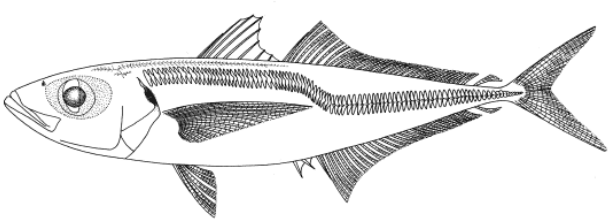
Jack-Mackerel stock assessment simulation

Niels T. Hintzen



IMARES Wageningen

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Contents

1 Assignment

IMARES, part of Wageningen UR representing an European approach within the Jack Mackerel Assessment Simulation Task Team (ASTT) reports on and discusses the results of the ICA assessments on the simulated datasets (version II, 22 October 2009) provided by Dr James Ianelli, participant in the Jack Mackerel sub-group. We report on: SSB, F, TSB, recruitment, measures of fit of catches and surveys, fitted selectivity pattern and assessed numbers at age. As well, we report on general characteristics of the data provided and setup of the assessment control settings will be reported and discussed.

2 Materials and Methods

2.1 Simulated data description

The simulated data, which consists of 100 replicates, each of which are similar in setup but differ in absolute values contain information on:

Data description	Dimensions	Units	Variable
Years	start – end year	years	-
Age	recruits – oldest age	years	-
Number of fisheries	-	#	-
Fisheries Catch	start – end year fisheries	tons	√
Fisheries years active	start – end year fisheries	years	-
Fisheries age samples	start – end year fisheries	#	-
Fisheries age data	start – end year fisheries, recruits – oldest age	1/#	√
Fisheries weight at age	start – end year fisheries, recruits – oldest age	kg	-
Number of surveys	-	#	-
Survey years active	start – end year surveys	years	-
Survey month	-	#	-
Survey index	start – end year surveys	tons	√

Survey age sample years	-	years	-
Survey age samples	start – end year surveys	#	-
Survey age data	start - end year surveys	1/#	√
Survey weight at age	start – end year surveys, recruits – oldest age	kg	-
Population weight at age	recruits – oldest age	kg	-
Population mature at age	recruits – oldest age	1/#	-
Population spawning month	-	#	-
Ageing error	recruits – oldest age, recruits – oldest age	Var	-
Fisheries effort	start – end year fisheries	cpue	√
Fisheries catch number at age	start – end year fisheries, recruits – oldest age	#	√

2.2 Simulated data analyses

In order to understand the general characteristics of the simulated data set, analyses have been performed to visualize different aspects of the data. The catch numbers and weights and surveys have been analyzed over time for irregularities. Other catch analyses have been performed as described under paragraph §3.2.

2.3 Model setup

The simulated dataset was analyzed using FLR (Kell et al. 2007). This software package, build into R (R Development Core Team 2008), is used to store all data provided in the simulated datasets into a predefined format that enables the user to perform the assessment, analyse and report on it in a standardized manner.

2.3.1 Fisheries

Within this project, it is assumed that all sub Jack Mackerel components belong to same spawning component i.e. stock. All three fisheries (Northern, Southern and Offshore) fish on the same stock, but in different geographical areas. Total landings are computed by summing landings from all three fisheries. Landing weights are computed as a weighted mean of the landing weights per fishery depending on the contribution of each fishery to

an age group as measured in numbers at age. As no discard information is provided, catches and catch numbers equal landings and landing numbers respectively.

2.3.2 Surveys

All four survey time series cover different years of the total range of years the fishery has been active, and hence there is no overlap between them. All surveys are assumed to present estimated biomass per year. Proportion at age for the first two surveys (trawl survey and acoustic survey) is given. Based on these proportions, a number-at-age matrix can be composed to transform these surveys from biomass to number based. However, as no proportion-at-age is provided for the terminal year of the acoustic survey, this transformation is not possible while maintaining its current time series length.

Fisheries effort is provided by fleet. These time series, ranging similar years as the fisheries are operating, have not been used as survey indices in this exercise.

Survey tuning weights per year have been set to equal the inverse of the variance of each survey year, as provided in the simulated dataset. Variances have been standardized to the interval [0,1]. Index models have been assumed 'relative' which enables the assessment method to estimate catchability per year.

2.3.3 Population

The population size is estimated within the assessment method. However, few population characteristics have to be set externally. Population weight at age, maturity at age and time of spawning are obtained from the simulated data set. No natural mortality estimates are provided, but from communication within the ASTT it was decided to set natural mortality at 0.23 at all ages.

2.4 Assessment settings

As the assessment method ICA uses a separable period, it is necessary to specify the year ranges of this period. As the longest survey time series (fleet effort time series excluded) only dates 6 years back in time, the upper bound of the separable period is fixed to this length. The separable period is estimated by evaluating the trend in log-transformed catch at age over the past 10 years. The changes over time are fitted by a smoother function (Tuckey's smoothing) to visualize the trends in log-transformed catches. Changes with this trend could serve as an indication of the length of the separable period. Next to the period, also the separable age has to be set. This age, at which selection in the assessment model is fixed to be 1, is assumed to be represented by the age group most efficiently targeted by the fleet. Log-transformed catch per cohort could be analyzed to find this age group. The changes over age are fitted by a smoother function (Tuckey's smoothing) to visualize the trends. The age with the highest smoothed log-transformed catch value is assumed to be a

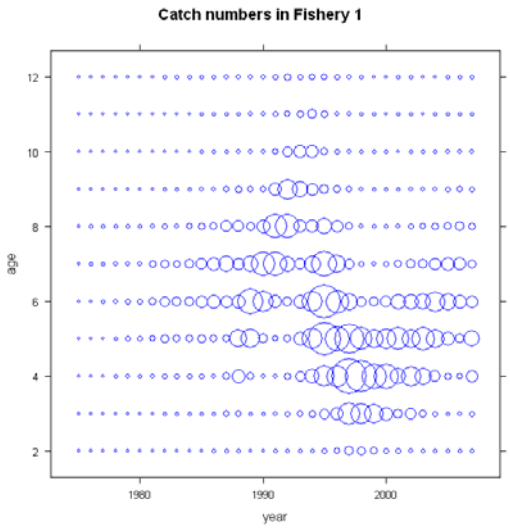
good candidate for the separable age group setting. Default settings are used for other ICA specific assessment settings (see table 2).

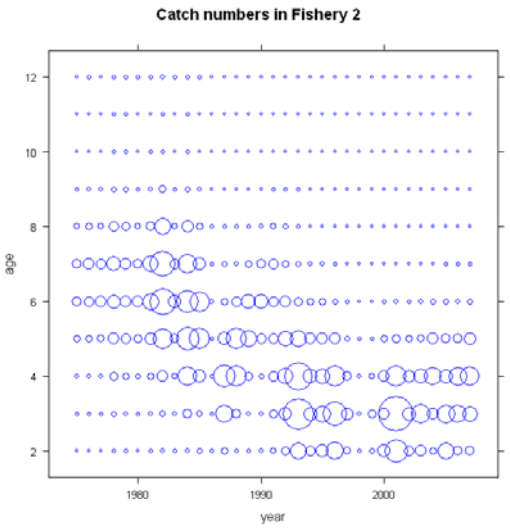
Parameter	Description	Setting
sr	Fitting Stock Recruitment relationship	False
sr.age	separable age	See result section
lambda.age	Weighting matrices for catch-at-age	1
lambda.year	Relative weights by year	1
index.model	Catcahability model	'relative'
index.cor	Are the age-structured indices are correlated across ages	0
sep.nyr	Number of years for separable model	See result section
sep.sel	Selection on last true reference age	True

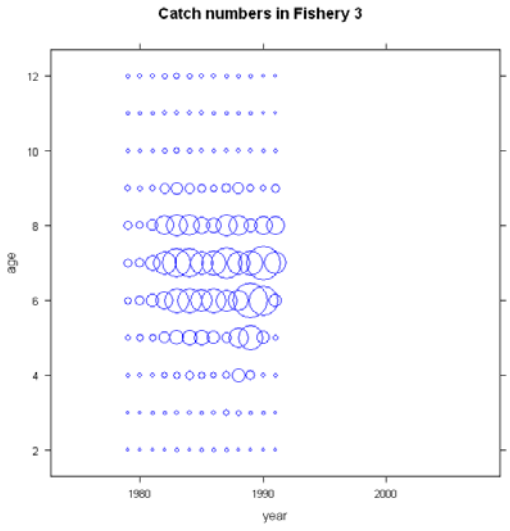
3 Results

3.1 Simulated data analyses

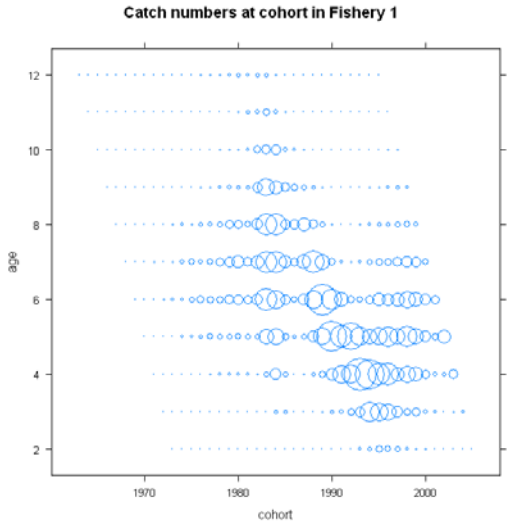
Graphically shown below are the scaled catches in number per fishery. Bigger bubbles indicate higher catches within a year at a certain age. Larger bubbles should appear at the ages most targeted by the fisheries.

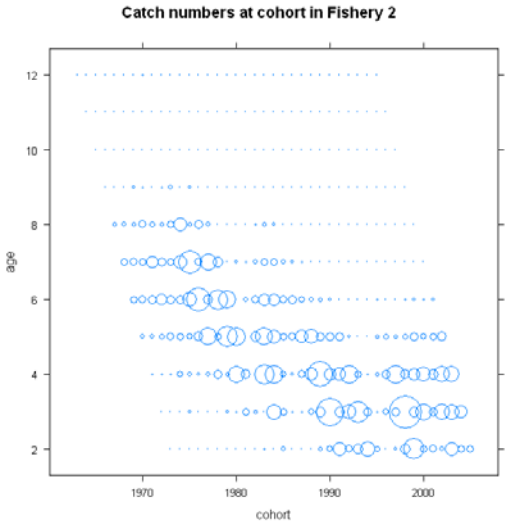

Catch numbers in Fishery 1
age
year
12
10
8
6
4
2
1980
1990
2000

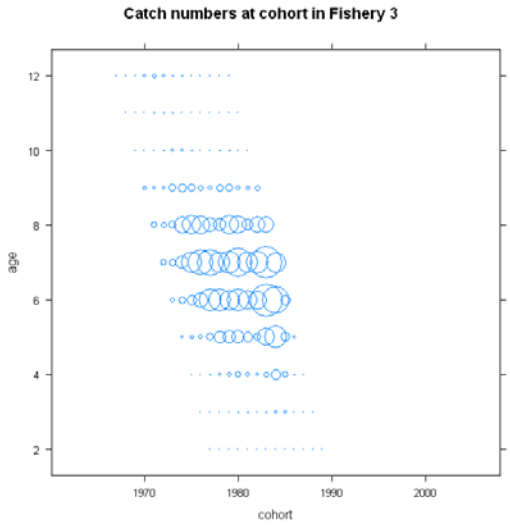

Catch numbers in Fishery 2
age
year
12
10
8
6
4
2
1980
1990
2000


Catch numbers in Fishery 3
age
year
12
10
8
6
4
2
1980
1990
2000

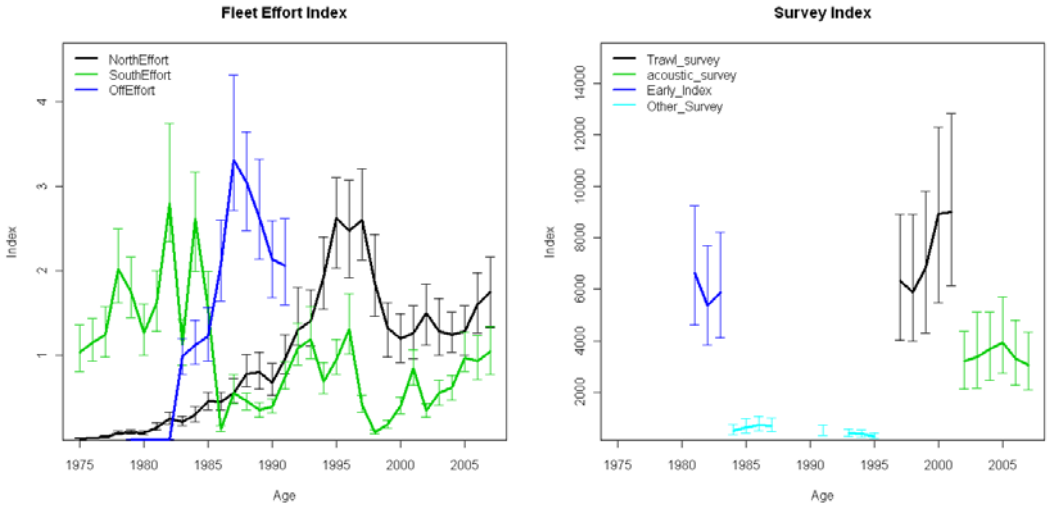
The figures below show the catch in numbers within a cohort. Cohorts are vertically lined up. Bigger bubbles indicate higher catches. Strong year classes could appear as bigger bubbles in the plots.



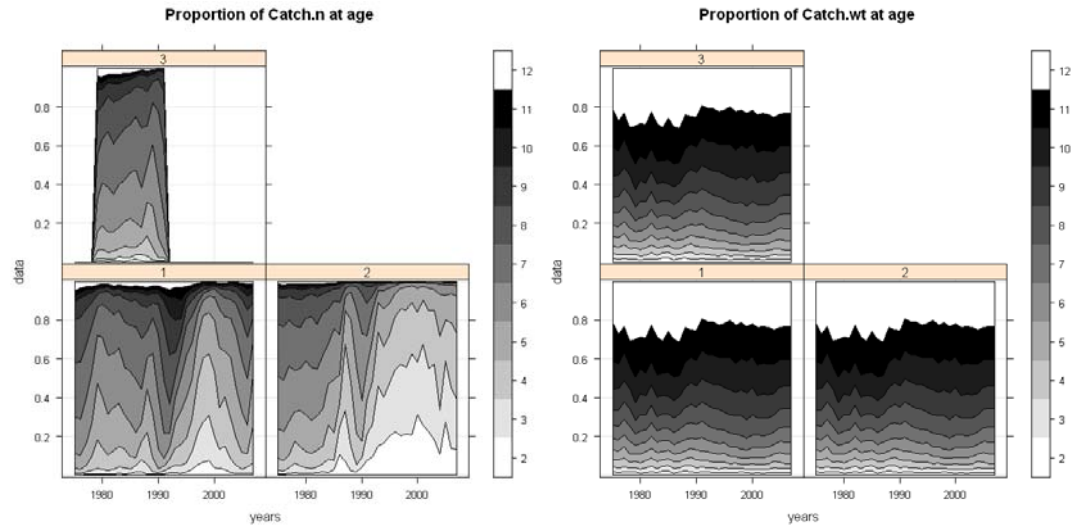




The trend of the fleet effort index is shown below (left). Vertical lines indicate 95% spread as computed based on the 100 simulated datasets. Each fleet effort time series has been given a different colour. The four different surveys, including a computed 95% spread, is given below too (right). As can be seen, no survey time series overlaps with another time series. As only 1 survey is available throughout the separable period, this is the most important survey as the assessment method uses the information in this survey to estimate stock numbers at age, and the terminal year fishing mortality.

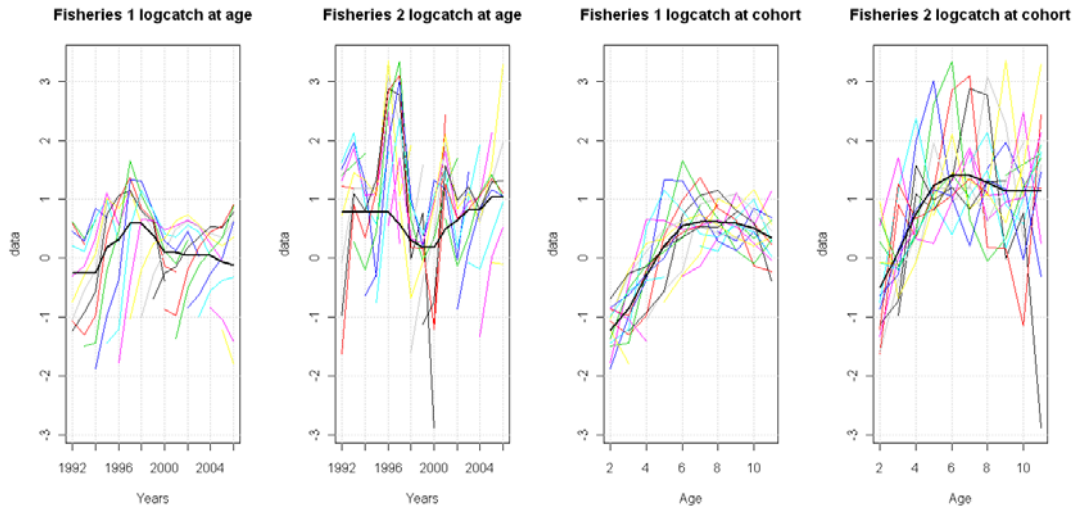


To investigate the development of catch number at age, their proportional contribution to the whole stock is plotted over the fishery, as well for catch weight at age. Catch numbers at age drop in all fisheries around 1990, while catch weight has been rather stable for a long period.



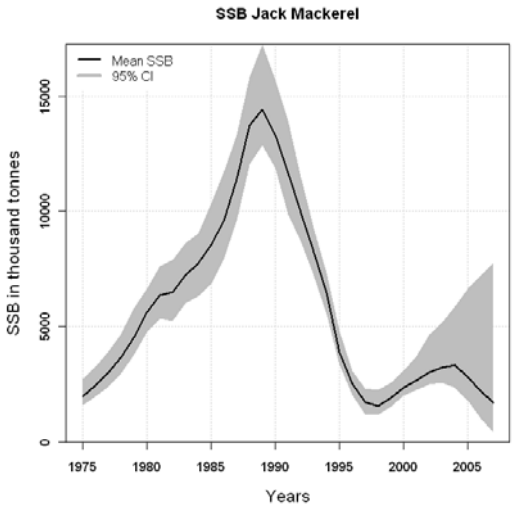
3.2 Assessment settings

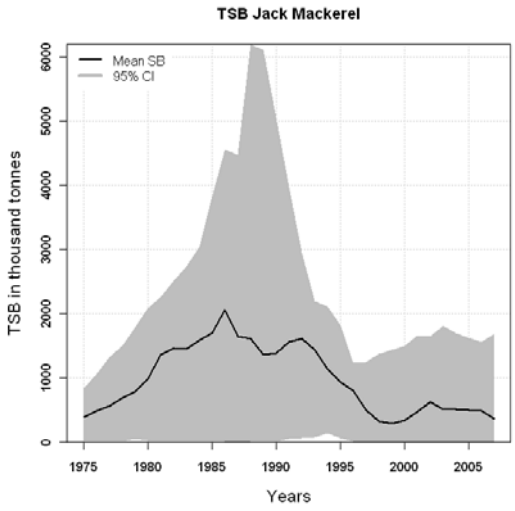
To distinguish the most appropriate separable period length, as well as the separable age, two different types of plots have been made. First, to find the separable period, log-transformed catches have been plotted by age over the years. The fitted smoothed function that indicates the change over time is represented by the black solid line. A change in fishing trend can be observed for the past 6 years of data in both fisheries. Hence, the separable period has been set to 6 years. The log-transformed catches plotted by cohort indicate which age is targeted most by the fisheries as this results in the highest catches. Here, the black solid line represents the smoothed function over ages too. In both cases, age 7 appears to be the most targeted age group, hence, the separable age has been set at age 7.

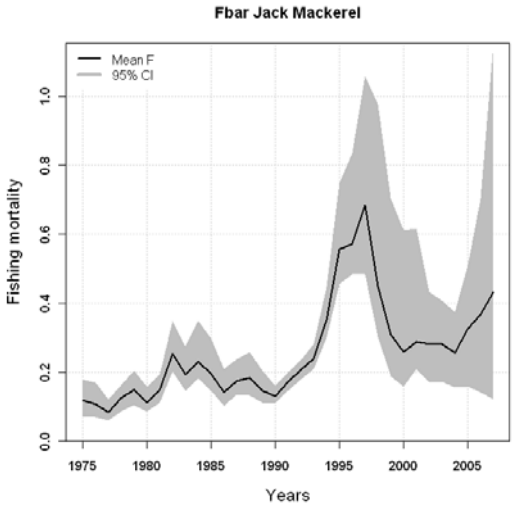


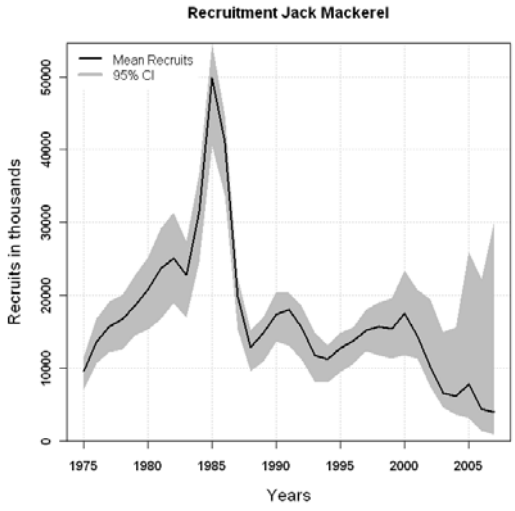
3.3 Assessment results

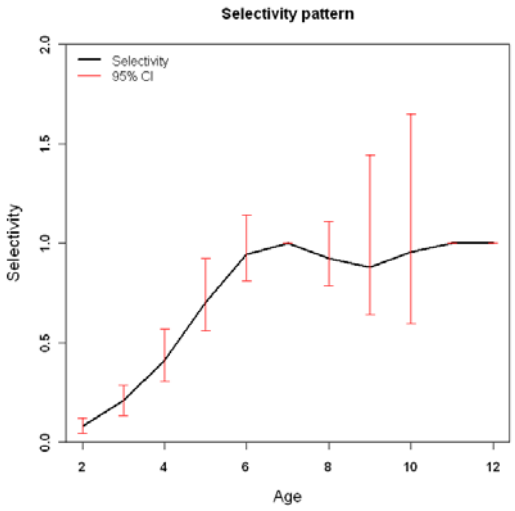
The scenario run to investigate the performance of the ICA assessment method in its ability to estimate the stock size of the simulated Jack Mackerel stock resulted in a range of diagnostic plots, used to evaluate the fit of the model.

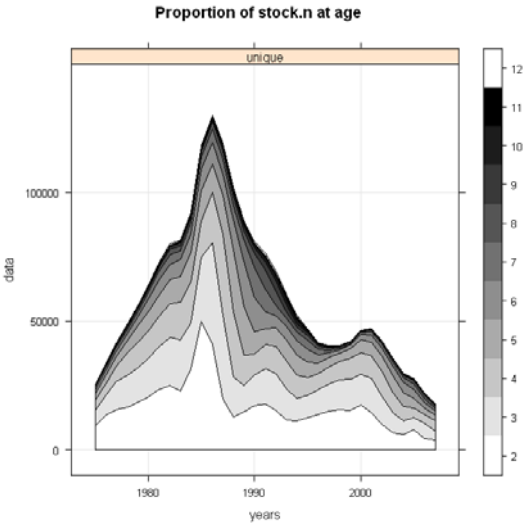

SSB Jack Mackerel
Mean SSB
95% CI
SSB in thousand tonnes
0
5000
10000
15000
1975
1980
1985
1990
1995
2000
2005
Years

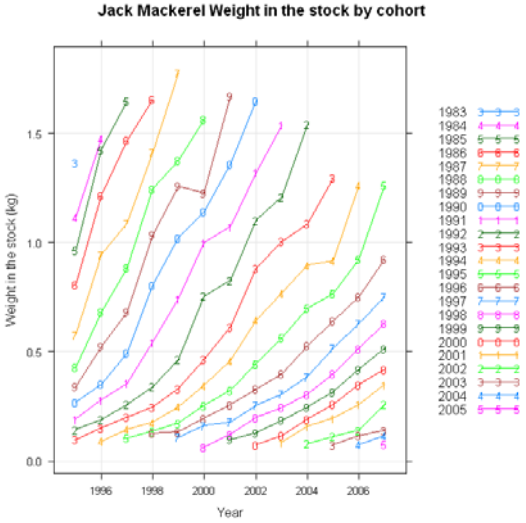

TSB Jack Mackerel
Mean SB
95% CI
TSB in thousand tonnes
0
1000
2000
3000
4000
5000
6000
1975
1980
1985
1990
1995
2000
2005
Years

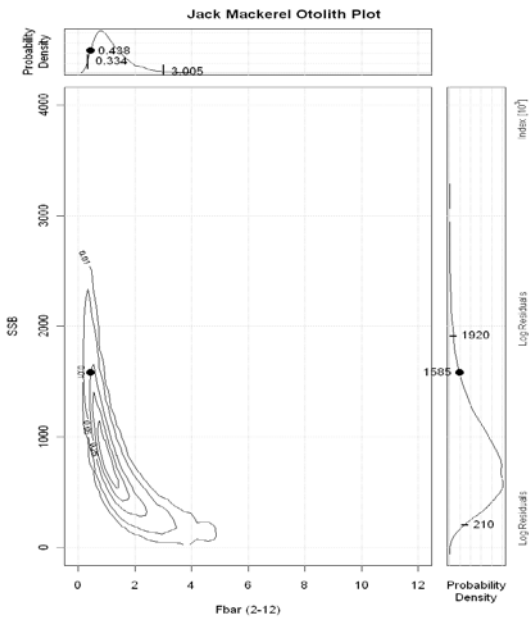

Fbar Jack Mackerel
Mean F
95% CI
Fishing mortality
0.0
0.2
0.4
0.6
0.8
1.0
1975
1980
1985
1990
1995
2000
2005
Years

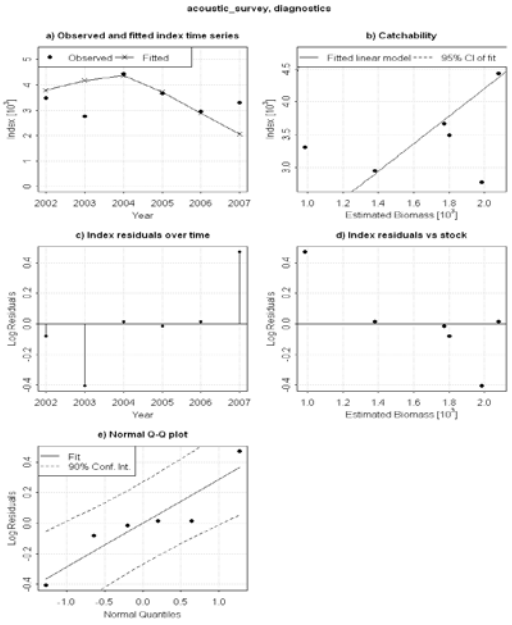

Recruitment Jack Mackerel
Mean Recruits
95% CI
Recruits in thousands
0
10000
20000
30000
40000
50000
1975
1980
1985
1990
1995
2000
2005
Years


Selectivity pattern
Selectivity
95% CI
Selectivity
Age


Proportion of stock.n at age
unique
data
years


Jack Mackerel Weight in the stock by cohort
Weight in the stock (kg)
Year


Jack Mackerel Otolith Plot
Probability Density
SSB
Fbar (2-12)
Probability Density


acoustic_survey, diagnostics
a) Observed and fitted index time series
b) Catchability
c) Index residuals over time
d) Index residuals vs stock
e) Normal Q-Q plot

The stock status indicators (TSB, SSB, Fbar and stock numbers at age) indicate that the stock size is declining over the past four years while fishing mortality is increasing, similar to the signal given within the acoustic survey. Recruitment failure is indicated by the recruitment plot and is reflected as well in the stock numbers at age where lower abundances for young ages can be observed. Uncertainty however on these trends is large, especially in the most recent years. Uncertainty on total biomass (TSB) is large too in the period in which fishery 3 was operational. The acoustic diagnostics show a reasonable fit of the time series where the most recent point is fitted rather poorly though. The uncertainty of the method is large and not estimated well as shown in the Otolith plot above.

4 Conclusions

4.1 Assessment conclusions

At the meeting in Lima, the assessment outcomes as listed above were presented and discussed. Based on the comparison with the underlying truth obtained from the model generated by Jim Ianelli, the ICA model estimated among other SSB, F and Recruitment reasonably well. However, its range of outcomes over the 100 simulations was unacceptably large for the exercise. As well, its inability to deal with multiple fisheries was considered a crucial disadvantage of using the model for further explorations.

References

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