which OMP-18 was simulation tested did include values below the critical biomass threshold of 600 000t, but only after a number of years of projection (Figure 1; the 5%ile decreases below 600 000t after 2022). The part of the HCR below a survey estimate of 600 000t was therefore simulation tested, but not during the former years of OMP implementation (including 2019/20). The risk to the anchovy resource was estimated over all simulated years. Should the simulations have included sufficient trajectories such that the lower percentiles would have been below 600 000t in the immediate future (e.g. 2017 – 2019), risk may have been higher.

Recommendation

Exceptional Circumstances should be declared for anchovy and the anchovy 2020 Total Allowable Catches should not be automatically recommended according to the OMP-18 HCR, but rather be advised based on other ad-hoc analyses. This is because the implementation of OMP-18 was not simulation tested for the circumstances which have been realised over recent years.

This does not automatically mean that the current status of anchovy is of concern, nor that the HCR of OMP-18 could ever again be applied to anchovy. However, what it does mean is that we do not currently know whether OMP-18 can be applied to sustainably manage the resource in the current anchovy circumstance. It is possible that the application of OMP-18 under these circumstances would result in a greater risk to the resource than was deemed acceptable during OMP-18 development and agreement.

Ideally OMP-18 should be retested against an updated OM. This could have a number of consequences including (but not limited to)

- i) confirmation that anchovy risk is still satisfied when OMP-18 is tested under the updated OM,
- ii) a revision to the anchovy control parameter (only) to ensure that anchovy risk is still satisfied when OMP-18 is tested under the updated OM,
- iii) a revision to other parts (e.g. constraints/thresholds) of the OMP HCR such that anchovy risk is satisfied.

Alternative ad-hoc methods that could be used to recommend anchovy TACs under Exceptional Circumstances include (but are not limited to) projecting the updated anchovy assessment forward under alternative catch scenarios for 2020, as is

similarly planned for sardine. This will require a number of assumptions, particularly regarding November 2019 recruitment which will be targeted by the anchovy fishery during 2020.

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. 2019. Is OMP-18 robust to alternative assumptions about anchovy dynamics? DAFF: Branch Fisheries Document FISHERIES/2019/JUL/SWG-PEL/17.
- de Moor CL. 2020. Assessment of the South African anchovy resource using data from 1984-2019: initial results. DEA: Branch Fisheries Document FISHERIES/2020/JAN/SWG-PWL/03.

Table 1. The lower 2.5%ile and 5%ile probability intervals for survey estimates of biomass (in thousands of tons) simulated during the anchovy robustness tests of OMP-18 (de Moor 2019). The realised survey estimates are given in red.

	\hat{B}_y^A	1568	1560	844	1568	1560	844
		2017	2018	2019	2017	2018	2019
			2.5%ile			5%ile	
Robustness Test	A_{BH}	3150	1941	1060	3462	2138	1281
	A_{2BH}	3100	1990	1300	3373	2322	1571
	A_R	3288	1963	1163	3517	2201	1449
	A_{HS}	3138	1884	952	3471	2067	1210
	A_{M1}	2969	2012	1233	3154	2240	1428
	A_{M2}	3099	1809	1068	3355	2068	1303
	A_{Mad}	3355	1971	1072	3642	2283	1386
	A_{Mj}	3310	2128	1475	3531	2432	1722
	A_{M2000+}	2943	1818	1178	3129	2047	1450
	A_{sur}	2999	1855	1050	3363	2132	1253
	A_{com}	2879	1919	1072	3078	2098	1327
	A_{com2}	3241	1856	1061	3428	2099	1296
	A_{kegg1}	3175	1995	1130	3478	2230	1375
	A_{kegg2}	3198	1937	1069	3425	2117	1223
	A_{lamR}	5596	3341	2092	5894	3785	2429
	A_{lamN}	3228	1931	1099	3433	2108	1286
	A_{lamN2}	3016	1946	1132	3243	2126	1352

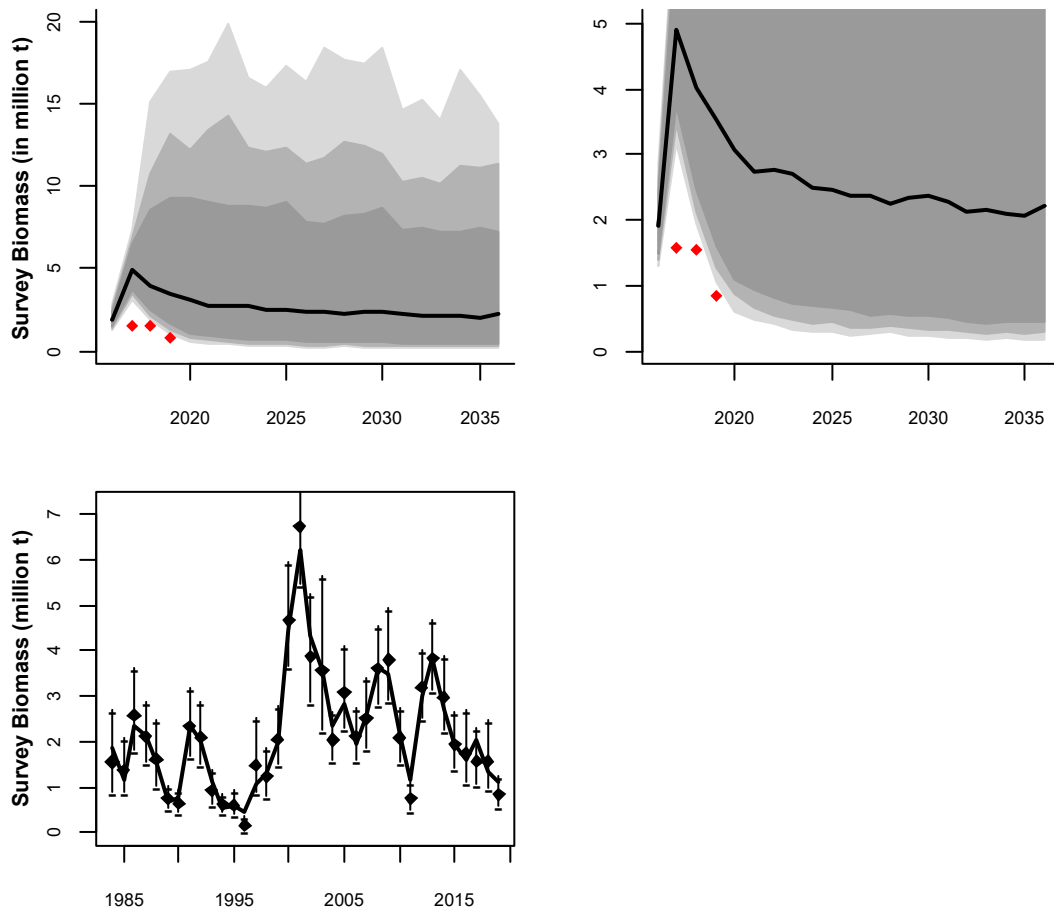


Figure 1. Median (black line), 80%ile, 90%ile and 95%ile (in progressively lighter grey colours) probability intervals for November survey estimates of anchovy biomass simulated under the baseline OM during the development of OMP-18 (from Appendix C of de Moor 2018) with realised survey estimates from 2017-2019 given in red (after the adjustment for the incomplete survey in 2019). The right panel is a repeat of the left, but over a smaller vertical axis range to show the lower percentiles more clearly. The lower plot shows the historical acoustic survey estimates together with the MLE (not median) bias corrected model estimated for comparison.

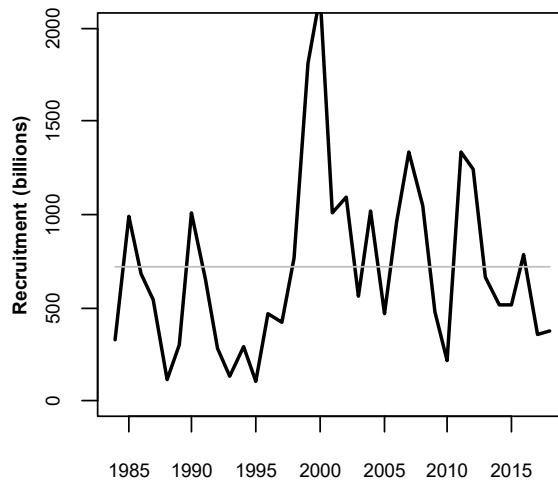


Figure 2. The timeseries of November recruitments estimated by de Moor (2020). The grey line indicates the average over the full timeseries.