DEVELOPMENT OF THE SCAS (STATISTICAL-CATCH-AT-SIZE) SOFTWARE[1]

October, 2020

Tom Nishida[1/], Toshihide Kitakado[2/] and Yoshinobu Odaira[3/]

1/ Fisheries Resources Institute (former National Research Institute of Far Seas Fisheries),
Japan Fisheries Research and Education Agency, Shizuoka, Japan (aco20320@par.odn.ne.jp)
2/ Tokyo University of Marine Science and Technology, Tokyo, Japan
3/ Environmental Simulation Laboratory Inc., Saitama, Japan

Abstract

We have been developing Statistical-Catch-At-Size (SCAS) software to improve our previous Age-Structured Production Model (ASPM)/Statistical-Catch-At-Age (SCAA). The SCAS is the integrated age-structured stock assessment model based on size, similar to Stock Synthesis (SS3). SCAS is the AD Model Builder implemented application like our ASPM/SCAA software and SS3. SCAS aggregates season, area and spatial component (movement) as ASPM/SCASS, thus it is the simpler and more robust model. This software is driven by the four menus (applications) without any programming, including (a) batch job (grid search), (b) graphical evaluation of the initial results, (c) MCMC and (d) final graphics. Therefore, this software is suitable for the beginners and the non-stock assessment scientists who wish to run the simpler integrated stock assessments easily in a shorter time. This document describes the progress to date on (a)-(b). We plan to complete the remaining (c)-(d) in 2021. For the further development, a diagnosis component (e.g. hindcasting) is planned to be incorporated in the future.

Contents

[1] Submitted to the IOTC WPTT22 (October 19-23, 2020) by the Webinar (IOTC, Seychelles)

1. INTRODUCTION

1.1 Backgrounds

The first IOTC Working Party of Method (WPM) took place in the IRD office, Sète, France in 2001. The WPM discussed what type of stock assessment models need to be applied for the most important IOTC tuna species such as yellowfin tuna and bigeye tuna under the biological data limited situation especially size data, in the beginning stage of the Scientific Committee started in 1998. After the extensive discussion, the WPM recommended applying Age-Structured Production Model (ASPM) as the assumed(given) selectivity can be used without the size data.

Since then, ASPM has been used for stock assessments of yellowfin tuna, bigeye tuna, albacore tuna and swordfish (for example, Nishida *et al*, 2012 and 2019). Initially the FORTRAN based ASPM developed by Restrepo (1997) was used (2002-2009). Afterwards the AD Model Builder implemented ASPM software was developed by Rademeyer and Nishida (ver. 1 in 2010 and ver. 2 in 2012). Later we improved the software to ver. 3 (Nishida and Kitakado, 2014) incorporating Statistical-Catch-At-Age (SCAA) into the same software as more size data became available and CAA could be used. As a result, ASPM/SCAA has been used in the past 18 years (2002-2019). In later years, results of ASPM/SCAA were utilized as supporting information for SS3 (the main assessment model in the IOTC).

We had been recognizing the problems on the estimated CAA including biases and the model free selectivity (i.e. the model based one is more suitable) in the ASPM/SCAA joint software. Then to solve these problems, we started to develop the size based SCAS software in 2019 and plan to complete in 2021. This document describes the progress of the SCAS software development to date.

1.2 Objectives

The SCAS that we have been developing, is the season and area aggregated model without considering spatial components (movements), while SS3 allows the spatial disaggregation into the model incorporating movements. If the information of season, area and movements are less biased, SS3 will provide more plausible results than the SCAS and other models as such detail information are fully incorporated. However, SS3 is a bit complex for non-stock assessment scientists due to the involvement of spatial components and many input¥ requirements, which obliges high levels of technical skills.

To reduce this complexity, we have been developing the SCAS software with the simpler specs (season and area aggregated without movements) which can be easily driven by the menus without any programming. Thus, the main objective to develop our SCAS software is to provide the user-friendly SCAS software especially for beginners and non-technical scientists who want to apply the integrated age structured stock assessment model based on size. It is noted that the total number of information to be entered into SCAS is 60 (> 200 for SS3) and the maximum number of parameters to be estimated is 8 (> 50), which demonstrates the simplicity of SCAS. We also wish to contribute stock assessments using our SCAS as a supporting information for SS3 in IOTC as in the past using ASPM/SCAA.

2. OUTLINE OF THE SOFTWARE

Fig. 1 shows the flowchart of the SCAS software. As in the ASPM/SCAA, we may produce not only one plausible result, but also for other acceptable runs to demonstrate the range of uncertainties. This software has four menus (Fig. 2), i.e., batch job (grid search), graphic evaluation of the results, MCMS and final graphics.

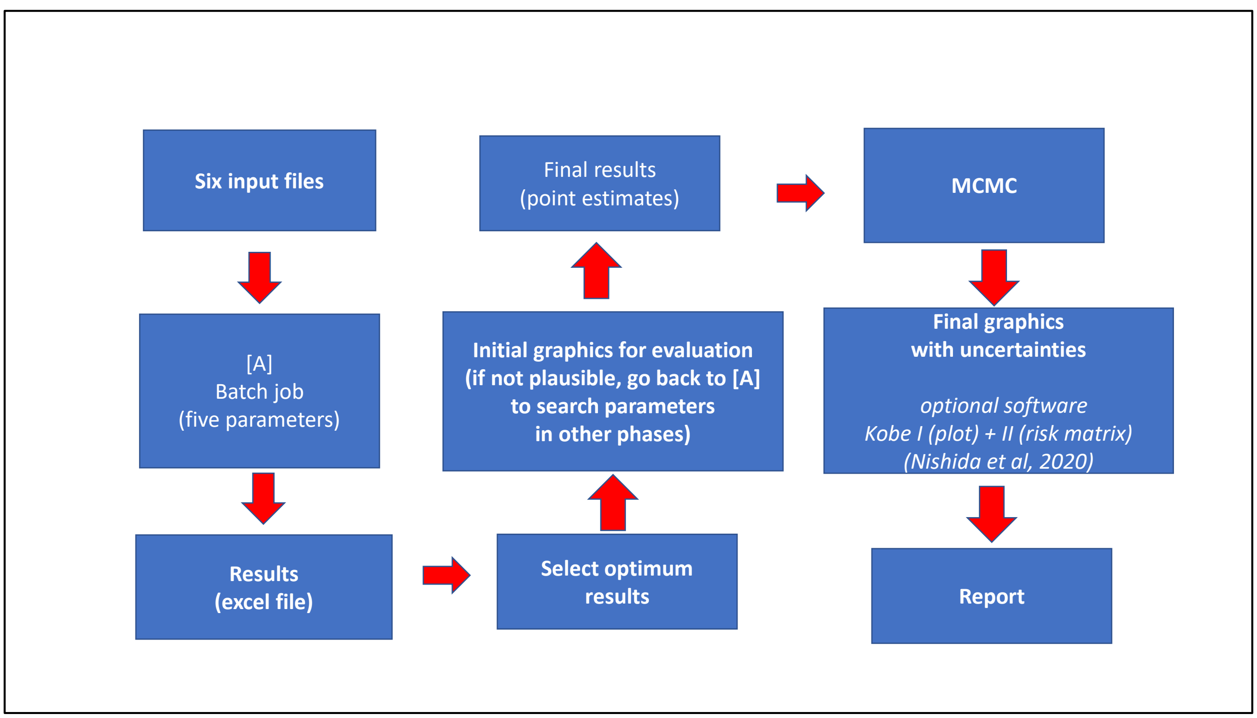


Fig. 1 The flowchart of the menu-driven SCAS software

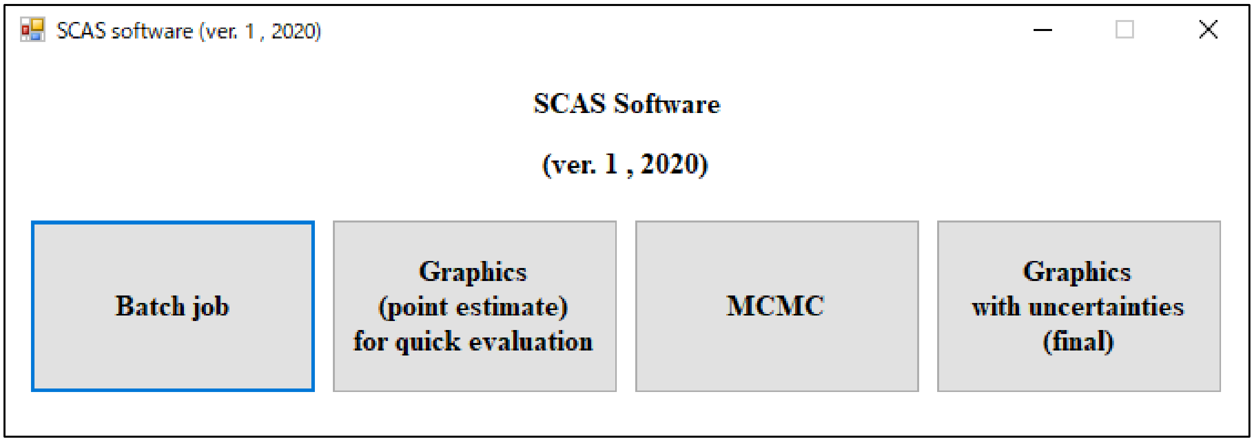


Fig. 2 Four menus in the SCAS software

3. INPUT FILES

There are six input files to run the SCAS as shown in Fig 3. The actual files and detail descriptions using the sample data are provided in Annex A. Table 1 shows the list of information to be entered to the 6 input files of the SCAS software.

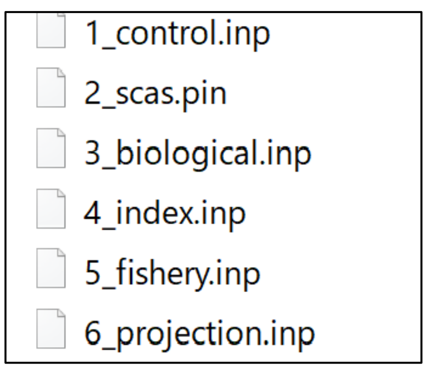


Fig.3 Six input files in the SCAS software

Table 1 List of information (codes, values and number of entries) to be entered to the 6 input files of the SCAS software (total 60 entries and maximum eight parameters will be estimated).

(Note 1) Yellow markers indicate the default code number or values, while Sky blue markers for parameters to be estimated.
(Note2) If parameters need to estimated, any positive integers will be assigned, while, for the non-estimation option, any negative integers.

Input file name	**Section**	**Information**	**Information to be entered**			**Contents**
			Code	Value	No. of entries	
1_Control.inp	0	Verbose	0 or 1			# 1 to write out stuff while running or 0 not to write
	1	Basic info (year, age, size & fleet)			7	# 1st year, # Last year, # Minimum age, # Plus group age, # Minimum size, # Maximum size and # Number of fleets
	2-1	SR relation	1 or 2			# SR relation 1=Beverton-Holt or 2=Ricker
					2	# First year with recruitment residuals and # Last year with recruitment residuals
				Guess value 0.6		# Standard deviation for recruitment (sigma R). Deterministic model if sigmaR=0
	2-2	Growth eq.	1 or 2			# Select growth function (1=VB, 2=Two-stanza)
	3	Initial population	1 or 2			# initial condition (1=pre-exploitation/virgin stock) to enter the initial guess for SSB0 (tons) in *2_scas.pin.* 2=estimate maximum age to enter the initial guess (number of fish) in the year when the exploitation started (non-virgin stock level) in *2_scas.pin*.
				1		# If initial condition=2, the maximum age to estimate
	4	Error (catch)		0.2		# Sigma for the catches
		Error (CAS)		0.02		# Minimum proportion for CAS
			1 or 2			# CAS error type: 1=adj log-normal (Punt-Kennedy) 2=sqrt(p) (approximation of multinomial)
	5	Selectivity	1 or 2 (#Shape)		3	# Fleet number, # Shape (1=logistic, 2=double logistic), # Number of selectivity changes, # Years selectivity changes for each fleet
			1 or 2			# Dynamic MSY for Bratio and Fratio? (1=yes, 2=fixed) *(Note) when 1 is selected, the different MSY by year will be estimated, while, for 2, only one MSY in the last year will be estimated)*
	6	Phase of parameter estimation		*(9 entries)* *Negative integer (to estimate)* *Positive Integer (not to estimate)*		# Phase for estimation of M # Phase for estimation of steepness # Phase for estimation of SSB0 if the initial condition =1 (virgin) in Section 3. # Phase for estimation of the numbers-at-age in the first year (from age-at-recruitment+1 to mm) # Phase for estimation of phi (initial F) *(see 2_scas.pin)* # Phase for estimation of indices additional variance # Phase for estimation of recruitment residuals # Phase for estimation of Bi (growth eq.) # Phase for estimation of commercial selectivity by fleet
	7	Weight for CAS		*One entry (refer to contents)*		# Weight for CAS (for example, 0.1, 01, 0.1, 0.1, 0.1 in case of 5 fleets)

(Table 1 continued)

Input file name	**information**	**Information to be entered** Code	Value	No. of entries	**Contents**
2_scas.pin	SSB0		Guess value (Log SSB0)		# Log of virgin SSB if the initial condition =1 (virgin) in Section 3 and the positive integer *in Section 6, 1_Control.inp file.*
	Initial population size		Guess value (log N0 & N1)		# Initial population size for N0(age 0) and N1(age 1) (number) when the initial condition=2 is selected. (*Section 3, 1_Control.inp file)*. In this case, the maximum age =1 (as an example).
	Initial F		Guess value		# Initial F in the year when the exploitation starts.
	Additional variance (CPUE CV)		0.1 0.1 (in case of 2 CPUE series)		# add variance to CPUE CV (0.2) for each CPUE if the phase for estimation of indices additional variance is a positive integer (*Section 6, 1_Control.inp file)*
	Selectivity		Guess values for all fleet		# selectivity: enter parameters of selectivity by fleet
3_Biological.inp	Steepness (h)		0.7-0.9		# h value if # Phase for estimation of h is the positive integer *in Section 6, 1_control.inp.*
	Natural mortality (M)		Guess value by age		# M vector by age if # Phase for estimation of M is the positive integer *in Section 6, 1_control.inp.*
	CAS (CV)		0.2		# enter the value (0.2 for default)
	Growth equation (parameters)	1 or 2			# parameters for VB (∞ and Kappa) if code=1 or parameters for 2 stanza (∞,Kappa1, Kappa2, Alpha and Beta) if code=2 *(refer to Section 2.2, Control.inp)*
	Fraction of mortality		0		# Fraction of mortality that occurs before spawning
	Maturity-at-age		Estimated value by age		# Maturity-at-age vector by age (%)
	LW relation		Estimated values		# 2 parameters for the LW relation
4_Indiex.inp	CPUE	1, 2 or 3 (# unit) 1 or 2 (# sigma)		7	# Number of index series # Number of observations for each index # To which fleet the index corresponds to # Units (1=numbers, 2=biomass, 3=spawning) # Timing (month in which index is taken) # Minimum age indexed # Maximum age indexed # Weight given to each index # Compute sigma (=1), or use input CV (=2)
5_Fishery.inp	Catch			1	# Total catch in tons by fleet
	CAS			5	# Min and max length # Length classes # Number of CAS series # Number of CAS vector for each series
6_Projection file	Projection			1	# Number of years for projections
				1	# Future catch for each fleet for projection
Total no. of information to enter (# of input) (no. of parameters to be estimated) (max case)		10	23 (8)	27	Total number of information to be entered: 60 (8)

4. GRID SEARCH

4.1 Batch job application

The batch job application of the software allows users to change values of five key parameters (minimum, maximum and intervals), i.e., CAS weight, σ value (deviation in the spawner - recruit relation), h (steepness), B1/K (depletion) and M (natural mortality). The batch jobs are automatically executed for the number of combinations assigned to five parameters. Fig. 4 shows one example of the batch job setting, i.e. in this case, the settings are CAS weight (3 different values), σ (3), h(3), B1/K(1) and M(1), thus the batch jobs are executed 36 times.

If users want to make a single run, untick five check boxes (parameters) in the batch job window, so that the values in the six input files set by the users are read to run. Or using the DOS prompt, users can simply type ‘scas’ then press Enter to make a single run.

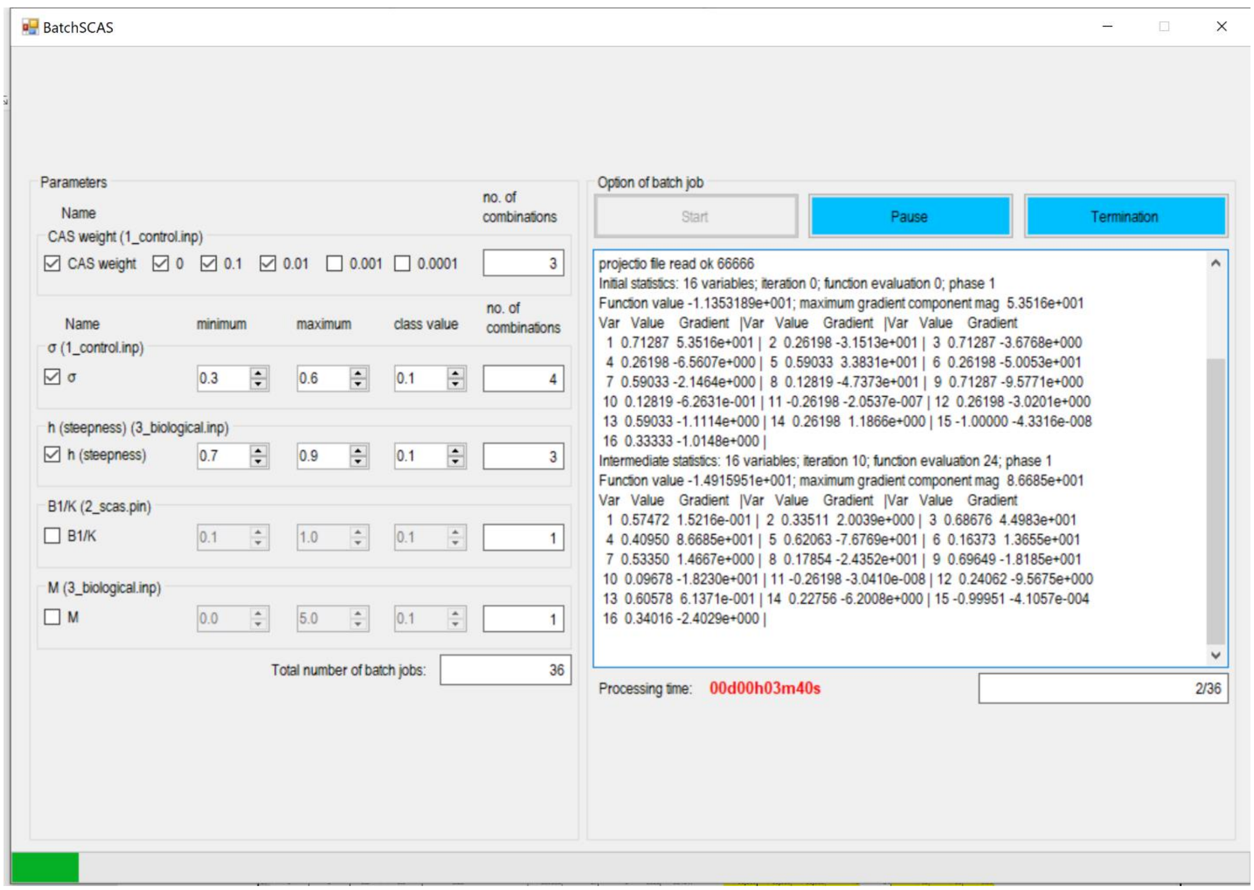


Fig. 4 Batch job window showing the sample set-up of five parameters and the view of the actual runs.

4.2 Output and selection of the most plausible run

The output of key results in all runs are stored in one excel file composed of two sheets, i.e. (a) results with convergence and (b) results with non-convergence and/or errors (Fig. 5). Items included in the output is shown in Fig. 5. Non convergent results are indicated by *'Warning -- Hessian does not appear to be positive definite'* in the error message. Errors are indicated by yellow markers. Errors are implausible values, for example, extreme values, MSY > SSB (current), etc. Using the converged results, users evaluate and select the most optimum (plausible) run by referring to the likelihood and estimated parameter values. It should be well noted that results in different CAS weights and sigma (SR) values are not comparable because both are different quality of metrics, thus the scales of likelihood are heterogenous from others.

Time	00h30m	No. of jobs	10	Average	3.1	min/job

Range (step) of 5 parameters						
CAS weight	Sigma (SR)	h (steepness)	depletion (B0/K)	M	Likelihood components	1,000 tons
0,0.1,0.01	0.3-0.6 (0.1)	0.7-0.9 (0.1)	fixed	fixed		

Run no.	CAS weight	Sigma (SR)	h (steepness)	depletion (B0/K)	M	Total	Indices	CAS	SR_fitS	CT_fits	r2	SSB0	SSBmsy	SSB (current)	MSY	Catch (current)	Depletion	SSB /SSBmsy	F/Fmsy	Error Message
16	0.1	0.4	0.7	0.82		-1019	-4	-867	5	-153		585	164	205	38	34	0.35	1.25	0.78	
19	0.1	0.5	0.7	0.82		-1004	-4	-868	20	-153		614	142	227	47	34	0.37	1.59	0.54	
24	0.1	0.6	0.9	0.82		-991	-5	-867	33	-153		672	92	262	63	34	0.39	2.84	0.28	
25	0.01	0.3	0.7	0.82		-262	-6	-85	-18	-153		538	168	142	31	34	0.26	0.85	1.27	
28	0.01	0.4	0.7	0.82		-243	-8	-85	3	-153		537	160	132	33	34	0.25	0.83	1.19	
29	0.01	0.4	0.8	0.82		-243	-8	-85	3	-153		537	160	132	33	34	0.25	0.83	1.19	
31	0.01	0.5	0.7	0.82		-228	-10	-85	19	-153		544	155	124	35	34	0.23	0.80	1.13	
32	0.01	0.5	0.8	0.82		-228	-10	-85	19	-153		545	155	125	35	34	0.23	0.80	1.13	
35	0.01	0.6	0.8	0.82		-216	-11	-84	32	-153		570	157	122	38	34	0.21	0.78	1.07	
34	0.01	0.6	0.7	0.82		-214	-11	-83	32	-153		466	106	89	36	34	0.19	0.83	0.99	

(note) M Values in 3_biological.inp were used as they were not assigned in the batch job, I.e. 0.4000 0.3552 0.3104 0.2655 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207

Converged | Not converged or Errors

Time	01h07m	No. of jobs	25	Average	2.7	min/job

Range (step) of 5 parameters						
CAS weight	Sigma (SR)	h (steepness)	depletion (B0/K)	M	Likelihood components	1,000 tons
0,0.1,0.01	0.3-0.6 (0.1)	0.7-0.9 (0.1)	fixed	fixed		

Run no.	CAS weight	Sigma (SR)	h (steepness)	depletion (B0/K)	M	Total	Indices	CAS	SR_fitS	CT_fits	r2	SSB0	SSBmsy	SSB (current)	MSY	Catch (current)	Depletion	SSB /SSBmsy	F/Fmsy	Error Message
1	0	0.3	0.7	0.82		-168	-1	0	-15	-153		> 10,000	> 10,000	> 10,000	> 10,000	34	0.78	1.56	0.00	Warning -- Hessian does not appear to be positive definite
2	0	0.3	0.8	0.82		-169	4	0	-21	-153		442	108	60	33	34	0.14	0.56	1.90	Warning -- Hessian does not appear to be positive definite
3	0	0.3	0.9	0.82		-184	-14	0	-18	-152		1227	372	226	71	34	0.18	0.61	1.21	Warning -- Hessian does not appear to be positive definite
4	0	0.4	0.7	0.82		-163	-15	0	4	-153		5591	2642	2069	47	34	0.37	0.78	0.80	Warning -- Hessian does not appear to be positive definite
5	0	0.4	0.8	0.82		-162	-14	0	4	-153		960	350	237	44	34	0.25	0.68	1.23	Warning -- Hessian does not appear to be positive definite
7	0	0.5	0.7	0.82		9810	4624	0	5311	-126		> 10,000	> 10,000	> 10,000	< 1	34	> 10	> 10	0.00	Warning -- Hessian does not appear to be positive definite
8	0	0.5	0.8	0.82		-150	-18	0	21	-153		1052	1052	225	< 1	34	0.21	0.21	0.16	Warning -- Hessian does not appear to be positive definite
9	0	0.5	0.9	0.82		239602	67	0	5388	234147		> 10,000	> 10,000	> 10,000	< 1	34	> 10	> 10	0.00	
10	0	0.6	0.7	0.82		nan	17	0	29	nan		< 1	< 1	< 1	< 1	34	> 10	> 10	> 10	
11	0	0.6	0.8	0.82		-119	3	0	29	-152		516	110	38	45	34	0.07	0.35	1.96	Warning -- Hessian does not appear to be positive definite
12	0	0.6	0.9	0.82		-138	-19	0	33	-152		410	59	28	37	34	0.07	0.47	1.12	Warning -- Hessian does not appear to be positive definite
13	0.1	0.3	0.7	0.82		-1036	-3	-864	-16	-153		562	170	189	34	34	0.34	1.11	0.98	Warning -- Hessian does not appear to be positive definite
14	0.1	0.3	0.8	0.82		-1036	-3	-864	-16	-153		562	170	189	34	34	0.34	1.11	0.98	Warning -- Hessian does not appear to be positive definite
15	0.1	0.3	0.9	0.82		-1036	-3	-864	-16	-153		562	170	189	34	34	0.34	1.11	0.98	Warning -- Hessian does not appear to be positive definite
17	0.1	0.4	0.8	0.82		-1017	-4	-866	5	-153		584	162	206	39	34	0.35	1.27	0.77	Warning -- Hessian does not appear to be positive definite
18	0.1	0.4	0.9	0.82		-1017	-4	-866	5	-153		584	162	206	39	34	0.35	1.27	0.77	Warning -- Hessian does not appear to be positive definite
20	0.1	0.5	0.8	0.82		-1003	-4	-866	20	-153		613	138	229	48	34	0.37	1.65	0.52	Warning -- Hessian does not appear to be positive definite
21	0.1	0.5	0.9	0.82		-1003	-4	-866	20	-153		613	138	228	48	34	0.37	1.65	0.52	Warning -- Hessian does not appear to be positive definite
22	0.1	0.6	0.7	0.82		1390	301	-170	1372	-112		> 10,000	> 10,000	> 10,000	> 10,000	34	> 10	> 10	0.00	Warning -- Hessian does not appear to be positive definite
23	0.1	0.6	0.8	0.82		-991	-5	-867	33	-153		672	92	262	63	34	0.39	2.84	0.28	Warning -- Hessian does not appear to be positive definite
26	0.01	0.3	0.8	0.82		-261	-6	-85	-18	-153		540	168	143	31	34	0.26	0.85	1.27	Warning -- Hessian does not appear to be positive definite
27	0.01	0.3	0.9	0.82		-261	-6	-85	-18	-153		550	173	147	31	34	0.27	0.85	1.27	Warning -- Hessian does not appear to be positive definite
30	0.01	0.4	0.9	0.82		-242	-8	-85	3	-153		553	167	138	33	34	0.25	0.83	1.20	Warning -- Hessian does not appear to be positive definite
33	0.01	0.5	0.9	0.82		-228	-10	-85	19	-153		548	156	126	36	34	0.23	0.81	1.13	Warning -- Hessian does not appear to be positive definite
36	0.01	0.6	0.9	0.82		-216	-11	-84	32	-153		570	157	122	38	34	0.21	0.78	1.07	Warning -- Hessian does not appear to be positive definite

(note) M Values in 3_biological.inp were used as they were not assigned in the batch job, I.e. 0.4000 0.3552 0.3104 0.2655 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207

Converged | Not converged or Errors

Fig. 5. Sample output (results) of the batch job application stored in one excel file composed of two sheets: with converged case (*above*) and with error cases (not-converged and/or errors) marked in yellow (*below*).

4.3 Graphical evaluation of the results

After users select the most plausible run, they can quickly check the key results in the graphs via the graphics application accessible from the main menu. This application read key results available in the scas.rep (output) file that contain all the results and produce relevant graphs automatically at once. Figs. 6-10 show five types of graphs produced by this application, i.e., "Basic results 1 (catch by fleet, catch vs. MSY, F vs. Fmsy and depletion)", "Basic results 2 (SSB vs SSBmsy, Spawner-Recruit relation and Kobe plot)", "Selectivity by fleet", "Fitness of CPUE" and "Fitness of the size frequency distribution", respectively.

5. Presenting uncertainties and diagnosis

We plan to complete the remaining application (MCMC and final graphics) in 2021. For the further development, a diagnosis component (e.g. hindcasting) to evaluate candidate results, is planned to be incorporated in the future if funds become available.

Acknowledgements

We sincerely appreciate Fisheries Resources Institute (*formerly known as National Research Institute of Far Seas Fisheries*), Japan Fisheries Research and Education Agency, to provide funds for the SCAS software development project.

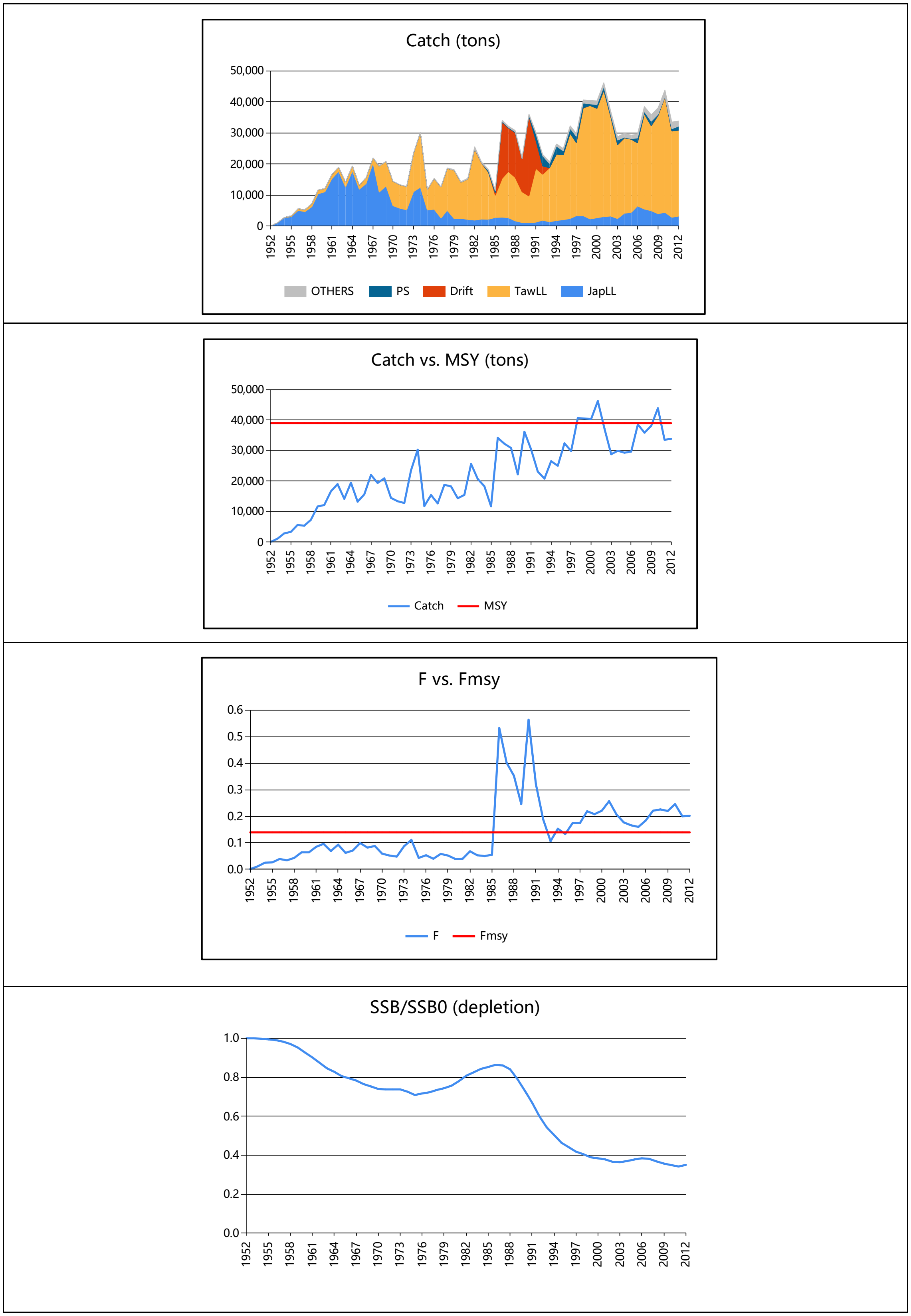


Fig. 6 Basic results 1 (example) *(catch, catch vs MSY, F vs. Fmsy, and SSB/SSB0)*

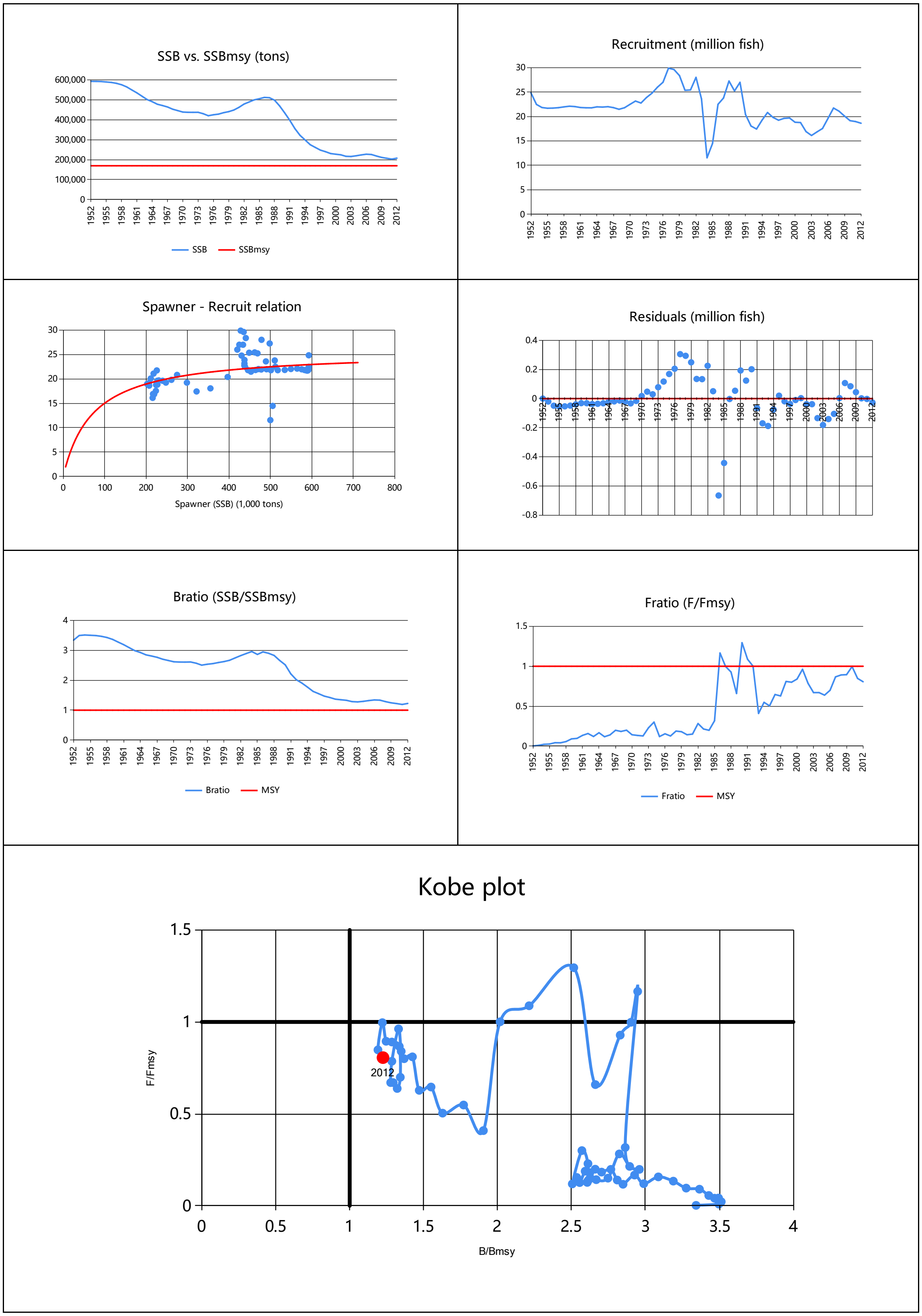


Fig. 7 Basic results 2 (example)

(SSB vs SSBmsy, recruitment, Spawner-Recruit relation, SSB/SSBmsy, F/Fmsy, and the Kobe plot)

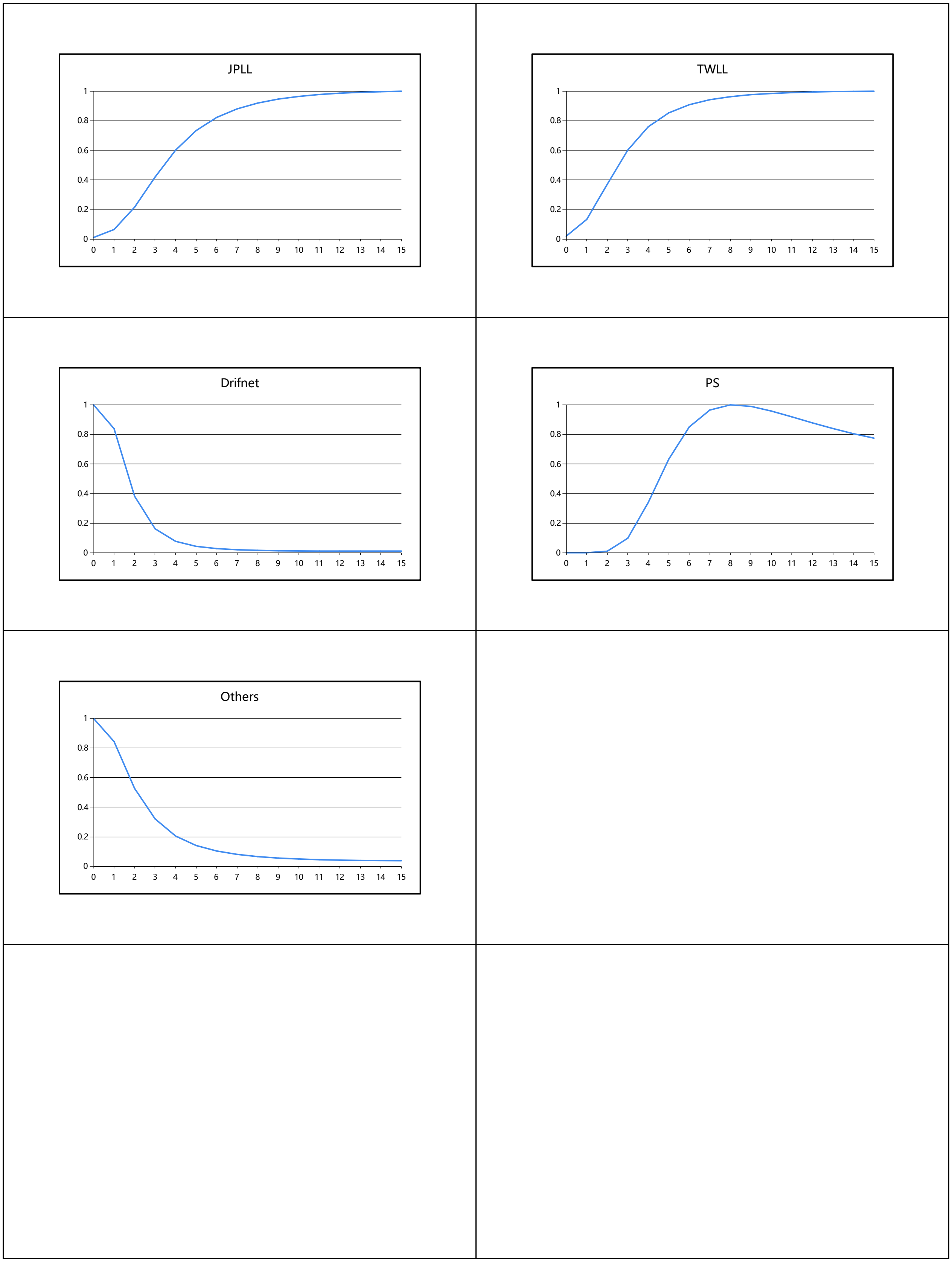
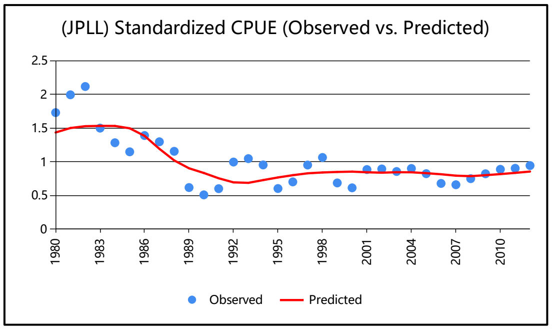


Fig. 8 Selectivity by fleet (example)



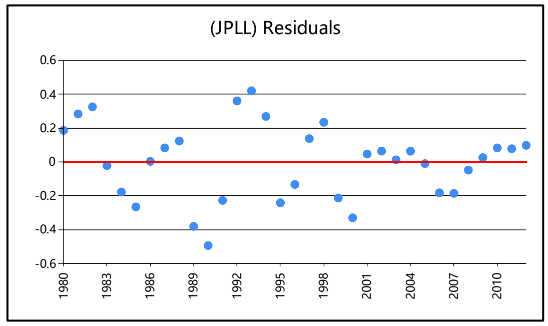


Fig. 9 Fitness of CPUE (example)

(note) The blank space will be used in case there are more CPUE series by different fleet.

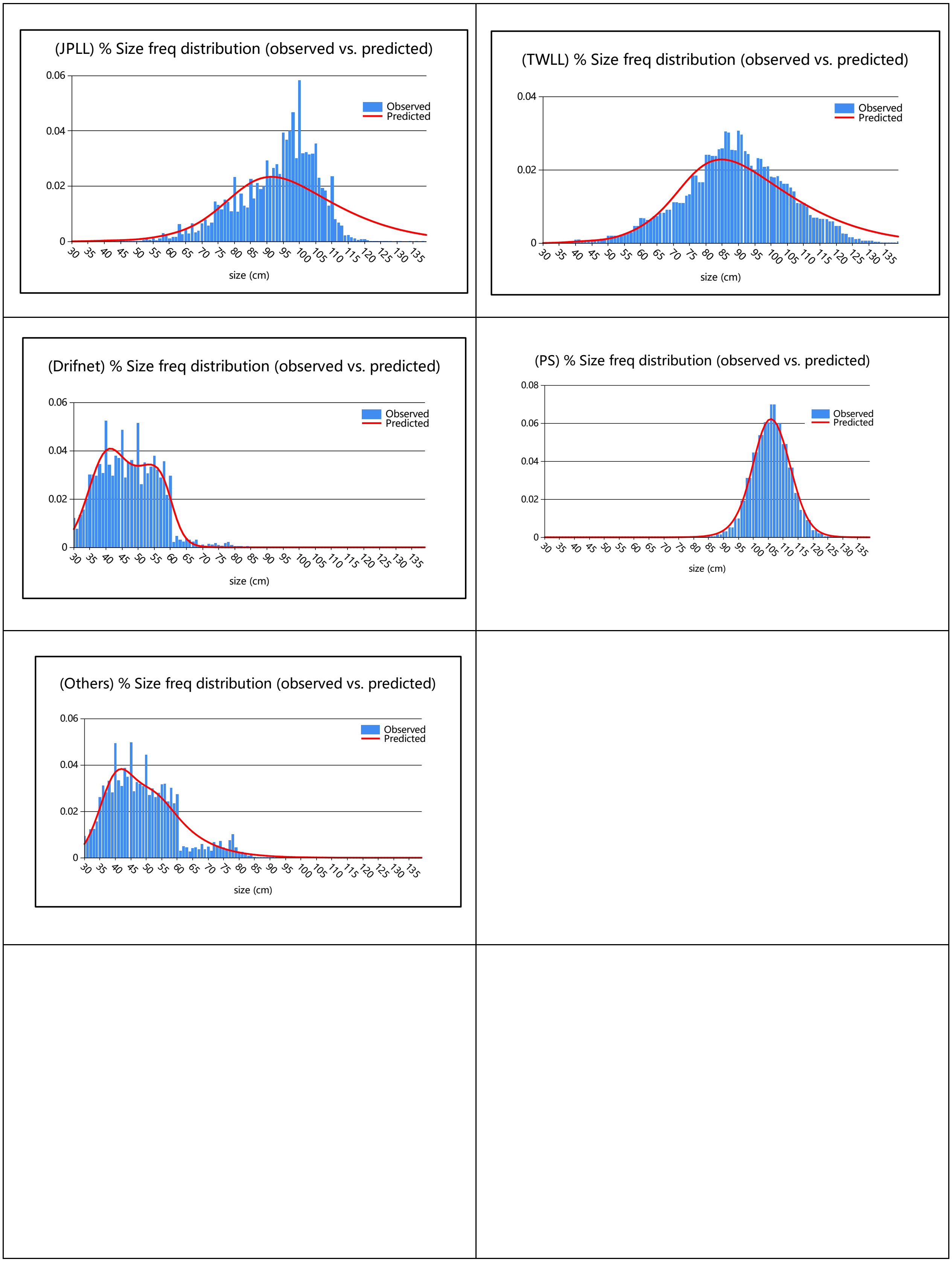


Fig. 10 Fitness of the size frequency distribution (example)

References

IOTC (2001) Report of the IOTC ad hoc working party on methods, Sète, France 23-27, April, 2001.

Nishida, T., Rademeyer, R., Ijima, H., Sato, K., Matsumoto, T., Kitakado, T., and Fonteneau, A. (2012) Stock and risk assessments on yellowfin tuna (*Thunnus albacares*) in the Indian Ocean based on ADMB implemented ASPM and Kobe I + II software (IOTC–2012–WPTT14–40 Rev_2).

Nishida, T., Kitakado, T., Iwasaki, K., and Itoh, K. (2014) User's manual for AD Model Builder Implemented ASPM/SCAA joint software (Version 3, 2014) (IOTC-2014-WPTT16-54 REV_1).

Nishida T. and Kitakado, T. (2019) Preliminary stock assessments of albacore (*Thunnus alalunga*) in the Indian Ocean using Statistical-Catch-At-Age (SCAA) (IOTC–2019–WPTmT07(AS)–17).

Nishida, T. (2020) Stock assessment software for capacity buildings (CPUE standardization, ASPIC, Kobe plot and Risk assessment) *http://ocean-info.ddo.jp/kobeaspm/all(2020)*

Rademeyer, R., and Nishida, T. (2010 and 2012) Uses' Guide for AD Model Builder Implemented Age-Structured Production Model (ASPM) software. Ver. 1 (IOTC-WPTT13-2010-46 (rev 1)) and Ver.2 (IOTC-2012-WPM04-06).

Restrepo, V. (1997) A stochastic implementation of an Age-structured Production model (ICCAT/SCRS/97/59), 23pp. with Appendix

ANNEX A SIX INPUT FILES *(Example using anonymous sample data)*

A.1 Control file (*1_control.inp*)

In this control file, basic information controlling the SCAS run will be entered. There are seven sections as follows:

```
#----------------------------------------------------------------------------------------------------
# File 1: "1_control.inp"
#----------------------------------------------------------------------------------------------------
# Section 0: Just for pre-setting
# Section 1: Year, age, length and number of fleets
# Section 2: Recruitment
# Section 3: Dynamics
# Section 4: Setting regarding quality/distribution of data
# Section 5: Selectivity
# Section 6: Phase (negative phase values mean "non-estimated" parameters
# Section 7: Likelihood setting
#----------------------------------------------------------------------------------------------------

#--------------------------------------------------------------------------------------------
# Section 0
0                       # Verbose (=1 to write out stuff while running)
#--------------------------------------------------------------------------------------------

#------------------------------------------------------------------------------
# Section 1 Basic information
1952        # First year
2012        # Last year
0           # Minimum age
15          # Overall plus group age
1           # Minimum length considered
300         # Maximum length considered
5           # Number of fleets
#------------------------------------------------------------------------------

#----------------------------------------------------------------------------------------------------------------
# Section 2-1 SR relation
1           # Which stock-recruit shape (1=Beverton-Holt, 2=Ricker)
1953        # First year with recruitment residuals
2012        # Last year with recruitment residuals
0.6         # Standard deviation for recruitment (sigma R). Deterministic model if sigmaR=0
# Section 2-2
1           # Which growth function shape (1=VB, 2=Two-stanza)
#----------------------------------------------------------------------------------------------------------------

#------------------------------------------------------------------------------------------------------------------------------------------
# Section 3 Initial population
1           # initial condition (1=at pre-exploitation/virgin level, 2=estimate N)
1           # if initial condition=1 then enter either the positive integer to estimate or the negative integer to fix.
            # If initial condition=2, then enter the maximum age to estimate
#------------------------------------------------------------------------------------------------------------------------------------------

#--------------------------------------------------------------------------------------------------------------------------------------------------
# Section 4    Errors for catch and CAS
0.2         # Sigma for the catches (0.2 for default)
0.02        # Minimum proportion for CAS (0.02 for default)
1           # CAS error type (1=adj log-normal (Punt-Kennedy), 2=sqrt(p) (approximation of multinomial)) (1 for default)
#--------------------------------------------------------------------------------------------------------------------------------------------------
```

```
#------------------------------------------------------------------------------------------------------------------------------------------
# Section 5 selectivity
#   1     2     3     4     5      # Fleet
    1     1     2     2     2      # Shape (1=logistic, 2=double logistic)
    0     0     0     0     0      # Number of selectivity changes
1952 1952 1952 1952 1952           # Years selectivity changes for each fleet
1                                  # dynamic MSY for Bratio and Fratio? (1=yes, 2=fixed)
#------------------------------------------------------------------------------------------------------------------------------------------

#------------------------------------------------------------------------------------------------------------------------------
# Section 6 Parameters to estimate or fix
-1000    # Phase for estimation of M
-1000    # Phase for estimation of steepness
 2       # Phase for estimation of SSB0
 3       # Phase for estimation of the numbers-at-age in the first year (from age-at-recruitment+1 to mm)
 4       # Phase for estimation of phi
 5       # Phase for estimation of indices additional variance
 6       # Phase for estimation of recruitment residuals
-1000    # Phase for estimation of SSBi
# Phase for estimation of commercial selectivity
1    1                #    1952    JPLL
1    1                #    1952    TWLL
1    1    1    1      #    1952    Drifnet
1    1    1    1      #    1952    PS
1    1    1    1      #    1952    Others
#--------------------------------------------------------------------------------------------------------------

#-----------------------------------------------------------------------------
# Section 7 Weight for CAS
0.1 0.1 0.1 0.1 0.1
#-----------------------------------------------------------------------------

#-----------------------------------------------------------------------------
# Section 9999
11111    # for check1
-----------------------------------------------------------
```

A.2 Parameter guess file (*2_scas.pin*)

This input file is to enter guess values of the initial population size, F and selectivity.

```
#-----------------------------------------------------------------------------
# File 2: "2_scas.pin" file for initial values
#-----------------------------------------------------------------------------
# Log of virgin SSB and initial N-distribution (by "maxNsyr_age" set in control file)
13.0             # lnSSB0 (if estimated in the control file)
16.5 16.0        # lnN1
0.2              # Initial F
0.10             # Additional variance (0.10 for default)
# Selectivity
4.5 2.0              #    1952    JLL
4.5 2.0              #    1952    TWLL
4.0 2.0 4.0 1.0      #    1952    Drifnet
4.5 1.0 -2.0 2.0     #    1952    PS
4.0 2.0 -5.0 2.5     #    1952    Others
#-----------------------------------------------------------------------------
22222    # Check2
```

A.3 Biological data file (*3_biological.inp*)

```
#------------------------------------------------------------------------------
# File 3: "3_biological.inp" file for biological parameters
#------------------------------------------------------------------------------
# Steepness
0.7
# Natural mortality (age-specific, given)
#0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0.4000 0.3552 0.3104 0.2655 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207
# For length-at-age and growth
0.20                                    # CV
124.10   -2.239   0.164                 #GR=1: Linf, to, Kappa
#124.10  -2.239   0.164 0.164, 3, 20    #GR=2: Linf, to, Kappa1, Kappa2, Alpha, Beta
# Fraction of mortality that occurs before spawning
0.0
# Maturity-at-age
#0      1      2      3      4      5      6      7      8      9      10     11     12     13     14     15
0.4000 0.3552 0.3104 0.2655 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207 0.2207
0      0      0      0      0.09   0.47   0.75   0.88   0.94   0.97   0.99   0.99   1.00   1.00   1.00   1.00
1.3718E-5         # Length-weight parameter A
3.0973            # Length-weight parameter B
#------------------------------------------------------------------------------
33333    # Check3
```

A.4 Index file (*4_index.inp*)

```
#------------------------------------------------------------------------------
# File 4: "4_index.inp" file for CPUE data
#------------------------------------------------------------------------------
1                       # Number of index series
33                      # Number of observations for each index
1                       # To which fleet the index corresponds to
1                       # Units (1=numbers, 2=biomass, 3=spawning)
6                       # Timing (month in which index is taken)
1                       # Minimum age indexed
9                       # Maximum age indexed
1                       # Weight given to each index
2                       # Compute sigma (=1), or use input CV (=2)
#------------------------------------------------------------------------------
#Fleet   year    CPUE     CV
1        1980    1.7311   0.20
1        1981    1.9958   0.20
1        1982    2.1189   0.20
1        1983    1.5011   0.20
1        1984    1.284    0.20

         (omitted)

1        2006    0.6799   0.20
1        2007    0.6607   0.20
1        2008    0.7508   0.20
1        2009    0.8234   0.20
1        2010    0.8895   0.20
1        2011    0.9043   0.20
1        2012    0.9447   0.20
#------------------------------------------------------------------------------
44444 #check4
```

A.5 Fishery file (*5_fisherey.inp*)

This input file is to enter catch and CAS by fleet.

```
#-------------------------------------------------------------------------------
# File 5: "5_fishery.inp" file for catch and CAS data
#-------------------------------------------------------------------------------
# Total catch in tons by fleet

# Total catch in tons by fleet
#year   JapLL   TawLL   Drift   PS      OTHERS
1952    61      0       0       0       19
1953    1094    0       0       0       20
1954    2734    90      0       0       23
1955    3059    276     0       0       23
1956    5075    530     0       0       24
1957    4662    656     0       0       23
1958    6285    991     0       0       23
1959    10410   1228    0       0       23

                (omitted)

2004    4155    24259   0       232     1288
2005    4413    23575   0       164     1147
2006    6489    20347   0       1548    1307
2007    5504    30688   0       725     1653
2008    4965    27352   0       1424    2137
2009    3988    31648   0       392     2105
2010    4454    37139   0       207     2119
2011    2845    27779   0       725     2203
2012    3234    27672   0       1297    1650

#-------------------------------------------------------------------------------
# Commercial catch-at-length
30 139                          # data min and max length
1                               # length classes
5                               # Number of CAS series
61 59 10 30 61                  # number of CAS vector for each series
#       Longline-Japan
NO      Year    L039    L040    L041    L042    L043    L044    L045    L046    L047
        L048    L049    L050    L051    L052    L053    L054    L055    L056    L057
        L058    L059    L060    L061    L062    L063    L064    L065    L066    L067
        L068    L069    L070    L071    L072    L073    L074    L075    L076    L077
        L078    L079    L080    L081    L082    L083    L084    L085    L086    L087
        L088    L089    L090    L091    L092    L093    L094    L095    L096    L097
        L098    L099    L100    L101    L102    L103    L104    L105    L106    L107
        L108    L109    L110    L111    L112    L113    L114    L115    L116    L117
        L118    L119    L120    L121    L122    L123    L124    L125    L126    L127
        L128    L129    L130    L131    L132    L133    L134    L135    L136    L137
        L138    L139
#       Longline-Japan
1       1952    0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0
        0       0       0       0       0       0       0       0       0       0       0
```

```
	0.038358849	0	0	0	1.352405015	1.352405015	0
	5.409620059	2.70481003	2.70481003	0	0	4.057215044
	13.562409	8.114430089	10.89595782	25.69569528	36.82180619	42.00127316
	55.64039985	84.15598171	97.56495531	143.8919555	128.7469883
	134.0798907	147.6806586	138.2521823	209.8145715	111.0122878
	151.6611559	120.4024052	125.7736664	159.6988683	102.7827811
	121.7164513	129.945958	73.1833062	120.5174817	48.68658053
	31.18203304	16.30557788	5.409620059	12.21000398	4.057215044
	8.114430089	5.409620059	4.057215044	4.057215044	0	1.352405015
	4.095573893	0	2.70481003	1.352405015	0	2.70481003	0
	0	0	0	0	0	0	0	0	0	0
1	1953	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
```

Omitted

```
#	Others
5	2012	5133.576431	3461.324598	5916.833265	6666.868715	8452.591753
	13129.57331	13672.33331	13228.38603	15364.0256	13483.96062
	23261.49617	15264.47858	13494.51269	17136.40554	16367.86208
	22056.61378	13002.95869	15610.99573	15830.21788	14937.83926
	22313.5732	11851.53609	15123.55159	13297.21	14348.34398	16509.57106
	14466.07625	12444.85684	15349.43284	9892.294454	13532.61465
	1299.62439	2361.541176	2020.861857	1114.951767	1979.033473
	2086.227559	1725.611978	3025.008803	1987.553445	2468.004769
	1560.302567	3552.071126	2775.064582	3899.197453	2345.184366
	2063.613637	4006.129996	5518.929886	2410.903712	1273.821486
	1273.821486	988.1343476	599.6310759	893.9839631	116.9774197
	175.917945	175.917945	97.9703382	97.9703382	164.5878722
	164.5878722	162.0710352	162.0710352	67.84257521	67.84257521
	264.7370664	264.7370664	140.1024341	140.1024341	321.4644799
	321.4644799	203.6913437	203.6913437	448.0222554	448.0222554
	727.8599936	727.8599936	388.3913973	388.3913973	638.2257697
	638.2257697	205.4667301	205.4667301	214.9435576	214.9435576
	430.8560397	430.8560397	19.88901018	19.88901018	203.5878518
	203.5878518	24.13920668	24.13920668	29.30044926	29.30044926
	54.22842237	54.22842237	0.59523214	0.59523214	28.15407003
	28.15407003	0	0	1.197653868	1.197653868	0.301210864
	0.301210864	0	0
#-------------------------------------------------------------------------------
55555	# Check5
```

A.6 Projection file (*6_projection.inp*)

```
#-------------------------------------------------------------------------------
# File 6: "6_projection.inp" file for projection spec
#-------------------------------------------------------------------------------
# Number of years for projections
10
# Future catch for each fleet for projection
0 0 0 0 0
#-------------------------------------------------------------------------------
66666 #check6
```