SPRFMO
South Pacific Regional Fisheries Management Organisation

6th SCIENTIFIC COMMITTEE MEETING REPORT

9-14 September 2018
Puerto Varas, Chile

Document name: SPRFMO SC6-Report

Report location: https://www.sprfmo.int/meetings/scientific-committee/6th-sc-2018/

PO Box 3797, Wellington 6140, New Zealand
P: +64 4 499 9889 – F: +64 4 473 9579 – E: secretariat@sprfmo.int
www.sprfmo.int

Contents

Executive Summary

The 6th Scientific Committee Meeting (SC6) of the South Pacific Regional Fisheries Management Organisation (SPRFMO) took place from 9-14 September in Puerto Varas, Chile.

Over 60 participants (scientists from 13 SPRFMO Members, representatives from 2 NGOs, external invited experts, and the Secretariat) reviewed and assessed almost 70 working papers, and SC recommendations (Annex 1) were provided on a large diversity of issues.

Annual reports were received from Australia, Chile, China, European Union, Korea, New Zealand, Peru, Russian Federation, Chinese Taipei, USA and Vanuatu.

The conditions for the jack mackerel stock continue to improve in general. The SC discussed the outcomes of the Assessment Workshop held in May 2018, focusing on reviewing new data sources and evaluating the model assumptions, leading to a "full" assessment and concluding with a preferred assessment configuration. This new information reduced previous estimates of recruitment such that the projected stock increase was somewhat moderated. Fishing mortality rates in the past three years decreased and this, along with a modest improvement in recruitment, contributed to an estimated increase in biomass.

Therefore, the SC recommended *status quo* fishing effort, which gives 2019 catches at or below 591 000 tonnes. The SC noted this precautionary approach was advisable since a) retrospective analysis shows a tendency for the assessment to overestimate stock size and b) new information suggests that growth of jack mackerel has historically been underestimated. These two factors warranted additional precaution until further research on their impacts on the assessment can be done. Furthermore, the SC recommended a revision of the Harvest Control Rule and requested that the Secretariat seek funds to re-evaluate the current management strategy and develop an alternative that is robust to assessment uncertainties.

Regarding deep-water issues, the SC accepted the generic acoustic survey design for surveying spawning aggregations of orange roughy in the SPRFMO area. Concerning orange roughy on the Louisville Ridge and in the Tasman Sea, no changes to the precautionary catch limits recommended by SC5 were proposed.

On data collection, the SC recommended that identification protocols and biological data collection for deepwater chondrichthyans be strengthened for SPRFMO demersal fisheries. Additionally, assessing and prioritising stocks for status assessment within the bottom fisheries tiered assessment framework was considered. The SC recommended that this work be continued and supported as part of the SC workplan.

Concerning the process and analyses used to develop threshold weights for a VME encounter protocol for bottom trawls, the SC recommended that Annexes 1 and 3 of CMM 02-2018 include data on bycatch of benthic species to be reported in logbooks. The SC also recommended a mandatory review process for VME indicator encounters, benthic data, and models underpinning spatial management approaches. Finally, the SC recommended that bottom fishing nations provide detailed analysis of all benthic bycatch data, particularly for fishing events that exceed the thresholds described.

Finally, a small intersessional working group will be formed to revise the SPRFMO Bottom Fishery Impact Assessment Standard, which will aim to present a draft to SC7.

In the last year, considerable progress has been made in developing stock assessment methods for jumbo flying squid. Three models were presented, and the SC noted that stock structure is particularly

uncertain. As such, it is necessary to develop a set of alternative stock hypotheses that are consistent with existing data. In addition, natural mortality is poorly known, and efforts should be made to obtain more reliable estimates. Therefore, the successful assessment of jumbo flying squid will require ongoing commitment from members and CNCPs to collect length frequencies from their fisheries. The SC recommended that members and CNCPs participating in this fishery join in the genetic analysis work for this species. The SC also recommended that coordinators within members and CNCPs be nominated to coordinate data sharing and sampling exchange. Finally, the SC recommended that a workshop on the jumbo flying squid stock structure and stock assessment be held immediately before SC7.

On the Ecosystem Approach to Fisheries Management the SC encouraged Members to collect and analyse data on seabird bycatch in a consistent way across fisheries. This will be guided by the Agreement on the Conservation of Albatrosses and Petrels (ACAP) recommendations. and reporting data or results from analysis on bycatch indicators to ACAP. In this regard, the SC advised the Commission that observer coverage of 20% or more may be required to robustly estimate incidental mortality of seabirds, marine mammals and other species of concern in some fisheries. Furthermore, a periodic review of observer coverage and the utility of the data generated should be used to fine-tune levels of observer coverage. On this topic, the SC seeks guidance from the Commission on the nature of its information needs for the bycatch of Seabirds, Marine Mammals, and Other Species of Concern, so that the SC can more precisely advise on observer deployment requirements in SPRFMO fisheries.

Particularly for the squid jigging fisheries, the SC advised the Commission of the risk posed to seabirds and encouraged all Members and CNCPs to collect and report specific data focussed on seabird interactions so that a more robust understanding of interactions and risks can be developed.

The SC recommended creating a Working Group on "Habitat Definition, Description, and Monitoring" with the main objective of providing environmental indicators to complement fisheries management decisions. The SC recommended that the WG begin with jack mackerel as a first case study.

The SC provided comments to the draft SPRFMO Observer Programme CMM, focussing on the elements relevant to the functioning of the SC, and the provision of data and information required to assess and manage the different species. After plenary and subgroup discussions, detailed comments and text were suggested, agreeing that a more detailed list of elements for an observer data validation protocol will be agreed by interested members intersessionally prior to the 2019 Commission meeting.

Three exploratory fishing applications were assessed during SC6. New Zealand's proposal to extend its exploratory demersal longline fishery for toothfish was modified based on input received from the SC. The SC recognized the cautious and exploratory nature of the New Zealand proposal and the scientific benefits of its proposed data collection and therefore advised the Commission that the revised proposal was acceptable.

The EU presented a proposal for an exploratory toothfish fishery which was also modified based on the input initially received from the SC. The EU committed to providing a detailed risk assessment before submitting the proposal to the 7th SPRFMO Commission meeting. The SC advised that the proposal adequately addressed 1 out of 7 relevant criteria, partially addressed 5 out of 7 relevant criteria, and did not adequately address 1 out of 7 relevant criteria for paragraph 8 of CMM 13-2016. The proposal adequately addressed 2 out of 4 relevant criteria, and partially addressed 2 out of 4 relevant criteria, for paragraph 10 of CMM 13-2016:

The Cook Islands presented a Fisheries Operation Plan for an Exploratory Potting Fishery. The SC discussed whether the proposed fisheries operation plan adequately addressed scientific aspects of the CMM to warrant continuance to a second year of exploratory fishing. The SC advised that the proposal adequately addressed 1 out of 7 relevant criteria, partially addressed 4 out of 7 relevant criteria, and

did not adequately address 2 out of 7 relevant criteria for paragraph 8 of CMM 13-2016. The SC also advised that the proposal adequately addressed 1 out of 5 relevant criteria, and partially addressed 4 out of 5 relevant criteria, for paragraph 10 of CMM 13-2016. Further, the SC advised that the proposal partially addressed 2 out of 3 relevant criteria and did not adequately address 1 out of 3 relevant criteria for paragraph 24 of CMM 14b-2018.

New Zealand presented a draft proposal for a CMM to enable research in the SPRFMO Convention Area as currently there is no mechanism in place. Following feedback from the SC, New Zealand amended the proposal and the SC recommended that the Commission adopt a CMM to provide for research activities in the Convention Area taking into account that research should be enabled within sustainable limits and that different types of research should be recognised. The SC agreed that New Zealand will work intersessionally with other Members to provide advice on a definition of 'additional impact' to inform development of a draft CMM to be presented to the Commission in January 2019.

Concerning scientific participation in outside arrangements, the SC strongly encouraged renewing and progressing the arrangement with CCAMLR and suggested including an item addressing observer programme knowledge exchange. The SC also expressed its support for FIRMS participation. With regards to ABNJ, the SC was cautious about cost, but in favour of participating.

Other relevant topics addressed include the increase in the number of papers presented in plenary and how to tackle this situation, the state of play of the Scientific support fund, and how to streamline the SC access to VMS data.

There were no offers for hosting the next SC meeting. The SC re-confirmed or appointed Chairs and vice-Chairs although there were no offers for the position of Chairperson for the Deepwater Working Group.

SPRFMO SC6-Report

Report of the 6th Meeting of the Scientific Committee

Puerto Varas, Chile, 9-14 September 2018

Adopted 14 September, 10:30 pm

1. Welcome and Introduction

1. The Scientific Committee Chairperson, Dr James Ianelli, opened the meeting and proceedings. Dr Ianelli introduced the Coordinator of International Affairs Unit at the Undersecretariat for Fisheries and Aquaculture (Subpesca), Ms Karin Mundnich, who welcomed the group to Puerto Varas, Chile. The SPRFMO Executive Secretary, Dr Sebastian Rodriguez thanked Chile for hosting the 2018 SC meeting, and for the warm welcome that the hosts extended to all participants. Participants (Annex 2) then introduced themselves.

2. Administrative Arrangements

2.1. *Adoption of Agenda*

2. The Chair sought proposed changes to the Provisional Agenda. A specific item for election of Chairs was added. After discussion, slight modifications were agreed upon regarding its schedule (SC6-Doc02) and the SC adopted the agenda as provided in Annex 3.

2.2. *Meeting Documents*

3. Meeting documentation, location and access was presented. The document list (SC6-Doc03) and Agenda items and related papers table (SC6-Doc04) were made available and referred to throughout the meeting.

4. Late papers were added to the document list and accepted.

2.3. *Nomination of Rapporteurs*

5. *Rapporteuring* was supported by Australia, the European Union, New Zealand, and the United States of America.

3. Discussion of Annual Reports

6. Annual Reports were received from Australia, Chile, China, European Union, Korea, New Zealand, Peru, Russian Federation, Chinese Taipei, USA and Vanuatu. Summaries for those reports are in Annex 4. Members were reminded to follow guidelines as presented and reviewed in 2017 and updated here in particular the provision of summary paragraphs.

> The SC **recommended** that for jack mackerel CPUE considerations, time spent searching be included in the annual reports, and reflected in the guidance for annual reports document (SC5-Doc07_rev3) and requested that the Secretariat facilitate this update.

4. Commission Guidance and Other Inter-Sessional Activities

4.1. *Commission SC Workplan*

8. Work planned for 2018 in the SC work plan was generally on track and will be discussed further under relevant agenda items at SC6. Specific items for later discussion were raised in regard to the use of self-sampling and acoustic data from jack mackerel fisheries, development of a standard for in-season data collection for squid, and potential for a specific work plan for the Habitat Task Group. It was also noted that the planned assessment of 'one Tasman Sea stock' in the deepwater work plan was not progressed this year due to a lack of funding available to support the work. Mauricio Galvez from Chile coordinated updating the multi-annual work plan which is provided in Annex 5.

4.2. *Secretariat SC-Related Activities*

9. The Secretariat introduced SC-Doc06 on the Secretariat's SC-related activities over the past 12 months. This included the attendance of SPRFMO Representatives at seven meetings/conferences. Highlights of these of particular interest to the SC included the Our Oceans Conference, a conference about the Protection of Vulnerable Marine Ecosystems in the North Pacific Fisheries Commission Area, attended on behalf of SPRFMO by Dr Martin Cryer (New Zealand), and the 2nd meeting of the Sustainable Ocean Initiative Global Dialogue on progressing towards Aichi Biodiversity Targets and Sustainable Development Goals.

5. Jack Mackerel

5.1. *Inter-Sessional Assessment/Research*

10. The Chair of the jack mackerel Working Group provided a report on the Assessment Workshop that was held in Valparaíso, Chile, on 28-30 May 2018. This report is provided as Annex 6.

11. The group discussed CPUE standardisation and prepared recommendations which can be found in Section 2.2 of the workshop report. Growth assumptions were discussed at length and updates from Chilean research are expected prior to SC7 in 2019. The group reviewed new data sources and extensively evaluated model assumptions. This led to a recommended assessment configuration to be used for advisory purposes by the SC. Reference points were deemed still appropriate. Recommendations towards the design of the harvest control rule were provided and highlight the need to review the management plan. This review is already part of the SC multi-annual work plan.

12. The EU presented SC6-JM05 on the nominal CPUE of the offshore fleet (EU, Russia, Korea and Vanuatu) fishing for jack mackerel which has previously been used as a nominal tuning index for the assessment of jack mackerel. The index previously only consisted of the nominal average catch per fishing day for the fleets of EU, Vanuatu and Korea. During the 2018 Jack mackerel workshop, a working document was presented describing the methods for a combined standardized CPUE of the four fleets mentioned above (SCW6-Doc5) was an extension of that work and now includes data for 2017. The selected CPUE standardization was based on a GAM model that considered a number of linear factors (year, vessel, month, SST) and a smoothed interaction factor between latitude and longitude.

13. The EU presented SC6-JM03 on the Pelagic Freezer-trawler Association (PFA) Self-Sampling Report for SPRFMO. The paper reported a description of the fisheries carried out by vessels belonging to members of the PFA within the SPRFMO area from 2015 to 2018. On the vessels, the PFA self-sampling programme was carried out during all trips and for all hauls. The self-sampling programme delivered information on spatial and temporal evolution of the fishery, species and length compositions and ambient fishing conditions (temperature and depth). Catch distributions and length compositions by quarter and division were presented for jack mackerel, chub mackerel and southern rays bream.

14. The EU presented SC6-JM04 on PFA Self-Sampling Compared with Observers. The pelagic freezer-trawler fleet (PFA) has been carrying out a self-sampling programme on the freezer-trawler fleet since 2015, within the northeast Atlantic, West Africa and the South Pacific. The pelagic freezer-trawler fisheries were characterized by a high level of sampling being carried out for commercial purposes. The self-sampling programme expanded on the ongoing sampling programme by standardizing the sampling methodology and the recording formats. During self-sampled trips, the crew member took a random sample of around 20 kg from the catch of each haul (or the majority of hauls), separated them into the different species and measured the length compositions for each of the subsamples. During some of the self-sampled trips, the vessel was also joined by a scientific observer. For those trips the species and length compositions from the scientific observer were compared to the self-sampling data.

15. Within the fishery for jack mackerel in the South Pacific, the PFA self-sampling programme was carried out on all trips. The scientific observer programme for that fishery is targeted to cover at least 10% of the effort. Over the years 2015-2017 the analysis showed that around 35% of the catch was covered by scientific observers. Over these years, eight trips were covered by both self-sampling and scientific observers.

16. The overall number of length measurements between the self-sampling and observer trips were comparable. However, self-sampling measured fewer fish per trip for all trips whereas the observers measured more fish per trip while covering fewer trips. Comparisons of the cumulative catch per trip showed close correspondence between the two sampling programmes, as did the species compositions.

17. Length compositions per sampled trips and hauls were comparable. However, during three out of the eight trips, differences were observed in the overall length compositions. They were found to derive from either problems in the sampling method employed by one of the scientific observers, or by the low number of measurements in the self-sampling programme. A comparison of the overall length compositions by year derived from all self-sampled trips or derived from the raised observer trips was conducted. It demonstrated that the self-sampling covered a wider part of the fishery (season, area) which explained some of the differences between the two data sources. Thus, self-sampling provided a substantial improvement in the coverage of the fishery and thereby a more realistic length composition to be used in the assessment of jack mackerel. The combination of self-sampling and observer trips allowed for quality control of both programmes while being able to assure a wide coverage of the fishing season.

18. In summary the SC:

- Noted that the comparison between self-sampling data and observer data in the EU jack mackerel fishery showed reasonable agreement in species compositions and length distributions of jack mackerel during hauls that were observed through both methods.
- Noted that a full coverage in time and space was achieved in the self-sampling programme whereas a more limited coverage was achieved in the observer programme.
- Noted that the observer programme delivered more detailed biological data on age, sex and maturity than the self-sampling programme.
- Noted that additional verification of the self-sampling programme may be derived from Electronic Monitoring (EM) that records the self-sampling process.
- Agreed that self-sampling can provide a valuable addition to the observer programme by extending observations to more seasons and area
- Encouraged that members explore the possibility of utilizing self-sampling programmes to complement the observer programme.
- Encouraged that within self-sampling programmes, members explore the application of EM as additional verification tools.

19. Chile presented SC6-JM02 "Spatio-temporal dynamics of the Chilean jack mackerel fishery off central-southern Chile, 2017-2018 period". This related the oceanographic features of this area to the distribution of fishing grounds of jack mackerel. It is recognized that jack mackerel distribution and migration patterns are influenced by interannual changes of ENSO (El Niño/La Niña). Based on the analysis of El Niño Southern Oscillation (ENSO) Indices and satellite information of sea surface temperature (SST) and sea level anomalies for the area of the South Pacific, the transition of a weak La Niña to a neutral condition was observed. In 2018, the purse seine fleet of South-Central (S-C) Chile operated very close to the coast, maintaining the pattern of 2012. Fishing grounds in 2018 were concentrated close to coastal areas in operating between 35-43°S. Relative to 2017 and 2016, the 2018 fishery to-date has reduced the level of fishing in the more northern zones (26-34°S). This was due to the fact that juveniles tend to inhabit warmer waters (often typical after El Niño events). In particular, the fishery tried to avoid fish below 26 cm FL due to good practices programmes, size limit restrictions and market targets. Length compositions from January to July 2018 showed different modes between 20 to 60 cm FL. These data showed a main mode centred at 30 cm FL and a secondary mode at 42 cm FL. Fish below 26 cm FL and juveniles also appeared in the southern areas with warm water extensions and along frontal zones. Based on collaborative work with EU vessels, Chilean fleet size compositions from June were consistent with the EU data in July.

20. It was **noted** that fishing strategies and fleet-specific decisions can influence CPUE and size compositions in the catch due to different patterns of fish distribution and changing oceanographic conditions.

21. To the extent practical, the SC **noted** that such factors should be considered in the CPUE standardisation and for evaluating selectivity estimates of the S-C Chilean fleet.

5.2. Inter-Sessional Progress with the Jack mackerel Stock Structure Research Programme

22. No new information on stock structure was presented. The SC agreed to continue to present both the one-stock as well as the two-stock hypothesis assessment results.

5.3. Jack mackerel Stock Assessments

23. Most Members reported the required data for the jack mackerel assessment to the data coordinator in line with the requirements as specified by the SC. Chile further reported an updated CPUE series on jack mackerel. Peru reported an updated CPUE series for the Peruvian fleet fishing for jack mackerel.

24. A "full" assessment was executed during the May 2018 workshop, held in Valparaiso, Chile. The workshop evaluated many different model sensitivities as well as alternative assessment methodologies. The workshop concluded on a preferred assessment configuration (model 1.13) for Commission advisory purposes using the Joint Jack Mackerel (JJM) model. A number of relevant sensitivity scenarios were evaluated at the workshop and specifically highlighted further science needs for the near future. These needs are reflected in the SC workplan.

25. The SC **noted** that assessment model sensitivities evaluating alternative growth for Jack Mackerel, which suggested faster growth of jack mackerel off Chile and in the high seas, resulted in substantial downward scaling of SSB and increase in estimated Fishing mortality (SPRFMO-2018-SCW6).

26. Furthermore, the SC **noted** that these sensitivities do not affect, in the short term, sustainable exploitation of jack mackerel.

27. The standardized data templates developed over the past two years were again used to receive catch, age, and length data from the fisheries and from the data used to derive indices. Catch data were updated for all fleets including their age or length compositions. The Chinese CPUE index, offshore combined index (Russia, China, Korea, Vanuatu and EU), Chilean CPUE index, and echo-abundance index from Chile were all updated. All datasets were added in an incremental way to the dataset used for the assessment to allow testing the impact on stock perception following from each data addition. A complete list of the model configurations and access to the data tables can be found online (https://goo.gl/Gdc2c7[1]) or in Annex 7 of this report.

5.3. a. *Updating of data sets for additional stock assessment runs*

28. The Secretariat presented SC6-JM01; an annual paper providing information on catch histories and expected catches for the most recent year to be used as data inputs into the jack mackerel stock assessment model. There were no significant changes to previous versions for this data series apart from minor updates to the 2017 final figures as advised by Members. The paper showed that generally previous estimates for total current catches have been within 10% of the final figures with Fleets 1 (Northern Chile) and 4 (far North) showing the highest variance. The initial 2018 estimates were accepted for Chile (both North and South-central) and Ecuador. The China, EU and Russian Federation vessels have finished fishing for the year and they were able to provide final estimates. Korea adjusted its initial estimate upwards based upon the recent entry of its vessel into the fishery and the expectation of a second vessel entering into the fishery during late September. The estimate for Peru was influenced by a very large August catch report which became available during the meeting. The complete catch data series used in the assessment is shown in Annex 7 (refer Tables A7.1 and A7.2, and Figure A7.1).

5.3. b. *Selection and specification of base-case assessment, and specification of additional stock assessment sensitivity runs to be conducted*

29. As in past years, the assessment process first evaluated the influence of new data. A set of sensitivities was evaluated during the workshop and a final set of base-case runs was selected based on a number of factors as presented in the workshop report.

5.3. c. *Synthesis and summary of key results from all stock assessment runs conducted*

30. Conditions for the jack mackerel stock continue to improve in general. New information reduced previous estimates of recruitment such that the projected stock increase was somewhat moderated. Fishing mortality rates in the past three years decreased and this, along with modest improvement in recruitment, contributed to the estimated increase in biomass. Results are summarised in Annex 8. During the meeting, limited sensitivities were examined, including the two-stock models as a check to what was evaluated at the workshop.

31. As in past meetings, model 1.4 was configured for projections to reflect alternative productivity regimes (i.e., resiliency and carrying capacity as effectively modelled through stock-recruitment steepness and the unfished mean recruitment level). Model 1.5 (lower stock productivity and recent recruitment regime) was selected since it was most precautionary for near-term productivity expectations.

[1] Due to data confidentiality, permissions to this site is limited.

32. As a reminder, there remains a number of key uncertainties associated with both the assessment and projections both in estimation and expectations of future environmental conditions. These were addressed by exploring different assumptions in model runs and comparing the results. Key uncertainties in the assessment include:

    - Stock structure: considered through applying both single and two stock models.
    - Natural mortality, M: highly uncertain, assumed constant for all ages and through time in the accepted models.
    - Input data quality: a number of model runs excluded various data components and others changed the weighting of different data components.
    - Growth: work continues on this important issue, yet a better understanding along with exchanges of samples and methods between members is still needed.

33. Changes in regime may affect future recruitment levels, which in turn will affect estimates of biomass through projections. Uncertainties about environmental regimes have thus been addressed through the range of scenarios used in the projections with differing values of recruitment regimes and stock recruitment steepness parameters.

34. Projections using the entire time series of recruitment (1970-2015) under the assumption of constant fishing mortality equal to 2018 levels (Model 1.4) indicate that the biomass is expected to increase over the next 10 years. Projections using recruitment levels from 2000-2015 (a period of lower productivity compared to that prior to 2000; Model 1.5) indicate that the biomass is expected to increase over the next 5 years but then stabilize at a point below the provisional B_{MSY}.

5.4. Other Jack Mackerel Topics

35. No working documents were presented to the SC to discuss other research on Jack Mackerel. It should be noted however that country reports contain relevant information on jack mackerel habitat, changes in environmental conditions and collection of bycatch information in the fishery. The SC created a Habitat Monitoring working group as discussed under agenda item 8.

5.5. Advice to The Commission on Jack Mackerel

36. A comparison was made between the 1-stock and 2-stocks model configuration and both models showed very similar trends for overall biomass. Under the two-stock hypothesis model the Northern unit shows stable and low biomass levels over the past decade. The 1-stock model suggested a more precautionary biomass estimate and hence is used for advice purposes. CPUE estimates from all around the distribution area show similar upward trends while the Peruvian CPUE shows a stable trend in the past years. Indications of a strong recruiting 2015 year-class showed up in the Northern Chile acoustic survey in 2016 and again in 2017. The strong year class also showed up in the catches of the EU fleet in the summer of 2017, just outside of the northern Chilean EEZ. The 2018 inputs did not confirm the strength of this year class as it was missing from the acoustic surveys and from the catch data.

37. Model biomass estimates increased from 2017 to 2018 from just above 4 million tonnes to 5 million tonnes, suggesting a small downward revision in biomass from last year's estimate. Biomass is estimated at 90% of the interim B_{MSY} biomass reference point. Simultaneously, fishing mortality decreased further to a rate of 0.09 in 2018, being well below the F_{MSY} reference point.

38. Results of the 2018 assessment resembled the estimates provided by the 2017 assessment, except for the most recent SSB and recruitment estimates, influenced by the anticipated higher 2015 and 2016 year-classes, which seemed to have been overestimated. Downward revision of SSB was furthermore driven by an update in the Chinese CPUE and a change in assumptions on fleet selectivity, allowing freer estimation of F-at-age in recent years compared to more rigid assumptions in the 2017 model configuration. New statistical weights of age-composition data were calculated with the Francis method, as agreed upon during SCW6. The weights calculated in this meeting were relatively similar to those calculated at the workshop. Re-weighting resulted in biomass estimates similar to the results then, although historical estimates (1970s - 1980s) were consequently scaled higher.

39. Short term projections were carried out using the updated 2018 assessment outcomes, evaluating, among others, a status-quo fishing mortality scenario for 2019 as well as a 15% increase in TAC. Both show high probability of reaching B_{MSY} by 2020.

40. The SC was tasked with giving advice on the status of jack mackerel. 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. Conditions for the jack mackerel stock in its entire distribution range in the southeast Pacific shows a continued recovery since the time-series low in 2010. Under the two-stock model the Northern unit shows stable and relatively low biomass over the past decade. Fishing mortality is estimated to be below F_{MSY} levels and biomass just below interim B_{MSY} levels. Recruitment in the most recent is at or just below long term mean recruitment since the 1970s.

41. Near term spawning biomass is expected to increase from the 2018 estimate of 4.8 million t to 5.6 million t in 2019 (with approximate 90% confidence bounds of 4.5 – 7.0 million t).

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.

42. Furthermore, given this recommendation:

The SC **recommended** a revision of the Harvest Control Rule and requests the Secretariat seek funds for re-evaluating the current management strategy and develop an alternative that is robust to assessment uncertainties.

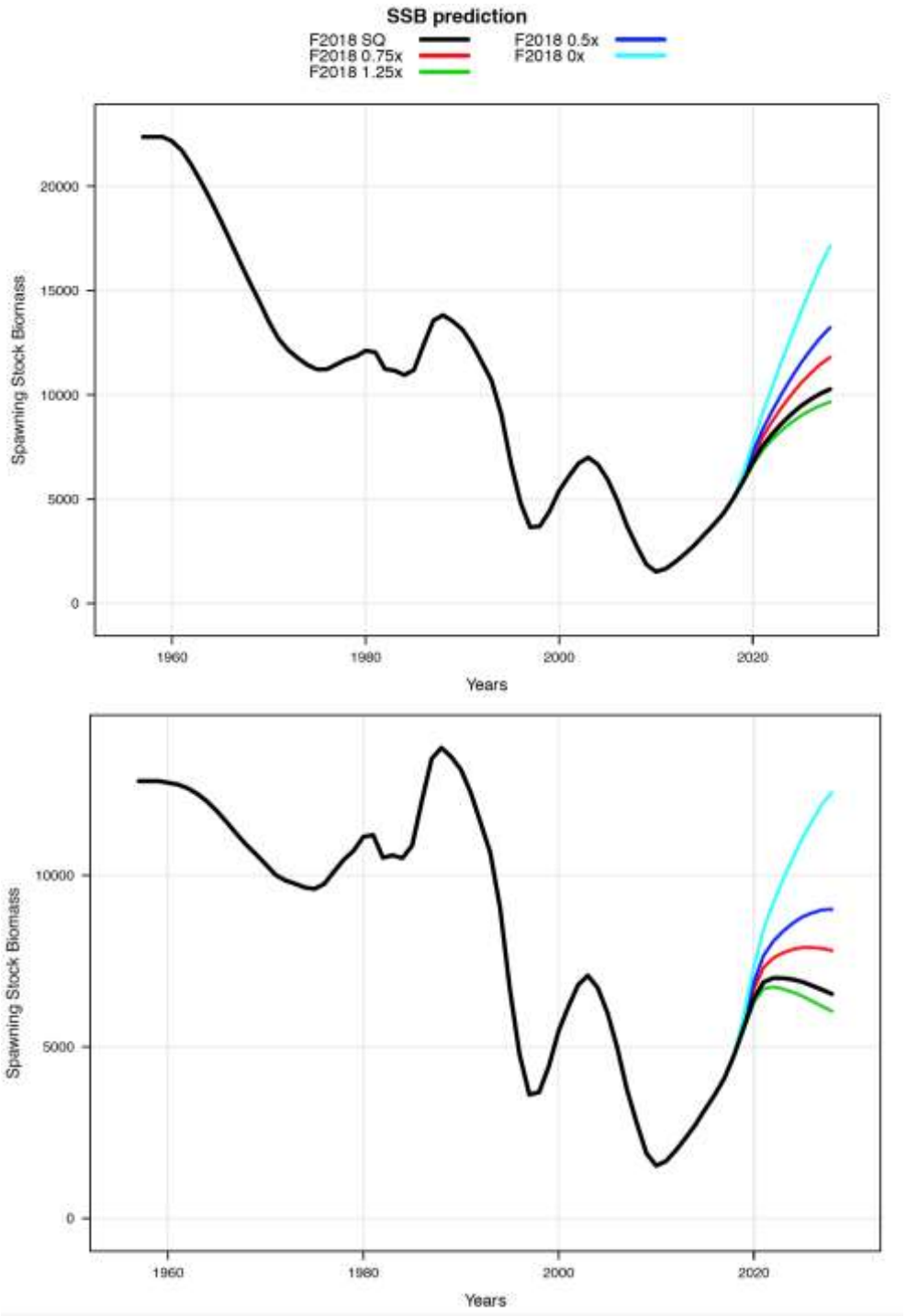

Figure 1. Spawning biomass projections with stock-recruit steepness parameter equal to 0.8 and using the full time series (1970-2015; top panel) and for steepness set to 0.65 and the recent recruitment period (2000-2015; bottom panel)

Table 1. Summary results for the short-term predictions for models with different parameters (a more optimistic scenario). Note that "B" in all cases represents thousands of t of spawning stock biomass and B_{MSY} is taken to be 5.5 million tonnes of spawning biomass in all cases.

Model 1.5, steepness=0.65, recruitment from 2000-2015				
Multiplier of F_{2018}	B_{2020}	P ($B_{2020} > B_{MSY}$)	Catch 2019 (kt)	Catch 2020 (kt)
0.00	7,337	98%	0	0
0.50	6,888	95%	280	341
0.75	6,680	92%	415	494
1.00	6,415	86%	591	683
1.25	6,293	82%	674	769
Model 1.4, steepness=0.8, recruitment from 1970-2015				
Multiplier of F_{2018}	B_{2020}	P ($B_{2020} > B_{MSY}$)	Catch 2019 (kt)	Catch 2020 (kt)
0.00	7,690	99%	0	0
0.50	7,236	98%	282	344
0.75	7,025	96%	418	499
1.00	6,756	93%	596	690
1.25	6,632	91%	680	776

Table 2. Summary results for the medium and long-term predictions for models 1.4-1.5. Note that "B" in all cases represents thousands of t of spawning stock biomass and B_{MSY} is provisionally taken to be 5.5 million t of spawning biomass in all cases.

Model 1.5, steepness=0.65, recruitment from 2000-2015

Multiplier of F_{2018}	B_{2020}	P($B_{2020} > B_{MSY}$)	B_{2024}	P($B_{2024} > B_{MSY}$)	B_{2028}	P($B_{2028} > B_{MSY}$)	Catch 2019 (kt)	Catch 2020 (kt)
0	7,337	98%	10,509	100%	12,416	100%	0	0
0.5	4,241	95%	8,606	99%	9,011	98%	280	341
0.75	4,091	92%	7,842	96%	7,808	92%	415	494
1	3,948	86%	6,963	87%	6,541	76%	591	683
1.25	3,814	82%	6,591	81%	6,040	65%	674	769

Model 1.4, steepness=0.8, recruitment from 1970-2015

Multiplier of F_{2018}	B_{2020}	P($B_{2020} > B_{MSY}$)	B_{2024}	P($B_{2024} > B_{MSY}$)	B_{2028}	P($B_{2028} > B_{MSY}$)	Catch 2019 (kt)	Catch 2020 (kt)
0	7,690	99%	12,825	100%	17,142	100%	0	0
0.5	7,236	98%	10,824	100%	13,228	100%	282	344
0.75	7,025	96%	10,015	99%	11,806	100%	418	499
1	6,756	93%	9,081	98%	10,276	99%	596	690
1.25	6,632	91%	8,683	97%	9,660	98%	680	776

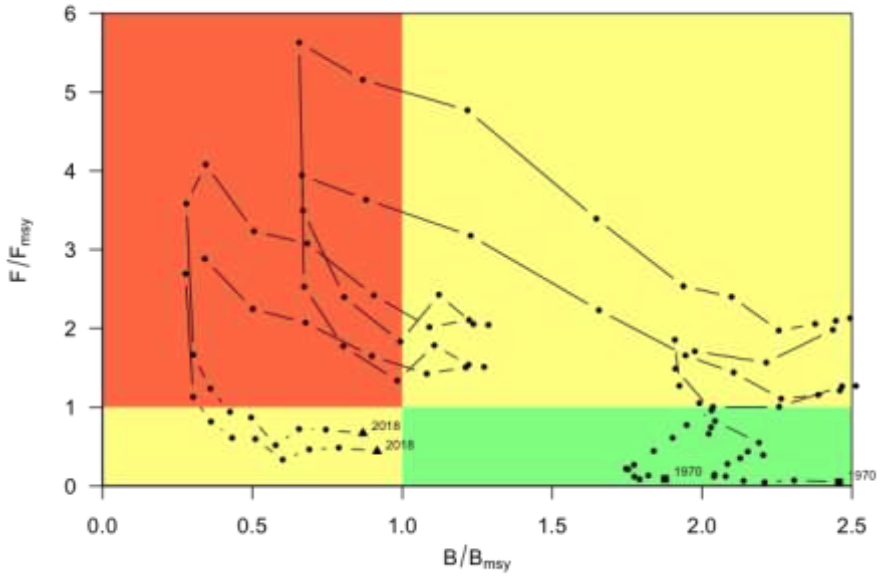

Figure 2. Phase plane (or "Kobe") plot of the estimated trajectory for jack mackerel under Model 1.4 (steepness = 0.80;) compared with Model 1.5 (steepness = 0.65;) with reference points set to F_{MSY} estimated for the time series 1970-2015 and B_{MSY} set to 5.5 million t.

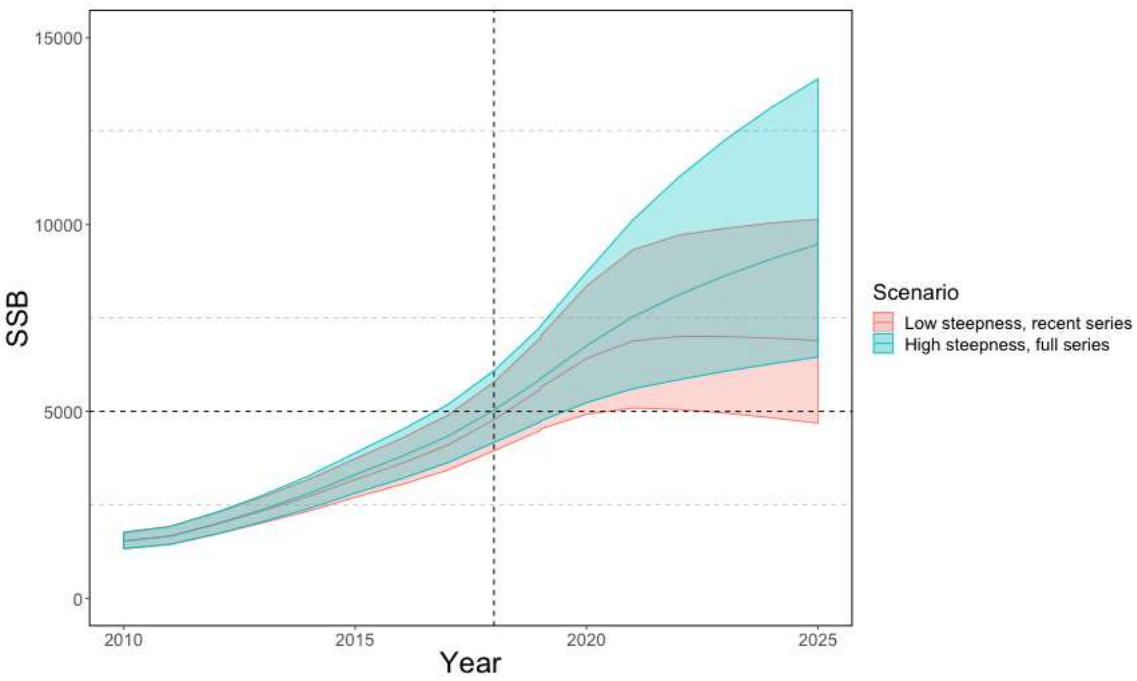

Figure 3. Projections of jack mackerel population for status quo fishing (2018 value) under different recruitment assumptions. The provisional B_{MSY} is 5.5 million t.

6. Deepwater

6.1. *Inter-Sessional Assessment/Research*

43. There were no specific topics discussed under this agenda item.

6.2. *Orange Roughy Assessments*

44. The SC queried whether Members were comfortable with the advice on catch limits for the Louisville Ridge and the Tasman Sea that was generated at SC5 and reiterated that the approach to the setting of these catch limits was precautionary. No changes to these limits were proposed.

45. New Zealand provided SC6-INF02 - The 2014 orange roughy stock assessments to the SPRFMO SC to assure the SC of the quality and credibility of the stock assessment of the biological stock that includes orange roughy on the Westpac Bank. New Zealand reminded Members that the paper was available and that they were available to answer questions or provide additional information. The Deep-Sea Conservation Coalition (DSCC) asked about information available in the stock assessment to support setting a catch limit for the Westpac portion of the stock. New Zealand clarified that there is no spatial aspect to the current stock assessment that allows for a clear estimation of that proportion of the stock, and that there are other methods by which a catch limit for that area could be calculated.

46. After considering SC6-INF02, the SC:

- **Noted** that New Zealand's 2014 assessment of the biological orange roughy stock that includes the Westpac Bank was reviewed by New Zealand's working groups and is appropriate to support management.
- **Noted** that the stock assessment estimated the biomass of the stock to be 42% B_0, estimated an annual yield of 1 764 tonnes to maintain the biomass of the stock at or above 35% B_0, and that the current total allowable commercial catch limit for the entire area applied by New Zealand is 1 600 tonnes.

6.3. *Deepwater Data Collection*

47. New Zealand presented SC6-DW05 which describes a generic acoustic survey design that is appropriate for surveying spawning aggregations of orange roughy in the SPRFMO area. The purpose of the paper was to allow specific survey designs to be quickly written and accepted by reference to the generic design in this document. The generic design discusses all aspects of an acoustic survey of spawning orange roughy. The requirements of the vessel, equipment, personnel, survey design, and data analysis are all considered. The generic design, by nature, is far less specific than a design for a particular area. A specific survey design will include details that are relevant to the particular survey and the area being surveyed and may include objectives for species other than orange roughy.

48. The SC expressed their gratitude at the proactive response of developing this document. Specifically, this responds to an element in the SC DW workplan from the Commission.

49. The SC requested clarification on the rationale for application of the design to only spawning aggregations. New Zealand responded that if what was being surveyed was a feeding aggregation then it was likely that they were feeding on something which would mean the acoustic marks would be a mix of species which would compromise the estimate of orange roughy biomass. By restricting the design to spawning aggregations the assumption that the aggregation solely comprises orange roughy was more robust.

50. The SC noted that substantial resources would be needed to achieve the design requirement for 3 hauls and asked how critical this was to the design. New Zealand noted that the requirement for 3 hauls could be relaxed but the minimum 300 sexed fish samples should not be compromised. New Zealand noted that it was likely on smaller aggregations that 3 tows may not be feasible.

51. The SC also sought clarification on the issues of assigning marks and portioning out backscatter. New Zealand explained that past acoustic surveys on genuine spawning plumes of orange roughy partitioned backscatter, with the knowledge that there were some assumptions that could not be validated and were potentially wrong. Past assessment models of orange roughy in New Zealand have been sensitive to these assumptions. The new design did not partition backscatter. However, the design required that different species aggregations be distinguished, and preferably confirmed by trawl composition and dB differences from a multi-frequency system.

52. The DSCC noted that having suitably experienced personnel on the vessels was very important to make sure the design was implemented properly and to ensure data reliability.

53. The SC discussed how SPRFMO should be involved in accessing raw acoustic data and data summaries. New Zealand noted that this was not covered explicitly in the paper. Raw data are normally held by those who did the survey and summaries of that data are available, although it would be ideal to have this stored and made available for SPRFMO stocks. The SPRFMO Secretariat noted that this could be included in the data CMM. New Zealand also noted that its domestic policy required such data to be held by the management agency as specified in its research and science standards.

54. After considering SC6-DW05, the SC:

Recommended that the SPRFMO Secretariat make sure that the protocol is visible on the SPRFMO website; and,
Accepted the recommendation of the paper, including the proposed specification to "spawning aggregations of orange roughy", and suggested that an alternative to the word "yardstick" be used.

- **Agreed** that the generic acoustic survey design described here is appropriate for spawning aggregations of orange roughy within the SPRFMO Area; and,
- **Adopted** it as a standard for considering research proposals for such work.

6.4. Deepwater Stock Structure

55. The SC work plan included an item for 2018, to establish an orange roughy sampling plan to ensure appropriate genetic samples are being collected from deep water stocks. There were no formal papers submitted on this topic, but it was noted that paper SC6-DW05 included the collection of genetic samples for future analysis. Australia summarised current discussions to advance this work, which intends to apply next generation sequencing and single nucleotide polymorphisms (SNPs) markers to evaluate stock and sub-stock structures. The work is proposed to be undertaken in collaboration with the Southern Indian Ocean Fisheries Agreement (SIOFA) where there are similar benefits of advancing the definition of stock structures of orange roughy. A joint analysis will also potentially allow for greater data contrast which is expected to improve delineation of stocks. SIOFA are currently collecting data to the same protocol. Australia commented that the proposed sampling design for the genetic study was to collect 100 random samples per spawning aggregation.

6.5. *Other Stock Assessments Including Ecological Risk Assessment*

56. Australia presented SC6-DW08, which described an ecological risk assessment for the effects of demersal trawl, midwater trawl and demersal longline gears on deepwater chondrichthyans (sharks, rays and chimaeras) in the SPRFMO Convention Area. Productivity-Susceptibility Analysis (PSA) and Sustainability Assessment for Fishing Effects (SAFE) methods were used to assess potential vulnerability of deepwater chondrichthyans species to fishing using demersal trawl, midwater trawl and demersal longline gears. Despite a number of methodological limitations, the results estimated a number of species to be at high or extreme vulnerability to fishing using all gears. The analysis highlighted a lack of information on deepwater chondrichthyans, particularly relating to their identification, stock structuring, selectivity to fishing gears and post capture mortality. This work forms part of the SC's requirement to consider the impacts of fishing on target, non-target and bycatch species.

57. The SC acknowledged that the risk assessment was a step forward and useful for identifying information gaps and prioritising data collection. The SC was surprised that the SAFE method appeared more precautionary than the PSA method. Australia advised the SC that testing the reliability of risk categories had been undertaken which suggested that the threshold that PSA applies for high risk was not equivalent to the SAFE criteria for high and extreme risk categories and therefore some species categorised as medium risk under PSA could be high risk under SAFE (Zhou et al. 2016. Ecological risk assessments for the effects of fishing: A comparison and validation of PSA and SAFE. Fisheries Research, 183:518-529). Australia advised the SC that where there are data deficiencies PSA is more precautionary as it assumed the highest vulnerability scores in this scenario.

58. The SC asked for advice from Australia on the next steps to progress these analyses. Australia suggested that in addition to progressing scientific publication of this work it considered several priorities to reduce uncertainties in the results. These included improving the estimates of the spatial overlaps of fishing effort and species distributions as well as obtaining better information about selectivity of the fishing gears and post-capture mortality. Australia noted that the results were most robustly interpreted as relative rankings of species within gears and should not be interpreted at this stage as absolute estimates of risk. Australia also noted that comparing vulnerability rankings between gears was also not informative due to a series of methodological limitations.

59. The SC noted that some of the uncertainties in the analyses could be attributed to the methods, spatial scale and data sources for estimating the overlap between species distribution and fishing effort. Australia agreed and noted that results could differ considerably depending on which data source was used for species distribution. Australia also suggested that the observed differences between line and trawl fishing gears in the number of species identified to be at higher vulnerability could be attributed to the aggregation to a 20-minute spatial scale. It could also be due to potential scaling factors underlying gear-specific estimates of catchability in the SAFE method. Applying this level of aggregation to line gears may be overly precautionary, as the actual line fishing effort footprint is much smaller than that assumed. Analyses at a finer spatial resolution may reduce the number of species categorised into the high-vulnerability categories for line fishing. Similarly, the number of species in the higher-vulnerability categories may reduce for trawl gears if analysed at a finer resolution.

60. The SC noted that a limitation to the PSA method was the relatively arbitrary choices for the number and types of attributes used and that this could alter scores. Australia agreed and advised that recent research on the application of PSA methods (Hordyk and Carruthers 2018 A quantitative evaluation of a qualitative risk assessment framework: Examining the assumptions and predictions of the Productivity Susceptibility Analysis (PSA)" *PLoS ONE 13(6)*: e0198298) have suggested that not only choice of the number and types of attributes but consideration of some weighting of attributes may improve the robustness of PSA results.

61. Australia also advised the SC that there was further potential for both false positives and false negatives in the results. The fisheries records available to develop the species list for the analyses contained species groupings. To address this, these groups were disaggregated to species level based on the literature of what species are known to occur in the SPRFMO area. This means that there are some species that may not interact with any of the fisheries that were included in the analyses. As a consequence, Australia advised the SC that there was a low level of correlation between the deepwater sharks in the SPRFMO database and those included in the analysis. Australia reiterated that this was the basis for its recommendation that SPRFMO improve the capacity for species identification by observers and vessel crew. Australia commented that low levels of fishing mortality are known to have collapsed some shark populations and this emphasised the need to improve species identification and reporting of mortalities. Australia noted that there are no dedicated shark fisheries in SPRFMO and this may offset concern that current levels of fishing mortality are depleting shark populations to the extent that they could be in an overfished state.

62. The Deep-Sea Conservation Coalition queried whether the low levels of observer coverage in the longline fisheries have limited data collection and how that influences relative risks between longline and other fisheries. Australia noted that the 10% observer coverage for longline fisheries meant that if shark interactions are rare events the probability of reporting such an interaction may be low.

63. Following discussion of SC6-DW08, the SC:

- Noted that there are a number of species assessed to be at high or extreme vulnerability to fishing using demersal trawl, midwater trawl and demersal longline gears.
- Noted that the results are precautionary as they may include false positives (species assessed to be at a higher vulnerability than reality) from assuming that the degree of interaction with the fishing gear is higher than what actually occurs.
- Noted the results may also include some false negatives (species assessed to be low vulnerability that are actually higher in reality) due to a lack of reporting species interactions with fishing gears or poor species identification.
- Noted that the assessment has highlighted information gaps on the identification, productivity, distribution, stock structuring and other life history attributes for many species.
- Noted that the assessment has highlighted that additional work on post capture mortality and gear selectivity of deepwater chondrichthyans would aid future analyses and inform potential future mitigation strategies that would minimise risk associated with susceptibility.
- Noted that additional work would be attempted to refine the spatial resolution used in the analysis, and an update on this would be provided to SC7 in 2019.

Recommended to the SPRFMO Commission that identification protocols and biological data collection for deepwater chondrichthyans be strengthened for SPRFMO demersal fisheries.

64. Australia presented paper SC6-DW07 which updates the SC on a preliminary ecological risk assessment for teleost species that may interact with demersal trawl, midwater trawl and demersal longline gears in the SPRFMO Convention area. Productivity-Susceptibility Analysis (PSA) and Sustainability Assessment for Fishing Effects (SAFE) were used to assess potential vulnerability of each species to each gear. This work forms part of the SC's requirement to consider the impacts of fishing on target, non-target and bycatch species.

65. The SC reaffirmed its earlier discussion following presentation of DW08 on the application of ERA methods. The table of sensitivities (Table 7 in DW08) indicates that spatial scale of the analyses potentially has a strong influence on results. In terms of development of ERA methods, the SC suggested that methods that do not assume homogeneity in species and fishing effort distribution would be useful if there were data available to undertake such analyses.

66. The SC asked, based on the analyses to date, whether the results indicate any immediate sustainability issues. Australia responded that they considered the current results preliminary and have not been sufficiently evaluated to determine if they are robust enough to identify sustainability issues.

Following discussion of SC6-DW07, the SC:

- **Noted** that the methodological assumptions and results of this assessment are preliminary and will need further refinement.
- **Noted** that a provisional species list has been developed and was used for this assessment but contains some species outside SPRFMO's mandate and potentially species that do not interact with SPRFMO fisheries.
- **Noted** that the results, once refined, may help the SC prioritise species for consideration for other non-standard assessment approaches as part of the categorisation of SPRFMO demersal species into the tiered assessment framework.

67. Australia presented SC6-DW06 which provides for the SC's consideration of a preliminary characterization of SPRFMO species within the tiered assessment framework for bottom fisheries in the SPRFMO Convention area (adopted at SC5). This characterization is intended to help the SC formulate potential assessment options for the large number of species with which SPRFMO bottom fisheries interact. Given the large number of species, and a lack of information to undertake Tier 1 assessments for the vast majority of species, it is likely that a number of data-limited assessment approaches will need to be applied at Tier 2. The paper demonstrates various data-limited assessment approaches and the types of fishery-dependent and fishery-independent data that are required for each approach. The categorization of species into the assessment framework (Annex 1 to paper SC6-DW06) and a characterization of data availability defines which of the assessment options may be possible given the data that are available as well as the characteristics of each species or fishery. As agreed at SC5, prior to categorization into Tier 1 or Tier 2 the SC may place some species into Tier 3 (no assessment required) based on the presentation of sufficient evidence that existing measures provide adequate precaution for the interactions known (for example, for species that rarely, if ever, interact with SPRFMO demersal fisheries).

68. The SC acknowledged that the paper represented a "proof of concept" for categorising species into the tiers of the assessment framework. In response to a question from the SC on the likely number of species that can be expected to fall into each tier of the assessment framework, Australia advised that the preliminary categorisation and data characterization indicated that the SC can expect fewer than 5 species in Tier 1, up to 20-30 species in Tier 2 and the remainder in Tier 3.

69. The SC, noting that preliminary work had been undertaken to characterise the data available for each species, queried whether there were sufficient data to undertake assessments for those species that may be categorised into Tier 2. Australia advised that their exploration of data requirements for low information stock assessments methods identified in DW06 suggested that assessment using a number of approaches was theoretically feasible; however, they advised that expectations should be moderated as although these methods may be feasible, the results may be misleading given the assumptions that need to be applied. Australia noted that it planned to undertake further evaluations of the performance of the data-limited methods to understand the influence of these assumptions on the validity of outputs and planned to report back to SC7 on the results of this work. It also hoped to include an evaluation of whether simple catch triggers could be robustly used for some Tier 2 species (i.e. no assessment required until catches exceeded particular levels).

70. The SC encouraged linking the ERA work for teleost species with the assessment framework as it would be desirable to prioritise assessments to those species that appear to be most at risk.

Following discussion of SC6-DW06, the SC:

- **Noted** that the species list and the preliminary categorisation of stocks into the SPRFMO tiered assessment framework is a work in progress and Australia and New Zealand will continue to work together to refine them.

- **Noted** that the preliminary categorisation of species into the tiered assessment framework highlights a number of potential assessment options at Tier 1 and Tier 2.
- **Noted** that the preliminary categorisation could be used in conjunction with the results of the teleosts ecological risk assessment to prioritise stocks into Tier 3 (as well as strengthening justification for assessment of species at Tiers 1 and 2).

Recommended that this work be continued and supported as part of the SC workplan.

6.6. *Revision of bottom fishing CMM*

71. New Zealand presented SC06-DW09, "Methods for deriving thresholds for VME encounter protocols for SPRFMO bottom fisheries", which presents an overview of the process and analyses used to develop potential threshold weights that could be used to inform a VME encounter protocol for bottom trawls within the SPRFMO Convention Area and includes three Sections. The first section provides an overview of the key steps in the development of international resolutions, recommendations and guidelines relating to the avoidance of significant adverse impacts on VMEs on the high seas. This information is provided as background to the development of VME indicator taxa thresholds that could be used to inform encounter protocols. The second section summarises historical bottom trawl catch information, including the number and weight of VME indicator taxa per trawl, and potential taxon-specific weight thresholds calculated from cumulative weight distributions. The third section combines the first two, and based on best available scientific information, suggests triggers for a potential bottom trawl encounter protocol for the western SPRFMO Area that incorporates both a VME indicator taxa weight and a biodiversity component as in the current New Zealand protocol. The paper also presents a simple rapid assessment form that could be used by observers to check whether the bycatch in a particular tow has exceeded a proposed threshold. The proposed thresholds were applied directly to the 8,850 bottom trawl tows conducted by New Zealand-flagged vessels between 2008 and 2018 to evaluate the implications of the proposed encounter protocol for fishers.

72. The SC thanked New Zealand for outlining the recent outcomes from the 2018 North Pacific Fisheries Commission (NPFC)/FAO Workshop on the Protection of Vulnerable Marine Ecosystems, on the hierarchy of methods that might be used to generate VME indicator encounter thresholds.

73. The SC **recognised** that for SPRFMO the best option to develop thresholds from those proposed by that workshop was mostly arbitrary, but could be based on actual historical catch records, and that:

    a. catch records could come from the fisheries for which a threshold is required, with or from similar fisheries, and

    b. thresholds could be based on medians, percentiles, or other metrics.

74. The SC discussed the influence that trawl duration and length may have on the data used to generate the VME indicator taxa and biodiversity threshold values. When considering long tows, it is possible that the volume of VME indicator taxa is generated by accumulation of frequent but low-volume interactions with indicator taxa along the tow path or from an interaction with a few high-volume areas along the tow. Exceedance of thresholds in short duration tows may be more likely due to the latter. New Zealand commented that it did look at differences between the Tasman area (a mix of short and long tows) and the Louisville area (predominately short tows), however there are no comparable amounts of data across the two areas. The SC agreed that attempting to standardise the VME encounter data to account for tow length or other influences was unlikely to be informative as the type of data available was not conducive to this type of analyses. In this context the SC reiterated that the data should not be overinterpreted and that the aim is to get something useful from the limited data available. The SC recognised that in the absence of standardising the VME indicator encounter data that the ability to interpret what a threshold may mean was likely to be different for long tows as opposed to short tows. The Deep-Sea Conservation Coalition noted that depending on the interpretation of what the threshold means may create unexpected incentives to fish longer or shorter tows.

75. The SC discussed which of the potential percentiles identified in the analysis would be appropriate to apply as a high threshold, as recommended by SC5. Although the selection of a particular threshold from the list of candidate thresholds identified by the analysis is somewhat arbitrary, there was agreement that the 99th percentile was more likely to indicate that the threshold represented evidence a VME had potentially been encountered than a lower threshold (particularly for longer duration tows). DSCC observed that other RFMOs use lower percentiles, for example in NAFO a percentage of 75% is used for bycatch in research trawl surveys.

76. The SC discussed that the method applied could be adaptive. The calculations would change as new data are added. New Zealand described the sensitivity analyses that had been undertaken by removing the top fraction, which demonstrated the potential influence of new data on the calculated thresholds. This supported the recommendation for regular review of encounter protocols and thresholds to incorporate additional data as they become available.

77. The SC discussed the importance of a review process to respond to encounters and new data. The SC noted that there is 100% observer coverage on all trawl operations and all benthic bycatch is required to be recorded. This means that the data are available to re-evaluate thresholds and also refine how to interpret the likelihood of VME presence when VME indicator thresholds are triggered should be improved. It was noted that one application of the VME indicator threshold would be to evaluate the performance of the underlying models used to define the proposed spatial management arrangements for trawl and longline fisheries. Given that, the SC could review the locations of occasions when the VME indicator thresholds were exceeded and whether that corresponded to the predictions of the VME habitat models. If a tow is in an area that has predicted presence of VME taxa, exceeding a threshold could be expected, however if it is in an area where VMEs are not expected, that would be 'surprising' and suggest the need for model review. Such reviews of benthic bycatch data could be part of the SC's annual workplan, with major reviews of all data and recalibration of underlying models every five years. The SC agreed it should recommend a mandatory review process for any encounters, benthic data, and underpinning models.

78. The SC, noting that the threshold calculations were made using data from 2008-2018, discussed how representative in space the tows were in comparison to earlier years. New Zealand responded that years selected was based on the quality of data available. Fishing pattern changed around 2008, noting that was when interim measures closed some areas to fishing based on the reference years (2002-06). The main changes over the time within the data series were in relation to the quality of identification by observers.

79. The SC noted that inclusion of other VME indicator taxa may be desirable if they qualify as VME taxa in the SPRFMO area, but further work was needed to describe their growth form and ecology in SPRFMO waters before they should be considered for inclusion as VME indicators.

80. The NZHSFG expressed its concern that if exceeding VME indicator encounter thresholds invoked temporary closure of areas the current threshold values and biodiversity values would severely limit the capacity for fishing. Talking about encounter protocols, the terms 'arbitrary' and 'uncertainty' have been used. The impact of this is on fishermen who will end up closed out of the area. The NZHSFG rejected the need for a threshold or encounter protocol and noted that they have been fishing in these areas over 30 years, and currently bottom fishing is restricted to only 0.13% of the entire SPRFMO Convention Area.

81. The SC requested future clarification on the calculation that under the thresholds proposed and using the historical bycatch data that on average 5 tows would exceed the thresholds per year. Specifically, the SC asked if this calculation needed to account for an expected lower encounter rate as the proposed open areas are expected to be in areas with few VMEs.

82. The NZHSFG commented that the current regime is already precautionary given that the remainder of the SPRFMO Area is closed to fishing and reminded SC that the historical footprint years 2002-2006 were chosen arbitrarily and did not represent the fact that NZHSFG members have fished right across to Chile on the many features.

83. NZHSFG questioned about whether the science behind the thresholds is sufficiently robust for there to be a closure associated with the trawl path. If the science behind the thresholds is not robust enough to suggest that we believe the encounter indicates an encounter with a potential VME, what is the evidence that would justify closing the area to subsequent fishing.

84. DSCC commented that the UNGA resolutions and FAO Guidelines make it clear that the encounter protocol and move-on rules are required and must be precautionary.

85. Following discussion of SC6-DW09, the SC:

- **Noted** that a data-informed approach has been used to identify a range of candidate thresholds, but the selection of a final VME taxa threshold for bottom trawls is a somewhat arbitrary process;
- **Noted** that insufficient data on VME distribution and density and on trawl catchability exist to apply more sophisticated methods;
- **Noted** that insufficient data from bottom longline fisheries exist to develop a data-informed VME indicator taxa threshold for that method, but within this context **noted** that, based on the cumulative impact assessment for bottom line fishing, line fishing within candidate areas open to fishing (which are yet to be finalized) are likely to have risks to VMEs several orders of magnitude lower than bottom trawl fishing.
- **Agreed** that two VME indicator taxa thresholds for bottom trawl have been estimated (a weight threshold and a biodiversity threshold):
  - a catch of any one of the six most commonly-caught VME taxa over a taxon-specific threshold weight (based on the 99th percentile of the distribution of historical positive catch weights); OR
  - a catch of three or more VME taxa over a taxon-specific qualifying biodiversity weight (based on the 80th percentile of the distribution of historical positive catch weights);
- **Agreed** that the taxon-specific weight thresholds are:
  - for individual VME indicator taxa referred to in the first component would be 50 kg of Porifera, 15 kg of Gorgonacea, 250 kg of Scleractinia, 5 kg of Antipatharia, 40 kg of Actinaria and 60 kg of Alcyonacea.
  - for the VME indicator taxa referred to in the biodiversity component, their associated qualifying weights for the biodiversity component, would be 5 kg of Porifera, 1 kg of Gorgonacea, 5 kg of Scleractinia, 1 kg of Antipatharia, 5 kg of Actinaria, 1 kg of Alyonacea, 1 kg of Stylasteridae, 1 kg of Pennatulacea, 1 kg of Crinoidea, 1 kg of Brisingida.
- **Reaffirmed** that fine resolution data should continue to be collected on the quantities and type of all interactions with VME indicator taxa, regardless of the volume or diversity and that this should be reported to the Secretariat.

- **Agreed** that the VME indicator taxa thresholds can be used to inform management measures additional to spatial management areas to prevent Significant Adverse Impacts on VMEs.

Recommended that Annexes 1 and 3 of CMM02-2018 be updated to include a requirement for data on bycatch of benthic species to be reported in logbooks to fill a current gap in the understanding of the frequency of interactions with benthic species, particularly in bottom line fisheries;
Recommended a mandatory review process for VME Indicator encounters (annual), benthic data (annual), and models underpinning spatial management approaches (roughly every 5 years or when evidence suggests those models are misleading), and to include the development of the review process in suggested SC work plans for consideration by the Commission;
Recommended that bottom fishing nations should provide detailed analysis of all benthic bycatch data and particularly those fishing events that exceed the thresholds described herein for annual review by the SC.

Other deliberations by SPRFMO Observers

86. The NZHSG rejected the need for an encounter protocol and thresholds given the already precautionary approach under current measures. The NZHSFG also referred to papers SC2-INF04, SC2-INF05, SC3-INF02 and COMM2-Obs01 discussed in the past with the view that they are still relevant and help inform on issues currently faced by NZHSFG.

87. The DSCC noted that elements of encounter protocols could be further updated and include:

- Refinement of VME indicator taxa
- Refinement of VME indicator taxa weight thresholds
- Refinement of biodiversity component of encounter protocols
- Refinement of encounter protocols

88. The DSCC also noted that the taxa included as VME indicator taxa should be reviewed in light of species reported caught in SPRFMO fisheries.

89. New Zealand presented SC6-DW14, "Review of benthic sampling and bycatch data, including VME taxa in SPRFMO bottom fisheries", which provides a summary of the benthic bycatch, including of species thought to be indicators of vulnerable marine ecosystems, of New Zealand bottom fisheries in the SPRFMO Area. Due to difference in the selectivity of different fishing gear, as well as differences in fishing locations, there were marked differences in the quantity and composition of benthic invertebrate bycatch, including components of vulnerable marine ecosystems, between bottom longline and trawl fisheries. Over the 2008-2018 period, observers reported approximately 34 tonnes of benthic invertebrate bycatch in the bottom trawl fishery (which has 100% observer coverage) and approximately 32 kg in the bottom longline fishery (which has a minimum of 10% observer coverage). In both fisheries, benthic invertebrate bycatch was dominated by VME indicator taxa. There were also differences in the quantity and composition of benthic invertebrate bycatch between fishing areas. These differences may be due to a combination of differences in species composition between biogeographic regions and a distinction between fishing occurring on relatively flat seafloor in some areas versus feature-based fishing, especially on the Louisville Seamount Chain, that have harder substrates that allow the development of benthic assemblages dominated by large sessile species such as scleractinian corals.

90. The SC asked how catchability could potentially be estimated. New Zealand commented that one option was to place cameras on fishing gear and try to correlate camera observations with landed bycatch.

91. The SC noted that the figures that show temporal variability in the bycatch reported do not match the values reported in the Tables and asked for an explanation. New Zealand noted that the quantities in the figures come from particular fisheries management areas (regional divisions of the area) and the data presented in the Tables is an aggregation of this data. If the Table was disaggregated, then the values would equal those in the figures.

92. The NZHSFG commented that doing more work to assess catchability may not be cost-effective. Given that catchability is suspected to be very low, endless resources could be spent trying to make such estimates more precise. It may be more prudent to develop other ways of working out if there is a VME present, as just improving estimates of catchability is not going to resolve the issue. New Zealand responded that this was part of SC5 recommendations to think about this topic, and this could help in developing better predictive models for VME taxa, e.g. potentially estimate density rather than just presence/absence. However, this was a longer-term goal and New Zealand would not be committing large resources to solving the problem in the short term.

93. Following discussion of SC6-DW14, the SC:

- **Noted** the variability in benthic invertebrate bycatch of different fishing methods and fished areas.
- **Agreed** that further work should be done to assess catchability in both trawl and bottom line fisheries
- **Requests** that work to determine when observed bycatch rates indicate the models used to predict the distribution of VME taxa and underpin spatial management measures are misleading be added to the SC work plan for delivery in 2019.
- **Agreed** that further work should be done to enable more sophisticated use of bycatch data in habitat suitability models and the development of VME indicator taxa thresholds that may inform encounter protocols, where these might be required.

94. New Zealand presented SC6-DW10 "Cumulative bottom impact statistics for SPRFMO bottom fishing methods". Using a slight simplification of the method approved by SC5, it was estimated that the total areal impact of bottom line fisheries in the SPRFMO Area since 2007 (Australian and New Zealand vessels combined) was probably <10 km^2. This is more than three orders of magnitude lower than the areal impact of bottom-impacting trawl fisheries and, thus, bottom line fisheries contribute much less than 1% of total impact. Given the various uncertainties in the analysis, and data quality issues, there are likely to be some biases in the estimation, but none of those biases is sufficiently large to lead to different conclusions about the relative scale of impacts by line and trawl methods.

95. The DSCC asked why the table presented didn't show any difference in the number of cells impacted when the assumed line width was changed. New Zealand responded that, for a longline set to impact another cell, it would have to shift or expand by about 1 km whereas the biggest assumed expansion was only 8 m.

96. Following discussion of SC6-DW10, the SC:

- **Noted** the combined analysis of cumulative bottom impact for Australian and New Zealand bottom line data conducted using the method agreed by SC5;
- **Noted** that the estimated impact of bottom line fishing is more than three orders of magnitude smaller than the estimated impact of bottom trawl fishing in the western SPRFMO Area
- **Agreed** that the potential biases in the estimation of the impact of bottom line fishing are not sufficiently large to alter the main conclusions meaningfully;
- **Agreed** that, based on this analysis and comparison to similar statistics for bottom trawl fishing, bottom line fisheries are unlikely to cause significant adverse impacts on vulnerable marine ecosystems at current or similar levels of fishing effort.

97. New Zealand presented SC6-DW11 on "Methods for designing spatial management areas using outputs from Zonation software and other spatial data".

98. The SC asked whether the ratios in Table 1 should be used to evaluate performance of the application of zonation. New Zealand responded that a greater penalty on Louisville Ridge was due to the scale of fishing operations meaning that the 6-8 nautical mile scale was more appropriate for than a 1 km^2 scale.

99. The NZHSFG questioned the high conservation value layer and asked what information this uses, or whether this layer is a model prediction. New Zealand noted that this layer is based on model predictions which are based on the available distribution data.

100. The SC discussed the value to the fishery later and the catch history used. New Zealand advised that the fishery data used were based on the entire catch history, which includes a period of time when areas were open. It was noted that values may be an underestimate. During the stakeholder engagement process, industry has been given the option to identify areas of higher value.

101. The SC discussed the timeframe for the revision of open and closed areas proposed as part of the spatial management approach. Between 4-6 years was suggested as a reasonable review timeframe.

102. The SC asked how long it would take fishers to find fish in newly opened areas or where there are changes to the areas available for fishing. NZHSFG clarified that most areas are quite small and have previously been fished, so the skippers generally know where fish are already.

103. NZHSFG raised a question about the need for fishery areas being re-opened to be considered as new or exploratory fisheries under Article 22 of the Convention (and CMM13-2016) given they haven't been fished in over 10 years. New Zealand stated that the Convention didn't clearly define a 'fishery', and that this has been considered in the development of the draft bottom fishing CMM.

104. The SC queried how future management would deal with a situation where it is determined that there is a VME in a management area, and as a result the area boundary should change. Would the fishing areas continually shrink? New Zealand responded that it is too early to say how management will respond in future, but that it is considered that there should be regular review of the bycatch data and models that underpin the spatial management regime.

105. The SC asked about the use of the 6 minutes of arc size of the boxes used for the automatic selection and why that size was selected. New Zealand clarified that it was the finest scale SC has previously recommended that would be useful for management. The habitat suitability models and zonation outputs were retained at 1 km^2 to allow that resolution to be considered within the constraints of creating management areas feasible for management. Members discussed the scale to best interpret available scientific information.

106. The SC raised the option that in developing a mandatory review process for VME Indicator encounters (annual), benthic data (annual), and models underpinning spatial management approaches that some consideration could be given to exploring how and what quantity of information gathered from observer data would inform the review of spatial management boundaries. The SC asked if this could be included as a separate layer in zonation or could it only be included in re-analyses of the underpinning habitat models. The SC considered that it might be useful to know how sensitive the zonation and habitat models will be to new information as this may inform the review timeframes being considered. The SC also commented that it would also be useful to incorporate new data into additional runs of the zonation/habitat modelling to determine the sensitivity of analyses to new data and how this should be considered in the review process.

107. DSCC suggested removing the 'naturalness' layer from the zonation analyses to see what impact that would have on the selection of management areas. DSCC also noted the lower protection statistics for potential VME taxa habitat on the Louisville Ridge and the proposal for there to be areas open to fishing within the EBSA on the Louisville Ridge.

108. New Zealand advised the SC that the EBSA layer was not included in the Zonation analysis. This was due to it being a large polygon without additional information. However, the performance of each set of candidate management areas was assessed for the Louisville EBSA. New Zealand is aware that the protection of modelled VME habitat is lower on the Louisville Ridge than in the Tasman Sea. This will continue to be a consideration as the management areas are finalised, noting the difficulties on the Louisville Ridge because of the feature-based, small-scale nature of that area.

109. The US asked about the values used for the automatic selection of 6 minutes of arc (m.o.a.) cells for the conservation value and/or fishing value initial areas, and whether other values had been considered. New Zealand explained that a few values were tested to inform the automated process. It was important to recall that the automated searches were just a starting point for the design of candidate management areas.

110. After discussion of paper SC6-DW11, the SC:

- **Noted** that the process used to design proposed spatial management areas for a bottom fishing CMM combined outputs on conservation priority (for prevention of significant adverse impacts on VMEs) from Zonation decision-support software with information on the distribution and relative value for bottom fishing in different locations;
- **Noted** that the scale of the Zonation input data layers (~1 km) is too fine for realistic management areas (~10s of km);
- **Agreed** that, given the scale mismatch, the use of automated GIS searches followed by expert-based adjustment and consultation with stakeholders is an appropriate process for designing spatial management areas;
- **Noted** that New Zealand and Australia will conduct additional workshops and consultation and may fine-tune the boundaries of proposed spatial management areas for the new bottom fishing CMM.

111. New Zealand presented paper SC6-DW12, "Proposals for a revised conservation and management measure for bottom fisheries within the SPRFMO Convention Area".

112. The SC confirmed that the proposed Oct/Nov 2018 workshop was necessary to finalise the boundaries proposed to implement the spatial management arrangement in the new CMM. New Zealand confirmed that this would not require SC budgetary support.

113. Following consideration of SC6-DW12, the SC:

- **Noted** the fine tuning that has occurred since the Commission meeting in 2018 to the scientific analyses required to underpin a comprehensive bottom fishing CMM for the SPRFMO Area;
- **Noted** that further work is required, and New Zealand and Australia will continue to progress the development of a revised bottom fishing CMM in order to submit a proposed draft CMM to the Commission meeting in early 2019;
- **Agreed** that the scientific approaches applied by Australia and New Zealand can be used to underpin a revised bottom fishing CMM;
- **Agreed** to support, if necessary, an additional workshop in October or November 2018 to finalise the boundaries of spatial management areas or other management controls with stakeholders.

Other deliberations from SPRFMO Observers

114. The NZHSFG did not agree with the third point, that there is enough science to underpin a revised CMM. It was noted during discussions that perhaps the link between the science and the CMM is too strong. VMEs have not been clearly defined, and defining threshold limits should be done in a less arbitrary way.

6.7. Other deepwater topics

115. Australia presented SC6-DW13, "Review of the SPRFMO Bottom Fishery Impact Assessment Standard".

116. The SC welcomed the analysis undertaken by Australia and agreed that there appears to be sufficient ambiguity in the implementation of other SPRFMO instruments to warrant a revision of the BFIAS. Australia and New Zealand offered to progress this review over the coming year with the intent to present a draft of a revised BFIAS back to SC7.

117. Australia and New Zealand noted that under the proposed new bottom fishing CMM that a joint BFIAS could be developed.

118. DSCC welcomed the review and offered to assist in the process of revising the current BFIAS. They considered the option of having combined assessments a good way of examining cumulative impacts.

119. After considering SC6-DW13, the SC:

Recommended that a small intersessional working group be formed by members from Australia, New Zealand and other interested parties to systematically revise the BFIAS and to present a draft to SC7.

7. Squid

7.1. Inter-Sessional Activities

121. Chile presented SC6-SQ02 on "Biological-fishing aspects of jumbo squid, *Dosidicus gigas*, in Chilean waters and its supposed position in population structure in the Southeast Pacific".

122. Squid, *D. gigas*, is registered along the entire coast of Chile. The main fishing areas are concentrated between 32ºS and 38ºS for the traditional artisanal fleet and 36ºS-38ºS for the industrial fleet with mid-water trawls.

123. Fishing has been important since 2003, but since 2012 developed as a target fishery and for human consumption. It has been regulated for the last six years with a Chilean annual catch quota of 200,000 t, with 80% for the artisanal fleet and 20% for the industrial fleet.

124. The Monitoring Program of jumbo squid (INPESCA) between the years 2011-2018 has compiled the biological fishing information aboard the industrial and artisanal motor boats. On the basis of this a temporary space stability of jumbo squid fishing areas that do not extend more than 20-60 nautical miles from the coast was determined.

125. In the catches of both fleets, samples of jumbo squid from 30 to 100 cm are detected, with a predominance of sizes above 60-70 cm between January and September. From May to July they appear (in a minor percentage) and the smaller-sized specimens are predominant in October-December.

126. The presence of two generations of squid in the fishery within the annual season is assumed: those present from the previous year and those incoming during the current year. It is estimated that a cohort remains in the Chilean fishery, from its entry from the adjacent ocean waters (May-June of year 1) to its exit in North-Northwest direction towards the spawning areas (September-October of year 2), at around 15-16 months. The exit of the fishery happens at the approximate age of 21-23 months assuming that spawning happens in November-December of year 0.

127. Concentrations of jumbo squid are found in Chilean coastal zones in an active process of fattening; practically no specimens are registered in a stage of maturation and/or mature. Predominance is detected in the fishing with jiggers of *D. gigas* females above males in a proportion of 2.2-2.5: 1.0; in industrial pelagic fishing a male-female ratio is close to 1.0: 1.0.

128. A conceptual scheme of the population structure of jumbo squid in the Southeast Pacific is proposed. It is composed of three size groups (S, M, L), which have preferences to different bodies of water in fattening but are combined in the same spawning area.

129. According to this proposed scheme, the jumbo squid in Chile is composed mainly of the group of larger sizes ("L"). Its permanence and levels of abundance are dependent on the strength of the seasonal inputs of medium size specimens (Group "M") towards the coastal areas from the adjacent ocean waters where the latter are predominant.

130. There is recurrent detection of the aggregations of the new generation (sizes less than 50-60 cm) in the months of May-July. Its permanence in the fishery until October and its total predominance in the months of October- December can be a predictive indicator for the forecast of the state of the resource for the new fishing seasons.

131. However, during the last two years (2017-2018) there is a concern about the future status of the giant squid off the Chilean coast, reflecting that:

    a) the annual fishery of this resource is concentrated in just one generation (and not in two before 2017) which appears in January and leaves towards spawning in August;

    b) in these years CPUE of the industrial fishing boats decreased as they lengthened times in monthly operations (from 8-10 to 15-20 days). It is supposed that these processes may be related to possible changes in the structure of the jumbo squid population at the southern Pacific level.

132. Peru presented SC6-SQ03 on “Biology, population structure and fishery of jumbo flying squid (*Dosidicus gigas*) in Peru”.

133. Jumbo flying squid is found in high abundance along the whole Peruvian coast from ten to more than 500 nautical miles from the coast. It performs diel vertical migrations from zero to more than 650 m of depth, with regular inshore-offshore ontogenetic migrations and less regular latitudinal migrations of several hundred nautical miles.

134. It is a very aggressive predator, having a wide food spectrum with predominance, in the last 14 years, of cephalopods (42.33%, by weight), mesopelagic fishes *Vinciguerria lucetia* (13.05%) and Myctophidae (12.38%).

135. Observed differences in their size at sexual maturity, growth and distribution areas suggested that there are at least three phenotypic groups or population subunits off Peru. The size frequency distribution in catches by both artisanal and industrial fleets in Peruvian waters has been highly variable. There is a significant shift to much larger sizes that started in 2000, and it became evident in 2001. Since then, squid caught in Peruvian waters have generally been much larger than those caught in the adjacent high seas.

136. The Peruvian squid fishery developed rapidly during the early 1990s, with increased catches by a licensed foreign industrial jigger fleet and a rapidly expanding local artisanal fishery that gradually phased out the industrial fishery. Total Peruvian catches of jumbo flying squid peaked at 556 thousand tons in 2014, all taken by local artisanal fleets.

137. The stock or stocks of jumbo flying squid in Peruvian waters are considered to be underexploited or moderately exploited, and the assessments are based on biomass estimates from acoustic surveys combined with surplus production modelling. The suitability of these and other stock assessment methods is discussed. Particular attention was given to the observed population structure, the presence of three phenotypic groups or possible stock subunits, as well as other characteristics of jumbo flying squid off Peru and what they may imply for the assessment and management of this fishery.

138. Peru informed the SC of the recent publication of its IMARPE Bulletin (Bol. Inst. Mar Perú Vol 33 N° 2, July-December 2018, SC6-INF01) devoted entirely to the publication of 12 scientific contributions dealing with various aspects of the biology, population dynamics and fishery of the jumbo flying squid (*Dosidicus gigas*) in Peru.

139. The 12 articles in this new issue of the Boletín deal with various aspects of squid biology and its fishery. These include topics such as reproduction, sexual maturity, embryonic development, distribution and abundance of paralarvae, age and growth of life stages, spatial and temporal variability in the size frequency distributions and the concentrations of juvenile and adult squids, incidental presence in other fisheries, possible fleet improvements, the Peruvian fishery monitoring system, habitat, migrations, trophic ecology, possible population or stock sub-units, stock assessment, climate variability and the management of the Peruvian fishery.

140. All articles are published in Spanish and English, side by side. A limited number of hard copies as well as electronic versions of this new publication were made available during the SC meeting. It was noted that further copies in PDF version can be freely accessed through the web pages of IMARPE's Digital Repository at: http://biblioimarpe.imarpe.gob.pe/handle/123456789/3238

141. Chile presented SC6-SQ04 on "Diet and feeding of jumbo squid (*Dosidicus gigas*) in the southern Humboldt upwelling system".

142. The trophic spectrum of 2,672 jumbo squid (*Dosidicus gigas*) individuals collected by scientific observers onboard fishing vessels in coastal waters of central-south Chile was analysed. The analysis of diet was carried out during 2014-2017 on a size range between 35-99 cm MDL.

143. A total of 28 prey items (13 fish, 10 crustaceans, 5 molluscs) were determined, with higher values of relative importance index for crustaceans (mainly euphausiids= 14.5%), fishes (Diaphus sp.= 8.1, Lampanyctus sp.= 4.6%, Teleostei indeterminate= 3.9%, *Merluccius gayi*= 3.2%), and molluscs (*D. gigas*= 44.6%).

144. Trophic diversity was higher during 2014-2015 (H'= 1.706-1.484) according to the occurrence of 19-20 preys, while lower diversity values (H'= 0.814-0.878) were observed during 2016-2017 due to a lower number of preys (7), dominated by common hake and jumbo squid (cannibalism), describing a generalist trophic behaviour during 2014-2015.

    Cluster analysis of preys showed that the smaller size-group (G1, ≤50 cm MDL) consumed crustaceans (mainly euphausiids), the intermediate size-groups (G2-G3, 51-70 cm MDL) mainly predated on myctophiids and squids, and the large-size groups (G4-G5, >70 cm MDL) consumed squids (cannibalism) and fish (especially myctophiids).

7.2. Squid Assessment

145. Chile presented SC6-SQ05 on "Depletion models with successive pulses of Humboldt squid (*Dosidicus gigas*) in coastal waters off Central Chile". Due to its short life span, squid stocks are often assessed with intra-annual depletion models. However, there were no descriptions about this type of depletion processes in Chile.

146. Mantle length frequencies and fishing yields were analysed on a weekly basis. A general migration pattern with the arrival of squid in November and their migration in October the following year was identified. This pattern showed variations including the sequential arrival of two or three squid pulses before the migration of the cohort in October.

147. A weekly depletion model was implemented and programmed in Auto Differential Model Builder (ADMB). It was fitted to the relative index of abundance generated by the CPUE standardization from artisanal boats. The model included a prior distribution of the natural mortality with a mean at 1.5 and known standard deviation.

148. The model was adjusted separately for 2014, 2015, and 2016, and generated natural mortality estimates between 0.5 and 0.72. The biomass level varied between 350-400 thousand tonnes, in 2015 and 2016, and 1.8 million t in 2014.

149. Estimation of potential biomass (without fishing) at the end of the depletion period allowed for the estimation of biomass escapement percentages of around 56 to 94%, which were higher than the 40% of escapement recommended to maintain the sustainability of a stock.

150. However, it is likely that squid that escape from the catch in Chile are captured in spawning areas in the EEZ of Peru and in the SPRFMO Area. Also, squid that recruit to Chile are large individuals that have escaped the fishing in the SPRFMO area and in the EEZ of Peru.

151. It is proposed to integrate all the information at a regional level and to develop a scheme of intra-annual stock assessment through depletion models.

152. The SC noted that:

- There are local squid biomass depletion events in Chilean waters. These depletions are not related with stock status. The escapement biomass percentages seem to be greater than recommended.
- The depletion model code in ADMB is available, and SC members can explore and use it.
- The same squid stock fished in Chile might be fished in the Convention Area and coastal country EEZs before and after passing by feeding grounds in Chile.

153. China proposed SC6-SQ06, a paper on a Jumbo Squid (*Dosidicus gigas*) Size-Structured Assessment Model (JSSAM). It is a statistical size-structured assessment model specifically developed and configured for jumbo squid in the South-east Pacific.

154. The model was constructed in ADMB. The purpose of this paper is to demonstrate a model which can potentially be used or further developed for the assessment of Jumbo Squid once the required data and information are available.

155. The paper emphasized the complexity of life history of jumbo squid in South-east Pacific and the difficulty to model their population dynamics.

156. Evaluating the model performance using simulation method to better understand how different sources and levels of uncertainties may affect the model performance (e.g. mis-defining the three phenotypic groups) was recommended for future research.

157. Peru presented SC6-SQ07 on a stock assessment method for jumbo flying squid (*Dosidicus gigas*) in Peruvian waters and its possible extension to the wider SPRFMO Convention Area. This paper was presented in SC6 with the expectation that it will contribute to the fulfilment of relevant squid tasks and objectives of the 2018 Work Plan for the SC.

158. Jumbo flying squid are an incredibly productive species which appear to have adapted to enable them to thrive whatever the environmental conditions. Stock structure is not known for the Southeast Pacific and the squid within any country's jurisdiction at any time are probably only part of a larger more widely distributed stock or stock sub-unit.

159. A traditional stock assessment, using data from all of the major fisheries over an extended history is very unlikely to be successful because of the difficulties of modelling the spatial distribution of the squid and the response to environmental change.

160. In this paper Peru presented and illustrated a method that can be applied to part of a biological stock within a given area over a time period during which the distribution of the stock is reasonably stable. The method requires length frequency and maturity data from the fisheries in the area and also acoustic biomass estimates to provide information on the scale of the biomass present.

161. With multiple time segments assessed within a given area (e.g., the Peruvian jurisdictional waters) a picture of the carrying capacity of that area can be developed. If the areas associated with all of the major fisheries in the Southeast Pacific were assessed in this way, then a picture of the carrying capacity of the Southeast Pacific could also be developed.

162. The proposed method was developed during a stock assessment workshop for jumbo flying squid which was held at the Instituto del Mar del Peru (IMARPE), Callao, Peru, from 11 to 22 June 2018. The main purpose of the workshop was to explore stock assessment methods for jumbo flying squid in Peruvian waters, with the awareness that those squid could be part of a larger stock or stock sub-units.

163. Chile presented SC6-SQ09 on SquidSIM (version 1) on a program to simulate individual, population and fishery components of Humboldt Squid stock on a month scale. Two growth functions (exponential or von Bertalanffy) were included. Maturity was modelled as a logistic function.

164. Two options for modelling stock-recruitment relationship (Ricker or Beverton Holt) with steepness parameters and process errors were included. Three options (constant, exponential and sinusoidal) for seasonal recruitment patterns were allowed. The fishing component includes two fleets with selectivity patterns modelled as double half-normal functions. A length-age key is calculated based on the growth model in order to estimate the mantle length frequency in the population and in the commercial catches.

165. This simulator was coded in R Markdown in R Studio, which allows the user to automatically knit text, R codes, tables and figures to produce a report in html, word and pdf formats. In order to run the simulation with different cases, the parameters must be input in a csv formatted file.

166. Chile also presented SC6-SQ08 which was a report developed in R Markdown to compare results of different cases of Humboldt Squid Stock simulations. It collects the output files of the "Run HSquid_Rmd.R" script. The parameters by cases are shown in tables and the main variables (recruitments, biomass, fishing selectivity, catches, etc.) are shown in graphs.

167. The SC noted that the programme:

- Can simulate the in-season biomass variability.
- Can simulate the monthly length frequencies observed in fleets either fishing for large squid and/or fishing for small squid.
- Is written in Rmarkdown and is open source.

168. In relation to all papers presented on jumbo flying squid stock assessment and modelling, the SC agreed:

- In the last year considerable progress has been made in developing stock assessment methods for jumbo flying squid. Three models have been put forward for use in assessment and each model takes account of jumbo flying squid biology and its short life cycle.
  - The model from Peru appears to be appropriate for the complex population dynamics found in Peruvian waters where mature squid can be found in at least three different size classes (or phenotypic groups) and spawning can occur at any time of the year.
  - The depletion model from Chile appears to be appropriate for the immature squid found in their waters (spawning did not appear to occur in Chilean waters).
  - The length-based model proposed by China, although yet to be used with real data, appears to be an appropriate model for jumbo flying squid.
  - Each of the models should be further developed and tested.
- Stock structure is particularly uncertain for jumbo flying squid and it is necessary to develop a set of alternative stock hypotheses that are consistent with existing data. In addition to possible genetic work, there are simpler tasks that could provide useful information:
  - Ageing of mature animals to determine if the squid that mature at small and medium sizes are much younger in age than those that mature at large sizes (which are known to live up to 2 years of age).
  - Collation and/or collection of maturity data for squid caught outside the Chilean EEZ to determine if spawning occurs in Chilean latitudes.
- Natural mortality is poorly known for jumbo flying squid and efforts should be made to obtain more reliable estimates.
- The successful assessment of jumbo flying squid will require an ongoing commitment from members to collect length frequencies from their fisheries:

    - By sex and maturity stage
    - At least monthly (preferably weekly)
    - Stratified and scaled
- The acoustic target strength of jumbo flying squid appears to be poorly known and experimental exercises, and/or a literature review are required to determine the best length to target strength relationship to use and an appropriate range of uncertainty.
- Information on the scale of jumbo flying squid biomass can be obtained by a well-designed acoustic survey that cover the whole stock area. Although such surveys can be expensive, members are encouraged to consider developing such surveys when and where resources allow.
- It is unclear whether standardized CPUE can provide reliable biomass indices and members are encouraged to investigate approaches for better understanding of the quality of standardized CPUE, for example, using their commercial jig fleet to undertake scientifically designed jig surveys to obtain relative biomass indices if it is logistically possible.
- Although the results are preliminary, the reference points estimated using the Peruvian model show that jumbo flying squid is a very productive species that can probably sustain exploitation rates of 50% while maintaining spawning biomass well above B_{MSY}.
- Though it is out of the Convention area, it is worth noting that given the preliminary results of the Peruvian model it seems unlikely that exploitation rates for jumbo flying squid in Peruvian national jurisdiction waters have ever exceeded 50%.

169. There remain significant uncertainties associated with the status of the stock(s) in the South-east Pacific.

170. A stock assessment workshop is recommended before the next SC meeting.

171. A table comparing stock assessment methods was drafted but the discussions need more time and such comparisons should be pursued in the future.

7.3. Squid assessment data

172. The Secretariat presented SC6-SQ01 "Jumbo flying squid datasets held by the Secretariat". This paper identifies and describes jumbo flying squid data sets held by the SPRFMO Secretariat. It also shows a comparison of the data sets held by the Secretariat versus the FAO data series and provides some starter questions intended to progress a specific task contained in the 2018 work plan being - Reconstruct historical total catch records including non CNCPs and non-members.

173. Based on the discussion of SC6-SQ01, the SC:

- **Agreed** that 1990 is a suitable start year for historic squid data. Prior to this period the catches were smaller (with a noted exception for 1985).
- **Noted** that for all models introduced, fishery (catch and effort) and biological data size frequency, weight and maturity) at a suitable intra-annual time scale is needed.
- **Requests** that relevant members make recommendations regarding their historic catch data;

Recommended that direct correspondence with Japan be done to more accurately represent their data;
Recommended that the Secretariat work with Members to evaluate the potential for double counting of catch (e.g., catch reported by flag and also within EEZs).

7.4. Squid Connectivity

174. China presented SC6-SQ10 on "Genetic assessment of diversity and population structure of *Dosidicus gigas* in the Pacific Ocean". The fast growth and short life span of *D. gigas* make this squid a valuable model to evaluate how environmental fluctuations affect the genetic diversity of marine populations.

175. *D. gigas* is composed of two genetic units in the Pacific Ocean. The first one, composed of individuals from Canada, USA and Mexico and the second one of squids from Peru and Chile. Each genetic unit was characterized by an absence of population genetic structure and a star-like haplotype network.

176. Genetic diversity was related to the molecular marker. The mitochondrial ones showed low diversity compared with microsatellites. Neutrality test, genetic diversity and demographic analyses were consistent with a past population expansion related to oceanographic changes from the last glacial-interglacial transition.

177. China presented SC6-SQ11 on "Standard Operating Procedure of Gene Sequencing for Jumbo Flying Squid in the South East Pacific". The purpose of the standard operating procedure of gene sequencing is to facilitate this work.

178. Biological sample sharing among members and CNCPs can be difficult but sharing and exchanging results of the genome sequencing are relatively easy. Different genetic techniques might have different results, so it was proposed that all Members and CNCPs use the same techniques, software, and calculation approaches to avoid bias and different interpretations.

179. The Chairperson of the squid working group organized a small group meeting to discuss the research about the evaluation of jumbo flying squid stock structure and phenotypes using genetic techniques.

180. Noting the important role of biological sampling, a protocol on jumbo flying squid sampling in the South-East Pacific for genetic study was drafted by the Chairperson. The drafted protocol was discussed and modified by the small working group (Annex 9).

181. All the relevant Members and CNCPs agreed to continue the work intersessionally to evaluate and identify a suitable and optimal genetic technique which can be adopted by all the Members and CNCPs.

182. The exchange of biological information and genetic samples/data was discussed and encouraged in the working group discussion.

183. The SC discussed the planned work and:

- Noted that suitable data analysis methods should be figured out to identify if there were gene diversities among different geographic areas and phenotypes in recent years in the SPRFMO convention area and national jurisdictional area. Following these methods will facilitate exchange of results.

Recommended that members and CNCPs participating in the jumbo flying squid fishery join in the genetic analysis work for this species. This includes facilitating the exchange and sharing of jumbo flying squid samples between Members and CNCPs.
Recommended that coordinators within members and CNCPs be nominated to coordinate data sharing and sampling exchange.
Recommended that a workshop on the jumbo flying squid stock structure and stock assessment be held immediately before the next SC meeting.

8. Ecosystem Approach to Fisheries Management

8.1. *Further developments of standardized oceanographic data products and modelling*

184. Discussions held under agenda items 5.3 and 8.4

8.2. *Seabird / bycatch monitoring*

185. On behalf of the Agreement on the Conservation of Albatrosses and Petrels (ACAP), New Zealand presented SC6-Doc29 "The development of ACAP seabird bycatch indicators, data needs, methodological approaches and reporting requirements". The paper provides a framework for coordinating and undertaking international activity to mitigate known threats to ACAP species, including fisheries bycatch. In order to monitor and report on the performance of the Agreement, a system of indicators following the State-Pressure-Response framework is being developed and implemented. The primary pressure indicator for bycatch comprises two linked components:

(i) the seabird bycatch rate across each of the fisheries of Member Parties, and

(ii) the total number of birds (ACAP species) killed (bycaught) per year (per species where possible).

186. A number of issues are recognised in the paper that need to be considered and addressed when estimating and interpreting these two metrics. These include:

(i) underestimations due to undetected mortality,

(ii) uncertainty in estimation associated with simplistic extrapolations from limited and unrepresentative observed coverage, and

(iii) uncertainty in species identification due to the inaccurate identification of bycaught seabirds by observers (or limitations in the capacity of observer programmes to identify the bycatch at species level).

187. These matters are discussed together with recommendations and guidelines on how they could be addressed for the purpose of consistent reporting and seabird bycatch assessments. It is intended that the indicator should ultimately be able to report cumulative bycatch levels and rates across fisheries for all ACAP (and other threatened) species explicitly accounting for these factors.

188. The SC questioned if it would be useful to ask ACAP to revisit the SPRFMO data collection standards and advise on how they might be updated to better reflect the ACAP data priorities as described in this paper. New Zealand replied that it is not certain of ACAP's role in that regard but agreed that it would be a useful exercise and will follow up with ACAP.

189. The SC queried if New Zealand is aware of e-monitoring approaches being taken and explored globally to gather more data than just relying on human observers. The SC also highlighted the potential value of a paper to SPRFMO that examines the need for observers for biological sampling purposes and other data collection priorities. Such priorities could comprise of quantifying interactions, that could be collected with other approaches and the balance and prioritisation of those requirements. This includes consideration of the number of tasks an observer can complete and the need to prioritise across a range of data needs during their available time at sea. New Zealand agreed this would be a useful topic to explore.

190. There was a brief discussion of the link with the observer programme CMM, noting that it is looking to specify tasks of observers and priorities for data collection and how that data could be collected. New Zealand clarified that the current observer programme CMM is focused on developing an accreditation process and standards to establish a human observer programme. It is not looking at different ways of collecting data at this point.

191. Following discussion of SC6-Doc29, the SC:

- **Noted** the system of indicators following the Pressure-State-Response framework being developed and implemented by ACAP;
- **Encouraged** Members to collect and analyse data on seabird bycatch in a consistent way across fisheries, guided by the recommendations from ACAP; and
- **Encouraged** Members (not only those who are also Parties to ACAP) to report data or results from analyses on bycatch indicators to ACAP.

192. New Zealand presented SC6-Doc30 on observer coverage to monitor seabird captures in fisheries. The paper addressed an item in the 2018 SC work plan item to provide a discussion paper on the interaction and trade-offs between observer coverage levels and Commission management objectives for major SPRFMO fisheries. The paper reviews observer coverage in place in longline and trawl fisheries internationally, identifies limitations inherent in low levels of coverage, and provides guidance on levels of observer coverage appropriate to developing bycatch estimates for seabirds in SPRFMO fisheries.

193. The discussion of the paper began with a clarification of the use of the term bias in the presentation which was defined as a comparison between two estimates. The SC requested more information on why the recommendations focused on 5% and 20%, in particular, asking why 20% is suggested as being considered to provide sufficient information to robustly estimate bycatch. It was agreed that this would be discussed in the margins and the recommendations amended to provide additional rationale for the selection of this number.

194. The NZHSFG highlighted the focus of New Zealand fishers on mitigating seabird captures and noted that the figures presented were modelled estimates, while captures within a fishery are variable. The SC queried whether the risk estimates that compared estimated fatalities to the PBR-like PST threshold took into account the whole range of the species, or only the in-zone. New Zealand clarified that the mortality estimates were for New Zealand fisheries only, and therefore may underestimate total risk to seabird populations.

195. New Zealand clarified that the risk plot in the presentation did not include species where the estimated risk to the population from New Zealand fisheries is negligible, which includes the sooty shearwater, which is traditionally harvested for consumption.

196. Following discussion of SC6-Doc30, the SC:

- **Noted** that the extent of observer coverage needed to generate robust estimates of the frequency and total number of interactions with seabirds varies with the characteristics of the fishery, the species of interest, and bycatch patterns, particularly patchiness and the prevalence of multiple captures; and
- **Noted** that observer coverage of ~5% may be adequate to identify some bycatch risks and issues but is unlikely to enable robust quantification of those issues; and
- **Noted** that international experience suggested that ~20% observer coverage may be sufficient to estimate total bycatch and bycatch of frequently-caught species with a CV of <30% in some fisheries, although data presented by New Zealand show that performance varies among fisheries; and
- **Noted** that observer coverage levels of >50% may be necessary to robustly estimate bycatch of individual species that are caught infrequently but are nevertheless still at risk;
- **Noted** that, in addition to observable bycatch, there can also be unobservable mortality (i.e. “cryptic” mortality) that can vary substantially between fisheries;
- **Advised** the Commission that observer coverage of 20% or more may be required to robustly estimate the incidental mortality of Seabirds, Marine Mammals, and Other Species of Concern in some fisheries, and that design should address multiple influencing factors to obtain representative coverage;
- **Advised** the Commission that periodic review of observer coverage and the utility of the data generated should be used to fine-tune levels of observer coverage; and

- **Seeks guidance** from the Commission on the nature and certainty of its information needs on the bycatch of Seabirds, Marine Mammals, and Other Species of Concern, so that SC can more precisely advise on observer deployment requirements in SPRFMO fisheries.

197. New Zealand presented SC6-Doc31 on the Potential risk to seabirds from interactions with squid jig fisheries in the SPRFMO Area. The paper assesses the overlap between SPRFMO squid jig fisheries and key New Zealand-nesting seabirds. It uses available data on rates of interactions between seabirds and jig fishing operations in New Zealand waters to provide indicative estimates of the potential interactions in SPRFMO squid jig fisheries.

198. It was noted that the paper extrapolates the interaction rate from New Zealand's squid jig fishery (which is relatively close to shore) to SPRFMO fisheries which are further offshore and may have less overlap with seabirds. New Zealand agreed and there was a brief discussion about the limitations of the method, including the extrapolation of interaction rates, and the very non-specific consideration of seasonality of seabird (and fishery) distributions.

199. The SC noted that it would be useful to identify the different squid species being fished by New Zealand compared to the SPRFMO squid jig fishery. The SC suggested that perhaps it would be useful to look in more detail at which seabird species are more likely to overlap with the distribution of the fishery and identify if any of them are at higher risk of impacts from fishing impacts to bound the potential impacts and need for additional data collection. New Zealand noted that there may be some value in doing this, but that there is currently no information on which to base an estimation. It is possible that interaction rates are low, but with the high levels of effort this could still be significant.

200. The SC agreed that there may be some risk to seabird species from jig fishing and encouraged Members and CNCPs to collect additional data to help quantify this risk. The SC asked about the availability of observer data on interactions with seabirds and marine mammals and queried whether this data could be made more accessible to allow for more work to be done on interactions of SPRFMO fisheries with seabirds, marine mammals and other species of concern.

201. Following discussion of SC6-Doc31, the SC:

- **Noted** that a number of seabirds, including albatrosses and petrels, overlap spatially with squid jig fisheries in the SPRFMO area and could be at risk of bycatch;
- **Noted** that bycatch of seabirds occurs in New Zealand and south Atlantic squid jig fisheries, and is likely to occur in SPRFMO squid jig fisheries, given the spatial distribution of seabirds and fishing;
- **Advised** the Commission of the risk posed to seabirds by squid jig fisheries;
- **Encouraged** all Members and CNCPs to collect and report specific data focussed on seabird interactions with squid jig fisheries so that a more robust understanding of interactions and risks can be developed.

8.3. Species of concern

202. The Secretariat presented SC6-Doc09 "A summary of current SPRFMO bycatch records (Including species of concern)", which was a summary of bycatch information held by the Secretariat and originating from fishing activity or observer reports, in order to assist the SC to fulfil its obligations.

203. Fishing activity information from 2007 and observer information from 2008 was presented, and both sets of information were examined for captures of marine mammals, seabirds, reptiles and other species of concern. Notable additions include an increased number of recent Porbeagle shark captures.

204. The Secretariat clarified to DSCC that there are no benthic species on the list of 'other species of concern' at present, and that there has been some recent work considering expansion of the list.

205. A question was raised if the SC would be supportive of looking at capture estimates based on the information in the paper presented by the Secretariat. It was pointed out that without information on the levels of observer coverage associated with the observed interactions, this would not be possible, and the SC suggested that this should be provided in this table in future.

206. The SC raised a concern with potential extrapolation of the data provided in this table. Others considered that it might be beneficial and provide incentive for Members to report on interactions and levels of observation to inform estimates based on extrapolation of available data.

> The SC **recommended** that observer coverage levels and total effort be reported in this summary document in future.

8.4. Report of the Task Team on Ecosystem and Habitat Monitoring

207. The chair of the Habitat Monitoring Task Group presented SC6-Doc07 outlining a proposal for developing activities on the ecosystem approach and monitoring through a synthetic indicator, the habitat, e.g. creating a specific working group within the SPRFMO SC.

208. Following discussion, the SC:

> **Recommended** creating a Working Group (WG) on "Habitat Definition, Description and Monitoring" with the main objective of providing environmental indicators associated to the habitat of the main commercial resources exploited in the SPRFMO area to complement decision making of fisheries management. The terms of reference for this Working Group can be found in Annex 10.
>
> **Recommended** the WG activities to begin with the Chilean Jack Mackerel *Trachurus murphyi* as first case study, continuing with others as soon as possible.
>
> **Recommended** Dr. Mariano Gutierrez from IHMA (Peru) as Chairperson and Dr. Aquiles Sepúlveda from INPESCA (Chile) as Vice-Chairperson for a renewable mandate of 2 years.
>
> For the period 2018-2019, the SC **recommended** that the Habitat WG will:
>
> - 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.
> - Explore the concept of CJM habitat through retrospective analysis (including bibliographical analysis).
> - 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.
> - Explore possibilities to organize a symposium on the topic of pelagic habitat in the 2020s.
> - Organize a workshop on the state of the art of habitat research in the same place as, and immediately before, the SC meeting.

8.5. Other Ecosystem considerations

209. No specific discussions were held under this section.

9. Observer Programmes and Monitoring Approaches

9.1. *Observer coverage trade-offs.*

210. Discussion held under agenda item 8.2 above.

9.2. *Seabird interaction rates by fishery.*

211. Discussion held under agenda item 8.2 above.

9.3. *Observer Programmes CMM*

212. The draft CMM-16 (SC6-Doc08) "Establishing the SPRFMO Observer Programme" was presented to the SC by the Chairperson of the SPRFMO Commission (Mr. Osvaldo Urrutia). The SC was requested to provide comments on the draft CMM, particularly focussing on the elements that are relevant to the functioning of the SC and the provision of data and information required for assessment and management of the different species.

213. After a plenary discussion, a subgroup of the SC went through the draft CMM in detail and provided comments to the different considerations, articles and annexes. Detailed comments and text suggestions by the SC members are provided in Annex 11.

214. The SC **agreed** that a more detailed list of elements for an observer data validation protocol will be agreed by interested Members intersessionally prior to the Commission meeting in January 2019.

10. Exploratory Fisheries

215. To better assess exploratory fishing applications, the SC developed a summary table. This table was considered very useful and has been provided in Annex 12.

10.1. *Exploratory Toothfish Fishing (New Zealand)*

216. New Zealand presented SC6-DW03 on its proposal to extend its exploratory fishery for toothfish. The SC asked for clarification on the potential reasons to explain the observed differences in the estimated mean CPUE for Areas A and B in the fishing undertaken to date. New Zealand advised that this may be associated with the different features in each area and associated abundances of toothfish. The NZHSG also advised that the catch rates in Areas A and B were similar to those that had been reported from the neighbouring CCAMLR regions. These CCAMLR areas are currently closed to fishing but had been open to research surveys four to five years ago. Consequently the comparison provided by the NZHSG needed to be interpreted with the knowledge that they were not estimates from fishing in the same years.

217. The SC asked for clarification on the priority for the collection of bathymetry as an objective of the new proposal. New Zealand advised that collection of this data remained a priority as most bathymetric information for the region was derived from satellites and likely inaccurate. Finding suitable bathymetry is a precursor to setting gear for fishing and information will be collected as part of the exploratory fishing. NZHSG outlined the methodology they apply when identifying a new area for fishing. This includes a grid-based survey of the bathymetry before setting of gear. The NZHSG advised that any existing bathymetry data their vessels collect could be made available to SPRFMO.

218. The SC requested further information on the connectivity between the areas proposed in the exploratory fishing proposals and the CCAMLR populations. New Zealand advised that two tags had been recaptured in the exploratory fishing areas (from fish tagged in the exploratory fishing areas) but no tags had yet been recovered from the CCAMLR area. New Zealand reiterated that the information available to date on the timing of spawning in the exploratory fishing areas appear to coincide with that which has been reported in CCAMLR which gives some evidence that it is a straddling stock between the jurisdictions.

219. The SC asked what the longer-term objective for the exploratory fishing is and whether they expected it to develop into a normal commercial fishery. New Zealand noted that this was a policy decision that they as members of the SC were not in a position to answer. They suggested that any such decision to move into a commercial fishery would not be for some time (5 yrs +). They reiterated that at this stage their priority is the collection of scientific information that would allow such a decision to be made and to contribute to CCAMLR Ross sea stock and its assessment. New Zealand noted that it hadn't considered genetics to assist with stock description and would look to update the data collection plan to accommodate this option.

220. The SC queried whether the catch tonnage was consistent with the precautionary principle, noting that the tonnages were calculated by using the catch rates estimated from 2016 and 2017 and extrapolating these to cover the whole area of the new proposal. New Zealand advised that it was using the mean 2016-2017 catch rate applied to 72 sets to calculate the tonnages which was more precautionary than the 75th percentile which is used in CCAMLR.

221. The SC also queried whether there were any overall effort constraints proposed for the exploratory fishery to add extra precaution. New Zealand noted that in the proposal the number of hooks per set is restricted to a maximum of 6900 hooks per set and 5 sets per spatial cluster with clusters being at least 10 nautical miles in distance from each other (i.e. once 5 sets is reached the vessel must move on). New Zealand acknowledged that this did not place an overall effort restriction. The SC also asked if local depletion could be a possibility if fishing occurred in the same cluster area after a short period of separation. New Zealand recognized that this may be a shortcoming of the proposal and would get back to the SC.

222. The SC noted that there were discrepancies between the figures provided in table 2 and table 3 of the proposal. New Zealand proposed to correct these errors and respond back to the SC.

223. The SC asked for clarification on the expected bycatch in the new areas of the proposal. As this included areas further to the north there could be a chance of increase in bycatch. The SC asked whether it would be prudent to have some catch limits specified for species with high vulnerabilities such as deepwater sharks. New Zealand noted that the information they had available suggested that bycatch rates might be higher but would still be low. Similarly, the risk of interactions with deep water sharks was considered low but catch limits for the species could be considered.

224. The SC note that the proposed recommendation on area and stratification should be specific (at this stage) to toothfish, the current exploratory proposal, and any extension to it.

225. New Zealand modified their proposal based on input received from the SC and provided to Members. For the updated New Zealand Exploratory Toothfish Fishery Proposal, the SC:

- Noted New Zealand's proposal and its Fisheries Operation Plan to extend its exploratory demersal longline fishery for toothfish (limited at 220 tonnes liveweight (= greenweight) retained annually);
- Recognized the cautious, exploratory nature of the proposal;
- Recognized the scientific benefits of the proposed data collection, especially for understanding the distribution, movement, spawning dynamics, and stock structure of toothfishes and can be used to support 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 accepted by SPRFMO for this exploratory fishery for toothfish to facilitate the collection and sharing of data and a similar approach be considered for any future exploratory fisheries for toothfish;
- **Adopted** the Data Collection Plan included in the revised proposal;
- **Advised** the Commission that the revised proposal is acceptable in terms of Articles 2 and 22, CMM-13-2016 (exploratory fisheries), CMM-03-2018 (bottom fisheries), and the BFIAS.
- **Advised** that the proposal adequately addressed 5 out of 5 relevant criteria contained in paragraph 10 of CMM 13-2016.

Recommended that the assessment is adequate given relevant CMMs and that the revised proposal adequately addressed 8 out of 8 relevant criteria for paragraph 8 of CMM 13-2016.
Recommended observer data be provided 30 days prior to the SC meeting.

10.2. Exploratory Toothfish Fishing (EU)

226. The EU presented SC6-DW02 on its proposal for an exploratory Toothfish fishery.

227. The SC asked for clarification on the extent of knowledge about past catches of toothfish on the South Tasman Rise as the SC understood that when the area was fished by Australia and New Zealand in the 1990s there were few if any records of toothfish in the catch history. The EU noted that in preparing their proposal they had not found much literature on past catches for the South Tasman Rise. They indicated that their analyses of the bathymetry suggested that the depths were likely to be suitable for Patagonian toothfish and that Patagonian toothfish were caught in similar latitudes in Uruguay. Past fishing on the South Tasman Rise by Australia and New Zealand was predominately trawl and targeting orange roughy which would have likely been at different depths to that proposed for Patagonian toothfish. Trawl fishing is also less likely to include toothfish captures.

228. The SC raised concerns that managing and minimising bycatch interactions may not be adequately addressed in the proposal, in particular incidental catches of orange roughy (considered to be in an overfished state in the south Tasman rise), deepwater sharks (high vulnerability to fishing), seabirds and marine mammals. The SC suggested that a risk assessment be prepared to better allow the likelihood and consequences of bycatch interactions to be evaluated and the adequacy of proposed avoidance and mitigation measures in the proposal to be assessed. The SC noted that the proposal included a move on rule if skates or rays make up more than 5% catch (compared to toothfish catch). However, this didn't include deepwater shark species and the SC suggested that inclusion of deepwater sharks in the move on rule would be preferable. The SC pointed the EU to its recent work on risk assessments for deepwater sharks as a useful starting point. The SC also noted that the move on rule only related to the catch of toothfish and therefore if there is no toothfish were caught, the bycatch limit would not work as intended. The SC also noted that there may be increased chances of marine mammal and seabird interactions given the close proximity of the South Tasman Rise to land. The SC provided the authors with a list of marine mammals known to occur in the South Tasman Rise. The SC referred the EU to CMM14b-2018 and suggested that the data plan in the proposal would be improved if it used language on monitoring of mammals, reptiles and birds that was consistent with this CMM. The SC noted that it expected that risks of SAI from interacting with VMEs with the gear proposed were likely to be low.

229. The EU thanked the SC for these suggestions. It noted that the proposed move on rule could be easily strengthened to minimise risk to deepwater sharks. The EU clarified that it had no interest in developing a fishery for deepwater sharks. It also recognised the current move on rule needed to be modified to account for scenarios where toothfish catch was low but bycatch interactions sufficiently high. The EU proposed that they would look into develop thresholds for certain vulnerable species. The EU advised the SC that its experience in the south Atlantic showed interactions with marine mammals with the gear proposed was likely to be low. In the south Atlantic fishery there has only been reported one whale entanglement and no seals or sea lion interactions.

230. The SC noted that an exploratory fishing proposal should describe arrangements made to share information and apply management procedures that are equivalent to those imposed in neighbouring areas. The South Tasman Rise extends into the Australian EEZ where it is closed to fishing and considered a marine protected area. The SC requested information on how the proposal would be consistent with Australia's management of the South Tasman Rise and its other domestic arrangements in the neighbouring areas to manage fisheries and bycatch interactions. This included toothfish fishery operating at Macquarie Island where the EU noted that some connectivity with the South Tasman Rise is likely. The EU undertook to converse with Australia on these matters in the margin of the meeting.

231. The SC requested clarification on the catch limits proposed for toothfish in the proposal (whether they applied to both species) and how these were derived. The SC noted that the catch limits proposed were approximately 10% of the current TAC for Macquarie Island. In particular the SC sought information on how comparable the catch limits were to the New Zealand fishing plan for Antarctic toothfish and whether they were sufficiently precautionary.

232. The EU modified their proposal based on the input initially received from the SC and provided the updated proposal to members. The EU noted the limited time available here at the meeting, as well as lack of access to data and experts in the relevant fields at short notice. As such, the EU was unable at this stage to present any detailed risk assessment work on potential impacts on at-risk species, which had been raised during initial discussion as something important for this proposal to consider to be viewed favourably. Such species include seabirds such as the larger albatrosses and petrels, reptiles and mammals. The EU stated that they would engage an expert in ecosystem modelling who should be able to undertake this work in the coming months and commits to add this into the proposal. It will also add latest developments, such as the collaboration with Oritain Ltd and Museums Victoria. The EU noted conversations they had with experienced longline and orange roughy fishermen who stated that orange roughy is not a species caught on longlines.

233. In regard to the updated European Union Exploratory Toothfish Fishery Proposal, the SC:

- **Noted** the European Union's proposal and its Fisheries Operation Plan for an exploratory demersal longline fishery for Patagonian toothfish (limited at 45 tonnes liveweight (= greenweight)) to occur for no more than 3 weeks during one year and consist of no more than 120 sets of 5000 hooks/set
- **Noted** the commitment by the European Union to provide a detailed risk assessment by engaging with experts on potential impacts on at-risk seabirds such as the larger albatrosses and petrels, reptiles and mammals, and deepwater sharks prior to submission of the proposal to the 7th meeting of the SPRFMO Commission
- **Advised** that development of a data collection plan is contingent on the extent to which requirements outlined in paragraphs 5 and 8 of CMM 13-2016 are addressed
- **Recognized** the importance of data sharing and collaboration with neighbouring jurisdictions
- **Advised** that the proposal adequately addressed 1 out of 7 relevant criteria, partially addressed 5 out of 7 relevant criteria, and did not adequately address 1 out of 7 relevant criteria for paragraph 8 of CMM 13-2016:
  - **Noted** that the criterion the proposal did not address is related to the risk assessment for birds, reptiles, mammals, and deepwater sharks and is planned to be addressed prior to the Commission meeting

- **Noted** that the criteria the proposal partially addressed all relate to the uncertainty around the presence of toothfish in the proposed fishing area and impact on VME and bycatch species

- **Advised** that the proposal adequately addressed 2 out of 4 relevant criteria, and partially addressed 2 out of 4 relevant criteria, for paragraph 10 of CMM 13-2016:
  - **Noted** that the criteria the proposal partially address are all related to the proposed fishing being to determine presence/absence of the resource in the area.

Recommended observer data be provided 30 days prior to the SC meeting.

10.3. *Exploratory Pot Fishery*

234. The Cook Islands presented its Fisheries Operation Plan for an Exploratory Potting Fishery in the SPRFMO Area (SC6-DW01). The SC Chair clarified that discussion of the proposal for the SC was on whether the proposed fisheries operation plan adequately addressed scientific aspects of the CMM to warrant continuance to a second year of exploratory fishing. The recommendation of the SC to the January 2019 Commission should be based on the documentation provided to SC. The SC Chair outlined that the current CMM14b has a conflict in timelines with the proposed end of year 1 fishing not occurring until after the SC would next meet to review progress. The SC Chair suggested that the timeline could be altered to the first 4 trips to be reported and reviewed by SC and used to provide advice to the Commission. Trips 5 and 6 proposed for the first year would then proceed after the Commission meeting. The SC Chair also reminded the SC that relevant parts of CMM14b for the SC to consider are described in paragraphs 24, 25, 26 of the CMM.

235. The SC asked for further clarification on the reasons behind the vessel change to the *Altar 6* and whether this may compromise the advice the SC provided to the Commission in 2017. The Cook Islands advised that the new vessel has a lower gross tonnage than that originally proposed and consequently did not envisage any increase in risk to the resource from use of this vessel. The SC asked that the description of the *Altar 6* be provided in the proposal. The Cook Islands noted in response that with the 1000 t a year catch limit that the vessel needed to only have capacity for 340 t

236. The SC requested more information on how the catch limits were estimated and whether they were sufficiently precautionary and commensurate with the objectives of the exploratory CMM. In particular the SC was concerned that the effective fishing area for each pot used by the Cook Islands to calculate its proposed catch limit could result in an overestimate of biomass in the area, which would translate into an underestimate of the potential fishing mortality the proposed catch would impose on the stock. The SC noted that a quick literature search (albeit dominated by more inshore fisheries and including some other species) report effective fishing area of 500 to 6000 m^2 whereas the Cook Islands proposal uses 10 to 100 m^2. The SC suggested that it would be beneficial if the assumptions underlying how the biomass estimates were determined were also clearly described in the proposal.

237. The Cook Islands reminded the SC that the proposal put to SC5 in 2017 was 3000 tonnes which was based on the catches reported historically from the areas (in the early 1990s). This was subsequently revised to 1000 tonnes which they considered precautionary. The SC noted this amount was (as an example) considerably more than the ~450 t annual catch limit that applies to all Australian fisheries in SPRFMO. The NZHSG noted that there are not many other deepwater lobster fisheries around the world making it difficult to draw on the experience of others to guide catch limits and their impacts. The SC noted that some of the literature it was aware of included high seas lobster fisheries. The Cook Islands agreed to come back to the SC with information on how its calculations were made.

238. The SC requested that more explanation be provided on the merits and limitations of applying a depletion model for these species. The SC was concerned that there are numerous examples where depletion models have not been reliable or robust to uncertainties in assumptions.

239. The SC noted that there were several other areas where the proposal needed revision to align the Fisheries Operation Plan with CMM14b. These include the reporting of seabirds and marine mammals and the use of video over-hauling stations. The SC also noted that the proposal mentions that if conditions aren't favourable or no intended target species are caught, fishing will move to another seamount. CMM14b specifies eight seamounts to be fished, so the proposal to move to an 'alternate' from the identified eight seems inconsistent with CMM14b. The SC also requested clarification on whether the eight-seamount limit was per year or overall.

240. In the last SPRFMO Commission meeting, held in Lima, Peru, the Cook Islands presented a revision of its proposal for an exploratory pot fishery in the SPRFMO Area, explaining how they took into account the advice received from the SC at its Fifth Meeting. The Commission acknowledged that the proposal now met SC advice on the fishing effort and the total allowable catch. Taking into account the advice of the SC, the Commission adopted the proposal noting that the Cook Islands will present the outstanding information required under CMM 13-2016. It is further noted that the Deep-Sea Conservation Coalition voiced concerns that in its opinion the proposal did not meet the standards required by the SPRFMO measures for the protection of seabirds and for bottom fishing.

241. The Cook Islands modified their initial proposal to SC6 based on the input received from the SC and provided the updated proposal to Members. Based on the updated proposal, the SC:

- **Noted** that under CMM 14b-2018 (Exploratory Pot Fishery in the SPRFMO Area), the Cook Islands presented a revision of its proposal of the Fisheries Operation Plan (FOP) in the SPRFMO Area, with consideration of the advice received from the 6th SC.
- **Noted** that no exploratory activity has been done to date, therefore its recommendation is based on the current standing of the FOP.
- **Noted** further consideration of literature values that report effective fishing areas of 500-6000 m^2 per pot, which are notably different than the values reported in the proposal.
- **Noted** that one literature paper was for deepwater crab species in the Pacific (which has an effective area of 564 m^2) yet others are for other lobster/crab in other coastal areas.
- **Noted** that the proposal did not consider the implications that such values would have on estimated exploitation rates, which SC noted could be 5% for Jasus species but could at the extreme range up to 60%.
- **Noted** three options to address precautionary catch limits:
  - **Option 1**- Although no detailed analysis is presented in the proposal, lowering the catch limit for the second year so as to reduce the potential risk of exploitation and localized depletion from two years of fishing at 1000 t, which would be commensurate with a gradual and precautionary approach for an exploratory fishery. Noted that no current fishing data exist to inform catch limit.
  - **Option 2** - Alternatively, lowering the catch in the first 30-day trip of year two to a value less than 333 t, which is one-third of the current yearly catch limit, to reduce potential risk of exploitation and localized depletion and allow for further data analysis to inform decisions.
  - **Option 3** - Alternatively, year 2 fishing could be delayed until further data is collected and analysed to inform a precautionary catch limit for future fishing activities.
- **Revised** the Cook Islands Data Collection plan from the proposal to:
  - include clear indication that once fishing occurs on a seamount, that seamounts become part of the limit of 8 seamounts total within a year, and
  - that threshold limits for VME move-on rules for this exploratory fishery be adopted as stated in Appendix 7 of the proposal
- **Advised** that the proposal adequately addressed 1 out of 7 relevant criteria, partially addressed 4 out of 7 relevant criteria, and did not adequately address 2 out of 7 relevant criteria for paragraph 8 of CMM 13-2016.
- **Noted** that the criteria the proposal did not address were all related to catch limits, and that the criteria the proposal partially addressed all related to the proposed VME threshold.

- **Advised** that the proposal adequately addressed 1 out of 5 relevant criteria, and partially addressed 4 out of 5 relevant criteria, for paragraph 10 of CMM 13-2016:
- **Noted** that the criteria the proposal did not address were all related to the design of proposed depletion studies and the determination of effective fishing area, and the design of the camera study for identifying VME interactions.
- **Advised** that the proposal partially addressed 2 out of 3 relevant criteria, and did not adequately address 1 out of 3 relevant criteria for paragraph 24 of CMM 14b-2018:
  - Noted that the criteria the proposal partially addressed were related to the design of proposed depletion studies, design of the camera study for identifying VME interactions, and the sustainability of proposed catch level.
  - Noted that the criterion the proposal did not address related to the significance of the proposed catch level

Recommended observer data be provided 30 days prior to the SC meeting.

11. Other Matters

11.1. *SC Workload/Capacity building/SC protocol*

242. The SC noted that the number of papers and work presented in plenary continues to grow. As such the SC recommended that the Secretariat develop guidelines for presentations during plenary discussions.

243. These guidelines should consider:

- Describe clearly the SC research question being addressed. Indicate if the presentation is an 'update from previous work', 'new unfinished work' or considered a 'final product':
  - Update from previous work: Similar advice / recommendations can be expected as in years before
  - New unfinished work: take the presentation as FYI (one or two slides of main points)
  - Final product: advice / recommendations will follow at the end
- Omit large, unreadable tables
- Finish with a slide that requests advice / provides recommendations to the SC
- Presentations should be less than 15 minutes
- Use one slide per minute as a rule of thumb
- If more than 15 minutes is needed seek permission from Chair or SC

11.2. *Scientific support fund*

244. The Secretariat provided an update on the Status of the fund for "Scientific Support". The indicative expense plan from SC5 was followed closely, although there was no spending for deep-sea research. Forecasting through to SC7 indicates there will be $16,500 which is not committed that can be carried over to the 2019-20 financial year if not spent.

245. The SC was disappointed to be using scientific funds to ensure the attendance of key Secretariat staff, given the importance of that attendance to the meeting. The SC Chair also highlighted the opportunity for Members to request support for attendance at or participation in specific activities.

11.3. *VMS data*

246. The Secretariat presented paper SC6-Doc12 on the SPRFMO VMS recently implemented at the Secretariat. The SC suggested to streamline SC access to VMS data provided appropriate objectives are specified.

11.4. *CMM on scientific sampling - SC6-Doc32*

247. New Zealand presented a proposal for development of a draft conservation and management measure to enable research in the SPRFMO Convention Area. The paper includes proposed principles to guide research, criteria for defining types of research, and reporting and/or approval requirements for each type of research.

248. The Secretariat noted that research is currently a gap and that low impact methods such as plankton tows (e.g., New Zealand to CCAMLR through SPRFMO) or benthic grabs (e.g., benthic grabs to support VME models) currently require fishing authorization. They were therefore encouraged to see a proposal coming forward that supports research in the SPRFMO area without requiring authorization to take fisheries resources. Although they highlight the need to think about how current fishing rules, exploratory fishing and research fishing work together.

249. The SC noted that Chilean research catch is included within their entitlement, and they would like to see this included within the proposal. New Zealand responded that the proposal provides a mechanism for research but isn't the only mechanism for research. For example, it could already be discounted against a members TAC, in which case only a registration of the activities would be required.

250. The SC queried if the limits for some species and bottom contact was based on any scientific research. New Zealand responded that they weren't, with the exception of bottom contact, for which 5 km^2 seems about the amount a study would need to achieve an "adequate" survey. DSCC noted they would prefer an impact evaluation rather than 5 km^2 limit.

251. The SC noted that the proposal was focussed on orange roughy and it was unclear how it would apply to other fisheries resources (e.g., chub, jack mackerel), especially those that might be important within zone but less important in the SPRFMO area. The SC was concerned that the proposal could constrain the ability to undertake research on resources that are abundant within national jurisdictions and require some extension of research into convention area.

252. The SC queried if the proposal would allow current TACs to increase beyond what they are at present and if there should be a cap on research requests and/or total scientific TAC. New Zealand responded that increases in current quotas would need to be evaluated on a case by case basis, or alternatively, that TAC would need to be adjusted to allow for research. The SC suggested that a cap could be put on the total amount of research quota, and New Zealand agreed that this should be explicitly considered. New Zealand also noted that for flag states with current TAC already, proposed research above the TAC threshold is allowed for under row 2 of Table 1, and thus would not necessarily increase the TAC for that flag state.

253. The SC also queried if the notification could be for multiple years, which New Zealand confirmed was the case.

254. New Zealand emphasized that the intention of the proposal was to be enabling rather than restrictive and was not any requirement for approval for a research activity to occur, but to provide a notification of activity with minimal administration involved. The SC agreed that all research within the Convention area should be reported to the Secretariat.

255. Following feedback from the SC, New Zealand amended the proposal and the SC:

- **Noted** the current lack of a mechanism to provide for research activities in the SPRFMO Convention Area;

Recommended that the Commission adopt a Conservation and Management Measure to provide for research activities in the Convention Area taking into account the following key principles:

- Research should be enabled within sustainable limits.
- Different types of research should be recognised and considered in terms of the risks and opportunities for the fishery resources managed by the SPRFMO Convention.

- Research that will have additional impacts on SPRFMO target species or the wider ecosystem should have a high probability of meeting research objectives and contributing to SPRFMO's objectives and the SC's work plan.
- Catch of fishery resources taken during scientific research should be accounted for within sustainable yield estimates, catch limits, and estimates of stock status as appropriate.

- **Agreed** that two categories of research (low-impact research and fishing research) be defined in the Conservation and Management Measure to enable research activities in the Convention Area

Recommended that, based on the risk to sustainability and the importance of avoiding significant adverse impacts on VMEs, low-impact research be defined as research meeting either of two scenarios:

1) Where there is not expected to be any additional impact on SPRFMO target species or the wider ecosystem, noting that 'additional impact' will need to be clearly defined, or
2) Where the research will be carried out during normal fishing operations and all catch will be accounted for within current impact assessments and catch limits.

- **Suggested** that criteria to define 'additional impact', for the purposes of defining 'low-impact' research, should consider a) a maximum catch of species for which there is a SPRFMO catch limit, b) a limit on the amount of bottom contact, c) a limit on total fish catch in the research, and d) impact on the ecosystem in the course of a year.

Recommended that research that is expected to have additional impact on target species or the wider ecosystem be assessed by the SC against the key principles and the Commission consider each proposal based on advice from the SC, including potential advice on incorporation of the research catch within relevant catch limit advice, noting that 'additional impact' will need to be clearly defined.

Recommended to the Commission that low-impact research be notified to the Secretariat at least two weeks in advance, containing information on the planned activities including but not limited to:

- Vessel(s) to be involved
- General area of research
- Expected timeframe for research
- Objectives of the research (e.g. biomass estimate for X species)
- Expected maximum catch
- Expected bottom contact area (if any)

- **Agreed** that New Zealand will work intersessionally with other members to provide advice on a definition of 'additional impact' to inform development of a draft CMM to be presented to the Commission in January 2019.

11.5. *MoUs and Outside arrangements*

256. The Secretariat presented papers SC6-Doc28, SC6Doc33 and SC6Doc34 all detailing external arrangements. The SC **expressed** its support for FIRMS participation. Regarding ABNJ the SC was cautious about cost, but generally in favour and **noted** that SPRFMO is the largest area in ABNJ.

257. In regard to CCAMLR the SC strongly **encouraged** renewing and progressing the arrangement and suggested including an item addressing observer programme knowledge exchange

12. Next Meeting and Election of Chairpersons

258. There were no offers for hosting the next SC meeting. The Secretariat developed a table (Annex 13) to record future possible venues and the SC **recommended** that this table be forwarded to the Commission to encourage commitments.

12.1. *Election of Chairs*

259. Dr James Ianelli was re-confirmed as the SC Chair (including JM WG). The SC was extremely grateful that he was willing to accept the position for a further 2-year term but noted that he was unlikely to extend. Mr Niels Hintzen was re-confirmed as vice-Chair.

260. Dr. Gang Li was re-confirmed as the Chairperson for the Squid WG. There were no offers for the position of Chairperson for the deepwater WG.

261. New officers for the Habitat WG are Dr. Mariano Gutierrez from IHMA (Peru) as Chairperson and Dr. Aquiles Sepúlveda from INPESCA (Chile) as Vice-Chairperson for a renewable mandate of 2 years.

13. Adoption of Report and Meeting Closure

262. The report was adopted at 10:30pm, September 14, 2018.

SPRFMO SC6-Report
Annex 1. Collated Advice from the SC

1. Jack Mackerel

Intersessional Assessment/Research (SC6-Report, Section 5.1)

In summary the SC:

- **Noted** that the comparison between self-sampling data and observer data in the EU Jack mackerel fishery showed reasonable agreement in species compositions and length distributions of Jack mackerel during hauls that were observed through both methods.
- **Noted** that a full coverage in time and space was achieved in the self-sampling programme whereas a more limited coverage was achieved in the observer programme.
- **Noted** that the observer programme delivers more detailed biological data on age, sex and maturity than the self-sampling programme.
- **Noted** that additional verification of the self-sampling programme may be derived from Electronic monitoring that records the self-sampling process.
- **Agreed** that self-sampling can provide a valuable addition to the observer programme by extending observations to more seasons and area
- **Encouraged** that members explore the possibility of utilizing self-sampling programmes to complement the observer programme.
- **Encouraged** that within self-sampling programmes, members explore the application of EM as additional verification tools.

Following discussion of SC6-JM02 (*Spatio-temporal dynamics of the Chilean Jack mackerel of the Chilean jack mackerel fishery off central-southern Chile, 2017-2018 period),* it was noted that fishing strategies and fleet-specific decisions can influence CPUE and size compositions in the catch due to different patterns of fish distribution and changing oceanographic conditions.

- To the extent practical, the SC **noted** that such factors should be considered in the CPUE standardisation and for evaluating selectivity estimates of the S-C Chilean fleet.

Jack Mackerel Stock Assessments (SC6-Report, Section 5.3)

- The SC **noted** that assessment model sensitivities evaluating alternative growth for Jack Mackerel, which suggested faster growth of jack mackerel off Chile and in the high seas, result in substantial downward scaling of SSB and increase in estimated fishing mortality (SPRFMO-2018-SCW6).
- Furthermore, the SC **noted** that these sensitivities do not affect, in the short term, sustainable exploitation of jack mackerel.

Advice to the SPRFMO Commission (SC6-Report, Section 5.5)

- 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 growth of jack mackerel has been underestimated. These two factors warrant additional precaution and further investigation.
- the SC **recommended** a revision of the Harvest Control Rule and requests the Secretariat seek funds for re-evaluating the current management strategy and develop an alternative that is robust to assessment uncertainties.

2. Deepwater Fisheries

Orange Roughy Assessments (SC6-Report, Section 6.2)

After considering SC6-INF02 (*The 2014 Orange Roughy Stock Assessments*), the SC:

- **Noted** that New Zealand's 2014 assessment of the biological orange roughy stock that includes the Westpac Bank was reviewed by New Zealand's working groups and is appropriate to support management.
- **Noted** that the stock assessment estimated the biomass of the stock to be 42% B_0, estimated an annual yield of 1,764 tonnes to maintain the biomass of the stock at or above 35% B_0, and that the current total allowable commercial catch limit for the entire area applied by New Zealand is 1,600 tonnes.

Deepwater Data Collection (SC6-Report, Section 6.3)

Following the discussion of SC6-DW05 (*Design of acoustic surveys and sampling for Orange roughy stock assessments*), the SC:

- **Recommended** that the SPRFMO Secretariat make sure that the protocol is visible on the SPRFMO website.
- **Accepted** the recommendation of the paper, including the proposed specification to "spawning aggregations of orange roughy" and also suggested that an alternate to the word yardstick be used.
- **Agreed** that the generic acoustic survey design described here is appropriate for spawning aggregations of orange roughy within the SPRFMO Area and
- **Adopted** it as a standard for considering research proposals for such work.

Other Stock Assessments Including Ecological Risk Assessment (SC6-Report, Section 6.5)

Following the discussion of SC6-DW08 (*Quantitative risk assessment for Deepwater sharks caught in SPRFMO bottom Fisheries*), the SC:

- **Noted** that there are a number of species assessed to be at high or extreme vulnerability to fishing using demersal trawl, midwater trawl and demersal longline gears.
- **Noted** that the results are precautionary as they may include false positives (species assessed to be at a higher vulnerability than reality) due to assuming that the degree of interaction with the fishing gear is higher than what actually occurs.
- **Noted** the results may also include some false negatives (species assessed to be low vulnerability that are actually higher in reality) due to a lack of reporting species interactions with fishing gears or poor species identification.
- **Noted** that the assessment has highlighted information gaps on the identification, productivity, distribution, stock structuring and other life history attributes for many species.
- **Noted** that the assessment has highlighted that additional work on post capture mortality and gear selectivity of deepwater chondrichthyans would aid future analyses and inform potential future mitigation strategies that would minimise risk associated with susceptibility.
- **Noted** that additional work would be attempted to refine the spatial resolution used in the analysis, and an update on this would be provided to SC7 in 2019.
- **Recommended** to the SPRFMO Commission that identification protocols and biological data collection for deepwater chondrichthyans is strengthened for SPRFMO demersal fisheries.

Following the discussion of SC6-DW07 (*Update on progress on PSA and SAFE ecological risk assessment for secondary teleosts)*, the SC:

- **Noted** that the methodological assumptions and results of this assessment are preliminary and will need further refinement.

- **Noted** that a provisional species list has been developed and was used for this assessment but contains some species outside SPRFMO's mandate and potentially species that do not interact with SPRFMO fisheries.
- **Noted** that the results, once refined, may help the SC prioritise species for consideration for other non-standard assessment approaches as part of the categorisation of SPRFMO demersal species into the tiered assessment framework.

Following the discussion of SC6-DW06 (*Interim categorisation of SPRFMO species into tiered assessment framework)*, the SC:

- **Noted** that the species list and the preliminary categorisation of stocks into the SPRFMO tiered assessment framework is a work in progress and Australia and New Zealand will continue to work together to refine them
- **Noted** that the preliminary categorisation of species into the tiered assessment framework highlights a number of potential assessment options at Tier 1 and Tier 2
- **Noted** that the preliminary categorisation could be used in conjunction with the results of the teleosts ecological risk assessment to prioritise stocks into Tier 3 (as well as strengthening justification for assessment of species at Tiers 1 and 2)
- **Recommended** that this work is continued and supported as part of the SC workplan.

Revision of Bottom Fishing CMM (SC6-Report, Section 6.6)

The SC **recognised** that, for SPRFMO, the best option to develop thresholds from those proposed by that workshop was arbitrary but based on actual historical catch records, and that:

a. catch records could come from the fisheries for which a threshold is required, with or from similar fisheries, and
b. thresholds could be based on medians, percentiles, or other metrics

Following discussion of SC6-DW09 (*Methods of deriving thresholds for VME encounter protocols for SPRFMO bottom fisheries)*, the SC:

- **Noted** that a data-informed approach has been used to identify a range of candidate thresholds, but the selection of a final VME taxa threshold for bottom trawls is a somewhat arbitrary process;
- **Noted** that insufficient data on VME distribution and density and on trawl catchability exist to apply more sophisticated methods;
- **Noted** that insufficient data from bottom longline fisheries exist to develop a data-informed VME indicator taxa threshold for that method, but within this context **noted** that, based on the cumulative impact assessment for bottom line fishing, line fishing within candidate areas open to fishing (which are yet to be finalized) are likely to have risks to VMEs several orders of magnitude lower than bottom trawl fishing.
- **Agreed** that two VME indicator taxa thresholds for bottom trawl have been estimated (a weight threshold and a biodiversity threshold):
    - a catch of any one of the six most commonly-caught VME taxa over a taxon-specific threshold weight (based on the 99th percentile of the distribution of historical positive catch weights); or
    - a catch of three or more VME taxa over a taxon-specific qualifying biodiversity weight (based on the 80th percentile of the distribution of historical positive catch weights);
- **Agreed** that the taxon-specific weight thresholds are:
    - for individual VME indicator taxa referred to in the first component would be 50 kg of Porifera, 15 kg of Gorgonacea, 250 kg of Scleractinia, 5 kg of Antipatharia, 40 kg of Actinaria and 60 kg of Alcyonacea.

    - for the VME indicator taxa referred to in the biodiversity component, their associated qualifying weights for the biodiversity component, would be 5 kg of Porifera, 1 kg of Gorgonacea, 5 kg of Scleractinia, 1 kg of Antipatharia, 5 kg of Actinaria, 1 kg of Alyonacea, 1 kg of Stylasteridae, 1 kg of Pennatulacea, 1 kg of Crinoidea, 1 kg of Brisingida.
- **Reaffirmed** that fine resolution data should continue to be collected on the quantities and type of all interactions with VME indicator taxa, regardless of the volume or diversity and that this should be reported to the Secretariat.
- **Recommended** that Annexes 1 and 3 of CMM02-2018 be updated to include a requirement for data on bycatch of benthic species to be reported in logbooks to fill a current gap in the understanding of the frequency of interactions with benthic species, particularly in bottom line fisheries.
- **Agreed** that the VME indicator taxa thresholds can be used to inform management measures additional to spatial management areas to prevent Significant Adverse Impacts on VMEs.
- **Recommended** a mandatory review process for VME Indicator encounters (annual), benthic data (annual), and models underpinning spatial management approaches (roughly every 5 years or when evidence suggests those models are misleading), and to include the development of the review process in suggested SC work plans for consideration by the Commission.
- **Recommended** that bottom fishing nations should provide detailed analysis of all benthic bycatch data and particularly those fishing events that exceed the thresholds described herein for annual review by the SC

Following discussions of SC6-DW14 (*Benthic Sampling and bycatch data, Including VME taxa, in SPRFMO bottom Fisheries*), the SC:

- **Noted** the variability in benthic invertebrate bycatch of different fishing methods and fished areas.
- **Agreed** that further work should be done to assess catchability in both trawl and bottom line fisheries.
- **Requests** that work to determine when observed bycatch rates indicate the models used to predict the distribution of VME taxa and underpin spatial management measures are misleading be added to the SC work plan for delivery in 2019.
- **Agreed** that further work should be done to enable more sophisticated use of bycatch data in habitat suitability models and the development of VME indicator taxa thresholds that may inform encounter protocols, where these might be required.

Following the discussion of SC6-DW10 (*Cumulative Bottom Impact for Line Fisheries in the Western SPRFMO Area, 2007 to 2018)*, the SC:

- **Noted** the combined analysis of cumulative bottom impact for Australian and New Zealand bottom line data conducted using the method agreed by SC5;
- **Noted** that the estimated impact of bottom line fishing is more than three orders of magnitude smaller than the estimated impact of bottom trawl fishing in the western SPRFMO Area;
- **Agreed** that the potential biases in the estimation of the impact of bottom line fishing are not sufficiently large to alter the main conclusions meaningfully;
- **Agreed** that, based on this analysis and comparison to similar statistics for bottom trawl fishing, bottom line fisheries are unlikely to cause significant adverse impacts on vulnerable marine ecosystems at current or similar levels of fishing effort.

After the discussion of paper SC6-DW11 (*Methods of designing spatial management areas using outputs from Zonation*), the SC:

- **Noted** that the process used to design proposed spatial management areas for a bottom fishing CMM combined outputs on conservation priority (for prevention of significant adverse impacts on VMEs) from Zonation decision-support software with information on the distribution and relative value for bottom fishing in different locations;
- **Noted** that the scale of the Zonation input data layers (~1 km) is too fine for realistic management areas (~10s of km);
- **Agreed** that, given the scale mismatch, the use of automated GIS searches followed by expert-based adjustment and consultation with stakeholders is an appropriate process for designing spatial management areas;
- **Noted** that New Zealand and Australia will conduct additional workshops and consultation and may fine-tune the boundaries of proposed spatial management areas for the new bottom fishing CMM.

Following consideration of SC6-DW12 (*Summary of scientific underpinnings of proposals for a revised bottom fishing CMM*), the SC:

- **Noted** the fine tuning that has occurred since the Commission meeting in 2018 to the scientific analyses required to underpin a comprehensive bottom fishing CMM for the SPRFMO Area;
- **Noted** that further work is required, and New Zealand and Australia will continue to progress the development of a revised bottom fishing CMM in order to submit a proposed draft CMM to the Commission meeting in early 2019;
- **Agreed** that the scientific approaches applied by Australia and New Zealand can be used to underpin a revised bottom fishing CMM;
- **Agreed** to support, if necessary, an additional workshop in October or November 2018 to finalise the boundaries of spatial management areas or other management controls with stakeholders.

After considering SC6-DW13 (*Review of the SPRFMO Bottom Fishery Impact Assessment Standard [BFIAS]*), the SC:

- **Recommended** that a small intersessional working group be formed by members from Australia, New Zealand and other interested parties to systematically revise the BFIAS and to present a draft to SC7.

3. Squid

Squid Assessment (SC6-Report, Section 7.2)

The SC **noted** that:

- There are local squid biomass depletion events in Chilean waters. These depletions are not related with stock status. The escapement biomass percentages seem to be greater than recommended.
- The depletion model code in ADMB is available, and SC members can explore and use it.
- The same squid stock fished in Chile might be fished in the Convention Area and coastal country EEZs before and after passing by feeding grounds in Chile.

Following consideration of SC6-SQ08 (*Comparison of different squid simulations*), the SC **noted** that:

- The program can simulate the in-season biomass variability.
- The program can simulate the monthly length frequencies observed in fleets either fishing for large squid and/or fishing for small squid.

- The program is written in R markdown and is an open code.

In relation to all papers presented on jumbo flying squid stock assessment and modelling, the SC agreed:

- In the last year considerable progress has been made in developing stock assessment methods for jumbo flying squid. Three models have been put forward for use in assessment and each model takes account of jumbo flying squid biology and its short life cycle.
    - The model from Peru appears to be appropriate for the complex population dynamics found in Peruvian waters where mature squid can be found in at least three different size classes (or phenotypic groups) and spawning can occur at any time of the year.
    - The depletion model from Chile appears to be appropriate for the immature squid found in their waters (spawning did not appear to occur in Chilean waters).
    - The length-based model proposed by China, although yet to be used with real data, appears to be an appropriate model for jumbo flying squid.
    - Each of the models should be further developed and tested.
- Stock structure is particularly uncertain for jumbo flying squid and it is necessary to develop a set of alternative stock hypotheses that are consistent with existing data. In addition to possible genetic work there are simpler tasks that could provide useful information:
    - Ageing of mature animals to determine if the squid that mature at small and medium sizes are much younger in age than those that mature at large sizes (which are known to live up to 2 years of age).
    - Collation and/or collection of maturity data for squid caught outside the Chilean EEZ to determine if spawning occurs in Chilean latitudes.
- Natural mortality is poorly known for jumbo flying squid and efforts should be made to obtain more reliable estimates.
- The successful assessment of jumbo flying squid will require an ongoing commitment from members to collect length frequencies from their fisheries:
    - By sex and maturity stage
    - At least monthly (preferably weekly)
    - Stratified and scaled
- The acoustic target strength of jumbo flying squid appears to be poorly known and experimental exercises, and/or a literature review are required to determine the best length to target strength relationship to use and an appropriate range of uncertainty.
- Information on the scale of jumbo flying squid biomass can be obtained by a well-designed acoustic survey that cover the whole stock area. Although such surveys can be expensive, members are encouraged to consider developing such surveys when and where resources allow.
- It is unclear whether standardized CPUE can provide reliable biomass indices and members are encouraged to investigate approaches for better understanding of the quality of standardized CPUE, for example, using their commercial jig fleet to undertake scientifically designed jig surveys to obtain relative biomass indices if it is logistically possible.
- Although the results are preliminary, the reference points estimated using the Peruvian model show that jumbo flying squid is a very productive species that can probably sustain exploitation rates of 50% while maintaining spawning biomass well above B_{MSY}.
- Though it is out of the Convention area, it is worth noting that given the preliminary results of the Peruvian model it seems unlikely that exploitation rates for jumbo flying squid in Peruvian national jurisdiction waters have ever exceeded 50%.
- There remain significant uncertainties associated with the status of the stock(s) in the South-east Pacific.
- A stock assessment workshop is recommended before the next SC meeting.
- A table comparing stock assessment methods was drafted but the discussions need more time and such comparisons should be pursued in the future.

Squid Assessment Data (SC6-Report, Section 7.3)

Based on the discussion of SC6-SQ01 (Jumbo flying squid datasets held by the Secretariat), the SC:

- **Agreed** that 1990 is a suitable start year for historic squid data. Prior to this period the catches were smaller (with a noted exception for 1985).
- **Recommended** that direct correspondence with Japan be done to more accurately represent their data;
- **Noted** that for all models introduced, fishery (catch and effort) and biological data size frequency, weight and maturity) at a suitable intra-annual time scale is needed.
- **Requests** that relevant members make recommendations regarding their historic catch data;
- **Recommended** that the Secretariat work with members to evaluate the potential for double counting of catch (e.g., catch reported by flag and also within EEZs).

Squid Connectivity (SC6-Report, Section 7.4)

The SC discussed the planned work and:

- **Recommended** that members and CNCPs participating in the jumbo flying squid fishery join in the genetic analysis work for this species. This includes facilitating samples of the jumbo flying squid exchange and sharing between Members and CNCPs.
- **Noted** that suitable data analysis methods should be figured out to identify if there were gene diversities among different geographic areas and phenotypes in recent years in the SPRFMO convention area and national jurisdictional area and following these methods will facilitate exchange of results.
- **Recommended** that coordinators within members and CNCPs be nominated to coordinate data sharing and sampling exchange.
- **Recommended** that a workshop on the jumbo flying squid stock structure and stock assessment be held immediately before the next SC meeting

4. Ecosystem Approach to Fisheries Management

Seabird / bycatch management (SC6-Report, Section 8.2)

Following discussion of SC6-Doc29 (*ACAP seabird bycatch indicators, data needs, methodological approaches and reporting requirements*), the SC:

- **Noted** the system of indicators following the Pressure-State-Response framework being developed and implemented by ACAP;
- **Encouraged** Members to collect and analyse data on seabird bycatch in a consistent way across fisheries, guided by the recommendations from ACAP; and
- **Encouraged** Members (not only those who are also Parties to ACAP) to report data or results from analyses on bycatch indicators to ACAP.

Following discussion of SC6-Doc30 (*Cost-quality trade-offs in observer coverage for capture estimates in SPRFMO fisheries*), the SC:

- **Noted** that the extent of observer coverage needed to generate robust estimates of the frequency and total number of interactions with seabirds varies with the characteristics of the fishery, the species of interest, and bycatch patterns, particularly patchiness and the prevalence of multiple captures; and
- **Noted** that observer coverage of ~5% may be adequate to identify some bycatch risks and issues but is unlikely to enable robust quantification of those issues; and

- **Noted** that international experience suggests that ~20% observer coverage may be sufficient to estimate total bycatch and bycatch of frequently-caught species with a CV of <30% in some fisheries, although data presented by New Zealand show that performance varies among fisheries, and
- **Noted** that observer coverage levels of >50% may be necessary to robustly estimate bycatch of individual species that are caught infrequently but are nevertheless still at risk;
- **Noted** that, in addition to observable bycatch, there can also be unobservable mortality (i.e. "cryptic" mortality) that can vary substantially between fisheries;
- **Advised** the Commission that observer coverage of 20% or more may be required to robustly estimate the incidental mortality of Seabirds, Marine Mammals, and Other Species of Concern in some fisheries, and that design should address multiple influencing factors to obtain representative coverage;
- **Advised** the Commission that periodic review of observer coverage and the utility of the data generated should be used to fine-tune levels of observer coverage; and
- **Seeks guidance** from the Commission on the nature and certainty of its information needs on the bycatch of Seabirds, Marine Mammals, and Other Species of Concern, so that SC can more precisely advise on observer deployment requirements in SPRFMO fisheries.

Following discussion of SC6-Doc31 (*Estimates of potential seabird captures in SPRFMO Jig fisheries*), the SC:

- **Noted** that a number of seabirds, including albatrosses and petrels, overlap spatially with squid jig fisheries in the SPRFMO area and could be at risk of bycatch;
- **Noted** that bycatch of seabirds occurs in New Zealand and south Atlantic squid jig fisheries and is likely to occur in SPRFMO squid jig fisheries, given the spatial distribution of seabirds and fishing
- **Advised** the Commission of the risk posed to seabirds by squid jig fisheries;
- **Encouraged** all Members and CNCPs to collect and report specific data focussed on seabird interactions with squid jig fisheries so that a more robust understanding of interactions and risks can be developed.

Species of Concern (SC6-Report, Section 8.3)

Following consideration of SC6-Doc09 (*A Summary of Current SPRFMO Bycatch Records [Including Species of Concern]*), the SC:

- **Recommended** that observer coverage levels and total effort be reported in this summary document in future.

Task Team on Ecosystem and Habitat Monitoring (SC6-Report, Section 8.4)

Following presentation of SC6-Doc07 and the discussions around it, the SC:

- **Recommended** creating a Working Group (WG) on "Habitat Definition, Description and Monitoring" with the main objective of providing environmental indicators associated to the habitat of the main commercial resources exploited in the SPRFMO area to complement decision making of fisheries management. The terms of reference for this Working Group can be found in Annex 10.
- **Recommended** the WG activities to begin with the Chilean Jack Mackerel *Trachurus murphyi* as first case study, continuing with others as soon as possible.
- **Recommended** Dr. Mariano Gutierrez from IHMA (Peru) as Chairperson and Dr. Aquiles Sepúlveda from INPESCA (Chile) as Vice-Chairperson for a renewable mandate of 2 years.

For the period 2018-2019, the SC **recommended** that the Habitat WG will:

- 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.
- Explore the concept of CJM habitat through retrospective analysis (including bibliographical analysis).
- 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.
- Explore possibilities to organize a symposium on the topic of pelagic habitat in the 2020s.
- Organize a workshop on the state of the art of habitat research in the same place as, and immediately before, the SC meeting.

5. Observer Programmes and Monitoring Approaches

Observer Programmes CMM (SC6-Report, Section 9.3)

Following discussions around SC6-Doc08 (*Establishing the SPRFMO Observer Programme*), the SC:

- **Agreed** that a more detailed list of elements for an observer data validation protocol will be agreed by interested members intersessionally prior to the Commission meeting in January 2019.

6. Exploratory Fisheries

Exploratory Toothfish Fishing - New Zealand (SC6-Report, Section 10.1)

Following consideration of SC6-DW03 (*New Zealand's Proposal for an extension to its Exploratory Toothfish fishery*), the SC:

- **Noted** New Zealand's proposal and its Fisheries Operation Plan to extend its exploratory demersal longline fishery for toothfish (limited at 220 tonnes liveweight (= greenweight) retained annually);
- **Recognized** the cautious, exploratory nature of the proposal;
- **Recognized** the scientific benefits of the proposed data collection, especially for understanding the distribution, movement, spawning dynamics, and stock structure of toothfishes and can be used to support 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 accepted by SPRFMO for this exploratory fishery for toothfish to facilitate the collection and sharing of data and a similar approach be considered for any future exploratory fisheries for toothfish;
- **Adopted** the Data Collection Plan included in the revised proposal;
- **Advised** the Commission that the revised proposal is acceptable in terms of Articles 2 and 22, CMM-13-2016 (exploratory fisheries), CMM-03-2018 (bottom fisheries), and the BFIAS.
- **Advised** that the proposal adequately addressed 5 out of 5 relevant criteria contained in paragraph 10 of CMM 13-2016.
- **Recommended** that the assessment is adequate given relevant CMMs and that the revised proposal adequately addressed 8 out of 8 relevant criteria for paragraph 8 of CMM 13-2016.
- **Recommended** observer data be provided 30 days prior to the SC meeting.

Exploratory Toothfish Fishing - European Union (SC6-Report, Section 10.2)

Following consideration of SC6-DW02 (*European Union's Proposal for an Exploratory Toothfish fishery*), the SC:

- **Noted** the European Union's proposal and its Fisheries Operation Plan for an exploratory demersal longline fishery for patagonian toothfish (limited at 45 tonnes liveweight (= greenweight)) to occur for no more than 3 weeks during one year and consist of no more than 120 sets of 5000 hooks/set
- **Noted** the commitment by the European Union to provide a detailed risk assessment by engaging with experts on potential impacts on at-risk seabirds such as the larger albatrosses and petrels, reptiles and mammals, and deepwater sharks prior to submission of the proposal to the 7th meeting of the SPRFMO Commission
- The SC **advised** that development of a data collection plan is contingent on the extent to which requirements outlined in paragraphs 5 and 8 of CMM 13-2016 are addressed
- **Recognized** the importance of data sharing and collaboration with neighboring jurisdictions
- **Advised** that the proposal adequately addressed 1 out of 7 relevant criteria, partially addressed 5 out of 7 relevant criteria, and did not adequately address 1 out of 7 relevant criteria for paragraph 8 of CMM 13-2016:
- **Noted** that the criterion the proposal did not address is related to the risk assessment for birds, reptiles, mammals, and deepwater sharks and is planned to be addressed prior to the Commission meeting
- **Noted** that the criteria the proposal partially addressed all relate to the uncertainty around the presence of toothfish in the proposed fishing area and impact on VME and bycatch species
- **Advised** that the proposal adequately addressed 2 out of 4 relevant criteria, and partially addressed 2 out of 4 relevant criteria, for paragraph 10 of CMM 13-2016:
- **Noted** that the criteria the proposal partially addressed were all related to the proposed fishing being to determine presence/absence of the resource in the area.
- **Recommended** observer data be provided 30 days prior to the SC meeting.

Exploratory Pot Fishery (SC6-Report, Section 10.3)

Following consideration of SC6-DW01 Cook Islands Fisheries Operational Plan for an Exploratory Potting Fishery), the SC:

- **Noted** that under CMM 14b-2018 (Exploratory Pot Fishery in the SPRFMO Area), the Cook Islands presented a revision of its proposal of the Fishing Operation Plan (FOP) in the SPRFMO Area, with consideration of the advice received from the 6th SC.
- **Noted** that no exploratory activity has been done to date, therefore its recommendation is based on the current standing of the FOP.
- **Noted** that upon further consideration of literature values that report effective fishing areas of 500-6000 m^2 per pot, which are notably different than the values reported in the proposal.
    - **Noted** one literature paper was for deepwater crab species in Pacific (which has effective area of 564 m^2) yet others are for other lobster/crab in other coastal areas.
    - **Noted** that proposal did not consider the implications that such values would have on estimated exploitations rate, which SC noted could be 5% for *jassus* species but could at the extreme range up to 60%.
- **Noted** three options to address precautionary catch limits:
    - Option 1- Although no detailed analysis is presented in the proposal, lowering the catch limit for the second year so as to reduce the potential risk of exploitation and localized depletion from two years of fishing at 1000 t, which would be commensurate with a gradual and precautionary approach for an exploratory fishery. Noted that no current fishing data exist to inform catch limit.

    - Option 2 - Alternatively, lowering the catch in the first 30 day trip of year two to a value less than 333 t, which is one-third of the current yearly catch limit, to reduce potential risk of exploitation and localized depletion and allow for further data analysis to inform decisions.
    - Option 3 - Alternatively, year 2 fishing could be delayed until further data is collected and analysed to inform a precautionary catch limit for future fishing activities.
- **Revised** the Cook Islands Data Collection plan from the proposal to:
    - include clear indication that once fishing occurs on a seamount, that seamount becomes part of the limit of 8 seamounts total within a year.
    - adopt the threshold limits for VME move-on rules as stated in Appendix 7 of the proposal for this exploratory fishery.
- **Advised** that the proposal adequately addressed 1 out of 7 relevant criteria, partially addressed 4 out of 7 relevant criteria, and did not adequately address 2 out of 7 relevant criteria for paragraph 8 of CMM 13-2016:
    - **Noted** that the criteria the proposal did not address are all related to catch limits, and that the criteria the proposal partially addressed all relate to the proposed VME threshold.
- **Advised** that the proposal adequately addressed 1 out of 5 relevant criteria, and partially addressed 4 out of 5 relevant criteria, for paragraph 10 of CMM 13-2016:
    - **Noted** that the criteria the proposal did not address are all related to the design of proposed depletion studies and the determination of effective fishing area, and the design of the camera study for identifying VME interactions.
- **Advised** that the proposal partially addressed 2 out of 3 relevant criteria, and did not adequately address 1 out of 3 relevant criteria for paragraph 24 of CMM 14b-2018.
- **Noted** that the criteria the proposal partially addressed are related to the design of proposed depletion studies, design of the camera study for identifying VME interactions, and the sustainability of proposed catch level.
- **Noted** that the criterion the proposal did not address related to the significance of the proposed catch level.
- **Recommended** observer data be provided 30 days prior to the SC meeting.

7. Other Matters

SC Workload/Capacity Building/SC Protocols (SC6-Report, Section 11.1)

The SC **noted** that the number of papers and work presented in plenary continues to grow. As such the SC **recommended** that the Secretariat develop guidelines for presentations during plenary discussions.

CMM on Scientific Sampling (SC6-Report, Section 11.4)

Following consideration of SC6-Doc32 (*Proposals for a new CMM to provide for scientific sampling or fishing*), the SC:

- **Noted** the current lack of a mechanism to provide for research activities in the SPRFMO Convention Area;
- **Recommended** that the Commission adopt a Conservation and Management Measure to provide for research activities in the Convention Area taking into account the following key principles:
    - Research should be enabled within sustainable limits.
    - Different types of research should be recognised and considered in terms of the risks and opportunities for the fishery resources managed by the SPRFMO Convention.
    - Research that will have additional impacts on SPRFMO target species or the wider ecosystem should have a high probability of meeting research objectives and contributing to SPRFMO's objectives and the SC's work plan.
    - Catch of fishery resources taken during scientific research should be accounted for within sustainable yield estimates, catch limits, and estimates of stock status as appropriate.

- **Agreed** that two categories of research (low-impact research and fishing research) be defined in the Conservation and Management Measure to enable research activities in the Convention Area
- **Recommended** that, based on the risk to sustainability and the importance of avoiding significant adverse impacts on VMEs, low-impact research be defined as research meeting either of two scenarios:
    1. Where there is not expected to be any additional impact on SPRFMO target species or the wider ecosystem, **noting** that 'additional impact' will need to be clearly defined, or
    2. Where the research will be carried out during normal fishing operations and all catch will be accounted for within current impact assessments and catch limits.
- **Suggested** that criteria to define 'additional impact' for the purposes of defining 'low-impact' research, should consider a maximum catch of species for which there is a SPRFMO catch limit, a limit on the amount of bottom contact, a limit on total fish catch in the research, and impact on the ecosystem in the course of a year.
- **Recommended** that research that is expected to have additional impact on target species or the wider ecosystem be assessed by the SC against the key principles and the Commission consider each proposal based on advice from the SC, including potential advice on incorporation of the research catch within relevant catch limit advice, noting that 'additional impact' will need to be clearly defined.
- **Recommended** to the Commission that low-impact research be notified to the Secretariat at least two weeks in advance, containing information on the planned activities including but not limited to:
    - Vessel(s) to be involved
    - General area of research
    - Expected timeframe for research
    - Objectives of the research (e.g. biomass estimate for X species)
    - Expected maximum catch
    - Expected bottom contact area (if any)

- **Agreed** that New Zealand will work intersessionally with other members to provide advice on a definition of 'additional impact' to inform development of a draft CMM to be presented to the Commission in January 2019.

MoU's and Outside Arrangement (SC6-Report, Section 11.5)

Following the presentation of papers SC6-Doc28 (*SPRFMO and FIRMS*), SC6Doc33 (*SPRFMO and the ABNJ project*), and SC6Doc34 (*Renewal of the Arrangement between SPRFMO and CCAMLR*) –all detailing external arrangements–, the SC **expressed** its support for FIRMS participation. Regarding ABNJ the SC was cautious about cost, but generally in favour and **noted** that SPRFMO is the largest area in ABNJ.

In regard to CCAMLR, the SC strongly **encouraged** renewing and progressing the arrangement and suggested including an item addressing observer programme knowledge exchange.

SPRFMO SC6-Report
Annex 2. List of Participants

SCIENTIFIC COMMITTEE CHAIRPERSON

NAME: James IANELLI
AFFILIATION: AFSC
ADDRESS: 7600 Sand Point Way, Seattle WA 98115 USA
EMAIL: jim.ianelli@noaa.gov

COMMISSION CHAIRPERSON

NAME: Osvaldo URRUTIA
AFFILIATION: Undersecretariat for Fisheries and Aquaculture
ADDRESS: Victoria University of Wellington
EMAIL: Ourrutia@subpesca.cl

MEMBERS

AUSTRALIA

NAME: Simon NICOL
AFFILIATION: Australian Bureau of Agricultural and Resource Economics and Sciences
ADDRESS: 18 Marcus Clarke Street Canberra
EMAIL: Simon.Nicol@agriculture.gov.au

NAME: Lee GEORGESON
AFFILIATION: Australian Bureau of Agricultural and Resource Economics and Sciences
ADDRESS: 18 Marcus Clarke Street Canberra
EMAIL: lee.georgeson@agriculture.gov.au

CHILE

NAME: Karin MUNDNICH
AFFILIATION: Undersecretariat for Fisheries and Aquaculture
ADDRESS: Bellavista 168, Piso 16, Valparaiso
EMAIL: kmundnich@subpesca.cl

NAME: Mario ACEVEDO
AFFILIATION: Undersecretariat for Fisheries and Aquaculture
ADDRESS: Bellavista 168, Piso 16, Valparaiso
EMAIL: macevedo@subpesca.cl

NAME: Luis COCAS
AFFILIATION: Undersecretariat for Fisheries and Aquaculture
ADDRESS: Bellavista 168, 14th floor
EMAIL: lcocas@subpesca.cl

NAME: Marcos TRONCOSO
AFFILIATION: Undersecretariat for Fisheries and Aquaculture
ADDRESS: Bellavista 168, 14th floor
EMAIL: mtroncoso@subpesca.cl

NAME: Mauricio GALVEZ
AFFILIATION: Fisheries Development Institute
ADDRESS: Blanco 839, Valparaíso
EMAIL: mauricio.galvez@ifop.cl

NAME: Ignacio PAYA
AFFILIATION: Fisheries Development Institute
ADDRESS: Blanco 839, Valparaiso
EMAIL: ignacio.paya@ifop.cl

NAME: Aquiles SEPULVEDA
AFFILIATION: Fisheries Development Institute
ADDRESS: Av. Colon 2780, Talcahuano
EMAIL: asepulveda@inpesca.cl

NAME: Cristian CANALES
AFFILIATION: Pontificia Universidad Católica de Valparaíso
ADDRESS: Avda. Altamirano 1480, Valparaíso
EMAIL: cristian.canales.r@pucv.cl

NAME: Eleuterio YAÑEZ
AFFILIATION: PUCV
ADDRESS: Balmaceda 537, Cerro Castillo
EMAIL: eleuterii.yanez@pucv.cl

NAME: Albert ARTHUR
AFFILIATION: Consultant, Anapesca
ADDRESS:
EMAIL: albarthur@gmail.com

NAME: Andrés COUVE
AFFILIATION: SONAPESCA
ADDRESS: Barros Errazuriz 1954, Of. 206, Providencia, Santiago de Chile
EMAIL: andrescouve@entelchile.net

NAME: Andrés DAROCH
AFFILIATION: FoodCorp Chile S.A
ADDRESS: Av. P. Aguirre Cerda 995, Coronel 4200570
EMAIL: adaroch@fcc.cl

NAME: Álvaro DE CASO
AFFILIATION: Especialistas Pesqueros
ADDRESS: Luis Thayer Ojeda 166 Of. 902
EMAIL: alvarodecaso@gmail.com

NAME: Jorge Francisco OLIVA
AFFILIATION:
ADDRESS:
EMAIL: joliva@ciamchile.cl

NAME: Alexandre GRETCHINA
AFFILIATION: Inpesca
ADDRESS: Talcahuano CP 4270789
EMAIL: agretchina@inpesca.cl

CHINA

NAME: Gang LI
AFFILIATION: Shanghai Ocean University
ADDRESS: 999 Huchenghuan Rd, Shanghai 201306
EMAIL: g-li@shou.edu.cn

NAME: Yong CHEN
AFFILIATION: University of Maine
ADDRESS: 218 Libby Hall, University of Maine, Orono
EMAIL: ychen@maine.edu

NAME: Bilin LIU
AFFILIATION: Shanghai Ocean University
ADDRESS: 999 Huchenghuan Rd, Shanghai 201306
EMAIL: bl-liu@shou.edu.cn

NAME: Luoliang XU
AFFILIATION: Shanghai Ocean University
ADDRESS: 999 Huchenghuan Rd, Shanghai 201306
EMAIL: 463253025@qq.com

COOK ISLANDS

NAME: Mario WICHMAN
AFFILIATION: Ministry of Marine resources
ADDRESS: PO Box 85, Avarua, Rarotonga
EMAIL: m.wichman@mmr.gov.ck

NAME: Alexander EPSTEIN
AFFILIATION: Advisor
ADDRESS:
EMAIL: alex.epstein@osf.pe

ECUADOR

NAME: Manuel PERALTA
AFFILIATION: Instituto Nacional de Pesca
ADDRESS: Letamendi 102 y La Rúa
EMAIL: mperalta@institutopesca.gob.ec

NAME: Guillermo MORAN
AFFILIATION: Ministerio Acuacultura y Pesca
ADDRESS: Fishing Port of San Mateo, Manabí
EMAIL: gamv6731@gmail.com

EUROPEAN UNION

NAME: Niels HINTZEN
AFFILIATION: Wageningen Marine Research
ADDRESS: Haringkade 1, 1976CP
EMAIL: niels.hintzen@wur.nl

NAME: Francois GERLOTTO
AFFILIATION: Research and Development Institute
ADDRESS: Montpellier 34090
EMAIL: francois.gerlotto@ird.fr

NAME: Martin PASTOORS
AFFILIATION: Pelagic Freezer-trawler Association
ADDRESS: Louis Braillelaan 80, 2719 EK Zoetermeer
EMAIL: mpastoors@pelagicfish.eu

NAME: Joost POMPERT
AFFILIATION: Georgia Seafood
ADDRESS: Waverley House, Philomel Street, Stanley, Falkland Islands
EMAIL: joostpompert@georgiaseafoods.com

KOREA

NAME: Seok-Gwan CHOI
AFFILIATION: National Institute of Fisheries Science
ADDRESS: 216 Gijanghaean-ro, Gijang-gun, Busan, 46083
EMAIL: sgchoi@korea.kr

NAME: Sang-gyu SHIN
AFFILIATION: National Institute of Fisheries Science
ADDRESS: 216 Gijanghaean-ro, Gijang-gun, Busan, 46083
EMAIL: gyuyades82@gmail.com

NEW ZEALAND

NAME: Martin CRYER
AFFILIATION: Ministry for Primary Industries
ADDRESS: P.O. Box 2526, Wellington
EMAIL: martin.cryer@mpi.govt.nz

NAME: Shane GEANGE
AFFILIATION: Department of Conservation
ADDRESS: 18-32 Manners Street, Wellington
EMAIL: sgeange@doc.govt.nz

NAME: Tiffany BOCK
AFFILIATION: Ministry for Primary Industries
ADDRESS: P.O. Box 2526, Wellington
EMAIL: tiffany.bock@mpi.govt.nz

PERU

NAME: Jorge CSIRKE
AFFILIATION: Instituto del Mar del Peru (IMARPE)
ADDRESS: IMARPE, PO Box 22, Callao
EMAIL: jorge.csirke@gmail.com

NAME: Arturo GONZALES ARAUJO
AFFILIATION: Ministerio de la Producción
ADDRESS: Calle Uno Oeste N° 060, CORPAC, San Isidro, Lima
EMAIL: agonzales@produce.gob.pe

NAME: Miguel ÑIQUEN
AFFILIATION: Instituto del Mar del Perú (IMARPE)
ADDRESS: Esquina Gamarra y General Valle S/N Chucuito, Callao
EMAIL: mniquen@imarpe.gob.pe

NAME: Luis MARIATEGUI
AFFILIATION: Instituto del Mar del Perú (IMARPE)
ADDRESS: Esquina Gamarra y General Valle S/N Chucuito, Callao
EMAIL: lmariategui@imarpe.gob.pe

NAME: Edgar ARGUMEDO GUILLEN
AFFILIATION: Instituto del Mar del Perú (IMARPE)
ADDRESS: Esquina Gamarra y General Valle S/N Chucuito, Callao
EMAIL: eargumedo@imarpe.gob.pe

NAME: Enrique RAMOS-VASQUES
AFFILIATION: Instituto del Mar del Perú (IMARPE)
ADDRESS: Esquina Gamarra y General Valle S/N Chucuito, Callao
EMAIL: enramos@imarpe.gob.pe

NAME: Mariano GUTIERREZ
AFFILIATION: Humboldt Institute of Marine and Aquaculture Research
ADDRESS: Av. República de Panamá 3591, piso 9, Lima
EMAIL: mgutierrez@ihma.org.pe

NAME: Aníbal ALIAGA
AFFILIATION: Sociedad Nacional de Pesquerías
ADDRESS: Los Laureles 365, San Isidro, Lima
EMAIL: snpnet@snp.org.pe

RUSSIAN FEDERATION

NAME: Alexander GLUBOKOV
AFFILIATION: VNIRO
ADDRESS: Moscow, Russia
EMAIL: glubokov@vniro.ru

CHINESE TAIPEI

NAME: Chih-Shin CHEN
AFFILIATION: National Taiwan Ocean University
ADDRESS: 2, Bei-Ning Road, Keelung City
EMAIL: cschen@mail.ntou.edu.tw

NAME: Shih-Ming KAO
AFFILIATION: National Sun Yat-Sen University
ADDRESS: 70 Lien-Hai Road, Kaohsiung City
EMAIL: kaosm@udel.edu

UNITED STATES OF AMERICA

NAME: Brian LANGSETH
AFFILIATION: NOAA Fisheries
ADDRESS: 1845 Wasp Boulevard, Honolulu HI. 96818
EMAIL: brian.langseth@noaa.gov

VANUATU

NAME: Gerry GEEN
AFFILIATION: Vanuatu Department of Fisheries
ADDRESS: Mail bag 9045, Port Vila
EMAIL: ggeen@bigpond.net.au

NON-GOVERNMENTAL ORGANISATIONS

DEEP SEA CONSERVATION COALITION (DSCC)

NAME: Barry WEEBER
AFFILIATION: DSCC
ADDRESS: 3 Finnimore Tce, Vogeltown, Wellington 6021
EMAIL: baz.weeber@gmail.com

NEW ZEALAND HIGH SEAS FISHERIES GROUP (NZHSFG)

NAME: Andy SMITH
AFFILIATION: NZHSFG
ADDRESS: Maitai Wharf Port Nelson
EMAIL: Andy.Smith@talleys.co.nz

NAME: Dean JURASOVICH
AFFILIATION: Sanford Ltd
ADDRESS: Hall Street
EMAIL: djurasovich@sanford.co.nz

NAME: Kyijin SEOK
AFFILIATION: NZHSFG
ADDRESS: Maitai Wharf Port Nelson,
EMAIL: pisces21c@naver.com

SPRFMO SECRETARIAT

NAME: Sebastian RODRIGUEZ
AFFILIATION: SPRFMO
ADDRESS: PO Box 3797, Wellington 6140
EMAIL: srodriguez@sprfmo.int

NAME: Craig LOVERIDGE
AFFILIATION: SPRFMO
ADDRESS: PO Box 3797, Wellington 6140
EMAIL: cloveridge@sprfmo.int

EXTERNAL EXPERTS

NAME: Patrick CORDUE
AFFILIATION: Scientist
ADDRESS: 11 Rangoon Street, Khandallah, Wellington,
EMAIL: plc@isl-solutions.co.nz

NAME: LEE QI
AFFILIATION: University of California
ADDRESS: 2400 Bren Hall, Univ. of California, Santa Barbara, CA 93106-5131
EMAIL: leeqi@ucsb.edu

SPRFMO SC6-Report
Annex 3. SC6 Agenda

1. Welcome and Introduction
2. Administrative Arrangements
   2.1Adoption of Agenda
   2.2Meeting documents
   2.3Nomination of Rapporteurs
3. Discussion of Annual Reports
4. Commission guidance and other Inter-Sessional activities
   4.1Commission SC Workplan
   4.2Secretariat SC related activities
5. Jack Mackerel
   5.1Inter-Sessional assessment/research including Jack mackerel assessment workshop report
   5.2Inter-Sessional Progress with the Jack Mackerel Stock Structure Research Programme
   5.3Jack Mackerel Stock Assessments – Technical Session
   5.4Other Jack Mackerel topics
   5.5Advice to the Commission on Jack mackerel
6. Deepwater Working Group
   6.1. ..... Intersessional activities
   6.2. ..... Orange roughy assessment
   6.3. ..... Deepwater Data collection
   6.4. ..... Deepwater stock structure
   6.5. ..... Other stock assessments including ecological assessment
   6.6. ..... Revision of bottom fishing CMM
   6.7 ..... Other Deepwater topics
7. Squid
   7.1. ..... Inter-Sessional activities
   7.2. ..... Squid assessment
   7.3 ..... Squid assessment data
   7.4 ..... Squid connectivity
8. Ecosystem Approach to Fisheries Management
   8.1. ..... Further developments of standardized oceanographic data products and modelling
   8.2Seabird / bycatch monitoring
   8.3. ..... Species of concern

Australia

SC6-Doc13 provides an update on fishing activity by Australian-flagged vessels in the South Pacific Regional Fisheries Organisation (SPRFMO) Convention Area. Three Australian-flagged vessels fished in the SPRFMO Convention Area in 2017; one trawl vessel and two non-trawl vessels. The total retained catch reported in logbooks by Australian vessels in the SPRFMO Convention area was 243 t in 2017. The trawl catch for 2017 reported in logbooks was 98 t. *Hoplostethus atlanticus* comprised 95 per cent of the 2017 trawl catch (93 tonnes (t)). Total effort for the trawl fishery was 52 trawl hours in 2017. Total non-trawl catch retained by Australian vessels in the SPRFMO Convention area was 145 t in 2017. Bottom longline was the only non-trawl method used in 2017. *Seriola lalandi* accounted for 24 per cent (35 t) of the 2017 non-trawl catch; the remainder comprised *Nemadactylus macropterus* (16 per cent; 23 t), *Lethrinus miniatus* (15 per cent; 22 t), *Etelis coruscans* (11 per cent; 16 t), *Gymnocranius grandoculis* (9 per cent; 13 t) and other species (24 per cent; 35 t). Effort was 840,700 hooks in 2017. During 2017, observer coverage levels met or exceeded the minimum requirement (10 per cent coverage for non-trawl, and 100 percent coverage for trawl trips) as required under CMM 03-2018. Observers did not record any bycatch of marine mammals, seabirds or marine reptiles in trawl or non-trawl operations in the SPRFMO Area in 2017. The threshold limits for vulnerable marine ecosystems (VME) indicators, which trigger Australia's move-on protocols, were not triggered in 2017.

Chile

Jack mackerel fishery: Between January and July 2018, 72 Chilean purse seiners were fishing jack mackerel in both the SPFRMO area and the Chilean EEZ. The number of vessels is lower than 2017, mainly because of a reduction of vessels targeting anchovy in the northern waters. During 2018, the fleet operating within the center-south area has shown a catch pattern similar to previous years with the particularity of extending its operation area further south than in previous years (38° SL - 43°SL), with all catches made within the Chilean EEZ. Size structure of jack mackerel has shown a constant growth from 2012 to 2018, with a shift of the mode size from 27 cm FL as mode size in 2015, to 30-31 cm FL in 2018 (first semester). Unlike 2017, sizes between 40-50 cm FL have not been well represented this year in catches. The first semester of 2018 has shown a unimodal size structure between 30 and 31 cm FL mode size.

Squid fishery: Since 2013, an annual domestic quota of 200,000 tons has been established. Chilean total captures of squid has not exceeded this amount. The two main fleets in Chile are the artisanal fleet (smaller than 18 m in length), which are entitled to fish up to 80% of the national quota, operating with hand line and jigging and the industrial fleet that are entitled to fish the remaining 20% of the national quota, operating with mid-water trawl. 2017 total catches amounted to 154 thousand tons, entirely within the EEZ. The artisanal fleet registered an unimodal distribution composed of 99% of adult specimens larger than 60 cm length of mantle (LOM) prevailed, whose main mode is around 70-80 cm LOM.

China

The number of Chinese pelagic trawlers remained unchanged at two in 2017. The total of catch was 17,133 tons including 16,586 tons of Jack mackerel and 538 tons of Chub mackerel. Jack mackerel

catches and fishing days, as well as trawling hours were decreased sharply compared to 2015 and 2016 because of the shortening of fishing seasons, however, the nominal and standardized CPUE increased significantly. Nominal CPUE for 2017 was 11.2 tons per hour, peaked during the last ten years. The spatial and temporal distribution mode did not change fundamentally in recent years. A scientific observer was sent to the sea and boarded on July 19 and worked until 23 October. A total of 28 fishing days were observed and the coverage rate was about 17.0%

A total of 356 Chinese squid jigging vessels were recorded to operate in the Convention area and caught 296 thousand tons of jumbo flying squid in 2017, but actual number of the active fishing vessels varied from 180 (April) to 327 (November). The number of operated fishing vessels, as well as annual catch, fishing days and nominal CPUE increased in 2017. More fishing vessels operated around the equator area. No observers were send to work on board but biological sampling continued into 2016 by three study vessels. A total of 3,725 biological samples of the jumbo flying squid were collected.

European Union

The European Union (EU) fishing fleet activity in 2017 (and partially for 2018) in the South Pacific Regional Fisheries Management Organization (SPRFMO) Convention area presented in this report. The data on catches of Jack mackerel by EU trawlers in 2017 cover the period from March to December and for 2018 from January to June. A short section on the PFA self-sampling program has been included in the report.

Korea

SC6-DOC27 provides an update on fishing activity by Korean-flagged vessels in the South Pacific Regional Fisheries Organization(SPRFMO) Convention Area. The annual catch of *T. murphyi* in 2017 was 1,429 t, the lowest catch recorded since the member's participation. Probable cause for such low catch is the low number of days, i.e. 40 days, spent for actual fishing as the fleet spent most of its time on fish detection. Korea is maintaining 100% observer coverage for the jack mackerel fishery in the Convention Area since 2013. There are no bottom fishing activities operated by Korean-flagged vessels in the Convention Area since 2008. Eight Korean squid-jigging vessels operated in the Convention Area in 2017, and the total catch of *D. gigas* during 456 days of their fishing was 3,460t. The report noted that 17 registered Korean squid-jigging vessels will be operating in the Convention Area in 2018 and also shares Korea's plan to dispatch two scientific observers to squid-jigging vessels to collect biological information and bycatch. Please refer to the paper for other information such as catch history, distribution of effort, biological measurements, bycatch, and observer program.

New Zealand

SC6-Doc14 provides an update on New Zealand's fishing activities in the SPRFMO Convention Area in 2017. Eight New Zealand vessels fished in the SPRFMO Convention Area, five using trawl methods and three using bottom line methods. Overall all catch and effort increased slightly in 2017, with a total of 1,456 trawl tows completed, taking 1,677 tonnes of fish. The vast majority of trawl caught fish was orange roughy (1,093 tonnes). Bottom line fisheries had a similar level of effort, with around 115,000 hooks set and a total catch of 106 tonnes, the majority of which was bluenose and wreckfish (46 and 47 tonnes respectively). Additionally, the second year of New Zealand's exploratory toothfish fishery was completed, comprising a total of 12 sets and a catch of 28 tonnes.

New Zealand met all requirements for observer coverage, with 100% coverage in bottom trawl fisheries, 15% coverage of bottom line fisheries, and 100% coverage of the exploratory fishing activity. Over 13,000 fish were measured including nearly 8,000 orange roughy, nearly 3,000 alfonsino, 70 bluenose, and nearly 500 Antarctic toothfish. Length frequency information is provided in the report for these species for the past five years.

The majority of research activities by New Zealand in 2017 were continuations of previous projects initiated to inform the development of the new bottom fishing conservation and management measure.

New Zealand also provides information on interactions with seabirds, marine mammals, reptiles, other species of concern, and other ecosystem considerations including non-target fish catch and catch of benthic organisms. There were three seabird captures observed on New Zealand vessels in 2017, one prion caught in a bottom line fishery, one great-winged petrel, and one storm petrel. All seabird captures were released alive. There were no encounters with potential VMEs that triggered New Zealand's move-on rule in 2017.

Peru

None of the 98 Peruvian vessels registered and authorized to fish within the SPRFMO Convention area participated in the jack mackerel (*Trachurus murphyi*) fishery in the Convention area during 2017 or the first six months of 2018 and there are no jack mackerel fishing activities or jack mackerel catches to report for this period. There are no other fishing activities or commercial catches by Peruvian fleets to report for this period in the SPRFMO Convention area. Limited research activities on jumbo flying squid (*Dosidicus gigas*) have been conducted by IMARPE in part of the SPRFMO Convention area, beyond and adjacent to the Peruvian jurisdictional waters. These activities took place during three research surveys conducted in January-February and November-December 2015 and in November-December 2017. A summary of the observations made in the Convention area during these research surveys is provided together with comparable observations in nearby areas within Peruvian jurisdictional Waters.

The In-zone report updates information on the biology and fishery of jack mackerel (*Trachurus murphyi*) in Peru presented in previous SPRFMO SC meeting reports. During 2014, 2015, 2016 and the first part of 2017 the Peruvian coastal areas have been affected by warmer than normal conditions that are typical of El Niño, followed by colder than normal conditions that are typical of La Niña in 2018. There was a weak El Niño during 2014, a strong El Niño during 2015 and 2016, a moderate coastal El Niño in early 2017 and a weak-to-moderate La Niña towards the end of 2017 and first part of 2018. With these warmer than normal environmental conditions the front usually formed by the mixed layer of warm Subtropical Surface Waters and Cold Coastal Waters almost disappeared and moved closer to the coast, disrupting what is known to be the preferred habitat of jack mackerel off Peru. This contributed to the observed low abundance and low catches of jack mackerel in 2014 and particularly in 2015, 2016 and the first part of 2017. The situation didn't change much with the cooler than normal conditions during early 2018 as far as the distribution and dispersal of the jack mackerel concentrations of commercial interest is concerned, even if there was a more extended presence of Cold Coastal Waters and of the mixed layer of Subtropical Surface Waters and Cold Coastal Waters. Jack mackerel concentrations continue to be found in very coastal areas (within 20 nm and sometimes within 10 nm from the coast), within reach of the artisanal and small-scale fleets but outside of the usual fishing grounds of the industrial purse seine fleet. In early January 2018 the Peruvian Institute of Marine Research (IMARPE) updated the available 2017 jack mackerel assessment made for the Peruvian (far-north) stock during the SC-05 and estimated a TAC for 2018 using the same version of the JJM model used in SC-05. This resulted in an estimated TAC of 75 000 t and an F2018 = 0.027 with an estimated risk of 12.1% that the biomass projected to January 1st 2019 will be lower than that estimated for January 2018. An updated 2018 assessment using the same configurations of the 2017 JJM assessment is also presented, incorporating a newly revised CPUE abundance index and the most recent data and information up to May 2018. The results of the preliminary application of the Stock Synthesis using the same data and parameters used in the JJM assessment are also presented.

Russian Federation

Russia presented national report. In 2018 only one Russian trawler “Maironis” worked in the high seas of the Southeast Pacific. The total catch was 4689.4 t for jack mackerel and 52,2 t for chub mackerel in 102 fishing days. The average catch from April to June 2018 was 6.4 tons per hour. The highest catch was reached in May (1698 tons). The Russian scientific observer was onboard the trawler “Maironis” during the whole period of activities in 2018. In 2017, 14930 specimens of jack mackerel, 1011 specimens of chub mackerel were measured. 2,300 specimens of jack mackerel, 300 specimens of chub mackerel were fully analyzed, according to CMM`s. For 522 samples of jack mackerel and 219 specimens of chub mackerel the age samples were taken.

Chinese Taipei

Jumbo flying squids inhabit the eastern Pacific and have 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 2017. The catch of jumbo flying squid was 7,338 tons in 2017, less than that of 2016 (12,989 tonnes). The nominal CPUEs of this fishery were at a similar level for 2016-2017. The major fishing grounds were located around 75-83 degrees W and 14-25 degrees S, while few vessels operated in the region of 115-119 degrees W and 2 degrees N to 2 degrees S in 2017. Data of logbook, transshipment and landing of Chinese Taipei’s squid-jigging fleet have been collected entirely and submitted to the Secretariat of SPRFMO. Researches on the stock status and spatial dynamics of jumbo flying squid have been conducted. The length composition of jumbo flying squid was converted from weight category. A biological sampling program has been conducted by one study vessel in the fishing season of 2018. The observer programme, modified from tuna fishery, has been developed in 2018.

United States of America

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 2018. 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.

Vanuatu

Vanuatu flagged vessels commenced operations in the jack mackerel fishery in 2003. The number of vessels operating each year is shown in Table 1. The vessels are all ‘sister ships’ of 105 metres in length with a GRT of 7,805. The vessels ceased operating at the end of the 2016 season when they were sold and reflagged.

SPRFMO SC6-Report
Annex 5. Scientific Committee Proposed Multi-Annual Work Plan

1. Deepwater Working Group

Task	Objective	Timeline
Orange roughy assessment	Conduct Orange roughy stock assessments: • Explore alternative stock assessment models • Estimate stock status • Provide advice on sustainable catch levels Louisville Ridge stock(s) Relevant Tasman Sea stocks Louisville Ridge stock(s)	 2019 2020 2021
Orange roughy assessment data	• Ageing of existing and new orange roughy samples • Coordinate and design acoustic surveys for relevant stocks (intersessional consideration)	2019-2021
Deep water stock structure (US$15k)	• Provide priority list for deepwater stock structure analyses based on assessment for non ORY stocks • Use modelling and observation data to predict connectivity: Using genetic, microchemistry, morphometric, parasite prevalence and tagging experiments	2019 2021
Other stock assessments, including ecological risk assessment	• Refine quantitative risk assessment of DW sharks caught in SPRFMO bottom fisheries • Propose categorisation of stocks into assessment framework • Refine risk assessment of teleost stocks • Recommend relevant reference points and/or management rules for all assessed DW stocks	2020 2019 2018-2020 2020
VME Encounter	• Annual review of benthic and VME indicator taxa • Collect and review VME catch and other benthic sampling data • Design approach for benthic bycatch review	Annual from 2019 2020 2019
Spatial management	• Update and re-assess VME and habitat suitability modelling as appropriate	2020
Bottom Fishery Impact Assessment	• Revise and update BFIAS • Review updated BFIA, including cumulative impacts, from members relative to revised BFIAS	2019 2021

2. Squid Working Group

Task	Objective	Timeline
Squid assessment and CMM development	• Develop and present alternative assessment approaches	2019-2021
	• Develop a plan for more detailed within-season fishery monitoring	2018
	• Evaluate possible management approaches against Commission objectives	2019+
Squid assessment data	• Identify data needs and recover historical data	2018-2020
	• Sample biological information year-round in its entire distribution area	
	• Reconstruct historical total catch records including non-CNCPs and non-members	
	• Record and analyse diet data	
	• Review on the acoustic surveys for Squid biomass estimation (pros, cons, challenges)	
Squid connectivity	• Develop standardised approaches, e.g., for genetic sampling	2018-19
	• Collect and analyse genetic samplings (Convention area and adjacent EEZs)	2019-2021
	• Use modelling and observation data to predict connectivity and seasonal to decadal variability possibly using genetic, microchemistry, morphometric, parasite prevalence, and tagging experiments	2019-2022

3. Jack mackerel Working Group

Task	Objective	Timeline
Jack mackerel assessment data	• Review available input data JM assessment • Evaluate the impact on age-length keys due to any revisions in age determinations • Standardization of commercial tuning indices • Review industry data availability and usability (using self-sampling biological data and acoustic data from fishing vessels in the JM assessment).	2019
Jack mackerel assessment (US$80k)	• Conduct an assessment of Jack mackerel and have a workshop: • SC and other funds to support experts • An evaluation of alternative stock structure hypotheses • Review appropriate data weightings (2019) • Explore alternative stock assessment models (Benchmark in 2020?) • Review biological reference points (BRPs), rebuilding plan, commence MSE development to design alternative harvest control rule (2019-2020) • Provide TAC advice (2019)	2019 and on
Estimation of growth	• Analyse growth estimation in light of spatial-temporal changes using a variety of techniques such as daily increment, carbon dating, tagging • Update growth estimation to be provided to the SC intersessional prior to SC07 to allow the SC to schedule a data compilation workshop at its earliest convenient	2019-2020
Predict recruitment under climatic drivers	• Investigate SPRFMO specific drivers of recruitment such as El Nino to improve productivity prediction	2020-2025
Jack mackerel connectivity	• Use modelling and observation data to predict connectivity and seasonal to decadal variability herein	2019-2021

4. Habitat Monitoring Working Group

Task	Objective	Timeline
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 by industry vessels.	2019-2020
Further developments of standardized oceanographic data products and modelling	• Characterize jack mackerel habitat (e.g., past studies done in Peru and Chile) • Provide ecosystem status overview for SC at seasonal to decadal scale	2019-2020
Habitat working group (US$40k)	• 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. • Explore the concept of CJM habitat through retrospective analysis (including bibliographical analysis). • 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. • Explore possibilities to organize a symposium on the topic of pelagic habitat in the 2020s. • Organize a workshop on the state of the art of habitat research in the same place as, and immediately before, the SC meeting • Habitat suitability modelling of Jack Mackerel	2019-2021

5. Other (Cross-cutting issues)

Task	Objective	Timeline
Observer programme	• Analyze observer coverage rates from simulation study for SPRFMO fisheries and recommend values to Commission • Evaluate available observer data on seabird interaction rates (jack mackerel, different squid fisheries, demersal) and determine where estimates can be improved	2019 2019
Exploratory fishing	• Evaluate review analyses on data collected from first voyages of Cook Islands exploratory lobster/crab fishery and provide advice to Commission • Review any results from exploratory toothfish fishery (assuming approved)	2019 2019 2020 2021
Seabird / bycatch monitoring	• Evaluate available observer data on seabird interaction rates (jack mackerel, different squid fisheries, demersal) and determine where estimates can be improved • Progress southern hemisphere quantitative risk assessment (SEFRA)	2019 2019
EBSA	• Evaluate impacts of fishing activities	2019

SPRFMO SC6-Report

Annex 6. Jack Mackerel Assessment Workshop Report

Available on the SPRFMO website at:

http://www.sprfmo.int/assets/SCW6-CJM-assessment/Report-of-Jack-mackerel-stock-assessment-workshop-SCW6.pdf

SPRFMO SC6-Report
Annex 7. Jack mackerel Technical Annex

1. Introduction

This document and content are based on discussions and analyses conducted at the Scientific Committee (SC) Jack mackerel benchmark workshop (SCW6) conducted earlier in 2018 and finalized at SC6 meeting. The analyses updated the model and assumptions from SC5 (the last full assessment was in SC4 (2016)), and a preferred model configuration was agreed upon at the workshop. A summary of discussions during the workshop can be found in the meeting report. The model was updated with new data, and subsequently adopted at the SC6 meeting. Discussions at SCW6 and SC6 focused on the following topics:

- Review and update of data sets
- The weighting of different data sets (which are of different quality) and scientific approaches to assigning weights
- How to deal with ageing error and its potential impacts on the assessment
- Assumptions on fisheries and survey selectivity over the years
- Assumptions on growth and natural mortality
- The extent and mechanisms affecting how selectivity may vary over time
- The need for guidelines for CPUE data collection and standardisation methods

Scientific name and general distribution

The Chilean Jack mackerel (*Trachurus murphyi*, Nichols 1920) is widespread throughout the South Pacific, along the shelf and oceanic waters adjacent to Ecuador, Peru, and Chile, and across the South Pacific along the Subtropical Convergence Zone in what has been described as the "jack mackerel belt" that goes from the coast of Chile to New Zealand within a 35° to 50° S variable band across the South Pacific.

Main management units

At least five management units of *T. murphyi* associated to distinct fisheries are identified in the SE Pacific: the Ecuadorian fishery, which is managed as part of a more general pelagic fishery within the Ecuadorian EEZ; the Peruvian fishery, which is managed as part of a Jack mackerel, mackerel and sardine fishery directed exclusively for direct human consumption taking place almost entirely within the Peruvian EEZ; the northern and the central-southern Chilean fisheries which are managed as separate management units, with the northern fishery being mostly within Chilean EEZ and the central-southern Chilean fishery which straddles the Chilean EEZ and the adjacent high sea; and, the purely high sea fishery which is a multinational fishery being managed entirely within the context of the SPRFMO. At present there is no directed fishery for *T. murphyi* in the central and western South Pacific and around New Zealand, where, if any, incidental catches are very small.

Stock structure

There are a number of competing stock structure hypotheses, and up to five and more separate stocks have been suggested: i) a Peruvian stock (northern stock) which is a straddling stock with respect to the high seas; ii) a Chilean stock (southern stock) which is also a straddling stock with respect to the high seas; iii) a central Pacific stock which exists solely in the high seas; iv) a southwest Pacific stock which exist solely in the high seas; v) and, a New Zealand-Australian stock which straddles the high seas and both the New Zealand and Australian EEZs. Regarding specifically the eastern and central South Pacific, the SPRFMO has identified the following four alternative stock structure working hypotheses: 1) Jack mackerel caught off the coasts of Peru and Chile each constitute separate stocks which straddle the

high seas; 2) Jack mackerel caught off the coasts of Peru and Chile constitute a single shared stock which straddles the high seas; 3) Jack mackerel caught off the Chilean area constitute a single straddling stock extending from the coast out to about 120°W; and, 4) Jack mackerel caught off the Chilean area constitute separate straddling and high seas stocks.

Accordingly, the Jack Mackerel Sub-group (JMSG) of the Science Working Group (SWG) of the SPRFMO at its 11th Session (SWG-11) carried out parallel assessments of the Jack mackerel stock(s) in the Eastern South Pacific under the two main working hypotheses already identified. That is: that Jack mackerel caught off the coasts of Peru and Chile each constitute separate stocks (Peruvian or northern and Chilean or southern stocks - hypothesis 1) which straddle the high seas; and, that Jack mackerel caught off the coasts of Peru and Chile constitute a single shared stock (hypothesis 2) which straddles the high seas. In following up on the SWG-11 recommendations, the SPRFMO Commission at its 1st Commission Meeting requested the newly established SC to continue the work on evaluating alternative hypotheses on Jack mackerel stock population. Pending more conclusive findings on the stock population structure of Jack mackerel, the 2nd Commission meeting requested the SC to continue and expand the stock assessment work under both stock hypotheses considered in the 11th SWG Meeting, and this continues to be one of the main tasks undertaken at SC6.

Fishery

The fishery for jack mackerel in the south-eastern Pacific is conducted by fleets from the coastal states (Chile, Peru and Ecuador), and by distant water fleets from various countries, operating beyond the EEZ of the coastal states.

The fishery by the coastal states is done by purse seiners. The largest fishery exists in Chile, where the fish are used for fish meal. In Peru, the fishery is variable from year to year. Here the fish are taken by purse seiners that also fish for other pelagic species (e.g., anchovy, mackerel, sardines). According to government regulations, the jack mackerel in Peru may only be used for human consumption. Ecuador constitutes the northern fringe of the distribution of jack mackerel. Here the fish only occur in certain years, when the local purse seiners may take substantial quantities (70 000 tons in 2011). Part of the catch is processed into fish meal but recently jack mackerel has been promoted to be used for human consumption.

The distant water fleets operating for jack mackerel outside the EEZs have been from a number of parties including Belize, China, Cook Islands, Cuba, European Union (Netherlands, Germany and Lithuania), Faroe Islands, Korea, Japan, Russian Federation, Ukraine and Vanuatu. These fleets consist exclusively of pelagic trawlers that freeze the catch for human consumption. In the 1980s a large fleet from Russia and other Eastern European countries operated as far west as 130° W. After the economic reforms in the communist countries around 1990, the fishery by these countries in the eastern Pacific was halted. It was not until 2003 that foreign trawlers re-appeared in the waters outside the EEZ of the coastal states.

The jack mackerel fishery in Chilean and offshore waters is mono-specific. In the offshore fishery, the catch consists for 90 – 98% of jack mackerel, with minor bycatch of chub mackerel (*Scomber japonicus*) and Pacific bream (*Brama australis*). The available time series of jack mackerel catches in the south-eastern Pacific by country are shown in Table A7.1 with the catch summarised by fleets in Figure A7.1.

Management

Jack mackerel were managed by coastal states beginning in the mid-1990s. National catch quotas for jack mackerel were introduced by Peru in 1995 and by Chile in 1999. Peru introduced a ban on the use of jack mackerel for fish meal in 2002. For the international waters, the first voluntary agreement on limitation of the number of vessels was introduced in 2010. Starting from 2011, catch limits for jack mackerel were established for all countries fishing in the convention area in the south-eastern Pacific.

Information on the environment in relation to the fisheries

Important environmental events (e.g., the 2016 El Niño) affect oceanographic dynamics. During such events, the depth of the 15^{o}C isotherm and oxycline changed significantly affecting the spatial distribution of Jack mackerel and their availability in different regions. The extent that such changes affect the overall population productivity is unclear.

Reproductive biology

The main spawning season happens from October to December; however, spawning has been described to occur from July to March. Gonadosomatic index and eggs surveys have been used to determine the time of spawning.

2. Data used in the assessment

Fishery data

The catch data for the model sum values from various countries, and from four "fleets", which are intended to be consistent with the gear and general areas of fishing (Figure A7.1). The catches from each of these fleets are presented in Table A7.2

Length data are available from all major fisheries both inside and outside the EEZs. Length distributions from Chile and the older international fleet were converted into age distributions using annual Chilean age-length keys. The more recent length composition data from China and EU were converted to age compositions by applying Chilean age-length keys as compiled by quarter of the year and then aggregated (Table A7.3, Table A7.4, and Table A7.5). In some years, including 2018, the EU provided age-length keys which were used to convert EU length distribution data to age. For Peruvian and Ecuadorian fisheries, length frequency data (Table A7.6) were used directly and fit within the model according to the specified growth curve.

Several CPUE data series are used in the model, with some changes introduced during SC6. For the Chilean purse seiner fleet, a "General Linear Model" (GLM; McCullagh & Nelder, 1989) approach was used to standardize the CPUE. Here CPUE was modelled as a linear combination of explanatory variables with the goal to estimate a year-effect that is proportional to jack mackerel density. Factors in the GLM included year, quarter, zone, and vessel hold capacity. Effort units were computed as the number of days spent fishing by each vessel. This CPUE series was revised during SC4 to exclude trips with no jack mackerel catches. This was preferred because it better reflects changes in management over time (particularly the introduction vessel-level quotas starting in 2000). To account for changes in fleet behaviour arising from the changes in management, the revised CPUE series from the GLM was modelled to have a catchability change in year 2000. Up to 2018, Peru had been using a CPUE abundance index derived from the industrial purse seine fleet. This fishery has a strong focus on anchoveta and other stocks such as chub mackerel (*Scomper japonicus*) and bonito (*Sarda chiliensis*) and with increasing catch rates in these fisheries, the focus on Jack mackerel has shifted and hence the CPUE was no longer deemed indicative of Jack mackerel biomass. This resulted in a lack of CPUE data between 2015 and 2017 for previous assessments. In 2018 therefore a change was introduced, calculating CPUE indicators based on artisanal and small-scale fleets that are and have been targeting the jack mackerel on a regular basis and operating at a closer distance to the coast than the industrial fleets. Historical data on catch by haul capacity for the artisanal fleets were recovered beginning in 2000. A Generalized Additive Model, in which the dependent variable (catch per trip) is gamma-distributed using a log-link function, was applied by removing the operational (holding capacity) and temporal effects (year, month). The GAM combined data from both artisanal and industrial fleets, although concerns were raised about the accuracy of the historical data (e.g., from missing fleet identifiers) and thus there is a need for continued development.

The Chinese CPUE was standardized using a GLM and updated earlier studies. This series was included as a separate index of exploitable biomass for offshore fleet. In previous assessments, the Russian time series of CPUE was included but with low weight since it remains unstandardized. In 2018, however, the Russian data were added to a combined standardized offshore CPUE index. The entire time series now represents data from Russia, Korea, Vanuatu and the EU. A GAM model is fitted on catch data with an offset of log(effort) assuming a negative binomial distribution. Vessel, month of the year, year and sea surface temperature were taken as linear effects while two-dimensional smoothers were applied to correct for spatial effects. It was noted that these fleets share similar temporal and spatial dynamics.

In all standardized CPUE series, no explicit correction for search time has been incorporated. In some products, such as the offshore CPUE, effort in weeks is taken rather than effort by day (of positive registrations) to account for searching time. However, the inability to consistently define and accurately measure searching time remains an issue. Further, the lack of a defined protocol for CPUE standardisation was noted, and it was agreed that the development of CPUE standardisation guidelines should be a priority to improve the quality of the assessment. These guidelines should include some guidance on the best types of models to use (e.g., GLM vs. GAM), and explore how best to define search time. Considerations should also be made to include flexibility for future improvements and revisions.

Fisheries independent data

China has a system of observers on board fishing vessels that, among other data collection activities, routinely record environmental variables (wind direction and speed, Sea Surface Temperature (SST), etc.) while on the fishing grounds. Although this data are presently unavailable to the SC, they may be in the future.

The Chilean jack mackerel research program has included conducting surveys using hydro-acoustics and the daily egg production method (DEPM). Acoustic estimates and egg survey results are used as relative abundance indices. For the northern region (N-Chile) data on acoustic biomass and number and weight at age are available annually from 2006 to 2018. For the central-southern regions, these data are available from 1997 to 2009. In previous jack mackerel assessments, the acoustic survey in northern Chile was assigned the same selection-at-age curve as the northern Chile fishing fleet; however, given the survey age composition data indicate that it catches younger ages than the fishing fleet, the SC6 considered it more appropriate to assign the survey its own selectivity. To estimate the abundance of the spawning stock, egg surveys (through the DEPM) were conducted on an annual basis from 1999 to 2008 along the central zone of the Chilean coast. In addition, there are estimates of abundance and numbers-at-age for the central-southern regions based on DEPM for the years 2001, 2003, 2004, 2005, 2006, 2008. Age composition data for the acoustic and DEPM Chilean surveys are shown in

Table A7.7, Table A7.8, and Table A7.9.

The Peruvian jack mackerel research programme includes egg and larvae surveys and hydro-acoustic stock assessment surveys. Results of these egg and larvae surveys provide information on the spatial and temporal variability of jack mackerel larvae along the Peruvian coast from 1966 to-date. During SC3, a new series of acoustic biomass was provided by Peru for years 1986-2013. This series represented estimations based on the assumption of shifts in habitat area and its impact over traditional estimations. Acoustic biomass estimates of jack mackerel are available from 1983 to-date. Because these surveys have the Peruvian anchoveta as the target species, the data only covered the first 80 miles, and eventually 100 miles from the coast. Corrections to compensate for this partial coverage of acoustic biomass estimates of jack mackerel were being made by using an environmental index describing the potential habitat of this species based on available monthly data on SST, Sea

Surface Salinity (SSS), water masses (WM), oxycline depth (OD) and chlorophyll (CHL), since 1983 to the present.

An additional alternative acoustic index for Peru was presented at SC3. This was constructed using backscatter information without converting the information to biomass estimates using length-frequency data. This method was proposed to address the reduced quality of the available length-frequency data in recent years. This alternative series was included in the jack mackerel assessment in SC4, thus replacing the Peruvian acoustic series used in previous assessments. The last value provided for this series corresponds to 2013. The El Niño conditions in 2014 and 2015 affected the distribution of jack mackerel making them more dispersed and outside the area covered by the anchovy survey. Further work is needed to standardise and analyse the survey data to develop a reasonable index from these data. This index has been retained in the current assessment.

Acoustic surveys, to estimate the biomass and distribution of jack mackerel, have also been conducted along the Chilean coast, inside and outside of the EEZ and in the Peruvian EEZ, using scientific vessels. Additionally, comprehensive acoustic surveys have been conducted from the Chilean commercial fleet. The time series of available acoustic estimates extends from 1985 to 2013 (depending on the area). All abundance index (fishery CPUE and survey) series used in the model are presented in Table A7.10.

Biological parameters

The maturity-at-age assumed for jack mackerel was based on a Chilean study (Leal et al. 2012). The application of these results reduced the age at first reproduction by about one year, to 2-3 years from the 3-4 years used in the assessment a few years ago. Maturity at length was consistently observed with L50 at about 23 cm fork length (FL). The maturity-at-age values, and those for the far-north stock, are shown in Table A7.11.

To fit the length composition data from the far-north fleet, a growth curve was used to convert age compositions predicted by the model to predicted lengths, with the conversion occurring within the model. The values for the von Bertalanffy growth parameters are given in Table A7.12. Ageing imprecision is acknowledged using an age-error matrix, as shown in Table A7.13. However, because this matrix is based on expert judgement instead of actual data, the discussions during SC4 led to selecting the final assessment model with this ageing error option turned off.

Mean weight-at-age is required for all fishing fleets and biomass indices in order to relate biomass quantities to the underlying model estimates of jack mackerel abundance (in numbers). The four weight at-age matrices for the fishing fleets correspond to: fleet 1 (northern Chile), fleet 2 (central-south Chile), fleet 3 (the far north fleet) and fleet 4 (the offshore trawl fleet). These values are shown in Table A7.14, Table A7.15, Table A7.16, and Table A7.17.

In Chile, the mean weight-at-age is calculated by year by taking the mean length at age in the catch and a length-weight relationship of the year. Before SC3, the same weight at age matrix was used for the Northern Chilean Fleet (Fleet 1) and Southern Chilean Fleet (Fleet 2). Beginning in SC3, a weight-at-age matrix specific for Northern Chile has been applied. The method uses two information sources: the length-age keys and the parameters of the weight-at-length relationship from IFOP's monitoring program of the Chilean fisheries. The information was separated into two zones which correspond to fishing areas (and acoustic surveys) that occur in Chile. Annual weight-at-length relationship was fitted to the data by each fleet independently, and these relationships were applied to mean length-at-age within each zone (Table A7.14 and Table A7.15). The information covers the period 1974-2017; for earlier years the weight-at-age from 1974 was used.

In Peru, mean weight-at-age is calculated by year taking the invariant mean length-at-age estimated from the growth function (Table A7.12) and the length-weight relationship of the year. The information

covers the period 1970-2017 (Table A7.16). The weights-at-age for the offshore fleet are derived from age-extrapolations from Chilean length frequency data and averages when unavailable.

For the offshore fleet, the EU reported both age, length, and weight data, allowing for weight-at-age to be reported for their catches based on observer programme data compiled in 2018. For China, Vanuatu, Russia and Korea, length-weight information is transformed using the Chilean fleet-2 quarter-specific age-length keys Table A7.17. Note that for most countries weight-at-length information is available. In some years however, including 2018, weight-at-length data from the Chinese fleet were missing, which resulted in using the weight-length relationship from the Chilean fleet 2.

Estimates of natural mortality are derived from Pauly´s method, using the Gili et al. (1995) growth function for Chile and the Dioses (2013) growth function for Peru. The estimated M values are assumed to be the same for all ages and all years within the given stock (see Table A7.12).

Data sets

A full description of data sets used for the assessment of jack mackerel is in Annex 3 of the SC Data workshop 2015. A summary list of all data available for the assessment is provided in Table A7.18.

3. The assessment model

A statistical catch-at-age model was used to evaluate the jack mackerel stocks. The JJM ("Joint Jack Mackerel Model") is implemented in ADMB and considers different types of information, which corresponds to the available data of the jack mackerel fishery in the South Pacific area from 1970 to 2018 (Table A7.18).

The JJM model is an explicit age-structured model that uses a forward projection approach and maximum likelihood estimation to solve for model parameters. The operational population dynamics model is defined by the standard catch equation with various modifications such as those described by Fournier and Archibald (1982), Hilborn and Walters (1992) and Schnute and Richards (1995). This model was adopted as assessment method in 2010 after several technical meetings (http://www.sprfmo.int/jack-mackerel-sub-group/).

JJM developments

Since its adoption, the JJM model has been improved by participating scientists. The most noted change has been options to include length composition data (and specifying or estimating growth) and the capability to estimate natural mortality by age and time. The model is now more flexible and permits the use of catch information either at age or size for any fleet, and explicitly incorporates regime shifts in population productivity.

The model can be considered to consist of several components, (i) the dynamics of the stock; (ii) the fishery dynamics; (ii) observation models for the data; and (v) the procedure used for parameter estimation (including uncertainties).

Stock dynamics: recruitment is considered to occur in January while the spawning season is considered as an instantaneous process at mid-November. The population's age composition considers individuals from 1 to 12+ years old for the single stock hypothesis (hypothesis 2) as well as for the southern stock in the two-stock hypothesis (hypothesis 1), while for the northern stock (hypothesis 1) 1 to 8+ years old are considered. In all cases a stochastic Beverton-Holt relationship (Beverton & Holt 1957) between stock and recruitment is included. The survivors follow the age-specific mortality composed by fishing mortalities at-age by fleet and the natural mortality, the latest one supposed to be constant over time and ages. The model is spatially aggregated except that the fisheries are geographically distinct. The initial population is based on an equilibrium condition and occurs in 1958 (12 years prior to the model start in 1970) in the case of the single stock (hypothesis 2) and in the southern stock in the case of the

two-stock hypothesis (hypothesis 1), while in the northern stock equilibrium condition occurs in 1962 (8 years prior to the model start in 1970).

Fishery dynamics: The interaction of the fisheries with the population occurs through fishing mortality. Fishing mortality is assumed to be a composite of several processes – selectivity (by fleets), which describes the age-specific pattern of fishing mortality; catchability, which scales fishing effort to fishing mortality; and effort deviations, which are a random effect in the fishing effort – fishing mortality relationship. The selectivity is non-parametric and assumed to be fishery-specific and time-variant. The catchability is index-specific, and there are nine abundance indexes. For some of the indices, time variations in catchability and / or selectivity have been considered.

Observation models for the data: There are five data components that contribute to the log-likelihood function – the total catch data, the age-frequency data, the length-frequency data and the abundance indices data.

The probability distributions for the age and length-frequency proportions are assumed to be approximated by multinomial distributions. Sample size is specified to be different by gear but mostly constant over years. For the total catch by fishery (4) and abundance indices (9), a log-normal assumption has been assumed with constant CV; the CV for the fisheries is 0.05 whereas the CVs for the abundance indices depend on the index. Beginning in 2018, as discussed in SC4 and agreed upon in SCW6, the Francis T1.8 weighting method (Francis 2011) is used to assign weighted sample sizes for age-frequency data.

Parameter estimation: The model parameters are estimated by maximizing the log-likelihoods of the data plus the log of the probability density functions of the priors and smoothing penalties specified in the model. Estimation was conducted in a series of phases, the first of which used arbitrary starting values for most parameters. The model has been implemented and compiled in ADMB and whose characteristics can be consulted in Fournier et al (2012)

Model details

Parameters estimated conditionally are listed in Table A7.19. The most numerous of these involve estimates of annual and age-specific components of fishing mortality for each year from 1970-2018 and each of the four fisheries identified in the model. Parameters describing population numbers at age 1 in each year (and years prior to 1970 to estimate the initial population numbers at ages 1-12+ and 1-8+) were the second most numerous type of parameter.

Equations and specifications for the assessment model are given in Table A7.20 and Table A7.21. Table A7.22 contains the initial variance assumptions for the indices and age and length compositions.

The treatment of selectivity and how they are shared among fisheries and indices are given in Table A7.23 and Table A7.24 for the two-stock hypothesis, and Table A7.25 for the single-stock hypothesis. Selectivity for the FarNorth fleet was specified with a regime shift in 2002 under the two-stock hypothesis, while annual variations beginning in 1981 were specified under the single-stock hypothesis. Depending on the model configuration, some growth functions were employed inside the model to convert model-predicted age compositions to length compositions, in order to fit the model to the length composition data.

Models for stock structure hypothesis

During SWG 11, two types of population structure were evaluated and this was continued for SC1 and SC2 evaluations. Models under the two-stock hypotheses carry the same naming convention but have the letters “N” or “S” appended to designate split-stock model runs (for North and South stock structure hypothesis).

Description of model explorations

The first set of explorations involved incrementally adding new data components relative to last year's jack mackerel model. These are labelled "Mod0.x" where x represents the number when a component was added (Table A7.26).

The rationale for the main updates and data revisions occurring through model configurations 0.0 to 0.12 has been explained in the "Data used in the assessment" section, earlier in this Annex. The data exercise concluded with Model 0.12.

The next set of explorations (1.0 – 1.5) started from Model 0.12, renamed as Model 1.0 with an updated control file, and evaluated aspects such as changes in the weighting of specific input datasets, changes in CPUE indices (specifically Chinese and Peruvian datasets), and alternative growth assumptions. The most salient features from this exploration for the assessment of jack mackerel (for simplicity under the single stock hypothesis) are described below.

Some models were run purely as sensitivity tests, (e.g., models 1.1 and 1.2). In Model 1.3 an alternative assumption on growth was evaluated, similar to the settings used in the benchmark workshop (SPRFMO-2018-SCW6, model 1.14). In Model 1.4, an alternative weighting scheme for the multinomial age composition sample sizes, based on Francis T1.8 method (Francis 2011), was used, as proposed in SC-04-JM-07. Given that SCW6 agreed to use Francis weights for its final model, this model was taken as the preferred model to provide advice on. The final agreed-upon model, Model 1.5, assumed low steepness (h=0.65) based on the most recent recruitment time-series (2000-2015), similar to assessments prior to SC5, proposing a precautionary approach to assessment and advice.

4. Results

Results comparing the impact of new data (Models 0.0-0.12) show that updating the Chinese CPUE series in particular resulted in a change of biomass and recruitment trends in recent years. This CPUE series estimated high biomass in 2015 and low biomass in 2016, which changed perceptions of recruitment and biomass. Other major data updates include the replacement of the Peruvian CPUE index with a new one, and the incorporation of the Russian index into the offshore CPUE index, as mentioned previously.

Models 1.0 – 1.4 evaluated the sensitivity of the model to the new Peruvian CPUE data, the new Chinese CPUE, the alternative growth assumptions and the Francis T1.8 method (2011) of weighting data sources. The final model (1.5) is the same as the model agreed at SCW6, albeit with a precautionary assumption of lower steepness for the stock recruitment model and a shorter time period for estimating stock-recruitment.

The analytical retrospective analysis (which involves running the model multiple times, each time removing the final year of data, done for five years) shows that the time series of recruitment and SSB have a slight tendency to be over-estimated relative to the next year's estimates when more data were added. Further, as more data are accumulated, the magnitude of recruitment estimates can change (Figure A7.2).

An alternative to the analytical retrospective analysis, which is based on the current model formulation, the "historical retrospective analysis" instead compares quantities derived from assessments previously adopted by the SC (raw values for biomass found in Table A7.27; graphically visualised in Figure A7.3 and Figure A7.4). This indicates the year-to-year changes in estimates of stock trends and reference points. Results indicate that the current model formulation is consistent in the most recent years for biomass and fishing mortality. The recruitment comparison shows that high recruitment of the 2016 year class that was estimated in 2017 is no longer evident from the most recent assessment (Figure A7.3). Downward revision of SSB was further driven by an update in the Chinese CPUE and a change in assumption on fleet selectivity, allowing free estimation of F-at-age in recent years compared to more rigid assumptions in the 2017 model configuration.

Assumed fishery mean weight-at-age assumed for all models are shown in Figure A7.5. Estimates of numbers-at-age from the model are given in

Table A7.28. The fishery age and length composition fits are shown in Figure A7.6, Figure A7.7, Figure A7.8, and Figure A7.9. The fits to age composition data from the surveys are given in Figure A7.10 and Figure A7.11. This model fit the indices well (Figure A7.12). Fits to the fishery and survey mean age compositions are shown in Figure A7.13 and Figure A7.14 respectively. Fits to mean length compositions for the Far North fleet are shown in Figure A7.15. Selectivity estimates for the fishery and indices are shown over time in Figure A7.16.

A summary of the time series stock status (spawning biomass, F, recruitment, total biomass) for the single-stock hypothesis is shown in Figure A7.17. As in past years, the biomass can be projected forward based on the estimated recruits to evaluate the impact of fishing under four scenarios with different recruitment (and hence productivity) assumptions. This can be informative to distinguish environmental effects relative to direct fishing impacts. For the jack mackerel stock, fishing appears to be a major cause of the population trend, with the current level at below 37% of what is estimated to have occurred had there been no fishing (Figure A7.18).

Fishing mortality rates at age (combined fleets) were high starting in about 1992 but has declined in the past years (Table A7.29 and Figure A7.17). To evaluate the potential for alternative "regimes", stock recruitment curves were estimated over different periods (as defined in Annex 4 of SC1). Within the current period (2001-2015), the level of expected recruitment was lower than the alternatives although recruitment has increased in recent years to about the long-term average mean. Time series of quantities derived by the model are presented in Table A7.30.

The JJM assessment model was also run under the 2-stock hypothesis, and a summary figure of the northern (far-north) and southern stocks can be found in Figure A7.19. Conditions of the jack mackerel stock in its entire distribution range in the southeast Pacific shows a continued recovery since the time-series low in 2010. It is noted that under the two-stock model, the northern unit shows stable and relatively low biomass over the last decade, while the southern unit shows an increasing trend. The southern unit showed similar results to that of the single-stock hypothesis, although being SSB was estimated slightly higher under the former scenario. Estimates of stock size and exploitation rate for the Northern stock were comparable to previous years and show a small increase in stock size in the last year while fishing mortality is low (Figure A7.19).

5. Management Advice

New data and indicators on the status of the jack mackerel stock suggest that conditions evaluated in detail from the last benchmark assessment (completed in 2018) are relatively unchanged. The population trend is estimated to be increasing. The indications of stock improvement (higher abundance observed in the acoustic survey in the northern part of Chile, better catch rates apparent in some fisheries, and increase in average age in the Chilean fisheries) drive the increase.

Historical fishing mortality rates and patterns relative to the provisional biomass target are shown in Figure A7.17. Near term spawning biomass is expected to increase from the 2018 estimate of 4.8 million t to 5.6 million t in 2019 (with approximate 90% confidence bounds of 4.5 – 7.0 million t).

Given current stock status, the second tier of the jack mackerel rebuilding plan could be applied, thereby increasing the potential catch by a maximum of 15%. This would result in a 2019 catch level for jack mackerel within the entire jack mackerel range to be at or below 662 kt. However, this stock status is based on an assessment configuration that assumes a constant 5.5 million t B_{MSY} level. Recent increases in the theoretical B_{MSY} values (estimated in the model; likely due to changes in selectivity of all fisheries combined) would imply a ratio of about 70% of B_{MSY}. This indicates that under the rebuilding plan, the status quo fishing mortality would apply resulting in catch levels at or below 591 kt.

Projections show a high likelihood of rebuilding beyond B_{MSY} by 2020 under all recruitment productivity scenarios evaluated. As such, a re-evaluation of the rebuilding plan is recommended to analyse sustainable exploitation rates of a re-build jack mackerel stock.

6. Assessment Issues

Based on results from the 2018 assessment workshop, as noted previously, assessment plans for 2020 should be developed several months prior to SC7 and SC8 so that data coordinators can configure alternatives and conduct a careful evaluation of all available information to best guide the commission. One of the higher priority items for consideration continues to be the catch-at-age estimates (based on age-determinations being conducted from different labs) and mean body weights at age assumed in the model. Another priority for consideration is the development of guidelines for standardisation of CPUE indices and the collection of relevant data. Results of the data weighting and the retrospective pattern analysis also warrant further investigation.

The issue of evaluating sensitivities to the early fishery age composition data was raised. The SC noted that this might be a fruitful avenue for investigation in subsequent assessments, particularly since these data (pre-1990) are less well-documented.

7. References

Dioses, T. 2013. Edad y crecimiento del jurel Trachurus murphyi en el Perú. In: Csirke J., R. Guevara-Carrasco & M. Espino (Eds.). Ecología, pesquería y conservación del jurel (Trachurus murphyi) en el Perú. Rev. Peru. biol. número especial 20(1): 045- 052

Fournier, D. & C.P. Archibald. 1982. A general theory for analyzing catch at age data. Can. J. Fish. Aquat. Sci. 39: 1195-1207

Fournier, D.A., H.J. Skaug, J. Ancheta, J. Ianelli, A. Magnusson, M.N. Maunder, A. Nielsen, and J. Sibert. 2012. AD Model Builder: using automatic differentiation for statistical inference of highly parameterized complex nonlinear models. Optim. Methods Softw. 27:233-249.

Francis, RICC. 2011. Data weighting in statistical fisheries stock assessment models. Canadian Journal of Fisheries and Aquatic Sciences, 2011, 68:1124-1138, https://doi.org/10.1139/f2011-025

Gili, R., L. Cid, V. Bocic, V. Alegría, H. Miranda & H. Torres. 1995. Determinación de la estructura de edad del recurso jurel. In: Estudio biológico pesquero sobre el recurso jurel en la zona centro-sur, V a IX Regiones. Informes Técnicos FIP/IT-93-18.

Hilborn, R. & C.J. Walters. 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Chapman and Hall, New York: 570 p.

McCullagh, P. and Nelder, J. 1989. Generalized linear models. Chapman and hall. London. 511 pp.

Schnute, J.T., & L.J. Richards. 1995. The influence of error on population estimates from catch-age models. Canadian Journal of Fisheries and Aquatic Sciences, 52(10): 2063-2077

8. Tables

Table A7.1. Sources and values of catch (t) complied for the four fleets used for the assessment (data for 2017 are preliminary, and 2018 are provisional).

Assigned Fleet	Fleet 1	Fleet 2	Fleet 3 (Far North						Fleet 4 (Offshore Trawl)												Grand
Year	N Chile	Chile CS	Cook Islands	Cuba (2)	Ecuador (ANJ)	Peru (ANJ)	USSR	Subtotal	Belize	China	Cuba	European Union	Faroe Islands	Japan	Korea	Peru	Russia/ USSR	Ukraine	Vanuatu	Subtotal	Total
1970	101,685	10,309				4,711		4,711												0	116,705
1971	143,454	14,988				9,189		9,189												0	167,631
1972	64,457	22,546				18,782		18,782									5,500			5,500	111,285
1973	83,204	38,391				42,781		42,781												0	164,376
1974	164,762	28,750				129,211		129,211												0	322,723
1975	207,327	53,878				37,899		37,899												0	299,104
1976	257,698	84,571				54,154		54,154						35						35	396,458
1977	226,234	114,572				504,992		504,992						2,273						2,273	848,071
1978	398,414	188,267				386,793	0	386,793						1,667	403		49,220			51,290	1,024,764
1979	344,051	253,460		6,281		151,591	175,938	333,810			12,719	1,180		120			356,271			370,290	1,301,611
1980	288,809	273,453		38,841		123,380	252,078	414,299			45,130	1,780					292,892			339,802	1,316,363
1981	474,817	586,092		35,783		37,875	371,981	445,638			38,444			29			399,649			438,123	1,944,670
1982	789,912	704,771		9,589		50,013	84,122	143,724			74,292	7,136					651,776			733,204	2,371,611
1983	301,934	563,338		2,096		76,825	31,769	110,690			52,779	39,943		1,694			799,884			894,300	1,870,262
1984	727,000	699,301		560		184,333	15,781	200,674			33,448	80,129		3,871			942,479			1,059,927	2,686,902
1985	511,150	945,839		1,067		87,466	26,089	114,622			31,191			5,229			762,903			799,323	2,370,934
1986	55,210	1,129,107		66		49,863	1,100	51,029			46,767			6,835			783,900			837,502	2,072,848
1987	313,310	1,456,727		0		46,304	0	46,304			35,980			8,815			818,628			863,423	2,679,764
1988	325,462	1,812,793		5,676		118,076	120,476	244,229			38,533			6,871			817,812			863,215	3,245,699
1989	338,600	2,051,517		3,386	0	140,720	137,033	281,139			21,100			701			854,020			875,821	3,547,077
1990	323,089	2,148,786		6,904	4,144	191,139	168,636	370,823			34,293			157			837,609			872,059	3,714,757
1991	346,245	2,674,267		1,703	45,313	136,337	30,094	213,447			29,125						514,534			543,659	3,777,618
1992	304,243	2,907,817		0	15,022	96,660	0	111,682			3,196						32,000	2,736		37,932	3,361,674
1993	379,467	2,856,777			2,673	130,681		133,354												0	3,369,598
1994	222,254	3,819,193			36,575	196,771		233,346												0	4,274,793
1995	230,177	4,174,016			174,393	376,600		550,993												0	4,955,186
1996	278,439	3,604,887			56,782	438,736		495,518												0	4,378,844
1997	104,198	2,812,866			30,302	649,751		680,053												0	3,597,117
1998	30,273	1,582,639			25,900	386,946		412,846												0	2,025,758
1999	55,654	1,164,035			19,072	184,679		203,751						7						7	1,423,447
2000	118,734	1,115,565			7,122	296,579		303,701		2,318										2,318	1,540,318
2001	248,097	1,401,836			133,969	723,733		857,702		20,090										20,090	2,527,725
2002	108,727	1,410,266			604	154,219		154,823		76,261										76,261	1,750,077
2003	143,277	1,278,019			0	217,734		217,734		94,690					2,010		7,540		53,959	158,199	1,797,229
2004	158,656	1,292,943			0	187,369		187,369		131,020					7,438		62,300		94,685	295,443	1,934,411
2005	165,626	1,264,808			0	80,663		80,663	867	143,000		6,187			9,126		7,040		77,356	243,576	1,754,673
2006	155,256	1,224,685			0	277,568		277,568	481	160,000		62,137			10,474		0		129,535	362,627	2,020,136
2007	172,701	1,130,083	7		927	254,426		255,360	12,585	140,582		123,523	38,700		10,940		0		112,501	438,831	1,996,975
2008	167,258	728,850	0		0	169,537		169,537	15,245	143,182		108,174	22,919		12,600		4,800		100,066	406,986	1,472,631
2009	134,022	700,905	0		1,934	74,694		76,628	5,681	117,963		111,921	20,213	0	13,759	13,326	9,113		79,942	371,918	1,283,473
2010	169,012	295,796	0		4,613	17,559		22,172	2,240	63,606		67,497	11,643	0	8,183	40,516			45,908	239,593	726,573
2011	30,825	216,470	0		69,373	257,241		326,614	0	32,862	8	2,248	0	0	9,253	674	8,229		7,617	60,891	634,800
2012	13,256	214,204	0		77	187,292		187,369		13,012	0	0	0	0	5,492	5,346	0		16,068	39,917	454,746
2013	16,361	214,999	0		3,563	77,022		80,585		8,329		10,101	0		5,267	2,670			14,809	41,175	353,120
2014	18,219	254,295	0		9	74,528		74,537		21,155		20,539	0		4,078	2,557			15,324	63,652	410,703
2015	34,886	250,327			289	22,158		22,447		29,180		27,955	0		5,749	0	2,561		21,227	86,672	394,332
2016	24,657	295,160			0	15,087		15,087		20,208		11,962	0		6,430	0			15,563	54,163	389,067
2017	35,002	311,863			54	8,813		8,867		16,802		27,652	0		1,235	0	3,188		0	48,877	404,609
2018	10,896	391,632			28	28,000		28,028		24,030		9,691	0		4,000	0	4,689		0	42,410	472,966

Table A7.2. Catch (tonnes) by fleet (combined) for the stock assessment model. Note that 2018 data are preliminary.

Year	Fleet 1	Fleet 2	Fleet 3	Fleet 4
1970	101.69	10.31	4.71	0
1971	143.45	14.99	9.19	0
1972	64.46	22.55	18.78	5.5
1973	83.2	38.39	42.78	0
1974	164.76	28.75	129.21	0
1975	207.33	53.88	37.9	0
1976	257.7	84.57	54.15	0.04
1977	226.23	114.57	504.99	2.27
1978	398.41	188.27	386.79	51.29
1979	344.05	253.46	333.81	370.29
1980	288.81	273.45	414.3	339.8
1981	474.82	586.09	445.64	438.12
1982	789.91	704.77	143.72	733.2
1983	301.93	563.34	110.69	894.3
1984	727	699.3	200.67	1059.93
1985	511.15	945.84	114.62	799.32
1986	55.21	1129.11	51.03	837.5
1987	313.31	1456.73	46.3	863.42
1988	325.46	1812.79	244.23	863.22
1989	338.6	2051.52	316.25	875.82
1990	323.09	2148.79	370.82	872.06
1991	346.25	2674.27	213.45	543.66
1992	304.24	2907.82	111.68	37.93
1993	379.47	2856.78	133.35	0
1994	222.25	3819.19	233.35	0
1995	230.18	4174.02	550.99	0
1996	278.44	3604.89	495.52	0
1997	104.2	2812.87	680.05	0
1998	30.27	1582.64	412.85	0
1999	55.65	1164.04	203.75	0.01
2000	118.73	1115.57	303.7	2.32
2001	248.1	1401.84	857.74	20.09
2002	108.73	1410.27	154.82	76.26
2003	143.28	1278.02	217.73	158.2
2004	158.66	1292.94	187.37	295.44
2005	165.63	1264.81	80.66	243.58
2006	155.26	1224.69	277.57	362.63
2007	172.7	1130.08	255.36	438.83
2008	167.26	728.85	169.54	406.99
2009	134.02	700.9	76.63	371.92
2010	169.01	295.8	22.17	239.59
2011	30.82	216.47	326.39	60.89
2012	13.26	214.2	187.4	39.92
2013	16.36	215	80.59	41.18
2014	18.22	254.29	74.53	63.65
2015	34.89	250.33	22.45	86.72
2016	24.66	295.16	15.09	53.67
2017	35	311.86	8.87	48.88
2018	10.9	391.63	28.03	41.41

Table A7.3. Catch at age for fleet 1. Units are relative value (they are normalized to sum to 100 for each year in the model). Green shading reflects relative level.

Age group (years)

Year	1	2	3	4	5	6	7	8	9	10	11	12
1975	0	1	2	8	10	28	29	14	5	1	1	0
1976	0	0	0	2	10	30	37	17	3	1	0	0
1977	0	2	3	7	20	33	25	9	1	0	0	0
1978	0	1	8	15	14	9	25	20	7	1	0	0
1979	0	0	4	9	18	22	23	18	6	1	0	0
1980	0	1	3	6	17	23	27	19	4	0	0	0
1981	0	0	2	9	20	24	29	14	3	0	0	0
1982	0	0	1	14	15	20	27	16	5	1	0	0
1983	0	0	0	7	20	29	27	14	3	0	0	0
1984	0	0	11	28	13	13	17	15	3	0	0	0
1985	0	0	4	17	27	29	17	5	1	0	0	0
1986	4	13	12	7	8	15	22	13	5	1	0	0
1987	0	5	40	41	10	2	2	1	0	0	0	0
1988	0	0	11	41	38	9	0	0	0	0	0	0
1989	0	1	1	6	45	38	8	1	0	0	0	0
1990	1	9	1	3	28	48	10	1	0	0	0	0
1991	0	2	20	20	11	17	24	6	0	1	0	0
1992	0	3	21	12	23	23	13	5	1	0	0	0
1993	0	3	62	25	5	4	1	0	0	0	0	0
1994	0	14	34	10	26	13	2	0	0	0	0	0
1995	0	16	32	28	14	8	2	0	0	0	0	0
1996	8	16	31	34	9	2	0	0	0	0	0	0
1997	0	5	55	36	4	0	0	0	0	0	0	0
1998	0	2	57	24	12	4	0	0	0	0	0	0
1999	0	6	72	17	4	1	0	0	0	0	0	0
2000	7	30	17	30	14	2	0	0	0	0	0	0
2001	0	12	63	23	1	0	0	0	0	0	0	0
2002	6	12	47	21	11	2	1	0	0	0	0	0
2003	1	14	55	22	5	2	1	0	0	0	0	0
2004	0	2	13	59	24	1	0	0	0	0	0	0
2005	4	26	38	16	12	4	0	0	0	0	0	0
2006	2	3	33	52	6	2	1	0	0	0	0	0
2007	0	9	32	44	10	3	2	1	0	0	0	0
2008	1	49	24	8	9	8	1	0	0	0	0	0
2009	0	7	29	51	4	8	0	0	0	0	0	0
2010	0	46	5	32	12	3	1	0	0	0	0	0
2011	6	59	28	3	1	2	0	0	0	0	0	0
2012	4	12	15	61	8	0	0	0	0	0	0	0
2013	4	68	26	1	0	0	0	0	0	0	0	0
2014	6	93	1	0	0	0	0	0	0	0	0	0
2015	11	3	11	49	20	6	1	0	0	0	0	0
2016	0	0	12	19	13	21	15	8	8	3	1	1
2017	0	18	15	45	16	4	1	0	0	0	0	0

Table A7.4. Catch at age for fleet 2. Units are relative value (they are normalized to sum to 100 in the model). Green shading reflects relative level.

Age group (years)

Year	1	2	3	4	5	6	7	8	9	10	11	12
1975	0	0	1	2	6	18	28	25	14	5	2	0
1976	0	1	0	0	1	14	36	31	14	2	0	0
1977	0	0	0	3	11	19	35	27	4	0	0	0
1978	0	0	1	6	19	31	26	12	3	0	0	0
1979	0	0	1	13	18	18	18	16	11	4	0	0
1980	0	0	1	9	23	25	22	12	6	1	0	0
1981	0	0	0	4	17	31	28	14	4	1	0	0
1982	0	0	0	3	18	24	26	18	7	2	0	0
1983	0	2	4	7	17	25	26	13	5	1	0	0
1984	0	0	4	8	10	23	27	20	7	1	0	0
1985	0	0	1	8	14	25	31	16	4	0	0	0
1986	0	1	1	5	15	24	33	18	3	0	0	0
1987	0	4	9	8	5	15	32	22	4	1	0	0
1988	0	0	3	21	24	10	17	18	6	1	0	0
1989	0	0	0	4	23	32	19	15	6	1	0	0
1990	0	0	0	1	8	26	33	19	11	2	0	0
1991	0	1	2	2	1	7	28	31	16	8	3	1
1992	0	0	1	4	6	7	8	24	21	18	8	3
1993	0	0	4	12	15	14	13	12	14	12	4	1
1994	0	0	1	11	17	18	11	10	15	12	4	0
1995	0	0	4	18	14	25	18	9	6	4	2	0
1996	0	1	11	14	20	18	16	11	5	2	1	0
1997	0	2	17	31	22	11	6	4	4	2	1	0
1998	0	4	28	35	14	6	3	3	3	1	1	0
1999	0	4	37	34	14	5	2	1	1	1	1	1
2000	0	1	15	40	25	10	3	1	1	1	1	1
2001	0	1	10	26	34	16	5	2	2	2	1	2
2002	0	1	12	26	26	16	6	3	2	2	2	3
2003	0	0	6	25	30	20	8	3	2	2	1	1
2004	0	0	4	14	29	29	13	5	3	2	1	1
2005	1	1	1	5	17	39	19	8	5	2	1	1
2006	0	0	1	4	8	21	27	14	10	7	4	3
2007	0	0	1	13	15	11	15	15	13	9	5	4
2008	1	2	0	1	7	21	19	15	11	9	5	9
2009	0	0	4	9	2	19	22	17	11	7	5	4
2010	0	0	4	29	20	10	10	6	9	7	2	2
2011	0	0	1	16	13	35	10	6	13	5	1	1
2012	0	0	0	7	31	31	18	7	4	1	0	0
2013	0	0	2	18	29	33	14	3	0	0	0	0
2014	0	0	4	17	38	24	14	2	0	0	0	0
2015	0	0	11	40	17	11	10	7	2	1	0	0
2016	0	0	3	20	26	22	14	8	4	2	1	1
2017	0	0	8	19	15	18	15	10	5	4	3	3
2018	0	0	1	15	29	20	18	8	6	1	2	1

Table A7.5. Catch at age for fleet 4. Units are relative value (they are normalized to sum to 100 for each year in the model). Green shading reflects relative level. Catch-at-age 1979-2013 were calculated considering Age-Length Key from fleet 2. Catch-at-age 2017 was calculated with an Age-Length Key from Chile from the EU.

Age group (years)

Year	1	2	3	4	5	6	7	8	9	10	11	12
1979	0	0	0	0	4	13	25	30	19	8	1	0
1980	0	1	1	5	16	24	26	17	9	2	0	0
1981	0	0	0	2	10	24	31	22	8	2	0	0
1982	0	0	0	1	7	20	31	26	11	3	1	1
1983	0	2	4	3	10	23	30	18	7	1	0	0
1984	0	0	2	7	11	19	26	23	9	1	0	0
1985	0	0	1	10	17	25	28	14	5	1	0	0
1986	0	1	2	7	20	25	26	15	3	0	0	0
1987	0	4	5	3	8	24	33	18	4	1	0	0
1988	0	1	4	15	16	16	24	17	6	1	0	0
1989	0	0	1	5	22	27	21	15	8	2	0	0
1990	0	0	0	1	10	33	28	15	10	3	0	0
1991	0	0	0	1	2	16	40	23	10	5	2	1
2000	0	3	18	27	17	11	7	6	5	4	2	0
2001	0	2	15	30	30	14	4	2	2	1	0	0
2002	1	2	20	42	21	9	3	1	1	0	0	0
2003	0	1	18	48	25	7	1	0	0	0	0	0
2006	0	0	0	1	13	37	29	10	5	3	1	0
2007	0	0	0	1	7	22	23	16	15	10	6	0
2008	0	0	0	0	1	11	30	26	16	10	6	0
2009	0	0	1	1	0	2	15	35	25	14	9	0
2010	0	1	29	14	0	0	5	10	19	15	5	0
2011	0	0	1	9	8	17	11	10	24	14	6	0
2012	0	0	0	0	0	0	2	4	50	27	8	8
2013	0	0	1	18	21	25	17	8	3	4	1	1
2014	0	2	28	21	14	14	12	5	2	1	1	1
2015	0	0	10	19	14	15	16	14	5	3	2	2
2016	0	2	13	21	24	17	11	6	3	2	0	1
2017	30	31	15	11	5	3	3	2	1	0	0	0

Table A7.6. Catch at length for fleet 3. Units are relative value (they are normalized to sum to 100 for each year in the model). Green shading represents the relative level.

Total length (cm)

Year	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1980	1	2	2	2	3	2	5	3	2	1	0	0	0	1	1	1	0	0	1	3	3	5	8	12	11	9	7	5	3	2	1	1	1	1	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	9	11	9	10	10	9	8	7	6	4	3	3	2	2	2	1	0	0	0	0	0	0
1982	0	0	1	3	6	6	6	5	4	5	6	4	1	0	0	0	0	0	0	1	1	4	8	12	9	6	3	2	2	2	1	1	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	7	15	18	15	13	7	5	3	2	1	1	1	1	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	6	8	8	8	11	11	10	8	6	4	3	2	1	1	1	1	1	0	1	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	4	5	7	7	8	8	7	7	7	7	6	5	3	3	2	2	2	1	2	1	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	2	4	7	10	13	12	12	8	6	5	3	3	2	2	2	1	1	1	0
1987	0	0	0	0	0	0	0	1	0	0	1	1	1	2	2	4	5	8	11	12	10	8	5	3	2	3	4	4	3	2	2	2	1	1	1	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	7	9	10	9	7	5	4	3	3	3	3	3	2	2	2	3	3	2	3	3	2	2	1	1	0
1989	0	0	0	0	0	0	0	0	0	0	0	1	7	10	5	6	4	3	2	2	2	3	4	6	8	8	8	6	4	3	1	1	1	1	1	1	1	1	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	5	6	7	9	12	13	10	8	6	4	3	3	2	1	1	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	1	1	1	2	2	3	4	5	5	7	8	8	8	7	6	4	3	3	2	2	2	2	1	1	1
1992	0	0	0	0	0	0	0	0	0	0	1	2	1	1	1	1	1	1	1	2	3	4	7	9	12	11	8	6	6	5	5	4	3	2	1	1	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	1	2	2	3	4	6	9	12	9	7	6	5	5	6	5	5	5	4	2	1	1	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	3	3	5	11	14	11	8	6	4	3	3	3	3	2	3	2	2	2	1	1	1	1	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	4	5	6	7	8	9	11	12	10	6	3	2	2	1	1	1	1	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	1	2	2	2	3	5	6	6	6	6	7	9	8	6	6	5	4	4	3	3	2	1	1	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	7	11	10	5	4	8	14	16	8	4	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	1	2	4	3	2	4	7	16	20	14	8	4	3	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	1	1	1	1	1	1	1	2	3	5	7	12	13	16	15	8	5	3	2	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	4	8	7	5	4	4	10	8	7	8	12	11	7	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	1	2	1	1	2	4	7	10	12	16	16	14	9	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	1	3	9	16	19	19	14	7	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	1	1	2	5	7	8	6	5	6	9	10	7	5	4	3	4	5	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	6	7	9	12	13	11	8	8	7	5	3	2	1	0	0	0	0	0	0	0	0
2005	0	0	1	1	1	0	0	1	3	6	8	8	10	10	6	3	1	1	1	1	1	0	0	0	0	0	0	0	2	5	9	9	5	3	2	1	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	2	3	6	8	7	8	8	8	7	8	8	8	7	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	8	5	6	4	3	6	10	12	11	8	6	3	1	1	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	3	10	18	21	17	10	6	3	2	1	2	1	1	0	0	0	0	0	0	0	0	0
2009	1	1	1	1	0	0	0	0	0	0	1	4	4	4	2	2	1	0	1	1	0	0	0	0	0	1	2	5	11	19	20	11	5	1	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	2	0	2	25	49	18	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	18	23	24	18	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	15	32	27	14	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	2	2	4	4	11	8	5	2	0	1	1	1	3	12	20	15	4	1	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	5	20	31	19	8	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	1	1	3	10	13	12	14	14	9	5	4	4	3	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	1	2	5	6	6	7	8	7	8	8	8	8	7	6	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	1	2	3	4	5	6	8	8	7	7	8	8	7	5	5	3	3	3	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Table A7.7. Catch at age for acoustic surveys at southern of Chile. Units are relative value (they are normalized to sum to 100 for each year in the model). Green shading reflects relative level.

Age group (years)

Year	1	2	3	4	5	6	7	8	9	10	11	12
1997	0	1	39	42	12	3	1	1	1	0	0	0
1998	0	1	48	44	4	1	1	1	1	0	0	0
1999	0	2	29	43	11	6	2	1	3	2	1	0
2000	0	0	10	45	31	11	2	0	0	0	0	0
2001	0	1	21	46	23	6	1	1	1	0	0	0
2002	0	0	6	28	23	30	7	4	1	0	0	0
2003	0	0	3	23	34	26	7	2	2	1	1	0
2004	0	0	1	7	18	23	17	11	9	9	3	1
2005	0	0	0	9	21	41	18	5	2	0	1	1
2006	0	0	0	0	18	43	27	5	3	2	1	1
2007	0	0	0	0	0	7	21	20	19	17	8	8
2008	0	0	0	0	0	10	33	27	12	9	4	5
2009	0	0	0	0	0	0	1	33	21	18	16	12

Table A7.8. Catch at age for acoustic surveys at northern of Chile. Units are relative value (they are normalized to sum to 100 for each year in the model). Green shading reflects relative level.

Age group (years)

Year	1	2	3	4	5	6	7	8	9	10	11	12
2006	12	42	28	16	2	0	0	0	0	0	0	0
2007	0	5	17	55	21	1	0	0	0	0	0	0
2008	0	49	48	1	1	0	0	0	0	0	0	0
2009	0	41	42	16	0	1	0	0	0	0	0	0
2010	0	0	7	71	17	3	1	0	0	0	0	0
2011	0	27	12	50	4	5	1	0	0	0	0	0
2012	0	43	5	17	25	9	1	0	0	0	0	0
2013	11	35	2	17	16	15	4	1	0	0	0	0
2014	30	66	1	1	0	1	1	0	0	0	0	0
2015	62	10	5	15	4	2	1	0	0	0	0	0
2016	70	4	10	10	4	1	0	0	0	0	0	0
2017	19	57	7	10	5	1	0	0	0	0	0	0
2018	78	15	2	3	1	0	0	0	0	0	0	0

Table A7.9. Catch at age for DEPM surveys at southern of Chile. Units are relative value (they are normalized to sum to one for each year in the model). Green shading reflects relative level.

Age group (years)

	1	2	3	4	5	6	7	8	9	10	11	12+
2001	15	36	37	6	3	2	2	1	0	0	0	0
2003	2	15	24	10	16	11	12	6	2	1	0	0
2004	2	15	35	19	9	5	7	5	2	1	0	0
2005	0	0	1	38	24	16	11	5	3	2	0	0
2006	0	0	4	20	31	24	14	5	2	1	0	0
2008	0	0	4	12	22	27	20	9	5	0	0	0

Table A7.10. Index values used within the assessment model.

Year	Chile (1)	Chile (2)	Chile (3)	Chile (4)	Peru (2)	Peru (3)	China	Offshore
1983			0.582					
1984		99	0.532					
1985		324	0.46		94.316			
1986		123	0.379		108.116			
1987		213	0.462		109.789			
1988		134	0.406		114.18			
1989			0.391		157.394			
1990			0.322		229.757			
1991		242	0.368		231.672			
1992			0.353		180.355			
1993			0.299		145.726			
1994			0.332		95.245			
1995			0.297		54.257			
1996			0.284		29.967			
1997	3530		0.215		31.664			
1998	3200		0.207		43.994			
1999	4100		0.216	5724	52.681			
2000	5600		0.21	4688	105.784			
2001	5950		0.265	5627	131.586		1.34	
2002	3700		0.213		96.661	4.016	1.9	
2003	2640		0.207	1388	67.471	4.859	1.92	
2004	2640		0.239	3287	51.853	5.316	1.45	
2005	4110		0.224	1043	75.171	4.206	1.51	
2006	3192	112	0.233	3283	111.259	5.572	1.05	1788
2007	3140	275	0.166	626	79.75	7.986	1.19	1595
2008	487	259	0.102	1935	24.251	3.904	0.91	1099
2009	328	18	0.083			1.45	0.81	873
2010		440	0.052		7.247	2.678	0.58	543
2011		432	0.034		35.283	6.79	0.35	497
2012		230	0.132		50.332	6.033	0.4	476
2013		144	0.111		64.504	2.599	0.58	580
2014		87	0.086			3.678	0.53	468
2015		459	0.068			3.076	1.35	589
2016		587.244	0.133			2.685	0.77	551
2017		610.47	0.162			3.545	1.28	775
2018		375.639	0.169					

Legend:
Chile (1): Acoustics for south-central zone in Chile
Chile (2): Acoustics for northern zone in Chile
Chile (3): Chilean south-central fishery CPUE for fleet 1
Chile (4): Daily Egg Production Method
Peru(1): Peruvian acoustic index in fleet 3
Peru(2): Peruvian echo-abundance index in fleet 3 (alternative)
Peru(3): Peruvian fishery CPUE in fleet 3
China: Chinese CPUE for fleet 4
Offshore: Combined CPUE for EU, South Korea, Russia/USSR, and Vanuatu in fleet 4

Table A7.11. Jack mackerel sexual maturity by age used in the JJM models.

Age (yr)	1	2	3	4	5	6	7	8	9	10	11	12
Single Stock	0.070	0.310	0.720	0.930	0.980	0.990	1.000	1.000	1.000	1.000	1.000	1.000
Far North Stock	0.000	0.370	0.980	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table A7.12. Jack mackerel growth and natural mortality parameters used in JJM models.

Parameter	Far North stock	Single stock
L_∞ (cm) (Total length)	80 .4	74.4
k	0.16	0.16
L_0 (cm)	18.0	18.0
M (year^{-1})	0.33	0.23

L_o is the mean length at the recruitment age (1 yrs).

Table A7.13. Ageing error matrix of jack mackerel.

	1	2	3	4	5	6	7	8	9	10	11	12+
1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.76	0.22	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.24	0.51	0.23	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.02	0.23	0.50	0.23	0.02	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.02	0.23	0.49	0.23	0.02	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.03	0.23	0.48	0.23	0.03	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.03	0.24	0.46	0.24	0.03	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.03	0.24	0.45	0.24	0.03	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.24	0.44	0.24	0.04	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.24	0.43	0.24	0.04
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.24	0.42	0.29
12+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.24	0.71

Table A7.14. Input mean body mass (kg) at age over time assumed for fleet 1.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1971	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1972	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1973	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1974	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1975	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1976	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1977	0.05	0.089	0.129	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
1978	0.05	0.105	0.124	0.163	0.204	0.314	0.369	0.405	0.434	0.453	0.59	1.115
1979	0.05	0.108	0.163	0.179	0.217	0.274	0.37	0.42	0.474	0.629	0.633	1.115
1980	0.05	0.069	0.118	0.21	0.256	0.324	0.41	0.451	0.511	0.998	0.88	1.115
1981	0.05	0.094	0.139	0.214	0.269	0.331	0.412	0.481	0.58	0.661	1.112	1.115
1982	0.071	0.093	0.168	0.202	0.248	0.305	0.356	0.411	0.446	0.471	0.719	1.115
1983	0.084	0.099	0.119	0.221	0.264	0.314	0.377	0.429	0.475	0.528	0.54	1.115
1984	0.05	0.164	0.186	0.217	0.273	0.345	0.394	0.437	0.497	0.568	0.786	1.115
1985	0.05	0.167	0.173	0.224	0.271	0.34	0.401	0.465	0.536	0.582	0.726	1.115
1986	0.096	0.099	0.143	0.222	0.289	0.332	0.418	0.497	0.55	0.869	0.88	1.115
1987	0.092	0.121	0.146	0.189	0.233	0.336	0.427	0.477	0.513	0.65	0.803	1.115
1988	0.05	0.11	0.167	0.197	0.23	0.298	0.472	0.545	0.586	0.61	0.88	1.115
1989	0.05	0.123	0.167	0.23	0.27	0.31	0.379	0.491	0.541	0.569	0.713	1.115
1990	0.069	0.099	0.16	0.248	0.29	0.338	0.409	0.533	0.651	0.677	0.756	1.115
1991	0.049	0.121	0.143	0.201	0.277	0.366	0.408	0.478	0.637	0.72	0.794	0.883
1992	0.069	0.092	0.127	0.201	0.268	0.3	0.373	0.444	0.512	0.595	0.681	0.786
1993	0.021	0.116	0.152	0.205	0.298	0.364	0.422	0.489	0.528	0.596	0.774	0.889
1994	0.059	0.097	0.107	0.235	0.291	0.33	0.387	0.459	0.565	0.748	0.798	0.898
1995	0.069	0.101	0.137	0.186	0.263	0.321	0.357	0.434	0.561	0.668	0.88	1.115
1996	0.067	0	0.14	0.17	0.229	0.295	0.367	0.507	0.657	0.639	0.88	1.115
1997	0.029	0.063	0.125	0.177	0.246	0.357	0.503	0.615	0.584	0.728	0.88	1.115
1998	0	0.082	0.104	0.195	0.249	0.29	0.39	0.475	0.634	0.728	0.88	1.115
1999	0.071	0.074	0.089	0.147	0.27	0.315	0.446	0.722	0.584	0.728	0.88	1.115
2000	0.043	0.054	0.138	0.191	0.225	0.251	0.372	0.488	0.584	0.728	0.88	1.115
2001	0.066	0.093	0.112	0.133	0.204	0.286	0.421	0.488	0.584	0.728	0.88	1.115
2002	0.029	0.059	0.092	0.172	0.238	0.327	0.398	0.416	0.628	0.728	0.88	1.115
2003	0.036	0.082	0.102	0.141	0.227	0.309	0.416	0.464	0.534	0.728	0.88	1.115
2004	0.037	0.078	0.164	0.186	0.203	0.257	0.342	0.488	0.584	0.728	0.88	1.115
2005	0.029	0.076	0.111	0.175	0.222	0.268	0.281	0.488	0.584	0.728	0.88	1.115
2006	0.032	0.074	0.114	0.132	0.204	0.374	0.442	0.506	0.606	0.728	0.88	1.115
2007	0.087	0.075	0.122	0.158	0.222	0.296	0.404	0.514	0.614	0.723	0.723	1.115
2008	0.042	0.047	0.066	0.187	0.243	0.291	0.388	0.563	0.616	0.748	0.88	1.115
2009	0.015	0.047	0.106	0.138	0.239	0.285	0.335	0.526	0.584	0.728	0.88	1.115
2010	0.013	0.048	0.101	0.172	0.233	0.301	0.397	0.493	0.639	0.772	0.88	1.115
2011	0.019	0.065	0.095	0.167	0.276	0.314	0.398	0.488	0.584	0.728	0.88	1.115
2012	0.016	0.048	0.088	0.202	0.235	0.269	0.396	0.488	0.584	0.728	0.88	1.115
2013	0.038	0.052	0.069	0.151	0.255	0.43	0.495	0.664	0.525	0.687	0.821	1.086
2014	0.018	0.04	0.082	0.189	0.248	0.313	0.396	0.488	0.584	0.728	0.88	1.115
2015	0.027	0.058	0.177	0.183	0.298	0.442	0.621	0.52	0.583	0.729	0.868	1.109
2016	0.027	0.058	0.158	0.195	0.235	0.3	0.353	0.535	0.692	0.742	0.859	0.974
2017	0.024	0.063	0.14	0.164	0.181	0.223	0.299	0.4	0.6	0.528	0.88	1.115
2018	0.024	0.063	0.14	0.164	0.181	0.223	0.299	0.4	0.6	0.528	0.88	1.115

Table A7.15. Input mean body mass (kg) at age over time assumed for fleet 2.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1971	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1972	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1973	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1974	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1975	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1976	0.05	0.07	0.15	0.21	0.27	0.33	0.39	0.47	0.63	0.71	0.89	1.53
1977	0.05	0.09	0.10	0.23	0.27	0.31	0.37	0.45	0.52	0.73	0.65	1.13
1978	0.05	0.08	0.10	0.14	0.21	0.32	0.39	0.44	0.51	0.58	0.63	1.53
1979	0.05	0.10	0.16	0.19	0.24	0.30	0.38	0.46	0.58	0.87	1.26	1.97
1980	0.02	0.06	0.13	0.23	0.27	0.35	0.44	0.51	0.71	0.82	1.07	1.85
1981	0.05	0.09	0.14	0.24	0.29	0.34	0.40	0.50	0.63	0.76	1.18	1.9
1982	0.05	0.08	0.16	0.20	0.26	0.32	0.37	0.47	0.53	0.64	0.98	1.18
1983	0.07	0.09	0.12	0.23	0.27	0.32	0.37	0.46	0.59	0.70	1.19	1.76
1984	0.03	0.13	0.15	0.18	0.26	0.33	0.38	0.44	0.57	0.68	1.01	1.84
1985	0.05	0.14	0.18	0.22	0.27	0.33	0.39	0.47	0.57	0.79	1.37	1.64
1986	0.07	0.07	0.17	0.24	0.28	0.34	0.42	0.51	0.64	0.84	1.35	2.11
1987	0.07	0.11	0.14	0.19	0.27	0.35	0.43	0.50	0.57	0.68	1.08	1.97
1988	0.1	0.12	0.15	0.19	0.23	0.34	0.44	0.51	0.58	0.75	1.01	1.37
1989	0.05	0.10	0.22	0.24	0.27	0.33	0.46	0.58	0.70	0.77	0.88	1.53
1990	0.06	0.09	0.15	0.26	0.30	0.37	0.46	0.58	0.69	0.83	0.97	1.59
1991	0.03	0.10	0.13	0.18	0.27	0.38	0.45	0.54	0.66	0.78	0.90	1.05
1992	0.06	0.08	0.11	0.17	0.23	0.27	0.40	0.52	0.59	0.70	0.85	1.04
1993	0.01	0.08	0.12	0.18	0.24	0.32	0.40	0.57	0.71	0.85	0.96	1.17
1994	0.04	0.08	0.11	0.22	0.27	0.33	0.46	0.64	0.80	0.86	1.05	1.42
1995	0.07	0.09	0.14	0.19	0.27	0.34	0.42	0.57	0.80	0.96	1.11	1.36
1996	0.06	0.09	0.15	0.19	0.28	0.35	0.52	0.68	0.94	1.21	1.42	1.47
1997	0.10	0.10	0.14	0.20	0.26	0.35	0.49	0.68	0.88	1.08	1.46	1.64
1998	0.08	0.12	0.13	0.17	0.24	0.34	0.54	0.80	1.03	1.24	1.41	1.65
1999	0.09	0.10	0.13	0.17	0.25	0.33	0.46	0.74	1.02	1.25	1.37	1.77
2000	0.04	0.06	0.16	0.19	0.25	0.34	0.46	0.75	0.99	1.14	1.22	1.56
2001	0.06	0.09	0.12	0.17	0.25	0.32	0.46	0.61	0.82	1.07	1.36	1.67
2002	0.03	0.07	0.13	0.2	0.25	0.32	0.44	0.64	0.88	1.10	1.32	1.64
2003	0.03	0.08	0.11	0.18	0.24	0.30	0.4	0.56	0.76	1.00	1.20	1.53
2004	0.03	0.08	0.15	0.19	0.24	0.30	0.38	0.52	0.7	0.89	1.08	1.54
2005	0.02	0.07	0.11	0.19	0.25	0.31	0.39	0.51	0.64	0.76	0.91	1.29
2006	0.03	0.07	0.11	0.14	0.26	0.35	0.41	0.51	0.63	0.75	0.92	1.26
2007	0.08	0.07	0.12	0.17	0.22	0.33	0.43	0.51	0.62	0.75	0.90	1.17
2008	0.03	0.04	0.06	0.18	0.25	0.31	0.41	0.51	0.60	0.71	0.86	1.14
2009	0.01	0.04	0.10	0.14	0.25	0.33	0.41	0.53	0.62	0.76	0.88	1.14
2010	0.01	0.05	0.10	0.17	0.23	0.31	0.41	0.53	0.64	0.78	0.96	1.47
2011	0.01	0.06	0.10	0.19	0.28	0.35	0.46	0.61	0.77	0.92	1.17	1.51
2012	0.00	0.01	0.08	0.20	0.26	0.35	0.47	0.55	0.71	0.91	1.14	1.6
2013	0.05	0.15	0.25	0.26	0.31	0.38	0.45	0.55	0.70	0.82	1.11	1.97
2014	0.05	0.09	0.18	0.24	0.37	0.48	0.53	0.68	1.09	1.28	1.30	1.65
2015	0.05	0.34	0.35	0.39	0.48	0.71	0.92	1.33	1.04	1.49	1.13	1.26
2016	0.05	0.13	0.2	0.26	0.31	0.37	0.47	0.57	0.77	0.85	1.11	1.23
2017	0.01	0.05	0.20	0.24	0.30	0.38	0.46	0.56	0.72	0.95	1.09	1.61
2018	0.01	0.05	0.18	0.24	0.31	0.37	0.46	0.55	0.77	0.92	0.85	1.81

Table A7.16. Input mean body mass (kg) at age over time assumed for fleet 3.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.04	0.17	0.37	0.64	0.94	1.26	1.58	1.9	2.19	2.47	2.72	2.94
1971	0.04	0.17	0.37	0.64	0.94	1.26	1.58	1.90	2.19	2.47	2.72	2.94
1972	0.03	0.13	0.30	0.54	0.83	1.14	1.47	1.78	2.09	2.38	2.64	2.88
1973	0.03	0.14	0.33	0.56	0.84	1.13	1.43	1.71	1.99	2.24	2.47	2.68
1974	0.03	0.14	0.32	0.55	0.82	1.10	1.39	1.67	1.93	2.17	2.40	2.60
1975	0.03	0.13	0.31	0.54	0.80	1.09	1.38	1.67	1.94	2.20	2.43	2.64
1976	0.04	0.16	0.34	0.56	0.82	1.08	1.35	1.60	1.84	2.06	2.26	2.44
1977	0.03	0.13	0.29	0.51	0.76	1.02	1.3	1.56	1.81	2.05	2.27	2.46
1978	0.03	0.12	0.29	0.51	0.77	1.05	1.33	1.60	1.87	2.11	2.34	2.54
1979	0.03	0.13	0.30	0.51	0.76	1.02	1.28	1.53	1.77	1.99	2.19	2.37
1980	0.03	0.13	0.29	0.50	0.74	0.99	1.24	1.49	1.72	1.93	2.13	2.30
1981	0.04	0.14	0.31	0.52	0.75	1.00	1.24	1.48	1.70	1.90	2.08	2.25
1982	0.03	0.14	0.30	0.51	0.75	1.00	1.24	1.48	1.71	1.92	2.10	2.27
1983	0.04	0.13	0.28	0.45	0.63	0.82	1.01	1.19	1.35	1.50	1.64	1.76
1984	0.04	0.15	0.32	0.54	0.77	1.02	1.26	1.50	1.71	1.92	2.10	2.26
1985	0.04	0.14	0.32	0.54	0.78	1.04	1.30	1.55	1.79	2.01	2.21	2.38
1986	0.04	0.15	0.32	0.53	0.78	1.03	1.28	1.52	1.75	1.96	2.15	2.32
1987	0.03	0.13	0.29	0.50	0.74	1.00	1.26	1.51	1.75	1.97	2.17	2.35
1988	0.03	0.14	0.31	0.53	0.78	1.04	1.30	1.55	1.79	2.01	2.21	2.39
1989	0.04	0.15	0.33	0.56	0.81	1.07	1.33	1.58	1.82	2.03	2.23	2.41
1990	0.04	0.15	0.32	0.53	0.76	1.01	1.26	1.49	1.72	1.92	2.11	2.28
1991	0.03	0.14	0.30	0.51	0.74	0.98	1.22	1.46	1.68	1.88	2.06	2.23
1992	0.04	0.14	0.31	0.53	0.77	1.03	1.28	1.53	1.76	1.97	2.17	2.34
1993	0.03	0.14	0.32	0.54	0.80	1.08	1.35	1.62	1.87	2.10	2.31	2.50
1994	0.03	0.14	0.33	0.58	0.87	1.18	1.50	1.81	2.10	2.38	2.63	2.86
1995	0.03	0.14	0.31	0.54	0.79	1.05	1.32	1.58	1.82	2.05	2.26	2.44
1996	0.03	0.14	0.31	0.53	0.78	1.05	1.31	1.57	1.82	2.04	2.25	2.43
1997	0.04	0.15	0.31	0.50	0.72	0.94	1.15	1.36	1.55	1.72	1.88	2.03
1998	0.04	0.14	0.29	0.48	0.69	0.91	1.12	1.33	1.52	1.70	1.86	2.00
1999	0.03	0.14	0.32	0.55	0.82	1.10	1.39	1.67	1.93	2.18	2.40	2.61
2000	0.03	0.14	0.33	0.59	0.89	1.21	1.55	1.87	2.18	2.48	2.75	2.99
2001	0.03	0.13	0.32	0.57	0.86	1.18	1.50	1.82	2.12	2.41	2.67	2.91
2002	0.03	0.14	0.33	0.57	0.86	1.16	1.47	1.78	2.07	2.34	2.59	2.81
2003	0.04	0.15	0.34	0.58	0.86	1.15	1.45	1.74	2.01	2.27	2.50	2.71
2004	0.03	0.14	0.33	0.57	0.85	1.14	1.44	1.74	2.01	2.27	2.51	2.72
2005	0.03	0.15	0.34	0.59	0.89	1.20	1.52	1.84	2.14	2.42	2.67	2.91
2006	0.03	0.15	0.34	0.60	0.90	1.23	1.55	1.88	2.18	2.47	2.73	2.97
2007	0.03	0.14	0.33	0.57	0.86	1.16	1.46	1.76	2.04	2.30	2.54	2.76
2008	0.03	0.14	0.33	0.58	0.87	1.19	1.51	1.82	2.12	2.4	2.65	2.88
2009	0.03	0.15	0.33	0.58	0.86	1.16	1.47	1.77	2.05	2.32	2.56	2.78
2010	0.03	0.15	0.33	0.56	0.83	1.12	1.41	1.69	1.95	2.20	2.42	2.63
2011	0.03	0.14	0.35	0.64	1	1.39	1.80	2.21	2.61	2.99	3.33	3.65
2012	0.03	0.14	0.34	0.63	0.97	1.34	1.73	2.11	2.48	2.83	3.15	3.44
2013	0.03	0.14	0.34	0.63	0.97	1.34	1.73	2.11	2.48	2.83	3.15	3.44
2014	0.03	0.14	0.34	0.63	0.97	1.34	1.73	2.11	2.48	2.83	3.15	3.44
2015	0.03	0.14	0.34	0.62	0.95	1.31	1.68	2.05	2.40	2.73	3.04	3.32
2016	0.03	0.14	0.34	0.62	0.95	1.31	1.68	2.05	2.40	2.73	3.04	3.32
2017	0.03	0.14	0.34	0.62	0.95	1.31	1.68	2.05	2.40	2.73	3.04	3.32
2018	0.03	0.14	0.34	0.62	0.95	1.31	1.68	2.05	2.40	2.73	3.04	3.32

Table A7.17. Input mean body mass (kg) at age over time assumed for fleet 4. Weight-at-age 1970-2013 were assumed to be the same as fleet 2.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1971	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1972	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1973	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1974	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1975	0.05	0.09	0.13	0.17	0.26	0.29	0.34	0.39	0.54	0.73	0.98	1.09
1976	0.05	0.07	0.15	0.21	0.27	0.33	0.39	0.47	0.63	0.71	0.89	1.53
1977	0.05	0.09	0.10	0.23	0.27	0.31	0.37	0.45	0.52	0.73	0.65	1.13
1978	0.05	0.08	0.10	0.14	0.21	0.32	0.39	0.44	0.51	0.58	0.63	1.53
1979	0.05	0.10	0.16	0.19	0.24	0.30	0.38	0.46	0.58	0.87	1.26	1.97
1980	0.02	0.06	0.13	0.23	0.27	0.35	0.44	0.51	0.71	0.82	1.07	1.85
1981	0.05	0.09	0.14	0.24	0.29	0.34	0.40	0.50	0.63	0.76	1.18	1.9
1982	0.05	0.08	0.16	0.20	0.26	0.32	0.37	0.47	0.53	0.64	0.98	1.18
1983	0.07	0.09	0.12	0.23	0.27	0.32	0.37	0.46	0.59	0.70	1.19	1.76
1984	0.03	0.13	0.15	0.18	0.26	0.33	0.38	0.44	0.57	0.68	1.01	1.84
1985	0.05	0.14	0.18	0.22	0.27	0.33	0.39	0.47	0.57	0.79	1.37	1.64
1986	0.07	0.07	0.17	0.24	0.28	0.34	0.42	0.51	0.64	0.84	1.35	2.11
1987	0.07	0.11	0.14	0.19	0.27	0.35	0.43	0.50	0.57	0.68	1.08	1.97
1988	0.1	0.12	0.15	0.19	0.23	0.34	0.44	0.51	0.58	0.75	1.01	1.37
1989	0.05	0.10	0.22	0.24	0.27	0.33	0.46	0.58	0.70	0.77	0.88	1.53
1990	0.06	0.09	0.15	0.26	0.30	0.37	0.46	0.58	0.69	0.83	0.97	1.59
1991	0.03	0.10	0.13	0.18	0.27	0.38	0.45	0.54	0.66	0.78	0.90	1.05
1992	0.06	0.08	0.11	0.17	0.23	0.27	0.40	0.52	0.59	0.70	0.85	1.04
1993	0.01	0.08	0.12	0.18	0.24	0.32	0.40	0.57	0.71	0.85	0.96	1.17
1994	0.04	0.08	0.11	0.22	0.27	0.33	0.46	0.64	0.80	0.86	1.05	1.42
1995	0.07	0.09	0.14	0.19	0.27	0.34	0.42	0.57	0.80	0.96	1.11	1.36
1996	0.06	0.09	0.15	0.19	0.28	0.35	0.52	0.68	0.94	1.21	1.42	1.47
1997	0.10	0.10	0.14	0.20	0.26	0.35	0.49	0.68	0.88	1.08	1.46	1.64
1998	0.08	0.12	0.13	0.17	0.24	0.34	0.54	0.80	1.03	1.24	1.41	1.65
1999	0.09	0.10	0.13	0.17	0.25	0.33	0.46	0.74	1.02	1.25	1.37	1.77
2000	0.04	0.06	0.16	0.19	0.25	0.34	0.46	0.75	0.99	1.14	1.22	1.56
2001	0.06	0.09	0.12	0.17	0.25	0.32	0.46	0.61	0.82	1.07	1.36	1.67
2002	0.03	0.07	0.13	0.2	0.25	0.32	0.44	0.64	0.88	1.10	1.32	1.64
2003	0.03	0.08	0.11	0.18	0.24	0.30	0.4	0.56	0.76	1.00	1.20	1.53
2004	0.03	0.08	0.15	0.19	0.24	0.30	0.38	0.52	0.7	0.89	1.08	1.54
2005	0.02	0.07	0.11	0.19	0.25	0.31	0.39	0.51	0.64	0.76	0.91	1.29
2006	0.03	0.07	0.11	0.14	0.26	0.35	0.41	0.51	0.63	0.75	0.92	1.26
2007	0.08	0.07	0.12	0.17	0.22	0.33	0.43	0.51	0.62	0.75	0.90	1.17
2008	0.03	0.04	0.06	0.18	0.25	0.31	0.41	0.51	0.60	0.71	0.86	1.14
2009	0.01	0.04	0.10	0.14	0.25	0.33	0.41	0.53	0.62	0.76	0.88	1.14
2010	0.01	0.05	0.10	0.17	0.23	0.31	0.41	0.53	0.64	0.78	0.96	1.47
2011	0.01	0.06	0.10	0.19	0.28	0.35	0.46	0.61	0.77	0.92	1.17	1.51
2012	0.00	0.01	0.08	0.20	0.26	0.35	0.47	0.55	0.71	0.91	1.14	1.6
2013	0.05	0.12	0.26	0.26	0.31	0.36	0.43	0.50	0.67	0.72	0.93	1.14
2014	0.05	0.09	0.21	0.26	0.37	0.47	0.60	0.65	0.74	0.75	1.63	1.72
2015	0.05	0.34	0.35	0.39	0.48	0.71	0.92	1.33	1.04	1.49	1.13	1.26
2016	0.05	0.13	0.21	0.28	0.34	0.38	0.48	0.61	0.80	0.91	1.09	1.19
2017	0.05	0.09	0.44	0.35	0.36	0.43	0.52	0.61	0.65	0.83	1.07	1.11
2018	0.05	0.09	0.44	0.35	0.36	0.43	0.52	0.61	0.65	0.83	1.07	1.11

Table A7.18. Years and types of information used in the JJM assessment models.

Fleet	Catch-at-age	Catch-at-length	Landings	CPUE	Acoustic	DEPM
North Chile purse seine	1975-2017	-	1970-2018	-	Index: 1984-1988; 1991; 2006-2018 Age comps: 2006-2015	Index: 1999-2008 Age comps: 2001-2008
South-central Chile purse seine	1975-2018	-	1970-2018	1983-2018	1997-2009 Age comps: 1997-2009	-
FarNorth	-	1980-2017	1970-2018	2002-2017	1985-2013	-
International trawl off Chile	1979-1991; 2000-2004; 2006-2017	2007-2015*	1970-2018	China (2001-2017); EU, Korea, Russia, & Vanuatu (2006-2017)	-	-

(*) Are converted to age using age-length keys of central-southern area off Chile

Table A7.19. Symbols and definitions used for model equations.

General Definitions	Symbol/Value	Use in Catch at Age Model
Year index: *i* = {1970, …., 2016}	I	
Fleets (f) and surveys (s)	f,s	Identification of information source
Age index: *j* = { 1,2,…, 12^{+}}	J	
length index: *l* = { 10,11,…, 50}	l	
Mean length at age	L_j	
Variation coefficient the length at age	cv	
Mean weight in year *t* by age *j*	$W_{t,j}$	
Maximum age beyond which selectivity is constant	$Maxage$	Selectivity parameterization
Instantaneous Natural Mortality	M	Constant over all ages
Proportion females mature at age *j*	p^j	Definition of spawning biomass
Ageing error matrix	T	
Proportion of length at some age	Γ	Transform from age to length
Sample size for proportion in year *i*	T_i	Scales multinomial assumption about estimates of proportion at age
Survey catchability coefficient	q^s	Prior distribution = lognormal(μ_q^s , σ_q^2)
Stock-recruitment parameters	R_0	Unfished equilibrium recruitment
	h	Stock-recruitment steepness
	σ_R^2	Recruitment variance
Unfished biomass	φ	Spawning biomass per recruit when there is not fishing
Estimated parameters		
$\phi_i(\#), R_0, h, \varepsilon_i(\#), \mu^f, \mu^s, M, \eta_j^s(\#), \eta$		

Note that the number of selectivity parameters estimated depends on the model configuration.

Table A7.20. Variables and equations describing implementation of the joint jack mackerel assessment model (JJM).

Eq	Description	Symbol/Constraints	Key Equation(s)
1)	Survey abundance index (s) by year. The symbol Δ^s represents the fraction of the year when the survey occurs.	I_i^s	$I_i^s = q^s \sum_{j=1}^{12} N_{ij} W_{ij} S_j^s e^{-\Delta^s Z_{ij}}$
2)	Catch biomass by fleet (f=1,2,3,4), year(i) and age (j) /length (l)	$\hat{C}_{il}, \hat{C}_{ij}, \hat{Y}_i$	$\hat{C}^f_{i,j}, = N_{i,j} \frac{F^f{}_{i,j}}{Z^f{}_{i,j}} \left(1 - e^{-Z^f{}_{i,j}}\right)$
			$\hat{\mathrm{Y}}^f{}_i = \sum_{j=1}^{12+} \hat{C}^f_{i,j} w^f_{i,j}$
	(transformation from age to length composition. Fleet 3, FarNorth)		$\hat{C}_{il} = \Gamma \ \hat{C}_{ij}$
			$\Gamma_{l,j} = \int_j^{j+1} e^{-\frac{1}{2\sigma_j^2}(l-L_j)^2} dl$
			$L_j = L_{00}(1-e^{-k}) + e^{-k} L_{j-1}$
			$\sigma_j = cv L_j$
3)	Proportion at age j, in year i		$p^f_{ij} = \frac{\hat{C}^f_{ij}}{\sum_j \hat{C}^f_{ij}} \quad p^s_{ij} = \frac{N_{ij} S^s_j e^{-\Delta^s Z_{ij}}}{\sum_j N_{ij} S^s_j e^{-\Delta^s Z_{ij}}}$
	Proportion at length l, in year i		$P_{il} = \frac{C_{il}}{\sum_{l=10}^{50} C_{il}}$
4)	Initial numbers at age	j = 1	$N_{1970,j} = e^{\mu_R + \varepsilon_{1970}}$
5)		1 < j < 11	$N_{1970,j} = e^{\mu_R + \varepsilon_{1971-j}} \prod_{j=1}^{j} e^{-M}$
6)		j = 12+	$N_{1970,12+} = N_{1970,11} e^{-M} (1 - e^{-M})^{-1}$
7)	Subsequent years (i >1970)	j = 1	$N_{i,1} = e^{\mu_R + \varepsilon_i}$
8)		1 < j < 11	$N_{i,j} = N_{i-1,j-1} e^{-Z_{i-1,j-1}}$
9)		j = 12+	$N_{i,12^+} = N_{i-1,11} e^{-Z_{i-1,10}} + N_{i-1,12} e^{-Z_{i-1,11}}$
10)	Year effect and individuals at age 1 and i = 1958, …, 2016	$\varepsilon_i, \sum_{i=1958}^{2018} \varepsilon_i = 0$	$N_{i,1} = e^{\mu_R + \varepsilon_i}$

Eq	Description	Symbol/Constraints	Key Equation(s)
11)	Index catchability	μ^s, μ^f	$q_i^s = e^{\mu^s}$
	Mean effect		$s_j^s = e^{\eta_j^s}$ $j \le \text{maxage}$
	Age effect	$\eta^s{}_j, \sum_{j=1958}^{2018} \eta^s{}_j = 0$	$s_j^s = e^{\eta^s_{\text{maxage}}}$ $j > \text{maxage}$
12)	Instantaneous fishing mortality		$F_{ij}^f = e^{\mu^f + \eta_j^f + \phi_i}$
13)	Mean fishing effect	μ^f	
14)	Annual effect of fishing mortality in year i	$\varphi_i, \sum_{i=1970}^{2018} \varphi_i = 0$	
15)	age effect of fishing (regularized) In year time variation allowed	$\eta^f{}_j, \sum_{j=1958}^{2018} \eta^f{}_j = 0$	$s_{ij}^f = e^{\eta_j^f}$ $j \le \text{maxage}$ $s_{ij}^f = e^{\eta^f_{\text{maxage}}}$ $j > \text{maxage}$
	In years where selectivity is constant over time	$\eta^f_{i,j} = \eta^f_{i-1,j}$	$i \ne \text{change year}$
16)	Natural Mortality	M	fixed
17)	Total mortality		$Z_{ij} = \sum_f F_{ij}^f + M$
17)	Spawning biomass (note spawning taken to occur at mid of November)	B_i	$B_i = \sum_{j=2}^{12} N_{ij} e^{-\frac{10,5}{12} Z_{ij}} W_{ij} p_j$
18)	Recruits (Beverton-Holt form) at age 1.	$\tilde{R}_i$	$\tilde{R}_i = \frac{\alpha B_t}{\beta + B_i}$, $\alpha = \frac{4hR_0}{5h-1}$ and $\beta = \frac{B_0(1-h)}{5h-1}$ where h=0.8 $B_0 = R_0 \varphi$ $\varphi = \sum_{j=1}^{12} e^{-M(j-1)} W_j p_j + \frac{e^{-12M} W_{12} p_{12}}{1-e^{-M}}$

Table A7.21 Specification of objective function that is minimized (i.e., the penalized negative of the log-likelihood).

	Likelihood /penalty component		Description / noted
19)	Abundance indices	$L_1 = 0.5 \sum_s \frac{1}{cv_s^2} \sum_i log\left(\frac{I_i}{\hat{I}_i}\right)^2$	Surveys / CPUE indexes
20)	Prior on smoothness for selectivities	$L_2 = \sum_l \lambda_2^l \sum_{j=1}^{12} \left(\eta_{j+2}^l + \eta_j^l - 2\eta_{j+1}^l\right)^2$	Smoothness (second differencing), Note: *l={s,* or *f}* for survey and fishery selectivity
21)	Prior on recruitment regularity	$L_3 = \lambda_3 \sum_{i=1958}^{2018} \varepsilon^2{}_i$ $\lambda_3 = \frac{0.5}{\sigma_R^2}$	Influences estimates where data are lacking (e.g., if no signal of recruitment strength is available, then the recruitment estimate will converge to median value).
22)	Catch biomass likelihood	$L_4 = 0.5 \sum_f \frac{1}{cv_f^2} \sum_{i=1970}^{2018} log\left(\frac{Y^f{}_i}{\hat{Y}^f{}_i}\right)^2$	Fit to catch biomass in each year
23)	Proportion at age/length likelihood	$L_5 = -\sum_{v,i,j} n^v P_{i,j/l}^v \log(\hat{P}_{i,j/l}^v)$	*v={s, f}* for survey and fishery age composition observations $P_{i,j/l}$ are the catch-at-age/length proportions n effective sample size
24)	Dome-shaped selectivity	$L_6 = \lambda_4 \sum_{j=6}^{12} \left(lnS_{j-1} - lnS_j\right)^2$ $S_{j-1} > S_j$	(relaxed in final phases of estimation)
25)	Fishing mortality regularity	F values constrained between 0 and 5	(relaxed in final phases of estimation)
26)	Recruitment curve fit	$L_7 = \lambda_5 \sum_{j=1970}^{2015} log\left(\frac{N_{i,1}}{\tilde{R}_i}\right)^2$ $\lambda_5 = \frac{0.5}{\sigma_R^2}$	Conditioning on stock-recruitment curve over period 1970-2015. (Model 1.5 used the period 2000-2015)
27)	Priors or assumptions	R_0 non-informative	$\sigma_R = 0.6$
28)	Overall objective function to be minimized	$\dot{L} = \sum_k L_k$	

Table A7.22. Coefficients of variation and sample sizes used in likelihood functions, with adjustments based on calculated Francis weights. Initial sample sizes are in parentheses.

Abundance index	cv	Catch biomass likelihood	cv
Acoustic CS- Chile	0.20	N-Chile	0.05
Acoustic N-Chile	0.50	CS- Chile	0.05
CPUE – Chile	0.15	Farnorth	0.05
DEPM – Chile	0.50	Offshore	0.05
Acoustic-Peru	0.20		
CPUE – Peru	0.20		
CPUE- China	0.20		
CPUE-EU	0.20		
CPUE- ex USSR	0.40		
Smoothness for selectivities (indexes)	λ	Proportion at age likelihood (indexes)	n
Acoustic CS- Chile	100	Acoustic CS- Chile	15.4 (30)
Acoustic N-Chile	100	Acoustic N- Chile	27.1 (30)
CPUE – Chile	100	DEPM – Chile	13.1 (20)
CPUE- China	100		
CPUE-EU	100		
CPUE ex-USSR	100		
Smoothness for selectivities (fleets)	λ	Proportion at age (or length) likelihood	n
N-Chile	1	N-Chile	5.37 (20)
CS- Chile	25	CS- Chile	4.07 (50)
Farnorth	12.5	Farnorth (length)	30
Offshore	12.5	Offshore	26.1 (30)
Recruitment regularity	λ	S-Recruitment curve fit	cv
	1.4		0.6

Table A7.23. Description of JJM model components and how selectivity was treated (two-stock hypothesis; Far North Stock).

Item	Description	Selectivity assumption
Fisheries		
1)	Peruvian and Ecuadorian area fishery	Estimated from length composition data (converted to age inside the model). Two time blocks were considered – before and after 2002. This is a different assumption than 1.5 (one-stock), which has annual variations in selectivity between 1981 and 2018.
Index series		
2)	Acoustic survey in Peru	Assumed to be the same as in fishery 1)
3)	Peruvian fishery CPUE	Assumed to be the same as in fishery 1)

Table A7.24. Description of JJM model components and how selectivity was treated (two-stock hypothesis; South stock).

Item	Description	Selectivity assumption
Fisheries		
1)	Chilean northern area fishery	Estimated from age composition data. Annual variations were considered since 1984
2)	Chilean central and southern area fishery	Estimated from age composition data. Annual variations were considered since 1984.
3)	Offshore trawl fishery	Estimated from age composition data. Annual variations were considered since 1980.
Index series		
4)	Acoustic survey in central and southern Chile	Estimated from age composition data. Two time-blocks were considered 1970-2004; 2005-2009.
5)	Acoustic survey in northern Chile	Estimated from age composition data. Selectivity changes were implemented in 2012 and 2016.
6)	Central and southern fishery CPUE	Assumed to be the same as 2)
7)	Egg production survey	Estimated from age composition data. Two time-blocks were considered 1970-2002; 2003-2008.
8)	Chinese fleet CPUE (from FAO workshop)	Assumed to be the same as 3)
9)	Offshore fleet (EU, Korea, Russia, Vanuatu) CPUE	Assumed to be the same as 3)

Table A7.25. Description of JJM model components and how selectivity was treated under the single stock hypothesis.

Item	Description	Selectivity assumption
Fisheries		
1)	Chilean northern area fishery	Estimated from age composition data. Annual variations were considered since 1984
2)	Chilean central and southern area fishery	Estimated from age composition data. Annual variations were considered since 1984.
3)	Peruvian and Ecuadorian area fishery	Estimated from length composition data (converted to age inside the model). Annual variations were considered since 1981
4)	Offshore trawl fishery	Estimated from age composition data. Annual variations were considered since 1980.
Index series		
5)	Acoustic survey in central and southern Chile	Estimated from age composition data. Two time-blocks were considered 1970-2004; 2005-2009.
6)	Acoustic survey in northern Chile	Estimated from age composition data 2006-2016. Selectivity changes were implemented in 2015 and 2016
7)	Central and southern fishery CPUE	Assumed to be the same as 2)
8)	Egg production survey	Estimated from age composition data 2001, 2003-2006, 2008. Two time-blocks were considered around 2003.
9)	Acoustic survey in Peru	Assumed to be the same as 3)
10)	Peruvian fishery CPUE	Assumed to be the same as 3)
11)	Chinese fleet CPUE (from FAO workshop)	Assumed to be the same as 4)
12)	Offshore fleet (Vanuatu, Russia, Korea & EU) CPUE	Assumed to be the same as 4)

Table A7.26. Systematic model progression from the 2018 assessment data to the agreed revised datasets for 2018. Note that the data file names corresponding to each model follow the convention e.g., "Mod0.1.dat" and "Mod0.1.ctl".

Model	Description
Models 0.x	*Data introductions*
mod0.00	Exact 2018w model and data set through 2018w (mod1.13 from SCW6)
mod0.01	Data file as 0.0 with revised catches through 2017; 2018w model used through mod0.11
mod0.02	As 0.01 but with updated Chile AcousN index
mod0.03	As 0.02 but with updated Chile CPUE index
mod0.04	As 0.03 but with updated Peru CPUE index
mod0.05	As 0.04 but with updated Chinese CPUE index
mod0.06	As 0.05 but with updated Offshore CPUE index
mod0.07	As 0.06 but with updated age comps for Chile_AcousN
mod0.08	As 0.07 but with updated Iwtatage for Chile_AcousN
mod0.09	As 0.08 but with updated Fwtatage for N_Chile, SC_Chile, and Offshore_Trawl
mod0.10	As 0.09 but with updated age comps for N_Chile, SC_Chile, and Offshore_Trawl
mod0.11	As 0.10 but with updated length comps from FarNorth
mod0.12	Remove Russian index from model and data
Models 1.x	*Configuration sensitivities*
mod1.0	As mod0.11 data file but model updated to 2018
mod1.1	As mod1.0 with Chinese CPUE downweighted
mod1.2	As mod1.0 with old Peruvian data
mod1.3	As mod1.0 with alternate growth assumptions (as mod1.14 from May 2018 BM Workshop)
mod1.4	As mod1.0 with Francis weights (one iteration, based on sample sizes from May 2018 BM Workshop 2018)
mod1.5	As mod 1.4 but with low steepness and short recruitment time series (2000-2015) Final Model for SC6 (2018)
Mod 1.4.x	*Projection configurations to reflect regime and uncertainty in stock productivity*
mod1.4.ll	As mod1.4 but low steepness and long recruitment time series (1970-2015)
mod1.4.ls	As mod1.4 but low steepness and short recruitment time series (2000-2015)
mod1.4.hl	As mod1.4 (i.e., high steepness and long recruitment time series (1970-2015))
mod1.4.hs	As mod1.4 but high steepness and short recruitment time series (2000-2015)

Table A7.27. Spawning biomass of jack mackerel obtained in previous SPRFMO scientific Committee (SC) meetings.

Year	SC1	SC2	SC3	SC4	SC5	SC6
1970	8761	6726	10082	9770	9928	10319
1971	8112	6384	9164	8872	9037	10015
1972	7818	6173	8527	8289	8457	9854
1973	7726	6015	8042	7911	8079	9756
1974	7676	5910	7673	7633	7800	9646
1975	7763	5894	7446	7511	7675	9604
1976	8141	6075	7454	7638	7799	9752
1977	8810	6589	7808	8027	8186	10113
1978	9551	7151	8224	8445	8603	10459
1979	10189	7613	8553	8810	8965	10717
1980	10854	8276	9085	9349	9494	11124
1981	11171	8521	9213	9561	9693	11174
1982	10806	8122	8679	9137	9252	10513
1983	11092	8503	8926	9487	9578	10584
1984	11122	8635	8942	9653	9722	10502
1985	11554	9342	9557	10297	10351	10869
1986	13159	11355	11531	11890	11936	12177
1987	14919	13284	13459	13371	13411	13402
1988	15496	13717	13895	13801	13830	13717
1989	15050	13082	13256	13389	13406	13455
1990	14228	12207	12371	12701	12699	13076
1991	13098	11032	11197	11792	11763	12408
1992	11909	9856	10018	10772	10716	11542
1993	10802	8942	9082	9800	9722	10658
1994	9271	7518	7634	8165	8070	9061
1995	7154	5448	5532	5901	5794	6696
1996	5819	3820	3862	4174	4073	4775
1997	4950	2991	2965	3254	3181	3609
1998	4985	3158	3074	3539	3498	3677
1999	5668	3937	3795	4475	4457	4434
2000	6671	5018	4834	5616	5624	5463
2001	7481	5892	5690	6368	6404	6172
2002	8083	6699	6544	7010	7073	6805
2003	8201	6952	6848	7274	7349	7080
2004	7641	6564	6475	6908	6979	6725
2005	6708	5763	5676	6159	6225	5997
2006	5486	4682	4595	5102	5160	4979
2007	4119	3430	3324	3846	3890	3754
2008	3067	2545	2382	2890	2915	2779
2009	2130	1850	1598	2070	2074	1893
2010	1709	1647	1291	1775	1758	1538
2011	1855	1861	1382	1868	1832	1667
2012	2304	2115	1552	2065	2015	1980
2013	3085	2383	1814	2308	2248	2339
2014		2738	2222	2667	2572	2725
2015		3206	2720	3273	3103	3176
2016			3174	4116	3885	3606
2017					5294	4097
2018						4777

Table A7.28. Estimated begin-year numbers at age (Model 1.5), 1970-2018. Green shading reflects relative level.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	10260.7	6913.01	5057.97	3783.27	2567.22	2047.14	1572.91	1369.7	1191.37	1031.15	886.034	3929.07
1971	9899.81	8150.69	5489.45	4010.53	2993.57	2019.84	1592.16	1203.4	1054.23	936.475	812.029	3791.89
1972	10383.4	7862.83	6469.8	4346.8	3166.65	2344.24	1555.05	1196.44	912.266	824.373	734.367	3610.31
1973	10879.2	8245.18	6238.71	5115.41	3437.24	2494.37	1828.5	1195.21	922.247	716.089	649.887	3425.08
1974	13299.8	8633.62	6533.07	4908.54	4032.49	2698.23	1933.07	1389.7	911.507	720.598	563.511	3206.71
1975	18690.5	10530.5	6805.45	5046.36	3827.89	3138.24	2062.06	1435.95	1041.77	708.805	563.222	2946.81
1976	22256.9	14833	8343.56	5353.82	3963.25	2971.86	2372.79	1500.04	1055.5	803.99	552.105	2734.05
1977	21594.9	17659.5	11746.2	6551.21	4194.26	3060.59	2221.06	1690.58	1082.14	808.679	623.418	2548.1
1978	22379.7	16985.5	13713.3	8602.79	4968.2	3204.84	2274.74	1573.52	1208.07	821.884	625.109	2451.58
1979	22253.2	17659.1	13282.2	10295.5	6551.18	3720.24	2256.71	1456.36	1024.72	884.595	619.303	2318.34
1980	22985.1	17581.6	13848.2	10072.9	7875.11	4894.04	2577.68	1383.56	893.661	721.657	645.534	2143.75
1981	27809.2	18140.4	13755.8	10416.8	7703.22	5939.44	3475.08	1660.75	891.762	640.391	534.181	2064.67
1982	32236.3	21973.5	14188.2	10308.5	7897.47	5654.95	3952.62	1981.39	942.544	600.097	459.844	1866.15
1983	26479.7	25516.7	17331.1	10981.7	7809.2	5539.31	3335.72	1781.28	884.483	560.71	390.394	1513.18
1984	43037	21009.5	20178.8	13500.6	8460.71	5707	3572.13	1767.44	911.226	543.763	370.59	1258.13
1985	52108.9	34129.9	16558.2	15537.1	10125.8	5943.85	3403.05	1623.03	754.673	496.249	320.01	958.519
1986	28761.9	41342.9	26969	12884.9	11762.5	7211.96	3659.84	1634.9	723.073	408.361	295.099	760.288
1987	27012	22834.8	32755.7	21222.8	9975.33	8749.78	4856.42	1987.54	775.182	394.789	245.563	634.645
1988	32171.6	21432.4	18028.7	25517.7	16117.1	7270.1	5790.18	2551.39	861.642	372.458	210.257	468.78
1989	27973	25492.1	16765.1	13874.2	19063.8	11397.9	4746.86	3160.46	1095.12	357.016	166.444	303.449
1990	30555.1	22160.3	19950.3	12850.7	10414.4	13486.6	7322.99	2702.49	1540.3	473.963	148.857	195.921
1991	21225	24205.7	17406.1	15266.8	9596.24	7460.02	8848.51	4251.7	1383.15	697.399	191.193	139.081
1992	21870.5	16815.9	19022.7	13354.1	11378	6894.07	4936.23	5040.88	2010.45	574.357	248.605	117.734
1993	15438.8	17325.8	13201.4	14538.7	9909.72	8061.87	4551.38	2920.72	2362.65	739.825	164.881	105.165
1994	14537.8	12218.6	13475.7	9802.54	10486	6841.19	5253.81	2728.5	1532.94	975.157	212.594	77.5997
1995	19065.6	11494.6	9462.91	9852	6753.16	6732.96	4074.95	2900.03	1289.82	515.892	229.623	68.3328
1996	20982.6	14989.3	8606.53	6196.94	5849.63	3628.03	3261.61	1854.4	1182.01	384.467	100.488	58.0375
1997	28118.4	16426.7	10897.8	5344.67	3291.25	2654.46	1578.01	1430.24	760.039	393.903	93.8628	38.7021
1998	26583.2	21968.7	11740	6520.83	2499.46	1262.03	1063.17	692.091	600.248	257.36	102.111	34.3647
1999	31476.1	20825.9	15982.2	7900.24	3588.72	1270.78	660.576	582.452	371.008	289.459	108.741	57.6646
2000	32402	24820.6	15796.8	11298.9	4876.11	2085.15	750.628	405.508	356.289	213.896	153.667	88.3407
2001	21388	25450.9	18680.4	11491.1	7301.35	2922.74	1278.48	483.346	263.413	223.225	127.218	143.938
2002	14777.9	16534	17778.6	12630.6	7264.38	4031.31	1653.09	778.877	299.826	157.246	125.563	152.524
2003	8392.91	11649.2	12768.7	13124.4	8605.34	4424.82	2375.57	1013.21	479.958	175.005	85.2025	150.68
2004	8649.42	6579.55	8802.53	9327.26	9095.61	5421.3	2630.31	1442.45	621.088	277.591	94.4051	127.245
2005	6592.93	6788.66	5037.36	6401.96	6461.31	5835.76	3156.67	1528.36	847.292	344.081	146.163	116.708
2006	6743.08	5173.63	5171.36	3644.78	4450.98	4274.4	3408.52	1814.26	885.674	467.615	183.294	140.033
2007	4703	5260.89	3781.13	3519.12	2398.31	2899.48	2526.31	1827.55	966.97	441.466	227.023	156.973
2008	4257.62	3671.53	3856.21	2392.37	2141.24	1457.66	1667.46	1307.39	847.157	413.587	177.639	154.513
2009	7996.75	3319.12	2644.79	2433.95	1452.85	1286.42	810.396	867.432	620.026	364.102	162.715	130.676
2010	10734.9	6251.73	2456.83	1768.31	1405.18	788.219	606.453	353.893	339.559	222.07	117.372	94.5773
2011	5618.88	8361.66	4516.46	1669.14	1046.83	794.307	421.323	316.794	173.35	141.78	89.3648	85.292
2012	9455.05	4409.2	6055.81	3028.11	1182.81	715.787	486.137	261.781	200.335	102.645	84.6879	104.326
2013	7181.84	7476.8	3422.88	4418.89	2246.31	811.724	436.511	298.625	170.362	129.787	67.1237	123.604
2014	9428.17	5683.94	5830.92	2612.39	3325.63	1609.93	534.275	286.76	201.887	114.676	87.1964	128.139
2015	8099.43	7459.3	4422.63	4442.71	1978.52	2451.06	1153.51	370.241	196.171	133.626	74.519	139.93
2016	14624.6	6414.21	5846.69	3443.39	3388.68	1494.17	1853.26	856.884	265.455	134.153	89.1195	143.023
2017	14836.3	11593.1	5050.83	4562.02	2612.09	2503.74	1086.17	1342.22	603.736	176.125	86.2995	149.336
2018	21598.1	11756.3	9139.32	3939.77	3461.48	1940.47	1836.27	784.609	961.223	413.971	116.684	156.11

Table A7.29. Estimated total fishing mortality at age (Model 1.5), 1970-2018. Green shading reflects relative level.

Year	1	2	3	4	5	6	7	8	9	10	11	12
1970	0.0002	0.0006	0.0020	0.0041	0.0098	0.0214	0.0378	0.0318	0.0107	0.0089	0.0089	0.0089
1971	0.0004	0.0010	0.0034	0.0063	0.0145	0.0315	0.0557	0.0470	0.0159	0.0131	0.0131	0.0131
1972	0.0006	0.0014	0.0049	0.0048	0.0086	0.0185	0.0332	0.0303	0.0121	0.0078	0.0078	0.0078
1973	0.0012	0.0028	0.0098	0.0079	0.0121	0.0249	0.0444	0.0410	0.0167	0.0096	0.0096	0.0096
1974	0.0035	0.0079	0.0282	0.0187	0.0207	0.0389	0.0673	0.0582	0.0215	0.0164	0.0164	0.0164
1975	0.0012	0.0028	0.0099	0.0116	0.0231	0.0496	0.0882	0.0778	0.0291	0.0198	0.0198	0.0198
1976	0.0014	0.0033	0.0118	0.0141	0.0285	0.0612	0.1090	0.0966	0.0364	0.0244	0.0244	0.0244
1977	0.0101	0.0229	0.0814	0.0466	0.0391	0.0667	0.1147	0.1060	0.0451	0.0275	0.0275	0.0275
1978	0.0069	0.0159	0.0567	0.0424	0.0593	0.1208	0.2159	0.1989	0.0817	0.0530	0.0530	0.0530
1979	0.0056	0.0131	0.0466	0.0380	0.0616	0.1369	0.2592	0.2584	0.1206	0.0851	0.0851	0.0851
1980	0.0067	0.0154	0.0547	0.0382	0.0521	0.1124	0.2096	0.2092	0.1032	0.0708	0.0708	0.0708
1981	0.0055	0.0157	0.0585	0.0469	0.0791	0.1772	0.3318	0.3364	0.1661	0.1012	0.1012	0.1012
1982	0.0038	0.0073	0.0262	0.0477	0.1247	0.2978	0.5670	0.5766	0.2894	0.1999	0.1999	0.1999
1983	0.0014	0.0047	0.0198	0.0308	0.0836	0.2087	0.4052	0.4403	0.2565	0.1841	0.1841	0.1841
1984	0.0019	0.0081	0.0314	0.0577	0.1231	0.2870	0.5589	0.6210	0.3777	0.3002	0.3002	0.3002
1985	0.0014	0.0055	0.0208	0.0483	0.1093	0.2549	0.5031	0.5785	0.3841	0.2898	0.2898	0.2898
1986	0.0008	0.0028	0.0096	0.0259	0.0659	0.1654	0.3805	0.5162	0.3752	0.2786	0.2786	0.2786
1987	0.0014	0.0063	0.0197	0.0452	0.0863	0.1829	0.4137	0.6058	0.5030	0.4000	0.4000	0.4000
1988	0.0027	0.0156	0.0319	0.0616	0.1165	0.1963	0.3754	0.6158	0.6511	0.5755	0.5755	0.5755
1989	0.0029	0.0151	0.0359	0.0568	0.1161	0.2124	0.3333	0.4887	0.6075	0.6448	0.6448	0.6448
1990	0.0029	0.0115	0.0376	0.0620	0.1036	0.1914	0.3137	0.4398	0.5624	0.6778	0.6778	0.6778
1991	0.0029	0.0110	0.0350	0.0640	0.1007	0.1830	0.3327	0.5190	0.6489	0.8015	0.8015	0.8015
1992	0.0029	0.0120	0.0388	0.0683	0.1145	0.1852	0.2948	0.5278	0.7697	1.0180	1.0180	1.0180
1993	0.0039	0.0213	0.0677	0.0968	0.1406	0.1982	0.2817	0.4146	0.6549	1.0170	1.0170	1.0170
1994	0.0049	0.0256	0.0832	0.1426	0.2130	0.2881	0.3642	0.5192	0.8590	1.2162	1.2162	1.2162
1995	0.0105	0.0594	0.1933	0.2913	0.3913	0.4948	0.5573	0.6675	0.9804	1.4059	1.4059	1.4059
1996	0.0148	0.0888	0.2464	0.4028	0.5601	0.6025	0.5944	0.6619	0.8689	1.1800	1.1800	1.1800
1997	0.0168	0.1059	0.2836	0.5300	0.7285	0.6850	0.5942	0.6383	0.8529	1.1200	1.1200	1.1200
1998	0.0141	0.0881	0.1661	0.3672	0.4464	0.4174	0.3718	0.3935	0.4993	0.6315	0.6315	0.6315
1999	0.0076	0.0464	0.1168	0.2525	0.3130	0.2965	0.2580	0.2615	0.3207	0.4032	0.4032	0.4032
2000	0.0115	0.0542	0.0882	0.2066	0.2818	0.2592	0.2102	0.2014	0.2376	0.2896	0.2896	0.2896
2001	0.0274	0.1288	0.1613	0.2286	0.3640	0.3399	0.2656	0.2475	0.2859	0.3454	0.3454	0.3454
2002	0.0079	0.0284	0.0735	0.1537	0.2658	0.2989	0.2595	0.2542	0.3084	0.3828	0.3828	0.3828
2003	0.0134	0.0502	0.0841	0.1367	0.2320	0.2901	0.2689	0.2594	0.3175	0.3872	0.3872	0.3872
2004	0.0122	0.0371	0.0884	0.1371	0.2138	0.3108	0.3129	0.3021	0.3606	0.4114	0.4114	0.4114
2005	0.0124	0.0421	0.0936	0.1335	0.1832	0.3077	0.3238	0.3156	0.3644	0.3998	0.3998	0.3998
2006	0.0182	0.0836	0.1549	0.1885	0.1986	0.2959	0.3933	0.3993	0.4662	0.4926	0.4926	0.4926
2007	0.0176	0.0806	0.2277	0.2668	0.2679	0.3232	0.4287	0.5388	0.6193	0.6804	0.6804	0.6804
2008	0.0190	0.0980	0.2302	0.2688	0.2795	0.3571	0.4235	0.5160	0.6145	0.7029	0.7029	0.7029
2009	0.0162	0.0708	0.1726	0.3194	0.3815	0.5220	0.5985	0.7079	0.7968	0.9021	0.9021	0.9021
2010	0.0198	0.0951	0.1566	0.2943	0.3404	0.3964	0.4194	0.4837	0.6434	0.6803	0.6803	0.6803
2011	0.0124	0.0926	0.1698	0.1144	0.1501	0.2610	0.2459	0.2283	0.2940	0.2853	0.2853	0.2853
2012	0.0047	0.0232	0.0851	0.0686	0.1465	0.2646	0.2573	0.1996	0.2041	0.1947	0.1947	0.1947
2013	0.0039	0.0186	0.0402	0.0542	0.1031	0.1882	0.1902	0.1615	0.1658	0.1677	0.1677	0.1677
2014	0.0042	0.0209	0.0419	0.0479	0.0751	0.1034	0.1368	0.1497	0.1827	0.2011	0.2011	0.2011
2015	0.0033	0.0136	0.0203	0.0408	0.0508	0.0496	0.0673	0.1027	0.1500	0.1751	0.1751	0.1751
2016	0.0023	0.0090	0.0181	0.0463	0.0727	0.0889	0.0926	0.1202	0.1803	0.2112	0.2112	0.2112
2017	0.0027	0.0078	0.0184	0.0461	0.0672	0.0800	0.0952	0.1039	0.1473	0.1817	0.1817	0.1817
2018	0.0033	0.0078	0.0145	0.0342	0.0610	0.0792	0.0910	0.1049	0.1370	0.1711	0.1711	0.1711

Table A7.30. Summary of results for model 1.5. Note that MSY values are a function of time-varying selectivity and average weight.

Year	Landings ('000 t)	SSB ('000 t)	Recruitment (age 1, millions)	Fishing mortality (Mean over ages 1-12)	Fmsy	SSBmsy ('000 t)
1971	168	10015	9900	0.02	0.13	3728
1972	111	9854	10383	0.01	0.13	3610
1973	164	9756	10879	0.02	0.13	3501
1974	323	9646	13300	0.03	0.12	3488
1975	299	9604	18691	0.03	0.13	3649
1976	396	9752	22257	0.04	0.13	3647
1977	848	10113	21595	0.05	0.12	3545
1978	1025	10459	22380	0.08	0.13	3546
1979	1302	10717	22253	0.10	0.13	3886
1980	1316	11124	22985	0.08	0.13	3794
1981	1945	11174	27809	0.13	0.13	3790
1982	2372	10513	32236	0.21	0.14	3818
1983	1870	10584	26480	0.17	0.13	4248
1984	2687	10502	43037	0.25	0.13	4222
1985	2371	10869	52109	0.23	0.14	4246
1986	2073	12177	28762	0.20	0.13	4713
1987	2680	13402	27012	0.26	0.13	4712
1988	3246	13717	32172	0.32	0.15	4372
1989	3582	13455	27973	0.32	0.15	4409
1990	3715	13076	30555	0.31	0.15	4470
1991	3778	12408	21225	0.36	0.18	4088
1992	3362	11542	21871	0.42	0.18	4359
1993	3370	10658	15439	0.41	0.16	4456
1994	4275	9061	14538	0.51	0.15	4539
1995	4955	6696	19066	0.66	0.14	4407
1996	4379	4775	20983	0.63	0.12	4412
1997	3597	3609	28118	0.65	0.12	4422
1998	2026	3677	26583	0.39	0.11	4464
1999	1423	4434	31476	0.26	0.11	4562
2000	1540	5463	32402	0.20	0.11	4305
2001	2528	6172	21388	0.26	0.11	4301
2002	1750	6805	14778	0.23	0.11	4526
2003	1797	7080	8393	0.23	0.11	4488
2004	1934	6725	8649	0.25	0.12	4419
2005	1755	5997	6593	0.25	0.12	4295
2006	2020	4979	6743	0.31	0.13	4116
2007	1997	3754	4703	0.40	0.13	4074
2008	1473	2779	4258	0.41	0.13	4160
2009	1283	1893	7997	0.52	0.13	4246
2010	727	1538	10735	0.41	0.11	4566
2011	635	1667	5619	0.20	0.12	3952
2012	455	1980	9455	0.15	0.12	3983
2013	353	2339	7182	0.12	0.13	4074
2014	411	2725	9428	0.11	0.13	4258
2015	394	3176	8099	0.09	0.16	3787
2016	389	3606	14625	0.11	0.15	4174
2017	405	4097	14836	0.09	0.13	4473
2018	472	4777	21598	0.09	0.13	4514

9. Figures

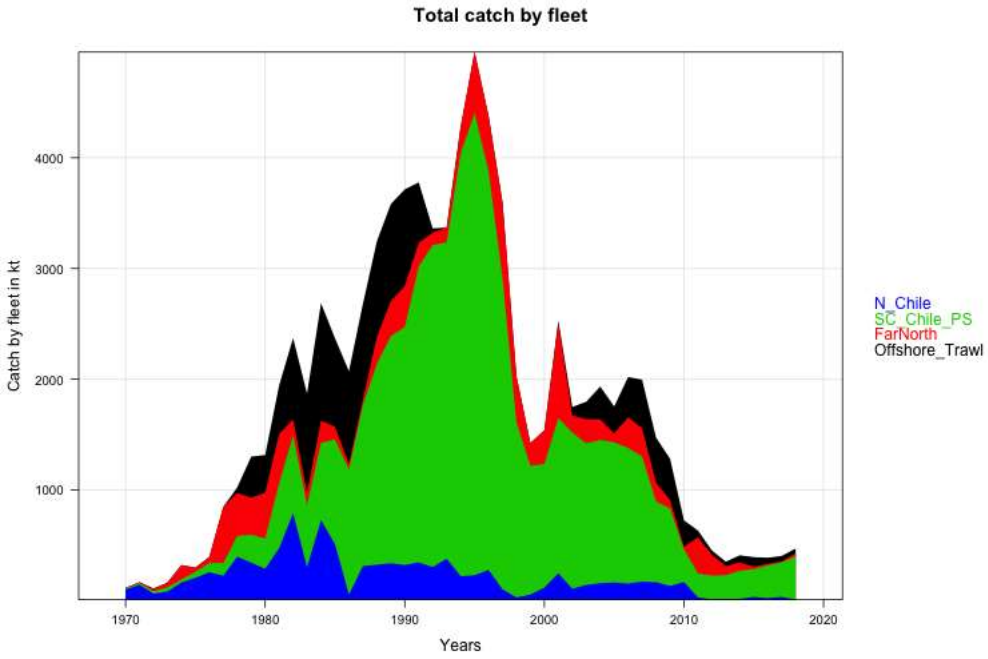

Figure A7.1. Catch of jack mackerel by fleet. Green is the SC Chilean fleet, black is the offshore trawl fleet, red is the far-north fleet, and blue in the northern Chilean fleet.

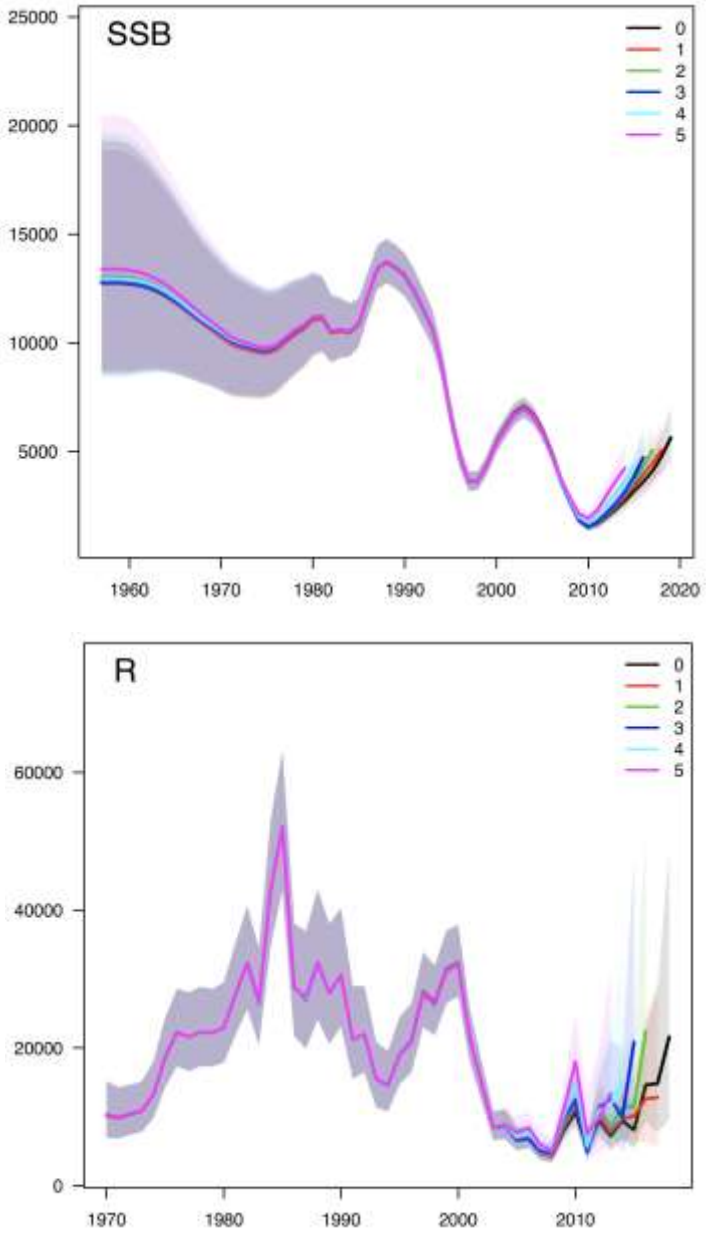

Figure A7.2. Model retrospective of spawning biomass (top) and recruitment (bottom) from 5 separate model runs.

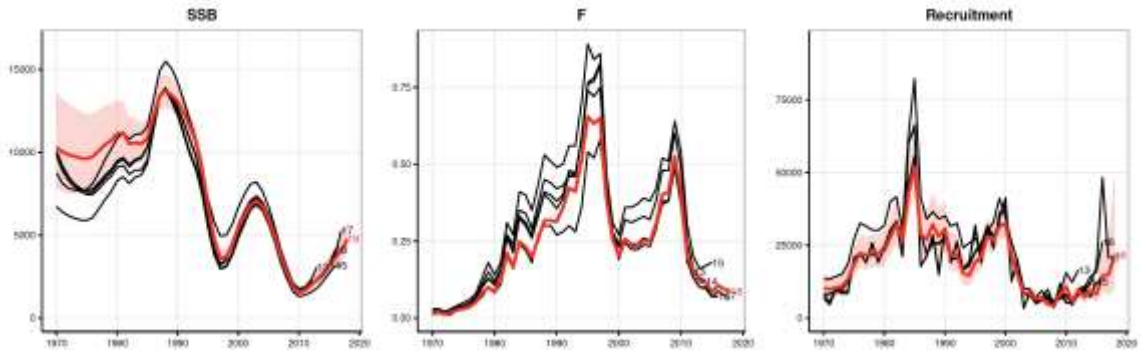

Figure A7.3. Historical retrospective of spawning stock biomass, fishing mortality, and recruitment (single-stock hypothesis), as estimated and used for advice from past (and present) SPFRMO scientific committees.

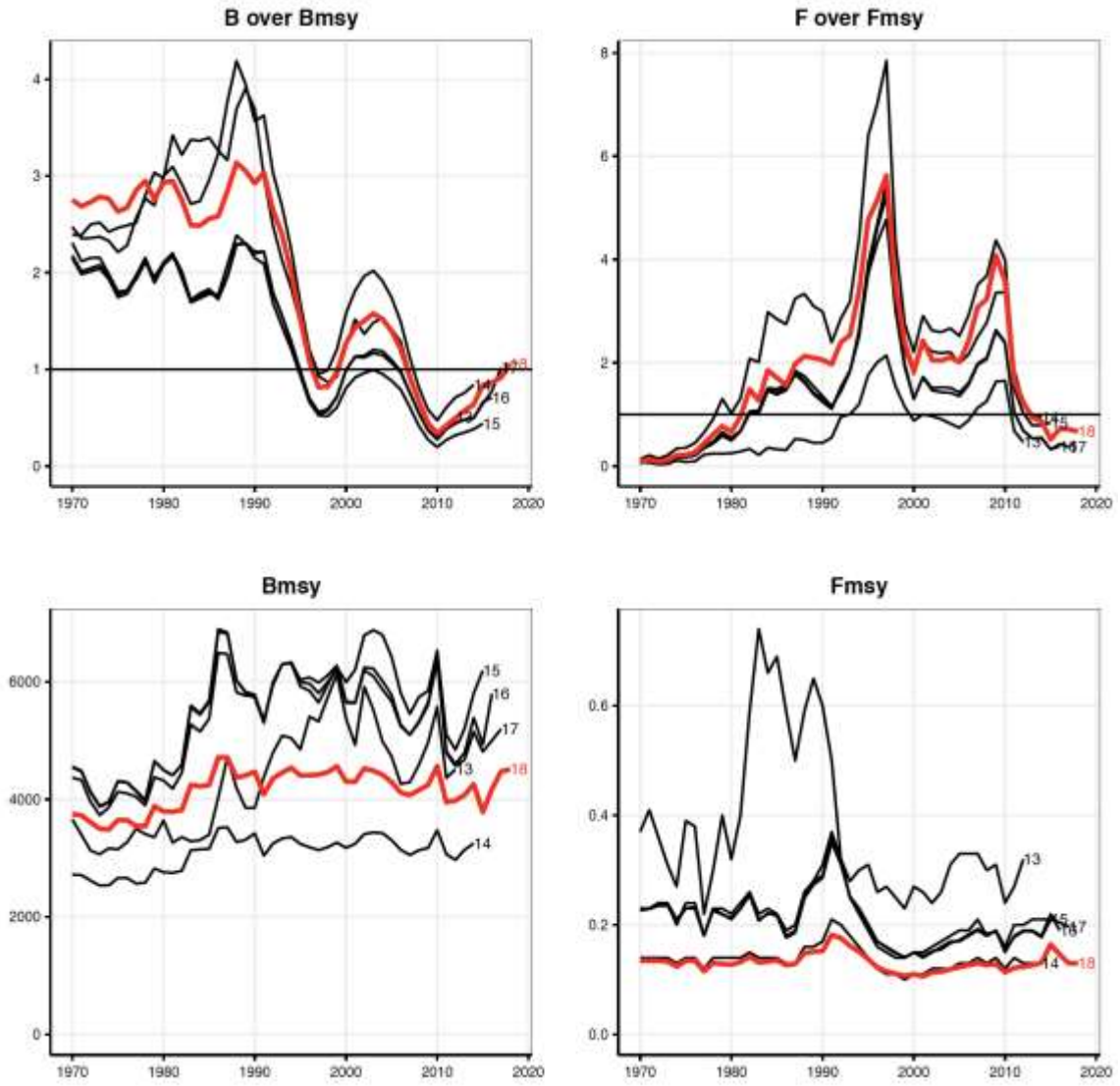

Figure A7.4. Historical retrospective of management reference points (single-stock hypothesis), as estimated and used for advice from past (and present) SPRFMO scientific committees.

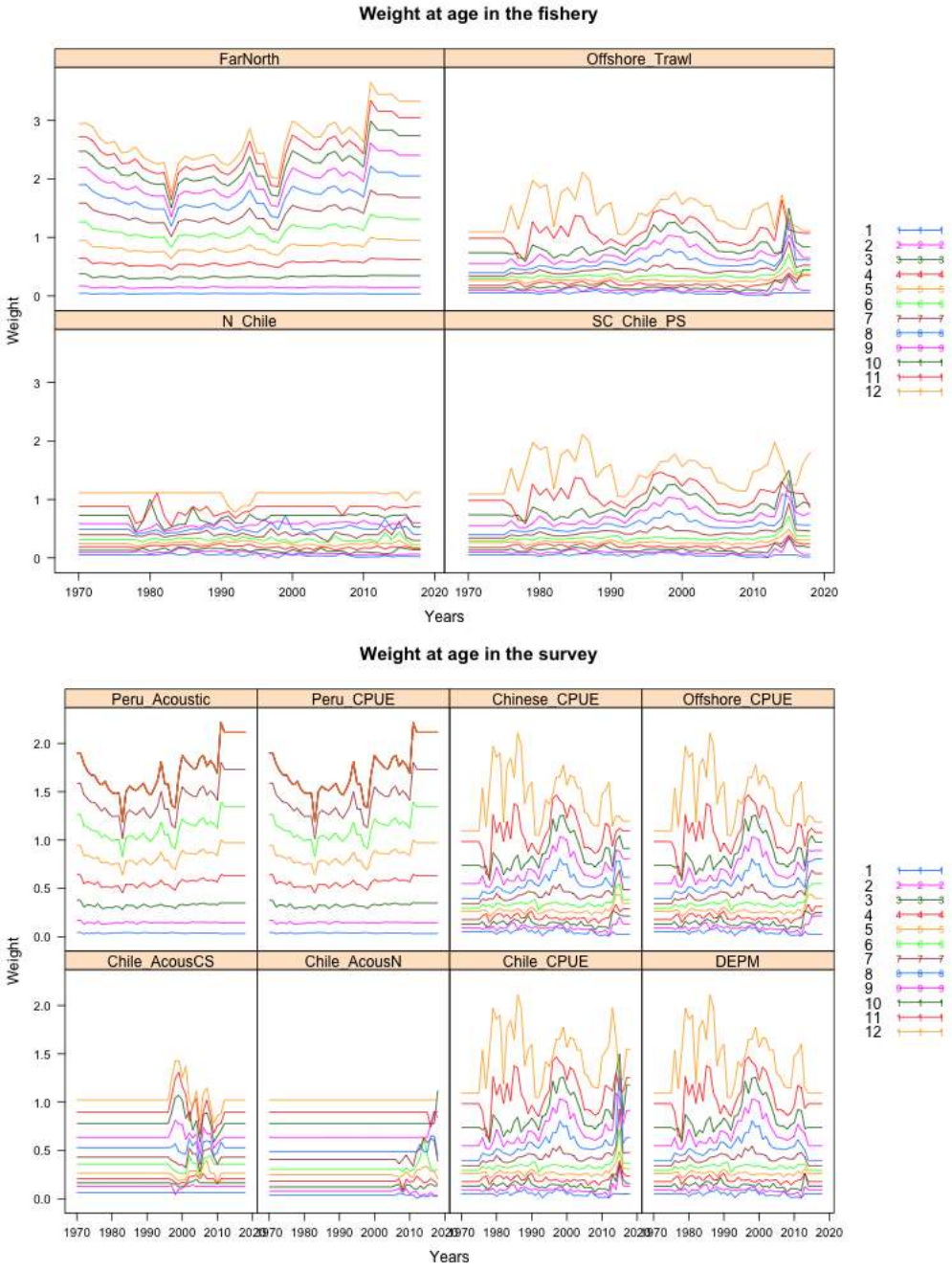

Figure A7.5. Mean weights-at-age (kg) over time used for all data types in the JJM models. Different lines represent ages 1 to 12.

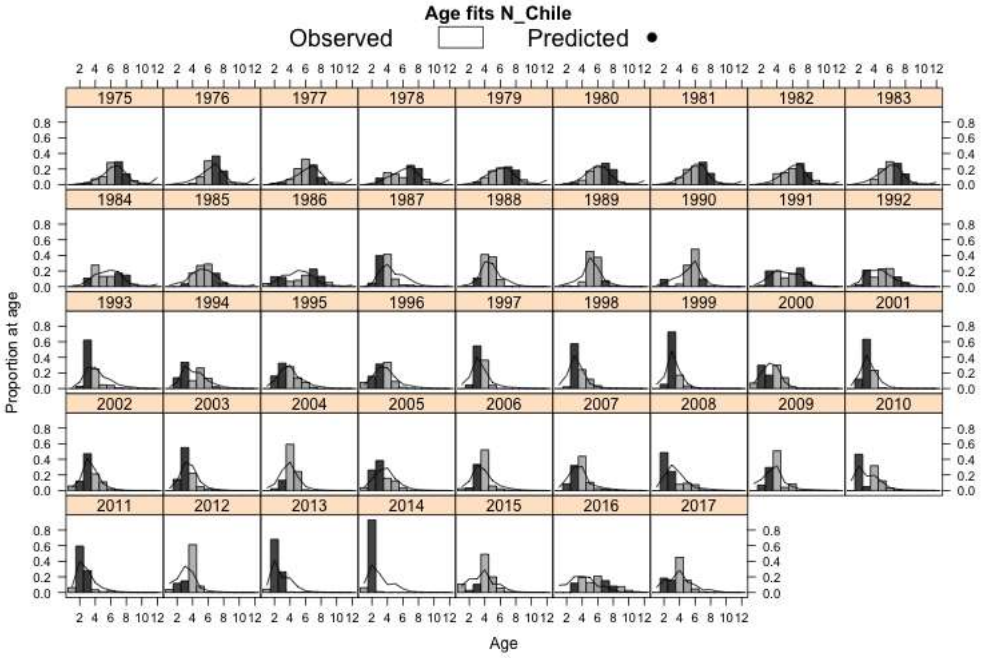

Figure A7.6. Model 1.5 fit to the age compositions for the Chilean northern zone fishery (Fleet 1). Bars represent the observed data and lines represent the model predictions.

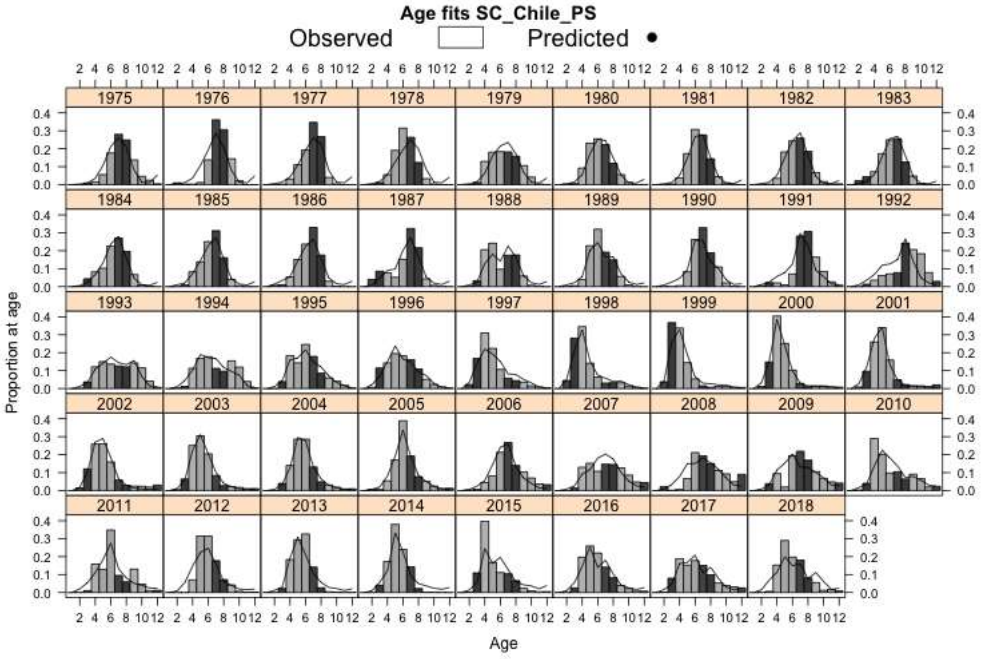

Figure A7.7. Model 1.5 fit to the age compositions for the South-Central Chilean purse seine fishery (Fleet 2). Bars represent the observed data and lines represent the model predictions.

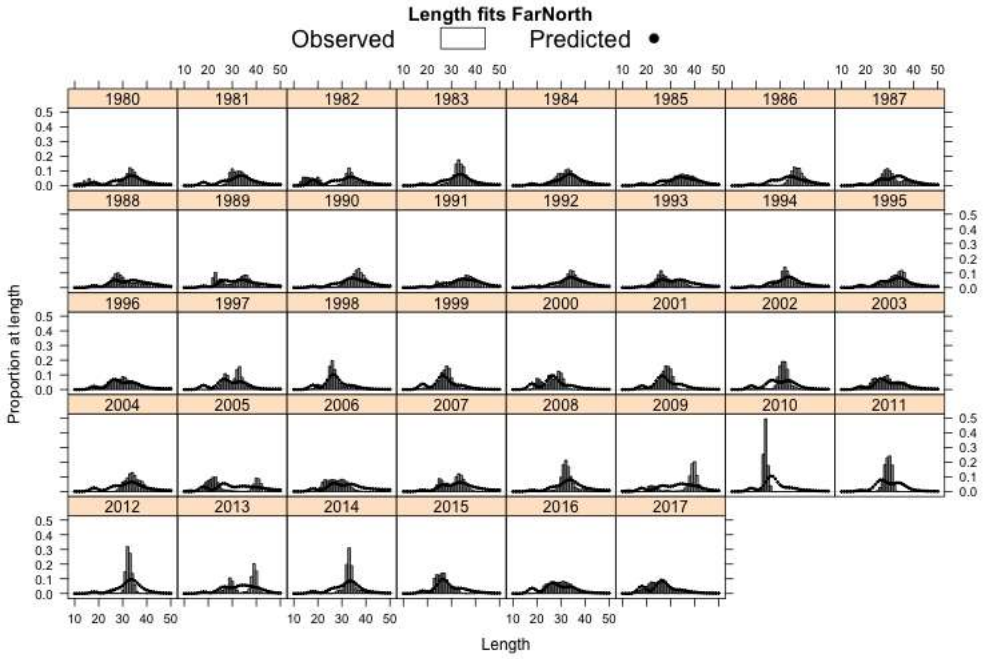

Figure A7.8. Model 1.5 fit to the length compositions for the far north fishery (Fleet 3). Bars represent the observed data and lines represent the model predictions.

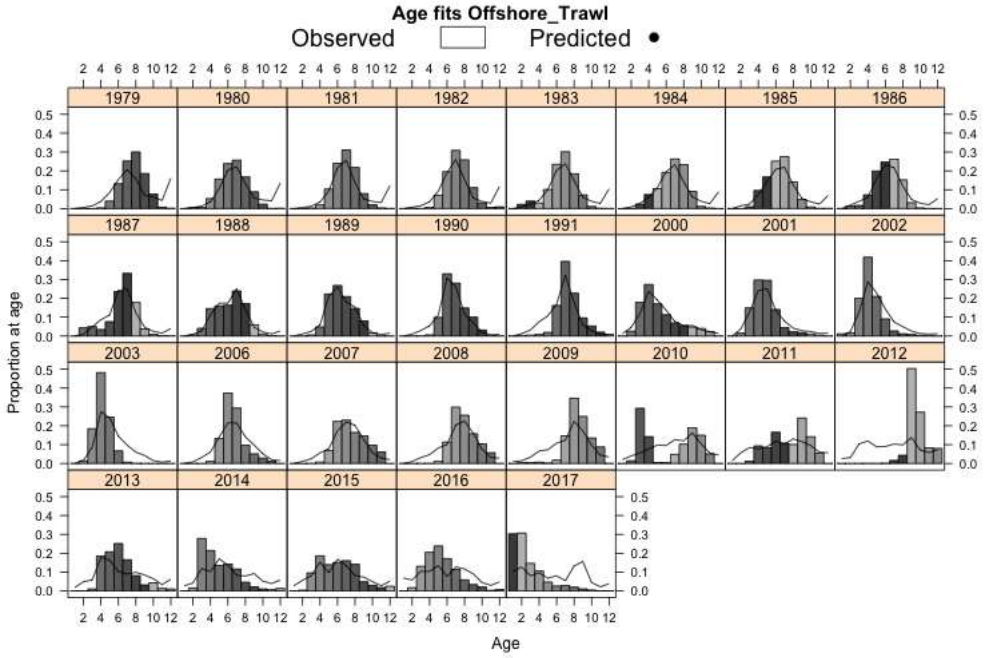

Figure A7.9. Model 1.5 fit to the age compositions for the offshore trawl fishery (Fleet 4). Bars represent the observed data and lines represent the model predictions.

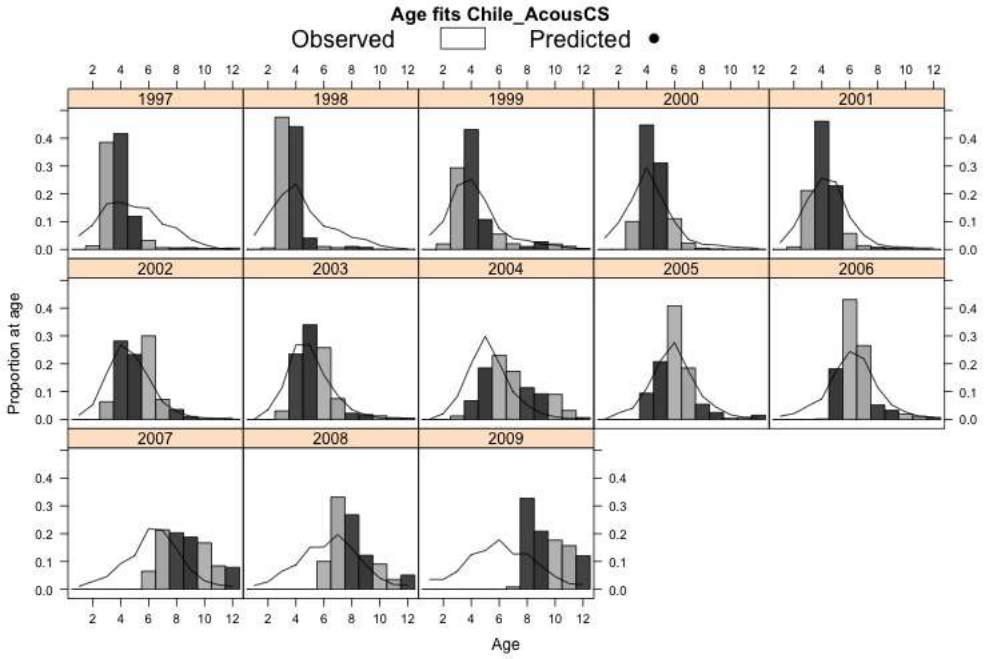

Figure A7.10. Model 1.5 fit to the age compositions for the S-Central Acoustic survey. Bars represent the observed data and lines represent the model predictions.

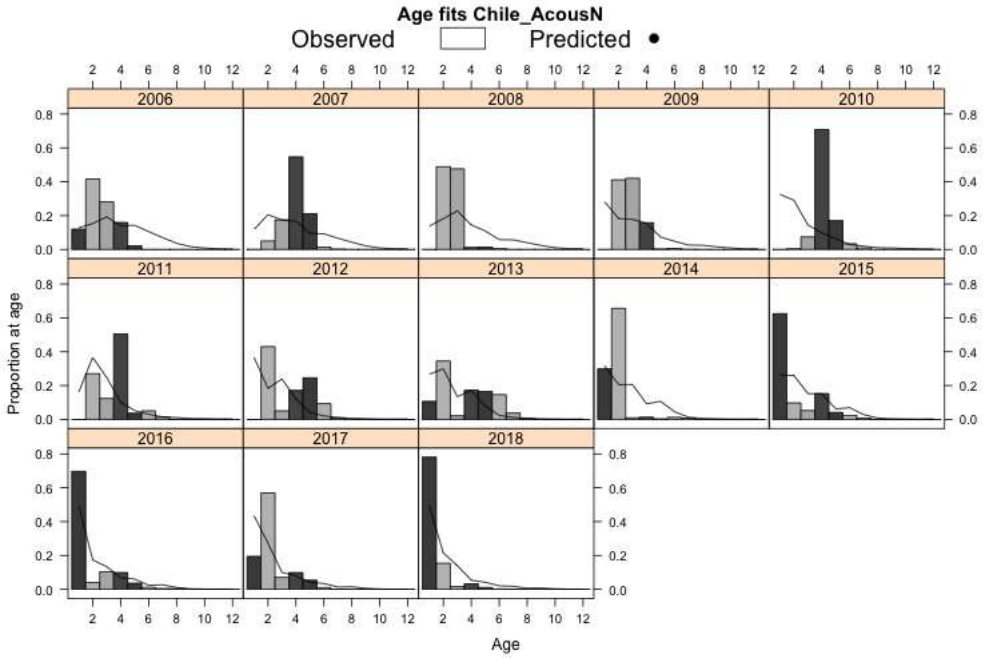

Figure A7.11. Model 1.5 fit to the age compositions for the N Chilean acoustic survey (bottom). Bars represent the observed data and lines represent the model predictions.

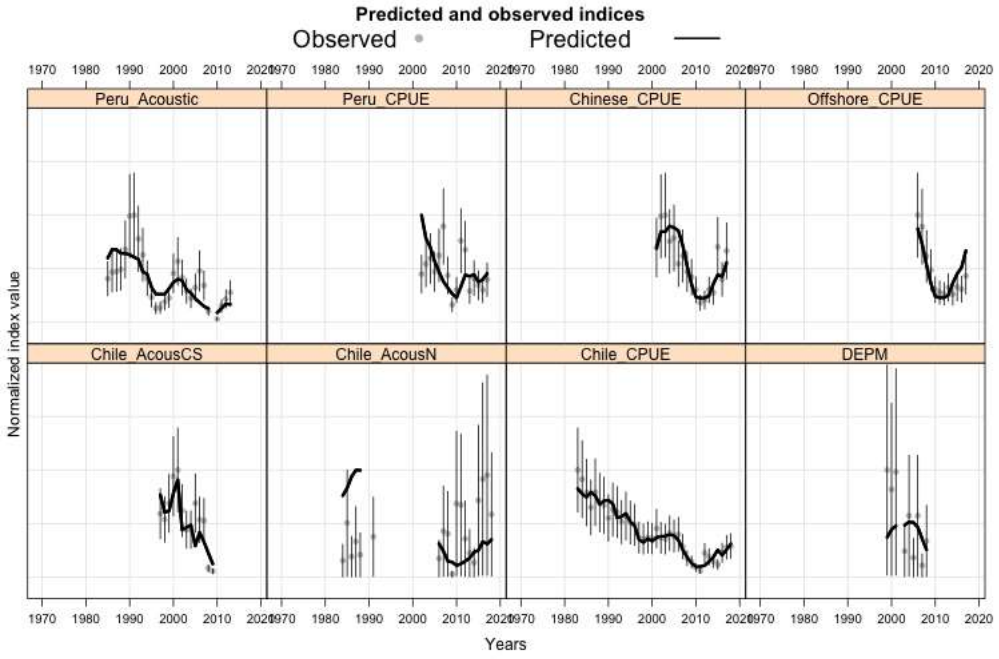

Figure A7.12. Model 1.5 fit to different indices. Vertical bars represent 2 standard deviations around the observations.

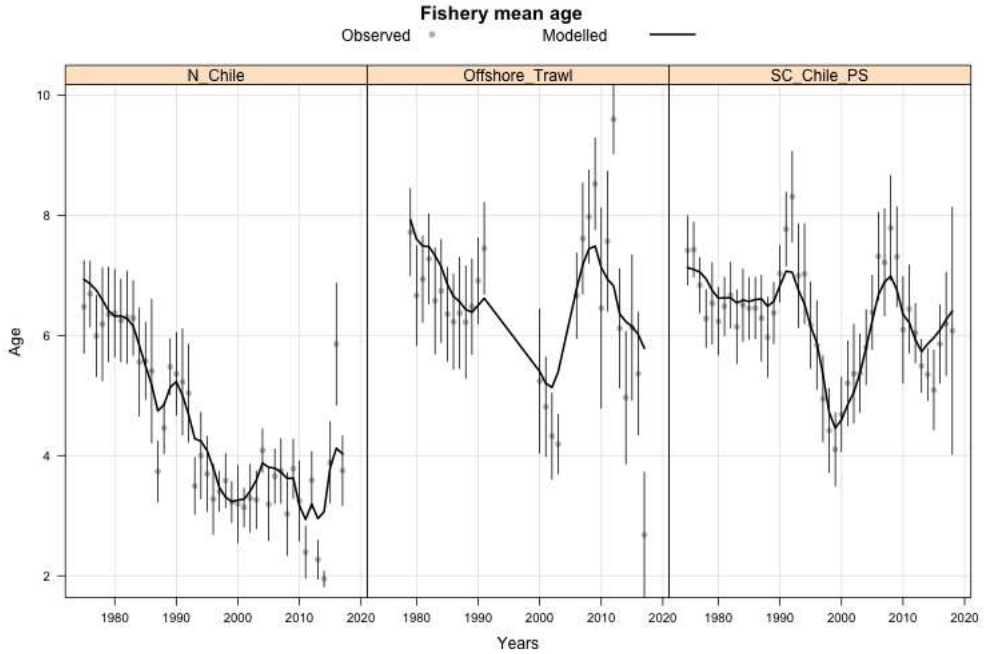

Figure A7.13. Mean age by year and fishery. Line represents the model 1.5 predictions and dots observed values with implied input error bars.

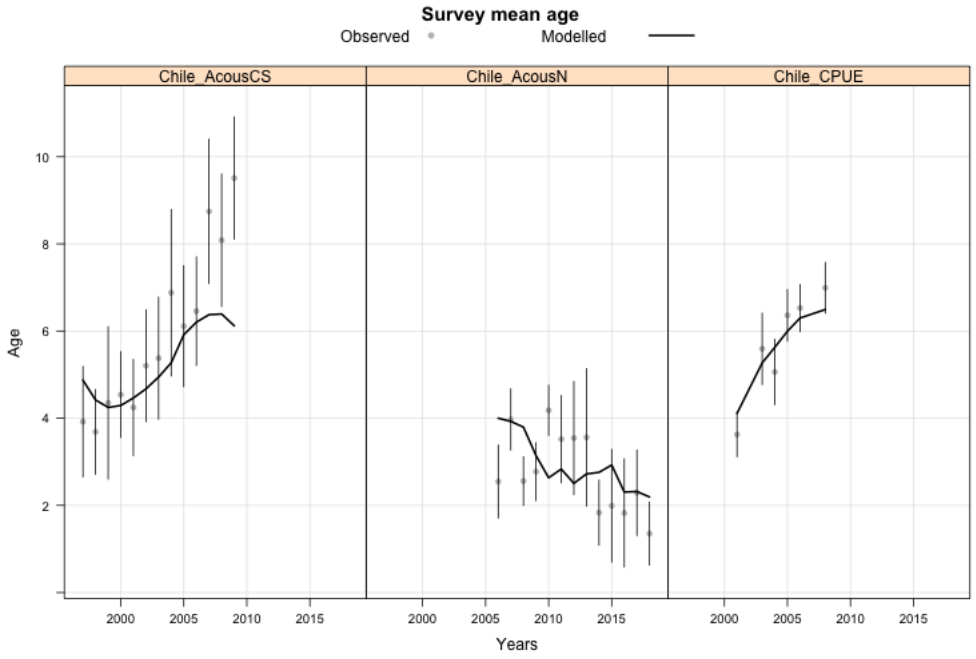

Figure A7.14. Mean age by year and survey. Line represents the model 1.5 predictions and dots observed values with implied input error bars.

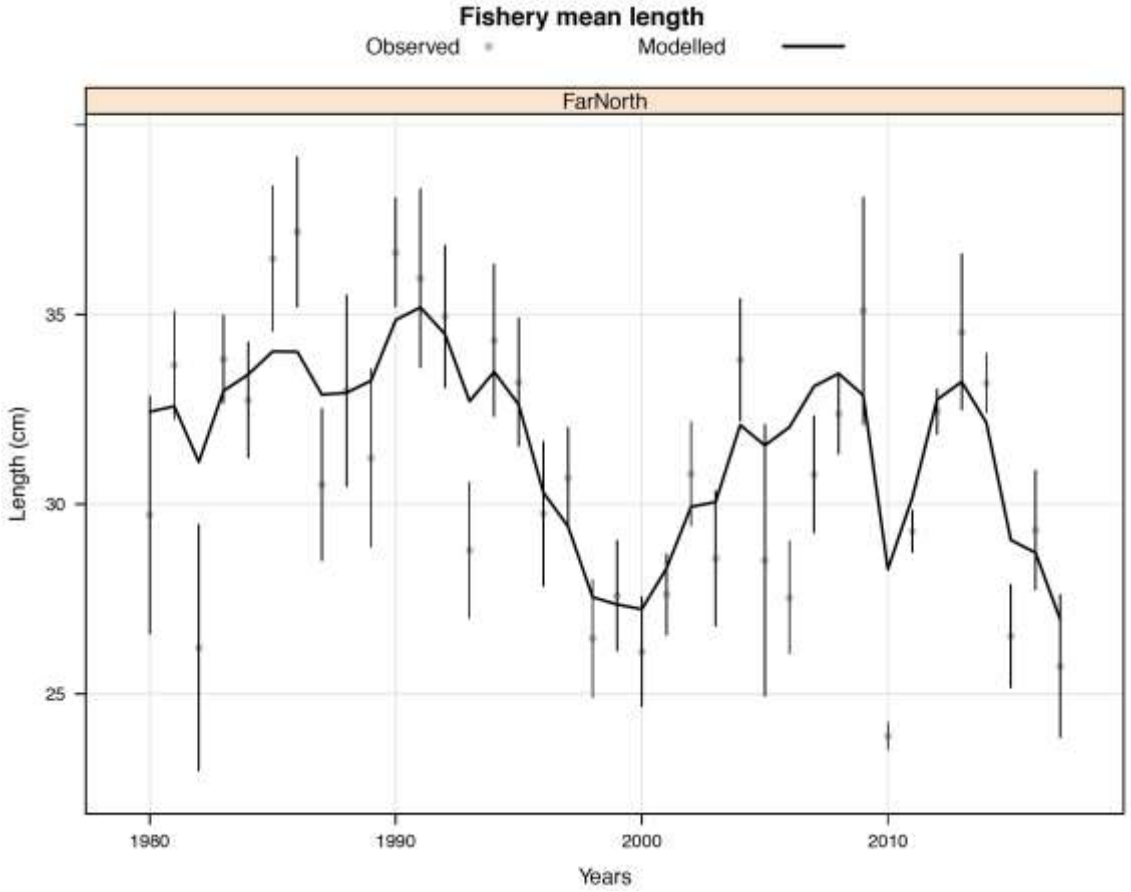

Figure A7.15. Mean length by year in fleet 3 (Far North). Line represents the model 1.5 predictions and dots observed values with implied input error bars.

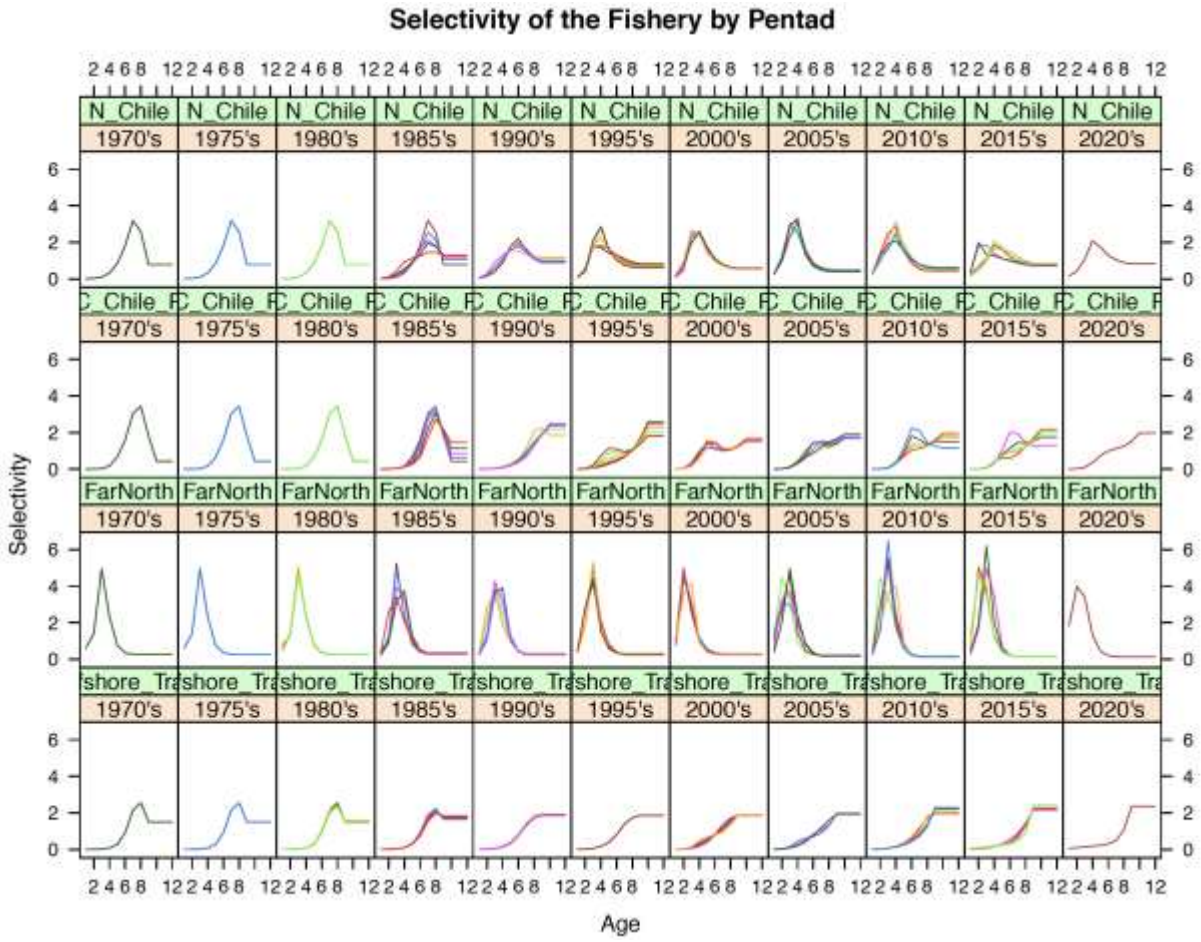

Figure A7.16. Estimates of selectivity by fishery over time for Model 1.5. Each cell represents a 5-year period).

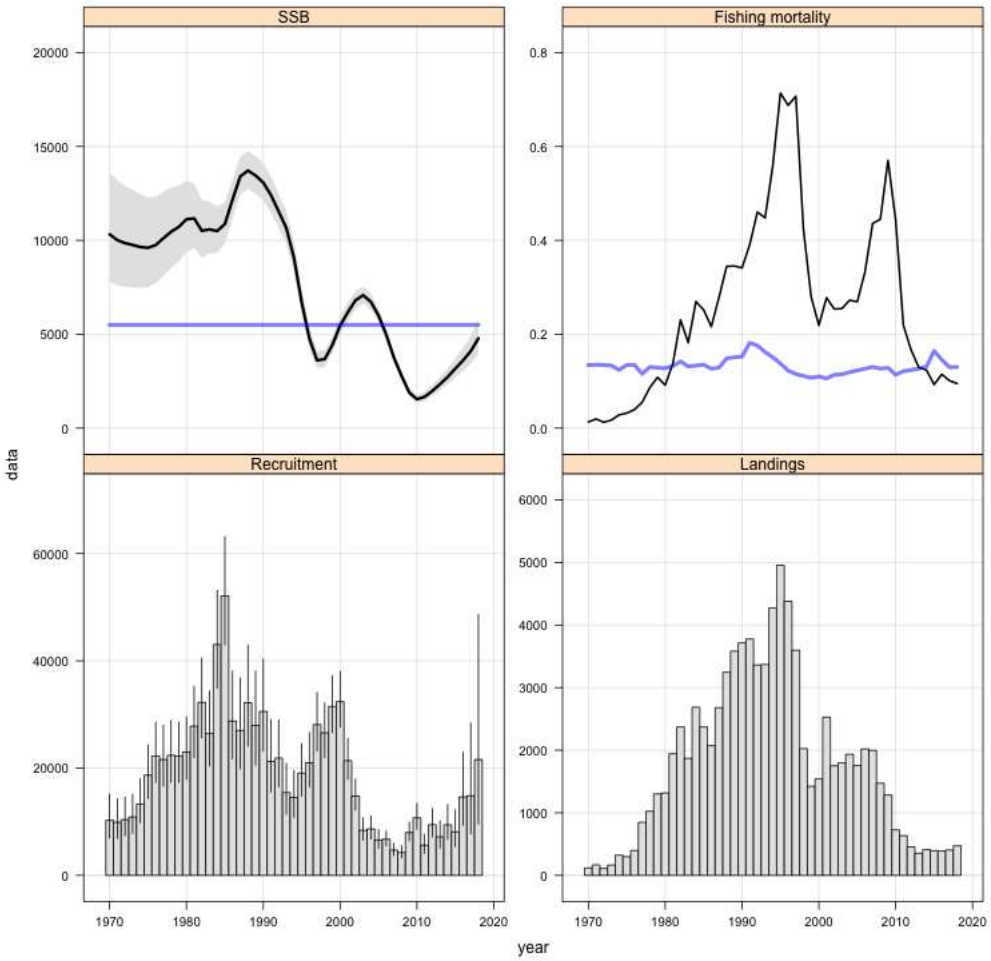

Figure A7.17. Model 1.5—single-stock hypothesis—summary estimates over time showing spawning biomass (kt; top left), recruitment at age 1 (millions; lower left) total fishing mortality (top right) and total catch (kt; bottom right). Blue lines represent the provisional B_{MSY} (upper left) and dynamic estimates of F_{MSY} (upper right).

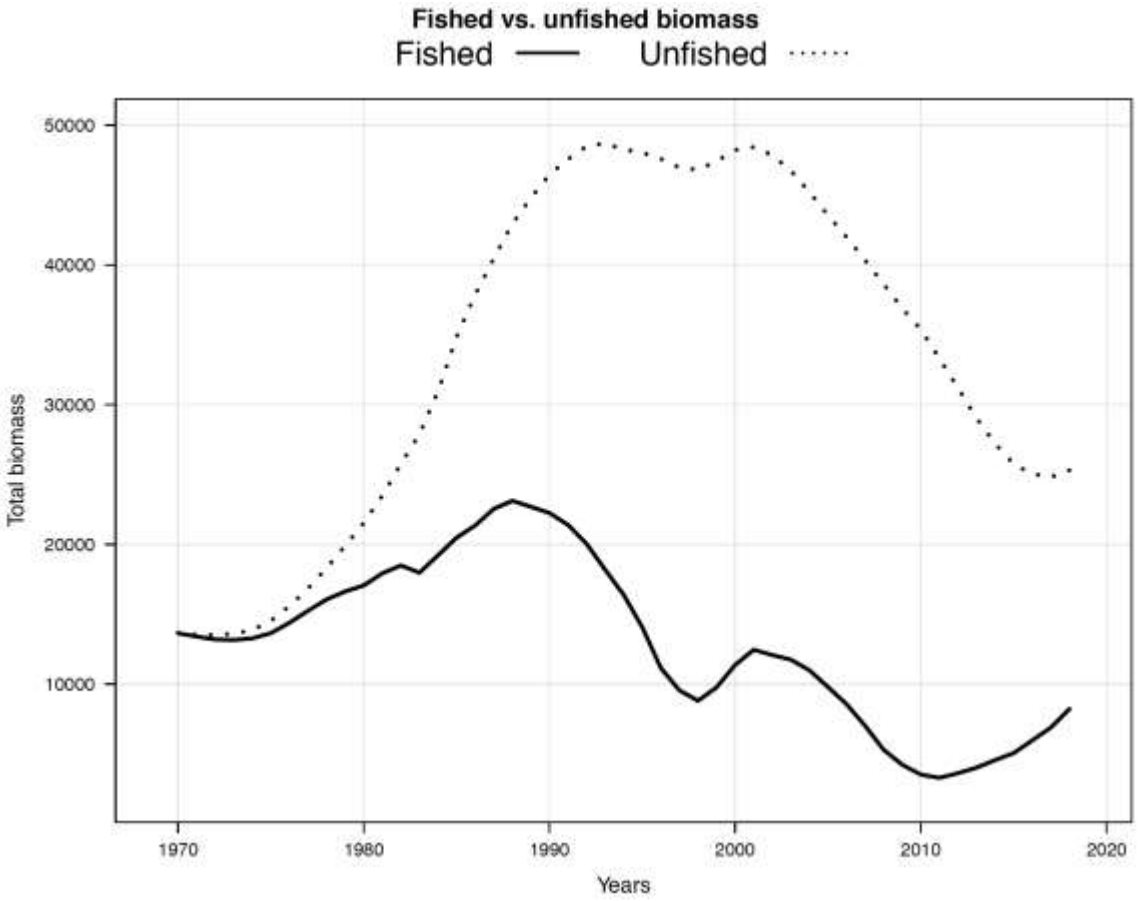

Figure A7.18. Model 1.5 results for the estimated total biomass (solid line) and the estimated total biomass that would have occurred if no fishing had taken place, 1970-2018.

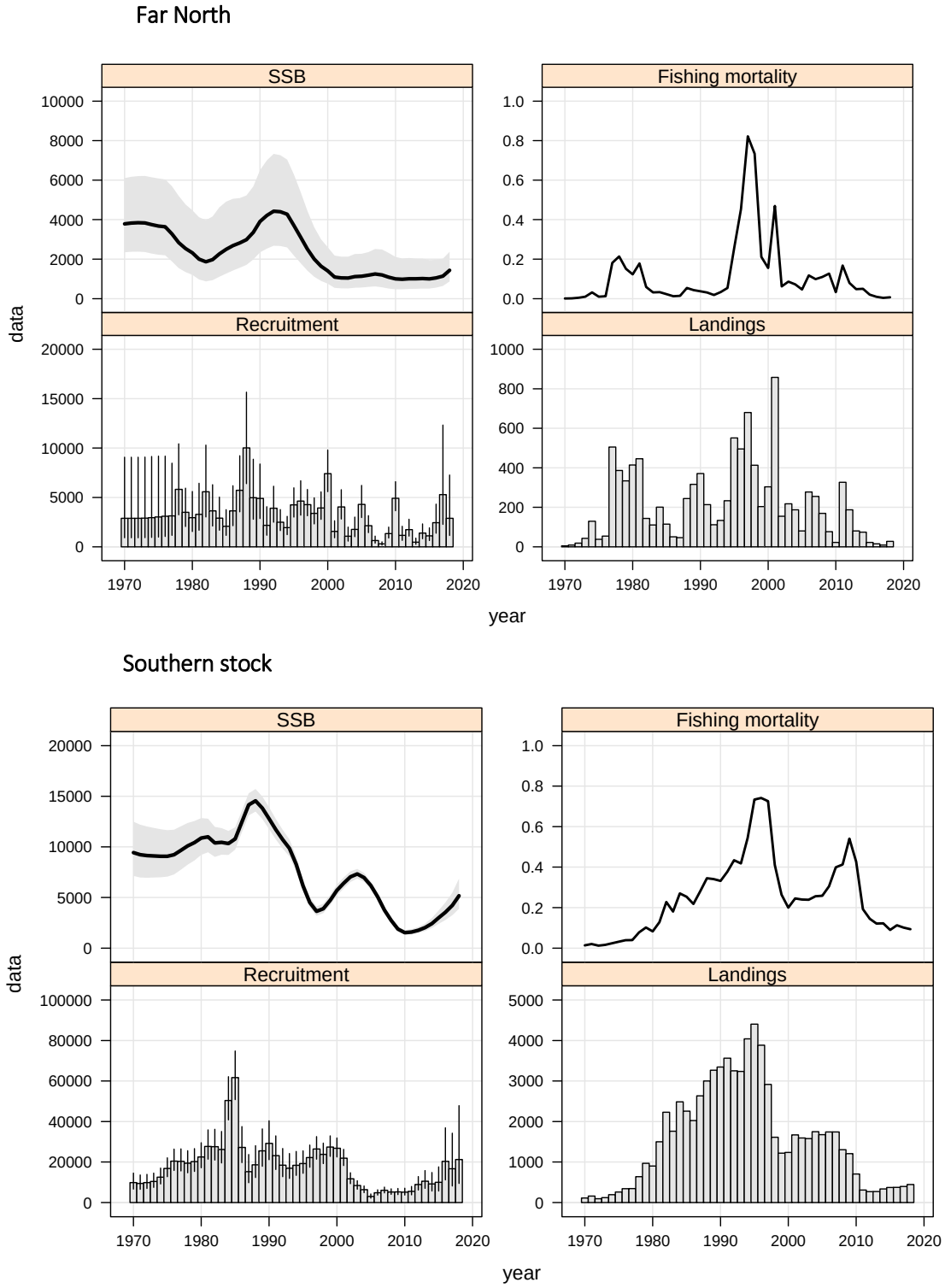

Figure A7.19. Model 1.5—two-stock hypothesis—summary estimates over time showing spawning biomass (kt; top left), recruitment at age 1 (millions; lower left) total fishing mortality (top right) and total catch (kt; bottom right) for the "Far North" stock (top set) and for the "Southern" stock (bottom set).

Stock status summary for Jack mackerel, September 2018

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

Advice for 2019

The SPRFMO Science Committee advised to increase 2019 catches to or below 591 000t.

Stock status

		2016	2017	2018
Fishing mortality in relation to:	F_{MSY}	Below	Below	Below
Spawning stock biomass in relation to:	B_{MSY}	Below 80%	Below 80%	Below 100%

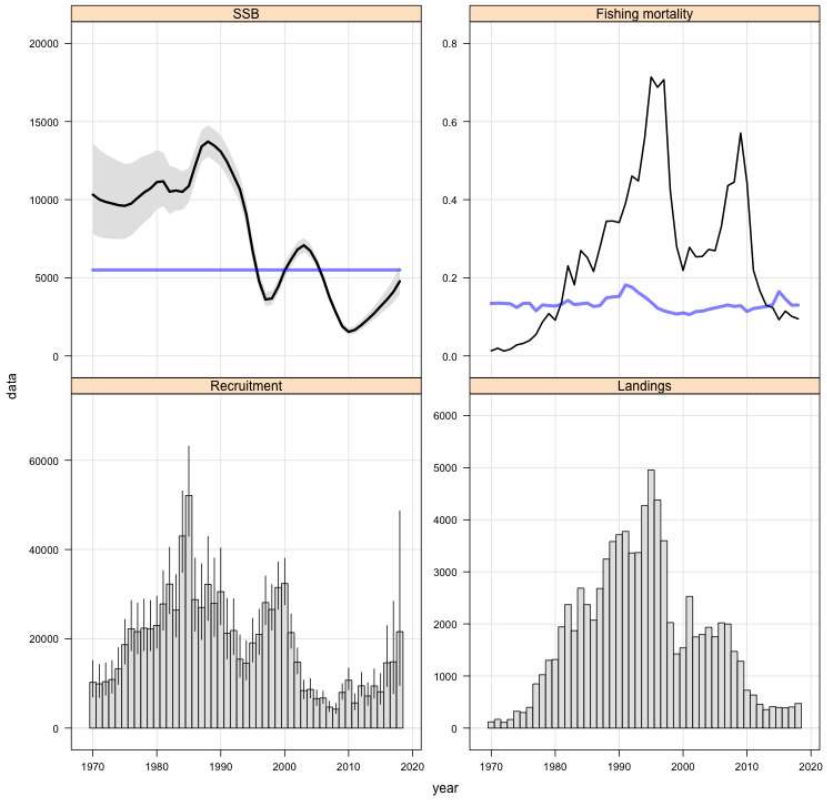

Figure 1. Jack mackerel in the southeast Pacific. Summary of stock assessment. Recruitment (age one) is measured in thousands, catch and SSB in thousands of tonnes, and harvest (fishing mortality) as a rate per year. Note that B_{MSY} is fixed at 5.5 million t (shown as the horizontal blue line in the top left), while dynamic values for F_{MSY} are used for the horizontal blue line in the top right.

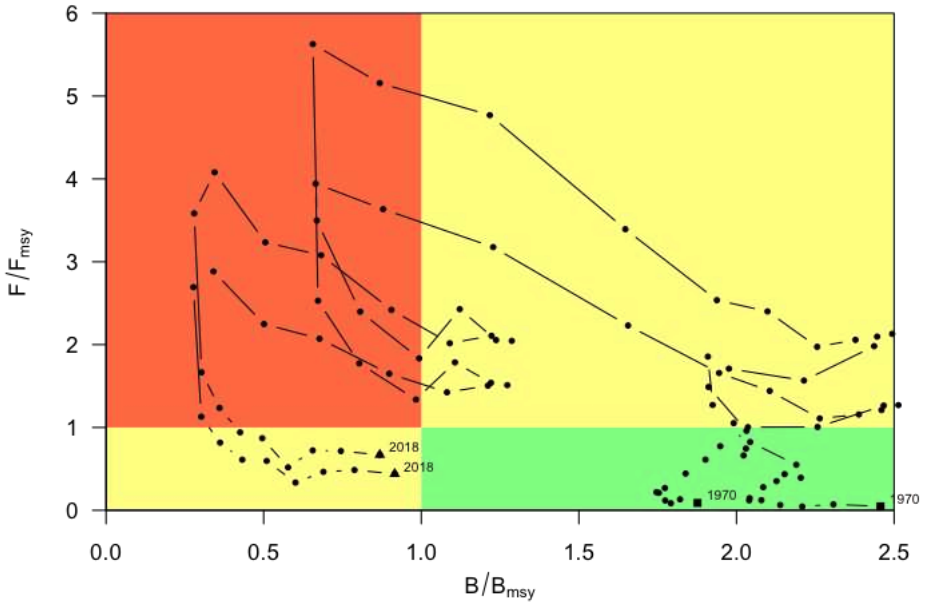

Figure 2. Phase plane (or "Kobe") plot of the estimated trajectory for jack mackerel under high productivity and low productivity with reference points set to F_{MSY} estimated for the time series 1970-2015 and B_{MSY} set to 5.5 million t.

Constant fishing mortality scenarios were explored at 125%, 100%, 75%, 50% and 0% of F_{2014}. Advice is based on maintaining the likelihood of spawning biomass to increase (above the 2018 estimate of 4.8 million t).

Table 1. Summary results for the short-term predictions for models with different parameters (a more optimistic scenario). Note that "B" in all cases represents thousands of t of spawning stock biomass and B_{MSY} is taken to be 5.5 million tonnes of spawning biomass in all cases.

Model 1.5, steepness=0.65, recruitment from 2000-2015				
Multiplier of F_{2018}	B_{2020}	$P(B_{2020} > B_{MSY})$	Catch 2019 (kt)	Catch 2020 (kt)
0.00	7,337	98%	0	0
0.50	6,888	95%	280	341
0.75	6,680	92%	415	494
1.00	6,415	86%	591	683
1.25	6,293	82%	674	769
Model 1.4, steepness=0.8, recruitment from 1970-2015				
Multiplier of F_{2018}	B_{2020}	$P(B_{2020} > B_{MSY})$	Catch 2019 (kt)	Catch 2020 (kt)
0.00	7,690	99%	0	0
0.50	7,236	98%	282	344
0.75	7,025	96%	418	499
1.00	6,756	93%	596	690
1.25	6,632	91%	680	776

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

Year	Advice	Catch
2009		1 283 474
2010		726 573
2011	711 783	634 800
2012	520 000	454 746
2013	441 000	353 120
2014	440 000	410 703
2015	460 000	394 332
2016	460 000	389 067
2017	493 000	404 609
2018	576 000	471 966*
2019	591 000	

2011, 2012 & 2013 advice was given by the Science Working Group.
* As estimated at SC06

Annex 9. Sampling Protocol of Jumbo Flying Squid in the South East Pacific for Genetic Study

Representative biological sampling is the foundation of a well-defined genetic study for jumbo flying squid that are widely distributed in the South East Pacific and adjacent equatorial area. This requires that the sampling covers main and/or different habitat of jumbo flying squid. We divide the whole stock area to 10 sampling zones and coded by O1 to O5 and E1 to E5, referred to the Convention Area and jurisdiction area of coastal nations respectively. Noting that no single member or CNCP can cover all the 10 zones alone, and international cooperation among members or CNCPs is needed. Furthermore, different tissues derived from the same sample may affect results of genome sequencing. Thus, we need to standardize sampling protocol to make the results comparable for samples collected by different members/CNCP across the stock area.

The following protocol is proposed for Jumbo Flying Squid Sampling:

1. Collecting squid samples in the 10 zones (figure 1);
2. Area and time:
    a. Record sampling locations (zones) time and essential biological information (Annex 1);
3. No. of specimens:
    a. At least 20 specimens per stratum (phenotype and zone) in each replicate.
    b. Two phenotypes (mature squid): a) ML less than 50 cm; and b) ML greater than 60 cm.
4. Tissue and statolith:
    a. Collect at least 2 pieces of muscle tissue (~10g each) from dorsal mantle of the squid with its statolith.

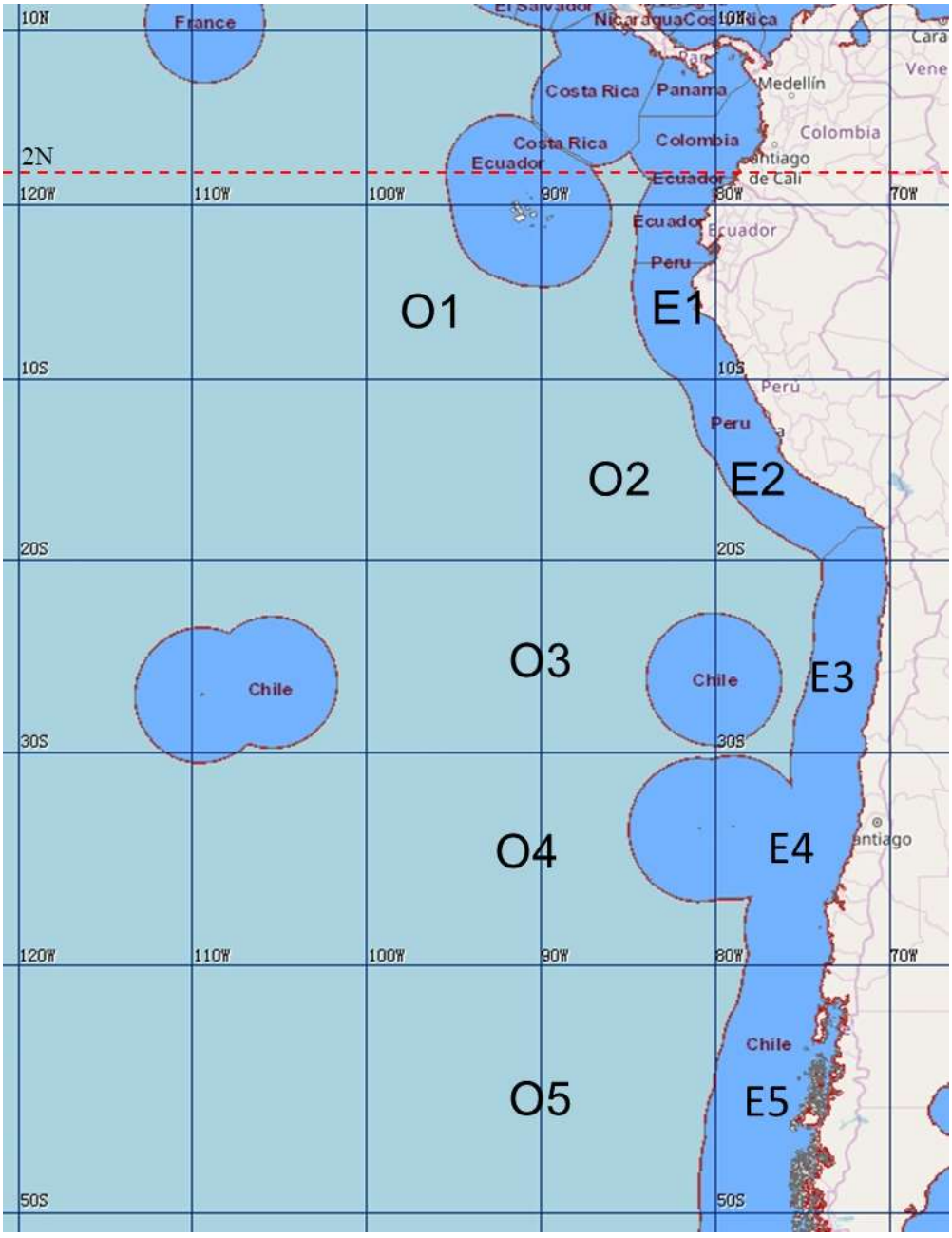

Figure 1 Illustration of the 10 subarea for jumbo flying squid sampling

Annex 1 to the Jumbo Squid Sampling Protocol
Information for the specimen

Specimen information:

1. Date
2. Location (latitude and longitude to 0.01 degree)
3. Mantle length (mm)
4. Body weight (g)
5. Sex
6. Maturity stage

Annex 2 to the Jumbo Squid Sampling Protocol
Three Phenotype for jumbo flying squid

Phenotype	Male mode (cm)	Female mode (cm)
Medium	15–55	25–55
Late 1	55–80	55–85
Late 2	80–105	85–120

Annex 10. General Terms of Reference for the Habitat Definition, Description and Monitoring Working Group

1. Main Objective

Providing environmental indicators associated to the habitat of the main commercial resources exploited in the SPRFMO area to complement decision making of fisheries management.

To achieve this main objective, the habitat of jack mackerel should be determined, characterized and monitored primarily to contribute to fisheries management within an ecosystem approach.

Main specific objectives

- Determine and characterize the environmental variables and oceanographic mechanisms or processes associated with the spatial-temporal distribution of jack mackerel; study the relationships between habitat and environment (El Niño, Regime shift, Climate change).

- Review the state of the art of habitat research through retrospective analysis (including bibliographical analysis) in order to recommend specific lines of investigation in this topic within the framework of the SPRFMO.

- Delineate the habitats of the most important species habitat in the South Pacific Ocean, beginning with CJM.

- Identify and prioritize relevant indices or indicators to improve habitat monitoring.

- Establish a list of environmental data: satellite, acoustic surveys, acoustic fisheries surveys, fishing data, available data (VMS, Observers…) and technologies aboard fishing vessels in time and space that already exist inside the SPRFMO area.

- Review protocols of data collection, processing and analysis used within the working group's main objective (i.e. data, acoustics, data quality, opportunity platforms, fishing boats, VMS, etc.).
- Establish standard formats for data and information exchange.

- Introduce information on the most important micronekton species using acoustic data to monitor their abundance in the context of the Working Group mission.

- Review, identify, develop and validate the appropriate prediction models for the working group's objectives.

- Explore possibilities to organize a symposium on the topic of pelagic habitat in the 2020.

- Promote the development of a research project in the topic of habitat monitoring.

- Others identified by the WG.

2. Working Group Composition

The WG will be comprised of researchers identified both by SPRFMO Commission Members and other national and international institutions and headed by a Chairperson supported by a Vice-Chairperson and national coordinators to accomplish the WG objectives.

3. Working Group Procedures and Activities

The WG will work by correspondence during the year.

The WG will identify activities to be carried out in each institution to fulfil for the terms of reference of the year.

The WG will recommend activities in each country to produce standardized national reports (e.g. through Workshops).

The WG will collect national reports to prepare syntheses and annual reports under responsibility of the WG chairpersons.

When possible, the WG would organize a workshop immediately before the SPRFMO SC annual meeting to review the report of WG activities and submit recommendations to the Committee.

The Chair and/or vice-chair will participate in meetings of the SPRFMO SC to submit the result from the work of the year.

The WG will organize meetings on specific topics in case of particular interest and existence of funding.

CMM [16]- [2019]

Conservation and Management Measure Establishing the SPRFMO Observer Programme

The Commission of the South Pacific Regional Fisheries Management Organisation;

RECOGNISING United Nations General Assembly Sustainable Fisheries Resolution 71/123 which encourages the development of observer programmes by regional fisheries management organisations and arrangements (RFMOs) to improve data collection;

RECALLING that, according to Article 28 of the Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean (the Convention), the Commission shall establish an observer programme, to be operated in accordance with standards, rules and procedures developed by the Commission;

NOTING that Article 28 of the Convention sets out the functions of the observer programme and that the observer programme shall be coordinated by the Secretariat of the Commission in a flexible manner to take account of the nature of the fisheries resources and other relevant factors;

NOTING that the primary function of observers on board fishing vessels is the collection of scientific information and that observers are not enforcement officials, but that Article 28 of the Convention specifies that the information collected by the observer programme shall, as appropriate, also be used to support the functions of the Commission and its subsidiary bodies, including the Compliance and Technical Committee (CTC);

ACKNOWLEDGING that high-quality data is essential for the Commission to implement effective and timely Conservation and Management Measures (CMMs);

DETERMINED to ensure the collection of data that can be used for assessment and management of SPRFMO fisheries resources, including target species and bycatch, and interaction of fishing activities with the environment and species occurring in the Convention Area, to improve the certainty of future scientific advice while taking into account ecosystem considerations;

RECOGNISING the international nature of fishing activity and management of SPRFMO fisheries resources, and the consequent need to deploy well-trained and accredited observers.

RECOGNISING the nature of the observer's work at sea and that the collection of information needs to be coupled with safe conditions for observers while on board fishing vessels;

Formatted: Top: 2.5 cm

Deleted:

Commented [MP1]: Suggested by Chile: on board data collection is an encompassing task and that ...

PO Box 3797, Wellington 6140, New Zealand
P: +64 4 499 9889 – F: +64 4 473 9579 – E: secretariat@sprfmo.int
www.sprfmo.int

ACKNOWLEDGING that electronic monitoring systems, study fleets and self-sampling have been successfully tested in some fisheries and that the Commission, with the advice of the Scientific Committee (SC), could explore minimum standards for their implementation, as practical and appropriate;

COMMITTED to ensuring that the SPRFMO Observer Programme (SPRFMO OP) is developed under a robust and transparent governance framework;

RECOGNISING the need to establish clear procedures for attaining accreditation under the SPRFMO OP of National observer programmes and service providers;

ADOPTS the following CMM in accordance with Articles 8 and 28 of the Convention:

GENERAL RULES

1.- This CMM establishes the SPRFMO OP setting the standards, rules and procedures to govern the effective conduct of the SPRFMO OP and to ensure it achieves the objectives specified in Article 28 of the Convention.

2.- The purpose of the SPRFMO OP is to facilitate the collection of verified catch and effort data, other scientific data and additional information related to fishing activities in the Convention Area and its impacts on the marine environment, and to support the functions of the Commission and its subsidiary bodies, including the CTC.

3.- The SPRFMO OP shall apply to fishing vessels flying the flag of a Member or Cooperating non-Contracting Party (CNCP) fishing for fisheries resources in the Convention Area for which a minimum level of observer coverage applies in the relevant CMMs in force.

4.- Observers shall have the rights and obligations set out in Annex A. Members and CNCPs, as the flag States, shall ensure that such rights and obligations are enforced and complied with.

5.- Members and CNCPs, as the flag States, shall also ensure that owners and fishing operators, vessel captains, officers and crew comply with the standards and duties set out in Annex B.

6.- The Commission, based on the advice of the SC, may explore and, where feasible, implement complementary means of collecting data and information in conjunction with human observers.

DEPLOYMENT OF OBSERVERS

7.- To fulfil their obligations under the Convention and the relevant CMMs adopted by the Commission, Members and CNCPs shall only deploy observers sourced from a national observer programme or service provider accredited according to the provisions of this CMM, including Annex C, with the sole exception

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

Commented [MP2]: Required: definitions of "Member", "CNCP", "National Observer Programme", "Service provider"

Commented [MP3]: China and Chinese Taipei suggest to add: "which may contribute to increase the coverage of a given observer program" – CMM 16-2018 par. 29

Deleted: other

Deleted: . This can include using other means of collecting data

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

provided in the next paragraph.

8.- Members and CNCPs may continue using their own national observer program to meet observer coverage requirements until 31 December 2023. From 1 January 2024 Members and CNCPs shall only deploy observers from national observer programmes or service providers accredited under the SPRFMO OP.

9.- Observers from a national observer programme of a Member or CNCP shall only be made available for deployment on vessels flagged to another Member or CNCP with the consent of both Members or CNCPs involved.

10.- Individual observers have the right to refuse a deployment on board a particular fishing vessel for justified reasons, including where safety issues have been identified. The national observer programme or service provider shall ensure that the reasons for such refusal are documented and that a copy of such document is provided to the SPRFMO Secretariat, which will forward it to the flag State of the vessel.

LEVELS OF COVERAGE

11.- Members and CNCPs shall ensure that all applicable fishing vessels flying their flag carry observers from a national observer programme or service provider accredited under the SPRFMO OP to meet the minimum level of observer coverage required by the relevant SPRFMO CMMs while operating in the Convention Area[1].

12.- For fisheries where 100 percent observer coverage is not in effect, Members and CNCPs shall ensure that the method of assigning observer coverage is representative of the fishery and commensurate with the specific data needs of the fishery, subject to practical constraints relating to Members and CNCPs with a small number of fishing vessels or trips.

Commented [MP4]: This seems somewhat arbitrary

13.- In relation to paragraph 12, Members and CNCPs are required to explain or document the reasons or methods used to allocate observers on fishing vessels flying their flag and provide this information in its their Annual National Report to the SC. The SC shall review the method used by each Member or CNCP and provide recommendations for improvement, as requested by the Commission.

Commented [MP5]: China and Chinese Taipei suggest to retain "encouraged" in line with CMM 16-2018 par 9.

ACCREDITATION

Accreditation Provider

14.- The SPRFMO OP Accreditation Provider is the public or private person or entity tasked by the Commission to assess and evaluate the applications for accreditation submitted by national observer programmes or service providers under the SPRFMO OP. The evaluation and accreditation of each national observer programme or service provider shall only be undertaken by the Commission's designated Accreditation Provider, except for the provisional accreditation provided for in paragraph 28.

[1] CMM 01-2018 (*Trachurus murphyi*), CMM 03-2018 (bottom fishing) and CMM 13-2016 (management of new and exploratory fisheries) specifies observer coverage levels for these fisheries.

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

15.- The SPRFMO OP Accreditation Provider shall grant accreditation to those national programmes and service providers that meet the requirements and standards set by the Commission in Annex C. Only national observer programmes and service providers that meet the minimum standards prescribed in Annex C shall be accredited by the OP Accreditation Provider under the SPRFMO OP.

16.- The Secretariat shall ensure that the designated SPRFMO OP Accreditation Provider is required, through its service contract, to maintain the confidentiality of any information received by a Member, CNCP or service provider pursuant to this accreditation process.

17.- A Decision of the Commission will designate a SPRFMO OP Accreditation Provider no later than at its 8th annual meeting. The procedure for appointing the SPRFMO OP Accreditation Provider, as well as the conditions and terms services, are outlined in Decision [XX – to be adopted at COMM 7 in 2019].

All the costs associated with accreditation shall be borne by the Commission budget.

Accreditation of Members and CNCPs' observer programs and service providers by the SPRFMO OP Accreditation Provider

18.- Consistent with Article 28(1) of the Convention, the SPRFMO OP, including the accreditation process, shall be coordinated by the Secretariat and operated in accordance with the standards, rules and procedures detailed in this CMM.

19.- A Member and/or CNCP seeking to accredit its observer program or service provider under the SPRFMO OP shall submit to the Secretariat, at any time, all the relevant information and documentation to fulfil the standards provided for in Annex C, including manuals, guides and training materials. All the information and documentation shall be provided in the official language of the Commission or with appropriate translations.

20. The Secretariat shall promptly provide the information and documentation to the SPRFMO OP Accreditation Provider. The Secretariat may also recommend the Member or CNCP to complete the application when there is clear evidence that substantive or essential information is missing.

21. Members and CNCPs are encouraged to inform the Secretariat in advance of their intention to pursue accreditation under the SPRFMO OP.

22.- The SPRFMO OP Accreditation Provider shall liaise with the Member, CNCP or service provider, as applicable. Members, CNCPs and service providers shall have the opportunity to provide additional information and corrections relevant to their assessment. This process will be conducted by the SPRFMO OP Accreditation Provider in a fair, equitable, transparent and non-discriminatory manner.

23.- Following evaluation and bilateral consultation, the SPRFMO OP Accreditation Provider shall provide a Final Evaluation Report to the Member, CNCP or service provider pursuing accreditation under the SPRFMO OP indicating whether the nominated national observer programme or service provider has met the

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

minimum standards for accreditation under the SPRFMO OP, and therefore whether accreditation is granted.

24. The SPRFMO OP Accreditation Provider will have "special consideration" for those national programmes and service providers currently accredited by other RFMOs. The Member or CNCP shall provide to the Secretariat the name of the national observer programme or service provider, the RFMO that has accredited it, and any other supporting information it wishes to include.

Commented [MP6]: May need more specific definitions

Commented [MP7]: Chile comments: The special consideration should be a case by case study and cannot involve an "automatic" certification. RFMO have different standards and not necessarily meet SPRMO.

25. The Secretariat shall circulate every Final Evaluation Report to all Members and CNCPs. Members shall have the opportunity to comment on any Final Evaluation Report.

26.- If the decision by the SPRFMO OP Accreditation Provider is favourable, it will indicate the duration of the accreditation period. Accreditation under the SPRFMO OP shall not extend for less than 4 years and more than 6 years from the date upon which accreditation is granted or was last granted. Once the SPRFMO OP Accreditation Provider has ensured that the minimum standards for accreditation are met, it shall decide on the duration of the accreditation period considering the following factors: experience, safety records, previous SPRFMO accreditations and other RFMOs or arrangements accreditations.

27.- If the Final Evaluation Report by the SPRFMO OP Accreditation Provider indicates that the application does not meet the minimum standard required for accreditation, or that having met the minimum standards it should be granted a longer accreditation period, the Member or CNCP concerned may ask for the case to be included on the agenda of the next annual CTC meeting. The CTC shall consider the Final Evaluation Report and any other document or information presented by the Member or CNCP in accordance to the Rules of Procedure and advise the Commission thereon. Only Members and CNCPs may request the CTC to advise the Commission on the Final Evaluation Report by the SPRFMO OP Accreditation Provider, including on the findings related to service providers.

28. If the Commission decides that, despite the findings of the Final Evaluation Report by the SPRFMO OP Accreditation Provider, the application meets the minimum standard required for accreditation (annex C), the SPRFMO OP Accreditation Provider shall be asked to provide accreditation to the Member or CNCP's national observer programme or to the service provider under any conditions as may be specified by the Commission. These conditions may include the accreditation of a national observer programme or a service provider on a temporary and conditional basis pending the fulfilment by that Member, CNCP, National Observer Programme or service provider of the deficiencies detected during the accreditation process.

29. If the Commission decides that accreditation should be granted for a longer period, but no longer than 6 years, it shall express the reasons to do so and will ask the SPRFMO OP Accreditation Provider to proceed accordingly.

30.- In case an application for accreditation is not accepted, nothing prevents a Member, CNCP, National Observer Programme or service provider from presenting a new application to seek accreditation. Members, CNCPs, National Observer Programme or service providers shall take into account the findings and

Deleted: are encouraged

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

recommendations of the SPRFMO OP Accreditation Provider.

31.- Members, CNCPs, National Observer Programme and service providers shall be entitled to renew accreditation.

32.- A Member may request the Commission revoke, condition or suspend accreditation for a national observer programme or service provider at any time but not later than 30 days in advance of the next CTC meeting by providing evidence that the national observer programme or service provider is not meeting the minimum standards for accreditation. The Executive Secretary shall circulate the request for revocation, condition or suspension to Members as soon as possible and the SPRFMO OP Accreditation Provider shall be asked to advise the CTC on the matter no later than 20 days after the request was circulated.

33. The CTC shall assess the request and information provided at its next annual meeting, as well as any information provided by other Members, and may provide recommendations to the Commission. The Commission shall consider the CTC's recommendations and the request to revoke or suspend accreditation at its next annual meeting.

Commented [MP8]: Comment by Chile: for revoking, conditioning or suspending an accreditation

34.- The Secretariat shall publicise all observer programs and service providers accredited under the SPRFMO OP, together with relevant contact details, on the SPRFMO website and include a list of all national observer programmes or service providers accredited in the SPRFMO OP in the annual OP Implementation Report described in paragraph 38.

DATA COLLECTION

35.- Members and CNCPs shall ensure observers deployed on vessels flying their flag collect and provide the information specified in Annex 7 of CMM 02-2018 (Standards for the Collection, Reporting, Verification and Exchange of Data) in the manner set forth in that CMM and shall also provide relevant observer information required under any other CMM.

Commented [MP9]: Comment by Chile: This should also apply to complementary means of collecting data and information implemented by the Commission

36.- Nothing in this CMM shall prevent flag States from taking additional measures compatible with this measure in relation to data collection.

REPORTING

37.- Members and CNCPs shall include a brief overview of the national observer programmes or service providers covering its fishing activity as a component of the Annual National Reports submitted by Members and CNCPs to the SC and developed in accordance with the "Guidelines for Annual National Reports to the SPRFMO Scientific Committee".

38.- The Secretariat shall prepare a SPRFMO OP Implementation Report on the implementation of the SPRFMO OP for presentation at each annual meeting of the CTC, using information from annual reports, observer data, and all other suitably documented relevant information. The SPRFMO OP Implementation Report will address, *inter alia*: (1) information on problems that have been encountered; (2)

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

recommendations for improving current standards and practices; (3) developments in observer and observational methods; (4) constraints to accreditation and (5) in general any identifiable problem or obstacle in fulfilling the objectives and purpose of this CMM as outlined in paragraphs 1 and 2.

39. The SPRFMO OP Implementation Report shall be distributed to Members and CNCPs 30 days prior to each annual CTC meeting.

40.- The CTC shall review the recommendations produced by the SPRFMO OP Implementation Report and provide advice to the Commission thereon, including in relation to any proposed actions to be taken.

41.- The Secretariat shall make available the observer data to the SC, at its request., Data confidentiality shall be maintained as set forth in procedures specified in Paragraph 6 of CMM 02-2018 and in any other data confidentiality procedures that may be adopted by the Commission.

Deleted: most recent year's

Deleted: holdings

Deleted: to ensure that the best scientific information is available

REVIEW

42.- The CTC shall review the effectiveness and implementation of this CMM at least every five years, including the development of additional observer safety requirements, the applicability of the SPRFMO OP to other fishing vessels and any additional requirements as may be necessary to meet the objectives of Article 28 and this CMM.

43.- The SC shall periodically review and provide advice on the appropriate level of observer coverage needed in each fishery to meet data needs.

44. Should the SC recommend that a change in coverage or research priorities for specific fisheries is needed, the revised coverage levels, if adopted by the Commission, will be specified in the relevant fishery CMMs.

ENTRY INTO FORCE

44.- This CMM shall enter into force 120 days after the conclusion of the Commission's 2019 Annual Meeting. Members and CNCPs may continue using their own national observer program to meet observer coverage until 31 December 2023, as provided in paragraph 8 of this CMM.

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

Annex A

Minimum Standards for Observers

Observers rights

In fulfilling their tasks and duties, observers shall have the following rights:

a) Freedom to carry out their duties without being assaulted, obstructed, delayed, intimidated or interfered with.
b) Access to and use of all facilities and equipment of the vessel necessary to carry out the observer's duties, including but not limited to full access to the bridge, catch before being sorted, processed catch and any bycatch on board, as well as areas which may be used to hold, process, weigh, and store fish, as safety permits.
c) Access to the vessel's records including logbooks and documentation for reviewing records, inspection and copying, vessel diagrams, as well as access to navigational equipment, charts and radios, and access to other information related to fishing activities.
d) Access to and use of communications equipment and personnel, upon request, for entry, transmission, and receipt of work-related data or information and that allows the observer to communicate with the observer program on land at any time, including in case of emergencies.
e) Access to additional equipment, if present, to facilitate the work of the observer while on board the vessel, such as high-powered binoculars, electronic means of communication, freezer to store specimens, scales, etc.
f) Access to the working deck or hauling station, once determined to be safe by both the crew and the observer, during net or line retrieval and to specimens (alive or dead) on deck in order to collect and remove samples.
g) Access to food, accommodations and medical facilities that meet international maritime standards, as well as sanitary facilities of a standard equivalent to those normally available to an officer on board the vessel.
h) Access to verify safety equipment onboard (through a safety orientation tour provided by officers or crew) before the vessel leaves the dock.
i) Unrestrained permission to record any pertinent information relevant for scientific purposes and data collection.
j) A permanent contact or supervisor on land to communicate with at any time while at sea.
k) To refuse deployment on board a particular fishing vessel for justified reasons, including where safety issues have been identified. The national observer programme or service provider shall ensure that the reasons for such refusal are documented and a copy of such document is provided to the SPRFMO Secretariat, which will forward it to the flag State of the vessel.
l) The ability to communicate at any time the safety issues to the vessel captain, National Observer Programme, service provider, the Secretariat, and flag State, as appropriate.
m) Upon request by the observer, receiving reasonable assistance of the crew to perform their

Deleted: observer
Deleted: 2
Formatted: Font: (Default) Calibri Light, 9 pt
Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

activities including sampling, handling large specimens, releasing incidental specimens, measurements, etc.

n) Privacy in the observer's personal areas.
o) Observer data, records, documents, and equipment will not be accessed, harmed, or destroyed.

Members and CNCPs shall ensure that operators, captains, officers and crew on board vessels flying their flag respect the rights of observers.

Observer Duties

The duties of observers include:

a) Carrying complete and valid documents before boarding the vessel, including, when relevant, identification documents, passport, visas, and certificates of onboard security training, and submitting copies of such documents to the programme managers of the national observer programme or service provider, as required.
b) Maintaining independence and impartiality at all times while on duty.
c) Complying with SPRFMO OP protocols for observers while carrying out SPRFMO OP duties on board a vessel.

Commented [MP10]: Suggest deleting or refer to protocols as specified by the accredited national program

d) Complying with the laws and regulations of the Member or CNCP whose flag the vessel is flying, as applicable.
e) Respecting the hierarchy and general rules of behaviour that apply to the vessel personnel.
f) Performing duties in a manner that does not unduly interfere with the operations of the vessel and while carrying out their functions giving due consideration to the operational requirements of the vessel and communicating regularly with the captain or master of the vessel.
g) Being familiar with the emergency procedures aboard the vessel, including the locations of life rafts, fire extinguishers, participating in emergency drills, and first aid kits.
h) Communicating regularly with the vessel captain on relevant observer issues and duties.
i) Refraining from actions that could negatively affect the image of the SPRFMO OP.
j) Adhering to any required codes of conduct for observers, including any applicable laws and procedures.
k) Communicating as regularly as is required with the program managers and/or national program coordinator on land.

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

Annex B

Duties of Vessel Operators, Captain, Officers and Crew

Members and CNCPs shall ensure that its observer programmes or service providers comply with the following provisions regarding vessel operators and captains, and officers and crew as applicable, on their flagged vessels:

Rights of vessel operators and captains

Vessel operators and captains shall have the following rights:

a. To agree to the timing and placement, when required to take on board one or more observers;
b. To conduct operations of the vessel without undue interference due to the observer's presence and performance of the observer's duties;
c. To assign, at his or her discretion, a vessel crew member to accompany the observer when the observer is carrying out duties in hazardous areas.

Duties of vessel operators and captains

Vessel operators and captains shall have the following duties:

a. Accept on board the vessel one or more persons identified as observers by the SPRFMO OP when required by the Commission or the Member or CNCP to which the vessel is flagged.
b. Ensure the vessel crew does not assault, harass, obstruct, resist, intimidate, influence, or interfere with the SPRFMO OP observer or impede or delay the observer in the performance of duties.
c. If required by the Commission, as a complementary monitoring tool, install and maintain functioning electronic monitoring systems or devices throughout the selected fishing trips.
d. Ensure the observer has access to the catch before any sorting, grading or other separation of the components of the catch are made.
e. Ensure that vessels operating in the Convention Area include adequate space for the observer to conduct bycatch sampling or other sampling as needed, in a safe manner that limits interference with vessel operations. A dedicated sample station and other equipment (such as MCP scales and/or flow scales) to the extent that there are established standards set by the Commission for different types of vessels would satisfy this responsibility.
f. Maintain an inspection report of the sampling area, and making a diagram available to the observers.
g. Not alter the sampling space during an observed trip without consultation with the observer. Any alterations shall be documented.
h. Inform the crew regarding the timing and objectives of the SPRFMO OP and schedule for observer boarding, as well as their responsibilities when an observer from the SPRFMO OP boards the vessel.

Commented [MP11]: Unclear what is meant by inspection report

Commented [MP12]: To whom and in which document?

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

i. Assist the SPRFMO OP observer to safely embark and disembark the vessel at an agreed upon place and time.
j. Allow and assist the SPRFMO OP observer to carry out all duties safely and ensure the observer is not unduly obstructed in the execution of duties unless there is a safety issue that requires intervention.
k. Allow and assist the SPRFMO OP observer to remove and store samples from the catch and allow the observer access to stored specimens.
l. Provide the SPRFMO OP observer, while onboard the vessel, at no expense to the observer or the SPRFMO OP, National programme, service provider or government, with food, accommodation, adequate sanitary amenities, and medical facilities of a standard equivalent to those normally available to an officer onboard the vessel.

Deleted: observer's

m. Allow and assist full access to and use of all facilities and equipment of the vessel that is necessary for the observer to carry out his or her duties, including but not limited to full access to the bridge, catch before being sorted, processed catch and any bycatch on board, as well as areas which may be used to hold, process, weigh and store fish.
n. Follow an established mechanism, if adopted by the Commission, for solving conflicts that would complement the established dispute settlement processes provided by observer programmes and providers.
o. Cooperate with the observer when the observer is sampling the catch.
p. Provide notice to the observer at least fifteen (15) minutes before fishing gear hauling or setting procedures, unless the observer specifically requests not to be notified.
q. Provide to the observer adequate space on the bridge or other designated area for clerical work and adequate space on the deck or factory to perform observer duties.
r. Provide personal protective equipment, and, where appropriate, an immersion suit.
s. Provide to the observer timely medical attention in case of physical or psychological illness or injury.
t. Develop and maintain an emergency action plan (EAP) regarding observer safety.

Safety orientation briefing

Vessel captains shall also provide the observer with a safety orientation briefing at the time of boarding and before the vessel leaves the dock. The orientation shall include:

a. Safety documentation of the vessel.
b. Location of life rafts, raft capacities, observer's assignment, expiration, installation, and any other relevant safety related information.
c. Location and handling of emergency radio beacons indicating position in case of an emergency.
d. Location of immersion suits and personal floating devices, their accessibility, and the quantities for everyone onboard.
e. Location of flares, types, numbers, and expiration dates.
f. Location and number of fire extinguishers, expiration dates, accessibility, etc.

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

g. Location of life rings.
h. Procedures in case of emergencies and essential actions of the observer during each type of emergency, such as a fire on board, recovering a person overboard, etc.
i. Location of first aid materials and familiarity with crew members in charge of first aid.
j. Location of radios, procedures for making an emergency call, and how to operate a radio during a call.
k. Safety drills.
l. Safe places to work on deck and safety equipment required.
m. Procedures in case of illness or accident of the observer or any other crew member.

Procedure in the event of an emergency

In the event that a SPRFMO observer dies, is missing or presumed fallen overboard the Member whose flag the vessel is flying shall ensure that the fishing vessel:

a. immediately ceases all fishing operations;
b. immediately commences search and rescue if the observer is missing or presumed fallen overboard, and searches for at least 72 hours, unless the observer is found sooner, or unless instructed by the Member whose flag the vessel is flying to continue searching;
c. immediately notifies the Member whose flag the vessel is flying;
d. immediately notifies the Member or observer provider to whom the SPRFMO OP observer belongs, if applicable;
e. immediately alerts other vessels in the vicinity by using all available means of communication;
f. cooperates fully in any search and rescue operation;
g. whether or not the search is successful, return the vessels for further investigation to the nearest port, as agreed by the Member whose flag the vessel is flying and the national observer program or service provider;
h. provides the report to the observer providers and appropriate authorities on the incident; and
i. cooperates fully in any and all official investigations, and preserves any potential evidence and the personal effects and quarters of the deceased or missing observers.

Flag States shall take and implements all steps, as a matter of due diligence, to prevent incidents causing serious harm or death to observers on board vessels flying their flag, and to sanction or punish those involved, including criminal investigation and procedure. The flag State and other Members and CNCPs shall cooperate to that end.

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

Annex C

Minimum standards for accreditation under the SPRFMO OP

These minimum standards are the Commission's minimum standards for accreditation under the SPRFMO OP. Therefore, the OP Accreditation Provider shall assess and decide all the applications against these standards.

Impartiality, independence and integrity

1. National observer programmes and service providers shall only deploy independent and impartial observers. This means that neither the national observer programme or service provider, as the case requires, nor the individual observers, have a direct financial interest, ownership or business links with vessels, processors, agents and retailers involved in the catching, taking, harvesting, transporting, processing or selling of fish or fish products.
2. The national program or service provider, and the individual observers:
   a) may not have a direct financial interest, other than the provision of observer services, in the fisheries under the purview of the Commission, including, but not limited to: i) any ownership, mortgage holder, or other secured interest in a vessel or processor involved in the catching, taking, harvesting or processing of fish; ii) any business selling supplies or services to any vessel or processor in the fishery; iii) any business purchasing raw or processed products from any vessel or processor in the fishery;
   b) may not solicit or accept, directly or indirectly, any gratuity, gift, favour, entertainment, inordinate accommodation, loan or anything of monetary value from anyone who either conducts activities that are regulated by a Member or CNCP connected with its services or the Commission, or has interests that may be substantially affected by the performance or non-performance of the observer's official duties;
   c) may not serve as an observer on any vessel or at any processors owned or operated by a person who previously employed the observer in another capacity within the last three years (e.g., as a crew member); and,
   d) may not solicit or accept employment as a crew member or an employee of a vessel or processor while employed by a national observer programme or service provider.

Commented [MP13]: CTC to consider whether may or shall is required in these paragraphs

Observer Qualifications

The qualification of individual observers is the responsibility of national observer programmes or service providers. The national observer programme or service provider shall demonstrate that observers that are recruited into their programme have relevant education or technical training and/or experience for the fleets concerned, including for the fisheries involved; ability to meet the observer duties described in this annex; no record of convictions calling into question the integrity of the observer or indicating a propensity

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

towards violence; and the ability to obtain all necessary documentation, including passports and visas.

Observer Training

National observer programmes or service providers shall demonstrate that observers are adequately trained before their deployment. Training shall include the following:

1. The relationship between fisheries science and fisheries management and the importance of data collection in this context
2. The relevant provisions of the Convention and SPRFMO CMMs relevant to the functions and duties of observers
3. Importance of observer programmes, including understanding the duties, rights authority and responsibilities of observers
4. Safety at sea, including emergencies at sea, donning survival suits, use of safety equipment, use of radios, survival at sea, management of conflicts, and cold-water survival
5. First aid training, appropriate to working at-sea or in remote situations
6. Species identification and record of species encountered at sea, including target and non-target species, protected species, seabirds, marine mammals, sea turtles, invertebrates indicating vulnerable marine ecosystems, etc.
7. Proper use of bycatch mitigation devices required by a SPRFMO CMM
8. Safe handling protocols to rehabilitate and release seabirds, marine mammals and sea turtles
9. Fishing vessel and fishing gear types relevant to SPRFMO
10. Techniques and procedures for estimating catch and species composition
11. Use and maintenance of sampling equipment including scales, callipers, etc.
12. Sampling methodologies at sea, fish sampling, fish sexing, measuring and weighing techniques, specimen's collection and storage, and sampling methodologies
13. Understand potential biases in sampling, how they arise and how they could be avoided
14. Preservation of samples for analysis
15. Data collection codes and data collection formats
16. Familiarity with catch logbooks and recordkeeping requirements to aid observers' collection of data as required under SPRFMO CMMs
17. Use of digital recorders or electronic notebooks
18. Electronic equipment used for observer work and understanding their operation
19. Verbal debriefing and report writing.

Refresher training should be ongoing dependent on the qualification requirements. Relevant updates to CMMs and observer requirements should be communicated to observers before each deployment as part of the briefing process, for example in an updated manual.

Observer Trainers

National programmes or service providers shall demonstrate that observer trainers have the appropriate skills and have been authorised by that national programme or service provider to train observers.

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

Deleted: Fisheries management

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

Briefing and Debriefing

National observer programmes or service providers shall demonstrate that there are systems for briefing and debriefing observers and communicating with vessel captains.

The briefing and debriefing process shall be conducted by properly trained personnel and shall ensure that observers and vessel captains clearly understand their respective roles and duties. This process shall be conducted by properly trained personnel.

Data Validation Process

National observer programmes or service providers shall demonstrate that they have in place an observer data validation process. The data validation process shall be conducted by properly trained personnel and shall ensure that data and information collected by an observer are checked for discrepancies and is corrected before the information is entered into a database or used for analysis. Data and information that should, at minimum, be checked for species codes, dates and times, location, effort, and catch information.

Commented [MP14]: SC would like to contribute a specific document on data validation that will be developed intersessionally

Observer Identification Cards

National observer programmes or service providers shall provide observers with identification cards that include the full name of the observer, date of issue and expiration, the name of the national observer programme or service provider, a unique identifying number (if issued by the national observer programme or service provider) a passport style photo of the observer, an emergency phone number and an expiry date.

Coordinating Observer Placements and Observer Deployments

National observer programmes or service provider must demonstrate responsibility and capacity for the timely deployment of observers and will ensure that the selected observer receives all possible assistance during the entire length of their placements. National observer programmes or service providers shall also seek, to the extent possible, to avoid deploying a single observer on multiple consecutive trips on the same vessel.

It is the responsibility of a national observer programme or service provider to administer observer placements, to maintain the independence and impartiality of observers as described in this measure and ensure that all placements are completed as soon as practicable after the observers return to port. The national observer programme or service provider is expected to communicate with the observer regarding upcoming deployments, coordinate observer travel, and provide the necessary supplies for observer duties.

Observer Safety Equipment

National observer programmes or service providers must demonstrate that observers are provided with appropriate equipment, including safety equipment, which is in good working order, routinely checked and

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 10 pt, Font color: Text 2

renewed to carry out their duties onboard a vessel. Essential equipment includes a lifejacket, independent two-way communication device capable of sending and receiving voice or text communications, personal locator beacons (PLBs), immersion suits, hard hat, proper deck working boots or shoes, gloves and protective glasses (including sunglasses).

Responding to Allegations of Observer Misconduct

National observer programmes or service providers must establish procedures for preventing, investigating, and reporting on the misconduct of observers, in coordination with observers, vessel captains, and relevant Members and CNCPs.

Dispute Settlement

National observer programmes or service providers shall demonstrate the existence of a dispute resolution process fair to all parties that provides a process to resolve issues through appropriate means including facilitation and mediation.

Observer Safety

National programmes or service providers must demonstrate that procedures are in place to support observers in their ability to carry out their duties unimpeded and in a safe working environment, including an established Emergency Action Plan (EAP). The EAP must provide instructions on sending reports to the provider's designated 24-hour point(s) of contact to report unsafe conditions, including instances of harassment, intimidation or assault.

National observer programmes or service providers must also provide a permanent delegate or supervisor on land to communicate with the observer at any time while at sea.

Insurance and Liability

National observer programmes or service providers must demonstrate that observers have health, safety and liability insurance commensurate with the national standards of the observer programme or service provider for such insurance for the duration of any deployment before placing the observer on a vessel.

Deleted: 2

Formatted: Font: (Default) Calibri Light, 9 pt

Formatted: Font: (Default) Calibri Light, 9 pt

SPRFMO SC6-Report

Annex 12. Checklist for Exploratory Fisheries Proposals

CMM 13-2016 and CMM 14b-2018

1. Scientific Committee Considerations - Fisheries Operation Plans – CMM 13-2016

Par 8. The Scientific Committee shall provide recommendations and advice to the Commission on each Fisheries Operation Plan on the following matters, as appropriate:

	NZ	EU	Cook Islands
a) management strategies or plans for fishery resources; [**Noted** that SC Interpreted this as to mean as having a clear objective for the fishery]	Yes	Partial	Yes
b) reference points, including precautionary reference points as described in Annex II of the 1995 Agreement;	Yes. If assuming straddling stock, linked to CCAMLR assessment	Not available	Not available
c) an appropriate precautionary catch limit;	Yes. Calculated as per CCAMLR approach for research and exploratory	Yes	No. Resource and impact calculations are based on assumptions and potentially optimistic
d) the cumulative impacts of all fishing activity in the area of the exploratory fishery;	Yes. No other fisheries	Partial. Cumulative impact with past trawl fisheries were not considered	Partial
e) the impact of the proposed fishing on the marine ecosystem;	Yes, highly detailed risk assessment and data from previous fishing	No	Partial, impact on VMEs and seabirds incomplete
f) the sufficiency of information available to inform the level of precaution required and the degree of certainty with which the Scientific Committee's advice is provided;	Yes, detailed and linked to CCAMLR stock assessment if straddling stock.	Partial	No, resource and impact calculations are based on assumptions and potentially optimistic
g) the degree to which the approach outlined in the Fisheries Operation Plan is likely to ensure the exploratory fishery is developed consistently with its nature as an exploratory fishery, and consistently with the objectives of Article 2 of the Convention[2]; and	Yes, focussed on data collection to advance CCAMLR stock assessment and understanding of toothfish biology	Partial, is for a single voyage to determine presence	Partial, General approach to wide area survey is appropriate but detail lacking on how CPUE can be used to assess and develop fishery given potential for pot saturation
h) in respect of a Fisheries Operation Plan that proposes any bottom fishing activity, advice and recommendations in accordance with paragraph 12 of CMM 03-2018 (Bottom Fishing)[3].	Yes. Bottom impact very low to negligible and distribution of VMEs considered	Partial. Impact on VME likely low but distribution not fully considered. Some consideration of straddling stock.	Partial. Impact on VME likely low but distribution not fully considered and move-on rule allows for high VME catches

[2] The objective of this Convention is, through the application of the precautionary approach and an ecosystem approach to fisheries management, to ensure the long-term conservation and sustainable use of fishery resources and, in so doing, to safeguard the marine ecosystems in which these resources occur.

[3] The Scientific Committee shall:

a) assess, on the basis of the best available scientific information, whether the proposed bottom fishing would have significant adverse impacts on VMEs and if it is assessed that these activities would have significant adverse impacts, recommend measures to prevent such impacts, or recommend that the proposed bottom fishing should not proceed;
b) assess, taking into account, inter alia, the cumulative impacts of other fishing occurring in the region where such information is available, whether the proposed activities are consistent with paragraph 1 of this CMM and Article 2 of the Convention;
c) provide recommendations and advice to the Commission on the assessment.

2. Scientific Committee Considerations – Data Collection Plans – CMM 13-2016

Par 9. When considering a Fisheries Operation Plan… the Scientific Committee shall develop a Data Collection Plan in respect of that exploratory fishery which should include research requirements, as appropriate. The Data Collection Plan shall identify and describe the data needed and any operational research actions necessary to obtain data from the exploratory fishery to enable an assessment of the stock, the feasibility of establishing a fishery and the impact of fishing activity on non-target, associated or dependent species and the marine ecosystem in which the fishery occurs. The Scientific Committee shall review and update the Data Collection Plan for each exploratory fishery annually as appropriate.

Par 10. The Data Collection Plan shall require, as appropriate:

	NZ	EU	Cook Islands
a) a description of the catch, effort and related biological, ecological and environmental data required to undertake the evaluations described in paragraph 24;	Yes	Partial	Partial
b) the dates by which the data must be provided to the Commission;	Yes	Yes	Yes
c) a plan for directing fishing effort in an exploratory fishery to allow for the acquisition of relevant data to evaluate the fishery potential and the ecological relationships among harvested, non-target and associated and dependent populations and the likelihood of adverse impact;	Yes	Partial, proposal is for single voyage	Partial, further work on design of depletion study and determination of effective fishing area would provide relevant data.
d) where appropriate, a plan for the acquisition of any other research data obtained by fishing vessels, including activities that may require the cooperative activities of scientific observers and the vessel, as may be required by the Scientific Committee to evaluate the fishery potential and the ecological relationships among harvested, non-target, associated and dependent populations and the likelihood of adverse impacts; and	Yes	Yes	Partial, some aspects are not as clear (e.g. camera study)
e) an evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities	Yes	Not applicable, is for single voyage	Partial

3. Particularly regarding Exploratory Fisheries for Cook Islands – CMM 14b-2018

Par 24. …The proposal will include the following:

a) A detailed and specific proposal and Fisheries Operation Plan that includes formal sampling designs and data collection plans for all phases of the proposed exploratory fishery that conform with CMM13-2016;

Partial--**Noted** some design details remain not fully described, especially for camera surveys and depletion survey.

b) A description of how the proposed fishing meets the requirements of the Convention and relevant CMMs, including a bottom fishing impact assessment;

No-------**Noted** concerns that resource calculation and resulting exploitation rates are based on assumptions and are potentially optimistic.

Noted that once fishing occurs on a seamount it becomes part of the limit of 8 seamounts total within a year.

c) Propose measures to ensure the long-term viability of the target species, including reproduction

Partial--**Noted** the proposal addressed action to mitigate impact on berried females. **Noted** that CPUE-based approach did not fully consider and address issues with pot saturation and concerns on sustainability of catch levels dependent on selected seamounts.

d) A description of any fishing conducted to date, including effort, catch, and information on measures taken to protect VMEs.

Not applicable--**Noted** that no fishing has currently been conducted under CMM14b-2018

Particularly Regarding the Cook Islands proposal, the SC:

Relative to the check list above for exploratory fisheries which contains the specific SC assessments and recommendations relative to the fisheries operational plans, Data collection plans and other considerations; In respect of the Cook Islands proposal, the SC:

8.b **Noted** no reference points for target species exist in SPRFMO

8.c **Noted** that upon further consideration of literature values that report effective fishing areas of 500-6000 m^2 per pot, which are notably different than the values reported in the proposal. **Noted** one literature paper was for deepwater crab species in Pacific (which has effective area of 564 m^2) yet others are for other lobster/crab in other coastal areas.

Noted that proposal did not consider the implications that such values would have on estimated exploitations rate, which SC noted could be 5% for *jassus* species but could at the extreme range up to 60%.

Noted three options to address precautionary catch limits:

- Option 1- Although no detailed analysis is presented in the proposal, lowering the catch limit for the second year so as to reduce the potential risk of exploitation and localized depletion from two years of fishing at 1000t, which would be commensurate with a gradual and precautionary approach for an exploratory fishing. Noted that no current fishing data exist to inform catch limit.

- Option 2 - Alternatively, lowering the catch in the first 30 day trip of year two to a value less than 333 t, which is one-third of the current yearly catch limit, to reduce potential risk of exploitation and localized depletion and allow for further data analysis to inform decisions.
- Option 3 - Alternatively, year 2 fishing could be delayed until further data is collected and analysed to inform a precautionary catch limit for future fishing activities.

8.d For cumulative effects related to the targeted population then 'No' and see considerations for 8.c. for cumulative effects to VMEs then 'Yes'.

8.e Noted that a move-on rule for VMEs of 1% of targeted catch for a catch limit of 1000 t could potentially far exceed the current member-specific thresholds for VMEs.

Noted proposal stated impact on birds would be low given nature of gear but lacked more detailed exploration on potential interactions.

8.f See concerns stated with precautionary nature of catch limit (8.c) especially with regards to the range of literature values reported for effective fishing areas.

8.g See concerns stated with precautionary nature of catch limit (8c). Noted that possible presence of pot saturation could limit the utility of the depletion study to ensure long-term development.

8.h.a Noted that assessment based on likely minimal impact of bottom line fishing on VMEs and take measures to further reduce the likely minimal impact, however the proposed move one rule could result in substantial catch of VMEs (see 8.e).

Recommended that threshold limits for VME move-on rule for this exploratory fishery be as stated in Appendix 7 of the proposal.

8.h.b Noted that no other fishing is occurring in the region and incorporates consideration of past fishing activity

8.h.c Advised that assessment adequately addressed 1 out of 7 relevant criteria, partially addressed 4 out of 7 relevant criteria, and did not adequately address 2 out of 7 relevant criteria for paragraph 8 of CMM 13-2016.

Noted that the criteria the proposal did not address are all related to catch limits, and that the criteria the proposal partially addressed all relate to the proposed VME threshold.

Noted that adequate revisions could be made in the proposal to the Commission to better address SC concerns.

10.a Noted concerns that the details of how to estimate effective sample area from collected data could be clarified, and improvement to design of depletion study be done, and therefore better provide information to evaluate the abundance of the target species and to inform the exploratory fisheries potential yield.

10.b Noted the data standard on timeline for submission of data and report for consideration by the SC of June 30 for catch data and Sept 30 for observer.

10.c See concerns noted in 10a.

10.d Noted the camera study design is beneficial yet would benefit from more detailed objectives.

10.e Noted the inclusion of the depletion study in year 2 could be used to inform the response of the targeted species and could be improved for how to address the potential for saturation.

… while noting papers for analysis of data are to be submitted for SC consideration 30 days prior to SC meeting.

Related to CMM14b-2018

24.a: Noted that the Fisheries Operation Plan specifies details for the third year will be dependent on the results of sampling and therefore the Fisheries Operation Plan for this third year will be provided at the 7th Meeting of the SC.

Noted concerns specific for the depletion study as described for 10e.

24.b: Noted the proposal addressed potential impacts on non-target stocks and VMEs, but noted the point raised in 8e about concerns on the proposed move-on rule, and concerns with the lack of details to determine the sustainability of the target stock given the catch limits.

24.c: Noted the proposal addressed action to mitigate impact on berried females, however noted the concerns raised in 8c.

Particularly Regarding the New proposal, the SC:

Relative to the check list for exploratory fisheries above which contains the specific SC assessments and recommendations relative to the fisheries operational plans, Data collection plans and other considerations; In respect of the New Zealand proposal, the SC:

8.c: Noted catch limit of 220 tonnes per annum (calculated using the CCAMLR approach for comparable research surveys using cluster designs in the northern parts of the CCAMLR Area) is a large increase from 30 tonnes per annum.

8.f: Noted that stock is likely straddling but information for determining certainty remains missing.

8.h.a: Noted that assessment is based on likely minimal impact of bottom line fishing on VMEs, and proposal takes measures to further reduce the likely minimal impact.

10.e: Noted plan in Fishery Operation Plan of sharing data with CCMALR for use in their assessments and updating SPRFMO.

10.b: Noted the data standard on timeline for submission of data and report for consideration by the SC of June 30 for catch data and Sept 30 for observer.

8.h.b: Noted that no other fishing is occurring in the region.

Particularly Regarding the European Union proposal, the SC:

Relative to the check list for exploratory fisheries above which contains the specific SC assessments and recommendations relative to the fisheries operational plans, Data collection plans and other considerations; In respect of the EU proposal, the SC:

8.a: Noted the proposal specifies a clear objective.

Noted concern that previous trawl and line fisheries operating in and/or near the area have never caught toothfish and distributional maps have not been provided to convince SC toothfish occur in area.

Noted that previous fisheries may have been fishing at depths shallower than those anticipated for the occurrence of toothfish.

8.b: Noted no reference points for toothfish exist in SPRFMO.

8.d: Noted cumulative impacts with past trawl fishing likely to be low.

8.e: Noted that as currently written the proposal did not include consideration of the risks to seabirds, reptiles, marine mammals, and deepwater sharks,

Noted that such consideration of the risks stated above is planned in time for the Commission.

Noted that proposed seabird mitigation is adequate.

8.f: Noted that sufficiency of information on target species was as addressed in 8c.

Noted that SC considers 8.f. to sufficiently address information for non-target species, and that the catch limit of the target species and bycatch limits of non-targets species are sufficiently precautionary but noted that precautionary levels of bycatch depend on the availability of toothfish.

Noted additional information on expectation of catching toothfish in the area would better inform SC's advice.

8.h.b: Noted that the proposed area could be part of neighbouring jurisdictions and could represent a non-trivial amount of the total catch allowed for that jurisdiction.

8.h.c: Advised that assessment adequately addressed 1 out of 7 relevant criteria, partially addressed 5 out of 7 relevant criteria, and did not adequately address 1 out of 7 relevant criteria for paragraph 8 of CMM 13-2016.

Noted that the criterion the proposal did not address is planned to be addressed prior to the Commission meeting.

Noted that the criteria the proposal partially addressed all relate to the uncertainty around the presence of toothfish in the proposed fishing area and impact on VME and bycatch species.

10a: Noted the intention of the proposal is to indicate presence rather than abundance as specified in paragraph 24.

Noted proposal currently did not have risk assessment complete, yet that completed risk assessment is planned in time for the Commission.

10.b: Noted the data standard on timeline for submission of data and report for consideration by the SC of June 30 for catch data, and Sept 30 for observer.

10c: Noted the intention of the proposal is to indicate presence rather than abundance.

10e: Noted the intention of the proposal is to indicate presence rather than abundance.

SPRFMO SC6-Report
Annex 13. Call for Interest to organise forthcoming SC meetings

1. Background

According to Rule of Procedure 3 "Before the end of each annual meeting, the Commission[4] shall, if possible, decide on the date and location of the next annual meeting".

To facilitate medium-term planning both for SPRFMO Member National scientific & research administrations and the Secretariat, the Scientific Committee (SC) members are requested to consider how feasible would be to organise forthcoming SC meetings.

This exercise is not a formal commitment (unless confirmation is given by the SC member) but a finding exercise to check where potentially SC meetings could be organised in the next three years. Therefore, each year column is open to more than one Member.

MEMBERS OF THE COMMISSION	SC	2019	2020	2021
Australia				
Republic of Chile	2018			
People's Republic of China	2017			
Cook Islands				
Republic of Cuba				
Republic of Ecuador				
European Union	2016			
The Kingdom of Denmark in respect of Faroe Islands				
Republic of Korea				
New Zealand				
Republic of Peru				
Russian Federation				
Chinese Taipei				
The United States of America	2013, 2014			
Republic of Vanuatu	2015			

[4] Rule of Procedure 1: For the purpose of each subsidiary body, in the following rules, the word Commission shall be understood as referring to the concerned Committee, and the word decision as referring to advice or recommendation.