SPRFMO

Scientific Committee

Port Vila, Vanuatu
28 September - 3 October 2015

COMM-04-05

REPORT OF THE 3rd SCIENTIFIC COMMITTEE MEETING

1. Welcome & Introductions

The participants were welcomed to the meeting by Mr. James Matariki, assistant to the Minister of Agriculture, Forestry, Fisheries, Livestock, and Biosecurity for Vanuatu. Dr James Ianelli, Chair of the Scientific Committee (SC) opened proceedings, and participants introduced themselves.

2. Meeting administrative matters

2.1 Adoption of Agenda

The Chair adopted agenda is attached as Annex 1.

2.2 Meeting documents

Meeting documentation, location and access was presented. The list of participants is attached as Annex 2. Options to consider late papers were reviewed and given their support for activities during the week (rather than requiring careful scientific review) these papers were accepted by the SC.

2.3 Nomination of rapporteurs

Rapporteurs were assigned and included members from several delegations.

3. Annual Reports from participants

Annual Reports were provided for this meeting by Australia, Chile, China (2), Colombia, European Union, Korea, New Zealand (2), Peru (2), Chinese Taipei, United States of America and Vanuatu (papers SC-03-06 to 10, 13, 14, 17-20, 22, 23, and 28). Participants made brief presentations of their reports and provided answers and explanations in response to questions.

The presentations of the annual reports were followed by discussions among representatives as summarised in Annex 3.

4. Commission Guidance and other intersessional activities

4.1. Commission SC roadmap

The roadmap (COMM03 Annex C) provides guidance to the SC. The items were reviewed and it was noted that nearly all should be accommodated based on intersessional activities and from work to be done during the week.

4.2. Secretariat SC related activities

The Secretariat presented paper SC-03-31 informing the SC about relevant meetings that the Secretariat had attended as an observer over the past year, in particular: the Steering Committee meeting of the Fisheries and Resources Monitoring System (FIRMS); the intercessional meeting of the Coordinating Working Party on Fishery Statistics (CWP), the FAO Workshop on VME process and practices and as a stakeholder in the New Zealand South Pacific VME project. The SC is invited to consider whether it would like to recommend that SPRFMO joins the FIRMS and CWP.

Some SC participants emphasised the importance of the Secretariat being cost-effective. Other participants recognised the contribution that CWP and FIRMS make to maintaining linkages and consistency across RFMOS. While issues of data coverage are usually pursued directly between RFMO secretariats, involvement in CWP and FIRMS provides opportunities for staff to keep abreast of the latest developments in fisheries and associated data collection programs. It was decided to postpone a final recommendation to the next SC meeting.

4.3. Data Workshop report

Niels Hintzen chaired a workshop of a sub-group of member scientists that preceded the SC03 meeting. The purpose of the workshop was to provide more focus on the data used for assessments within SPRFMO. While the discussions at the workshop centred on jack mackerel data issues, the recommendations from the group broadly extend to other stocks. Specific activities included evaluating the sampling and procedures that precede data delivery to the SPRFMO Science Committee for assessment purposes, identifying data quality issues and ways to improve the current process (e.g., through the use of data templates).

Recommendations from the group are that in order to improve and provide needed background for the data as input to the assessment, the group recommends the following to the SC:

1. Continue to develop, refine, and use the **data submission protocols and templates** identified during the data workshop for future data submission to the SC. This includes (with current status):
    a. The age and length data for each fleet (1st draft available)
    b. The survey (DEPM and acoustics) data (can be refined further from fishery data)
    c. The CPUE information (needs to be developed)
    d. Biological data, weight-at-age etc; (needs to be developed or added on)
2. Assign a data coordinator or coordinators to streamline the data collation from the completed templates for assessment purposes. This would ensure that any elements included in the assessment are reviewed and made clear and that the protocols were followed. This would support the data manager of SPRFMO with this task.
3. Continue to use the provisional catch estimates (where necessary, e.g., for current year) for the current and previous year and evaluate the impact this variability on advice to the Commission
4. That an inter-sessional benchmark meeting for jack mackerel and other species as requested be pursued. This should include an evaluation of the quality and sensitivity of data (as is normally done) but also in light of the protocols developed at this workshop. Given meeting schedules, a web-based workshop may be an alternative.

The SC endorsed these recommendations with some minor amendments as follows. Relative to recommendation 2 above, the SC recommended that it be adopted and for jack mackerel, the assigned coordinators from the major fleets (Chile, Offshore, and Peru) be identified. They should have the requisite skills and familiarity with the approaches and software involved in developing datasets to those used by the assessment model (e.g., the R package, git, etc). Relative to item 3 regarding the update assessment and provisional catch estimate, the SC discussed this in context of the jack mackerel modelling below.

4.4. Fishery dependent acoustic Task Group

Francois Gerlotto presented a report on the activities of the Task group during the period October-September 2015 using the terms of references defined during the SC02 meeting in Honolulu. Inside these intersessional activities the members of the task group had the opportunity to present results and also participated in discussions during international events (7th ICES Symposium on fisheries acoustics and ICES WGFAST meeting, Nantes, May 2015; Workshop on acoustics from fishing vessels, Schiphol, June 2015; SNP workshop on acoustic protocols for fishing vessels, Lima, Sept. 2015). A workshop was organized in Lima, Sept. 2015 to synthesize the intersessional work, produce a protocol for calibrating echo sounders aboard fishing vessels and list the scientific activities to be developed in the future. The two main results of the task group activities are: the redrafting of the calibration protocol which was submitted to SPRFMO in the annual task group report; and the demonstration that acoustic data from fishing vessels presented all the characteristics allowing incorporating the data in scientific data bases and analyses. For future activities, the suggestion was to continue to work by e-mail in intersessional periods and to organise a workshop in 2016 on the theme of "Acoustic data collection, processing and management".

Ulises Munaylla made a presentation on the report of the 6th Workshop on Diagnosis of the Status of Jack Mackerel Fishery in Peru. He reported that the year 2015 represents a phase of great environmental disturbances in the Peruvian sea, with a phenomenon El Niño that is expected to grow from strong to extraordinary; such environmental situations are likely to affect the state of Jack Mackerel (JM) populations. With low jack mackerel catches in 2015 and almost no new data to process, the SNP Scientific Committee decided to focus the activities of the 6th workshop towards a general review of the methodology used and to produce sound protocols for: estimation of abundance by acoustic and geostatistical methods; estimation of CPUEs; estimation of the potential habitat; estimation of the modal progression of the demographic dynamics; protocol of calibration of echosounders; design of indicators of the fleet fishing effort through VMS data analysis. It was presented abstracts of protocols.

According to the development and use of this information, acoustic indicators provided by fishing vessels should be defined for potential and effective habitat use of jack mackerel. Future work should consider data and information provided by different participant and the use of this information as complementary indices for habitat considerations, complementary information outside surveys areas and their use in assessments.

During its workshop the task group found terminology difficulties for defining in a common way four types of results:

a. The quantity of fish expressed in acoustic units inside the survey area;
b. The quantity of fish expressed in kilos inside the survey area;
c. The quantity of fish expressed in acoustic units all over the population distribution area (including extrapolated values outside the survey area);
d. The quantity of fish expressed in kilos all over the population distribution area (including extrapolated values outside the survey area).

The SC recommends that SPRFMO adopt the following terminology:

- Survey abundance for case (a)
- Survey biomass for case (b)
- Population abundance for case (c)
- Population biomass for case (d)

5. Jack Mackerel

5.1. Report on Intersessional assessment/research by Participants

The group reviewed the report from the web-based meeting held in July and the papers that have been prepared for this SC specific to jack mackerel issues. Key developments include self sampling work covered in SC03-12, likelihood profile for evaluating data and model likelihood components (SC03-JM04).

5.2. Intersessional Progress with the Stock Structure Research Programme

Niels Hintzen presented an update of the EU work on stock structure hypotheses and laid out key remaining uncertainties. He demonstrated that the hydrodynamics as modelled shows a narrowing of coastal habitat which divides the northern part of Chile (and Peru) from the South-Central region of Chile. Key results from the study suggest that the two stock hypothesis is likely more risk averse and should be considered for assessment and advice in order to ensure sustainable exploitation. For a more detailed summary please refer to Annex 4.

Aquiles Sepulveda presented an analysis that has been done recently in Chile regarding the location and seasonality of jack mackerel spawning, included in a scheme of a biophysical modeling with the aim of studying connectivity between spawning and nursery areas and its effect on the dynamics of recruitment under El Niño 97/98 and La Niña 2011. Results demonstrated that the hydrodynamic model in use performed well in reproducing the inter-annual variability of oceanographic conditions of the study area and represent inter-annual variability. There is connectivity between the main spawning area located in the oceanic area off central-southern Chile with the nursery grounds located at the coastal zone of northern Chile and southern Peru. Also, early stages of jack mackerel can be transported from Peru to the North of Chile, reaching the nursery ground and eventually contributing to recruitment. Finally, spawning in the coastal area of Northern Chile are highly retained within the area of the nursery and could contribute to the recruitment dynamics of jack mackerel. In addition, the results suggested that the transport paths for early stages are closely linked to the pattern of surface circulation and mesoscale processes can affect retention or advection locally. This modelling scheme reasonably simulates the early life history of jack mackerel and connectivity between different spawning areas and the nursery area off Northern Chile and can be considered to understanding relative stock structure hypotheses as well.

Cristian Canales presented an analysis where the risk of overfishing and overexploitation was evaluated assuming that there is a single stock when actually are two, and it was compared with the risk of managing two stock units when there is in fact only one (SC03-JM05). In the first case, the impact of the spatial allocation of the catches on local stocks was analysed, while in the second case, it was analysed the impact that has on a single stock, the total catch as result of the management of two independent stocks. The simulation's results showed that under the current fishing management scenario (single stock), the risk of overfishing or overexploitation in the two possible independent stock units was determined to be low and the population recovery could occur before 10 years. In the other case, if fishery management is based on the assumption of two stock units when in fact there is only one, results showed that the probability of overfishing and overexploitation of the true single stock in the long term is estimated to be high. In this paper overfishing and overexploitation are defined as F exceeding Fmsy and spawning biomass being less than Bmsy. This is due to the fact that the sum of Allowable Biological Catches (ABC) of each independent stock generates catches that are larger than the ABC for a single stock.

The SC acknowledges the above presentations and indicated that all of these results were of interest to the group, each with strengths and weaknesses regarding assumptions.

5.3. Intersessional Progress with Age/Growth Task Team

Age and growth data and analyses is an ongoing issue among SPRFMO member scientists. Chile presented two papers on age and growth of jack mackerel—one dealing with micro-structure and another on protocols. The objective was to define methods and develop a manual on how to read the growth structures. A task team was assigned and a schedule for workshops and coordination with Francisco Cerna at IFOP (Valparaiso, Chile). A workshop is planned for December 14-17, 2015 to look at microstructure comparisons and a second workshop in March 14-18 2016 will be chaired by Beatriz Morales-Nin and will focus on annual ring identification. The goal of these workshops are to develop a consistent protocol for jack mackerel age determination approaches.

During the meeting Cristian Canales noted that some progress has been made on the development of an age-determination error matrix to be used within the assessment model. It was noted that there is a paper and software available that may help in further estimating this "ageing error" matrix (see footnote).[1]

The SC noted that these are encouraging developments and **recommends that the Commission encourage members to support scientists' participation. Furthermore, the SC requests that members actively encourage participation within their respective agencies.**

5.4. Jack Mackerel Stock Assessments

The Commission advised the SC that an "update" assessment was preferred this year so that other agenda items can be covered in more detail (summary result provided in Annex 7). The SC discussed and clarified what an "update" involves: incrementing the accepted model configuration by one calendar year and updating the catch and accepted "standard" information. In contrast, a "benchmark" assessment (as has been done annually from 2012-2014) may be conducted in every 2nd or 3rd year, for example. The data and assessment results for this update are provided in Annex 8.

5.4.1. Updating data for stock assessments

The Secretariat provided an updated historical catch data series to 2014 as well as an initial estimate of 2015 catches for use in the assessment (SC03-JM02). Changes to previous versions for this data series are limited to the 2014 final figures as advised by Members and CNCPs. 2015 initial estimates were created by applying the mean observed difference, by fleet, between the provisional 2010-14 figures and the final 2010-14 figures, to the available 2015 monthly catches.

Adjustments based on participant's knowledge were applied for 2015 estimates and comparisons with previous years' performance were evaluated. The SC noted that in some cases the total difference was as high as 4% but that this was based on only two years of data. Such differences are relatively small but the **SC recommended that this type of evaluation be continued next year and allow for some sensitivity analyses within the planned benchmark assessment.** The complete catch data series used in this update assessment are shown in Annex 8, Table A8.1.

Issues arose during the meeting about the "updated" indices and other data differences. This was clarified as there were some modifications to the Northern stock data (as presented in the Peruvian report (SC03-19). The data presented below were based on the same assumptions and indices between the single and two-stock models.

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[1] Thorson, James T, Stewart, Ian J, and Punt, Andre E. 2012. nwfscAgeingError: a user interface in R for the Punt et al. (2008) method for calculating ageing error and imprecision. Available from: http://github.com/nwfsc-assess/nwfscAgeingError/.

5.4.2. Model configurations

Based on the advice of the Commission and as noted above, the SC was tasked with updating the data without major modifications or sensitivity analyses regarding model configurations. In previous years several model alternatives were explored in a “benchmark” fashion. This involved large numbers of sensitivities occurring and a considerable amount of extra work required to run the assessment for each area separately then combine them in a software package. Peruvian scientists streamlined this process by developing the assessment software to be more adaptable and deal with multiple stocks and simultaneous treatment of environmental “regimes” which can be specified to have different levels of productivity. Tests of this new model (which can handle multiple stocks) were presented and incorporated into the main SPRFMO github site (www.github.com/sprfmo/jjm) replacing the 2014 repository at www.github.com/sprfmo/jack_mackerel.

The group also developed a list of activities for the benchmark assessment. **The SC recommended that is to be refined by intersessional work and decided at by June 2016**. The current list is:

1. Model diagnostics, e.g., likelihood profiles, retrospective runs, MCMC posterior evaluations, etc…
2. Catch estimation methods
3. Treatment of acoustic data and other indices
4. Review of the sample sizes and CV for all data
5. Growth alternatives (emphasis on average body mass at age assumed)
6. Natural mortality
7. Model fits to catch at age in numbers instead of biomass
8. Standardization of CPUE time series
9. Age-determination error

5.4.3. Stock indicators

Based on new data and indicators, the status of jack mackerel evaluated in detail at the 2014 benchmark assessment are relatively unchanged. The population trend is estimated to be increasing. On balance, the indications of stock improvement (higher abundance observed in the acoustic survey in the northern part of Chile, relatively abundant age 3 jack mackerel in the fisheries, better catch rates apparent in some fisheries) are somewhat offset by declines observed in the Chilean CPUE.

The SC noted the low SSB estimates in the northern area based on preliminary results presented at the last benchmark evaluation (SC02). Alternative exploratory (results presented in SC03-19) provide additional data refinements needed which will be taken up in the next assessment.

5.5. Other jack mackerel topics

5.5.1 Suitable habitat indicators

Aquiles Sepulveda presented analysis of habitat work that has been done recently in Chile. This expands on the initial work of Vasquez et al. (2013) and is summarized in section 5.2 above.

Under the EU study, results on suitable habitat had been presented. Results indicate that suitable habitat may be limited by dissolved oxygen concentration, temperature, depth and food availability.

5.5.2 Tagging feasibility

No papers nor analyses were presented on the feasibility of tagging for jack mackerel.

6. Deepwater species

6.1. Intersessional assessments of deepwater species

New Zealand presented paper SC-03-DW-02 describing how low-information stock assessment methods for orange roughy could be applied within the SPRFMO Area. Analysis of genetic information, life history parameters, size structure of the catch, timing of spawning, and the distribution of fisheries collectively suggest that the stock assessment areas for orange roughy to the west of New Zealand remain appropriate and need not be changed. Areas to the east of New Zealand, on the Louisville Ridge, were refined by shifting the boundaries between the North, Central, and South components. A fine-scale, spatially disaggregated CPUE analysis has been applied to these revised areas. This approach provides better fits to observed data than previous analyses and is designed to overcome potential problems caused by serial depletion of sub-areas. Sensitivities to spatial sub-area weighting choices and the imputation assumptions necessary for this approach have been tested. CPUE indices from these models are assumed proportional to abundance and have been used to develop simple Bayesian state-space biomass dynamic models for putative stocks on the West Norfolk Ridge and the adjusted North, Central and South Louisville Ridge areas. Sensitivity to the assumed shape parameter has been tested, and retrospective performance appears acceptable. Estimated median stock status for these four stocks ranged from 0.23 of K to 0.44 of K, with relatively wide confidence limits. Attempts to model stocks on the Lord Howe Rise and Northwest Challenger Plateau have not been completely successful and biomass estimates were very poorly constrained.

SC sought clarification of the key determinants of the changes to stock assessment area boundaries, especially for the Louisville Ridge. Timing of spawning was the key driver, but all other available data had been examined for patterns. Fishing is generally focussed on spawning orange roughy on features and on the slope.

SC discussed elements of the spatial CPUE modelling seeking clarification on the process of area validation which was explained as cross checking of area data against skipper experience. This had been successfully conducted for New Zealand oreo fisheries but not yet for this analysis. Some catch had been taken outside the modelled areas and vessels have changed over time, and SC sought clarification of how those issues had been dealt with. The models and stock assessments were limited to the six management areas identified, but they contained the great majority of the catch of orange roughy. Vessels were identified individually in the data, offered as an explanatory variable to all GLM models, and usually found to be significant explanatory variables. Changes in the management settings and the spatial distribution of fisheries were also incorporated, and corrected for, in the models. The spatially disaggregated approach can also correct to some extent for the possible effects of disturbance on orange roughy spawning aggregations. SC discussed the sensitivity of the CPUE results to modelling choices, and New Zealand agreed to conduct a simulation analysis to assess performance.

SC noted the scarce data available for stock assessment. New Zealand confirmed that additional data could be included, and it would be especially important to include the catches (and CPUE) of other nations. Other more sophisticated modelling approaches for orange roughy are commonplace in New Zealand and the example of the 2014 New Zealand assessment of three in-zone stocks was raised (and the report provided), but biomass indices in the SPRFMO Area were almost entirely restricted to CPUE so more sophisticated approaches are not yet possible. A summary of multi-frequency acoustic surveying on the Westpac Bank area was shown to the SC (this being part of the straddling stock assessed by New Zealand as ORH7A). SC agreed this was a useful development but the results could not yet contribute to any other stock in the SPRFMO Area. The Bayesian state-space BDM approach had been simulation tested using data from New Zealand's largest in-zone fishery with good results. Stock-specific priors had not yet been applied but would be explored.

The Deep-Sea Conservation Coalition questioned whether New Zealand plans to analyse otoliths already collected for aging information. New Zealand indicated that if any were held this was a possibility depending on funds.

This work is still incomplete but the SC considered that further development, simulation testing, and review would be worthwhile. New Zealand indicated that such work is routinely reviewed through its domestic working group processes but will also explore opportunities to publish the work in the primary literature and present to the SC4.

The Scientific Committee:

- **recognised** the good progress made by New Zealand on the development of stock assessment methods for demersal species in the SPRFMO Area, particularly orange roughy
- **noted** the preliminary estimates of initial biomass, productivity, and stock status for four of the six orange roughy sub-stocks
- **noted** that the work would continue, including simulation testing of the spatially disaggregated CPUE models, and subject to rigorous review
- **agreed** that this work should contribute to the development of a revised CMM for bottom fisheries in the SPRFMO Area

Graham Patchell of HSFG presented a summary on the use of multi-frequency acoustic systems on the Westpac Bank area, part of the straddling stock assessed by New Zealand as ORH 7A, including preliminary biomass estimates for two areas in 2014. Further work in 2015 on the Puysegur area was presented showing how the multi-frequency echo sounder results can be viewed on the vessel real time, and also HD video footage. It was noted that this net-attached AOS has been successfully used to get TS measurements and length of fish the latter using calibrated stereo cameras.

The WG commended the investigations and noted this method could also be useful for acquiring target strength information for jack mackerel. SC discussed the difficulties in distinguishing signals of black oreo and orange roughy as both share a number of key characteristics including being closely associated with the bottom. This was a problem when the species are found together however this is not always the case. From the video, this work appears to have been done on flat sandy bottom, and SC queried the functionality on other bottom types. HSFG indicated this gear had been operated on a number of bottom types and offered to make all of the video footage available. While acknowledging the significant development, New Zealand noted that information from the studies presented could not currently be used in stock assessments for orange roughy in SPRFMO areas other than Westpac Bank and a comprehensive stock assessment is available for the straddling stock in which the work was conducted.

With respect to the work that has been undertaken on Orange Roughy, the representative from the Deep Sea Conservation Coalition (DSCC) provided a statement on assessments concerning CMM 2.03 and noted that there may be insufficient data.

6.2. Applications to fish outside the footprint or above reference period catch levels

For information purposes, Martin Cryer presented paper SC-03-DW-03: *New Zealand notification of amendments to the status of blocks within its bottom fishing footprint for trawl*. Following the classification of midwater trawling for bentho-pelagic species, including alfonsinos, as bottom fishing by SC-02, New Zealand has developed an interim approach to permitting New Zealand vessels to fish in this manner in the SPRFMO Area while reducing the potential for significant adverse effects on VMEs. In this paper, New Zealand notifies changes to the categories within its bottom trawl footprint; two blocks (#s 1 and 2) previously open to bottom trawl methods (subject to move-on considerations) have been closed, and one block previously within the footprint but closed to bottom trawl methods (block #18) has been opened (subject to move-on considerations). Because substantially more records of VME indicator taxa have come from the blocks to be closed than from the block to be opened (for similar numbers of trawl tows), New Zealand is confident that the potential for significant adverse effects on VMEs will be reduced.

The SC noted that through its BFIAS and under CMM 2.03 New Zealand has implemented suitably precautionary arrangements for bottom fishing. New Zealand's arrangements involve a mixture of open, closed and 'move-on' blocks, which are not a formal requirement under SPRFMO's bottom fishing CMM. Block #18 was originally closed because it had been only lightly fished during the reference period and part of New Zealand's approach was to close those parts of the footprint that had been least-heavily fished. Mid-water trawling for bentho-pelagic species like alfonsino had not been considered in the original design.

Block #18 contains slope areas with substantial concentrations of alfonsino and was, therefore, of more interest to mid-water trawling. The SC noted that block #18 also appeared in Australia's bottom fishing footprint and was open to trawling by Australian vessels (subject to move-on rules with higher thresholds for evidence of VMEs than those applied by New Zealand).

New Zealand indicated that it would continue to manage mid-water trawling for bentho-pelagic species under the bottom fishing CMM and that no further changes to its footprint were anticipated to accommodate the redefinition of mid-water trawling by SC2, keeping in mind that CMM 2.03 is considered an interim measure.

The SC **noted** that New Zealand has amended the status of three blocks within its bottom fishing footprint for trawl to reduce possible impacts on VMEs while providing opportunities for the utilisation of bentho-pelagic species.

New Zealand presented a proposal to conduct exploratory bottom longlining (SC-03-DW-01) for toothfish (*Dissostichus* spp) in the SPRFMO Area close to the boundary of the CCAMLR Area in mid-Pacific. This paper forms the first stage of an application for New Zealand vessels to use bottom longlines outside New Zealand's bottom longline footprint and to catch toothfish in excess of catch in the reference years. New Zealand has a small catch history of *Dissostichus* spp. in the SPRFMO Area but the proposed exploratory fishing is for a species that has not been fished for more than 10 years; and this constitutes a new or exploratory fishery in terms of the SPRFMO Convention. This proposal is, therefore, drafted to conform to Article 22 of the Convention, paragraphs 16–18 of CMM 2.03 and the Bottom Fishery Impact Assessment Standard (BFIAS). A survey design analogous to those adopted for CCAMLR surveys is proposed (see also CCAMLR document WG-FSA-14/61) and a qualitative, expert-based risk assessment for potential adverse impacts has been conducted. Total fishing effort, effort at a given location and retained catch will be limited during the first exploratory fishing visit and, for consistency with work in the adjacent CCAMLR region, a minimum tagging rate of three fish of each *Dissostichus* species per greenweight tonne will be implemented (see CCAMLR CM 41-01 Annex C). Any results will be used to develop proposals for the consideration of New Zealand's domestic technical working group and (depending on timing) the SC on the design of subsequent trips and fishing. A New Zealand observer will be carried and video recordings will be made of all lines hauled (data to be provided to the New Zealand government). Contingent on the approval of the SC and the SPRFMO Commission, the first trip will take place between July and September 2016 with a precautionary retention limit of 30 t (greenweight, *Dissostichus eleginoides* and *D. mawsoni* combined).

SC participants complimented the level of detail presented in New Zealand's proposal, noting that it represented a systematic and controlled approach to exploratory fishing in the SPRFMO Area. The SC noted the close proximity of the survey to the CCAMLR Area and the likelihood that it will interact with toothfish stocks managed by CCAMLR. CCAMLR currently assesses the Antarctic toothfish stock in the adjacent area as at 77% of unfished biomass. New Zealand undertook to maintain close linkages with CCAMLR for these activities; circulating copies of the proposal for the information of CCAMLR members prior to the October CCAMLR meeting, data sharing and involving CCAMLR scientists in reviewing results.

The biological data and tagging (perhaps amounting to the release of 90 tagged toothfish per year) alone is unlikely to explain the stock structure of toothfish in this area. However, the proposal can be viewed as an extension of CCAMLR's biological research program that was currently underway in adjacent CCAMLR waters (CCAMLR SSRUs 88.1 and 88.2 North). New Zealand's survey will contribute to CCAMLR's wider program and thereby add to the broader understanding of regional stocks.

The SC acknowledged that the SPRFMO Convention and existing CMMs and standards provided little guidance for the development and approval of exploratory fishing proposals. This is an area that needs further attention. Detailed proposals, like New Zealand's, and subsequent results might inform the development of a future exploratory fishing standard or guidelines.

Based on discussions of the paper, New Zealand explained that the 'medium' rating for the duration and overall impact on seabirds in the proposal's risk table was due to seabirds being long-lived and highly migratory; it did not reflect the likely low frequency of interactions. Regardless, SC stressed that the implementation of appropriate and effective mitigation measures was crucial to preventing seabird impacts. The survey would use the most stringent of CCAMLR and SPRFMO seabird mitigation measures, including line-weighting, strict offal management and bird-scaring lines. It was not possible to deploy two observers per trip, but electronic monitoring will be implemented to augment the observer's work. The survey would be subject to New Zealand's existing VME protocols and move-on rules.

The SC noted the possibility of interactions with marine mammals in this area, particularly through depredation (killer whales and sperm whales robbing hooked fish from longlines). Obvious indications of depredation would be recorded by the observer. There was no arrangement to deduct such damaged or removed toothfish from the survey's annual 30 tonne limit. Nevertheless, experience in nearby CCAMLR Areas suggests that depredation is unlikely to occur.

At the completion of this survey, New Zealand intended to present results to its own domestic working group and to CCAMLR and the SPRFMO SC for review. SC agreed that, while it supported New Zealand's proposal, this endorsement did not indicate any prior commitment to an extension of exploratory fishing beyond this two-year survey. Neither does it indicate any future commitment to extending New Zealand's footprint and establishing a commercial fishery in the area (if a commercial resource is eventually proven).

The SC **assessed** New Zealand's proposal to conduct demersal longline fishing for toothfish outside its footprint and in excess of catches in the reference period (limited to 30 tonnes per year) during 2016 and 2017 and the SC:

1. **confirmed** that the proposal is acceptable under Article 22 (CMM 2.03) and the BFIAS.
2. **recognised** the cautious, exploratory nature of the proposal and the scientific benefits of the proposed data collection, including the understanding of the distribution, movement and stock structure of toothfishes.
3. **emphasised** the importance of implementing stringent seabird mitigation measures throughout the surveys, including integrated weighted lines, bird scaring lines when setting gear and strict offal management.
4. **suggested** that, in addition to being reviewed by New Zealand’s domestic working group and the SPFRMO SC, data and analyses from the surveys should be shared with CCAMLR.

The SC **stressed** that this evaluation does not indicate any commitment to extending this survey beyond 2017 or to extending New Zealand's footprint if a toothfish fishery is eventually proved in this area.

6.3. CMM2.03 (bottom fishing) para 5 a-f advice:

(a) undertake an assessment of the likely impact of specific gear types, particularly trawl, on VMEs, to further inform the definition of bottom fishing

No new work assessing the likely impacts of specific gear types was discussed but **The SC reaffirms its recommendation** that the Commission should modify CMM 2.03 to take into account the relative impact on VMEs of different fishing methods and practices, and to specifically address midwater trawling for bentho-pelagic species.

(b) undertake stock assessments of principal deep-sea fishery resources targeted, and, to the extent possible, taken as bycatch and caught incidentally in these fisheries, including straddling resources

New Zealand has made good progress developing stock assessment models for orange roughy stocks straddling the New Zealand EEZ and within the SPRFMO Area. Work on the latter models is not yet complete but final results should be available for SC4. This area of work will be progressed inter-sessionally by a sub-group that has been established by the SC.

(c) develop and provide advice and recommendations to the Commission on criteria for what constitutes evidence of an encounter with a VME, in particular threshold levels and indicator species

In 2014, SC2 recommended that the Commission implements a spatial management approach for bottom fisheries in order to protect VMEs from significant adverse impacts while enabling viable fisheries to operate. SC2 further recommended that the spatial management approach should use open and closed areas defined by the best available evidence, including evidence of where VMEs occur or are likely to occur. Such spatial management may render unnecessary the need for a move-on rule which they considered to be an interim approach. New Zealand has made good progress developing the tools necessary to design such a spatial management system but more work on refining and applying these is required before CMM 2.03 can be revised.

The SC therefore recommends that the Commission develops and implements a scientifically robust spatial management approach for bottom fisheries in order to appropriately protect VMEs while enabling viable fisheries to operate.

The SC also recommends that, to the extent possible, a spatial management approach should seek to define open and closed areas and minimise the need for move-on rules that are impractical to administer.

(d) develop and provide advice and recommendations to the Commission on the most appropriate response to a VME encounter, including inter alia closing particular areas to a particular gear type or types

Responses to evidence of a VME are defined by two different move-on rules (implemented by Australia and New Zealand). If a spatial management approach is implemented, as recommended in (c), and assuming good knowledge of the ecosystem, then encounters with VMEs will be minimised, VMEs will be appropriately protected, and no additional response would be necessary. This area of work will be progressed intersessionally by a sub-group that has been established by the SC.

(e) review and streamline the SPRFMO Bottom Fishery Impact Assessment Standard (SPRFMO BFIAS) agreed by the Scientific Working Group in 2011 to take account of the latest scientific information available

Given other priorities in SPRFMO research, there were no resources to address this issue during the last year. This area of work may be progressed intersessionally by a sub-group that has been established by the SC.

(f) provide advice on the appropriate spatial resolution and time period for footprint mapping

Paper SC-01-20 showed that alternative periods and mapping resolutions have a substantial effect on effort maps and fished area estimates for demersal trawl fisheries in the western SPRFMO Convention Area. These effects vary as a result of historical trends in different fishing areas. Estimates of 'fished area' generated using any mapping resolution other than actual trawl tracks substantially exaggerate the areas within footprints that have actually been impacted: 86% to 91% of a footprint mapped using 6-minute blocks is actually unfished (i.e., 9-14% of the footprint area fished) and 95% to 96% of a footprint mapped using 20-minute blocks is unfished (i.e., 4-5% of the footprint area fished).

The SC reaffirms its recommendation to the Commission that:

- the smallest practical spatial scale should be used for defining footprints and for spatial management purposes; at present, the most practical spatial scale is 6-minute blocks;
- for defining the extent of fishery impacts on VMEs, the longest time period of historic effort information that is available for each fishery should be used provided that the quality (accuracy and completeness) of the positional data is adequate.

(g) develop maps of VME distribution in the Convention Area

New Zealand has made good progress on the very difficult task of predicting the distribution of VMEs within the SPRFMO Area. This had included a research voyage to the Louisville Ridge to test the predictions of previous models. Partly because the global depth layers used in the models were found to be very inaccurate in some of the locations surveyed, the SPRFMO-scale predictive models were found also to be inaccurate. Work has since focussed on finer-scale models of the New Zealand region and additional information has been included. The new models have been tested by cross-validation using independent data and different modelling approaches give broadly similar results.

The SC noted that New Zealand, Australia, and Chile had agreed to work together intersessionally in an ad hoc working party on the developments needed to recommend revisions to CMM 2.03. The SC recommends that this ad-hoc working group develop a plan for work intersessionally and present this to the 2016 SC.

7. Squid Assessments

The SC evaluated the request from the Commission relative to squid:

> *"The Road map requests the SC to evaluate examples of Squid assessments and determine if they are applicable for the SPRFMO Area."*

To this end, during the online Webinar meeting (SC-03-05) it was reported that:

- Korea and Chinese Taipei presently fish for Jumbo flying squid in the Convention area outside of Peru and have expressed an interest in developing assessment. Korea will start to evaluate stocks as well.
- The Korean government is examining haul-by-haul data using observer data for more samples.
- Peru is preparing a document with detailed information on Jumbo flying squid biology, distribution, assessment, etc.
- Ecuador will send some information on squid captures.
- China fishing for Jumbo flying squid outside of Peru and Chile, and recent two years, the fishing area extend to north of the equatorial. China has done biological research on squid and will present some research about squid such as age, reproduce and stock assessment.

The SC received the following reports relevant to squid:

- SC-03-09: Annual report of China. Part II: the Squid Jigging Fishery.
- SC-03-14: Chilean annual report.
- SC-03-07: Chinese Taipei's annual report
- SC-03-26: Progress with in-season modelling of squid within New Zealand's EEZ and Management strategy evaluation (MSE)
- SC-03-27: Main Biological and fishery aspects of the Jumbo flying squid in the Peruvian Humboldt Current System.
- SC-03-32: The secretariat collated and presented the squid data on catches on official submissions.
- Ecuador provided an executive report on the squid fishery within their national waters.

Summaries of the squid papers are given in Annex 5.

Data

Some annual catches have been voluntarily reported within EEZ waters and international waters by countries but remains incomplete. Participants were encouraged to update the official data in timely fashion to meet the SPRFMO data standards.

Main countries fishing squid in the south eastern Pacific are Perú, Chile, China, Korea, Chinese Taipei and Ecuador. Most of the catches of squid of Perú, Chile and Ecuador are taken by artisanal or small-scale boats, while the others countries fish with industrial jigging vessels. Perú, Chile and Ecuador fish squid mostly within their own jurisdictional waters while the others countries fish in the Convention area, in international waters.

Stock structure and biology

Squid have complex life histories, recruitment processes and population structure and the research presented noted a recent shift in size structure. Such complexity poses a challenge for stock assessment and effective management.

Stock assessments

The countries have applied and continue to develop different stock assessment methods and some have already adopted some fisheries management measures in their EEZ.

Perú presented a paper on the biology and fishery aspects of Jumbo flying squid (*Dosidicus gigas*) in the Peruvian Humboldt Current System, explaining the characteristics of the squid fleet, landings, fishing areas, size structure, reproductive and trophic aspects, main mature and spawning areas, vertical distribution, fishery management and stock assessment.

Since 1999 the assessments of Jumbo flying squid in Peruvian waters has been based predominantly on the biomass estimates obtained through hydro-acoustic surveys, complemented by the monitoring of size frequency distributions and CPUE from the industrial and the artisanal fisheries to obtain an as early possible estimate of recruitment. More recently, as longer CPUE data-series have become available, the Jumbo flying squid assessments have also included the application of a biomass dynamic model. The estimated fishing mortality (F) has been maintained below the estimated F_{MSY} indicating that the stock in Peruvian and adjacent international waters is likely healthy. Since 2012 Peruvian fishery management authorities restricted fishing for jumbo squid and presently only artisanal and small scale fisheries are allowed.

Chile presented two methods (from 2014 work): one based on catch only, and the other using a Schaefer production model tuned to an abundance index based on squid as bycatch of hake scientific surveys and commercial CPUE. The update of these two methods in 2015, suggest a MSY around 200-250 thousand tons for Chilean Coastal waters. In 2015 Chile also applied a depletion model by week based on catch per trip of artisanal vessels. This method was sensitive to the start and ending week and is thus preliminary. Since 2012 Chilean fishery management authority limited effort to the squid fishery and set a quota.

China has applied Schaefer production model with annual catch data derived from FAO to assess the status of Jumbo flying squid in the South East Pacific (2002-2012). However, the annual catch data was incomplete without Peru's annual catch from 2009 to 2012 and this likely resulted in underestimates of biomass. Catch rate of Chinese squid jigging fishery was standardized and was used as the abundance index.

Korea submitted the haul by haul catch data of squid jigging fishery to secretariat of SPRFMO since 2012, and will continue to submit these data. Korean observers will collect the biological data of jumbo flying squid and bycatch information this year and report at the next SC meeting. Korea will do the CPUE analysis and find the stock assessment method for Jumbo flying squid in the future.

Chinese Taipei has applied generalized additive models (GAMs) to study the variation of squid abundance and effects of environmental variables between 2002 and 2013. The results suggested that variation of squid abundance could be explained by the temporal and spatial variables to a degree.

New Zealand is developing and testing an in-season generalized depletion model on its arrow squid *Nototodarus sloanii* fishery. The NZ model allows for pulses in recruitment and non-proportionality between abundance and catch via the inclusion of hyper-parameters. Model outputs and the in-season approach can serve to inform a management strategy evaluation (MSE) with depletion thresholds/triggers and associated decision rules.

Based on these summaries, **the SC agrees**:

- **To recognize and acknowledge** the significance of the fishery for *D. gigas* within the SPRFMO Area, and to engage in the development of science and management tools that will contribute to ensure the long-term sustainability of the Jumbo flying squid stock and fisheries.
- **That monitoring and reporting procedures** on Jumbo flying squid research and fishing activities should be implemented in the Convention area.
- **That countries should be requested to** complete and update their official submissions.
- **To promote** the collation of and standardisation of datasets in the area of the SPRFMO for the database.
- **To consider** the Management Strategy Evaluation (MSE) framework for the integration of biological information and stock assessment methods for the species in the Convention Area.
- **To recognize** that more time will be needed within the SC meeting to address squid assessments and further MSE development and trade-offs will be required.

SC further noted that, with depletion approaches, it was particularly important to have detailed understanding of the temporal and geographical distribution of spawning.

8. Ecosystem Approach to Fisheries Management

8.1. Evaluate the impact of fishing activities (including, inter alia, gear type) on Ecologically or Biologically Significant Marine Areas (EBSAs) and on Vulnerable Marine Ecosystems (VMEs)

Martin Cryer presented paper SC-03-DW-04 Progress on predicting the distribution of VMEs and options for designing spatial management areas for bottom fisheries within the SPRFMO Convention Area. Information on the distribution of VMEs in the SPRFMO Area is very sparse, and limits our ability to design spatial management measures to avoid significant adverse effects in bottom fisheries. This necessitates the use of models to predict the distribution of key VME indicator taxa, especially habitat-forming species, from information that is more readily available, including depth and physico-chemical variables. Many difficulties have been encountered developing such models, and some of these were highlighted by a recent research voyage to the Louisville Ridge, funded by New Zealand. Modelled depths were found to be very inaccurate in places, and this is important because key physico-chemical variables used to predict VME indicator taxa depend strongly on actual depth. Combined with the very scarce biological data outside EEZs, the poor information on substrate in many areas, and the presence-only models being used, these problems led to unreliable habitat suitability predictions by SPRFMO-scale models. New models are being developed at a smaller, New Zealand region-scale, and “absences” from historical databases are being included as well as “presences”. The performance of these new models has been assessed using cross-validation against spatially independent data. Predicted distributions of key taxa from habitat suitability models can be combined with the distribution of bottom fishing to design spatial management areas that provide for fishing while avoiding significant adverse impacts on VMEs. Decision-support software is available and New Zealand has focussed primarily on the use of Zonation software to demonstrate the utility of the method and explore sensitivity to modelling choices.

SC noted that cost benefit trade-offs have not always been considered in the development of VME protection measures and commended New Zealand for taking this approach because trade-offs are important to consider in the design of appropriate spatial management. SC requested the rationale for using the 2002-2006 reference years for the footprint. New Zealand indicated that, for several reasons, it was probably better to use the full footprint as a “cost layer”, but the precise details of what the industry saw as their “costs” given particular spatial management configurations should be discussed with them. SC also noted that a large number of “absences” had been generated for the New Zealand regional scale models and would like to see maps of these; they also requested that a representative sample of images from the voyage be made available for the SC to study. A copy of the voyage report was made available and will be posted on the SPRFMO website.

SC noted the wide scope of the recommendations in the paper and wanted to understand whether it was New Zealand’s intention to pursue all avenues. New Zealand indicated that the cost of modelling was very small relative to research voyages, especially now the groundwork has been done, and it was considered important to draw the most from the available information. SC members enquired as to the specific VME taxa used in these assessments (asking also to have the VME manuals made available) and whether it was intended that the results should inform the spatial management of other nations. New Zealand clarified the 11 taxa used, including four species of reef-forming stony corals, but suggested that application beyond New Zealand vessels was for individual members to consider. New Zealand did consider, however, that there would be advantages of having a single consistent spatial management approach for bottom fisheries. HSFG voiced its concerns with the New Zealand VME encounter protocols and noted that they were more stringent than those used by Australia. New Zealand acknowledged the difference but reiterated that its protocols had been developed using information from deepwater fisheries and rigorously reviewed, including by SC, and the move-on rules were only rarely triggered.

The SC:

- **recognised** the good progress New Zealand had made on the very difficult task of predicting the distribution of VMEs and VME indicator taxa in key parts of the SPRFMO Area for bottom fisheries
- **commended** New Zealand for developing methods of designing spatial management measures for bottom fisheries that can avoid significant adverse effects on VMEs while

minimizing costs to the fishery

- **agreed** that this work should contribute to the development of a revised CMM for bottom fisheries in the SPRFMO Area and, in particular:
    - **agreed** that a range of data sources and modelling approaches should be explored to predict the distribution of VME indicator taxa in the SPRFMO Area and,
    - **agreed** that a range of methods and assumptions should be explored when designing spatial management measures to avoid significant adverse impacts of fishing on VMEs while minimizing costs to the fishery

A discussion paper was tabled by HSFG dealing with the competing narratives related to VMEs (SC03-INF02 summarized in Annex 6). The HSFG paper criticized frequent referencing of 2006 UN Resolution 61/105, and resulting subjective concepts and definitions of a VME as well as claiming that VME related benthic research had only tangential benefits for sustainable fishing.

The representative from the Deep Sea Conservation Coalition observed that the New Zealand Report to the third Scientific Committee (report SC03-22 at page 19) reported that the move-on rule had not been triggered since 2012 and had been triggered only 6 times since 2008. During the meeting a representative from the HSFG noted that industry actively avoided areas in which the move-on rule was implemented.

Martin Cryer thanked HSFG (see Annex 6 for a summary of SC03-INF02) for a thought-provoking paper and presentation and welcomed HSFG's commitment to balance in the design of Conservation and Management Measures. He responded to some of the claims in the paper and noted in particular that information from the NORFANZ voyage had been used extensively, that New Zealand's move-on triggers for evidence of a VME had been developed and reviewed through a formal science process, and that, although it was important to use as much information as possible when making predictions, it was rarely possible to use all information in any particular model. Expert interpretation was always likely to be needed (the sophisticated jack mackerel model is a good example). The New Zealand government and industry had worked closely together on a number of issues in the past 6 months, with good outcomes, and Dr Cryer was keen to see that continue. A working party to start development of a revised CMM for bottom fisheries had been established by SC2 but, following the retirement or resignation of two key members, progress had not been as fast as hoped. However, it appears that Australia and Chile remain committed to the work and Dr Cryer warmly welcomed HSFG's offer of data and participation. He noted there was much work to do for a new CMM for bottom fisheries, especially if consistent measures across the SPRFMO Area were contemplated. The work that had been done was advancing rapidly and would contribute to that development, but it would not be possible to develop new measures in time for the Commission meeting in January 2016 as HSFG proposed.

The Secretariat introduced information received from the Secretariat of the Convention on Biological Diversity (CBD) regarding five areas within the Convention Area that meet the CBD criteria for EBSAs. In line with the roadmap, the SC might consider these areas and evaluate appropriate spatial management options. Chile noted that they have taken action and established MPAs that include part of some identified EBSAs.

FAO provided an update on the ABNJ Deep Seas Project to which the SPRFMO is a partner. FAO described the new VME database and the need for data inputs from SPRFMO. The SC was informed about the development of a range of tools designed to assist future data collection including SMARTFORMS an electronic data collection form for onboard use. FAO is also continuing to produce identification guides for vulnerable deep-sea species, a manual on the collection of data on deepseas species.

FAO confirmed that the VME portal and database was focussed on facilitating access to metadata on VMEs. The SC participants reiterated SPRFMO's long-term need to compile and manage detailed information on VMEs that would eventually support the development of spatial management arrangements. This might include historical and recent observer data, surveys and research datasets. The structure of such a database is yet to be decided, as it might take the form of metadata pointing to relevant datasets (including their data access conditions) through to more detailed data on VME encounters.

FAO encouraged SPFRMO involvement in international FAO workshops on deepsea species descriptions of commercial fish stocks and their fisheries. The 2012 review of alfonsino, for example, included information on species biology, life history, distribution, stock status and management. A similar workshop on orange roughy is scheduled for 2016. FAO would welcome any suggestions from the SC on other deep-sea fish species that might be subject to these reviews. The SC noted FAO's planned expert workshop on orange roughy in 2016. The SC noted that there might be potential for the summaries that are being developed by the SPFRMO secretariat to be aligned with the FAO summaries. At this stage it would be difficult for SPRFMO to develop summaries of other species of interest, such as deepwater sharks.

FAO was also seeking feedback on two options for the SmartForm app: for electronic VME reporting forms or for marine biodiversity (e.g. marine mammal and seabird sightings). Additional uses of the app could be considered if there is further interest to move forward and test the app. There was broad interest among SC participants to involve their national observers in trialling the app. The SC noted that SPRFMO was yet to establish a regional observer program. There can be no commitment to implementing the app at a regional level until a regional program is established.

FAO's work in developing identification guides and data collection manuals (e.g. deepwater corals) is of further interest to SPRFMO and members. Participants emphasised that access to such material needed to be provided down to the level of crewmembers as well as observers and other fishery officers.

The SC reaffirms earlier recommendations that the Commission:

- **remains aware of EBSAs within the Convention Area and of the factors that led to their definition; and**
- **addresses any conservation needs for EBSAs through the normal process of developing Conservation and Management Measures (CMMs) for the fisheries.**

8.2. Other species of concern

No papers nor analyses were presented on defining other species of concern.

8.3. Bycatch information

Kris Ramm (DOC-NZ) introduced document SC-03-25 on data collection protocols for seabird interactions around fishing vessels. The paper provides a comparative assessment of bird observation data collected in the SPRFMO area compared to longer term data sets collected in New Zealand. The paper used this analysis to recommend protocols of data collection for seabird attendance at fishing vessels and standardised protocols for observations of seabird warp strikes or impacts with monitoring cables in trawl fisheries should seabird attendance observations indicate sufficient risk.

The EU and Korea supported this work on defining data protocols and logbooks and enquired how the data would be analysed and used. New Zealand clarified that these protocols were also intended to be presented to ACAP as best practice guidelines. It was clarified that this was intended to be an observer rather than crew task.

Some discussion was had around the potential for camera monitoring to assist this work and how misidentification of species could be dealt with. New Zealand clarified that currently human observers were still the most effective option and the use of generic species codes would ensure that where precise species identifications were not possible appropriate codes were still available.

The SC sought clarity on whether appropriate variables were being collected to ensure that warp-strike observations would be able to inform future mitigation and management. New Zealand confirmed that the range of environmental and operational variables being collected could better inform future mitigation options. Additional materials were presented on a New Zealand initiative to conduct a southern hemisphere seabird risk assessment and support of the SC was sought.

Chile highlighted the need to maintain the appropriate levels of confidentiality for any data being submitted. New Zealand responded that the data scoping stage is only beginning now. Ideally the target for spatial scale and resolution would be similar to the spatial and temporal resolution of data release for RFMOs however this could be adjusted and standardize based on what's available.

SC supported the work being undertaken by New Zealand on seabird risk assessments. It noted that, although it covered the entire southern hemisphere, the risk assessments were limited to seabirds that nested in New Zealand. There is likely to be a future need to extend such assessments to other seabird species that occur in the SPRFMO Area.

The SC **recommends that the Commission:**

- encourage Members and CNCPs to collect data on bird attendance at fishing vessels using the protocols provided in SC-03-25 Appendix 1;
- where potential risk of seabird warp strikes is identified, encourage Members and CNCPs to collect data on warp / monitoring cable strikes using the protocols provided in SC-03-25 Appendix 2;
- request Members and CNCPs to report results from seabird counts and warp / monitoring cable strike observations to the SC.

8.4. Minimizing bycatch

Kris Ramm (DOC - New Zealand) introduced document SC-03-24 on Standardised recording of hook parameters in demersal and pelagic longline fisheries. This paper summarised hook parameter reporting in both New Zealand and international longline fisheries and provided recommendations on those parameters most critical to understanding fisheries interactions with marine mammals, seabirds, reptiles and other species of concern. Specifically, it recommends that observers collect six additional data fields describing hook parameters when working in bottom longline fisheries in the SPRFMO Area.

Some discussion was had by the group as to the wide range of hook types available. It was clarified that the protocols are intended to be easily measurable by observers using standard equipment. Australia noted that a third broad category was the Japanese tuna hook and it was agreed to add this category to the recommendations.

Korea and Chile both noted that in their experience circle hooks were effective in reducing bycatch of turtles however some fishers have found they also reduce target catch. New Zealand confirmed that this proposal was not to alter what hooks fishers used, rather to better document the fishing gear.

Scientific Committee **recommend to the Commission the addition** of the following data fields to Annex 7 D of CMM3.02:

- Brand
- Model name / number
- Hook type (Circle / J / Japanese tuna);

- Total Length (in millimetres measured in a straight line from the tip of the eye to the base of the bend);
- Gape (in millimetres measured from the tip of the point to the inside edge of the shank);
- Bite/Throat (in millimetres from the tip of the point to the inside base of the bend)

8.5. Data collection and reporting

In 2015, a self-sampling protocol has been initiated for the two Pelagic Freezer-Trawler Association (PFA) vessels fishing in the SPRFMO area (KW174 Annelies Ilena and KL855 Margiris; Paper SC-03-12). The self-sampling protocol aims to collect the information required by SPRFMO for all trips carried out in the area. The focus of the self-sampling is on data for jack mackerel.

The SC discussed this work and considered it an extremely valuable complement to the efforts of observer, EM, and other data collection systems. It was clear that the potential for leveraging work already done on some vessels would benefit scientific data collection programs and this type of activity was strongly encouraged by the SC. It was noted that the new system, since coupled with conventional observer data, was used to compile catch-at-length estimates from the EU fleet for 2015 catch-at-age estimates.

From paper SC-03-21 Chile presented a proposal to amend the CMM 3.02 (Data Standards) to include biological data collected by observers during landings. This proposal has already been considered by the SC in 2014 with the result that it was recommended for adoption by the Commission. However, at the last Annual Meeting, the proposal could not be addressed and the SC is now requested to renew its recommendation. In addition, the SC is requested to consider the endorsement of the proposed standards as informal SC guidelines to support the management and utilisation of these types of data. The SC recognizes that the reporting of this data is voluntary, that this dataset will be separate from the at-sea observer dataset, and that these added standards will ensure this data is submitted in a format consistent with data collected from observers at-sea. Participants highlighted the importance of ensuring that such samples are statistically representative and that there is sufficient information to link the sample back to the actual fishing operation and haul. **The SC recommends that Annex 7 (of CMM3.02) be amended to include the proposed data components outlined in the Chilean paper (SC03-21) and that reporting of these data should be facilitated (currently it is voluntary).**

9. Observer programme

Three presentations on observer program schemes were made in the plenary session. Chile introduced its proposal for the establishment of an Observer Programme Working Group (SC-03-29), the SPRFMO Secretariat provide an overview of the Observer Programmes of RFMOs (SC-03-34), and the Pelagic Freezer-trawler Association shared its experience on self-sampling programmes in the SPRFMO Area (SC-03-12).

Chile introduced a proposal for the establishment of an Observer Programme Working Group (OPWG) to be further considered at the upcoming Commission Meeting. The aim of the proposal was to convene a working group in charge of developing – intersessionally - a proposal in accordance with the Article 28 of the Convention and by the provisions of CMM 3.02. The Scientific Committee agreed on the importance of the issue highlighted by Chile, and the discussions were mainly around the mechanism for working on this issue along with the Compliance and Technical Committee (CTC).

During the Secretariat´s presentation it was noted that the nature of RFMO´s observer programs may vary depending on the purpose of the programmes, in particular on whether they are intended primarily for gathering biological information, or primarily for surveillance and compliance purposes although both purposes are often part of each program. It was also noted that the percentage of observer coverage often depends on the purpose of the programme, ranging from 10% (only for scientific observation) to 100% (for monitoring control and surveillance purposes).

Paper SC-03-30 updated the SPRFMO SC on the electronic monitoring program implemented for Australian demersal automatic longline vessels fishing on the high seas areas of the South Pacific Ocean. Electronic monitoring ('e-monitoring') involves a system of sensors and video cameras mounted on fishing vessels to record detailed information on fishing activities. Sensors transmit information in real time to management agencies on the vessel's location, activities and the status of equipment, e.g. winch activity, status of cameras. The cameras, which are activated by the sensors, are positioned to obtain footage of various aspects of the fishing operation, e.g. line setting, hauling, fish processing. The Australian Fisheries Management Authority collects camera hard disks at the completion of domestic fishing trips and analyses a sample of 10% or more of the footage.

E-monitoring is being increasingly used by other countries and considered by other RFMOs, partly to replace human observers due to comparative advantages in cost, data quality and coverage. E-monitoring is also believed to improve logbook quality, especially for interactions with non-target species. At the same time, e-monitoring has several limitations, including the collection of biological data and samples. With the increasing use of such systems in Australia and elsewhere, SPFRMO will need to consider how e-monitoring can be accommodated to meet data requirements.

SC-03-30 provides technical details of e-monitoring systems currently used in Australia. The Australian Fisheries Management Authority has successfully implemented e-monitoring systems in its domestic pelagic longline, demersal longline and gillnet fisheries. E-monitoring systems have also been fitted on the two Australian demersal longliners that currently operate in the SPRFMO Area. At the same time, human observers have deployed on those vessels to meet SPFRMO's observer coverage requirements.

Australia plans to present a paper at the next SC meeting to initiate the process of reviewing e-monitoring and consideration of how it may meet SPRFMO's data standard (including the specific data requirements set out under Annex 7 of CMM3.02) and how it may relate to observer coverage requirements. Australia's paper will compare data from e-monitoring and human observers, both from the Australian longliners currently fishing in the SPRFMO Area and also comparisons from other relevant fisheries. The intention is that this will lead to the consideration of modifications to the data standard to accommodate new developments, such as e-monitoring.

The Pelagic Freezer-trawler Association showed the results of their 2015 self-sampling programme. Some results of the samples gathered under self-sampling scheme were compared with information collected by observers onboard in the same fishing trips. Slight differences were noted in length distribution between self-sampling method and observer. It was noted that this kind of programme is cost-effective, but the accuracy of the data obtained and the traceability of the self-sampling scheme was questioned.

The **SC agreed to** (a) establish an ad-hoc working group of the SC develop recommendations on the SPRFMO observer programme regarding scientific aspects of the programme, and (b) **recommends that the Commission establish a joint SC and CTC working group to discuss both Scientific and Monitoring, Compliance and Surveillance (MCS) terms of reference for the programme.** The group should start with members from Chile, Australia, New Zealand and the USA.

10. Advice to the Commission

10.1. Jack Mackerel

As presented in section 5 above, new data and indicators on the status of jack mackerel suggest that conditions evaluated in detail from the last benchmark assessment (completed in 2014) are relatively unchanged. The population trend is estimated to be increasing. On balance, the indications of stock improvement (higher abundance observed in the acoustic survey in the northern part of Chile, relatively abundant age 3 jack mackerel in the fisheries, better catch rates apparent in some fisheries) are somewhat offset by declines observed in the Chilean CPUE.

A downward revision in SSB has been observed from the 2014 to the 2015 assessment, as a result of revisions in catch-at-age and weight-at-age data, as well as slightly lower historical recruitment estimates.

Environmental conditions (e.g., strong El Nino that developed in 2015) likely affects jack mackerel distribution and thus age-specific vulnerability to surveys and fisheries. This may have affected the improved CPUE in some of the fisheries.

Historical fishing mortality rates and patterns relative to the provisional biomass target (5.5 million t of spawning biomass) is shown in Figure 1 (so-called Kobe plot).

The SC agreed that the recommendation from 2014 for catches in 2016 is still appropriately precautionary. Namely, that the Commission should set 2016 catches limits for the entire jack mackerel range in the southeast Pacific at or below 460 kt, based on a status quo fishing mortality of 2014. Fishing mortality in the next 10 years at or below current (2015) levels are continuing to have a reasonably good probability of increased spawning biomass from the current level of 2.71 million t with projected increase to 3.2 million t in 2016.

The advice presented above is based on evaluation of indicators including the single and two-stock hypotheses. Within the area of the SE Pacific, the two-stock model shows generally similar trends in the biomass compared to those using single stock model (when summed).

Currently, there is some uncertainty in the “update” assessment for the northern stock under the two stock hypothesis. Indications demonstrated in SC03-19 suggest the importance of considering regime-shift for this region. The SC expects more reliable information on stock status for the northern stock will be available given assessment and data developments planned for 2016.

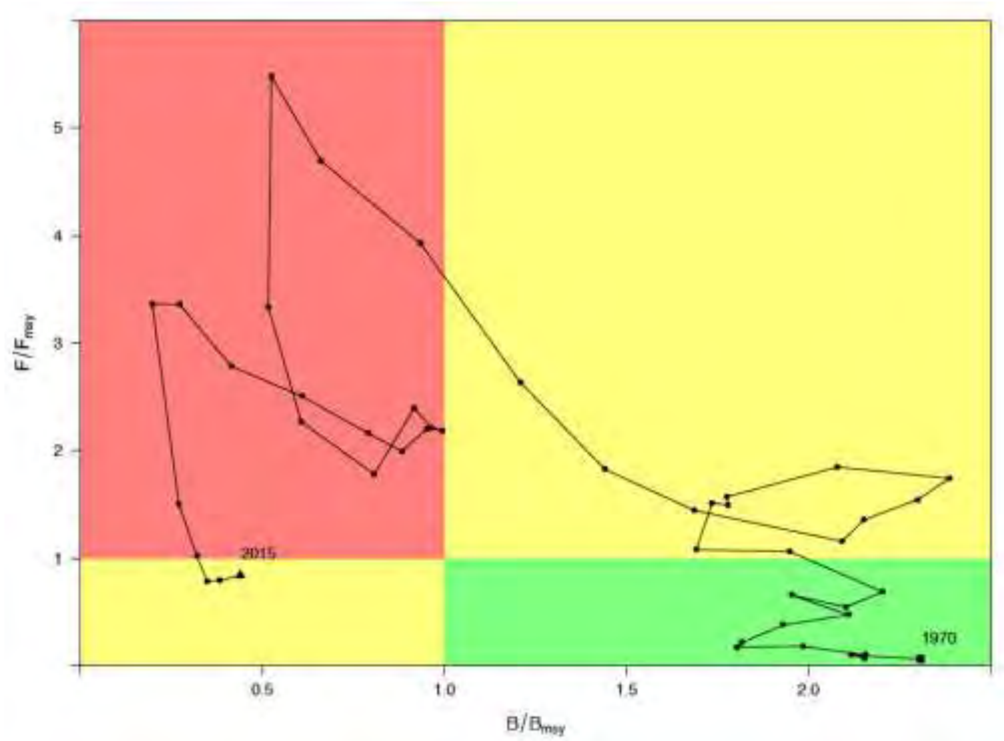

Figure 1. Phase plane (or "Kobe") plot of the estimated trajectory for jack mackerel under updated from Model 0.4 based on the single stock hypothesis with F_{MSY} and B_{MSY} estimated for the time series 1970-2015.

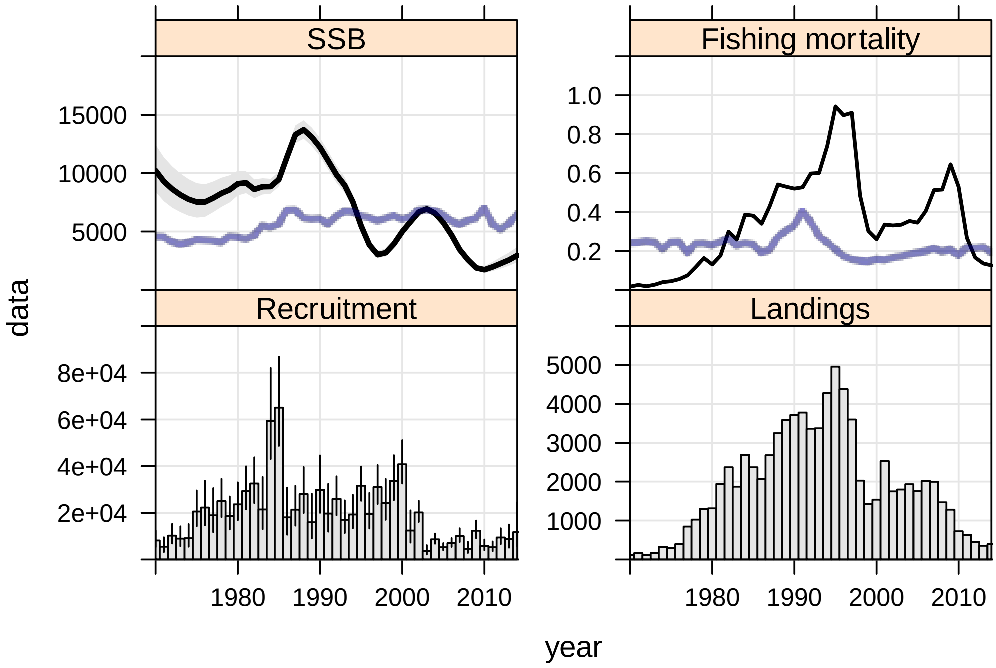

Figure 2. Summary estimates over time showing spawning biomass (kt; top left), recruitment at age 1 (millions; lower left) total fishing mortality (top right) and total catch (kt; bottom right). Blue lines in top figures represent dynamic estimates of F_{MSY} and B_{MSY} for each year (for model 0.4). Confidence bands reflect $\pm$1 standard deviation of the estimate.

10.2. Deepwater

Recent average landings of orange roughy from SPRFMO Areas have been substantially below those in the reference years 2002-2006 as the average number of participating vessel has declined from 24 to 7. New Zealand has taken an average of 991 t over the past 4 years compared with 1,852 t in the reference years (54%) and Australian has taken an average 52 t over the past 4 years compared with 257 t in the reference years (20%). These landings are similar to existing estimates of sustainable yield for orange roughy combined across areas.

As presented in section 6 above, the SC notes that progress has been made on the development of stock assessment models for orange roughy stocks in the SPRFMO Area. While the work is incomplete, the SC identified additional analyses that will increase the robustness for providing advice in the future. In particular, it will be important to include the catches of all nations from the areas.

Encouraging progress has also been made in the difficult task of predicting and mapping the distribution of VMEs and VME indicator taxa in the SPRFMO Area. New Zealand will continue to conduct scientific studies on VMEs and spatial management and every effort will be made to use all available information. **The SC supports moving towards spatial management**, recognizing that such progress will likely take time. Both Australia and New Zealand would work closely with their industries and both welcome industry participation in providing information for that process.

10.3. Squid

Relative to the squid resources, **the SC recommends that the Commission:**

- Implement monitoring and reporting procedures on Jumbo flying squid research and fishing activities in the Convention area.
- Engage in the development of science and management tools that will contribute to ensure the long-term sustainability of the Jumbo flying squid stock and fisheries.

11. SC Research Programme

In 2013 the SC published its Research Programme, which highlights SPRFMO's medium and long term research priorities. Based on discussions at SC**, short term** priorities include:

Jack mackerel

1. The SC reviewed the current research programme and determined that no updates are required at this time. The SC noted that progress is being made on a number of Research Programme topics, including jack mackerel stock structure; stock assessment (including acoustic surveys); biology and ecology (including age and growth); and conservation, rebuilding plan and management procedures (MSEs). Such research efforts should continue.
2. The SC recommended that the Commission support the continued development and activities of the fishery-dependent acoustic task group. Specifically, the group should organise a workshop in 2016 on the theme of “Acoustic data collection, processing and management.” It should cover:
    a. data collection method,
    b. the data base to compile the data and
    c. the Target Strength (TS) equation(s) to be applied to the CJM data.

    To develop a TS value for CJM, the task group will collate, compare and evaluate the existing information on CJM TS, compare the effect of TS on biomass estimates, and if possible, trial the collection of in situ reference data (i.e. using the AOS methodology developed by initially by Australia and subsequently modified NZ scientists) for estimating TS of CJM. The SC is encouraged that there will be fishing sectors of different countries involved in the work of this task-group.

Squid

3. To promote research on the effects that the depletion by fishing of potential predators of the different life-history stages of Jumbo flying squid may have in favouring the growth and expansion of Jumbo flying squid.
4. To promote research on the population structure and the presence and distribution of strains, groups or population subunits of Jumbo flying squid and their migration routes and intermix patterns throughout the Southeast Pacific.
5. To promote research on the reproductive process and the effect of environmental factors in determining the timing and the location and extension of spawning areas.
6. To promote or undertake research to obtain early estimations of recruitment and timely assessment of escapement.

Deepwater

7. Finalise the preliminary assessments of orange roughy stocks, including the addition of data from other fleets and simulation testing of spatial CPUE analyses and biomass dynamics models.
8. Continue the collation of relevant data and development of models to predict VME indicator taxa.
9. Continue the testing of methods to design spatial management areas.
10. Convene the ad hoc working party (currently involving New Zealand, Australian and Chile) to initiate the development of a revised CMM for bottom fisheries.

Ecosystem approach to fisheries management

11. Support New Zealand's risk assessments of southern hemisphere seabird populations through the collection and provision of seabird observations using standard protocols.

Observer programme (new section)

12. Compare observer data and data collected through e-monitoring to inform the consideration of how e-monitoring might meet SPRFMO's data requirements.
13. Establish an ad-hoc Observer Programme Working Group which will include advice on scientific issues related to the development of a draft SPRFMO Observer Programme to meet the requirements of Article 28 and CMM 3.02.

12. Next Meeting

The SC was informed that the EU offered to host SC04 in the Netherlands (most likely the Hague). Dates proposed are 7th-8th of October for jack mackerel benchmark preparation, and the week of October 10th 2016 for the SC. **The SC accepted this generous offer**.

13. Other Matters

The Secretariat noted that some funds are available for the SC purposes. The SC discussed that having a reserve of funds for high-priority issues would be advantageous so that activities highlighted in the research programme can be effectively pursued. One example high-priority activity would be support for the age-determination workshops that are planned within the next year.

The Secretariat paid tribute to Dr. Robin Allen who passed away in March of 2015. The SC observed a moment of silence in remembrance of the former SPRFMO Executive Secretary. The SC extends their condolences to Robin's family. His energy, humour, and integrity will be greatly missed.

14. Adoption of Report

The SC unanimously adopted the report.

15. Meeting Closure

The meeting was closed at 2222 hours on 2nd October 2015.

Annex 1. Adopted Agenda

1. Welcome and Introduction
2. Administrative Arrangements
    - 2.1. Adoption of Agenda
    - 2.2. Meeting documents
    - 2.3. Nomination of Rapporteurs
3. Discussion of Annual Reports
4. Commission guidance and other Intersessional activities
    - 4.1. Commission SC Roadmap
    - 4.2. Secretariat SC related activities
    - 4.3. Data Workshop report
    - 4.4. Fishery dependent acoustic Task Group
5. Jack Mackerel Working Group
    - 5.1. Report on Intersessional assessment/research by Participants
    - 5.2. Intersessional Progress with the Jack Mackerel Stock Structure Research Programme
    - 5.3. Intersessional Progress with Jack Mackerel Age/Growth Task Team
    - 5.4. Jack Mackerel Stock Assessments – Technical Session
        - 5.4.1. Updating stock assessment data sets
        - 5.4.2. Re-run of the 2014 stock assessment model configuration including new data
        - 5.4.3. Conducting additional stock assessment runs to investigate alternative stock structures
    - 5.5. Advice to the Commission on Jack Mackerel stock status
        - 5.5.1. Apply the Adjusted Rebuilding plan
    - 5.6. Other Jack Mackerel topics
        - 5.6.1. Suitable Habitat Indicators
        - 5.6.2. Tagging Feasibility
6. Deepwater Working Group
    - 6.1. Intersessional assessments of Deepwater species
    - 6.2. Applications to fish outside the footprint or above reference period catch levels
    - 6.3. Collate and present advice as requested under CMM 2.03 Para 5(a)-(f)
        - 6.3.1. Impact of gear type on VMEs
        - 6.3.2. Deepwater stock assessments
        - 6.3.3. VME encounter evidence
        - 6.3.4. VME encounter response
        - 6.3.5. SPRFMO Bottom Fishery Impact Assessment Standard
        - 6.3.6. Bottom Footprint definition
        - 6.3.7. VME distribution in the Convention Area
7. Squid Assessment
8. Ecosystem Approach to Fisheries management
    - 8.1. Fishing activities, Vulnerable Marine Ecosystems (VMEs) and EBSAs
    - 8.2. Other Species of Concern
    - 8.3. Bycatch information
    - 8.4. Minimizing bycatch
    - 8.5. Data collection and reporting
9. Observer Programme
10. Advice to the Commission
    - 10.1. Jack Mackerel
    - 10.2. Deepwater
    - 10.3. Other
11. SC Research Program
12. Other Matters
13. Next Meeting
14. Adoption of Report
15. Meeting Closure

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Annex 3. Summaries of annual reports

New Zealand

Paper SC-03-22 noted that New Zealand did not fish for jack mackerel in the Convention Area during 2014 but conducted bottom fishing for orange roughy (by trawl, 6 vessels) and bluenose / wreckfish (by line, 4 vessels). No New Zealand vessels fished for bentho-pelagic species (e.g., alfonsinos) using midwater trawls in 2014. The catch of orange roughy remained at about 1,000 t, well below the average for the reference years (1,852 t). Most was taken from the Louisville Ridge. The total catch by bottom line fishing was 99 t, well below the average for the reference years (144 t). New Zealand observers were present on all bottom trawling trips and on two bottom longlining trips (see also **SC-03-23**). They observed 340 trawl tows and 30 bottom longline sets and measured 3,520 fish. Length frequency distributions for the key target species were typical of those collected over the last 5 years. Only two bottom trawls were conducted in move-on areas and neither exceeded the move-on triggers.

New Zealand has made progress on developing “low information” stock assessments for orange roughy in the SPRFMO Area (see also SC-03-DW-02) and has updated the stock assessment for the straddling stock on the Challenger Rise. These should contribute to the development of a revised CMM for bottom fisheries. Work on predicting and mapping the distribution of Vulnerable Marine Ecosystems (VMEs) has continued, including a field test of model predictions on the Louisville Ridge in 2014 and trialling of spatial decision support tools (see also SC-03-DW-04). Further development and testing is clearly required but this work should also contribute to the development of a revised CMM for bottom fisheries. The development and testing of an in-season depletion method for New Zealand’s domestic squid trawl fishery has continued (see also SC-03-26) and this may be useful for considering approaches in the SPRFMO Area.

In paper SC-03-23 New Zealand reported on the observer implementation report and noted that the data standards and coverage requirements set out in CMM2.03 (Bottom Fishing) are easily met. Observers were placed on 100% of trawl trips and at least 10% of trips where other types of gear were used in 2014. In addition to training on data requirements and standards, observers were also informed on benthos identification related to the VME evidence process. All 2014 data in the SPRFMO region have been reported to the SPRFMO Secretariat.

Chile

Between January and July 2015, the industrial purse seine fleet operating on jack mackerel fishery in both, the SPFRMO area and Chilean EEZ combined, consisted of 88 vessels operating.

Until July 2015 the accumulated catch was 269,893 metric tons, which is higher than the catch registered at the same month in 2014 (by 17,000 metric tons). Unlike 2014, this year 56,223 metric tons have been caught in the SPRFMO Area, which represent nearly 20% of the total catch of the national fleet.

During the first quarter of 2015, monthly catches of jack mackerel fluctuated around 22 thousand metric tons, the lowest value recorded for period 2010-2015. This condition is mainly explained by low catches registered in February, when a high presence of juveniles was detected. Nevertheless, a significant increase in catches occurred during second quarter of current year, which reflects a slight shift in the fishing season, extending the fleet’s operations by more than one month.

Until May of 2015, the spatial distribution of jack mackerel catches were concentrated inside the Chilean EEZ, between 29°- 37° SL. Nevertheless in June 2015 the fleet exhibited a different operational pattern with catches obtained away from the coast, even outside the EEZ.

Unlike the observed between 2012 and 2014, during the first half of 2015, the size structure of jack mackerel showed a multimodal distribution, with a shift of the main mode toward smaller individuals. In 2015, the main mode was 26-27 cm FL, followed by a secondary mode of 35 cm FL. These modes belong to fish caught in the south-center area of the fishery, where juveniles have been present during most part of this year

The Chilean government announced that it will set aside a large no-take marine protected area within the Chilean EEZ around the Nazca ridge/Desventurada Islands, which includes jack mackerel juvenile habitat. Penalties for discarding, defined as release of an organism back to the sea, range from fines to sanctions, depending on the species discarded and the number of violations. These penalties are waived when an observer is on board to facilitate scientific data collection. The size structure of jack mackerel off of central Chile differs from the size structure in the north. Smaller jack mackerel are concentrated north and closer to the coast, and also in the central area. The size structures off of central and southern Chile are similar. In 2015, jack mackerel catches continued into August which is an extension of the season from previous years. This season extension is occurring because the fleet caught fewer fish in February as it was avoiding the capture of smaller juvenile fish, so the fleet is continuing to fish in July and August as it tries to capture its full quota. There was a question of whether Chile has any information about jack mackerel Gonadosomatic index studies over time (similar to that compiled and reported on from Peru) in that it may be useful for comparisons (stock structure) and in identifying anomalous patterns that may relate to environmental conditions.

Chinese Taipei

The scientist from Chinese Taipei report on their jumbo flying squid fishery in the region. The number of vessels varied between 5 and 29 from 2002 to 2014. The catch of Jumbo flying squid declined to 4,795 tons in 2014 along with the decrease in number of vessels and fishing days (nominal CPUE has been stable in recent years). The major fishing ground for this fishery was located at the area around 76–83°W and 15–20°S. Detailed logbook, trans-shipment and landing records from this fleet have been reported. Analyses on the stock status and spatial dynamics of jumbo flying squid but limited port and at sea scientific sampling has occurred.

China

The update on 2014 jack mackerel fishery notes that three large pelagic trawlers operated in the South East Pacific with a total catch of jack mackerel was 21,154 tons from 3,655 hours of trawling. The nominal CPUE was 5.8 tons per hour which is nominally higher than that observed in 2013. However, the estimated standardized CPUE decreased from 0.57 in 2013 to 0.52 in 2014. The fishing season was shortening and there was no fishing activity in the first-three-month in 2013 and 2014. Spatial distribution of catch in 2014 was similar to that in 2012 and 2013. Fishing ground moved eastward and closed to the Chilean EEZ and jack mackerel catch form North Chile was increasing. The scientific observer sampled 4967 jack mackerel randomly on board, measured fork length and weight and collected other biological information.
For the squid fishery, developments from 2001-2014 indicate a steady increase with annual catch and numbers of active fishing vessels reaching a peak in 2014. Furthermore, the fishing effort also remained at high level with the nominal CPUE fluctuant between 4.0 and 6.4 ton/day-vessel. The two observers took biological samples from 732 jumbo flying squid in the Eastern Central Pacific in 2014.

The SC had a number of questions for clarification. Given that 2015 is considered an El Nino year, there was interest in biological information collected from the Chinese JM fishery but unfortunately there is only catch information available. For the squid jigging fishery, the Chinese delegation indicated they consider asking observers to record squid size to 1 cm for next year instead of by 5 cm bins used in 2015, to facilitate future calculation of size distributions. The Chinese delegation also clarified that there is minimal observed bycatch by this fishery, due to depth and the fact that fishing operations are conducted at night. Although the number of vessels has increased in the past few years, it may be less likely that squid fishing effort will increase in the future.

European Union

In 2015 trawlers fished in different areas relative to previous years. At the start of the season in April and early May, the fishery occurred further to the south and from May to July unusual quantities of young jack mackerel were taken in the area between 40 - 44°S. The abnormal distribution of both the adult and juvenile component of the jack mackerel stock in the first half of 2015 may have been caused by the El Niño conditions during this time of the year. Therefore, the high abundance of young jack mackerel outside the Chilean EEZ may have been partly the result of an abnormal distribution of this year-class, rather than of its absolute size.

Peru

During 2013-2014 the Peruvian fleet that fished in the SPRFMO Convention area operated off Peru and Chile at distances from 201 nm to 1000 nm from the coast, in a general area encompassed by 14°00'S and 45°00'S and 79°40'W and 80°50'W. No fishing activity (through July) in the SPRFMO area has occurred in 2015. Only 1 fishing vessel operated during 2013 catching a total of 2697 tonnes between April and July 2013. No catches were reported latter in the year. Jack mackerel (*Trachurus murphyi*) represented 99% (2670 tonnes) of this total, chub mackerel (*Scomber japonicus*) represented 0.7% and other species 0.3%. The fishing areas in 2013 were within the 38°S and 45°S with a general distribution within 220 and 480 miles from the coast. Up to 5 fishing vessels operated in the Convention area during 2014, accumulating a total catch of 3574. No catches were reported until mid-June although some unfruitful attempts to search and trawl for Jack mackerel in a wide area off central-southern Chile were made between 10 March and 10 June 2014. During late June and July 2014 the fleet mainly targeted on jumbo squid (*Dosidicus gigas)* further north, between 14°S and 1rs off Peru. Their total catch was 1092 tonnes in the two months, of which 1087 tonnes (99%) were jumbo squid while the other species (1 %) included lightfish (*Vinciguerria* sp) and bonito (*Sarda chiliensis*). From August to October 2014 the fleet moved back south to a fishing area between 26°S and 29°S at around 300 miles from the coast off central Chile. The total catch reported during this three-month period was 2482 tonnes, of which 2223 tonnes (almost 90%) where Jack mackerel, 256 tonnes (1 0%) chub mackerel and 4 tonnes of other species. Jack mackerel CPUE values during the second semester of 2014 were lower than those observed during the second semester of 2012 and the first semester of 2013, but similar to those observed during the first semester of 2012. The size frequency distribution of Jack mackerel caught between August and October 2014 ranged from 18 to 54 cm total length, with a main modal size at 30 cm and secondary modes at 21 and 37 cm. The size frequency distribution of jumbo squid caught between 24 June and 31 July 2014 ranged from 13 to 41 cm mantle length, with a main modal size at 21 .7 cm for females and 21.3 for males. A variety of biological and fisheries data is collected by the Onboard Observer's Programme, which for the Peruvian fishing fleet had an almost 100% coverage during 2014, with an observer on each of the 5 Peruvian fishing vessels that operated in the Convention area.

Within national jurisdiction, Peruvian jack mackerel catches have been small relative to recent years likely due to a weak El Niño that developed during 2014 and a moderate to strong one developed during the first part of 2015. During 2014 and particularly during 2015 Jack mackerel concentrations were only found in coastal areas, within 20 and sometimes within 10 nm from the coast. This change in the spatial distribution is related to the closeness to the coast of the Subtropical Surface Waters and the almost disappearance of the mixed layer with Cold Coastal Waters. In 2014 the Jack mackerel landings in Peru by all fleets was 74,528 t.

Catches of jack mackerel by the industrial purse seine fleet during the first semester of 2015 were reported as zero and the only catches of this species in Peruvian waters during the first semester of 2015 consist of the ~13,000 t caught by the artisanal and small scale fleets. Several modal groups of Jack mackerel were observed in the fishery between January and May 2014, with a predominance of adults with modal lengths between 31 and 34 cm total length. Jack mackerel ranging from 15 to 37 cm TL were observed from September 2014 to May 2015, with a predominate of fish with modal sizes between 25 and 31 cm TL and a higher incidence of juveniles (smaller than 31 cm TL). The estimated TAC for 2015 using the JJM model assuming a risk of 16% that the projected biomass to January 1st 2016 be lower than that estimated for 2015 was 96,000 t and this was the TAC included in the recommendations to the Government, which also included a proposal for an intensified monitoring of the fishery and of the environmental conditions to ensure early detection of possible stock and environmental changes. This IMARPE recommendation was accepted by the Government and was included in the R.M. N° 003-2015-PRODUCE of 6 January 2015, which sets the total allowable catch (TAC) to be taken between January and December 2015.

In response to questions from the SC regarding the figure indicating variability of Gonadosomatic Index of Peruvian Jack Mackerel, they noted that samples are collected from commercial catches at landing sites along the coast, with a sample size of at least 100 individuals per month per port, and only individuals greater than 31 cm total length (~29 cm fork length) are sampled for this purpose. Reproduction of jack mackerel is affected by El Nino/La Nina temperature effects.

The diet studies were completed using samples obtained from survey vessels and not fishing vessels. The shift in species composition of jack mackerel diet starting in ~2000 is unlikely due to shifts in stock distribution.

Australia

The Australian annual report summarised catch and fishing activities in the SPRFMO Convention Area, up to and including the 2014 calendar year. Two demersal longline and two bottom trawl vessels actively fished in the SPRFMO Area in 2014, for a total catch of 204 t. The 99 t of longline catch consisted of 30 t of morwong (30%), 21 t of blue-eye trevalla (21%) and 26 t of yellowtail kingfish (26%). The 104 t of trawl catch consisted of 102 t of orange roughy (98%). Australia's trawlers did not target alfonsino in 2014 (<1 t). Observers participated in two non-trawl trips, monitoring 22% of all hooks deployed in 2014. Observers covered six of the seven trawl trips (72% of all tows). Observers reported no catches of marine mammals, seabirds or marine reptiles during 2014, and VME thresholds were not triggered.

USA

In SC-03-06 the United States delegate noted that the US is currently a Cooperating non-Contracting Party (CNCP) of SPRFMO and has applied for continued CNCP status. The U.S. process for final ratification under domestic law is ongoing. The United States remains committed to participation in SPRFMO. Currently, the United States has no vessels participating in the fisheries managed by SPRFMO.

Colombia

Members were referred to their annual report (SC-03-13).

Vanuatu

Vanuatu observed that the catch rate of its vessels in 2015 has increased significantly, that the entire Vanuatu quota had been caught and that there was a substantial quantity of small (apparently 3 yr-old) fish in its catches.

Ecuador

Jack Mackerel

During the 2015 catches of jack mackerel they occurred from April to August with a total of 250t, 140t being captured on June with sea surface temperatures around 25° C and 26° C.

Catches of this species were in the Santa Elena lace (the fullest part of the coast of Ecuador), being unusual, it is only presented something when the resource has remained steadily (several weeks) in our waters as well as north of the island of Santa Clara (the western Gulf of Guayaquil). They were punctual events on certain days of the months mentioned above.

The size structure of organisms was captured between 25-32 cm total length, the individuals of 28-29 cm when the most representative sampling. With regard to maturity all captured sexually immature individuals (stage 2) were found.

Squid

Ecuador has maintained a handmade squid fishery since the 70 s basically in coastal waters and seasons when there is influence of the Humboldt Current in this fishery have been estimated some reference data as cpue and fishing areas that we gladly can present to the Commission at this meeting.

Occasionally industrial fishing has been carried out in previous years but at the end of 2014 Ecuador opened an industrial fishery with 6 vessels interested in this activity, which are capable of operating in international waters, at this time only 2 fishing vessels has begun the tasks of fishing, these boats are improving in their operation and which is still collecting information, according to information submitted by the company is estimated that until the first half of 2015 has captured about 1500 tons, this information will be sent to the Commission as the same is complete.

Korea

Observers on Jack mackerel vessels also record other species encountered (sightings), and the incidence of these ~20 species is quite low. Species observed include pelagic armorhead, sunfish, jumbo flying squid, skipjack, blue shark, swordfish, 10-11 observed seabird species, and some marine mammals. Since this information is publicly available, there was a request to append this useful information to the Korea annual report (understanding the information is currently available only in Korean).

Russia

The Russian delegation presented preliminary data of the Russian fisheries in the SPRFMO Convention area for 2015 and provided information about Russian studies in the South Pacific in the past. Observers collect otoliths and will be investigating age structure of jack mackerel. The studies on the genetic differentiation of jack mackerel populations are ongoing, but sampling programme needs to be re-initiated.

Annex 4. EU study summary

Jack mackerel in the South Pacific has been exploited by fisheries since the 1970's. Owing to large recruitment influxes in the mid-eighties, the stock grew to approximately 14 million tonnes of spawning biomass, estimated to have been one of largest fish stocks in the world, sustaining catches up to 5 million tons per year. This stock is distributed throughout the sub-tropical waters of the South Pacific Ocean, from South America to New Zealand and Australia. Management of Jack mackerel at the high seas is officially organised through the South Pacific Regional Fisheries Management Organisation since 2013. The SPRFMO area does not include the jurisdictional areas of Chile and Peru, while in both these areas the majority of Jack mackerel is observed throughout the year where it migrates from the high-seas into the coastal zones and vice versa. The stock assessment that is carried out yearly assumes that Jack mackerel constitute one single stock. Survey, climatic and catch observations suggest that more complex stock structures may exist. These observations have resulted in intense discussions among SPRFMO scientists on likely population and stock structure and preparation of TAC advice.

Therefore, in this study we were tasked to identify the most likely stock structure hypotheses of Jack mackerel, considering the most likely stock structure, identify management objectives for Jack mackerel and finally evaluate sustainable management strategies to achieve these objectives. These three elements were considered through literature review, statistical and population dynamics modelling. Two different structure conclusions were drawn: a conclusion towards most likely population structure and a conclusion towards most likely stock structure. The latter is predominantly relevant for management while the first needs to be considered to appropriately address the second.

In total, six different population structure hypotheses were considered. In this study, information has been collected that clearly shows that the population structure of Jack mackerel cannot be considered as a single discrete population, two or multiple discrete populations or a patchy population. No strong evidence was presented to reject the metapopulation hypothesis. Therefore, we conclude that the metapopulation structure is most likely for Jack mackerel in the South Pacific.

Considering stock structure required the analyses of fishing patterns in combination with likely population structure. The Jack mackerel inside Peruvian waters is bounded by its habitat during the fishing season from January till May with peak catches in April. We therefore conclude that Jack mackerel in the Northern area constitutes a separate stock. Jack mackerel inside the Chilean coastal areas is targeted around the same time of the year, with a peak around April. The catches inside the Chilean coastal area however cannot be considered in isolation from the catches at the high-seas. The Jack mackerel in the Southern area is considered to constitute another stock, resulting in a two-stock assumption for the entire South Pacific. Given that over years changes in the dynamics of Jack mackerel in the Southern zone affect Jack mackerel in the Northern zone, management of the two areas cannot be considered in complete isolation from each other.

Sustainable exploitation of the Jack mackerel population in the short term will be associated with an FMSY around 0.14. Under more optimistic recruitment scenarios, sustainable exploitation can be associated with an FMSY around 0.21 under the single stock hypothesis and between 0.15 – 0.2 for the two stock hypothesis. Any Harvest Control Rule that ensures setting TACs in the short to medium term close to an FMSY of 0.14 can be considered sustainable. In addition, there appears to be little gain in implementing an increase in either mesh size or minimum landing size. Given that conclusions related to population and stock structure are uncertain, different Harvest Control Rules were tested under a range of population and stock structure hypotheses. Results suggest that management structures assuming two stocks rather than one are less likely to over-exploitation than under a one stock assumption, even when in reality there is only one population unit. It is therefore recommended to consider two-stocks in the South Pacific, each being managed by a separate Harvest Control Rule, though these rules being co-developed to account for the connectivity between the two main population units.

Annex 5. Summary of papers relating to squid

In paper SC-03-27 authors note that jumbo squid (*Dosidicus gigas*) are found in high abundance along the whole Peruvian coast from 10 to more than 500 nm from the coast. Jumbo squid performs diel vertical migrations from 0 to more than 650 m depth, and regular inshore—offshore ontogenetic migrations and less regular latitudinal migrations of several hundred miles. Younger and/or smaller jumbo squids predominate in oceanic waters, while larger jumbo squids are more neritic. Jumbo squid maintains some reproductive activity all year round, with increased reproductive activity from July to February and peaks between October and January. The life span is usually one year, although some specimens can live up to two years. Slight differences in the age or size of sexual maturity and main distribution areas suggests that there are least three strains, groups or population subunits of jumbo squid inhabiting the Peruvian Humboldt Current System. Is a very aggressive predator and prey availability seems to be more important than temperature or other environmental parameters in shaping its geographic distribution. It has a wide food spectrum, mostly feeding on cephalopods (26.4%, by weight) and mesopelagic fish *Vinciguerria lucetia* (24.4%) and Myctophidae (18.3%).

The development of the jumbo squid fishery in Peru is characterized an initial rapid development in the early 1990s of a licensed foreign industrial fishery and a local artisanal fishery that gradually has phased out of the industrial fishery. Total catches of jumbo squid in Peruvian jurisdictional waters peaked at 559,000 t during 2008, with a total of 506,000 t in 2014, all taken by the local artisanal fleet. The size frequency distribution of jumbo squid in both the artisanal and the industrial fishery has been highly variable with a significant shift since 2000. From 1989 to 1999 most jumbo squid was under 50 cm ML, with one or two modes between 20 and 40 cm ML; while since 2000 there is a prevalence of jumbo squid larger than 50 cm ML, with 2 or 3 modes between 22 cm and 93 cm ML. Since 1999 the assessments of jumbo squid in Peruvian waters has been based predominantly on the biomass estimates obtained through hydro-acoustic surveys and more recently, as longer CPUE time series become available ,these assessments have also included the application of a surplus production model. Both assessment methods have provided estimates that are compatible with the high current catches and an under-exploited state.

Paper SC-03-32 identifies and describes Jumbo flying squid data sets held by the SPRFMO Secretariat. The Jumbo flying squid fishery is a very large fishery, recent catches within the SPRFMO Area have exceeded 330 000 t while catches from within adjacent areas under national jurisdiction are around 580 000 t. During 2014 there were 264 Chinese vessels, 6 Korean vessels, 5 vessels from Peru and 5 vessels from Chinese Taipei operating in the SPRFMO Area.

Ecuador discussed how jumbo squid migrates and performs vertical movements towards deepwater in the day (06h00) and surface at night (18h00) with daily horizontal movements and a South-North movement, is captured overnight (18h00-06h00), mainly in dark (newmoon). Three species of squid in Ecuadorian waters belonging to Ommastrephid family and one species belonging to Thysanoteuthidae family, dominated by the species *Dosidicus gigas* (95%) were identified. In coastal waters, fishing areas with the highest concentration were distributed facing the Gulf of Guayaquil, mainly on the border with Peru from July to October and spread north to the coast of Ecuador in the provinces of Manabí and Esmeraldas. In the Galapagos Islands, jumbo squid found mainly distributed in front of the Isabela and San Cristobal Islands. Little is known about his abundance out of the 80 nm, but is considered an excellent potential for giant squid fishing area. The sea surface temperature (SST), conditioned the presence and / or absence of the giant squid fishing areas of the Ecuadorian sea.

New Zealand presented paper SC-03-26 describing a CPUE-depletion analysis of squid fishery dynamics that has been successful for squid stocks around the Falkland Islands and appears to have potential for developing in-season management advice on New Zealand stocks, including on limiting catch. CPUE from various fishing seasons has sufficient signal to enable the depletion model to be fitted. Further investigation is required to determine how to fit the depletion model through the season when there are breaks in effort. Future developments will include: the sensitivity of the model to variation in natural mortality; testing the utility of remote-sensed chlorphyll concentrations as a pre-season indicator; and developing predictive capability within the model (using historical data to estimate probabilities that depletion will go below a certain point given the current state). This analysis is in its early stages but the approach appears to have potential within the New Zealand EEZ and may be useful for squid fisheries in the SPRFMO Area.

Annex 6. Summary of information papers

Summary of SC-03-INF01

The representative from Oceana presented a stock assessment of the South Eastern Pacific (SEP) jack mackerel stock that was conducted considering two hypotheses about stock structure and two scenarios for the steepness of the stock-recruitment function. Life history parameters such as somatic growth were taken from the most recent and updated parameters available from literature. Testing both hypotheses lead to the conclusion that the biomass from Peru and Ecuador did not make a significant contribution to the spawning biomass of the jack mackerel stock in the South Pacific. All combinations of stock hypotheses and scenarios of h (h=0.80 and h=0.65) lead to the same diagnosis of stock status. Jack mackerel stock in South Eastern Pacific is overexploited and with some probability of being depleted (close to Blim). We explore robustness of the model using a retrospective analysis concluding that he model proposed is robust to estimate abundance in jack mackerel. Projections of the abundance included the combination of two level of recruitments (1970-2012 and 2000-2012), two level of steepness (h=0.80 and h=0.65) and five level of fishing mortality (F) obtained from different multiplier of F in 2014. We assessed the probabilities to reach the maximum sustainable yield (MSY) or the 80% of MSY under different combinations of recruitment, steepness and F. Results show that the selection of recruitment period for projections is the factor that mostly influences the recovery of abundance. Steepness plays a secondary role, by influencing the time or the probability required to accomplish the management strategies based on MSY. Using long periods of recruitment (1970-2012) is misleading and overestimates the rebuilding capacity of the stock; thus the last period of recruitment (2000-2012) is recommended when simulating exploitation strategies. Harvesting at a 50% of fishing mortality estimated in 2014 has a 30% chance of reaching Bmsy at the end of the projection period (year 2034). Harvesting with any higher fishing mortality (>50%F), will reduce the chances below an 8% to reach Bmsy in 2034 and thus it is not recommendable as a sustainable management strategy.

Summary of SC-03-INF-02

Andy Smith of HSFG presented paper SC-03-INF-02 Competing narratives – Getting your VME story heard above the rest. He noted three themes that stood out in the ongoing debate over conservation and protection of fragile deep-sea benthic fauna from the effects of fishing activities. The first of these is the frequent reference to Resolution 61/105 on Sustainable Fishing of the United Nations General Assembly in 2006. Four paragraphs of this resolution, 83 - 86, have gained almost iconic status in this ongoing discourse. These paragraphs provide an early use, but no definition, of the concept of a vulnerable marine ecosystem, and the obligation of states to protect such entities through controls of high seas fishing operations. The second theme has been the evolution of the concept of the vulnerable marine ecosystem and what constitutes a VME, and the related issue of what is destructive fishing. In this regard we have seen groups of 'experts' undertake subjective definitions of these concepts and then commonly undertake analyses leading to conclusions framed in terms of the definitions they have proposed.

Equally often, the scientific literature may use the term without any formal description. The third of the themes has been the manner of adoption of the concept of the vulnerable marine ecosystem, inevitably uncritically, to describe or justify a wide range of research on benthic fauna and justified by the need to undertake research on vulnerable marine ecosystems. However, much of this research may be better described as basic marine research that is of tangential benefit to ensuring better practices of sustainable fishing no matter the quality of the research being undertaken.

This paper examines the growing development of the concerns with conservation of fragile deep-sea benthic fauna, starting with the IMO resolution of 1992 and continuing through a series of advisory reports of the Secretary General of the United Nations, meetings of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea, an initiative of the Division of Ocean Affairs and Law of the Sea, and resolutions of the United Nations General Assembly. These resolutions become the 'marching orders' for national delegations and through them, national departments of fisheries of states undertaking fishing on the high seas. Jointly, UNGA Resolution 61/105 and the implicit importance of vulnerable marine ecosystems have provided the basis for the different stakeholder groups to promote and develop narratives pertaining to fragile benthic fauna and the programmes of their respective institutions. A series of future steps are identified to address the deficiencies of the various narratives that are discussed in this paper. A particular concern has been claims based on the UNGA Resolution 61/105 and subjective definitions as to what is a VME to justify public funding of self-evidently flawed applications of predictive model.

Annex 7. Jack mackerel stock status summary

Stock status summary for jack mackerel, October 2015

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

Advice for 2016

Noting that The SPRFMO Science Committee conducted an "update" assessment in 2015, they advise to maintain 2016 catches at or below 460 000t.

Stock status

		2013	2014	2015
Fishing mortality in relation to	F_{MSY}	Below	Below	Below
Spawning stock biomass in relation to	B_{MSY}	Below	Below	Below

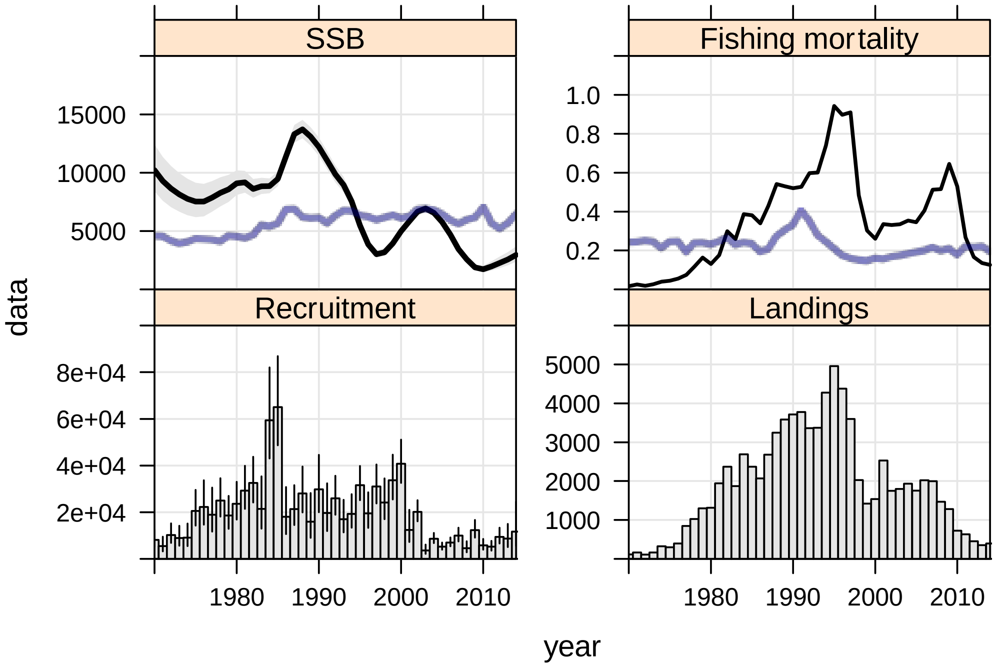

Figure 3. Jack mackerel in the southeast Pacific. Summary of stock assessment. Recruitment (age one) is measured in thousands, catch and SSB in thousands of tonnes, and harvest (fishing mortality) as a rate per year. Note that *dynamic* values for F_{MSY} and B_{MSY} are shown by horizontal blue lines. Confidence bands reflect $\pm$1 standard deviation of the estimate.

Table 1. Advised and reported catch of Jack Mackerel in the southeast Pacific.

Year	Advised maximum catch	Reported catch
2008		1,472,631
2009		1,283,474
2010		726,573
2011	711,783	634,580
2012	520,000	454,774
2013	441,000	353,123
2014	440,000	410,335*
2015	460,000	433,650*
2016	460,000	

2011, 2012, 2013, & 2014 advice was given by the Science Working Group.
* As estimated at SC03