Summary of impact of survey estimates on the hake TAC

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Procedure in event of missing data

Below is an extract from the OMP specification document (Rademeyer *et al*., 2010) that states the procedure in the event of missing surveys:

a) If at most two of the four survey estimates are not available in a given year, the computations continue as indicated, with the missing data omitted from the regression estimates of slope.

b) If more than two such estimates are missing, or if for more than one survey two years have been missed, computations will continue on the basis in a), but an OMP review will commence immediately."

Role of surveys in OMP TAC computations

The full OMP computations specifications are given in Appendix A.

Specifically, the surveys play a role through the trend and target computations within the OMP.

The measure of recent trend for each species is computed over six years and is a weighted average of the recent trends of two CPUE and two survey series:

$$s_y^{para} = \left(s_y^{WC\_CPUE,para} + 0.75s_y^{SC\_CPUE,para} + 0.5s_y^{WC\_surv,para} + 0.25s_y^{SC\_surv,para}\right)\Big/2.5 \quad (1)$$

$$s_y^{cap} = \left(s_y^{WC\_CPUE,cap} + 0.75s_y^{SC\_CPUE,cap} + 0.5s_y^{WC\_surv,cap} + s_y^{SC\_surv,cap}\right)\Big/3.25 \quad (2)$$

As can be seen from these equations, the two CPUE series receive relatively greater weight than the surveys. This was based, in part, on lesser residual variance for CPUE compared to survey data in assessment model fits.

Similarly, a measure of recent level (2007-2009 for surveys) for the abundance indices uses a weighted average of such levels for two CPUE and two survey series:

$$J_y^{para} = \frac{1.0J_y^{WC\_CPUE,para} + 0.75J_y^{SC\_CPUE,para} + 0.5J_y^{WC\_surv,para} + 0.25J_y^{SC\_surv,para}}{2.5} \quad (3)$$

$$J_y^{cap} = \frac{1.0J_y^{WC\_CPUE,cap} + 0.75J_y^{SC\_CPUE,cap} + 0.5J_y^{WC\_surv,cap} + 1.0J_y^{SC\_surv,cap}}{3.25} \quad (4)$$

Robustness tests

In the development of the current OMP, robustness tests were constructed to evaluate the impact of missing or reduced surveys in the future:

Rob31a: no future surveys

Rob31b: only West Coast surveys would take place in the future

Rob31c: only South Coast surveys would take place in the future

Rob 31d: both surveys would be missing every three years

Rob31e: the CVs of all future surveys are increased by a multiplicative factor of $\sqrt{2}$

Rob31f: no future surveys plus an undetected increase in catchability related to CPUE

In the rush to complete the OMP evaluation by the deadline, these particular robustness tests were however not run. It is hoped that some results might be reported during the course of this workshop.

Example

Below is an example of the impact of the surveys on the OMP output. In instances where the actual survey results were increased or decreased, their logged values were increased/decreased by 1.96σ (i.e. assuming distribution lognormality), where:

$$\sigma^i = \sqrt{\ln(1+\overline{CV^i}^2)+\sigma_a^2} \qquad (5)$$

For *M. paradoxus*, the survey specific average $\overline{CV^i}$ is 0.185 and 0.372 for the West Coast summer and South Coast autumn surveys respectively, and for *M. capensis*, $\overline{CV^i}$ is similarly 0.178 and 0.112. The species-specific additional variance σ_a^2 is 0.145 and 0.111 for *M. paradoxus* and *M. capensis* respectively. The resulting σ^i are shown in Table 1.

Table 1: OMP outputs for the 2012 TAC (with and without constraints) for a series of survey values. The σ^i are shown in parenthesis in the second row.

	M. paradoxus		*M. capensis*		2012 TAC recommendation	% difference	OMP output before constraints	% difference
	WC 2011	SC 2011	WC 2011	SC 2011				
TRUE	347.08	24.11	89.28	117.22	144.671	-	144.671	-
σ^i	(0.42)	(0.52)	(0.38)	(0.35)				
SC missing	347.08	x	89.28	x	144.958	0.20%	148.983	2.98%
SC missing, WC up	795.61	x	186.77	x	144.958	0.20%	152.653	5.52%
SC missing, WC down	151.41	x	42.68	x	144.958	0.20%	145.312	0.44%
WC missing	x	24.11	x	117.22	144.958	0.20%	146.406	1.20%
WC missing, SC up	x	67.38	x	233.16	144.958	0.20%	149.310	3.21%
WC missing, SC down	x	8.62	x	58.93	143.502	-0.81%	143.502	-0.81%
All missing	x	x	x	x	144.958	0.20%	150.717	4.18%
All up	795.61	67.38	186.77	233.16	144.958	0.20%	151.246	4.54%
All down	151.41	8.62	42.68	58.93	138.096	-4.54%	138.096	-4.54%

APPENDIX A: Full OMP Computation Specifications

The formula for computing the TAC recommendation is as follows:

$$TAC_y = C_y^{para} + C_y^{cap} \qquad \text{(A1)}$$

with

$$C_y^{spp} = w_y C_{y-1}^{*spp}\left[1+\lambda_{up/down}\left(s_y^{spp} - T_y^{spp}\right)\right] + \left(1-w_y\right)\left[a^{spp} + b^{spp}\left(J_y^{spp} - 1\right) - Pen_y^{spp}\right] \qquad \text{(A2)}$$

where

TAC_y is the total TAC recommended for year *y*,

C_y^{spp} is the intended species-disaggregated TAC for year *y*,

C_{y-1}^{*spp} is the achieved catch[1] of species *spp* in year *y*-1,

w_y is a year-dependent tuning parameter,

$\lambda_{up/down}$ are tuning parameters; λ_{up} is used if $s_y^{spp} \geq 0$ and λ_{down} is used if $s_y^{spp} < 0$,

T_y^{spp} is the year-dependant target rate of increase for species *spp*,

s_y^{spp} is a measure of the immediate past trend in the abundance indices for species *spp* as available to use for calculations for year *y*,

a^{spp}, b^{spp}, c^{spp} and p^{spp} are tuning parameters, and

$$Pen_y^{spp} = \begin{cases} 0 & \text{if } J_y^{spp} \geq p^{spp} \\ c^{spp}\left(J_y^{spp} - p^{spp}\right)^2 & \text{if } J_y^{spp} < p^{spp} \end{cases} \qquad \text{(A3)}$$

where

J_y^{spp} is a measure of the immediate past level in the abundance indices for species *spp* as available to use for calculations for year *y.*

Measure of recent trend

The trend measure s_y^{spp} is computed as follows from the species- and coasts- disaggregated GLM-CPUE ($I_y^{WC\_CPUE,spp}$ and $I_y^{SC\_CPUE,spp}$), west coast summer survey ($I_y^{WC\_surv,spp}$) and south coast autumn survey ($I_y^{SC\_surv,spp}$) indices:

- linearly regress $\ln I_y^{WC\_CPUE,spp}$ and $\ln I_y^{SC\_CPUE,spp}$ *vs* year *y'* for $y' = y - p - 1$ to $y' = y - 2$, to yield two regression slope values $s_y^{WC\_CPUE,spp}$ and $s_y^{SC\_CPUE,spp}$,
- linearly regress $\ln I_y^{WC\_surv,spp}$ and $\ln I_y^{SC\_surv,spp}$ *vs* year *y'* for $y' = y - p$ to $y' = y - 1$, to yield two regression slope values $s_y^{WC\_surv,spp}$ and $s_y^{SC\_surv,spp}$,

[1] Implemented by applying the species ratio of the catch in year *y*-2 to the TAC for year *y*-1, as the species ratio for year *y*-1 would not yet be known by the time at which a recommendation for the TAC for year *y* would be required.

where *p*=6 is the length of the periods considered for these regressions. Note that the reason the trend for surveys is calculated for a period moved one year later than for CPUE is that by the time of year that the TAC recommendation would be computed for the following year, survey results for the current year would be known, but not CPUE as fishing for the year would not yet have been completed. Note also that surveys carried out using the old gear are made comparable to those carried out using the new gear by multiplying them by a species specific calibration factor (0.95 for *M. paradoxus* and 0.8 for *M. capensis*).

Then:

$$s_y^{para} = \left(s_y^{WC\_CPUE,para} + 0.75s_y^{SC\_CPUE,para} + 0.5s_y^{WC\_surv,para} + 0.25s_y^{SC\_surv,para}\right)/2.5 \quad \text{(A4)}$$

$$s_y^{cap} = \left(s_y^{WC\_CPUE,cap} + 0.75s_y^{SC\_CPUE,cap} + 0.5s_y^{WC\_surv,cap} + s_y^{SC\_surv,cap}\right)/3.25 \quad \text{(A5)}$$

Measure of recent level

The measure of the immediate past level J_y^{spp} in the abundance indices is computed as follows:

$$J_y^{para} = \frac{1.0J_y^{WC\_CPUE,para} + 0.75J_y^{SC\_CPUE,para} + 0.5J_y^{WC\_surv,para} + 0.25J_y^{SC\_surv,para}}{2.5} \quad \text{(A6)}$$

$$J_y^{cap} = \frac{1.0J_y^{WC\_CPUE,cap} + 0.75J_y^{SC\_CPUE,cap} + 0.5J_y^{WC\_surv,cap} + 1.0J_y^{SC\_surv,cap}}{3.25} \quad \text{(A7)}$$

with

$$J_y^{WC\_CPUE,spp} = \frac{\sum_{y'=y-4}^{y-2} I_y^{WC\_CPUE,spp}}{\theta^{spp} \sum_{y=2006}^{2008} I_y^{WC\_CPUE,spp}} \quad \text{(A8)}$$

$$J_y^{SC\_CPUE,spp} = \frac{\sum_{y'=y-4}^{y-2} I_y^{SC\_CPUE,spp}}{\theta^{spp} \sum_{y=2006}^{2008} I_y^{SC\_CPUE,spp}} \quad \text{(A9)}$$

$$J_y^{WC\_surv,spp} = \frac{\sum_{y'=y-3}^{y-1} I_y^{WC\_surv,spp}}{\theta^{spp} \sum_{y=2007}^{2009} I_y^{WC\_surv,spp}} \quad \text{and} \quad \text{(A10)}$$

$$J_y^{SC\_surv,spp} = \frac{\sum_{y'=y-3}^{y-1} I_y^{SC\_surv,spp}}{\theta^{spp} \sum_{y=2007}^{2009} I_y^{SC\_surv,spp}} \quad \text{(A11)}$$

with

θ^{para}= 1.67 and θ^{cap} = 1.50,

Maximum allowable change in TAC

While the maximum allowable annual increase in TAC is 10%, the maximum allowable decrease in TAC from one year to the next is:

$$MaxDecr_y = \begin{cases} 5\% & \text{if } J_y > Q_{\min} \\ \text{linear between } 5\% \text{ and } 25\% & \text{if } Q_{\min} - 0.2 \le J_y \le Q_{\min} \\ 25\% & \text{if } J_y < Q_{\min} - 0.2 \end{cases} \quad \text{(A12)}$$

where

$$J_y = \frac{J_y^{para} + J_y^{cap}}{2} \quad \text{(A13)}$$

and

$Q_{\min}$ is a tuning parameter.

Table A1: Tuning parameters for OMP-2010

	M. paradoxus	*M. capensis*
λ_{up}	1.25	
λ_{down}	1.50	
T_y^{spp}	0.75% if $y < 2015$ linear between 0.75% and 0% $2015 \le y \le 2018$ 0% if $y \ge 2019$	0%
w_y	1 if $y \le 2011$ linear between 1 and 0.5 $2012 \le y \le 2015$ 0.5 if $y \ge 2016$	
a^{spp}	104.5	40
b^{spp}	60	20
c^{spp}	180	20
p^{spp}	0.75	0.75
$Q_{\min}$	0.75	