OMP-14

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Introduction

OMP-14, the management procedure to be used to recommend total allowable catches (TACs) and bycatches (TABs) for sardine and anchovy in South African waters, was adopted by the Small Pelagic Scientific Working Group (SPSWG) at its meeting on 29th October 2014. This OMP is to be used to recommend catch and bycatch limits for 2015 to 2018, unless refined in the interim (work on the development of a spatially explicit OMP is currently in progress).

Important Changes from OMP-08

OMP-08 (de Moor and Butterworth 2008) was used to recommend TACs and TABs for sardine and anchovy from 2008 to 2012. Due to the extensive testing required for the update of this OMP, particularly to take into consideration the possibility of two mixing sardine stocks, Interim OMPs have been used to recommend the TACs and TABs in 2013 and 2014 (de Moor and Butterworth 2012, 2013a,b). Some of the key differences between OMP-08 and OMP-14 include the following[1]:

i) The maximum total anchovy TAC has been decreased from 600 000t to 450 000t, to reflect the maximum catch which the industry could more realistically achieve (Table 1).

ii) The normal season has been extended from the end of August to the end of the year, thereby removing the "additional season" altogether[2].

iii) The Exceptional Circumstances November survey biomass threshold below which the anchovy TAC is decreased rapidly has been increased from 400 000t to 600 000t (Table 1).

iv) A new "buffer zone" has been introduced for the directed sardine TAC in cases where the November survey estimate of sardine biomass is between 300 000t (below which Exceptional Circumstances would be declared) and 600 000t. In these circumstances, a conservative initial sardine TAC is recommended at the beginning of the year, with a mid-season increase dependent on the survey estimate of sardine recruitment (Figures 1, 2).

v) A number of new (relatively small) TABs (e.g. a bycatch pool for anchovy landed by sardine only right holders and a bycatch for small sardine landed with directed (large) sardine) have been introduced so that all landings can be accounted unambiguously. These bycatch limits have been

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[1] Most of these updates were added sequentially during the period when Interim OMPs were being applied.

[2] The results upon which this decision was based used data from September – December from years in which the additional season sardine bycatch restrictions were imposed. Thus the small sardine bycatch with anchovy in the last four months of the year under OMP-14 will need to be monitored to ensure that these simulations reflect future bycatches accurately (see Appendix B) after the removal of the additional season.

intentionally set quite generously so that the chance of them being reached is small. Formally, if any of these limits, which are administered as pools to which all rights holders have access, are exceeded, the season is to be closed. However, given that experience is still to be gained regarding the appropriate levels at which to set these limits, it is accepted that *ad hoc* decisions may need to be taken to deal with unforeseen eventualities until values for the limits for these pools which are better based can be evaluated.

vi) The key control parameters have been re-tuned based on updated perceptions of the sardine and anchovy resource productivity and dynamics (i.e. updated operating models), and changes made to the operating models to account for the removal of the additional season and inclusion of additional bycatches.

Trade-off curves

The definitions of risk have remained unchanged from OMP-08:

$risk_S$ - the probability that total sardine 1+ biomass falls below the average total sardine 1+ biomass over November 1991 and November 1994 at least once during the projection period of 20 years.

$risk_A$ - the probability that anchovy 1+ biomass falls below 10% of the average anchovy 1+ biomass between November 1984 and November 1999 at least once during the projection period of 20 years.

The acceptable level of risk changes from one management procedure to the next, given changes in the perceived level of productivity of a resource resulting from the inclusion of revised and new data when conditioning the underlying operating models. de Moor and Butterworth (2010) developed an objective method of determining an acceptable level of risk for a new MP. This method was applied to obtain a new maximum risk level of 0.21 for sardine. However, given changes to key assumptions in the base case operating model for anchovy, particularly those relating to natural mortality and stock-recruit relationships, the method of de Moor and Butterworth (2010) could not be applied straightforwardly to obtain a new risk level for anchovy. The SPSWG thus agreed use a maximum risk level of 0.25 for anchovy. The trade-off curve with $risk_S < 0.21$ and $risk_A < 0.25$ for OMP-14 is shown in Figure 3. The 'corner point' of the trade-off curve, where the directed average sardine catch is maximised while maintaining a near-maximum average anchovy catch, was used to choose the directed sardine-anchovy trade-off (Figure 4).

Spatial Management

The control parameters of OMP-14 have been tuned based on an operating model which reflects a single sardine stock hypothesis. Although there is strong evidence for the possibility of two sardine stocks (which mix) (see, for example de Moor and Butterworth In Review and references therein), the SPSWG agreed to the use of this OMP until such time as an OMP developed and tested assuming a defensible two sardine stock hypothesis is ready to be implemented, but this was on condition that some guidelines for spatial management of the directed sardine catches be developed and accepted as part of OMP-14. The guidelines agreed, following examination of a number of options, are as follows.

> The target percentage for the directed ≥14cm sardine caught west of Cape Agulhas in a year is the average of the percentages of sardine found west of Cape Agulhas in the November surveys in the preceding two years. Tolerance about this percentage of at most 10% is permissible, i.e. if average the percentage from the preceding two surveys is *p*, the percentage of the directed sardine catch west of Cape Agulhas must lie between *p*-10 and *p*+10.

In Summary

The details of all the rules governing OMP-14 are described in full in Appendix A, while Table 1 lists the control parameters of OMP-14, with comparisons to those for previous OMPs. Table 2 lists the data required for input to this OMP. Table 3 lists some key summary performance statistics for the sardine and anchovy resources under OMP-14. Figure 5 shows the simulated distributions of sardine and anchovy at the end of the projection period under OMP-14, compared to those for a no-catch scenario. While OMPs are typically updated every 4-5 years, Appendix B describes the agreed procedures for deviating from the recommended OMP TAC/Bs and for initiating an earlier-than-intended OMP review.

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Table 1. Definitions of control parameters and constraints used in OMP-08, Interim OMP-13v2 and OMP-14, together with their values. All mass-related quantities are given in thousands of tons. Values for OMP-14 which differ from OMP-08 are given in bold face.

	Key Control Parameters	OMP-08	Interim OMP13v2	OMP-14
β	Directed sardine catch control parameter	0.097	0.090	**0.0869**
α_{ns}	Directed anchovy catch control parameter for normal season	0.78	0.871	**0.889**
α_{ads}	Directed anchovy catch control parameter for additional season	1.17	N/A	**N/A**
	Fixed TABs	**OMP-08**	**Interim OMP13v2**	**OMP-14**
TAB_{big}^{S}	Fixed >14cm sardine bycatch	3.5	7	**7**
TAB^{A}	Fixed anchovy bycatch for sardine only right holders	N/A	0.5	**0.5**
$TAB_{y,small,rh}^{S}$	Fixed ≤14cm sardine bycatch with round herring	N/A	1.0	**1.0**
	Fixed Control Parameters	**OMP-08**	**Interim OMP13v2**	**OMP-14**
δ	Scale-down factor applied to initial anchovy TAC	0.85[3]	0.85	0.85
p	Weighting given to recruitment survey in anchovy TAC	0.7[4]	0.7	0.7
q	Relates to average TAC under OMP-99 if $\alpha_{ns} = 1$	300[5]	300	300
$\bar{B}_{Nov}^{A}$	Historical average 1984 to 1999 index of anchovy abundance from the November spawner biomass surveys	1 380	1380	1380
$\bar{N}_{rec0}^{A}$	Average of 1985 to 1999 observed anchovy recruitments in May, back-calculated to November of the previous year	198 billion	217 billion	**217 billion**
ϖ	Estimate of the proportion of ≤14cm sardine bycatch in the >14cm sardine catch	N/A	0.07	**0.07**
γ_y	Range within which initial estimate of juvenile sardine : anchovy ratio is set, dependent upon November survey sardine biomass estimate	0.1-0.2	0.1-0.2	0.1-0.2
$\gamma_{\max}$	Maximum of the logistic curve for γ_y	0.1	0.1	0.1
B_{50}	Biomass of sardine where the logistic curve for γ_y reaches 50%	2 000	2000	2000

[3] A value of $\delta = 0.85$, used since OMP-02 was introduced, reflects the industry's desire for greater 'up-front' TAC allocation for planning purposes, even if this means some sacrifice in expected average TAC to meet the same risk criterion.
[4] A value of $p = 0.7$ reflects the greater importance of the incoming recruits in the year's catch relative to the previous year's biomass survey.
[5] Leaving $q = 300$ unchanged facilitated easy comparison between the outputs from OMP-02 and subsequent revised OMP candidates

Table 1 (continued)**.**

	Constraints	OMP-08	Interim OMP13v2	OMP-14
B_{95}	Biomass of sardine where the logistic curve for γ_y reaches 95%	3 178	3178	3178
c^S_{mntac}	Minimum directed sardine TAC	90	90	90
c^A_{mntac}	Minimum anchovy TAC	120	120	120
c^S_{mxtac}	Maximum directed sardine TAC	500	500	500
c^A_{mxtac}	Maximum total anchovy TAC	600	450	**450**
c^S_{tier}	Two-tier threshold for directed sardine TAC	255	255	255
c^A_{tier}	Two-tier threshold for normal season[6] anchovy TAC	330	330	330
c^S_{mxdn}	Maximum proportion by which directed sardine TAC can be reduced annually	0.20	0.20	0.20
c^A_{mxdn}	Maximum proportion by which normal season[6] anchovy TAC can be reduced annually	0.25	0.25	0.25
$c^{ns,A}_{mxinc}$	Maximum increase in normal season anchovy TAC	150	N/A	**N/A**
$c^{ads,A}_{mxinc}$	Maximum additional season anchovy TAC	120	N/A	**N/A**
TAB^S_{ads}	Maximum sardine bycatch during the additional season	2	N/A	**N/A**
B^S_{ec}	November survey biomass threshold at which Exceptional Circumstances are invoked for sardine	300	300	300
B^A_{ec}	November survey biomass threshold at which Exceptional Circumstances are invoked for anchovy	400	600	**600**
Δ^S	Threshold above B^S_{ec} at which linear smoothing is introduced before sardine Exceptional Circumstances are declared (to ensure continuity)	500	400	**400**
Δ^A	Threshold above B^A_{ec} at which linear smoothing is introduced before anchovy Exceptional Circumstances are declared (to ensure continuity)	100	100	100
B_1	Threshold above which the anchovy additional season TAC can increase more rapidly	1 000	N/A	**N/A**
B_2	Threshold above which the anchovy additional season TAC reaches a maximum	1 500	N/A	**N/A**
x^S	The proportion of B^S_{ec} below which sardine TAC is zero	0.25	0.25	0.25
x^A	The proportion of B^A_{ec} below which anchovy TAC is zero	0.25	0.25	0.25
R_{avg}	Sardine recruitment threshold at which the mid-year increase in sardine TAC under Exceptional Circumstances results in the final TAC equalling the original TAC	14.48	13.74	**13.74**

[6] The normal season applied from January to September for OMP-08 and applies to January to December for Interim OMP-13v2 and OMP-14.

Table 2. The data required as input to the OMP-14 formulae in December of year $y-1$ to provide the directed sardine TAC and initial anchovy TAC and sardine TAB recommendations for year y, and in June of year y to set the revised and final anchovy TAC and sardine TAB recommendations.

	Input	Definition
December y-1	$B^S_{y-1,N}$	November survey estimate of sardine 1+ biomass in year $y-1$ (in thousands of tons)
	$B^A_{y-1,N}$	November survey estimate of anchovy 1+ biomass in year $y-1$ (in thousands of tons)
June y	$N^A_{y,r}$	May survey estimate of anchovy recruitment in year y (in billions)
	$N^S_{y,r}$ [7]	May survey estimate of sardine recruitment in year y (in billions)
	t^A_y	Day of commencement of recruitment survey (time in months after 1 May)
	$C^A_{y,1}$	Anchovy catch at age 1[8] from 1 November of year $y-1$ to the day before the commencement of the recruitment survey (in billions)
	$C^A_{y,0bs}$	Anchovy catch at age 0[8] from 1 November of year $y-1$ to the day before the commencement of the recruitment survey (in billions)
	$r_{y,sur}$	Ratio of juvenile sardine to anchovy (by mass) indicated by the recruitment survey
	$r_{y,com}$	Ratio of juvenile sardine to anchovy (by mass) in the commercial catches during May, based on the commercial catches comprising at least 50% anchovy only
	$\overline{w}^A_1 = 10.689$	Average historical anchovy weight-at-age 1 in November (in gm)
	$\overline{w}^A_2 = 13.671$	Average historical anchovy weight-at-age 2 in November (in gm)
	$\overline{w}^A_{0c} = 4.847$	Average historical catch weight-at-age 0 (in gm)
	$\overline{w}^A_{1c} = 10.983$	Average historical catch weight-at-age 1 (in gm)

[7] Needed only if $B^S_{y-1,N} < 600$.

[8] Monthly cut-off lengths are used to split the anchovy catch into juveniles and adults. The monthly cut-off lengths for November to March are given in de Moor *et al.* (2012), while the monthly cut-off lengths for April, May and June (if needed) are dependent on the recruit cut-off length used for the recruit survey in year y.

Table 3. Key summary statistics for the sardine and anchovy resources under a no-catch scenario and OMP-14:

- the probability that sardine 1+ biomass falls below the average sardine 1+ biomass over November 1991 to November 1994 (the "risk threshold", $Risk^{S}$) **at least once during the projection period** of 20 years, $risk_{S}$;
- the probability that anchovy 1+ biomass falls below 10% of the average anchovy 1+ biomass between November 1984 and November 1999 **at least once during the projection period of 20 years**, $risk_{A}$;
- the probability of breaching the sardine/anchovy risk threshold **in any one year, averaged over the years** during the projection period ($risk_{*S/A}$);
- average minimum biomass over the projection period ($B^{S/A}_{\min}$) as a proportion of carrying capacity ($K^{S/A}$) and as a proportion of the risk threshold ($Risk^{S/A}$);
- average biomass at the end of the projection period ($B^{S/A}_{2032}$) as a proportion of carrying capacity, as a proportion of the risk threshold, and as a proportion of biomass at the beginning of the projection period ($B^{S/A}_{2011}$);
- average (median in brackets) directed catch (in thousands of tons), $\overline{C}^{S}/\overline{C}^{A}$;
- average sardine bycatch comprising juvenile sardine bycatch with anchovy, round herring and large sardine (in thousands of tons), $\overline{C}^{S}_{by}$;
- average proportional annual change in directed catch, AAV^{S}/AAV^{A} ;
- proportion of occasions Exceptional Circumstances are/are not declared ($EC^{declared}/EC^{NOTdeclared}$) when true biomass is/is not below the corresponding threshold ($B^{A/S}_{y} <$ or $\geq Threshold$);
- proportion of occasions the directed TAC drops below the minimum TAC (i.e., Exceptional Circumstances are declared), $TAC^{A/S}_{y} < c^{A/S}_{mntac}$;
- average number of years for which Exceptional Circumstances, if declared, are declared consecutively, $EC^{A/S}_{con\sec}$;
- proportion of occasions the anchovy fishery is closed due to the sardine TAB limit[9], $p(Close)$;
- average normal season anchovy catch lost in each of those years in which the fishery was closed, $\overline{C}^{A}_{lost}$;

[9] This is the proportion of occasions the revised sardine TAB with anchovy is reached and excludes any occasions when the initial sardine TAB with anchovy may be reached.

- average normal season anchovy TAC in years in which the fishery was closed $\overline{TAC}^{A}_{close}$; and
- average rate of increase of number of moulters of adult penguins on Robben island from November 2012 to November 2017 and to November 2022, ROI_y ; the average number of moulters of penguins on Robben Island compared to the initial year, $\overline{P_y/P_{2011}}$.

	Sardine	No Catch	Interim OMP-13v2	Anchovy	No Catch	Interim OMP-13v2
Key Control Parameters	β		0.0869	α_{ns}		0.8890
Risk Statistics	$risk_S$	0.047	0.209	$risk_A$	0.008	0.234
	$risk_{*S}$	0.008	0.066	$risk_{*A}$	0.002	0.041
Biomass Statistics	$\overline{B^S_{\min}/K^S}$	0.50	0.39	$\overline{B^A_{\min}/K^A}$	0.26	0.10
	$\overline{B^S_{\min}/Risk^S}$	1.94	1.51	$\overline{B^A_{\min}/Risk^A}$	9.21	3.62
	$\overline{B^S_{2032}/K^S}$	0.99	0.77	$\overline{B^A_{2032}/K^A}$	1.20	0.56
	$\overline{B^S_{2032}/Risk^S}$	4.13	3.15	$\overline{B^A_{2032}/Risk^A}$	49.27	22.71
	$\overline{B^S_{2032}/B^S_{2011}}$	2.08	1.57	$\overline{B^A_{2032}/B^A_{2011}}$	4.55	1.80
Catch Statistics	$\overline{C}^S$ ('13-'32)	0	153 (129)	$\overline{C}^A$ ('13-'32)	0	290 (321)
	$\overline{C}^S_{by}$	0	33			
	$\overline{C}^S$ ('13-'15)	0	121 (96)	$\overline{C}^A$ ('13-'15)	0	341 (375)
	AAV^S ('13-'32)		0.38	AAV^A ('13-'32)		0.21
	AAV^S ('13-'15)		0.62	AAV^A ('13-'15)		0.13

		Sardine	No Catch	Interim OMP-13v2		Anchovy	No Catch	Interim OMP-13v2
Exceptional Circumstances		$p\left(EC^{declared}, B_y^S < Threshold\right)$	0.00	0.01		$p\left(EC^{declared}, B_y^A < Threshold\right)$	0.02	0.25
		$p\left(EC^{declared}, B_y^S \geq Threshold\right)$	0.01	0.05		$p\left(EC^{declared}, B_y^A \geq Threshold\right)$	0.01	0.02
		$p\left(EC^{NOTdeclared}, B_y^S < Threshold\right)$	0.00	0.00		$p\left(EC^{NOTdeclared}, B_y^A < Threshold\right)$	0.01	0.04
		$p\left(EC^{NOTdeclared}, B_y^S \geq Threshold\right)$	0.99	0.94		$p\left(EC^{NOTdeclared}, B_y^A \geq Threshold\right)$	0.96	0.69
		$p\left(TAC_y^S < c_{mntac}^S\right)$	-	0.05		$p\left(TAC_y^A < c_{mntac}^A\right)$	-	0.27
		EC_{consec}^S	-	1.3 years		EC_{consec}^A	-	3.5 years
Anchovy Fishery Closure						$p(Close)$	-	0.23
						$\overline{C}_{lost}^A$	-	36
						$\overline{TAC}_{close}^A$	-	169
Penguins	Assuming sardine biomass distributed west of Cape Agulhas similar to 1980-90s	ROI_{2017}	0.018	0.006	Assuming sardine biomass distributed west of Cape Agulhas similar to 2000s	ROI_{2017}	-0.065	-0.080
		ROI_{2022}	0.011	-0.003		ROI_{2022}	-0.050	-0.065
		$\overline{P_{2017}/P_{2011}}$	1.091	1.032		$\overline{P_{2017}/P_{2011}}$	0.676	0.601
		$\overline{P_{2022}/P_{2011}}$	1.108	0.970		$\overline{P_{2022}/P_{2011}}$	0.497	0.353

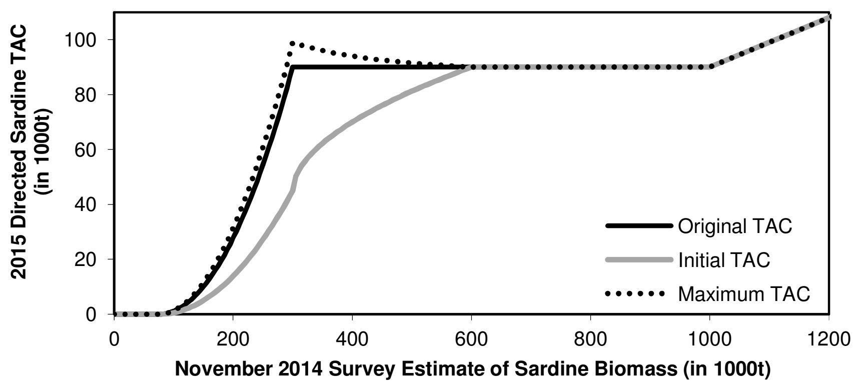

Figure 1. The Harvest Control Rule for directed ≥14cm sardine TAC in 2015 under OMP-14. The initial sardine TAC increases smoothly from 50% of the original TAC at a November survey estimate of 300 000t, matching that recommended under Exceptional Circumstances below 300 000t, to 100% of the original TAC at a November survey estimate of 600 000t. The maximum possible TAC decreases smoothly from 110% of the original TAC at a November survey estimate of 300 000t, matching that recommended under Exceptional Circumstances, to 100% of the original TAC at a November survey estimate of 600 000t.

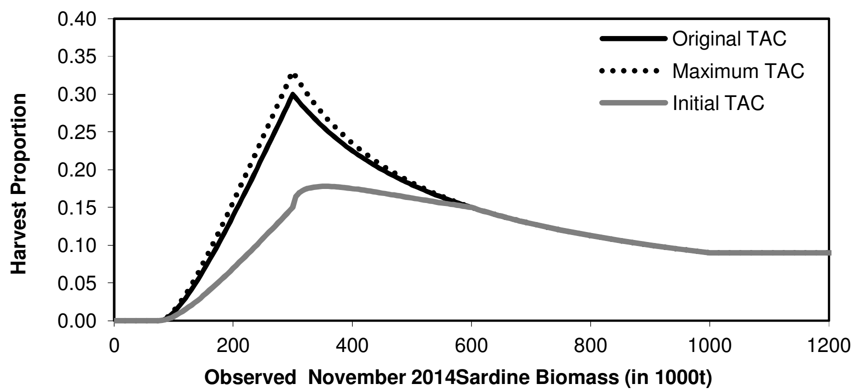

Figure 2. The harvest rate (TAC/survey estimate of sardine 1+ biomass) for the original, initial and maximum directed ≥14cm sardine TACs shown in Figure 1.

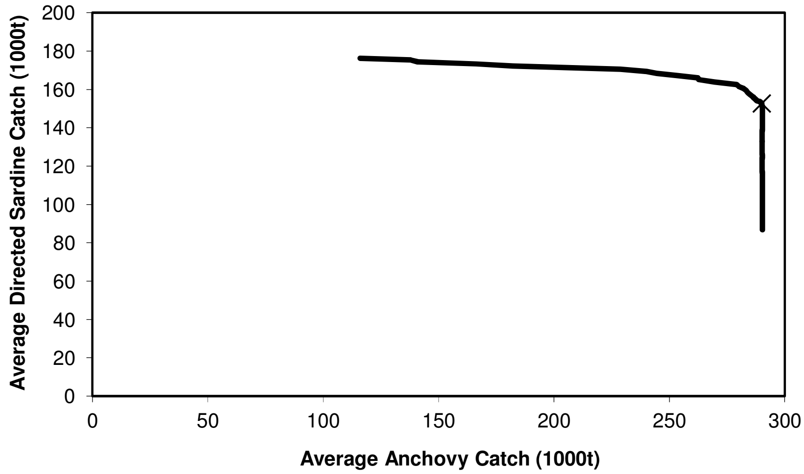

Figure 3. The trade-off curve for OMP-14, determined by satisfying $risk_S < 0.21$ and $risk_A < 0.25$. The corner point is marked with a cross.

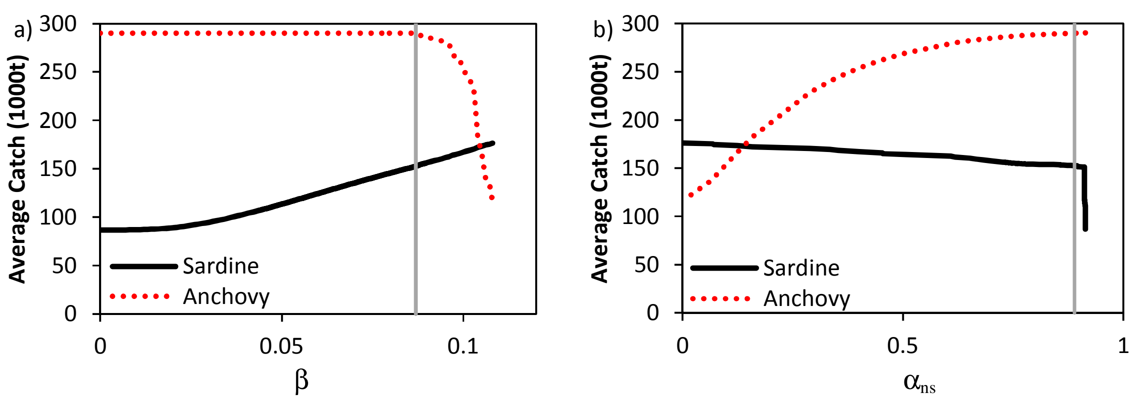

Figure 4. The average directed sardine and anchovy catches (as shown on the trade-off curve in Figure 3) plotted against a) the sardine control parameter, β and b) the anchovy control parameter, α_{ns}. The grey vertical lines indicate a value of a) $\beta = 0.0869$ and b) $\alpha_{ns} = 0.889$ corresponding to the corner point of OMP-14.

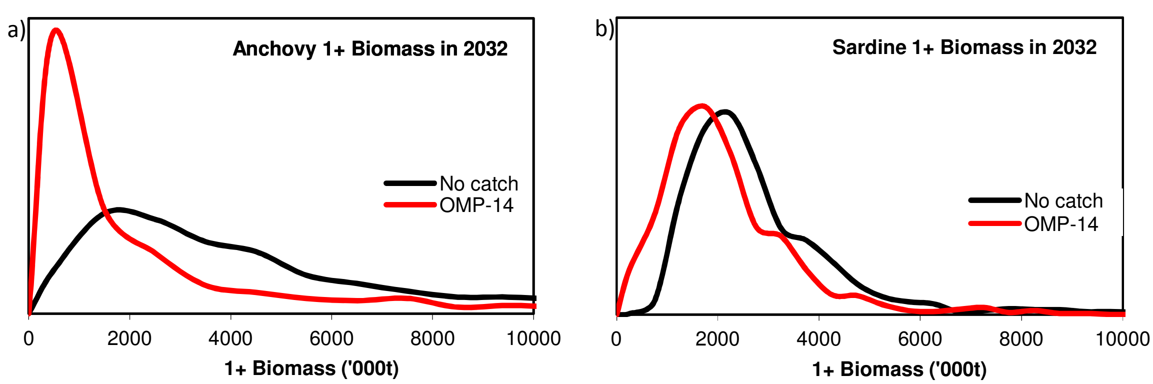

Figure 5. Comparison of a) anchovy and b) sardine 1+ biomass distributions in the final projection year under a no catch scenario and under OMP-14.

Appendix A: OMP-14 Harvest Control Rules

In this Appendix, catches-at-age are given in numbers of fish (in billions), whereas the TACs and TABs are given in thousands of tons. Sardine and anchovy total allowable catches (TACs) and sardine total allowable bycatches (TABs) are set at the start of the year and the latter two are revised during the year (or all three if the November survey estimate of sardine 1+ biomass is below 600 000t).

Initial TACs / TAB (January)

The directed >14cm sardine TAC and initial directed anchovy TAC and TAB for ≤14cm sardine bycatch with anchovy directed fishing are based on the results of the November biomass survey. These limits are announced prior to the start of the pelagic fishery at the beginning of each year.

The directed sardine TAC is set at a proportion of the previous year's November 1+ biomass index of abundance, but subject to the constraints of a minimum and a maximum value. If the previous year's TAC is below the 'two-tier' threshold, then the TAC is subject to a maximum percentage decrease from the previous year's TAC. If it is above this threshold, any reduction in TAC is limited only by a lower bound of the corresponding threshold less the maximum percentage decrease. If the previous year's November 1+ biomass index of abundance is below a "buffer" threshold, only a portion of the TAC is given as an initial TAC.

The directed anchovy initial TAC is based on how the most recent November biomass survey estimate of abundance relates to the historical (non-peak) average between 1984 and 1999. In the absence of further information, which will become available after the May recruitment survey, this initial TAC assumes the forthcoming recruitment (which will form the bulk of the catch) will be average. A 'scale-down' factor, δ, is therefore introduced to provide a buffer against possible poor recruitment. The anchovy TAC is subject to similar constraints as apply for sardine.

A fixed anchovy TAB, TAB^A, for sardine-only right holders has been introduced in OMP-14 (see Table A.1).

A fixed >14cm sardine TAB, TAB^S_{big}, consisting mainly of adult sardine bycatch with round herring and to a lesser extent with anchovy has been introduced in OMP-14 (replacing the "adult sardine bycatch with round herring" TAB in OMP-08) (see Table A.1).

A new ≤14cm sardine TAB has been introduced in OMP-14. This consists of a fixed allocation for bycatch with round herring, $TAB^S_{y,small,rh}$, and an allocation for small sardine bycatch in the >14cm directed sardine landings, set proportional to the directed sardine TAC.

The final TAB is a ≤14cm sardine TAB with anchovy, and is set proportional to the anchovy TAC.

Directed >14cm sardine TAC: $TAC_y^S = \beta\, B_{y-1,Nov}^{obs,S}$ (OMP.1)

subject to:
$$\begin{array}{ll} \max\left\{\left(1-c_{mxdn}^S\right)TAC_{y-1}^S\,;\,c_{mntac}^S\right\} \le TAC_y^S \le c_{mxtac}^S & \textit{if } TAC_{y-1}^S \le c_{tier}^S \\ \max\left\{\left(1-c_{mxdn}^S\right)c_{tier}^S\,;\,c_{mntac}^S\right\} \le TAC_y^S \le c_{mxtac}^S & \textit{if } TAC_{y-1}^S > c_{tier}^S \end{array} \qquad \text{(OMP.2)}$$

Initial directed anchovy TAC: $TAC_y^{1,A} = \alpha_{ns}\,\delta\, q\left(p + (1-p)\dfrac{B_{y-1}^{obs,A}}{\overline{B}_{Nov}^{A}}\right)$ (OMP.3)

subject to:
$$\begin{array}{ll} \max\left\{\left(1-c_{mxdn}^A\right)TAC_{y-1}^{2,A}\,;\,c_{mntac}^A\right\} \le TAC_y^{1,A} \le c_{mxtac}^A & \textit{if } TAC_{y-1}^{2,A} \le c_{tier}^A \\ \max\left\{\left(1-c_{mxdn}^A\right)c_{tier}^A\,;\,c_{mntac}^A\right\} \le TAC_y^{1,A} \le c_{mxtac}^A & \textit{if } TAC_{y-1}^{2,A} > c_{tier}^A \end{array} \qquad \text{(OMP.4)}$$

≤14cm sardine TAB with directed >14cm sardine catch:

$$TAB_{y,small}^S = \omega TAC_y^S \qquad \text{(OMP.5)}$$

Initial ≤14cm sardine TAB with anchovy: $TAB_{y,anch}^{1,S} = \gamma_y TAC_y^{1,A}$ (OMP.6)

where:
$$\gamma_y = 0.1 + \frac{\gamma_{\max}}{1+\exp\left(-\ln(19)\dfrac{\left(B_{y-1,N}^{S,obs} - B_{50}\right)}{\left(B_{95}-B_{50}\right)}\right)}. \qquad \text{(OMP.7)}$$

Here γ_y increases according to a logistic curve from 10% in years in which the survey estimated sardine November 1+ biomass, $B_{y-1,N}^{S,obs}$, is poor to average, towards a maximum when sardine biomass is higher.

To maintain continuity in the directed sardine and initial anchovy TACs as the Exceptional Circumstances thresholds (see below), B_{ec}^S and B_{ec}^A, are approached from above and below, the following linear smoothing is applied.

If $B_{ec}^S \le B_{y-1,N}^{obs,S} \le B_{ec}^S + \Delta^S$:

$$TAC_y^S = \left(1-\frac{B_{y-1,N}^{obs,S} - B_{ec}^S}{\Delta^S}\right)\times TAC_y^{S-EC} + \left(\frac{B_{y-1,N}^{obs,S} - B_{ec}^S}{\Delta^S}\right)\times TAC_y^S \qquad \text{(OMP.8)}$$

where TAC_y^{S-EC} is the value output from equation (OMP.18) when $B_{y-1,N}^{obs,S} = B_{ec}^S$, while TAC_y^S is the value output from equation (OMP.2) when $B_{y-1,N}^{obs,S} = B_{ec}^S + \Delta^S$.

If $B_{ec}^A \le B_{y-1,N}^{obs,A} \le B_{ec}^A + \Delta^A$:

$$TAC_y^{1,A} = \left(1-\frac{B_{y-1,N}^{obs,A} - B_{ec}^A}{\Delta^A}\right)\times TAC_y^{1,A\_EC} + \left(\frac{B_{y-1,N}^{obs,A} - B_{ec}^A}{\Delta^A}\right)\times TAC_y^{1,A} \qquad \text{(OMP.9)}$$

where TAC_y^{1,A_EC} is the value output from equation (OMP.19) when $B_{y-1,N}^{obs,A} = B_{ec}^A$, while $TAC_y^{1,A}$ is the value output from equation (OMP.4) when $B_{y-1,N}^{obs,A} = B_{ec}^A + \Delta^A$.

Buffer rule:

If $B_{ec}^S \leq B_{y-1,N}^S < 2\times B_{ec}^S$, only a portion of the TAC calculated above is given at the start of the year:

$$TAC_{y,init}^S = \frac{TAC_y^S}{2} + \frac{TAC_y^S}{2}\times\left(\frac{B_{y-1,N}^{obs,S} - B_{ec}^S}{B_{ec}^S}\right)^{0.535} \qquad \text{(OMP.10)}$$

where TAC_y^S is the value output from equations (OMP.2) and (OMP.8).

In the above equations the symbols used are as follows (see Table A.1 for fixed values):

$B_{y,N}^{obs,S}$ - the estimate of sardine abundance from the hydroacoustic biomass survey in November of year y.

β - a control parameter reflecting the proportion of the previous year's November 1+ biomass index of abundance that is used to set the directed sardine TAC, which is tuned to meet target risk levels for sardine and anchovy.

$B_{y,N}^{obs,A}$ - the estimate of anchovy abundance from the hydroacoustic biomass survey in November of year y

$\overline{B}_{Nov}^A$ - the historical average index of anchovy 1+ biomass from the November surveys from 1984 to 1999.

α_{ns} - a control parameter which tunes the anchovy TAC to meet target risk levels for sardine and anchovy.

δ - a 'scale-down' factor used to lower the initial anchovy TAC to provide a buffer against possible poor recruitment.

p - the weight given to the recruit survey component compared to the 1+ biomass survey component in setting the anchovy TAC.

q - a constant value reflecting the average annual TAC expected under OMP99 under average conditions if $\alpha_{ns} = 1$.

c_{mntac}^S - the minimum directed TAC to be set for sardine.

c_{mntac}^A - the minimum directed TAC to be set for anchovy.

c_{mxtac}^S - the maximum directed TAC to be set for sardine.

c_{mxtac}^A - the maximum directed TAC to be set for anchovy.

c_{tier}^S - the two-tier threshold for directed sardine TAC.

c_{tier}^A - the two-tier threshold for directed anchovy TAC.

c_{mxdn}^S - the maximum proportional amount by which the directed sardine TAC can be reduced from one year to the next.

c^A_{mxdn} - the maximum proportional amount by which the directed anchovy TAC can be reduced from one year to the next.

ϖ - an estimate of the maximum percentage of ≤14cm sardine bycatch in the >14cm sardine catch.

γ_y - a conservative estimate of the anticipated ratio of juvenile sardine to juvenile anchovy in subsequent catches.

$\gamma_{\max}$ - maximum of the logistic curve for γ_y.

B_{50} - biomass where the logistic curve for γ_y reaches 50%.

B_{95} - biomass where the logistic curve for γ_y reaches 95%.

B^S_{ec} - the biomass threshold below which Exceptional Circumstances apply for sardine.

B^A_{ec} - the biomass threshold below which Exceptional Circumstances apply for anchovy.

Δ^S - the threshold above the Exceptional Circumstances threshold, B^S_{ec}, below which the sardine TAC is smoothed until B^S_{ec} is reached.

Δ^A - the threshold above the Exceptional Circumstances threshold, B^A_{ec}, below which the anchovy TAC is smoothed until B^A_{ec} is reached.

Spatial management of the directed ≥14cm sardine TAC

The proportion of the directed >14cm sardine TAC to be caught west of Cape Agulhas in year y, $p_{west}(y)$, is restricted by a 10% error about the average of that observed from the most recent two November surveys:

$$0.5\left(p^{obs}_{west}(y-1)+p^{obs}_{west}(y-2)\right)-0.1 \le p_{west}(y) \le 0.5\left(p^{obs}_{west}(y-1)+p^{obs}_{west}(y-2)\right)+0.1$$

where $p^{obs}_{west}(y)$ denotes the proportion of sardine abundance surveyed west of Cape Agulhas in November y.

Revised TACs / TAB (June)

If only a portion of the directed sardine TAC was given as an initial TAC, the midyear increase is dependent on the survey estimate of recruitment, compared to a historical average.

The anchovy TAC and sardine TAB midyear revisions are based on the most recent November and now also recruit surveys. As the estimate of recruitment is now available, the 'scale-down' factor, δ, is no longer required to set the anchovy TAC. The additional constraints include ensuring that the revised anchovy TAC is not less than the initial anchovy TAC.

The revised ≤14cm sardine TAB with anchovy is calculated using an estimate of the ratio, r_y, of juvenile sardine to anchovy, provided this ratio is larger than γ_y, which was used to set the initial TAB.

Revised sardine TAC if Buffer Rule applied:

If $B_{ec}^{S} \leq B_{y-1,N}^{S} < 2 \times B_{ec}^{S}$:

$$TAC_{final,y}^{S} = TAC_{y,init}^{S} + \left(\frac{N_{y,r}^{obs,S}}{R_{avg}}\right)^{1.5} \times \left(TAC_{y}^{S} - TAC_{y,init}^{S}\right) \tag{OMP.11}$$

subject to: $TAC_{final,y}^{S} \leq \left(1.1 + \frac{0.1}{1-2^{-1.66099}}\left\{\left(\frac{B_{y-1,N}^{obs,S}}{B_{ec}^{S}}\right)^{-1.66099} - 1\right\}\right) \times TAC_{y}^{S}$

Revised anchovy TAC: $$TAC_{y}^{2,A} = \alpha_{ns}\, q \left(p \frac{N_{y-1,rec0}^{A}}{\overline{N}_{rec0}^{A}} + (1-p)\frac{B_{y-1,N}^{obs,A}}{\overline{B}_{Nov}^{A}}\right) \tag{OMP.12}$$

subject to:
$$\begin{array}{ll} \max\left\{TAC_{y}^{1,A}; \left(1-c_{mxdn}^{A}\right)TAC_{y-1}^{2,A}\right\} \leq TAC_{y}^{2,A} \leq c_{mxtac}^{A} & TAC_{y-1}^{2,A} \leq c_{tier}^{A} \\ \max\left\{TAC_{y}^{1,A}; \left(1-c_{mxdn}^{A}\right)c_{tier}^{A}\right\} \leq TAC_{y}^{2,A} \leq c_{mxtac}^{A} & TAC_{y-1}^{2,A} > c_{tier}^{A} \end{array} \tag{OMP.13}$$

Revised <14cm sardine TAB with anchovy:

$$TAB_{y,anch}^{2,S} = \lambda_y\, TAC_{y}^{1,A} + r_y\, (TAC_{y}^{2,A} - TAC_{y}^{1,A}) \tag{OMP.14}$$

where: $\lambda_y = \max\{\gamma_y, r_y\}$

As for the initial TAC, continuity in the revised anchovy TAC as the Exceptional Circumstances thresholds are approached from above and below, is maintained by applying the following linear smoothing.

If $B_{ec}^{A} \leq B_{y,proj}^{A} \leq B_{ec}^{A} + \Delta^{A}$ we have:

$$TAC_{y}^{2,A} = \left(1 - \frac{B_{y,proj}^{A} - B_{ec}^{A}}{\Delta^{A}}\right) \times TAC_{y}^{2,A\_EC} + \left(\frac{B_{y,proj}^{A} - B_{ec}^{A}}{\Delta^{A}}\right) \times TAC_{y}^{2,A} \tag{OMP.15}$$

where TAC_{y}^{2,A_EC} is the value output from equation (OMP.24) when $B_{y,proj}^{A} = B_{ec}^{A}$, while $TAC_{y}^{2,A}$ is the value output from equation (OMP.13) when $B_{y,proj}^{A} = B_{ec}^{A} + \Delta^{A}$, and $B_{y,proj}^{A}$ is determined by equation (OMP.21).

Note that by construction $TAB_{y}^{2,S} \geq TAB_{y}^{1,S}$ as $\lambda_y \geq \gamma_y$ and $TAC_{y}^{2,A} \geq TAC_{y}^{1,A}$. In addition to the previous definitions, we have:

$N_{y,r}^{obs.i}$ - the estimate of recruitment of sardine ($i = S$) or anchovy ($i = A$) from the hydroacoustic recruit survey in May of year y.

R_{avg} - the level of sardine recruitment required in order to achieve the original HCR calculated sardine TAC.

$N^{A}_{y-1,rec0}$ - the simulated estimate of anchovy recruitment from the recruitment survey in year y, $N^{obs,A}_{y,r}$ [10], back-calculated to 1 November $y-1$ by taking natural and fishing mortality into account (equation (OMP.16) below).

$\overline{N}^{A}_{rec0}$ - the average 1985 to 1999 anchovy recruitment surveyed in May, back-calculated (using equation (OMP.16)) to November of the previous year.

$r_y = \frac{1}{2}(r_{y,sur} + r_{y,com})$ - the ratio of juvenile sardine to anchovy "in the sea" during May in year y, calculated from the recruit survey and the sardine bycatch to anchovy ratio in the commercial catches[11] during May.

The anchovy TAC equations require that $N^{obs,A}_{y,r}$, the recruitment numbers estimated in the survey, be back-calculated to November of the previous year, assuming a fixed value of 1.2 *year*$^{-1}$ for M^{A}_{j}. The back-calculated recruitment numbers are evaluated as follows:

$$N^{A}_{y-1,rec0} = (N^{obs,A}_{y,r} e^{t^{A}_{y}\times 1.2/12} + C^{A}_{y,0bs})\, e^{0.5\times 1.2} \qquad \text{(OMP.16)}$$

In the equation above:

$C^{A}_{y,0bs}$ - the observed juvenile anchovy landed by number (in billions) from the 1st of November year $y-1$ to the day before the recruit survey commences in year *y*; and

t^{A}_{y} - the timing of the anchovy recruit survey in year *y* (number of months) after the 1st of May year y.

Exceptional Circumstances

Sardine directed TAC

Exceptional Circumstances for the sardine directed TAC apply if:

$B^{obs,S}_{y-1,N} < B^{S}_{ec}$

in which case the TAC under Exceptional Circumstances is calculated as follows. Only a portion (half) of the directed sardine TAC is awarded with the initial TACs, with a revised TAC in June dependent on the May survey estimate of sardine recruitment (Figure 1):

[10] This estimate of recruitment is calculated using a cut-off length determined from modal progression analysis. In the event of this modal progression analysis being unable to detect a clear mode, a recruit cut-off (caudal) length of 10.5cm for anchovy and 15.5cm for sardine will be used. These are the cut-off lengths used historically and from which there has not been substantial deviation over a 10 year period (Coetzee pers. comm.).

[11] Only commercial catches comprising at least 50% anchovy with sardine bycatch are considered.

Initial TAC:

$$TAC_{y,init}^{S} = 0.5 \times \begin{cases} 0 & \text{if } \dfrac{B_{y-1,N}^{obs,S}}{B_{ec}^{S}} < x^{S} \\ TAC_{y}^{S\_before}\left(\dfrac{\dfrac{B_{y-1,N}^{obs,S}}{B_{ec}^{S}} - x^{S}}{1 - x^{S}}\right)^{2} & \text{if } x^{S} < \dfrac{B_{y-1,N}^{obs,S}}{B_{ec}^{S}} < 1 \end{cases} \qquad \text{(OMP.17)}$$

Revised TAC:

$$TAC_{y}^{S} = \begin{cases} TAC_{y,init}^{S} + \dfrac{N_{y,r}^{obs,S}}{R_{avg}} TAC_{y,init}^{S} & \text{if } N_{y,r}^{obs,S} \le 1.2 \times R_{avg} \\ TAC_{y,init}^{S} + 1.2 \times TAC_{y,init}^{S} & \text{if } N_{y,r}^{obs,S} > 1.2 \times R_{avg} \end{cases} \qquad \text{(OMP.18)}$$

where $TAC_{y}^{S\_before} = \beta\, B_{y-1,N}^{obs,S}$, subject to $c_{mntac}^{S} \le TAC_{y}^{S\_before} \le c_{mxtac}^{S}$. The rule allows for the TAC to be set to zero if the survey estimated sardine biomass falls below x^{S} of the threshold B_{ec}^{S} (see Table 1).

Initial Anchovy TAC

Exceptional Circumstances for the initial anchovy TAC apply if

$B_{y-1,N}^{obs,A} < B_{ec}^{A}$

in which case the TAC under Exceptional Circumstances is calculated as follows:

$$TAC_{y}^{1,A} = \begin{cases} 0 & \text{if } \dfrac{B_{y-1,N}^{obs,A}}{B_{ec}^{A}} < x^{A} \\ TAC_{y}^{1,A\_before}\left(\dfrac{\dfrac{B_{y-1,N}^{obs,A}}{B_{ec}^{A}} - x^{A}}{1 - x^{A}}\right)^{2} & \text{if } x^{A} < \dfrac{B_{y-1,N}^{obs,A}}{B_{ec}^{A}} < 1 \end{cases} \qquad \text{(OMP.19)}$$

where $TAC_{y}^{1,A\_before} = \alpha_{ns}\,\delta\, q\left(p + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\bar{B}_{Nov}^{A}}\right)$, subject to $c_{mntac}^{A} \le TAC_{y}^{1,A\_before} \le c_{mxtac}^{A}$. The rule allows for the TAC to be set to zero if the survey estimated anchovy biomass falls below x^{A} of the threshold B_{ec}^{A} (see Table 1).

Revised Anchovy TAC

The results of the most recent November and recruit surveys are projected forward, taking natural and anticipated fishing mortality into account, in order to provide a proxy ($B_{y,proj}^{A}$) for the forthcoming November survey, and hence have a basis for invoking Exceptional Circumstances, if necessary. Defining

$TAC_{y}^{2,A\_before} = \alpha_{ns}\, q\left(p\dfrac{N_{y-1,rec0}^{A}}{\bar{N}_{rec0}^{A}} + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\bar{B}_{Nov}^{A}}\right)$, subject to $\max\{TAC_{y}^{1,A}; c_{mntac}^{A}\} \le TAC_{y}^{2,A\_before} \le c_{mxtac}^{A}$, a projected anchovy biomass, $B^{A}_{y,proj0}$, is calculated as follows:

$$B^{A}_{y,proj0} = \max \text{ of} \left\{ 0; \left(N^{obs,A}_{y,r} - \left[\frac{TAC^{2,A\_after}_{y} + TAB^{A} - \overline{w}^{A}_{1c} C^{A}_{y,1}}{\overline{w}^{A}_{0c}} - C^{A}_{y,0bs} \right] \right) e^{-(6-t_y)*1.2/12} \overline{w}^{A}_{1} \right\}. \qquad \text{(OMP.20)}$$

Calculate $B^{A}_{y,proj}$ as follows:

$$B^{A}_{y,proj} = \left(\frac{B^{obs,A}_{y-1,N}}{\overline{w}^{A}_{1}} e^{-5*1.2/12} - C^{A}_{y,1} \right) e^{-7\times 1.2/12} \overline{w}^{A}_{2} \quad + \quad B^{A}_{y,proj0} \qquad \text{(OMP.21)}$$

If $B^{A}_{y,proj} < B^{A}_{ec}$, then Exceptional Circumstances apply. The recruit survey result in year y (in numbers) that would be sufficient to yield a $B^{A}_{y,proj}$ value of exactly B^{A}_{ec} is calculated as follows:

$$\theta = \frac{[B^{A}_{ec} - (B^{A}_{y,proj} - B^{A}_{y,proj0})]}{\overline{w}^{A}_{1}} e^{(6-t_y)*1.2/12} \quad + \quad \frac{TAC^{2,A\_after}_{y} + TAB^{A} - \overline{w}^{A}_{1c} C^{A}_{y,1}}{\overline{w}^{A}_{0c}} - C^{A}_{y,0bs} \qquad \text{(OMP.22)}$$

This is back-calculated to November of the previous year in the same way as equation (OMP.16) during OMP implementation:

$$N^{A*}_{y-1,rec0} = (\theta\, e^{t^{A}_{y}\times 1.2/12} + C^{A}_{y,0bs})\, e^{6\times 1.2/12} \qquad \text{(OMP.23)}$$

In the equations above:

$C^{A}_{y,1}$ - the observed anchovy catch at age 1 landed by number (in billions) from the 1st of November year $y-1$ to the day before the recruit survey commences in year y.

$\overline{w}^{A}_{a}$ - average historical anchovy weight-at-age a in November (in gm).

$\overline{w}^{A}_{ac}$ - average historical anchovy catch weight-at-age a (in gm).

The revised anchovy TAC is calculated by reducing TAC^{2,A_before}_{y} by the ratio (squared) of TAC^{2,A_before}_{y} evaluated with the annual recruitment for year y to $TAC^{2,A}_{y}$ calculated using θ, thus providing a means to reduce the TAC fairly rapidly when the Exceptional Circumstances threshold is breached. The rule allows for the TAC to be set to zero (or to the initial anchovy TAC, if greater than zero) if the survey estimated anchovy recruitment or biomass falls below a quarter of the corresponding threshold:

$$TAC_y^{2,A} = \max \text{ of} \begin{cases} TAC_y^{1,A}; TAC_y^{2,A\_before} \dfrac{\left(\dfrac{p\dfrac{N_{y-1,rec0}^{A}}{\overline{N}_{rec0}^{A}} + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\overline{B}_{Nov}^{A}}}{p\dfrac{N_{y-1,rec0}^{A*}}{\overline{N}_{rec0}^{A}} + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\overline{B}_{Nov}^{A}}} - x^A \right)^2}{\left(1-x^A\right)^2} & \text{if } x^A < \dfrac{p\dfrac{N_{y-1,rec0}^{A}}{\overline{N}_{rec0}^{A}} + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\overline{B}_{Nov}^{A}}}{p\dfrac{N_{y-1,rec0}^{A*}}{\overline{N}_{rec0}^{A}} + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\overline{B}_{Nov}^{A}}} < 1 \\ TAC_y^{1,A}; 0 & \text{if } \dfrac{p\dfrac{N_{y-1,rec0}^{A}}{\overline{N}_{rec0}^{A}} + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\overline{B}_{Nov}^{A}}}{p\dfrac{N_{y-1,rec0}^{A*}}{\overline{N}_{rec0}^{A}} + (1-p)\dfrac{B_{y-1,N}^{obs,A}}{\overline{B}_{Nov}^{A}}} < x^A \end{cases} \quad \text{(OMP.24)}$$

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Appendix B: Procedures for deviating from OMP output for the recommendation for a TAC, and for initiating an OMP review

1. Metarule Process

Metarules can be thought of as "rules" which pre-specify what should happen in unlikely, exceptional circumstances when application of the TAC generated by the OMP is considered to be highly risky or inappropriate. Metarules are not a mechanism for making small adjustments, or 'tinkering' with the TAC from the OMP. It is difficult to provide firm definitions of, and to be sure of including all possible, exceptional circumstances. Instead, a process for determining whether exceptional circumstances exist is described below (see Figure B1). The need for invoking a metarule should be evaluated by the DAFF BRANCH FISHERIES [Small Pelagics] Scientific Working Group (hereafter indicated by WG), but only provided that appropriate supporting information is presented so that it can be reviewed at a WG meeting.

1.1 Description of Process to Determine Whether Exceptional Circumstances Exist

While the broad circumstances that may invoke the metarule process can be identified, it is not always possible to pre-specify the data that may trigger a metarule. If a WG Member or Observer, or DAFF BRANCH FISHERIES Management, is to propose an exceptional circumstances review, then such person(s) must outline in writing the reasons why they consider that exceptional circumstances exist, and must either indicate where the data or analyses are to be found supporting the review, or must supply those data or analyses in advance of the WG meeting at which their proposal is to be considered.

Every year the WG will:

- Review population and fishery indicators, and any other relevant data or information on the population, fishery and ecosystem, and conduct a simple routine updated assessment (likely no more than the core Reference Case model used in the OMP testing refitted taking a further year's data into account).
- On the basis of this, determine whether there is evidence for exceptional circumstances.

Examples of what might constitute an exceptional circumstance in the case of [sardine and anchovy] include, but are not necessarily limited to:

- [Survey estimates of abundance 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]

Every two years the WG will:

- Conduct an in depth stock assessment (more intensive than the annual process above, and in particular including the full Reference Set of assessment models and conducting of a range of sensitivity tests).
- On the basis of the assessment, indicators and any other relevant information, determine whether there is evidence for exceptional circumstances.

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. Similarly, if the review process noted regulatory changes likely to effect appreciable modifications to outcomes predicted in terms of the assumptions used for projections in the OMP evaluations (e.g. as a result, perhaps, of size limit changes or closure of areas), or changes to the nature of the data collected for input to the OMP beyond those for which allowance may have been made in those evaluations, this would constitute grounds for concluding that exceptional circumstances exist in the context of continued application of the current OMP.

(Every year) IF the WG concludes that there is no or insufficient evidence for exceptional circumstances, the WG will:

- Report to the Chief Director Research, DAFF BRANCH FISHERIES that exceptional circumstances do not exist.

IF the WG has agreed that exceptional circumstances exist, the WG will:

- Determine the severity of the exceptional circumstances.
- Follow the "Process for Action" described below.

1.2 Specific issues that will be considered annually (regarding Underlying Assumptions of the Operating Models (OMs) for the OMP Testing Process)

The following critical aspects of assumptions underlying the OMs for [sardine and anchovy] need to be monitored after OMP implementation. Any appreciable deviation from these underlying assumptions may constitute an exceptional circumstance (i.e. potential metarule invocation) and will require a review, and possible revision, of the OMP:

- [Whether survey estimates of abundance are appreciably outside the bounds predicted in the OMP testing.
- Whether selectivities-at-length differ substantially from assumptions made to generate operating model projections.
- Whether future recruitment levels are within the 95% probability envelopes for projections generated by the operating models.
- Whether updates of major data sets or ageing practices indicate substantial differences from what were used to condition the operating models for the OMP testing.
- Whether there have been a series of instances where the catches actually made exceeded the TACs or TABs allocated to non-trivial extents.

- Whether new data or information suggest a substantial revision of assumptions of stock structure or estimates of stock status.
- Whether there is information to suggest a substantial change in the relationship between ≤14cm sardine bycatch and anchovy directed catch from that assumed in the OMP testing, particularly during the last four months of the year.]

1.3 Description of Process for Action

If making a determination that there is evidence of exceptional circumstances, the WG will with due promptness:

- Consider the severity of the exceptional circumstances (for example, how severely "out of bounds" are the recent survey abundance estimates).
- Follow the principles for action (see examples below).
- Formulate advice on the action required (this could include an immediate change in TAC, a review of the OMP, the relatively urgent collection of ancillary data, or conduct of analyses to be reviewed at a further WG meeting in the near future).
- Report to the Director Research, DAFF BRANCH FISHERIES that exceptional circumstances exist and provide advice on the action to take.

The Chief Director Research, DAFF BRANCH FISHERIES will:

- Consider the advice from the WG.
- Decide on the action to take, or recommendations to make to his/her principals.

Examples of 'Principles for Action'

If the risk is to the resource, or to dependent or related components of the ecosystem, principles may be:

- The OMP-derived TAC should be an upper bound.
- Action should be at least an x% decrease in the TAC output by the OMP, depending on severity.

If the risk is to socio-economic opportunities within the fishery, principles may be:

- The OMP-derived TAC should be a minimum.
- Action should be at least a y% increase in the TAC output by the OMP, depending on severity.

For certain categories of exceptional circumstances, specific metarules may be developed and pre-agreed for implementation should the associated circumstances arise (for example, as has been the case for OMP's for the sardine-anchovy fishery where specific modified TAC algorithms come into play if abundance estimates from surveys fall below pre-specified thresholds). Where such development is possible, it is preferable that it be pursued.

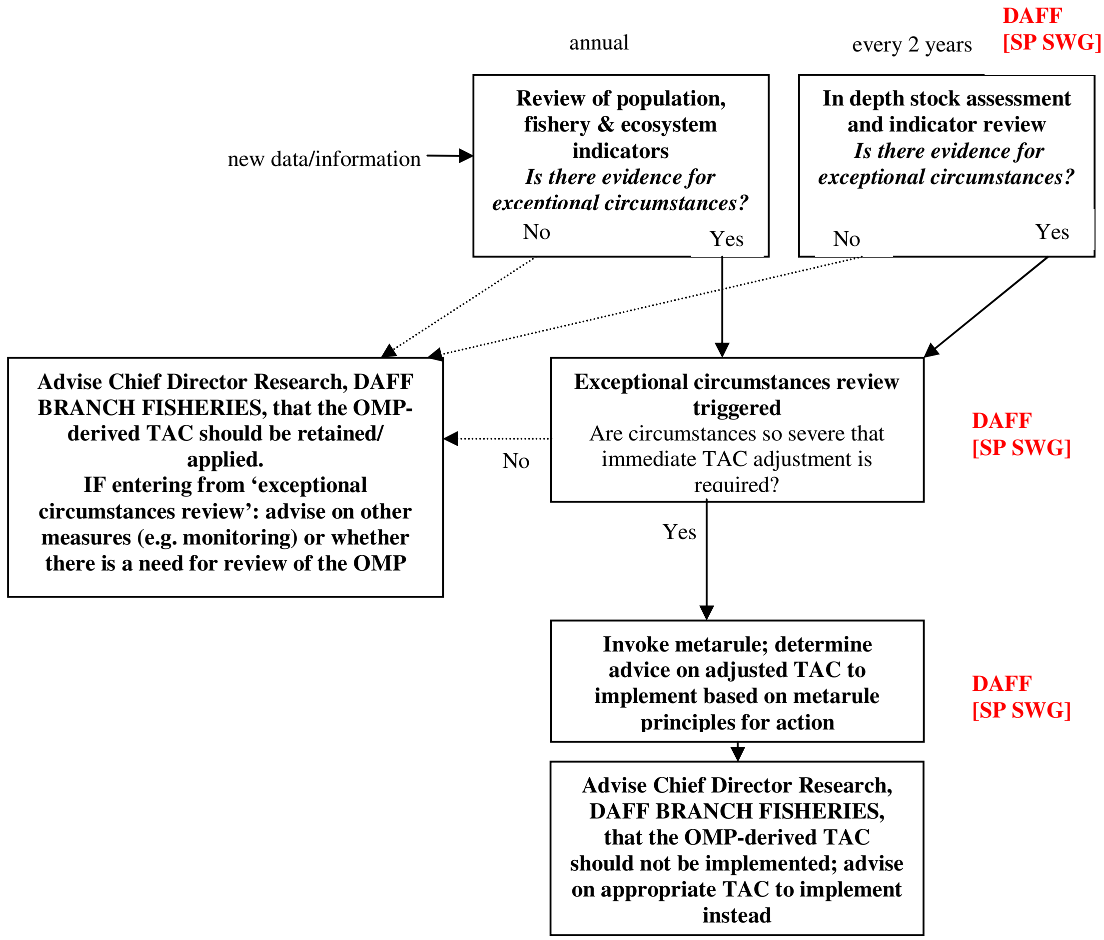

Figure B1: Flowchart for Metarules Process

2. Regular OMP Review and Revision Process

The procedure for regular review and potential revision of the OMP is the process for updating and incorporating new data, new information and knowledge into the management procedure, including the operating models (OMs) used for testing the procedure. This process should happen on a relatively long time-scale to avoid jeopardising the performance of the OMP, but can be initiated at any time if the WG consider that there is sufficient reason for this, and that the effect of the revision would be substantial. During the revision process the OMP should still be used to generate TAC recommendations unless a metarule is invoked.

2.1 Description of Process for Regular Review (see Figure B2)

Every year the WG will:

- Consider whether the procedure for Metarule Process has triggered a review/revision of the OMP. Note that if proposals by a WG Member or Observer, or DAFF BRANCH FISHERIES Management, for an exceptional circumstances review include suggestions for an OMP review and possible revision, they must outline in writing the reasons why they consider this necessary, and must either indicate where the data or analyses are to be found supporting their proposed review, or must supply those data or analyses in advance of the WG meeting at which their proposal is to be considered. This includes the possibility of a suggested improvement in the manner in which the OMP calculates catch limitation recommendations; this would need to be motivated by reporting results for this amended OMP when subjected to the same set of trials as were used in the selection of the existing OMP, and arguing that improvements in anticipated performance were evident.

Every two years the WG will:

- Conduct an in depth stock assessment and review population, fishery and related ecosystem indicators, and any other relevant data or information on the population, fishery and ecosystem.
- On the basis of this, determine whether the assessment (or other) results are outside the ranges for which the OMP was tested (note that evaluation for exceptional circumstances would be carried out in parallel with this process; see procedures for the Metarule Process), and whether this is sufficient to trigger a review/revision of the OMP.
- Consider whether the procedure for the Metarule Process triggered a review / revision of the OMP.

Every four years since the last revision of the OMP the WG will:

- Review whether enough has been learnt to appreciably improve/change the operating models (OMs), or to improve the performance of the OMP, or to provide new advice on tuning level (chosen to aim to achieve management objectives).
- On the basis of this, determine whether the new information is sufficient to trigger a review/revision of the OMP.

In any year, IF the WG concludes that there is sufficient new information to trigger a review/revision of the OMP, the WG will:

- Outline the work plan and timeline (e.g. over a period of one year) envisaged for conducting a review.
- Report to the Chief Director Research, DAFF BRANCH FISHERIES that a review/revision of the OMP is required, giving details of the proposed work plan and timeline.
- Advise the Chief Director Research, DAFF BRANCH FISHERIES that the OMP can still be applied while the revision process is being completed (unless exceptional circumstances have been determined to apply and a metarule invoked).

In any year, IF the WG concludes that there is no need to commence a review/revision of the OMP, the WG will:

- Report to the Chief Director Research, DAFF BRANCH FISHERIES that a review/revision of the OMP is not yet required.

The Chief Director Research, DAFF BRANCH FISHERIES will:

- Review the report from the WG.
- Decide whether to initiate the review/revision process.

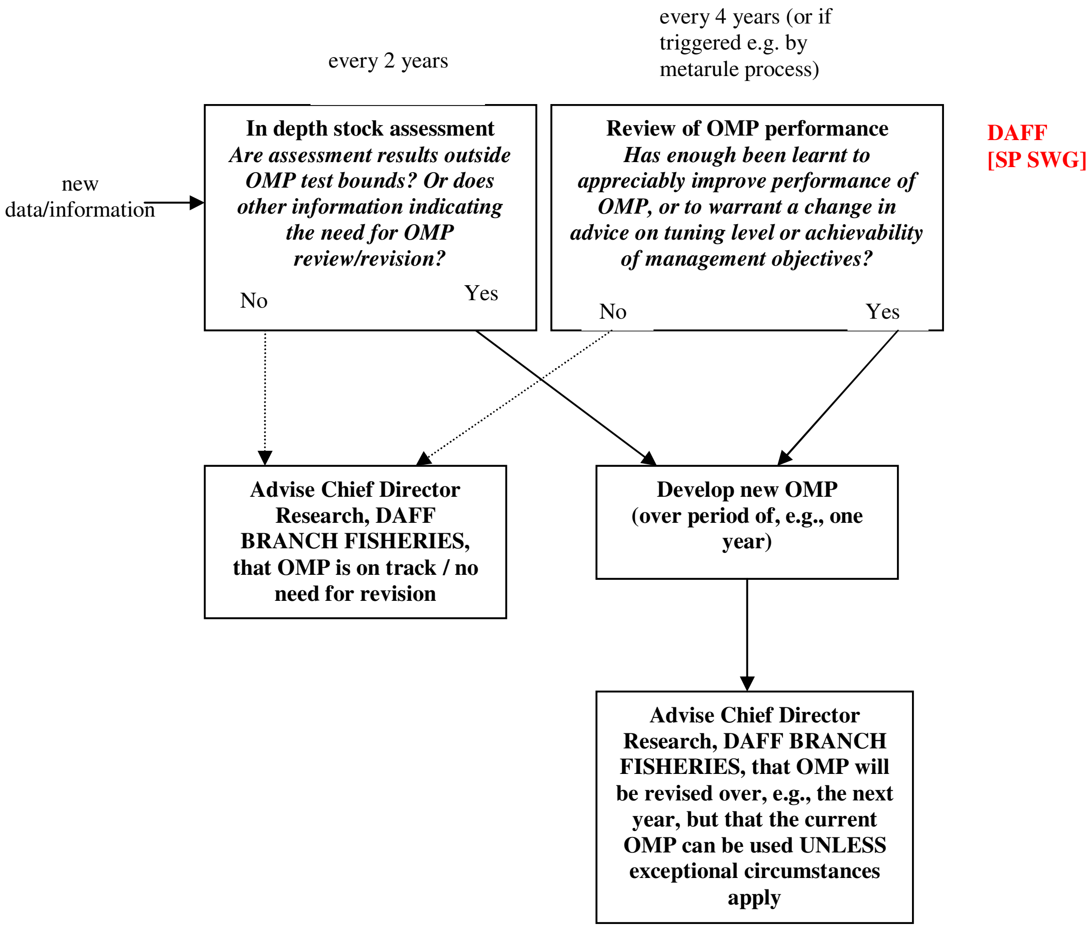

Figure B2: Flowchart for Regular Review and Revision Process