Application of the proposed Management Procedure for the Toothfish (*Dissostichus eleginoides*) Resource in the Prince Edward Islands vicinity to provide a TAC recommendation for the 2021 "fishing" year

A. Brandão and D.S. Butterworth

Marine Resource Assessment and Management Group (MARAM)
Department of Mathematics and Applied Mathematics,
University of Cape Town,
Rondebosch 7701, South Africa

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ABSTRACT

Application of the proposed toothfish Management Procedure provides a TAC recommendation for the 2021 "fishing"[1] year of 524.9 tonnes.

THE MP PROPOSED

The proposed Management Procedure (MP), where the TAC is modified in synchrony with the trends in indices related to resource abundance (provided by CPUE and tag recapture data) is specified as:

$$TAC_{y+1} = TAC_y \left[1 + \lambda\left(\frac{\mu_y^{CPUE} - t*}{t*}\right)\right]\left[1 - \gamma\left(\frac{s_y^{cum(recap)} - s_t^*}{s_t^*}\right)\right], \quad (1)$$

where

TAC_y is the TAC recommended for year *y*,

μ_y^{CPUE} is the mean trotline CPUE for the years $y-4, y-3$ and $y-2$,

$s_y^{cum(recap)}$ is the slope of a linear regression of the cumulative number of recaptured tags against time for the years $y-6$ to $y-2$, and

$\lambda,\ \gamma,\ t*$ and s_t^* are control parameters given by:

$\lambda = 1,\ \ \gamma = 1,\ \ t* = 0.760$ and $s_t^* = 44.$

The MP constrains TACs to a maximum inter-annual change of 10% so that TAC_{y+1} is adjusted accordingly as:

$$TAC_{y+1} = \begin{cases} TAC_y(1+0.1) & \text{if } TAC_{y+1} > TAC_y(1+0.1) \\ TAC_y(1-0.1) & \text{if } TAC_{y+1} < TAC_y(1-0.1) \\ TAC_{y+1} & \text{otherwise} \end{cases}$$

An initial smoothing of the TAC is also applied so that the final TAC is given by:

$$TAC_{y+1}^{final} = \psi_{y+1} TAC_{y+1},$$

where

[1] A "fishing"- year *y* is defined to be from 1 December of year *y*-1 to 30 November of year *y*.

ψ_{y+1} is the initial smoothing factor, given by:

$$\psi_{y+1} = \begin{cases} x & \text{for } y+1 \leq 2025 \\ z & \text{for } 2025 < y+1 < 2030 \\ 1 & \text{for } y+1 \geq 2030 \end{cases}$$

where

$1-x$ is the percentage by which the TAC is reduced initially, with $x = 0.95$ for the MP, and

z reflects the linear increase from x in 2025 to 1 in 2030.

Table 1 provides the GLMM-standardised trotline CPUE estimates and the cumulative number of tag-recaptures observed that include data up to 2019.

The mean CPUE μ_y^{CPUE} is calculated as:

$$\mu_y^{CPUE} = \frac{1}{3}\sum_{y=2017}^{2019} CPUE_y = \frac{0.545 + 0.930 + 0.892}{3} = 0.789.$$

The slope of the linear regression of the cumulative number of recaptured tags against time $s_y^{cum(recap)}$ is calculated by fitting a linear regression to the pairwise series (2015, 64), (2016, 85), (2017, 107), (2018, 138) and (2019, 149) and is given by $s_y^{cum(recap)} = 22.3$.

Thus

$$TAC_{2021} = \left(502.3\left[1 + 1\left(\frac{0.789 - 0.76}{0.76}\right)\right]\left[1 - 1\left(\frac{22.3 - 44}{44}\right)\right]\right) = 778.6.$$

However, as the MP constrains the TACs to a maximum inter-annual change of 10%, and also applies an initial smoothing of the TAC, the final TAC is given by:

$$TAC_{2021}^{final} = \psi_{y+1}\big(TAC_{2020}(1+0.1)\big) = 0.95\big(502.3(1.1)\big) = 524.9.$$

Therefore, the final TAC recommendation for 2021 (i.e. the 2021 "fishing" year) is 524.9 tonnes.

Table 1. The GLMM relative abundance indices for toothfish provided by the standardised commercial trotline CPUE series for the Prince Edward Islands EEZ. This series has been updated to include the 2019 "fishing" year data that is now available. The cumulative number of all recaptured tags is also given.

"Fishing"-year	**GLMM *CPUE***	**Cumulative number of recaptured tags**
2007	—	2
2008	—	2
2009	—	5
2010	1.179	7
2011	1.000	16
2012	1.125	21
2013	0.938	26
2014	0.741	38
2015	0.821	64
2016	0.531	85
2017	0.545	107
2018	0.930	138
2019	0.892	149