South Pacific Regional Fisheries Management Organisation

Science Working Group

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SWG-09-JM-02B

Report from the assessment simulation task team workshop on using the joint jack mackerel assessment model (JJM)

Seattle
August 23-27th, 2010

Summary

The workshop on using the Joint Jack Mackerel (JJM) assessment model succeeded the meeting of the ASTT in the week of 16-20 August; the results of which have been reported separately (ASTT 2010). The present workshop involved 1 week of working and developing software to accommodate the available data for the SPRFMO jack mackerel assessment. To gain an appreciation of the "type" of statistical catch-age (SCA) model that underlies the joint assessment model, the group worked through a simplified version starting from 1st principles and writing code together during the first morning. This was further developed through an interface using the R programming language to run the application and make some basic figures. This model was run with 3 alternative configurations (increasing in data usage) to be both informative and also to practice making figures for comparing results (Fig. 1). These example files can be found at http://tinyurl.com/32ke7h7. The group was given a presentation on writing R packages. The advantage of this is that it requires documentation at each step and can be easily shared over different systems (data, functions, and even source and executable code can be readily packaged). As such, this may be a good way for standardizing some graphical functions and model documentation/sharing in the future for SPRFMO (R is a freely available public domain package).

The activities for the rest of the week focussed on understanding and implementing refinements to the Joint Jack Mackerel assessment model (JJM) and in developing routines for producing diagnostics and outputs desired for an assessment. Key modifications include allowing any index to share selectivities between different gear types and to have a power coefficient that can be used to relate an abundance index (e.g., in fishery CPUE data) to the population biomass. This can help resolve the potential of hyper-stability that is common in pelagic species.

The treatment and inclusion of the different available data included how to incorporate the Peruvian fishery length frequency data. This was considered important since the time series is long and there appears to be significant progressions of modes that may inform the assessment model. Because of time limitations, a first pass using cohort-slicing was employed. This seems to be effective since the

younger age modes appear to be well separated. Using methods where the growth model is included within the JJM was preferred but due to the added complexity, the group deferred this refinement for future assessments. The application of alternative growth functions to the Peruvian length frequency data was recommended from the ASTT Aug 16-20th 2010 meeting (ASTT 2010) and the impact of these were evaluated below.

The spawning biomass over the model period relative to that if no fishing had occurred was added to JJM and is now part of the standard output. This provides some reference to the impact of fishing (assuming that recruitment processes would be unaffected by density dependent effects). Catch projection scenarios were investigated given alternative future recruitment scenarios. It was noted that from preliminary results, recent recruitments appear to be well below average and that fishing mortality rates are relatively high. Projections from these results suggest that improved medium-term yields can be expected under lower levels of effort.

The following sections are intended to provide documentation and example results compiled during the week. The code and data files for all models are available from the SPRFMO website (TBD).

The assessment model

Parameters estimated conditionally are listed in Table 1. The most numerous of these involve estimates of annual and age-specific components of fishing mortality for each year from 1970-2010 and each of the four fisheries identified in the model. Parameters describing population numbers at age 2 in each year (and years prior to 1970 to estimate the initial population numbers at ages 2-12) were the second most numerous type of parameter.

The table of equations for the assessment model is given in Tables 2, 3, and 4.

The treatment of selectivities and how they are shared among fisheries and indices is given in Table 5. The numbers of parameters for different model configurations evaluated ranged from about 120 to over 1200 (typically by letting selectivity at age parameters vary freely for all gears—this configuration is similar to a VPA-like model where catches at age are implied to be known without error).

Modifying model configurations

During the week, modifications to assessment model configurations were completed by changing options within an excel spreadsheet interactively and on the screen. As a preliminary document on steps involved to change and run the JJM the group provides Attachment 1.

Example model evaluation

Data sensitivity from these exercises was examined that included evaluation of alternative treatments of the Peruvian fishery length composition data and assumptions about the proportionality of indices to biomass and also how statistical weights applied to different indices. This resulted in the following sequence of models were explored and are summarized in Table 6.

1. Fix selectivity for CS Chilean fishery to be constant from age-8 and constant over the whole period
    a. Using the age composition based on Peruvian growth model (for Peruvian fishery)

   b. Modify to use Kochkin's growth on Peruvian length frequency data
   c. Modify using Gili et al. (1995) growth estimate for Peruvian length frequency data
2. Like 1.c but with all CPUE indices with power function = 0.5 (hyper stability as suggested from Fig. 2)
3. Like 2. but downweight all acoustic indices (fit to DEPM)
4. Like 2. but decrease CV on acoustic indices (upweight acoustic surveys).
5. Like 1.c but with 4 periods for the CS Chilean fishery selectivities

Preliminary Results

For Model 1.c, using all available data results in good fits to the catch biomass (Fig. 3) and shows that recent recruitments are well below average (Fig. 4). Comparing model with the square-root relationship in CPUE to biomass suggests some improvement in some indices but not all (Fig. 5) and this is reflected by the table of likelihood components over the different models (Table 7). The displays of selectivity by gear types is shown in Fig. 6 and these were useful to evaluate different models and constraints on selectivity types. Figures 7, 8, 9, and 10 show the fits to the fisheries age composition data for Model 1c. Interestingly, the Peruvian catch-age data show consistent cohorts over time (these were derived from the growth function of Gili et al. (1995) using cohort-slicing of the length frequencies).

Projections

Recruitment scenarios

The following recruitment scenarios were proposed for projections during the ASTT assessment planning workshop:

1) Uncorrelated, based on a stock-recruitment relationship (could result in artificially high increase in near-term values).
   Rationale: the spawning biomass directly impacts expected recruitment
2) Use recent 5 year average recruitment (with historical variability).
   Rationale: the recent 5-year average may be a new state for the jack mackerel stock but with the same level of historical variability.
3) Use recent 5 year average recruitment (with recent 5-year variability).
   Rationale: the recent 5-year average may be a new state for the jack mackerel stock (mean and variability)
4) Use recent 10 year average recruitment (with historical variability).
   Rationale: the recent 5-year average may be overly pessimistic

Harvest strategies evaluated

SPR (spawning biomass per recruit) rates were presented and discussed as alternative harvest strategies that are commonly used in other parts of the world. These are considered as proxies for F_{msy} levels and have the advantage of being independent of assumptions and/or estimates from stock-recruitment relationships. The $F_{40\%}$ SPR rate was proposed as being an appropriate value to consider (this level is the fishing mortality that would reduce spawning biomass per recruit to 40% of the unfished value).

During the workshop, the different status quo catch levels failed for a number of model configurations. Consequently, an alternative projection model was developed with different average recruitment scenarios applied to different relative fishing mortality multipliers. This resolved the problem of fixing near-term future catches to values that were unobtainable for some model configurations. Results indicate that the recruitment assumption for projections has a large influence on future stock size and that current levels of fishing effort will likely reduce expected yields (Figs. 11 and 12).

The spawning biomass over the model period relative to that if no fishing had occurred was added to JJM and is now part of the standard output. This provides some reference to the impact of fishing (assuming that recruitment processes would be unaffected by density dependent effects).

References

ASTT 2010. Report from the assessment simulation task team on Chilean jack mackerel stock assessment, August 16-20th 2010, University of Washington, Seattle USA

Gili, R., L. Cid, V. Bocic, V. Alegría, H. Miranda & H. Torres. 1995. Determinación de la estructura de edad del recurso jurel. In: Estudio biológico pesquero sobre el recurso jurel en la zona centro-sur, V a IX Regiones. Informes Técnicos FIP/IT-93-18.

Kochkin, P.N., 1994. Age determination and estimate of growth rate for the Peruvian jack mackerels, Trachurus symmetricus murphyi. J. of Ichthyol. 34(3): 39-50.

Tables

Table 1. Symbols definitions used for model equations

General Definitions	Symbol/Value	Use in Catch at Age Model
Year index: i = {1970, …., 2010}	i	
Age index: j = { 2, 3, …, 12^{+}}	j	
Mean weight in year t by age j	$W_{t,j}$	
Maximum age beyond which selectivity is constant	*Maxage*	Selectivity parameterization
Instantaneous Natural Mortality	M	Fixed M=0.23, constant over all ages
Proportion females mature at age j	p_j	Definition of spawning biomass
Sample size for proportion in year i	T_i	Scales multinomial assumption about estimates of proportion at age
Survey catchability coefficient	q^s	Prior distribution = lognormal(μ_q^s , σ_q^2)
Stock-recruitment parameters	R_0	Unfished equilibrium recruitment
	h	Stock-recruitment steepness
	σ_R^2	Recruitment variance
Virginal biomass	φ	Spawning biomass per recruit when there is not fishing

Estimated parameters

$\phi_i(\#), R_0, h, \varepsilon_i(\#), \mu^f, \mu^s, M, \eta_j^s(\#), \eta_j^f(\#), q^s(\#)$

Note that the number of selectivity parameters estimated depends on the model configuration.

Table 2. Variables and equations describing implementation of the joint jack mackerel assessment model (JJM).

Eq	Description	Symbol/Constraints	Key Equation(s)
1)	Survey abundance index (s) by year (Δ^s represents the fraction of the year when the survey occurs)	I_i^s	$I_i^s = q^s \left(\sum_{j=2}^{12} N_{ij} e^{-\Delta^s Z_{ij}} S_j^s W_{ij} \right)^{b_s}$
2)	Catch biomass by year	C_i	$\hat{C}_{ij}^f = \sum_{j=2}^{12} N_{ij} W_{ij} \frac{F_{ij}^f}{Z_{ij}} (1 - e^{-Z_{ij}})$
3)	Proportion at age j, in year i	P_{ij}, $\sum_{j=2}^{12} P_{ij} = 1.0$	$p_{ij}^f = \frac{\hat{C}_{ij}^f}{\sum_j \hat{C}_{ij}^f}$ $p_{ij}^s = \frac{N_{ij} S_j^s e^{-\Delta^s Z_{ij}}}{\sum_j N_{ij} S_j^s e^{-\Delta^s Z_{ij}}}$
4)	Initial numbers at age	$j = 2$	$N_{1970,j} = e^{\mu_R + \varepsilon_{1970}}$
5)		$2 < j < 11$	$N_{1970,j} = e^{\mu_R + \varepsilon_{1971-j}} \prod_{j=1}^{j} e^{-M}$
6)		$j = 12^+$	$N_{1970,12} = N_{1970,11} \left(1 - e^{-M}\right)^{-1}$
7)	Subsequent years ($i > 1970$)	$j = 2$	$N_{i,2} = e^{\mu_R + \varepsilon_i}$
8)		$2 < j \leq 11$	$N_{i,j} = N_{i-1,j-1} e^{-Z_{i-1,j-1}}$
9)		$j = 12^+$	$N_{i,12^+} = N_{i-1,11} e^{-Z_{i-1,10}} + N_{i-1,12} e^{-Z_{i-1,11}}$
10)	Year effect and individuals at age 2 and i = 1958, …, 2010	$\varepsilon_i, \sum_{i=1958}^{2010} \varepsilon_i = 0$	$N_{i,2} = e^{\mu_R + \varepsilon_i}$
11)	Index catchability		$q_i^s = e^{\mu^s}$
	Mean effect	μ^s, μ^f	$s_j^s = e^{\eta_j^s}$ $j \leq$ maxage
	Age effect	$\eta_j^s, \sum_{j=2}^{12^+} \eta_j^s = 0$	$s_j^s = e^{\eta_{\text{maxage}}^s}$ $j >$ maxage
12)	Instantaneous fishing mortality		$F_{ij}^f = e^{\mu^f + \eta_j^f + \phi_i}$
13)	Mean fishing effect	μ^f	
14)	Annual effect of fishing mortality in year i	$\phi_i, \sum_{i=1970}^{2010} \phi_i = 0$	
15)	age effect of fishing (regularized) In year time variation allowed	η_{ij}^f , $\sum_{j=2}^{12^+} \eta_{ij} = 0$	$s_{ij}^f = e^{\eta_j^f}$, $j \leq$ maxage $s_{ij}^f = e^{\eta_{\text{maxage}}^f}$ $j >$ maxage
	In years where selectivity is constant over time	$\eta_{i,j}^f = \eta_{i-1,j}^f$	$i \neq$ change year
16)	Natural Mortality	M	*Set fixed at 0.23*
17)	Total mortality		$Z_{ij} = \sum_f F_{ij}^f + M$
17)	Spawning biomass	B_i	$B_i = \sum_{j=2}^{12} N_{ij} e^{-\frac{10,5}{12} Z_{ij}} W_{ij} p_j$ *(note spawning taken to occur at mid of November)*

18)	Recruitments (Beverton-Holt form) at age 2.	$\tilde{R}_i$	$\tilde{R}_i = \frac{\alpha B_i}{\beta + B_i}$, $\alpha = \frac{4hR_0}{5h-1}$ and $\beta = \frac{B_0(1-h)}{5h-1}$ where $B_0 = R_0\varphi$ $\varphi = \sum_{j=2}^{12} e^{-M(j-1)} W_j p_j + \frac{e^{-12M} W_{12} p_{12}}{1-e^{-M}}$ $h=0.8$

Table 3. Specification of objective function that is minimized (i.e., the penalized negative of the log-likelihood).

	Likelihood /penalty component		Description / notes
19)	Abundance indices	$L_1 = \sum_s \lambda_1^s \sum_i \ln\left(\frac{I_i^s}{\hat{I}_i^s}\right)^2$	Survey abundances
20)	Prior on smoothness for selectivities	$L_2 = \sum_l \lambda_2^l \sum_{j=2}^{12^+} \left(\eta_{j+2}^l + \eta_j^l - 2\eta_{j+1}^l\right)^2$	Smoothness (second differencing), Note: l={s, or f} for survey and fishery selectivity
21)	Prior on recruitment regularity	$L_3 = \lambda_3 \sum_{i=1958}^{2010} \varepsilon_i^2$	Influences estimates where data are lacking (e.g., if no signal of recruitment strength is available, then the recruitment estimate will converge to median value).
22)	Catch biomass likelihood	$L_4 = \sum_f \lambda_4^f \sum_{i=1970}^{2010} \ln\left(\frac{C_i^f}{\hat{C}_i^f}\right)^2$	Fit to catch biomass in each year
23)	Proportion at age likelihood	$L_5 = -\sum_{l,i,j} T_i^l P_{ij}^l \ln\left(\hat{P}_{ij}^l\right)$	l={s, f}for survey and fishery age composition observations
24)	Fishing mortality regularity	F values constrained between 0 and 5	(relaxed in final phases of estimation)
25)	Recruitment curve fit	$L_6 = \lambda_6 \sum_{i=1977}^{2004} \ln\left(\frac{N_{i,2}}{\tilde{R}_i}\right)^2$	Conditioning on stock-recruitment curve over period 1977-2004.
26)	Priors or assumptions	R_0 non-informative σ_R^2 fixed at 0.6 b 0.5 or 1.0 depending on the scenario	
27)	Overall objective function to be minimized	$\dot{L} = \sum_k L_k$	

Table 4. Penalties used on log-likelihood functions in the base model

L	*s*	**Abundance index**	$\lambda^{s\,(1)}$
1	1	Acoustic CS- Chile	5.6
	2	Acoustic N-Chile	2.0
	3	CPUE - Chile	12.5
	4	DEPM - Chile	3.1
	5	Acoustic-Peru	5.6
	6	CPUE - Peru	12.5
	7	CPUE- China	3.1
	8	CPUE-EU	12.5
2	*s*	**Smoothness for selectivities**	λ^{s}
	1	Acoustic CS- Chile	100
	2	Acoustic N-Chile	100
	3	CPUE - Chile	100
	7	CPUE- China	100
	8	CPUE-EU	100
	f		$\lambda^{f\,(1)}$
	1	N-Chile	1
	2	CS- Chile	25
	3	Peru	12.5
	4	International	12.5
3		**Recruitment regularity**	$\lambda^{(1)}$
			1.4

L	*f*	**Catch biomass likelihood**	$\lambda^{f\,(1)}$
4	1	N-Chile	200
	2	CS- Chile	200
	3	Peru	200
	4	International	200
5	*s*	**Proportion at age likelihood**	T^{s}
	1	Acoustic CS- Chile	30
	2	DEPM - Chile	20
	f		T^{f}
	1	N-Chile	20
	2	CS- Chile	50
	3	Peru	30
	4	International	30
6		**S-Recruitment curve fit**	$\lambda^{(1)}$
			1.4

(1) corresponds to $1/(2\sigma^2)$

Table 5. Description of the different model components and how selectivity was treated

Item	Description	Selectivity assumption
Fisheries		
1)	Chilean northern area fishery	Estimated from age composition data
2)	Chilean central and southern area fishery	Estimated from age composition data
3)	Peruvian fishery	As a first proposal, use cohort sliced length comps directly as derived from different assumed growth relationships (Peruvian and that of Kochkin) to evaluate sensitivity
4)	International fishery	Estimated from age composition data
Index series		
5)	Acoustic survey in central and southern Chile	Estimated from age composition data
6)	Acoustic survey in northern Chile	Assumed to be the same as 1)
7)	Central and southern fishery CPUE	Assumed to be the same as 2)
8)	Egg production survey	Estimated from age composition data
9)	Acoustic survey in Peru	Assumed to be the same as 3)
10)	Peruvian fishery CPUE	Assumed to be the same as 3)
11)	Chinese fleet CPUE (from FAO workshop)	Assumed to be the same as 4)
12)	EU fleet CPUE	Assumed to be the same as 4)

Table 6. Description and file naming convention for different model configurations examined during the workshop.

Model	Control file	Datafile	Description
Model 1.a	Mod1a.ctr	Mod1a.dat	Peruvian growth
Model 1.b	Mod1b.ctr	Mod1b.dat	Kochkin growth
Model 1.c	Mod1c.ctr	Mod1c.dat	Gili growth
Model 2	Mod2.ctr	Mod1c.dat	Power function for CPUE
Model 3	Mod3.ctr	Mod3.dat	Downweight Acoustic
Model 4	Mod4.ctr	Mod4.dat	Up-weight acoustic surveys
Model 5	Mod5.ctr	Mod5.dat	Variable selectivity for CS Chilean fishery

Table 7. Likeklihood and prior components from the different model configurations

	Data total	Catch	Age_Fish	Sel_Fish	Indices	Age_Ind	Select	Rec	F
Mod1a	1,133.1	0.9	739.6	28.8	275.6	117.0	22.4	22.5	0.0
Mod1b	1,156.5	1.4	749.5	27.4	282.1	123.4	21.9	18.7	0.0
Mod1c	1,142.8	2.1	743.0	25.9	273.9	123.8	21.7	20.4	0.0
Mod2	1,141.5	1.3	741.2	27.6	281.1	117.9	20.3	24.7	0.0
Mod3	1,050.3	0.6	719.9	25.8	211.6	118.1	25.2	17.6	0.0
Mod4	1,295.9	5.7	772.0	26.9	392.1	126.0	21.7	28.0	0.1
Mod5	1,054.5	1.9	661.5	35.5	269.5	121.6	21.3	23.7	0.0

Figures

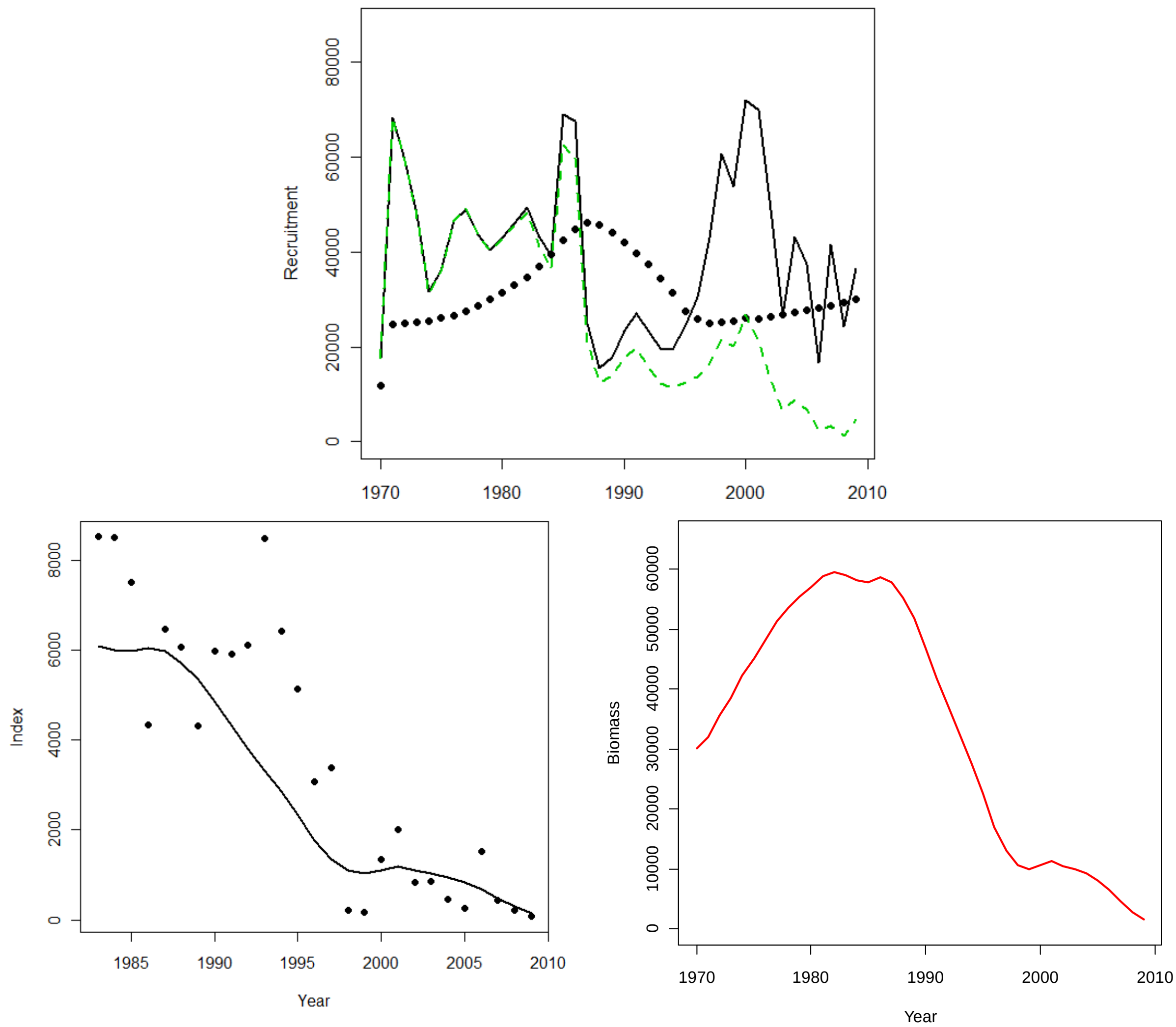

Figure 1. Example results from the simple single-fishery, single index version of the SCA model developed on the first day of the workshop. The top figure shows recruitment estimates when data in the model include only the total catch and a prior assumption that fishing mortality averaged 0.1 over the entire period (dots), The solid line in the top figure represents results with catch-age data included, and the dashed line is when both catch-age and an index is included. The bottom two figures show the results from this latter model; left: fit to the index and right: total biomass trajectory.

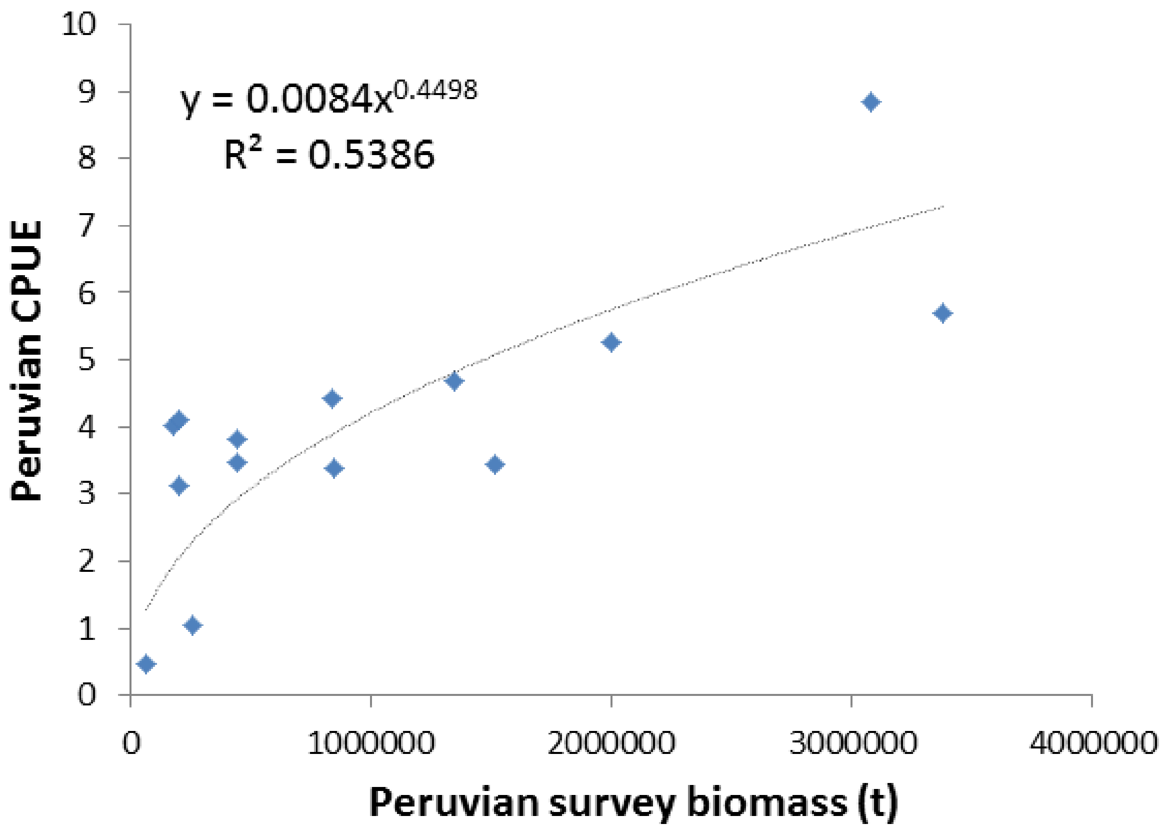

Figure 2. Example of fishery independent biomass index (acoustic survey estimates from Peru) compared with fishery CPUE values suggesting that the fishery may have some hyper-stability.

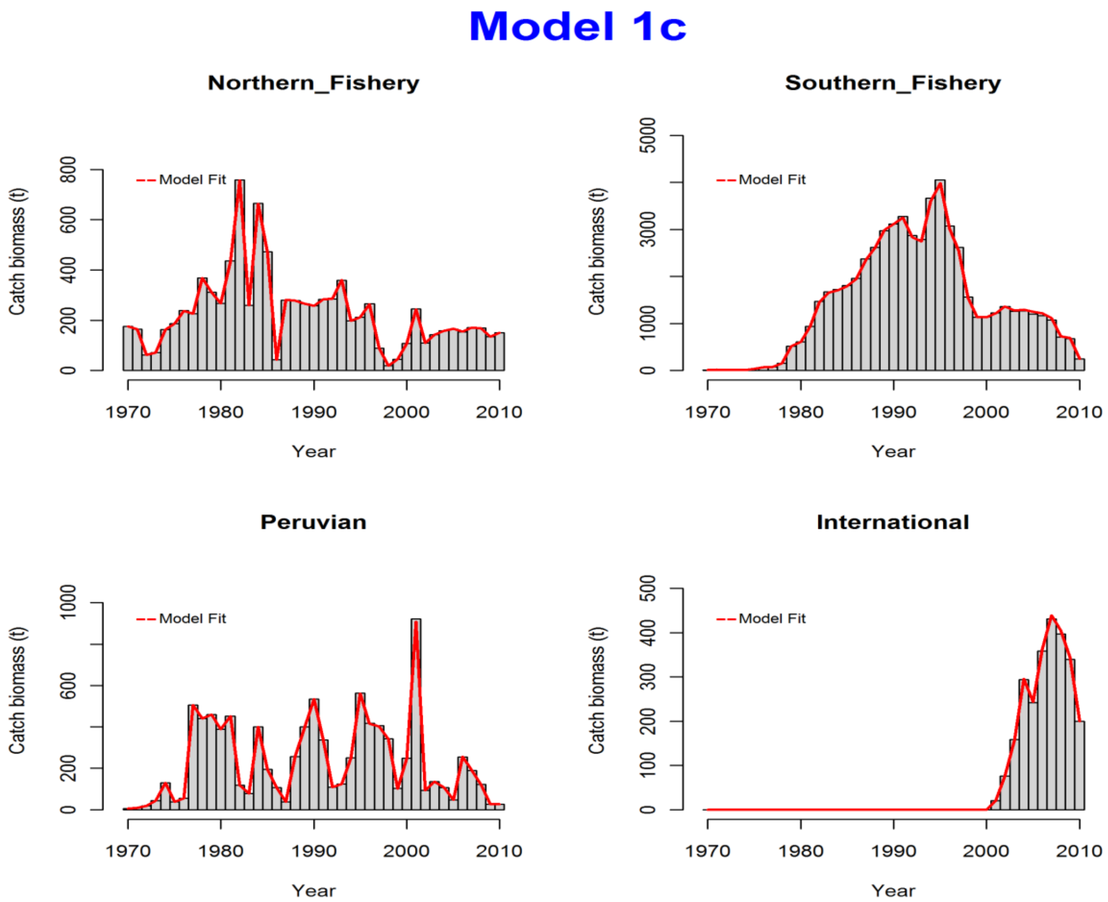

Figure 3. Example fit of catch biomass (landings) to the different fisheries identified for this assessment.

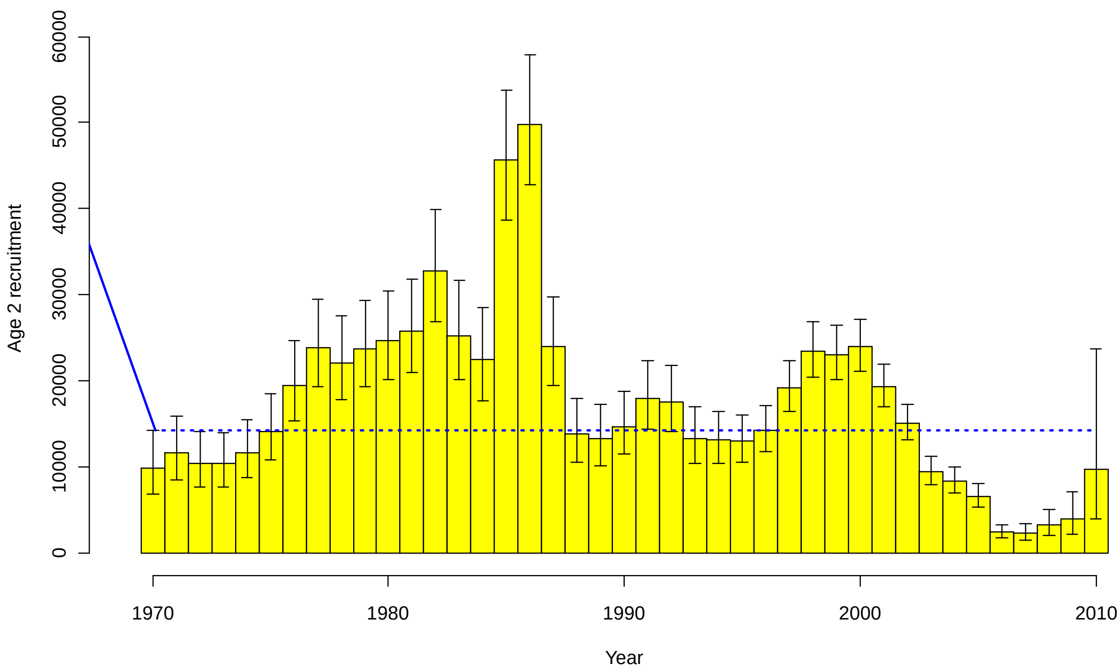

Figure 4. Example of recruitment estimates using the JJM (Model 1c).

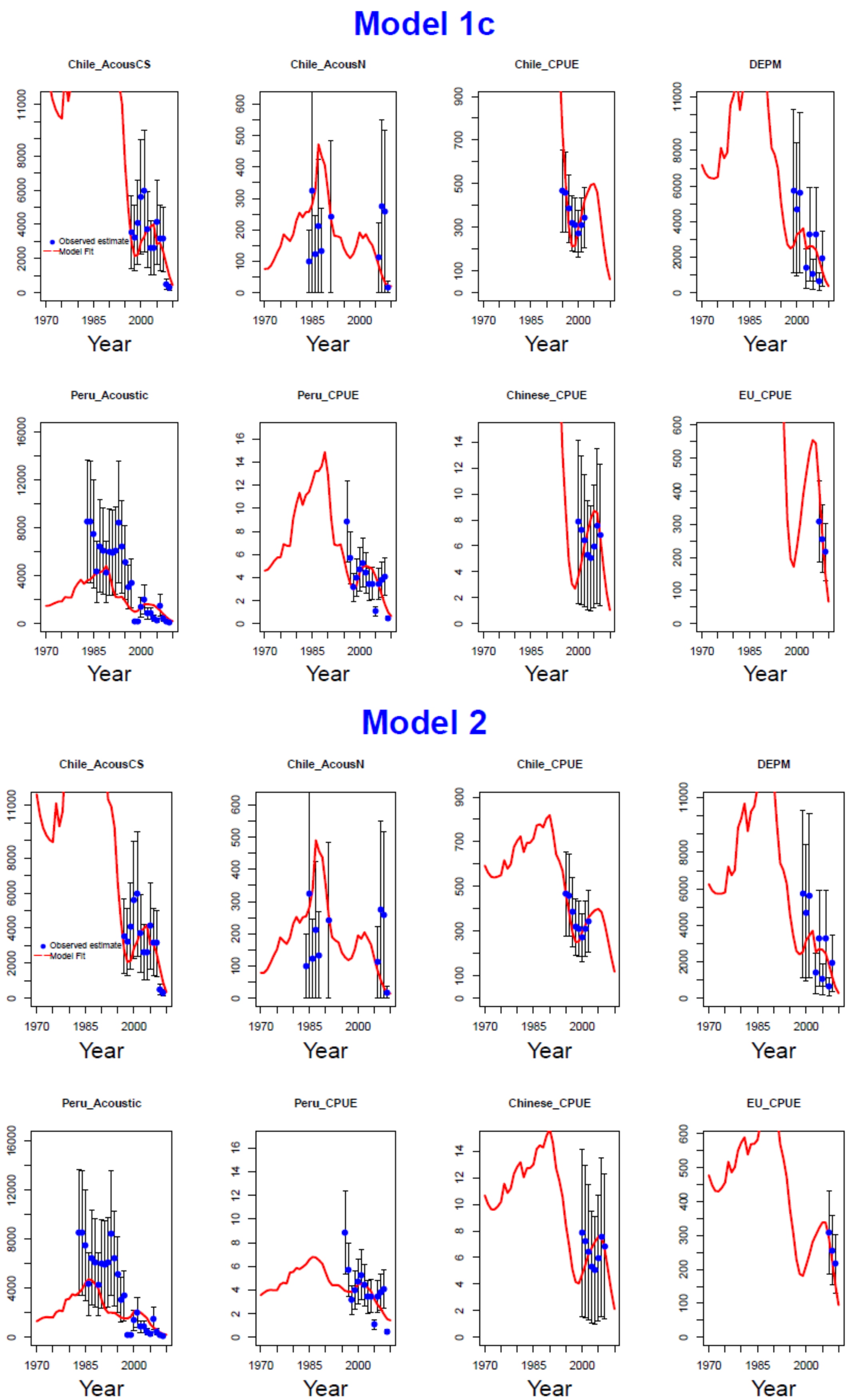

Figure 5. Example of model fits to different indices for Model 1c (top set) and Model 2 (with CPUE set to be proportional to the square root of biomass).

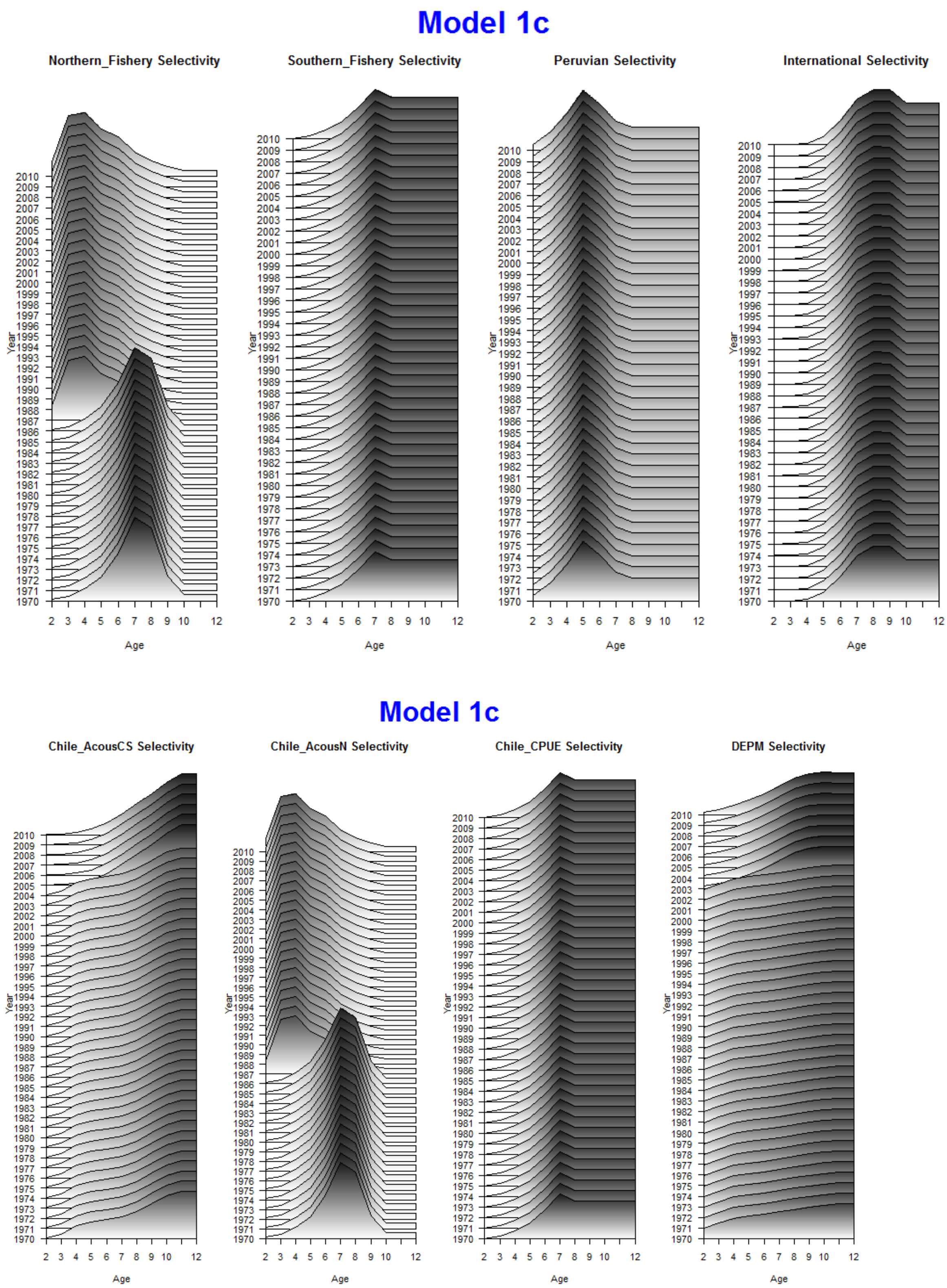

Figure 6. Example of time series of selectivity estimates by index type for model 1c.

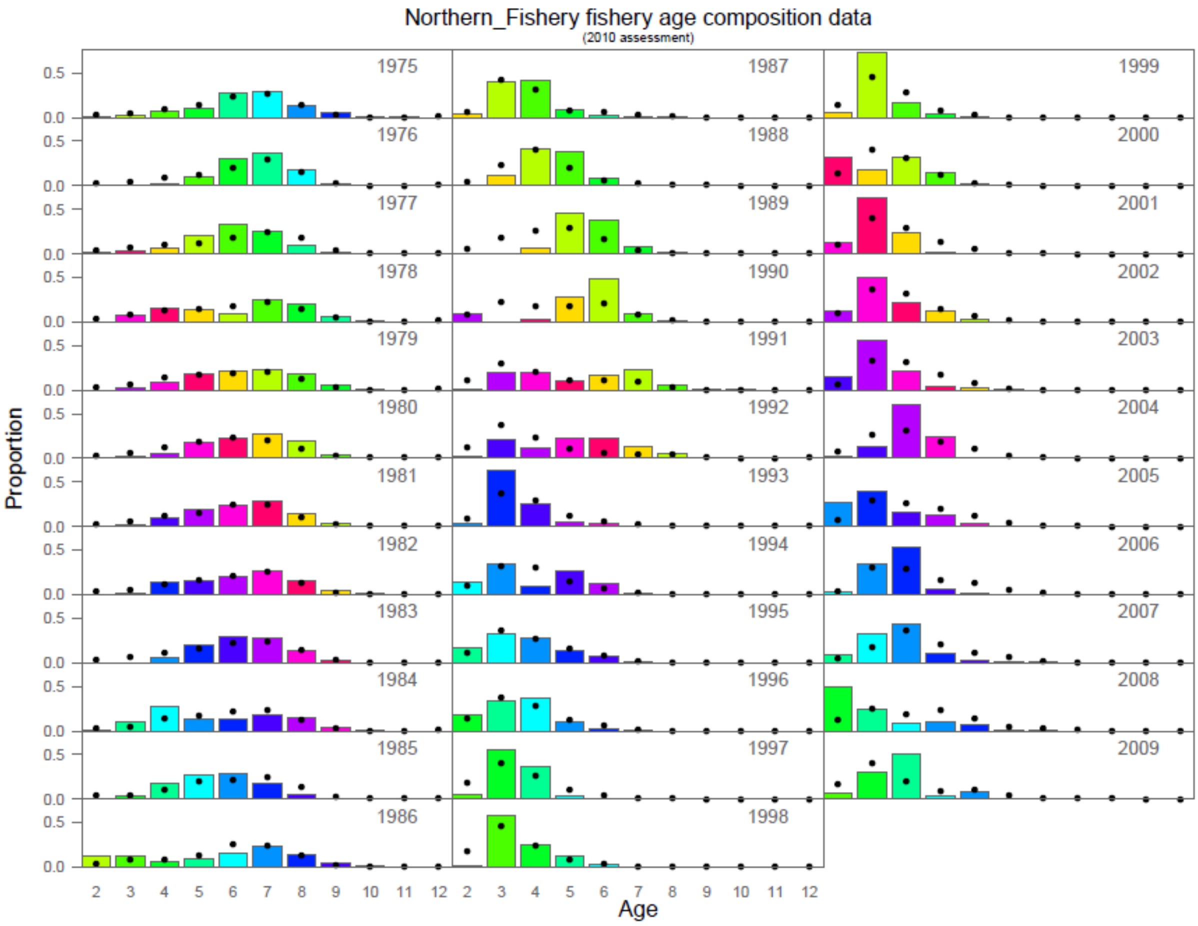

Figure 7. Example of the model fit (dots) to the age composition data (columns) for the Chilean northern fishery for model 1c.

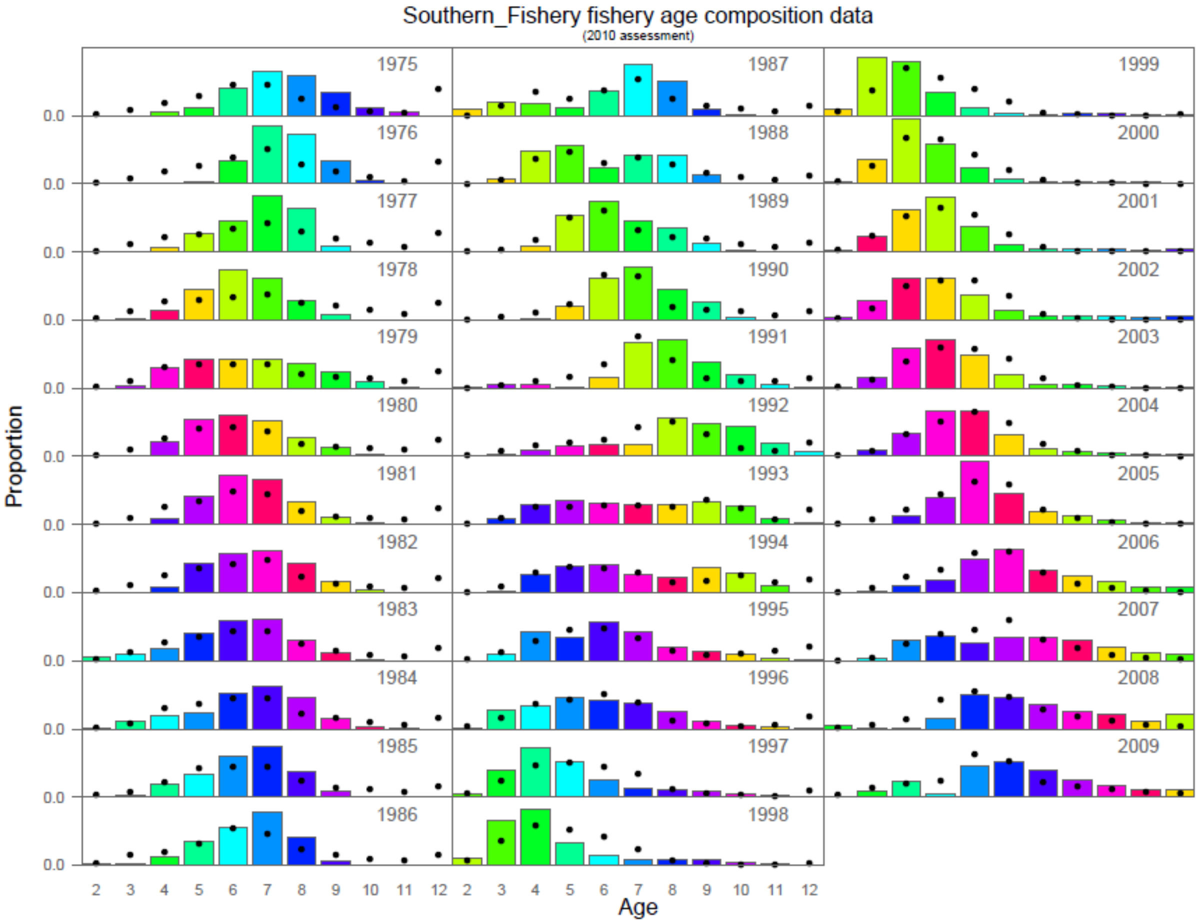

Figure 8. Example of the model fit (dots) to the age composition data (columns) for the Chilean central-south fishery for model 1c.

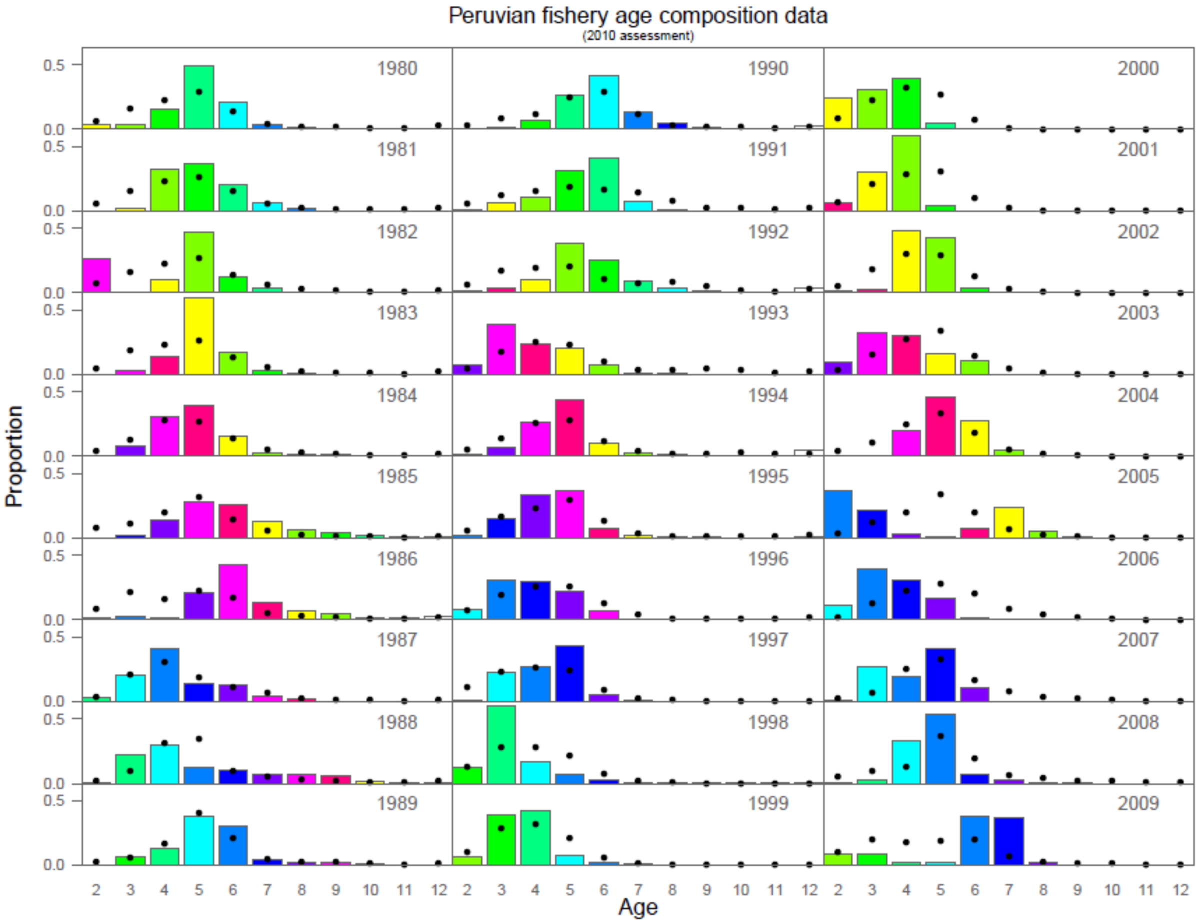

Figure 9. Example of the model fit (dots) to the age composition data (columns) for the Peruvian fishery for model 1c.

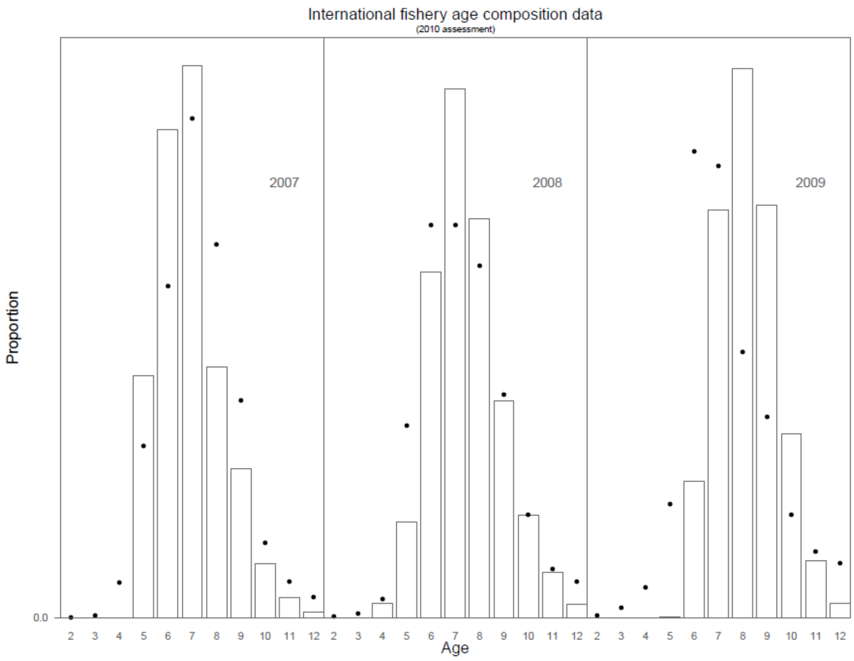

Figure 10. Example of the model fit (dots) to the age composition data (columns) for the International fishery for model 1c.

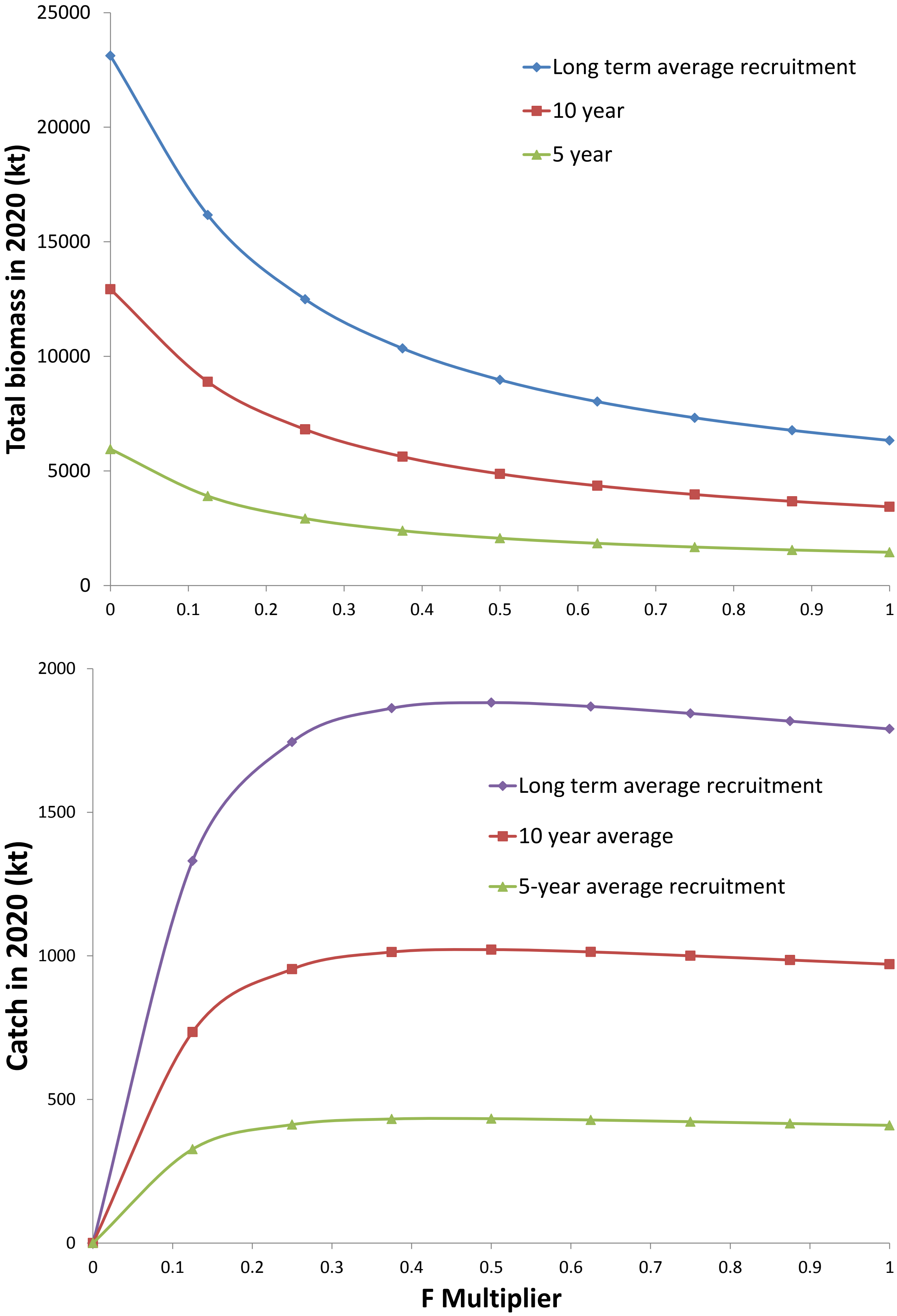

Figure 11. Example of projection results under different multipliers (of 2010 estimated fishing mortalities for each fishery) showing total biomass (top) and catch in 2020 (bottom).

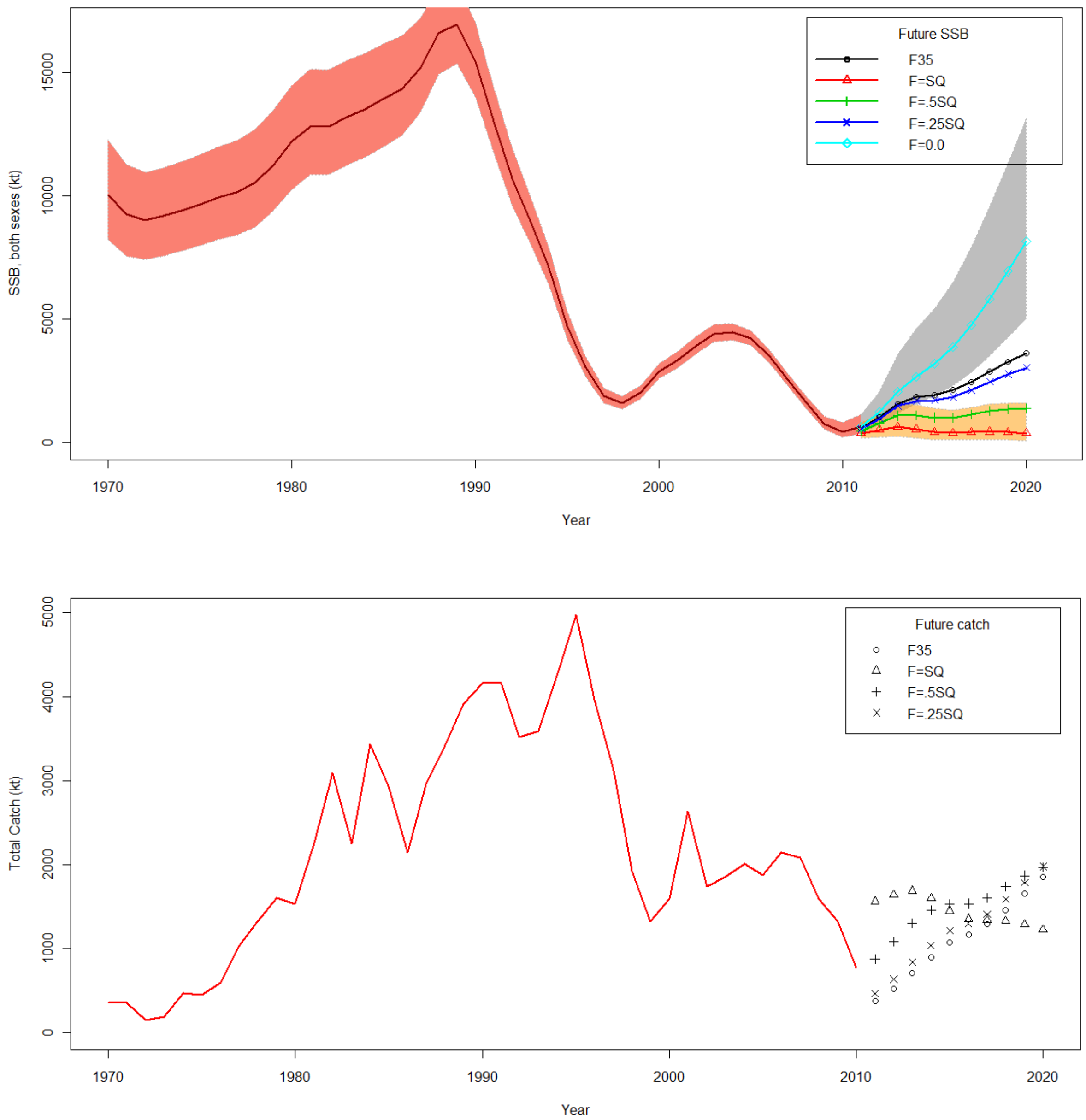

Figure 12. Example of trajectories under different multipliers (of 2010 estimated fishing mortalities for each fishery) showing total spawning biomass (top, with uncertainty bands) and catch (bottom) compared to historical values. R-scripts for these figures are included (FutBiom, and FutCatch).

Attachment 1. Guidelines for modifying files controlling JJM runs

Files

The file jjm.tpl contains the source code for the model and has a number of features that require some control and once compiled using ADMB, generally requires 2 files for running: the "control" file (snippets of which are shown in Table 8) and a companion data file (Table 9). The "control" file contains the options (including the name of the data file) that configure model options. For example the following command will run the model with the file "mod1c.ctr" to completion (the –ind specifies the input datafile and the –nox simply reduces the verbosity of the output):

```
jjm –ind mod1c.ctr -nox
```

TIP: Alternatively, if the control file is renamed to jjm.dat then the model can be executed by simply typing:

```
jjm
```

Users should be aware of needing to save results from individual runs separately. Some batch files were created to illustrate this concept and are provided in the package. There are a number of output files that are created when the model completes (assuming it has done so successfully).

TIP: if the model fails to run correctly and suspicion is the datafile, it may be useful examine to the file "writeinput.log" which is intended to contain all of the data that were read in.

Steps to make modifications

NOTE: making modifications to files for analysis in the jjm requires careful practice. At the moment, approaches to simplify data configurations through an R graphical interface are being explored. The following provides a non-exhaustive set of steps to consider when modifying and configuring model runs for JJM.

Adding a fishery

Adding a fishery requires the following steps:

1) Change the datafile by adding the number of fisheries
2) For each section in the datafile, add a new line or set of lines in the correct order (i.e., if it is the 5th fishery then related values should appear after the 4th fishery for all blocks.

For the control file

3) Specify the selectivity options if it is to be shared (top of file)
4) Insert a block for the new fishery below the last one e.g., after the 4th if the fishery to be added is the 5th.

Adding an index

Similar steps are required for adding a new index to the model:

1) Change the datafile by adding the number of indices
2) For each section in the datafile, add a new line or set of lines in the correct order (i.e., if it is the 5th fishery then related values should appear after the 4th fishery for all blocks.

For the control file

3) Specify the selectivity options if it is to be shared (top of file)
4) For each subsection dealing with "q" a line must be added (see description in column 1 of Table 8)
5) Insert a block for the new index below the last one e.g., after the 8^{th} if the index to be added is the 9^{th}.

Changing the number of years modelled

A number of places need to be extended in the control file and data file should the numbers of years modelled be changed. These include:

1) The catch biomass sections
2) The year-specific CVs of catch biomass

For the control file

3) The year-by-year changes in selectivity (whether there's a change or not) for all fisheries and surveys
4) The mean weights at age (one vector for every year in every fishery and survey/index)
5) …

Table 8. Example basic structure of control file for JJM. Note that the … imply more data and # means a comment (data to right of comment is not read in.

Data File	Mod1c.dat							
Model name	**Model_1c**							
1=fshry, 2 = ind	1	1	1	1	2	**1**	**1**	2
1,2,nfsh.1,2,nind	1	2	3	4	1	1	2	4
Recruitment Model Flag 1=Ricker, 2=B-Holt	2							
use age-error matrix, 0=FALSE, 1=TRUE	0							
reserved	0							
Prior on Srec steepness	0.8							
CV on Srec steepness	300							
Phase for Srec steepness	-6							
Prior on SigmaR	0.6							
CV on SigmaR	15							
Phase for SigmaR	-4							
1st year Srec fit	1977							
Last yr recruitment fit	2004							
Natural mortality	0.23							
CV for M	0.05							
Phase for M	-4							
Q prior mean, indx 1	0.5000							
Q prior mean, indx 2	0.0200							
…	…							
Q prior mean, indx 8	0.0600							
Q prior ln sd indx 1	1.2							
Q prior ln sd indx 2	1.2							
…	…							
Q prior ln sd indx 8	1.2							
phase est q indx 1	3							
phase est q indx 2	2							
…	…							
phase est q indx 8	1							
q-pow prior mean, indx 1	1							
q-pow prior mean, indx 2	1							
…	…							
q-pow prior mean, indx 8	0.5							
q-pow prior ln sd indx 1	1.2							
q-pow prior ln sd indx 2	1.2							
…	…							
q-pow prior ln sd indx 8	1.2							
phase est q-pow indx 1	-1							
phase est q-pow indx 2	-1							
…	…							
phase est q-pow indx 8	-1							
min age q indx 1	2							
min age q indx 2	2							
…	…							
min age q indx 8	2							
max age q indx 1	10							
max age q indx 2	10							
…	…							
max age q indx 8	10							

Defunct (no longer used)	0.05							
Number of projection years	10							
	#	Fishery	1	N	Chile			
Select type for fshry 1	**1**							
n_sel_ages	9							
phase sel	2							
curvature penalty	1							
Dome-shape penalty	1							
yr-yr change penalty	0	0	0	0	0	0	…	0
Init Param Vals.	0.2	0.7	1	1	1	1	…	1
	#	Fishery	2,	Central	South	Chile		
Select type for fshry 1	**1**							
n_sel_ages	7							
phase sel	**3**							
curvature penalty	1							
Dome-shape penalty	25							
yr-yr change penalty	0	0	0	0	0	0	0	0
Init Param Vals.	0.2	0.7	1	1	1	1	1	1
….	#	Fishery	…					
…	…							
1	#	Index	number	1	AcousCS			
SelOption	1							
n_sel_ages	10							
phase sel	2							
curvature penalty	0.25							
Dome-shape penalty	100							
yr-yr change penalty	0	0	0	0	0		0	0
Init Param Vals.	0.3	1	1	1	1		1	
2	#	Index	number	2	Acous_N			
SelOption	1							
n_sel_ages	10							
phase sel	-5							
curvature penalty	0.25							
Dome-shape penalty	100							
yr-yr change penalty	0	0	0	0	0		0	0
Init Param Vals.	0.3	1	1	1	1		1	
3	#	Index	…					
…	…							
8	#	Index	number	8	EU_CPUE			
SelOption	1							
n_sel_ages	10							
phase sel	-5							
curvature penalty	0.25							
Dome-shape penalty	100							
yr-yr change penalty	0	0	0	0	0		0	0
Init Param Vals.	0.04	0.43	0.93	1	1		1	
	#Test							
Final read test	123456789							

Table 9. Example basic structure of the data file for JJM. Note that the … imply more data and # means a comment (things to the right of comment is not read in).

#	4	fisheries	8 Indices							
1970	# First year									
2010	# Last year									
2	# First age									
12	# Last age									
#	Number of fisheries									
4										
#	Names	of	fisheries							
Northern_Fishery%Southern_Fishery%Peruvian%International										
#	Catch biomass by fishery			1000						
#	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
175.208	164.838	62.634	71.762	163.396	186.89	237.876	225.907	367.762	311.682	266.697
7.938	21.934	7.1	8.904	12.678	34.951	65.57	77.858	151.986	518.53107	608.2
4.711	9.189	18.782	42.781	129.211	37.899	54.154	504.992	440.796	458.90893	388.58
0	0	0	0	0	0	0	0	0	0	0
#	Catch biomass uncertainty (CV)									
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
#	Number	Years	With	Fishery age						
35										
35										
30										
3										
#	Fishery	Years of age composition data								
1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2007	2008	2009								
#	Fishery	age composition sample size								
20	20	20	20	20	20	20	20	20	20	20
50	50	50	50	50	50	50	50	50	50	50
30	30	30	30	30	30	30	30	30	30	30
30	30	30								
#	Fishery 1	age composition	Northern Chilean							
4	14	44	61	166	171	81	30	8	5	1
0	2	10	62	191	230	110	17	5	0	0
…										
#	Fishery	2 Central-Southern Chile								
0	0	1	2	7	11	10	6	2	1	0
1	0	0	2	18	46	39	18	3	0	0
…										
#	Fishery	3 peruvian Gili								
…										
#	Fishery	4 international								
…										
#	Fishery	1	wt-age							
0.093	0.131	0.178	0.262	0.294	0.34	0.396	0.549	0.738	0.984	1.093
…										
#	Number	of	Indices							
8										
#	Names of indices									
Chile_AcousCS%Chile_AcousN%Chile_CPUE%DEPM%Peru_Acoustic%Peru_CPUE%Chinese_CPUE%EU_CPUE										
#	Nobs	Indices								
13										
10										
8										
9										
27										
14										
8										

3										
#	**Index**	**years**								
1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1984	1985	1986	1987	1988	1991	2006	2007	2008	2009	
1995	1996	1997	1998	1999	2000	2001	2002			
1999	2000	2001	2003	2004	2005	2006	2007	2008		
1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2000	2001	2002	2003	2004	2005	2006	2007			
2007	2008	2009								
#	**Month**	**Indices**								
6										
11										
6										
6										
1.5										
2										
6										
6										
#	**Index**	**values**								
3530	3200	4100	5600	5950	3700	2640	2640	4110	3192	3140
99	324	123	213	134	242	112	275	259	18	
467	460	385	318	311	270	311	344			
5724	4688	5627	1388	3287	1043	3283	626	1935		
8512.6	8511.021	7493.285	4329.87		6065.75				6099.27	8471.0
74	892	598	4	6472.042	429	4302.93	5971.71	5915.25	83	96
8.8359	5.696803	3.128518	4.00627	4.692003	5.27170	4.42272	3.39787	3.46575	1.05582	3.4429
71	358	243	561	594	868	727	54	76	63	68
7.86	7.2	6.39	5.26	5.07	5.95	7.52	6.81			
308	256	217								
#	**Index**	**std errors**								
706	640	820	1120	1190	740	528	528	822	638.4	628
49.5	162	61.5	106.5	67	121	56	137.5	129.5	9	
93.4	92	77	63.6	62.2	54	62.2	68.8			
2862	2344	2813.5	694	1643.5	521.5	1641.5	313	967.5		
…										
61.6	51.2	43.4								
#	**Number**	**of**	**Index**	**age**	**data**					
13										
0										
0										
6										
0										
0										
0										
0										
#	**Index**	**age years**								
1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
#										
#										
2001	2003	2004	2005	2006	2008					
#										
#										
#										
#										
#	**Index**	**age composition sample sizes**								
30	30	30	30	30	30	30	30	30	30	30
#										
#										
20	20	20	20	20	20					
#										
#										
#										
#										
#	**Index**	**age comp**								

265	7857	8492	2422	668	131	115	128	75	76	95
…										
#	**Index**	**age comp MPH (egg production)**								
…										
#	**Index**	**age comp**								
#										
#	**Index**	**wt-age**	**1**	**AcousCS**						
0.093	0.131	0.178	0.262	0.294	0.34	0.396	0.549	0.738	0.984	1.093
#	**Populati on**	**Weight**	**at**	**Age**	**1000**					
0.0636	0.1056	0.1674	0.2506	0.3282	0.4152	0.518	0.6246	0.7516	0.8984	1.2056
#	**Maturity**	**at**	**Age**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
0	0.04	0.5	0.96	1	1	1	1	1	1	1
#	**Month**	**of**	**Spawning**							
10.5										
#	**Ageing**	**error**								
0.7624747	0.221462976	0.015884766	0.00017723	2.86587E-07	6.4402E-11	0	0	0	0	0
0.244133	0.511733942	0.225333907	0.01853435	0.000264162	6.1248E-07	2.2212E-10	1.232E-14	0	0	0
0.0217316	0.228717557	0.499101646	0.22871756	0.021349435	0.00038096	1.2286E-06	6.904E-10	6.617E-14	0	0
0.0005358	0.024309571	0.231644317	0.48702065	0.231644317	0.02430957	0.00053346	2.329E-06	1.956E-09	3.094E-13	0
4.204E-06	0.000727565	0.027393414	0.23414454	0.475460564	0.23414454	0.02739341	0.0007276	4.198E-06	5.102E-09	1.28E-12
1.236E-08	7.23325E-06	0.000969066	0.0305793	0.236248096	0.46439258	0.2362481	0.0305793	0.0009691	7.233E-06	1.236E-08
1.591E-11	2.79982E-08	1.19648E-05	0.00126344	0.033845732	0.23798409	0.45378949	0.2379841	0.0338457	0.0012634	1.199E-05
1.028E-14	4.88008E-11	5.97474E-08	1.9078E-05	0.001615703	0.03717176	0.23938058	0.4436256	0.2393806	0.0371718	0.0016348
3.764E-18	4.35816E-14	1.3815E-10	1.2077E-07	2.94269E-05	0.00203027	0.04053734	0.2404644	0.4338769	0.2404644	0.0425972
8.659E-22	2.23231E-17	1.66888E-13	3.6356E-10	2.32402E-07	4.4042E-05	0.00251086	0.0439235	0.2412611	0.4245206	0.2877397
1.368E-25	7.23157E-21	1.17101E-16	5.8273E-13	8.95387E-10	4.277E-07	6.4133E-05	0.0030604	0.0473127	0.2417947	0.7077677

Annex 1. List of participants

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