Report of the Fourth SIOFA Protected Areas and Ecosystems Working Group

(PAEWG4)

Held via Zoom videoconferences on 7-11 March 2022

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Agenda item 1 – Opening

Agenda item 1.1 Opening statement from the Chair

1. The fourth meeting of the SIOFA SC Protected Areas and Ecosystems Working Group (PAEWG4) was opened by the Chair, Dr Patrice Pruvost of France (Territories), at 6:00 am (UTC) on 7 March 2022.

2. The Chair welcomed the participants to the meeting.

Agenda item 1.2 Introduction of participants

3. The list of participants is attached (**Annex A**).

Agenda item 1.3 PAEWG Chair and co-Chair

4. The Chair invited the PAEWG to consider nominating a co-Chair to serve alongside him.

Agenda item 2 – Administrative arrangements

Agenda item 2.1 Adoption of the Agenda

5. The agenda was adopted (**Annex B**).

Agenda item 2.2 Confirmation of meeting documents

6. The meeting documents (**Annex C**) were confirmed.

Agenda item 2.3 Appointment of rapporteurs

7. Mr Alex Meyer (Urban Connections, Tokyo) was appointed as rapporteur with assistance from delegations.

Agenda item 3 – Vulnerable Marine Ecosystems (VME)

Agenda item 3.1 VME taxa list (proposals for taxa revision/inclusion)

8. The VME taxa list is available in Annex1 of CMM 2020/01 (interim management of bottom fishing) and the VME taxa guide was updated in 2020. The PAEWG did not propose any updates to the VME taxa list.

Agenda item 3.2 VME encounter thresholds

9. The Chair reminded the PAEWG that the Meeting of the Parties (MoP) had tasked the PAEWG to work intersessionally to conduct a review of the VME encounter thresholds adopted by other RFMOs (para 100, MoP8 Report).

10. SIODFA presented an overview of PAEWG-04-INFO-01 on the setting of thresholds of sessile benthos bycatch from benthopelagic trawling, which uses gear both in continuous contact with the seafloor and off-bottom 'midwater' trawling that usually is not touching the bottom. SIODFA stated that an integrated scientific treatment of all the issues of mitigating the impact of demersal trawling on sedentary or sessile benthos has yet to be done and that the decision of threshold values is not a scientific one but rather a managerial one. SIODFA also pointed out that different fisheries and areas will have different shapes of their cumulative distributions of benthic bycatch and that if bycatch from the two types of gear used in the SIOFA benthopelagic fishery are combined into a single cumulative distribution function, the high frequency of low or zero benthic bycatch from the off-bottom fishery will reduce the point that the threshold occurs and disproportionately affect the demersal fishery. SIODFA highlighted the value of Cryer and Nicol (2017)'s paper on the utility of move-on rules to prevent significant adverse impacts (SAIs) of bottom fisheries on VMEs.

11. The Data Officer informed the PAEWG that there have not yet been any reports of the encounter threshold being reached (as defined in CMM 2020/01 para 12).

Agenda item 3.3 VME mapping (Final consultant report, project PAE2020-02)

Summary of paper

12. The consultant, BOREA Laboratory, Biology of Aquatic Organisms and Ecosystems, Muséum national d'histoire naturelle, presented report PAEWG-04-09, which provided an update on work to develop predictive bioregionalisation maps, specifically work done using two types of two-stage approach: 1. grouping biological features into bioregions first, and then spatially predicting these bioregions ("group first, then predict") and spatially predicting all biological features first, and then grouping them with a clustering approach ("predict first, then group"). Work is also ongoing on a third, one-stage approach of grouping and predicting bioregions in a single modelling approach ("analyse simultaneously").

13. Most of the available biological records were obtained from the publicly available repositories the Ocean Biodiversity Information System (OBIS), the Global Biodiversity Information Facility (GBIF), which contained information with the finest taxonomic resolutions, as well as records collated from the National Oceanic and Atmospheric Administration's (NOAA's) Deep-sea Corals Data Portal and the Smithsonian Natural History Museum, which also stored information up to species level. The consultant also had access to records from the SIOFA Secretariat, but these are very few in number and presented at a coarser taxonomic rank (order) of limited use for biodiversity assessments, although useful for model validation. Data from research campaigns by the Muséum national d'histoire naturelle were also used. The data were filtered to retain any species for which 90% of records of occurrence were deeper than 200 m water depth, and to remove species known to inhabit shallow waters according to peer-reviewed deep-sea taxa lists. Various environmental data were sourced from the General Bathymetric Chart of the Oceans (GEBCO), Bio-ORACLE, Global Marine Environment Datasets (GMED) and OceanSODA.

14. The consultant applied a network approach for bioregionalisation and used the algorithm "Map Equation" (Rosvall and Bergstrom, 2008) to delineate the bioregions, grouping sites with similar species composition and separating sites with different composition. The advantage of this over other clustering methods is that it keeps species identity and enables hierarchical clustering to test whether larger regions show a nested hierarchy of subregions.

15. For the group first, then predict predictive mapping, the consultant collated environmental predictors for VME indicator taxa, modelled the relationship between bioregions and predictors using an ensemble modelling approach based on multiple algorithms in order to obtain predictive suitability maps for each biogeographical region, and stacked these predictive suitability maps in order to obtain in each pixel the predicted suitability of biogeographical regions of VME indicator taxa.

16. This identified three main bioregions in Southern Indian Ocean and eight sub-bioregions with geographic and bathymetric differences. The biogeographical network of VME indicator taxa for the three main bioregions showed a distinct faunal composition for each, indicating that not many species are shared among regions. In this sense, the SIOFA area has a unique species composition with a high percentage of endemism. The biogeographical network of the eight subregions similarly indicated that there are few shared species among them.

17. For the predict first, then group predictive mapping, the consultant collated environmental predictors for VME indicator taxa, modelled the relationship between taxa and predictors with random forest models in order to obtain predictive suitability maps for each taxon, converted suitability into binary suitable/unsuitable maps using a threshold optimised on the Jaccard index, and detected bioregions on these predictive maps using Map Equation.

18. The consultant produced bioregionalisations based on family, genus, and species level for all taxa and for taxa with more than 30 occurrences. There was more spatial heterogeneity at family and genus level than at species level. As expected, there was less spatial coverage at the species level due to there being less information with finer taxonomic resolution. Contrary to what was expected, there was also more spatial coverage at the species level in some areas not predicted at the genus or family level due to the different complexity of the models at the

three taxonomic levels. Having more occurrences per taxa would enable the inclusion of more predictor variables resulting in more precise models. The genus level seemed to be an adequate compromise among the three levels. Compared to the group first, then predict approach, the predict first, then group approach enabled modelling to account for individual environmental requirements of each taxon and had a finer spatial resolution.

19. The consultant concluded that:

- Biodiversity knowledge of VME indicator taxa in the Southern Indian Ocean is both limited and spatially aggregated.

- Data shortfalls evidenced the need for predictive approaches that will be instrumental to inform and guide the future conservation planning procedure of this consultancy.

- Despite this data-poor situation, the "group first, then predict" approach detected three main and eight nested biogeographical regions based on observed occurrence records that provided an approximation of the assemblages of the SIOFA area. However, data scarcity did not allow a reliable prediction of the latter.

- The findings were validated by previous works on bioregionalisation that were based on expert opinion (i.e., Global Open Oceans and Deep Seabed; Watling et al., 2013), biologically data-driven (Costello et al., 2017) and model-based (Global Ocean Biodiversity Initiative; Dunstan et al., 2020).

20. Based on the paper, the consultant recommended that:

- Data scarcity in the Indian Ocean calls for urgent research exploration in areas beyond national jurisdiction.

- The taxonomic level of observer data is too broad for biodiversity analysis, and it was not included for the modelled maps, although it would be useful to model effort data and validate habitat suitability for certain groups. It is recommended that SIOFA develop an image catalogue of encountered VMEs that may evolve into a resource that could be developed into a formal *in situ* guide for observers to use for annotation during trips.

- To validate the models' predictions further, research campaigns should be organized.

- Interpretation of the resulting maps must be exerted with caution. For instance, the species-level bioregionalisation was subject to over-prediction. It is of paramount importance to understand the limitations and characteristics of any modelled outputs.

- Only with an understanding of the aforementioned limitations and characteristics of any modelled outputs is it recommended that these maps be used for the conservation planning procedure.

PAEWG discussion

21. The PAEWG **NOTED** the report and **ENDORSED** the following recommendations:

- Data scarcity in the Indian Ocean calls for urgent research exploration in areas beyond national jurisdiction.

- The taxonomic level of observer data is too broad for biodiversity analysis, and it was not included for the modelled maps, although it would be useful to model effort data and validate habitat suitability for certain groups. It is recommended that SIOFA develop an image catalogue of encountered VME indicator taxa that may evolve into a resource that could be used as a formal *in situ* guide for observers to use for identification during trips. To validate the models' predictions further, research campaigns should be organized.

- Interpretation of the resulting maps must be exerted with caution. For instance, the species-level bioregionalisation was subject to over-prediction. It is of paramount importance to understand limitations and characteristics of any modelled outputs.

- Only when the aforementioned limitations are resolved could these maps be used for conservation planning.

22. In addition to developing an image catalogue for use by observers, the PAEWG **NOTED** the potential value of compiling a VME image database. The PAEWG also discussed developments in AI and the potential to eventually use such technology to identify taxa from photographs.

23. The PAEWG discussed the potential impact of sampling bias on the model given that most of the data used in the modelling came from global databases and few from the SIOFA database. The consultant explained that the impact of sampling bias would be analysed and included in the final consultancy report.

24. The PAEWG pointed out some maps in the report that may show unrealistic clustering information, e.g., showing a potential shallow-water cluster in a known deep-water area, and requested the consultant to investigate why this may be the case.

25. The PAEWG requested that the consultant add main bathymetric lines to future maps and provide descriptions of results by each SIOFA subarea.

26. The PAEWG discussed the fact that data from observers were hardly used in the analysis. The consultant explained that limited observer data were used due to the poor species identification. If observer data were recorded at the species level, it would be possible to include them in the model to fill in areas where VME taxa are known to be occurring. At the current taxonomic level, however, these areas show up as overpredicted or with no prediction. The current observer data could be used to validate the model outputs by plotting the observer data over the model outputs to compare the outputs to the reality. The observer data were also used to model sampling effort.

27. The PAEWG questioned the decision by the consultant to filter shallow-water species, pointing out that some parts of the SIOFA area, such as the Saya de Malha Bank, are in fact quite shallow, and the inclusion of shallow-water species is needed to understand the VME taxa situation in such areas. The consultant explained that, given the nature of the dataset used (all publicly available species and records), there was a need to compromise and restrict the data and exclude certain species. The consultant suggested that it would be possible to run the models again with all species but estimated that it would require three more months of work.

28. The PAEWG **NOTED** the importance of leveraging the knowledge of observers and fishing companies and developing a mechanism for receiving feedback on the maps developed by the consultant. The PAEWG **RECOMMENDED** that the reviewed and finalised maps be uploaded to the website and made available for feedback.

29. The PAEWG discussed advances in studies using DNA barcoding for species identification and environmental DNA and the potential for such studies to improve knowledge of the biodiversity of the SIOFA area.

30. The Deep Sea Conservation Coalition (DSCC) suggested that there is a clear need for more data to ensure the synthesised, observed and predictive work can sufficiently inform the management advice to be developed by the SC, particularly at the finer scale. Furthermore, the DSCC suggested that if SIOFA continues to work in a data-poor situation over the long-term, it will be necessary to take a precautionary approach until the relevant data are gathered and analysed.

Agenda item 4 – Bioregionalisation and VME's project (Draft report from consultant, project PAE2021-01)

Agenda item 4.1 Holistic framework for VMEs

Agenda item 4.2 Benthic Bio-regionalisation

Summary of paper

31. The consultant, BOREA Laboratory, Biology of Aquatic Organisms and Ecosystems, Muséum national d'histoire naturelle, presented report PAEWG-04-10, which described the current progress and planned work under Project PAE2021-01.

32. For Terms of Reference (ToR) 1 (classification of key biological, geological, and oceanographic data to provide a spatial framework for classifying the area's marine environment into bioregions and, where possible, smaller spatial entities within bioregions), the consultant has produced preliminary bio-regionalisation maps using two of the three planned approaches. The third approach (analyse simultaneously) will also enable the development of an improved map of regions of common profile. In addition, the consultant will synthesise existing work on enviro-regions.

33. For ToR2 (investigate and advise on the identification of representative protected areas), the consultant will develop a systematic conservation planning approach using the bio-regionalisation maps from ToR1, ToR3, and ToR5, select a systematic conservation mapping tool, and set a range of potential conservation objectives with the guidance of a group of experts (e.g., SIOFA and other regional experts).

34. For ToR3 (benthic diversity and distribution in the SIOFA management area), the consultant will develop biodiversity indices from predicted species distributions (i.e., richness maps), investigate models that account for rare species in predicting diversity, and compare the strengths and shortcomings of different modelling approaches recognising the potential effect of sampling artefacts.

35. For ToR4 (investigate and advise on a holistic framework on assessing and preventing SAIs on VMEs), the consultant will synthesise emerging knowledge from the scientific literature on SAI to provide the most up-to-date guidelines for SIOFA.

36. For ToR5 (SAIs in the SIOFA area), the consultant will compare maps of fishing footprint to maps of bioregions and maps of diversity of VMEs and develop a spatialized index for highlighting areas most at-risk of SAIs in the SIOFA area.

PAEWG discussion

37. The PAEWG **NOTED** the report.

Agenda item 5 – Management of other system components (Seabird and mammals)

Agenda item 5.1 Presentation of Project PAE2021-02 (ToR1)

Summary of paper

38. The consultant, Ross Analytics, presented report PAEWG-04-06, which described the ongoing work to document the seabird and mammal species that commonly interact with fishing activity in the SIOFA area and to undertake Ecological Risk Assessments for the Effects of Fishing (ERAEF) on those species, and report PAEWG-04-13, which provided a review of mitigation measures to reduce the impacts of fishing on high-risk non-target species taken during fishing operations within the SIOFA area.

39. Applying the tiered approach developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO; Hobday et al. 2011), the consultant aimed to assemble the information required to undertake a Level 1 ERA (a comprehensive process that examines the distribution of species and activities of interest to establish qualitative measures of the ''Scale, Intensity, Consequence'' of any interactions) for seabirds and marine mammals and to undertake an initial Level 2 ERA (a semi-quantitative ''Productivity-Susceptibility'' analysis that further developed the potential consequences of any interactions on species of interest).

40. The consultant aimed to compile a list of seabird and marine mammal species that was representative of the biology and ecology of all species that are likely to be involved. Thus, any species that occur in the area, but were not explicitly included in the ERA, would be likely to share the ecological and behavioural traits that guide the development of mitigation strategies and would therefore benefit from the introduction of such measures. Moreover, as the overall aim was to progress multi-species ERA according to the data available and the assessed risk, the need for increased data collection could be considered an important part of the risk mitigation strategy.

41. The data on each seabird species and the spatial overlap with fishing activity were used to produce a risk score for that species-fishing activity combination and the measures of relative risk (R) for each species was then estimated. The risk scores ranged from 1.8 to 4.24. Of the 32 species included, 13 species had a risk score of ≥ 3, 5 species had scores ≥ 2.5-<3 and 14 species had risk scores < 2.5. Species with a risk score of ≥ 3 included 11 albatrosses, one *Procellaria* petrel and one *Pterodroma* petrel. The highest risk score was for Tristan albatross, while all of the *Diomedea* albatrosses – Wandering, Antipodean and Amsterdam albatrosses as well as white-chinned and the endemic Barau's petrel were also in the high priority group of species. The non-breeding distribution of Barau's petrel (Pinet et al. 2011) indicated that they overlap with the southern section of subarea 8.

42. To estimate the potential degree of overlap with SIOFA fisheries, the distribution of each marine mammal species found in the SIOFA area was assigned a distribution category based on the International Union for Conservation of Nature (IUCN) distribution maps for each taxon (https://www.iucnredlist.org/). The distribution categories were assigned overlap scores and these overlap scores were combined with IUCN status to give an overall susceptibility score.

43. There were 40 species of marine mammal identified as occurring in the SIOFA area, of which there were 12 mysticetes (baleen whales) including 2 subspecies of blue whale, 27 odontocetes (toothed whales) including 9 dolphins and 9 beaked whales, and 3 pinnipeds. The risk scores ranged from 0.25 to 6.25. Of the 40 species included, 7 species had a risk score of ≥ 1.5, 18 species had scores ≥ 1 – < 2 and 15 species had risk scores < 1. The highest risk scores were for those species with IUCN statuses of critically endangered or endangered (blue whale spp. and sei whale). Of those species known to interact with fishing gear, only sperm whale had a risk score >2.

44. Based on the ERAs for seabirds and marine mammals, the consultant identified SIOFA subareas 1, 2 and 3b (west of 40° E) as an area where high risk species have the greatest likelihood of interacting with SIOFA fisheries and recommended that:

   • The greatest risk for seabirds appears to be from interaction with the pelagic longline fishery and it is recommended that CMM 2019/13 be revised to address all fishing gear used in SIOFA and include specific mitigation measures for seabird bycatch consistent with ACAP best practice advice.

   • To address potential impacts on marine mammals, SIOFA should provide an annual report on all lost gear reported under CMM 2021/02. Annex A. Observations of marine mammals interacting with fishing gear should be reported under CMM 2021/02 Annex B.

   • SIOFA should engage with the Important Marine Mammal Area (IMMA) designation process in order to ensure that fishing in areas of particular importance to marine mammals is managed accordingly.

PAEWG discussion

45. The PAEWG **NOTED** the report and **ENDORSED** the following recommendation:
   • To address potential impacts on marine mammals, SIOFA should provide an annual report on all lost gear reported under CMM 2018/09 para 7. Annex A. Observations of marine mammals interacting with fishing gear should be reported under CMM 2021/02 Annex B.

46. The PAEWG discussed the consultant's recommendation that the greatest risk for seabirds appears to be from interaction with the pelagic longline fishery and that CMM 2019/13 should be revised to address all fishing gear used in SIOFA and include specific mitigation measures for seabird bycatch consistent with ACAP best practice advice. One CCP suggested that the Level 1-2 tiered approach of the SIOFA ERA is designed to "sort out potentially high-risk species and lead to more quantitative detailed analysis and assessment", thus, as has been the case in the past, the development of management measures directly from the recommendations in such a study should not be considered before further numerical analysis and assessment is done. Other CCPs supported the recommendation, pointing out that the aim of an ERA is to identify where the area of highest risk is likely to be and that the risk of longlines to seabirds is well known.

47. The PAEWG discussed the consultant's recommendation that SIOFA should engage with the IMMA designation process. The PAEWG pointed out that this concerns organisational-level cooperation between SIOFA and IUCN, and the MoP would therefore be the more appropriate forum for discussing this matter.

48. The PAEWG questioned the consultant's use of an additive approach in the susceptibility analysis, pointing out that a multiplicative approach is often used and that an additive approach can produce 'false positives' whereby a species and/or area is identified as high risk when it is in fact not. The consultant acknowledged this point and explained that the additive approach had been used as part of a precautionary approach. While this may produce 'false positives', from a precautionary standpoint, this would be preferable to a 'false negative'.

49. The PAEWG discussed the data used in the ERA and how representative they were of the fishing effort. Publicly available information, particularly from bottom fishing impact studies, were used in this work. Also data were requested from the SIOFA Secretariat and released upon authorisation by relevant CCPs. The Data Officer and the consultant clarified that most of the longline data were made available and included in the study, but there were gaps in the trawl data because they had not been made available by one CCP. Other data were made available by CCPs but without useful spatial information. Observer data were also not used and there were very few data available on incidental capture of seabirds from SIOFA, which may be a reflection of the infrequency of such interactions, or the lack of availability of such data. The PAEWG discussed the value of addressing such data gaps when conducting future analyses.

50. The PAEWG discussed the use of 5x5° aggregated cells in the assessments. One CCP pointed out the large size of such cells and suggested that future assessments should be conducted at finer spatial resolution. Another CCP believed that even though the data have been aggregated, useful conclusions can still be drawn for them and pointed out that at other regional fisheries management organisations (RFMOs), even when analyses use finer data, these data tend to get aggregated to 5x5° cells because that is a useful size for making management decisions. It was pointed out that other RFMOs also provide data by seabird habitat, density and numbers.

51. The PAEWG discussed the value of ground-truthing the study by comparing the results to actual interactions between fisheries and seabirds or marine mammals.

52. The PAEWG suggested that the final consultancy report should include descriptions of the data that were available for each analysis and their spatial resolution, and the amount of information available for different species.

53. The PAEWG discussed the difficulty of accurately identifying certain species of seabird bycatch, especially distinguishing between certain types of albatross. Nevertheless, in many cases, the mitigation measure is equally effective regardless of the seabird species, making distinguishing between certain species non-essential. Australia informed the PAEWG that it has developed a guide on how to take pictures of albatross to enable a taxonomic expert to identify them more easily and that it could share this guide.

54. The Agreement on the Conservation of Albatrosses and Petrels (ACAP) pointed out that while some seabird species in the study are well tracked, for some others there are substantial gaps, particularly in their juvenile stages. There is therefore a need to be cautious about whether some of the distributions in the study capture the full range of areas where certain seabird species occur.

55. The DSCC suggested that in addition to taking photographs, unidentified specimens could be returned for expert identification.

Agenda item 5.2 Presentation of Info Paper PAEWG-04-INFO-03

56. ACAP presented PAEWG-04-INFO-03, which provided a review of seabird data collection and bycatch mitigation measures stipulated in CMM 2019/13 and CMM 2019/02 (now CMM 2021/02) against ACAP best practices, while taking into consideration SC-03-06.2 (05). The review identified a number of proposed amendments to the relevant SIOFA CMMs to achieve more complete alignment to ACAP advice and ensure the effectiveness of SIOFA's management measures to reduce the impact of relevant fisheries on seabirds.

PAEWG discussion

57. The PAEWG held initial discussions on the paper, recognising that it had been submitted as an information paper and was submitted as a working paper to the SC. One CCP requested that this paper be submitted to SC7 and should be treated as an information paper following Rule of Procedure 18 para 4. Following clarification of Rule of Procedure 18 para 4, the paper was submitted to SC as an information paper.

58. One CCP expressed reservations about several recommendations in the paper, pointing out the need for more quantitative assessments and that some recommendations referenced ACAP protocols that were still under development.

59. The PAEWG recognised the value of the paper in providing an administrative comparison between SIOFA measures and ACAP best practice and suggested that, as a next step, further discussions on the science behind the recommendations, as well as their practical application, were needed.

60. The PAEWG **NOTED** that there are some areas where fishing activities and seabird species are known to occur, but where there are no mitigation measures in place. The PAEWG suggested that in the short-term, it may be worthwhile prioritising the development of measures for these areas before working on improving existing measures in other areas.

61. The DSCC expressed support for SIOFA's ongoing efforts to avoid or mitigate seabird bycatch and noted that seabird bycatch and mitigation is strongly researched globally and often used in regional fisheries management bodies adjacent to SIOFA. The DSCC supported SIOFA taking precautionary approaches in the absence of full data and giving consideration to updating its CMMS to align with ACAP best practice.

Agenda item 6 – Bottom Fishing Impact Assessments (BFIA)

Agenda item 6.1 Saya de Malha bank study (Project SER2021-03, ToR2)

Summary of paper

62. The consultant, MRAG, presented report PAEWG-04-11, which provided an assessment of whether bottom trawl fisheries on Saya De Malha have severe adverse impact (SAI) on VME indicator species, using the information collected and collated under the Scoping Study on Saya de Malha Fisheries. Several VME taxon have already been defined by SIOFA in CMM-2020-01 and these were assessed. Seagrass was also assessed given its prevalence on Saya de Malha. Assessing the potential for SAI on VMEs needs to consider 'impact' and 'risk' (the intensity, duration, spatial extent and cumulative effects of fishing activities), and define the dependency of these elements on spatial and temporal scales. 'Overall risk' can be defined as the risk remaining after monitoring, management and mitigation measures are accounted for.

63. At present, the identification of VME species, their distribution and the impacts of bottom trawl fisheries on Saya de Malha are poorly understood. The first assessment of flora and fauna of Saya de Malha was completed 20 years ago. Recent studies on Saya de Malha and or the SIOFA area since have focused on physical oceanography, ocean productivity and pelagic and demersal resources. This study took the first steps towards an informed assessment of bottom trawling impacts on VME species on Saya de Malha by inferring the potential distributions of VME species based on estimated depth ranges from closely related species, or the same species but from different regions, and considering their spatial overlap with the known spatial distribution of bottom trawl fisheries (based on Automatic Identification System (AIS) data from Global Fishing Watch, available for 2020 only) and semi-quantitative assessments of species tolerance to and recovery from trawling activities.

64. The findings indicated that the highest-risk VME species are *Euryalida* (basket star), closely followed by *Actiniaria* (sea anemones), *Alcyonacea* (soft corals), *Antipatharia* (black coral), *Crinoidea* (crinoids), *Pennatulacea* (sea pens) and *Stylasteridae* (lace corals), all of which have low recovery potential from trawling impacts. Other groups of relative concern, particularly if trawling activities were to increase in the coming years, include *Cidaroida* (sea urchin),

Scleractinia (stony/hard corals), *Serpulidae* (tube-building worms), and the extensive seagrass beds formed of *Cymodoceaceae* spp.

65. At present the level of trawling activity appears low with Thailand the only confirmed fishing nation operating only two and three vessels in 2019 and 2020, respectively. This low effort serves to limit the spatial overlap between many VME species and trawling activities. However, if trawling were to increase toward levels seen in earlier years (i.e., 56 and 58 vessels in 2015 and 2016, respectively) the spatial overlap with, and thus the risk to, many VME species would likely increase substantially and may be a cause for major concern.

66. Based on the paper, the consultant recommended that, in order to better understand the bottom trawl fisheries interactions with VME species of Saya de Malha, SIOFA should prioritise efforts to more precisely document species and fisheries effort distributions both historically and in future. This would serve to improve confidence in the assessment of impacts from ongoing fisheries and allow for evidence-based management decision-making and the formulation and implementation of appropriate management actions if required.

PAEWG discussion

67. The PAEWG **NOTED** the report and **ENDORSED** the following recommendation:

- that, in order to better understand the bottom trawl fisheries interactions with VME species of Saya de Malha, SIOFA should prioritise efforts to document species and fisheries effort distributions more precisely both historically and in future. This would serve to improve confidence in the assessment of impacts from ongoing fisheries and allow for evidence-based management decision-making and the formulation and implementation of appropriate management actions if required.

68. The PAEWG discussed the data available for the study. Several CCPs and flag states that are not members of SIOFA are known to have operated in the area, but the only fisheries data used in the study were five years of effort data and one year of spatial footprint data from one CCP. Such data gaps make accurately assessing any cumulative impact difficult. The consultant explained that AIS data from Global Fishing Watch were also available but were omitted from the study as many data points were not labelled or confirmed to be from bottom trawling. The Data Officer explained that other CCP data were available but were not of a sufficiently fine spatial resolution to be used.

69. The DSCC expressed concern that the report seemed not to consider some of the best available data from VME experts on defining VME indicator species and determining their distribution, including MoP-08-INFO-09, which included a number of very up-to-date habitat maps. The DSCC proposed that these data should be updated prior to the completion of the impact assessment, and also noted that as many impacted species are slow growing and slow to recolonise damaged areas, it was essential that the impact assessment be based on all years of fishing. The consultant explained that the study was done using evidence review, i.e., a systematic literature review using search engines and combining search terms relevant to VMEs and relevant fisheries interactions and suggested that the method perhaps needed to be revised to identify more of the work that the DSCC was referring to.

Agenda item 6.2 Final report BFIA (Project PAE2020-01, Mormede 2021)

Summary of paper

70. The consultant, Dr Sophie Mormede, presented report PAEWG-04-05 (project PAE2020-01), which provided the final calculations, including the recommended revisions at SC6, of bottom fishing impact for trawl and longline gears in the SIOFA area.

71. A bottom fishing impact assessment method was developed for trawl and longline gears in the SIOFA area. A relative benthic status method was used, considering both the sensitivity of VME to the effects of bottom fishing, and their potential for recovery.

72. Preliminary results were presented at the third SIOFA protected areas and ecosystems working group (PAEWG-03-08). They highlighted the need for more fine-scale information, which was then provided for further analysis. The final BFIA calculation reported here was carried out at a 0.1° resolution south of 20°S (SIOFA subareas 1 to 7) and 1° resolution north (SIOFA subarea 8) for both trawl and bottom longline gears.

73. Results indicated that, at that scale, the cumulative bottom fishing impact of trawl and longline gears on stony corals, *Demospongiae* and *Hexactinellida*, and on *Anthiparia* is expected to range from 0.4% to 1% on average in 2020 in the various SIOFA subareas and reach up to a maximum value of 13% in a single one-degree cell when not corrected for fishable depth, or 100% when corrected for fishable depths. The SIOFA subarea found to be most impacted was subarea 2 followed by subareas 3a, 3b and 4.

74. When considering fishable area at the cell level, 48% of subarea 3b and 45% of subarea 2 have been fished by trawl and longline gears since 1998 at the 0.1° resolution; and 88% of subarea 8 has been fished at the 1° resolution. Moreover, the area fished has been expanding steadily between 1998 and 2020. As noted by SC6, this expansion of the SIOFA footprint "could not be solely explained by the addition of data from CCPs that newly acceded to SIOFA in the later years of the study period, as well as the limited availability of historical fishing data." (SC6 Report, para 80).

75. Sensitivity analyses showed that the two parameters of most influence in the estimation of bottom fishing impact were the size of the cell used for calculation and the inclusion of fishable depth. Further sensitivity analyses showed that at the 0.1° resolution, the VME characteristics (steepness of the stock-recruit curve, sensitivity and recovery parameters) were the most influential parameters in the calculation of bottom fishing impact, followed by the width of the bottom impact of trawl gear.

76. Based on the paper, the consultant recommended:

- That VME characteristics, in particular sensitivity to fishing gear, recovery rates and likely stock recruit relationship be discussed, and values agreed.

- That the actual population status of a range of VMEs in the SIOFA area be calculated once spatial distribution maps are available.

- That all future fishing effort be recorded on a haul-by-haul basis, including start and end positions, distance trawled, trawl width and longline length.

PAEWG discussion

77. The PAEWG **NOTED** the report and **ENDORSED** the following recommendations:

- That VME characteristics, in particular sensitivity to fishing gear, recovery rates and likely stock recruit relationship be discussed, and values agreed.

- That the population status of a range of VME indicator taxa in the SIOFA area be calculated once spatial distribution maps are available.

- That all future fishing effort continue to be recorded on a haul-by-haul basis, including start and end positions, distance trawled, trawl width and longline length.

78. The PAEWG discussed the fact that the most recent year's haul-by-haul data were provided from one CCP directly to the consultant, as they were required prior to the SIOFA annual submission date. These same data were later submitted to the Secretariat as part of the annual data submission. The PAEWG requested that this be noted in the final consultancy report.

79. The PAEWG **NOTED** that the impact estimated for some individual cells may be affected by inaccurate or low resolution bathymetric data.

80. The PAEWG **NOTED** the value of dialogue between the consultant and industry and industry's feedback on matters such as the length and width of tows, and how to identify trawl tows as being bottom tows or midwater trawls when they were not labelled.

81. The PAEWG **NOTED** that the use of high resolution effort data in this year's updated assessment enabled a more precise assessment of risk and impact compared to last year's assessment, when such data were not available.

82. The PAEWG **RECOMMENDED** that the SC consider how to consolidate the advice derived from the different BFIAs submitted to the PAEWG and work on VME mapping / bio-regionalisation.

Agenda item 7 – Advice on management and/or research plans in the proposed and/or validated protected zones

Agenda item 7.1 Review of the validated protected areas and protocols

Agenda item 7.2 Proposal for new protected areas

83. No papers were submitted under agenda item 7.

Agenda item 8 – SIOFA fishing footprint update

Agenda item 8.1 Update for consideration of MoP8 recommendations (ref report para 110)

Summary of paper

84. The Data Officer presented PAEWG-04-12, which provided maps of the spatial footprint of SIOFA bottom fishing that were computed from set level data, as requested by the MoP. Two sets of footprints were computed. Set1 used only available historical data (up to 2015) and set 2 included historical and recent set level data (up to 2020). Deeper areas were not removed from the footprint.

85. The difference in the maps showed that the inclusion of 2016 to 2020 fishing activities increased the footprint compared to the historical footprint (1998 to 2015 fishing activities). The total footprint at 20' resolution increased by 22%, and at 30' the increase was 19%. Increasing the resolution from 20' to 30' squares almost doubled the total footprint areas. Producing an additive footprint, using 20' and 30' resolution, additionally increased the footprint by about 4% compared to a 30' grid.

86. The Data Officer invited the PAEWG and the SC to advise which map would be most suitable as a historical baseline that would be used to assess, and potentially constrain, the spatial extension of future SIOFA bottom fishing.

PAEWG discussion

87. The PAEWG suggested that, as future work, it would be useful to compare the fishing footprint maps generated by the Secretariat with those generated by the consultant in Project PAE2020-01.

88. The PAEWG suggested that gear-by-gear footprint and SIOFA subarea maps be made available to CCP scientists for ad hoc analysis and future workshops.

89. The PAEWG suggested that it would be useful to generate heat maps showing fishing intensity.

90. The DSCC noted the need to fill in data gaps, including historical data from non-CCPs.

Agenda item 8.2 Recommendations for Scientific Committee

91. The PAEWG4 **RECOMMENDED** that, in the interim, the historical and recent footprint at 20' + 30' square resolution (as shown in the lower panel of figure 2 of PAEWG-04-12) be used.

92. The PAEWG encouraged CCPs to submit to the Secretariat a copy of the shapefile of their bottom fishing footprint at a 20' resolution (or finer scale), to verify that their fishing footprints are encompassed by the fishing footprints generated by the Secretariat.

- For data falling outside the footprint proposed by the Secretariat, the Secretariat will notify CCPs of outlying data, and the CCPs and the Secretariat would resolve those discrepancies.

Agenda item 9 – Consideration of PAEWG work plan and resource requirements

Agenda item 9.1 Development of fishery and ecosystem reports (Project SEC2021-07)

Summary of paper

93. The Data Officer presented PAEWG-04-08, which provided a draft ecosystem report template as requested by the SC and the MoP (MoP8 para 115; SC6 paras 142-146). The template was prepared by the SC Chair and filled in by the Secretariat, and focused on ecosystem components and bycatch.

94. The Data Officer invited the PAEWG to review the report template and provide its feedback.

PAEWG discussion

95. The PAEWG considered the draft template and suggested the following improvements:

- Inclusion of a definition for how bycatch species were determined and separation of bycatch by gear

- More specific categorisation of gear types

- Inclusion of more contextual information, e.g. level of observer coverage, for tables showing observer data

- Inclusion of cross references between the fishery and ecosystem report templates

- Inclusion of a mechanism to synchronise updates to the report and updates to information held by organisations with which SIOFA has data-sharing agreements.

96. The PAEWG **REQUESTED** that the Secretariat and the SC Chair work in consultation with CCPs over the intersessional period to further develop the template and present a draft ecosystem summary at PAEWG5. The PAEWG **NOTED** that this may be combined with the workshop on defining bycatch species.

Summary of paper

97. PAEWG-04-07, which provided a draft fishery report template, was submitted to the meeting for the PAEWG's reference. The paper was presented and discussed at the fourth Stock Assessment and Ecological Risk Assessment Working Group (SERAWG4) meeting.

Agenda item 9.2 Future workplan update (2022-2024)

98. The PAEWG reviewed and updated its work plan **(Annex D)**.

Agenda item 9.3 Consideration of the EU-grant and other funding allocation

99. Dr Gary Morgan, the Science Manager in charge of overseeing the implementation and monitoring of EU-funded projects (Project SCM2021-01), reported that the current projects being undertaken under the funding Agreement with the EU have generally been progressing on schedule.

100. The SIOFA Science Officer reported that the SC and WG Chairs and the Secretariat have submitted a proposal to the EU's European Maritime, Fisheries and Aquaculture Fund (EMFAF) to fund several scientific studies aimed mainly at assessing Protected Areas in SIOFA, improving scientific understanding of Patagonian toothfish population spatial structure, and establishing a framework for scientific observation of fisheries (as described in PAEWG-04-INFO-02). In addition, the Secretariat is drafting another proposal to EMFAF to fund the organisation and running of the SC8 meeting.

Agenda item 9.4 The Scientific Committee workplan and budget

101. The PAEWG **RECOMMENDED** that the SC take the updated PAEWG work plan **(Annex D)** into consideration when updating the SC workplan.

Agenda item 10 – Other business

Agenda item 10.1 Appointment of a new Co-chair/Vice-Chair of the PAEWG

102. No nominations for the appointment of a new Co-chair/Vice-Chair of the PAEWG were received.

Agenda item 10.2 Future meeting arrangements

103. The PAEWG **REQUESTED** the SC to consider future meeting arrangements in conjunction with arrangements for SC8.

Agenda item 11 – Adoption of the meeting report

104. The report of the fourth meeting of the SIOFA PAEWG was adopted at 07:13 am (UTC), 11 March 2022.

Agenda item 12 – Close of meeting

105. The meeting was closed at 07:15 am (UTC), 11 March 2022.

References
Costello et al. (2017), *Nature communications*, *8*(1).
Cryer & Nicol (2017), 5th Meeting of the SPRFMO Scientific Committee, SC5-DW08.
Dunstan et al. (2020), *Bioregions of the Indian Ocean*. CSIRO, Australia.
Hobday et al. (2011), *Fisheries Research, 108*.
Pinet et al. (2011), *Marine Ecology Progress Series, 423*.
Rosvall and Bergstrom (2008), *Proceedings of the national academy of sciences, 105*(4).
Watling et al. (2013). *Progress in Oceanography, 111*.

ANNEX A – List of registered participants of the 4th PAEWG of SIOFA

Delegation	Title	Name	Function	Contact
MEETING CHAIRPERSON				
	Mr	Patrice Pruvost	PAEWG Chairperson	
SIOFA CCPs				
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Delegation	Title	Name	Function	Contact
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SIOFA	Ms	Laura Osborne	SIOFA Assistant	
SIOFA	Mr	Alex Meyer	SIOFA Rapporteur	meyer@urbanconnections.jp

ANNEX B – Agenda

Agenda
4th Meeting of the Protected Areas and Ecosystems Working Group (PAEWG4)

By videoconference
07- 11 March 2022
06:00 UTC to 10:00 UTC

Chair: Dr Patrice Pruvost

1.   Opening
1.1   Opening statement from the Chair
1.2   Introduction of participants
1.3   PAEWG Chair and co-Chair

2.   Administrative arrangements
2.1   Adoption of the agenda
2.2   Confirmation of meeting documents
2.3   Appointment of rapporteurs

3.   Vulnerable Marine Ecosystems (VME
3.1   VME taxa list (proposals for taxa revision/inclusion)
3.2   VME encounter thresholds
3.3   VME mapping (Final consultant report, project PAE2020-02)

4.   Bio-regionalisation and VME's project (Draft report from consultant, project PAE2021-01)
4.1   Holistic framework for VMEs
4.2   Benthic Bio-regionalisation

5.   Management of other system components (Seabird and mammals)
5.1   Presentation of Project PAE2021-02 (ToR1)

6.   Bottom Fishing Impact Assessments (BFIA)
6.1   Saya de Malha bank study (Project SER2021-03, ToR2).
6.2   Final report BFIA (Project PAE2020-01, Mormede 2021)

7.   Advice on management and/or research plans in the proposed and/or validated protected areas
7.1   Review of the validated protected areas and protocols
7.2   Proposal for new protected areas

8.   SIOFA Fishing footprint update
8.1   Update for consideration of MoP8 recommendations (ref report para 110)
8.2   Recommendations for Scientific Committee

9.   Consideration of PAEWG work plan and resource requirements
9.1   Development of fishery and ecosystem reports (Project SEC2021-07)
9.2   Future workplan update (2022-2024)
9.3   Consideration of the EU-grant and other funding allocation
9.4   The Scientific Committee workplan and budget

10.   Other business
10.1   Appointment a new Co-chair/Vice-Chair of the PAEWG
10.2   Future meeting arrangements

11.   Adoption of the meeting report

12.   Close of meeting

ANNEX C – Table of agenda items and related papers

Table of agenda items and related papers
(as at 02/03/2022)

Agenda Item	Related Papers

1. Opening
 	
    1.1 Opening statement from the Chair
    1.2 Introduction of participants
    1.3 PAEWG Chair and co-chair	

2. Administrative Arrangements
 	
    2.1 Adoption of the agenda
    2.2 Confirmation of meeting documents
 	
    2.3 Appointment of rapporteur
	PAEWG-04-01 Revised Provisional Agenda rev1
	PAEWG-04-02 Template for meeting documents
	PAEWG-04-03 Table of agenda items and related papers rev3 (this)
	PAEWG 04-04 List of registered participants

3. Vulnerable Marine Ecosystems (VME)
 	
    3.1. VME taxa list (proposals for taxa revision/inclusion)
    3.2. VME encounter thresholds
 	
    3.3. VME mapping (project PAE2020-02)
	
	PAEWG-04-INFO-01 Bycatch-thresholds-settings-SIODFA
	
	PAEWG-04-09 VME mapping progress report (consultant report, restricted)

4. Bio-regionalisation and VME's project (Project PAE2021-01)
    4.1. Holistic framework for VMEs
    4.2. Benthic Bio-regionalisation
	PAEWG-04-10 Bioregionalization and VME-project (consultant progress report; restricted)

5. Management of other system component (seabirds and mammals) 5.1. Presentation of project PAE2021-02 (ToR1, seabirds and mammals)	PAEWG-04-INFO-03 Review of seabird bycatch and data standards against ACAP advice PAEWG-04-06 PAE202102 ToR1 seabird mammal-ERAEF (consultant report, restricted) PAEWG-04-13 PAE2021-02 ToR3 bycatch mitigations-recommendations (consultant report, restricted)
6. Bottom Fishing Impact Assessments (BFIA) 6.1. Saya de Malha bank study (project SER2021-03, ToR2)	PAEWG-04-11 Saya De Malha ToR2 Bottom Impact Assessment (consultant report, restricted)

Agenda Item	Related Papers
6.2. Final report BFIA (Project PAE2020-01, Mormede 2021)	**PAEWG-04-05** BFIA trawl longline (consultant report, restricted)
7. Advice on management and/or research plans in the proposed and/or validated protected areas 7.1. Review of the validated protected areas and protocols 7.2. Proposal for new protected areas	
8. SIOFA Fishing footprint update 8.1. Update for consideration of MoP8 recommendations (MoP report para 110) 8.2. Recommendations for Scientific Committee	**PAEWG-04-12** SIOFA bottom fishing footprint update (restricted)
9. Consideration of PAEWG work plan and resource requirements 9.1. Development of fishery and ecosystem reports (Project SEC2021-07) 9.2. Future workplan update (2022-2024) 9.3. Consideration of the EU-grant and other funding allocation 9.4. The Scientific Committee workplan and budget	**PAEWG-04-07** SIOFA-fishery-summary-template (ORY) (restricted) **PAEWG-04-08** SIOFA-ecosystem-summary-report (restricted) **PAEWG-04-INFO-02**-EU-funding proposal SIOFA-SEAs **PAEWG-04-INFO-04** EU-funded Projects Progress-Report
10. Other business 10.1. Appointment a new Co-chair/Vice-Chair of the PAEWG 10.2. Future meeting arrangements	
11. Adoption of the meeting report	
12. Close of meeting	

ANNEX D – PAEWG work plan

Year	Project code	Lead	Project Status	Summary Title	Provider	Date ToR published	Consultant Recruitement	Draft report submission date	Date final report due	WG/SC meeting
2020/21	-	PAEWG	Complete	VME indicator species	Secretariat	N/A	N/A	-	01-03-2021	PAEWG3
2020/21	-	PAEWG	Complete	SIOFA Fishing Footprint	Secretariat	N/A	N/A	-	01-01-2021	SC6
2020/21	PAE2020-01	PAEWG	Complete	BFIA trawl & longline	Consultant	05-10-2020	05-11-2020	31-01-2021	01-06-2021	PAEWG4
2020/21	PAE2020-02a	PAEWG	Complete	VME mapping (year 1)	Consultant	Completed	Completed	30-01-2021	01-03-2021	PAEWG3
2021/22	-	PAEWG	-	VME indicator species	SC Delegations	N/A	N/A	05-01-2022	05-02-2022	PAEWG4
2021/22	PAE2020-02b	PAEWG	In development	VME mapping (year 2)	Consultant	Completed	Completed	05-02-2022	01-03-2022	PAEWG4
2021/22	PAE2021-01a	PAEWG	In development	Bioregionalisation for smaller spatial entities within a larger area using a range of environmental information	Consultant	04-08-2021	13-09-2021	05-01-2022	05-02-2022	PAEWG4
2021/22	PAE2021-01b	PAEWG	In development	Representative protected areas (ToR1)	Consultant	04-08-2021	13-09-2021	05-02-2022	30-11-2022	PAEWG4 (Draft report); PAEWG5 (Final report)
2021/22	PAE2021-01c	PAEWG	In development	Representative protected areas (ToR2)	Consultant	04-08-2021	13-09-2021	05-02-2022	30-11-2022	PAEWG4 (Draft report); PAEWG5 (Final report)
2021/22	PAE2021-01d	PAEWG	In development	Holistic framework for VMEs (ToR4)	Consultant	04-08-2021	13-09-2021	05-02-2022	30-11-2022	PAEWG4 (Draft report); PAEWG5 (Final report)
2021/22	PAE2021-01e	PAEWG	In development	Holistic framework for VMEs (ToR5)	Consultant	04-08-2021	13-09-2021	05-02-2022	30-11-2022	PAEWG4 (Draft report); PAEWG5 (Final report)
2021/22	PAE2021-01f	PAEWG	In development	Support work on benthic bioregionalization (underway) and (future) investigate possible habitat suitability modelling	Consultant	04-08-2021	13-09-2021	05-02-2022	30-11-2022	PAEWG4 (Draft report); PAEWG5 (Final report)
2021/22	PAE2021-02	PAEWG	In development	Updates to the ERA work - Considering seabirds & mammals	Consultant	25-10-2021	01-10-2021	05-01-2022	05-02-2022	PAEWG4
2021/22	PAE2021-03a	PAEWG	-	VME indicator species threshold development plan	Intersessional WG	TBD	TBD	TBD	TBD	PAEWG5
2021/22	PAE2021-03b	PAEWG	-	VME indicator species thresholds	Intersessional WG	TBD	TBD	TBD	TBD	PAEWG5
2021/22	PAE2021-04	PAEWG	-	SIOFA Fishing Footprint (update)	Secretariat	N/A	N/A	19-01-2022	19-02-2022	SC7
2021/22	PAE2021-05	PAEWG	-	Review seabird bycatch mitigation (CMM2021/02, 2019/13, ACAP)	SC Delegations	N/A	N/A	N/A	05-02-2022	PAEWG4

Year	Project code	Lead	Project Status	Summary Title	Provider	Date ToR published	Consultant Recruitement	Draft report submission date	Date final report due	WG/SC meeting
2022/23	PAE2022-03	PAEWG	-	Development of research and monitoring plans for protected areas	TBD	TBD	TBD	TBD	31-01-2023	PAEWG5
2022/23	PAE2022-02	PAEWG	-	Annual review of VME encounters	Secretariat	TBD	TBD	TBD	31-01-2023	PAEWG5
2022/23	SEC2021-06	PAEWG	-	Work on the PAEWG-04-08-SIOFA-ecosystem-summary-report.docx	Secretariat	N/A	N/A	N/A	31-01-2023	PAEWG5
2022/23	PAE2022-04	PAEWG	-	CCPs footprints checked against Secretariat footprint	Secretariat	N/A	N/A	N/A	N/A	PAEWG5
2022/23	PAE2022-05	PAEWG	-	Further ERA for benthic species on the Saya de Malha bank	TBD	TBD	TBD	TBD	TBD	PAEWG5
2022/23	PAE2022-01	PAEWG	-	Review of VME indicator species	TBD	TBD	TBD	TBD	TBD	PAEWG5