SPRFMO
South Pacific Regional Fisheries Management Organisation

9TH SCIENTIFIC COMMITTEE MEETING REPORT

27/28 September- 2/3 October 2021

Held remotely

SPRFMO SC9 Report 2021

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The 9th Scientific Committee meeting report was prepared under the overall direction of the SPRFMO Scientific Committee Chairperson Dr James Ianelli and Vice Chairperson Dr Niels Hintzen.

Tiffany Bock, Shane Geange, Martin Pastoors and Emily Reynolds are acknowledged for their significant rapporteuring contributions.

The publication also benefited from contributions by the SC9 invited expert Ms Lee Qi.

In Memoriam: It was with great sadness that SC Members received the news of the passing of Luis Mariátegui and Miguel Ñiquen from Peru. SC Members would like to honour our colleagues and friends. We would like to extend our most heartfelt condolences to their families.

CONTENTS

SPRFMO SC9 REPORT EXECUTIVE SUMMARY

The 9th Scientific Committee Meeting (SC9) of the South Pacific Regional Fisheries Management Organisation (SPRFMO) took place from 27/28 September – 2/3 October 2021 and was held as a virtual meeting and chaired by Dr Jim Ianelli (USA). Over 150 participants (scientists from 14 SPRFMO Members and 1 CNCP, representatives from 9 NGOs, 2 IGOs, one invited expert and the Secretariat), reviewed and assessed over 80 working papers. The Scientific Committee (SC) provided recommendations on a wide diversity of issues. Due to the continuing effects of the COVID-19 pandemic an in-person meeting was not possible, so the meeting was held remotely, across 16 different time zones. Two sessions of three hours were held per day, as well as 4 SC web meetings held prior to SC9, and 13 web meetings and workshops held by Working Groups in which work was presented and discussed to develop recommendations for consideration by the SC.

Annual Reports were received from Australia, Chile, China, Cook Islands, Cuba (nil report), Curacao (nil report), Ecuador, European Union, Faroe Islands (nil report), Korea, Liberia (nil report), New Zealand, Panama (nil report), Peru, Russian Federation, Chinese Taipei, United States of America, and Vanuatu. Members had a range of questions about the material in these reports and the questions and answers are included as an Annex to the report.

With regards to Deepwater issues, a significant body of work was considered and approved, including a framework for providing advice on species of concern captures and an Addendum to the 2020 Bottom Fishing Impact Assessment that had been approved at SC8. In particular, the SC discussed a number of papers relating to protection of Vulnerable Marine Ecosystems (VME), including an updated list of VME taxa, updated candidate encounter thresholds for VME taxa, an analysis of move-on distance, and a proposed review process for encounters with potential VMEs.

The SC also reviewed a specific 2020 New Zealand VME encounter event. Noting that the Commission is still deliberating on appropriate levels of protection, the SC recommended that if assessing Significant Adverse Impacts (SAI) on VMEs at the scale of FMAs, then reopening the Encounter Area would likely not result in SAI on VMEs but that if assessing Significant Adverse Impacts on VMEs at the scale of the Encounter Area, then reopening the Encounter Area may result in SAIs on VME.

The SC also discussed a large amount of work, on the development of spatial management scenarios for bottom trawling based on methods that had been agreed at workshops prior to SC8. In accordance with the Commission request, potential spatial management scenarios for protection levels of 70%, 80%, 90%, 95% for the modelled VME indicator taxa, using temporally static and temporally dynamic assessment methods, have been provided for reference. The SC recommended that the Commission consider these scenarios to inform its determination of the level of protection required to prevent SAI on VMEs in the SPRFMO Convention Area. The SC noted that ecologically relevant spatial scales for assessing protection levels to prevent SAIs on VME indicator taxa still remain to be agreed, but that the existing information at the FMA is likely to be a more biologically appropriate compared with larger scales.

The SC agreed that work had progressed in a number of areas in relation to addressing the ongoing effectiveness of management measures as requested by CMM 03 but noted that the appropriateness of the management of VMEs under CMM 03 in FMAs open to fishing depends on three main choices:

The spatial scale of the assessment of fishing impacts on VMEs, which should be relevant to the life-history traits of component VME species that limit recovery, the spatial extent of VME habitat type and connectivity between populations to ensure viable VME populations at a given spatial scale.

What fraction of total VME indicator taxa abundance should be protected at a given spatial scale. This needs to be relevant to the life-history traits of component species that limit recovery, the spatial extent of VME habitat type and connectivity between populations to ensure viable VME populations at a given spatial scale. There is

very limited guidance on the question from other RFMOs or elsewhere. The estimation of the fraction of VME indicator taxa abundance protected depends strongly on the ability of the available habitat suitability models to infer abundance, noting that abundance models using survey presence-absence or abundance data and relevant environmental/benthic data could improve this accuracy.

What weight thresholds are set to trigger the protocol for an encounter with a potential VME. This depends on the catchability of VME indicator species, the accuracy of abundance models and the fraction of total VME that is protected at a given spatial scale. To prevent SAI, the weight thresholds should be linked to the fraction of VME indicator taxa abundance protected (i.e., a lower abundance protected would warrant a lower weight threshold and vice versa).

All three choices have been underpinned by some scientific understanding of VMEs, but the scientific understanding does not provide precise limits or reference levels for each of these three choices. Addressing one of these concerns, the SC recommended the commencement of a research programme to allow the determination of taxon-specific estimates of catchability for VME indicator taxa.

The estimated biomass of Jack Mackerel in the southeast Pacific increased from 2020 to 2021 and is estimated to be well above the interim B_{MSY}. Both the 1-stock and 2-stocks model configurations showed similar trends with an increasing overall biomass, high recruitments in recent years, and low fishing mortality. The combined single-stock model resulted in slightly lower recruitment and biomass estimates than the summed 2-stock model and slightly higher projected catch. The SC noted that the stock is estimated to be in the third tier of the harvest control rule within which catches should be limited to a fishing mortality of F_{MSY}. This would be expected to result in catches in 2022 of 1641 kt. However, according to the accepted rebuilding plan ("Adjusted Annex K") a maximum change in the catch limit of 15% applies. Hence the SC recommended a 15% increase in 2021 catches throughout the range of Jack mackerel to a level at or below 900 kt. This advice for catch limits in 2022 does not depend on the stock structure hypothesis that is used.

The SC emphasised that there was additional uncertainty in this year's assessment that should be considered by the Commission in their development of a Jack mackerel CMM. Namely, the Jack mackerel growth rate estimates have been revised substantially which affect much of the data used in the assessment and subsequent advice. Additionally, issues have been raised about the CPUE series used in the assessment. The SC recommended that a Jack mackerel benchmark workshop is a high priority to resolve some of these issues and that it should be held in 2022.

The SC agreed that the new criteria of age assignment presented by Chile was justified by the data for younger fish but there was still some uncertainty as to whether it was fully validated for older fish or whether it was consistent with age determination protocols and methods used by other Members. Therefore, the SC recommended that a Jack mackerel ageing analysis task group be initiated, with a workshop scheduled for May 2022.

The SC also recognised the need for a comprehensive research plan to improve the understanding of origin and admixture of populations or subpopulations of Jack mackerel in the Southern Pacific, and therefore recommended that a task group on CJM connectivity be formed to develop and carry out a research plan.

In paragraph 28 of CMM 01-2021 (*Trachurus murphyi*) the Commission specifically requested advice from the SC regarding the possible impact of the national measures adopted on the *Trachurus murphyi* fishery. The SC noted that in 2020, the sum of realised catch of Jack mackerel has been higher (3%) than the maximum recommended by the SC. Preliminary estimates of the catch in 2021 result in a similar potential overshoot (3%). The SC noted that due to the estimated high abundance and apparent low fishing mortality, the impact of the overcatch appears to be negligible. However, it is necessary to evaluate the potential structural impacts of national measures on the *Trachurus murphyi* fishery. This would best be carried out as part of the management strategy evaluation.

The SC recalled that the Commission has been asking for a Jumbo flying squid stock assessment and discussed a wide range of possible assessment models. The SC updated a 2016 table comparing possible approaches and as

a first step in progressing some stock assessment modelling recommended the collection of a joint dataset of Catch (kg), Effort (e.g., vessels, vessel days, hauls, hours) and (where available) mean weight by month and area. But it noted that it was also necessary to have better temporal and spatial information on maturity in order to make possible the identification of the three different phenotypes that could present in the catches. The SC encouraged that Members strive to improve the biological sampling levels and ensure that the spatio-temporal coverage is appropriate. The SC also recommended that further templates for biological and fishery data be agreed upon, aligned with stock assessment methods, and developed further prior to SC10.

The SC discussed the similarities and differences between the different Jumbo flying squid genetics programmes being undertaken by Members, to try to find ways that the programmes could work together. The SC recommended that Members register obtained mtDNA (COI and ND2) sequences in a public nucleotide database such as GenBank and that these be analysed in a 2022 workshop. The importance of gathering samples from the whole range of squid species within the Convention Area was highlighted because otherwise it will be a struggle to determine stock structure due to the mobility and migratory behaviour of Jumbo flying squid. Some Members therefore agreed to exchange samples, to give them access to genetic material from a wider range of squid.

There was considerable discussion what science-based information was available to aid the Commission in developing an effective squid CMM. As an initial consideration, the SC deliberated extensively on how constraining fishing effort could be useful, at least until more information becomes available on the stock status and productivity of the SPRFMO squid resources. After debate, the SC recommended limiting both the number of vessels and the total Gross Tonnage of squid jigging vessels Authorised as at 31 December 2020. Members were requested to confirm which of the vessels that were Authorised in the SPRFMO Record of Vessels at that date should be considered part of the squid fishery for this purpose. For clarity, the SC noted that coastal States should still be able to expand or develop their fisheries, either with jigging or other fishing gear used to fish Jumbo flying squid, in a manner consistent with SPRFMO CMMs.

Peru presented documentation describing the methods and procedures applied to obtain biological and fisheries information and data on Jumbo flying squid in Peruvian waters as an alternative to the Observer Programme for Peruvian artisanal vessels. The SC recommended that the programme was suitable and did meet the requirements detailed in paragraph 4 of CMM 16-2021 (Observer programme).

The SC discussed work presented in the Habitat Monitoring workstream, noting that research has applications to SPRFMO stocks. For example, the Jack mackerel assessment uses Chilean CPUE based on catch per trip but research showed that this may be problematic given data that the relative abundance has moved closer to the coast in recent years. The SC agreed that the scope of the Habitat Monitoring Working Group includes activities contributing to defining habitat at a basic level, and at a more detailed level, to provide data useful for understanding hypotheses about a species population structure, although defining population structure of species is a responsibility of the specific existent working groups. The SC noted that the HMWG is in the process of reviewing its ToR to clarify its functions. The HMWG included a number of activities in the proposed multi-annual workplan to collect, compile and analyse acoustics data from fishing vessels.

Chile presented a request for research into protection of the Salas y Gómez and Nazca ridges and this was added to the SC Workplan under Cross-cutting issues. The SC also noted an EU proposal for an acoustic survey (with associated validation trawling) of alfonsino on the Salas y Gómez and Nazca ridges and requested a number of improvements to reduce risk. The SC agreed that the research would be beneficial but was unable to achieve consensus on approving the research without reviewing a new draft.

With regards to Exploratory fishing, the SC considered New Zealand's proposal and its Fisheries Operation Plan to extend its exploratory demersal longline fishery for toothfish and advised the Commission that the proposal is acceptable in terms of Articles 2 and 22, CMM 13-2021 (Exploratory fisheries), CMM 03-2021 (Bottom Fishing), and the BFIAS.

The SC agreed that the extremely outdated Species Profiles currently on the website should be removed and replaced with short profiles that did not require frequent updating. Species Profiles for Jack mackerel (CJM), chub

mackerel (MAS) and squid (GIS) were accepted by the SC and finalisation of Species Profiles for the remaining SPRFMO relevant species will be coordinated by the Secretariat.

The SC also agreed on a template for the provision of future Fisheries Operations Plans that had been requested by SC8.

Given the persistent pandemic environment, the SC again struggled to progress items in the workplan provided by the Commission. As such, they requested that the Commission agree to carry funds over to the next financial year above the level of the cap specified in the financial regulations. The SC also recommended that the Commission consider removing the cap in the financial regulations noting that the current cap reduced flexibility to undertake multi-annual activities or adapt the timing of activities. The discussions on how to deal with getting expenditures to fall within the cap added burden to the already heavily tasked SC.

Finally, the SC extended their gratitude to the Secretariat for providing extensive support for the highly productive pre-SC web meetings and workshops. This allowed many effective presentations and preliminary discussions to occur before SC9 started. The SC recommended that these web meetings continue in future years and that the SC formalise the status of these meetings in drafting recommendations to be considered by the SC at its Annual Meeting. Also, the SC requested that the Commission recognise these efforts by the Secretariat and that, given staffing changes, additional support will be required prior to SC10.

SPRFMO SC9-REPORT

Report of the 9th Meeting of the Scientific Committee

Held remotely, 27/28 September to 2/3 October 2021
Adopted 3 October 2021, 16:37 hrs (NZDT)

1 Welcome and Introduction

1. The Scientific Committee (SC) Chairperson, Dr Jim Ianelli (USA), opened the meeting and proceedings.
2. Heads of Delegations (HoDs) were asked to introduce themselves and their delegations. A list of participants is included in Annex 2.

1.1 Adoption of agenda

3. The Chairperson sought proposed changes to the Provisional Agenda (SC9-Doc01_rev3). After discussion, the final agenda was adopted (Annex 3).

1.2 Meeting documents

4. Meeting documentation, location and access was presented. The posted document list (SC9-Doc03_rev2) and annotated agenda (SC9-Doc02_rev1) were made available and referred to throughout the meeting.
5. There were 3 late papers that were considered and were all accepted by the meeting.
6. There was some discussion about whether SC9-JM08 should be considered as a Jack mackerel paper or an information paper, but the status was maintained.

1.3 Nomination of rapporteurs

7. Rapporteuring was supported by Tiffany Bock, Shane Geange, Emily Reynolds, Martin Pastoors, Niels Hintzen, Aquiles Sepulveda and Working Group Chairs.

1.4 Meeting programme and schedule

8. The indicative meeting schedule was introduced (SC9-Doc04_rev3) and made available. The Meeting agreed to move the agenda item regarding the Alfonsino research survey before the Habitat Monitoring items in Session 1 of Day 3. Other minor modifications were made to the schedule throughout the meeting. The final schedule is shown in Annex 4.
9. Cook Islands noted that SC8 had a long report adoption and suggested that SC9 take the same approach as COMM9 and agree on recommendations but have full report adoption after the end of the session. EU suggested that SC9 adopt as much as possible of the report during the meeting, with a focus on the Recommendations, but covering the rest of the report if time allows.

2 Annual Reports

10. Annual reports were received from Australia, Chile, China, Cook Islands, Cuba (nil report), Curacao (nil report), Ecuador, European Union, Faroe Islands (nil report), Korea, New Zealand, Liberia (nil report), Panama (nil report), Peru, Russian Federation, Chinese Taipei, United States of America, and Vanuatu (SC9-Doc14 to SC9-Doc30).

2.1 Summaries from Members

Australia

11. Document SC9-Doc27 provides an update on fishing activity by Australian-flagged vessels in the SPRFMO Convention Area. One Australian-flagged vessel fished in the SPRFMO area in 2020 using demersal longline gears and no Australian-flagged vessels fished using trawl gears. In 2020, the total retained catch reported in logbooks was 12 t for demersal line gears. *Nemadactylis* spp. (morwongs) accounted for 30% (3.7 t) of the 2020 longline catch; the remainder comprised *Hyperoglyphe antarctica* (blue-eye trevalla; 22%; 2.7 t), *Seriola lalandi* (yellowtail kingfish; 18% 2.2 t), *Helicolenus percoides* (reef ocean perch; 15%, 1.8 t), and other species (15%; 1.8 t). During 2020, observer coverage levels met or exceeded the levels as required by relevant CMMs. One interaction with a basking shark (*Centorhinus maximus*; dead) was reported in the trawl fishery in 2019. In the non-trawl fishery in 2020, observers reported 33 kg of non-living 'benthos' in 28 separate fishing operations, including 29 kg Gorgoniidae, 1.8 kg Antipatharia and 1.5 kg of Scleractinia.

Chile

12. Document SC9-Doc24 provides Chile's Annual Report 2021 for Jack mackerel. The industrial purse seine fleet operating on the Jack mackerel fishery in the SPFRMO area and Chilean EEZ between January and July 2021 consisted of 54 fishing vessels. As of 2016, Jack mackerel operations have been concentrated within the Chilean EEZ (99%). In particular, during this fishing season (2020-2021), the fleet has been operated 100% in the Chilean EEZ, with fishing areas close to the coast. During the first half of 2021, 527,370 metric tonnes of Jack mackerel were caught in the Chilean EEZ. This value exceeds the national catch limit and is explained by transfers from other fishing nations. These catches begin in December of the previous year (2020) until June of this year (2021), with a monthly average of around 80,000 tonnes; monthly average that is below 89,000 tonnes in the period between January to May 2021. This situation is consistent with what was reported by the hydroacoustic survey that was carried out during 2021 in the northern central zone (March-May), also reporting high levels of biomass. The survey that reported 1,904,359 tonnes (+ 10.17% compared to 2020), having included a smaller area than previous studies due to the restrictions derived from the COVID-19 pandemic; that is, between the north of Antofagasta (23° 25´SL) and Valparaíso (33°00'SL). Nevertheless, the survey carried out on the high seas during 2020 evidenced a significant reduction in the spawning area, representing 16% with respect to the total study area, together with a change in the distribution and the use of the area by the resource. This situation has been taking place since 2007, considering that the area surveyed in the historical series of this project has not changed significantly within years, characterised by both a low daily egg production and a low reproductive biomass.

13. During the first half of 2021, the sizes from catches ranged between 27 and 50 cm in FL. The main mode was 30 cm in FL and the secondary mode was 39 cm in FL. Finally, it is important to reiterate that, as of January 2020, an Electronic Monitoring System has been implemented to survey compliance with Bycatch Reduction Plans and Fishery regulation in general. Furthermore, during 2020, the mandatory use of Electronic Logbooks has been implemented in the entire industrial fleet to report on a set by set basis, total catches, bycatch and discards, locations of sets and other fishery information according to legal requirements.

14. Document SC9-Doc25 provides Chile's Annual Report 2021 for squid. Artisanal and industrial vessels participate in the jumbo squid fishery. In 2020, the artisanal fleet landed 53,967 tonnes of jumbo squid, equivalent to 98.11% % of the national total (55,006 tonnes). This activity involved the participation of 2,079 vessels equal to or less than 18 metres in length. The largest fishing operation was carried out by vessels 12 metres or less in length, with a participation of 94.52%, equivalent to 1,965 vessels. This group of vessels

landed the 83.32% of the total landings made by the artisan fleet. The industrial landings of jumbo squid involved 35 vessels. 19 of them landed more than 3 tonnes per fishing trip. Only one vessel targeted jumbo squid, representing 5.26% of the vessels that operated on this resource. It landed more than 3 tonnes. Therefore, 94.74% of the vessels that operated in 2020 did so with jumbo squid landings as by-catch in the operation on other fisheries. Unlike previous years, during 2020 the fishing activity of the industrial fleet was mainly carried out as by-catch, landing a total of 1,039 tonnes, corresponding to 1.89% of the national total. Of the 18 vessels with jumbo squid landings as by-catch, 15 corresponded to vessels that operated with purse seine (78.95%) and 3 (15.79%) with mid-water trawl. Regarding the total tonnes landed and their relation with the fishing gear used during 2020, 60.90% corresponded to catches made with mid-water trawling; 37.91% to purse seine and only 1.19% of landings corresponded to jigging. On the other hand, all of the catches have been made in the Exclusive Economic Zone (EEZ) of the Chilean maritime territory.

China

15. Document SC9-Doc28_rev1 provides the China Annual Report for Squid. A total of 567 Chinese squid jigging vessels were recorded to operate in the Convention Area and caught 358 thousand tonnes of jumbo flying squid in 2020, but the actual number of active fishing vessels varied from 205 (the fifth week of December) to 432 (the first week of January). The estimated fishing days were 126,958 days and continued to increase comparing with the historical level. Catch rate is about 2.8 tonnes per fishing day, a number consistent with last year. Two observers were designated to perform the observer programme in 2020 with another five studying vessels. A total of 300 fishing days were observed and 21,682 squids were measured by observers on the sea in the 2020-2021 observer mission.

16. Document SC9-Doc29 provides the China Observer Implementation Report for the squid fishery during 2020 - 2021. Only two observers were deployed finally because some candidate observers were unwilling to work on board for safety concerns at the circumstance of COVID-19 pandemic. The total observed days by the two observers were 172 and 128 days, respectively. During the observation period, eight transhipment activities were monitored. No birds were found to be caught by the jiggers or entangled by the lines. In addition, a sea turtle was wrapped by jig lines during the period of the observations, and released alive.

Cook Islands

17. Document SC9-Doc26 provides the Cook Islands Annual Report. In 2020 one vessel carried out exploratory trap fishing activities in the Convention Area. The Cook Islands vessel undertook one fishing trip in line with CMM 14b-2019, targeting *Chaceon spp*. The vessel landed a total of 15.73t, including 13.95t of *Chaceon spp*., 1.46t of *J. Caveorum* and small amount of bycatch (0.37t). There were very low encounter rates with VME indicator species on only one of the six seamounts the vessel conducted sets on. 100% observer coverage was maintained for the duration of the trip and no seabird or marine mammal interactions with the gear and/or mortalities were observed.

Ecuador

18. Documents SC9-Doc18 and SC9-Doc19 provide the scientific reports for Ecuador on jumbo giant squid and jack mackerel in accordance with the Commission's CMM. Among the aspects to be highlighted, it is identified that both species are present, stationary, in the economically exclusive zone of Ecuador adjacent to the Commission's zone of jurisdiction. In 2020, no vessels were registered to catch jack mackerel in use of the quota assigned to Ecuador, so it was transferred to Chile.

19. This report presents biological and fishing information on jack mackerel, collected for the small pelagic fish monitoring program of the Public Institute for Aquaculture and Fisheries Research (before National Institute of Fisheries), when this resource is available in Ecuadorian waters; catch information of JM is recorded in the Public Institute for Aquaculture and Fisheries Research data base since 1984. The Institute classified these ships into four different class, related to Total Register Tonnage (TRT), it should be noted that when Jack Mackerel is available in continental Ecuadorian waters, vessels class III and IV can capture this species (related to operational activity, 15 miles), while it is found near the coast, class I and II vessels can capture this species. The principal fishing zones are recorded in the Gulf of Guayaquil and around Peninsula de Santa Elena. The

first historical records highlight significant captures of this species, however during the last years the captures have decreased considerably and in certain years they are not even recorded. The size structure ranges from 14 to 66 cm TL, denoting the presence of three groups of size classes (19 - 31, 32 - 51, and 55-65 TL), as well as two strong modal groups (28 and 29 cm TL).

20. In 2020, the jumbo giant squid was caught in the Gulf of Guayaquil in directed fishing with hand lines and jiggers and incidental fishing with surface gillnets, according to the availability of the resource. The fishing effort was carried out by artisanal vessels established in the fishing ports of Santa Rosa and Anconcito, Province of Santa Elena, where there are seafood processing plants. On the species captured within the economically exclusive zone of Ecuador, the following findings were made on the maturity of the species (the Nesis 1983 scale was used to determine the stages of maturity), the female organisms analysed (1182) registered 28.2 % in stage I (immature), 70.3% in stage II (maturing) and 1.5% stage III (mature). It should be noted that, in the sampling period, females were more frequent and numerous than males throughout the year. In the case of giant squid in the area of jurisdiction of the Convention, no landings were recorded during 2020, however, the Ecuadorian Fisheries Authority issued regulations for the jumbo giant squid fishery that encouraged several Shipowners and operators to request their inclusion in the Regional Vessel Registry of the SPRFMO, to date, resulting in 373 Ecuadorian vessels that have expressed interest in starting activities on this fishery.

European Union

21. Document SC9-Doc20 provides the Annual Report for the EU. The EU did not fish in 2020 in the SPRFMO Convention Area due to the COVID-19 pandemic. As such is there no catch data or scientific observer data to be reported. To maintain a time-series perspective, the EU annual report builds upon the report for 2019, including empty cells for 2020.

Korea

22. Document SC9-Doc17 provides the Annual Report for Korea. A total of 13 squid jigging vessels operating in the Convention Area caught 1,003 tonnes of jumbo flying squid (*Dosidicus gigas*) in 2020. A total number of fishing days of 13 jigging vessels was 212 days, which is the lowest fishing effort in the last 5 years. Catch rate is about 4.7 tonnes per fishing day. One observer was placed to a jigging vessel. A total of 41 fishing days was observed by him, which covers the entire fishing days of the vessel. 782 squids were measured on the sea. Korean trawl did not fish since 2020 in the Convention Area due to the COVID-19 pandemic. Korean scientific observer programme is currently in the process of Accreditation Assessment.

New Zealand

23. Document SC9-Doc15_rev1 provides an update on New Zealand's fishing activities in the SPRFMO Convention Area in 2020. Eight New Zealand vessels fished in the SPRFMO Convention Area, three using trawl methods and five using bottom line methods. Overall catch and effort remained low, with 337 trawl tows completed taking 477 tonnes of fish. The majority of the trawl catch was orange roughy (301 t), with a small amount of alfonsino (6 t). There were 105,000 hooks set using bottom line methods with a total catch of 57 t, the majority of which was wreckfish and bluenose (26 t and 17 t respectively). New Zealand met all requirements for observer coverage, with 100% coverage in trawl fisheries and 19% of hooks observed in bottom line fisheries. Over 2,000 fish were measured by observers including 1,292 orange roughy, nearly 300 alfonsino, and around 250 wreckfish. Unscaled length frequency information for main species caught is provided in the report. The majority of research activities by New Zealand in 2020 were continuations of previous projects and additional work to support the ongoing review of the bottom fishing CMM. New Zealand also provides information on a range of ecosystem considerations. These include interactions with seabirds, marine mammals, reptiles, other species of concern, non-target fish and elasmobranch catch, and catch of benthic organisms. Information on abandoned, lost, or discarded fishing gear is also provided. There were no observed interactions with seabirds, marine mammals, or other species of concern on New Zealand vessels in 2020. There was one encounter with a potential VME pursuant to CMM03-2020 (Bottom Fishing).

Peru

24. Document SC9-Doc22 provides an update on Peru's fishing activities in the SPRFMO Convention Area. Reporting that as of June 2021, there were 100 Peruvian vessels authorised and registered in the Commission record of vessels authorised to fish within the SPRFMO Convention area. No fishing activities or sea going research activities by Peruvian flagged vessels directed to non- highly migratory species in the SPRFMO Convention area have been carried out during 2020 and the first semester of 2021.

25. Document SC9-Doc23 provides an update on the situation of the Peruvian stock of Jack mackerel and the Jack mackerel fishery in Peruvian jurisdictional waters. It is noted that the Peruvian marine environment is characterised by its high productivity and high variability and is particularly exposed to the effects of the opposed significantly warm (El Niño) and cold (La Niña) climatic patterns in the Pacific Ocean, that alternate with relatively short periods of close-to-neutral or 'normal' conditions in Peruvian waters. Worth mentioning are the weak El Niño in mid 2014, the strong El Niño during 2015 and first half of 2016, the moderate-coastal El Niño from late 2016 to early in 2017, the weak-to-moderate La Niña from late 2017 to early 2018, the weak El Niño from late 2018 to early 2019 and the weak La Niña from the second half of 2020 to early 2021. All with transitional periods and closer to neutral conditions in between. These changing environmental conditions caused a more dispersed distribution, reduced availability, lower abundance indexes and consequently lower catches of Jack mackerel in Peru between 2014 and the first part of 2018. And this has been followed by an expanded distribution in denser concentrations farther offshore, much higher abundance indexes, increased availability to the industrial purse seine fleet and higher catches of Jack mackerel during the second half 2018 and throughout 2019, 2020 and the first half of 2021. The poor 2018-2019 reproductive cycle has been followed by almost normal 2019-2020 and well above normal 2020-2021 reproductive cycles. At least four main size groups with a low incidence of juveniles were observed in the commercial catches throughout 2020 and the first part of 2021 while a fair presence of juveniles as small as 3 cm TL were observed during summer research surveys in 2020 and 2021. In late December 2020 IMARPE (Instituto del Mar del Peru) updated the available 2020 Jack mackerel assessment made for the Peruvian (far-north) stock with the JJM model during the 8th meeting of the Scientific Committee (SC08). This resulted in a range of options for setting the 2021 TAC that were included in its advice to the Government, recommending that a TAC for 2021 be established that considers a multiplier of F2020 not exceeding 2.0, which corresponded to a maximum estimated F = 0.077 and a maximum projected TAC = 132,000 t, accepting a risk of 45.1% that the estimated biomass by January 1st 2022 be lower than that estimated for January 1st 2021. Conservative catch limits aiming at a total catch limit of 101,000 t corresponding to the intermediate reference level recommended by IMARPE were set by the Government in January 2021. An updated assessment with the same JJM model has been made by IMARPE on the basis of the most recent information and data available up to June 2021. The recent observations and assessments confirm the increasing trend in the biomass estimates observed since 2016 as well as the overall healthy situation of the Peruvian Jack mackerel stock considering both, the natural low abundance regime through which the stocks appear to have been going through during the last two decades as well as the apparent intermediate stage or possible temporary shift being observed since 2019.

Russian Federation

26. Document SC9-Doc30 provides the Annual Report for the Russian Federation. According to COVID-19 situation the Russian fisheries in the SPRFMO area in 2020 was started at August 12th only. In 2020 only one Russian trawler "Admiral Shabalin" worked in the high seas of the Southeast Pacific. The total catch was 5,245 t for Jack mackerel and 396 t for chub mackerel in 55 fishing days. The average catch from August to October 2020 was 4.6 t per hour. The highest CPUE was recorded in August – 5.4 t per hour. The Russian scientific observer was onboard the trawler "Admiral Shabalin" during the whole period of activities in 2020. In 2020, 18,289 specimens of Jack mackerel were measured, 2,850 specimens were analysed, and 529 specimens were taken for age sampling by the scientific observer. The amount of collected material for chub mackerel was composed of 17,754 measured specimens, 1,800 analysed specimens, 150 specimens were taken for age sampling.

Chinese Taipei

27. Document SC9-Doc21 provides the Annual Report for Chinese Taipei. Jumbo flying squid widely distributes in the eastern Pacific Ocean and has been targeted by Chinese Taipei's squid-jigging fleet since 2002. The number of operating fishing vessels varied from 5 to 29 between 2002 and 2020. 5 vessels involved in the fishery in 2020, producing 2,087 tonnes of jumbo flying squid. The nominal CPUE was 2.55 t/vessel/day, which was less than that of 2019. The major fishing grounds were located around 13°–20° S, 77°–85° W, while some vessels operated in the equatorial waters (around 0°–3° S, 103°–113° W). Data of logbook, transhipment and landing have been collected entirely and submitted to the Secretariat of SPRFMO. Research on the stock status and spatial dynamics of jumbo flying squid have been conducted. Using catches by weight category, the monthly length composition of jumbo flying squid was also calculated. The observer programme for squid-jigging fishery was initiated in 2018, and one observer was onboard one vessel in June 2021.

United States of America

28. Document SC9-Doc16 provides the Annual Report for the USA. The United States currently has no vessels participating in the fisheries managed by SPRFMO. As such, the United States has no data or information to provide regarding U.S. fisheries operating under SPRFMO jurisdiction in 2020 or 2021. Similarly, the United States has no information to provide regarding 1) catches, effort, and CPUE summaries; 2) fisheries data collection and research activities; 3) biological sampling and length/age composition of catches; 4) ecosystem approach considerations; and 5) observer implementation reports for fishing activities under SPRFMO jurisdiction. The United States has a continuing interest in the fisheries managed by SPRFMO and may have vessels that enter these fisheries in the future. If U.S.-flagged vessels enter SPRFMO-managed fisheries, the United States would provide the Commission with all relevant data and information and abide by all relevant measures adopted.

2.2 Discussion of annual reports

29. A wide range of questions were posed and addressed leading up to and during SC9. These are included as in Annex 5. Additional questions raised during the SC were taken in respective working group sessions. The SC thanked the Members for the annual report summaries and expressed its appreciation for Member responsiveness to addressing related questions.

3 Commission guidance and intersessional activities

3.1 SC multi-annual workplan

30. The 2021 SC multi-annual workplan was posted as SC9-Doc05. The 2022 workplan would be developed during the sessions. It was agreed that within each workstream this could be covered within the sub-agenda item Advice to the Commission.

31. The 2022 SC multi-annual Workplan is included in Annex 6.

3.2 Review of intersessional work

32. SC9-Doc06_rev1 is a compilation of the reports of the four SC web meetings held prior to the SC as well as the numerous web meetings held by subsidiary Working Groups. It was agreed that this document is a good source for content for the SC report.

3.3 Secretariat SC-related activities

33. The Data Manager also tabled a series of papers describing Secretariat SC-related intersessional activities and how the objectives of the Organisation have been progressed since SC8 (SC9-Doc07, SC9-Doc08, SC9-Doc11). The SC Members were very appreciative of the work that the Data Manager had put into preparing these documents.

34. SC9-Doc12 is a compilation of Species Profiles for important SPRFMO species aimed at replacing the extremely outdated working draft Species Profiles (dated 2007 and 2014) currently on the website. Working Group chairs have been coordinating review of new profiles. **The SC agreed** that the Secretariat remove the outdated versions, finalise drafts based on this expert review and load the new short versions to the website. The Species Profiles for Jack mackerel (CJM) and chub mackerel (MAS) and squid (GIS) were accepted by the SC, pending final editorial changes. The new Species Profiles for BWA, BYS, ORY, JMC and PJJ are not complete, and finalisation of these will be coordinated by the Secretariat. **The SC decided not** to update the species profiles for YMO, OFJ, EPI or ORD as they are not considered to be important SPRFMO species, and these will be removed from the website entirely. **The SC also requested** longer species synopses (similar to those produced by FAO), and this was added to the Workplan.

35. In absence of an FAO representative, the Executive Secretary presented an update on progress for planning the second phase of the Common Oceans ABNJ Deep Sea Fisheries project (SC9-Doc13). SPRFMO was a key partner during the first phase of this project and made valuable contributions to help meet the project's objectives during its first phase (2014-2019). Planning for the 2nd phase of the project is nearly complete and paper SC9-Doc13 shows several activities where SPRFMO expertise could be valuable. Due to the nature of the project FAO is required to identify areas where the partners intent to contribute by way co-financing (often in-kind contributions to project activities). This paper requests that the SC consider the list presented and provide advice to the Commission on the usefulness of such activities so that the extent to which SPRFMO contributes may be determined. In order to be able to secure funding FAO needs to be able to identify partners and the level to which those partners are going to contribute to the project's outcomes.

36. **The SC agreed** to keep this item on the SC Workplan.

4 Deepwater

4.1 Review of inter-sessional activities

37. A 3-day Deepwater Working Group workshop (SCW13) was held prior to SC9 from 21-23/22-24 September 2021, at which many of the Deepwater papers were presented and discussed in detail. The Workshop report is available on the SPRFMO website.

38. At SCW13 Australia and New Zealand presented SC9-DW14, an analysis of age data of orange roughy from the Lord Howe Rise. This paper describes the age data from samples of the commercial catch of orange roughy (*Hoplostethus atlanticus*) taken from the Lord Howe Rise in 1989, 1990, 1992, 1993, 2013, and 2015. Estimated age at maturity, based on the timing of formation of the transition zone, was 27 years for both sexes. Age estimates ranged from 19 to 133 years.

39. There was a brief discussion about whether there needed to be more details on the number of otoliths that would be helpful in future, or a line added to the workplan. New Zealand confirmed that they had an ongoing programme to collect orange roughy otoliths to provide samples for future ageing and stock assessments, but preferred not to add a specific line to the Workplan at this point. This will not create any bottleneck for completion of future stock assessments.

40. **The SC noted** that additional age samples of orange roughy are available to inform future stock assessment of the Lord Howe stock.

41. At the first Deepwater Working Group meeting on Exploratory topics the European Union presented SC9-DW15, a proposed plan for a 2022 industry acoustic survey on alfonsinos (BYS; *Beryx splendens*) and redbait (EMM; *Emmelichthys nitidus*). There was some discussion as to whether this should be assessed as a research survey or as an exploratory fishery. There is no specific CMM to cover research within SPRFMO, and the Exploratory Fisheries CMM 13-2021 defines a fishery as exploratory fishing if it has not been subject to fishing in the previous ten years; or for the purposes of fishing with a particular gear type or technique, if it has not been subject to fishing by that particular gear type or technique in the previous ten years. The EU explained that the intention and the goal of this proposal is for research rather than for an exploratory fishery, but that

it is an industry survey and it is likely that an exploratory fishery proposal might be envisaged in future years. The Working Group decided that its role was to consider the scientific and methodological aspects of the research, rather than to assess whether it was an exploratory fishery, but invited the EU to prepare an exploratory fishing checklist, to assist the SC in their considerations (SC9-WP04).

42. The SC discussed the research proposal at length. The EU made clear that their intention was to prepare a CMM proposal that would cover the research, either as part of a general research CMM or something specific for this project. The SC advised against attempting a general research CMM as research was such a broad concept.

43. There was support for the research in principle, and SC guidance was that verification trawling was required for mark identification. It was intended that these verification trawls be a dip into the aggregation, aiming to catch no more than 1-5 tonnes (around 30 minutes). There was substantial discussion about this verification trawling and ways that risks to the sensitive and high biodiversity area and the potential for localised depletion could be mitigated. These included a suggested total cap of 200 tonnes on the amount of fish (alfonsino and redbait combined) to be taken during verification trawling (with the acoustics survey to complete as planned even if the cap was reached). The 200-tonne cap is an estimate of current average annual catch, and it was considered that it would not be detrimental, if spread over a large number of small trawls. There was also concern about the possibility of large catches being taken unintentionally within a single tow and so the use of a small, research net was suggested, rather than the large commercial jack mackerel nets already on the vessel.

44. To reduce risk to the bottom, it was suggested that verification trawls should go no closer than 50 m to the bottom, even if an aggregation was close to the sea floor. To reduce risk to seabirds, marine mammals, reptiles and other species of concern, normal seabird mitigation equipment would be needed, as well as protocols for reviving sea turtles or sealions in case they were encountered.

45. Other aspects of research fishing were also discussed and such as the collection of length and biological information, and the recording of bycatch. The possibility of tagging sharks was suggested if there is time to do this kind of additional work in addition to the achieving the core objectives of the research. For example, the fishing vessel was not identified and more information on where the catches were taken in 2020 were missing.

46. Members noted that there are methodological issues with surveying alfonsino with acoustics, such as the risk of double counting, properly identifying the aggregation, and working out how much of the population is being counted. Uncertainty regarding stock structure, isolation of individual stocks, and the relationship with orange roughy, which may coexist, was also noted. A more complete description of the operation and mitigation of risks was requested. The proponent planned on putting out a new proposal which would include these suggestions and be more explicit on these points.

47. While there was support for the concept of a research project, it was noted that pending the outcomes of other processes and fora, such as the BBNJ, development of a fishery in this area would have to be very carefully considered at a later stage.

48. **The SC:**

> **noted** the EU proposal, **and agreed** that the research would be beneficial. **The SC requested** some improvements to reduce risk, as discussed in SC, including in particular the use of a small research net, verification trawls to stay at least 50 m above the bottom at all times, and abide by an overall cap on catch in verification trawls of less than 200 t. Pending a revision of the research plan, **the SC could not achieve consensus** on approving this research without reviewing the new draft.

4.2 VME Encounters and benthic bycatch (including potential move on distance)

49. At SCW13, New Zealand presented SC9-DW07 a determination of optimal move-on distance in SPRFMO bottom trawl fisheries under CMM 03. After discussing how challenging it is to answer this question, given the limited data available, the Workshop made a series of recommendations to the SC. The SC discussed the recommendations from the Workshop and clarified the final bullet point to say that the previously fished area had not been reduced, but the availability of it had been.

50. The SC:

a. **noted** that an analysis has been provided detailing the effectiveness and impact of the current move-on distance in SPRFMO, and its comparison with other potential move-on distances to avoid additional encounters with VMEs;

b. **noted** that the analysis was focused on stony coral reef habitat on the Louisville Seamount Chain, as it was the only available information suitable for this task at this time. Also notes that other taxa and areas could only be addressed in the future, when abundance models are available to perform such analyses (in particular, such models for 'slope' environments). Finally notes that abundance models are already included in the SC multi annual work plan for 2022;

c. **agreed to recommend** to the Commission that: utilising the best available scientific information, for the stony coral *Solenosmilia variabilis* on the Central Louisville Seamount Chain, increasing the move-on distance from 1 to 5 nm would increase encounter avoidance by an additional 7% and reduce availability of the previously fished area by an additional 53%.

4.3 VME Encounter thresholds

51. At the Deepwater Workshop SCW13 Observer organisation DSCC presented (SC9-Obs01), The Precautionary Approach and Ecosystem Approach in the context of Prevention of Significant Adverse Impacts on Vulnerable Marine Ecosystems. This paper notes that the SC is required to apply the ecosystem and precautionary approaches to safeguard marine ecosystems, and recommended that the SC recognise and describe the uncertainties inherent in the scientific approaches used, including catchability of different VME taxa, advises that there is high risk that the amount of VME in areas closed to fishing is less than predicted by the models, and therefore follow the mandated UNGA approach of closing areas where VMEs are known to occur or likely to occur; advises that it is not possible to develop reliable protection level options for VME indicator taxa at ecologically-meaningful spatial scales, to encompass different protection levels due to the inadequate data and identified uncertainties in the models; advise that where VMEs are known to occur or likely to occur, the Commission should close such areas to bottom fishing and ensure that bottom fishing does not proceed, and advise that to date, reliable conservation and management measures cannot be established to prevent significant adverse impacts on VMEs; ensure in its advice that all species, including rare and cryptic species, will be protected; and that the Commission identifies and protects vulnerable marine ecosystems properly so called and identified, rather than just single taxa.

52. At SCW13 DSCC also presented SC9-Obs02, "Vulnerable Marine Ecosystems, Communities, and Indicator Species: Confusing concepts for conservation of seamounts". This paper warns against confusing and conflating the designation and use of VME indicator species with the concept of the ecosystem of which they are a part. For example, where the probability of an encounter was calculated for one indicator taxon it was concluded that changing the move-on distance from 1 nautical mile would not make much difference to the encounter probability. But this is only one indicator taxon, and may in fact not be the best indicator of the overall ecosystem on that seamount. If a multiple indicator taxon model was used, it is possible that no move-on distance would allow any additional trawling on the seamount without disturbing at least one of the indicator species, because they are all part of the integrated ecosystem of the seamount. The SC thanked DSCC for these contributions.

53. At SCW13 New Zealand presented SC9-DW10, with updated candidate encounter thresholds for VME indicator taxa in the SPRFMO Area. This paper updates candidate encounter thresholds for the 13 VME indicator taxa included in annex 5 of CMM03-2021, with the intention of developing an authoritative set of candidate encounter thresholds for all VME indicator taxa. A range of percentiles (70th, 80th, 85th, 90th, 95th, 96th, 97th, 98th, 99th) were calculated using linear interpolation on ordered bycatch records of each taxon. The use of interpolation overcomes issues related to the lower limit of the sample size required for the estimation of the percentile from ordered values. These thresholds can be used to inform any future refinement of VME encounter thresholds to adjust the level of precaution included in CMM03 (if required).

54. The Workshop agreed that the paper responded to the Commission's needs and updates the previously presented statistical analysis to provide the full range of percentiles for taxa and there was support for the methodological improvements in estimation. After some suggestions about ways that the analysis could be improved in future, the Workshop made a series of recommendations to the SC.

55. The SC discussed these recommendations, and whether the range of thresholds as presented in appendix 4 of SC9-DW10 should be drawn to the attention of the Commission. It was agreed to include a reference to the values in the paper and there was some discussion as to whether a particular value could be chosen. The SC agreed that they were disappointed not to be able to recommend a particular level for thresholds in an ecological meaningful way. Hence **the SC agreed** to refer the Commission to the paper as a whole.

56. Regarding SC9-DW10, **the SC:**

a. **Noted** that the candidate encounter thresholds for VME indicator taxa presented in Table 3 have been updated using the most up-to-date New Zealand bycatch data.

b. **Recommended** to the Commission that the updated candidate encounter thresholds for VME indicator taxa presented in SC9-DW10 are used to inform any future refinement of the VME indicator taxa thresholds included in Annex 6A and 6B of SPRFMO CMM03-2021.

c. Noting the need for the SC to provide more biologically meaningful guidance on appropriate VME thresholds **recommends** to the Commission that it adds to the VME Encounters and Benthic Bycatch task in the SC Multi-Annual Work Plan a 2023+ subtask to develop a research programme within the SPRFMO Convention Area to allow the determination of taxon-specific estimates of catchability for VME indicator taxa.

d. **Recommended** that in the interim, the best available catchability estimates are used to improve the Commission's understanding of the implications of the current encounter thresholds with regard to preventing significant adverse impacts on VMEs.

4.4 VME Taxa updates

57. SCW13 New Zealand presented SC9-DW11 which is an updated list of VME taxa (incorporating FAO criteria). This paper updates the lists of Vulnerable Marine Ecosystem (VME) indicator taxa known from the Evaluated Area of the SPRFMO Convention Area by identifying taxa that meet a combination of FAO criteria for defining VMEs, rather than a single criterion. The criteria were: uniqueness or rarity, functional significance of the habitat, fragility, life-history traits of component species that make recovery difficult, and structural complexity. These lists will provide an important resource for future SC work on defining VME indicator taxa.

58. After discussion about the definition of "slow" and "fragile" and the consistency of the recommendations with FAO criteria and UN resolutions and the effect of the FAO criteria being used individually or in combination, the Workshop made a series of recommendations to the SC.

59. The SC:

a. **Noted** that the lists of VME taxa presented in SC8-DW11 have been updated to take into consideration combinations of the FAO's VME criteria.

b. **Reaffirmed** that the lists of VME taxa should be reviewed periodically and updated as necessary when better information on the taxa become available, so that taxa can be assessed against more VME criteria.

c. **Recommended** discussion with the FAO and other RFMOs on the potential usefulness of different criteria combination approaches and how they could be standardised among RFMOs.

4.5 ID guides for VME Taxa

60. At SCW13 New Zealand presented SC9-DW12 which is an assessment on how ID guides for VME taxa could be developed. This paper proposes 10 steps for the development of a user-friendly identification (ID) guide and training videos that can be used by observers and fishers to identify benthic bycatch landed during bottom fishing activities. Additionally, this paper proposes the development of training videos to familiarise users with the ID guides, and enable information provided to observers to be standardised, accurate and clear, paying particular attention to the identification, weighing, subsampling and collection of benthic bycatch samples.

61. From this work, the SC:

a. **Noted** that steps have been proposed for the development of an updated SPRFMO-specific ID guide for benthic bycatch and the development of associated training videos.

b. **Recommended** that the development of ID guide for benthic bycatch, following the steps proposed in this paper, and associated training videos, are added to the SC Multi-annual Work Plan with a 2022+ timeframe.

4.6 Review process regarding encounters with VMEs

62. At SCW13 New Zealand presented SC9-DW08, the design of a review process for VME encounters in bottom fisheries in the SPRFMO Area. This paper proposes the process for Members to review encounters with potential VMEs in bottom fisheries. This paper also outlines a suggested process for the SC to implement when it reviews Member submissions on encounters at its annual meeting. In summary, the paper proposes that Members provide a suite of details of the encounter area environment, known VME indicator taxa distributions and historical bycatch data. The Member should also provide an evaluation of the presence of a potential VME, the encounter impact and the likelihood of future impacts to formulate a suggestion of appropriate management measures to prevent SAIs. This information is meant to inform a subsequent review of the encounter by the SC and the development of SC advice to the Commission on management actions.

63. The Workshop agreed that this is a challenging and complex task, especially without in situ cameras and data. What comes up in the net only gives a partial picture of what was on the bottom. It was agreed that the CMM requirement to assess consistency of encounters with models was of limited benefit to assessing SAIs resulting from the encounter, but makes a useful contribution to determining the ongoing appropriateness of the spatial management measures.

64. After considerable discussion, including regarding issues of spatial scale and of catchability, **the SC agreed with the workshop findings and:**

a. **Noted** that a geodatabase with Habitat Suitability layers for 10 VME indicator taxa is held by the Secretariat and can be provided to Members and CNCPs to aid in the evaluation of encounters each year.

b. **Adopted** the components of a process identified in SC9-DW08 as an interim protocol for the review of encounters with potential VMEs under CMM 03-2021.

c. **Agreed** that this protocol be further developed intersessionally and as science advances or to reflect any changes to the CMM.

d. Agreed to **recommend** to the Commission that it Notes that SC9 has adopted an interim protocol for reviewing encounters.

4.7 Reported encounters with VMEs

65. At SCW13 New Zealand presented SC9-DW09, a review of a 2020 New Zealand VME encounter. This paper provides a Member review of the VME encounter that occurred in 2020 on a New Zealand flagged vessel that was bottom trawling in the SPRFMO area (North Lord Howe Rise Fisheries Management Area). New Zealand provided a Member review of its encounter, including details of the encounter and its consistency with habitat suitability models, and an evaluation of impacts and management actions to prevent significant adverse impacts on VMEs. Given the small scale of historical impacts and the assessment of a low likelihood of VME presence based on available data, New Zealand recommended that reopening the area to fishing was unlikely to cause further SAIs to VMEs at the FMA scale.

66. DSCC did not agree that empirical evidence supports the conclusion that there are no other impacted areas, as there are clearly VMEs elsewhere. They challenged the estimate that 82.8% of Gorgonia Alcyonacea abundance is currently in areas closed to fishing, as it was solely dependent on habitat suitability models which have been shown to be inaccurate in terms of describing VME abundance.

67. HSFG disagreed that there was even an encounter, as it did not appear to have been detected at the time. In their view it was inappropriate that was used as a test case to establish an encounter protocol due to a misapplication of the CMM and the reporting requirements. HSFG acknowledged the work New Zealand scientists and managers have done in their review of this encounter but suggested that SC should advise the Commission to disregard this event.

68. After lengthy discussion, **the SC agreed** that the general message from the Workshop was that at the encounter area scale there appeared to have been a Significant Adverse Impact, but that this was not true at a larger, Fishery Management Area (FMA), scale. **The SC therefore**:

a. **Noted** New Zealand assessed the risk of SAI resulting from reopening the encounter area to be moderate at the spatial scale of the encounter area, low at the spatial scale of the Bottom Trawl Management Area and low at the spatial scale of the FMA.

b. **Noted** that the Deepwater Working Group:

   i) Agreed that a high-density area of Gorgonian Alcyonacea indicating the presence of a VME which was impacted by fishing, and is likely to persist at this location;

   ii) Noted that available empirical evidence did not suggest the presence of other areas with high density of Gorgonian Alcyonacea (or combinations of other VME indicator taxa) being present near the encounter area;

   iii) Agreed that the risk of SAI resulting from reopening the encounter area to be high at the spatial scale of the encounter area and low at the spatial scale of the FMA;

   iv) Noted that reviews of future encounters would be improved by the explicit use of catchability to support more robust review outputs.

c. **Noted** the previous agreement from SC8 that, while the appropriate scale to assess and manage impacts on VMEs has not been defined in SPRFMO, the scale of the Fishery Management Areas is likely to be a more biologically appropriate scale at which to assess and manage SAIs on VMEs than larger scales;

d. **Noted** that at the scale of the North Lord Howe Rise FMA, 82.8% of the Gorgonian Alcyonacea (based on PowerMean, unimpacted baseline from SC9-DW06_rev1) is afforded protection through the spatial management regime acknowledging the uncertainty in the underlying habitat suitability models;

e. Noting that the Commission is still deliberating on appropriate levels of protection; the SC **recommended** that:

   i) If assessing SAI on VMEs at the scale of FMAs, reopening the Encounter Area would likely not result in SAI on VMEs; and

   ii) If assessing SAI on VMEs at the scale of the Encounter Area, reopening the Encounter Area may result in SAIs on VME.

4.8 CMM 03 request regarding ongoing appropriateness

69. No specific papers were presented under this agenda item; however, it was noted that most of the papers discussed at SCW13 and SC9 were related to assessing ongoing effectiveness of CMM 03.

70. CMM 03 requests that at its annual meeting in 2021, the Scientific Committee shall review and provide advice on the effectiveness of the applied management measures, including:

a. VME indicator thresholds; this was covered in SC9-DW10 and the SC agreed on the information that should be used when thresholds are being reviewed;

b. the Management Areas; the level of protection provided within management areas was addressed in an evaluation of spatial management scenarios (SC9-DW06_rev1), and in the 2020 BFIA, which was amended in SC9-DW02;

c. the number of encounters; the single encounter in 2020 was reviewed in SC9-DW09;

d. the relationship between benthic bycatch from fishing vessels (including encounter events) and the habitat suitability models; the relationship between benthic bycatch and habitat suitability models was included in the review of the encounter (SC9-DW09_rev1);

e. the relationship of benthic bycatch to estimates of abundance of VME taxa, where information is available; catchability is specifically addressed is recommendations from SC9-DW10 and a research programme to assess catchability is recommended for 2023+ on the 2022 workplan;

f. the appropriateness of the management approach (e.g., scale); the issue of the appropriate scale for management was discussed at length in discussions about SC9-DW09_rev1; SC9-DW07 investigates optimal move-on distance in SPRFMO bottom fisheries;

g. additional relevant VME indicator taxa or species that have not been modelled, assessed or for which thresholds have not been established; SC9-DW11 provided an updated list of VME taxa for potential consideration by the SC;

h. refinement of the encounter protocol; A new interim encounter review process was agreed in recommendations from SC9-DW08;

i. measures to prevent the catch of and/or impacts on rare species; A framework for providing advice on captures of marine mammals, seabirds, reptiles and other species of concern was developed in SC9-DW13;

j. anything else the SC considers relevant to ensure the measure is achieving its objective and the objectives of the Convention; SC9-DW12 assesses how ID guides for VME taxa could be developed.

71. The appropriateness of the management of VMEs under CMM 03 in FMAs open to fishing depends on three main choices:

a. The spatial scale of the assessment of fishing impacts on VMEs, which should be relevant to the life-history traits of component VME species that limit recovery, the spatial extent of VME habitat type and connectivity between populations to ensure viable VME populations at a given spatial scale.

b. What fraction of total VME indicator taxa abundance should be protected at a given spatial scale. This needs to be relevant to the life-history traits of component species that limit recovery, the spatial extent of VME habitat type and connectivity between populations to ensure viable VME populations at a given spatial scale. There is very limited guidance on the question from other RFMOs or elsewhere (but see SC9-DW06_rev1). The estimation of the fraction of VME indicator taxa abundance protected depends strongly on the ability of the available habitat suitability models to infer abundance, noting that abundance models using survey presence-absence or abundance data and relevant environmental/benthic data could improve this accuracy.

c. What weight thresholds are set to trigger the protocol for an encounter with a potential VME. This depends on the catchability of VME indicator species, the accuracy of abundance models and the fraction of total VME that is protected at a given spatial scale. To prevent SAI, the weight thresholds should be linked to the fraction of VME indicator taxa abundance protected (i.e., a lower abundance protected would warrant a lower weight threshold and vice versa).

All three choices have been underpinned by some scientific understanding of VMEs, but the scientific understanding does not provide precise limits or reference levels for each of these three choices.

72. DSCC commented that it is VMEs, rather than components, that are subject to prevention of SAI; that the UNGA resolutions and the FAO Guidelines make it clear that it is the site and VME level that SAIs must be prevented., that the fraction of total VME abundance protected is not and will not be known in the foreseeable future. The HSI model doesn't predict abundance and there are no proposals for research surveys, and that the UNGA resolutions and the FAO Guidelines make it clear that it is the site and VME level that SAIs must be prevented.

73. The SC:

> **agreed** that work had progressed in a number of areas in relation to addressing the ongoing effectiveness of management measures as requested by CMM03.

4.9 Bottom Fishery Impact Assessment review

74. At SCW13 New Zealand presented SC9-DW02 which is an addendum to the Cumulative BFIA for Australian and New Zealand bottom fisheries in the SPRFMO Convention Area 2020, which was presented and agreed at SC8. The addendum details missing information on the current protection levels afforded in the Westpac Bank area.

75. The SC:

> **agreed** that to provide the best scientific advice available, the BFIA should be supplemented with this new information.

4.10 Bottom protection scenarios

76. At SCW13 New Zealand presented SC9-DW06_rev1 on behalf of Australia and New Zealand which describes the development of spatial management scenarios for bottom trawling. This paper updates the SC on the methods being used and on the progress in developing spatial management scenarios for bottom trawling. In accordance with the Commission request, potential spatial management scenarios for protection levels of 70%, 80%, 90%, 95% for the modelled VME indicator taxa, using temporally static and temporally dynamic assessment methods, are provided for reference. The paper also provides information to the Commission on approaches or references to potentially inform determination of the level of protection required to prevent SAIs on VME in the SPRFMO Convention Area.

77. The Workshop expressed its appreciation for the work, with the addition of various scenarios and incorporating what had been learned from the BFIA. It represents a large amount of work, based on methods that had been agreed at SPRFMO SC workshops in 2020.

78. The Workshop made a series of recommendations to the SC, and the SC:

> a. **Noted** the metrics used to assess the protection levels for VME indicator taxa, ROC 0-linear and Power Mean, are representative of the metrics spectrum presented in the BFIA.
>
> b. **Noted** that protection level assessment was completed for all protection levels using both temporally static and a temporally dynamic methods, as requested by the Commission.
>
> c. **Agreed** that the approach taken to develop spatial management protection scenarios and report on their performance is appropriate and work will continue intersessionally to refine scenarios to meet all protection targets for presentation to Commission
>
> d. **Recommended** that the Commission consider the results of the spatial protection scenarios including to inform its determination of the level of protection required to prevent SAI on VMEs in the SPRFMO Convention Area.
>
> e. **Noted** that ecologically relevant spatial scales for assessing protection levels to prevent SAIs on VME indicator taxa still remain to be agreed, but that the existing information at the FMA is likely to be a more biologically appropriate compared with larger scales

79. DSCC noted its disagreement with these recommendations as it felt that the term "appropriate" was limited by the terms of the Commission request, rather than being used in a wider sense. It was noted that the language of the recommendation was consistent with the usage in SC8.

4.11 CMM 03 request regarding species of concern

80. New Zealand presented SC9-DW13 describing the development of a framework for providing advice on species of concern captures. This paper proposes a framework for providing precautionary advice on captures of marine mammals, seabirds, reptiles and other species of concern, which are rare in midwater trawl for bentho-pelagic species and bottom trawl fisheries and appear to be rare in bottom line fisheries. However, the small number of reported and observed captures does not necessarily mean that the captures are inconsequential, as some of these species face a risk of extinction in the wild, so even a low number of captures can present a substantial species level threat. An assessment of relevant data sources proposed minimum criteria and methodological approaches for the key questions that are required to assess the risk to a species from fisheries captures are considered and could be used by the SC when providing advice to the Commission.

81. There was considerable discussion about some lack of clarity in the recommendation that came from the Workshop, and **the SC agreed** to reword the third recommendation to include a reference to table 1 of SC9-DW13.

82. **The SC:**

> a. **Adopted** the proposed set of guidance as a framework for providing scientific advice on the capture of seabirds, marine mammals, reptiles and other species of concern.
>
> b. **Noted** the potential of electronic monitoring (EM) as a relevant data source for providing scientific advice on such captures and for improving the quality of fishery dependent (logbook) data
>
> c. **Recommended** the Commission notes the four different types of advice (Table 1 from SC9-DW13) that can be sought from SC on the capture of seabirds, marine mammals, reptiles and other species of concern, and associated resourcing and other implications related to the data required to provide different types of scientific advice, as outlined in this framework.

4.12 Advice to the Commission on Deepwater

83. The 2021 Workplan was revised (SC9-Doc05_rev1) with the updating of dates and removal of items where work was complete.

84. New items for the Workplan included:

    a. Develop VME taxa guide;

    b. Investigate catchability of benthic bycatch using existing data to support design of a wider research programme (see next task);

    c. Develop a research programme within the SPRFMO Convention Area to allow the determination of taxon-specific estimates of catchability for VME indicator taxa.

85. **The SC noted** that one of the tasks that was removed from the Workplan section "Deep water stock structure" was to receive $23.6k in SC funding. **The SC recommended** that this amount as well as the voluntary contribution from Australia be used to commence a research programme within the SPRFMO Convention Area to allow the determination of taxon-specific estimates of catchability for VME indicator taxa.

5 Jack mackerel

5.1 Review of inter-sessional activities

86. A 2-day Jack Mackerel Working Group Data workshop (SCW11) was held prior to SC9 from 9/10 - 10/11 August 2021, at which many data issues of the Jack mackerel stock assessment were discussed in detail. The Workshop report is available on the SPRFMO website.

87. Chile presented SC9-JM04 which is a research proposal for a project to study the population genetics of Chilean jack mackerel (*Trachurus murphyi*) in the South Pacific Ocean in order to reduce uncertainty in the management of the Chilean jack mackerel (*T. murphyi*) fishery by investigating the genetic signatures of the connectivity and admixture proportions of this species, key topics that are needed to understand its population dynamics. The genetic methodological approach involves the identification and analysis of CJM Single Nucleotides Polymorphism (SNPs) to identify genetically divergent groups in the South Pacific, comparing its patterns of genetic divergence with previously documented phenotypic and biological fishing gradients. Furthermore, phenotypic differences will be analysed through body shape morphometry from individuals collected in different regions of the global distribution of the CJM population. In addition, biological samples (i.e. otoliths) will be collected for complementary analysis. In order to propose a conceptual model for the spatial structure of the CJM population, the study considers the analysis of habitat-based population connectivity through species distribution models and individual-based models for larval dispersal. Taking into account the implications of this proposal, Chile asked the members to get involved in the project activities. The need to generate a long-term programme for the genetic study of CJM is recognised, however considering the current logistical and budgetary limitations, this project is proposed as a starting point.

88. Peru presented SC9-JM08 with comments on the genetics research proposal in document SC9-JM04 from Chile. Peru noted that the proposal by Chile only included 13 sampling sites over 7 months, and stressed the need to expand the suggested sampling scheme and proposed a more thorough analysis of the population structure of *T. murphyi* through a more expanded multidisciplinary approach, besides the genetic analysis, for the identification of the population genetic structure, connectivity and admixture, and the delimitation of geographical boundaries of divergent groups at a fine scale. Peru proposed a population structure analysis including spatial criteria to define populations´ boundaries (coverage of species distribution, genetic contribution of organisms in spawning areas); and temporal criteria (multi-year sampling for monitoring stability of population genetic diversity, in short and long-terms, due to the migratory response under environmental changes), taking also into account the different five hypothesis to be evaluated. Peru also suggested to complement the genetic studies with other types of stock structure analyses, such as on morphometry, parasites, hard parts microchemistry, life history patterns, food habits and spatiotemporal diet variability, distribution patterns and habitat preferences and constrains, and tagging experiments. It will be of crucial importance that participating parties analyse and agree on a list of parameters to be integrated into the genetic studies, but with an extended spatio-temporal multidisciplinary approach for the holistic interpretation of the jack mackerel population structure. The importance of agreeing on uniform sample sizes, protocols, analysis criteria, etc., was also stressed.

89. EU confirmed an interest to participate in a genetic research project on jack mackerel. EU has recently been active in generating genetic information on populations of herring and horse mackerel in the Northeast Atlantic and offers the following suggestions for a potential project on jack mackerel in the South Pacific: 1) Desk study to pull together all available existing knowledge and data on the species and the stock id issues. Are there any life-history characteristics that appear to be different between different areas etc. From this develop a proper sampling plan for (if possible) the full distribution of the species and sample spawning baselines over a couple of years. 2) For the identification of the most informative genetic markers use the approach used for Horse mackerel to develop a reference genome and then use Pool-Seq of your suspected populations to compare overall genetic population structure across the distribution. Need outgroups here as you suspect they are most divergent and will help place the relationship of closer populations into context. 3) Once the main populations are known, then use the pool-seq results to identify informative areas of the

genome and mine them for markers specific to your particular stock identification question. These will likely be markers under selection. Then validate these markers by genotyping a subset of individuals from each population. 4) Once markers are validated then use them to screen larger numbers of baseline samples over multiple years to build up a temporal stable baseline or known origin/population fish, which can be used to develop an assignment model. 5) Once the assignment model is ready and thoroughly tested, then start to assign non-spawning fish from potentially mixed aggregations or juvenile fish of unknown origin. This will build up the knowledge of annual movements etc. 6) If more genetic based analyses are required to look at genetic divergence or demographic parameters, one could use the pool-seq data and add some neutral markers too.

90. There was considerable discussion about the advantages and disadvantages of the various proposals for genetic studies, with Members contributing their experience in this area. The importance of a long-term study with a well stratified sampling design that takes into account the known spatial and temporal variability and the inclusion of additional (multidisciplinary) information was stressed. New Zealand indicated that it would be interested in the details of the planned sampling, but in principle they would be able to provide specimens for the study.

91. The SC:

> **recognised** the need for a comprehensive research plan to improve the understanding of origin and admixture of populations or subpopulations of jack mackerel in the Southern Pacific.

92. The research plan would need to be developed and carried out by a group of SC Members. Such a task group on CJM connectivity would have a terms of reference (ToR) proposed as follows:

    a. Carry out a desk study to pull together all available existing knowledge and data on the species and the stock identity issues. Agree on protocols for processing samples and methods for analysis.
    b. Derive a proper sampling plan from the desk-study for the full spatio-temporal distribution of the species.
    c. Collect and analyse (preferably spawning) baselines samples over a period of 2-3 years. Such sampling work could already start immediately with the proposed project by Chile, preferably a focus on spawning jack mackerel.
    d. Develop genetic research programme (including whole genome sequencing). In the process explore the possible utilization of commercial genetic laboratories for processing of samples.
    e. Collect, collate, review and (re-) analyse information from e.g., morphometry, parasites, hard parts microchemistry, life history patterns, food habits, spatiotemporal diet variability, distribution patterns and habitat preferences.
    f. Explore feasibility of tagging methods (e.g., spaghetti tags, pop-up tags) to provide additional information on the actual movements of fish.

93. It was recognised that the proposed research efforts have substantial financial implications for which funding would need to be requested. The SC agreed that Jack mackerel connectivity research plan should be included in the multi-annual workplan.

94. Chile tabled SC9-JM05 regarding Catch-at-age and abundance-at-age using a new criteria of age assignment. This information was previously discussed at the Jack mackerel data workshop SCW11. The report shows the progress status of age structure data series of the Chilean jack mackerel, based on validated age-length keys, that was changed accord at the new ageing criteria. The results include 1) the commercial catch age structure from 1980 to 2020 by quarter and fleet; 2) the abundance by age group of acoustic surveys in fleet 1 area for 2006, 2007, 2009, from 2013 to 2020 and fleet 2 from 2001 to 2012, 2017, 2020. These age structure include the mean length and weight fish by age group.

95. The SC agreed that the new criteria of age assignment is justified by the data for younger fish, but there was still some uncertainty as to whether it was fully validated for older fish or whether it will be consistent with ageing for other Members. The Data Workshop SCW11 recommended an otolith exchange programme to

improve consistency of age-reading methods among Members as well as to progress with developing Age Length Keys for all relevant data prior to the Benchmark workshop and to come up with proposed demographic values (natural mortality, growth, maturity) for use in the assessment.

96. Chile presented SC9-JM07 regarding updating information associated with age and growth of jack mackerel This document summarises the new project that Chile started to improve accuracy of age and precision of jack mackerel otolith reading among SPRFMO scientists. The aim is to standardise methods and ageing criteria by means of an age protocol based on an otolith reference collection. This addresses a recommendation from the Jack mackerel Data Workshop SCW11 "Conduct an otolith exchange to improve consistency of age-reading methods among Members."

97. Chile stated that the objectives of its new project are: 1) To elaborate a reference collection of otoliths based on reproducibility percentages among experienced readers from SPRFMO countries. 2) To elaborate a graphic catalogue by means of a reference collection of otoliths validated by readers and a manual that contains protocols and criteria for otolith reading. 3) To reconstruct historical length-age keys, catch matrices, mean weights according to the new ageing criteria. 4) To estimate growth parameters, natural mortality and mean age-at-maturity (A50), and 5) To reduce uncertainty of age validation of adults (age 2+) using otolith microstructure analysis methods with electronic microscopy. Chile presented a detailed planning of activities between September 2021 and May 2022.

98. EU, Korea and Russia indicated that they had otoliths available from the offshore fleet and were willing to participate in the otolith exchange. China was likewise willing to participate but does not have otoliths available for such an exchange.

99. Peru reminded the SC that in the recent past there had been several age reading harmonization exercises that concluded that age reading was carried out differently in Peru and Chile. The discrepancy has diminished due to the new Chilean age reading criteria but may not have been resolved for the older ages. Therefore, Peru suggested that an otolith exchange may not be sufficient to improve the harmonization of age reading practices by different Members.

100. Chile reminded the SC that Chile has validated its ageing criterion for old fish using the Radio Carbon Bomb methodology, nevertheless is open to discuss results from other validation methods that could have been applied to old jack mackerel elsewhere. In fact, its new project includes validation of fish of 2+ yr-old jack mackerel using electronic microscopy.

101. Following discussions in the margin of the meeting, the SC:

recommended that a Jack mackerel ageing analysis task group could be initiated that would address the following terms of reference:

a. Compile approaches and results of all previous Jack mackerel ageing harmonization initiatives; Generate a comprehensive description of ageing techniques for Jack mackerel.
b. Compile scientific underpinning, manuals and instructions in counting rings / age reading protocols in different laboratories.
c. Collate a reference collection of otoliths amongst interested parties and organise a comparative analysis based on reproducibility percentages among experienced readers from SPRFMO members, first focusing on counting of rings, secondly on conversion of rings to ages.
d. Agree on validation techniques of ages of adults (age 2+) using direct and indirect techniques. For instance, starting methods might include otolith microstructure analysis methods with electronic microscopy, or length frequency modal progression analysis.
e. Develop a graphic catalogue of otoliths by means of the reference collection.
f. Initial workshop to discuss results, May 2022.

102. It was recognised that the proposed research efforts are expected to span multiple years and may exceed the budget that might be estimated from the Chilean proposal (SC9-JM07) and that additional funding would need to be requested. **The SC agreed** that a comparative analysis of ageing techniques, possibly including the otolith exchange amongst interested parties should be included in the multi-annual workplan.

103. At the Jack mackerel Data Workshop SCW11 EU presented SC9-JM06 regarding the Pelagic Freezer-trawler Association report on self-sampling data. The Workshop discussed the possibility of using such industry sampled data for assessment purposes and **the SC:**

> **recommended** that a protocol be developed on how the self-sampling data could be integrated with the observer data for consideration at the Benchmark workshop.

5.2 Management Strategy Evaluation update

104. The EU tabled SC9-JM03 which is the final report of a project to develop an MSE framework for Jack mackerel. The document reports of the progress of work towards the development of a simulation platform for the evaluation of candidate management procedures for the Chilean jack mackerel, *Trachurus murphyi*, stock in the South Pacific including areas under national jurisdiction. A platform has been developed and tested, based on the FLR libraries, that is able to condition operating models based on the current stock assessment model, apply a range of procedures that mimic current data sampling and stock assessment, and compute their performance according to a set of indicators. Discussion and agreement on a number of items, like sources and levels of observation and implementation error, or performance indicators and initial management objectives, is required before complete analyses can be performed.

105. **The SC agreed** that the next step is to organise a meeting with stakeholders or managers in the second half of 2022. This is to be included in the workplan.

5.3 Assessment data review and evaluation

106. The SC reviewed SCW11, the Jack mackerel data workshop report. The workshop was held virtually in three sessions each of three hours duration. The workshop covered data reporting and processing steps, age-determination methods and updates, a detailed review of the methods for deriving the data used in the assessment, and other aspects relevant to available data for the Jack mackerel assessment. The workshop compiled a set of technical recommendations which have already begun to be adopted. Larger items arising from the workshop discussions include recommendations to: 1) conduct an otolith exchange to improve consistency of age-reading methods among Members, 2) make ALKs and methods used to derive all of the age composition data available prior to the benchmark, 3) convene a small group prior to the benchmark to come up with proposed demographic values for the assessment. The SC noted these recommendations and they are reflected (with some modifications) elsewhere.

107. The initial model runs incrementing data updates show that the Peruvian CPUE index appeared to have the highest impact on stock trend with an increase particularly noticeable in the model for the 1-stock hypothesis. It was explained that this is likely caused by the CPUE from Peru (fleet 3) being assigned the same relative weight as the CPUEs from Chile (fleets 1 and 2) and from the off-shore (fleet 4) in the single-stock model. The SC noted that the Peruvian CPUE trend fell more in line with the other indices compared to the preliminary values presented in the 2020 assessment. Other incremental data updates have limited impact on consistency of estimates of spawning stock biomass.

108. It was noted that Jack mackerel in the Chile North fleet were traditionally juvenile, but recently it appears to have been an adult fishery. Chile explained in the last two years the industrial fleet has been forbidden to operate in the coastal fishing grounds (due to an appeal brought by the artisanal fleet), so it has moved to fish further from the coast (20 - 60 miles), where they have caught the larger Jack mackerels.

109. At the first 2021 Working Group meeting the Secretariat tabled SC9-JM01 which is a compilation of Jack mackerel Catch history including predicted catches for 2021 (SC9-JM01 Annex_rev1). This was implemented and informed the updated assessment as presented in Annex 10.

110. At the second 2021 SPRFMO SC Jack Mackerel Working Group meeting the EU presented SC9-JM02 which is the standardisation of CPUE data for the offshore fleet fishing for Jack mackerel in the SPRFMO area. A small change was needed to the model this year because with only one vessel fishing in 2020 (which fished for the first time in 2020), the model was unable to estimate a 2020 year effect with a Vessel variable in the model and Contracting Party was used instead. The Working Group agreed that a higher standard error should be put on the 2020 CPUE estimate from the offshore fleet and other CPUE indices as it was based on a very limited amount of data, as a sensitivity analysis.

5.4 SPRFMO Jack mackerel assessment

111. From the web preparation meetings, and recognizing that the planned benchmark assessment review had not occurred, the SC agreed that the assessment would be constrained in the evaluation of sensitivities and alternative model configurations. The usual incremental analyses of adding each new data component was completed. One larger change was replacing the old data with a revised time series of conventional age composition data provided by Chile during the data workshop. The SC agreed that this was considered most appropriate for updating the accepted model. The "new" age-determination methods for estimating Chilean fishery and survey data will be evaluated during the benchmark.

5.5 Advice to the Commission on Jack mackerel

112. Advice on Jack mackerel stock status at this meeting was based on stock assessments conducted using the Joint Jack Mackerel (JJM) statistical catch-at-age model as developed collaboratively by participants since 2010. The Jack mackerel stock(s) in the southeast Pacific show(s) a continued recovery since the time-series low in 2010.

113. An overview of the advice provided by the SC, the management decisions by the SPRFMO Commission and the estimated catch by year has been compiled in Annex 7. This Annex demonstrates that the advice from the SC has been taken up by the Commission.

114. Because of the continued difficulties introduced by the COVID-19 pandemic, it was agreed that this year's assessment would again be based on a simple update of last year's assessment model and applying the harvest control rule ("Adjusted Annex K").

115. In conformity with the approach by the SC since 2012, a comparison was made between the 1-stock and 2-stocks model configurations. Both models showed similar trends with an increasing overall biomass, high recruitments in recent years, and low fishing mortality. Under the two-stock hypothesis model, the northern stock is estimated to have stable and low biomass levels over the past decade with an increase in the last few years. The combined single-stock model resulted in slightly lower recruitment and biomass estimates than the summed 2-stock model and slightly higher projected catch.

116. Estimated biomass increased from 2020 to 2021 and is estimated to be well above the interim B_{MSY}. Therefore, the SC noted that the stock is estimated to be in the third tier of the proposed harvest control rule (COMM2 Annex K). However, the SC also noted that there is additional uncertainty in the assessment that was carried out this year. That is because the SC is aware of substantial differences in the new ageing technique from Chile, that the CPUE series does not take into account the possible effects of increased efficiency of the fleets and that distribution patterns of Jack mackerel appear to be changing in recent years. All these issues will be taken up in the 2022 benchmark meeting on Jack mackerel. Within the third tier of the harvest control rule, catches should be limited to a fishing mortality of F_{MSY} rather than the lower status quo fishing mortality applied under the previous tier of the Jack mackerel rebuilding plan. Fishing at F_{MSY} would be expected to result in catches in 2022 of 1641 kt. However, according to the directive of the Commission to the SC

(described in COMM6, annex 3) the "adjusted Annex K"; a maximum change in the catch limit of 15% which would be based off the 2021 TAC should apply.

117. In line with the accepted rebuilding plan ("Adjusted Annex K") and because the Jack mackerel biomass is estimated to be above 100% of B_{MSY}, the SC:

> **recommended** a precautionary 15% increase in 2022 catches throughout the range of Jack mackerel- at or below 900 kt. This advice for catch limits in 2022 does not depend on the stock structure hypothesis that is used.

118. The technical aspects related to the Jack mackerel assessment are detailed in Annex 10.

119. Paragraph 28 of CMM 01-2021 (*Trachurus murphyi*) states that "At its next annual meeting, the Scientific Committee will assess the information received and provide advice to the Commission regarding the possible impact of the national measures adopted on the *T. murphyi* fishery". **The SC noted** that in 2020, the sum of realised catch of Jack mackerel has been higher (3%) than the maximum recommended by the SC. Preliminary estimates of the catch in 2021 result in a similar potential overshoot (3%). **The SC noted** that due to the estimated high abundance and apparent low fishing mortality, the impact of the overcatch appears to be negligible. However, it is necessary to evaluate the potential structural impacts of national measures on the *T. murphyi* fishery. This would best be carried out as part of the management strategy evaluation. This requires a precise specification of the type of national measures that should be considered.

120. The 2021 Workplan was revised (SC9-Doc05_rev1) with the updating of dates and the removal of items where work was complete (such as the Data Workshop SCW11).

121. New items for the Workplan included:

    a. Jack mackerel connectivity research proposal (SC9-JM04, SC9-JM08);

    b. Ageing determination analysis and otolith exchange proposal (SC9-JM07);

    c. Carry out a software upgrade to JJM model to upgrade diagnostics, and explore embedding in FLR. (3-day online workshop);

    d. Review of potential bias in CPUE indices due to possible increased efficiency of the fleet and observed changes in the jack mackerel spatial distribution (benchmark);

    e. The Benchmark Workshop which had been unable to be carried out in 2021 because of COVID-19 would be put back on the 2022 Workplan (possibly for mid 2022), and would need clarification of all the topics to be considered, including a complete list of different survey data that may now need to be reviewed. Four different modalities of the benchmark workshop may be considered:

        i) Option A In person 5-day meetings;

        ii) Option B Virtual 5-day meeting;

        iii) Option C Virtual, spread out over a longer period;

        iv) Option D Hybrid (based on Option B).

The SC noted that a final choice on the modality and dates to be selected should be drafted prior to the Commission meeting 2022 and finalised by the end of COMM10.

5.6 Suggested terms of reference for a benchmark workshop of Jack mackerel

122. The most recent benchmark assessment of Jack mackerel was held in 2018. Since then, several new sources of information and new assessment issues have come up, that warrant a new benchmark assessment of Jack mackerel. Due to the Covid-19 pandemic, it has not been possible to organise the planned benchmark meeting in 2021. Therefore, the benchmark is now scheduled for 2022.

123. The SC:

> **recommends** that a Jack mackerel benchmark workshop be held in 2022 to address *inter alia* some of the following topics (a final terms of reference will be developed prior to COMM10):
>
> a. Evaluate how the new age data affect other model assumptions, namely natural mortality and weight-at-age variability over time;
>
> b. Review the potential bias in CPUE indices due to fishing efficiency changes and changes in jack mackerel distribution;
>
> c. Review the useability of any other survey series that could be included in the assessment;
>
> d. Review the single stock and two-stock hypothesis implementations of the JJM assessment model, projections, environmental regimes and reference points;
>
> e. Review the methods used to carry out projections and, if needed, explore alternatives. Ensure documentation and options are up to date;
>
> f. Generate initial estimates of biological reference points using the same methodology as used in the 2018 benchmark workshop.

6 Squid

6.1 Review of inter-sessional activities

124. Chair of the Squid Working Professor Group Gang Li gave a brief summary of the three working group meetings prior to SC9 (See SC9-Doc06_rev1). At the first meeting the main topics were genetics and CMM development. In genetics, a coordinated approach to the exchange of genetic samples was suggested. At the second web meeting there was a discussion of the species profiles and further discussion of possible approaches to CMM development including a recommendation on capping fishing effort. At the third web meeting the working group discussed Annual Reports and a variety of stock assessment approaches for jumbo flying squid.

125. The Secretariat tabled SC9-SQ01_rev1, an update of squid datasets held by the Secretariat.

6.2 Alternative approach for scientific monitoring

126. Peru presented SC9-SQ03, an alternative to the Observer Programme for Peruvian artisanal vessels (as required under paragraph 4 of CMM 16-2021). This document describes the methods and procedures applied by the Instituto del Mar del Perú (IMARPE) to obtain biological and fisheries information and data on the jumbo flying squid *Dosidicus gigas* in the Peruvian waters. Which, in cooperation with other institutions, is in the process of being expanded in order to strengthen the systematic collection, sampling and recording of information and data on the fishery, the biology and population dynamics of this species, both on board artisanal fishing vessels and in the main landing sites and coastal research laboratories of IMARPE. This IMARPE observers programme already provides a standardised tool for collecting, sampling and recording information and data that contributes to generating of reliable and comparable information from the jumbo flying squid fishery in Peruvian jurisdictional waters and, with the necessary adjustments, it will be strengthened and expanded to meet the requirements of the SPRFMO Observer Program (CMM 16-2021) and CMM 18-2020 (Squid) with respect to Peruvian artisanal vessels less than 15 m in length that will be authorised and participate in jumbo flying squid fishery in the high seas, in the area of application of the SPRFMO Convention. The current measures and those that will be expanded for those artisanal vessels fishing in the Convention area are described.

127. The SC inquired on the number and type of vessels registered in the Commission Record of Vessels during 2020 and also 2021? It was clarified that the information was provided in document SC9-Doc22 (Table 1 and text in page 3). As of 30 June 2021, the Peruvian vessels authorised and registered in the Commission record of vessels were 100, including 93 purse seiners, 1 trawler/freezer, 2 multipurpose (purse seine/trawler), 1 support tanker and 3 scientific fishery research vessels. The only Peruvian vessel added to the Commission registry between 1 January 2020 and 30 June 2021, was the Peruvian scientific research vessel B.A.P. CARRASCO, that was included in the SPRFMO record of vessels on 16 November 2020. As of 1 July 2021 (after the closing date of SC9-Doc22), a total of 6 artisanal fishing vessels have been authorised and included in the SPRFMO registry of vessels authorised to fish in the Convention area. These are all liners-handliners, with lengths between 10.65 and 11.0 metres and gross tonnage between 14.02 and 19.6 t.

128. There was considerable interest in this programme which consists of three components, onboard observer data, observers in ports, and the third being the TrazApp phone application which acts like an electronic logbook which can collect GPS information and with which fishers can use to record fishing data while at sea. It can collect GPS data even when the vessel is on the high seas, but data will not be downloaded until the vessel returns to port. Peru is in negotiation to gain the licence for this app, which was developed by WWF. It is already used by a portion of the fleet, as it is useful for both the vessels and the companies but will soon become a condition of fishing.

129. Peru presented SC9-SQ04, the main results of the biological and fisheries monitoring of the jumbo flying squid *Dosidicus gigas* on board the artisanal fleet dedicated to its capture in Peruvian jurisdictional waters, which could also be extended to the area of application of the SPRFMO Convention. Reference is made to the abundant and valuable data and information that was collected through IMARPE scientific observers on board the large industrial squid fishing vessels that operated in Peruvian jurisdictional waters between 1999 and 2011. This contributed significantly to improve the current knowledge on the biology and fishery of the jumbo flying squid *D. gigas* in Peruvian jurisdictional waters and the adjacent high seas, as well as on its environmental preferences and interactions. Since 2012, all the jumbo flying squid catches in Peruvian waters are made by a large fleet of (more than 4,000) small artisanal fishing vessel. Since the operations of the large industrial fleet ceased, IMARPE developed a monitoring system for the jumbo flying squid fishery that included on-land as well as on-board observers to monitor the catches and fishing activities of the artisanal fleet. This on-board monitoring has been operational since September 2015 and this paper describes the main results of the observations made during this on-board monitoring of the artisanal jumbo flying squid fishery in Peruvian jurisdictional waters. The usefulness and feasibility of operating this type on-board monitoring system in Peruvian jurisdictional waters is highlighted, and the case is made that, with some minor adjustments, this on-board monitoring system being run by IMARPE can be expanded as needed, to achieve a larger coverage of artisanal vessels, including those that eventually may be authorised and start fishing for jumbo flying squid in the adjacent high seas, in the SPRFMO Convention area. It is also concluded that this IMARPE on-board monitoring would satisfy some of the main requirements set forth for artisanal fishing vessels less than 15 metres in paragraph 4 of the SPRFMO conservation and management measures CMM 16-2021 (SPRFMO Observer Programme).

130. The SC inquired about when the monitoring activities that were suspended in March 2020 would resume and if there was an alternative plan. Peru responded that the on-board monitoring described in SC-SQ04 that was suspended in March 2020 due to COVID19 related sanitary measures and was reinstated gradually and with due precautions since late 2020, as testing and then vaccination became available. At present, the on-board monitoring is operating in full, with the same number of pre-COVID on-board observers (12 total, routinely moving from one vessel to another). An alternative was in place for if on-board monitoring was not possible. IMARPE has a well-developed monitoring system for the jumbo flying squid fishery as described in document SC7-SQ09. It includes both, on-board observers as well as a capillary network of on-land observers (deployed in all the main landing sites). The in-port monitoring was also suspended temporarily due to COVID, but it resumed faster and was back in full operation six months later.

131. The SC was very interested in the results from this programme, and asked particularly about coverage by the app and by on-board Observers. On-board observer coverage is prioritised for vessels authorised to operate in the Convention area, so it is clear that the minimum 5% coverage requirement would be met. The Observers are independent from the vessel operators and are trained by IMARPE. Sixty to 70 vessels are currently using the app and the objective is to have the app on all vessels that are authorised to fish in the SPRFMO Area. Cross checking of information between the different sources will be possible in the future. Biological information is able to be collected both by on-board observers and by observations in port, although the port data collection is currently low (there are plans to increase sampling by use of agreements to ensure unprocessed squid are selected appropriately and brought back to port by the fisherman).

132. The SC evaluated the information presented so that it could advise the Commission on the suitability of the alternative scientific monitoring approach for carrying out the data collection contained in CMM16-2021 (Observer Programme) and in CMM 18-2020 (Squid), in a manner that ensures comparable coverage.

133. The SC:

> **recommended** that the programme was suitable and did meet the requirements detailed in paragraph 4 of CMM 16-2021 (Observer programme).

6.3 Assessment models for squid

134. At the third Squid Working Group meeting China presented SC9-SQ05, which describes a state-space production model for assessing squid stock. In this study, a state-space surplus production model is used to assess the jumbo flying squid stock in Southeast Pacific. The state-space model accounts for process and observation errors. The Bayesian approach is used to estimate parameters and biological reference points. The population dynamics of jumbo flying squid are highly sensitive to interannual environmental variations. Therefore, the assumption that the key parameters of the model are unique constants is possibly invalid. In this study, an attempt is made to identify two categories for key parameters (i.e., r and K). The categories are determined by sea surface temperature anomaly (SSTA) in the Nino 1+2 area. The results of the two model scenarios (hereafter traditional model and environmental dependent model) indicate that the biomass of jumbo flying squid in the terminal year (2018) is higher than B_{MSY} and the exploitation rate is lower than F_{MSY}.

135. At the third Squid Working Group meeting Ecuador presented SC9-SQ08 which is a proof of concept note for a stock assessment of jumbo flying squid in Ecuadorian waters using generalised depletion models. The flying jumbo squid fishery is one of the largest fisheries of the world and the largest invertebrate fishery. In the region of the South-East Pacific Ocean 20 (SEP) it is fished in four sub-regions: Ecuadorian, Peruvian and Chilean national jurisdictional waters, and international waters off those areas under national jurisdiction. In this meeting of OROP-PS, the CALAMASUR group is proposing a regional stock assessment model that includes flows among these sub-regions (SC9-Obs04). Therefore, the question arises: is there any evidence for flows of the stock among sub-regions? In this note this issue was investigated by modelling Ecuadorian catch, effort and mean weight data taken during 2018 using intra-annual generalised depletion models. The model runs on weekly time steps and the presence of pulses of abundance that enter the Ecuadorian sub-region is tested by fitting models with 1, 2, 3 and 4 pulses of abundance. Under the hypothesis that there are incoming pulses of abundance, the best model should have more than one pulse of abundance, while under the alternative hypothesis of no flows from outside the Ecuadorian sub-region, the best model should have just one pulse of abundance, the pulse corresponding to the annual recruitment of squids that grow to the size captured and retained by the fishing gears. SC9-SQ08 shows that the best model for the Ecuadorian weekly catch, effort and mean weight data is a model with three pulses of abundance, thus supporting the hypothesis in the conceptual proposal of SC9-Obs04.

136. At the third Squid Working Group meeting Observer organisation CALAMASUR presented SC9-Obs04 which is a conceptual proposal for a regional stock assessment of jumbo flying squid in the South Eastern Pacific. The

flying jumbo squid fishery is the largest invertebrate fishery in the world and one of the largest of the world even when including finfish fisheries. In the South East Pacific Ocean (SEP) it is fished in four regions: Ecuadorian, Peruvian and Chilean national jurisdictional waters, and international waters off those areas under national jurisdiction. In international waters, the main operators currently are China and Chinese Taipei and South Korea, and a Japanese fleet with substantial catches also operated until 2012. In recent years, efforts have been made toward sharing and standardising databases among countries fishing jumbo squid in the SEP. However, a common regional framework for stock assessment on the SEP is still lacking. Knowledge of abundance and productive capacity of Jumbo squid will allow moving forward to a regional management of the stock aiming at sustainability. A recent review of stock assessment for cephalopod fisheries argued that the best approach to assess cephalopod stocks involves innovative depletion models. In this note, we propose such a model to be applied at the SEP regional level building upon recent progress with a family of stock assessment methods called generalised depletion models. The proposal aims at building an elementary regional database of fisheries data to apply the model, as a first step in the direction of a regional stock assessment and management.

137. The Squid Working Group recommended that the SC pursue the collection of a joint dataset from all Members of Catch (kg), Effort (e.g. vessels, vessel days, hauls, hours) and (where available) mean weight by month and area. This joint dataset could be used by different stock assessment models and was a necessary first step in progressing some stock assessment modelling for jumbo flying squid in the SPRFMO area.

138. Some Members expressed an interest in accessing this joint dataset, and testing some models, but there was lack of agreement about what information was necessary for modelling, or whether modelling for the whole area is even appropriate at this time. Templates have been suggested in the past for different modelling approaches, some of which have more information requirements because of the complex dynamic and short lifespan of squid. The addition of information about maturity stages, mean weight and the identification of micro cohorts was also suggested. The importance of identifying the proportion of different phenotypes was stressed.

139. The SC recognised that the different fishing power of different vessels was important for obtaining a reliable measure of fishing effort. The SC recommended that the fishing effort workshop (originally related to CMM development) that had been proposed for 2020 and then 2021 be put back onto the workplan for 2022.

140. The SC noted it was necessary to have better temporal and spatial information on maturity in order to make possible the identification of the three different phenotypes that could present in the catches, because it is not possible to identify them based on mean weight only. The SC encouraged that members strive to improve the biological sampling levels and ensure that the spatio-temporal coverage is appropriate. The SC noted that the Commission had requested that the minimum observer coverage levels be reviewed at the latest, during the 2023 SC meeting.

141. The SC also discussed logistical issues about the template, as someone will need to take responsibility to collect the information and compile it and chase up missing information to ensure that the dataset is complete each year. The SC recalled that the Commission has been asking for a stock assessment so that advice can be supplied, and this template was intended to support a simple model as a first step to support some sort of advice.

142. The SC therefore:

> recommended the collection of a joint dataset from all Members of Catch (kg), Effort (e.g. vessels, vessel days, hauls, hours) and (where available) mean weight by month and area. This joint dataset could be used by different stock assessment models and was a necessary first step in progressing some stock assessment modelling for jumbo flying squid in the SPRFMO area.

143. The SC also:

> **recommended** using the full templates for biological and fishery data initially proposed in previous WG and SC meetings. The templates were proposed for different stock assessment models and did not constrain the data collection to that needed for one specific stock assessment model. The SC **noted** that some templates have been finalised and can be used for some assessment methods. The SC also **recommended** that any outstanding draft templates be agreed upon, aligned with stock assessment methods, and developed further prior to SC10.

144. The Squid Working Group initiated a discussion on a table of the advantages and disadvantages of the different proposed modelling approaches. The SC updated this table from an earlier version provided by Peru (SC-04-20) which is included as Annex 8 to this report. It was suggested that Members could consider the different modelling approaches. This could help guide model selection and data needs as they become available from the templates referred to in the previous paragraph. Members are encouraged to contribute updates to refine the table for regional applications.

6.4 Genetics and connectivity

145. At its first 2021 meeting, the Squid Working Group discussed the similarities and differences between the different squid genetics programmes within SPRFMO. A summary of this comparison is given in SC9-SQ02.

146. Chile presented SC9-SQ06, a study of the genetic diversity and population structure of *Dosidicus gigas* (Cephalopoda:Ommastrephidae) in the Pacific Ocean. Jumbo squid samplings were carried out in northern (Coquimbo), central (San Antonio and Quintay) and southern Chile (Lebu). The squid collected were large sized (> 60 dorsal mantle length) and most males were maturing and mature (stages II and III), while all females were immature (stage II). DNA extractions were conducted for the samples collected during this project. Preliminary results of mitochondrial cytochrome oxidase I (COI) gene sequences generated here were presented. The genetic diversity inferred from COI gene sequences was low, which is similar to previous studies. The genealogical network and pairwise comparisons suggested an absence of population structure comparing samples from the four localities along the northern, central and southern Chilean coast.

147. There was considerable discussion about this work. The small sample size was queried and whether the results are being influenced by sample size. It was also noted that the spatial extent of the study was quite limited and reasonably central; this was due to the characteristics of the fishery and the availability of squid for sampling. The SC also noted that smaller phenotypes had been found in oceanic waters a large distance from the coast and it was proposed that temperature at early life history stages could be influencing phenotype.

148. Peru presented the SC9-SQ07 Progress report on the genetic analysis of jumbo flying squid *D. gigas,* collected in different areas within the Peruvian jurisdictional waters (north, central and south; coastal and oceanic areas) during 2018 and 2019. Mature organisms of small (n=48) and medium-size (n=46) phenotypes were analysed. The mtDNA (ND2 and COI) genes and SNPs analysis with ddRAD-seq technique are being evaluated. Preliminary results of mitochondrial genes analysis were presented, comparing the genetic diversity between groups established according to different phenotypes (small and medium sizes), latitudinal (north, central and south) and longitudinal (coastal and oceanic) distribution. From the ND2 gene analysis, no genetic differences were observed between small and medium phenotypes, while the highest haplotype diversity was observed in oceanic organisms, and the highest nucleotide diversity from organisms collected in the central part of Peru marine area. In addition, the optimization of ddRAD-Seq protocol for the *D. gigas* library preparation using the EcoRI-HF and SbfI-HF restriction enzymes was presented, and further analysis are being performed for the evaluation of SNPs. Also, Peru mentioned that is continuing with sampling activities and recently (August 2021) got a few large-size phenotype organisms (mature stage III, from southern coastal area) that are being included into the genetic analysis.

149. Korea noted that its preliminary SNPs research also shows genetic difference between longitudinal samples which matched the pattern Peru had hypothesised to try to help explain the coastal vs oceanic differences. Peru suggested that this could be an area for future complementary work.

150. The importance of gathering samples from the whole range of squid species within the Convention Area was highlighted because otherwise it will be a struggle to determine stock structure due to the mobility and migratory behaviour of jumbo flying squid.

151. The SC:

> **recommended** that participants proceed to register obtained mtDNA (COI and ND2) sequences in a public nucleotide database (such as GenBank, https://www.ncbi.nlm.nih.gov/genbank/) with a minimum of information of the samples collected as shown in the template prepared during the meeting and included as Annex 9.

152. The SC also:

> **recommended** that the mtDNA sequences obtained by participants be used to elaborate a unique report describing the genetic diversity of the species based on both genes that can be analysed in a workshop to be held in 2022.

153. The SC discussed these papers, and it was noted that different Members appear to be using different techniques, for example different enzymes. It was suggested that although data is easier to exchange than samples, in the first instance sample exchange and the application of different techniques to the same samples may give further information about how big the differences are. A template was circulated asking Members with active squid genetics programmes what samples they could make available and what samples they were interested in. Three sample exchanges were identified, and relevant Members were invited to progress these exchanges intersessionally.

154. Peru noted that they had some concerns about genetic sample exchange, and felt that it was premature to enter into an exchange of samples. Several years ago the SC agreed on a sampling scheme and analytical methods, which would lead to the ability to exchange analysis results, but this process has not yet been completed. Peru would prefer to follow the process agreed originally.

155. **The SC noted** that there some issues with tissue exchanges among some Members.

6.5 CMM development

156. At the second meeting of the Squid Working Group, the Working Group agreed (SC9-Doc06_rev1) on a draft recommendation to the Commission to limit fishing effort in the squid fishery on the basis of the number of vessels and the total Gross Tonnage of squid jigging vessels Authorised as at 31 December 2020, with a note that coastal States should still be able to develop their fisheries, in a way for the Commission to decide.

157. **The SC noted** that, limiting effort based on Authorised vessels may allow effective effort to increase (measured as vessel Gross Tonnage) over that which fished. Some members noted that in practice, the potential for increase for some fleets might be low.

158. CALAMASUR noted that, based on data presented in "SC9-SQ01 For Teams_rev1.xlsx", limiting effort based on authorised vessels may allow an increase in effective effort (measured as vessel Gross Tonnage) over that which fished in 2020 of about 26%. Chinese Taipei responded that some historic figures of its fleet reflected in the above mentioned document were inconsistent with the data it has provided to the Secretariat, and has requested the Secretariat for further clarification after the SC meeting.

159. **The SC noted** that for some fleets, the number of active vessels may have been impacted by the COVID19 pandemic but overall, the number of active vessels in 2020 was higher than the previous two years of records.

160. After considerable discussion, particularly about whether the effort limit should be on the basis of active or authorised vessels, and about the way in which the sentence about coastal States should be worded, **the SC agreed to:**

> **recommend** that fishing effort in the squid fishery be limited by both the number of vessels and the total Gross Tonnage of squid jigging vessels Authorised as at 31 December 2020, with Members to confirm which of the vessels that were Authorised in the SPRFMO Record of Vessels at that date should be considered part of the squid fishery for this purpose.
>
> **The SC notes** that coastal States should still be able to expand or develop their fisheries, either with jigging or other fishing gear used to fish Jumbo Flying Squid, in a manner consistent with SPRFMO CMMs.

6.6 Advice to the Commission on Squid

161. The SC reviewed the current Squid aspects of the Multi-annual workplan and updated it.

7 Habitat Monitoring

7.1 Review of inter-sessional activities

162. A 1-day Habitat Monitoring Working Group workshop (SCW12) was held prior to SC9 from 20/21 September 2021, at which the Habitat Monitoring papers were presented and discussed in detail. The Workshop report is available on the SPRFMO website.

163. At SCW12 the EU presented SC9-HM01, Adapting the concept of metapopulations to large scale pelagic habitats. The authors observed a continuum in population organization schemes, from one single to several discrete populations, with two metapopulation cases: the “territory-bounded-habitat” (TBH) metapopulation, where each sub-population is confined in a “territory” surrounded by geographical borders that cannot be currently crossed, and the “environment-bounded-habitat” (EBH) metapopulation where the sub-populations live in moving areas only limited by the favourable conditions of the local environment. A pelagic metapopulation was defined as an EBH-metapopulation, in which most of the necessary conditions for metapopulation existence are fulfilled. EBH metapopulation characteristics were analysed for two case studies: triggerfish and jack mackerel. It was concluded that pelagic metapopulations represent an efficient evolutionary tool that makes local adaptations to changing environmental conditions possible, local adaptations being eventually extended to the whole species during the short episodes of synchronous life when all the sub-populations are connected.

164. The SC discussed whether questions of stock structure of a particular species came within the Terms of Reference of the Habitat Monitoring Working Group, and it was suggested that a recommendation be made that the Terms of Reference be clarified to emphasise the ecosystem modelling or essential habitat aspects of the subject, so that the working group did not end up taking on the question of Jack mackerel stock structure which is already on the Jack mackerel Working Group Workplan.

165. At SCW12 Peru presented SC9-HM02, Interannual variability of the habitat suitability of Jack mackerel in the Northern Peru Current System, 2011-2019. The authors built a Species Distribution Model through using the Random Forest method (RF) by month between 2011 and 2019. The RF has a 98% capacity to predict the observed habitat of jack mackerel concentrations available to the Peruvian industrial fishing fleet. Chlorophyll-a gradient was the most recurrent variable in predicting the habitat in different seasons of the year. After chlorophyll, temperature and salinity were the most important variables. Based on the results of habitat prediction, a seasonal pattern was observed, where in warmer months the probability values of presence of the fish were higher than during colder months. In addition, a high internal variability of the habitat was observed, which was computed using the Empirical Orthogonal Function (EOF) analysis. This interannual

variability is modulated by El Niño events, which were observed through the Oceanic Niño Index (ONI) for the Niño 1+2 region.

166. At SCW12 Peru presented SC9-HM03, Relationship between oceanic vorticity and catches of Jack mackerel (*Trachurus murphyi*) by the industrial purse-seine fishing fleet in Peruvian jurisdictional waters between 2011 and 2019. The authors studied the relationship between ocean vorticity and the availability of jack mackerel. It used satellite information on sea level anomaly (SLA) and georeferenced catch data from industrial purse seine vessels operating in Peru between 2011 and 2019. It used acoustic data from surveys performed by the Peruvian Marine Research Institute (IMARPE) along the Peruvian coast during 2011. To identify structures such as internal waves a wavelet analysis was used in order to demonstrate that zooplankton and fish were denser when oxygen minimum zone (OMZ) was deeper and geographically confined to the internal structures. Also catches were found invariably and positively correlated with the local abundance of macrozooplankton and with the location of the fronts between the cyclonic (divergent) and anticyclonic (convergent) eddies, so that ranges have been defined on the SLA values in order to be used in the habitat modelling of adult jack mackerel in Peru.

167. At SCW12 Peru presented SC9-HM04 regarding Habitat conditions for Jack and Chub mackerel in the Peruvian Sea Jan 2020 to Jun 2021. The authors described various analysed variables regarding the habitat of Jack mackerel and Chub mackerel, which permitted them to conclude that in 2020 and 2021 the oceanic conditions have been different from in previous years, where the only analysed parameter that remained similar is salinity. Another noticeable observation is that both species have been available to the fishing fleet in areas with decreasing gradient of the chlorophyll concentration and relatively high values of sea surface altimetry and its anomalies. In the case of Jack mackerel, its distribution was larger in the south, and less abundant in the north, while Chub mackerel showed a wider latitudinal availability. Finally, in recent years there has been a positive trend with respect to Jack mackerel availability, i.e., an increase towards average levels of abundance.

168. At SCW12 Peru presented SC9-HM05 a preliminary classification of the Peruvian fleet based on its acoustic data collection capabilities and with a proposal for its application to vessels operating in the Convention area. A preliminary classification has been adopted by SNP in Peru, which, among others, attempts to establish the number of vessels in each class, with an indication of the possible uses of the data each vessel can contribute, including the collection of biological information and data on the interactions between top predator species and the fleet.

169. At SCW12 EU presented SC9-HM06, two studies of Jack mackerel habitat, consisting of two sub-projects. Their first sub-project looked at whether patterns can be found between ENSO events (both La Niña and El Niño events) as reflected by observations in the Niño 3.4 region and the amount of commercial Jack mackerel (JM) catches in the Peruvian coastal fleet. The study found no relationship between catches and ENSO at any time lag. It was pointed out that preliminary analyses by IMARPE suggest that a different situation may be reflected for the Peruvian catches if the more coastal Niño 1+2 region and even more coastal indices are used.

170. The second sub-project in SC9-HM06 looked at the influence of habitat on fleet distribution. The EU reported that they were lacking available VMS data to progress the second sub-project as planned. An automated process has however been designed to retrieve environmental data that is relevant for studying the fleet distribution of the Jack mackerel fishery. Once VMS data is available, habitat preference of the fleet, variability herein and spatial distribution maps can be created as input for the SC.

171. At SCW12 Chile presented SC9-HM07 Space-time dynamics of the Jack mackerel fishery off south central Chile 2004-2021. During the year 2021 (January-July) there was a strong concentration of fishing activity of Chilean jack mackerel (*Trachurus murphyi*) within the coastal area of 60 nm of the coast as well as that recorded in 2020 from where 97% of the total industrial landing were landed, this was allowed by: a) the high level of commercial aggregation presented by the schools of jack mackerel near the coast; (b) the high recurrence of school sighting areas throughout this strip; c) the high abundance of schools, caused largely by the presence of areas of high biological productivity, and d) also because these specimens captured during this year largely

met the requirements (size and quality) of the industry for the production of by-products for human consumption, as observed in 2020. The few incursions into the ocean sector did not yield positive results, also the presence of a small fleet of trawlers outside the EEZ that searched for jack mackerel and finally maintained its operation between High Sea waters off Iquique and Antofagasta, and the results of the direct evaluation of jack mackerel 2021 that indicated that the resource was distributed mainly within the 60 nm strip confirming its coastal distribution, this breaks in part with the space-temporal dynamics traditionally recorded in past decades, in which commercial schools were observed to migrate to the ocean sector during June and July approaching the limit of the EEZ and outside it, which was registered in previous years by the national fleet and by the international fleet.

172. The SC noted that figures in this paper show that during the period of highest removals, fish were closer to shore than in later years, and then in recent years there again appear to be in dense schools close to the coast. The SC discussed the Workshop recommendation that the effect of this on the trip based Jack mackerel CPUE index might need to be evaluated, as it could cause bias.

173. At SCW12 Chile presented SC9-HM08_rev1 Spatial Distribution and Acoustic Habitat Monitoring of Chilean Jack Mackerel vessels 2021. Mean density estimates and spatial distribution obtained from acoustic data recorded by 6 vessels of the Chilean jack mackerel (CJM) fishing fleet in their usual fishing operations during year 2021 were estimated and compared with previous years. The abundance calculation was made for the years 2019, 2020 and 2021 based on a completely random sampling design through the geostatistical method. Acoustic data was collected with eco- integration systems that allow digital recording of the information during the entire trip of the vessels from the harbour to the fishing grounds and back to the harbour. During the fishing season of 2021 and unlike previous years, the CJM was located near the coast. It was also observed that the distribution of CJM expanded towards the north during the months of January, March, April and May, arriving near to Valparaíso. In June, July and August, CJM was observed near the port of Talcahuano. The highest acoustic densities were observed during the months of May and July. In 2021, the average densities obtained during almost every month were the highest in the series, except for 2019 with higher values in April. A bimodal condition was observed in the size structure of CJM with modes at 30 and 37 cm FL and a large contribution of specimens over 40 cm FL, evidencing a significant increase in specimen size of CJM, compared to previous years. An estimated abundance of 4,612 million individuals was calculated in 2021 representing a biomass of 3,217,169 tonnes (CV 3.79%). Estimated abundance and biomass represent a significant increase compared to 2020 that can be explained by a high density of schools in a reduced area of distribution and the increase in fish size. A comparison with the results obtained from the scientific acoustic survey conducted in the Central-South area between June and July 2021 was considered. An important decrease depending on the period considered for the estimation of biomass was obtained, in this case a decrease in the average densities between June and July of the year 2021 was observed. The estimated abundance of CJM only in June and July of 2021 was 1,857 million individuals, which represents a biomass of 1,295,440 tonnes (CV 3.77%).

174. The workshop noted that the maps presented show very clearly that there is a change in the concentration of schools which used to be more offshore, and are now closer into the coast. The working group considered the implication of this for trip based CPUE analysis and whether, if the schools are closer to the coast now, CPUE based on catch per trip might be artificially inflated by the fact that fish are now more accessible to the fishery. The workshop therefore recommended that the CPUE index be updated to evaluate this potential impact prior to the planned Jack mackerel benchmark assessment.

175. At SCW12 Chile presented SC9-HM09 Acoustic Equipment of the Purse Seine Fleet of Central-South Chile with the purpose to identify fishing platforms able to collect ecological data, this paper provides an inventory or updated list of the acoustic equipment in use by vessels participant in the Chilean Jack mackerel fishery of Central-South Chile. In year 2000 the Fishery Research Institute (Instituto de Investigación Pesquera, INPESCA) start recording acoustic information from fishing vessels operating in the Central-South fleet of Chile for research purposes, using SIMRAD EK-60 echosounders and ES-38 split beam transducers. Since 2012, there exist a register of acoustic equipment in use by vessels of the industrial fishing fleet targeting mostly on small pelagics and Chilean jack mackerel, which is updated annually. The vessels were separated according to their

acoustic equipment based on the type of echosounder. There are 29 vessels corresponding to 8 fishing companies, where most have acoustic equipment, mainly echosounders, which allow the recording and subsequent analysis of this information. It is important to highlight that a significant number of vessels are equipped with echosounders that allow the collection of digital data and the measurement of fish sizes, in order to develop good fishing practices.

176. The SC discussed the possible need for a shared repository for acoustic data, and there was some discussion about the logistical issues of dealing with such large datasets coming from different Members. **The SC noted** that in the first instance a "test case" repository holding only a sample of data might be developed. In this way the magnitude of such an undertaking can be evaluated.

7.2 Symposium update

177. The Symposium Steering Committee presented SC9-HM10, the draft Terms of Reference for the Habitat Monitoring Symposium planned for December 2022, which had been discussed at SCW12.

178. The SC reviewed the plan and Members were invited to provide comments for the development of a new version which would be developed after SC9.

7.3 Advice to the Commission on Habitat Monitoring topics

179. Based on reviews of the intersessional work from the HMWG **the SC:**

a. **agreed** that the Terms of Reference (ToR) for the two task Groups of the HMWG (for the review of assessment methods, and classification of fishing vessels according to their technological capabilities) are being developed;

b. **agreed** with the proposal of conducting a HMWG workshop testing different analytical methods to evaluate acoustic data from a common database;

c. **agreed** to creating a test-case repository for storage of acoustic data at SPRFMO, where SC members can contribute acoustic data and metadata to be used in the different quantitative exercises oriented to test different assessment methods to be reviewed by the HMWG, adopting the ICES metadata convention system (ICES 2016) in order to properly identify the collected acoustic data and its use for quantitative purposes;

d. **noted** that based on presentations from the working group meetings, research coming from the HMWG has applications to SPRFMO stocks. For example, the jack mackerel assessment uses Chilean CPUE based on (roughly) catch per trip. The HMWG showed that this may be problematic given data that the relative abundance has moved closer to the coast in recent years. The workshop recommended, and the SC supported, that the CPUE index be updated to evaluate this potential impact prior to the planned Jack mackerel benchmark assessment (~May 2022);

e. **noted** that the scope of the HMWG ToR includes activities contributing to defining habitat at a basic level, and at a more detailed level, to provide data useful for understanding hypotheses about a species population structure though defining population structure of species is a responsibility of the specific existent working groups. The HMWG is in the process of reviewing its ToR to clarify its functions so as to take into account that the JMWG is looking into those matters.

These activities, along with others, are included in the proposed SC multiannual workplan.

8 Exploratory fisheries

8.1 New Zealand Exploratory Toothfish Fisheries Operation Plan

180. At the first Deepwater Working Group meeting, to cover Exploratory fisheries issues, New Zealand presented SC9-DW01 and SC9-DW05 regarding their proposal for exploratory bottom longlining for toothfish by New Zealand vessels 2022-2024 noting that this builds on the previous exploratory fishery, adding new strata towards the East. The objective of the project is to use CPUE and depletion monitoring from the data collected to obtain a density estimate for the SPRFMO area, and at the end of the period a stock assessment and potentially a fishery.

181. There was discussion about the relationship between the SPRFMO and the CCAMLR research. This data will be integrated with data from CCAMLR, as there is evidence that there is a single stock or at least some connectivity across the whole of FAO area 88, and the edge of the SPRFMO area. There is a tagging programme in CCAMLR in the bordering area, and the situation in the CCAMLR area is not giving cause for concern. The catch limit in the SPRFMO area is very small compared to the estimated biomass of the CCAMLR stock. **The SC noted** that CCAMLR has defined reference points for toothfish which may be considered in SPRFMO given the joint management approach.

182. The SC asked a number of clarification questions about some of the figures quoted in the document such as how the maximum catch of 240 t was derived and whether the catch limit in Stratum O was sufficiently precautionary (in terms of bycatch species) given the low catches there in the past. What appeared to be a decline in catch rates in Stratum N was also noted. This constructive discussion led to the development of SC9-DW01_rev1. Overall, the SC felt that the proposal was of good quality, and appreciated the extended risk assessment.

183. On the basis of this discussion, **the SC:**

a. **noted** New Zealand's proposal and its Fisheries Operation Plan to extend its exploratory demersal longline fishery for toothfish (limited at 240 tonnes greenweight retained annually);

b. **recognised** the cautious, exploratory nature of the proposal;

c. **recognised** the scientific benefits of the proposed data collection, especially for understanding the distribution, movement, spawning dynamics, and stock structure of toothfishes and supporting the CCAMLR stock assessment models for Antarctic toothfish;

d. **agreed** that data and analyses from New Zealand's exploratory fishing continue to be shared in a timely manner with CCAMLR;

e. **agreed** that a spatial stratification consistent with CCAMLR's should be adopted by SPRFMO to facilitate the collection and sharing of data;

f. **approved** the Data Collection Plan included in the proposal;

g. **advised** the Commission that the proposal is acceptable in terms of Articles 2 and 22, CMM 13-2021 (exploratory fisheries), CMM 03-2021 (bottom fisheries), and the BFIAS.

8.2 Exploratory Fishery updates (Chile, Cook Islands, EU, NZ)

184. Chile briefly presented SC9-DW16, its Annual Report for Exploratory Fishing for Toothfish. Chile reports that it has not been possible to carry out the activities committed for 2021. The reason for this is due to the difficult situation affecting the company that owns the vessel that would carry out this fishery, which has been strongly affected by the crisis caused by the pandemic. The company has also informed that it will not be in a position to develop the exploratory fishery during 2022. Given these circumstances, Chile will explain to the

Commission the obstacles they face for the development of this exploratory fishery and will request to the Commission advice on how to proceed, it could mean waiting for the measure expire or ask for an early expiration of CMM 14d. Chile hopes that once the health and economic situation improves, it will be able to propose a new exploratory fishery.

185. The Cook Islands updated the SC on its progress in its Exploratory Fishery in its Annual Report SC9-Doc 26. The vessel only conducted one trip in 2020, and then became unavailable to continue operations. The Cook Islands are intending to bring another vessel to continue the fishing operations.

186. The EU reported in its Annual Report (SC9-Doc20) that there was no EU fishing activity in 2020.

187. At the first Deepwater Working Group meeting (to cover Exploratory fisheries issues) New Zealand presented SC9-DW04, the final report on NZ's exploratory fishery for toothfish noting in particular the importance of this research for the understanding of the relationship with the straddling stock in the CCAMLR area. Seven tags had been recovered in SPRFMO, of which one had been tagged in the CCAMLR zone. None of the fish tagged in SPRFMO had been recovered within CCAMLR.

8.3 Fisheries Operation Plan templates

188. At the first Deepwater Working Group to cover exploratory issues, the Deepwater Chair presented a template for Fisheries Operation Plans aimed to assist proponents to meet the requirements of CMM 13-2021. This had been requested by SC8 and the outline drafted by the Secretariat as requested by SC8.

189. The Cook Islands suggested adding a new section called "Overlapping fisheries" which would include information on any overlapping fisheries. This would include information on any fisheries operating in the same area with the same gear in the previous 10 years. This should outline any agreed co-operation with other SPRFMO Members or CNCPs. The SC asked that this be broadened to extend to overlapping fisheries both current and planned.

190. **The SC:**

> **agreed** that this template (SC9-DW03_rev1) will be a useful tool for developing Fisheries Operations Plans in future, and it was accepted by the SC and should be used for future FOPs.

9 Other Matters

9.1 Reappointment of Officers

191. The SC commended the work of the Chairperson and Vice-Chairperson of the SC and of the Working Group chairs. It was confirmed that both Dr James Ianelli (USA) and Dr Niels Hintzen (EU) were currently in the 1st year of a standard 2-year term, and both had indicated their willingness to continue in their respective roles. The SC warmly welcomed this news and was grateful that both would be able to complete their current terms.

192. Dr John Syslo (USA) was thanked for stepping in as interim Chair of the Deepwater Working Group and invited to take a permanent role. He accepted, pending discussions with his organisation. Martin Pastoors (EU), Dr Gang Li (CHN), Dr Mariano Gutiérrez (PER) and Dr Aquiles Sepúlveda (CHL) were re-confirmed in their roles with the Jack mackerel, Squid and Habitat Monitoring Working Groups.

193. Because of the heavy commitment required in the role of SC Chairperson, the SC discussed the possibility that in future a professional, independent Chair be employed. This depends on a decision of the Commission, but the SC was supportive of the idea if it became necessary.

194. **The SC noted** that in line with the standard term for Chairperson this item would be revisited in 2022.

9.2 Level and use of the Commission's scientific support budget item

195. The Executive Secretary presented SC9-Doc09, the current status of the Commission's scientific support budget, noting the difficulty in planning activities in the current pandemic environment, and indicating that the SC would again need to ask that the Commission agree to carry funds over to the next financial year above the level of the cap specified in the financial regulations.

196. The SC:

> **recommended** that the Commission consider removing the cap in the financial regulations noting that the current cap reduced flexibility to undertake multi-annual activities or adapt the timing of activities. The SC acknowledged that the cap was originally introduced to avoid developing significant surplus of unused scientific funds, however the SC considered this risk could be managed through the budget process.

9.3 Planned intersessional activities

197. The SC:

> **noted** how much work had been achieved this year at pre-SC web meetings and workshops, which had allowed many discussions to occur before SC9 started. **The SC recommended** that these web meetings continue in future years and that the SC formalise the status of these meetings in drafting recommendations to be considered by the SC at its annual meeting.

198. The SC:

> **requested** that in future years the pre-SC web meetings and workshops be planned well in advance to allow Members to organise their own work plans and budgets (e.g., SC9-Doc06_rev1). The additional workload on the Secretariat was recognised and the SC recognised that additional support for the Secretariat might be needed to enable this to happen, which could potentially be covered out of SC funds. **The SC recommended** that the Secretariat maintain a dynamic document accessible to members. To the extent practicable, it should be regularly updated with dates, locales, reports (if completed), and other relevant information.

199. The SC thanked the Secretariat, but especially the activities, support and dedication shown by the Data Manager (Ms Marianne Vignaux) both in the lead up to and during SC9.

9.4 Next meeting venue and timing

200. Future meeting plans are discussed in SC9-Doc10. Korea confirmed their offer to host in 2022 if an in-person meeting is possible. **The SC requested** the Secretariat to liaise with Korea regarding specific dates and location. The potential of in person workshops prior to the SC should also be considered.

201. **The SC requested** that the Secretariat contact Panama to see if they would be interested in taking up the opportunity to host a future SC due to the unfortunate circumstances that had prevented them from hosting the current meeting.

9.5 Chile's request for research into protection of the Salas y Gómez and Nazca ridges

202. Chile presented SC9-Doc31_rev1, their paper on the High Seas of Nazca and Salas y Gómez Submarine Ridges. The Salas y Gómez and Nazca ridges are two seamount chains of volcanic origin, which include over 110 seamounts that collectively stretch across over 2,900 km in the southeastern Pacific. Ecosystems in this region are isolated by the Atacama Trench, the Humboldt Current System, and an extreme oxygen minimum zone.

This isolation has produced a unique biodiversity that is marked by one of the highest levels of marine endemism. These areas also provide important habitats and ecological stepping stones for whales, sea turtles, corals, and a multitude of other ecologically important species, including 82 species that are threatened or endangered. This paper provides a synthesis of the relevant science that has been conducted on the Salas y Gómez and Nazca ridges, we recommend the SPRFMO SC carefully consider the scientific value of the information provided in this report and, evaluates if there is sufficient scientific evidence to recommend the Commission to proceed with further analyses, incorporating these ridges in the workplan of the SC in order to explore management and conservation options, including area-based measures.

203. Several delegates thanked Chile for their presentation and initiative. A number of questions were raised relating to the presentation from Chile, covering the following aspects: 1) the confusing terminology around Marine Protected Areas (MPA), Area-based measures and Conservation and Management Measures (CMM) while noting that SPRFMO is not mandated to impose MPAs; 2) the unclear link between the proposed protection measures and climate change; 3) the basis for the boundaries for the areas to be considered and whether there was any differentiation in the level of biodiversity in different parts of the areas; 4) whether there was any differentiation between different types of fishing in the area 5) whether effects of the current MPAs in the Chilean and Peruvian areas under national jurisdiction of the Salas y Gómez and Nazca ridges could be shared 6) the contradictory information on fishing effort in the area as evident from different tables in the document and 7) a lack of clearly articulated objectives outlining what any research in that area would be trying to achieve, or what direction any enhanced management in the area is envisaged that could direct future research. In addition, the SC asked what the final intention was of the document that was submitted to the SC.

204. Chile responded to the questions received and explained that the term MPA was only used in the introduction and not as part of the proposal itself. The boundaries of the areas were derived from the CBD designation (where they were hand drawn). The SC is invited (among other questions) to evaluate whether such area designation is appropriate. The contradictory information on fishing activities is derived from a recent publication and could be further investigated. Chile requests the SC to support a recommendation to progress science for the seamount areas. This would require specific research tasks to carry out in the future. Some ideas are to compare the situation in the seamount areas with other areas in SPRFMO. Sending a dedicated research vessel could be an option, but Chile wants to do it within the framework of the SPRFMO.

205. In principle Pew and DSCC supported the proposal to consider protection in this area, and HSFG clarified that the area was extensively fished in the late 1990s, by a number of methods, resulting in catches of alfonsinos and boarfish, while a Chilean research vessel undertook a survey in 1998.

206. **The SC noted** that before sending a recommendation to the Commission, discussion on a more specific potential research plan would be needed and consequently this was presented and made part of the Multi-annual Workplan of the SC.

207. It was clarified that research vessels involved in the location, collection or taking of fisheries resources in SPRFMO should be (as the vessel named in the proposal is) on the SPRFMO Record of Vessels. At this stage biological and oceanographical characterisation was planned.

208. **The SC agreed** that this work should be added to the SC Workplan, as part of the advice that the SC gives to the Commission.

9.6 Other Business

209. CALAMASUR tabled SC9-Obs03 which recognised the great efforts made by the members of the SC to meet before SC9 and stressed the crucial and imperative challenges that needed to be addressed. This paper noted a recent report by Global Fishing Watch warning SPRFMO of the potential impact of Illegal Unreported and Unregulated fishing on the outcomes and recommendations that might be made by the SC and the Commission, for example due to the potential of missing catch which could affect stock assessment models, particularly depletion studies.

210. Some Members noted that there were inaccuracies in the cited Global Fishing Watch report, and the SC agreed that this issue was largely outside of the SC area of responsibility.

9.7 Report adoption and Meeting Closure

211. The report was adopted at 16:37 (NZDT) on 3 October 2021. The meeting was closed at 16:40 on 3 October 2021 (NZDT).

Annex 1: Collated Scientific Committee Recommendations and Requests

Deepwater

With regard to a proposed plan for a 2022 industry acoustic survey on alfonsinos and redbait, **the SC:**

- **noted** the EU proposal and
- **agreed** that the research would be beneficial;
- **requested** some improvements to reduce risk, as discussed in SC, including in particular the use of a small research net, verification trawls to stay at least 50 m above the bottom at all times, and abide by an overall cap on catch in verification trawls of less than 200 t.
- Pending a revision of the research plan, **the SC could not achieve consensus** on approving this research without reviewing the new draft.

With regard to determination of optimal move-on distance in SPRFMO bottom fisheries, **the SC**:

- **noted** that an analysis has been provided detailing the effectiveness and impact of the current move-on distance in SPRFMO, and its comparison with other potential move-on distances to avoid additional encounters with VMEs;
- **noted** that the analysis was focused on stony coral reef habitat on the Louisville Seamount Chain, as it was the only available information suitable for this task at this time. Also notes that other taxa and areas could only be addressed in the future, when abundance models are available to perform such analyses (in particular, such models for 'slope' environments). Finally notes that abundance models are already included in the SC multi annual work plan for 2022;
- **Agreed to recommend** to the Commission that utilising the best available scientific information, for the stony coral *Solenosmilia variabilis* on the Central Louisville Seamount Chain, increasing the move-on distance from 1 to 5 nm would increase encounter avoidance by an additional 7% and reduce availability of the previously fished area by an additional 53%.

With regard to encounter thresholds for VME indicator taxa in the SPRFMO area, **the SC:**

- **Noted** that the candidate encounter thresholds for VME indicator taxa presented in Table 3 have been updated using the most up-to-date New Zealand bycatch data.
- **Recommended** to the Commission that the updated candidate encounter thresholds for VME indicator taxa presented in SC9-DW10 are used to inform any future refinement of the VME indicator taxa thresholds included in annex 6A and 6B of SPRFMO CMM 03-2021.
- Noting the need for the SC to provide more biologically meaningful guidance on appropriate VME thresholds, **recommended** to the Commission that it adds to the VME Encounters and Benthic Bycatch task in the SC Multi-Annual Work Plan a 2023+ subtask to develop a research programme within the SPRFMO Convention Area to allow the determination of taxon-specific estimates of catchability for VME indicator taxa
- **Recommended** that in the interim, the best available catchability estimates are used to improve the Commission's understanding of the implications of the current encounter thresholds with regard to preventing significant adverse impacts on VMEs.

Concerning the lists of VME Taxa, the SC:

- Noted that the lists of VME taxa presented in SC8-DW11 have been updated to take into consideration combinations of the FAO's VME criteria.
- Reaffirmed that the lists of VME taxa should be reviewed periodically and updated as necessary when better information on the taxa become available, so that taxa can be assessed against more VME criteria.
- Recommended discussion with the FAO and other RFMOs on the potential usefulness of different criteria combination approaches and how they could be standardised among RFMOs.

Regarding the review process regarding encounters with VMEs, the SC:

- Noted that a geodatabase with Habitat Suitability layers for 10 VME indicator taxa is held by the Secretariat and can be provided to Members and CNCPs to aid in the evaluation of encounters each year.
- Adopted the components of a process identified in SC9-DW08 as an interim protocol for the review of encounters with potential VMEs under CMM 03-2021.
- Agreed that this protocol be further developed intersessionally and as science advances or to reflect any changes to the CMM.
- Agreed to recommend to the Commission that it notes that SC9 has adopted an interim protocol for reviewing encounters.

With respect to the Member review of the VME encounter that occurred in 2020 on a New Zealand flagged vessel that was bottom trawling in the SPRFMO area (North Lord Howe Rise Fisheries Management Area) the SC:

- Noted New Zealand assessed the risk of SAI resulting from reopening the encounter area to be moderate at the spatial scale of the encounter area, low at the spatial scale of the Bottom Trawl Management Area and low at the spatial scale of the FMA.
- Noted that the Deepwater Working Group:
    i) Agreed that a high-density area of Gorgonian Alcyonacea indicating the presence of a VME which was impacted by fishing, and is likely to persist at this location;
    ii) Noted that available empirical evidence did not suggest the presence of other areas with high density of Gorgonian Alcyonacea (or combinations of other VME indicator taxa) being present near the encounter area;
    iii) Agreed that the risk of SAI resulting from reopening the encounter area to be high at the spatial scale of the encounter area and low at the spatial scale of the FMA;
    iv) Noted that reviews of future encounters would be improved by the explicit use of catchability to support more robust review outputs
- Noted the previous agreement from SC8 that, while the appropriate scale to assess and manage impacts on VMEs has not been defined in SPRFMO, the scale of the Fishery Management Areas is likely to be a more biologically appropriate scale at which to assess and manage SAIs on VMEs than larger scales;
- Noted that at the scale of the North Lord Howe Rise FMA, 82.8% of the Gorgonian Alcyonacea (based on PowerMean, unimpacted baseline from SC9-DW06_rev1) is afforded protection through the spatial management regime acknowledging the uncertainty in the underlying habitat suitability models;

- Noting that the Commission is still deliberating on appropriate levels of protection; the SC recommended that:
    i) If assessing SAI on VMEs at the scale of FMAs, reopening the Encounter Area would likely not result in SAI on VMEs; and
    ii) If assessing SAI on VMEs at the scale of the Encounter Area, reopening the Encounter Area may result in SAIs on VME.

With regards to the CMM03 request that at its annual meeting in 2021, the Scientific Committee shall review and provide advice on the effectiveness of the applied management measures,

- The SC agreed that work had progressed in a number of areas in relation to addressing the ongoing effectiveness of management measures as requested by CMM03.

The SC considered an addendum to the Cumulative BFIA for Australian and New Zealand bottom fisheries in the SPRFMO Convention Area 2020, which was presented and agreed at SC8. The addendum details missing information on the current protection levels afforded in the Westpac Bank area.

- The SC agreed that to provide the best scientific advice available, the BFIA should be supplemented with this new information.

Regarding the development of spatial management scenarios for bottom trawling, the SC:

- Noted the metrics used to assess the protection levels for VME indicator taxa, ROC 0-linear and Power Mean, are representative of the metrics spectrum presented in the BFIA.
- Noted that protection level assessment was completed for all protection levels using both temporally static and a temporally dynamic methods, as requested by the Commission.
- Agreed that the approach taken to develop spatial management protection scenarios and report on their performance is appropriate and work will continue intersessionally to refine scenarios to meet all protection targets for presentation to Commission.
- Recommended that the Commission consider the results of the spatial protection scenarios including to inform its determination of the level of protection required to prevent SAI on VMEs in the SPRFMO Convention Area
- Noted that ecologically relevant spatial scales for assessing protection levels to prevent SAIs on VME indicator taxa still remain to be agreed, but that the existing information at the FMA is likely to be a more biologically appropriate compared with larger scales.

Regarding the development of a framework for providing advice on species of concern captures the SC:

- Adopted the proposed set of guidance as a framework for providing scientific advice on the capture of seabirds, marine mammals, reptiles and other species of concern.
- Noted the potential of electronic monitoring (EM) as a relevant data source for providing scientific advice on such captures and for improving the quality of fishery dependent (logbook) data.
- Recommended the Commission notes the four different types of advice (Table 1 from SC9-DW13) that can be sought from SC on the capture of seabirds, marine mammals, reptiles and other species of concern, and associated resourcing and other implications related to the data required to provide different types of scientific advice, as outlined in this framework.

Jack Mackerel

The SC:

- Recognised the need for a comprehensive research plan to improve the understanding of origin and admixture of populations or subpopulations of jack mackerel in the Southern Pacific.
- Recommended that a Jack mackerel ageing analysis task group could be initiated (terms of reference are in the body of the report).
- Recommended that a protocol be developed on how the self-sampling data could be integrated with the observer data for consideration at the Benchmark workshop.
- Recommended a precautionary 15% increase in 2022 catches throughout the range of Jack mackerel- at or below 900 kt. This advice for catch limits in 2022 does not depend on the stock structure hypothesis that is used.
- Recommends that a Jack mackerel benchmark workshop be held in 2022 (a final terms of reference will be developed prior to COMM10).

Squid

Following Peru's presentation of an alternative to the Observer Programme for Peruvian artisanal vessels the SC:

- Recommended that the programme was suitable and did meet the requirements detailed in paragraph 4 of CMM 16-2021 (Observer programme).

Under assessment models for squid, the SC:

- Recommended the collection of a joint dataset of Catch (kg), Effort (e.g., vessels, vessel days, hauls, hours) and (where available) mean weight by month and area from all Members. This joint dataset could be used by different stock assessment models and was a necessary first step in progressing some stock assessment modelling for jumbo flying squid in the SPRFMO area.
- Recommended using the full templates for biological and fishery data initially proposed in previous WG and SC meetings. The templates were proposed for different stock assessment models and did not constrain the data collection to that needed for one specific stock assessment model. The SC noted that some templates have been finalised and can be used for some assessment methods. The SC also recommended that any outstanding draft templates be agreed upon, aligned with stock assessment methods, and developed further prior to SC10.

Under genetics and connectivity, the SC:

- Recommended that participants proceed to register obtained mtDNA (COI and ND2) sequences in a public nucleotide database (such as GenBank, https://www.ncbi.nlm.nih.gov/genbank/) with a minimum of information of the samples collected as shown in the template prepared during the meeting and included as Annex 9.
- Recommended that the mtDNA sequences obtained by participants be used to elaborate a unique report describing the genetic diversity of the species based on both genes that can be analysed in a workshop to be held in 2022.

In terms of CMM development, the SC:

- Agreed to recommend that fishing effort in the squid fishery be limited by both the number of vessels and the total Gross Tonnage of squid jigging vessels Authorised as at 31 December 2020, with Members to confirm which of the vessels that were Authorised in the SPRFMO Record of Vessels at that date should be considered part of the squid fishery for this purpose.
- Notes that coastal States should still be able to expand or develop their fisheries, either with jigging or other fishing gear used to fish Jumbo Flying Squid, in a manner consistent with SPRFMO CMMs.

Habitat Monitoring

The SC:

- agreed that the Terms of Reference (ToR) for the two task Groups of the HMWG (for the review of assessment methods, and classification of fishing vessels according to their technological capabilities) are being developed;
- agreed with the proposal of conducting a HMWG workshop testing different analytical methods to evaluate acoustic data from a common database;
- agreed to creating a test-case repository for storage of acoustic data at SPRFMO, where SC members can contribute acoustic data and metadata to be used in the different quantitative exercises oriented to test different assessment methods to be reviewed by the HMWG, adopting the ICES metadata convention system (ICES 2016) in order to properly identify the collected acoustic data and its use for quantitative purposes;
- noted that based on presentations from the working group meetings, research coming from the HMWG has applications to SPRFMO stocks. For example, the jack mackerel assessment uses Chilean CPUE based on (roughly) catch per trip. The HMWG showed that this may be problematic given data that the relative abundance has moved closer to the coast in recent years. The workshop recommended, and the SC supported, that the CPUE index be updated to evaluate this potential impact prior to the planned Jack mackerel benchmark assessment (~May 2022);
- noted that the scope of the HMWG ToR includes activities contributing to defining habitat at a basic level, and at a more detailed level, to provide data useful for understanding hypotheses about a species population structure though defining population structure of species is a responsibility of the specific existent working groups. The HMWG is in the process of reviewing its ToR to clarify its functions so as to take into account that the JMWG is looking into those matters.

Exploratory Fisheries

Following discussions about New Zealand's SC9-DW01_rev1 and SC9-DW05, regarding their proposal for exploratory bottom longlining for toothfish 2022-2024, the SC:

- noted New Zealand's proposal and its Fisheries Operation Plan to extend its exploratory demersal longline fishery for toothfish (limited at 240 tonnes greenweight retained annually);
- recognised the cautious, exploratory nature of the proposal;
- recognised the scientific benefits of the proposed data collection, especially for understanding the distribution, movement, spawning dynamics, and stock structure of toothfishes and supporting the CCAMLR stock assessment models for Antarctic toothfish;

- agreed that data and analyses from New Zealand's exploratory fishing continue to be shared in a timely manner with CCAMLR;
- agreed that a spatial stratification consistent with CCAMLR's should be adopted by SPRFMO to facilitate the collection and sharing of data;
- approved the Data Collection Plan included in the proposal;
- advised the Commission that the proposal is acceptable in terms of Articles 2 and 22, CMM 13-2021 (exploratory fisheries), CMM 03-2021 (bottom fisheries), and the BFIAS.

Regarding the template for Fisheries Operations Plans requested by SC8, the SC:

- agreed that this template (SC9-DW03_rev1) will be a useful tool for developing Fisheries Operations Plans in future, and it was accepted by the SC and should be used for future FOPs.

Other Matters

The SC:

- Recommended that the Commission consider removing the cap in the financial regulations noting that the current cap reduced flexibility to undertake multi-annual activities or adapt the timing of activities. The SC acknowledged that the cap was originally introduced to avoid developing significant surplus of unused scientific funds, however the SC considered this risk could be managed through the budget process.
- The SC noted how much work had been achieved this year at pre-SC web meetings and workshops, which had allowed many discussions to occur before SC9 started. The SC recommended that these web meetings continue in future years and that the SC formalise the status of these meetings in drafting recommendations to be considered by the SC at its annual meeting.
- The SC requested that in future years, the pre-SC web meetings and workshops be planned well in advance to allow Members to organise their own work plans and budgets (e.g., SC9-Doc06_rev1). The additional workload on the Secretariat was recognised and the SC recognised that additional support for the Secretariat might be needed to enable this to happen, which could potentially be covered out of SC funds. The SC recommended that the Secretariat maintain a dynamic document accessible to members. To the extent practicable, it should be regularly updated with dates, locales, reports (if completed), and other relevant information.

Annex 2: SC9 List of Participants

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Annex 3: SC9 Meeting Agenda

1) OPENING OF THE MEETING	Documents
a) Adoption of Agenda	SC9-Doc01_rev3, SC9-Doc02_rev1
b) Meeting Documents	SC9-Doc03_rev2
c) Nomination of Rapporteurs	
d) Meeting programme and timetable	SC9-Doc04_rev1
2) ANNUAL REPORTS DISCUSSION	(via email/Teams) SC9-Doc14 to 30
3) COMMISSION GUIDANCE AND INTER-SESSIONAL ACTIVITIES	
a) SC multi-annual workplan	SC9-Doc05
b) Review of intersessional SC meetings	SC9-Doc06_rev1,
c) Secretariat SC related activities	SC9-Doc07,08,11,12,13
4) JACK MACKEREL	
a) Review of inter-sessional activities	SC9-JM04,05,06,08
b) Management Strategy Evaluation update	SC9-JM03
c) Assessment data review and evaluation	SC9-JM01,02
d) SPRFMO Jack mackerel assessment	
e) Advice to the Commission on Jack mackerel	
5) DEEPWATER	
a) Review of inter-sessional activities	SC9-DW14,15, Obs02
b) VME Encounters and benthic bycatch (*including potential move on distance*)	SC9-DW07,10,11,12
c) CMM 03 request regarding encounters with VMEs (*including reported VME encounters*)	SC9-DW08,09_rev1
d) CMM 03 request regarding ongoing appropriateness	
e) Bottom Fishery Impact Assessment review (*including protection scenarios*)	SC9-DW02,06_rev1
f) CMM 03 request regarding species of concern	SC9-DW13
g) Advice to the Commission on Deepwater	
6) SQUID	
a) Review of inter-sessional activities	SC9-SQ01_rev1, 05,08, Obs 04
b) Genetics and connectivity	SC9-SQ02,06.07
c) CMM development	SC9-SQ03, SQ04
d) Advice to the Commission on Squid	
7) HABITAT MONITORING	
a) Review of inter-sessional activities	SC9-HM01-07, SC9-
b) Symposium update	HM08_rev1, SC9-HM09
c) Advice to the Commission on Habitat Monitoring topics	SC9-HM10
8) EXPLORATORY FISHERIES	
a) New Zealand Exploratory Toothfish Fisheries Operation Plan	SC9-DW01,05
b) Exploratory Fishery updates (Chile, Cook Islands, EU, NZ)	SC9-DW16, SC9-DW04
c) Fisheries Operation Plan templates	SC9-DW03
9) OTHER MATTERS	
a) Appointment of Officers	
b) Level and use of the Commission's Scientific Support budget	SC9-Doc09
c) Planned Inter-sessional activities	
d) Next meeting venue and timing	SC9-Doc10
e) Chile's proposal for a SPRFMO Marine Protected Area	SC9-Doc31_rev1
f) Other business	SC9-Obs01,03
10) REPORT ADOPTION AND MEETING CLOSURE	

Annex 4: SC9 Meeting Schedule

Timetable with start times for 3-hour sessions

(Days relative to date in Seattle, USA)

Location	Session 1 (3 hours)	Session 2 (3 hours)	Time Zone
Rarotonga, Cook Islands	Day X at 03:00 am	Day X at 03:00 pm	CKT
Honolulu, United States of America	Day X at 03:00 am	Day X at 03:00 pm	HST
Seattle, United States of America	Day X at 06:00 am	Day X at 06:00 pm	PDT
Guayaquil, Republic of Ecuador	Day X at 08:00 am	Day X at 08:00 pm	ECT
Lima, Republic of Peru	Day X at 08:00 am	Day X at 08:00 pm	PET
Panama City, Panama	Day X at 08:00 am	Day X at 08:00 pm	EST
La Havana, Cuba	Day X at 09:00 am	Day X at 09:00 pm	CDT
Santiago, Republic of Chile	Day X at 10:00 am	Day X at 10:00 pm	CLST
Tórshavn, Kingdom of Denmark in respect of Faroe Islands	Day X at 02:00 pm	Day X+1 at 02:00 am	WEST
Amsterdam, Netherlands, European Union	Day X at 03:00 pm	Day X+1 at 03:00 am	CEST
Moscow, Russian Federation	Day X at 04:00 pm	Day X+1 at 04:00 am	MSK
Shanghai, People's Republic of China	Day X at 09:00 pm	Day X+1 at 09:00 am	CST
Taipei, Chinese Taipei	Day X at 09:00 pm	Day X+1 at 09:00 am	CST
Seoul, Republic of Korea	Day X at 10:00 pm	Day X+1 at 10:00 am	KST
Canberra, Australia	Day X at 11:00 pm	Day X+1 at 11:00 am	AEST
Port Vila, Vanuatu	Day X at 12:00 Mid	Day X+1 at 12:00 Noon	VUT
Wellington, New Zealand`	Day X+1 at 02:00 am	Day X+1 at 02:00 pm	NZDT

Legend: SC General | Jack mackerel | Deepwater | Squid | Habitat | Exploratory

Date (Day X)	Session 1 (3 hours)	Session 2 (3 hours)
Day 1: 27 September 2021 (PDT Timezone– Seattle, USA)	1) Opening of the meeting 2) Annual reports (taken as read) 3) Commission guidance and Inter-sessional activities 3a) SC multi-annual workplan 3b) Review of intersessional SC meetings 3c) Secretariat SC related activities 9e) Chile's proposal for a SPRFMO MPA	Deepwater 5a) Review of inter-sessional activities 5b) VME encounters and benthic bycatch 5c) CMM 03 request regarding encounters with VMEs 5e) Bottom Fishery Impact Assessment Review 5f) CMM 03 request regarding species of concern
Day 2: 28 September 2021 (PDT Timezone– Seattle, USA)	Jack mackerel 4a) Inter-sessional activities 4b) Management Strategy Evaluation update 4c) Assessment data review and evaluation	Squid 6a) Review of inter-sessional activities 6c) CMM development
Day 3: 29 September 2021 (PDT Timezone– Seattle, USA)	5a) Proposed 2022 industry acoustic survey on alfonsinos and redbait	Deepwater 5d) CMM 03 request regarding ongoing appropriateness 5g) Advice to the Commission on Deepwater
	Habitat monitoring 7a) Review of inter-sessional activities 7b) Update on Symposium 7c) Advice to the Commission on Habitat Monitoring topics	Squid 6b) Genetics and connectivity 6d) Advice to the Commission on Squid
Day 4: 30 September 2021 (PDT Timezone– Seattle, USA)	4d) SPRFMO Jack mackerel assessment 4e) Advice to the Commission on Jack mackerel	Exploratory Fisheries 8a) New Zealand Exploratory Toothfish Fisheries Operation Plan 8c) Exploratory Fishery updates (Chile, Cook Islands, EU, NZ) 8d) Fisheries Operation Plan templates
Day 5: 01 October 2021 (PDT Timezone– Seattle, USA)	Other matters 9f) Other Business 9a) Appointment of Officers 9b) Level and use of the Commissions' Scientific Support budget 9c) Planned inter-sessional activities 9d) Next meeting venue and timing	Outstanding issues Including any issues identified in the text of the DRAFT report
Day 6: 02 October 2021 (PDT Timezone– Seattle, USA)	10) Report adoption	10) Report adoption and meeting closure

Annex 5: Pre-meeting Questions and Responses on Annual Reports

Questions on Chile's annual report

a. European Union asked Chile whether more information could be provided on how their Electronic Monitoring System is being used in practice (e.g. number of vessels, handling of the data, reporting on outcomes etc).

   - At the second Jack Mackerel Working Group Chile explained that this system was composed of both a tablet on board so that vessels could report their data manually (Electronic Reporting) as well as a set of cameras on board recording footage that can be reviewed at a later stage. As it is a new system Chile agreed to do a presentation at SC10 once they have had more experiences with how the system is working.

Questions on China's annual report

a. Chile asked China a number of questions about their squid fishery, and their 2020 Observer programme. Were there any changes in jigging gear required to fish large squid or is it just a change in size availability by fishing ground?

   - The jigging gear were the same as before and the size availability did not necessarily change. A higher ratio of large squid presented showed that the sampling design of the Observer and studying fleet are more representative than in previous years.

b. Where were large squid caught in 2019 and 2020?

   - High seas off Peru

c. Having the proportion of different maturity stages by squid length, how do you identify different phenotype individuals when maturing stages were stage I or II?

   - We estimated the frequency of maturity stages as well as the sex-specific mean mantle length of each stage. However, the information mentioned above are divided into two groups, small plus medium phenotype (Fig 9) and large phenotype (Fig 10). Samples derived from equatorial waters are small phenotype, however we cannot distinguish which phenotypes the samples are when maturing stages were stage I or II and mantle length smaller than the criteria from Csirke et. al (2018). For large squid, it's easy to identify the phenotype according to the mantle length whatever the maturity stage, because the mantle length of the samples is bigger than 50 or 55 cm. Of course, the ratio of small and medium phenotype might be overestimated and vice versa.

d. Is it possible to confirm the presence of the three genotypes, or different sizes belonging to the same large phenotype, or both situations?

   - It depends on where the samples were taken and what the maturity stage was. In the equatorial waters and inside/outside Chile waters, we can confirm the phenotypes, but inside/outside Peru waters we can only use the mature squid to confirm the phenotype.

e. Is it possible to estimate the whole Chinese catch in numbers by phenotypes?

   - Yes, it's possible in theory. We can try that in future.

f. What is the proportion of whole fishing days during 2020 that were sampled for biological data?

   - We didn't collect this statistic in terms of actual fishing days, the approximate estimation is about 1-2%. It can be estimated in future.

g. What is the proportion of whole fishing days during 2020 that was sampled for catch and effort data?

- If this question is referring to the Observer and Studying fleet, then again we didn't collect this statistic in terms of actual fishing days, but the approximate estimate is about 1-2%. Besides collecting biological samples and data, Observers and Studying fleet are required to report date, position and catch.

h. How is the procedure during 2021 and 2022 for the compliance of the Conservation and Management Measure 18-2020 since the number of observed reported do not meet the 5% or 5 full-time observers. The previous question is because we noted that only 300 fishing days are monitored. This number is equivalent to 0.25% of the total fishing days reported and only 2 observers were reported.

- This is the first time that observers have been dispatched officially in the squid jigging fishery since CMM 18-2020 entered into force in 2021. As required by the CMM, the coverage rate should be 5% or 5 full time at sea observers, however, this has been an impossible mission under the circumstances of the COVID-2019 global pandemic. Some crucial aspects such as recruitment, training and dispatching had been restricted or greatly limited, and many candidates didn't want to work on board during the outbreak. In the end, only two experienced observers were recruited and willing to perform the tasks of the Observer Programme.

Questions on Ecuador's annual report

a. Chile had a question about Ecuador's Annual Report in which squid were categorized by size class according to the stage of sexual maturity, that is, small (14-24 cm ML), medium (25-39 cm ML) and large (40-50 cm ML). Since there were no mature squids (stage IV), what was the classification criterion? Is there any relation to small, medium and large phenotypes?

- Ecuador replied that Squid were categorized by size class according to maturity stage by sex, that is, small (14-24 cm ML), medium (25-39 cm ML) and large (40-50 cm ML). Since there were no mature squid (stage IV).

b. Regarding the Classification criterion, in the works to describe the population structure of the giant flying squid in Ecuadorian waters in the period 1979 and 2021, the monthly and/or annual variability in the size structure was analysed according to the availability of information, showing differences in sexual maturity and in the structure of sizes in female and male organisms combined.

- In the 2019 and 2020 fishing season in the Gulf of Guayaquil, high proportions of immature individuals (stage I) were recorded in small sizes (14-24 cm ML), followed by organisms in the maturing stage (stage II) composed of Medium-sized individuals (25-39 cm ML), while sexually mature individuals (stage III) were observed to a lesser extent in large sizes (40-50 cm ML), with the absence of spawning organisms (stage IV), which shows that the Gulf of Guayaquil does not correspond to a special breeding area.

- The small, medium, and large phenotypes show slight changes in skin color and pigmentation and an increase in muscle mass.

c. Chile asked Ecuador whether the fishing gear "Jars" could be clarified? Could Ecuador please explain what kind is this fishing gear indicated on page 1 of SC9-Doc19?

- Ecuador replied that this species is seasonally distributed in Ecuadorian waters. Temporary changes in the availability of the resource are determined by the Humboldt Current System.

- In the 2019 and 2020 fishing season, the giant squid was caught in the Gulf of Guayaquil in directed fishing with hand lines and jars (Jigging); and incidental fishing with surface gillnet, according to the availability of the resource. The fishing effort was carried out by artisanal vessels with outboard motors established in the fishing ports of Santa Rosa and Anconcito, where there are processing plants for seafood.

- Artisanal vessels in the months of greatest availability of giant squid (July to October), increased the effort in directed fishing with hand line and jigging, while in the low season (January-April) and medium (May-June / November-December), increased bycatch of giant squid with the surface gillnet.
- It should be noted that in the mid and high season many artisanal vessels carry out multipurpose fishing activities using the surface gillnet and hand lines with manual jigging. Incidental catches of giant squid were also recorded this fishing season with the industrial purse seine and the multipurpose trawl.

Questions on Korea's annual report

a. Chile asked Korea a number of questions about their Annual Report (SC9-Doc17). Is there any explanation for the maximum CPUE at 2015 and the later decline in Figure 4?
   - Only two jigging vessels operated in 2015 (Table 3). They operated only four months of the year; January, October, November, and December. The monthly catch in November and December 2015 were more than twice that in same months of 2016. We do not know why the catch was high and their fishing area was very similar and occurred in limited area. We would like to know what makes the decline after 2015, too.

b. How do fishing grounds change by year?
   - No, fishing grounds haven't changed much in the last five years, mainly aggregated in 15~20S. We will consider adding the jigging fishing ground maps in the Annual report from next year.

c. Is there any relationship between the two groups (K=2) and squid length frequencies or phenotype?
   - The size frequencies of two groups have no significant size difference. A sample group with high red population (>90%) was similar in size with the other sample group with high yellow population (>90%).

d. Is it possible to estimate the whole catch Republic of Korea in numbers by phenotypes?
   - No, the jigging vessels only report the total catch, so the size information can only be collected by observers.

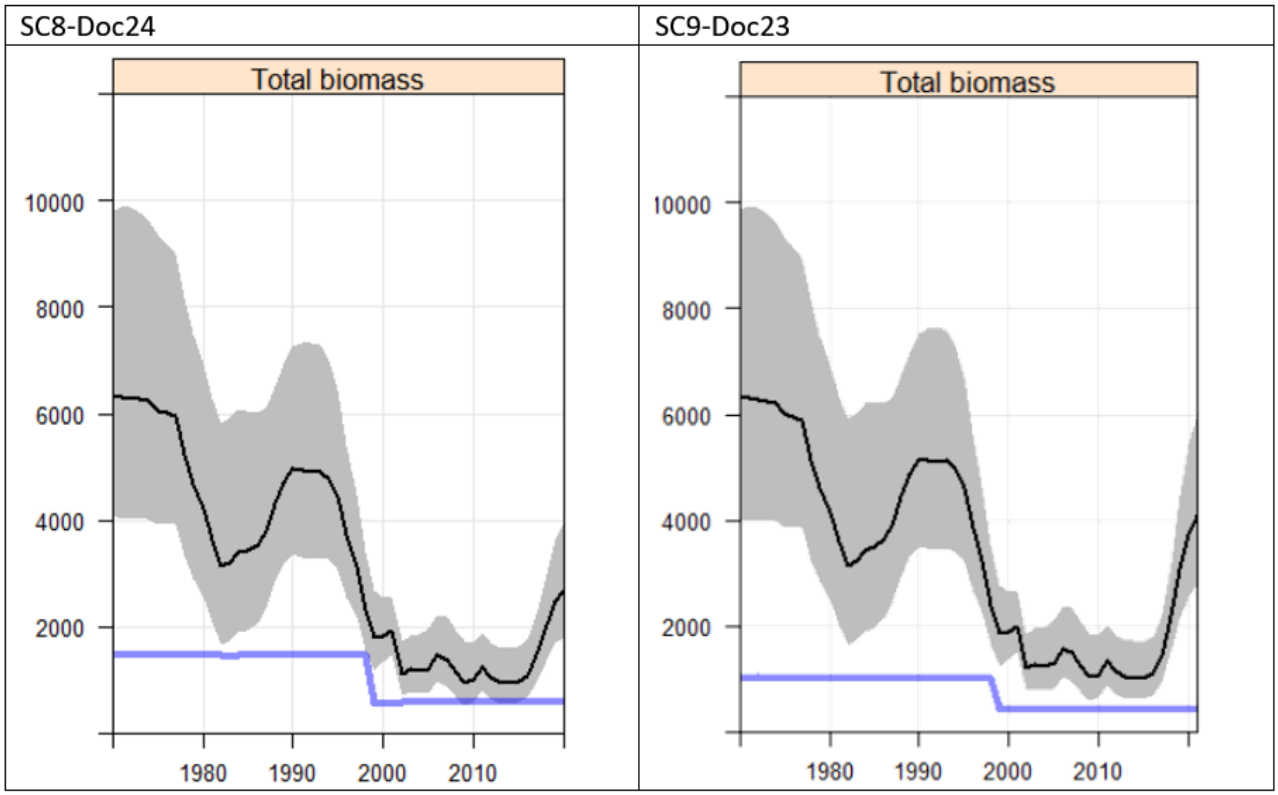
Questions on Peru's annual report

a. European Union asked Peru a number of questions related to SC9-Doc23 in which figure 18 gives the updated CPUE time series of Jack mackerel *Trachurus murphyi* caught in Peruvian jurisdictional waters by the industrial and the artisanal and small-scale fleets between 2002 and 2021. The CPUE for 2020 that is estimated in June 2021 is almost double of the CPUE that was estimated in December 2020.

b. Can the difference between those two estimates be explained?

c. Is this based on modelled CPUE, and if so, how?

- Figure 20 gives the output of the final configuration of the JJM model for the northern stock. Below a comparison is made between the total biomass estimated in SC8-Doc24 and SC9-Doc23. The apparent increase in total biomass is more pronounced in the SC9-Doc23 assessment.



d. How can that result be explained given the data and assumptions that are used in the assessment? Could a comparison be presented between the assessment in SC9-Doc23 and the final assessment (two-stock model) of SC8?

- Peru replied that the difference between the two 2020 CPUEs and the updated 2021 CPUE in figure 18 is explained in the body of the SC9-Doc23 report (pages 24-25), where we explain that:
- "It is noted that the updated 2021 CPUE (updated to June 2021) is much higher than the 2020 CPUE, which is also a bit higher than the 2019 CPUE. This is consistent with the increasing trend in monthly CPUE indexes from both industrial fleet and particularly from the group of artisanal and small-scale fleets since 2018, as shown in figure 14. It is also noted that the 2020 CPUEs estimated in June 2020 and in December 2020 are much lower than the 2020 CPUE estimated with this recent June 2021 update. This is because the June 2021 update included the complete data from the industrial and artisanal and small-scale fisheries up to June 2021, while the December 2020 update included the complete data from the industrial fleet and only partial and/or incomplete data from the artisanal and small-scale fleets for the second semester of 2020, which were much higher than during the first semester. Neither of the higher monthly CPUEs observed during the second semester of 2020 were represented in the June 2020 CPUE update"
- Additional information was provided by Peru that responded to additional questions that arose during SC9. This information was presented in SC9-WP05, and additional context was provided in SC9-WP05_rev1 after the meeting.

e. European Union had a follow up question for Peru regarding the reference points used in Peru's model.

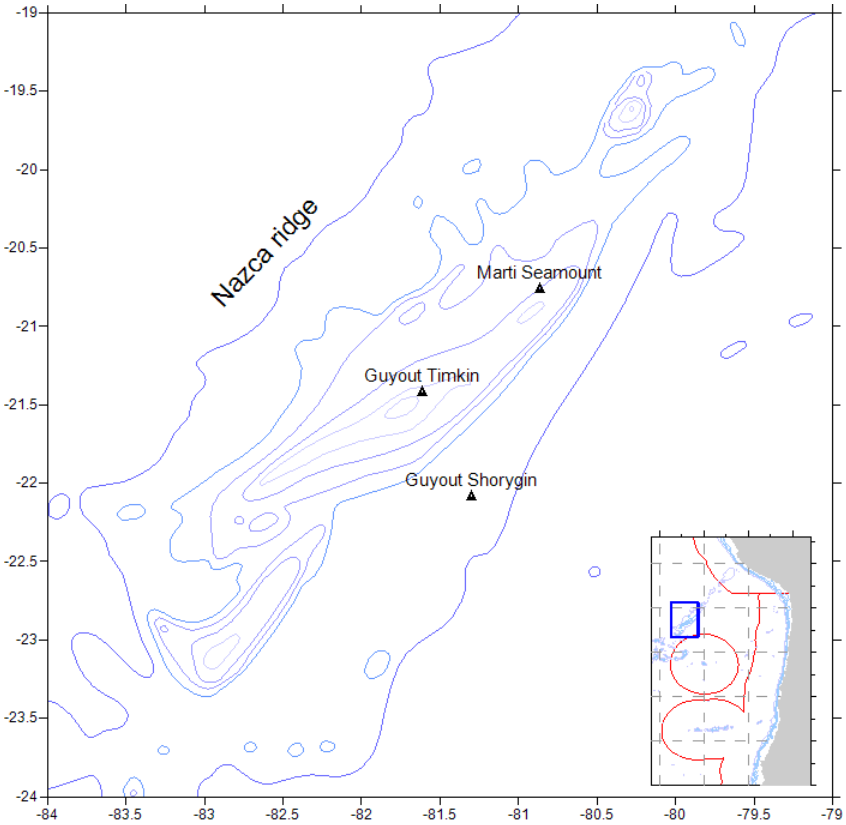
- Additional information was provided by Peru that responded to additional questions

that arose during SC9. This information was presented in SC9-WP06, and additional context was provided in SC9-WP06_rev1 after the meeting.

Questions on the Russian Federation annual report

a. The Secretariat asked a question regarding figure 10 in the Russian Federation Annual Report SC9-Doc30 which shows that a new area was fished in October 2020 compared to previous years. Are you able to provide more information for the October catches for this new area (considering for example changes in catch composition, depth fished, etc)?

- Russian Federation replied that from 21 to 24 October 2020, the vessel operated on the seamounts of the Nazca ridge. Seamounts Shorygin, Timkina and Marty were surveyed. The vessel fished over a depth of 225-320 m, catching at night mixed accumulations of horse mackerel (54%), berix (41%), southern red-eyed (4%) and mackerel (1%) at depths of 75-170 m. Average daily productivity fishing was 34.7 tonnes of horse mackerel, 27.3 tonnes of beryx, 2.3 tonnes of red-eyed and 0.8 tonnes of mackerel.



b. The Secretariat asked Russian Federation a question about how the ecosystem approach has been considered, particularly the seabird mitigation measures used and observed seabird interactions (refer para 9 of CMM 09-2017 (Seabirds)) and asked if they could provide additional information?

- Russian Federation replied "In line with CMM 09-2017 to minimize seabird by-catch in the Convention Area, special attention was paid to the observation of vessel-seabird interactions, associated by-catch and death of seabirds caught in fishing gear. Additionally, daily monitoring of the number of birds around the vessel was carried out.
- In accordance with CMM 09-2017, the vessel used a bird baffler consisting of side barriers (Fig. 1-2). The stern trawl was not used, since during the maneuvering of the vessel when catching warp accumulations the trawls deviated up to 80 ° relative to the stern.
- 15 species of seabirds belonging to 6 families were found and identified outside the EEZ of Chile:

albatross (Diomedeidae), petrels (Procellariidae), kachurkovye (Oceanitidae), pomornikovye (Stercorariidae), gannets (Sulidae) and gulls (Laridae). During ornithological observations, the number of birds around the ship varied from single individuals to 100-200 specimens, the average daily number of birds around the ship was from 7 to 14 specimens. The most widespread seabirds that formed the basis of the avifauna during the observation period were black-browed albatrosses, white-throated petrels and typhoons. Other species of seabirds were much rarer, their number was low. Basically, the birds followed the wake of the vessel at a distance of 100 to 200-300 m, without approaching the stern of the vessel, even during the sampling of trawls (Fig. 3).

- According to the observations made during the voyage, no cases of seabirds, reptiles (turtles) and other species from the list of other species of concern being caught in the trawl or their death during fishing operations were recorded. During the observation period, no VME indicator organisms were recorded in the catches. In accordance with the CMM 17-2019, no cases of loss of fishing gears, as well as cases of detection of abandoned, lost or discarded fishing gear were recorded during the observation period.

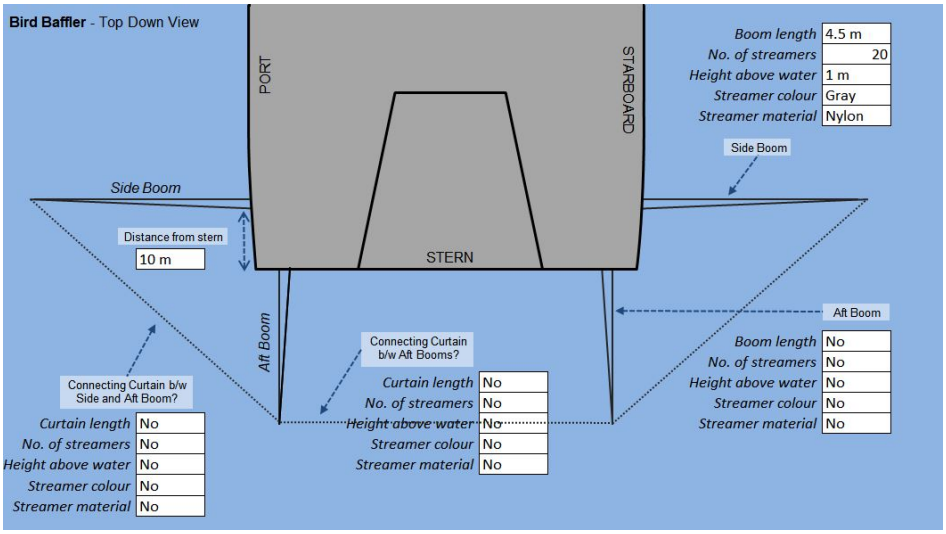


Figure 1: Description of the design of the bird repeller used on the RTMKSm "Admiral Shabalin".

Figure 2: The side fence of the bird repeller used on the RTMKSm "Admiral Shabalin"

Figure 3: Clusters of birds above the wake of the RTMKSm "Admiral Shabalin"

Questions on Chinese Taipei's annual report

a. Chile asked Chinese Taipei a number of questions about their Annual Report SC9-Doc21. The maximum CPUE was obtained in 2015, which were the fishing grounds in that year?

   - The fishing grounds in 2015 were covered in figure 5 of Annual Report 2020 (SC8-Doc22).

b. What are mantle length compositions for the commercial category?

   - The ML composition for four categories are follows, between 200–340 mm for A, between 320–419 mm for B, between 380–480 mm for C, and between 440–580 mm for D.

c. What was the mean mantle length of extra-large size individuals (>3 kg)?

   - It is around 510 mm ML.

d. Does your delegation believe that biological information is informative with too low sample sizes (the whole sample size for 3 months was 25 squids)?

   - The sampling was conducted by one fishing vessel from Oct to Dec in 2020. The operation of sampling vessel was influenced by COVID-19 pandemic, which also limited the sample size. It is planned to increase sample size in 2021.

e. In the near future, is there any possibility to estimate the whole Chinese Taipei catch in numbers by phenotypes?

   - The measurement of length and weight data from the catch everyday was designed for the observer onboard. This may improve the estimate of mean weight of individual squid and apply to estimate the catch in number.

Annex 6. Scientific Committee Multi-Annual Workplan

1. Jack Mackerel Working Group

Task	Subtask	Timeline	Coordinator	Funding
JM Assessment data	Review available input data JM assessment	2022	US/EU	In-kind
	Finalize development of quality control diagnostics of the catch input data to the assessment	2022	EU	In-kind
	Evaluate the impact of revisions in age determinations on the assessment of Jack mackerel (*benchmark*)	2021-2022	EU	In-kind
	Update and compare standardizations of commercial tuning indices among different fleets and review the potential bias in CPUE indices due to possible increased efficiency of the fleet and observed changes in the jack mackerel spatial distribution (*benchmark*)	2022		In-kind
	Explore availability of different survey time series for the Jack mackerel assessment (*benchmark*)	2022	Chile	In-kind
	Develop protocol for inclusion of industry self-sampling or acoustic data in the JM assessment (*benchmark*)	2022	EU	In-kind
JM assessment	SC and other funds to support experts during benchmark and SC assessment	2021+	SC Chair/ Secretariat	NZ$10k (SC)
	Provide TAC advice according to Commission request ("adjusted Annex K")	2022		In-kind
	Software upgrade to JJM model (upgrade diagnostics, explore embedding in FLR) (*3-day online workshop/ capacity building*)	2022		NZ$8k (SC)
	A Jack mackerel stock assessment *benchmark workshop in the first half of 2022* to cover topics such as updated growth estimates, standardized CPUE modelling and a review of the single and two-stock hypothesis implementations of the JJM assessment model and estimation of reference points.	2022	EU	NZ$42K (EU)
	MSE objectives workshop with stakeholders or managers in second half of 2022	2022 (or 2023)	EU	NZ$50k (EU)
	Develop and carry out MSE evaluation to design alternative management procedures (see COMM8-Report Annex 8b). This to include biological reference points, carryover, accumulating quota over 2 years, and stock hypotheses (paragraphs 80, 102,118 COMM8-Report).	2022-2023	EU	Pending
Jack mackerel connectivity research	Task group on CJM connectivity to improve the understanding of origin and admixture of populations or subpopulations of jack mackerel in the Southern Pacific. Genetic research will be an important element in such a research plan, next to, where possible, additional information from e.g., morphometry, parasites, hard parts microchemistry, life history patterns, food habits, spatiotemporal diet variability, distribution patterns and habitat preferences.	2022-2026	Chile Peru EU?	Sources TBD Total NZ$150k / year

Task	Subtask	Timeline	Coordinator	Funding
Jack mackerel ageing techniques	Task group on CJM ageing analysis and otolith exchange to addresses the current practices in ageing of Jack mackerel, the validation techniques to verify ages, an otolith exchange program and a comprehensive documentation of ageing techniques and protocols.	2022-2024	Chile Peru EU?	Sources TBD, Total NZ$75k / year

2. Deepwater Working Group

Task	Subtask	Timeline	Coord.	Funding
Orange roughy assessment	Louisville Ridge stock(s): • Explore alternative stock assessment models • Estimate stock status • Provide advice on sustainable catch levels	2022	NZ	In-kind
Orange roughy assessment data	Coordinate and design acoustic surveys for relevant stocks (*intersessional consideration*)	2022+	NZ	In-kind
Deep water stock structure	Review the list for deepwater stock structure analyses based on assessment for non-orange roughy stocks	2025		In-kind
	Develop workplan to drive stock structure delineation studies for orange roughy and alfonsino and other key target species	2022+		In-kind
Other stock assessments, & ecological risk assessment	Review the risk assessment of teleost and elasmobranch species considering new available information and methods	2024-2025		In-kind
	Develop a tier-based assessment framework for all DW stocks and recommend relevant reference points and/or management rules for these stocks	2022+		In-kind
VME Encounters and benthic bycatch	Annually collect and review VME catch and other benthic sampling data	2022 +		In-kind
	Develop VME taxa ID guide for benthic bycatch, following the steps proposed in SC9-DW12, and associated training videos	2022+	NZ	In-kind
	Investigate the relationship between benthic bycatch from fishing vessels (including encounter events) and the habitat suitability models	2022+		In-kind
	Investigate the relationship of benthic bycatch to abundance models of VME taxa	2022+		In-kind
	Development of a process to review all recent and historical benthic bycatch data to determine the ongoing effectiveness of the spatial management measures	2022+		
	Investigate catchability of benthic bycatch using existing data to support design of a wider research programme (*see next task*)	2022+	NZ	
	Develop a research programme within the SPRFMO Convention Area to allow the determination of taxon-specific estimates of catchability for VME indicator taxa. (*The total cost for such a programme will need to be determined. The two amounts indicated will be used to commence the programme*).	2023+	NZ	NZ$58k (AUS) NZ$23.6k (SC)
CMM 03 request regarding Encounters with VMEs.	Review all reported VME encounters	2022+		In-kind
CMM 03 request regarding ongoing appropriateness	Review all available data and provide advice on the ongoing appropriateness of the management measures to	2022+		In-kind

Task	Subtask	Timeline	Coord.	Funding
	ensure the CMM continues to achieve its objective and the objectives of the Convention			
Bottom Fishery Impact Assessment	Consider any possible changes to BFIAS adopted in 2019 in the light of the cumulative BFIA done in 2020.	2022		In-kind
	Develop abundance models for VME taxa	2022+	NZ	In-kind
	Work to reduce uncertainties in risk assessments for benthic habitats and VMEs	2022+		In-kind
CMM 03 request regarding Marine mammals, seabirds, reptiles and other species of concern.	The Scientific Committee shall provide advice biennially to the Commission on: • Direct and indirect interactions between bottom fishing and marine mammals, seabirds, reptiles and other species of concern; • Any recommended spatial or temporal closures or spatially/temporally limited gear prohibitions for any identified hotspots of these species; and • Any recommended bycatch limits and/or measures for an encounter protocol for any of these species.	2022 2024 2026		In-kind

3. Squid Working Group

Task	Subtask	Timeline	Coordinator	Funding
Squid workshop	Squid Workshop including potential assessment techniques and appropriate measures of fishing effort (*prior to SC10*)	2022	SQWG Chair/ Secretariat	NZ$10K (SC)
Squid assessment and CMM development	Develop a plan for more detailed within-season fishery monitoring	2022	SQ WG	In-kind
	Develop and present alternative assessment approaches	2022+	SQ WG	In-kind
	Design and evaluate MSE and harvest control rules	2023+	SQ WG	In-kind
Standardise biological sampling	Identify where protocols differ e.g. type of sampling, areas and timing of sampling, ageing	2022	Peru, Chile	In kind
Observer Coverage	Review minimum observer coverage (including in relation to different fleet segments, CMM18-2020)	2023		In kind
Squid assessment data	Sample biological information year-round in its entire distribution area	2022		In-kind
	Record and analyse diet data	2022		In-kind
	Review on the acoustic surveys for Squid biomass estimation (pros, cons, challenges)	2022		In-kind
	Evaluate stock structure and assessment approaches applicable to stocks found in the SPRFMO area throughout their entire range (*potential benchmark workshop)*	2022		In-kind
	Determination of the necessary data for the models for stock evaluation (revision of templates 2020 or others)	2022		In kind
Squid connectivity	Collect and analyse genetic samplings (Convention Area and adjacent National Jurisdiction Areas)	2022		NZ$36k (China)
	Sample exchange where Members choose to do	2022+		In-kind
	Register DNA sequences in public DNA databases (such as GenBank), considering a list of metadata related to samples analysed (using the template in the SC9-Report).	2022		In-kind
	Description of genetic diversity based on mtDNA markers, integrating data from all members	2022		In-kind

	Reaching an updated agreement on consistent approaches to genetic analyses for Jumbo flying squid (SNPs) Sample exchange where Members choose to do so.	2022		In-kind
	Use modelling and observation data to predict connectivity and seasonal to decadal variability possibly using genetic, microchemistry, morphometric, parasite prevalence, and tagging experiments	2022+		In-kind

4. Habitat Monitoring Working Group

Task	Subtask	Timeline	Coord.	Funding
Evaluate the applicability of data collected from fishing vessels targeting pelagic species	Mapping spatial-temporal population density distribution of jack mackerel using a combination of the existing acoustic survey data and acoustic information as obtained from industry vessels	2022+	Peru/Chile	In-kind
	Subgroup of specialists to evaluate advantages and biases of analysis methods (1) Draft of ToR and intersessional work, December 2021. (2) Workshop for testing different assessment methods on a common data base (*prior to SC10*).	2022	Peru/Chile	In-kind
	Subgroup of specialists to organise classification of fishing fleets and develop an inventory of technologies available aboard fishing vessels to identify the potential to collect data using the technologies currently being deployed (1) Draft of ToR and intersessional work, December 2021. (2) Draft of proposal to SC on classification of fishing vessels. (3) Draft of proposal on the use of sonars for marine ecosystem studies.	2022	Peru/Chile	In-kind
Development of standardised oceanographic data products/modelling	Characterise jack mackerel habitat (e.g., past studies done in Peru and Chile)	2023	Peru/Chile	In-kind
	Provide ecosystem status overview for SC at seasonal to decadal scale	2024	Peru/Chile	In-kind
Habitat monitoring	Review the state of the art of habitat research in order to recommend specific lines of investigation in this topic within the framework of the SPRFMO	2022	Peru/Chile	In-kind
	Explore the concept of jack mackerel habitat under an interdisciplinary ontogeny approach for jack mackerel and other species (by life history stages and regions). *Workshop to be conducted during 2021/22.*	2021+	Peru/Chile	In-kind
	Define a list of existing environmental data: satellite, acoustic surveys, acoustic fisheries surveys, fishing data, fishing vessel data (VMS, Observers) in time and space that already exist inside the SPRFMO area	2022+	Peru/Chile	In-kind
	Integration of databases provided by different members of the HMWG and other working groups of the SC with linkage to a metadata repository	2022+	Peru/Chile	In-kind
	Develop an inventory of research programmes being developed by industry and scientific institutions regarding data collection and monitoring of marine habitats	2022	Peru/Chile	In-kind

Task	Subtask	Timeline	Coord.	Funding
Species behaviour and preferences	Analyse the habitat preferences of jumbo squid and Jack mackerel, noting the useful data and analyses provided by Peru and Chile	2023	Peru/Chile	In-kind
	Habitat suitability modelling of Jack Mackerel	2022+	Peru/Chile	In-kind
	Incorporate behaviour, distribution, and abundance information about mesopelagic, euphausiids and other key species of the Humboldt Current System	2022+	Peru/Chile	In-kind
Use of new Tools	Develop new approaches based on different tools such as GAM, GLM, INLA, ROMS, Biogeochemical, Geostatistics, big data and machine learning (e.g. for acoustic classification of targets) and utilisation of different platforms.	2022+	Peru/Chile	In-kind
2022 Symposium	Symposium on Habitat Monitoring prior to the 2023 meeting of the Commission to review the state of the art of habitat research in order to recommend specific lines of investigation in this topic within the framework of the SPRFMO	2023	Chile/Peru	NZ$63k (SC)

5. Other (Crosscutting issues)

Task	Subtask	Timeline	Coord.	Funding
Observer programme	Advise on the appropriate levels of observer coverage for each of the major fisheries to: • Identify bycatch issues related to seabirds and other species of concern (short and medium term) • provide statistically robust quantitative estimates for all species of seabird combined and some of the more common bycatch species (medium term) • Periodically review the appropriate levels of observer coverage for SPRFMO fisheries in support of stock assessment needs.	2022+		In-kind
Seabird / bycatch monitoring	Progress southern hemisphere quantitative risk assessment (SEFRA)	2022+		In-kind
EBSA	Evaluate impacts of fishing activities	2022+		In-kind
CMM 17 Marine pollution	SC Members and CNCPs are encouraged to undertake research into marine pollution related to fisheries in the SPRFMO Convention Area to further develop and refine measures to reduce marine pollution and are encouraged to submit to the SC and the CTC any information derived from such efforts	2022+		In-kind
Climate change	Identify key area and management implications of climate change on VMEs and main fisheries in the SPRFMO area	2022+		In-kind
CMM02-2020 Data Standards	Review and update data standards to ensure appropriate scientific data are collected in SPRFMO fisheries (Paragraph 8 of CMM02-2020)	2022+		In-kind
FAO ABNJ Deep Sea Fisheries Project	Planning phase has been completed, the SC supports Secretariat involvement in coordinating activities over their next five-year plan that could involve member scientists and a number of SPRFMO science projects	2022+	Secretariat	In-kind
Alignment	Work involving the alignment of Deepwater and Habitat Monitoring workstreams	2022+		In-kind
Intersessional meetings	External support for the planning and execution of SC intersessional webmeetings and workshops	2022	SC Chair	NZ$10k (SC)

Task	Subtask	Timeline	Coord.	Funding
Species synopses	To update long version profiles (FAO species synopsis format) for jack mackerel, chub mackerel and jumbo flying squid	2022+		
Research in the Nazca and Salas y Gomez ridges area	Identification of the area, by comparing of biodiversity, ecological significance and fishing effort.	2022	Chile	In-kind
	Summary of existing management measures in adjacent Chilean MPAs	2022	Chile	In-kind
	Research cruises aimed to know the bio-oceanographic and meteorologic characteristics of Salas y Gomez ridge; as well as biodiversity, current circulation, morphology and geology of sea bottom.	2023 - 2024	Chile	In-kind
	Climate change impacts of fisheries in Salas y Gomez and Nazca ridges	2023	Chile	In-kind
	Expedition to Salas y Gomez and Nazca aboard oceanographic research vessel	2023-2025 (TBD)	Chile	In-kind

Annex 7. Jack Mackerel Summary of Advice

Stock status summary for Jack mackerel, October 2021

Stock: Jack Mackerel (*Trachurus murphyi*)
Region: Southeast Pacific

In conformity with the approach by the SC since 2012, a comparison was made between the 1-stock (H1) and 2-stock (H2) model configurations for Jack mackerel. Both models showed similar trends with an increasing overall biomass, high recruitments in recent years, and low fishing mortality.

Advice for 2022

Following the guidelines set out by the accepted rebuilding plan and given stock assessment results, 2021 catches should be at or below 900 000t.

Stock status

		2020	2021
Fishing mortality in relation to:	F_{MSY}	Below	Below
Spawning stock biomass in relation to:	B_{MSY}	Above 100%	Above 100%

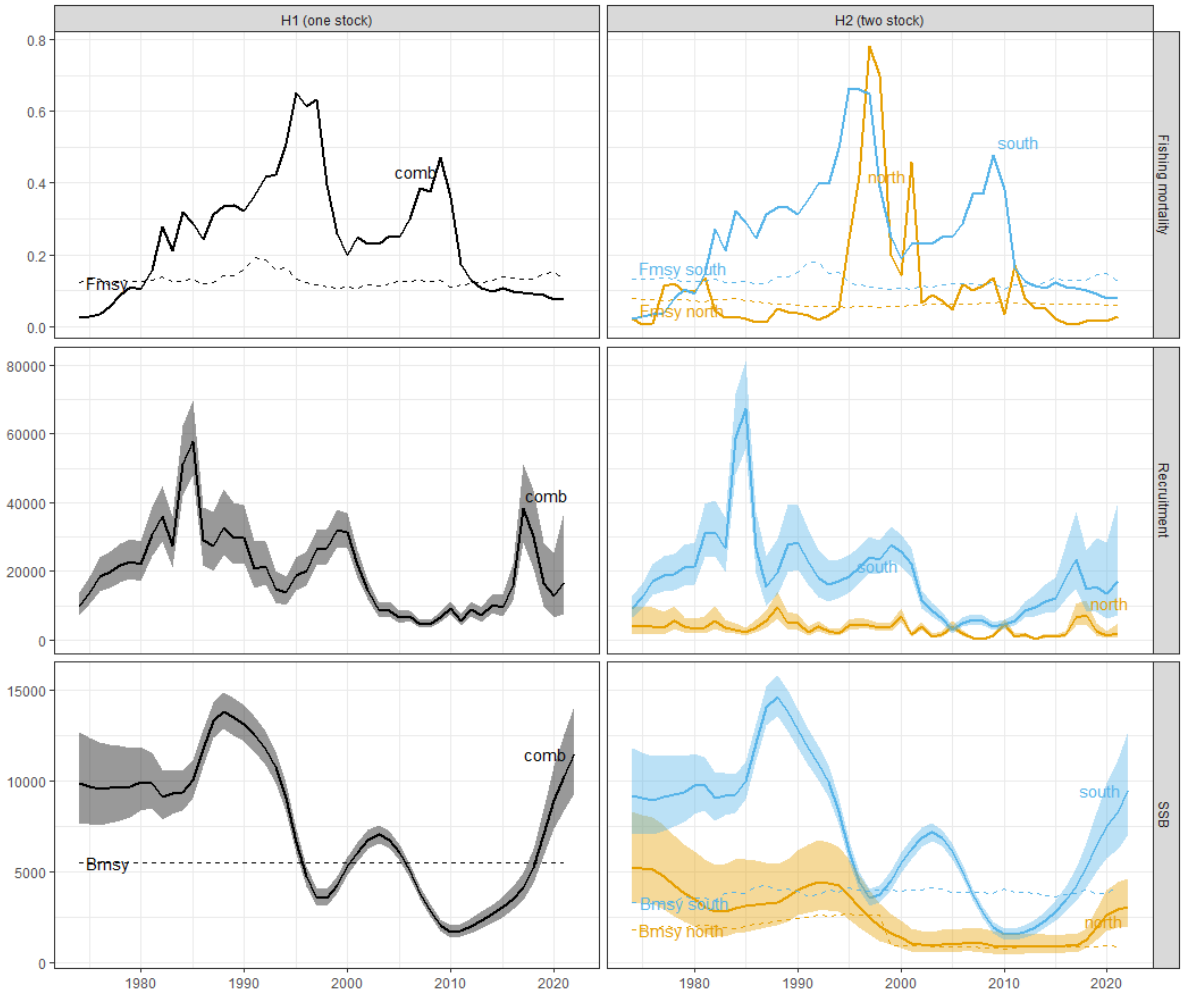


Figure 1. Jack mackerel in the southeast Pacific. Summary of stock assessment estimates over time showing total fishing mortality (as an instantaneous rate per year; top), recruitment at age 1 (millions; middle), and spawning biomass (in thousands of tonnes; bottom). Columns show results for the one-stock hypothesis (H1, left) and two-stock hypothesis (H2, right, "north" stock in yellow and "south" stock in blue). Shaded areas refer to the estimated uncertainties

Table 2: Advised catch, Catch Limits and reported catch of Jack Mackerel in the southeast Pacific.

Year	Advice	Recommended Maximum Catch	Catch Limit CMM area	Catch Limit throughout range	Catch throughout range
2013	Projection results under the assumption of recent average recruitment at the levels estimated for the recent period (2000–2012) indicate that fishing mortality should be maintained at or below 2012 levels to improve the likelihood of spawning biomass increasing. This results in catches for 2013 on the order of 441kt or lower.	441,000	360,000	438,000	353,120
2014	In sum, the advice to the Commission is to aim to maintain 2014 catches for the entire jack mackerel range in the southeast Pacific at or below 440 kt.	440,000	390,000	440,000	410,703
2015	The Commission should aim to maintain 2015 and 2016 catches for the entire jack mackerel range in the southeast Pacific at or below 460 kt.	460,000	410,000	460,000	394,332
2016	The SC agreed that the recommendation from 2014 for catches in 2016 is still appropriately precautionary. Namely, that the Commission should set 2016 catches limits for the entire jack mackerel range in the southeast Pacific at or below 460 kt, based on a status quo fishing mortality of 2014.	460,000	410,000	460,000	389,067
2017	On the application of the adjusted rebuilding plan adopted by the 2nd Meeting of the Commission as proposed from SC02, the Commission should aim to maintain 2017 catches for the entire jack mackerel range in the southeast Pacific at or below 493 kt.	493,000	443,000	493,000	404,845
2018	Given current stock status, the second tier of the Jack mackerel rebuilding plan could be applied, thereby substantially increasing the potential catch. Considering the uncertainties in the assessment however, the Scientific Committee adopts a precautionary approach and advises to maintain 2018 catches for the entire Jack mackerel range in the southeast Pacific at or below 576 kt.	576,000	517,582	576,000	526,323
2019	The SC recommended status quo fishing effort which gives 2019 catches throughout the range of the Jack mackerel stock(s) at or below 591 kt. Although the stock is estimated to be in the "second tier" of the harvest control rule (>80% of B_{MSY}), the retrospective analysis shows a tendency of overestimating the stock size. In addition, there is information that suggests that the growth of jack mackerel has been underestimated. These two factors warrant additional precaution and further investigation.	591,000	531,061	591,000	631,545
2020	In line with the accepted rebuilding plan ("Adjusted Annex K") and because the Jack mackerel biomass is estimated to be above B_{MSY}, the SC recommended a 15% increase in 2020 catches throughout the range of Jack mackerel resulting in a total catch limit at or below 680 thousand tonnes.	680,000	618,001	680,000	706,675
2021	In line with the accepted rebuilding plan ("Adjusted Annex K") and because the Jack mackerel biomass is estimated to be above B_{MSY}, the SC recommended a 15% increase in 2020 catches throughout the range of Jack mackerel resulting in a total catch limit at or below 782 thousand tonnes.	782,000	710,702	782,000	*814,512**
2022	In line with the accepted rebuilding plan ("Adjusted Annex K") and because the Jack mackerel biomass is estimated to be above 100% of B_{MSY}, the SC recommended: a precautionary 15% increase in 2022 catches throughout the range of Jack mackerel- at or below 900 kt.	900,000			

2013 advice was given by the Science Working Group.
* Preliminary value estimated at SC09

Annex 8. Squid Stock Modelling Approaches

Table 1. Type, level of detail and coverage of fishery dependent data that would be required to facilitate the application of selected methods in the monitoring and assessment of the state of exploitation of jumbo flying squid (*Dosidicus gigas*) by the Scientific Committee of the SPRFMO.

	Biomass dynamic models[1]	Depletion estimates of stock size[2]	Depletion Model with pulses of recruitment[3]	VPA and statistical catch-at-age[4]	Statistical Age or length models (e.g., to JJM)[5]	Generalised depletion / biomass dynamic model[6]	CASAL Bayesian stock assessment)[7]
Catch	Yes, Monthly (totals, by fleet)	Yes, monthly-and/or-weekly if possible	Yes /weekly-and/or-monthly	Yes, monthly-and/or-weekly if possible	Yes, monthly-and/or-weekly if possible	Yes / monthly	Yes / monthly by fleet
Fishing effort	Yes, monthly (by fleet)	Yes, monthly-and/or-weekly if possible	Yes /weekly-and/or-monthly	Yes, monthly-and/or-weekly if possible	Yes, monthly-and/or-weekly if possible	Yes /Monthly, by fleet	Yes / monthly by fleet
Size structure	No	Yes, monthly-and/or-weekly if possible	Yes /weekly-and/or-monthly	Yes, monthly-and/or-weekly if possible	Yes, monthly-and/or-weekly if possible	No	Yes / monthly by fleet
Abundance index	Yes, monthly (CPUE)	No	Yes /Standardized CPUE - and/or Acoustic Biomass	Yes, monthly-and/or-weekly if possible	Yes (CPUE), monthly-and/or-weekly if possible	No	No
Biological data	No	No	Yes/Mean weight by week and/or month	Yes, length and/or age) /monthly-and/or-weekly if possible	Yes	Mean weight in the catch	Yes, length, maturity/monthly
Age	No	No	No	Age-length relationship	Age-length relationship	No	Age-length relationship
Natural mortality	No	Yes	Yes	Yes	Yes	No	Yes
Time / space coverage required	5-10 yrs (whole stock area for catch & sample area for CPUE)	1-2 years (whole stock area)	Fishing Seasons (Fishing Ground areas)	5-10 years (whole stock area for catch & sample area for others)	5-10 years (whole stock area for catch & sample area for others)	3-any number of years (whole stock and 4 major areas)	4 yrs
Main assumptions	Catch is proportional to stock size and fishing effort. Strong density dependent effect dominates population dynamics, implying a strong depensatory stock-recruitment relationship	Stock is randomly distributed. No recruitment. Closed stock that mainly declines due to fishing mortality. Abundance index is proportional to total abundance by mortality coefficient	Sequential arrival of recruitment pulses (squid groups) Squid group abundance declines due to fishing mortality and M. Indices are proportional to group abundance. Arrival of new squid groups can be identified by change in mean weights.	The fished stock is formed by discrete cohorts	Abundance index is proportional to population size	Sufficiently strong relation between monthly effort (cause) and catch (effect), with linear or power form. Mean weight per month from the sample is close to the true mean weight in the monthly catch (i.e. a representative sample).	The basic premise for using relative biomass indices is that the catch drives changes in biomass. However, for jumbo flying squid, there is very little memory in the population of a pulse of high catch

Table 1. Type, level of detail and coverage of fishery dependent data that would be required to facilitate the application of selected methods in the monitoring and assessment of the state of exploitation of jumbo flying squid (*Dosidicus gigas*) by the Scientific Committee of the SPRFMO.

	Biomass dynamic models[1]	Depletion estimates of stock size[2]	Depletion Model with pulses of recruitment[3]	VPA and statistical catch-at-age[4]	Statistical Age or length models (e.g., to JJM)[5]	Generalised depletion / biomass dynamic model[6]	CASAL Bayesian stock assessment)[7]
Main Limitations	Requires good contrast in the timeseries with observations above and below B_{MSY}. Can't incorporate biological information (as body growth, maturity or natural mortality)	Requires good separation among cohorts throughout the whole period under analysis. Observed increases in CPUE can result from recruitment events and also due to part of the fleet moving effort to a different and more abundant/higher density patch of squid	Evidence of depletion events based on CPUE decline. Significant changes in mean weights are required to identify the arrivals of new squid groups. Observed increases in CPUE can result from recruitment events and also due to part of the fleet moving effort to a different and more abundant/higher density patch of squid	Requires an abundance index and length frequency and maturity data for a good separation among cohorts	Requires an abundance index and length frequency and maturity data for a good separation of cohorts	Depending on the number of years, optimization of the depletion model may take very long on any run (minutes to over a day), and the detection of episodic input/output events require running several versions with different timings.	Requires length frequency and maturity data from the fisheries and biomass estimates (e.g., from acoustics) that contain scale information in the area(s) being assessed.
Main Expected Outputs	Estimates of MSY, current biomass relative to B_{MSY}, current F relative to F_{MSY} and estimated catch that would correspond to F_{MSY} or to a multiplier of F_{MSY}	Estimates of initial biomass or stock size, or recruitment size if single cohort is assessed. Time series of initial biomass estimates or stock sizes If repeated over time	Biomass by week or month during fishing season in each fishing ground. Whole biomass is the sum of biomasses by fishing ground. Percentage of biomass escapement at the end of the season. Series of initial biomass if repeated overtime	Estimates of recruitment, total biomass and fishing mortality coefficients	Time series estimates of stock abundance, biomass, recruitment abundance, fishing mortality coefficient, growth and recruitment parameters	Natural mortality, time series of regional abundance and biomass, time series of fishing mortality per fleet, time series of recruitment portions to each fleet, estimates of Pella-Tomlinson biomass dynamic model and related BRPs.	Monthly recruitment by phenotype, mature biomass, equilibrium yield and depletion curves, references points
Considers phenotype differences	No	No	Yes	Yes	Yes	No	Yes
Assessment-management-time / longevity (Years)	2/1 for Small-Medium Phenotype 2/2 for Large Phenotype	2/1 for Small-Medium	1/1 for Small-Medium Phenotype 1/2 for Large Phenotype	2/1 for Small-Medium Phenotype 2/2 for Large Phenotype	2/1 for Small-Medium Phenotype 2/2 for Large Phenotype		2/1 for Small-Medium Phenotype 2/2 for Large Phenotype

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Annex 9. Source modifiers Template for recording DNA sequences data

Source modifiers Template for recording DNA sequences data in NCBI Databases (such as GenBank for mtDNA)

https://www.ncbi.nlm.nih.gov/WebSub/html/help/genbank-source-table.html#modifiers

Source modifiers	Description and examples
For collection data:	
Country	The country where the sequence's organism was located. May also be an ocean or major sea. Additional region or locality information must be after the country name and separated by a ':'. For example: USA: Riverview Park, Ripkentown, MD
Lat_Long	Latitude and longitude, in decimal degrees, of where the sample was collected
Collection date	Date the specimen was collected. EXAMPLE: MONTH-YEAR
Collected by	Name of person/institution who collected the sample. EXAMPLE: IMARPE
Dev_stage	Developmental maturity stage of organism EXAMPLE: MATURE + SCALE Mature stage III …
Note	Any additional information that you wish to provide about the sequenced organism. EXAMPLE: Phenotype size: Small-size / Medium-size / Large-size
Sex	Sex of the organism from which the sequence was obtained. EXAMPLE: Female/Male
Tissue_type	Type of tissue from which sequence was obtained. EXAMPLE: Mantle muscle
For DNA sequences (haplotypes):	
Haplotype	Haplotype of the organism. EXAMPLE: Dg-Pe-H#... (for haplotypes ID in Peru waters) Dg-Cl-H#… (for haplotypes ID in Chile waters)
Fwd_primer_name	- name of forward PCR primer
Fwd_primer_seq -	nucleotide sequence of forward PCR primer
Rev_primer_name	name of reverse PCR primer
Rev_primer_seq	nucleotide sequence of reverse PCR primer

Annex 10. Jack Mackerel Technical Advice

Accessible via the SC9 meeting webpage when available.

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