

# The 2020 Operational Management Procedure for the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity

**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*

*June 2021*

## ABSTRACT

A detailed specification of the agreed OMP for toothfish in the Prince Edward Islands vicinity is provided. Suggestions are made for Exceptional Circumstances provisions.

**Keywords:** Patagonian toothfish; Operational Management Procedure; Exceptional Circumstances

## INTRODUCTION

The Operational Management Procedure (OMP) agreed for recommending the TAC for toothfish in the Prince Edward Islands region is based on an empirical algorithm. This algorithm modifies the TAC in synchrony with the trends in the cumulative number of recaptured tags as well as the recent mean of the trotline CPUE.

The conditioning of a Reference Set of Operating Models used to in the simulation testing of OMP-2020 was reported in Brandão and Butterworth (2019). The parameters of OMP-2020 were tuned to achieve a target median final depletion level of 40% under OM10.

Appendix A gives a summary of the General Linear Mixed Model to be used to standardise the trotline CPUE series. Appendix B sets out draft procedures for deviating from OMP output for the recommendation for a TAC, and for initiating an OMP review, under “Exceptional Circumstances”.

## THE 2020 OMP

The algorithm for recommending the TAC for the  $y+1$  “fishing”<sup>1</sup> year 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

---

<sup>1</sup> A “fishing”- year  $y$  is defined to be from 1 December of year  $y-1$  to 30 November of year  $y$ .

$TAC_y$	is the TAC recommended for year $y$ ,
$\mu_y^{CPUE}$	is the mean trotline GLMM standardised 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 $s_t^* = 44$ .

### Constraints

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

$$TAC_{y+1} = \begin{cases} TAC_y(1 + 0.1) & \text{if } TAC_{y+1} > TAC_y(1 + 0.1) \\ TAC_y(1 - 0.1) & \text{if } TAC_{y+1} < TAC_y(1 - 0.1) \\ TAC_{y+1} & \text{otherwise} \end{cases} \quad (2)$$

A smoothing of the TAC over its first five years of implementation is also applied so that the final TAC is given by:

$$TAC_{y+1}^{final} = \psi_{y+1} TAC_{y+1}, \quad (3)$$

where

$\psi_{y+1}$  is the initial period smoothing factor, given by:

$$\psi_{y+1} = \begin{cases} x & \text{for } y + 1 \leq 2025 \\ z & \text{for } 2025 < y + 1 < 2030 \\ 1 & \text{for } y + 1 \geq 2030 \end{cases} \quad (4)$$

where

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

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

### Data

It is anticipated that the availability of CPUE and tag-recapture data will continue in the future. The OMP has been developed under the assumption that the trotline gear will be used in the future.

### REFERENCES

Brandão, A. and Butterworth, D.S. 2019. Conditioning of the Reference Set of Operating Models for the toothfish resource in the Prince Edward Islands vicinity. Department of Agriculture, Forestry and Fisheries Document: FISHERIES/2019/MAR/SWG-DEM/04.

## Appendix A

### Summary of the General Linear Mixed Model to standardise the trotline CPUE series for the toothfish resource in the Prince Edward Islands EEZ.

#### INTRODUCTION

The standardisation of the trotline CPUE series is based on a “fishing”-year<sup>2</sup> for better comparability with the structure of the toothfish assessment, and also assumes that the two *Koryo Maru* vessels are identical in terms of power (considered reasonable by the fact that the same skipper operated on both vessels).

The trotline CPUE series shows relatively low values for the first two years (2008 and 2009). These low values might reflect a “learning use of new gear” aspect, rather than depicting a lower abundance of toothfish and are therefore omitted from the GLMM analysis.

The data used in the analyses are obtained from the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) database and is requested by the Department of Forestry, Fisheries and Environment (DFFE). Any record that does not fall within the defined fishing areas as depicted in Figure 1 of Brandão and Butterworth (2014) are excluded from the analysis, as are those that have missing data for any of the variables that are incorporated in the GLMM analysis.

#### TROTLINE EFFORT

The effort for a trotline is defined as:

$$\left( \frac{\text{Length of line}}{\text{Spacing of droppers}} \right) \times \text{Number of clusters per dropper.}$$

#### THE GENERAL LINEAR MIXED MODEL

The GLMM applied to the trotline CPUE data is of the form:

$$\ln(\text{CPUE} + \delta) = X\alpha + Z\beta + \varepsilon,$$

where

<i>CPUE</i>	is the trotline catch per unit effort for a set,
$\delta$	is a small constant (10% of the average of all nominal CPUE data values for trotlines), which is added to the toothfish CPUE to allow for the occurrence of zero CPUE values,
$\alpha$	is the vector of fixed effects parameters (whose values are unknown) which includes:  $\mu + \kappa_{vessel} + \omega_{year} + \gamma_{month} + \lambda_{area}$ , where  $\mu$ is the intercept,  <i>vessel</i> is a factor with two levels associated with each of the vessels that have operated in the trotline fishery:

<sup>2</sup> A “fishing”- year *y* is defined to be from 1 December of year *y*-1 to 30 November of year *y*.

*El Shaddai*

*Koryo Maru 11* (which represents the old and the new *Koryo Maru* vessels),

*year* is a factor associated with the “fishing”-years 2010 to the previous year in which the GLMM analyses is conducted for trotlines,

*month* is a factor with 12 levels (January – December), and

*area* is a factor with 18 levels associated with the new spatially distinct fishing areas shown in Figure 1 of Brandão and Butterworth (2014). Some areas have been combined if their data were similar as some contained few sets. Thus, area 11 has been combined with area 10, areas 21 and 22 with area 20, and area 104 with area 103.

**X** is the design matrix for the fixed effects,

$\beta$  is the vector of random effects parameters whose values are unknown, which includes the following interaction terms:

$$\eta_{year \times area} + \theta_{year \times month} + \phi_{month \times area},$$

*year* × *area* is the interaction between year and area (this allows for the possibility of different trends in abundance with time in the different areas),

*year* × *month* is the interaction between year and month,

*month* × *area* is the interaction between month and area,

**Z** is the design matrix for the random effects, and

$\varepsilon$  is an error term assumed to be normally distributed and independent of the random effects.

#### THE STANDARDISED CPUE

The standardised CPUE indices are given by  $CPUE_y = e^{\omega_{year}}$ .

#### REFERENCE

Brandão, A. and Butterworth, D.S. 2014. Standardisation of the CPUE series for toothfish (*Dissostichus eleginoides*) in the Prince Edward Islands EEZ using finer scale fishing areas. DAFF Branch Fisheries document: FISHERIES/2014/JUN/SWG-DEM/17.

## Appendix B

**Note:** This proposal follows the standard template applicable to all DFFE OMPs.

### **Procedures for deviating from OMP output for the recommendation for a TAC, and for initiating an OMP review**

This appendix has been reproduced from Rademeyer *et al.* (2014) but slightly adapted to the Prince Edward Toothfish resource in the Prince Edward Islands vicinity.

#### **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 Fig. B1). The need for invoking a metarule should be evaluated by the DFFE BRANCH FISHERIES MANAGEMENT Demersal 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.

#### ***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 DFFE 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 [toothfish] include, but are not necessarily limited to:

- CPUE trends that are appreciably outside the bounds predicted in the OMP testing.
- Cumulative tag recapture numbers that are appreciably outside the bounds predicted in the OMP testing.

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 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 affect 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, DFFE BRANCH FISHERIES MANAGEMENT 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.

***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 [toothfish] 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 selectivities-at-length for the major fisheries differ substantially from assumptions made to generate operating model projections.
- Whether standardised CPUE estimates are within the bounds indicated in operating model projections, where bounds here and in similar cases following shall be taken to be the 5%ile and 95%ile of projections under the Reference Set (RS) of operating models.
- Whether future recruitment levels are within the bounds projected by the RS operating models.
- Whether there have been a series of substantial differences between TACs allocated and the catches subsequently made (e.g. if under-catching continues).
- Whether fishing regulations and/or strategies have changed substantially (e.g. a gear change from trotlines occurs), and in a manner such that continuing use of the agreed GLM-standardisation procedures would likely introduce substantial bias in resource abundance trend estimates based on CPUE indices.
- Whether the protocol for the number of tags released changes substantially from the assumptions made to generate operating model projections.
- Whether estimates of the amount of cetacean depredation changes appreciably from that assumed in generating operating model projections.
- Whether there are occurrences of IUU catches which are of an appreciable size.

A guide as to what constitutes “substantial” is a change that would alter the recommended TAC by more than 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 CPUEs estimates or recruitment 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, DFFE BRANCH FISHERIES MANAGEMENT that exceptional circumstances exist and provide advice on the action to take.

The Chief Director Research, DFFE BRANCH FISHERIES MANAGEMENT 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.

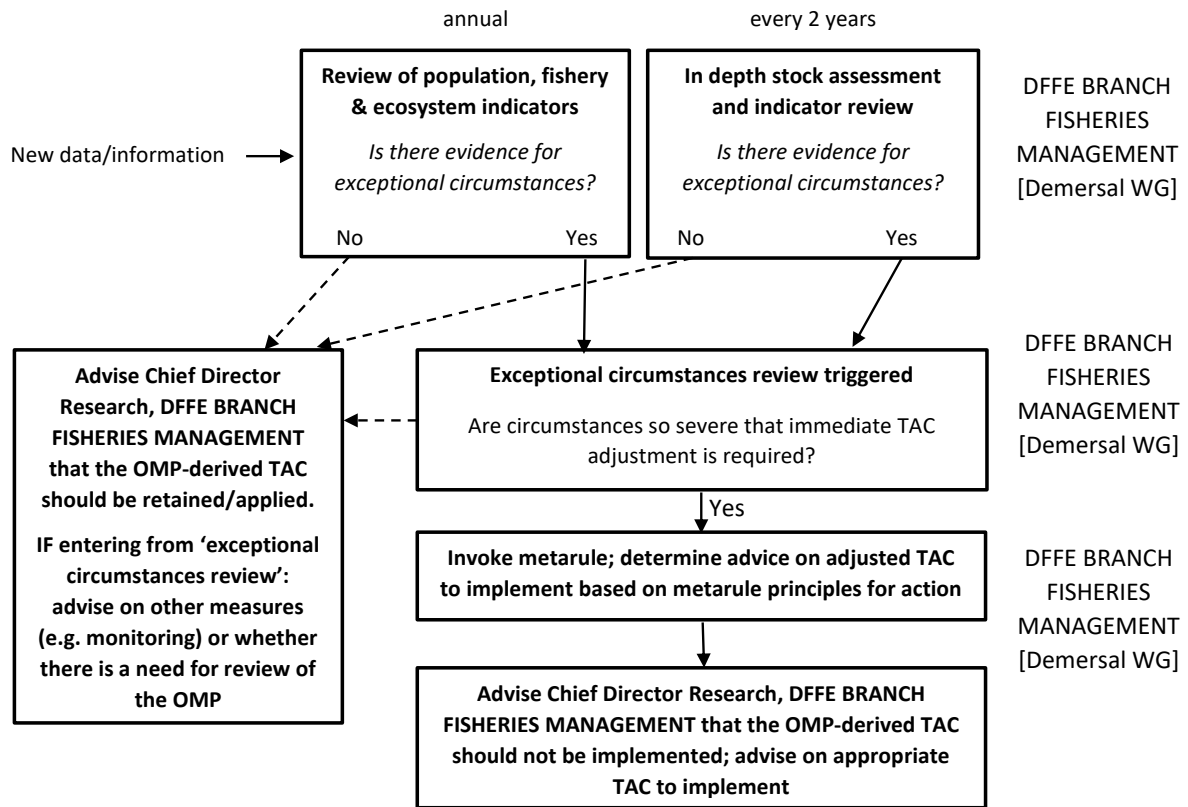


Figure B1: Flowchart for Metarules Process.

**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.

**Description of Process for Regular Review (see Fig.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 DFFE 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:

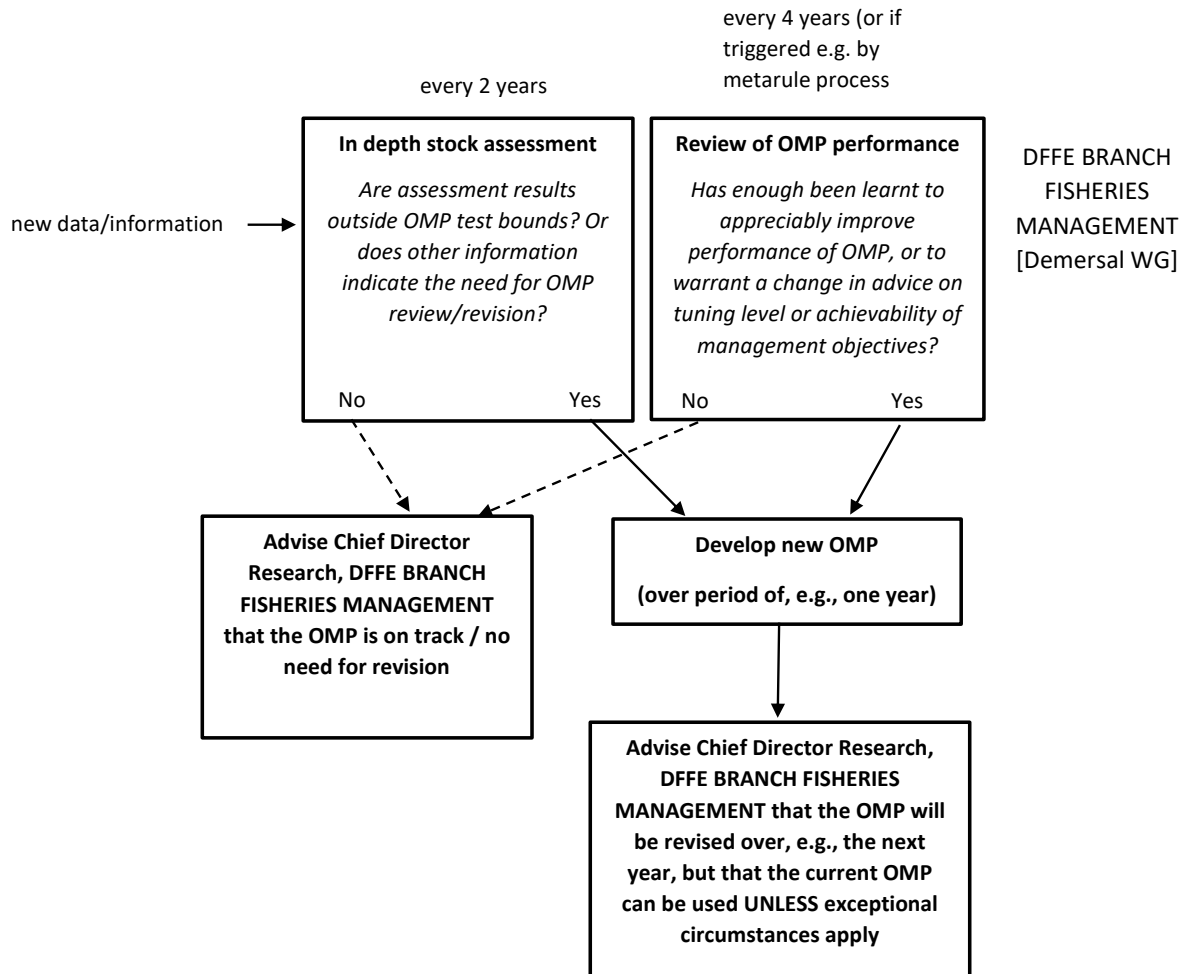
- Outline the work plan and timeline (e.g. over a period of one year) envisaged for conducting a review.
- Report to the Chief Director Research, DFFE BRANCH FISHERIES MANAGEMENT that a review/revision of the OMP is required, giving details of the proposed work plan and timeline.
- Advise the Chief Director Research, DFFE BRANCH FISHERIES MANAGEMENT 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, DFFE BRANCH FISHERIES MANAGEMENT that a review/revision of the OMP is not yet required.

The Chief Director Research, DFFE BRANCH FISHERIES MANAGEMENT will:

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



**Figure B2:** Flowchart for Regular Review and Revision Process.

**REFERENCE**

Rademeyer, R.A., Butterworth, D.S., Cooper, R., Durholtz, M.D., Fairweather, T.P., Glazer, J.P., Leslie, R.W., Singh, L. and Somhlaba, S. 2014. The 2014 Operational Management Procedure for the South African *Merluccius paradoxus* and *M. capensis* resources. DAFF Branch Fisheries document: FISHERIES/2014/OCT/SWG-DEM/64.