# External Independent Peer Review by the Center for Independent Experts (CIE)

Toothfish stock assessments within the CCAMLR area, in particular for South Georgia in Subarea 48.3, the South Sandwich Islands in Subarea 48.4, Heard Island and McDonald Islands in Division 58.5.2, and the Ross Sea in Subarea 88.1 and SSRUs 882A–B,

Online meeting

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Dr.Sc. MSc. BSc. Henrik Sparholt

Independent Fisheries Scientist

Member of the Nordic Marine Think Tank (NMTT) and Scientist at the University of Copenhagen

Email: henrik.sparholt@gmail.com

# Contents

## Executive Summary


The science behind the assessment of four toothfish stocks in the CCAMLR area was reviewed. The stocks were: *Dissostichus eleginoides* in Heard Island and McDonald Islands in Division 58.5.2, *Dissostichus mawsoni* in the Ross Sea in Subarea 88.1 and SSRUs 882A–B, *Dissostichus eleginoides* in South Georgia in Subarea 48.3, and *Dissostichus eleginoides* in the South Sandwich Islands in Subarea 48.4.

The science was very well documented, lived up to the international best practise in fish stock assessment, and used the available science. These stocks are very data rich, and the tagging data were especially impressive both in quantity and in quality.

The assessments provide a sound basis for making management decisions of the fisheries for the coming years.

The stock projections are likely to be conservative. Density dependence in growth, maturity and natural mortality are not accounted for in the historic stocks trend estimates or in the projects. This mean that $B_0$ probably are overestimated, $B_{current}$ underestimated, and the catch which leads to $B_{50\%}$ in 35 years underestimated. For the 48.3 stock, recruitment is assumed to stay at the current low level for the next 35 years and this is further contributing to a conservative projection for this stock.

Suggestions for further improvements in the assessment are made. The most important of these are: 1) include density dependence in growth, maturity and natural mortality, 2) test more carefully whether the level of natural mortality might be overestimated, and 3) explore a set of steepness factors in the stock-recruitment model in the projection rather than use a fixed factor.

The models are already very complex. This reduces transparency and puts strong demands on computer capacity and on human skills. The above issues add to the complexity. However, various simplifications of the existing elements of the models are suggested.

## Background

CCAMLR's toothfish stocks are assessed every two years on a routine basis. Four Bayesian age-structured integrated stock assessments for toothfish using CASAL were reviewed by three independent stock assessment scientists in 2018 (SC-CAMLR-XXXVII/02 Rev. 1, Division 58.5.2, Subarea 88.1 and SSRUs 882A–B, Subareas 48.3 and 48.4). Since then, each assessment has been further developed to address the recommendations detailed by the review (SC-CAMLR-XXXVII, Appendix 9, Table 3). As it has been five years since the review, a new assessment of the performance of these stock assessments is appropriate.

In addition, concerns have been raised by one CCAMLR Member since 2018 about the performance of the stock assessment in Subarea 48.3 and the resulting precautionary management of the fishery. Currently, this disagreement has resulted in a lack of consensus to agree a conservation measure for Subarea 48.3 in 2021 and in 2022. To progress resolution of the issue, the Scientific Committee recommended an independent review of relevant data, the stock assessment, and application of CCAMLR decision rules, in the context of the assessment and management of all CCAMLR toothfish stocks (SC-CAMLR-41, paragraph 3.108).

## Role of the reviewer

The review meeting was a formal, multiple-day meeting of stock assessment experts who serve as a panel to peer-review four CCAMLR toothfish stock assessments. The purpose of this meeting was to provide an external peer review of the approach that CCAMLR uses to develop management advice for toothfish stocks as well as a technical review of four toothfish stock assessments (SC-CAMLR-41, paragraph 3.108, CCAMLR-41, paragraph 4.39):

(i) *Dissostichus eleginoides* in Heard Island and McDonald Islands in Division 58.5.2

(ii) *Dissostichus mawsoni* in the Ross Sea in Subarea 88.1 and SSRUs 882A–B

(iii) *Dissostichus eleginoides* in South Georgia in Subarea 48.3

(iv) *Dissostichus eleginoides* in the South Sandwich Islands in Subarea 48.4.

The panel meetings were online meetings and participants were based in Tasmania, Australia, New Zealand, USA, England and Denmark. I was based in Denmark and for me the meetings took place from 21:00 to 01:00 local time each day. Tasmania was probably the other extreme where the meetings took place from 06:00 to 10:00 local time. This worked fine but might have been difficult if the meetings lasted more than four hours each day.

# Summary of Findings for each ToR

The aim for the CIE review is to provide advice to the Scientific Committee on the adequacy of the data collection, modelling approaches and methods used in CCAMLR's integrated toothfish stock assessments and if they are appropriate for all toothfish stocks relative to international best practices.

Specifically, the terms of reference for the CIE review are to determine if the integrated toothfish stock assessments within the CCAMLR area, in particular for South Georgia in Subarea 48.3, the South Sandwich Islands in Subarea 48.4, Heard Island and McDonald Islands in Division 58.5.2, and the Ross Sea in Subarea 88.1 and SSRUs 882A–B, use the best available science, are consistent with Article II of the Convention, and likely to achieve CCAMLR's objective by:

(i) Reviewing the status and report on the implementation of the recommendations arising from the CCAMLR Independent Stock Assessment Review for Toothfish in 2018 (SC-CAMLR-XXXVII/02 Rev. 1, and SC-CAMLR-XXXVII, Annex 9, Table 3).

(ii) Reviewing if biological parameters used in the assessment models are estimated using best available science and appropriately used in the stock assessment models:
   a. Sex-specific maturation
   b. Natural mortality
   c. Length-weight relationship
   d. Growth
   e. Stock-recruitment steepness.

(iii) Reviewing the extent to which the choice and analyses of observations are estimated using the best available science and appropriately used in the stock assessment models, including the representativeness of observations in space and time:
   a. Catch observations
   b. Survey data
   c. Catch per unit effort (CPUE) abundance indices
   d. Tag release and recapture observations
   e. Age and length compositions
   f. Selectivity.

(iv) Determining whether the statistical modelling (including model assumptions, model structure, priors and penalties, data selection and weighting) and the resulting inferences on stock status and dynamics and catch limits are implemented using best-practice methods.

(v) Reviewing if there are trends in parameters through time or other spatial and temporal effects on the biological parameters, other parameters such as selectivity, and observations that should be taken into account in each stock assessment.

(vi) Reviewing whether population projection methods, recruitment series used, and implementation of decision rules are conducted using the best available science.

(vii) Identify and consider any additional stock specific analyses or investigations that are critical for this assessment and warrant peer review, and develop additional TOR(s) to address as needed.

It seems to me that these toothfish stock might be compared to Greenland Halibut in the Arctic area. Both are large species, living in deep and very cold waters, are piscivorous, and both lack a swim bladder, and thus both are suitable for large scale tagging experiments and monitoring. A recent very comprehensive study of Greenland halibut can be found in Vihtakari et al. (2022).

**TOR (i)** .Reviewing the status and report on the implementation of the recommendations arising from the CCAMLR Independent Stock Assessment Review for Toothfish in 2018 (SC-CAMLR-XXXVII/02 Rev. 1, and SC-CAMLR-XXXVII, Annex 9, Table 3).

Last time these stocks were reviewed in 2018, a large list of tasks was suggested to the assessment teams to improve the assessment. Most of these tasks have been addressed in a competent and scientific way which live up to the standard of best practise and best available science. There are a few exceptions. An important one is the temporal change in growth, maturity and natural mortality. Here density dependent (DD) factors could be considered in future improvements of the assessment. Density dependent growth, maturity and natural mortality, as a feature, have gone under the radar in international fisheries biology for a number of decades probably due to overfishing being the general phenomenon. DD factors have not been so important because the stocks were depleted. In recent years density dependence have been re-vitalised in international science because overfishing in many parts of the world has been rectified, fishing pressure has been reduced substantially, and fish stocks are rebounding. This means density dependence, which is predation between predators and prey and food competition between fish, is increasing and needs to be considered in fish stock assessment. The toothfish stocks considered in the present review have always been on a high stock size level as fisheries has been relatively low. Hence density dependence might be a prominent issue for these stocks. Including DD will influence the estimation of the B0, B50% and B20% and therefore be relevant for the CCAMLR management of these fisheries.

Exploitation pattern (also called selectivity of the fishing gear) is important to get right for the assessment to be precise. In some of the toothfish stocks there are three types of fisheries: a trawl fishery, a longline fishery and a trap net fishery. The trawl fishery catches smaller fish than the longline fishery, which catches smaller fish than the trap net fishery. The review panel was informed by the assessment team at the meeting that longline fishery and trap fishery are conducted in the same spot, and the difference is in the size of the fish caught. This rules out the possibility that the reason could be solely ontogenetic migration and spatial difference in fishing by gear type. The reason for this difference was not clear for the scientists, but maybe it had something to do will small fish being scared away from the traps by larger fish. Anyway, this might be a fruitful issue to explore further because it could give insights or information about the best exploitation pattern by gear to use in the assessments.

**TOR (ii).** Reviewing if biological parameters used in the assessment models are estimated using best available science and appropriately used in the stock assessment models:

a. Sex-specific maturation
b. Natural mortality
c. Length-weight relationship
d. Growth
e. Stock-recruitment steepness.

The biological parameters used in the assessment models are in general based on very solid data and science. It is living up to the best practise and have a high quality.

However, as stated above DD is an issue which is getting more and more attention in science, globally (Froese et al. 2016, Lorentzen 2016, Morgan and Shelton 2016, Horbowy and Luzenczyk 2017, Zimmermann and Heino, 2018, ICES 2021, and Rindorf et al. 2022). This is already well accounted for in the recruitment model via the B&H stock-recruitment relationship, which implicitly takes account of DD in survival from the egg stage to the recruitment stage.  DD is not as important for the length-weight relationship because the condition factor of the fish is rarely impaired. But for growth, sexual maturation and natural mortality of post-recruits it is a factor which could be taken more into account in the future assessments. Data on annual growth and maturity are available and seem to be of a high quality.

For natural mortality, M, it is more complicated to establish a DD relationship. However, for these toothfish stocks tagging data are very good and might offer an opportunity which is unique, globally, to estimate DD in natural mortality. As usual, it will be difficult to disentangle from the selectivity in the fishery, but for these stocks where we have trawl catches, longline catches and pot catches it might be possible to come up with useful estimates of DD in natural immortality. Alternatively, the general formula M(L) = K*(Linf/L)**1.5 by Charnov et al. (2012) could be considered. In relation to DD in growth, DD in M could be modelled via its effect on L. For instance, when the stock gets smaller the growth of individual fish increases and a given age group of fish will have a longer length. Applying the Charnov et al. (2012) formula will then give it a lower M. Pope et al. (2021) has elaborated on the formula by considering the effect of fishing level on M via changed predation, but I am not sure that this is of enough importance to these toothfish stocks as there seems to be little predation on them and, for instance, no cannibalism.

The formula by Charnov et al. (2012) is built on the hypothesise that species with a larger $L_\infty$ had relatively higher M at a given length than species with a smaller $L_\infty$. This would compensate for the higher number of eggs produced per female and reduce the subsequent R of the larger species. It also takes account of the size spectra of the ecosystem. Thus, the formula is built on solid biological reasoning.

The stock recruitment relationship and the steepness factor are notoriously difficult to estimate. I would anyway suggest that the steepness factor is estimated as well as its statistical distribution, based on the historic relationship from the assessment, maybe moderated to be in line with what we see in other fish stocks from meta-analysis. This could be used in alternative forecast models in order to get more correct estimates of the uncertainty of the predictions.

The von Bertalanffy growth curve could be moderated to include the change in the growth curve when fish get mature and some of the annual growth is manifested in egg and sperm production and therefore not in somatic growth.

**TOR (iii)** Reviewing the extent to which the choice and analyses of observations are estimated using the best available science and appropriately used in the stock assessment models, including the representativeness of observations in space and time:

f. Catch observations
g. Survey data
h. Catch per unit effort (CPUE) abundance indices
i. Tag release and recapture observations
j. Age and length compositions
k. Selectivity.

Overall, the choice and analysis of observations are estimating using the best available science and appropriately used in the stock assessment models.

The tag release and recapture data are unique for these stocks compared to almost all other global stocks. The data seem to be of a very high quality and properly used in the assessment. However, the way they are used in the assessment is not very transparent and it is very helpful to see whether some simple analyses made outside the model give the same recapture rates and total mortality rates as the assessment models. Time did not allow for a careful and comprehensive review of the precise way the tag data are used in the assessment. Factors like tagging mortality, tag shedding rate, retarded growth of tagged fish, and fishing gear selectivity were all included in the modelling in a way that seems very sound.

In order to reduce the complexity of the models it might be an idea not to split the assessment by sex. In well-established assessments of fish stocks in other parts of the world, combined sexes have been working relatively well despite even greater differences in growth and maturity between the sexes than seen for these toothfish stocks. A good example for this is the North Sea plaice stock which have greater sex differences in growth and maturity than these toothfish stocks and where sexes are combined, and the assessment is one of the most precise fish stock assessments in the Northeast Atlantic.

One probably important condition for this is that the plaice assessment is age-based and does not need to fit into length distribution data into the assessment model. Length data and sex data still need to be collected because these are used to create the input catch-at-age, weight-at age and maturity-at age data. It is probably also important to watch for unexpected changes in the stock (although I have never seen changes occur that significantly influence the ratio between females and male in a marine species). In other words, the reason why a simplification by combining the sexes seems to work is that the ratio between female and males almost always is relative constant over time.

**TOR (iv).** Determining whether the statistical modelling (including model assumptions, model structure, priors and penalties, data selection and weighting) and the resulting inferences on stock status and dynamics and catch limits are implemented using best-practice methods.

The statical modelling and inferences on status and dynamics and catch limits implemented are using the best practise methods and are living up to a very high scientific standard. The models have been worked on for many years, being reviewed previously and have reached a level where only minor improvements may be required by further tweaking the current model parameters and sub-models. However, as stated in other parts of my review report, the next step in the assessment of these stocks could be related to including DD in growth, sexual maturity, and natural mortality, as well as simplifications of other parts of the model, if possible.

The reason why the DD growth, sexual maturity and natural mortality are important for the assessment is that these can rectify issues related to any systematic error in BO% estimates if these DD are ignored. This is because the growth curve (being an average one for the entire time period) overestimates growth of individual fish at B0%, which leads to an overestimation of B0% because tagging data are driving the assessment – but tagging data relate to the number of fish and not biomass. When B0% is overestimated then of course so are B50% and B20%. Bcurrent will furthermore be underestimated because the growth curve underestimates the growth of individual fish at that stock size level. This is of course also a problem for the forecasts and DD in growth, sexual maturity and natural mortality should also be included here, if possible. DD in recruitment (i.e., survival from the egg stage to the recruit stage) is already included via the S-R model. This DD is more important here than DD in the other three factors, but my point is that the other three factors are also important and, if ignored, can yield a systematic error in the forecasts. In the Northeast Atlantic a recent meta-analysis of 53 data rich fish stocks showed that DD in recruitment contributed 2/3rds of the Fmsy values estimated and DD in the other three factors contributed 1/3rds (if there were no DD in any of the four factors, Fmsy would be zero, because the smaller the F, the more you build up the stock towards infinity).

The current models are very complicated and computer demanding, and including DD in the models may make them even more complicated. Therefore, simplification could be considered. This is of course more easily said than done. I suggest the following actions. If ageing is validated and found sound, it might be possible to avoid length composition considerations in the models and only base them on age data and following cohorts. Such models are widely used in other parts of the world. The Bayesian approach to modelling might not be needed in the future and the statistical distributions of the parameters could be obtained from what the current Bayesian models have estimated them to be. Such simplifications of the models would also improve transparency and be less demanding on the scientists working with the models. In the present review we are suggesting new things to include in the assessment and forecast models and therefore simplifications of the existing elements in the models are even more relevant.

In recent years, science has developed towards the type of forecast models that is called management strategy evaluations (MSE). This is a forecast approach which is based on an operating model (OM) generating future populations supposed to reflect the true stock development and an assessment model which is then applied to the data generated by the operating model. This allows for testing alternative operating models in terms of how robust a given management approach, like a constant catch by year, is at generating desired stock developments, like meeting the B50% criteria. Such an MSE approach could be considered for these toothfish stocks to test for e.g., a set of steepness factors in the stock-recruitment model as hinted at above.

The fish stocks considered in the present review have very similar population dynamics and stock status. Fishing mortality of 0.05 has reduced the stocks from B0% to about B50% in about 25 years. If we assume that the stocks follow a Schaefer production model, B50% is BMSY. Thorson et al. (2012) conducted a meta-analysis and found that 147 data rich stocks on average followed a slightly skewed production curve with a Bmsy of B40%, which is not too far away from a Schaefer curve. It is a bit surprising that a fishing mortality of only 1/3 of the natural mortality has been able to reduce the stocks this much. In general, it is regarded as a safe management approach to keep fishing mortality at the natural mortality level or below it, but the current assessment of these toothfish stocks indicates it is not a sage approach. Furthermore, given the growth and age-at-50% maturity for these stocks, Fmsy should be around 0.15, based on the experience from stocks in the temperate and boreal zone on the Northern Hemisphere. The experience there is that temperature does not influence the Fmsy value further than what is “hidden” in the growth and maturity dynamics (slow growth and late maturation at cold water). Toothfish stocks are living in extremely cold water and that could be an explanation, but the growth is quite good given the hostile conditions. An alternative explanation might be that natural mortality is overestimated. From the tagging data we know that total mortality, Z, is well determined and is about 0.20. Knowing that natural mortality is difficult to estimate, could it be at natural mortality is only 0.05? This will give us a fishing mortality of 0.15 instead of 0.05. Then we will be in line with the population dynamics of fish stocks as in other parts of the world, when taking due account of the temperature regime via the growth dynamics and age-at-50% maturity.

The lack of including DD in growth, maturity and natural mortality in the assessment models, is contributing to the issue above as it probably means an overestimation of B0% and an underestimation of Bcurrent.

**TOR (v).** Reviewing if there are trends in parameters through time or other spatial and temporal effects on the biological parameters, other parameters such as selectivity, and observations that should be taken into account in each stock assessment.

As discussed above, trends in growth, maturity, and natural mortality related to stock size, i.e., density dependence, could be included in the assessment models.

There was no obvious change in the ecosystem identified by the review panel which needs to be taken into account. Potentially increases in sea mammal biomass might influence natural mortality, but there was no indication of great predation pressure on the stocks from sea mammals.

Global changes in temperature due to the greenhouse effect is of course something to watch over in the future to see whether it will impact the biological parameters for the stocks.

**TOR (vi)** Reviewing whether population projection methods, recruitment series used, and implementation of decision rules are conducted using the best available science.

The population projection methods, the recruitment series used, and the implementation of decisions rules were conducted using the best available science.

The issues of including or not including DD, and the issue of an MSE (including a few alternative operating models) approach, are for longer term. Until now, only very few forecasts globally have included DD, but many will hopefully in the future; this is because ecosystems work via DD mechanisms across populations. Many assessments globally, including historic stock trends, do include DD, mostly just implicitly by allowing weight-at-age, maturity-at-age, and natural mortality-at-age to vary by year.

For the near future the only issues which might be discussed are the recruitment forecast models. In one assessment, the recent low recruitment was projected into the future with the argument that it was lower than the average recruitment from the entire historical time series. In another assessment where recruitment was higher than the average recruitment, the average recruitment was used in the recruitment forecast model. This seems a little inconsistent. I tend to prefer to use the average recruitment in both assessments because the forecasts are not for the near future, but for the coming 35 years and probably the best estimate of that recruitment is the average recruitment from the entire historical time series.

The forecasts seem to be on the conservative side due to the lack of including DD in growth, maturity, and natural mortality, and for the 48.3 stock due to the low recruitment assumed for the future.

**TOR (vii)**. Identify and consider any additional stock specific analyses or investigations that are critical for this assessment and warrant peer review, and develop additional TOR(s) to address as needed.

There are no additional stock specific analysis or investigations that are critical for the assessment in the short term. The only exception to that might be the assumption about future recruitment for the 48.3 stock as mentioned above.

As I see it, the three most important issues for the longer-term future of the assessment work are 1) the level of natural mortality, 2) the inclusion of DD growth, maturity, natural mortality, and 3) running the predictions with a set of steepness parameters instead of just a fixed one. The issues are discussed in detail above.

The following is an overall list of recommendations:

<table>
<tr><th>Issue</th><th>Comment</th><th>Time frame suggested</th></tr>
<tr><td>DD individual fish growth. Develop a DD submodel and include this in the assessment and projections</td><td rowspan="3">This is important because it will correct a current systematic error in the relationship between $B_0$, B20%, and B50%.</td><td>1-3 years</td></tr>
<tr><td>DD individual fish sexual maturity. Develop a submodel and include this in the assessment and projections</td><td>1-3 years</td></tr>
<tr><td>DD individual fish natural mortality of post recruits. Develop a submodel and include this in the assessment and projections</td><td>1-3 years</td></tr>
<tr><td>Explore natural mortality levels down to 0.05 per year</td><td>To make “room” for a higher estimate of in F more in line with other stocks and the observed depletion of the stocks</td><td>1-3 years</td></tr>
<tr><td>Explore natural mortality by fish size</td><td>To get a more realistic model and hopefully an</td><td>1-3 years</td></tr>
</table>

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|---|---|---|
| | even better fit to observations | |
| In the projections, explore a wide range of S-R steepness factors consistent with data and general fish population dynamics | To get a more correct picture of the uncertainty of the projections | 0-1 year |
| For the 48.3 stock, explore the use in the projection of the mean recruitment over the entire historic time series. | The best predictor of the next 35 years is probably the average of the entire past | 0-1 year |
| Further work on ageing procedures and verification, using the unique tagging data available | The growth of recaptured tagged fish can be compared to the growth based on ageing data and thus verify or falsify the ageing procedures | ongoing |
| Simplify the assessment model.<br><br>Suggestions:<br><br>1. Use an age-based assessment rather than the current length-based one. Length data are still relevant to sample because these data are used to create the needed input catch-at-age data.<br>2. Perhaps a Bayesian model is not needed every year, and general age-based software like SAM can be used instead.<br>3. If going for an age-based assessment, sexes can be combined without | A model should be as simple as possible …but not more simple than that, according to Einsten. The current model is probably too complex on certain issues and too simple on others (DD in growth, maturity and natural mortality, and the use of only a single steepness factor used in projections) | 2-5 years |

| | | |
|---|---|---|
| losing much precision. | | |
| MSE for projections. | This is not realistic with the current length-based models but may be realized if age-based models are implemented. | 3-8 years |

## Conclusions and recommendations

The science was very well documented, lived up to the international best practise in fish stock assessment, and used the available science. These stocks are very data rich, and the tagging data were especially impressive, both in quantity and in quality.

The assessments provide a sound basis for making management decisions for the fisheries for the coming years.

The stock projections are likely to be conservative. Density dependence in growth, maturity and natural mortality are not accounted for in the historic stocks trend estimates or in the projects. This mean that $B_0$ probably is overestimated, $B_{current}$ is underestimated, and the catch which leads to B50% in 35 years is underestimated. For the 48.3 stock, recruitment is assumed to stay at the current low level for the next 35 years and this is further contributing to a conservative projection for this stock.

Suggestions for further improvements in the assessment are made. The most important are: 1) include density dependence in growth, maturity and natural mortality, 2) test more carefully whether the level of natural mortality might be overestimated, and 3) explore a set of steepness factors in the stock-recruitment model in the projection rather than using it as a fixed factor.

The models are already very complex. This reduces transparency, put strong demands on computer capacity and on human skills. The above issues add to the complexity. However, various simplifications of the existing elements of the models are suggested above, where probably the most important is a suggested transition to age-based models which avoids the very complex length data. Length data will be used outside the model to e.g., obtain the best estimate of catch-at-age and other length related issues. In an age-based modelling splitting data and model components into female and male fish might not be needed.

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# Appendix 1. Bibliography

**Documents for independent review of toothfish stock assessments, 2023**

## 1 Division 58.5.2

### 1.1 Stock assessment


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### 1.2 Main supporting documents


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## Appendix 2. List of participants.

**List of participants**
**2023 Independent review of toothfish stock assessments**

**Reviewers**

Cieri, Matthew
Chen, Yong
Sparholt, Henrik

**Participants**

Belchier, Mark
Collins, Martin
Devine, Jennifer
Dunn, Alistair
Earl, Timothy
Fields, Lauren
Ghebrezgabhier, Danait
John, Mitchell
Maschette, Dale
Masere, Cara
Parker, Steve
Readdy, Lisa
Stoute, Selina
Walker, Nathan
Wallis, Claire
Welsford, Dirk
Ziegler, Philippe

## Appendix 3. Statement of work

**Performance Work Statement (PWS)**
**National Oceanic and Atmospheric Administration**
**(NOAA) National Marine Fisheries Service (NMFS)**
**Center for Independent Experts (CIE)**
**Program External Independent Peer**
**Review**

**Independent Review of Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Toothfish Stock Assessments**

**Background**

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one (1) or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination. Specifically, science products that the agency can reasonably determine that will have, when disseminated*, "a clear and substantial impact on important public policies or private sector decisions*." Additionally, peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[1].

[1]https://www.whitehouse.gov/wpcontent/uploads/legacy_drupal_files/omb/memoranda/2005/m05-03.pdf

**Scope**

The CCAMLR toothfish stocks are assessed every two (2) years on a routine basis. Four (4) Bayesian age-structured integrated stock assessments for toothfish using an advanced software package (**C++ Algorithmic Stock Assessment Laboratory** (CASAL)) were reviewed by three (3) independent stock assessment scientists in 2018 (SC-CAMLR-XXXVII/02 Rev. 1, Division 58.5.2, Subarea 88.1 and SSRUs 882A–B, Subareas 48.3 and 48.4). Since then, each assessment has been further developed to address the recommendations detailed by the review (SC-CAMLR- XXXVII, Appendix 9, Table 3). As it has been five (5) years since the review, a new assessment of the performance of these stock assessments is appropriate.

In addition, concerns have been raised by one (1) CCAMLR Member since 2018 about the performance of the stock assessment in Subarea 48.3 and the resulting precautionary management of the fishery. Currently, this disagreement has resulted in a lack of consensus to agree on an appropriate conservation measure for Subarea 48.3 in 2021 and in 2022. In an effort to resolve this issue, the Scientific Committee recommended an independent review of relevant data, the stock assessment, and application of CCAMLR decision rules, in the context of the assessment and management of all CCAMLR toothfish stocks (SC-CAMLR-41, paragraph 3.108). This task order will support a portion of this recommended independent review.

It should be noted that the independent reviewer reports for this task order will be used by the U.S. Delegation to CCAMLR to inform the U.S. position on whether toothfish fisheries are managed in a manner consistent with U.S. objectives for these fisheries. Since decision making within CCAMLR is by consensus of all Members to the Commission, the U.S. position will affect how these fisheries are managed in the future.

**Tasks**

CCAMLR will convene a formal, virtual, multiple-day panel review meeting involving three (3) independent CIE stock assessment experts to conduct a peer review of the four (4) CCAMLR toothfish stock assessments in August 2023. The purpose of this meeting will be to provide an external peer review of the approach that CCAMLR uses to develop management advice for toothfish stocks as well as a technical review of four (4) toothfish stock assessments (SC- CAMLR-41, paragraph 3.108, CCAMLR-41, paragraph 4.39). Note that this task order is not responsible for any of the logistics, attendance, or facilitation of the multiple-day panel meeting.

**Task 1: Synthesize, quality control, and review all information and final materials from the panel review meeting**

- The three (3) CIE reviewers will evaluate the information provided at the August 2023 CCMALR review meeting for use as the basis for developing three (3) independent CIE-peer review reports.

(i) *Dissostichus eleginoides* in Heard Island and McDonald Islands in Division 58.5.2
(ii) *Dissostichus mawsoni* in the Ross Sea in Subarea 88.1 and SSRUs 882A–B
(iii) *Dissostichus eleginoides* in South Georgia in Subarea 48.3
(iv) *Dissostichus eleginoides* in the South Sandwich Islands in Subarea 48.4.

**Task 2: Produce draft independent CIE reviewer reports**

- The contractor shall have the three (3) independent reviewers develop and create draft peer review reports addressing the PWS Terms of Reference (TORs) for the four (4) toothfish stock assessments.

**Task 3: The contractor shall review and finalize all three (3) individual peer review reports.**

- The contractor shall evaluate the reports to ensure that these work products address all the Terms of Reference and whether they are of a quality and robustness that qualifies these products as having met the CIE-standard of independence and effectiveness. This task also includes all post-review contracting, invoicing, and related matters.

**Final Task Order Deliverables - Independent CIE Peer Review Reports**

Each CIE reviewer shall complete an independent peer review report in accordance with this PWS. Each CIE reviewer shall complete the independent peer review addressing each TOR as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 2**.

**Period of Performance**

The period of performance shall be from the time of award through **October 2023**. Each reviewer's duties shall not exceed **7** days to complete all required tasks.

**Place of Performance**

The place of performance shall be at the contractor's facilities and/or home site.

**Schedule of Milestones and Deliverables:** The contractor shall complete the tasks and deliverables in accordance with the following schedule.

| Timing | Deliverable/activity |
| --- | --- |
| Immediately following panel meeting | Reviewers evaluation information and materials received from the panel meeting and commence work on draft independent peer review reports |
| **August 2023** | Virtual panel review meeting |
| Approximately two (2) weeks following the panel meeting | Contractor receives draft independent peer review reports |
| Within two (2) weeks of receiving draft reports | Contractor submits final reports to the Government |

* Tasks under this task order may not begin until the panel review meeting has concluded. Any modifications in the timing of the milestones shall be approved by the Contracting Officer Representative (COR) and the CIE contractor.

**Travel**

No travel is necessary.

**Applicable Performance Standards**

The acceptance of the task order deliverables shall be based on three (3) performance standards: (1) The reports shall be completed in accordance with the required formatting and content (2) The reports shall address each TOR as specified (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

**NMFS Project Contact**

George Watters, Ph.D.
Antarctic Ecosystem Research Division Director
Antarctic Ecosystem Research Division
Southwest Fisheries Science Center
Office: (858) 546-7198
Email: george.watters@noaa.gov

## Annex 1. Terms of Reference

The aim for the CIE review is to provide advice to the Scientific Committee on the adequacy of the data collection, modelling approaches and methods used in CCAMLR's integrated toothfish stock assessments and if they are appropriate for all toothfish stocks relative to international best practices.

Specifically, the terms of reference for the CIE review are to determine if the integrated toothfish stock assessments within the CCAMLR area, in particular for South Georgia in Subarea 48.3, the South Sandwich Islands in Subarea 48.4, Heard Island and McDonald Islands in Division 58.5.2, and the Ross Sea in Subarea 88.1 and SSRUs 882A–B, use the best available science, are consistent with Article II of the Convention, and likely to achieve CCAMLR's objective by:

(i) Reviewing the status and report on the implementation of the recommendations arising from the CCAMLR Independent Stock Assessment Review for Toothfish in 2018 (SC- CAMLR-XXXVII/02 Rev. 1, and SC-CAMLR-XXXVII, Annex 9, Table 3).

(ii) Reviewing if biological parameters used in the assessment models are estimated using are sufficient and appropriately used in the stock assessment models:
   a. Sex-specific maturation
   b. Natural mortality
   c. Length-weight relationship
   d. Growth
   e. Stock-recruitment steepness.

(iii) Reviewing the extent to which the choice and analyses of observations are estimated using the best available science and appropriately used in the stock assessment models, including the representativeness of observations in space and time:
   a. Catch observations
   b. Survey data
   c. Catch per unit effort (CPUE) abundance indices
   d. Tag release and recapture observations
   e. Age and length compositions
   f. Selectivity.

(iv) Determining whether the statistical modeling (including model assumptions, model structure, priors and penalties, data selection and weighting) and the resulting inferences on stock status and dynamics and catch limits are implemented using best- practice methods.

(v) Reviewing if there are trends in parameters through time or other spatial and temporal effects on the biological parameters, other parameters such as selectivity, and observations that should be taken into account in each stock assessment.

(vi) Reviewing whether population projection methods, recruitment series used, and implementation of decision rules are conducted using the best available science.

(vii) Identify and consider any additional stock specific analyses or investigations that are critical for this assessment and warrant peer review, and develop additional TOR(s) to address as needed.

## Annex 2. Individual Independent Peer Reviewer Report Requirements

1. The independent Peer Reviewer report shall be prefaced with an Executive Summary providing a concise summary of whether they accept or reject the work that they reviewed, with an explanation of their decision (strengths, weaknesses of the analyses, etc.).

2. The report must contain a background section, description of the individual reviewers' roles in the review activities, summary of findings for each TOR in which the weaknesses and strengths are described, and conclusions and recommendations in accordance with the TORs. The independent report shall be an independent peer review, and shall not simply repeat the contents of the Peer Reviewer Summary Report.

    a. Reviewers shall describe in their own words the review activities completed during the panel review meeting, including a concise summary of whether they accept or reject the work that they reviewed, and explain their decisions (strengths, weaknesses of the analyses, etc.), conclusions, and recommendations.
    b. Reviewers shall discuss their independent views on each TOR even if these were consistent with those of other panelists, but especially where there were divergent views.
    c. Reviewers shall elaborate on any points raised in the Peer Reviewer Summary Report that they believe might require further clarification.
    d. The report should include recommendations on how to improve future assessments.

3. The report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review Appendix 2: A copy of this Performance Work Statement

Appendix 3: Panel membership or other pertinent information from the panel review meeting.