Revised Anchovy TAC and Sardine TAB for 2007, using Re-Revised OMP-04

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The 2007 directed sardine TAC, initial 2007 anchovy TAC and sardine TAB were calculated using the re-revised OMP-04 to be as follows (Cunningham and Butterworth 2006a):

Directed sardine TAC: 162 436 tonnes

Initial normal season anchovy TAC: 186 942 tonnes

Initial normal season sardine TAB: 29 413 tonnes

Following the recent 2007 recruit survey, the TAC for anchovy and the sardine TAB are to be revised in terms of standard practice. The following data have been used for input to the OMP-04 formulae:

1) November 2006 survey sardine spawner biomass: 712 553 tonnes.
   (November 2005 = 962 229 tonnes)
2) November 2006 survey anchovy spawner biomass: 2 106 273 tonnes.
   (November 2005 = 3 062 712 tonnes)
3) Directed sardine TAC for 2006: 204 000 tonnes.
4) Directed anchovy normal season TAC for 2006: 212 251 tonnes.
5) Anchovy recruitment from May 2007 survey: 420.875 billion (May 2006 = 118.599 billion).
6) Anchovy recruit catch from 1 April to day prior to commencement of survey: 6.159 billion (0.978 billion in 2006).
7) Time after 1 May that the survey commenced: 0.548 months (18th May).
8) Anchovy 1-year-old catch from 1 November to 31 March: 0.424 billion (0.303 billion in 2005/6).
9) Mean weight of anchovy 1-year-old in catch from 1 November to 31 March: 7.03 grams (12.43 grams in 2005/6).
10) Juvenile sardine : anchovy ratio (by mass) during the May survey: 0.031 (0.326 in 2006).
11) Juvenile sardine : anchovy ratio (by mass) during the May commercial catch: 0.0399 (0.139 in 2006).

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Using the above data, the final South African pelagic TACs and TAB for 2007 are calculated by OMP-04 to be (Cunningham and Butterworth 2005, 2006b):

Directed sardine TAC:	162 436 tonnes	(eqn (A.1))
Normal season anchovy TAC:	386 942 tonnes	(eqn (A.3))
Additional season anchovy TAC:	150 000 tonnes	
Total anchovy TAC:	536 942 tonnes	(eqn (A.5))
Normal season sardine TAB:	36 503 tonnes	(eqn (A.9))
Additional season sardine TAB:	2 000 tonnes	
Total sardine TAB:	38 503 tonnes	(eqn (A.10))

The normal season anchovy TAC is constrained by the maximum 200 000 ton limitation on increase to the initial normal season TAC.

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References

Cunningham, C.L., and Butterworth, D.S. 2005. Re-Revised OMP-04. MCM document SWG/DEC2005/PEL/05

Cunningham, C.L. and Butterworth, D.S. 2006a. Initial Sardine and Anchovy TACs and Sardine TAB for 2007, using Re-Revised OMP-04. MCM document SWG/DEC2006/PEL/04.

Cunningham, C.L. and Butterworth, D.S. 2006b. Proposed modification to OMP-04 as a result of the sardine population being outside the range tested. MCM document SWG/NOV2006/PEL/03.

Appendix: Summary of Final TAC and TAB Equations of Re-Revised OMP-04

The directed sardine TAC was set in proportion to the 2006 November spawner biomass index of abundance:

$$TAC_y^S = \beta\, B_{y-1,Nov}^S \tag{A.1}$$

where here, and below where appropriate, y = 2007. This results in $TAC_{2007}^S = 104439\,\text{t}$.

This TAC was subject to the constraints of a minimum and a maximum value. As the directed sardine TAC in 2006 was below the 'two-tier' threshold, a maximum interannual decrease of 15% in the directed sardine TAC would have applied for observed sardine biomass above B^* = 800 thousand tonnes, while the TAC would decrease linearly from this constraint down to a minimum (being the maximum of either $c_{mntac}^S = 90\,000\,\text{t}$ or the result of equation (A.1)) for observed biomass between 800 and 250 thousand tonnes. Letting $TAC_y^{S*} = \max\left\{\beta\, B_{y-1,Nov}^S \times 1000; c_{mntac}^S\right\}$, the constraints are given as follows:

if $TAC_{y-1}^S \le c_{tier}^S$:

$$\max\left\{\left(1-c_{mxdn}^S\right)TAC_{y-1}^S \times \frac{B_{y-1,Nov}^S - 250}{B^* - 250} + TAC_y^{S*}\,\frac{B^* - B_{y-1,Nov}^S}{B^* - 250};\, c_{mntac}^S\right\} \le TAC_y^S \le c_{mxtac}^S \quad \text{if } B_{y-1,Nov}^S \le B^*$$

$$\max\left\{\left(1-c_{mxdn}^S\right)TAC_{y-1}^S;\, c_{mntac}^S\right\} \le TAC_y^S \le c_{mxtac}^S \quad \text{if } B_{y-1,Nov}^S > B^*$$

if $TAC_{y-1}^S > c_{tier}^S$:

$$\left(1-c_{mxdn}^S\right)c_{tier}^S \le TAC_y^S \le c_{mxtac}^S \tag{A.2}$$

As the observed sardine biomass in the November 2006 survey was below B^*, the above constraints result in $TAC_y^S = 162\,436$ tonnes. In the above equations we have:

$\beta = 0.14657$ - 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.

$B_{y,Nov}^S$ - the observed estimate of sardine 1+ abundance (in thousands of tonnes) from the hydroacoustic survey in November of year y.

$c_{mxdn}^S = 0.15$ - the maximum proportional amount by which the directed sardine TAC can be reduced from one year to the next.

$c_{mntac}^S = 90\,000\,\text{t}$ - the minimum directed TAC that may be set for sardine.

$c_{mxtac}^S = 500\,000\,\text{t}$ - the maximum directed TAC that may be set for sardine.

$c_{tier}^S = 240\,000t$ -2-tier break for directed sardine TAC

$B^* = 800$ - the threshold (in thousands of tonnes) below which the directed sardine TAC may be reduced by more than c_{mxdn}^S from one year to the next.

The directed anchovy normal season TAC is based on how the 2006 November spawner biomass survey estimate of abundance and the 2007 recruitment survey estimate related to the historic averages.

Revised anchovy TAC:
$$TAC_y^{2,A} = \alpha_{ns}\, q\left(p\frac{N_{y-1,rec0}^A}{\overline{N}_{y-1,rec0}^A} + (1-p)\frac{B_{y-1,Nov}^A}{\overline{B}_{Nov}^A}\right) \tag{A.3}$$

This results in $TAC_{2007}^{2,A} = 425\ 152$t. The anchovy normal season TAC is subject to constraints related, *inter alia*, to the intitial normal season TAC, $TAC_{2007}^{1,A}$:

$$\begin{array}{ll} \max\left\{\left(1-c_{mxdn}^A\right)TAC_{y-1}^{2,A};TAC_y^{1,A};c_{mntac}^A\right\} \le TAC_y^{2,A} \le \min\left\{c_{mxtac}^A;TAC_y^{1,A}+c_{mxinc}^{ns,A}\right\} & TAC_{y-1}^{2,A} \le c_{tier}^A \\ \max\left\{TAC_y^{1,A};\left(1-c_{mxdn}^A\right)c_{tier}^A\right\} \le TAC_y^{2,A} \le \min\left\{c_{mxtac}^A;TAC_y^{1,A}+c_{mxinc}^{ns,A}\right\} & TAC_{y-1}^{2,A} > c_{tier}^A \end{array} \tag{A.4}$$

Since $TAC_{2007}^{1,A} = 186\ 942$t, the anchovy normal season TAC is restricted to increase by no more than $C_{mxinc}^{ns,A} = 200\,000$t yielding $TAC_{2007}^{2,A} = 386\,942$t. Because the anchovy additional sub-season is treated as completely separate from the anchovy normal season, the anchovy TAC actually applied during the sub-season is $TAC_y^{3,A} - TAC_y^{2,A}$, where:

Final anchovy TAC:
$$TAC_y^{3,A} = \alpha_{ads}\, q\left(p\frac{N_{y-1,rec0}^A}{\overline{N}_{y-2,rec0}^A} + (1-p)\frac{B_{y-1,Nov}^A}{\overline{B}_{Nov}^A}\right) \tag{A.5}$$

This results in $TAC_{2006}^{3,A} = 850\ 304$t, subject to the constraints:

$$\max\{TAC_y^{2,A};c_{mntac}^A\} \le TAC_y^{3,A} \le \min\{c_{mxtac}^A;TAC_y^{2,A}+c_{mxinc}^{ads,A}\} \tag{A.6}$$

Thus $TAC_{2006}^{3,A}$ is limited to $TAC_y^{2,A} + c_{mxinc}^{ads,A} = 536\,942$t.

In the above equations we have:

$B_{y,Nov}^A$ - the observed estimate of anchovy abundance (in thousands of tonnes) from the hydroacoustic spawner biomass survey in November of year y.

$\overline{B}_{Nov}^A$ - the historic average index of anchovy abundance from the spawner biomass surveys from November 1984 to November 2003, of 2149.15 thousand tonnes.

$N_{y-1,rec0}^A$ - the simulated estimate of anchovy recruitment from the recruitment survey in year y, back-calculated to 1 November $y-1$ by taking natural and fishing mortality into account, calculated using equation (A.7).

$\overline{N}_{y-1,rec0}^A = 299.889$ - the average back-calculated (see below) estimate of anchovy recruitment at the beginning of November from 1984 to $y-2$.

$\alpha_{ns} = 0.73752$ - a control parameter which scales the anchovy TAC to meet target risk levels for sardine and anchovy.

$\alpha_{ads} = 1.47504$ - a control parameter which scales the anchovy TAC to meet target risk levels for sardine and anchovy.

$\delta = 0.85$ - a 'scale-down' factor used to lower the initial anchovy TAC to provide a buffer against possible poor recruitment.

$p = 0.7$ - the weight given to the recruit survey component compared to the spawner biomass survey component in setting the anchovy TAC.

$q = 300$ - reflects the average annual TAC expected under OMP99 under average conditions if $\alpha_{ns} = 1$.

$c^{A}_{mxdn} = 0.25$ - the maximum proportional amount by which the normal season directed anchovy TAC can be reduced from one year to the next (note that the additional season anchovy TAC is not taken into consideration in this constraint).

$c^{A}_{mntac} = 150\,000t$ - the minimum directed TAC that may be set for anchovy.

$c^{A}_{mxtac} = 600\,000t$ - the maximum directed TAC that may be set for anchovy.

$c^{ns,A}_{mxinc} = 200\,000t$ - the maximum amount by which the anchovy TAC is allowed to be increased within the normal season.

$c^{ads,A}_{mxinc} = 150\,000t$ - the maximum amount by which the anchovy TAC is allowed to be increased within the additional sub-season.

r_y - the average of the juvenile sardine to anchovy ratio in the commercial catches in May and in the recruit survey, in year y, calculated using equation (A.8).

The observed $N^{A}_{y,rec}$ is back-calculated to November of the previous year, assuming a fixed value of 0.9 *year*$^{-1}$ for M^{A}_{ju}:

$$N^{A}_{y-1,rec0} = (N^{A}_{y,rec} e^{0.5(1+t^{A}_{y})0.9/12} + C^{A}_{y,0bs})\, e^{[5+0.5(1+t^{A}_{y})]0.9/12}. \qquad (A.7)$$

In the above equations we have

$C^{A}_{y,0bs}$ - the observed anchovy landed by number (in billions) from the 1st of April to the day before the recruit survey commences in year *y*, all assumed to be 0-year-old fish.

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

In calculating the ratio of juvenile sardine to anchovy "in the sea" during May, r_y, only the commercial catches comprising at least 50% anchovy with sardine bycatch are considered. The ratio r_y is calculated as follows:

$$r_y = \tfrac{1}{2}(r_{y,sur} + r_{y,com}), \tag{A.8}$$

where $r_{y,sur}$ denotes the observed ratio in the May recruit survey and $r_{y,com}$ denotes the observed ratio from the commercial catches in May.

The revised normal season sardine TAB is calculated using:

$$TAB_y^{2,S} = \lambda\, TAC_y^{1,A} + r_y\,(TAC_y^{2,A} - TAC_y^{1,A}) + TAB_{rh}^{S} \tag{A.9}$$

where: $$\lambda = \max\left\{\gamma_y = 0.1 + \frac{0.1}{1+\exp\left(-\frac{1}{0.1}0.00025\left(B^{S}_{y-1,Nov} - 2000\right)\right)} = 0.1038;\ r_y = 0.0355\right\}$$

Because the anchovy additional sub-season is treated as completely separate from the anchovy normal season, the sardine TAB actually to apply during the sub-season is $TAB_y^{3,S} - TAB_y^{2,S}$, where

Final sardine TAB: $$TAB_y^{3,S} = TAB_y^{2,S} + \min\left\{TAB_{ads}^{S}\,;\ \gamma_y\,(TAC_y^{3,A} - TAC_y^{2,A})\right\} \tag{A.10}$$

In the above equations we have:

$TAB_{rh}^{S} = 10\,000\,\text{t}$ - the fixed tonnage of adult sardine bycatch set aside for the round herring fishery each year.

$TAB_{ads}^{S} = 2\,000\text{t}$ - the maximum fixed tonnage of juvenile sardine bycatch set aside for the anchovy additional sub-season each year.

Since observed November 2006 sardine spawner biomass was above 250 000t, no exceptional circumstances provisions for sardine are invoked. Similarly, since the observed November 2006 anchovy spawner biomass was above 400 000t, no exceptional circumstances for anchovy are invoked.