



Report of the Fourth Meeting of the Southern Indian Ocean Fisheries Agreement (SIOFA)
Scientific Committee (SC) Stock Assessment and Ecological Risk Assessment Working
Group (SERAWG)

Held via Zoom videoconferences on 28 February to 4 March 2022

TABLE OF CONTENTS

Agenda item 1 – Opening	4
Agenda item 1.1 Opening statement from the Chair	4
Agenda item 1.2 Introduction of participants.....	4
Agenda item 2 – Administrative arrangements	4
Agenda item 2.1 Adoption of the Agenda	4
Agenda item 2.2 Confirmation of meeting documents	4
Agenda item 2.3 Appointment of rapporteurs	4
Agenda item 3 – Update on the Fisheries	4
Agenda item 4 – Orange Roughy	5
Agenda item 4.1 Consultant report on the orange roughy age estimation by otolith [project SER2021-02].....	5
Agenda item 4.2 New studies and information (Biology, stock analyses and others).....	6
Agenda item 4.3 Consultant Report on the orange roughy acoustic data processing [project SER2021-01].....	7
Agenda item 4.4 Consultant report on the 2021 Stock Assessment [project SER 2021-04].....	8
Agenda item 4.5 Advice to SC and Future workplan	11
Agenda item 5 – Patagonian toothfish	12
Agenda item 5.1 Review of the recommendations from the CCAMLR-SIOFA Workshop on the Exchange of Scientific P. toothfish data (WESTD).....	12
Agenda item 5.2 SIOFA tagging process.....	12
Agenda item 5.3 New studies and information (Biology, stock analyses and others)....	12
Agenda item 5.4 Advice to SC and Future work plan.....	13
Agenda item 6 – Alfonsino	14
Agenda item 6.1 Standardised data collection protocols in relation to CMM 2021/02 (Data Standards).....	14
Agenda item 6.2 New studies and information (Biology, stock analyses and others)....	14
Agenda item 6.3 Advice to SC and Future work plan.....	14
Agenda item 7 – Other species	14
Agenda item 7.1 Consultant report of the Saya de Malha fisheries (ToR1 scoping study) [Project SER2021-03].....	14
Agenda item 7.2 New studies and information (Biology, stock analyses and others)....	15
Agenda item 7.3 Advice to SC and Future work plan.....	15
Agenda item 8 – Technical work to inform reference points and harvest strategy development	15
Agenda item 8.1 Consultant Report (ToR1) to evaluate 3 provisional Harvest Strategies [Project SER2021-05].....	15
Agenda item 8.2 Development of Roadmap for Formal Harvest Strategy.....	17

Agenda item 8.3 Advice to SC and Future work plan.....	17
Agenda item 9 – Ecological risk assessment	17
Agenda item 9.1 Deepwater chondrichthyans	17
Agenda item 9.2 Teleosts and others	18
Agenda item 9.3 Consultant Report on fish bycatches [Project PAE2021-02]	19
Agenda item 9.4 New studies and information	20
Agenda item 9.5 Advice to SC and Future work plan.....	20
Agenda item 10 – SIOFA stock assessment framework – implementation, including species categorisation and data characterisation, including refining SIOFA species list 22	
Agenda item 10.1 Development of fishery and ecosystem reports (Project SEC2021-07)	22
Agenda item 10.2 SIOFA species categorisation (Project SEC2021-07)	22
Agenda item 10.3 Other key target stocks and management units	22
Agenda item 10.4 Advice to SC and Future work plan.....	23
Agenda item 11 – Consideration of SERAWG work plan and resource requirements. 23	
Agenda item 11.1 Summary on the current EU funded activities	23
Agenda item 11.2 Consideration of the EU-grant and other funding allocation	23
Agenda item 11.3 Future workplan and budget (2022-2023).....	23
Agenda item 12 – Consolidated advice to Scientific Committee	24
Agenda item 13 – Other business.....	28
Agenda item 13.1 Appointment of a new Co-chair for the ERA part of the SERAWG ...	28
Agenda item 13.2 Future meeting arrangements.....	28
Agenda item 14 – Adoption of the meeting report.....	28
Agenda item 15 – Close of meeting	28
ANNEX A – List of registered participants of the 4th SERAWG of SIOFA	29
ANNEX B – Agenda.....	31
ANNEX C – Table of agenda items and related papers	33
ANNEX D – Work plan.....	36

Agenda item 1 – Opening

Agenda item 1.1 Opening statement from the Chair

1. The fourth meeting of the SIOFA SC Stock Assessment and Ecological Risk Assessment Working Group (SERAWG4) was opened by the Chair, Dr Tsutomu Nishida of Japan, at 6:00 am (UTC) on 28 February 2022.
2. The Chair welcomed the participants to the meeting.
3. The SC Vice Chair, Dr Sebastian Rodriguez Alfaro, served as the provisional co-Chair.

Agenda item 1.2 Introduction of participants

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

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 – Update on the Fisheries

Summary of paper

8. The Data Officer presented report SERAWG-04-12, which provided a summary of catches from 2013 to 2020 and, where possible, effort data for the SIOFA main species and figures on the availability of biological data. The Data Officer noted that 2021 data should be available after the yearly data submission due at the end of May 2022.
9. The Data Officer invited the SERAWG to:
 - consider the report in relation to the proposed fisheries summary reports under project SEC2021-07 (fisheries summary reports).
 - propose other species to be added to the update.

SERAWG discussion

10. The SERAWG considered the report and provided comments seeking clarification and suggesting improvements to how the data are presented, including the preparation of area-based summaries as recommended by SERAWG03 (SERAWG3 Report, para 73) and providing the catch total of all species. The SERAWG requested to have clarification on the missing data in the sampling table. FR-OT requested to have in this report information on the VME catches and threshold if this report is also available for the PAEWG.

11. The SERAWG recalled that the SC recommended that the overview of SIOFA fisheries be provided not only to the SC but also to the meetings of its working groups (SC6 Report, para 36).
12. The SERAWG requested Chinese Taipei to clarify why oilfish catch data for 2013 and 2014 were not available. Chinese Taipei explained that, CMM 2021/02 (Data Standards) only requires the submission of historical oilfish data dating back to 2015. Chinese Taipei requested that a footnote be added to the relevant figure in the fisheries overview explaining this point. The Secretariat reminded the SERAWG that CMM 2021/02 requires the provision of historical data up to 2015.
13. SIODFA pointed out that there are two distinct alfoncino fisheries in the SIOFA area, with one using benthopelagic (suprabenthic trawling close to but usually not touching the bottom) trawl gear and the other using a pelagic trawl gear. The two use different nets and operate in different sectors, albeit with some overlap in fishing grounds. In their opinion, the benthopelagic effort could be assessed by number of tows and the pelagic trawl effort could be best assessed by trawling hours. However, this would need an analysis to review what metrics are preferable and compare these to other effort metrics.
14. The SERAWG requested Chinese Taipei to clarify why there are zero or low numbers of oilfish samples. Chinese Taipei explained that it does conduct its own biological sampling projects and scientific research programs. Chinese Taipei explained that it has provided such information, in the form of figures, in its national reports submitted to the Secretariat, but not as data. The Secretariat requested Chinese Taipei to submit the relevant data as well.
15. SIODFA informed the SERAWG that one of its trawlers has been providing rubyfish otoliths for ageing and that ageing information will soon be available for this species. SIODFA also has aggregated all catch and effort data for this species.
16. The Data Officer presented revised versions of the Update of SIOFA Fisheries. Due to time limitations, the Secretariat was only able to reflect some of the comments of the SERAWG. The Secretariat will provide an updated revision, reflecting all of the SERAWG's comments to be included in the Overview of SIOFA Fisheries, at the SC7 meeting.

Agenda item 4 – Orange Roughy

Agenda item 4.1 Consultant report on the orange roughy age estimation by otolith [project SER2021-02]

Summary of paper

17. The consultant, National Institute of Water & Atmospheric Research (NIWA), presented report SERAWG-04-08, which provided the age estimation results for otoliths of orange roughy (*Hoplostethus atlanticus*) from the Southern Indian Ocean. The otoliths were selected and provided to NIWA for preparation and ageing by SIOFA. They were prepared and read by one reader following the accepted ageing protocol (Horn et al. 2016). Reference set reads indicated no bias with a CV of 7.1%. A total of 356 otoliths were provided. Twenty-four of these were broken and unable to be sectioned. A total of 325 were able to be aged, with 7 sections that were unable to be interpreted (readability score 5).
18. Age estimates ranged from 19 to 183 years. Median age at the transition zone (i.e., age at maturity) was 32 for males and 33 for females, but only 55% had

identifiable transition zones (i.e., with a transition zone classification code of 1 or 2). There were two obvious outliers, shown in the length-at-age plot, and the consultant recommended that these be excluded when the data are used to generate a growth curve.

19. The otoliths were selected to provide additional data to improve the current growth curve for the Southern Indian Ocean. As such, they were not representative of the population age frequency; however, it was noteworthy that substantial numbers of very old fish were in the sample provided.
20. The reference set utilised in this study was comprised of orange roughy sampled from the Tasman Sea and Pacific Ocean. If future ageing work is to be done on orange roughy in the Southern Indian Ocean, the consultant recommended that a reference set specific to the area be developed.
21. For future studies, the consultant recommended that otoliths be stored in vials rather than taped to paper or envelopes to prevent breakage.

SERAWG discussion

22. The SERAWG **ENDORSED** the recommendations in SERAWG-04-08.
23. The SERAWG **RECOMMENDED** using the age data in SERAWG-04-08 to update the orange roughy growth curve for the Southern Indian Ocean.

Agenda item 4.2 New studies and information (Biology, stock analyses and others)

Summary of paper

24. The Cook Islands presented report SERAWG-04-09, which provides an assessment of the length-at-age data for orange roughy collected in the SIOFA area from three regions and estimates of growth and length-at-age to inform age-based stock assessment models and estimates of mortality, age-at-maturity, longevity and production. Seven hundred and forty-four fish were aged at three locations; of these 427 were male and 317 were female. Fish length ranged from 20-60 cm for all fish; 20-58 cm for males and 20-61 cm for females. Age estimates in the study ranged from 10 to 183 years old. The von Bertalanffy growth parameters were provided for both sexes combined and for males and females separately. In addition, maturity estimates were derived for each of the three regions as well as the SIOFA area as a whole.
25. As with all orange roughy populations, orange roughy in the SIOFA area are slow growing and very long lived, maturing late in life at about 30 years old and spawn in the Austral winter. Due to the low level of fishing effort in this fishery, sampling overall has been uneven both between sub-regions within SIOFA and also through time, which complicates analyses. As a result, as with the previous assessment (Cordue, 2018), the 2022 stock assessment should be treated as relatively data poor.
26. The age data were not sufficient to comment on the stock structure of orange roughy within the SIOFA area. However, with additional sampling from areas that have been historically under sampled or using alternative techniques, stock structure could be explored in future if the SIOFA believes this to be necessary.
27. Based on the report, the Cook Islands recommended that:
 - The growth and maturity estimates from Walters Shoal should be used in the 2022 SIOFA orange roughy assessment of that region.
 - In future a stratified sampling selection should be employed for otolith collection to ensure more representative samples are collected across the size range of fish and between areas.

- The sampling protocols should be revised to prioritise biological data collection in tows made on the Southern Rise, Western Rise and areas to the East within the SIOFA area.
- If the assessment is sex separated, estimating sex and age specific mortality should be considered.

SERAWG discussion

28. The SERAWG **ENDORSED** the recommendations in SERAWG-04-09.
29. The SERAWG asked if seasonal sampling may impact the maturity function and estimation of the maturity outside the spawning season. The Cook Islands explained that the fishery does not operate year-round so there is only sporadic sampling from different parts of the year. However, over the history of the fishery it has been possible to collect year-round data except for January and December. Outside the spawning season, samples are relatively sparse, which will impact how maturity is estimated, although the plot of maturity stages in the paper suggested that the data were of good quality.
30. The SERAWG discussed how orange roughy spawning aggregation behaviour might create sampling bias in relation to size-at-maturity estimates, as is ubiquitous in other fisheries where fish are only caught on spawning aggregations or during the spawning season.
31. The SERAWG **RECOMMENDED** that a sensitivity analysis be conducted to assess the impact of age and the size-at-maturity estimates on the stock assessment results, given the potential bias in sampling.
32. The SERAWG **RECOMMENDED** that the maturity estimates from the paper be used in the assessment.

Agenda item 4.3 Consultant Report on the orange roughy acoustic data processing [project SER2021-01]

Summary of paper

33. The consultant, Aqualyd, presented a report on the orange roughy acoustic data processing project (reports SERAWG-04-05, SERAWG-04-06, and SERAWG-04-07). Data pertinent to acoustic surveys of orange roughy in SIOFA areas 1, 2, 3a, and 3b were collated and summarised. Data quality was generally high. Data were received from years 2005-2021 and 177 survey candidates for biomass estimation were identified. Of these, 125 appeared to be explicit surveys rather than survey-like datasets conducted as part of fishing operations. In the sub-period of 2017-2021, 77 potential surveys were found, 25 of which were explicit surveys. Some of the 177 surveys were potentially unsuitable for biomass processing due to data quality, weather conditions, and echosounder settings.
34. Measures of data quality were derived and after filtering the set of potential surveys using the data quality measures, 39 surveys remained. Most of the surveys (26) were in the Walters Shoal Region (WSR), with a small number also in the North Ridge (3), North Walter's (7), Seamounts (2), and South Ridge (1) areas.
35. 26 of the 39 surveys ultimately yielded sufficient data to estimate orange roughy biomass from years 2018, 2019, and 2020. Most of the surveys were in the WSR area (17), with a small number also in the North Ridge (3), North Walter's (4), Seamounts (1), and South Ridge (1) areas. Per-survey biomass estimates ranged from 200 to 50 400 t. The largest biomass was driven by a single strong school that was not confidently identified as orange roughy. Removing this school

gave a biomass of 4600 t. Highest biomass was then 11 000 t from the same feature.

36. Based on the report, the consultant recommended that:

- More structured collection and recording of acoustic and ancillary data, such as date and time of the start and end of surveys and survey-specific binned length frequencies, would significantly decrease the time/cost to process future datasets.
- That SERAWG note that there are several significant sources of uncertainty that will need addressing at some point: region-specific target strength, target identification and use of multiple frequencies, survey-specific length frequencies, and ad-hoc survey design.
- That SERAWG note that several otherwise suitable surveys were discarded because of the use of uncalibrated echosounder or incorrect echosounder settings.
- That SERAWG note that designed surveys could give increased comparability between surveys/years and reduce some error sources.

SERAWG discussion

37. The SERAWG **ENDORSED** the recommendations made by the consultant.
38. The SERAWG agreed that it would be useful to establish a small working group to further investigate the significant sources of uncertainty identified and means to resolve them.
39. Regarding the uncertainty associated with region-specific target strength and the lack of survey-specific length frequencies, the consultant suggested that this could be resolved by collecting the appropriate data.
40. Regarding the uncertainty associated with target identification and use of multiple frequencies, the consultant, suggested that this could be partially resolved by the collection of information on fish targeted and those actually caught.
41. Regarding the uncertainty associated with the use of ad-hoc survey designs, the consultant suggested that improvements could be made by providing vessels with a procedure to follow when conducting surveys and criteria that need to be met before survey is conducted to ensure the survey is likely to yield useful data. Furthermore, it would be useful to use an adaptive survey design in future based on the presumed distribution of orange roughy.
42. The SERAWG agreed that it would be useful to have the acoustic survey protocols reviewed. The SERAWG **RECOMMENDED** that the SC include a budget line for this work in its budget request to the Meeting of the Parties (MoP). The SERAWG requested that, after the review, the protocols be shared with the SERAWG and the SC as they may be useful for future SIOFA acoustic surveys not only for orange roughy, but also other species.

Agenda item 4.4 Consultant report on the 2021 Stock Assessment [project SER 2021-04]

43. Although SERAWG-04-17 was only submitted on 1 March, after the deadline for the submission of working documents, the SERAWG agreed to have the paper be presented at the meeting.

Summary of paper

44. The consultants, Dr Rubén Roa-Ureta, Dr Rodrigo Wiff, and Dr Andrés Flores, presented report SERAWG-04-17, which provided a stock assessment update of the orange roughy captured in the SIOFA area. The stock assessment update

was conducted using the following data: time series of fishing effort (number of hauls) and catch (kg) from 2000 to 2020 from logbook records, annually aggregated length frequency data from 2011 to 2020, acoustic biomass indices from 2004 to 2018, and age composition data from the catch of 2017.

45. The assessment updated a previous assessment done with data up to 2017 (SAWG (2018)-01-05 and SAWG (2018)-01-06) using code in the CASAL system for stock assessment for the WSR management unit (MU). The consultants updated the age structured model developed for the stock in the WSR, both with migration among features (sub-localities) of the MU as done previously, and by aggregating features inside the WSR as suggested by the spatial analysis.
46. For a larger aggregation of MUs connected spatially to the WSR, namely North Walter's, West Walter's, Walter's Shoal Ridge, Seamounts and Meeting (collectively 'the Long WSR'), the consultants also presented a stock assessment using the generalized depletion family of models with the R package CatDyn. This was applied to the MUs North Ridge, Middle Ridge and South Ridge (collectively 'the Long Eastern Ridge'). Predictions of annual biomass using the generalized depletion models were estimated from surplus production models to the Long WSR and the Long Eastern Ridge with code implemented in AD Model Builder.
47. The spatial analysis suggested that the MUs could be aggregated into two larger spatial units, the Long WSR and the Long Eastern Ridge, leaving only the Outside MU (i.e., the area to the west of Western Australia) outside the scope of the assessments.
48. The age structure data and acoustic indices of biomass indicated that the available information was not sufficient to model migration among features inside the WSR without introducing large degrees of subjectivity. The consultants recommended that the age-structured model be continued but with the features aggregated into a single WSR MU, and migration among features be ignored. The model of this area showed high sensitivity to prior distributions of the acoustic catchability coefficient. Nevertheless, results with a target biological reference point (BRP) of $0.5 \times B_0$ and steepness $h = 0.57$ suggested that the target BRP would be achieved with a constant exploitation rate of 3%. The model showed that the exploitation rate of the stock in the WSR was currently sustainable, with a low probability ($p = 0.25$) of the stock being overfished. Stock projections from 2021 to 2040 considered nine scenarios of constant catch using different multipliers of the 2020 catch level. All projected scenarios had zero probability ($p = 0.0$) that the exploitation rate would be higher than the BRP exploitation rate at the end of the projected period.
49. Generalized depletion models combined with Pella-Tomlinson surplus production models for Long WSR and Long Eastern Ridge showed that the stock was more productive in Long WSR. This assessment for Long WSR was consistent with the age structured assessment in showing the stock as being harvested at sustainable rates, with annual catches well below the maximum sustainable yield (MSY). The MSY in the Long WSR was estimated at 3276 tonnes but with very poor precision (CV=215.7 %). The MSY estimated for the Long Eastern Ridge was much lower, at 616 tonnes, but with much better precision (CV=88.8 %). In the Long Eastern Ridge the stock was found to be being harvested close to the MSY with frequent annual catches much higher than the MSY.
50. Projections from the surplus production model from 2021 to 2040 were carried for the Long WSR and the Long Eastern Ridge under three scenarios of constant catch: catch equal to the MSY, 75% of the MSY, and 50% of the MSY. In the Long Eastern Ridge annual catches at MSY led to a slow decay of biomass and

high probability ($p \approx 0.6$) of failing to keep the stock at a biomass equal or higher than the biomass producing the MSY (BMSY) and failing to keep fishing mortality at less than the fishing mortality at the MSY (FMSY). Catches aimed at 75% of the MSY led a slight increase and the stability of biomass with a moderately low probability ($p \approx 0.3$) of biomass lower than BMSY and fishing mortality higher than FMSY. Finally, catches aiming for 50% the MSY led to a stronger rise in biomass and subsequent stability with a low probability ($p \approx 0.1$) of biomass lower than BMSY and even lower probability ($p < 0.1$) of fishing mortality higher than FMSY.

51. In the Long WSR all scenarios for future annual catches led to falls in biomass but the rate of decline was substantially different. Aiming for the MSY led to a 3-times decline in biomass with high probability ($p \approx 0.8$) of biomass being below the BMSY and fishing mortality above FMSY. Aiming for annual catches at 75% of the MSY led to biomass dropping by about 30%, with a moderate probability ($p \approx 0.3$) of biomass below BMSY and fishing mortality being higher than FMSY ($p \approx 0.4$). Catches around 50% of the MSY led to a slight decrease in biomass with a low probability of biomass being less than BMSY ($p \approx 0.1$) and of fishing mortality being higher than FMSY ($p < 0.1$).
52. The consultants recommended that SIOFA consider a simplified spatial split of areas, reducing the current MUs to just two, the Long WSR and the Long Eastern Ridge.
53. The consultants recommended the continued use of both the age structured model implemented in CASAL (though without migration among features) for the Walter's Shoal Ridge MU and the generalized depletion model combined with surplus production models for the Long WSR and the Long Eastern Ridge.
54. The consultants concluded that the exploitation rates in the WSR and the larger Long WSR were within sustainability limits, while the exploitation rates on Long Eastern Ridge were too close to limit harvest rates (MSY) and should be considered for a biomass rebuilding program.

SERAWG discussion

55. The SERAWG discussed the importance of holding pre-assessment discussions on key stock assessment decisions such as which biological parameters to use and the final model configurations. In future, such discussions could be held as part of a pre-assessment meeting with the participation of the stock assessment scientists, the SC Chair, the Secretariat, and any interested CCPs or observers, and could be conducted as a virtual meeting even after the resumption of in-person meetings.
56. The SERAWG suggested that had this pre-meeting occurred the ageing work (presented in SERAWG-04-09) could have been done using the same management unit split as the stock assessment.
57. The SERAWG suggested that it would have been useful to conduct detailed sensitivity analyses on potentially influential biological parameters, such as growth, reproduction, steepness and mortality.
58. The SERAWG pointed out that the catch projections were conducted based on the single last year of catch, which was close to a historical low, and suggested that in future, projections should be based on multiple years. The SERAWG requested the consultants to present constant catch projections using the average catch over the last 6 years and the average catch over last 3 years (0%, $\pm 10\%$, $\pm 20\%$, $\pm 30\%$, $\pm 40\%$) at the SC7 meeting.
59. The SERAWG **NOTED** the orange roughy stock assessment report (SERAWG-04-17).

60. The SERAWG **RECOMMENDED** that the SC consider and hold further discussions on the orange roughy stock assessment report (SERAWG-04-17), and develop management advice for the MoP.
61. The SERAWG **RECOMMENDED** that for future stock assessments, a pre-assessment meeting to discuss key stock assessment decisions and data inputs should be held virtually with the participation of the stock assessment scientists, the SC Chair, the Secretariat, and any interested CCPs or observers.

Agenda item 4.5 Advice to SC and Future workplan

62. The future work plan is as described in **Annex D**.

63. **The SERAWG's summary of advice to the SC is:**

(Orange roughy age estimation by otolith)

- if future ageing work is to be done on orange roughy in the Southern Indian Ocean, it is recommended that reference sets specific to the area be developed.
- for future studies, it is recommended that otoliths be stored in vials rather than taped to paper or envelopes to prevent breakage.
- to use the age data presented in report SERAWG-04-08, excluding the outliers identified by NIWA, to update the orange roughy growth curve for the Southern Indian Ocean.

(Orange roughy growth, length-at-age, and maturity)

- that the growth and maturity estimates from Walters Shoal should be used in the 2022 SIOFA orange roughy assessment of that region.
- that a sensitivity analysis be conducted to assess the impact of age and the size-at-maturity estimates on the stock assessment results, given the potential bias in sampling.
- that in future, a stratified sampling selection should be employed for otolith collection to ensure more representative samples are collected across the size range of fish and between areas.
- that the sampling protocols should be revised to prioritise biological data collection in tows made on the Southern Rise, Western Rise and areas to the East within the SIOFA area.
- that if the assessment is sex separated, estimating sex and age specific mortality should be considered.

(Orange roughy acoustic data)

- that more structured collection and recording of acoustic and ancillary data, such as date and time of the start and end of surveys and survey-specific binned length frequencies, would significantly decrease the time/cost to process future datasets.
- to note that there are several significant sources of uncertainty that will need addressing at some point: region-specific target strength, target identification and use of multiple frequencies, survey-specific length frequencies, and ad-hoc survey design.
- to note that several otherwise suitable surveys were discarded because of the use of uncalibrated echosounder or incorrect echosounder settings.

- that designed surveys could give increased comparability between surveys/years and reduce some error sources.
- to include a budget line for a consultancy to review the acoustic survey protocols in the SC budget request to the Meeting of the Parties (MoP).

(2022 orange roughy stock assessment)

- to consider and hold further discussions on the orange roughy stock assessment report (SERAWG-04-17), and develop management advice for the MoP.
- that for future stock assessments, a pre-assessment meeting to discuss key stock assessment decisions and data inputs should be held virtually with the participation of the stock assessment scientists, the SC Chair, the Secretariat, and any interested CCPs.

Agenda item 5 – Patagonian toothfish

Agenda item 5.1 Review of the recommendations from the CCAMLR-SIOFA Workshop on the Exchange of Scientific P. toothfish data (WESTD)

Summary of paper

64. The SC Chair, Mr Alistair Dunn, presented SERAWG-04-INFO-04, which provided a summary of the SIOFA/CCAMLR Joint Workshop on Exchange of Scientific Toothfish Data.

SERAWG discussion

65. The SERAWG **NOTED** the report and **ENDORSED** its recommendations. The SERAWG **RECOMMENDED** that the SC request the MoP to endorse the process given in the paper for the exchange of scientific toothfish data between SIOFA and CCAMLR as described in Annex A and Annex B of SERAWG-04-INFO-04.

Agenda item 5.2 SIOFA tagging process

Summary of paper

66. The SIOFA Science Officer presented SERAWG-04-16, which provided SIOFA toothfish tagging methods prepared by the Secretariat and adapted from the methods of CCAMLR, with skate and ray specifications removed.

SERAWG discussion

67. The CCAMLR Science Manager, Dr Steve Parker, noted that CCAMLR had scheduled a workshop later in 2022 to update and revise the toothfish tag instructions and resources, and would undertake to inform the SIOFA Secretariat and the Scientific Committee on any revisions that were made as a result of that workshop.
68. The SERAWG **ENDORSED** the draft SIOFA toothfish tagging instructions (**SERAWG-04-16-SIOFA-Toothfish-Tagging-Instructions_rev1**) and **RECOMMENDED** that the SC adopt it.

Agenda item 5.3 New studies and information (Biology, stock analyses and others)

Summary of paper

69. Australia presented SERAWG-04-20, which provided a study of fishery trends for Patagonian toothfish on William's Ridge (WR) in SIOFA Statistical Area 7 from

2018 to 2022. The study used operational data (Australian and EU records) from SIOFA, provided through a data call to the SIOFA Secretariat, observer/biological data, and tagging release and recapture data. The operational data consisted mostly of only setting date and start setting locations with only limited estimates for soak time, and the fished grid cell could not always be determined. In addition, several catch rates and/or soak times from the records for fishing trip 164 stood out. No observer data were available for 2018 and those for 2021 and 2022 have yet to be submitted. There was also no unique identifier to link operational and observer data. Tag-recapture data were also incomplete.

70. Catch rates were standardised using a generalized linear model (GLM) with fishing season and depth. Since 2018, catches have declined substantially, in part due to introduced catch and effort limits in CMM-2019/15 (Management of Demersal Stocks). Catch rates also declined, but it is unclear whether the changes are due to declining biomass and/or other factors. Data collection requirements in CMM-2021/15 (Management of Demersal Stocks) will provide useful data for future fishery analyses.
71. Based on the study, Australia recommended that:
 - the current management arrangements be maintained.
 - data holders submit all available biological and tagging data to SIOFA Secretariat.
 - the Secretariat and data holder verify the validity of all data records from fishing trip 164.
 - set start and end locations of hauls and set and haul dates be provided to the Secretariat and in data requests, so that fishing cells and soak time can be determined.
 - unique identifiers to unambiguously link operational and observer data be provided in data requests.

SERAWG discussion

72. The SERAWG **ENDORSED** the recommendations in SERAWG-04-20.
73. The SERAWG requested that Australia include catches from the exploratory fishing activities it conducted in WR in 1998 and 2003 in the next analysis.
74. The SERAWG suggested that it would be useful for the CCPs operating fisheries in WR and the Kerguelen Plateau areas to hold further discussions on how to ensure greater coherence across the management regimes for the three areas.

Agenda item 5.4 Advice to SC and Future work plan

75. The future work plan is as described in **Annex D**.
76. **The SERAWG's summary of advice to the SC is:**
(CCAMLR-SIOFA workshop on the exchange of scientific Patagonian toothfish data)
 - to note the conveners report (SERAWG-04-INFO-04) and endorse its recommendations.
 - to request the MoP to endorse the process given in the paper for the exchange of scientific toothfish data between SIOFA and CCAMLR as described in Annex A and Annex B of SERAWG-04-INFO-04.

(SIOFA toothfish tagging process)

- to adopt the draft SIOFA toothfish tagging instructions (**SERAWG-04-16-SIOFA-Toothfish-Tagging-Instructions_rev1**)

(WR toothfish fishery)

- that the current management arrangements should be maintained.
- that data holders should submit all available biological and tagging data to SIOFA Secretariat
- that the Secretariat and data holder should verify the validity of all data records from fishing trip 164.
- that set start and end locations of hauls and set and haul dates should be provided to the Secretariat and in data requests, so that fishing cells and soak time can be determined.
- that unique identifiers to unambiguously link operational and observer data should be provided in data requests.

Agenda item 6 – Alfonsino

Agenda item 6.1 Standardised data collection protocols in relation to CMM 2021/02 (Data Standards)

Agenda item 6.2 New studies and information (Biology, stock analyses and others)

Agenda item 6.3 Advice to SC and Future work plan

77. No papers were presented under agenda item 6.

Agenda item 7 – Other species

Agenda item 7.1 Consultant report of the Saya de Malha fisheries (ToR1 scoping study) [Project SER2021-03]

Summary of paper

78. The consultant, MRAG, presented report SERAWG-04-10, which provided the results of the scoping study on the Saya de Malha Bank fisheries. The study collated information on fisheries, species abundance, species biology, resources analyses, and management measures. It considered fishing activities of SIOFA's Contracting Parties, cooperating non-Contracting Parties, participating fishing entities, signatories, and any third party for which information was available and relevant. The consultant noted that some fisheries activities are also related to the tuna fishery.
79. Saya de Malha is likely an important biodiversity hotspot which may be highly sensitive to the impacts of fishing. At present the fisheries exploiting Saya de Malha are poorly understood. Thailand and Mauritius are likely the most important fishing nations. At present only Thailand and the Comoros reports their catches / associated data to SIOFA. Sri Lanka and India have flagged vessels which operate on Saya de Malha. The scoping study demonstrates a clear need for SIOFA to foster engagement and improve cooperation between itself and key contracting and non-contracting parties. There are limited data and information on the status of target catch, by-product, and bycatch (including VME species).

Biological information for species on Saya de Malha is similarly limited. Sky emperors (*Lethrinus mahsena*) have received some attention, with studies addressing various aspects of the species. There are currently no SIOFA management measures that are specific to the fisheries on Saya de Malha, though a number of general measures are of relevance. Specific efforts should be made to improve the understanding of key elements of the ongoing fishing operations e.g., gear use, target species and CPUE. This understanding will be critical in underpinning informed decision making and effective management actions.

SERAWG discussion

80. The SERAWG **NOTED** the need to foster engagement and improve cooperation between SIOFA and key contracting and non-contracting parties.
81. The SERAWG **NOTED** the need to improve the understanding of key elements of the ongoing fishing operations e.g., gear use, target species and CPUE, to underpin informed decision making and effective management actions. The SERAWG discussed the possibility of collaborating with Monaco Explorations to fill some of the current information gaps.
82. The Deep Sea Conservation Coalition (DSCC) expressed concern over the limited understanding of catch on Saya de Malha and limited reporting of bycatch. DSCC noted that Saya de Malha is an ecologically or biologically significant area (EBSA) as designated by the Convention on Biodiversity. DSCC called for the environmental damage to Saya de Malha to be stopped and for fisheries and bycatch not to proceed until an environmental impact assessment is conducted.

Agenda item 7.2 New studies and information (Biology, stock analyses and others)

83. No papers were presented.

Agenda item 7.3 Advice to SC and Future work plan

84. The future work plan is as described in **Annex D**.
85. **The SERAWG's summary of advice to the SC is:**

(Saya de Malha fisheries)

- to note the need to foster engagement and improve cooperation between SIOFA and key contracting and non-contracting parties.
- to note the need to improve the understanding of key elements of the ongoing fishing operations e.g., gear use, target species and CPUE, to underpin informed decision making and effective management actions.

Agenda item 8 – Technical work to inform reference points and harvest strategy development

Agenda item 8.1 Consultant Report (ToR1) to evaluate 3 provisional Harvest Strategies [Project SER2021-05]

86. Although SERAWG-04-11 was only uploaded to the meeting website on 24 February, after the deadline for the submission of working documents, the SERAWG agreed to have the paper be presented at the meeting.

Summary of paper

87. The consultant, Marine Resource Assessment and Management Group (MARAM), University of Cape Town, presented SERAWG-04-11, which provided the initial results for comparing three approaches to set total allowable catches (TACs) for the alfonsino, orange roughy and toothfish fisheries in the SIOFA area. Simulation studies were used to provide a generic comparison of three approaches to set TACs for a selected stock of each of the above species: Reduction in the TAC only if there is a high probability of a recent downward trend in the abundance index (approach 1); a TAC that fluctuates up or down proportional to recent changes in that index (approach 2); and a fitted population model-harvest control rule combination (approach 3).
88. To achieve sensible target depletions after 20 years, case-specific selections of initial upward or downward trends in TACs were found to be needed. For technical reasons, the toothfish stock selected proved an unsatisfactory choice for this exercise. Furthermore, results for the orange roughy stock were dominated by the need to reduce current catches substantially to achieve sustainability, rendering comparisons of the approaches problematic.
89. For alfonsino, approach 1 is preferred to approach 2 because future TACs showed smoother trends; however, consideration of approach 3 would need further robustness tests to be investigated to offset its current advantage of equivalence between the testing model and the population model fitted within the procedure.
90. Overall, the combination of the nature of the statuses of the three stocks investigated, and the limited data available for them, led to limitations in what could be achieved in terms of the original objectives of the work:
 - The Operating Models required for testing could not be (straightforwardly) developed for the toothfish stock.
 - Results for the orange roughy stock were dominated by the need to reduce current catches substantially to achieve sustainability.
 - For alfonsino, more work on robustness tests would be needed before initial comments could be made by way of a comparison between the performance of the population model-based approach 3 approach, and the other two empirical approaches: approach 1 and approach 2.
91. The only somewhat firm conclusion thus far, drawn only from the alfonsino analyses, is a preference for approach 1 (maintain a slow steady increase in catch until the CPUE index might indicate a marked downward trend), rather than for approach 2 (vary catches up and down in response to shorter-term CPUE changes). However, even that is not very satisfactory, as certain control parameter value choices (especially the size of the initial upward trend in TACs) look likely to need to vary substantially from stock to stock, requiring stock-specific as well as generic analyses to proceed further.
92. Consequently, the prospects for developing entirely generic approaches/harvest strategies able to cover the major resources in the SIOFA region do not appear promising. A roadmap with suggestions about how SIOFA might best move towards adopting such strategies in these circumstances will be put forward as the second part of this project and presented at the SC7 meeting.

SERAWG discussion

93. The SERAWG **NOTED** the report SERAWG-04-11.
94. The SERAWG considered the report and discussed some of the technical details. In response to questions about possible future approaches, MARAM explained

that the aim of the work was to present the initial results of a generic investigation of alternative approaches to set TACs for the major SIOFA resources and to provide a basis to choose between them. It had not been to provide an optimal proposal for those stocks. As for how to move forward, this will be presented by MARAM at SC7.

Agenda item 8.2 Development of Roadmap for Formal Harvest Strategy

95. The roadmap for the development of a formal harvest strategy will be presented at SC7.

Agenda item 8.3 Advice to SC and Future work plan

96. The future work plan is as described in **Annex D**.

97. **The SERAWG's summary of advice to the SC is:**

- to note the consultant report to evaluate three provisional harvest strategies (SERAWG-04-11).

Agenda item 9 – Ecological risk assessment

Agenda item 9.1 Deepwater chondrichthyans

Agenda item 9.1.1 Implementation of FAO shark guides (CMM 2019-02, para. 8) and other efforts to improve data collection

98. SIODFA presented SERAWG-INFO-03, which provided a guide on how to photograph deep-sea sharks to enable more accurate species identification.

Agenda item 9.1.2 Review of progress against CMM 2019-12 (Sharks), including development of precautionary bycatch limits (CMM 2019-12 para. 4)

Summary of paper

99. The EU presented SERAWG-04-13, which described the EU's current voluntary measures to avoid shark bycatch and proposed additional voluntary measures to be taken by the EU to minimise shark bycatch and support sustainable harvesting levels.

100. Based on the paper, the EU recommended that the SERAWG and SC:

- assess the proposed additional voluntary measures to minimise shark bycatch.
- support the 2-day workshop in Tenerife (Spain) in 2023 to carry out an assessment of the stock status of the shark species involved in the SIOFA fisheries.

SERAWG discussion

101. The SERAWG **ENDORSED** the recommendations in SERAWG-04-13.

102. The SERAWG **RECOMMENDED** that the proposed workshop also discuss potential measures to reduce shark bycatch further.

103. The SERAWG discussed potential gear modifications that could mitigate shark bycatch and **RECOMMENDED** that this matter be discussed in more detail, including information on the survival rates of sharks hooked by such gear.

104. Regarding the voluntary EU measure of releasing all shark species listed as a "high risk" in Annex 1 of the CMM 2019/12(Sharks) that are alive and in good

condition, the SERAWG suggested that “in good condition” was ambiguous and open to interpretation. The SERAWG **RECOMMENDED** that the measure be modified to require the release of all the aforementioned shark species that “are alive”.

105. DSCC expressed concern at the level of shark bycatch especially in subarea 2, where it seems that a very high level of effort involved the requirement to move-on, and supported the use of shark mitigation measures which involve replacing wire traces with nylon close to the hook.

Agenda item 9.2 Teleosts and others

Summary of paper

106. Australia presented SERAWG-04-14, which provided an update on the previous ecological risk assessment conducted using Productivity-Susceptibility Analysis (PSA) and Sustainability Assessment for Fishing Effects (SAFE) tools to assess the vulnerability of teleosts to demersal trawl, midwater trawl, ‘shallow trawl’ (Saya de Malha bank fishery), demersal line and pelagic line gears in the SIOFA area. The species list was developed using catch and observer records in the SIOFA database and information from annual reports submitted by SIOFA Contracting Parties. The species list represents only a subset of the species for which interaction records exist in SIOFA due to poor resolution of catch data (e.g., catches reported at a genus or higher taxonomic level). Fishing effort data were updated to 2019. Species distribution data was sourced from AquaMaps.org and various probability of occurrence layers were assessed as sensitivities. Life history attribute data was sourced from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) database that underpins the CSIRO ERA online tool and was available for most species.
107. Results indicated fewer species were found to be at high or extreme risk compared to the preliminary analysis presented in 2020 mainly due to updated fishing effort data at a finer spatial scale from 2015 to 2019, which reduced the spatial overlap with some species. Most species found to be at high or extreme risk had missing productivity attributes.
108. Based on the paper, Australia recommended that the SERAWG and SC:
- note that Australia has updated the teleost ERA following the provision of new catch and effort data for the period 2015-2019.
 - note that revisions have been made to the species list and methodology, but continued taxa identification issues prevent a comprehensive species list being developed.
 - note that the results of the SAFE assessment indicate only a few species at high or extreme risk across all fishing gears and most of these species are data deficient.
 - note that the reduction in risk ratings for some species is due to the use of updated data at a finer spatial scale.
 - note that additional work could be undertaken to further refine the species list and reduce underlying uncertainties. However, this work may be of limited utility unless species reporting issues are rectified in some fisheries and/or the level of fishing effort and its spatial extent increases from that assessed (i.e., 2015-2019).
 - recommend that assessment efforts continue to be focused on targeted stock that are taken in high volumes.

- recommend that catches of *Nemadactylus* spp. and *Polyprions* spp. be closely monitored and consideration of developing catch triggers for further assessment in future.
- recommend that any future ERA concentrates on other taxa, such as chondrichthyans, rather than teleosts.

SERAWG discussion

109. The SERAWG **ENDORSED** the recommendations in SERAWG-04-14.
110. The SERAWG **RECOMMENDED** that *Nemadactylus macropterus* (TAK), *Polyprion americanus* (WRF) and *Polyprion oxygeneios* (WHA) be included in the overview of SIOFA fisheries.
111. The SERAWG **NOTED** that improved species identification for teleosts would reduce uncertainty and improve future assessments and **RECOMMENDED** that efforts be made to improve species identification by observers, particularly for the *Polyprion* genus.
112. The SERAWG discussed the potential timing of holding a future teleost ERA. The SERAWG suggested that, in light of the reduction in risk scores and the fact that it is currently difficult to include more species in the species list, sometime in the next 5 to 10 years, when the identification of species may have improved, would be appropriate.

Agenda item 9.3 Consultant Report on fish bycatches [Project PAE2021-02]

Summary of paper

113. The consultant, Dr Keith Reid, presented report SERAWG-04-15, which provided a review of important bycatch species taken during fishing operations within the SIOFA area towards conducting ERAs on these species. Catch data for the period 2016 to 2020 were made available from the SIOFA Secretariat and included 3811 individual fishing operations for demersal longline (n= 2594), trawl (n=1208), hand-operated line (n=237) and pelagic longline (n= 2386).
114. The definition of bycatch was complicated by the lack of specific identification of target species, as a result of which the analysis used all taxa reported in catches and each fishery (defined by gear type). Of the 44 taxa that contributed > 1% of the catch in a fishery, 23 were reported at species level and six of these are listed on the IUCN Redlist as either endangered (EN), vulnerable (VU) or near threatened (NT).
115. Tuna and deepwater sharks were identified as the two main groups of bycatch, as directed fishing for them is prohibited in SIOFA. Tuna taken in pelagic longline fisheries constituted the greatest bycatch by weight and deepwater sharks taken in demersal longline fisheries included the greatest number of high-risk species. Based on the available catch data and the identification of species of conservation concern, the inclusion of Leafscale gulper shark *Centrophorus squamosus* (GUQ) in the category of ‘key species of concern’ should be considered.
116. Conducting a semi-quantitative level 2 ERA of important bycatch in SIOFA fisheries would require clarity on the target species in a fishery and bycatch reporting at a lower taxonomic level. SIOFA should consider how ERA approaches can be used to determine the levels of risk for bycatch at the level of taxonomic resolution available in catch data.

SERAWG discussion

117. The SERAWG **NOTED** the report on fish bycatches (SERAWG-04-15).

118. The SERAWG **NOTED** the need to hold further discussions defining fisheries and target species as this would provide clarification of bycatch species, noting the importance of quantifying biological removals as well as distinguishing between retained bycatch and discarded bycatch. The SERAWG **RECOMMENDED** holding a half-day workshop to hold such discussions and review the existing literature on the subject.
119. The SERAWG **NOTED** the importance of improving species identification before conducting ERAs, as recommended by both SERAWG-04-14 and SERAWG-04-15. The identification of species reported at the genus level could potentially be improved using the judgment of taxonomic experts.
120. The SERAWG **RECOMMENDED** conducting spatio-temporal analyses of bycatch, such as analyses by SIOFA subarea, and comparisons of the periods before and after 2019, when CMM 2019/12 (Sharks) entered into force.
121. The SERAWG **NOTED** that orange roughy data did not appear in the report. The reason for this was that one CCP did not explicitly authorize the transmission of their data to the consultant. The consultant clarified that, based on catch data in CCP Annual Reports, the main outcomes and conclusions in reported in SERAWG-04-15, would not be substantively different had all catch data been made available.
122. The SERAWG suggested it would be useful to discuss further bycatch mitigation measures, such as potential spatial or temporal closures, and move-on rules. The consultant explained he would present a paper on potential mitigation measures at SC7, as part of TOR3 of this project (Project PAE2021-02).
123. The SERAWG **RECOMMENDED** that the SC consider how to consolidate the advice derived from the different ERAs presented to the SERAWG and Protected Areas and Ecosystems Working Group (PAEWG).

Agenda item 9.4 New studies and information

124. No papers were presented.

Agenda item 9.5 Advice to SC and Future work plan

125. The future work plan is as described in **Annex D**.

126. **The SERAWG's summary of advice to the SC is:**

(Teleosts)

- to note that Australia has updated the teleost ERA following the provision of new catch and effort data for the period 2015-2019.
- to note that revisions have been made to the species list and methodology, but continued taxa identification issues prevent a comprehensive species list being developed.
- to note that the results of the SAFE assessment indicate only a few species at high or extreme risk across all fishing gears and most of these species are data deficient.
- to note that the reduction in risk ratings for some species is due to the use of updated data at a finer spatial scale.
- to note that additional work could be undertaken to further refine the species list and reduce underlying uncertainties. However, this work may be of limited utility unless species reporting issues are rectified in some fisheries and/or the level of fishing effort and its spatial extent increases from that assessed (i.e., 2015-2019).

- to recommend that assessment efforts continue to be focused on targeted stock that are taken in high volumes.
- to recommend that catches of *Nemadactylus* spp. and *Polyprions* spp. be closely monitored and consideration of developing catch triggers for further assessment in future.
- to recommend that any future ERA concentrates on other taxa, such as chondrichthyans, rather than teleosts.
- that *Nemadactylus macropterus* (TAK), *Polyprion americanus* (WRF) and *Polyprion oxygeneios* (WHA) should be included in the overview of SIOFA fisheries.
- that improved species identification for teleosts would reduce uncertainty and improve future assessments and efforts should be made to improve species identification by observers, particularly for the *Polyprion* genus.

(Deepwater chondrichthyans)

- to assess the proposed additional voluntary measures to minimise shark bycatch.
- support the 2-day workshop in Tenerife (Spain) in 2023 to:
 - i. carry out an assessment of the stock status of the shark species involved in the SIOFA fisheries.
 - ii. discuss potential measures to reduce shark bycatch further.
- to hold more detailed discussions on potential gear modifications that could mitigate shark bycatch, including information on the survival rates of sharks hooked by such gear.
- regarding the voluntary EU measure of releasing all shark species listed as a “high risk” in Annex 1 of the CMM 2019/12(Sharks) that are alive and in good condition, “in good condition” is ambiguous and open to interpretation and the measure should be modified to require the release of all the aforementioned shark species that “are alive”.

(Bycatch species)

- to note the report on fish bycatches (SERAWG-04-15).
- to consider the inclusion of Leafscale gulper shark *Centrophorus squamosus* (GUQ) in the category of ‘key species of concern’, based on the available catch data and the identification of species of conservation concern.
- to consider how ERA approaches can be used to determine the levels of risk for bycatch at the level of taxonomic resolution available in catch data.
- to note the need to hold further discussions defining fisheries and target species as this would provide clarification of bycatch species, noting the importance of quantifying biological removals as well as distinguishing between retained bycatch and discarded bycatch, and hold a half-day workshop to hold such discussions and review the existing literature on the subject.
- note the importance of improving species identification before conducting ERAs.

- to conduct spatio-temporal analyses of bycatch, such as analyses by SIOFA subarea, and comparisons of the periods before and after 2019, when CMM 2019/12 (Sharks) entered into force.
- to consider how to consolidate the advice derived from the different ERAs presented to the SERAWG and PAEWG.

Agenda item 10 – SIOFA stock assessment framework – implementation, including species categorisation and data characterisation, including refining SIOFA species list

Agenda item 10.1 Development of fishery and ecosystem reports (Project SEC2021-07)

Summary of paper

127. The Secretariat presented SERAWG-04-18, which provided a draft fishery report template prepared by the SC Chair and the Secretariat, as requested by the SC and the Meeting of the Parties (MoP8 para 115; SC6 paras 142-146). The orange roughy fishery has been used as an example in the report.
128. The Secretariat requested that the SC:
- examine the template and its sections, and provide its feedback.
 - advise which other items could be summarized in this report and the desired reporting frequency.

SERAWG discussion

129. The SERAWG considered the draft template and suggested the following improvements:
- Specification of the MUs (SIOFA subareas or another unit to be discussed)
 - Regarding confidential data, the addition of a footnote explaining that such data may be available upon request for scientific work
 - Specification of how frequently each report is to be updated
130. The SERAWG **REQUESTED** that the Secretariat and the SC Chair work in consultation with CCPs over the intersessional period to further develop the template and present draft fisheries summaries at SERAWG5, with particular emphasis on toothfish, alfonsino, orange roughy, oilfish (*Ruvettus pretiosus* (OIL) and *Lepidocybium flavobrunneum* (LEC)), *Nemadactylus macropterus* (TAK), *Polyprion americanus* (WRF) and *Polyprion oxygeneios* (WHA). The SERAWG **NOTED** that this may be combined with the workshop on defining bycatch species.

Summary of paper

131. SERAWG-04-19, which provided a draft ecosystem report template, was submitted to the meeting for the SERAWG's reference. The paper will be presented at the PAEWG4 meeting.

Agenda item 10.2 SIOFA species categorisation (Project SEC2021-07)

132. No papers were presented.

Agenda item 10.3 Other key target stocks and management units

133. No papers were presented.

Agenda item 10.4 Advice to SC and Future work plan

134. The future work plan is as described in **Annex D**.

135. **The SERAWG's summary of advice to the SC is:**

(Development of fishery reports)

- to request that the Secretariat and the SC Chair work in consultation with CCPs over the intersessional period to further develop the template and present draft fisheries summaries at SERAWG5, with particular emphasis on toothfish, alfonsino, orange roughy, oilfish (*Ruvettus pretiosus* (OIL) and *Lepidocybium flavobrunneum* (LEC)), *Nemadactylus macropterus* (TAK), *Polyprion americanus* (WRF) and *Polyprion oxygeneios* (WHA). This may be combined with the workshop on defining bycatch species.

Agenda item 11 – Consideration of SERAWG work plan and resource requirements

Agenda item 11.1 Summary on the current EU funded activities

136. The Executive Secretary presented report SERAWG-04-INFO-05 on behalf of Dr Gary Morgan, the Science Manager in charge of overseeing the implementation and monitoring of EU-funded projects (Project SCM2021-01). The report presented the status of all current and planned projects being undertaken under the funding Agreement with the EU, including SERAWG-related projects as well projects that are managed by other SIOFA groups. Progress on individual projects has generally been on schedule and is expected to be enhanced with the appointment of a SIOFA Science Officer at the SIOFA Secretariat.

137. The SERAWG **NOTED** the report.

Agenda item 11.2 Consideration of the EU-grant and other funding allocation

Summary of paper

138. The SIOFA Science Officer presented SERAWG-04-INFO-02, which provided a summary of the proposal submitted by the SC and WG Chairs and the Secretariat to the EU for funding several studies to take place mid-2022 end 2023. The proposal was submitted in response to an invitation from the EU (EMFAF-2021-VC-SIOFA-IBA), aimed at strengthening the scientific basis for decision-making in the SIOFA area. The project proposal (Acronym: SIOFA-SEAs, Proposal number: 101078892) includes three strategic work components, focusing on the SIOFA area: 1. the assessment of Protected Areas in SIOFA; 2. the improvement of scientific understanding of Patagonian toothfish population spatial structure; and 3. the establishment of a framework for scientific observation of fisheries.

Agenda item 11.3 Future workplan and budget (2022-2023)

139. The SERAWG reviewed and updated its workplan (**Annex D**).

140. The SERAWG **RECOMMENDED** that the SC take the updated SERAWG workplan (**Annex D**) into consideration when updating the SC workplan.

Agenda item 12 – Consolidated advice to Scientific Committee

In relation to Agenda item 4 – Orange roughy:

The SERAWG's summary of advice to the SC is:

(Orange roughy age estimation by otolith)

- if future ageing work is to be done on orange roughy in the Southern Indian Ocean, it is recommended that reference sets specific to the area be developed.
- for future studies, it is recommended that otoliths be stored in vials rather than taped to paper or envelopes to prevent breakage.
- to use the age data presented in report SERAWG-04-08, excluding the outliers identified by NIWA, to update the orange roughy growth curve for the Southern Indian Ocean.

(Orange roughy growth, length-at-age, and maturity)

- that the growth and maturity estimates from Walters Shoal should be used in the 2022 SIOFA orange roughy assessment of that region.
- that a sensitivity analysis be conducted to assess the impact of age and the size-at-maturity estimates on the stock assessment results, given the potential bias in sampling.
- that in future, a stratified sampling selection should be employed for otolith collection to ensure more representative samples are collected across the size range of fish and between areas.
- that the sampling protocols should be revised to prioritise biological data collection in tows made on the Southern Rise, Western Rise and areas to the East within the SIOFA area.
- that if the assessment is sex separated, estimating sex and age specific mortality should be considered.

(Orange roughy acoustic data)

- that more structured collection and recording of acoustic and ancillary data, such as date and time of the start and end of surveys and survey-specific binned length frequencies, would significantly decrease the time/cost to process future datasets.
- to note that there are several significant sources of uncertainty that will need addressing at some point: region-specific target strength, target identification and use of multiple frequencies, survey-specific length frequencies, and ad-hoc survey design.
- to note that several otherwise suitable surveys were discarded because of the use of uncalibrated echosounder or incorrect echosounder settings.
- that designed surveys could give increased comparability between surveys/years and reduce some error sources.
- to include a budget line for a consultancy to review the acoustic survey protocols in the SC budget request to the Meeting of the Parties (MoP).

(2022 orange roughy stock assessment)

- to consider and hold further discussions on the orange roughy stock assessment report (SERAWG-04-17), and develop management advice for the MoP.
- that for future stock assessments, a pre-assessment meeting to discuss key stock assessment decisions and data inputs should be held virtually with the participation of the stock assessment scientists, the SC Chair, the Secretariat, and any interested CCPs.

In relation to Agenda item 5 – Patagonian toothfish:

The SERAWG’s summary of advice to the SC is:

(CCAMLR-SIOFA workshop on the exchange of scientific Patagonian toothfish data)

- to note the conveners report (SERAWG-04-INFO-04) and endorse its recommendations.
- to request the MoP to endorse the process given in the paper for the exchange of scientific toothfish data between SIOFA and CCAMLR as described in Annex A and Annex B of SERAWG-04-INFO-04.

(SIOFA toothfish tagging process)

- to adopt the draft SIOFA toothfish tagging instructions (**SERAWG-04-16-SIOFA-Toothfish-Tagging-Instructions_rev1**)

(WR toothfish fishery)

- that the current management arrangements should be maintained.
- that data holders should submit all available biological and tagging data to SIOFA Secretariat
- that the Secretariat and data holder should verify the validity of all data records from fishing trip 164.
- that set start and end locations of hauls and set and haul dates should be provided to the Secretariat and in data requests, so that fishing cells and soak time can be determined.
- that unique identifiers to unambiguously link operational and observer data should be provided in data requests.

In relation to Agenda item 7 – Other species:

The SERAWG’s summary of advice to the SC is:

(Saya de Malha fisheries)

- to note the need to foster engagement and improve cooperation between SIOFA and key contracting and non-contracting parties.
- to note the need to improve the understanding of key elements of the ongoing fishing operations e.g., gear use, target species and CPUE, to underpin informed decision making and effective management actions.

In relation to Agenda item 8 – Technical work to inform reference points and harvest strategy development:

The SERAWG’s summary of advice to the SC is:

- to note the consultant report to evaluate three provisional harvest strategies (SERAWG-04-11).

In relation to Agenda item 9 – Ecological risk assessment:

The SERAWG’s summary of advice to the SC is:

(Teleosts)

- to note that Australia has updated the teleost ERA following the provision of new catch and effort data for the period 2015-2019.
- to note that revisions have been made to the species list and methodology, but continued taxa identification issues prevent a comprehensive species list being developed.
- to note that the results of the SAFE assessment indicate only a few species at high or extreme risk across all fishing gears and most of these species are data deficient.
- to note that the reduction in risk ratings for some species is due to the use of updated data at a finer spatial scale.
- to note that additional work could be undertaken to further refine the species list and reduce underlying uncertainties. However, this work may be of limited utility unless species reporting issues are rectified in some fisheries and/or the level of fishing effort and its spatial extent increases from that assessed (i.e., 2015-2019).
- to recommend that assessment efforts continue to be focused on targeted stock that are taken in high volumes.
- to recommend that catches of *Nemadactylus* spp. and *Polyprions* spp. be closely monitored and consideration of developing catch triggers for further assessment in future.
- to recommend that any future ERA concentrates on other taxa, such as chondrichthyans, rather than teleosts.
- that *Nemadactylus macropterus* (TAK), *Polyprion americanus* (WRF) and *Polyprion oxygeneios* (WHA) should be included in the overview of SIOFA fisheries.
- that improved species identification for teleosts would reduce uncertainty and improve future assessments and efforts should be made to improve species identification by observers, particularly for the *Polyprion* genus.

(Deepwater chondrichthyans)

- to assess the proposed additional voluntary measures to minimise shark bycatch.
- support the 2-day workshop in Tenerife (Spain) in 2023 to:

- i. carry out an assessment of the stock status of the shark species involved in the SIOFA fisheries.
 - ii. discuss potential measures to reduce shark bycatch further.
- to hold more detailed discussions on potential gear modifications that could mitigate shark bycatch, including information on the survival rates of sharks hooked by such gear.
- regarding the voluntary EU measure of releasing all shark species listed as a “high risk” in Annex 1 of the CMM 2019/12(Sharks) that are alive and in good condition, “in good condition” is ambiguous and open to interpretation and the measure should be modified to require the release of all the aforementioned shark species that “are alive”.

(Bycatch species)

- to note the report on fish bycatches (SERAWG-04-15).
- to consider the inclusion of Leafscale gulper shark *Centrophorus squamosus* (GUQ) in the category of ‘key species of concern’, based on the available catch data and the identification of species of conservation concern.
- to consider how ERA approaches can be used to determine the levels of risk for bycatch at the level of taxonomic resolution available in catch data.
- to note the need to hold further discussions defining fisheries and target species as this would provide clarification of bycatch species, noting the importance of quantifying biological removals as well as distinguishing between retained bycatch and discarded bycatch, and hold a half-day workshop to hold such discussions and review the existing literature on the subject.
- note the importance of improving species identification before conducting ERAs.
- to conduct spatio-temporal analyses of bycatch, such as analyses by SIOFA subarea, and comparisons of the periods before and after 2019, when CMM 2019/12 (Sharks) entered into force.
- to consider how to consolidate the advice derived from the different ERAs presented to the SERAWG and PAEWG.

In relation to Agenda item 10 – SIOFA stock assessment framework – implementation, including species categorisation and data characterisation, including refining SIOFA species list

The SERAWG’s summary of advice to the SC is:

(Development of fishery reports)

- to request that the Secretariat and the SC Chair work in consultation with CCPs over the intersessional period to further develop the template and present draft fisheries summaries at SERAWG5, with particular emphasis on toothfish, alfonso, orange roughy, oilfish (*Ruvettus pretiosus* (OIL) and *Lepidocybium flavobrunneum* (LEC)), *Nemadactylus macropterus* (TAK), *Polyprion americanus* (WRF) and *Polyprion oxygeneios* (WHA). This may be combined with the workshop on defining bycatch species.

In relation to Agenda item 11 – Consideration of SERAWG work plan and resource requirements

The SERAWG's summary of advice to the SC is:

- to note the report on current EU funded activities (SERAWG-04-INFO-02).
- to take the updated SERAWG workplan (**Annex D**) into consideration when updating the SC workplan.

Agenda item 13 – Other business

Agenda item 13.1 Appointment of a new Co-chair for the ERA part of the SERAWG

141. The Chair explained that the position of the co-Chair for ERA remains vacant and invited the SERAWG to nominate a new co-Chair.

Agenda item 13.2 Future meeting arrangements

142. The SERAWG thanked the EU for offering to host the SERAWG5 meeting.
143. The SERAWG **REQUESTS** the SC to consider future meeting arrangements in conjunction with arrangements for SC8.

Agenda item 14 – Adoption of the meeting report

144. The report of the fourth meeting of the SIOFA SERAWG was adopted at 08:35 am (UTC), March 4, 2022.

Agenda item 15 – Close of meeting

145. The meeting was closed at 08:45 am (UTC), 4 March 2022.

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

Note: Participants listed in italics were registered for the meeting but did not attend.

Delegation	Title	Name	Function	Contact
MEETING CHAIRPERSON				
	Mr	Tom Nishida	SERAWG Chairperson	
SIOFA CCPs				
Australia	Mr	Trent Timmis	Head of Delegation	trent.timmiss@agriculture.gov.au
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Australia	Dr	Ian Butler	Advisor	ian.butler@awe.gov.au
Australia	Dr	Kurt Davis	Advisor	kurt.davis@awe.gov.au
Australia	Mr	Rhys Arangio	Advisor	arangio@australfisheries.com.au
<i>Australia</i>	<i>Mr</i>	<i>Patrick Sachs</i>	<i>Advisor</i>	<i>patrick.sachs@awe.gov.au</i>
<i>Australia</i>	<i>Ms</i>	<i>Fiona Hill</i>	<i>Advisor</i>	<i>fiona.hill@afma.gov.au</i>
Cook Islands	Dr	Steve Brouwer	Head of Delegation	steve@saggitus.co.nz
China	Dr	Heng Zhang	Head of Delegation	zhangziqian0601@163.com
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China	Mr	Sun Chong	Adviser	sunchong@cofa.com.cn
<i>China</i>	<i>Dr</i>	<i>Zhou Fang</i>	<i>Alternate</i>	<i>zfang@shou.edu.cn</i>
EU	Dr	Sebastian Rodriguez Alfaro	Head of Delegation	sebastian_chano@hotmail.com
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France OT	Dr	Jules Selles	Alternate	jules.selles@mnhn.fr
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<i>Japan</i>	<i>Mr</i>	<i>Kyo Uehara</i>	<i>Adviser</i>	<i>k-uehara@maruha-nichiro.co.jp</i>
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Mauritius	Mr	Vikash Munbodhe	Head of Delegation	vmunbodhe@gmail.com
Seychelles		Sabrena Lawrence	Head of Delegation	slawrence@sfa.sc
Chinese Taipei	Dr	Ching-Ping Lu	HoD	michellecplu@gmail.com
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Thailand	Mr	Weerapol Thitipongtrakul	Adviser	weerapol.t@gmail.com

Delegation	Title	Name	Function	Contact
<i>Thailand</i>	<i>Mr</i>	<i>Aekkarat Wongkeaw</i>	<i>Adviser</i>	<i>aekfish@hotmail.com</i>
<i>Thailand</i>	<i>Ms</i>	<i>Tirabhorn Yothakong</i>	<i>Adviser</i>	<i>tirabhorn@gmail.com</i>
<i>Thailand</i>	<i>Mr</i>	<i>Prasit Luesrithawornsini</i>	<i>Adviser</i>	<i>prasit_kim@hotmail.com</i>
Thailand	Ms	Kanyarat Woraprayoth	Adviser	kookky0053@gmail.com
OBSERVERS				
CCAMLR	Dr	Steve Parker	Representative	steve.parker@ccamlr.org
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<i>FAO-DSF</i>	<i>Dr</i>	<i>Anthony Thompson</i>	<i>Representative</i>	<i>anthony.thompson@fao.org</i>
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SIODFA	Mr	Charles Heaphy	Member	charles.heaphy@sealord.co.nz
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G. Morgan	Dr	Gary Morgan	Consultant	garymorgan@hotmail.com
SIOFA SECRETARIAT AND ASSISTANTS				
SIOFA	Mr	Alistair Dunn	SC Chairperson	alistair.dunn@oceanenvironmental.co.nz
SIOFA	Mr	Thierry Clot	SIOFA Executive Secretary	thierry.clot@siofa.org
SIOFA	Mr	Marco Milardi	SIOFA Sciences Officer	marco.milardi@siofa.org
SIOFA	Mr	Pierre Périès	SIOFA Data Officer	pierre.peries@siofa.org
SIOFA	Ms	Laura Osborne	SIOFA Assistant	laura.osborne@siofa.org
SIOFA	Mr	Alex Meyer	Rapporteur	meyer@urbanconnections.jp

ANNEX B – Agenda

Agenda

The 4th Meeting of the Stock and Ecological Risk Assessment Working Group (SERAWG4)

By videoconference
28 February – 04 March 2022
06:00 UTC to 10:00 UTC

Co-Chairs: Dr Tom Nishida (Agenda 1-8 and 11-16)
Dr Sebastian Rodriguez Alfaro (SC Vice Chair and provisional Co-Chair) (Agenda 9-10)

1. Openings

- 1.1 Opening statement
- 1.2 Introduction of participants

2. Administrative arrangements

- 2.1 Adoption of the agenda
- 2.2 Confirmation of meeting documents
- 2.3 Appointment of rapporteur

3. Update on the Fisheries (Secretariat)

4. Orange roughy

- 4.1 Consultant report on the orange roughy age estimation by otolith [project SER2021-02]
- 4.2 New studies and information (Biology, stock analyses and others) (CCP scientists)
- 4.3 Consultant Report on the orange roughy acoustic data processing [project SER2021-01]
- 4.4 Consultant report on the 2021 Stock Assessment [project SER 2021-04]
- 4.5 Advice to SC and Future workplan

5. Patagonian toothfish

- 5.1 Review of the recommendations from the CCAMLR-SIOFA Workshop on the Exchange of Scientific P. toothfish data (WESTD) (SC Chair)
- 5.2 SIOFA tagging process (SC Chair)
- 5.3 New studies and information (Biology, stock analyses and others) (CCP scientists)
- 5.4 Advice to SC and Future work plan

6. Alfonsino

- 6.1 Standardised data collection protocols in relation to CMM 2021/02 (Data Standards)
- 6.2 New studies and information (Biology, stock analyses and others) (CCP scientists)
- 6.3 Advice to SC and Future work plan

7. Other species

- 7.1 Consultant report of the Saya de Malha fisheries (ToR1 scoping study) [Project SER2021-03]
- 7.2 New studies and information (Biology, stock analyses and others) (CCP scientists)
- 7.3 Advice to SC and Future work plan

8. Technical work to inform reference points and harvest strategy development

- 8.1 Consultant Report (ToR1) to evaluate 3 provisional Harvest Strategies [Project SER2021-05]
- 8.2 *Development of Roadmap for Formal Harvest Strategy (to be presented in the SC7)*
- 8.3 Advice to SC and Future work plan

9. Ecological risk assessment

- 9.1 Deepwater chondrichthyans
 - 9.1.1 Implementation of FAO shark guides (CMM 2019-02, para. 8) and other efforts to improve data collection.
 - 9.1.2 Review of progress against CMM 2019-12 (Sharks), including development of precautionary bycatch limits (CMM 2019-12 para. 4)
 - 9.2 Teleosts and others
 - 9.2.1 Update on progress with teleosts ERA
 - 9.2.2 Priority species for further assessment
- 9.3 Consultant Report on seabirds, mammals, and other bycatches [Project PAE2021-02]
- 9.4 New studies and information (CCP scientists)
- 9.5 Advice to SC and Future work plan

10. SIOFA stock assessment framework – implementation, including species categorisation

and data characterisation, including refining SIOFA species list (Secretariat)

- 10.1 Development of fishery and ecosystem reports (Project SEC2021-07)
- 10.2 SIOFA species categorisation (Project SEC2021-07)
- 10.3 Other key target stocks and management units
- 10.4 Advice to SC and Future work plan

11. Consideration of SERAWG work plan and resource requirements

- 11.1 Consideration of the EU-grant and other funding allocation
- 11.2 Future workplan and budget (2022-2024)

12. Consolidated advice to Scientific Committee

13. Other business

- 13.1 Appointment of a new Co-chair for the ERA part of the SERAWG
- 13.2 Future meeting arrangements

14. Adoption of the meeting report

15. Close of meeting

ANNEX C – Table of agenda items and related papers

Note: papers highlighted with * were late submissions to this meeting due to a data confidentiality issue

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	
2. Administrative Arrangements 146. 2.1 Adoption of the agenda 147. 2.2 Confirmation of meeting documents 148. 149. 2.3 Appointment of rapporteur	SERAWG-04-01 Revised Provisional Agenda SERAWG-04-02 Template for meeting documents SERAWG-04-03 Table of agenda items and related papers rev5 SERAWG 04-04 List of registered participants
3. Update on the Fisheries (Secretariat)	SERAWG-04-12 Update on Fisheries rev1 (restricted)
4. Orange roughy (ORY) 4.1 Consultant report on the orange roughy age estimation by otolith [project SER2021-02] 4.2 New studies and information (Biology, stock analyses and others) (CCP scientists) 4.3 Consultant Report on the orange roughy acoustic data processing [project SER2021-01] 4.4 Consultant report on the 2021 Stock Assessment [project SER 2021-04] 4.5 Advice to SC and Future workplan	SERAWG-04-08 Orange Roughy Ageing (consultant report, restricted) * SERAWG-04-09 Orange Roughy age and growth (Cook Islands) SERAWG-04-05 ToR 1 Collation of the data (consultant report, restricted) * SERAWG-04-06 ToR 2 Data quality control (consultant report, restricted) * SERAWG-04-07 ToR 3 Estimation of the biomass (consultant report, restricted) * SERAWG-04-17 Orange Roughy stock assessment update (consultant report, restricted) *
5. Patagonian toothfish (TOP) 5.1. Review of the recommendations from the CCAMLR-SIOFA Workshop on the Exchange of Scientific P. toothfish data (WESTD) (SC Chair) 5.2. SIOFA tagging process (SC Chair)	SERAWG-04-INFO-04 Toothfish data exchange workshop summary SERAWG-04-16 SIOFA Patagonian Toothfish tagging process (revised and adapted from CCAMLR)

Agenda Item	Related Papers
<p>5.3. New studies and information (Biology, stock analyses and others) (CCP scientists)</p> <p>5.4 Advice to SC and Future work plan</p>	<p>SERAWG-04-20 Toothfish on Williams-Ridge (restricted)</p>
<p>6. Alfonsino (BYS)</p> <p>6.1 Standardised data collection protocols in relation to CMM 2021/02 (Data Standards)</p> <p>6.2 New studies and information (Biology, stock analyses and others) (CCP scientists)</p> <p>6.3 Advice to SC and Future work plan</p>	<p>SERAWG-04-INFO-01 Alfonsino Age estimation by otolith (Consultant report) *</p>
<p>7. Other species</p> <p>7.1 Consultant report of the Saya de Malha fisheries (ToR1 scoping study) [Project SER2021-03]</p> <p>7.2 New studies and information (Biology, stock analyses and others) (CCP scientists)</p> <p>7.3 Advice to SC and Future work plan</p>	<p>SERAWG-04-10 Saya De Malha scoping study ToR1 (consultant report, restricted)</p>
<p>8. Technical work to inform reference points and harvest strategy development</p> <p>8.1 Consultant Report (ToR1) to evaluate 3 provisional Harvest Strategies [Project SER2021-05]</p> <p>8.2 Development of Roadmap for Formal Harvest Strategy (<i>to be presented in the SC7</i>)</p> <p>8.3 Advice to SC and Future work plan</p>	<p>SERAWG-04-11 Initial results for comparing 3 approaches to set TACs (consultant report, restricted) *</p>
<p>9. Ecological risk assessment</p> <p>9.1 Deepwater chondrichthyans</p> <p>9.1.1 Implementation of FAO shark guides (CMM 2019-02, para. 8) and other efforts to improve data collection.</p> <p>9.1.2 Review of progress against CMM 2019-12 (Sharks), including development of precautionary bycatch limits (CMM 2019-12 para. 4)</p> <p>9.2 Teleosts and others</p> <p>9.3 Consultant Report on fish bycatches [Project PAE2021-02]</p> <p>9.4 New studies and information (CCP scientists)</p> <p>9.5 Advice to SC and Future work plan</p>	<p>SERAWG-04-INFO-03 How-to-Photograph-Sharks (SIODFA)</p> <p>SERAWG-04-13-Monitoring-Management-and-Impact-Mitigation-in-the-shark-bycatch (EU)</p> <p>SERAWG-04-14 SIOFA teleost ERA (AUS)</p> <p>SERAWG-04-15 PAE2021-02 fish bycatch ERAEF (draft consultant report, restricted)</p>
<p>10. SIOFA stock assessment framework – implementation (including species categorisation and data characterisation, including refining SIOFA species list)</p> <p>10.1 Development of fishery and ecosystem reports (Project SEC2021-07) (Secretariat)</p>	<p>SERAWG-04-18 SIOFA fishery summaries template-ORY (restricted) *</p>

Agenda Item	Related Papers
10.2 SIOFA species categorisation (Project SEC2021-07) 10.3 Other key target stocks and management units 10.4 Advice to SC and Future work plan	SERAWG-04-19 SIOFA ecosystem report (restricted) *
11. Consideration of SERAWG work plan and resource requirements 11.1 Summary on the current EU funded activities 11.2 Consideration of the EU-grant and other funding allocation 11.3 Future workplan and budget (2023-2025)	SERAWG-04-INFO-05 EU-Funded Projects Progress-Report SERAWG-04-INFO-02 EU funding proposal SIOFA SEAs
12. Consolidated advice to Scientific Committee	
13. Other business 13.1 Appointment of a new Co-chair for the ERA part of the SERAWG 13.2 Future meeting arrangements	
14. Adoption of the meeting report	
15. Close of meeting	

ANNEX D – Work plan

Workplan and budget (1,000 EURO) (2022-2023) (draft)				Activities with light marker are subject to decisions made by SC7 and/or MoP9 (2022)									
Year		2022									2023		
Month		4	5	6	7	8	9	10	11	12	1	2	3
Annual meetings					MoP9							SERA & PAE WG5 and SC8	
Orange roughy	Stock structure	Consultant(8.3 K) (EU grant: GO1.2)											
	Otolith	Development of the otolith reference set for the SIOFA area											
Alfonsino	Estimation of the growth equation (WEST)	National scientists : Aged data by otolith (Fish Ageing Services) are available & not yet analyzed (n=250 each ♂ & ♀)											
	Age validation using bomb calorimetry	Consultant(15K) (EU grant: GO1.3)											
	Stock assessment							Consultant (25K) (EU grant: GO1.1)					
								Pre-assessment web meeting with the Consultant					
	Acoustic abundance index	Consultant(15K) (SIOFA budget) subject to the decisions made by SC (small WG)											
Stock structure	Consultant(8.3 K) (EU grant: GO1.2)												
Patagonian toothfish	Tagging	National scientists and CCAMLR											
	Stock structure (molecular analysis)	(1) SIOFA(Del Cano) and CCAMLR (Crozet, Kerguelen & Prince Edward) (2) SIOFA (William's Ridge)+CCAMLR(Kerguelen's and Heard & McDonald's) (EU, France Territories, Japan & Australia) (Japan's cooperation is subject to the tissue sampling protocol) (3) Consultant (8.3K) (EU grant: GO1.2)											
	(1) Collection of otolith (2) Growth equation	(1) Collection of otolith(Del Cano Rise and William's Ridge) (EU, France Territories, Japan & Australia) (Japan will provide aged data by otolith) (2) Growth equation to be estimated by national scientists											
Common issues	ERA	Teleost (AUS) and National scientist (others)											
	Definition of bycatch	A half day intersessional web meeting subject to decisions made by SC7											
	Biological data collection protocol										Draft paper by Cook Islands will be discussed in SERA-WG5		
	Acoustic data protocol	Small WG to develop the protocol subject to decisions by SC7									Repository for acoustic data will be discussed		
	Harvest strategies (roadmap)	Tri party WS (scientists, managers & industry) subject to decisions by SC7											
	Monaco Exploration (Saya de Malha Bank)										Subject to decisions made by MoP		