South Pacific Regional Fisheries Management Organisation

Scientific Committee

La Jolla, USA: 21-27 October 2013

REPORT OF THE 1st SCIENTIFIC COMMITTEE MEETING

---

1. Welcome & Introductions
The participants were welcomed to the meeting by Dr Jim Ianelli, Chair of the Scientific Committee (SC) at the start of proceedings and participants introduced themselves.

2. Adoption of Agenda
The Chair sought proposed changes to the Draft Agenda. A proposal to expand the scope of Agenda Item 8 with 4 sub-items was discussed and accepted. A proposal to add an Agenda Item to discuss the creation of a Monitoring Working Group (WG) was discussed, and it was agreed that the existing Agenda could accommodate such a discussion. Provisional agenda item 7.3 was moved to the bottom of section 7. The revised agenda is attached as Annex 1.

3. Administrative Arrangements
Administrative arrangements were presented by the Chair.

3.1 Meeting documents

Meeting documentation, location and access was presented, including a final updated document list (SC-01-INF-03).

3.2 Protocol for submission of information and documents 30 days before meeting

A draft protocol (SC-01-18) describing how the SC should deal with documents that were submitted later than 30 days prior to the meeting of the SC was presented and agreed with minor amendments.

- The **agreed** protocol is attached as Annex 2.

The list of participants is attached as Annex 3.

4. Nomination of Rapporteurs
Five rapporteurs were appointed by the SC: Niels Hintzen (European Union), Rafael Duarte, (European Union), Andrew Penney (Australia), Aquiles Sepúlveda (Chile), and Geoff Tingley (New Zealand).

5. Discussion of Participant Reports
Annual Reports were provided for this meeting by Australia, Chile, China, Chinese Taipei, Ecuador, European Union, Korea, New Zealand, Peru and Vanuatu (documents SC-01- 08, 04, 03, 16, 24, 14, 07, 21, 12 and 13, and 22). Participants made brief presentations of their reports and provided answers and explanations in response to questions. Vanuatu was not represented at the meeting though their report was available. Participants who did not operate fisheries during 2013 did not submit reports.

6. Establishment of Working Groups
There was a discussion addressing the three sub-items 6.1, 6.2 and 6.3

6.1 Stock Assessment
6.2 Jack Mackerel

6.2 Deepwater

Following these discussions, the SC determined that a Stock Assessment WG was not currently required. The SC determined that stock assessments should be delivered though two fishery-defined WGs:

(i) Jack Mackerel WG, and
(ii) Deepwater WG.

Other species, including by-catch species, will continue to be considered under the SC agenda items, as is currently done.

The SC also discussed the need to have a WG dealing with data and information and noted that the current Data Standards (CMM 1.03) have some items that are related to the Compliance and Technical Committee. It was therefore decided that a science related data and information WG would not currently be required and that data subjects would be considered under the SC agenda.

- The SC **agreed** that Working Groups (WGs) must have a Chair [appointed by the SC] and will meet annually. Rodolfo Serra was elected chair of the Deepwater working group and Jim Ianelli was elected to chair the Jack Mackerel working group.

7. Jack Mackerel

7.1 Report on inter-sessional assessment work by participants

As directed by the Commission, the SC continued to evaluate alternative stock structure hypotheses and the consequences of alternative management approaches.

7.1.1 Stock assessments of Jack Mackerel

The Peruvian National report (SC-01-13) referred to an assessment of the far north stock for 2012 and an updated 2013 assessment.

7.1.2 Progress with the Jack Mackerel Stock Structure Research Programme

No progress has been made.

7.1.3 Progress with the jack mackerel ageing programme

Chile gave a brief presentation reporting the current state of the jack mackerel ageing programme. Otolith samples were obtained from the Ecuadorian and Chilean area of distribution of the jack mackerel and images of the otoliths were taken. Terms of reference for the task team were developed from the mandate from the Science Working Group resulting from the otolith interpretation and ageing workshop held in 2011 and were distributed to the task team together with the images. A time schedule for the work was also proposed. The terms of reference were sent as draft in order to receive feedback from the task team with the intention to have agreed terms on how to proceed to accomplish the mandate.

Peru presented a proposal (SC-01-19) for an integrated approach for tackling the uncertainties in the ageing and estimation of growth parameters of jack mackerel in the South Pacific. This was based on Peru’s experience of solving this problem for the jack mackerel in Peruvian waters. Basically the proposal consists of adopting different methodologies, in a complementary way, to validate the age readings. It was proposed that, in addition to the conventional method based on the interpretation of annual rings, age validation should be attempted based on other methods such as reading of daily micro-increments, repeated sampling for age while following the passage of one or more cohorts through the fishery, and length frequency analysis. The two proposals were considered complementary and it was decided that the two should be merged in a single agreed proposal. The draft produced during the meeting is attached as Annex 4.

The terms of reference were finally adjusted to reach a full agreement on methods and steps to fulfil the objectives.

7.2 Jack mackerel stock assessments

7.2.1 Updating of data sets for additional stock assessment runs

The SPRFMO Data Manager presented the updated historical catch data series to 2012. Notable changes to this data series included:

- final 2012 figures as advised by Members and CNCPs;
- a correction to Ecuador's 2009 figure;
- additional data from the EU (Polish), Cook Islands and Ukraine (as agreed during the July web meeting);
- additional data from Peru (pre 1970);
- updated data series from Chile for Fleets 1 & 2 extended back to 1963.

Provisional 2013 catch figures were provided by the SPRFMO Data Manager. The data task team recommended scaling up provisional figures so as to provide estimates for the entire 2013 year. Initial 2013 estimates were created by applying the observed percentage difference between 2012 provisional figures (used in SWG-11) and the final 2012 figures. Members and CNCPs were asked if the initial estimates were reasonable, and most initial estimates were accepted. Chile (Fleet 1), China and Peru (Fleet 3) asked for increases to their 2013 estimates as they expected additional fish would be caught in the later part of 2013.

The complete catch data series used in the assessment is shown in Table A5.1, Annex 5

7.2.2 Assessment model selections

A variety of models were evaluated and are summarized in the jack mackerel assessment (Annex 5).

Table A5.22 (in Annex 5) presents the model configurations evaluated. Model scenarios 0.0 – 0.4 describe the incremental addition of new data to the assessment. Model scenarios 1.1 – 1.9 describe changes in assumptions of key assessment parameters. Model scenarios 3.1 – 3.3 were considered sensitivities of the selected base model (1.4) while model scenarios 4.1 – 4.4 were selected as sensitivities to the projections.

7.2.3 Conducting of additional stock assessment runs

Similar to 2012, assessment runs were evaluated splitting the northern and the southern fleets into two assessments and summarizing results combining the two models. This resulted in scenarios 2.1-2.9 (Table A5.22, Annex 5). These scenarios were treated as sensitivities to the base case.

The assessment model configurations described above dealt with changes in survey catchabilities, assumed variability in estimated recruitment and weighting of survey indices. Assumptions on natural mortality rates were evaluated by allowing the model to estimate M. The influence of different datasets were tested by modifying the statistical weights on indices and catch-age and length compositions. In the final model configuration the potential for ageing error in catch-at-age and age composition of indices was allowed.

7.2.4 Synthesis and summary of key results from all stock assessment runs conducted

Results of all stock assessment runs conducted inter-sessionally or at the meeting are summarised in Annex 5. Given the model changes evaluated in the previous section, the SC proceeded to accept model 1.4 as a baseline from which to conduct more extensive evaluation of alternative specifications. During the meeting a series of alternatives were examined, including the two-stock models. To evaluate these, the negative-log likelihood components were presented to evaluate trade-offs between different data components and model assumptions. It is important to note that some values in this table for some subsets of models cannot be compared because data weightings may differ.

Models 1.4 (and complementary Model 2.4) were selected as the base case (modified to include the age-error conversion matrix; Model 3.1), under which selectivity of the four fishing fleets was given more freedom to change from year to year to fit the age and length composition data. Following discussions on assessment sensitivities resulted in adopting scenario 3.1 as the final model configuration.

Results from two-stock models show similar trends in the biomass compared to those using the same model configurations used for the single stock options. One difference was that the two-stock model showed much higher historical stock abundances. In particular, results for the southern stock are very close to the single combined stock results, and main differences are related to high levels of abundance for the Far north stock in the early period. The fit to the individual indices and age and length composition information was better in the two stocks model. This can be related to a different model structure (two stocks) or the increase in the number of parameters (independent recruitments, and natural mortality assumption for each stock). Full statistical comparisons between the models were difficult due to the differences in the number of parameters and model structures, and more efforts on model comparisons between alternative population structure hypotheses should be carry on, since this would have an impact in the management of the jack mackerel population.

Model 3.1 results indicate that the SSB increased from a 2012 estimate of 2.4 million t to a 2013 estimate of 2.8 million t (other models also indicated increases). Recruitment appears to remain in a low productivity phase. This increase in estimated SSB reflects increases apparent in the indices used in the models. Fishing mortality is estimated to be about 0.15, coming down from 0.23 in 2012.

There are a number of key uncertainties associated with both the assessment and projections. These have been addressed by exploring different assumptions in model runs and comparing the results. Key uncertainties in the assessment include:

- **Stock structure**: considered through applying both single and two stock models.
- **Natural mortality, *M***: highly uncertain, assumed constant for all ages and through time in the accepted models (M = 0.23). Model 1.8 was configured to estimate M and gave much higher biomass estimates due to the higher M compared to the other models.
- **Input data quality**: a number of model runs excluded various data components and others changed the weighting of different data components.

Uncertainties associated with projections include the assumed:

i) Temporal pattern of recruitment and
ii) Spatio-temporal catch composition.

Uncertainty in regime shifts/oceanographic conditions may affect future recruitment levels, which in turn will affect estimates of biomass through projections. These uncertainties have been addressed through the range of scenarios used in the projections with differing values of recruitment regimes and stock recruitment steepness parameters.

Projections using the entire time series of recruitment (1970-2011) under the assumption of constant fishing mortality equal to 2013 levels (Models 4.1 and 4.4) indicate that the biomass is expected to increase over the next 10 years, eventually reaching B_{MSY} in about 5 years. Projections using recruitment levels from 2000-2011 (believed be a period of lower productivity compared to that prior to 2000; Models 4.2 and 4.3) indicate that the biomass is expected to increase over the next 5 years but then stabilize at a point below the provisional B_{MSY}.

7.3 Jack Mackerel Research Programme

7.3.1. Future Jack Mackerel Work program and identification of short term research and assessment requirements

The jack mackerel research program was discussed and an updated version was made available. The updated SC Research Programme is in Annex 6.

7.4 Revisions to the jack mackerel species profile

Francois Gerlotto presented SC-01-INF-17, a literature review of the main traits of Jack Mackerel in the South Pacific Ocean. Participants indicated that the work shows interesting results and publication of the results in, for example, the IMARPE bulletin was suggested. Elements of the synthesis could be lifted into the already existing species profile.

- The SC adopted the updated species profile (SC-01-23) and **requested** that it be posted on the SPRFMO website.

7.5 SC advice on target and limit reference points

Cristian Canales and Niels Hintzen presented two working documents (SC-01-05 and SC-01-17 respectively) on estimating reference points and harvest control rules for the recovery of Jack Mackerel. Discussion on reference points followed the presentations in both the plenary session of the SC and in a technical break-out group. The discussions considered the issue of how environmental factors (e.g., regime shifts) may affect the estimation of biomass reference points. For example, in the most recent period (2000-2013) the average recruitment is estimated to be about 55% of the long term average. If this is due to a change in regime then the expectation of stock recovery to the long-term average may be unrealistic, particularly in the near-term if current conditions continue.

- Because of this issue, the SC **recommended** that biomass reference points should use the entire time series recognizing that such reference points represent long-term expectations which may not be realised in the near term.

Fishing mortality rate reference points are less affected by environmental changes and may be more robustly estimated. F_{MSY} or proxy thereof is currently considered as a limit for fishing mortality rate. Factors affecting this limit include the fishery selectivity, the relative catch by fleet, the stock recruitment relationship, natural mortality, mean weight-at-age, and maturity. In the current assessment model configuration, when plausible values of unknown parameters (i.e., natural mortality and stock recruitment steepness) are specified, the F_{MSY} estimates vary each year as a function of the selectivity and fleet catch composition (and changes in mean weight-at-age). As an initial attempt to display a stock trajectory commonly used to summarize values relative to reference points, a “Kobe” plot for two plausible stock recruitment relationships is shown in Figure 1. For projections run with the stock recruitment steepness parameter set to 0.65, B_{MSY} was achieved at approximately 31% of the unfished level. This value compares with a range of values around 30-40% assumed as proxies in other parts of the world.

Given the uncertainty in recruitment and estimation of reference points, Management Strategy Evaluation (MSE) was considered as a tool to further investigate the probability of stock recovery under a number of management scenarios (as adopted from the methods presented in SC-01-17). This MSE allows explicit simulation of uncertain processes such as recruitment, assessment error, and changes in fishery selectivity over time. It is therefore likely that MSEs resemble a realistic range of potential stock developments. SSB trajectories from MSE simulations, taking assessment model 3.1 as starting conditions, shows an increase in SSB over time under an $F=F_{MSY}$ projection. The SSB trajectory is associated with a high uncertainty, especially after 2020.

- The SC **recommended** that options for control rules (or management procedure) be developed enabling further evaluation of reference points and other management objectives identified by the Commission.

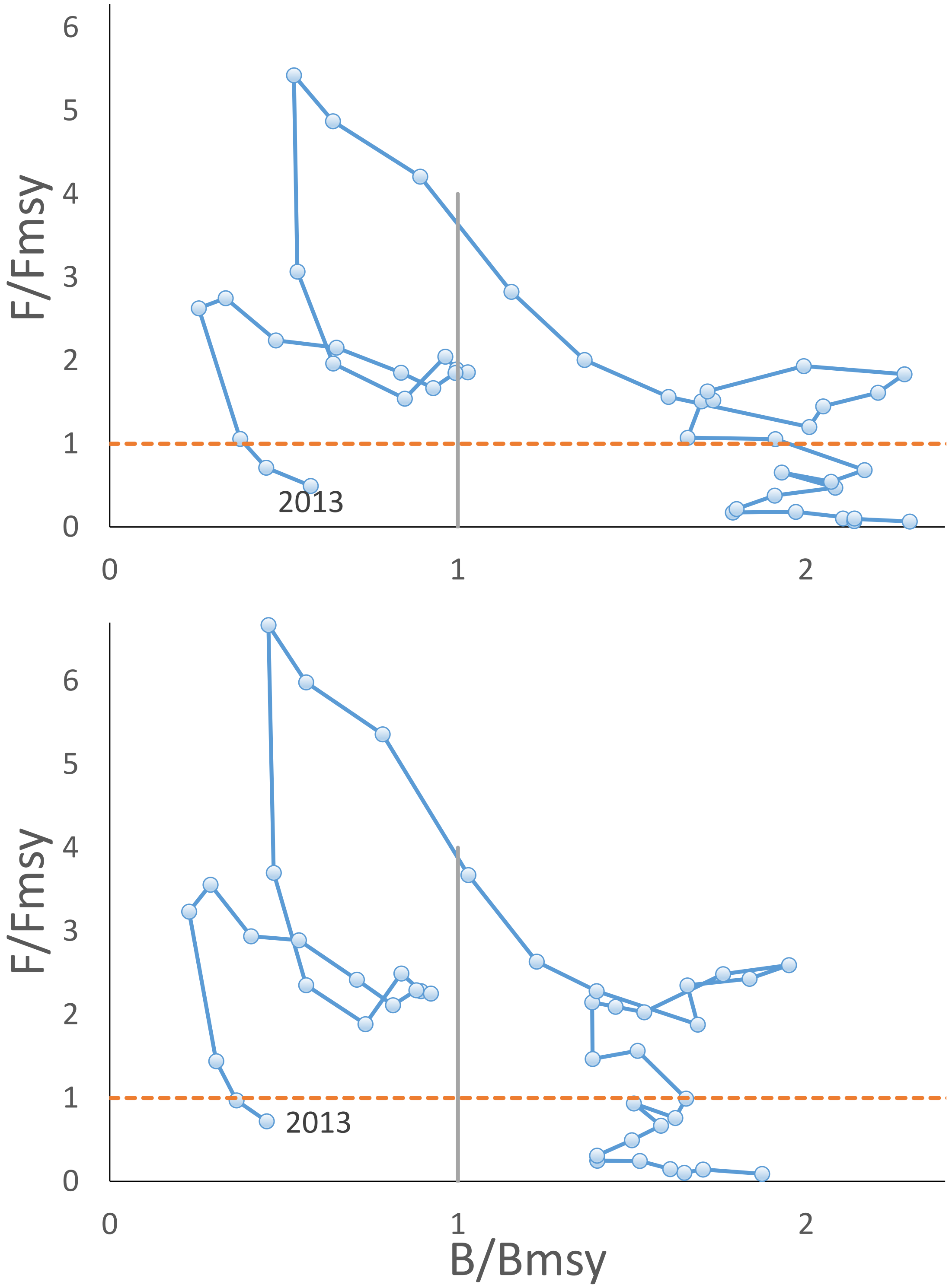

Figure 1. Phase plane (or "Kobe") plot of the estimated trajectory for jack mackerel under Models 4.1 (top; steepness = 0.8) and 4.4 (bottom; steepness = 0.65) with reference points set to F_{MSY} and B_{MSY} estimated for the time series 1970-2011.

7.6 Advice to the Commission on Jack Mackerel stock status

The SC is tasked to give advice on the status of Jack Mackerel. Similar to last year, the group agreed to present a range of plausible model configurations in order to reflect real concerns over model specification uncertainties. Advice on jack mackerel stock status at this meeting was based on stock assessments conducted using the Joint Jack Mackerel (JJM) statistical catch-at-age model developed collaboratively by participants since 2010.

Projection results under the assumption of recent average recruitment at the levels estimated for the recent period (2000–2011) indicate that effort should be maintained at or below 2013 levels to maintain the likelihood of spawning biomass increasing. This results in catches for 2014 on the order of 440 kt or lower. Fishing effort in the next 10 years at or below current (2013) levels are projected to have a high probability of increased spawning biomass from the current level of 2.8 million t.

The Commission noted the following in their roadmap to the SC:

> *Consider a range of exploitation levels and present the probabilities that the spawning stock biomass will reach target and limit reference points in 2015, and also 10 and 20 years into the future. In the absence of a target reference point, provisional values shall be used.*

The results addressing these requested projections are given in Table 1 for near-term consideration and Table 2 for longer term projections. In the latter table, Models 4.1 and 4.4, which assume long-term average recruitment conditions, are more applicable. Example population trajectories under the different fishing mortality rate multipliers and productivity scenarios is shown in Figure 2.

Table 1. Summary results for the near term predictions for models 4.2 and 4.3. Note that "B" in all cases represents thousands of t of spawning stock biomass and B_{MSY} is provisionally taken to be 5.5 million t of spawning biomass in all cases (as estimated from Model 4.1).

Model 4.2, steepness=0.8, recruitment from 2000-2011

Multiplier of F_{2013}	B_{2015}	$P(B_{2015} > B_{MSY})$	Catch 2014 (kt)	Catch 2015 (kt)
0.00	3,845	0%	0	0
0.50	3,480	0%	230	270
0.75	3,316	0%	340	380
1.00	3,163	0%	440	490
1.25	3,020	0%	540	580

Model 4.3, steepness=0.65, recruitment from 2000-2011

Multiplier of F_{2013}	B_{2015}	$P(B_{2015} > B_{MSY})$	Catch 2014 (kt)	Catch 2015 (kt)
0.00	3,802	0%	0	0
0.50	3,438	0%	230	270
0.75	3,274	0%	340	380
1.00	3,122	0%	440	490
1.25	2,980	0%	540	580

Table 2. Summary results for the predictions under alternative projection models. Note that “B” in all cases represents thousands of t of spawning stock biomass and B_{MSY} is provisionally taken to be 5.5 million t of spawning biomass in all cases (as estimated from Model 4.1).

Model 4.1, steepness=0.8, recruitment from 1970-2011

Multiplier of F_{2013}	B_{2015}	$P(B_{2015} > B_{MSY})$	B_{2023}	$P(B_{2023} > B_{MSY})$	B_{2033}	$P(B_{2033} > B_{MSY})$	Catch 2014 (kt)	Catch 2015 (kt)
0.00	4,155	1%	12,394	100%	18,443	100%	0	0
0.50	3,788	0%	8,859	96%	11,363	99%	230	270
0.75	3,622	0%	7,679	90%	9,408	97%	340	380
1.00	3,467	0%	6,757	78%	7,990	91%	440	490
1.25	3,321	0%	6,017	64%	6,924	80%	540	580

Model 4.2, steepness=0.8, recruitment from 2000-2011

Multiplier of F_{2013}	B_{2015}	$P(B_{2015} > B_{MSY})$	B_{2023}	$P(B_{2023} > B_{MSY})$	B_{2033}	$P(B_{2033} > B_{MSY})$	Catch 2014 (kt)	Catch 2015 (kt)
0.00	3,845	0%	7,697	94%	8,724	95%	0	0
0.50	3,480	0%	4,960	31%	5,074	37%	230	270
0.75	3,316	0%	4,136	8%	4,131	11%	340	380
1.00	3,163	0%	3,523	1%	3,465	2%	440	490
1.25	3,020	0%	3,056	0%	2,974	0%	540	580

Model 4.3, steepness=0.65, recruitment from 2000-2011

Multiplier of F_{2013}	B_{2015}	$P(B_{2015} > B_{MSY})$	B_{2023}	$P(B_{2023} > B_{MSY})$	B_{2033}	$P(B_{2033} > B_{MSY})$	Catch 2014 (kt)	Catch 2015 (kt)
0.00	3,802	0%	7,510	93%	8,695	95%	0	0
0.50	3,438	0%	4,776	25%	4,918	33%	230	270
0.75	3,274	0%	3,949	5%	3,933	8%	340	380
1.00	3,122	0%	3,332	1%	3,235	1%	440	490
1.25	2,980	0%	2,860	0%	2,720	0%	540	580

Model 4.4, steepness=0.65, recruitment from 1970-2011

Multiplier of F_{2013}							Catch 2014 (kt)	Catch 2015 (kt)
0.00	4,050	0%	11,666	100%	18,484	100%	0	0
0.50	3,685	0%	8,154	93%	11,108	99%	230	270
0.75	3,520	0%	6,990	82%	9,045	95%	340	380
1.00	3,366	0%	6,073	65%	7,541	86%	440	490
1.25	3,222	0%	5,337	45%	6,405	70%	540	580

The Commission also requested the SC to:

> *…Elaborate and evaluate other conservation measures (beyond catch limits) to the Commission that could be adopted as part of a rebuilding plan for jack mackerel.*

The SC did not evaluate alternative measures at this meeting.

In sum, the advice to the Commission is to aim to maintain 2014 catches for the entire jack mackerel range in the southeast Pacific at or below 440 kt.

The SC developed a Jack Mackerel advice sheet (Annex 7) based upon paper SC-01-INF-13.

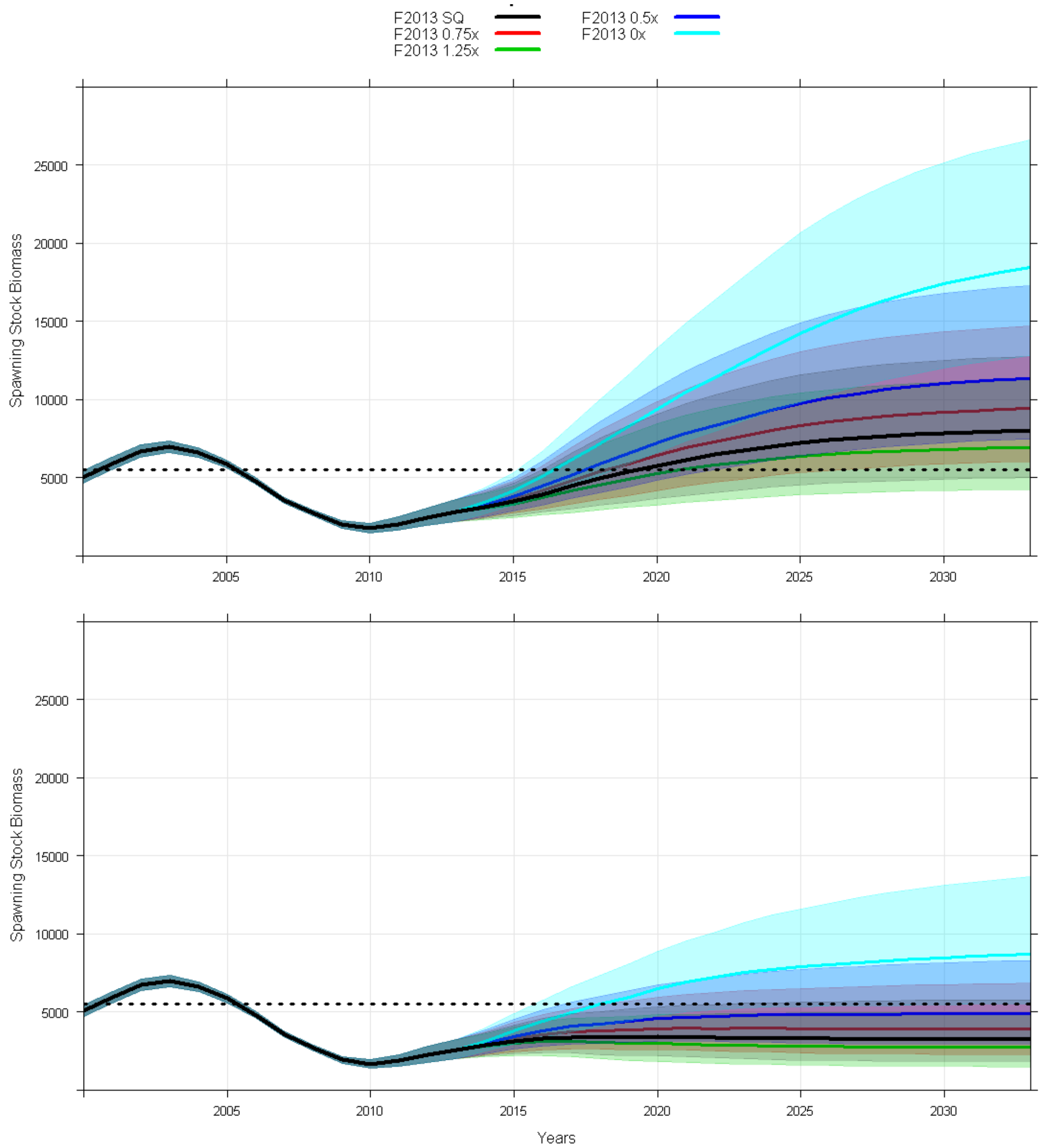

Figure 2. Jack mackerel population trajectories for different multipliers of the estimated 2013 fishing mortality rate under models 4.1 (top; stock recruitment steepness = 0.8, recruitment from 1970-2011) and 4.3 (bottom; steepness = 0.65, recruitment from 2000-2011). The horizontal line represents B_{MSY} (provisional target reference point)

8. Research to inform the development of a measure for Demersal fisheries

The SC Chair asked for nominations to chair discussions under the agenda items 8-11, to allow these to proceed in parallel with the jack mackerel stock assessment work. Rodolfo Serra of Chile was nominated and accepted as Chair to address these agenda items.

Geoff Tingley informed participants that New Zealand and Australia were working bilaterally to develop a draft Conservation and Management Measure (CMM) for demersal fisheries. The draft CMM will be based on the interim measures for bottom fisheries adopted in 2007, for consideration at the 2nd Commission meeting in January 2014. New Zealand and Australia will be engaging with other countries with an interest in demersal fisheries as this work progresses.

In order to inform the development of effective measures for demersal fisheries, four aspects had been identified that could benefit from additional scientific work and advice. Australia had accordingly requested the addition of the four agenda sub-items below to allow for reporting on the work conducted to date on these aspects.

8.1 Impact of fishing activities on ecologically or biologically significant marine areas (EBSAs) and on vulnerable marine ecosystems (VMEs)

Geoff Tingley reported on progress being made by New Zealand on their research on predictive habitat modelling of vulnerable marine ecosystems (VMEs) in the SPRFMO Convention Area. Draft reports for the initial predictive modelling phase of this work, conducted over 2010 – 2011, and more recent work addressing application of the modelling, conducted in 2013, are under review. It is intended to table these at the next SC meeting. New Zealand is also intending to conduct a research cruise to the Louisville Ridge region in February 2014 to gather additional data on the distribution of vulnerable marine taxa, to be used to validate and improve the predictive habitat models and to inform the planning of spatial management measures to protect such areas. This research will involve international collaboration, in particular with the USA.

In response to questions, Geoff noted that the models had been developed to be applicable to the entire SPRFMO Convention Area, but that most of the available data on occurrence of vulnerable benthic taxa were for the western SPRFMO Area around New Zealand and Australia. The Chair noted that this work would also be relevant when considering protection of EBSAs identified in the SPRFMO Area through processes conducted under the Convention on Biodiversity.

The Executive Secretary drew participant's attention to paper SC-01-INF-06. Andrew Penney noted that this report listed a number of areas nominated as potential EBSAs in the western SPRFMO Area, including the Kermadec-Tonga-Louisville Junction, the Monowai Seamount and the Central Louisville Seamount Chain. Under the criteria for VMEs listed in the Food and Agriculture Organisation of the United Nations (FAO) *International Guidelines for the Management of Deep-Sea Fisheries in the High Seas*, these seamount and ridge areas could also qualify as areas likely to contain VMEs. There is therefore a strong overlap of interests of Convention on Biological Diversity (CBD) and SPRFMO members in how these areas should be managed and protected. The Chair noted that the 2012 CBD workshop in the Galapagos Islands had also identified areas in the eastern Pacific Ocean that were being nominated as potential EBSAs.

Participants recognised the need for greater coordination between these parallel processes to identify and protect EBSAs and VMEs in the SPRFMO Area. In particular, there is a requirement for greater coordination between spatial management planning processes that might result under the CBD and SPRFMO in response to identification of EBSAs and VMEs.

The Executive Secretary noted that CBD processes do not establish any direct obligation on SPRFMO itself, but rather on CBD members, who may also be members of SPRFMO. Participants may choose to respond to nomination of EBSAs in some way during development of SPRFMO conservation and management measures. Participants may also request a SPRFMO representative to participate in CBD meetings relating to EBSAs in the Pacific Ocean and to invite CBD to observe SPRFMO meetings to improve coordination. Rafael Duarte noted that an example of an RFMO response to CBD nomination of EBSAs is provided by an RFMO in the Atlantic Ocean, which has requested their scientific committee to review the relevant nominations and provide advice on requirements and options for their protection.

Merete Tandstad, FAO, clarified the VME process noting that the criteria for identifying VMEs and associated guidance on management actions are included in the International Guidelines for the management of deep-sea fisheries in the high seas. She also highlighted the role of RFMOs in applying the criteria and developing appropriate management measures.

With regards to the EBSAs process she noted that the CBD Subsidiary Body on Scientific, Technical and Technological Advice would, based on the technical and scientific evaluations from regional workshops, prepare summary reports on areas that meet the EBSA criteria for consideration and endorsement by the Conference of the Parties to the Convention, with a view to include the endorsed report in the EBSA repository and submit them to the United Nations General Assembly, relevant international organizations, Parties and other Governments.

The SC **recommended** that:

- The Commission should take note of the nomination of EBSAs within the SPRFMO Convention Area and consider what information and advice the Scientific Committee should provide in order to enable the Commission to respond to these nominations.

8.2 Benthic protection, including spatial management and move-on rules for demersal fisheries

Andrew Penney gave a presentation on paper SC-01-09. This paper presents a review of the key elements of move-on rules developed and adopted by a number of RFMOs and states, including the North Atlantic Fisheries Organisation (NAFO), North East Atlantic Fisheries Commission, Commission for the Conservation of Antarctic Marine Living Resources and some SPRFMO members. Aspects considered in the review included the selection of benthic taxa to use as indicators of VMEs in different regions, weight or volume encounter thresholds indicating evidence of VMEs, move-on positions and distances and applicability of closures following triggering of move-on rules.

The SC **endorsed** the following characteristics of effective move-on rules:

- Lists of regionally specific VME indicator taxa should be identified for each fishery, using all available information on species occurrence and retention by fishing gears.
- VME taxa should be specified at a level that facilitates rapid and accurate onboard visual identification by trained observers.
- Encounter thresholds indicating evidence of a VME should be based on analyses of historical bycatch data, taking account of the different retention rates of species by each gear type. Multiple species can be used to indicate higher biodiversity.
- Once evidence of a VME is encountered using an agreed protocol, move-on areas should be closed to fishing by all demersal fishing vessels until further analysis or evidence indicates that area does not contain VMEs.
- Move-on distances and area closures should encompass the area covered by typical fishing operations using that gear type.

Rafael Duarte noted that complexities associated with development and implementation of effective move-on rules have resulted in NAFO moving towards protection of vulnerable areas preferably using designated spatial closures, rather than move-on rules.

- The SC emphasised that move-on rules should be considered to be temporary measures, providing precautionary protection for areas showing evidence of VMEs until objectively planned spatial closures can be implemented to protect known and highly bio-diverse VME areas.

8.3 Mapping of Demersal fished areas

Andrew Penney presented paper SC-01-20. This paper presents the results of geospatial analysis of joint Australia – New Zealand demersal trawl data in the SPRFMO Convention Area over the period 1990 – 2006. These analyses compare estimates of fished area using different mapping resolutions (actual trawl tracks, 6-minute blocks and 20-minute blocks) and time periods (2002 – 2006 and alternative historical time periods back to 1990). The purpose of these analyses is to provide scientific advice on the effect on fishing footprint maps and fished area estimates of using different mapping resolutions and time periods.

Participants noted the conclusions of the paper, that:

- Alternative periods and mapping resolutions both 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).

Geoff Tingley pointed out that designation of fishable depth ranges for the purpose of effort mapping should not be confused with identification of depth ranges that may contain VMEs. VME taxa are known to occur in shallower and deeper depths than the depth range currently fished by demersal trawl fisheries, as well as occurring outside fished areas. Planning of spatial protection measures will need to consider the full depth and distribution ranges of VME taxa in the SPRFMO Area.

8.4 Options for determining stock status and sustainable yields for target species

Geoff Tingley noted that the New Zealand Annual Report (SC-01-21) provides some information on work presented to previous science meetings on approaches for estimating sustainable yields of demersal stocks in the SPRFMO Convention Area. This work is being reviewed with the intention of reporting at the next SC meeting on options for approaches for evaluating status and estimating sustainable yields of stocks of orange roughy *(Hoplostethus atlanticus)*.

Graham Patchell drew the attention of participants to information papers SC-01-INF-14 and SC-01-INF-15. These provide information on methods and results of acoustic surveys of biomass of orange roughy and alfonsino (*Beryx splendens)* in the southern Indian Ocean area under jurisdiction of the South Indian Ocean Fisheries Agreement.

In response to questions, Geoff Tingley noted that acoustic methods for estimation of demersal species biomass are improving rapidly as a result of the application of multi-frequency acoustic technology. These systems can be deployed from commercial fishing vessels and acoustic survey methods may therefore be useful for generating biomass estimates for these species in the SPRFMO Convention Area. However, to date, such surveys have only been conducted in very limited portions of the SPRFMO Area.

The Executive Secretary drew the attention of participants to paper SC-01-INF-21 which provides an overview of a project under development by the FAO and UNEP on Sustainable Fisheries Management and Biodiversity Conservation of Deepsea Living Resources and Ecosystems in the Areas Beyond National Jurisdiction (ABNJ).

It was noted that the objectives are to achieve efficiency and sustainability in the use of deep-sea living resources and biodiversity conservation in ABNJ through the systematic application of an ecosystem approach for:

- improving sustainable management practices for deep-sea fisheries taking into account the impacts on related ecosystems,
- to improve the protection of VMEs and EBSAs, and
- to test improved area-based planning for deep sea ecosystems.

The FAO is encouraging RFMOs with a mandate related to deep-sea fisheries, such as SPRFMO, to consider becoming active partners in this project.

9. Report Deepwater Research Programme

9.1 Future deepwater research programme and identification of short-term research and assessment requirements

It was noted that the roadmap for the SC adopted by Members and CNCPs at the 1st Commission meeting endorsed the Draft Scientific Research Programme developed at the 11th meeting of the interim Science Working Group[1] and requested that the SC review and update this research programme annually.

The provisions for research on stock structure of deepwater species in section 4.1 of the Research Programme were amended by addition of the following component:

- Work conducted to identify straddling stocks and to investigate possible boundaries between high seas stocks of orange roughy and alfonsino.

The amended Research Programme is attached in Annex 6.

- It was **agreed** that the current Research Programme should be made available on the SPRFMO website, with previous versions also archived on the website.

10. Review of international best practices in bycatch and incidental catches (seabirds, marine mammals and reptiles) and mitigation options in pelagic and demersal fisheries

Igor Debski gave a presentation on paper SC-01-10. This paper reviews mitigation options for minimising the bycatch of species of concern, including seabirds, marine mammals, reptiles and fish species listed as endangered by the Convention on the Conservation of Migratory Species of Wild Animals or those protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The review found that robust and practical seabird mitigation options and best practice advice are international, well-developed and available for demersal longline and trawl fisheries. Seabird mitigation options for purse seine fisheries and mitigation options for other species of concern are less well developed.

[1] http://www.southpacificrfmo.org/eleventh-meeting/

The SC supported the following **recommendations** emanating from this review:

- Recognition that best practice seabird mitigation for demersal longline and trawl fisheries has been developed by working groups of the Agreement on the Conservation of Albatrosses and Petrels, and that a range of resources exist to support the implementation of these bycatch measures and;
- In order to better understand any potential bycatch of species of concern in SPRFMO fisheries, further robust data collection and reporting for species of concern is necessary.

11. Review the standards for data collection and reporting, and for observer coverage to ensure a full understanding of the nature and extent of bycatch interactions across all fisheries

Igor Debski gave a presentation on paper SC-01-11. This paper reviewed the current SPRFMO Standards for the Collection, Reporting, Verification and Exchange of Data (CMM 1.03) against a range of international standards for the collection of data on the bycatch of species of concern. The review found that CMM 1.03 is largely well aligned with international best practice. However, a few aspects require some further development to ensure full alignment with international best practice. These amendments will contribute to a proper understanding of the nature and extent of bycatch interactions across all SPRFMO fisheries. In addition to improvements in data collection and bycatch observation, the need for regular analysis and reporting of information on bycatch of species of concern was recognised.

Participants noted that collection of the recommended additional data may require additional resources for national observer programmes, and that some time was needed to consult internally and to consider the implications of amending CMM 1.03 to collect additional data on bycatch.

Regarding the regular reporting of information on bycatch of species of concern, the SC **agreed** that Section 2.5 of the *Guidelines for Annual National Reports* should be extended to include:

- Information on the level of observer coverage focussed on recording bycatch of seabirds, marine mammals, reptiles and other species of concern; and
- Reporting of observed bycatch by species and fishery for all seabirds, marine mammals, reptiles and other species of concern.

Craig Loveridge introduced paper SC-01-15. The SC agreed to **recommend** to the Commission that CMM 1.03 (Data Standards) be amended by replacing paragraph 7 with the following text:

- 7. Members and CNCPs are to report all data required by this measure to the Secretariat in accordance with the specifications and format described in Annex 9 of this measure, using the templates created by the Secretariat and stored on the SPRFMO website.

12. Next Meeting

Annie Yau offered to investigate the possibility of holding the 2nd meeting of the Scientific Committee in Honolulu in October 2014. Representative of the United States will communicate the results of this to the Executive Secretary.

- The SC **recommends** to the Commission that Jim Ianelli be retained as Chair of the SC.

13. Other Matters

Merete Tandstad, FAO, presented paper SC-01-INF-21 which provides an overview of a project under development by the FAO and UNEP on Sustainable Fisheries Management and Biodiversity Conservation of Deepsea Living Marine Resources and Ecosystems in the ABNJ, seeking interest and participation from SPRFMO and/or participants. The SC indicated that there was interest in the project but participants required time to consult on the practicalities of collaborating with the project.

- It was **recommended** that FAO and the SPRFMO secretariat follow up on modalities and process for SPRFMO engagement.

The current draft of the project activities matrix for the FAO components was shared with the Secretariat and interested parties.

14. Adoption of Report of the Scientific Committee

The SC unanimously adopted the report.

15. Meeting Closure

The meeting was closed at 0810 hours on 27 October 2013.

1st Meeting of the Scientific Committee

La Jolla, California
21 October - 27 October 2013
SC-01-01

Agenda

---

1. Welcome and Introduction
2. Adoption of Agenda
3. Administrative Arrangements
   - 3.1. Meeting documents
   - 3.2. Protocol for submission of information and documents 30 days before meeting.
4. Nomination of Rapporteurs
5. Discussion of National Reports
6. Establishment of Working Groups
   - 6.1. Stock Assessment
   - 6.2. Jack mackerel
   - 6.3. Deep water
7. Jack Mackerel
   - 7.1. Report on Inter-Sessional Assessment Work by Participants
     - 7.1.1. Inter-Sessional assessments of jack mackerel
     - 7.1.2. Inter-Sessional Progress with the Jack Mackerel Stock Structure Research Programme
     - 7.1.3. Inter-Sessional Progress with Jack Mackerel Ageing programme
   - 7.2. Jack Mackerel Stock Assessments – Technical Session
     - 7.2.1. Updating of data sets for additional stock assessment runs
     - 7.2.2. Selection and specification of base-case assessment, and specification of additional stock assessment sensitivity runs to be conducted
     - 7.2.3. Conducting of additional stock assessment runs
     - 7.2.4. Synthesis and summary of key results from all stock assessment runs conducted
   - 7.3. Jack Mackerel Research Programme
     - 7.3.1. Future Jack Mackerel Work program and identification of short term research and assessment requirements
   - 7.4. Revisions to the Jack Mackerel Species Profile
   - 7.5. SC Advice on target and limit reference points
   - 7.6. Advice to the Commission on Jack Mackerel stock status
8. Research to inform the development of a measure for bottom fisheries
   - 8.1. Impact of fishing activities on Ecologically or Biologically Significant Marine Areas (EBSAs) and on Vulnerable Marine Ecosystems (VMEs)
   - 8.2. Benthic protection, including spatial management and move-on rules for bottom fisheries
   - 8.3. Mapping of bottom fished areas
   - 8.4. Options for determining stock status and sustainable yields for target species

9. Deepwater Research Program
    9.1. Future Deepwater Research program and identification of short term research and assessment requirements
10. Review of international best practices in bycatch and incidental catches (seabirds, marine mammals and reptiles) and mitigation options in pelagic and bottom fisheries
11. Review the standards for data collection and reporting, and for observer coverage to ensure a full understanding of the nature and extent of bycatch interactions across all fisheries.
12. Next Meeting
13. Other Matters
14. Adoption of Report
15. Meeting Closure

South Pacific Regional Fisheries Management Organisation

1st Meeting of the Scientific Committee

La Jolla, United States of America, 21-27 October 2013

Agreed Protocol for Submission of meeting papers to the Scientific Committee

Protocol for timing for papers to be submitted to the Scientific Committee.

1. The Commission Rules of Procedure 4.1 and 4.2 provide for the Provisional Agenda and requested supplementary items to be circulated 30 days before the meeting. Consistent with this rule, papers pertaining to any item on the Provisional Agenda or supplementary items are to be provided by Commission Members and Cooperating Non-Contracting Parties to the Executive Secretary in electronic form at least 30 days before the meeting. These papers will be included in the draft Document List as meeting Papers.

2. Papers that are pertinent to the Provisional Agenda or supplementary items that are submitted later than 30 days before the meeting will be included as Late Papers in the draft Document List. These papers may be considered in the discussion of the relevant agenda item with the agreement[2] of the Scientific Committee.

3. The Commission's Rule of Procedure 4.3 provides for the possibility of additional items of an urgent character being included on the agenda. Supporting papers may accompany any request for additional items of an urgent character. The Scientific Committee will consider any such request in accordance with Rule 4.3.

4. Commission members, Cooperating Non-Contracting Parties and Observers may submit Information Papers to the Executive Secretary. Information Papers that are submitted at least 30 days before the meeting will be included in the draft Document List. Any information papers submitted later than 30 days before the meeting will be included as Late Information Papers in the draft Document list.

5. The Scientific Committee will decide whether or not to accept the late papers, and will approve the final Document list.

[2] Decisions of the Scientific Committee are made in accordance with Article 16 of the Convention.

First Commission Meeting of the South Pacific Regional Fisheries Management Organisation (SPRFMO)

21 to 27 October 2013

LIST OF PARTICIPANTS

CHAIR

Name: James IANELLI
Organisation: NOAA
Address: 7600 Sand Point Way, NE, Seattle, WA 98115
Email: jim.ianelli@noaa.gov

CHAIR'S ASSISTANT

Name: Roberto LICANDEO
Organisation: NOAA
Address: 416 NE 80th, Seattle, 98115
Email: robertolicandeo@gmail.com

MEMBERS

AUSTRALIA

Name: Andrew PENNEY
Organisation: Australian Bureau of Agricultural and Resource Economics and Sciences, Department of Agriculture
Address: GPO Box 1563, Canberra ACT 2601, Australia
Email: andrew.penney@daff.gov.au

CHILE

Name: Italo CAMPODONICO
Organisation: Undersecretariat for Fisheries and Aquaculture
Address: Bellavista 168, 16th Floor, Valparaiso, Chlle
Email: icampodo@subpesca.cl

Name: Albert ARIAS-ARTHUR
Organisation: Anapesca A.G.
Address: 127 244th St. SW Bothell WA 98021
Email: albarthur@gmail.com

Name: Cristian CANALES
Organisation: Instituto de Fomento Pesquero
Address: Blanco Encalada 839, Valparaiso, Chile
Email: cristian.canales@ifop.cl

Name: Andres COUVE
Organisation: Advisor
Address: L.Thayer Ojeda 166 OF.902 Santiago, Chlle
Email: andrescouve@entelchile.net

Name: Aurora GUERRERO
Organisation: Undersecretariat for Fisheries and Aquaculture
Address: Bellavista 168, 16th Floor, Valparaiso, Chlle
Email: aguerrero@subpesca.cl

Name: Silvia HERNANDEZ
Organisation: Undersecretariat for Fisheries and Aquaculture
Address: Bellavista 168, 16th Floor, Valparaiso, Chlle
Email: shernandez@subpesca.cl

Name: Ignacio PAYA
Organisation: Instituto de Fomento Pesquero
Address: Blanco Encalada 839, Valparaiso, Chile
Email: ignacio.paya@ifop.cl

Name: Aquiles SEPULVEDA
Organisation: Fishery Research Institute
Address: Av. Colón 2780 Talcahuano
Email: asepulveda@inpesca.cl

Name: Rodoflo SERRA
Organisation: Instituto de Fomento Pesquero
Address: Blanco Encalada 839, Valparaiso, Chile
Email: rodoflo.serra@ifop.cl

CHINA

Name: Gang LI
Organisation: Shanghai Ocean University
Address: No 999 Huchenghuan Road, Lingang New City, Shanghai, 201306, China
Email: g-li@shou.edu.cn

EUROPEAN UNION

Name: Rafael DUARTE
Organisation: European Commission
Address: Rue Joseph II 79; 02/217, 1000 Brussels, Belgium
Email: rafael.duarte@ec.europa.eu

Name: Adrianus CORTEN
Organisation: Ministry of Economic Affairs
Address: De Waterdief 52, 1911JT Uitgeest, The Netherlands
Email: adcorten@yahoo.co.uk

Name: Francois GERLOTTO
Organisation: Institut de Recherche Poor le Development
Address: Le Corfou, A1, 19 rue de la Galine, 34170 Castelnau-le-Lez, France
Email: francois.gerlotto@ird.fr

Name: Niels HINTZEN
Organisation: IMARES
Address: Haringkade 1, 1976CP, IJmuiden, The Netherlands
Email: niels.hintzen@wur.nl

KOREA

Name: Seok Gwan CHOI
Organisation: National Fisheries Research & Development Institute, Korea
Address: 216 Gijanghaeanro, Gijang-up, Gijang-gun, Busan, 619-705, Republic of Korea
Email: sgchoi@korea.kr

Name: Jiwon YOON
Organisation: Institute for international Fisheries Cooperation
Address: Level 2, KTGO Building, 1305 Dunsan Dong, Daejon, Republic of Korea
Email: jiwon.yoon@ififc.org

NEW ZEALAND

Name: Geoffrey Allan TINGLEY
Organisation: Ministry for Primary Industries
Address: 25 The Terrace, PO Box 2526, Wellington, New Zealand
Email: geoff.tingley@mpi.govt.nz

Name: Igor DEBSKI
Organisation: Department of Conservation
Address: PO Box 10-420, Wellington, New Zealand
Email: idebski@doc.govt.nz

RUSSIAN FEDERATION

Name: Alexander GLUBOCOV
Organisation: Russian Federal Research Instiute for Fisheries and Oceanography
Address: Moscow, V. Krasnoselskaya 17
Email: glubokov@vniro.ru

CHINESE TAIPEI

Name: Chih-Shin CHEN
Organisation: National Taiwan Ocean University
Address: 2, Pei-Ning Road. Keelung, 20224 Taiwan
Email: cschen@mail.ntou.edu.tw

COOPERATING NON-CONTRACTING PARTIES

ECUADOR

Name: Edwin MONCAYO
Organisation: National Institute of Fisheries
Address:
Email: direccion_inp@inp.gob.ec

Name: Viviana JURADO
Organisation: National Institute of Fisheries
Address:
Email: vjurado@inp.gob.ec

Name: Manuel PERALTA
Organisation: National Institute of Fisheries
Address:
Email: mperalta@inp.gob.ec

PERU

Name: Jorge CSIRKE
Organisation: Instituto del Mar del Peru (IMARPE)
Address: Esq. Gamarra & Gral. Valle s/n, Chucuito, PO Box 22, Callao, Peru
Email: Jorge.Csirke@gmail.com

Name: Anibal ALIAGA
Organisation: Sociedad Nacional De Pesqueria, Peru
Address: Av. Republica De Panama 3591 - Piso 9 - San Isidro - Lima 27 - Peru
Email: snpnet@snp.org.pe

Name: Oscar BERNALES
Organisation: Sociedad Nacional De Pesqueria, Peru
Address: Av. Republica De Panama 3591 - Piso 9 - San Isidro - Lima 27 - Peru
Email: snpnet@snp.org.pe

Name: Erich DIAZ
Organisation: Instituto del Mar del Peru (IMARPE)
Address: Esq. Gamarra & Gral. Valle s/n, Chucuito, PO Box 22, Callao, Peru
Email: ediaz@imarpe.gob.pe

Name: Teobaldo DIOSES
Organisation: Instituto del Mar del Peru (IMARPE)
Address: Esq. Gamarra & Gral. Valle s/n, Chucuito, PO Box 22, Callao, Peru
Email: tdioses@imarpe.gob.pe

Name: Renato GUEVARA-CARRASCO
Organisation: Instituto del Mar del Peru (IMARPE)
Address: Esq. Gamarra & Gral. Valle s/n, Chucuito, PO Box 22, Callao, Peru
Email: rguevara@imarpe.gob.pe

Name: Jaime MENDO
Organisation: Ministerio de la Produccion
Address: Calle Uno Oeste Nro. 060, Urb. Corpac, San Isidro, Lima 27, Peru
Email: jmendo@lamolina.edu.pe

Name: Ricardo OLIVEROS-RAMOS
Organisation: Instituto del Mar del Peru (IMARPE)
Address: Esq. Gamarra & Gral. Valle s/n, Chucuito, PO Box 22, Callao, Peru
Email: roliveros@imarpe.gob.pe

Name: Salvador PERALTILLA
Organisation: Sociedad Nacional De Pesqueria, Peru
Address: Av. Republica De Panama 3591 - Piso 9 - San Isidro - Lima 27 - Peru
Email: snpnet@snp.org.pe

Name: Paul PHUMPIU
Organisation: Ministerio de la Produccion
Address: Calle Uno Oeste Nro 060, Vrb. Corpac, San Isidro, Peru
Email: pphumpiu@produce.gob.pe

Name: Enrique RAMOS
Organisation: Instituto del Mar del Peru (IMARPE)
Address: Esq. Gamarra & Gral. Valle s/n, Chucuito, PO Box 22, Callao, Peru
Email: enrique756@gmail.com

Name: Jose SARMIENTO MADUENO
Organisation: Sociedad Nacional De Pesqueria, Peru
Address: Av. Republica De Panama 3591 - Piso 9 - San Isidro - Lima 27 - Peru
Email: snpnet@snp.org.pe

UNITED STATES OF AMERICA

Name: Annie YAU
Organisation: NOAA Fisheries, Pacific Islands Fisheries Science Center
Address: 2570 Dole Street, Honolulu, HI 96822, USA
Email: annie.yau@noaa.gov

Name: Paul CRONE
Organisation: NOAA Fisheries / SWFSC
Address: 8901 La Jolla Shores Dr.; La Jolla, CA 92037, USA
Email: paul.crone@noaa.gov

Name: Kevin Piner
Organisation: NOAA Fisheries / SWFSC
Address: 8901 La Jolla Shores Dr.; La Jolla, CA 92037, USA
Email: Kevin.piner@noaa.gov

Name: Dale SWEETNAM
Organisation: NOAA Fisheries / SWFSC
Address: 8901 La Jolla Shores Dr.; La Jolla, CA 92037, USA
Email: dale.sweetnam@noaa.gov

Name: Steve TEO
Organisation: NOAA Fisheries / SWFSC
Address: 8901 La Jolla Shores Dr.; La Jolla, CA 92037, USA
Email: steve.teo@noaa.gov

INTER-GOVERNMENTAL ORGANISATION OBSERVERS

FAO

Name: Merete TANDSTAD
Organisation: Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations (FAO)
Address: Viale delle Terme di Caracalla, 00153 Rome, Italy
Email: merete.tandstad@fao.org

IATTC

Name: Mark MAUNDER
Organisation: Inter-American Tropical Tuna Commission
Address: 8901 La Jolla Shores Dr., La Jolla, CA 92037-1508, USA
Email: mmaunder@iattc.org

NON- GOVERNMENTAL ORGANISATION OBSERVERS

Name: Karen Anne BAIRD
Organisation: Birdlife International
Address: PO Box 686,Warkworth, New Zealand
Email: k.baird@forestandbird.org.nz

Name: Ernesto Julio GODELMAN
Organisation: Center for Development and Sustainable Fisheries (CEDEPESCA)
Address: Rondeau 361 (7600) Mar Del Plata, Argentina
Email: ernesto.godelman@cedepesca.net

Name: Duncan CURRIE
Organisation: Deep Sea Conservation Coalition
Address: 6 Mt Pleasant Rd, Christchurch, New Zealand
Email: duncanc@globelaw.com

Name: Graham PATCHELL
Organisation: High Seas Fisheries Group Inc
Address: PO Box 11
Email: gjp@sealord.co.nz

SECRETARIAT

Name: Robin ALLEN
Organisation: SPRFMO
Address: PO Box 3937, Wellington, New Zealand
Email: robin.allen@southpacificrfmo.org

Name: Craig LOVERIDGE
Organisation: SPRFMO
Address: PO Box 3937, Wellington, New Zealand
Email: craig.loveridge@southpacificrfmo.org

Terms of Reference for the jack mackerel (*Trachurus murphyi)* age/growth Task Team - DRAFT

Original title **- Terms of Reference for the Task Team group for tackling the problem of jack mackerel (*Trachurus murphyi)* age reading and growth parameters estimates in the south Pacific**

Introduction

The main recommendation of the "Chilean jack mackerel otolith interpretation and ageing Workshop" held in Lima in July 2011 was to continue the work of comparison and discussion of ageing estimation criteria and to move forward to the development of an ageing protocol that could be applied by countries that conduct age estimations of this species, and whose results are used in the stock assessment. Chile took the responsibility to coordinate the work of the task team and distributed a draft proposal to reach the recommendation from the aging workshop and mandate from last SWG.

During the first meeting of the Scientific Committee on October 21-27 in La Jolla, California, Peru presented a proposal for an integrated approach for tackling the uncertainties in the ageing and estimation of growth parameters of jack mackerel in the south Pacific, based on its experience on solving this problem for the jack mackerel of the Peruvian waters. Basically its proposal consists in adopting different methodologies, in a complementary way, to validate the age readings. It was proposed that in addition to the conventional method based on the interpretation of annual rings, other methods such as reading of daily micro-increments, repeated sampling for age while following-up one or more single cohorts through their passage through the fishery and length frequency analysis.

Several points of coincidence between the two proposals were recognized and it was decided that the two should be merge in a single agreed proposal.

Objectives

Determine if the observed differences in the age and growth parameters estimated for the Jack mackerel (*Trachurus murphyi*) from different parts of the South Pacific are due to differences in the methods or practices adopted by different authors or due to real differences in the growth of *Trachurus murphyi* from different stocks, or a combination of both.

Prepare a framework for tackling the problem of age interpretation and growth parameters estimation for Jack mackerel.

Prepare a manual for age reading in otoliths including date of birth, readings of daily rings, interpreting rings and borders, and guidelines on how the best reading can be achieved.

Prepare a protocol on how to use information on length frequency analysis to complement growth parameters estimation if necessary.

Task team

Chile:	Francisco Cerna	francisco.cerna@ifop.cl
	Christian Valero	cristian.valero@ifop.cl
	Lizandro Muñoz	lizandro.muñoz@ifop.cl
China:	Gang Li	g-li@shou.edu.cn
Ecuador:	Natalia Gonzalez	ngonzalez@inp.gob.ec
	Viviana Jurado	vjurado@inp.gob.ec
Poland (EU):	Kordian Trella	trella@mir.gdynia.pl
Peru:	Teobaldo Dioses	tdioses@imarpe.gob.pe
	Carlos Goicochea	cgoicochea@imarpe.gob.pe

General Approach

1. **Reading of daily micro-increments for the first annual ring**

Determining the first annual ring through the determination of daily micro-increments in hard structures, preferably in otoliths (sagitta). Then use the analysis of micro-increments to determine the greater number of annual rings as possible. The determination of the first ring is crucial to determine and limit the potential biases encountered in the identification of annual rings based on the alternation of opaque and hyaline rings. For example, with criteria of relying on the formation of the annual hyaline ring to determine the age, a fish that is born closer the time or season when the hyaline rings are formed (June - August in the case of the Peruvian Jack mackerel) are more likely to be assigned 1 year of age much earlier, when in fact are only a few months old. This has been detected in the case of the Peruvian Jack mackerel, were some portion of the sampled otoliths have been found to have the first hyaline ring fully formed with only 180 to 270 daily rings or micro- increments.

For this purposes a sample of 100 (¿50?) otoliths, especially of young Jack mackerel (10 – 23 cm of fork length) are required, in order to determine the complete formation of the first annual ring. A general description of the methodology is in Goicochea et al. (2013). Russian background information on daily rings will be asked to A. Glubokov to be provided, that was presented by N.Timoshenko during the aging work shop. Also results obtained by M. Araya (UNAP Chile) should be consulted.

IMARPE (Instituto del Mar del Perú) can receive, prepare, photograph, encode all the samples, and distribute among different readers. IMARPE also has samples of otoliths of juvenile Jack mackerel (>100) that will be prepared for these purposes. On the other side, there also are samples of more than 400 otoliths from a cohort of Jack mackerel (28 to 36 cm of total length) followed along 13 months between 2011 and 2012, to study the growth between the second and the third ring. These samples can also be prepared and photographed for distribution among readers of different countries.

Results of this exercise can be gathered by IMARPE for their analysis and distribution for discussions.

For all these purposes, Teobaldo Dioses (tdioses@imarpe.gob.pe) will be the contact in Peru.

2. Conventional interpretation of marks in otoliths

Once there is agreement on the determination of the first annual ring for fish of different regions of the south Pacific, the next step is to conduct a conventional age determination based on annual rings reading. For that purpose samples may consists of 100 otolith's images from a wide length distribution from different regions.

By the moment there exists a sample of 74 images of otolith sampled in the Chilean region and 26 from Ecuador provided by the INP (Instituto Nacional de Pesca). The length distribution from Ecuador was rather narrow what explains the smaller number considered for this region.

Peru will contribute to this exercise with otolith´s photographs of a wide range of sizes of Jack mackerel of Peruvian waters from 6 to 60 cm of total length, of different years. For this purpose Teobaldo Dioses (IMARPE) will be in touch with Francisco Cerna (IFOP) for fine technical details.

The otoliths were selected, cleaned and photographed with an image analyzer system (a camera mounted on a stereomicroscope, connected to a computer equipped with the software Image-Pro Plus). Whole otoliths were immersed in oil over a dark background and illuminated with reflected light. The photographs were taken at 10X magnification and each contains a reference measure of 1 millimeters.

The 100 otolith collection is kept at Instituto de Fomento Pesquero (IFOP).

IFOP will distributed the images to participants and each is requested to read the complete set of 100 file images and share the results with all participants. The read data should include:

a) The number of the image,
b) The number of hyaline rings,
c) The type of edge (H = hyaline, O= opaque),
d) Total hyaline rings (hyaline rings number plus the edge when it is hyaline).

In the "Chilean Jack Mackerel Otolith Interpretation and Ageing Workshop" this simple rule for whole otoliths was agreed.

# Rings	Type of border	Age
1	Opaque	1
1	Hyaline	2
3	Opaque	3
3	Hyaline	4

The images file will be accessible in a Drop Box site that will be made available to the task team. The Drop Box will be made available to participants by Francisco Cerna through e-mail.

From the Chilean Jack Mackerel Otolith Interpretation and Ageing Workshop Report the following criteria and rules were taken which should be thought as a starting point. This Report should be considered as background information for the present working group.

These simple rules are:

- According to previous investigations of daily growth, the radius of first annulus may be between 1.5 and 2.5 mm length. In the case of Jack mackerel of Peruvian waters the first radius has an average size of 2.48 mm (2.26 – 2.78), the second radius 3.36 mm and the third radius 3.97 mmm (Goicochea et al., 2013). These criteria can be used to identify the first annual rings among others. Large serration in the shape of rings is an indication that it is a false ring or check.
- Consistency of the width of subsequent increments is a second important criterion. Split rings were also often observed in the first three years. The principle of gradual growth letdown by age can be used to recognize those split rings.
- Many additional rings (checks) are visible and impede or make very hard to identify annual rings in the central part of otolith when magnification is more than 20x. It is recommended therefore to read large otoliths using different magnifications for the central and marginal zones.
- A practical criterion is that the ring should be well defined and possible to follow around the otolith. Nonetheless in some otolith this is not possible especially near the edge due to the concave shape of the otolith and that it starts to build rings in the internal face of it in older (larger) fish. The best solution in this case is to compare the reading of whole and cross-section otolith. When a ring is not possible to be followed then it can be identified as a false ring.
- The examination should be all over the otolith, in the caudal and the rostrum. This is especially true when the caudal zone is disputable, then it is also necessary to examine the rostrum. False rings should also be checked in the rostrum.

In older fish (40 cm FL and larger) it is necessary to complement the readings with cross-section of otolith to avoid under-estimation of the age. This due to jack mackerel start to lay down ring in the internal face of the otolith and therefore they cannot be seen reading whole otolith. These readings should happen during the second workshop.

The distance of the first three hyaline rings for jack mackerel of different regions should be measured to facilitate future discussions.

The IFOP Laboratory will analyze and distribute the results of all participant readers. The precision analysis will be carried out according to the procedures described by Campana et al. (1995) and Campana (2001); another option is the Guidelines and tools for age Reading" by Eltink et al. (2000) that was used in the workshop held.

3. <u>Length frequency analysis</u>

Data on length frequency is usually available for all the countries, from their fisheries monitoring systems. Applying size frequency analysis methods to estimate growth parameters could help to contrast back-calculation estimates. Size frequency must be in monthly basis and all the data must be converted to fork length in ranges of 1 cm. A minimum of 5 years of data is advisable; however efforts will be made to use all the available data. If necessary the countries can share data to compare their results.

It is also advisable that this approach be part of the agenda of a future workshop on age and growth of Jack mackerel of the south Pacific.

Proposed Time schedule

October 2013 – March 2014
- Collect of otoliths for daily rings analysis. Otoliths should be sent to Teobaldo Dioses (IMARPE).

April – June 2014
- Sample preparation and distribution of photographs.

July – September 2014
- Analysis and conclusions on the first annual rings formation. Results can be presented in the next meeting of the Scientific Committee. A workshop from the task team on this step is found necessary. Lima was proposed by IMARPE as the venue.

October – December 2014
- Conventional annual readings (finalize distribution of photographs, and analysis). Reading results should be sent to Francisco Cerna (IFOP).

January – March 2015
- IFOP will send the result of the exercises.
- March 17-21 Proposed date for the 2nd workshop. Chile was proposed as the place for the workshop.

The results needs to be discussed in a jack mackerel otolith interpretation and ageing workshop and start to write the ageing protocol. Intersessional work should continue to produce an aging guide draft. A final discussion and review of the aging guide should happen on a second workshop. The venue and dates of the 3rd workshop should be agreed during the 2nd.

Chile will distribute this terms of reference to the task team for discussion. Later on the coordinators of each step will take the responsibility.

Reference

Report from the Chilean jack mackerel otolith interpretation and ageing workshop. SPRFMO Web page1[3]

Goicochea C., J. Mostacero, P. Moquillaza, T. Dioses, Y. Topiño & R. Guevara-Carrasco. 2013. Validación del ritmo de formación de los anillos de crecimiento en otolitos del jurel Trachurus murphyi Nichols 1920. En: Csirke J., R. Guevara-Carrasco & M. Espino (Eds.). Ecología, pesquería y conservación del jurel (Trachurus murphyi) en el Perú. Rev. peru. biol. número especial 20(1): 053- 060 (Septiembre 2013

[3] http://www.southpacificrfmo.org/assets/10th-SWG-and-9th-DIWG-meetings-Vanuatu/SWG-10/JMSG/SWG-10-JM-01-Chilean-Jack-Mackerel-Otolith-Interpretation-and-Ageing-Workshop-Report.pdf

Annex 5 is available as a separate document on the SPRFMO Website:
http://www.southpacificrfmo.org/1st-scientific-committee-meeting/

Research Programme 2013

1. Introduction

The development of a research programme within a Regional Fisheries Management Organization (RFMO) is essential to facilitate collaboration and coordination within and between different organizations and contracting parties.

These programmes should prioritise research in line with clearly defined objectives and should have a short, medium and long term scope.

The convention of the South Pacific Regional Fisheries Management Organization (SPRFMO) calls for cooperation in scientific research. The main fisheries identified in the SPRFMO convention area are the Chilean jack mackerel (*Trachurus murphyi*) fishery and associated species, the orange roughy (*Hoplostethus atlanticus*) fishery and associated species and the squid (*Dosidicus gigas*, *Sthenoteuthis oualaniensis*, *Ommastrephes bartrami*) fisheries.

The SPRFMO research programme should incorporate, as much as possible, the different components of the exploited resources and their associated ecosystems, and encompass both the Precautionary Approach and the Ecosystems Approach to Fisheries Management. Five main components are proposed:

- Environment and variability patterns at different temporal and spatial scales
- Chilean jack mackerel
- Deepwater species
- Squid
- Ecosystems Approach to Fisheries Management

The SPRFMO has already made important progress in summarising all available information, which is accessible at the web site of the organization[4] and constitutes a base line of information for the region.

2. Environmental variability at different temporal and spatial scales

The South Pacific is impacted by environmental variability from seasonal to secular scales, including El Niño - La Niña oscillations and the Pacific Decadal Oscillation (PDO) among other variables.

Seasonal changes are significant at high latitudes, diminishing at low latitudes near the equator. In contrast, equatorial waters are strongly influenced by El Niño events. The PDO is characterized by warm or cold waters and impacts the North, equatorial region and the South Pacific, with 20-30 year phases of warm or cool water alternating in the eastern Pacific. On the other hand the Arctic influence into the Southern Pacific is important and has different impact in the jack mackerel stock.

Tasks to be developed

- Determination of different environmental scenarios in the South Pacific.
- Identify patterns of seasonal, inter-annual (e.g. El Niño - La Niña), decadal or secular variation in environmental conditions that are likely to affect jack mackerel in the South Pacific.

[4] http://www.southpacificrfmo.org/swg-meetings/

- Investigate the effects of those environmental conditions on the distribution and population dynamics of jack mackerel on short-, medium- and long-term timescales.

The Permanent Commission for the South Pacific (CPPS)[5] has conducted regional oceanographic surveys since 1999 for the monitoring and forecasting of El Niño.

3. Jack mackerel

Jack mackerel (*T. murphyi*) is widely distributed in the South Pacific, from the south of Ecuador to southern Chile and extending from south-central Chile across the Pacific Ocean and reaching New Zealand and Tasmanian waters.

Information regarding the biology, geographical distribution and historical development of the fisheries is available at the SPRFMO web site[6].

The jack mackerel research programme is structured by: 1) Biology and Ecology, 2) Stock Structure, 3) Stock Assessment and 4) Conservation, Rebuilding Plan and Management Procedures. These components are interdependent and should be linked as progress is made.

3.1. Biology and Ecology

Research on biology and ecology of Chilean jack mackerel has included a wide range of topics such as geographical, seasonal and depth distribution, habitat, migration patterns, life history, spawning and growth biology, natural mortality, trophic interactions and the influence of environmental conditions on these parameters.

Tasks to be developed

Monitoring and evaluation of biological and environmental parameters is fundamental to understand how environment influences the distribution and biology of jack mackerel and also the whole ecosystem.

Tasks linking biology and environmental parameters:

- An important topic that deserves specific research is the effect of the Oxygen Minimum Zone (OMZ) on jack mackerel. There are indications that jack mackerel do not occur in waters with less than 1 ml O2/l and that dense schools require at least 3 ml O2/l (Bertrand et al, 2006-MEPS).Jack mackerel are also not observed in sea layers of less than 40 m high.
- The link between El Niño periods and recruitment. The occurrence of El Niño appears to have a positive influence on recruitment.
- Development of environmental indicators:
  - Observing the biological characteristics mentioned above requires research to define the interactions between the fish and the environment. Information from scientific surveys as well as from fishing vessels that simultaneously observe the fishing activity and the environment are able to provide data to study these points.
  - The continuous observation in situ of these interactions is also necessary. The simplest method is to define a series of indicators that are likely to describe in time and space the effects of these interactions. They may come from research

[5] www.cpps-int.org
[6] http://www.southpacificrfmo.org/jack-mackerel-sub-group/

institutes, from international databases and from the fishery itself. There is a preliminary need to define the list of relevant indicators and the collection/processing protocols.

Tasks on biological parameters:

- There is an apparent differential growth between jack mackerel in the north and in the south, with faster growth rates in the north. An age calibration workshop was organized in 2011 based on otoliths from the south. Further work is therefore necessary and the recommendations from the ageing workshop held in 2011 should be followed up. This includes age validation, calibration of age reading criteria (images and web based tools could be used) and the development of a reference collection of otoliths or images from the whole distribution area of jack mackerel (see document SWG-11-05 on the proposed working plan for age estimation). Peru performed an age validation study for the north and it would be important to include a collection of these otoliths in the age calibration study.
- Analyse the migration patterns linked to feeding and spawning. Chilean jack mackerel seems to aggregate for migration and feeding while it seems to scatter for spawning. Also, spawning areas appear to vary spatially and temporally.
- Fish behaviour is affected by environmental change, thus is a source of information likely to help understanding the effect of environment on the population and informing on the significance of fishery data (e.g. CPUE).

3.2. Stock Structure

The stock structure of the Chilean jack mackerel is a key subject for the management of this resource in the South Pacific. It is fundamental that the establishment of management areas is based on biological criteria.

Important research has been developed by different participants in the past and in recent years regarding the population structure analysis of jack mackerel. This information is available and summarised at the SPRFMO web site.

However, the different analyses and studies performed on population structure have yet to provide a clear picture and results are not entirely consistent.

Tasks to be developed

Two different research areas on population structure analysis are proposed to be developed:

- Development of the international joint research programme:
  The Science Working Group of the SPRFMO developed a proposal in 2008 for an international joint research programme to analyse the population structure of Chilean jack mackerel. This proposal includes a widescale biological sampling scheme and the application of a wide number of techniques as: genetics analysis, morphometrics (otoliths and body), parasites, life history and microchemistry of otoliths. This programme is very comprehensive and applies the state of the art methods used in other areas for population structure studies, but specifically excludes tagging.

  Currently, progress on this programme is based on collaborative research between parties.

The international joint research programme is available at the SPRFMO web site[7].

- Simulation based analysis on stock structure and management:
  This task should be linked to the stock assessment component and management strategy evaluation related to conservation and rebuilding plans. This task does not foresee additional biological sampling or processing techniques and should be complementary to the research programme on population structure.

  Through this task, all available data and information should be combined to identify the most likely stock structure hypothesis for Chilean jack mackerel. Different management strategies should be evaluated through simulations, in order to analyse the outcomes of considering uncertainty in population structure.

3.3. Stock Assessment

The main aim stock assessments is to provide managers with information on the exploitation status and what measures could be adopted to support sustainable exploitation in line with management objectives. For this purpose it is necessary to routinely collect:

- Fisheries related information, including detailed spatial and temporal catch and effort statistics, and biological information (fish length, age and maturity stage).
- Fisheries independent information as: 1) acoustic surveys to estimate abundance and the spatial distribution of the species; 2) acoustic and environmental data from the fishing vessels to monitor the changes in the interactions between population and environment; and 3) egg surveys to provide alternative relative estimates of the spawning biomass.

Fisheries dependent information should be submitted by all parties fishing actively for small pelagic species according to the data submission standard[8]. Fisheries independent information has been provided in the form of reports and presentations by the coastal states.

Stock assessment models are commonly used to describe the past dynamics of an exploited stock and its expected future development according to different management measures. Biological reference points are commonly used to classify the stock status and assess the future developments and these are currently under investigation by the SWG (see Tasks below).

During 2010, an Assessment Simulation Task Team within the SPRFMO developed the Joint Jack Mackerel stock assessment model (JJM)[9]. The JJM is a statistical catch-at-age model and further developments of this model should include a spatial and seasonal structuring and the incorporation of environmental variables that might influence the population dynamics.

Tasks to be developed

The following tasks should be maintained or developed.

Data related tasks:

- Collection and reporting of fisheries information as specified in the data collection standards.
- Acoustic and egg surveys should be routinely undertaken and reported.
- Acoustic and environmental data from fishing vessels should be routinely collected and reported.

---

[7] See Annex D of the Workshop Report: http://www.southpacificrfmo.org/2008-chilean-jack-mackerel-workshop-santiago/

[8] http://www.southpacificrfmo.org/standard-submission-templates/

[9] see SWG-09-JM Documents at http://www.southpacificrfmo.org/ninth-swg-meeting/

Stock assessment model related tasks:

- Further development of the JJM model to incorporate seasonal and spatial structuring in order to evaluate area specific management measures as seasonal and/or spatial closures (e.g. for areas with concentrations of juveniles or adults);
- Further development of the JJM model to incorporate the effect of environmental factors on the population dynamics, spawning success and recruitment of Chilean jack mackerel (see section on Biology and Ecology – effect on El Niño periods and the Oxygen Minimum Zone);
- Analyses of the effects of other possible management measures such as minimum landing size and minimum mesh sizes;
- Estimation of biomass and fishing mortality reference points;

3.4. Conservation, Rebuilding Plan and Management Procedures

The development of conservation and rebuilding plans and the adoption of management procedures require communication and close collaboration between fisheries management and science. Management Strategy Evaluation (MSE) is an important tool to incorporate uncertainties in stock assessment and provide managers with information on likely future stock dynamics according to different management procedures. This tool can help managers to find the right balance between biological risk and stability or profitability of harvesting over time.

Tasks to be developed

- For the development of conservation and rebuilding plans and adoption of a management procedure using MSE, it is necessary to have clear management objectives and biological reference points. This component of the Chilean jack mackerel research programme is therefore dependent on managers to decide on management objectives and on progress regarding the research components linked to stock assessment and development of biological reference points.
- It is emphasized that development and evaluation of Management Procedures and Harvest Control Rules are iterative processes that will require sequential, repeated and close consultation between scientists, fisheries managers and Commissioners throughout the process.
- Consider uncertainties related with stock dynamics, biology (e.g. density dependent maturity), ecology and stock structure.

4. The Deepwater Research Programme

The level of deepwater fishing activity in the SPRFMO Area is currently low. However, fishing effort levels have potential to increase; and relatively low levels of demersal fishing effort can have rapid and long-lasting impacts on Vulnerable Marine Ecosystems (VMEs)[10] and the sustainability of deep-sea fisheries resources. To address these concerns, Prepcon2 (Cali, 2011) agreed that the SWG work plan should include (1) predictive habitat modelling to evaluate the probability of the presence of VMEs, (2) development of methods to assess the sustainability of deepwater species and the provision of advice on their stock status and potential management approaches and (3) evaluate the composition and rates of bycatch of non-target, associated and

[10] www.cbd.int/doc/meetings/mar/ebsa-ettp-01/other/ebsa-ettp-01-background-info-en.pdf

dependant species, including risk and impact assessments.

Tasks to be developed

The following tasks focus on deepwater target species and vulnerable marine ecosystems. Research associated with assessing the impact of fishing on deepwater non-target, associated or dependent species is included under Section 5, which describes a general approach for assessing bycatch across all SPRFMO fisheries.

4.1. Biology of Target Species

In addition to catch and effort data inputs (described under 3.2.3), quantitative stock assessments require an understanding of species biology. Such information will also provide a guide to species productivity (the stock's ability to support fishing and to respond to rebuilding initiatives). Important biological information requirements include:

- Age and growth, including growth curves and age-length keys, estimates of size at maturity and maximum age (longevity). Differences in growth rates of males and females and spatial origin of samples should be explored. Standardised otolith interpretation and validation protocols will be required to guide otolith age determination.
- Estimation of reproductive capacity by size or age, including spatial and temporal variation.
- Estimates of natural mortality (*M*), using a range of estimation techniques.
- Allometric (length-weight) relationships.
- Characterisation of migration and movement, spatial and temporal patterns at appropriate scales (e.g. intra-season, inter- annual). This could use a range of techniques possibly including natural and artificial tags, commercial fishing location and density information.

Work on stock structure and on connectivity and mixing rates between deepwater fishing sites (e.g. seamounts), will contribute to the understanding of the sustainability of fishing. Work to investigate straddling stocks and possible boundaries of high-seas stocks of orange roughy and alfonsino to inform stock assessment.

Options to explore stock differentiation include:

- Genetic studies using high-resolution genetic markers.
- Studies of otolith microchemistry.
- Fine spatial scale analysis (e.g. by seamount) of CPUE trends and changes in age or length composition.
- Morphometric studies.
- Parasites of the target and fish bycatch species, including individual presence/absence and community structure analyses.
- Tagging experiments.

4.2. Assessment of Target Species

Data required for traditional quantitative stock assessments (catch, fishing effort, CPUE, acoustic surveys, swept-area surveys, age and length composition) for deepwater fisheries are sparse, and it is unlikely that traditional stock assessments will be possible for most deepwater species.

However, several approaches are available for evaluating the likely sustainable levels of catch (or fishing effort) for the main target species, such as orange roughy and alfonsino. The selection of approaches will depend on the availability of necessary data. The assessment approaches presented below range from those with low data requirements (spatial management or effort limitation) through to those with high data requirements (quantitative stock assessments).

Catch and fishing effort data at a suitable resolution are essential for all assessment approaches, including the spatial management of target species and protection of VMEs. For the purposes of scientific mapping of demersal fishing effort data, SWG10 recommended using a data resolution of 0.1^{o} (6 minutes) or finer. Appropriate fishing effort data will be required for CPUE analyses and quantitative assessments of deepwater species, including, for example, tow-by-tow data for trawl fisheries and set-by-set data for line fisheries. Catch history for long-lived, low productivity species can also be used to define useful statistics, including estimation of unfished biomass levels, when applied at appropriate spatial scales.

Science in support of spatial management approaches

One approach to estimating the sustainable levels of fishing mortality of deepwater species to is to develop spatial habitat prediction models for the species of interest, similar to those developed by Davies & Guinotte (2011) for scleractinian corals. For deep-water target species, habitat prediction models would provide estimates of habitat available in the SPRFMO Area for each species (e.g. orange roughy), with evaluation of the probability of occurrence of these species in different habitats. Fishing mortality levels might then be managed by limiting access to some proportion of the predicted orange roughy habitat, e.g. by closing a certain percentage of suitable flat areas or seamounts, or closing a percentage of the species total habitat in the SPRFMO Area. This approach would require additional work to 'ground-truth' the predicted habitat extent with real fish distribution and density information. It would also be necessary to explore a range of possible spatial management options in terms of the overall percentage closed and how the total area could be divided into effective subareas.

Estimation of sustainable yield by feature or area

The predicted habitat approaches described above can be extended to the estimation of sustainable yield levels per feature (e.g. seamount) or area. This would extend the meta-analysis estimation of carrying capacity for orange roughy by Clark et al. (2001, 2010). These analyses related estimates of biomass to physical characteristics of fished seamounts, e.g. latitude, geological association, depth at summit and estimated slope, to provide estimates of unfished biomass on seamounts across the entire Area. Results of such analyses could then be used to provide advice on sustainable yield levels for particular features or areas.

Acoustic surveys

Minimum biomass estimates might be derived from acoustic surveys, although in isolation they may provide estimates of absolute abundance. Technological developments are likely to enable the development of new operational approaches to estimating the stock size and status of deepwater species. For example, multibeam acoustics and acoustic optical systems (AOS) are now enabling resolution of mixed species targets according to their backscatter. This can enable, for example, differentiation of orange roughy (oil-based buoyancy) from gas-based buoyancy species and elasmobranches, based on the multi-frequency backscatter profile. This research technology is currently at an early stage of development for use by commercial vessels.

Quantitative stock assessment

Traditional quantitative stock assessments require time-series of catch and fishing effort data, the size or age composition of catches, information on growth and maturity and an index of abundance. The CPUE from deep-water trawling may not be a reliable index of abundance for species like orange roughy and alfonsino. Therefore, alternative indices of abundance need to be developed. For example, a time-series of abundance estimates might be compiled through regular acoustic surveys. Quantitative assessments would benefit from an understanding of stock boundaries and mixing rates between areas.

4.3. Identification and Mapping of Vulnerable Marine Ecosystems

It is not economically feasible to survey deep-water habitats across the entire SPRFMO Area. Therefore, alternative approaches should be used to identify and map probable VMEs:

- The primary approach is likely to rely on the development of predictive habitat models for VMEs in the SPRFMO Area, such as that developed by Davies & Guinotte (2011) for global scleractinian coral habitat. These models should be of an adequately high resolution, tailored to the SPRFMO Area, and should include all species considered to be VME indicator species in the SPRFMO Area (e.g. stony corals, gorgonians, soft corals and sponges).
- Several participants have introduced interim move-on rules to try to limit damage to potential VME areas. All benthic bycatch data collected as part of monitoring these move-on requirements should be regularly compiled and analysed to map the location of potential VMEs (i.e. areas that triggered a move-on rule). These benthic bycatch data should also be used to inform existing predictive habitat models for VMEs in the SPRFMO Area and to enable the development of these and new models.

5. The Squid Research Programme

There are three species of squid that have been identified as of interest within the SPRFMO Area:

- Jumbo flying squid (*Dosidicus gigas*).
- Purple-back flying squid (*Sthenoteuthis oualaniensis*)
- Neon flying squid (*Ommastrephes bartrami*)

The key areas of research required for squid are to do with improving understanding in the biology of the different species, including growth, mortality, migrations, stock structure and population dynamics. That these are very short lived species requires a somewhat different approach to both science and fisheries management.

Tasks to be developed

The key areas of science include both monitoring and research, including:

- Record and report catch (tonnes) and effort separately for each species and gear type.
    i. For jiggers record number of jig line hours separately for single and double machines.
    ii. For trawlers, number of tows, hours fished per tow and catch per tow.
- Collect detailed biological data from the fishery on a short timescale (e.g. weekly) for:
    i. length-frequency (dorsal mantle length – DML to the nearest cm below);
    ii. weight (g) to calculate length-weight;
    iii. sex (M, F, immature);
    iv. maturity.
- Consider the need to collect appropriate material to investigate questions of stock structure: natural tags (e.g. parasites), standard fisheries tagging studies, genetic samples.

- Consider the existing knowledge of and need to further investigate migrations using established tag technologies.
- Consider the need for stock assessment surveys, both swept area bottom trawl and acoustic surveys.
- Collect and analyse diet data for squid to identify the types and species of key prey types and spatial and temporal variability in diet, including cannibalism.
- Collect and analyse diet data for all predators of squid, focusing on fish, seabirds and marine mammals, to identify key predators and the seasonal and spatial patterns in predation.
- Assess the applicability of various stock assessment approaches and existing mathematical models with respect to estimating squid stock size, especially to define data needs. This principally includes survey methodologies and mathematical models.
- Define key habitats, including spawning and nursery grounds.

In order to address the different research areas described, collaboration with researchers working on the same and similar species outside of the SPRFMO Area would be important.

6. Ecosystems Approach to Fisheries Management

The Ecosystem Approach to Fisheries Management (Garcia *et al*., 2003) should consider the interaction between the fishing activity and the marine ecosystem and that fisheries are surrounded by and part of an environment and should not be managed in isolation. Impacts on species associated with certain fisheries should be considered but also on other species occurring in the ecosystem such as seabirds, marine reptiles and marine mammals that might be accidentally caught or experience direct or indirect competition for resources.

In particular, for the Chilean jack mackerel fishery, it is important to consider that general trophic interactions and relations between predator-prey species in the ecosystem may be affected by the large extractions due to fishing.

6.1. Assessment of the Impact of Fishing on Non-target, Associated or Dependent Species

An initial approach to assessing the impact of fishing on non-target ('bycatch'), associated or dependent species is to compare the distribution of species of concern with fishery distributions, such as the assessments by Baird et al. (2012) for seabirds. This information can be used in ecological risk assessments (ERAs) to evaluate the risk of significant impacts on bycatch species in particular fisheries or areas. Such risk assessments can be improved with the addition of fishery-specific information. In the absence of information on the fishery of interest (e.g. jack mackerel trawling in the SPRFMO Area), Baird et al. (2012), for example, substituted information from a Chilean trawl fishery for hake can be informative. Additional details on fishing seasons, time of day, characteristics of the fishing gear, type and use of existing mitigation measures and type and scale of observed interactions would improve the assessment of each fishery.

Adequate and representative observer data are essential for estimating interaction rates and the total mortality of bycatch species, and in identifying fisheries or areas where bycatch interactions may need to be managed. Observer data must be collected in accordance with the SPRFMO Observer Data Standards. Appropriate targeting and prioritisation of observer effort is required to obtain information on those species most at risk.

Observer data must be regularly summarised and reviewed in order to detect changes in bycatch risk ratings for each fishery. This will also ensure that observers are collecting the correct data and that coverage rates are adequate to detect interactions with bycatch species (including fish, marine mammals, seabirds, marine reptiles, sensitive benthic species and other vulnerable species). This should include information on the nature of interactions with bycatch species, life status and amounts released or discarded. This information can be used as a basis to recommend appropriate bycatch mitigation measures and performance standards. Observer data will also be useful for monitoring the effectiveness of, and improving, measures to manage bycatch.

Tasks to be developed

- Review observer data collection protocols and coverage levels for each SPRFMO fishery. This will help to align various national observer programmes and identify gaps in the observer coverage of particular areas, fisheries, bycatch species or groups, or types of interactions that may need to be addressed.
- Estimate interaction rates and total mortality for bycatch species across each fishery. This will require data to be collected and submitted in accordance with SPRFMO's data standards. It will provide initial guidance on trends in bycatch in fisheries and activities or areas where bycatch may need to be investigated.
- Undertake ecological risk assessments (ERAs) to evaluate the risk of significant impacts on bycatch species. Where possible, this work should be delivered at a spatial scales appropriate to the species concerned, as a bycatch species might be subject to low level interactions in a number of fisheries, but when combined these separate impacts might become significant.
- ERAs are a cost-effective way of identifying priority or 'high-risk' species in particular fisheries or areas that might require increased monitoring or management intervention. The final task would then be to select or develop and test appropriate mitigation measures and performance standards for managing fishery interactions with high-risk species. This may require more additional research or analysis such as in the types of interactions with bycatch species.

Using available observer and other appropriate data:

- Conduct initial evaluations of the composition and rates of by-catch of non-target, associated and dependant species, both retained and discarded, including impact assessments of the jack mackerel fisheries.
- Quantify accidental catches of non-target fish, seabirds, marine reptiles, marine mammals and other species potentially occurring in the fisheries targeting jack mackerel and conduct initial evaluations regarding potential impacts.

It should be noted that, to enable the above evaluations to be done, participants will need to ensure that data collected by observers includes data on retained and discarded by-catch, as required by the Data Standards for observer data.

7. Prioritization and recommended development of the programme

Financing and collaboration between contracting parties of the SPRFMO is essential to develop and deliver this research programme.

There is currently no centralised financing of research through the RFMO, which could be important to enhance and link the current research developing independently by contracting parties.

Observer Programmes

The Observer Data Standards provide a useful starting point for collecting data and samples of target species and addressing the SPRFMO's obligations in assessing the impact of fishing on non-target, associated or dependent species. However, the SPRFMO Secretariat will need appropriate funding and staffing if it is to effectively coordinate the various observer programmes across the SPRFMO Area. This will include work in developing data collection protocols (e.g. observer forms and lists of tasks), training (e.g. species identification and sampling procedures), managing data and reviewing coverage and data quality.

8. References

Baird K., Taylor P. and Small C. (2012) Potential impact of fishing activity in the SPRFMO Area to seabirds. SWG-11-INF-02 (rev 1) presented at the 11th Meeting of the Science Working Group, Lima, Peru, 15-19 October 2012.

Clark M.R., Bull B. and Tracey D.M. (2001) The estimation of catch levels for new orange roughy fisheries on seamounts: a meta-analysis of seamount data. *New Zealand Fisheries Assessment Report 2001/75*, 40 pp.

Clark M.R., Dunn M. and Anderson O. (2010) Development of estimates of biomass and sustainable catches for orange roughy fisheries in the New Zealand region outside the EEZ: CPUE analyses, and application of the “seamount meta-analysis” approach. *New Zealand Fishery Assessment Report* (in press), 46 pp.

Davies A. J. and Guinotte J. M. (2011) Global habitat suitability for framework-forming cold-water corals. PLoS ONE 6:e18483

Garcia S., Zerbi A., Aliaume C. et al. (2003) The ecosystem approach to fisheries. FAO fisheries technical paper no. 443, Rome, FAO p. 71.

South Pacific Regional Fisheries Management Organisation

Stock status summary for jack mackerel, October 2013

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

Advice for 2014

The SPRFMO Science Committee advises to maintain 2014 catches at or below 440 000t.

Stock status

		2011	2012	2013
Fishing mortality in relation to	F_{MSY}	Above	Below	Below
Spawning stock biomass in relation to	B_{MSY}	Below	Below	Below

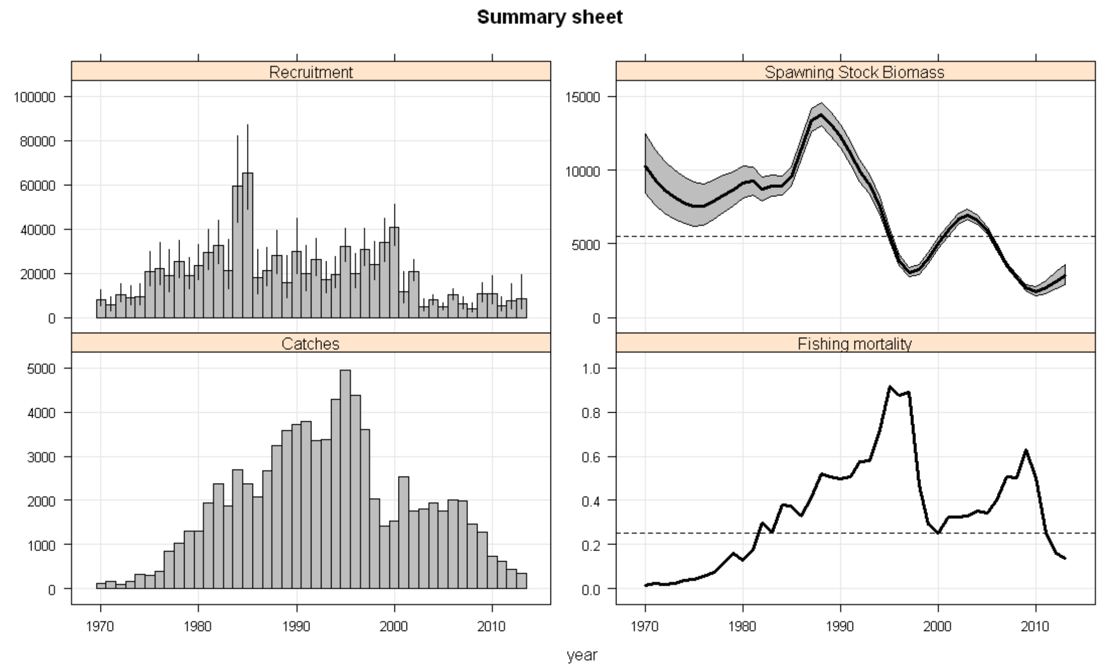

Figure 1. Jack Mackerel in the southeast Pacific. Summary of stock assessment. Recruitment is measured in thousands, SSB in thousand tonnes, catch in thousand tonnes and harvest (fishing mortality) as a rate per year. Provisional values for F_{MSY} and B_{MSY} are shown by horizontal dashed lines.

Outlook for 2014

Constant fishing mortality scenarios were explored at 125%, 100%, 75%, 50% and 0% of F_{2013} = 0.15. Advice is based on maintaining the likelihood of spawning biomass to increase (above the 2013 value of 2.8 million t).

Table 1. Summary results for the near term predictions. Note that "B" in all cases represents thousands of t of spawning stock biomass and B_{MSY} is taken to be a provisional value of 5.5 million t of spawning biomass in all cases.

Recruitment steepness=0.8, recruitment from 2000-2011

Multiplier of F_{2013}	B_{2015}	$P(B_{2015} > B_{MSY})$	Catch 2014 (kt)	Catch 2015 (kt)
0.00	3,845	0%	0	0
0.50	3,480	0%	230	270
0.75	3,316	0%	340	380
1.00	3,163	0%	440	490
1.25	3,020	0%	540	580

Recruitment steepness =0.65, recruitment from 2000-2011

Multiplier of F_{2013}	B_{2015}	$P(B_{2015} > B_{MSY})$	Catch 2014 (kt)	Catch 2015 (kt)
0.00	3,802	0%	0	0
0.50	3,438	0%	230	270
0.75	3,274	0%	340	380
1.00	3,122	0%	440	490
1.25	2,980	0%	540	580

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

Year	Advised maximum catch	Reported catch
2008		1,471,122
2009		1,283,474
2010		726,708
2011	711,783	605,817
2012	520,000	417,317
2013	441,000	
2014	440,000	