Some comments relating to the proposal by FISHERIES/2020/JUN/SWG-PEL/38rev

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Small Pelagic Scientific Working Group (SWG-PEL) members and observers were asked to provide written comments on the document submitted by Bergh (2020). Here I simply list a few points that should be borne in mind when considering Bergh (2020) and when considering the idea of simply using an expected exploitation rate to set a quota for the South African anchovy fishery.

Exploitation rates

- It is common knowledge that the anchovy TAC has been under-caught for many years (Figure 1). Bergh (2020) regularly refers to a historical average exploitation rate of South African anchovy of 0.086. This is not a reflection of the historical management of anchovy, but rather of realised catches by the industry.
- The historical average exploitation rate of South African anchovy of 0.086 which Bergh (2020) quotes is what is currently recorded in the RAM legacy database (www.ramlegacy.org), from the assessment using data up to 2015 only. An updated time series was given by de Moor (2020a). If the full 200 000t anchovy TAC currently set for 2020 were to be caught, that would reflect an exploitation rate of 11-18% using the point estimates of the models of de Moor (2020b), with the most recent models converging on a point estimate of 12% and +-1SE of 10-16%, and subject to finalisation of the maturity ogive. Using these same models, a catch of 250 000t would correspond to an exploitation rate of 12-20%.
- The estimation of historical exploitation rates improves over time as more data become available and historical biomass is estimated with greater accuracy. The inaccuracy of final year estimates of biomass (particularly when retrospective patterns indicate final year biomass is typically over-estimated) should be borne in mind when recommending the use of a particular exploitation rate on final year biomass to advise subsequent quotas. (An over-estimation of final year biomass could thus result in a higher realised exploitation rate than expected.) In the light of this uncertainty one may need to be more cautious if attempting to advise quotas based on expected exploitation rates.
- The South African anchovy fishery is primarily a recruit fishery off the west coast. If a quota (which will be predominantly landed from the recruits of the year) were to be calculated based on a 'target' exploitation rate linked to the preceding the November biomass (typically primarily distributed between Cape Point and Mossel Bay), there would, on average, be substantial risk due to the disconnect between the November biomass and forthcoming recruitment. This is one of the key reasons for the design of the anchovy TAC formula in previous OMPs (e.g. de Moor *et al*. 2011 and de Moor and Butterworth 2016) so that the quota is set at a lower initial level to allow for a buffer if recruitment is poor. The exploitation rates of other non-recruit fisheries which primarily remove catches from the estimated biomass can therefore not be directly compared with that of South African anchovy.
- As the South African anchovy fishery is primarily a recruit fishery, the historical exploitation rate of anchovy recruitment has, on average, been much higher than that of adult fish (Figure 2). However, it is impossible to predict what the expected recruit exploitation rate would be in the absence of an accurate estimate of recruitment.

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- Bergh (2020b) considered whether there was a difference between the exploitation rates which resulted in 'subsequent' intervals of 5-year biomass which were increasing or decreasing. This approach was originally requested by the SWG-PEL TG as a first step to considering the impact of exploitation rates on anchovy biomass elsewhere (if indeed such an impact exists). If average exploitation rate has an impact on subsequent abundance trends, one would expect the exploitation rates corresponding to the increasing trends to be lower than those corresponding to the decreasing trends, which isn't the case for the 1-year and 2-year lag results for TB (but is the case for SSB). Bergh (2020) notes that this analysis gives average exploitation rates of 0.25 (SSB) or 0.33 (TB) correspond to increasing [sustainably fished] resources, but fails to mention that a <u>lower</u> average exploitation rate corresponds to decreasing total biomass. These average exploitation rates cannot therefore be used as indicators of what a sustainable fishery could or should aim at. Shorter 'impact' periods may, however, be more appropriate for the short-lived anchovy resources. This analysis does not yet take 'stock status' into consideration which was the next step requested in the process. For example, the tables could be separated into increasing/decreasing trends against good/poor status.
- It is worth noting that there is no simple objective method to compare the exploitation rates between different anchovy fisheries worldwide – the Task Group has already considered a number of alternatives, none of which have thus far proved satisfactory. While Bergh (2020b) considered running means, Tables 5 to 7 of Bergh (2020) consider fixed bins or 'epochs' of time. The use of the latter to define "Sustainably Fished" resources, particularly when such a definition is linked to the maximum average epoch and final epoch, could be very sensitive to the selection of time periods. Robustness to such selection has not yet been explored.
- The choice of "Sustainably Fished" anchovy by Bergh (2020) from the RAM legacy database ignores the reference points already provided to the RAM database by local experts, suggesting the further exclusion of some time series or partial time series of stocks from Bergh (2020)'s "Proposal A" on an objective basis. As Bergh (2020) notes, however, a further set of "Sustainably Fished" anchovy resources will be considered by the Task Group – the current median of which is 0.14 if Peruvian Anchoveta is included and 0.21 if excluded (Bergh pers comm.).
- Figures 12 and 13 of Bergh (2020) are used to imply that low ER values have not been applied elsewhere when biomass is low. The lag considered is the assumed impact of ER (y) on subsequent biomass B(y+1). This therefore more likely indicates that low biomass *results* from a higher ER. Moreover, these figures may be sensitive to alternative definitions of what constitutes "Sustainably Fished", as referred to in the previous bullet point.

<u>Biomass reference points and Dynamic B_0</u>

- Target and limit reference points for small pelagics are not commonly compared with those of groundfish.
- Dynamic B_0 is currently being explored for South African small pelagics to provide some information on the proportion of the historical trajectory that is due to fishing compared to that due to the environment, in addition to the possibility of the ratio of (SS)B:Dynamic (SS)B_0 being used to provide reference points in the future (e.g. de Moor 2020c). The former is commonly used in some tuna and small pelagic assessments elsewhere, although the 'depletion' is not always calculated or reported based on an annually changing (SS)B_0, but often (SS)B is compared to the current 'regime' Dynamic (SS)B_0 (e.g. A'mar et al. 2009). (i.e. instead of the annual depletion of 0.69 (SSB) and 0.70 (TB) in 2019 of Table 1 of Bergh (2020) one would consider the 2019 depletion to be 0.33 of the recent 20-year 'regime' or 0.39 (SSB) and 0.40 (TB) of the whole time series.) Interestingly, Berger (2019) considers Dynamic B_0 to be more useful for management of longer-lived than shorter-lived species given its apparent ability to pick up changes in regimes over periods of time. This in contrast

to our exploration of Dynamic B_0 for the inter-annual changes in biomass due to the highly variable environmentally-linked recruitment. The use of Dynamic B_0 to provide reference points for management purposes, to provide management advice or to advise on stock status has thus far been avoided internationally. It would therefore be premature to compare the anchovy Dynamic B_0 depletion estimates of 0.48 to 0.92 (de Moor 2020b) to the MSC's $0.75B_0$ target. By present international standards 'static B_0' would be required (e.g. a range of 0.34 to 1.75 if considering a regime since the turn of the century based on de Moor (2020b) data).

- Figure 3 indicates some of the uncertainty associated with the time series of SSB: Dynamic SSB_0 depletion.

Estimation of F_{MSY}

- The Beverton Holt steepness for South African anchovy is estimated at 0.34 using 1984-2019 data (de Moor 2020a,b and reproduced as Figure 7 in Bergh (2020)), not 0.5 or higher.
- The formula Bergh (2020) uses to convert F_{MSY} to ER_{MSY} is not provided, although Figure 4 of Bergh (2020) plots the relationship up to just above 1 for ER_{MSY}. However, in applying the assumed formula for South African anchovy gives values for $ER_{MSY}>>1$ in Table 3, indicating MSY could be substantially more than available biomass. This raises the question of whether this deterministic evaluation of ER_{MSY} is pertinent to a recruit fishery.
- Hilborn *et al*. (2020) estimated ER_{MSY} for South African anchovy to be 0.18; this has been recommended for use to evaluate stock status only rather than as a quantitative target RP given its corresponding unreasonably high reference points.

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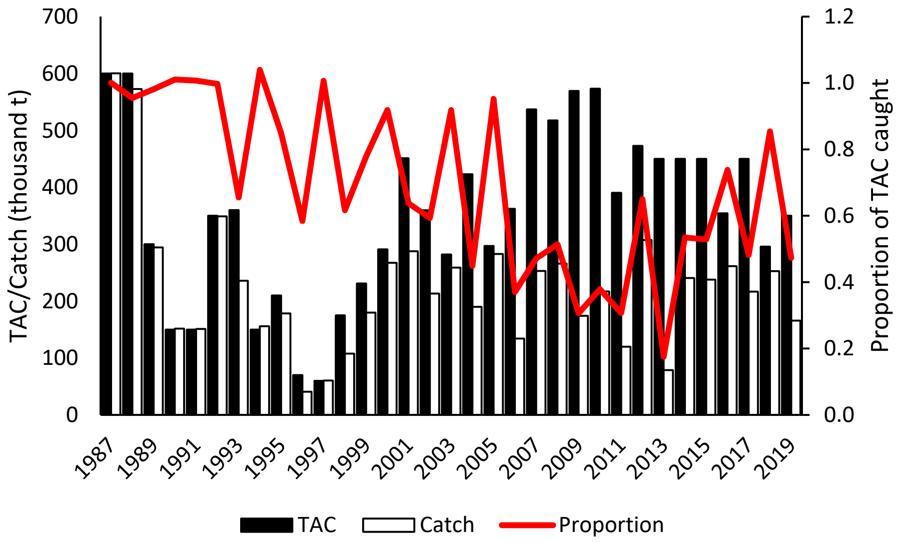

Figure 1. The historical annual anchovy TAC, catch and proportion of the TAC landed.

Figure 2. The historical exploitation rate of anchovy recruits and anchovy 1+ fish, from de Moor (2020b).