South Pacific Regional Fisheries Management Organisation

SPRFMO SC 3RD DEEPWATER WORKSHOP REPORT

Virtual meeting, 29 September – 2 October 2020

SPRFMO SCW10 Report 2020

Report location: https://www.sprfmo.int/meetings/scientific-committee/8th-sc-2020/

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Recommended citation:

SPRFMO (2020). SPRFMO SC 3rd Deepwater Workshop Report. 26 p. Wellington, New Zealand 2020.

Acknowledgements:

The 3rd Deepwater Workshop Report was prepared under the overall direction of the SPRFMO Scientific Committee Chairperson, Dr Jim Ianelli.

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SPRFMO SCW10-Report

Report of the Third SPRFMO Deepwater Workshop

New Zealand (held remotely), 29 September to 2 October 2020
Adopted 5 October 2020

1. First Session

1. The meeting was opened by Dr Jim Ianelli (SC Chairperson). Dr Ianelli gave a brief orientation to the Microsoft Teams environment and layout and highlighted where the workshop resources could be found.

2. Dr Ianelli asked participants to introduce themselves and a list of participants is available in Annex 1.

3. The need for the group to record relevant considerations or discussions for the question regarding the effectiveness of the Bottom Fishing CMM was highlighted.

1.1. New Bottom Fishery Impact Assessment Overview

4. Martin Cryer (New Zealand) presented a brief introduction to the joint Bottom Fishery Impact Assessment (BFIA) and the goals for this workshop. The intent is to ensure that all Members are able to understand the content of the BFIA and how it all fits together.

5. The BFIA has four Sections:

   1) Executive summary;

   2) Description of fishing activities;

   3) Mapping and description of fishing areas;

   4) Risk and impact assessment

6. Sections 2 and 3 will be covered briefly at this workshop, but the majority of the time will be spent on Section 4 which is the largest section. It is composed of eight subsections, the most substantive of which covers spatial management and VMEs.

7. Some key background information was highlighted, including the stability of the depth of fishing through time, changes in the duration of trawl tows through time, and information on the difference between midwater trawl, bottom trawl and demersal line fisheries, particularly in terms of benthic impact.

8. The quality and amount of feedback received on earlier versions was acknowledged and greatly appreciated, and it was noted that this resulted in significant improvements to the BFIA.

1.2. Information on status of deepwater stocks

Stock assessments

9. Martin Cryer (New Zealand) presented on the SPRFMO stock assessment framework for bottom fisheries (comprising 3 Tiers), including the current state of Orange roughy stocks (Tier 1), priorities for other stock assessments, and the SC assessment plan. Orange roughy stocks were first assessed in 2017 at SC5. Stock assessments for two Orange roughy stocks were updated in 2019 and updates for two additional stocks are being presented in 2020. Priority species for stock structure studies and/or other stock assessments include alfonsino, bluenose/blue-eye trevalla, wreckfish/hapuku, and toothfish. The SC multi-annual workplan includes regular ageing of otoliths and updates of Orange roughy stock assessments every three years or as new information becomes available.

10. It was noted that, in accordance with the objective of the SPRFMO Convention, SC7 had applied the precautionary principle in developing management advice for Orange roughy catch limits and yields in the face of significant uncertainty resulting from data-limited assessments. It was further noted that it was hoped that the same level of precaution be applied when assessing and managing other assets of value—such as VMEs—in SPRFMO.

11. The group noted that SPRFMO has not agreed on reference points for Orange roughy (or any stock) in the SPRFMO Area. It was clarified that the origin of the 'reference points' included on the graphs for the Orange roughy stock assessments was a Management Strategy Evaluation (MSE) completed for New Zealand Industry in 2014 and accepted for management of the New Zealand domestic Orange roughy stocks where additional information is available to inform that analysis. The group agreed that additional work on developing reference points was required and that this formed part of the SC workplan. The group also noted that Management Strategy Evaluation for Orange roughy in SPRFMO, which may inform appropriate reference points, may be feasible once there is more data derived from acoustic surveys.

12. DSCC noted that SPRFMO has different management objectives including precautionary requirements which do not exist in or are different to New Zealand fisheries management objectives and law. DSCC also noted that there may be Australian MSE or similar that may also inform SPRFMOs considerations.

13. The group queried whether age differences in the catch between long/short tows had any impact on the age composition of the catch from the Louisville area. NZ clarified that Louisville is nearly all short tows, so unlikely to have any impact on the proportion of old fish found in the Louisville.

Risk assessment for teleost fish stocks and deepwater chondrichthyans

14. Lee Georgeson (Australia) introduced the ecological risk assessments (ERAs) that have been undertaken for teleost and chondrichthyan species with which SPRFMO bottom fisheries may interact. The assessments apply two ERA tools (Productivity-Susceptibility Analysis (PSA) and Sustainability Assessment for Fishing Effects (SAFE)) to assess the relative risk of fishing using demersal trawl, midwater trawl and demersal longline gears to 159 teleost and 112 chondrichthyan species in the SPRFMO Area. Effort data used was Australian and New Zealand records for 2012-2016 for the three gear types.

15. Results for teleosts showed fewer species estimated to be at the higher end of the risk spectrum for midwater trawl and demersal trawl gears and a higher number of species estimated to be at the higher end of the risk spectrum for Demersal longline fisheries.

16. Results for chondrichthyans showed fewer species estimated to be at risk for midwater trawl gears and a higher number of species estimated to be at risk for demersal trawl and demersal longline gears.

17. The main conclusions of the assessments are that:

- A number of teleost and chondrichthyan species are assessed to be at high/extreme relative risk;
- In general, there is good concurrence between the PSA and SAFE results at the upper end of risk spectrum;
- SAFE and PSA results should be interpreted to be relative rankings and not absolute estimates of risk;
- As expected, the PSA resulted in many false positives (species assessed to be at high risk that are probably low risk in reality) and there were indications of a small number of PSA false negatives (species assessed to be low or medium risk that may be higher risk in reality);
- The results should be considered in the context of information on catches and species biology. Most species are caught in such low volumes that there is little cause for concern;
- Attempts have been made to categorise SPRFMO teleosts into the SPRFMO Stock Assessment Framework, with the majority of species proposed for inclusion under Tier 3 (no further assessment required); however, periodic updates to the ERAs for both teleosts and chondrichthyans would be beneficial;
- Teleost species of concern have been identified and workplans are being developed for stock structure studies, which may lead to assessment and/or development of precautionary management measures;

- Precaution is needed for deepwater chondrichthyans due to their low productivity, slow ability to recover, and lack of information on depletion.

18. A question was raised about taking management action based on outputs from these ERAs. It was clarified that these sorts of assessments as applied in SPRFMO are best used to prioritise species requiring more attention, but that there are examples of precautionary (but generally arbitrary) management measures that could be implemented using results from these assessments (such as catch triggers, for example) that may be useful future options.

1.3. *Interactions with marine mammals, seabirds, reptiles, and other species of concern*

Reported interactions

19. Martin Cryer (New Zealand) presented a summary (SC8-DW14) of information available on interactions with marine mammals, seabirds, reptiles, and other species of concern in bottom fisheries to meet the requirements of CMM-03-2020 (Bottom fishing). For the period 2007-2019, 27 records were held by the Secretariat on 29 reported interactions with marine mammals, seabirds, reptiles, and other species of concern, including one sea snake and one turtle, twelve sharks, 14 seabirds and one whale (nationally identified as being decomposing remains that should not be considered as a capture of a marine mammal in the fishery). Of these 27 records, eight (30%) were found through detailed inspection of Australian or New Zealand records to be erroneous or potentially misleading, suggesting that processes for verification of records and updating of databases need to be strengthened.

20. Recommendations to be presented to the SC were:

- **Notes** that documented interactions with marine mammals, seabirds, reptiles, and other species of concern are rare in bottom fisheries;
- **Agrees** that no further actions or management measures are required at this time;
- **Agrees** that monitoring of the implementation and effectiveness of mitigation approaches should continue, including periodic review of mitigation measures applied by other RFMOs and CCAMLR or advised by ACAP, to ensure best practice and consistent or complementary arrangements;
- **Agrees** that periodic exchanges of information held in SPRFMO databases with Members who submitted the data would assist in the maintenance of an accurate record of captures of marine mammals, seabirds, reptiles or other species of concern in fisheries in the SPRFMO Convention Area;
- **Agrees** that information collection and checking should continue with a view to including information from SPRFMO bottom fisheries in the Southern Hemisphere Seabird Risk Assessment.

21. The group discussed that despite the low number of records and indicative rates of interaction for these species, bycatch of very low numbers of some species may be detrimental to populations. The importance of captures needs to be considered in the context of population size and species productivity. As an example, 4 great white sharks reported captured in the period 2007-2019 should be considered in the context of a global population estimate around NZ/Australia of 5,460 individuals (with a potential range between 2,909 and 12,802). The group noted that there are some population estimates of basking sharks (10,000 individuals, probably a single global population). NZ noted that the Southern Hemisphere Seabird Risk Assessment considers seabird interaction rates and mortality against population estimates, but that data from SPRFMO fisheries are not yet included. The group noted that, ideally, this type of approach should be taken for the other species mentioned.

22. The group also noted that uncertainty in population structure and range makes it difficult to understand the potential impacts of fishing mortality (or mortality from other sources) on populations.

23. There was a suggestion that some of the uncertainty around the number of interactions and potential impacts on those populations could be addressed by increasing observer coverage in the longline fisheries. The group noted that the relatively low observer coverage (about 10%) is highly unlikely to be deployed so as to be spatially and temporally representative of the fishery. It was noted that the Risk Assessment uses capture numbers but

also uses distribution of birds and distribution of fishing effort to account for poor monitoring coverage. It was noted that electronic monitoring may be a useful way to improve data on interactions with some of these species.

24. A suggestion was made that more information or support (including, for example, identification guides) for observers to identify species of concern correctly would be useful across all SPRFMO fisheries (demersal, pelagic and squid).

1.4. Interactions with benthic habitats and VMEs

Updating and testing habitat suitability models for VME indicator taxa

25. Fabrice Stephenson (New Zealand) introduced the work done on updating Habitat Suitability Models (HSM) of VME indicator taxa. Habitat suitability models investigate the relationship between taxon occurrences (presences) and environmental variables (co-variates) to produce spatial predictions of habitat suitability.

26. The updated HSM for 10 VME indicator taxa built on previous research undertaken for SPRFMO and used the same modelling techniques – flexible machine learning models: Boosted Regression Trees (BRT); Random Forest (RF); Maximum entropy (Maxent) models which were 'ensembled' to produce a single prediction for each VME indicator taxa – and environmental variables as used by Georgian et al. (2019)[1]. The main differences between the updated HSM models and the previous Georgian et al. (2019) HMS were:

a. An increased availability of VME indicator taxa occurrence records

27. A comprehensive data collation exercise resulted in a large number of new VME indicator taxa records. This provided an opportunity to independently validate how well the models performed as well as produce final HSM predictions that are likely to be more robust.

b. A different approach to the way that 'absence' data was generated

28. True 'absence' records were not available, therefore informed pseudo absences were generated using "target-group background data" (i.e. the presence of another species as an absence). In order to reflect the assumptions that are required due to the use of (informed) pseudo absences, outputs of the HSM are referred to as habitat suitability index (HSI - which is not the same as probability occurrence).

c. A different assessment of spatial autocorrelation

29. Not accounting for the effects of spatial autocorrelation can affect the accuracy of model predictions. Effects of spatial autocorrelation were tested using Moran's I and for all taxa showed that this was unlikely to be affecting HSM predictions.

d. A more robust and comprehensive model ensembling and validation technique

30. The ensembling of individual HSMs (BRT, RF, Maxent) into a single estimate was based on how well each model performed (as assessed by Area Under the Curve – AUC) and the spatially explicit estimate of uncertainty from each model type. HSMs were first constructed using only VME indicator taxa records available for the Georgian et al. (2019) models and tested using the independent evaluation data (newly collated records). Results of this model evaluation showed that all VME indicator taxa HSMs had excellent predictive power (all AUCs for the ensemble models > 0.89). In most cases, the ensemble HSM performed as well or better than any single individual HSM (i.e. BRT, RF, Maxent). Final HSMs for each VME indicator taxa were produced using all of the available occurrence records.

[1] Georgian, S.E., Anderson, O.F., Rowden, A.A. (2019). Ensemble habitat suitability modelling of vulnerable marine ecosystem indicator taxa to inform deep-sea fisheries management in the South Pacific Ocean. Fisheries Research 211:256-274.

31. As would be expected, there were differences in the predicted distributions of HSI for different VME indicator taxa. Updated predicted distributions of VME indicator taxa HSI (using all data and the new methods) were similar to those previously produced by Georgian et al. (2019).

e. An additional estimate of spatial model uncertainty

32. In addition to producing spatial estimates of model variability, a further spatial estimate of uncertainty was generated here: the coverage of the environmental space by the VME indicator taxa records. The spatial distribution of 'environmental coverage' indicates which parts of the environmental space contain many sighting records (across all taxa) and therefore where we could expect the relationship between the environment and species to be robust. Conversely, where 'environmental coverage' is lower, greater caution should be used when interpreting the HSI values.

33. The group queried whether a lack of spatial autocorrelation may be a byproduct of sampling densities and if testing would be more challenging if there are a low number of samples adjacent to each other. In response, it was noted that that there were enough samples to test this, and autocorrelation was seen before the models were run but not after, indicating that the model has captured the predictive variables.

34. The group also queried whether there is an explanation for the drop in the AUC for "Gorgonacea" between the Georgian et al. 2019 models and the independent evaluation. In response, it was noted that this is not unexpected, and the ensemble model still performed well.

35. DSCC asked about what kind of sampling would be able to provide information on 'true' occurrence. In response, it was noted that this would likely require systematic surveys over a wide area, and that more concrete data points of 'zeros' rather that the pseudo-absences that are currently available would be needed.

36. A question was asked whether the models were better to predict rather than manage VME taxa. It was noted in reply that management takes place at a later stage than prediction. It was clarified that the data that goes into these models includes all the data that is used for the approaches that were discussed later in the workshop.

37. It was noted that absence data would need to be from unfished areas to reflect the true natural state of absences (because fished areas may result in 'artificial' true absences due to damage to or removal of VMEs or associated taxa), although it was noted that this assumption is often overlooked on data inputs for this type of modelling.

2. Second Session

2.1. Seamounts, VMEs and spatial management

38. Professors Peter Auster and Les Watling gave a presentation (SC8-Obs03) that emphasised that significant adverse impacts to indicator species alone simply defines a set of minimum bounds on the effects of human actions on VMEcosystems. Survey data on density and distribution of indicator species, while necessary, produces a static snapshot in time. Habitat suitability models and related geo-spatial analyses give an impression of precision and quantitative certainty while implicitly ignoring critical but poorly known elements of the ecology of communities and ecosystem dynamics. Management decisions, especially given the known characteristics of VMEcosystems, should be made by explicitly addressing the limits to understanding and the consequences of errors in decision-making.

39. The DSCC presentation suggested that SC should advise that:

- The encounter protocol thresholds should be reduced substantially from the current levels and instead be set to determine whether a VME has been encountered;
- the BFIA should be re-written to comply with the UNGA resolutions and FAO International Guidelines to avoid SAIs on VME;

- there is inadequate data underpinning the Habitat Suitability Index (HSI) models, the flaws in the model and note the lack of scientific underpinning of the CMM 03-2020's spatial management approach; and
- CMM 03-2020 is not appropriate for managing benthic impacts and DSCC advises that it should be rewritten to avoid SAIs on VMEs and to implement the UNGA resolutions, so that areas where VMEs are known or likely to occur –including seamounts and similar features– should be closed to bottom trawling, and that an encounter protocol be put into place which is designed to be triggered when a VME has been encountered.

40. DSCC further suggested that the SC should also note that the current measure contains no mechanism to close VMEs once they are identified.

41. A question was raised regarding a reference in the BFIA to a Department of Fisheries and Oceans (DFO) Canada report, the quote chosen and the validity of that report and its guidance, given that it was a report relating to Newfoundland waters, and not one directly subject to the UNGA resolutions and FAO Deep Sea Guidelines. It was noted that the report recommended that under a precautionary approach, 100% of Sensitive Biological Areas should be protected. It was clarified that the report was predicated on expert opinion based on existing analyses for Newfoundland waters and used as general guidance for approaches taken elsewhere, given the paucity of guidance in the literature.

42. It was observed that without understanding connectivity, we don't understand the spatial scale of impact. If there are source populations in the areas where the fishing is permitted to take place, this could result in impacting indicator species well beyond where fishing occurs.

43. It was also noted that one cannot conflate VMEs with VME indicator taxa, and that not all ecosystems with indicator taxa are alike. The protection of an indicator taxa doesn't necessarily equate to the protection of associated species, if there is high turnover of associated species between areas in which an indicator taxa occurs.

44. The workshop noted that a key challenge when interpreting the results of the BFIA was that there are no SPRFMO-agreed thresholds for what may be an appropriate level of protection for VMEs or an appropriate reference point for VME status. It was further noted that the ecological basis for the thresholds from the national DFO report on the Newfoundland and Labrador region (where, using expert opinion based on existing analyses, an interim limit of about 70% protection of Significant Biological Areas was given, subject to an recommended precautionary 100% protection requirement;) and the MSC guidelines ('serious or irreversible harm' is to be interpreted as reductions in VME habitat structure and function below 80% of the unimpacted level) was uncertain. In the absence of a scientific or ecological basis against which to consider thresholds relevant to the SPRFMO Area, it was observed that the selection of thresholds and reference points for VMEs was largely a management question relating to the desired level of precaution. The group suggested that the Scientific Committee may wish to request the Commission to provide advice on either what suitable reference points might be for either desired VME indicator taxa status or suitable measures for VME protection (or both).

2.2. Risk assessment for benthic habitats, biodiversity and VMEs

Estimating the footprint of SPRFMO fisheries

45. Owen Anderson (New Zealand) presented an analysis of the bottom fishing footprint for the Evaluated Area based on fishing activities by New Zealand and Australian vessels. The footprint, defined as the area of the sea floor potentially contacted by bottom fishing gear, was constructed from reported demersal and midwater trawling, and bottom longlining fishing effort records from 1989 to 2019. These records were dominated by New Zealand fishing, for both trawling and longlining, and for vessels of both nations trawl fishing effort far outweighed longline effort in most years.

46. The process of data cleaning was briefly discussed, in particular how overly long fishing events were dealt with, the need for jittering of positional data recorded at low precision, and corrections for the gear:ship offset in the trawl records.

47. The conversion of fishing events into segments for the calculation of footprint was described. A table of nominal trawl widths for fishing type (slope, UTF, midwater) and nationality was presented, noting that Australian vessels tend to have used smaller gear; and the further adjustment of these widths according to the varying level of impacts from these fishing types was described. It was noted that midwater trawls have very little contact on the seafloor. Bottom longline impact widths were due mostly to the movement of the backbone during line retrieval, and a depth-based formula for calculating this width was presented based on analysis of hauling lateral-movement data provided in Darby 2010[2] and Welsford et al. 2013[3].

48. The creation of a footprint raster layer was described, using the methods of Mormede et al. 2017 (SC5-DW06) and the relative contributions of the three fishing methods illustrated. Figures were presented which showed that about 6.6% of the fishable area within the Evaluated Area were contacted by fishing gear during the 30-year period. Higher percentages were shown for fishable depths within some of the management sub-areas, particularly where these fishable areas are quite limited in the three sub-areas of the Louisville Seamount Chain.

49. HSFG queried the figures given for the effective bottom contact width of UTF tows using trawl gears and clarification was provided as to how the trawl widths were further adjusted using bottom contact ratios in Mormede et al. 2017. HFSG noted that their understanding of bottom longline contact was significantly less than used here. The group clarified that the figures used were estimated based on lateral movements that mainly occur during line retrieval.

50. It was identified that the footprint calculation could be parsed into depth strata given the expectation that there are different biological communities by depth.

51. HSFG noted that in the Northwest Challenger stock assessment many east-west positional errors were found that were an artefact of Louisville Ridge effort that had been transposed onto the Northwest Challenger area. The presenter clarified that a similar east-west error checking process had been applied.

52. The group discussed the issue of positional accuracy of the data in relation to the ability to fish different features depending on their characteristics. It was noted that fishing is reported at a 1 minute resolution, which is the reason for the ±0.5 minute jittering. The group noted that such jittering could overestimate the true footprint, particularly on features. It was noted that the scale of cells was tested by Mormede et al. (2017) and was found to be the most appropriate but that some of the footprint could be overestimated and that it was unclear by how much. An analysis by Penney (2013) SC-01-20 showed that footprint analysis based on cells tended to substantially overestimate the footprint compared to using a direct measure of swept area.

53. It was also noted that only about 20% of midwater tows touch the seafloor and that any contact with the seafloor was typically of a very short duration as shown by Tingley (2014) SC-02-10.

54. DSCC noted that the question of scale is an area that needs further discussion and analysis and expressed a view that bioregions are an inappropriate scale to use for these analyses as they have not been proven to be biologically relevant to VMEs.

Assessing current status of benthic communities: "naturalness"

55. Owen Anderson gave a presentation describing the calculation of spatial estimates of naturalness, the degree of closeness to the natural state of a benthic taxon or habitat, for the VME taxa assessed in habitat suitability and Zonation models – based on the fishing footprint from New Zealand and Australian fishing.

56. Two existing modelling approaches were considered: 1) the Mormede et. al (2017) (SC5-DW06) method (MSRP) which applies impact indices to the fishing footprint segments which are then combined using random overlap,

[2] Darby, C. (2010). Preliminary assessment of the potential for the proposed bottom fishing activities to have significant adverse impact on vulnerable marine ecosystems. CCAMLR WG-EMM10/33.

[3] Welsford, D.C., G.P. Ewing, A.J. Constable, T. Hibberd, and R. Kilpatrick. (2013). Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal gears. Australian Antarctic Division.

and 2) the Relative Benthic Status (RBS) method of Pitcher et al. (2017)[4] based on cumulative fishing (the swept area ratio, SAR) with depletion (d) and recovery (R) rates using the equilibrium solution of the Schaeffer stock production model. For the purpose of estimating naturalness, however, both of these models have drawbacks; the MSRP method assumes no recovery of the habitat, and the RBS method implicitly considers future as well as historical fishing effort. An alternative to these methods was developed that uses the Schaeffer model and applies depletion and recovery with average annual SARs iteratively for each of the 30 years of reported fishing. This method provides an estimate of current-day relative status (naturalness), taking into account the potential for recovery and only historical-to-current effort.

57. A key element of the naturalness calculations is the determination of appropriate d and R values for the taxa being assessed. There are limited empirical studies reporting such values for deepwater VME indicator taxa in the region, with the best available values assembled from three key published reports (Pitcher et al. 2007 and 2015, Wellsford et al. 2014, and Mormede et al. 2017) and sensitivities (one pessimistic and one optimistic scenario) around base estimates determined from uncertainties in the original Pitcher et al. (2007) report. Naturalness was shown to be highest for sea pens and sponges, and lowest for stony coral species.

58. The group noted that alternative values for depletion and recovery rates have recently been published based on an international collaboration in 2019. The group also queried whether depletion and recovery rates were based on data from observations at Orange roughy fishing depths. It was clarified that the 2019 international collaboration looked at longevity of general benthic invertebrates rather than VME indicator taxa *per se*, rather than the organisms being considered in these analyses, and which may have higher depletion rates. Rates used are based on a number of previous studies that in turn were based on some empirical field data and/or field observations, and the uncertainty ranges were based on analysis of variability among estimates for the same types of biota from available data, including some similar species at similar depths (not specifically in SPRFMO).

59. Les Watling noted that groups like antipatharians and gorgonians have disparate longevities, and asked how can a single R value be used? Black corals Leiopathes in the area lives over 2000 years. Shouldn't the recovery value for a group be the worst-case Rate rather than the average?

Relationship between habitat suitability and abundance of VME indicator taxa

60. Roland Pitcher (Australia) presented on the relationship between the abundance of VME indicator taxa and habitat suitability models. The presenter noted that assessment of the spatial performance of CMM03-2020 in terms of VME taxa abundance requires relationships between observed abundances of VME taxa on the seabed and predicted HSI; that if relationships exist they can improve the post-accounting summation of the amount of VME taxa abundance assumed to be protected by CMM03-2020 and also the assessment of the status of VME indicator taxa; that the approach involves collating datasets from extensive research surveys and comparing and plotting observed absences and abundances of VME taxa against predicted HSI at the same locations; and that these results build on those presented in SC07-DW21-rev1, which used survey data from South East Australia and earlier predictions of Habitat Suitability Probability as used in CMM03-2019.

61. The presenter noted that the basic question is: What level of actual VME indicator taxa abundances on the seabed correspond with predicted habitat suitability probabilities? The relationship may be simple linear (as has been assumed previously), but could be complex or not evident. Can any kind of model be fitted, at all and consistently across multiple survey datasets that recorded different abundance metrics, in a way that can be synthesized?

62. The methods were outlined by the presenter and details and maps of 6 extensive integrated survey data-types were presented, including: SE Aus video (4 taxa, % cover); Australian survey sampling (incl. NORFANZ, 8 taxa,

[4] Pitcher, C.R., N. Ellis, S. Jennings, J.G. Hiddink, T. Mazor, M.J. Kaiser, M.I. Kangas, R.A. McConnaughey, A.M. Parma, and A. D. Rijnsdorp. (2017). Estimating the sustainability of towed fishing-gear impacts on seabed habitats: a simple quantitative risk assessment method applicable to data-limited fisheries. Methods in Ecology and Evolution 8:472-480

biomass); NIWA DTIS video compilation (of 3 taxa, counts); OS2020 DTIS video (6 taxa , counts); NIWA survey sampling (10 taxa, counts); Chatham's survey sampling (6 taxa, biomass).

63. Results of fitting procedures for each dataset were presented. The most frequently observed patterns were: 1) prevalence of zero observations extending well into high and very high predicted HSI, with 2) non-zero observations occurring predominantly at high and very high predicted HSI, with substantive non-zero abundances occurring primarily at the highest predicted HSI in for most taxa in most datasets. While many cases showed similar raw patterns of observed versus predicted, there were also cases of no clear pattern, and at least one case of an apparent negative pattern, and another of insufficient data. The plots of raw observations suggest that while there may be a relationship between observed abundance and predicted HSI, the relationship is not simple or linear. Given the frequent pattern of typically steeply increasing observed abundance relationships at high predicted HSI, a power relationship was considered appropriate and fitted to the mean trend of the observations and tested against the raw observations. The final range of power estimates were presented with an estimate of uncertainty range, for each taxon. The profile of predicted $HSI^{\wedge power}$ was used as an approximate surrogate for abundance in status assessment and post-accounting, but should not be interpreted as a prediction of abundance.

64. The group sought clarification as to what each data point (green **+** symbol) referred to on the HSI-abundance relationships figures. It was clarified that each point represented the percent coverage of a taxon across a transect, with transect area (about 2,000-4,000 m^2) varying depending on the sampling type (e.g. video versus sleds or beam-trawls).

65. High Seas Fishing Group queried the statistical approach taken, and whether it was mathematically robust and appropriately deals with the uncertainty around each of the inputs. Potential areas for more exploration included the use of the same data in the HSI models and for this analysis, the use of R-squared values for weighting, the treatment of the species/areas for which there was no relationship between the HSI and abundance, and how absence data were treated.

66. It was noted that one of the plots shown indicated good concurrence of observed presences with the HSI models, which was encouraging. Nevertheless, there are also larger numbers of observed absences at high values of predicted HSI.

67. After noting the complex and variable relationships between HSI and abundance and the associated uncertainty this has, DSCC expressed a view that the windows for impacting VMEs within seamounts is not an appropriate approach.

68. The presenter noted that it is an important issue that models are optimistically predicting presence where there are records of absence, and that this cannot be solely attributed to granularity/spatial mismatch of sampling. Secondly, the variable relationship between predicted HSI and abundance illustrates the uncertainty around what HSI means in terms of abundance.

Cumulative assessment of the status of VME taxa for the joint NZ-Australia BFIA

69. Roland Pitcher (Australia) presented 'Cumulative assessment of the status of VME taxa for the joint NZ-Australia BFIA' using the RBS risk assessment method. The presenter noted that the RBS method (Pitcher et al. 2017) had been applied in accordance with the BFIA Standard adopted at SC7, and that these methods were also being adopted by MSC and recommended by ICES to the European Commission for application under the Marine Strategy Framework Directive to ensure seafloor integrity. The presenter explained that RBS is a quantitative ERA method based on the Schaefer (1954) [5] stock assessment model, simplified to estimate long-term equilibrium relative abundance due to the data-limited circumstances of VME applications. RBS requires maps of fishing intensity and taxa distributions – and parameters for trawl impact and recovery rates (which are uncertain for VMEs, but have some empirical basis in published studies).

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[5] Schaefer, M.B. (1954). Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. Inter-American Tropical Tuna Commission Bulletin 1(2).

70. The presenter noted that, as with post-accounting, there are many possible permutations for RBS assessment: 1) three fishing effort scenarios (historical, recent/current, future); 2) predicted distributions for ten VME taxa; 3) seven taxa distribution uncertainties (base HSI; CV wtd; ROC threshold; extrapolated area; power transforms); 4) 21 Reporting areas (Evaluated Area; Fishery Management Areas; bottom trawl management areas); 5) three Taxa sensitivities of depletion/recovery (low|mean|high range sensitivity) — giving 13,230 combinations.

71. The fishing effort scenarios were: 1. the historical effort as an annual average; 2. Recent/current effort based on last 10 year for trawl and last 7 years for longline and confining effort to within current permitted areas; 3. a scenario that considered the potential limits imposed by the CMM, which are catch limits rather than effort limits, so assumed that future effort could increase to catch those limits.

72. Given that current effort is less than historical effort, current projected RBS is higher for all cases compared with that for historical effort, nevertheless, recovery may take a very long time (many decades to centuries) for most taxa to recover from historical impacts to the current RBS levels indicated.

73. Histograms of predicted HSI distributions were presented, which showed that for some taxa, the highest HSI values are relatively biased towards trawled cells, e.g. COB, SVA and some others, whereas some other taxa are not obviously biased, and some may be biased away from trawling, at regional scale. These patterns affect how the RBS result differs for different distribution uncertainties in some cases.

74. In general, RBS is lowest in the historical effort scenario; and in the future scenario, RBS is mostly lower than in the current scenario. RBS scores within BTMAs are lower than for FMAs, which are lower than for the Evaluated Area. At the scale of the Evaluated Area, overall RBS is lower for Solenosmilia and other hard corals than for other taxa, but varies among FMAs. Among FMAs, overall RBS is lower for NW Challenger, South Lord Howe, Central Louisville, North Louisville. It was noted that SPRFMO has no reference points for VMEs, but borrowing the Marine Stewardship Council's 80% threshold, in most cases RBS is >80% though RBS is <80% for: 42 historical, 17 current & 27 future cases at FMA scales (each out of 700 cases); 124 historical, 59 current & 89 future cases for BTMAs within FMAs. Nevertheless, it is not known whether 80% is an appropriate biological / ecological threshold for VMEs. Large uncertainties in taxa distributions and taxa sensitivities leads to low confidence in estimates of actual status of VMEs. The biologically/ecologically relevant scales for assessments of VMEs are not currently known.

75. The group noted that RBS is the best approach available to assess current status. A number of concerns were expressed about differences in how the Receiver Operator Characteristic (ROC) curves had been applied in the RBS versus the post-accounting statistics. The ROC approach adopted for RBS is not based on a classification of suitable / unsuitable habitat as is used in the post-accounting but, rather, a type of abundance proxy. It was noted that for the post accounting, three approaches were used; the first was a linear interpretation, the second was to classify suitable habitat using the ROC curve to identify a 'cut off' for what constituted suitable habitat, and a third using a proxy for abundance based on the power high and power low analyses. It was noted that for the RBS assessment, the power relationship analyses did not include areas of poor environmental coverage (e.g. the extrapolated environmental layer). Some participants thought this may result in the level of impact being overstated.

76. The group noted that for some scenarios in which RBS was estimated to be below 0.8 that it was important to consider the proportion of total assumed suitable habitat for each taxon that is estimated to occur within a particular area (e.g. FMA). The post-accounting statistics indicate that in some scenarios, this proportion is very small, but in others is substantive.

77. The group noted issues of scale around the question of appropriate reference points against which to consider RBS results. For example, it could be interpreted that the average status for the region being assessed could be a particular proportion of carrying capacity (e.g. 80% as used by MSC) but it could also be interpreted that each individual cell must be maintained above this threshold. It was clarified that for these analyses, the first interpretation is used and that this has been done for a range of scales.

78. It was stated that this was similar to how things are done in Europe, but that at the same time it is quite interesting to test for the other criteria too as these averages are relatively insensitive to changes in fishing activity.

79. There was continued discussion about the fitting of the model, and in particular if the super smoother was fitted outside of the range of the data. The presenter referred to Appendix G of the BFIA for plots of the data on the natural scale and concluded that the super smoother is a robust type of running-means of the observed data, using a 3x cross-validated window, and cannot be outside the range of the data.

2.3. HSFG perspective

80. Patrick Cordue (HSFG) presented some information about the power relationships and their concerns with the methods and its application. Plots were provided indicating examples where the 'super smoother' does not appear to fit the data. The super-smoother also seems to be constrained near zero due to the high prevalence zero data until the zero data runs out, at which point the super-smoother curve increases rapidly. The presenter argued that the power estimates are an artefact of the estimation process being used, and that the ROC estimates would be better to base the post-accounting process on.

81. Australia noted the importance of exploring uncertainty with the work but expressed concern that HSFG had not submitted a paper to the SC outlining their concerns and proposing credible alternatives. Australia also sought clarification as to whether HSFG was rejecting these analyses in the BFIA and whether this meant they were rejecting the BFIA in its entirety.

82. HSFG clarified that they were not rejecting the BFIA, but did feel that the presentation contained valid points. The HSFG do appreciate the work and time pressure associated with the work has been completed under but acknowledged the need to do the job correctly and not press ahead with approaches that have not been fully worked through.

83. The presenter suggested to use the ROC estimates and not use the power estimates given the methodological issues identified.

84. Australia noted that the relationships between abundance and habitat suitability is a particularly complicated topic. It was noted that if more time were available to do this work that different approaches could have been explored. Australia suggested that participants look at the plots provided to see the very uncertain relationship between HSI and abundance, but that even without fitting a relationship, it was clear that for many taxa, substantive non-zero abundances occur primarily at the highest predicted HSI and that there are high densities of observed zero observations even at high estimated HSI. It was reiterated that the reason that the curves often follow the x axis is due to the large number of zero observations—the high density of which may not be evident on the plots. It was also noted that the purpose of the approach is to build a surrogate for abundance and not to predict abundance.

85. New Zealand expressed concern about the ensembling of the curves and presented a table that showed that, of the 37 individual fits, 19 individual fits with shallow or no relationship between HSI and abundance fell outside the range of the high and low power curves used in the post accounting and RBS analyses. No individual fits had higher slopes than the high power curve used in the BFIA. Thus, the ensembling approach appears to have selected high-slope fits preferentially. They therefore requested plots of each of the 37 raw data sets against the final high and low power curves used in the BFIA – 37 possibly comparisons – to assess the extent to which the curves used faithfully represented all the data.

86. Australia noted that if relationships were actually linear then a power of 1 would have had the highest Rsqd, and that producing the requested plots was unlikely to resolve these issues because of the disparate nature of the survey datasets and that predicted HSI does not particularly reflect actual observed abundance or absences, resulting in a high level of uncertainty around what HSI means in terms of VME taxa abundance protected. It was noted in a presentation that the uncertainty ranges were based on +/- the SEs of the individuals taxa-by-dataset fits.

87. Australia noted that because the majority of survey datasets of VME taxa abundance on the seabed showed that the HSI values above the ROC threshold more often correspond to observed absences than presences, this adds another level of uncertainty that the BFIA needs to consider. Predicting VME taxa to be present where VME taxa are not present has important implications for the post-accounting and status assessment.

88. New Zealand noted that in their view, the FAO guidelines do not explicitly reference abundance and are clear that the extent of habitat is a factor that should be considered when assessing SAI. The ROC approach of classifying into suitable and unsuitable habitat is a natural use of the models and a good approach in the absence of abundance information.

89. DSCC noted that it was their understanding that the BFIA is required by the CMM for fishing to continue. The HSFG appears to be expressing concern over the uncertainties in the BFIA. As it also has not been demonstrated that the BFIA prevent SAI on VMES, this leads to the view that fishing should be halted until a revised BFIA is adopted.

3. Third Session

3.1. Mitigation, management, and monitoring measures

Spatial prioritisation for conservation: Zonation

90. Carolyn Lundquist (New Zealand) presented an analysis of the performance of the spatial management areas using the Zonation spatial decision support tool. This analysis built on prior spatial management analyses that informed CMM 03-2019 (Bottom fishing), and evaluated the sensitivity of the spatial prioritisation to new predictive models for VME indicator taxa and for estimating the degree of naturalness.

91. First, the presentation discussed sensitivity to the updated habitat suitability models for VME indicator taxa, including presentations of spatial prioritisations using boosted regression trees (BRT), maximum entropy (MaxEnt), random forest (RF) and Ensemble models. Prioritisations included weighted uncertainty layers, and were generally similar to those that informed CMM 03-2019 (Bottom fishing). Evaluation of spatial differences between spatial outputs showcased that largest differences were within areas with poor environmental coverage. These areas typically had low habitat suitability and limited overlap with highest priority areas for VMEs, such that these changes had limited influence on the location of highest priority areas identified within the prioritisation. A second evaluation demonstrated the limited sensitivity of the Zonation outputs to three different iterations of naturalness (base, optimistic, and pessimistic). Finally, comparisons of spatial outputs were compared between the 2020 Zonation outputs and those used to inform the CMM.

92. Evaluation metrics for VME taxa were presented in a subsequent presentation, including four scales of analysis: 1) full evaluated area (200 m – 3000 m depths); 2) biogeographic realms in the SPRFMO region, including 5 realms (Costello et al. 2017[6]); 3) broad fisheries assessment areas as used in the 2018 Zonation evaluation of the CMM; and 4) Orange roughy management areas based on FMAs presented in Clark et al. (2016)[7].

93. DSCC asked about whether there were differences in biomes by depth. The presenter noted that many of those biomes include large areas of deep water, but the exact percentages were not immediately available. In addition, it was noted that the majority of the areas considered for zonation are clipped to the depths covered by the HSI models. There is no summary of differences by depth among the biomes provided.

[6] Costello, M.J., P. Tsai, P.S. Wong, A.K.L. Cheung, Z. Basher, and C. Chaudhary. (2017). Marine biogeographic realms and species endemicity. Nature communications 8:1-10.

[7] Clark, M., P. McMillan, O. Anderson, and M. Roux. (2016). Stock management areas for orange roughy (*Hoplostethus atlanticus*) in the Tasman Sea and western South Pacific Ocean. New Zealand Fisheries Assessment Report 19:27.

94. DSCC also commented about the difference in HSI results between true occurrence and predictions and noted the previously mentioned issues with regional approaches. The reason for the lower protection of the rare taxa in the management area analysis was queried. It was clarified that it was an issue of sampling effort and a product of a high proportion of available samples coming from observed fishing effort and therefore somewhat biased towards fished areas.

95. The European Union asked why the level of protection is part of post-processing and not part of the zonation optimisation itself. New Zealand responded that Zonation only guided the drawing of boxes in this case and was not used to define them. The post-accounting assesses performance once the boxes are drawn.

Recap of 2018 approach to assessment

96. Martin Cryer presented a reminder of the rationale provided in 2018 for CMM03-2019 (and subsequently CMM03-2020). Bottom trawl management areas (BTMA) had been designed using priorities (for conservation) generated by Zonation and other information on the distribution and value of fishing in different locations, predicted naturalness, and depth. The estimated performance of the BTMAs at protecting proportions of each VME indicator taxon, as well as rare taxa, hydrothermal vents, and Ecologically or Biologically Significant Areas, (EBSA), was calculated at a range of spatial scales from the whole Evaluated Area to six fisheries administrative units. Performance was calculated by summing HSI indices inside and outside the BTMA. Because fishing occurs only to about 1,250 m depth and some VME indicator taxa are known to occur much deeper than this, especially on the Louisville Ridge, the performance of the BTMA was also estimated based on the assumption that VME indicator taxa deeper than 1,400 m were effectively protected from fishing. This was considered a conservative assessment. Allowing for this depth refuge, it was estimated that >70% of stony corals and other VME indicator taxa would not be exposed to impacts of fishing if the BTMA were established.

97. Australia commented on the depth distribution of the coral species, in particular the Scleractinia. The plot shown from the most recent reference (Tracey & Hjorvarsdottir 2019[8]) appeared to indicate that the core stony coral depth distribution is within the depth distribution of the fishing. The Clark paper indicates deeper distribution of the stony corals on a number of features on the Louisville Ridge, but it was noted that recent research on seamounts off southeastern Australia indicates that the core depth ranges for stony corals in these areas is shallower than what is indicated for the Louisville Ridge, and is within fishable depths. Based on these differences, Australia noted that core depth range of various other taxa was also likely to vary spatially.

98. In response, it was noted that the Tracey & Hjorvarsdottir (2019) paper is aggregated across a wider space, not just Louisville and the core distribution is within fishable depth. In the post-accounting, the sensitivity run that includes a depth cut-off only changes outputs on the Louisville Ridge where the coral distribution is estimated to be deeper. There are four particular features where half or more of the live stony coral distribution is below fishable depth and it was noted that the depth sensitivity in the post accounting uses a 'cut off' depth of 1400 m, 150 m deeper than actual fishing activity. The depth distribution sensitivity analysis is unlikely to be relevant in all areas and for all taxa and makes little difference outside the Louisville Ridge.

99. There was a question about the amount of shallower (<800 m) water there is in the areas being analysed as there is a lot of coral in shallower waters and not much Orange roughy fishing. It was identified that there is not much water shallower than 800 m, particularly in the Louisville Ridge. Information on depth of fishing is provided in the BFIA.

100. There was also some additional information provided from another study of coral depths across the Pacific that found results similar to the 2019 paper (that showed core coral distribution shallower than fishable depths) but also had more examples of distribution into deeper waters.

[8] Tracey, D.M. & Hjorvarsdottir, F. (eds, comps) (2019). The State of Knowledge of Deep-Sea Corals in the New Zealand Region. NIWA Science and Technology Series Number 84. 140 p.

101. DSCC expressed concerns about how the DFO report[9] is referenced and commented on in the BFIA and noted that the DFO work was based in Newfoundland which is continental shelf and slope areas (not features like the Louisville). There was also some concern from DSCC at the treatment of rare species as they are clearly a key part of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO Deep-Sea Guidelines) and need to be considered in any process and analysis. Until we know species are not rare, there is a need to be precautionary as per the Convention.

102. The challenges of identifying 'rare' species was identified as the limited sampling means species may be rare because of the low sampling or because they are actually rare, and it is not possible to differentiate. 'Rare' in the analysis was done based on the numbers of records of particular species.

103. Australia identified the need to be clear that the 2018 post accounting was based on a sum of HSI values, which implicitly assumes that the relationship between HSI and abundance is linear. This affects how performance statistics are calculated.

104. New Zealand agreed that this is an accurate characterisation of the post accounting done in 2018 and noted that there has been extensive discussion on this topic, resulting in the range of approaches presented to workshops and the Scientific Committee since. New Zealand noted a preference for assessment in terms of suitable habitat and noted that classifying suitable/non-suitable habitat is a natural approach to interpret the HSI models (e.g. the ROC method in the current post-accounting analyses). The point was also made that modelling abundance would be the best approach but that there is insufficient data available, which is why HSI was the approach selected.

Performance of current spatial management arrangements: "post accounting"

105. This agenda item was presented and discussed under the agenda item below.

3.2. Re-assessment in terms of suitable habitat and abundance

106. Tom Brough (New Zealand) presented methods and results towards the reassessment of the bottom trawl management areas (BTMAs) as conservation management measures for Vulnerable Marine Ecosystem (VME) taxa in the SPRFMO area. The reassessment was performed by calculating the percentage of VME taxa within and outside of areas open to bottom fishing by summing the values of each taxa from layers denoting their modelled distribution. Different reporting metrics were used that summed the raw HSI values, classified HSI values using a Receiver Operating Characteristic (ROC) curve, and two measures of 'abundance' using power relationships. Percentage outside of open fishing areas were reporting at three scales: entire evaluation area, bioregions, and at Orange roughy Fisheries Management Areas (FMA). While this assessment has been performed for each VME taxa independently, broad results were presented with taxa grouped into stony coral and 'other' VME taxa groupings.

107. At the broadest scales (evaluated area and bioregion), proportion of suitable habitat protected was qualitatively high, being less than 70% for stony corals within the New Zealand bioregion and under the Power scenarios only. At the finer FMA scale, proportion of suitable habitat protected was less than 70% for all reporting metrics and both taxa groupings (stony coral and 'other' VME taxa) within the NW challenger and Central and Southern Louisville FMAs. When viewed at higher taxonomic groupings, heterogeneity in distribution of certain taxa relative to the BTMAs was evident at this fine scale. In general, there was good accordance between the different reporting metrics across the different scale and taxa groupings.

108. The sensitivity of the reassessment was investigated in accordance with the distribution of sampling effort (environmental coverage) and under the assumption of a depth refuge for taxa distributed deeper than 1400 m. When clipped to regions of good environmental coverage, there was a small decline in the proportion of suitable habitat protected for most taxa across each reporting scale. When considering taxa deeper than 1400

[9] DFO. 2017. Guidance on the level of protection of significant areas of coldwater corals and spongedominated communities in Newfoundland and Labrador waters.

m 'protected', there was a substantial increase in the proportion of suitable habitat assumed to be protected in the Louisville FMAs and in the NW Challenger. However, the proportion of suitable habitat assumed to be protected for both taxa groupings largely remained below 70% in the NW Challenger FMA.

3.3. Discussion

109. There was a brief discussion about the challenges in identifying what the 'cut-off' value should be for consideration of what is an adequate/acceptable level of protection. There is very little guidance or scientific information to justify a recommendation on this, and without guidance from Commission it is difficult to justify any particular value. It was noted that 70% was used as that reference point arbitrarily for this presentation, based on the DFO (2017) paper.

110. Australia noted their concerns about how the ROC thresholds had been used in the post-accounting results. For these results, the cutoff value for the ROC threshold was used to classify protection as 1 (above the threshold) or zero (below the threshold). Using this method, cells with HSI above the threshold are summed to estimate the proportion of suitable habitat protected. The limitations of this approach were explained using the example of *Solenosmilia variabilis* (a habitat forming stony coral) where the ROC threshold estimated from the ensemble HSI model was estimated to be just under 0.5. However, data from observations suggests that presence of this taxon generally does not occur until HSI values of at least 0.6 are reached and significant abundances of this taxon don not occur until values of at least 0.8 are reached. Consequently, the method of transforming all HSI cells over the ROC threshold of 0.5 for this taxon into 1 is, in their view, difficult to justify given these observed abundance patterns.

111. DSCC reiterated their concerns about the appropriate levels of protection and noted that this presentation did not consider rare species. They also noted a view that bioregions are likely to be too coarse for VME processes and are not appropriate at a relevant biological scale. They queried how broader bioregions could be considered to be appropriate for VME taxa, noting earlier points about connectivity and how big those areas would be in comparison to the VME biological process.

112. Australia noted that the scientific understanding of connectivity and bioregionalisation relevant to VME taxa remains highly uncertain but that there is a requirement in the BFIA Standard that the BFIA consider bioregionalisation. It was suggested that it may be possible to analyse some data for VMEs to come up with a regionally specific bioregionalisation but that was not able to be done for this assessment. Data for determining connectivity, including genetic data (for example), are very scarce, and the circulation modelling that could be done to simulate larval movement patterns has not been done in this context. Scales for populations or connectivity and the usefulness of the bioregionalization is still an open question.

113. New Zealand clarified that the ROC method is used to classify records from the habitat suitability models into categories of whether the habitat is suitable or not (indicated as either 0 or 1) and that this is an objective way of using habitat suitability models because the models are not intended to predict abundance. A natural extension to the relative habitat suitability index scores is to classify these into categorical suitable/unsuitable habitat. Problems with using the ROC thresholds arise when trying to interpret them and the models in terms of abundance. Statistical diagnostics suggest that the HSI models have high skill at classifying presences and an equal number of psuedo-absences but were not designed to predict abundance.

114. CALAMASUR noted that the percentages for protection do not take into account the fact that only a relatively small proportion of each open area is actually fished (<10%) and therefore, in their view, protection statistics will underestimate 'protection'.

115. New Zealand clarified that there are areas outside the BTMAs that were previously fished and therefore some of the taxa outside the BTMAs have previously been impacted.

Overall post-accounting results and sensitivities

116. This agenda item was presented and discussed under the agenda item above.

4. Fourth Session

4.1. Key uncertainties, information gaps and next steps

Data and modelling issues that need to be advanced to reduce uncertainty in predicted distributions of VME indicator taxa

117. Roland Pitcher (Australia) presented on data and modelling issues that may need to be advanced to reduce uncertainty. As background, the presenter noted that the HSI modelling has used the best available data and used current leading methods. Nevertheless, there are a number of compromises and limitations affecting modelling over a very large region with sparse data, which affects the level of uncertainty in predictions, including: presence only data (does not use 'real' absences); limited suite of (primarily) large scale predictors; very large prediction grid with extensive unsampled areas (67% of area is extrapolated); HSI predicts "habitat suitability" whereas 'protection' needs to consider amounts of VME taxa abundance protected; predicted HSI does not particularly reflect actual observed abundance or absences; retro-fitting relationships between abundance vs HSI is not preferred but was a necessary compromise; evidence exists of 'over-prediction' of high predicted HSI corresponding to zero observed abundances. Potential causes of over-prediction include 1) sampling scale mis-match and 2) missing predictors, among others.

118. A suite of plots was presented to illustrate the frequency of over-prediction. Comparisons were made where the same observations data displayed over predicted HSI, whereas previous southeastern Australian modelling of abundance using the same data did not display over-prediction.

119. Overall confusion matrices for SPRFMO predicted HSI transformed to presence and absence cross-tabulated with all observed presences and absences, were presented for all collated survey datasets. Typically, large numbers of observed absences occurred at predicted presence, often with more observed absence and predicted presence than observed presence and predicted presence. These results of predictions against survey datasets suggest low 'positive predictive value' (precision), high 'false discovery rate' (over-prediction), low 'false omission rate' (under-prediction), and high 'diagnostic odds ratio' indicating a propensity to predict presence rather than absence.

120. The potential reasons for this were discussed, and represent issues that need to be advanced in any future modelling, including: use of pseudo-absences; modelling of presence rather than of abundance; missing important predictors (such as seabed substratum type, e.g. rock); sampling grain-size vs prediction grid scale issues; and extrapolation.

121. A simulation of sampling scale mismatch vs missing predictors was presented based on DTIS video counts of *Solenosmilia* on Louisville Seamount Chain and using the gamma distribution. This illustrated the purely sampling scale mismatch issue alone. Then, randomly half of the simulated sample means were set to zero, to illustrate an unknown factor that causes zero abundance when >0 is expected (e.g. missing hard / rock substrate predictor). Relatively, the sampling scale mismatch caused only minor sample false-zeros issues only when the simulated grid abundance was low, compared with the simulated missing predictor which caused zero abundance across the full range of simulated grid abundances.

122. The sampling scale mis-match vs missing predictors issue was examined further using the Tasmanian Seamounts data where observed *Solenosmilia* was frequently zero for the full range of predicted HSI. In a random Forest model of observed presence|absence, augmenting HSI with some predictors previously used in southeastern Australian modelling effectively removed most (but not all) of the over-prediction, suggesting that the missing predictors issue dominates. Some missing predictors issue and the sampling-grain size vs scale issue remained. A mapped illustration of what missing predictors looks like was presented for the Tasmanian Seamounts example, and the implications were discussed.

123. Extrapolation was examined, noting that the HSI modelling used randomForest, BRT and MaxEnt, which are powerful and useful machine learning methods. Nevertheless, these methods can only predict within the limits

of the observed inputs. A simple example of simulated VME taxa abundance by depth observed was presented, with tree model predictions. An un-observed decreasing abundance at deeper depths is over-predicted.

124. In summary, the presenter noted that considerations to reduce uncertainty in any future modelling include: preferably use scientific survey observed absences data; preferably use survey observed abundance data with full observed absences; expand suite of predictors to include fine scale topography and substratum variables known to be important habitat requirements for VME taxa; and avoid extrapolation beyond observed range into unsampled areas, by expanding surveyed observations and/or limiting predictions to within the observed range.

125. CALAMASUR noted that while it is preferable to use scientific surveys, a survey would still be looking at a small, confined area and the distribution of relevant taxa are patchy. It was also noted that defining a grid square as having no taxa in it based on some smaller scale scientific sampling is not appropriate.

126. Australia responded that their view is that, if the scientific survey is sampling abundance, then there is low risk of not observing or sampling taxa if they occur with substantive abundance in a cell. If models do not incorporate observed absences, the models predict taxa to occur in areas where they do not occur.

127. CALAMASUR question - For S. variabilis at the TAS seamounts, how much sampling was done off the seamounts?

128. Les Watling (DSCC) pointed out that HSI predicts where the habitat is suitable for *Solenosmilia*. The Tasmanian map shows no or not much *Solenosmilia* in areas with low HSI scores. The fact that *Solenosmilia* is not everywhere in the higher HSI values is not a problem. There could be a number of reasons, from substrate to poor larval delivery why some seamounts have no or little *Solenosmilia*. The presenter responded that the issue in this example is that HSI models predict high values on sediment substrates (off seamounts) throughout the slope in the depth band, whereas *Solenosmilia* can only occur on rock substrates, such as on seamounts.

129. HSFG – inquired about how many transects were done in depths > 1200 m. The last slide was an example of how the model might be unable to predict beyond the range of the data. The sampling simulation replicates observed data.

130. It was noted that the simulation used video data to condition a gamma distribution to simulate a set of sampling. Histograms of the simulation were checked to make sure it simulated the Louisville data, which it did almost exactly.

Advancing habitat suitability models

131. Fabrice Stephenson (New Zealand) presented a brief summary of VME habitat suitability models, some thoughts on validation, and potential next steps in how the habitat suitability models could be advanced. Habitat suitability models were created for 10 VME indicator taxa using robust, tried and tested methods following best practice peer reviewed guidelines. New data collation since 2018 provided an excellent independent model evaluation, and we have information on other model fit metrics (TSS, Sensitivity, Selectivity) all of which performed very well to excellent. In the previous presentation Australia presented confusion matrices and model evaluations of the VME indicator HSMs. Given the short time available to consider these new analyses, New Zealand was unable to comment on whether they agree with the methods or results of these assessments but would welcome a chance to discuss this in the near future. Further validation could focus on prioritising areas based on the coverage of the environmental space (where we have fewer samples to inform our model relationships). Further advancements in the HSMs could also focus on increased taxonomic resolution for those taxa that were modelled at the taxonomic level or family or order; incorporation of the possible effects of climate change; moving from habitat suitability to probability of occurrence (which would require the collection of standardised biological sampling from standardised surveys); and improved environmental predictor variables (it would be particularly useful to have improved information on substrate (e.g. multi beam echosounder but expensive, huge data processing and storage). To a certain extent, environmental variables are continually updated (as remote sensing techniques advance, e.g., particulate organic carbon export). The single biggest advancement may be generation of abundance estimates and the use of hurdle models to combine the probability of occurrence and abundance / density models. However, a limiting factor is that abundance data for VME indicator taxa are limited for more than a few regions. However, the generalisability

of some of these models from within the NZ EEZ where there are more data to the SPRFMO evaluated area could be investigated. SDM hybrids that incorporate stochastic dispersal, stage structured matrix population models, Allee effects and niche population dynamics could also be investigated.

132. New Zealand noted some outstanding uncertainty about the difference in sample numbers between this analysis and that completed by Australia and queried whether it might be the result of the records not being aggregated at the scale of 1 km grid cells in the Australian analysis.

133. There was general agreement on how the analyses could be advanced, although there remained some disagreement about the appropriate use of the outputs of the HSI models. DSCC noted that satellite derived bathymetry can be wrong by as much as 500 m in the vertical. The presenter clarified that specific testing was done that used validated depth data.

Catchability of VME indicator taxa

134. Roland Pitcher (Australia) presented work on the catchability of VME indicator taxa. As background, the presenter noted that understanding the effectiveness of the VME encounter thresholds requires understanding of the relationship between the amount of VME taxa bycatch caught in fish-trawl nets and the actual amount of VME biota present on the seabed; that previous analyses (SC07-DW21-rev1 and SC07-DW14) showed that fish-trawls typically catch (into the net) only very small proportions of VME taxa abundance on the seabed, suggesting that the VME move-on thresholds likely corresponded to very high covers/biomasses of VME taxa on the seabed; that the approach to the task involved comparing catch-rates of co-located sampling of VME taxa by different sampling gears —e.g. by fish-trawls with observed abundances of VME taxa on the seabed; and that the results build on those presented in SC07-DW21-rev1, by expanding the survey datasets used to include more extensive coverage of eastern Australia and Tasman Sea.

135. The methods were outlined, including acquisition of additional datasets, where surveys had purposely paired two or more sampling gears at the same location, including (1) paired biomass sampling by up to 3 gear-types in NORFANZ survey, SEF Ecosystem surveys and NOO SE Australian gear trials: fish-trawl, beam-trawl, benthic-sled and comparing mean catch rates only for matched gear-pairs; (2) gear-scale matching of Tasmanian Seamounts sled biomass sampling over video percent cover transects and plotting sled catches against video cover; (3) paired density (counts/m^2) sampling by beam-trawl or benthic-sled over tow-camera (stills) transects in SE Australian surveys and plotting mean sampled densities against mean observed densities. Maps of datasets were presented; only paired samples were used.

136. In the mean catch rate comparisons, overall, fish trawls catch approximately 30-40 times less sessile benthos biota than sleds or beam trawls, but this varies by taxa. The presenter noted that sleds do not sample all benthos present.

137. Plots of catch rates against seabed cover showed that sled samples are small even at high seabed covers. Inferred fish trawl catch rates, based on taxa relative catchability ratios from the mean catch rate comparisons were compared with the current encounter thresholds for 3 taxa. These thresholds corresponded to >40% to >100% cover depending on the taxa. Previously, approximately 30% cover considered was identified as significant concentration of VME taxa supporting high diversity of other taxa (Rowden et al. 2020[10]).

138. Plots of catch densities against seabed observed densities from paired sampling by beam-trawl or benthic-sled over towed camera (stills) transects, confirmed that benthic-sleds and beam-trawl do not sample all benthos observed to be present. It was estimated that sleds sample about 1.7% of observed, and beam-trawl sample about 1.1% of observed.

[10] Rowden, A. A., T. R. Pearman, D. A. Bowden, O. F. Anderson, and M. R. Clark. (2020). Determining coral density thresholds for identifying structurally complex vulnerable marine ecosystems in the deep sea. Frontiers in Marine Science.

139. The current trigger thresholds are 15 kg for gorgonians, 50 kg for sponges and 80 kg for stony corals. The trawl ground-gear contacts corresponding to these thresholds were estimated, with acknowledgement of uncertainty using two sets of ratios: scaling-up based on estimated catchabilities for trawl:sled and for sled:observed.

140. In summary, the results, using updated and additional data, are consistent with previous analyses and indicate that: fish-trawl catchabilities are low relative to benthic-sleds and beam-trawls; benthic-sled and beam-trawl catchability are similarly low relative to observed densities on seabed; and the encounter thresholds likely correspond to high covers and high biomasses of VME taxa contacted by trawl gear on the seabed.

141. In response to a query about whether fish trawls might do less damage on the seafloor as they are poor samplers of benthic habitat, the presenter clarified that the impacts are indicated by the estimates of depletion rates per pass and that only a small proportion of the contacted biota go into the net; most of the ground gear-contacted benthic organisms go under the net and may be impacted to varying extents as estimated by the depletion rates.

142. New Zealand expressed appreciation for the work. agreed that catchability of fishing gear is low and noted the value in the paired comparisons provided, especially given the attempts to use available data (unpaired) collected for other purposes to make such assessments last year (SC07-DW14).

143. New Zealand also suggested that, in their view, the estimates of the tonnages of taxa that could have been impacted should be compared with the abundance across the whole distribution of the taxa within any given region. The presenter responded that, to the extent that the distribution of the taxa are known, the RBS provides these overall estimates in a risk-type context, but that RBS is not intended to be a stock assessment, but to provide a status indicator.

144. The European Union noted that with the catchability information and the habitat suitability information combined with the work on observed presence of benthic species vs habitat suitability, could be used as a way to determine encounter threshold values. The workshop noted that it could be very complicated to implement given the variability across grid cells, and that while there is some work underway looking at this, these types of analyses require abundance information. The workshop has previously discussed the high uncertainty in information about the abundance distribution of VME taxa and the uncertainty in the catchability of these taxa that would be propagated into the estimates. It was noted that it is feasible to start building the kind of MSE tools that would be needed, but an operational approach to the encounter thresholds would still require empirical data.

Climate change and other external risks

145. In his presentation summarizing VME habitat suitability models Fabrice Stephenson (New Zealand) referred to work examining the vulnerability of coral species under future climate scenarios and identifying climate refugia. This work can be found here. The group's attention was also drawn to a report to SC7 on deep-ocean climate change impacts on habitat, fish, and fisheries (SC7-Doc25).

146. DSCC noted that for climate change the issue of ocean acidification is relevant to the question of refugia especially deeper than trawl depths

Other information gaps, other areas of the BFIA

147. DSCC observed that the best available science isn't necessarily enough. The precautionary principle also applies.

4.2. Implications of BFIA results for CMM03-2020

148. Australia provided the following statement in relation to the BFIA and the outcomes of the workshop:

"Australia is strongly committed to this process and we believe the BFIA is an essential tool from a technical and transparency perspective. The assessment is fundamental for achieving the objective of the SPRFMO Convention, bottom fishing CMMs and the action called for in relevant UNGA Resolutions. Australia has approached the requirement to undertake a cumulative BFIA with an open mind and in the spirit of good faith, cooperation and reciprocity.

As noted previously, we believe the BFIA is comprehensive and the robustness of the methods and analyses that are included are commensurate with the requirements to assess impacts of bottom fishing on ecosystems in accordance with the SPRFMO BFIAS. We believe that this BFIA represents the best science available to us at this time. Notwithstanding, we accept there will be work ahead to continually improve the science to support decisions of the Commission.

Australia's position is that we would like the workshop and the SC to accept the BFIA as a comprehensive and useful assessment that considers a range of methods and associated uncertainties, and provides a meaningful picture on which management advice can be formulated.

Regarding the question of scale, our view is that management of impacts on VMEs and assessment at the scale of the Evaluated Area and the bioregional level is not well supported by the scientific advice and relevant international guidance (UNGA resolutions and the FAO Deep-Seas Guidelines) and so assessment and management at a finer scale is more appropriate. Our view is that the FMA scale, while arbitrary, is likely to represent a more biologically relevant scale at which to assess and manage impacts on VMEs than larger scales. The SC advice to the Commission should, at a minimum, be provided at this finer scale.

Regarding the models of VME habitat suitability; while we consider that the HSI modelling is the best that can be done currently with the data available, the large uncertainties identified in the BFIA and throughout this workshop suggests that our confidence in HSI models of VME taxa is diminished substantially. This raises the question of whether it is fit for purpose in the context of the spatial management approach embodied in CMM 03. Further we also note that the broad uncertainties in the HSI modelling bring into question the process of reviewing the 'expectedness' of encounters in accordance with the [bycatch] thresholds identified in CMM 03. Given these uncertainties, we believe the SC should consider the full range of HSI-VME abundance and distribution sensitivities as they relate to the assessments of status (RBS) and the assessments of the protection of suitable habitat (post-accounting statistics) in formulating its advice.

We note that SPRFMO has yet to agree to reference points for VME status and protection below which impacts are considered to constitute significant adverse impacts or are unacceptable. The SC has not considered and we are not aware of any clear biological rationale for determining specific reference points for VMEs.

We draw the following conclusions from the BFIA regarding impacts to VMEs:

- That, according to the RBS, the equilibrium status of VME indicator taxa is generally favourable (qualitatively speaking).
- That, according to post-accounting statistics the proportion of suitable habitat protected for some VME indicator species in some areas is qualitatively concerning.

While recognising the need for additional guidance on reference points for VME impact and VME protection, these results may point towards a requirement for changes to CMM03 to better meet the objective to prevent SAIs on VMEs at biologically relevant scales."

149. New Zealand considered that they had lots of common ground with Australia. New Zealand views this is a comprehensive bottom fishery assessment containing the best available science. It is recognised that the SC might want to add notes or caveats to some areas of the assessment but, in general, New Zealand believes the assessment is fit for purpose. It meets the BFIAS and was designed to speak directly to the UNGA resolutions and FAO guidelines. It is also consistent with SC's previous agreements that HS modelling and spatial

management was a useful approach. Since the last guidance from SC, the enormous amount of work that has been done to explore and address the uncertainties raised should be recognised. There is uncertainty in the assessment, and there always will be, but the Commission needs to manage given the available information. New Zealand believes it is important for this workshop and the SC to identify the next most important uncertainties to work on. Ideally these should be identified in the SC report to the Commission so guidance can be provided on the multi-annual work plan.

150. In a general sense, New Zealand agrees on the issue of an appropriate scales of analysis. This is why the assessment was done using a variety of metrics at a range of spatial scales, acknowledging our uncertainty around the issues of connectivity and the features of ecosystems that Peter Auster addressed in his presentation. In a general sense, New Zealand considers that the FMA scale is more likely to be relevant than the whole of the Evaluated Area, which is likely too broad. Despite having some stated concerns about the implementation of the RBS assessment, New Zealand noted the generally favourable status for VME indicator taxa, despite the fishery being generally unfettered in its spatial distribution over about two-thirds of its history. New Zealand does not believe that SAIs have been caused or are likely to be caused in future given the current management settings. Having said that, fine tuning the management settings could be considered while uncertainties are resolved to further reduce risk for specified taxa and areas where those risks seem to be higher than the overall patterns.

151. DSCC noted the argument that the habitat suitability models, though flawed, represent the best available science and state that in their view this is not the appropriate test. The following intervention addresses this and suggests a way forward.

> "**First**, some background. A BFIA is required by CMM03-2020, which also asked the SC (para 37) to advise on "*the ongoing appropriateness of the management measures in this CMM to ensure the measure continues to achieve its objective and the objectives of the Convention*";
> **Second,** CMM 03-2020 requires the BFIA to reflect "appropriate best practice. " (para 24) *("24. The Scientific Committee shall update the SPRFMO BFIAS no later than 2019 and review every 5 years thereafter to ensure that it reflects, as appropriate, best practice.")*
> **Third,** the BFIA should be consistent with the SPRFMO Bottom Fishing Impact Assessment Standard (2019)
> The BFIAS notes the need to ensure that CMMs are based on and updated on the basis of the best available scientific information, noting in particular the need to improve effective implementation of thresholds and move-on rules.
> In summary, as the underlying model and BFIA incorporating it clearly contains significant uncertainties (Identified uncertainties include the potential level of over prediction of VMEs outside of the BTMAs, lack of information on connectivity, the protection of rare species, and catchability and impact on VME indicator species from trawling). DSCC suggests the SC should advise that the management measure is not appropriate because it does not demonstrate that the bottom trawl fisheries can be managed to prevent SAIs on VMEs, due to its reliance on the habitat suitability models to the extent and in the way that it does, and that more precautionary measures should be adopted.
> The SC could advise the Commission that pending the resolution of major uncertainties, closing all areas that the habitat suitability models predict may contain VMEs, and putting into place a move-on rule that is predicated on identifying when a VME is encountered could be appropriate management responses."

152. HSFG noted that there will be camera work done in some areas which will show what is actually there and noted there is 100 hours of video available now that could be checked against where open areas are now. It is also fair to say when you consider the whole of the SPRFMO Area, SAI is prevented by the scale of the closed area as shown in Cuba.

153. The HSFG stated that they have been involved in SPRFMO for many years and have always attempted to put forward a view from the coalface and provide actual data from the fishing grounds. They made the following statement:

"In this new Covid world there is room for and a need, to fish and farm sustainably. HSFG recognise and support this, but there is an absolute imperative to keep people employed and primary industry producing protein. Primary industry which includes fishing is an essential service to provide food security.

The continued attacks on sustainable fishing by the few operators in the very limited areas that remain open, and attacks on wider primary industry is unacceptable and will ultimately backfire, as cost-effective high value protein with a low environmental impact will be displaced in favour of terrestrial derived protein with a far higher environmental impact and footprint.

It will be no news to you that we still cling to the view that the term 'ecosystem' had (and has) a useful and widely accepted understanding in science and only confusion results by stepping away from its conventional meaning. Many other concepts advanced appear to be a thinly disguised ploy to close high seas fishing.

We continually refer to the out of date FAO (2009)[11] Deep-Sea Fisheries Guidelines which are long overdue for a review.

There have been too many illogical leaps of faith and too many inconsistencies in use of words and phrases in both technical and common sense.

We have shown time and again our footprint, actual fishing affects a very small percentage of the sea floor. We are currently restricted to fish in far less than 1% of the SPRFMO area using a combination of bottom and mid water trawling. Further to this, we have repeatedly shown that the area in question has only a fraction of its sea floor impacted, and we do not believe for one minute the survival of a species or particular benthic population is threatened.

Contrary to much of the rhetoric that we have heard, and the claims, that every area is by definition a unique vulnerable marine ecosystem, the limited scale of our fishing operations make it inconceivable that the benthos in the fishing areas is unique or widely impacted to the point that it endangers a species.

We are concerned that we have elevated "protection" above that of sustainable use and we have (as the record shows) been forced to operate in an ever-decreasing area. This is not what the UNGA or articles of SPRFMO require. Several fundamental realities appear to have been ignored and we see the regulatory process in SPRFMO and other RFMOs having been captured by groups claiming to be stakeholders.

To be more specific, emphasis is always given to what are the characteristics of these VMEs. The FAO guidelines refer to rarity but fail to give an indication as to how it is determined if a particular taxon is rare. They refer to the potential endemicity of benthos, but nearly a decade later it has become clear that hardly ever has it been shown with absolute evidence that deep-sea trawling, at least the SW Pacific, is threatening endemic benthic species.

We believe our views are evidence-based, certainly more so than the many models that we are being regulated by. This is because the information we are using comes directly from the areas fished from observers, and off the deck of fishing vessels, which have been recognised as excellent platforms to gather real data from.

Appreciating all the work that has gone into the benthic habitat work, a repeated theme heard over the last session and earlier during our preliminary domestic working group process, has been the tight deadline for these studies. This has meant that the most recent data could not be incorporated, and time-constraints have negatively impacted on the ability to fully complete the research. Given what is at stake, at the least peoples' livelihoods, as a leading fisheries management organisation we have a clear obligation to use all available information and the best possible science on which to base decisions. For this reason, we owe it to ourselves not to rush this work and ensure we take the time necessary to do the job correctly. I say this fully acknowledging all the hard work that has been carried out to date.

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[11] FAO (2009). International Guidelines for the Management of Deep-sea Fisheries in the High Seas. Rome, FAO. 2009. 73p.

We would once again urge Members to please take the time to review some of the papers HSFG have over the last decade presented to SPRFMO.

And finally, it has occurred to me that if there was in fact no fishing in the SPRFMO area, then none of us would be required in this forum."

154. The European Union noted appreciation for the work that has been done and their general support for Australia's statement and the BFIA in general. They noted the difficulty of linking so many pieces of science with so much uncertainty. They noted that the BFIA addresses the main concerns that were raised previously. The EU noted that they would like to see additional work on some areas, particularly on encounter thresholds and protection of species of concern. They noted that there are a number of areas where the BFIA is lacking in its current form, but that these could be improved over time and that the BFIA will probably always be a work in progress that may require regular updates as new science becomes available.

155. Korea noted their interest in this work and the complexity and scope of the issues that were presented and discussed. They noted that the spatial extent of fishing area is narrow and appreciated the work that Australia and New Zealand have done as the two Members that fish there. There are some areas of high uncertainty and it would be good to do some more work on those areas.

156. Cook Islands noted they did not have any specific comments at the current time.

157. The US noted that they had reviewed the document over the summer and were pleased to see the revisions that were made in the rev2, especially in the second half of the document. They noted that the assessments were very comprehensive and that there was high value in the bracketing of a range of possible scenarios, enhancing the ability to interpret the assessment. They agreed with Australia's sentiment around the need to consider the full range of HSI-abundance and distribution scenarios when formulating advice to the Commission. They noted that as someone who is new to this SC and these issues, the workshop has been useful and that it was good to see the collaboration and transparency between the main stakeholders.

158. Chile noted their interest in the workshop and thanked the Chair and participants. They noted the enormous amount of work done by New Zealand and Australia on the ecosystem and in pulling together this assessment. In general, Chile considered that the methodologies used by New Zealand and Australia in the BFIA provide results that favour management to avoid impacts on EMV.

159. Australia, New Zealand, and the workshop chairperson offered their sincere appreciation for the engagement from participants throughout the process of developing and reviewing the BFIA and during the workshop.

Other business as time permits

160. There was no time to consider any items of other business.

5. Report adoption and Meeting Closure

161. The groups agreed to a process for finalising report to SC8. The draft report remained open for editing in the Microsoft Teams platform and Members and Observers were urged to check the accuracy of the record of their interventions. The report was finalised and adopted at a work session within the SC8 timetable on Monday 5 October 2020.

ANNEX 1: List of Participants

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ANNEX 2: Workshop Agenda

Session 1: Wednesday 30 September starting 8pm (NZDT) (Slot B)

- Introductions, technology, scope of workshop, rapporteurs etc
- Overview of content and analyses in the Bottom Fishery Impact Assessment
- BFIA section 4.2: Information on status of deepwater stocks to be fished
    - Stock assessments (mostly for Orange roughy)
    - Risk assessment for teleost fish stocks
- BFIA section 4.3: Interactions with marine mammals, seabirds, reptiles, other species of concern
    - Reported interactions with marine mammals, seabirds, reptiles, other species of concern.
    - Risk assessment for deepwater chondrichthyans
- BFIA section 4.4: Interactions with benthic habitat and VMEs
    - Updating and testing habitat suitability models for VME indicator taxa

Session 2: Thursday 1 October starting 1pm (NZDT) (Slot A)

- Deep Sea Conservation Coalition papers
- BFIA section 4.5: Risk assessment for benthic habitats, biodiversity and VMEs
    - Estimating the footprint of SPRFMO bottom fisheries
    - Assessing current status of benthic communities: "naturalness"
    - Relationship between habitat suitability and abundance of VME indicator taxa (NB from section 4.8.3).
    - Assessing current and future status of benthic communities: relative benthic status
- High Seas Group perspective

Session 3: Thursday 1 October starting 8pm (NZDT) (Slot B)

- BFIA section 4.6: Mitigation, management and monitoring measures
    - Spatial prioritisation for conservation, spatial decision support tool Zonation and changes since 2018
    - Estimating the likely performance of current spatial management arrangements ("post-accounting")
        - Introduction and recap of 2018 approach to assessment.
        - Re-assessment in terms of suitable habitat and abundance.
        - Overall post-accounting results and sensitivity.

Session 4: Friday 2 October starting 1pm (NZDT) (Slot A)

- BFIA section 4.8: Key uncertainties, information gaps, and next steps with bottom fishery impact assessments
    - Stock assessment issues and the SPRFMO stock assessment framework
- Understanding risks to marine mammals, seabirds, reptiles, other species of concern
    - Advancing habitat suitability models.
    - Catchability of VME indicator taxa.
    - Climate change and other external risks
    - Other information gaps
- Other sections of the BFIA that require elaboration or other aspects of bottom fisheries that participants would like to see discussed (including but not necessarily limited to those identified in "other business")
- Implications of BFIA results for CMM03-2020
- Report adoption / process for finalising report to SC8