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Implications of unaccounted mortalities on stock status and projected rebuilding using the management procedure

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Contents

Abstract

In 2013 the CCSBT Extended Commission (EC) requested that the Extended Scientific Committee (ESC) conduct sensitivity analysis of the potential impacts of unaccounted mortalities (UAM) on the assessment of stock status and incorporate this in their advice on exceptional circumstances. In addition, the EC requested that the ESC provide preliminary advice on the impact of unaccounted mortalities on the management procedure based rebuilding plan for SBT and recommendations beyond the current TAC block (2015-2017).

From paragraph 67 of the Report of the Extended Commission of the Twentieth Annual Meeting of the Commission (Anon 2013a):

"... the EC requested the ESC to conduct sensitivity analysis around all sources of unaccounted catch mortality as part of the ESC's planned 2014 stock assessment and to incorporate this information in its advice on the existence of exceptional circumstances..."

"... The EC also asked the ESC to provide preliminary advice to CCSBT 21 on the impact of any unaccounted catch mortalities on the stock assessment projections and the possible Management Procedure recommendation beyond the 2015-17 quota block."

In addressing the EC's request we have separated the analysis of the impacts of unaccounted mortalities into two categories, impacts on 1) estimates of current (2014) stock status from the stock assessment, and 2) impacts on the SBT rebuilding plan and other outputs from projections from 2014-2035. We have used these results to inform the discussion of exceptional circumstances related to UAM for consideration by the ESC.

We note that the UAM scenarios that have been defined are based on limit available data on current or historical estimates and almost no information on how the unaccounted mortalities might vary over time, or continue into the future.

The impacts of the UAM scenarios on current stock status estimates are not substantial. The current range of OMs appear to be robust to a variety of levels of hypothetical additional sources of fishing mortality.

In the case of projections, for some scenarios the impact on the probability of rebuilding to the target level was substantial and this impact may be considered severe, if it is occurring.

In terms of exceptional circumstances and severity (stage 1 of the meta-rules), we note that if the total mortalities due to fishing are greater than the TACs recommended then the impact on the rebuilding plan may potentially be substantial.

In relation to the process and principles for action (stage 2 and 3 of meta-rules) we suggest that given the estimates of stock status indicate that spawning biomass has improved since the last full reconditioning and that the management procedure appears to respond to reductions in biomass from additional catches being taken (at least in the scenarios tested to date), that the actions to consider at this time are:

1. to closely monitor the stock status and indicators, in the coming period between full stock assessments;
2. to make an urgent request to the Commission for data to better inform and refine the development of specific UAM scenarios, so that impacts can be properly assessed and the mortalities included in known catch information used in the operating models in future.

1 Introduction

In 2013 the CCSBT Extended Commission (EC) requested that the Extended Scientific Committee (ESC) conduct sensitivity analysis of the potential impacts of unaccounted mortalities (UAM) on the assessment of stock status and incorporate this in their advice on exceptional circumstances. In addition, the EC requested that the ESC provide preliminary advice on the impact of unaccounted mortalities on the management procedure based rebuilding plan for SBT and recommendations beyond the current TAC block (2015-2017).

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In addressing the EC's request we have separated the analysis of the impacts of unaccounted mortalities into two categories, impacts on 1) current (2014) stock status estimates (stock depletion, biomass and fishing mortality rates relative to targets) from the stock assessment, and 2) impacts on the SBT rebuilding plan and other outputs (e.g. future relative biomass and future relative TAC, UAM catches as a % of TAC) from projections from 2014-2035. We discuss these results in the context of the ESC's consideration of exceptional circumstances related to UAM.

The 2014 ESC is undertaking an assessment of stock status using updated data provided through the data exchange. A reference set of operating models for conducting the stock assessment was agreed at the OMMP5 technical meeting Seattle, June 2014. The reconditioning and sensitivity tests of the operating models are provided in Hillary et al 2014 (CCSBT-ESC/1409/21). Both the conditioning model software and the projections software were updated prior to the OMMP5 meeting to allow for consideration of alternative unaccounted mortality scenarios (Anon 2014, Preece et al 2014a,b).

The OMMP5 technical meeting discussed the various potential sources of unaccounted mortality from all fisheries (Anon 2014, Attachment 5). There was, however, little information to provide current or historical estimates for many of these and almost no information on how these sources might vary over time. This in turn limits the scope to quantify unaccounted mortality estimates that may continue into the future and be taken into account in projections. Further work to collate additional information on all sources of mortality has been requested of the CCSBT members, the Compliance Committee and Extended Commission.

The OMMP5 proposed a set of unaccounted mortality scenarios in the absence of additional data, which seek to specify the potential scale of aggregated unaccounted mortalities for the purposes of sensitivity analysis (Anon 2014, Table 4). From these scenarios we can examine the types of impacts that may occur from UAMs of this approximate size and duration and provide an initial response to the EC's request. These scenarios apply to the historical data in conditioning models, or future simulated data used in the projections, or both.

2 UAM scenarios and implementation

At the OMMP5 meeting, Seattle June, 2014, a set of scenarios for unaccounted mortality were defined (Anon 2014, Table 4) for the purpose of examining the sensitivity of estimates of current stock status and potential impact on the rebuilding plan. In light of the lack of detailed data and/or information on the potential scale and nature of the UAM, it was noted at the OMMP5 meeting that a "comprehensive analysis

would require additional inputs". Without additional information, the ESC is limited in its ability to respond to the request from the Commission to evaluate impacts of UAMs (Anon 2014).

Four scenarios related to UAM were defined:

1. Added_catch.

In this scenario it is assumed that 1000t of additional catch is taken from the "*small fish*" component of the stock and 1000t of additional catch is taken from the "*large fish*" component. In addition to this, the surface fishery catch anomalies (described below in scenario SFOC20) are also included. The small and large fish UAM catches are assigned to a fishery with a similar selectivity pattern by size class. There is no assumption that the UAM was taken by that fishery; it is implemented in this way for technical simplicity in the OM.

For the historical data the assumptions are that UAM catch increases are from 0t in 1990 to 1000t in 2013 in fishery 1 (large fish) and fishery 6 (small fish), and additional catch and changes in proportions at age in the surface fishery described in SFOC20 (below) are also included. In the projections, the OMMP5 requested that the proportion of added catch remain the same as the proportion of the TAC in 2013. In consultation with Dr Sakai this has been interpreted as proportion of the 2013 catches (not TAC). This results in catch multipliers in the projections of 1.21 in fishery 1 and 1.44 in fishery 4. Note that 6 fisheries in the conditioning model are reduced to 4 in the projections models, and fishery 6 becomes fishery 4 in projections.

2. SFOC20. "Continue 20% over catch scenario from Australian surface fishery (SF) as if the stereo video system was not implemented".

In this scenario it is assumed that the 20% over-catch hypothesis, related to the possible size bias in the fish sampling in the Australian Surface fishery that is currently included in the reference set of operating models (i.e. in the historical data assumptions), continues in the future in projections. Therefore for this scenario, there is no impact on current stock status estimates, only on projections. In projections this is implemented as a 1.2 multiplier on the recommended TAC for the surface fishery to calculate the catches taken. This hypothesis for 20% over-catch was developed and agreed for inclusion in the conditioning models in 2006 (Anon 2006). It is implemented in the conditioning model as an increase in catches by 1% in 1992 to 20% by 1999 and onwards to 2014, and an adjustment to the proportions at age in the catch for the surface fishery. Various methods and data have been used to attempt to quantify the catch anomaly and further work and data have been requested by the OMMP5 meeting to assist in providing more information to refine this scenario (Anon 2014). The request for this hypothesis to continue into projections was first developed at the 2013 ESC as a contingency, in case the Australian Stereo Video catch monitoring system was not implemented. It was anticipated that implementation of the Stereo Video system would resolve the uncertainty in the size distribution and estimated total catch in weight (noting that numbers of fish are considered to be accurately estimated) (Anon, 2007).

3. SFOC40. "Apply 40% overcatch scenario from the Australian fishery (historical and projected)".

In papers presented at the OMMP5 meeting on the possible bias in size sampling in the Australian surface fishery, some results indicated that the potential bias associated with the size sampling may result in an over-catch greater than 20%. In the absence of data to quantify this, and while waiting for data and analyses to refine this hypothesis as requested by the OMMP5, a sensitivity test for a 40% catch anomaly was agreed to be used as an extreme scenario for the upper limit of the potential catch anomaly. This is twice the agreed 20% hypothesis and it was considered that, in combination with the 20% and 0% scenarios (see below), this was likely to bound the plausible range of the potential bias. For this scenario, the 40% hypothesis is applied to both the historical and future data used in the conditioning model and projections models, respectively. This requires adjustments to catch and proportions at age for historical data (consistent with the method described for the 20% scenario, but reaching 40% in 1999 and beyond). In

projections a catch multiplier of 1.4 is used on the recommended TAC in each year for the surface fishery to calculate the catch taken in that year.

4. SFOC00. "No historical or future additional catch in surface fishery".

In this scenario, there is no assumed over-catch related to potential size sampling bias in the Australian surface fishery in the historical data inputs or the future. This affects both the historical conditioning models and the projections. It is implemented by not altering the catch or proportions by age for the Australian fishery in the conditioning model, and in the projections the catch multiplier is set to 1, i.e. recommended TAC's are the same as catches taken.

Changes to the software for conditioning operating and projections models to accommodate the UAM scenarios were undertaken inter-sessionally by Ana Parma, Osamu Sakai and Ann Preece prior to the OMMP5 meeting and are described in (Anon2014, Preece et al 2014a,b). The TAC's recommended in 2013 are fixed in the projections (i.e. for the years 2014-2017). For future years, current nominal allocations are used to assign the TAC to the 4 fisheries defined in the projections.

3 Impacts on current stock status estimates

To assess potential impacts of the UAM scenarios on stock status, estimates of current stock status measures are provided for each scenario that includes changes in the historical data and for the reference set of operating models for comparison (Table 1). Note, UAM scenario 2 (SFOC20) does not involve changes in the conditioning model and therefore is does not appear in Table 1.

Table 1 Summary of impact of UAM scenarios that involve changes in the historical data on current stock status. Current relative spawning biomass estimates are calculated using the new definition of SSB (column 3), and also provided for Biomass aged 10+ (column 4).

SCENARIO NUMBER	SCENARIO NAME AND DESCRIPTION	CURRENT RELATIVE SPAWNING BIOMASS SSB(2014)/SSB(0) 10% 50% 90%	CURRENT RELATIVE B10+ B10+(2014)/B10+(0) 10% 50% 90%	F/FMSY 10% 50% 90%	BMSY/B0 10% 50% 90%	BCURR/ BMSY 10% 50% 90%	MSY 10% 50% 90%
	Reference Set Base2013sqrt	0.08 0.09 0.12	0.06 0.07 0.09	0.39 0.66 1.00	0.16 0.24 0.32	0.26 0.38 0.70	30167 33375 35675
1	Added_ catch Historical and projections	0.08 0.09 0.11	0.06 0.07 0.08	0.46 0.77 1.15	0.16 0.24 0.32	0.26 0.37 0.67	30509 33665 36140
3	SFOC40 40% over catch in Aus surf fishery historical and projections	0.08 0.09 0.12	0.06 0.07 0.09	0.43 0.72 1.10	0.16 0.24 0.32	0.26 0.38 0.70	31050 34132 36698
4	SFOC00 No historical or projection over catch in Aus surf fishery	0.08 0.09 0.12	0.06 0.07 0.09	0.35 0.60 0.91	0.16 0.24 0.32	0.26 0.38 0.69	29061 32438 34538

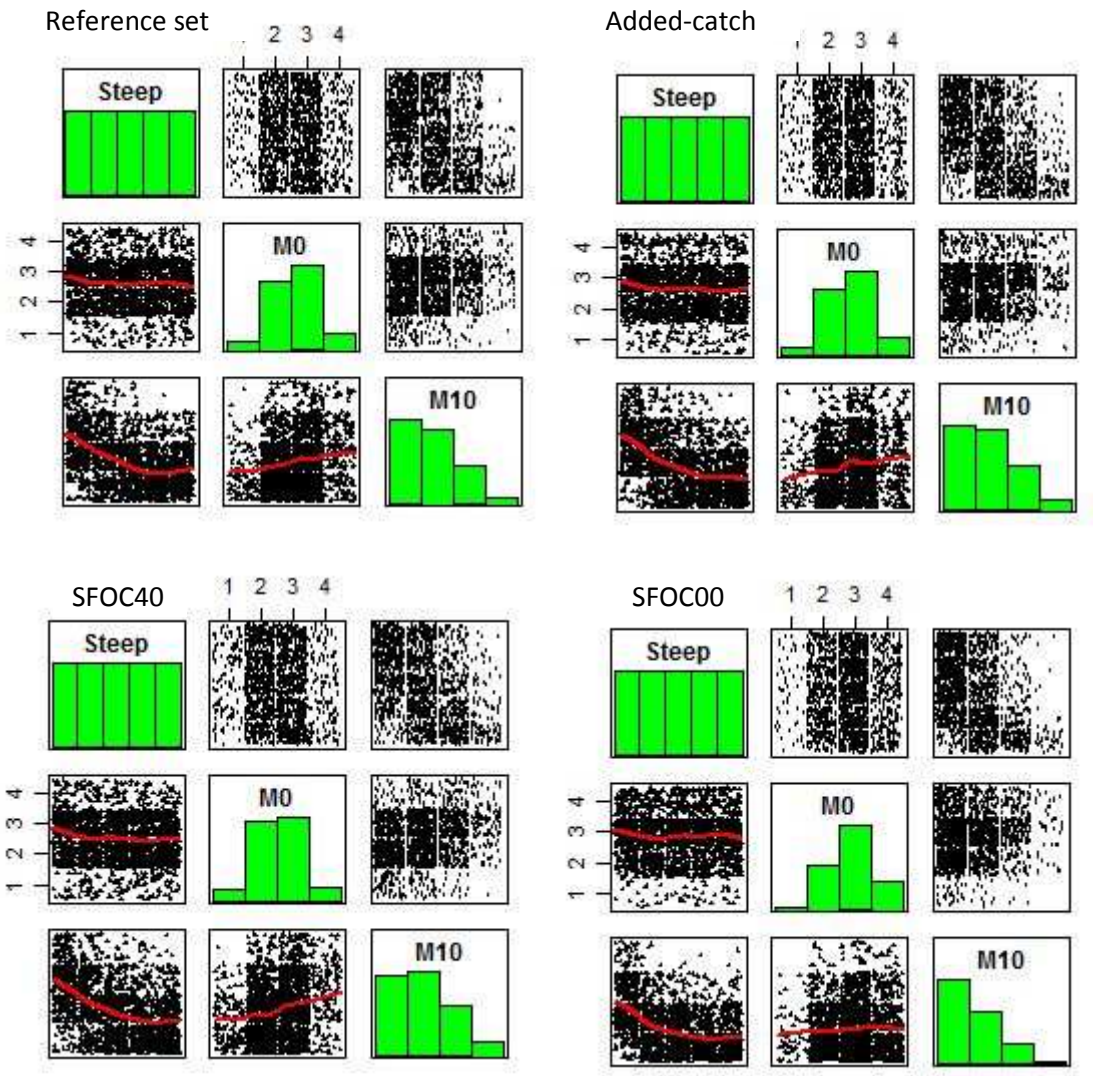

Figure 1 Level plots of M0 and M10 selected in the reference set and UAM scenarios. Top left is the reference case which is the same as for UAM scenario 2 (SFOC20), top right is UAM scenario 1 (Added-Catch), bottom left is UAM scenario 3 (SFOC40), bottom right is UAM scenario 4 (SFOC00).

Relative to the current stock status estimates for the reference set, which are explored in depth in Hillary et al (2014), stock status in terms of current relative spawning biomass (SSB(2014)/SSB(0)) estimates appears to be robust to alternative scenarios regarding unaccounted mortalities, with very small changes seen between the reference set estimates and any of the UAM scenarios. The range and median current fishing mortality estimates relative to fishing mortality at MSY (column 5), do vary with the UAM scenarios. The catches associated with the Added-Catch (scenario #1) and the 40% surface fishery over-catch scenario (#3), as indicated by the 90th percentile for F/FMSY, would lead to over-fishing (defined as F>FMSY) in some of the operating models. MSY and BMSY vary, as the model fits vary in their estimates of natural mortality parameters and selection of levels of M0 and M10 as a result of the additional catches in the scenarios (Figure 1), but these changes in MSY are small and the relative measures are almost unaffected. When the 20% over-catch in the Australian fishery is not included in the OMs (scenario 4), the natural mortality levels shift towards higher M0 levels and lower M10 levels, biomass is slightly rescaled and the overall result is that the models are slightly less productive.

4 Impacts on rebuilding and projections estimates

Impacts of the UAM scenarios on the SBT rebuilding plan (probability of rebuilding to 20%B0 by 2035) and projections measures (UAM catches as % of TACs, future relative biomass, future relative TAC and future TAC relative to MSY) are shown in Table 2. The projections results shown are the median, 10th and 90th percentile outcomes from 2000 projection models that start in 2014 using the population dynamics estimates from the related conditioning model results. In the projections models, the management procedure is used to set the TAC (from 2018 onwards, 2014-2017 TACs are fixed), and in the UAM scenarios the catch multiplier is used to calculate the actual catch taken given the calculated TAC. Biomass aged 10+ is reported in these comparisons because that was the measure used when the management procedure was adopted in 2011.

Table 2 Projections results for UAM scenarios and the reference set. The probability of rebuilding to 20%B0 by 2035 is shown in column 3. B10+ is the biomass aged 10 and older; this measure is reported because it is the same as the measure used when adopting the management procedure. UAM% is the amount of catch taken over the recommended TAC (as a % of the TAC). Future Relative Biomass is the Biomass 10+ in the target year (2035) relative to initial B10+ (1931). Future relative TAC gives the relative increase in TAC in 2035 (relative to 2014) that may potentially occur under this scenario. Future TAC relative MSY is the TAC(2035)/MSY for the scenario.

SCENARIO NUMBER	SCENARIO NAME, DESCRIPTION	P [B10+ (2035) > 0.2 X B10+ (0)]	UAM % CATCH >TAC	FUTURE RELATIVE BIOMASS B10+(2035)/B10+(0) 10% 50% 90%	FUTURE RELATIVE TAC TAC(2035)/TAC(2014) 10% 50% 90%	FUTURE TAC RELATIVE MSY TAC(2035)/MSY 10% 50% 90%
	Reference set OMs and no_UAM	0.74	0%	0.16 0.27 0.50	1.38 2.16 2.62*	0.60 0.81 0.95
1	Added_ Catch Scenario	0.4945	26%	0.11 0.20 0.39	1.07 1.85 2.60	0.42 0.69 0.91
2	SFOC20 Continue 20% over catch if Stereo video not implemented	0.685	7%	0.14 0.25 0.47	1.28 2.07 2.62	0.51 0.77 0.95
3	SFOC40 40% over catch in Aus surf fishery, historical and projections	0.67	14%	0.14 0.25 0.46	1.26 2.05 2.62	0.48 0.74 0.92
4	SFOC00 No historical or projections over catch in the Aus Surf Fishery	0.694	0%	0.15 0.25 0.47	1.31 2.10 2.62	0.54 0.81 0.98

* Note in the calculation of the 90th percentile for the TAC2035/TAC2014, 2.62 is the maximum increase attainable when the MP increases the TAC by 3000t (the max allowed) in each 3 year quota block.

These results indicate that under the reference set of operating models the probability of recovery is currently higher than anticipated when the MP was adopted. A change was expected given that there is additional (Close-kin) and updated data used in the 2014 conditioning models (Preece e al 2014c). Incorporation of the close-kin data and recent positive trends in the data used in the operating models have contributed to this estimated higher probability of rebuilding. These reference set results are discussed in detail in Hillary et al (2014).

In comparison to the reference set of models (Table 2 and Figure 2) the *added-catch* UAM scenario #1 (Table 2 and Figure 3) has the largest impact on the probability of rebuilding, i.e. a decrease from 74% to 49% of models having a biomass greater than 20% of B0 by 2035. The probability level for rebuilding set by the Commission was 70%. If additional catches in the range represented by the *added-catch* UAM scenario are actually occurring (~26% of the TAC in total/yr) then this is likely to substantially slow rebuilding, potentially increase the risk to the stock (of lower recruitment) and result in significant foregone losses in future catches in the form of lower TACs. The future relative biomass (Table 2, column 5), the future relative TAC (column 6) and the future TAC relative to MSY (column 7) are all lower than in the reference set, and indicate the scale of losses in biomass and TAC that may occur for this level of UAM in 2035 and in preceding years.

The *added-catch* UAM scenario is the most extreme of the UAM scenarios considered, in terms of impacts on projections; the results for the other UAM scenarios are less substantial. In all cases the probability of meeting or exceeding the rebuilding target in 2035, dropped below the 70% level set by the Commission.

For the *20% over catch* scenario #2 (Table 2 and Figure 4) the proportion of models reaching the rebuilding target drops to 68.5% in comparison to 74% for the reference set. The UAM catch component which is taken in addition to the TAC is approximately 7% of the TAC each year. Future relative biomass estimates are lower for this scenario than the reference set. Related to this are the future relative TACs that indicate that TAC would be lower for this scenario than for the reference set because of the impact on the biomass of the UAM catches taken. This is a good indication that the MP can adjust as expected to the changes in biomass, but future catch losses in terms of lower TACs are incurred. Recall that the historical population dynamics (i.e. conditioning model results) are the same in the reference set and "20% over-catch" scenario, and projections are starting from the same conditions.

For the *40% over catch* scenario #3 (Table 2 and Figure 5) the proportion of models reaching the target is 67%. The % UAM catch taken in addition to the TAC is approximately 14% of the TAC each year. This has a similar impact on future relative biomass and future relative TAC to the previous scenario (#2), but it is worth noting that because the underlying population dynamics have changed (by including the 40% over-catch in the conditioning model as well) the impacts are not double that of the *20% over catch* scenario. The future TAC relative to MSY should provide a measure of losses even when the historical conditioning model components are different between scenarios, and in this case future TACs relative to MSY are lower than the *20% over catch* scenario and the reference set.

The historical conditioning model component is quite different for scenario #4 (Figure 6), in which there is no historical over catch in the surface fishery and none in the projections. In this case the population dynamics are altered sufficiently for the proportion of models reaching the rebuilding target to fall below the 70% level even though less catch has been taken historically. In this case the models are slightly less productive. We have examined this more closely by looking at the parameter levels selected for each of these scenario sets in Figure 1. UAM scenario #4 is the most different from the reference set in selecting lower levels of M10 and higher M0 levels. This is most likely caused by the strong total mortality signal in the tagging data causing the M0 and M10 levels to pivot around the inherent change in *F* implied by the removal of the over-catch on the tagged ages in this case.

It should be noted that the median and lower bound of the trajectories for all of the scenarios shown here suggest that even with large amounts of additional mortality there aren't any predicted catastrophic future failures in SSB or B10+, or recruitment, and TACs do not drop lower than the current 2014 TAC level.

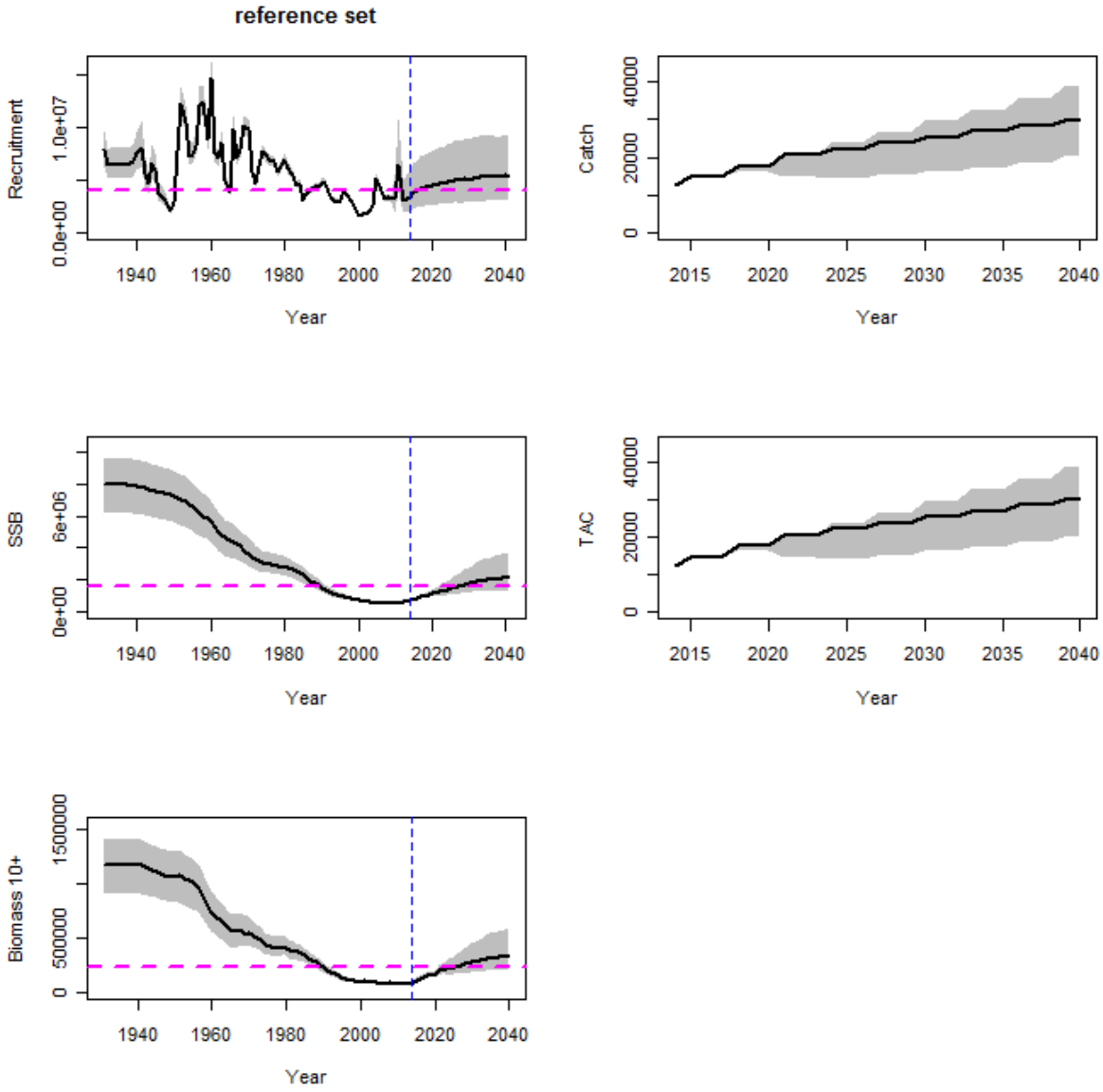

Figure 2 The reference set. Median (black line) and 90%-ile bounds on trajectories of estimates (grey area) of Recruitment, SSB (using the new method), Biomass aged 10+ for comparison with 2011 estimates of SSB, and catch and TAC. For the reference set there is no unaccounted mortality in the future projections and TAC and Catch are equal. The magenta horizontal line represents 0.5 median R(0) in the recruitment graph, 0.2 x median SSB(0) in the SSB graph, and 0.2 x median B10+(0) in the Biomass 10+ graph. The vertical blue line points out 2014.

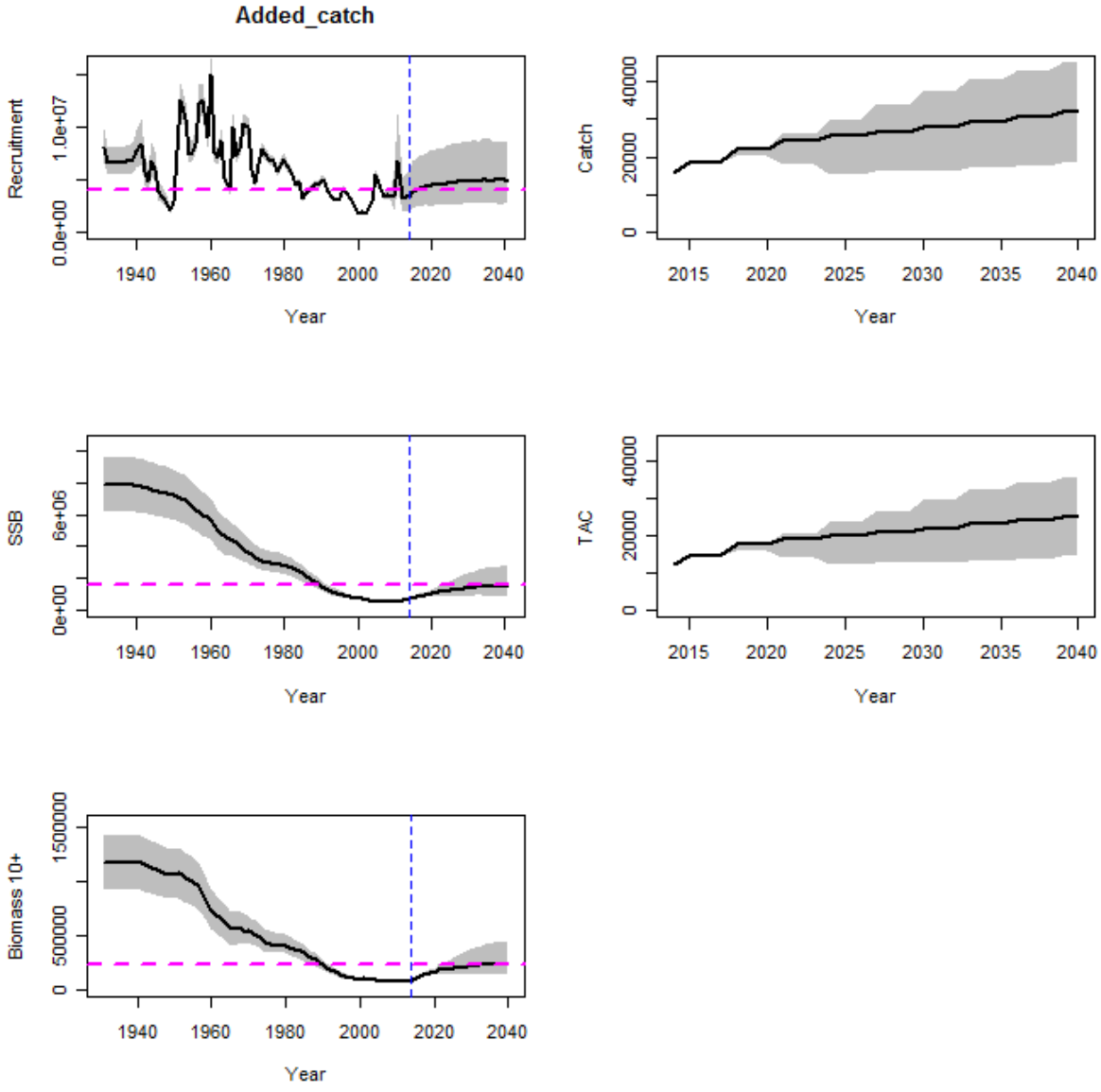

Figure 3 Added-catch UAM scenario #1. Median (black line) and 90%-ile bounds on trajectories of estimates (grey area) of Recruitment, SSB (using the new method), Biomass aged 10+ for comparison with 2011 estimates of SSB, Catch (which includes UAM) and TAC. The magenta horizontal line represents 0.5 median R(0) in the recruitment graph, 0.2 x median SSB(0) in the SSB graph, and 0.2 x median B10+(0) in the Biomass 10+ graph. The vertical blue line points out 2014.

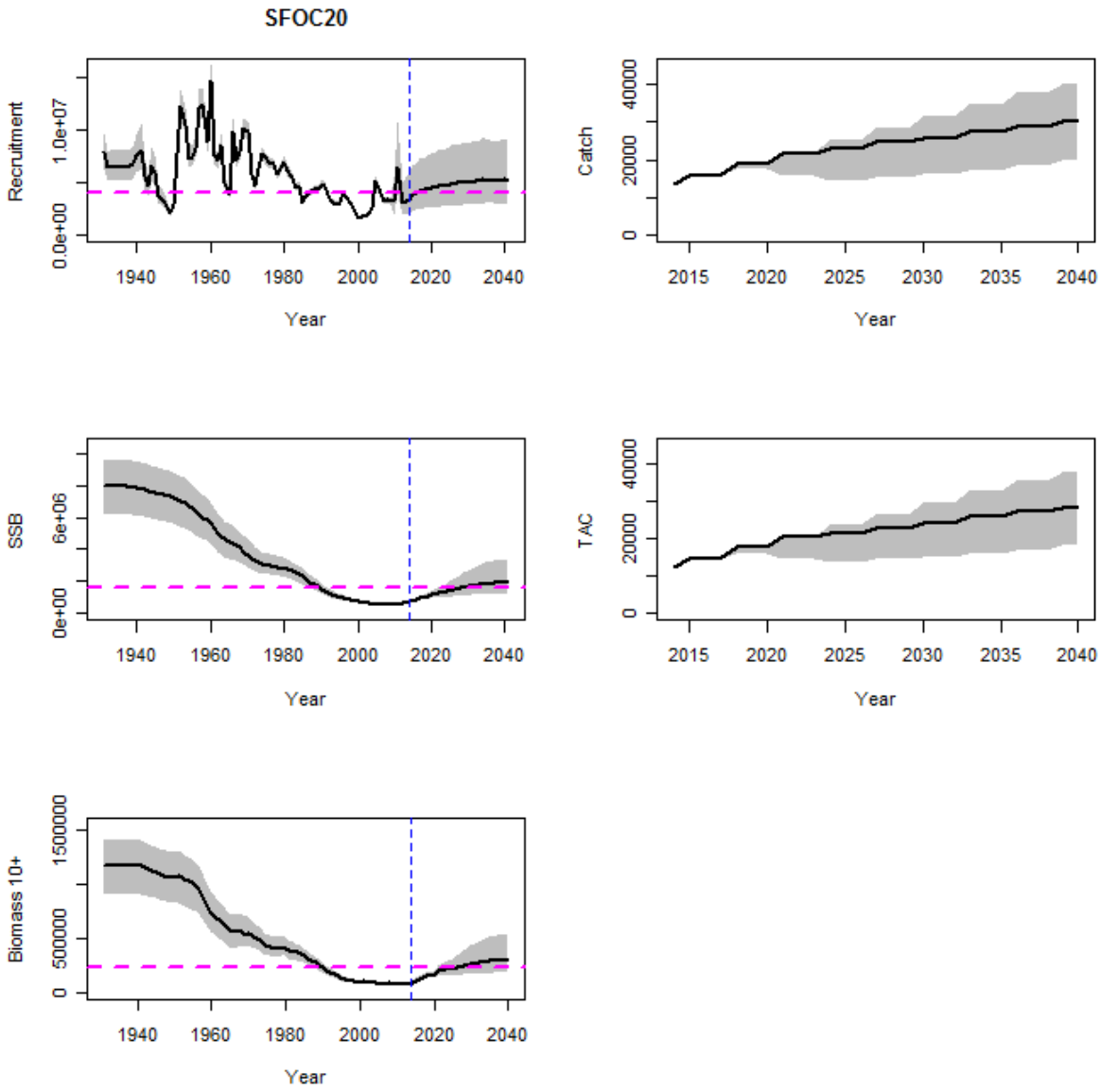

Figure 4 SFOC20 UAM scenario #2. Median (black line) and 90%-ile bounds on trajectories of estimates (grey area) of Recruitment, SSB (using the new method), Biomass aged 10+ for comparison with 2011 estimates of SSB, Catch (which includes UAM) and TAC. The magenta horizontal line represents 0.5 median R(0) in the recruitment graph, 0.2 x median SSB(0) in the SSB graph, and 0.2 x median B10+(0) in the Biomass 10+ graph. The vertical blue line points out 2014.

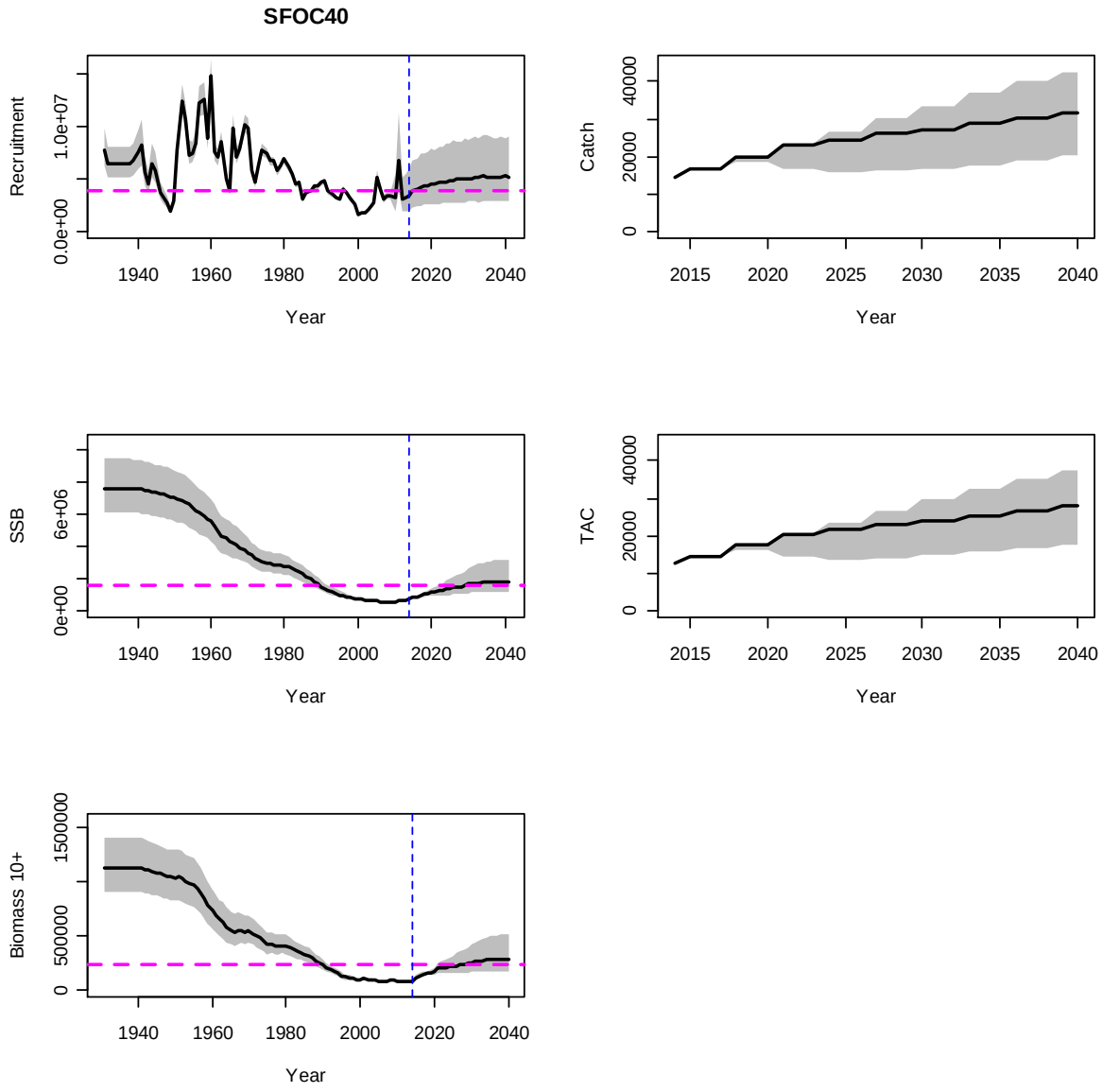

Figure 5 SFOC40 UAM scenario #3. Median (black line) and 90%-ile bounds (grey area), Recruitment, SSB (using the new method), Biomass aged 10+ for comparison with 2011 estimates of SSB, Catch (which includes UAM) and TAC. The magenta horizontal line represents 0.5 median R(0) in the recruitment graph, 0.2 x median SSB(0) in the SSB graph, and 0.2 x median B10+(0) in the Biomass 10+ graph. The vertical blue line points out 2014.

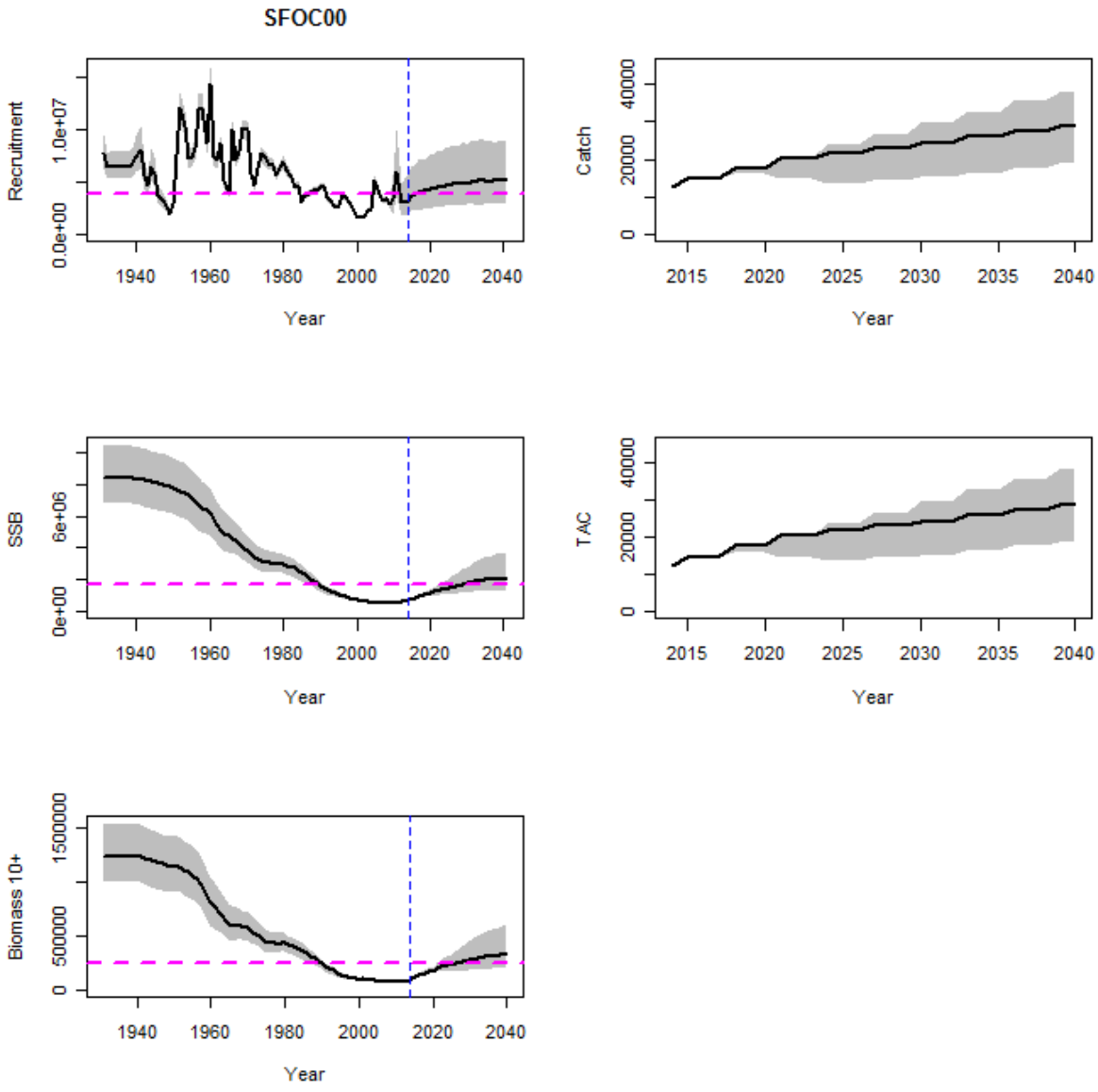

Figure 6 SFOC00 UAM scenario #4. Median (black line) and 90%-ile bounds (grey area), Recruitment, SSB (using the new method), Biomass aged 10+ for comparison with 2011 estimates of SSB, Catch (which includes UAM) and TAC. The magenta horizontal line represents 0.5 median R(0) in the recruitment graph, 0.2 x median SSB(0) in the SSB graph, and 0.2 x median B10+(0) in the Biomass 10+ graph. The vertical blue line points out 2014.

5 Consideration of exceptional circumstances

In this section we provide an initial consideration of the potential for exceptional circumstances in relation to unaccounted mortalities, as requested by the Commission (Anon 2013a). Existence of exceptional circumstances with respect to the OM reconditioning and robustness, conditions under which the MP was tested, and MP input data are discussed in Hillary et al (2014 [CCSBT-ESC/1409/21]).

As discussed in Preece et al (2014b), the meta-rules process adopted as part of the SBT management procedure, outlines the requirements of the ESC and the schedule of activities. The meta-rules process (2013 ESC Report (Anon, 2013b Appendix 10)) involves a number of steps:

1. determining whether exceptional circumstances exist,
2. a "process for action" that examines the severity of the exceptional circumstances for the operation of the MP, and the types of actions that may be considered, and
3. "principles for action" that determine how recommendations from the management procedure might be altered, if at all.

The schedule of activities also adopted as part of the meta-rules and Management Procedure are also relevant in considering the timing of the any proposed actions. In particular, the schedule for review of the Management Procedure in 2017.

In considering the potential for exceptional circumstances arising from the UAM scenarios, we have examined whether the results from the UAM scenarios indicate that 1) the input data to the MP are affected by the UAM, 2) the population dynamics under UAM scenarios are potentially significantly different from the conditions under which the MP was tested, 3) the fishery or fishing operations under UAM have changed substantially, 4) catches are greater than the MP recommended TACs, and 5) if there are impacts on the performance of the SBT rebuilding plan.

We examine each of these 5 items for "potentially occurring" exceptional circumstances:

1. Inputs to the MP: Of the scenarios tested, none directly impact the aerial survey data, but the *added-catch* scenario (#1) could potentially affect CPUE used in the MP. The UAM scenario results tend to indicate that the MP is performing reasonably well because the input data are relatively unaffected by the UAM, and the MP is able to respond to changes in biomass resulting from higher levels of fishing mortality, and this avoids the spawning stock being depleted to very low levels. However, the UAM's do impact on the extent to which the MP achieves the rebuilding criteria. Since the historical models vary very little with UAM scenarios, the issue of whether or not the AS is outside the range tested is not re-explored here as it is covered in Hillary et al. (2014).

2. Population dynamics of OMs: The UAM scenarios all ran well, without convergence problems, with the variables and parameter levels set for the reference set of operating models. This and the parameter level plots (Figure 1) indicate that the range of parameters considered in the reference set adequately covers the parameters for the UAM scenarios. It's clear from the results that estimates of current stock status change very little under the different UAM scenarios that affect the historical data. Fcurr/FMSY estimates change slightly in the median and upper bound (Table 1).

3. Fishery operations: The UAM scenarios aren't specified on the basis of any changes in fisheries operations other than through additional catches (due to a lack of data), i.e. the selectivity implications of the UAM hypotheses are dealt with by assigning the additional catches to a fishery with similar selectivity, or take into account the selectivity changes in the model, and therefore the model assumptions related to fishing operations are similar to those used to test the MP.

4. Catches greater than TAC: The UAM scenarios are based on hypotheses for additional catches that are greater than the TAC set by the management procedure. There was no "implementation error" robustness tests included in the 2011 evaluation of the management procedure. Given the current concern with

respect to UAM, it would seem prudent to include alternative forms of implementation error when the management procedure is reviewed (scheduled for 2017).

5. Impacts on the rebuilding plan: The potential impacts of historical and future unaccounted mortalities on the SBT rebuilding plan are substantial for the most extreme of the scenarios considered ("Added_catch", scenario #1) as defined at OMMP5. For this scenario, there is the substantial reduction in the probability of rebuilding the spawning stock, along with associated foregone losses in catch. The impacts of the potential surface fishery over-catch scenarios (SFOC20, SFOC40, SFOC00) are comparatively small, in that the current estimate of the probability of rebuilding to 20%B0 by 2035 in these projections are slightly lower than the target of 70%.

In summary, the UAM scenario results indicate that there remains sufficient uncertainty in key population processes that the OM adjusts natural and fishing mortality estimates and rescales biomass estimates to compensate for the additional catches taken, and the stock status remains relatively unchanged, but there is the potential for a reduction in the probability of meeting the interim rebuilding target. The management procedure wasn't tested for these hypotheses; but the feedback signal through the input data series (Aerial Survey and CPUE) in relation to reduced biomass appears to function in the way that was anticipated in the MP design and from other testing. Since the UAM scenarios are hypotheses and the information on UAM is poorly quantified, this initial examination must be considered preliminary, at best. Future analysis would no doubt benefit from more detailed information and/or data to specify the nature and duration of any UAM.

In the "process for action" stage of the meta-rules, the potential severity of the implications of the exceptional circumstances is to be considered and inform the types of actions that might be taken/recommended. In the case of these results for this set of UAM scenarios, the severity of impacts is low in the fits to the historical data and stock status estimates, but the severity can potentially be high in terms of rebuilding of the SBT stock and foregone TACs. Notwithstanding this, because one data source in the MP is fishery independent, and therefore not affected by the UAM scenarios, the other is not assumed to be directly impacted, the MP appears to still function as intended and for these projections the stock continues to rebuild, albeit to a lower level in the timeframe, and avoids further depletion to very low levels of SSB. Given that the potential severity in future projections is high, but the MP appears to be able to respond appropriately, the impact on current of stock status is low and current stock status estimates are higher than in 2011, then we do not consider that the results of these initial evaluations warrant immediate management action. We do however, consider that given the seriousness of the issues raised by these potential sources of UAM, in terms of implementation uncertainty in the MP recommended TACs and potential to undermine the agreed rebuilding plan of the Commission, it is incumbent on members and the Commission to provide data on all sources of mortality, so that these can be included in the known catch information used in the assessment of stock status and in the future review of the management procedure. In terms of the Scientific Committee, we consider the most important immediate action to increase efforts on the analysis and review of stock status indicators and request that better data be provided on potential sources of unaccounted mortality, so that these can be included in a re-evaluation of the potential impacts and be included in the known catch information used in the operating models.

The third stage of the meta-rules process is to consider "principles for action" that determine how recommendations from the management procedure might be altered, if at all. The types of actions suggested above are not related to altering management procedure recommendations, but rather for a watch on indicators and urgent action on collection and access to data for re-evaluation of potential impacts. The schedule of activities under the management procedure is: in 2016 to use the MP to recommend TACs for 2018-2020, and in 2017 to review of the MP and undertake the next stock assessment. In the interim years the Scientific Committee can re-assess impacts of UAM if data are provided, and prepare for the 2016 and 2017 work.

6 Summary

The UAM scenarios developed at the OMMP5 meeting are hypothetical and based on varying degrees of data and information. In the absence of more detailed data and information to define more specific scenarios, they are intended to examine the potential impacts of various levels of potential unaccounted mortalities. Hence, our ability to meet the request from the Commission is limited by the general nature of the information available to the working group on the scope, extent and specific nature of the potential sources of UAM. The ESC members present at the OMMP5 meeting discussed and requested access to data that may assist in refining some scenarios. It was also recognised that for some potential sources of UAM, there was little more for the working group to go on other than "the potential" for additional catches. As noted above, it is essential that the Commission and Compliance Committee are able to provide the ESC and its working groups with more specific information on the nature of alternative sources of unidentified mortality for the ESC is to provide more specific advice.

The impacts of the UAM scenarios on current stock status estimates are not substantial. The current range of OMs appear to be robust to a variety of levels of hypothetical additional sources of fishing mortality. In the case of projections, for some scenarios the impact on the probability of rebuilding to the target level was substantial and this impact may be considered severe, if it is occurring.

We have considered these results in the context of the meta-rules process, the existence of exceptional circumstances and process and principles for action. In terms of exceptional circumstances and severity, we note that if the total mortalities due to fishing are greater than the TACs recommended then the impact on the rebuilding plan may potentially be substantial.

In relation to the process and principles for action we suggest that given the estimates of stock status indicate that spawning biomass has improved since the last full reconditioning and that the management procedure appears to respond to reductions in biomass from additional catches being taken (at least in the scenarios tested to date), that the actions to consider at this time are:

1. to closely monitor the stock status and indicators, in the coming period between full stock assessments;
2. to make an urgent request to the Commission for data to better inform and refine the development of specific UAM scenarios, so that impacts can be properly assessed and the mortalities included in known catch information used in the operating models in future.

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