Scientific Committee
Port Vila, Vanuatu
26 -28 September 2015

REPORT OF THE 2015 DATA WORKSHOP

1 Welcome and Introduction

The participants were welcomed by the Chair of the meeting, Niels Hintzen (Vice chair of the Scientific Committee; SC). Participants introduced themselves.

2 Administrative Arrangements

2.1 Adoption of Agenda

The Chair sought proposed changes to the Draft Agenda. Explanations to individual agenda items were given and the agenda was adopted without revision as Annex 4. The Chair provided background on the reasons for having a data workshop and the expected results. A main goal was to improve transparency and develop a uniform approach and this view was shared among the participants.

2.2 Meeting documents

One document was prepared by Ad Corten on an exchange format for age-length data of jack mackerel. Corten explained his idea of sharing age-length information through a standard sheet (an example was attached to his working document) and ideally submitted to a data coordinator collecting all catch data and associated age-length keys.

From the discussions, the data workshop participants recommend to assign the role of data coordinator to one or two SC members, supported by the SPRFMO data manager. The role of the data coordinators will be to collect and compile the standard assessment data and where necessary, apply appropriate methods to format or transform supplied data for direct incorporation in assessment models.

3 Data collection and availability discussion

3.1 Identify and describe each dataset currently used for assessment purposes in SPRFMO

A list of datasets currently used in the Jack mackerel assessment was collated. This consisted of: annual catch data, catch by fleet, catch at age, length-frequency data of the catch, age-length-keys, CPUE time series, Acoustic survey time series, Egg survey time series, weight-at-age, growth parameters, maturity schedules, time of spawning value, natural mortality parameters, length-weight relationship parameters and recruitment steepness parameter. A description of the datasets can be found under Annex 3.

3.2 Select specific datasets to discuss in-depth throughout workshop

An inventory of potential quality and completeness issues related to each of the datasets listed under 3.1 was prepared. These issues related to the current quality, completeness and raising of the data for the assessment. The issues are provided under Annex 1.

3.3 Describe data collection process and data raising procedures

Participants proceeded to draft a complete overview of how the datasets mentioned above are prepared and submitted to either the SPRFMO secretariat or to the SC for assessment purposes. The data description is provided under Annex 3.

3.4 Identify any confidentiality and accessibility issues

An inventory of potential confidentiality issues related to each of the datasets listed under 3.1 was prepared. The issues are provided under Annex 1.

3.5 Identify other datasets (qualitative and/or quantitative) with potential assessments uses

An open discussion was held to identify those datasets that may become useful for assessment or advice purposes in the future. Datasets considered may not be used directly as input to a statistical assessment model but may serve as qualitative or quantitative indicators of ecosystem, foodweb and/or stock status. Core to the datasets listed below is their current availability but it does not necessarily reflect a wish-list of datasets to incorporate in the assessment. Each would require investigation prior to making use of the available data.

- Data collected on-board fishing vessels such as length-frequency information, (by) catch, acoustic biomass on a haul-by-haul basis
- VMS data to inform on spatial distribution of the fishing fleet
- Habitat suitability index as predicted from temperature, oxycline, food availability / primary productivity, physical structures
    - The IMOS database or Continuous Plankton Recorder data may be used for this purpose
- Patterns in e.g. seabird/mammals/prey abundance as indicator for small pelagic biomass and ecosystem status
    - The IMOS database or Continuous Plankton Recorder data may be used for this purpose
- Patterns in e.g. predator abundance used as information on predation mortality
- Available stomach content data to inform on diet of Jack mackerel and shifts in prey availability
- Discard and bycatch information to inform on total Jack mackerel removals in contrast to currently reported landings information

4 Data quality discussion

4.1 Define data standardization procedures, raising and product estimation

A general discussion was held to identify those factors that would be required to submit ‘standardized’ data products to the SC. A submission of a standardized data product should contain: (in a random order):

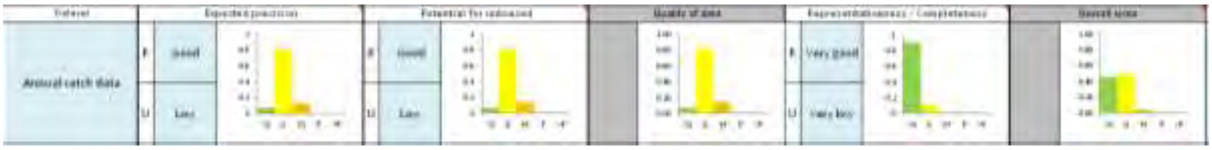
- A short description of the statistical model used / the type of analyses used to analyse the data (including a reference to the full description of the method / model used)
- A description of the units of the output data. The data templates may recommend reporting on a pre-defined unit.
- A short description of the sample design applied to sample the data. The data template may recommend minimum sample sizes to be taken
- A short description of the gear / device used to collect the data
- A list of meta-data information (where the data was collected, when the data was collected, how the data was collected, who collected the data, who to contact in case of questions)
- An expert view on bias and precision of the data where necessary
- Information on the method of calibration of the tools used to collect the data
- Furthermore, the standardized data product should be submitted considering:
    - A standard format the data is submitted in
    - A deadline before which the data should be submitted
    - Infographics that reflect on retrospective perception of the data, spatial distribution of the data concerned

4.2 Apply standardization procedures to specific datasets identified in 3.2 (others if time allows)

Time was allocated to prepare protocols for the data submission of age-length keys, acoustic datasets and CPUE data. These protocols especially focussed on the meta-data description and contribute to the development of data templates. Within these templates, space is available to list the meta-data and indicate potential issues with the data. Screenshots of the templates are provided in Annex 2a.

4.3 Describe and estimate precision & bias of datasets identified in 3.2

The group went through an exercise of scoring each of the datasets as identified under agenda item 3.2, and provided in Annex 1 with regard to precision, potential for bias and representativeness / completeness. For each dataset the participants scored, as a group, the expected precision on a scale between 1-5, where 1 indicates very high precision and 5 indicates very low precision. The level of confidence in the statement of the precision could be scored as well (e.g. information may indicate that precision is high in a specific dataset, but if expert opinion would question this high precision, the confidence in the precision statement could be low). The same procedure was followed for the potential for the data to be unbiased and the representativeness and completeness of the data.
Combining these three indicators provided the group with an overall score on quality of each dataset and the ability to compare the quality of these different datasets. This overview may be used in the future to prioritize research activities to improve the quality of the datasets and improved calibration of the assessment model settings. In Annex 1 the quality scoring is provided for each of the datasets.



5 Data protocol description and processing discussion

5.1 Describe data delivery protocol to SC and/or Secretariat

A set of data templates were presented starting with the length frequency and age-length key. The group agreed that these draft templates should be adopted and will be tested during the SC. Furthermore, templates will be developed for acoustic / egg survey data and CPUE data.
The working group emphasized that the traceability of historical data would benefit by clear documentation of all components. Also, they agreed that the current SC procedure for incorporating timely data for the assessment be continued and efforts to minimize delays be encouraged. Such streamlining of data for assessment purposes will help provide the Commission with harvest advice that is consistent with the best available scientific information.

5.2 Discuss dataset storage protocol

The group discussed data storage protocols specific for assessment purposes. They noted that for items currently unavailable from the secretariat's data management system, the github repository should be used to track data and changes through the years.

5.3 Discuss and define a protocol on treatment of historical data revisions

It was noted that landings data are obtained from National reporting and are less of a scientific issue. However, when changes in landings data occur, the Secretariat should provide a report to the SC when this occurs and the SC can evaluate whether more details and considerations are required.

5.4 Apply protocols on specific datasets identified in 3.2

Participants proceeded to check the templates, prepare meta-data descriptions of the data and store these at the SPRFMO server.

5.5 Store datasets as agreed and make available where appropriate

Participants proceeded to check the templates, prepare meta-data descriptions of the data and store these at the SPRFMO server.

6 Applicability of workshop discussions to other SPRFMO fishery resources

The workshop focussed primarily on Jack mackerel and the majority of the participants focussed on this species alone. It is expected that the templates developed can be used for other species as well.

6.1 Recommendations:

In order to improve and provide needed background for the data as input to the assessment, the group recommends the following to the SC:

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

6.2 Conclusions

After review of the datasets used in the Jack mackerel assessment, it was concluded that the quality of the data is appropriate for assessment purposes, although a number of datasets with potential quality issues were flagged. Ageing consistency between member states, the acoustic survey in Peru and the CPUE series of the EU stand out as datasets that require additional attention.

The workshop concluded that improvements should be made to the process of data submission, sharing of data and reporting on data quality and analyses types. Therefore, the workshop suggested assigning data coordinators to streamline the data delivery for assessment purposes. Three data coordinators were assigned this task, namely: Chile and Peru and the EU.

Furthermore, the workshop participants were successful in:

- discussing the sampling and procedures that precede data delivery to the SPRFMO Science Committee for assessment purposes
- identifying data quality issues and an overview is presented which reflects the quality scoring of each dataset used
- agreeing on how to improve voluntary data submission through the use of data templates including a description of meta-data
- defining clear recommendations to improve on data quality and streamlining data submission for SPRFMO usage

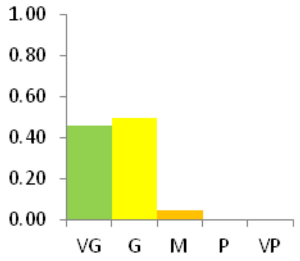
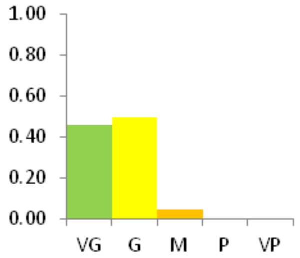
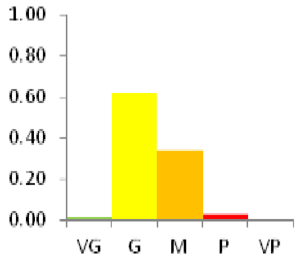
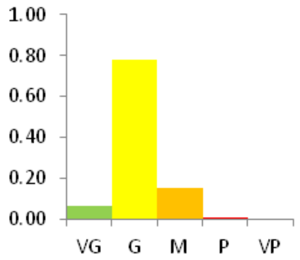
7 Adoption of Report

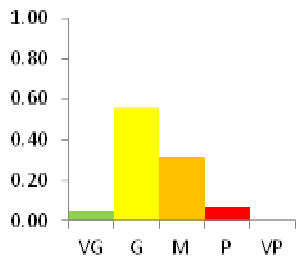
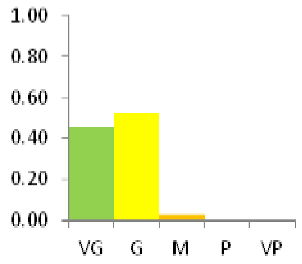
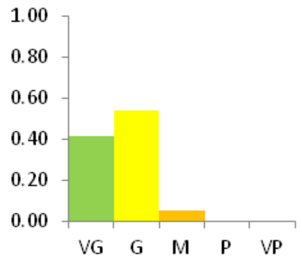
The workshop participants unanimously adopted the report

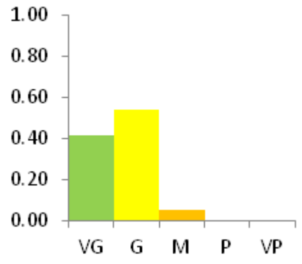
8 Meeting Closure

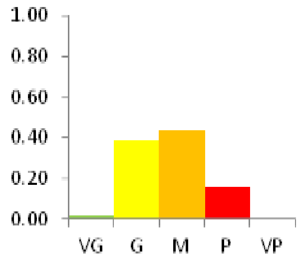
The meeting was closed at 9:30 on the 1st of October.

Annex 1 –Assessment datasets, issues and confidentiality

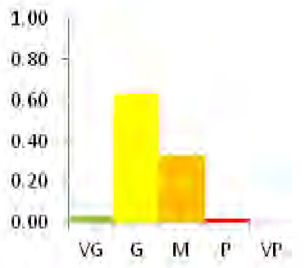
Dataset	Identified issues	Confidentiality / availability constraints	Quality evaluation
Annual catch data	• Split between fleet 1 and 2 from Chilean data not straight forward • Catch may comprise landings data only	No confidentiality issues identified	
Catch by fleet	• Historic allocation of catches to fleet may be biased • The proportional contribution of artisanal vs. industrial catches may be underestimated	No confidentiality issues identified	
Catch at age	• Fleet 3 catches use a fixed age-length conversion factor which may not be appropriate under all circumstances • Sampling of otoliths depends on size of the catch and therefore affects precision • The availability of age-length-key information prior to 2012 is limited • Exchange of ALK at quarterly level is limited	Information needs to be aggregated by month / quarter	Fleet 1  Fleet 2  Fleet 4

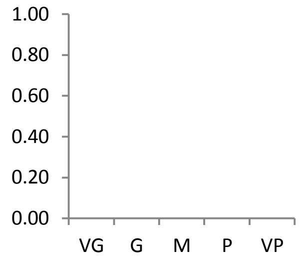
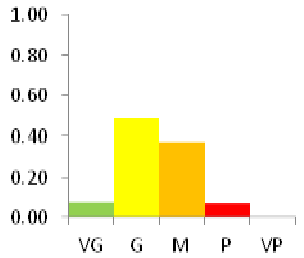
<table>
<tr><td></td><td></td><td></td><td>
</td></tr>
<tr><td>Catch at length</td><td>Conversion between total length to fork length may introduce bias
Measurement units (fork length vs standard length) not always known</td><td>Information needs to be aggregated by month / quarter</td><td>Fleet 3

</td></tr>
<tr><td>CPUE series</td><td>Standardization not always applied (nominal CPUE series)
Units of CPUE series may differ
CPUE may reflect flag rather than area</td><td>Data must be aggregated to follow data standards (3 vessels, 1 degree, by month)</td><td>Fleet 2 as sampled by Chile


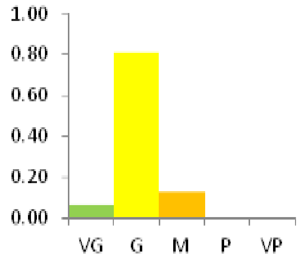
Fleet 3 as sampled by Peru


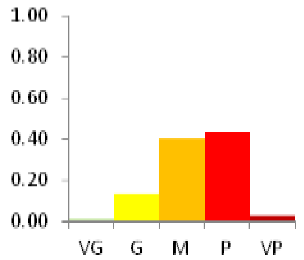
Fleet 4 as sampled by EU


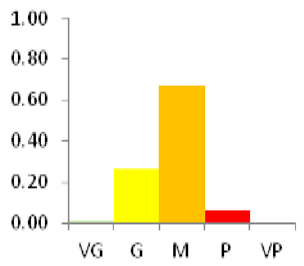
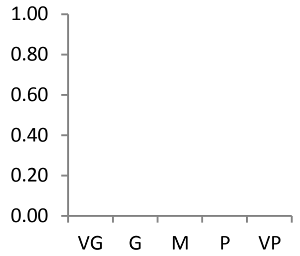
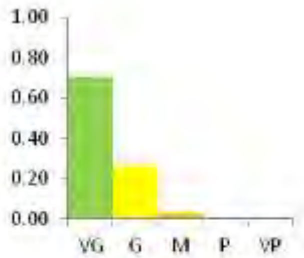
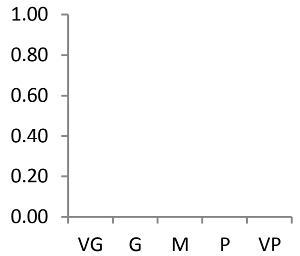
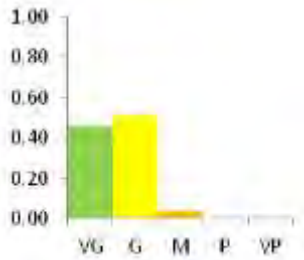
Fleet 4 as sampled by China</td></tr>
</table>

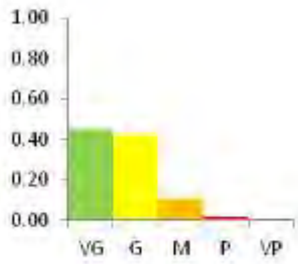
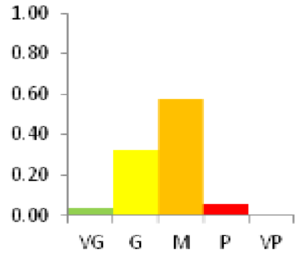
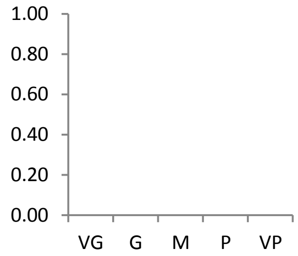
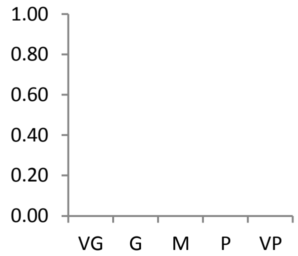
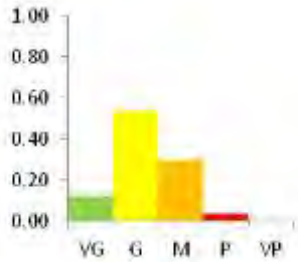
<table>
<tr>
<td></td>
<td></td>
<td></td>
<td>

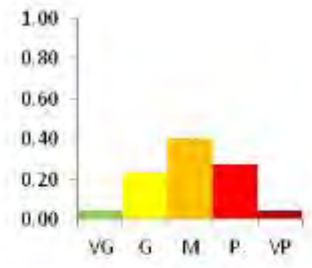
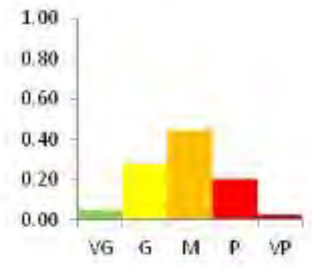
Fleet 4 as sampled by Russia

</td>
</tr>
<tr>
<td>Acoustic survey data</td>
<td>Procedure of collecting and processing data not always shared
Extend of survey area not always shared
Target strength relation not always communicated</td>
<td>Data not easily shared owing to size of datafiles and expertise necessary to process the data</td>
<td>Acoustic survey Fleet 1


Acoustic survey Fleet 2


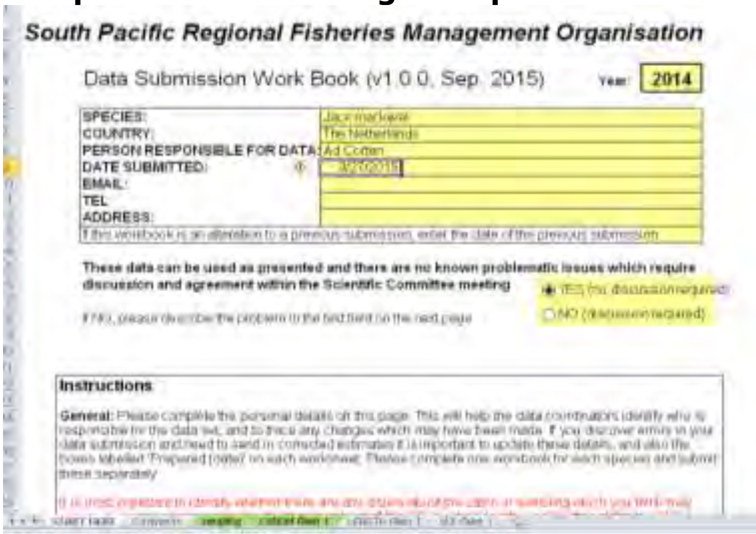
Acoustic survey Fleet 3

</td>
</tr>
</table>

Egg survey data	• Timing of the survey in relation to spawning peak may not overlap in every year	Data not easily shared owing to size of datafiles and expertise necessary to process the data	
Weight at age	• Quality of weight measurements on board may be noisy • Absence of cohorts in sampling creates gaps in weight at age timeseries • Estimation of weight at age at spawning time rather than sampling driven	Information needs to be aggregated by month / quarter	
Growth parameters	• Time invariant parameters for fleet 3 are used • Growth parameters lacking for fleet 1,2 and 4 to overcome interpolation of missing cohort sampling	No confidentiality issues identified	
Maturity parameters	• No historic estimation of maturity exists • Maturity is time-invariant	No confidentiality issues identified	
Time of spawning	• Variable for Peruvian area	No confidentiality issues identified	

Natural mortality	• Informed by model estimation • Data to inform natural mortality may be available • Potential for weighting against Chilean / Peruvian component lacking	No confidentiality issues identified	
Ageing error	• Based on simulated data • Estimation of ageing error available but not yet implemented	No confidentiality issues identified	
Length weight relationship parameters	• Missing information on cohorts may affect estimation	No confidentiality issues identified	
Steepness recruitment parameter	• No data available to estimate parameter outside assessment model	No confidentiality issues identified	
Catch biomass CV estimates	• Not considered	No confidentiality issues identified	

Sample size for age composition data	• Not considered	No confidentiality issues identified	
Variance of survey indices	• Not considered	No confidentiality issues identified	

Annex 2a – Example of data exchange template



South Pacific Regional Fisheries Management Organisation

Data Submission Work Book (v1.0.0, Sep. 2015) Year: 2014

SPECIES:	Jack mackerel
COUNTRY:	The Netherlands
PERSON RESPONSIBLE FOR DATA:	Ad Corten
DATE SUBMITTED:	
EMAIL:	
TEL:	
ADDRESS:	

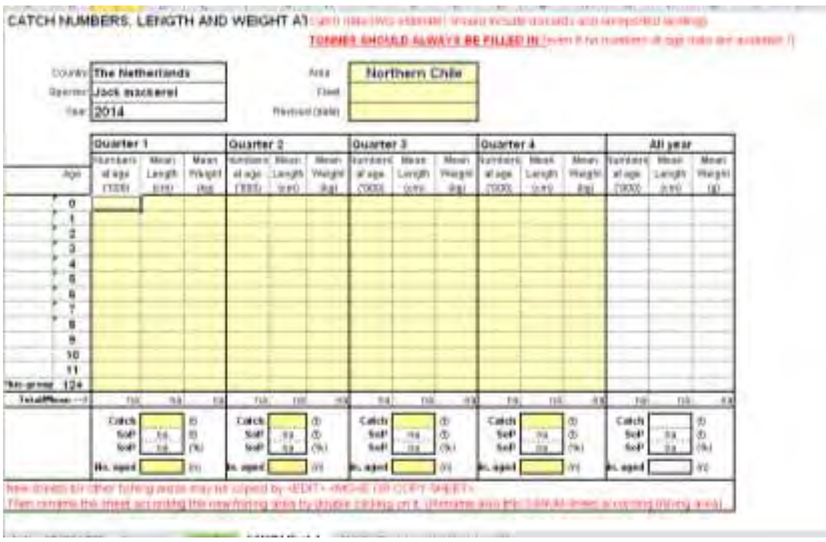
These data can be used as presented and there are no known problematic issues which require discussion and agreement within the Scientific Committee meeting

YES (no discussion required)

NO (discussion required)

Instructions

General: Please complete the personal details on this page. This will help the data coordinators identify who is responsible for the data set, and to trace any changes which may have been made.



CATCH NUMBERS, LENGTH AND WEIGHT AT

TONNES SHOULD ALWAYS BE FILLED IN

Country	The Netherlands	Area	Northern Chile
Species	Jack mackerel	Fleet	
Year	2014	Revised (date)	

Age	Quarter 1			Quarter 2			Quarter 3			Quarter 4			All year		
	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (g)
0															
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
Plus group 12+															
Total/Mean															

LENGTH DISTRIBUTIONS BY AREA, FLEET AND QUARTER

Country	The Netherlands	Area	Length Fleet 1
Species	Jack mackerel	Fleet	
Year	2014	Unit	'000
		Revised (date)	27-sep-2015

Fork length (cm)	Quarter 1 2014	Quarter 2 2014	Quarter 3 2014	Quarter 4 2014	All year
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					

Annex 2b – Example of potential exchange protocol.

Catch at age / length

I: General description.
The steps to calculate the catch at age and catch at length matrices are:
Otolith readings, Age-length key (ALK), Length frequency + Allometric parameters (W =aLb), Catch at length, ALK, Catch at age (expanded ALK) ← Allometric parameters (w=aLb), Weight at age

II. Meta-data information for Catch at age or length matrices.
Where
Chile EEZ: 2 zones: North (north1 and north2) and Central-South.
Perú EEZ: Far North zone. One key based in the whole area. But not used in the JJM model.
International Waters (Netherland (EU), Korea China and Vanuatu). North J. Fernandez and South of J Fernandez.

Fishing fleet and fishing gears
Purse Seiner: Chile and Perú.
Trawler: EU, Korea, China, Vanuatu.

When
Chile: By quarters
Perú: By year (Whole area), but not used in the JJM model.
International Waters (IW): Netherland: monthly available for the 2 years. It could be grouped by quarters. Poland may be available next year.

How
Otolith Sampling - The biological samples considered 80 to 100 individuals on land. Otoliths are collected per port (12 pairs per month per size range).
For Dutch catches, a biological sample of 25 randomly selected fish is taken by observers while at sea. For all fish in the sample, length, weight and other biological characteristics are measured, and the otolths are collected. The biological characteristics and age readings are summarised by month. The number of fish sampled for biological characteristics varies between 200 - 700 individuals. For months with no observers at sea, the biological characteristics of the adjacent months are used. In 2015 a system of self-sampling by the crew has been introduced which produces length distributions also for trips without observers on board.

Otolith Readings - So far the age labs (Chile, Perú, Netherland and China) are reading the otoliths annuli (rings with annual periodicity) to estimate age.
Chile: Validation based on 14C radiocarbon bomb techniques. A new protocol is under discussion for readings the first ring (by microstructure) and oldest rings (section of otoliths).

Age-length key - Chile: By 1 cm Fork length and 1 year-old ages. Minimum sample (based on statistical analysis) by quarter and area is about 200 otoliths.

Length frequency - Chile: Fork length are recorded with an ichthyometer (precision 1 cm), rounding to the nearest cm below. Samples for length are taken by randomly selecting 20 monthly trips per fishing zone. On land, the samples size is 80 - 100 individuals, whereas on board samples is about 100 to 130 fish per haul.

The basic unit of sample collection was a 25-kg bin that was filled at random according to the size of the specimens at the landing area. The compliance with the sample size is subject to the landing levels of the fleet, which, in certain periods of the year, are quite low due to the seasonality of the fishery, resource availability, weather conditions, or migration of the resource for reproductive purposes. Sample size by haul aprox = 80-100 on board by haul. Length frequency by quarters and area are weighted by catch.

For Dutch catches. Observers sample one or two catches per day. The length distribution of each catch is weighted by the size of the catch, and the total length composition of all sampled catches is calculated by summing all length distribution. This length composition is extrapolated to the total monthly catch using the ratio (total catch/sampled fraction total catch)

Mean weights per age groups - Mean weights are calculated using the mean length (age-length key), the allometric parameters and the bias correction (Pienaar & Ricker, 1968). For Dutch catches, individual fish are weighed at sea by observers, and mean weights/month/age are calculated. Expansion the length frequency to the catch at size by quarter and area. For expanding, the catch and the allometric parameters are estimated for each quarter and area. Whole matrix by zone is the sum of expanded catch at age matrices by areas.

Expert view on bias and precision

Chile: First ring (microstructure) and oldest rings (sectioned otoliths). Chile: Error between readers (periodically) for maintain reading criterion. Others possible biases (sample design).

- Name of otolith readers.
- Name of analysts that produce the catch at age/length matrices.
- Deadline. One month before the scientific meetings.
- Contact. Readers

CPUE

Data source

Details about the datasets that were used should be detailed, such as: data source, analysis period, fishing area, where and how the dataset was collected, fleet descriptions considering details about the fishing power changes in time and space, tables with main details about the effort distribution, for example in relative or absolute scale, distribution of hauls or trips by year and quarter/month, and year by vessel type/size, etc (as example see Table 1). Moreover, environmental factors such as temperature which may affect the habitat or catchability could be considered as well.

Models/approaches to be used

The models or approaches to be used should be described in details as be necessary in order to have a good understanding. For example the factors or effects that were used in a GLM, the link function, etc. Also, it will be important give details about criteria that was considered to select or exclude some factors from the analysis/model. As standards methods, models as GAM or GLM should be considered as analysis base.
Also, it is considered necessary to provide the details about how the annual effect as abundance indicator (CPUE) was estimated, including the details of its estimator.

Results

Tables with the statistical results should be provided (as ANOVA or ANDEVA), considering among others the significance criteria about the factors/ effects, and the levels within each factors. Deviance analysis, AIC criteria, and another statistical should be included. Also model's diagnostic measures should be considered. (As example see Figure 1, Table 2)

Figures and tables of main factors with confidence intervals, including the year effect, should be considered in a summarized way, providing clearly about the precision measures of these estimations (standard errors).

Acoustics

Instruments

Vessel type:

Definition of "research vessel": a ship equipped with at least one scientific echo sounder and where the survey design is elaborated by the scientist. Standardized.
Multiple-vessel surveys: several research vessels surveying jointly an area under a unique common design, mostly when areas are too large to allow a single ship survey, in order to fulfill the assumption that fish concentrations do not move during the survey. Standardized.
Type of instruments. Minimum requirement: one scientific split-beam single frequency echo sounder with standard frequency (120 or 38 kHz). In the near future multiple frequencies and/or broadband systems will be used. Within the SPRFMO area (open ocean excepting national jurisdictional waters), the use of 38 kHz should be recommended. Standardized.

Calibration

Standard calibration. Follows the protocol of Foote et al (1987) as updated and detailed in the ICES CRR 326. Standardized.
Inter-ship calibration. Performed for two reasons:
The signal to noise ratio of this ship. A very noisy ship will have a bad signal to noise ratio and therefore a poor capacity to record all the echoes of the fish population surveyed.
A "behavioral impact" which is the magnitude of avoidance reaction of the fish to this particular vessel.

Standardized: standard protocols for intercalibration can be found in the literature (e.g. protocol from SPRFMO task group, 2015).

Settings. The choice of settings (power, ping rate, pulse duration, etc.) depends on the local conditions and can be compensated for giving a standardized result in NASC. Standardized.
Units. A standard definition of units has been approved by the ICES WGFAST and published (MacLennan et al., 2002). Standardized.
Standard format of data. A standard format has been designed (HAC format) for data exchange, but working format depends on the software used. Standardized.
Software. The most common software is ECHOVIEW, although any other may provide HAC data. Standardized.

Data collection

Target strength. The basic formula used by the teams in the SPRFMO area is TS = 20 log L + C (Foote, 1981, see Simmonds and MacLennan, 2005). The equations used differ from one country to the other.
Peru: TS = 20 log L − 71.9 (Simmonds & MacLennan, 2005)
Chile: TS = 20.11 log L − 68.67 (Córdova et al. 1998)
EU: not documented
Korea: not documented
China: not documented
Russia: not documented
Two application methods exist: (1) considering a single common equation for the whole species; (2) apply local equations to local concentrations according to their own (expected different) meristic characteristics. The choice has not been decided yet and is to be discussed.
Types of data:
Raw data: digital echograms (in software and HAC formats)
Density data: two types are calculated, Sv and SA (NASC), see MacLennan et al., 2002). Standardized.
spatial distribution data : population distribution, school parameters, etc. No standardization so far.

Survey design

Target species. Should be recommended that CJM be considered as target species whenever possible. When target species different from CJM, some biases may occur and should be documented.

Sampling methods: data summarized by elementary distance sampling units (EDSU). Their length can vary according to local research, does not affect the general results. Standardized.
Survey design. Standardized.
Parallel equidistant transects.
Multiple-ship surveys when surveyed area too large; in this case intercalibration is performed.
Biological sampling. Ideally low selectivity pelagic trawls (this is the case for Chile and Peru, not for other countries that use commercial gear). Only biological characteristics (GSI, etc.), fish size and species proportions can be obtained through pelagic trawls (no information on density distribution). Standardized.
Behavioral characteristics (day/night, avoidance, vertical distribution, etc. : through expert analysis)

<u>biomass estimate</u>

Inside survey area (interpolation): standard methods (Simmonds & MacLennan, 2005) see diagram. Standardized.
Over the fish distribution area (outside the survey area): need for extrapolation, no bias-free method so far (expert view, potential habitat, use of additional data, etc.). In course
Statistical methods. Geostatistics (the only method taking into consideration regionalized variables: common to all teams) or systematic pre-stratification per elementary areas. Standardized.
Density allocation per species per /lengths / ages using trawl samples. Standard.
Precision: should include errors on all steps of the method (not only error on spatial distribution). Not yet standardized.
Accuracy: depend on the ships, seasons etc.

<u>Metadata</u>

The raw data in fisheries acoustics consist in chronological series of digitally sampled echo signals. This chronological series is then organized into a 3D matrix where y represents the succession of digital samples during a “ping”, x the succession of pings and z the echo intensity for each digital sample. This matrix is called the echogram and by convention time in axis y is transformed in depth (sound speed in water being almost constant) and time in x in distances (if the vessel speed is known).
Echograms are accompanied by the echo sounder settings; the time (in ms); the GPS coordinates for each ping; the calibration results; and other environmental informations. Biological samples (e.g. trawlings) are also included (Georeferenced and time-referenced proportion of species, fish length and weights, fish / plankton / micronekton abundances etc.). Echograms are standard and common to all teams (in the world).
Among the many metrics that acoustics can extract from this “echogram-metadata”, only biomass and abundance (per spp, length, area, year, etc.) are used in CJM management models.

Annex 3 – Description of data used in the assessment

Annual catch data

Historic catch data for the years prior to 2007 were initially provided to the (Interim) SPRFMO Secretariat under the 2007 interim data standards. As a result, the SPRFMO Secretariat holds catch data for all major fish species (including CJM) caught in the SPRFMO Area, in many cases reaching back to the 1970's. The data standards were later revised and the term "annual catch total" was introduced in the 2012 interim data standards. This term persists in the current Conservation and Management Measure 3.02 (data standards).

Members and CNCPs are to ensure that prior to 30th September each year, collated annual catch totals (raised to 'live' weight for all species/ species groups caught during the previous calendar year) are provided to the Secretariat (CMM 3.02, Para 1(a)). This information is stored in the SPRFMO database and a summary is available on the main SPRFMO website:
http://www.sprfmo.int/data/catch-information/

Annual catch data is composed of Calendar year, High Seas/EEZ, FAO Area, Species and live weight in kilograms. There are generally no confidentiality concerns and this data set is used as a basis for creating the historical landed catch series which is currently used in the SPRFMO CJM stock assessment.

The Science Working group initially spent some time checking the annual catch data series and the technical Jack mackerel annex, which accompanies the main report, contains a table showing the catch series used for each year's assessment. Members/CNCPs annual catch data is grouped into four fleets based primarily on gear type and area of operation. Fleet 1 (northern Chile) is a purse seine fishery generally catching CJM as a bycatch. Fleet 2 is a directed CJM fishery operating with purse seines situated mainly within the Chilean Zone, but which can also extend into the high seas. Fleet 3 operates solely within the Peruvian and Ecuadorian national zones while Fleet 4 is a trawl fishery that operates solely on the High seas.

SWG-10 split the former USSR catch into the separate fleets using a ratio provided by the Russian Federation; this same ratio was also applied to the Cuban catch record. Ukraine and Lithuanian catch records, although supplied separately, are not included for years prior to 1991 because they are also included in former USSR catch figures. As annual catch data are provided by Members generally updates are only done when Members/CNCPs submit revised datasets.

SC-01 made the decision that annual catch data prior to 1970 would not be used in the assessment. It should be noted that the SPRFMO Secretariat cannot currently split the Chilean total catch into the Fleet 1 and 2 proportions, this is because the annual catch data received by the Secretariat is split by High seas/EEZ and not by North/south proportion.

Catch by fleet – Chilean EEZ

Jack mackerel is exploited by the Chilean fleet mainly in two fishing areas in agreement with the SPRFMO assessment: in the north (roughly the area extending from Chile's northern border and parallel 26º 03'S) and the centre-south area (i.e. between parallels 32º 10'S and 43º 30'S). The fleet operating in the latter area operates both in Chile's exclusive economic zone (EEZ) as well as projecting into the high seas.

The northern fleet (F1) considers the Chilean catches reported by National Fisheries Services and grouped from Arica (norther limit of Chile) to southern of Coquimbo (around 32.10's). The catches of the fleet 2 (F2) considers all the catches grouped from 32.10's to 43º 30'S, caught only by Chilean fleet both in the EEZ and international adjacent waters.

Catch at age

Chile

Sampling and readings of otoliths

Independently the SPRFMO agreement about the 2 areas/fleets (north and south) considered for assessment purposes, on the annual jack mackerel fishery monitoring program, pairs of *sagitta* otoliths are monthly collected in 3 main zones: Zone 1: Arica (North boundary of Chile) – Antofagasta (24ºS); Zone 2: Caldera (25ºS) – Coquimbo (29ºS), and Zone 3: San Antonio (34ºS) – Valdivia (40ºS), are grouped in quarters. Sample selection is based on double sampling techniques (Kimura, 1977). The first stage considers a simple random sampling for length samples. The second one considers a random sampling stratified by length class, with age subsampling in proportion with catches size composition. A minimum of 300 otoliths are selected by zone-trimester stratum. Otoliths are collected per port (12 pairs per month per size range). The right otolith has been analyzed, transversally dissected, polished, and toasted for fish over 45 cm, in order to achieve a greater growth rings alternation, and thus, facilitating its reading. This technique has been used since mid of 70's.

Age-length keys (ALK)

An age group comprises all the fish born in the same year (annual class). The total number of years is based on the number of rings observed in the structure, the type of edge and the time of the year in which the sample was collected. The arbitrary date of birth is 1 January. The size-age key has a classification of the each otolith readings per age group. ALK is done by intervals of 1 cm Fork length and 1 year of age. Minimum sample (based on statistical analysis) by quarter and area is about 200 otoliths.

Length frequencies

A national fisheries monitoring program provides the base of length sampling of jack mackerel in Chile. The samples are collected at the main ports and fishing areas from the north of Chile (Arica) to 43º30'S. Jack mackerel specimens are sampled both on land and on board. Samples for length are taken by randomly selecting 20 monthly trips per fishing zone. On land, the samples for length include 80 to 100 specimens, whereas on board samples are made up of 100 to 130 specimens per haul. On land, the basic unit of sample collection is a 25-kg bin that was filled at random according to the size of the specimens at the landing area. A subsample is also considered to estimation of length-weight relationship and otoliths extraction among others biological variables. The length frequencies are aggregated by month and port. Later, the monthly structures in numbers are aggregated by zones and macro zones and the annual composition obtained. The expansion of length frequency to the catch at size by quarter and area is done based on allometric parameters estimated for each of these quarters and areas.

Catch at age

These have been elaborated considering that individuals present in each length interval are assigned to the different ages according to ALK. The length frequencies of the total catches come from each zone and quarter, and after are converted to age, once that the respective ALK is applied. Whole matrix by zone is the sum of expanded catch at age matrices by areas.

EU

For Dutch catches, a biological sample of 25 randomly selected fish is taken by observers while at sea. For all fish in the sample, length, weight and other biological characteristics are measured, and the otoliths are collected. The biological characteristics and age readings are summarised by month. The number of fish sampled for biological characteristics varies between 200 - 700 individuals. For months with no observers at sea, the biological characteristics of the adjacent months are used. In 2015 a system of self-sampling by the crew has been introduced which produces length distributions also for trips without observers on board.

Observers sample one or two catches per day. The length distribution of each catch is weighted by the size of the catch, and the total length composition of all sampled catches is calculated by summing all length distribution. This length composition is extrapolated to the total monthly catch using the ratio (total catch/sampled fraction total catch)

Catch at length

Peru

Sampling for estimating the length frequency distribution is done by IMARPE staff during the regular sampling program conducted by IMARPE in the main landing sites of the industrial and artisanal fleets distributed along the Peruvian coast. There are around 180 recognized landing sites and 10 IMARPE laboratories distributed along the Peruvian coast. Each laboratory covers between 8 and 18 landing sites guaranteeing a 100 % coverage of the (10) main landing sites used by the industrial fleet and a 60% coverage of the (180) main landing sites used by the artisanal fleet (108 total). These 108 landing sites are sampled for length frequency and other biometric and biological information of landings. Sampling is conducted on a daily basis and covers around 30% of the landing fleet in each sampled site. For species composition, if more than one species is observed the IMARPE observer takes a sample of 40-50 Kg from which the species composition by weight in the landing of the given vessel/day is estimated.

For jack mackerel the sample size for length frequency is 40 Kg and/or 120 individuals (whichever comes first). A standard aluminium measuring board is used in all cases for measuring fish length and the following data is recorded for each sample: name of vessel, geographical position of fishing area, hour and date of the landing, total catch (in tons), total sample weight taken from catch (in Kg), total weight by species in sample (in Kg), size frequency distribution, species and length type measured.

In the case of jack mackerel the total length is recorded to the nearest cm. Length frequency distributions are raised to the catch of the given vessel in the given day and landing site. These are then raised to the total jack mackerel catch of the day in each sampled site and for each landing site these are then aggregated by month, trimester and year.

Growth parameters

Several independent approaches have been used by IMARPE to determine the age and growth of the Peruvian Jack mackerel and to crosscheck results and parameters estimations, and all the approaches used have given reasonable and consistent results. Different methodologies of reading and measuring annual rings in otoliths have been used by Dioses (2013) and Goicochea et al. (2013) and Diaz (2013) estimated the growth parameters by length frequency analysis. The results of all these studies were strongly congruent confirming the estimates of the parameters of the von Bertalanffy growth function for the Peruvian Jack mackerel estimated by Dioses (1995, 2013) that have been in use since the 1990s, where: L_∞ = 80.77 cm total length, k= 0.1553 per year and to = -0.3562. These are the parameters used in the JJM and other applications. In addition, IMARPE collects and analyses a limited number of jack mackerel otoliths on an occasional basis to check if significant changes in length at age described by the above formulae occur finding so far no significant differences that would justify a full flesh review of the growth parameters currently in use.

CPUE

Chile:

Data source and treatments

Daily logbook records of the industrial purse-seine fleet in the centre-south of Chile for the years 1981-2015 were analysed. The studied zone considered three latitudinal strata: 32°10’S - 34°50’S; 34°50’S - 38°20’S and 38°20’S - 47°00’S, and three distance ranges from the coast: 0-100nm; 100-200nm; >200nm. The fleet was grouped into ten hold capacity strata: <250 m3; 250-350 m3; 350-500 m3; 500-600 m3; 600-750 m3; 750-850 m3; 850-910 m3; 910-1100 m3; 1100-1500 m3 and 1500-1850 m3, while the seasonality of the fishery allowed stratifying the months of operation, splitting them into quarters. The analysis measures the effort as a displaced hold capacity by the days out of port (m3).

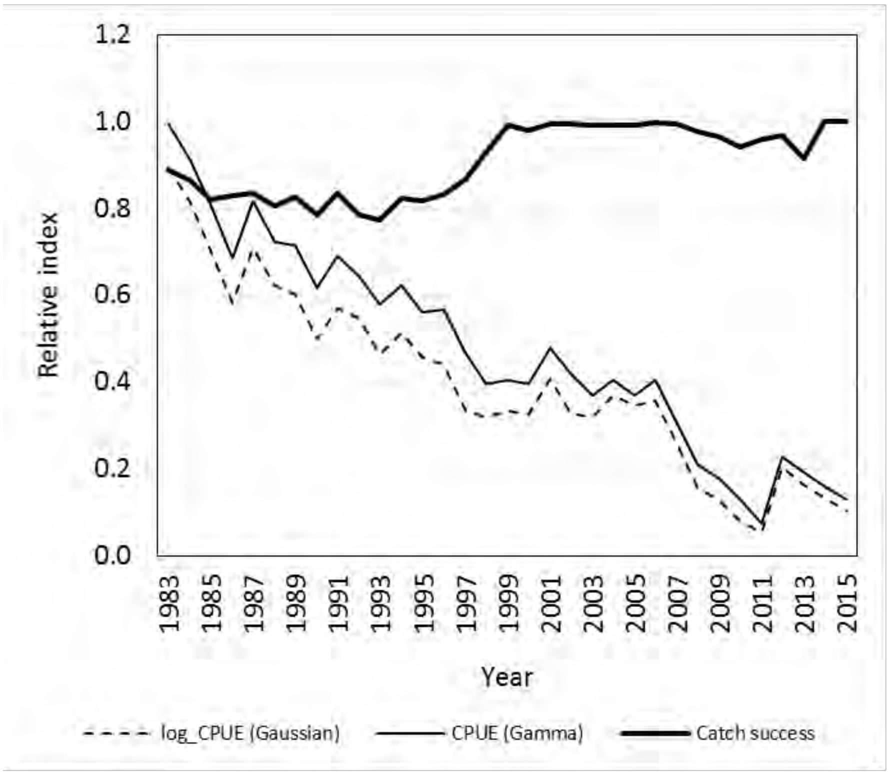
Data modelling

Generalized Linear Models (GLM; McCullagh & Nelder, 1989) were used to standardize the CPUE. Following this approach, CPUE is predicted as a linear combination of explanatory variables (year, hold capacity, quarter and zone), and the ultimate objective is to estimate the annual effect. Delta models were assessed (Pennington, 1983; Ortiz y Arocha, 2004) which allow separated modelling of the successful catch rates and the number of catch successes, where the index is obtained as the product between the proportion of fishing successes and the index estimated for the rates of fishing with catch (Lo et al, 1992). A deviance analysis was conducted to assess the importance of each main effect.

Results

Table 1. Relative distribution of the fishing effort on jack mackerel off Chile (Source: Canales, 2015).

	Distance from coast (nautical miles)								
	0-100 mn			100-200 mn			> 200 mn		
	Z11	Z21	Z31	Z12	Z22	Z32	Z13	Z23	Z33
1981	0%	100%	0%	0%	0%	0%	0%	0%	0%
1982	0%	100%	0%	0%	0%	0%	0%	0%	0%
1983	0%	99%	0%	0%	0%	0%	0%	1%	0%
1984	0%	100%	0%	0%	0%	0%	0%	0%	0%
1985	0%	100%	0%	0%	0%	0%	0%	0%	0%
1986	0%	100%	0%	0%	0%	0%	0%	0%	0%
1987	0%	100%	0%	0%	0%	0%	0%	0%	0%
1988	1%	99%	0%	0%	0%	0%	0%	0%	0%
1989	1%	98%	1%	0%	0%	0%	0%	0%	0%
1990	11%	86%	2%	0%	0%	0%	0%	0%	0%
1991	11%	86%	3%	0%	1%	0%	0%	0%	0%
1992	17%	71%	8%	1%	3%	0%	0%	0%	0%
1993	16%	62%	11%	1%	8%	1%	0%	1%	0%
1994	19%	52%	21%	2%	5%	2%	0%	0%	0%
1995	26%	49%	9%	9%	6%	0%	0%	1%	0%
1996	9%	63%	13%	6%	7%	1%	1%	0%	0%
1997	6%	56%	23%	0%	2%	1%	1%	10%	0%
1998	1%	44%	46%	0%	1%	4%	0%	3%	0%
1999	5%	47%	34%	1%	11%	2%	0%	0%	0%
2000	1%	56%	19%	0%	15%	5%	0%	4%	0%
2001	3%	67%	25%	0%	4%	0%	0%	0%	0%
2002	6%	38%	33%	1%	11%	8%	0%	1%	2%
2003	1%	24%	22%	0%	18%	5%	5%	17%	8%
2004	7%	25%	39%	0%	2%	3%	6%	9%	9%
2005	26%	13%	18%	2%	1%	10%	10%	10%	11%
2006	15%	17%	16%	5%	19%	12%	5%	4%	7%
2007	15%	7%	13%	3%	6%	11%	9%	25%	11%
2008	16%	3%	6%	1%	1%	6%	1%	15%	51%
2009	18%	12%	4%	7%	10%	2%	1%	8%	40%
2010	26%	7%	8%	3%	1%	0%	0%	6%	48%
2011	37%	9%	19%	3%	0%	2%	0%	1%	29%
2012	9%	59%	6%	11%	15%	0%	0%	0%	0%
2013	21%	33%	2%	20%	25%	0%	0%	0%	0%
2014	17%	20%	19%	3%	31%	6%	0%	1%	1%
2015	41%	4%	1%	37%	8%	0%	1%	0%	8%



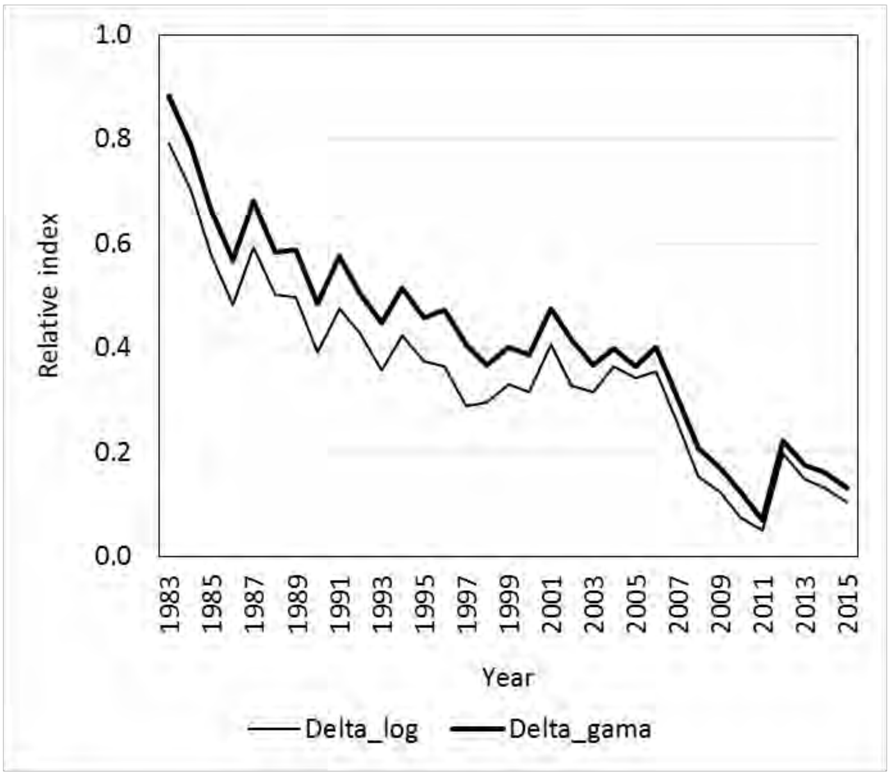


Figure 1. Relative Abundance indexes for Jack Mackerel for fleet F2.

Peru

For use in the JJM analyses Peru has been providing CPUE data from its industrial purse seine fleet. For this fleet, through its sampling and data collection system, IMARPE gathers information on total catch and general fishing areas by trip from 100% of the industrial purse seine fleet. This information provides monthly estimates of CPUE in catch/trip totals, by landing site and by general fishing areas, which can be standardized by hold capacity. In addition, IMARPE has an on-board observer programme that covers 10% of the industrial purse seine fleet, where vessels to be sampled are chosen randomly by day and landing site. These on-board observers fill a detailed logbook including information on the name of vessel, initial and final date-time of trip, total catch, number of sets, position (latitude and longitude) of each set, duration of each set, sea surface temperature at set site, species composition by set, length frequency distribution of main target species, etc. This logbook information provides estimates of CPUE in catch/set, catch/hours per trip and catch/searching time, for the whole fleet totals, by landing site and by general and more detailed fishing areas, which can all be standardized by hold capacity.

In addition, IMARPE also gathers information to estimate CPUE form the artisanal and small-scale fleet, which are used in some of IMARPE's analyses although which are not used in the JJM analyses within the Scientific Committee. CPUE data from this fleet is gathered through IMARPE's sampling and data collection system that covers 60% of the landing sites used. This information provides estimates of monthly CPUE in catch/trip totals, by landing site and by general fishing areas, which might be standardized by hold capacity but with large uncertainty at present.

For use in the JJM by the Scientific Committee, the Peruvian CPUE input data from the industrial purse seine fleet is standardized using a GAM model, allowing the inclusion of non-linear relationships between the explained and explanatory variables. The independent variable (catch by trip) in a monthly scale is normalized using the Box-Cox transformation and is then modelled using time (Gregorian), month, hold capacity, latitude, and distance to the coast as explanatory variables. The standardized CPUE is then estimated fixing the hold capacity, latitude, and distance from the coast to the median value and the month to March, assuming the continuous time captures the variability in the abundance of Jack mackerel.

EU

The CPUE for the EU fleet is calculated as the total catch divided by the total number of fishing days for the whole year. This method is based on the following considerations.

Fishing effort in the pelagic trawl fishery cannot be simply expressed in number of fishing hours. Depending on the concentration of the fish in schools, the duration of the haul may vary between 15 minutes and 8 hours. The CPUE in tons/hours is a measure of the concentration of the fish in schools, rather than the average density in the fishing area. Therefore, as a measure of stock abundance, the number of fishing days is used, which is a more robust estimator of fishing effort. We use as fishing days the number of days in which a haul has been reported. In theory, days in which the vessel has been searching but not made a trawl set, should also be counted as fishing effort. However, on the "fishing activity" forms, searching days cannot be distinguished from days in which the vessels has been inactive because of bad weather or transhipment of catches. Therefore only the days are counted when the vessels has actually performed at least one haul.

The data are not corrected for vessel, season and area. Since 2012, there have only been one or two EU trawlers in the area each year. The vessels change between years; the fishing season varies between years, and also the fishing area is different from year to year. Ideally the CPUE should be standardised for all these variations.

China

Data collection and treatment

Catch and effort data were collected from logbooks of Chinese fleets form 2001 to 2014. Information recorded in the logbooks include: name of the trawler, operational date, tow start and finish, catch per fishing net, start point and end location in latitude and longitude, trawling speed and direction. Environmental data including monthly sea surface temperature, sea surface height and chlorophyll-a concentration and Nino 3.4 index. El Niño and La Niña events (ELEs) were expressed as 1 and −1, respectively, while in normal years, the value of monthly ELE was 0. Each fishing vessel was coded and used as the category variable to characterize the catch efficiency. All CPUE data were transformed by adding 0.1 and then log-transformed.

GAM modelling and analysis

Temporal (Year and Month), spatial (Longitude and Latitude), fishing technological (Vessel code) and environmental factors (SST, SSH, Chl-a and Nino3.4 index) are the explanatory variables, and the natural logarithm of the Chilean jack mackerel catch-rate +0.1 is the response variable. The categorical variables Year, Month, Vessel code and ELE were the factors in GAMs, whereas the others were used as continuous variables (covariates). The identity link function was used with the Gauss distribution for the response variable ln(CPUE+0.1).
Q–Q plot was used following the application of a model to determine whether the residuals are consistent with the error distribution assumed. An F test is usually used to decide whether the factor of explanatory variable should be or not added in the GAM and AIC was used to confirm the final model structure or the best model.

Russia

To be completed after the meeting

Acoustic survey

Chile

Since 1984, acoustic surveys focused on the north of Chile, covering the area that extends from Chile's northern border and parallel 30°00'S, up to a maximum distance of 200 nautical miles from the coast. As of 1991, as a result of the jack mackerel fishery's greater significance in the centre-south area, the acoustic survey program included –on a regular basis– jack mackerel in the area ranging from parallel 33°00'S to parallel 42°00'S, the western boundary of which has been extended in some sectors up to 800 nautical miles from the coast. A systematic design has been employed for assessing the biomass and distribution of jack mackerel at the northern and southern of Chile, following equidistant transects perpendicular to the coast with a separation of 25 nm, with some variations depending on the presence of jack mackerel.
An echo sounder Simrad EK-60 has been used for these surveys. The acoustic information is the value of average density, expressed in the volume of backscattering in a nautical square mile (Sv), and the values of intensity of target strength (TS) of jack mackerel detected inside the integration limits of the sampling basic unit. The species identification from the acoustic echograms is realized by two methods. The first consists of the analysis of the echo traces by considering the jack mackerel behaviour and the coefficient backscattering volume (Sv). The second is the interpretation of echograms joint to the mid water fish catch. This information is complemented with the catch of the purse-seine fleet, when they coincide in space and time with the development of the survey. The jack mackerel biomass is estimated as the product of the area distribution of jack mackerel, mean density of the integration units (Sa) in the distribution area, the average weight of the jack mackerel in the area and mean target strength (TS).

Peru

The acoustic surveys to estimate distribution and biomass or abundance indexes of pelagic fish resources in Peruvian waters are primarily targeted on anchoveta but also include other commercially important species such as jack mackerel, jumbo squid and others. These acoustic surveys have been conducted on a regular basis by IMARPE since 1983, basically maintaining the same area coverage along the whole Peruvian coast (03° 20'S to 18°18'S) from 3 to 80 nm from the coast (sometimes up to 120 nm distance from the coast when anchoveta is more widely distributed). The surveys follow systematic parallel tracks (Johannesson and Robles 1977; MacLennan and Simmonds, 1992) perpendicular to the coast with inter-track distance between 12 and 17nm. Various research vessels have been used through time, including the Peruvian R/V SNP-1, R/V Humboldt, R/V Jose Olaya and R/V SNP-2. Also, in 1990 a joint acoustic survey was conducted with the ex-USSR R/V Nansen. During earlier surveys IMARPE used analogical scientific sounders SIMRAD EK, EKS and echo integrator Hewlett Packard. Digital scientific sounders SIMRAD

EK 500 and EK60 working in frequencies 38, 120 and 200 kHz, supported with Echoview processing software are used in more recent years.
A calibration exercise is made at the start of each acoustic survey to calculate instrument constant (Ci). Since 1992 the calibration is made with standard targets (Foote et al. 1987; SIMRAD 1991, 2012), using copper spheres of 23.0 mm (for 38kHz), 60.0 mm (for 120 kHz) and 13.7 mm (for 200kHz). Also, whenever more than one research vessel is used in the same survey the performance of the on-board acoustic systems is standardized by inter-calibration between research vessels sailing in parallel and close to each other, running simultaneous echo integration.
The acoustic sampling is through the Echo integration Sampling Distance Unit (ESDU) method, which integrates the signal or echo over a distance of 1 nm at a speed of about 10 knots giving a Nautical Acoustic Scattering Coefficient (NASC) per each 1 nm. Fishing operations are carried out to identify echo-traces and perform biological sampling. These are conducted with a mid-water trawl with effective tow duration of 15 to 30 minutes, depending on the density and number of schools. The behaviour of the fishing net is monitored with a net sounder.
The separation of the integrated values by species is done by direct recognition of the shoals and/or by assigning values based on the results of the fishing operations (Simmonds and Mac Lennan 2005). Integrated values of Nautical Area Backscattering Coefficients (NASC) or SA (m2/mn) are then separated by species, concentration and distribution areas and are interpolated with Surfer software (Kriging method) (Gutierrez 1997). Four abundance categories are used to identify concentration levels: highly dispersed (0-10 m2/nm); dispersed (>10-100 m2/nm); dense (>100-1000 m2/nm); and, very dense (>1000 m2/nm).
Biomass or abundance indexes are calculated by IMARPE's isoparalitoral areas (bound by 0.5° latitude intervals at the top and bottom and 10 nm distance from the coast intervals on the sides). These areas are defined in digital format (Gutierrez and Peraltilla, 1999). Calculations are done with the software R. The processing to estimate biomass can be divided in two periods. Between 1983 and 1991 the biomass was estimated from the product of the area of each layer (abundance categories), the integrated average values of the species in the given layer and the calibration constant. This calibration constant was estimated for each survey through electronic and acoustic measurements of live fish in a cage (Johanesson and Vilchez, 1981). From 1992 to-date the standard target calibration (copper sphere) is used to calculate the target strenght (TS) from fish length (L) using the following formulae for jack mackerel. From 1992 to 1997:
TS = 20 log L – 71.9 dB for 38 kHz (Foote, 1987)
And from 1998 to date: TS = 20 log L – 70.8 dB for 120 kHz (Gutiérrez et al., 1999, Castillo et al. 2009)
When total biomass is estimated, this is first done for each isoparalitoral area referred as one stratum, and is calculated using the Backscattering Coefficient Area (?) and the formulae published in Segura and Aliaga (2013). Three acoustic indices have been used by Peru during the JJM assessments:

a) The acoustic biomass, which is directly estimated as described above from the summer surveys;

b) The standardized acoustic index, which aims at correcting the observed biomass by using the potential habitat of jack mackerel. This index was estimated by modelling the presence and absence of Jack mackerel in the South-eastern Pacific from a series of environmental variables like Sea Surface Temperature (SST), Sea Surface Salinity (SSS), water masses (WM), oxycline depth (OD) and chlorophyll (CHL); and,

c) The echo-abundance, which is estimated directly as the mean value of all the Nautical Area Backscattering Coefficients (SA) recorded during the acoustic surveys. It has been noted that the biomass estimates in the above indexes relies on the use of jack mackerel length frequencies for each stratum (to estimate target strength), which cannot always be collected properly during these surveys. Under these circumstances, it is assumed that the SA is a better proxy of the actual abundance and this has been used in the most recent Peruvian assessments.

Egg survey

A monitoring program has been conducted simultaneously and synoptically (8 days) both inside and outside the EEZ up to a distance of 1000 nautical miles (parallel 92ºW) of Chile's central area. The results of this program provide relative estimates of the spawning biomass using the Daily Egg Production Method (DEPM) (Lasker, 1985). The spawning biomass thus estimated is used in the Jack mackerel stock assessment.

These surveys have been carried out in the second half of November, i.e. the period of highest reproductive activity. The area under study extends over a quadrant defined by parallels 31°40'S and 38°S and meridians 75°W and 92°W. Fishing vessels are used to perform 20 transects perpendicular to the coast separated by a distance of 20 nautical miles (n.m.). They take samples every 18 n.m. In total, the study collects samples of ichthyoplankton in over 700 oceanographic stations in the area under analysis.

Maturity parameters

Chile

The maturity at age comes from Leal et al (2013). In this work, the spawning period, length and age at maturity of jack mackerel (Trachurus murphyi) in the Chilean coast were analysed. For the maturity at age study of both sexes, along with the gonadal tissue, the otolith of each specimen started to be extracted since September (2011). Age was estimated through the growth rings of these structures. A logistic model was used to describe the mature specimens at length and at age. Here, the histological gonadal inspection confirmed that reproductive period of this species ranges between September and January. During the spawning season of 2011 the length at maturity (L50) of females was estimated in 22.7 cm fork length (FL) equivalent to an age of 2.44 years (E50). The authors indicate females reached full maturity between 24 and 25 cm FL, around 4 years old. The length at maturity in females did not show significant differences from previous estimates conducted through histological analysis.

Peru

Maturity parameters come from the results of recent studies by Perea et al. (2013) with samples and data from 1967 to 2012. The size at first maturity has been estimated in the range of 25-27 cm total length, equivalent to an age of 2 years. An important observation from these analyses is that this size at first maturity has remained nearly unchanged throughout the observed period (1967-2012) in spite of the observed large and long-term environmental and stock size changes. Samples for estimating monthly maturity stages by sex and size (total length) are taken as part of the regular sampling program conducted by IMARPE in the main landing sites of the industrial and artisanal fleets distributed along the Peruvian coast. Maturity at age is estimated by converting length to age using the growth parameters in use by Peru as described by Dioses (1995, 2013), Diaz (2013) and Goicochea et al. (2013).

Time of spawning

Chile

By analysing the gonad somatic index (GSI), estimated from the National Fisheries Monitoring Program carried out by IFOP, the period of maximum reproduction activity has been estimated in late spring and summer (November-December of each year), which is also reflected in the ratio of sexual maturity of females. For simplicity, the spawning time has been supposed at mid of November.

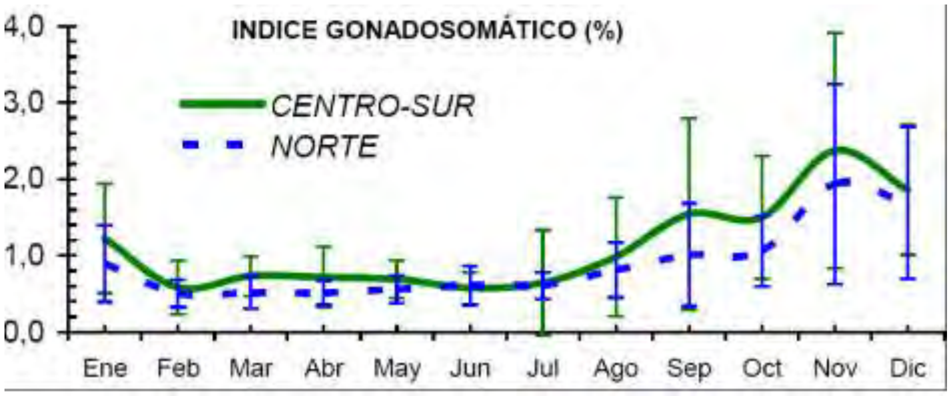


Figure 2. Maturity proportion and gonad somatic index of jack mackerel by month and zone.

Peru

The spawning cycle of the Peruvian jack mackerel extends from August to February, with a peak in November (Perea et al. 2013). This cycle is more flatten, extends over a longer time-period and is a bit out of phase with respect to what is observed for Jack mackerel off the Chilean central-southern region, whose spawning cycle is much shorter and peaks at higher values a bit latter. The spawning activity of the Peruvian Jack mackerel seems to be strongly influenced by the high environmental variability typical of this part of Southeast Pacific causing a more extended duration and increased variability in the timing of the spawning season. Time of spawning was determined after the monthly gonadosomatic index (GSI) of jack mackerel was calculated from a sample of 145,466 fish collected between 1967 and 2012 along the whole Peruvian coast. The monthly mean values show a clear peak in November, and this is taken as the time of (peak) spawning for the Peruvian jack mackerel stock. The method and detailed results are published in Perea et al (2013).

Natural mortality

The estimation of natural mortality (M) for jack mackerel as used in the JJM model was discussed at SWG-11 in Lima, Peru. Methods like Pauly (1980) and Hoening (1983) were tested. Peru presented Jack mackerel growth parameters including on which an estimate of M at 0.33 for the Far North was based. Taking a similar approach using a functional relationship between growth parameters and natural mortality, Chiles's estimate of M for its Area was 0.23.
An average of natural mortality was used for combined JJM model scenario (M=0.28) as model runs showed that (for the single stock scenario) the model fit was improved when natural mortality was increased from 0.23 to 0.28.

Ageing error

The ageing error matrix used in the jack mackerel stock assessment was simulated and assumed in a stock assessment Workshop carried out in Chile in 2008. Recently an ageing error matrix based on real data was prepared and was made by cross readings of otoliths (two readers, the same sample).

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

Calculated						Age (yrs)					
	1	2	3	4	5	6	7	8	9	10	11	12+
1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.71	0.24	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.21	0.52	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.07	0.20	0.47	0.30	0.05	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.04	0.29	0.42	0.32	0.18	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.02	0.27	0.46	0.27	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.36	0.38	0.25	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.14	0.13	0.25	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.25	0.25	1.00	0.20
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.20
12+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.60

Annex 4 - Data Workshop Agenda

1. Welcome and Introduction

   This workshop was convened to review and document all data components used for assessment purposes and to evaluate strengths and weaknesses of each, including a relative scale to be used for input into the assessment. As the SC currently only has one agreed assessment process this workshop will necessarily focus on Jack mackerel datasets.

2. Administrative Arrangements
   - 2.1. Adoption of Agenda
   - 2.2. Meeting documents

3. Data collection and availability discussion
   - 3.1. Identify and describe each dataset[1] currently used for assessment purposes in SPRFMO
   - 3.2. Select specific datasets to discuss in-depth throughout workshop
   - 3.3. Describe data collection process and data raising procedures
   - 3.4. Identify any confidentiality and accessibility issues
   - 3.5. Identify other datasets (qualitative and/or quantitative) with potential assessments uses

4. Data quality discussion
   - 4.1. Define data standardization procedures, raising and product estimation
   - 4.2. Apply standardization procedures to specific datasets identified in 3.2 (others if time allows)
   - 4.3. Describe and estimate precision & bias of datasets identified in 3.2

5. Data protocol description and processing discussion
   - 5.1. Describe data delivery protocol to SC and/or Secretariat
   - 5.2. Discuss dataset storage protocol
   - 5.3. Discuss and define a protocol on treatment of historic data revisions
   - 5.4. Apply protocols on specific datasets identified in 3.2
   - 5.5. Store datasets as agreed and make available where appropriate

6. Applicability of workshop discussions to other SPRFMO fishery resources

7. Adoption of Report
8. Meeting Closure

[1] The following page contains a preliminary list of datasets. Participants are encouraged to review this list in preparation for the workshop.

The SPRFMO 2015 Data Workshop

Port Vila, Vanuatu
24 - 26 September 2015

Preliminary list of Datasets to be considered at the Data Workshop

After, or during, the workshop, the following data types will be discussed, methods of standardization defined, and processed accordingly.

Survey data

- CPUE
  - Standardization
  - Time-series documentation
  - Data processing procedure
  - Precision estimates
  - Timing of survey
  - Weight-at-length / weight-at-age estimation
- Acoustic surveys
  - Data collection procedure
  - Data processing procedure
  - Time-series documentation
  - Precision estimates
  - Timing of survey
  - Weight-at-length / weight-at-age estimation

Biological data

- Age-length keys
- Growth estimation
- Weight-length keys
- Maturity-at-age
- Natural mortality-at-age
- Weight-at-age at spawning time
- Time of spawning
- Ageing error

Catch data

- Landings
- Catch weight-at-age
- Catch length composition
- Timing of fisheries
- Spatial distribution of fisheries

Annex 5 – List of participants

SPRFMO Scientific Committee Data Workshop

CHAIR

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

MEMBERS

AUSTRALIA

Name: Peter WARD
Organisation: Australian Bureau of Agricultural and Resource Economics and Sciences
Address: GPO Box 1563, Canberra ACT 2601, Australia
Email: peter.ward@agriculture.gov.au

CHILE

Name: Maria Angela BARBIERI
Organisation: Undersecretariat for Fisheries and Aquaculture
Address: Bellavista 168, 16th Floor, Valparaiso, Chile
Email: mbarbieri@subpesca.cl

Name: Mauricio GALVEZ
Organisation: Undersecretariat for Fisheries and Aquaculture
Address: Bellavista 168, 14th Floor, Valparaiso, Chile
Email: mgalvez@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: SONAPESCA
Address: L.Thayer Ojeda 166 OF.902 Santiago, Chile
Email: andrescouve@entelchile.net

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

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

Name: Aquiles SEPÚLVEDA
Organisation: Fishery Research Institute
Address: Av. Colón 2780 Talcahuano, Chile
Email: asepulveda@inpesca.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

ECUADOR

Name: Edwin MONCAYO
Organisation: National Institute of Fisheries
Address: Letamendi 102 y La Ria, Guayaquil
Email: direccion_inp@institutopesca.gob.ec

Name: Viviana JURADO
Organisation: National Institute of Fisheries
Address: Letamendi 102 y La Ria, Guayaquil
Email: vjurado@institutopesca.gob.ec

EUROPEAN UNION

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

Name: Francois GERLOTTO
Organisation: Institut de Recherche Poor le Development
Address: Le Jardin aux Fontaines G1, 9 rue de Nagareth, 34090, Montpellier, France
Email: francois.gerlotto@gmail.com

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

NEW ZEALAND

Name: Martin CRYER
Organisation: Ministry for Primary Industries
Address: 25 The Terrace, PO Box 2526, Wellington, New Zealand
Email: martin.cryer@mpi.govt.nz

VANUATU

Name: Gerry GEEN
Organisation: Vanuatu Department of Fisheries
Address: Vanuatu
Email: ggeen@bigpond.net.au

COOPERATING NON-CONTRACTING PARTIES

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

UNITED STATES OF AMERICA

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

SECRETARIAT

Name: Craig LOVERIDGE
Organisation: SPRFMO Secretariat
Address: PO Box 3937, Wellington, New Zealand
Email: cloveridge@sprfmo.int

Annex 6 – References

Bernal C., A. Aranis, C. Martinez and C. Canales. 2008. Catch size compositions for jack mackerel (*Trachurus murphyi*) off Chile (1975-2006). Chilean jack mackerel workshop (CHJMWS). Paper 12. Instituto de Fomento Pesquero.

Canales C. and R. Serra. 2008. Brief description of the jack mackerel sampling in the Chilean fisheries. Document SPRFMO-V-D&IWG. Guayaquil, Ecuador.

Castillo, P.R., S. Peraltilla, A. Aliaga, M. Flores, M. Ballón, J. Calderón & M. Gutiérrez, 2009. Protocolo técnico para la evaluación acústica de las áreas de distribución y abundancia de recursos pelágicos en el mar peruano. Versión 2009. Informe Inst. Mar Perú, 36(1-2): 7-28.

Díaz, E. 2013. Estimation of growth parameters of Jack mackerel *Trachurus murphyi* caught in Peru, from length frequency analysis. In: J. Csirke, R. Guevara-Carrasco & M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. peru. biol. special issue (published in Spanish with titles, abstracts and captions in English), 20 (1): 061-066

Dioses T. 1995. Análisis de la distribución y abundancia de los recursos jurel y caballa frente a la costa peruana. Inst. Mar Perú. Inf. Progresivo Nº 03: 55p

Dioses, T. 2013. Age and growth of Jack mackerel *Trachurus murphyi* in Peru. In: J. Csirke, R. Guevara-Carrasco & M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. peru. biol. special issue (published in Spanish with titles, abstracts and captions in English), 20 (1): 045-052

Foote, K.G., Knudsen H.P., Vestnes G., MacLennan D.N. and Simmonds, E.J. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. Int. Coun. Explor. Sea Coop. Res. Rep. No. 144. 69 pp

Foote, K.G., 1987. Fish target strengths for use in echo integrator surveys. Journal of the Acoustical Society of America 82:981-987.

Goicochea, C., J. Mostacero, P. Moquillaza, T. Dioses, Y. Topiño & R. Guevara-Carrasco. 2013. Validation of the formation rate of growth rings in otoliths of Jack mackerel *Trachurus murphyi* Nichols 1920. In: J. Csirke, R. Guevara-Carrasco & M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. peru. biol. special issue(published in Spanish with titles, abstracts and captions in English), 20 (1): 053-060

Gutierrez, M., 1997. Aplicación de software de interpolación en las evaluaciones hidroacústicas de la biomasa y distribución de los recursos pelágicos. Inf. Prog. Inst. Mar Perú 67: 21-30.

Gutiérrez, M. & S. Peraltilla. 1999. Aplicación de un sistema de información geográfica y de la carta electrónica isoparalitoral en las evaluaciones hidroacústicas de las biomasas de recursos pesqueros en el litoral peruano. Inf. Inst. Mar Perú 146: 25-29.

Johannesson, K. & A. Robles. 1977. Echo surveys of Peruvian anchoveta. Rapp. P.-V. Réu. Cons. Int. Explor. Mer., 170: 237-244.

Johannesson, K. & R. Vilchez. 1981. Application and some results of echointegration methods of monitoring Peruvian anchovy resources. In: J. Suomala (Ed.). Meeting on hydroacoustical methods for the estimation of marine fish populations, 25-19 June, 1979. Charles Stark Draper Laboratory Inc. Cambridge, MA. Vol. 2b: pp. 756-816.

Leal E, E. Díaz, J.C. Saavedra-Nievas and G. Claramunt, 2013. Reproductive cycle, length and age at maturity of jack mackerel *Trachurus murphyi*, in the Chilean coast. Revista de Biología Marina y Oceanografía, Vol. 48, Nº3: 601-611.

MacLennan, D. & J. Simmonds. 1992. Fisheries Acoustics. London, Chapman and Hall Eds. 325pp.

Perea, A., J. Mori, B. Buitron & J. Sánchez. 2013. Reproductive aspects of Jack mackerel *Trachurus murphyi*. In: J. Csirke, R. Guevara-Carrasco & M. Espino (eds). 2013. Ecology, Fishery and Conservation of Jack mackerel (*Trachurus murphyi*) in Peru. Rev. peru. biol. special issue (published in Spanish with titles, abstracts and captions in English), 20 (1): 020-034

Piennar, L. V. and W. E. Ricker. 1968. Estimating mean weight from length statistics. J. Fish. Res. Board Com. 25:2743-2747.

Segura, M. & A. Aliaga. 2013. Biomasa acústica y distribución del jurel *Trachurus murphyi* en el Perú. Rev. peru. biol. número especial 20(1): 087- 096

Simmonds, E.J. & D.N. MacLennan. 2005. Fisheries acoustics, theory and practice. Blackwell Science: 472 pp.

SIMRAD. 1992. Instruction Manual, Simrad EK 500 scientific echo sounder. P217E. Calibration of the EK 500 P2260E. Simrad Norge AS. Norway: 15-16

SIMRAD. 2012. Reference Manual, Simrad EK60 scientific echo sounder. Calibration of the EK 60. Kongsberg Maritime AS: 36-49.