Report from the assessment simulation task team on Chilean jack mackerel stock assessments

April 6-9th 2010
IMARPE, Lima Peru

1 Introduction

1.1 History of the ASTT

The Assessment Simulation Task Team (ASTT) was created in 2009 during the Chilean Jack Mackerel Assessment Methods Workshop in Lima (SPRFMO 2009). At that workshop, participants found it hard to reach agreement on a standard assessment methodology to be used for future assessments of jack mackerel. The various models presented at that meeting were widely different, and participants were unable to judge which of the models would be most suitable to be used as a standard model for future jack mackerel assessments. To solve this problem, it was proposed to apply all existing models on a set of simulated data, and to see how accurate the various models were in estimating the underlying hypothetical population. The task to conduct this simulation experiment was delegated to a subgroup of the workshop, the Assessment Simulated Task Team.

The ASTT subsequently invited Dr. Jim Ianelli of the Alaska Fisheries Science Centre to construct the necessary set of simulated data. Dr. Ianelli kindly agreed to take on this task, and in the following months, he prepared a simulated data set based on a hypothetical population that bore some resemblance to the Pacific jack mackerel (as described in ASTT-07). The simulated data set was refined using feedback from the ASTT members, and in October 2009 the definite set of simulated data was distributed to the members of the ASTT. By that time, it was too late to run the existing models with the simulated data before the start of the SPRFMO Science Working Group in Auckland in November 2009. Hence the simulation experiment was postponed until early 2010, and it was decided that the ASTT should have an inter-sessional meeting during the first half of 2010 to consider the results of the experiment.

1.2 Meeting arrangements

The meeting was organised from 6 – 9 April 2010 in Lima, Peru. The Peruvian institute IMARPE had kindly offered to host the meeting. The meeting was opened by President of IMARPE. The meeting was chaired by Ad Corten and the rapporteurs were Jim Ianelli and Ulises Munaylla. The agenda is provided in Annex 1 and the list of meeting participants in Annex 2. A list of all working documents provided to the meeting s provided in Annex 3

1.3 Terms of reference

To review results of jack mackerel assessment trials and select assessment methodologies and approaches to conduct assessment using real data (Report of SWG 8).

1.4 Simulation background

Table 1 summarizes the data provided to members on October 20th, 2009. Details of the simulation model and the equations for the simulation model are presented in ASTT-07. Examples of the variability of the datasets are shown in Figures 1 and 2.

2 Summary of stock assessment approaches

Four assessment models were applied to the simulated datasets. Table 2 shows the elements considered for the different models as developed during the meeting. The following summarizes these models and approaches.

2.1 Statistical Catch-Age model (SCA)

This model (contributed by the Chilean scientists) retains the statistical information and used each data source listed in Table 1. This statistical catch-age model uses a combination of age composition likelihoods (multinomial) from surveys and fisheries together with biomass indices modelled as being log-normally distributed (details were provided in ASTT-04). The data were screened for characteristics prior to applying the model. This provided a means to develop hypotheses on whether selectivities may have changed substantively over time and whether selectivity appears to be dome-shaped. A number of alternative model configurations were thus developed and tested. Two models involved using the continuous form of the catch equation with annual *F*s being estimated (so-called "F model") or using Pope's approximation where catch is removed at mid-year (so-called "U model"). The other factor evaluated was between using constant selectivities by fleet or varying selectivities by blocks of years. Based on considerations of computation time and apparent fits to the data (versus number of parameters estimated) the authors selected the "U-model" with varying selectivity. For the simulated datasets under this scenario, 63 parameters were estimated. The authors used MATLAB running on PCs for development and implementation of this model. The execution time was generally less than one minute per estimation.

As a supplement, a model developed for several Alaska stocks (and implemented in ADMB) was applied to the simulated datasets. This was done for contrast acknowledging that the model specification was very close to the simulation and is meant to serve as a reference model. This model is an extension of the SCA approach and is labelled as SCA-Ref,

2.2 Evolutionary model

A monthly-time step model (presented by Peruvian scientists) that explicitly included size-based dynamics (for selectivity and natural mortality) was applied to the simulated datasets (ASTT-09). The magnitude and size (length) of "age 0" recruitment were parameters that were estimated in each year. Uniquely, the model employs a "fitness function" and uses a genetic algorithm for estimation purposes (Duboz et al. 2010). For the runs presented, age composition data were not used and only the acoustic survey data (index 2) was applied. Four preliminary alternative scenarios were evaluated which compared how different catches by fleet were aggregated in the tuning and whether or not to estimate different biological parameters over different regimes. These scenarios were developed to evaluate the calibration characteristics. Unlike the other models, this approach used the effort time series to assist in estimating the annual *F*s by fleet (i.e., effort was used to capture the inter-annual range over which the algorithm searches for fishing mortality).

The selected model estimated 200 parameters and the authors used R running on PCs and multi-processor machines for development and implementation of this model. Convergence time for a single estimation run was on the order of 1 hour (on a typical PC) but much more quickly on a workstation (on the order of a few minutes).

2.3 ICA model

This model, presented by a Dutch scientist, extends classical VPA analyses by applying a traditional backwards-calculation mapping total catch-at-age into historical abundances at age for the early period. For a selected recent period, a forward mode of the model is applied which provides separability estimates that help tune recent fishing mortality estimates. Results from this analysis are presented in (ASTT-08).

The data were screened prior to applying the model. In particular, this was critical for determining when to begin the "separable period." The acoustic index alone was applied and all ages were treated as being fully available to this gear (Fig. 2).

This model exists in FORTRAN and runs under FLR (a library of R routines developed fisheries research) and source code for both are freely available. Due to the algorithmic form of the model (where catches are assumed to be known exactly for the VPA period) the execution time for solutions requires only a few seconds.

2.4 TISVPA

The "Triple Instantaneously Separable VPA" model (presented in absentia by Russian scientists, ASTT-05 and ASTT-06) is similar to the ICA approach except that a robust penalty function is used for tuning the model and there is a "*G*" effect on the separability estimates that links information over cohorts. It was unclear which indices were applied in the tuning part. This model exists in Visual Basic and may be freely available (although this was not confirmed during the meeting). Due to the algorithmic form of the model (where catches are assumed to be known exactly for the VPA period) the solution presumably requires very little computation time.

3 Strengths and weaknesses of models used

For the statistical catch-age (SCA) model implemented by IFOP scientists, a noted advantage was that the model was designed specifically to deal with this stock of jack mackerel. Also, a main advantage of this model is that it has considerable flexibility to adapt to different sources of information. The choice of programming the model specifically for the problem at hand (as opposed to using a canned package) is considered an advantage because it can provide for a clearer understanding of what is being done. The ability to include ageing errors is considered important. Separating observations from the underlying model (i.e., a state-space approach) is considered an important attribute of the Chilean model since observations are not required in every year.

There were concerns over the transferability—whether the software or model could be easily run or completed by other stock assessment scientists since it was written in MATLAB, a proprietary software package. It was pointed out that the source code is available and it would be relatively straightforward and easy to implement in other software (e.g., ADMB).

Estimates of uncertainty are available through calculation of the Hessian matrix (as an asymptotic approximation). Also, the MCMC algorithm can be applied to get confidence intervals for variables of interest.

For the evolutionary model, there is flexibility in allowing different time-steps and in the biological processes that are modelled. Advantages of this model include providing more flexible consideration of biological characteristics (e.g., recruitment can occur at different mean lengths). Also, this approach is useful when the data available are extensive and the calibration method requires fewer assumptions for the optimization algorithm than some traditional optimization approaches. This model can easily be adapted to more data than were provided for the simulation exercise. For example, length frequency data (which could have been generated with variability) may be more appropriately applied to this model (and may be more difficult or impossible to apply in the other models presented this week). Since a stock recruitment relationship is omitted the potential for mis-specifying processes controlling recruitment may be avoided. Confidence intervals are computed for all model outputs but these require more testing.

This approach has been applied to the Peruvian anchovy stock. The length-dynamics approach (e.g., the size-based selectivity) is applied in other stock assessment applications. However, the combination of this model (as implemented) with the optimization algorithm has had limited application so far in stock assessment settings.

The drawbacks for this model may be that using monthly time-steps is adding "noise" unnecessarily since data are available annually (but this could be changed). If changes in growth rates are small, then the importance of explicitly accounting for this variability may be less important. At present, this model does not make use of statistics. The dynamics may be improved by including migration and other components. This model is still in development and will require more work. The calibration algorithm is separate from the dynamics of the assessment model. Changes to the model dynamics are easy and can be more tailored for Chilean jack mackerel life-history characteristics. While written in R and using publicly available routines, there are concerns that the model may be difficult for other people to understand and run. The calibration algorithm may be too cumbersome to use and the advantages of the approach may be minor relative to the difficulty in understanding characteristics of the calibration in a working group context. The authors noted that a front-end interface is available that allows control over the fitness function, a set of input files, and implementing the calibration is straightforward (and does not require expertise in R).

For the ICA model the strengths are that it has been used extensively in many different environments and is easy to apply and provide answers. It is easy to understand and calculations are very quick. It is easy to explain to stakeholders how the results were derived. It is similar to many other VPA approaches (e.g., the TISVPA, ADAPT, XSA).

The ICA model weaknesses are that it fails to apply all available data, has strict data requirements, is implemented for only a single fleet, and assumes that the catch-at-age is known exactly for the VPA period (but estimates catch-at-age for separable period). When fishing mortality is low, this approach tends to become less robust. Also, application of survey indices requires continuous data over the period. Prior to using survey information, separate index-variance weighting analyses are required. Application of length frequency data and ageing error information are not possible to include.

For all models, the estimates of stock size become increasingly imprecise in recent years. For many situations where VPA methods are applied, the current year by definition is restricted to the most recent year in which fishery catch-at-age data are available.

For the TISVPA model, many of the strengths identified for the ICA model apply here. Additionally, this approach allows for better robustness and including the process of partial recruitment (separability assumption) by cohort in addition to the annual and age-specific factors that affect fishing mortality.

Similarly, many of the weaknesses of ICA also apply. However, the transparency of the application (ability for someone else to run the model) is questioned. Presumably, since the code is written in visual Basic, the ability for better comprehension should be possible in a workgroup setting.

4 Comparison of model results

4.1 Methods

The ASTT requested that each model provide the following output for summarization and comparisons:

- Beginning year numbers at age over all time
- Spawning biomass over time (at spawning time)
- Total mid-year biomass
- Matrix of total F-at-age (all time), or exploitation rate
- Predicted index values (all indices used, in each year)
- Predicted landings

The group selected a preliminary set of summary statistics and figures from which to compare model results. This included output on the:

- 2007 spawning biomass (absolute level, both sexes combined)
- 2007 spawning biomass / SSB in 2000
- Average absolute begin-year recruitment (2-year olds) from 2000-2007
- Average 2003-2007 recruitment / average 1990-2007 recruitment
- Average *F* ages 4-11, over last 5 years (2003-2007)
- Average *F* ages 4-11, in 2007
- Standard deviation of logged age 2 recruitment 1975-2007
- Mid year biomass in 2007

These results were shown as the absolute difference with the true underlying population (from which the datasets were simulated). I.e., the values $x - \hat{x}$ with $\hat{x}$ representing the true value.

4.2 Comparison of the results from different models

Results of the comparison of the different model outputs with the true values are presented in Figures 3 – 12. In general, results indicate that some models were consistent with the true simulated values for some statistics but not all. For example, the SCA did very well at estimating current fishing mortality rates (Fig. 3) but tended to overestimate current mean recruitment and spawning biomass (Figs. 4 and 5, and similarly the total mid-year biomass (Fig. 6). The TISVPA model predicted the trend in spawning biomass (expressed as the ratio of 2007 estimates over 2000) quite well (Fig. 7). The trend in recruitment (expressed as the mean from 2003-2007 divided by the 1990-2007 mean) was underestimated by the ICA and Evolutionary model whereas the SCA overestimated the trend (Fig. 8). The SCA model estimated the recruitment variability level well (Fig. 9). All of the models (except the SCA reference model which had the specification correct) displayed a wide range of results (e.g., the ICA model in Fig. 3) depending on the simulated dataset.

To compare the different model results for particular simulated datasets over time, the average *F* (Fig. 10), age-2 recruitment (Fig. 11), and spawning biomass (Fig. 12) were displayed. Except for the evolutionary model, all models tended to aggregate to similar values.

Based on the underlying true process, it is clear that the assumption of selectivity to be asymptotic for the SCA model was the cause for differences in results. In this case, the model specification mis-match appears to have a large influence compared to the SCA reference model (where the model specification was nearly the same as the simulated processes).

It was reiterated that the simulation exercise was designed with fairly simple dynamics but had complexity in selectivity that varied over time and between fleets and survey methods (ASTT-07). Many more evaluations would be required to complete a thorough test of methods, for example including alternative hypotheses on migration and stock structure may be important.

5 Conclusions about different approaches and choice of standard method

The group considered that the application of the ICA and TISVPA models was inappropriate for the main specification for assessment purposes because the data requirements are too restrictive. In particular, this approach fails to use much of the detail in the available data (e.g., disaggregation to multiple fleets). Acknowledging the Russian position, the group noted that it may be wise to include alternative assessments, especially the importance of evaluating different model specifications. The group also appreciated the application of a robust objective function and the application of the cohort-effect on fishing mortality. These attributes should be considered in future refinements to the statistical catch-age approach.

The Evolutionary model was considered to be a very interesting approach and one which the group considers should be continued. However, it appears to be too early in the stage of development to be adopted and put forward for the main assessment approach. It may be that the biological considerations that are acknowledged more explicitly in this approach can also be met with a statistical catch-age approach. For example, developing an application using stock synthesis may provide the biological complexity/flexibility that this model has implemented.

The results from comparing different assessment approaches made clear that model specifications were critical. For example, the reference model (presented above), which had the correct model specification (in terms of selectivities), performed well. While it is impossible to know what the correct specification is in reality (using real data), the additional flexibility of the reference model was seen as a benefit and one that should be pursued.

Therefore, the SCA approach was considered as a start for a standard method. An extra meeting prior to the SWG should be convened to implement an SCA application using real data. This should be given the highest priority (August seems to be the best time). As a secondary priority, training and a workshop to develop refinements to the method should be pursued.

The group discussed the issue of what and how data will be made available for this work. This was seen as a high priority and a deadline for providing data should be set by the SWG. A table of contributions and time frames was developed and discussed (Table 3). **The meeting recommended that a formal procedure be established through the SPRFMO to facilitate the provision of data from all members.**

Given these caveats and taking from the meeting discussions, the group recommended that a version similar to the reference model be developed and adopted for jack mackerel assessments.

6 Acknowledgments

The ASTT graciously acknowledges the excellent facilities and hospitality provided by the Peruvian colleagues and the efforts of the invited participant, J. Ianelli was acknowledged.

7 References

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Table 1. **Summary of data provided to participants on October 20th, 2009. A total of 100 replicates (with noise) were included.**

	Fleet			Survey			
	Southern	Northern	Offshore	Trawl	Acoustic	Early	Other
Catch-at-age proportions	1975-2007	1975-2007	1979-1991	1997-2001	2002-2006	N/A	N/A
Sample size	50	50	30	30	30		
Landings std error (cv)	1975-2007 0.05	1975-2007 0.05	1979-92 ; 2002-07 0.05				
Weight-at-age	1975-2007	1975-2007	1975-2007	1975-2007	1975-2007	1975-2007	1975-2007
Abundance index				1997-2001	2002-2007	1981-1983	1984-87 ;1991-95
std error				by year	by year	by year	by year

Table 2. Table of elements considered important for the structure of stock assessments.

	Evolutionary model	Statistical Catch-at-Age model (SCA)	TISVPA	ICA
Biological				
Natural mortality	M as a function of length, constant in this model, set to 0.4 (Peruvian survey data indicate M=0.33)	M=0.23 for all ages	M=0.23 for all ages	M = 0.23 for all ages
Maturity	Mat = 0,0.02,0.25,0.48, and 0.5 for all older ages	For total population (males+females). Its corresponds to double of the sexual maturity given	Mat = 0,0.02,0.25,0.48, and 0.5 for all older ages	Mat = 0,0.02,0.25,0.48, and 0.5 for all older ages (given in input)
SSB Calculation	Mean weights from growth model	Time-varying mean wt at age	?	Single mean-wt at age vector
Stock recruitment	NA	B&H with steepness h =0,75	NA	No model assumed
PlusGroup	Truncated (but can be modified)	Age 12	Age 12	Age 12
Fishery parameters				
Selectivity patterns	Maximum at age 7 (for parameter searching) asymptotic	Based on logistic (southern and offshore fleets) and normal (northern fleet). Vary by year groups (4 blocks in southern fleet and 2 blocks in northern fleet)	Two selectivity patterns for two periods. Combined fleets (one fishery) No restrictions on their shape – it is driven by the data.	Maximum selection at age 7 (estimated from catch data) Years to estimate selectivity: 6 (estimated from catch data)
Number of fleets	3	3	1	1
Effort	Used to define search space for Fs	Not used	Not used	Not used
Catch-at-age	Not yet used	Are used and fitted separately by fleet and surveys	Fit with errors	Fit with errors

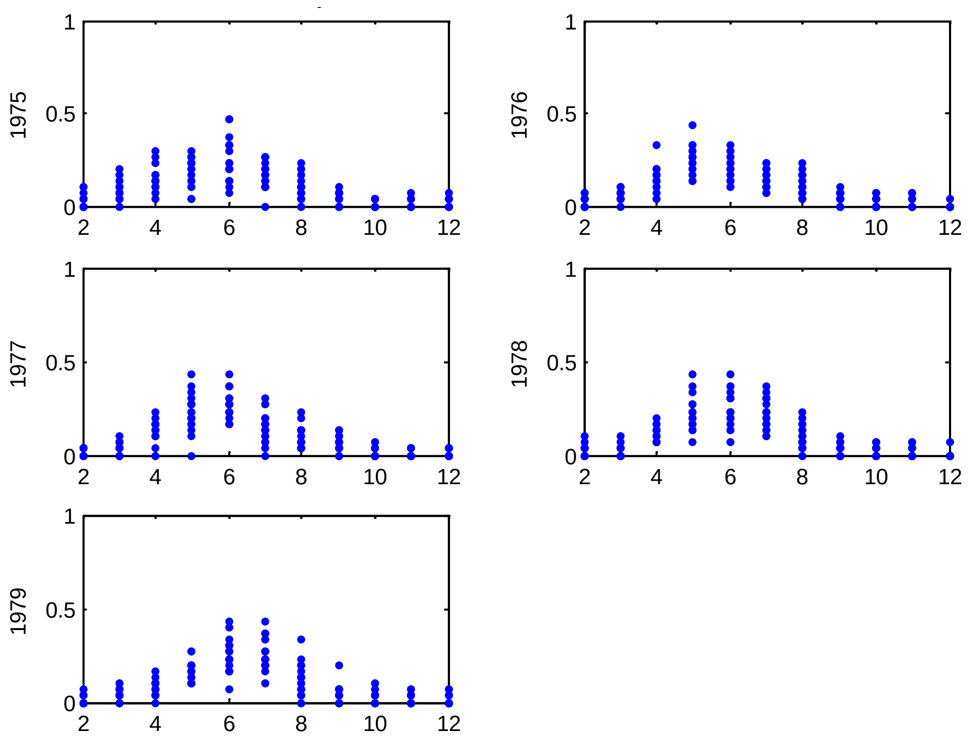
	Evolutionary model	Statistical Catch-at-Age model (SCA)	TISVPA	ICA
Catch biomass	Used for calibration for each fleet separately	Modeling explicitly in one of the models. In this case, an observation error is considered. The second model assume perfect information	NA	Not explicitly used in fitting
Survey parameters				
Type of index	Index 2 (Acoustic survey) was used	It is relative to the exploitable biomass at mid year. It is considered an explicit selectivity for two surveys (acoustic and trawl).	Assumed aggregated biomass indices for all 4	Assumed biomass indices for all 4
Catchability at age	Estimated to be the same over all ages	It corresponds to separability assumption. The global effect estimated within the model (MLE) and the age specific effect is the specific selectivity.	Estimated within the assessment method, weighted equally over all surveys over all years	Estimated within the assessment method
Age composition data	Not used	Fit for index 1 and 2 (no data for 3 and 4)		Not used
Survey selectivity	Same for all ages	It corresponds to selectivity model (logistic for two surveys)	1 for all ages?	1 for all ages
Relative weights	Not considered for this model as only one index was used	They are variables by year. They depend on the standard deviation given (CV)		Inverse variance weighting of the survey errors available
Estimation features				
Observation error	Not considered for this model.	Each data type is modeling via a likelihood function	Estimated within the method	Estimated within the method
Aging error	Not considered explicitly – taking into account considering different lengths for each cohort.	Incorporated in the observation process. It operate over expected age compositions	Not considered explicitly – only as a part of overall errors in catch-at-age	Not taken into account
Error models	Not assumed for this model.	Process error is assumed in the	Robust measures of closeness	Not taken into account

	Evolutionary model	Statistical Catch-at-Age model (SCA)	TISVPA	ICA
		recruitments and age composition of initial population.	– not dependent upon the choice of error model	
Likelihood	Not used for this model.	Multinomial for age compositions and lognormal for biomass indexes	No direct use of likelihoods – robust measures of closeness instead. Unbiased solution (in terms of model description of log-transformed catch-at-age data) is guaranteed by the procedure.	Breakdown by catch at age by year, survey at age by year
Key model assumptions / characteristics	New cohorts are characterized by their abundance and length. Variability of biological parameters according to different regimes of productivity. Natural mortality and selectivity length-dependent. Monthly time-step	-Statistical catch-at-age model -any hypothesis can be modelling -any information type can be used -All observables variables are estimated subject to observation errors. -Model parameters are estimated maximizing the posterior distribution of the parameters		Model estimates catches (at age?) with error Estimation of selectivity bound to appropriate period (e.g. 6 years). VPA for historic part of the model
Time step	Monthly	Annual	Annual	Annual
Software and technical considerations		-Main functions apply matrix operations -Easy to translate to any language -open code (no executable file) -All optimization routine output are available (Hessian,		

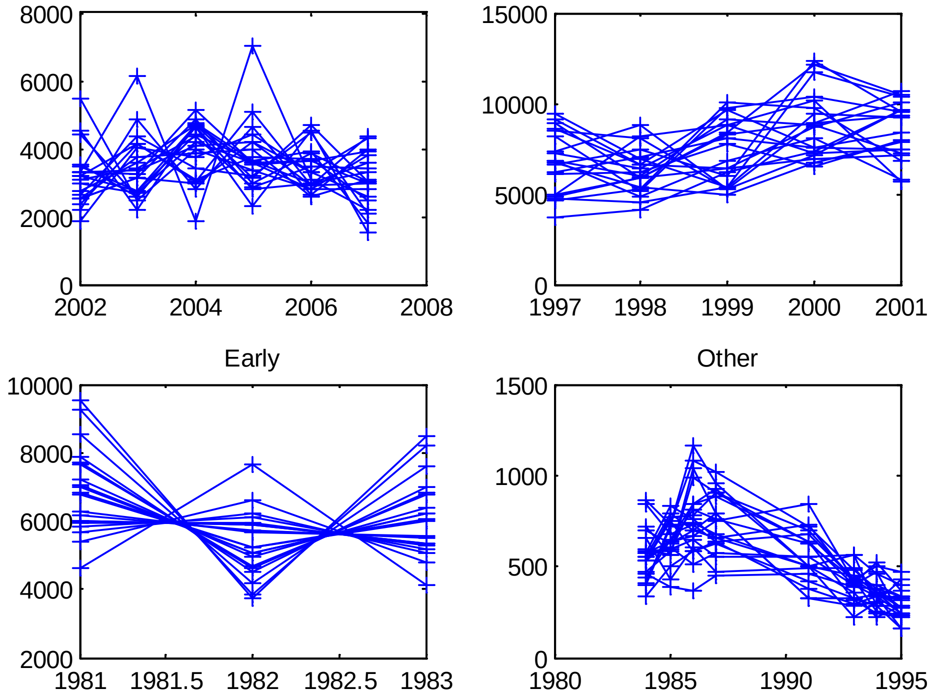
	Evolutionary model	Statistical Catch-at-Age model (SCA)	TISVPA	ICA
Comprehension		Jacobian, etc) -All modelling biological processes are explicit		
Computation time	~1 hr per assessment	~40 sec/run		few seconds per assessment run
Language	R	MATLAB, wide use on engineering and based on C++	Visual basic	FLR, R and Fortran
Reference	Oliveros-Ramos et al. (in press)	Canales C. 2010. Serra, R. and C. Canales 2009	Vasilyev, D. A. 2005	Patterson, K. R. (1998)

Table 3. Data availability for jack mackerel stock assessments.

		Chile	China	EU	Faroe Island	Korea	Peru	Russia (off Chile)	Russia (off Peru)	Vanuatu
Removals	Catch biomass	1970-2009	2001-2008	2005-2008	2007-?	2003-2008	1970-2009	1979-1992; 2003-2005	1979-1992	2003-2008
	Catch at age	1975-2009								
	Catch at length			2006-2009			1980-2009	1979-1992	1979-1992	
	By fleet (fisheries)	Yes								
	Weight at age	1975-2009								
	Weight at length						1993-2009			
	L-W relationship	1975-2009					1993-2009			
Abundance	CPUE	1981-2005					1997-2009			
	Acoustic Survey	1997-2009				??	1983-2009			
	Egg survey	1999-2008								
	Trawl survey									
Biology	Natural mortality	0.23					0.33			
	Growth function	Yes					Yes	Yes		
	Maturity at age/size	Yes					Yes			
	aging	Yes					Yes			
	Maps of catch distribution						Yes			



Samples of the simulated age composition for the trawl survey



Samples of simulated indices

Figure 1. The first 50 simulated datasets showing the variability in observations between data .

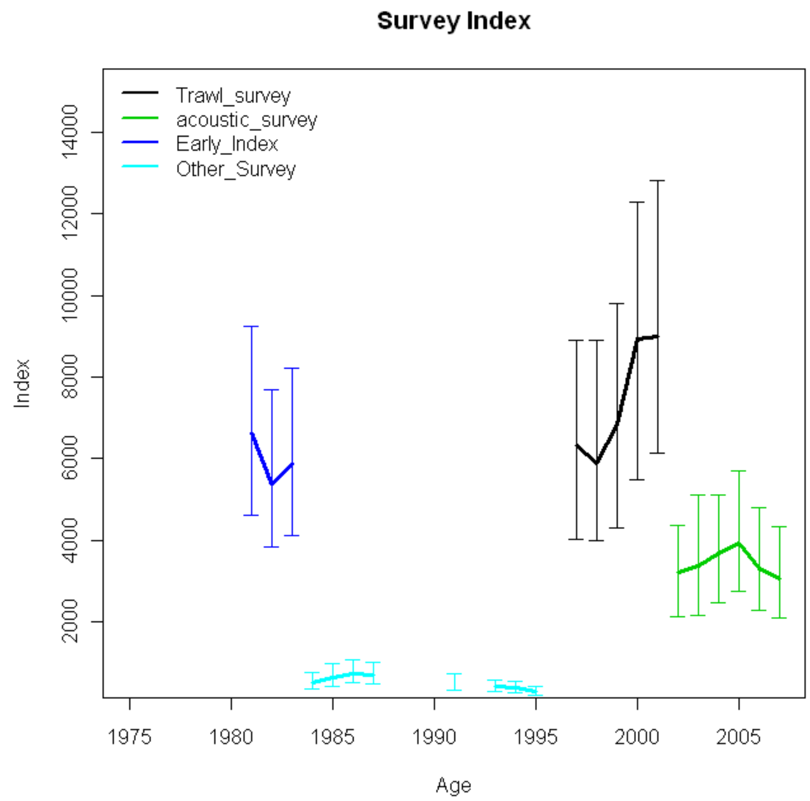


Figure 2. The first 50 simulated datasets showing the variability in observations between data

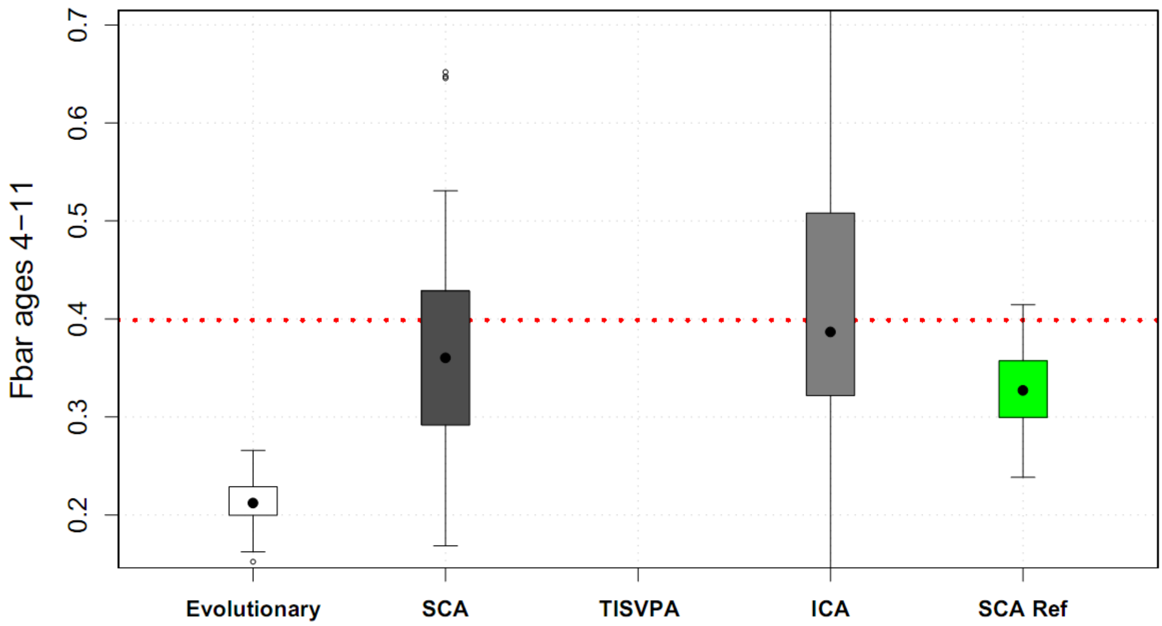


Figure 3. Average F in over ages 4-11, over 2003-2007 compared to the true underlying population value (horizontal line). The first and third quartile of each dataset are represented by the shaded boxes, while minimum and maximum observations, not being outliers, are represented by the dotted vertical lines. Outlying results (more than 1.5 times the inter-quantile distance away from the 1st or 3rd quantile) are represented by open circles.

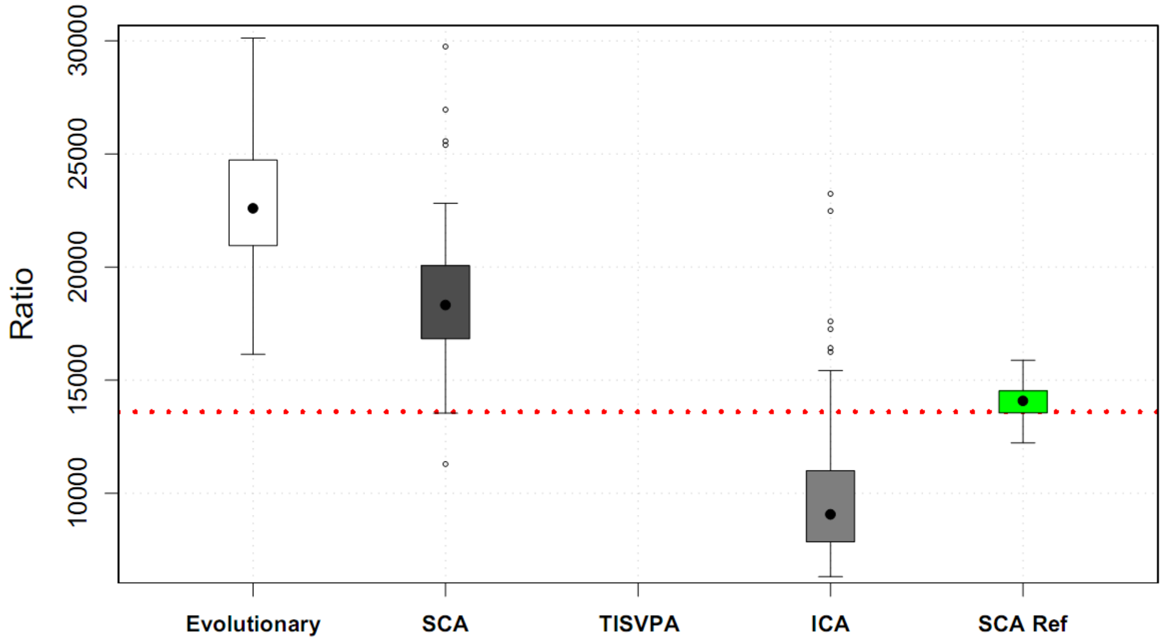


Figure 4. Average age-2 recruitment from 2000-2007 compared to the true underlying population value (horizontal line). The first and third quantile of each dataset are represented by the shaded boxes, while minimum and maximum observations, not being outliers, are represented by the dotted vertical lines. Outlying results (more than 1.5 times the interquantile distance away from the 1st or 3rd quantile) are represented by open circles.

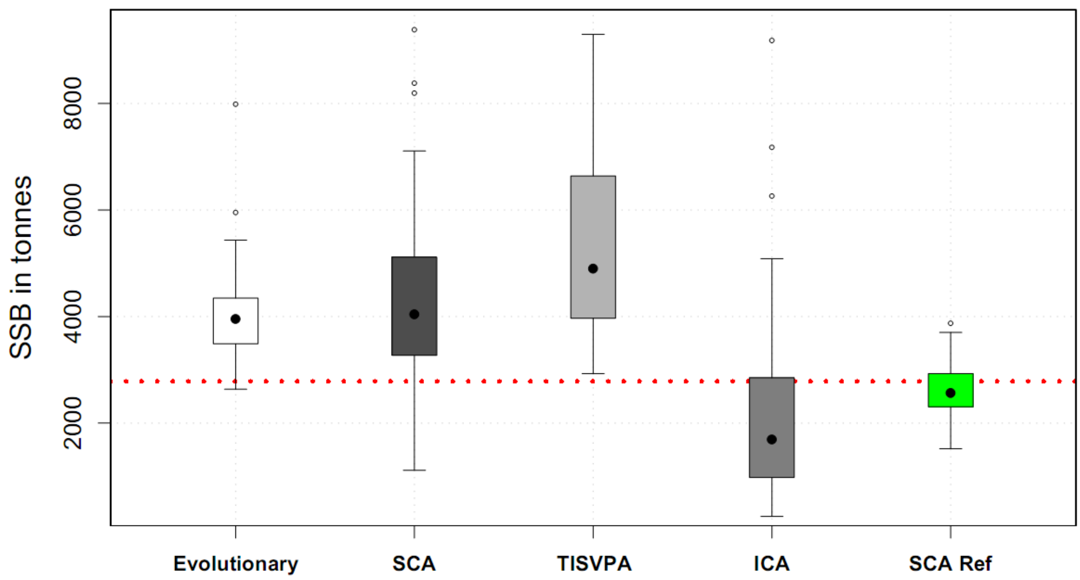


Figure 5. Spawning stock size estimates in 2007 compared to the true underlying population value (horizontal line). The first and third quantile of each dataset are represented by the shaded boxes, while minimum and maximum observations, not being outliers, are represented by the dotted vertical lines. Outlying results (more than 1.5 times the interquantile distance away from the 1st or 3rd quantile) are represented by open circles.

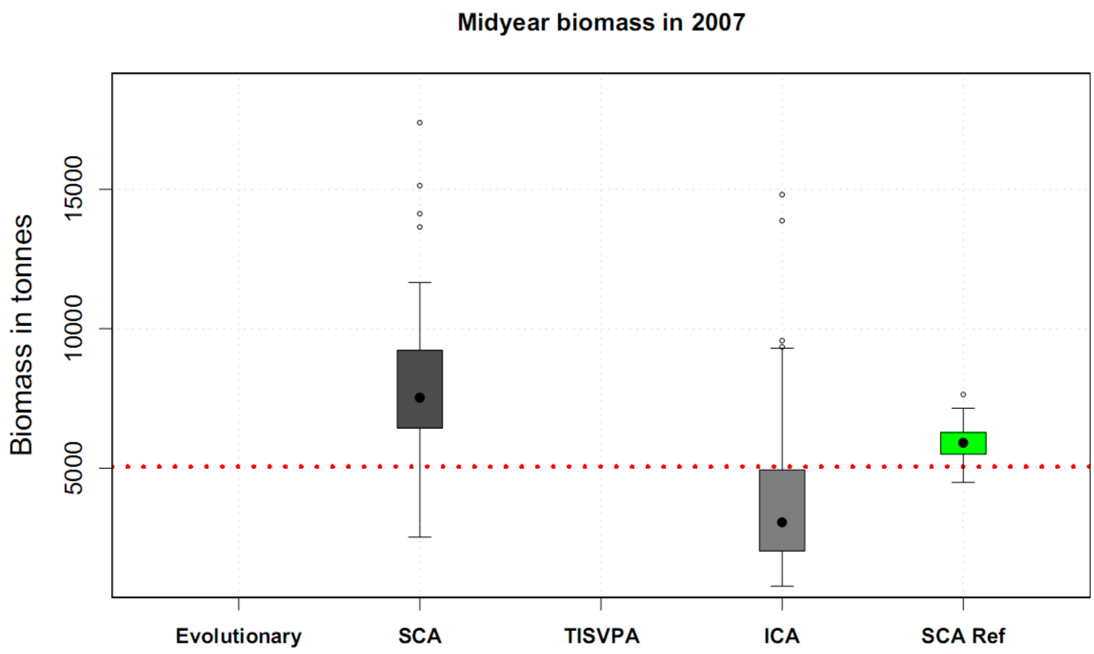


Figure 6. Total mid-year biomass in 2007 compared to the true underlying population value (horizontal line). The first and third quantile of each dataset are represented by the shaded boxes, while minimum and maximum observations, not being outliers, are represented by the dotted vertical lines. Outlying results (more than 1.5 times the interquantile distance away from the 1st or 3rd quantile) are represented by open circles.

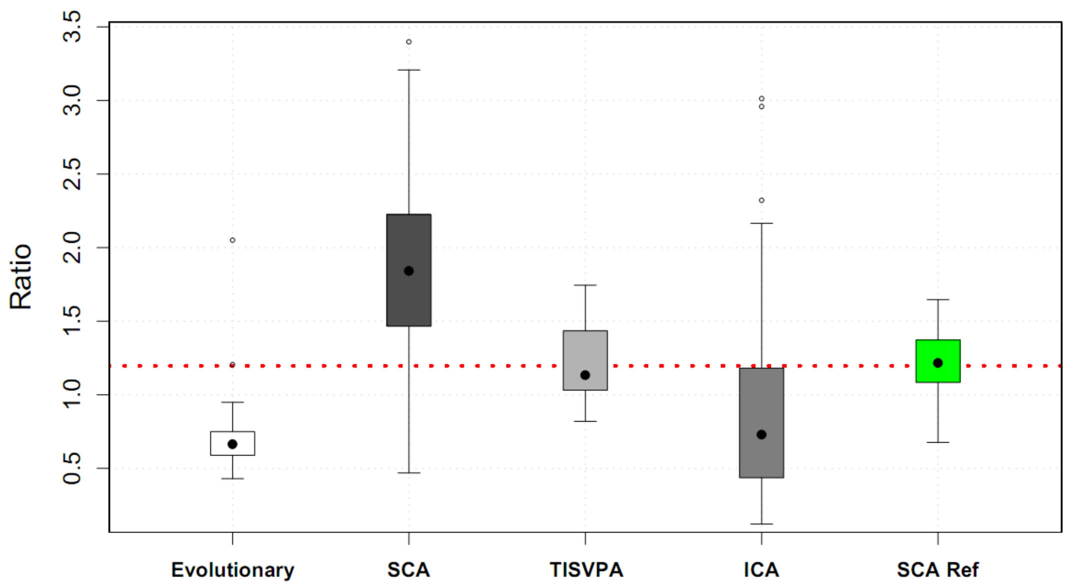


Figure 7. Recent trend in spawning stock size computed as the ratio of 2007 over 2000 relative to the true underlying population value (horizontal line). The first and third quantile of each dataset are represented by the shaded boxes, while minimum and maximum observations, not being outliers, are represented by the dotted vertical lines. Outlying results (more than 1.5 times the interquantile distance away from the 1st or 3rd quantile) are represented by open circles.

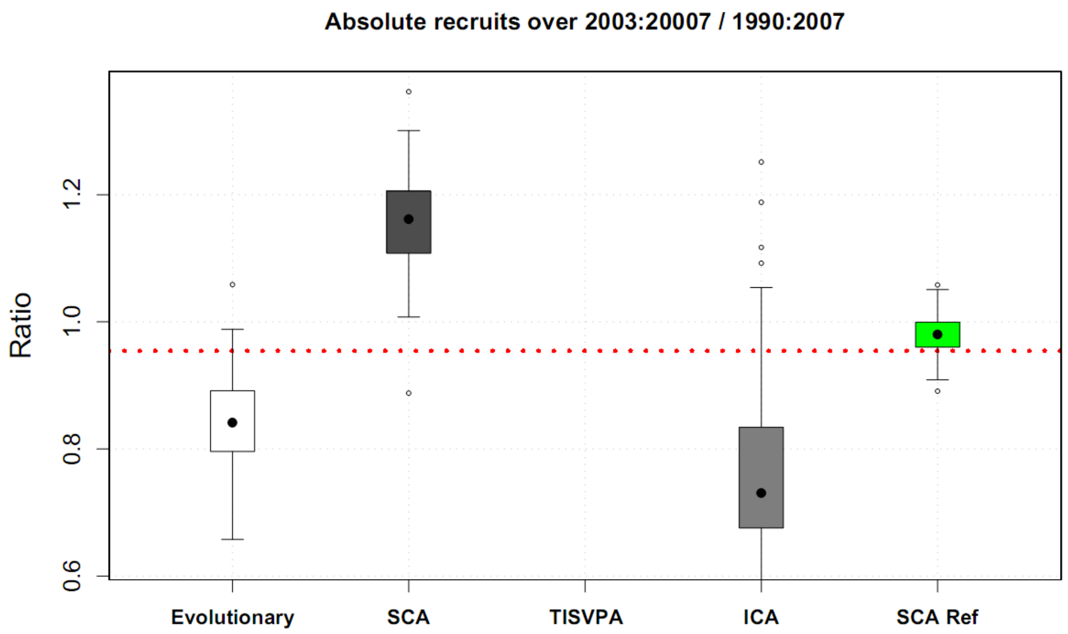


Figure 8. Recent age-2 recruitment (mean of 2003-2007) over the mean from 1990-2007 compared to the true underlying population value (horizontal line). The first and third quantile of each dataset are represented by the shaded boxes, while minimum and maximum observations, not being outliers, are represented by the dotted vertical lines. Outlying results (more than 1.5 times the interquantile distance away from the 1st or 3rd quantile) are represented by open circles.

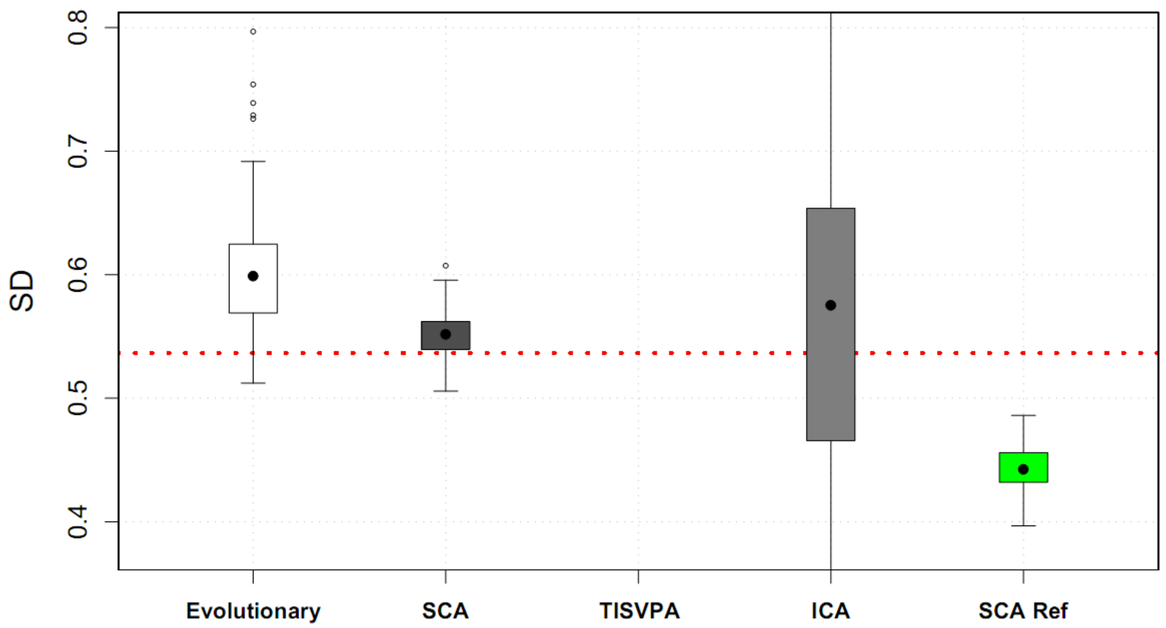


Figure 9. Standard deviation of logarithm-age-2 recruitment, 1975-2007, compared to the true underlying population value (horizontal line). The first and third quantile of each dataset are represented by the shaded boxes, while minimum and maximum observations, not being outliers, are represented by the dotted vertical lines. Outlying results (more than 1.5 times the interquantile distance away from the 1st or 3rd quantile) are represented by open circles.

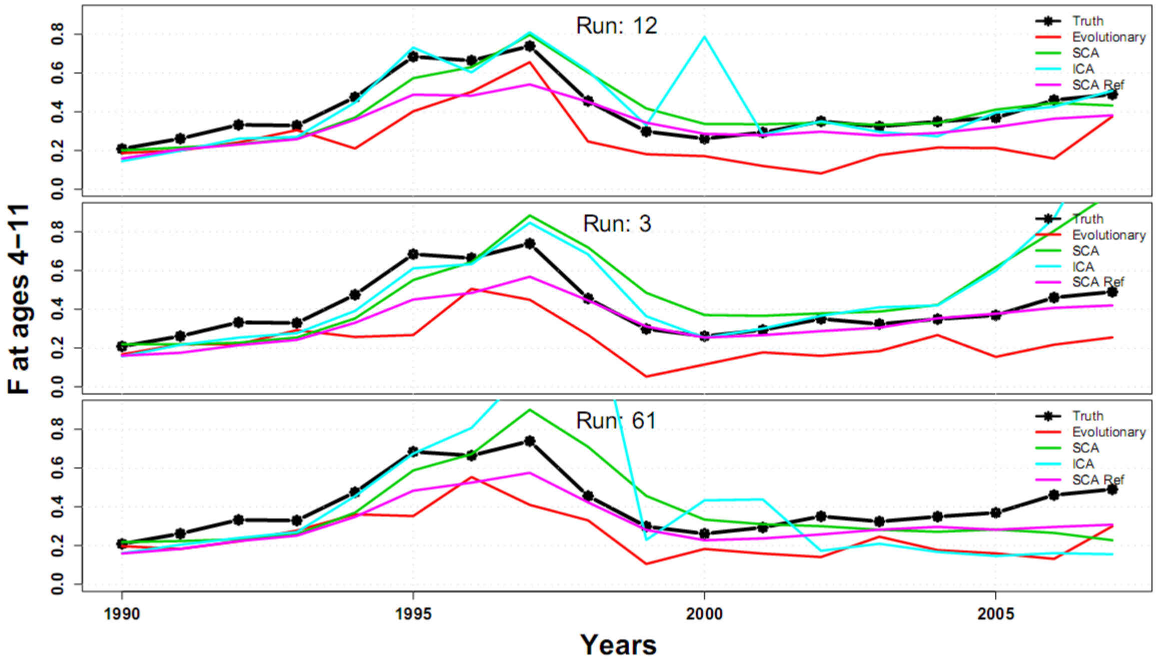


Figure 10. Average *F* in over ages 4-11 for three selected simulated datasets.

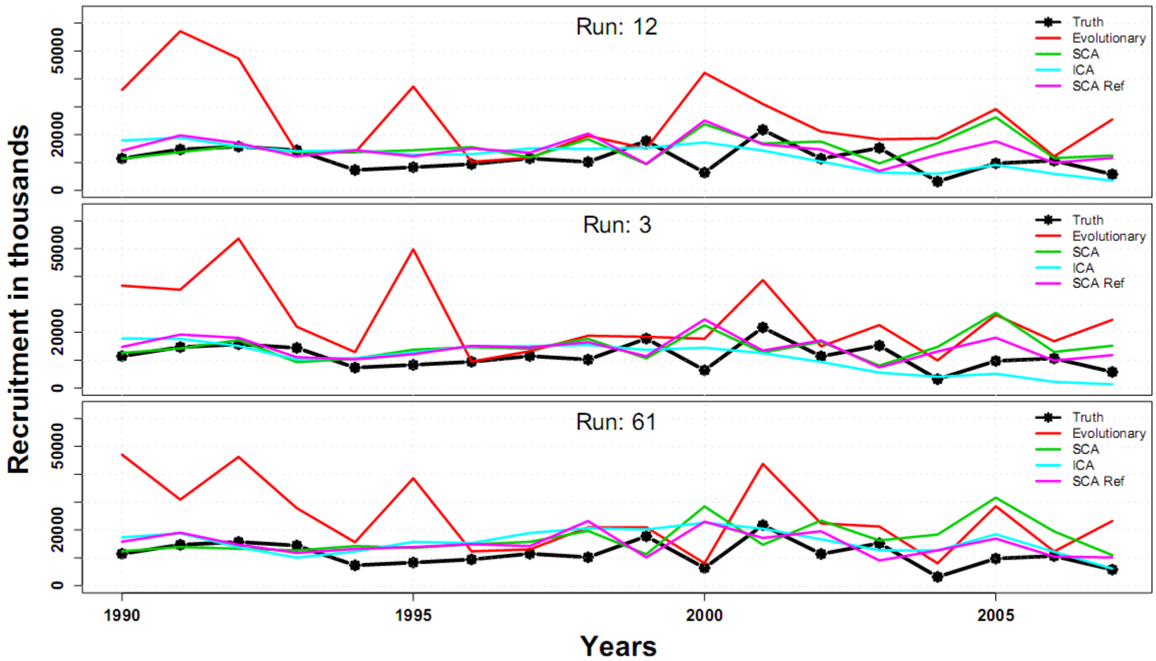


Figure 11. Recruitment estimates based on three selected simulated datasets compared to the true values.

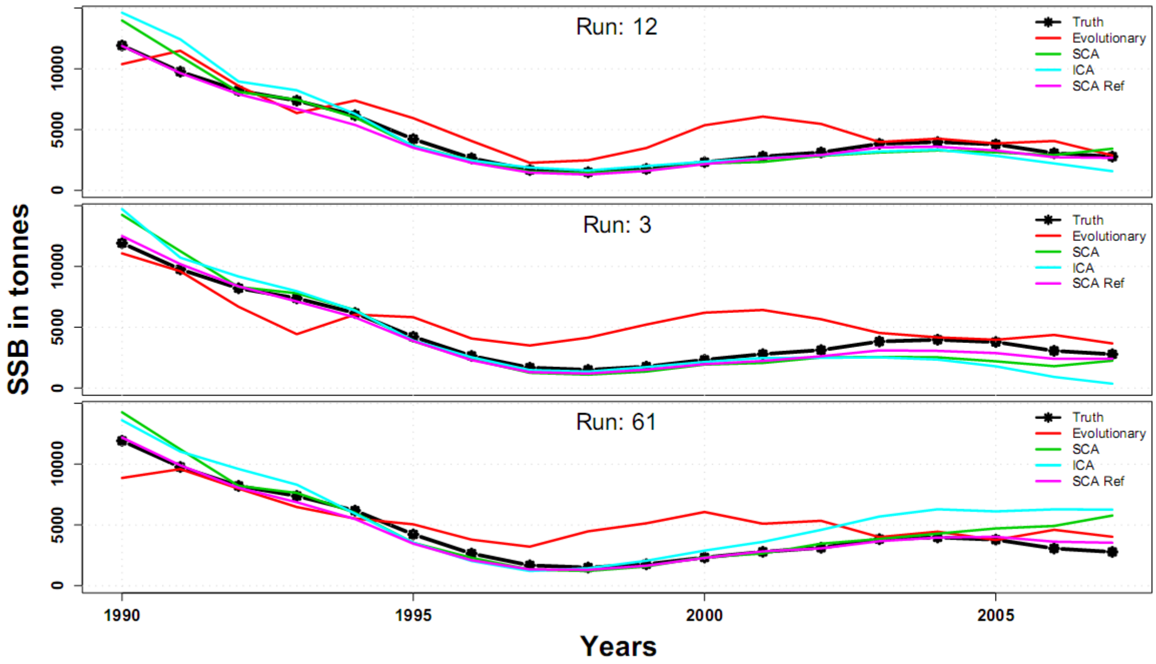


Figure 12. Spawning biomass estimates based on three selected simulated datasets compared to the true values.

Annex 1. Agenda

Tuesday 6 April	Opening of the meeting Terms of reference Agenda for the meeting Assigning of rapporteurs Overview of existing stock assessment models Results of Chilean model
Wedenesday 7 April	Results of Peruvian model Results of ICA model Results of Russian model
Thursday 8 April	Comparison results of various models with theoretical population Discussion of strength and weaknesses of various models Choice of standard method for JMSG Data and other input parameters for standard model
Friday 9 April	Biological reference points for generating outputs Specification of outputs from standard model Projection methods Time frame for real assessment, including data exchange Adopt Report

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Annex 3. List of working documents

1. ASTT-01 Draft Agenda
2. ASTT-02 Draft Document List
3. ASTT-03 Observations and Proposals Regarding SPRFMO Jack Mackerel Stock Assessments
4. ASTT-04 Chile Executive Report
5. ASTT-05 Results of the TISVPA model
6. ASTT-06 TISVPA Overview
7. ASTT-07 Simulation model specifications
8. ASTT-08 ICA documentation
9. ASTT-09 Evolutionary assessment application (still to be provided)