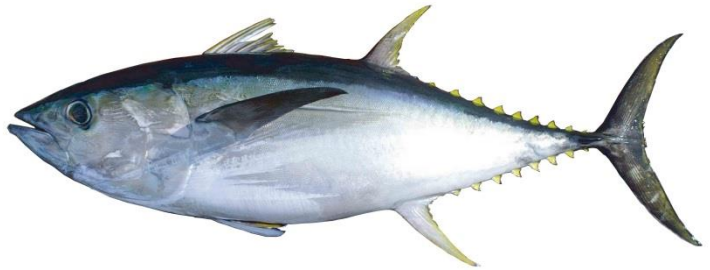
IOTC-2022-WPTT24-INF02_Rev1

Preliminary stock assessments of Indian Ocean bigeye tuna using Statistical-Catch-At-Size (SCAS) (1950-2021)

Nishida and Kitakado



Abstract

Basic structure

- Single stock, 12 fleets, 3 areas, life span age 9+ and annual based assessments (1950-2021).

Catch and CPUE

- Catch (Secretariat, 2022) and joint annual CPUE (Kitakado *et al*, 2022)

Biological information

- LW (Chassot *et al,* 2016), 2 growth equations : Eveson *et al (*2012) and Eveson & Fraley (per. comm. 2022) age 0-1 modified Farley vB eq. (2021) and corresponding maturity-at-age, 2 types of M : base case M (2019) and Lorenzen based M by Hoyle (2022) and selectivity (logistic or double logistic).

Stock assessments

- 4 scenarios (2 types of growth eq. and 2 types of M) with 9 variants (3-σ_R and 3-steepness) (36 runs)
- No convergences were obtained, probably by 3 reasons: (a) not use other relevant parameters in the grid search (CV for growth, relative weight to CAS against CPUE, CV for CPUE etc.), (b) too poor fits to length compositions (BB, OT1, OT2 & PSFS2) and (c) need to use additional selectivity (cubic spline) (currently logistic & double logistic are available).
- But 9 runs (out of 36) produced plausible results suggest (**perceptional views only** as no convergences):

  (a) stock status (2021) Bratio (0.74~1.55) and Fratio (0.73~2.16)

  Median point : Bratio(1.07) and Fratio (1.10) (orange zone close both MSYs)

  (b) Base case M (2019) with Eveson & Fraley (2022)(age 0-1 modified Farley vB, 2021) likely produce plausible results.

Contents

1. Introduction

Objective to conduct the SCAS assessments

➔ for reference to SS3 (main assessment model).

Note:

Both SCAS and SS3 ➔ Age structured integrated model (SCAS is simpler).

Differences between SS3 and SCAS

(1) Annual (SCAS) vs. Quarter(SS3), (2) Movements (tagging) (SS3) (not for SCAS)

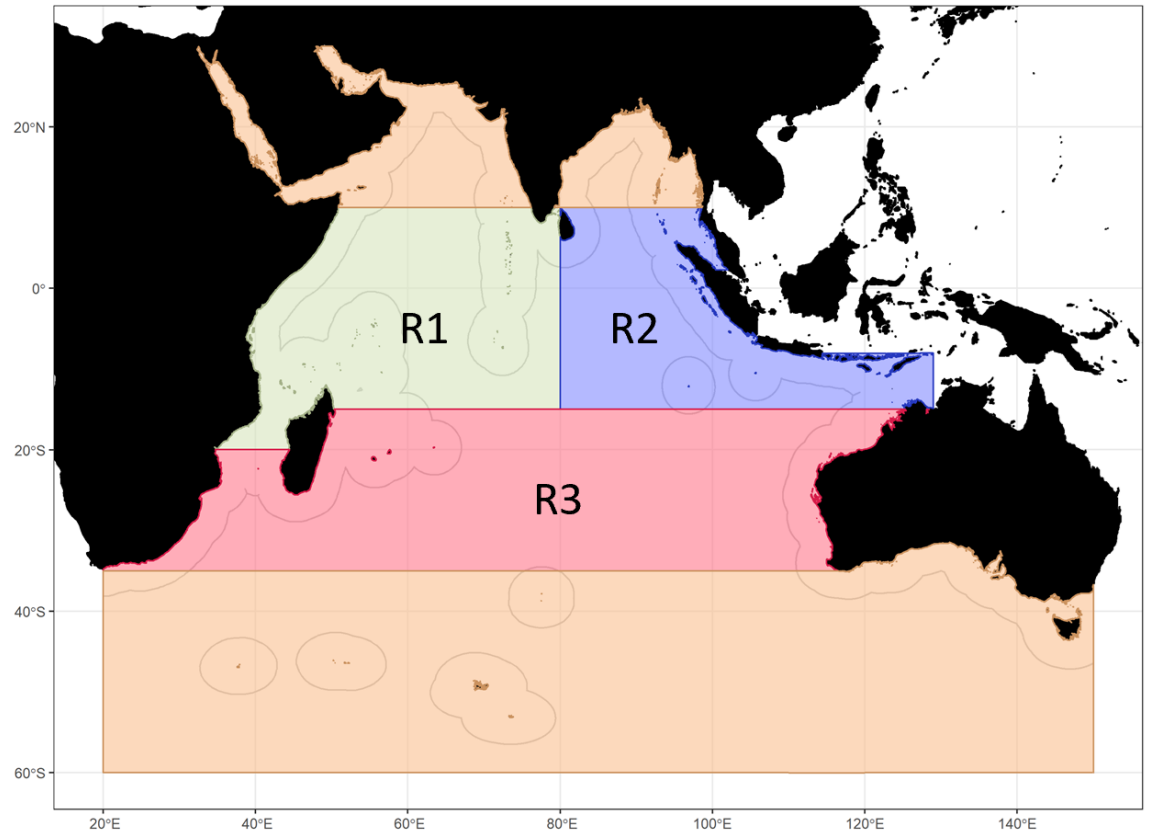
(3) SSB: SCAS (male + female) vs. SS3(female)

2. Input Information

- Basic structure
- Nominal catch
- CPUE
- Biology

2. Input Information: basic structure

- Stock structure : single stock
- Time variant : Annual
- Areas : 3 sub areas
  (R1, R2 and R3)



Note : R1N and R1S combined

- following the assessment area definition WPTT24(AS)-DATA14-SA_BET_01-summary

- BET_03-CAS is based on 3 sub areas

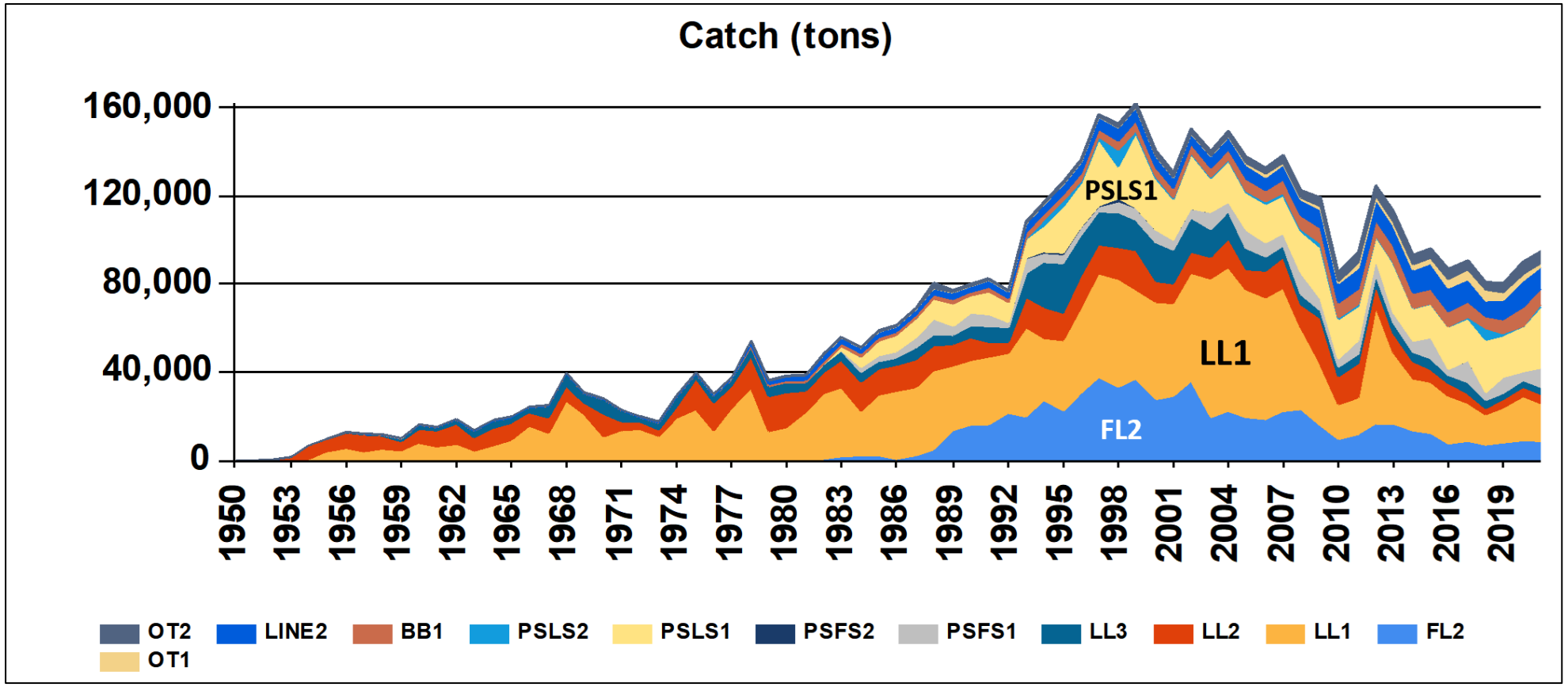
- interested in the aggregated nature of SA

2. Input Information: Basic structure

12 fleets (same as in SS3 except area R1)

Fleet #	Code	Fisheries	Area	Notes
F1	FL2	Longline, fresh tuna fleets	2	
F2	LL1	Longline, distant water (frozen tuna) fleet	1	
F3	LL2	Longline, distant water (frozen tuna) fleet	2	
F4	LL3	Longline, distant water (frozen tuna) fleet	3	
F5	PSFS1	Purse seine, free school	1	
F6	PSFS2	Purse seine, free school	2	
F7	PSLS1	Purse seine, associated sets	1	
F8	PSLS2	Purse seine, associated sets	2	
F9	BB1	Baitboat and small-scale encircling gears (PSS, RN)	1	Primarily catch from the Maldives baitboat fishery.
F10	LINE2	Mixed gears (hand-line, gillnet/longline combination)	2	Gears grouped on the basis that primarily catch large bigeye.
F11	OT1	Other(troling, gillnet, unclassified)	1	
F12	OT2	Other(troling, gillnet, unclassified)	2	

2. Input Information: Nominal catch by fleet



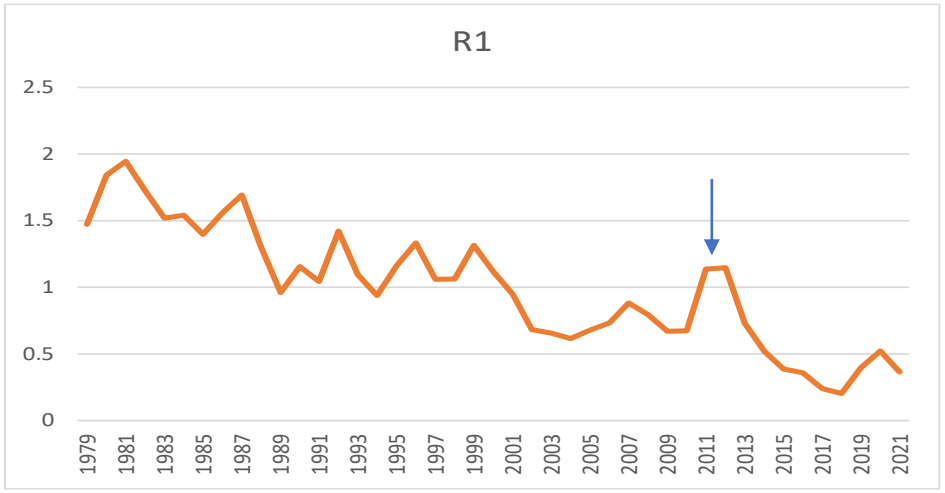
Recent catch : 95,000 t (low level)

LL1+PSLS1: 2 Dominant fleets

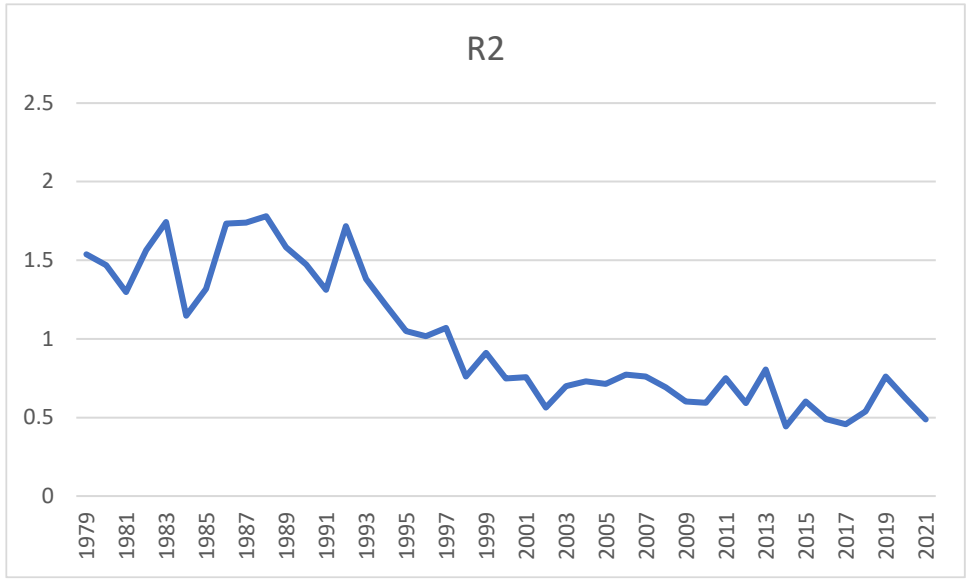
FL2: Dominant (before) now low level

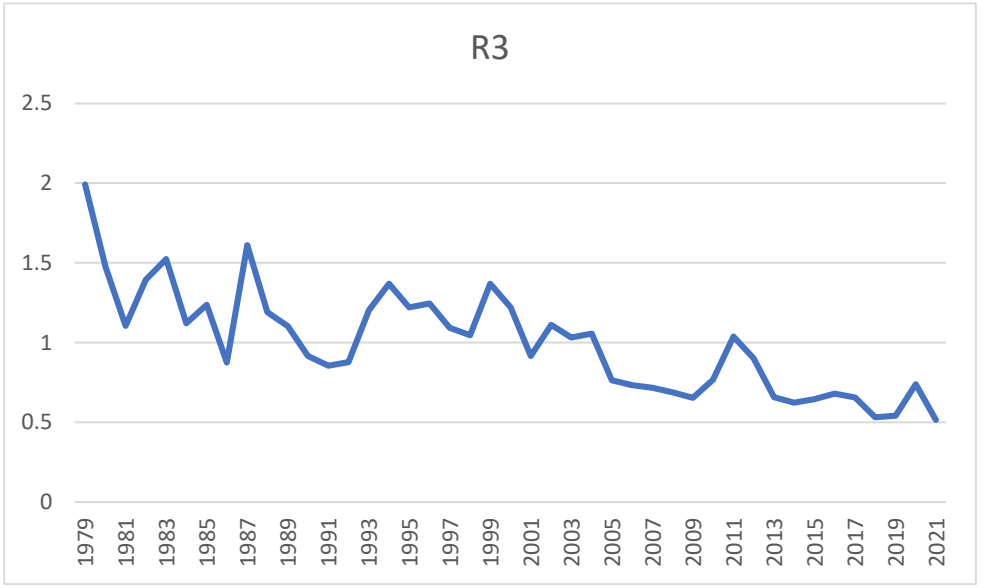
2. Input Information: annual joint CPUE

(Kitakado et al, 2022) (all: decreasing trends)



R1N big spike mitigated





2. Input Information: Biology (age and sex ratio)

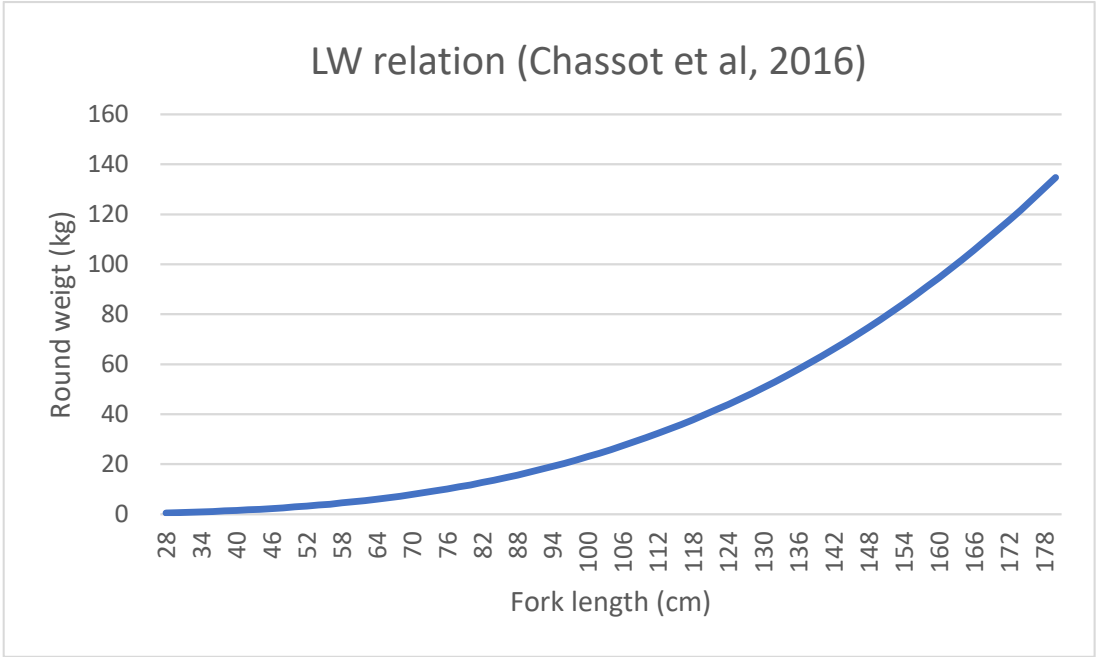
Life span

9 years old (based on tagging and otolith studies)

Sex ratio

Male : Female = 1:1 is assumed for all ages

2. Input Information: Biology (LW relation)



Based on the samples from Purse seine, Pole & Line and Gillnet in the Indian Ocean

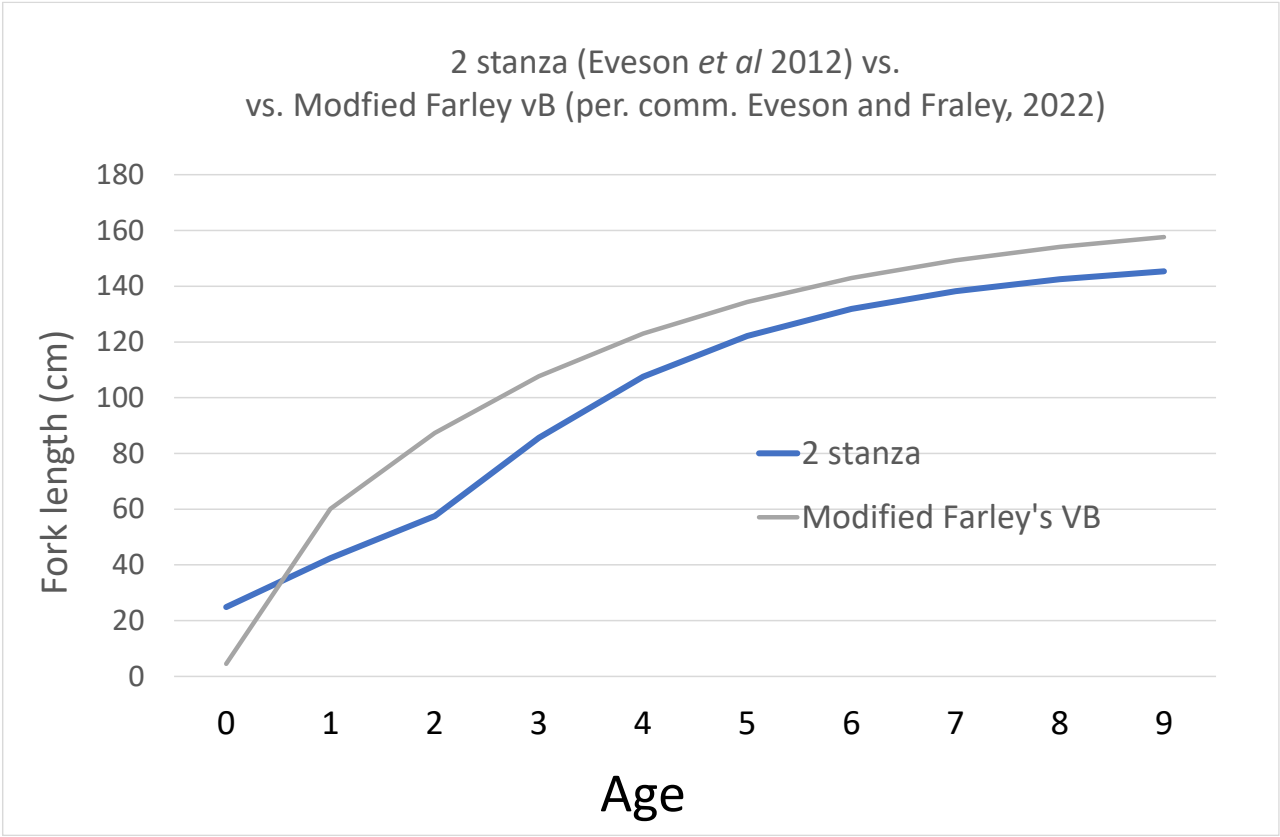
Chassot, E. et al, (2016) Length-weight relationships for tropical tuna in the Indian Ocean: Update and lessons learned, IOTC-2016-WPDSC12-INF05.

2. Input Information: Biology (2 growth equations)

DP discussion
on the Farley new growth vB eq (2021)

(a) Likely more plausible than 2 stanza
(b) But not enough sample size

Eveson & Farley
(personal communication) (2 points)
(Sept 5, 2022)
(a) Sample size will be improved (future)
(b) Age 0-1 ➔ a bit high
➔ Devloped age 0-1 modified Farley vB eq.



2 stanza (Eveson et al 2012)

$$L(t) = L_\infty \left[1 - e^{-k_2\ (t-t_0)} \left\{ \frac{1 + e^{-\beta\ (t-t_0-\alpha)}}{1 + e^{\beta\alpha}} \right\}^{-\ (k_2-k_1)\ /\beta} \right]$$

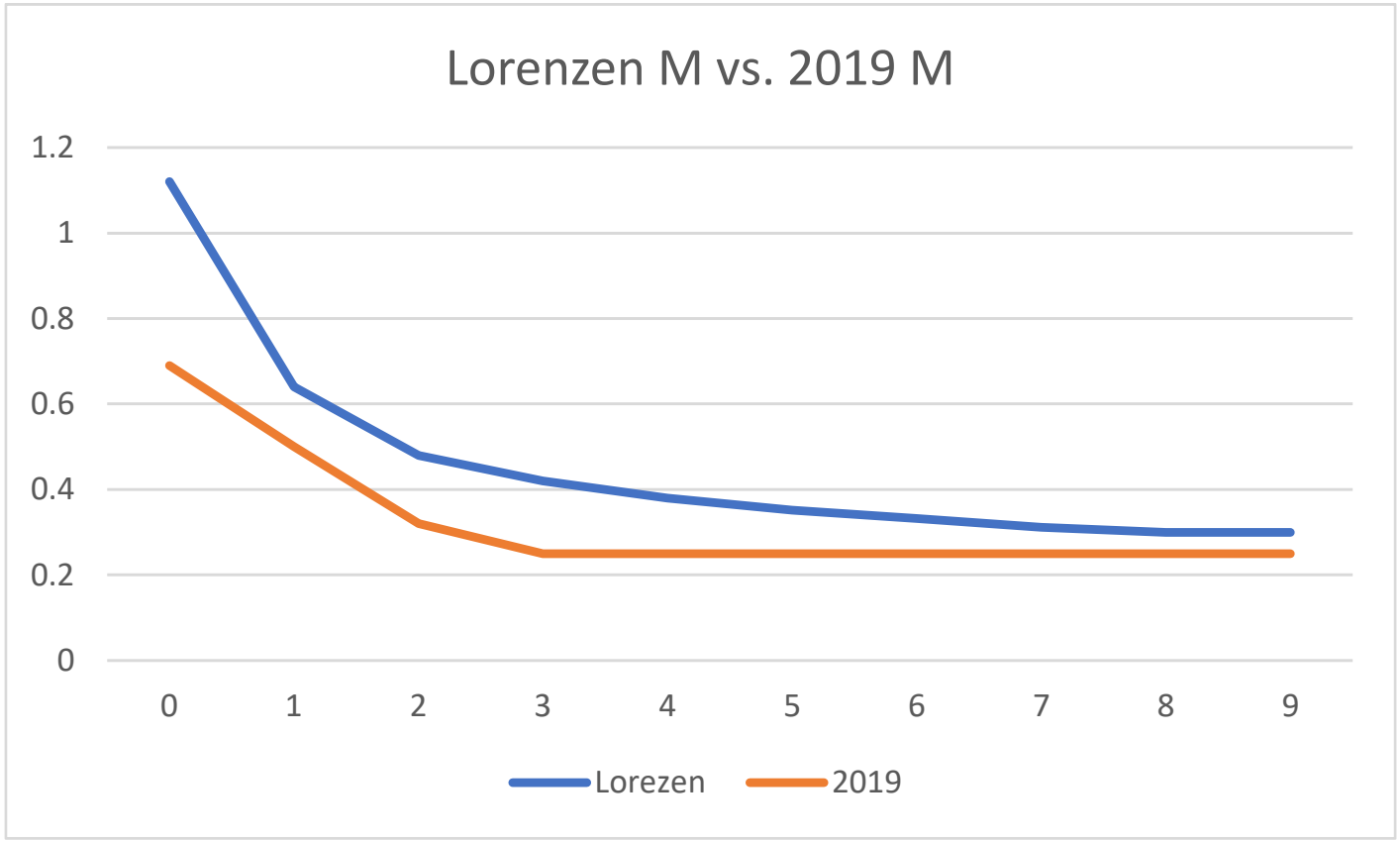
$L_\infty = 150.9$、 $k_1 = 0.15$、 $k_2 = 0.41$、 $\alpha = 3.4$、 $\beta = 20$、 $t_0 = -1.2$

Modified (age 0-1) Farley's vB (2021) (per. comm. Eveson & Farley, 2022)

L(age) = 168.3*{1-exp(-0.29(age+0.04))*g)}
where:
g = (d1/d2)^theta =((1+exp(-13.1*(age+0.04-0.35)))/99.0032))* 0.03053

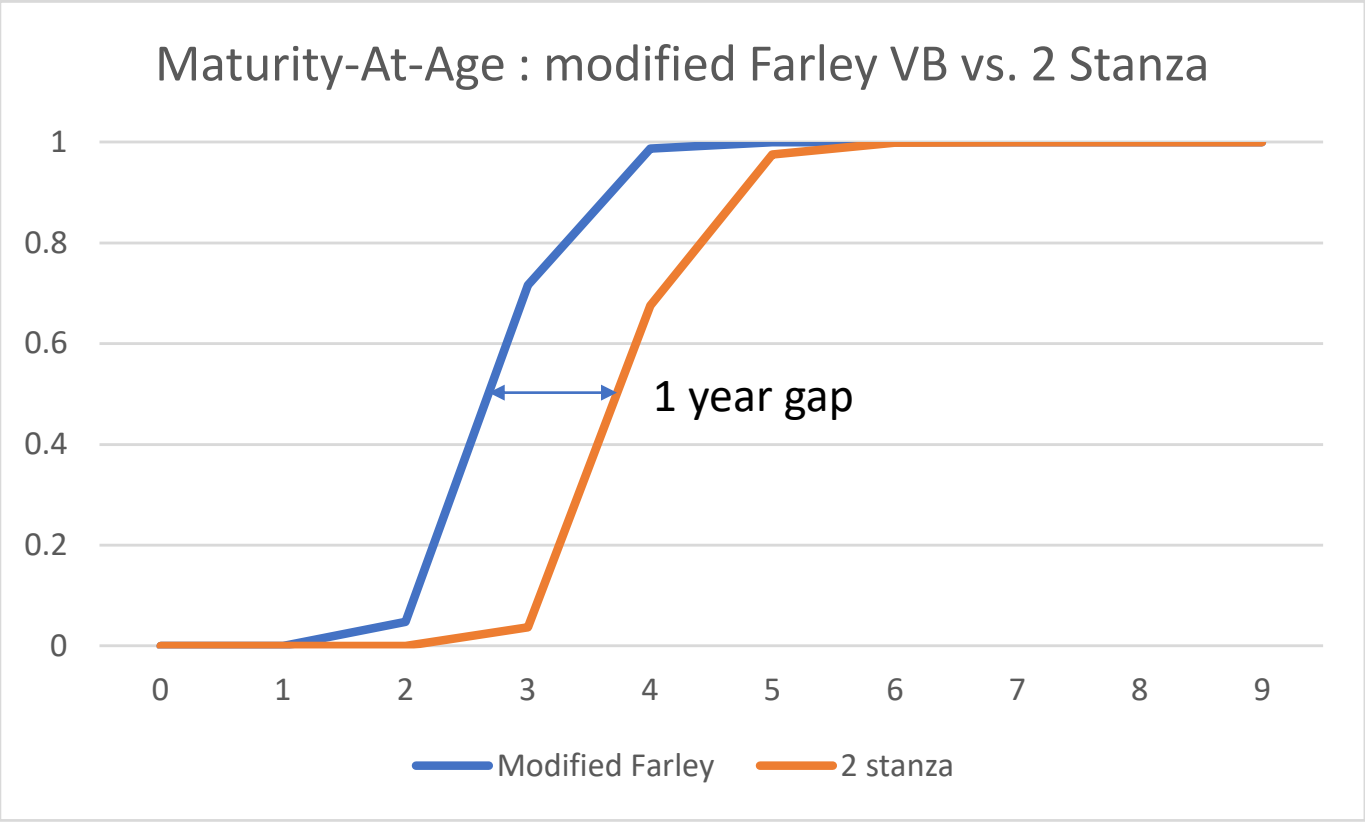
d1 = (1+exp(-13.1*(age+0.04-0.35)))
d2 = (1+exp(0.35*13.1)) =99.0032
theta = -(0.29-0.69)/13.1 =0.03053

2. Input Information: Biology M (2 types)
- Lorenzen based M (HC14.7) (Hoyle, 2022)
(*HC: Hamel and Cope in review with max age=14.7)*
- M (base case in the 2019 assessment)



2. Input Information: Biology (2 Maturity Ogives) based on..

Modified Farley vB growth eq. (per. comm. Eveson & Farley, 2022) 50%➔age 2.6
2 stanza growth eq. (Eveson *et al*, 2012) 50%➔ age 3.6



2. Input Information: Biology (Fecundity-at-age)

Fecundity is assumed to be proportional to female weight at age

(by individual)

2. Input Information: Selectivity

Fleet #	Code	Fisheries	Area	Selectivity
F1	FL2	Longline, fresh tuna fleets	2	Logistic
F2	LL1	Longline, distant water (frozen tuna) fleet	1	Logistic
F3	LL2	Longline, distant water (frozen tuna) fleet	2	Logistic
F4	LL3	Longline, distant water (frozen tuna) fleet	3	Logistic
F5	PSFS1	Purse seine, free school	1	Double logstics
F6	PSFS2	Purse seine, free school	2	Double logstics
F7	PSLS1	Purse seine, associated sets	1	Double logstics
F8	PSLS2	Purse seine, associated sets	2	Double logstics
F9	BB1	Baitboat and small-scale encircling gears (PSS, RN)	1	Double logstics
F10	LINE2	Mixed gears (hand-line, gillnet/longline combination)	2	Logistic
F11	OT1	Other(troling, gillnet, unclassified)	1	Double logstics
F12	OT2	Other(troling, gillnet, unclassified)	2	Double logstics

3. Stock assessment : 4 scenarios & specification

Scenario					
		1	2	3	4
M		Base case (2019 assessment)		Lorenzen based (Hoyle, 2022)	
Growth equation		Age 0-1 modified Farley vB (2021) (per. comm. Eveson & Fraley, 2022)	2 stanza (Eveson et al, 2012)	Age 0-1 modified Farley vB (2021) (per. comm. Eveson & Fraley, 2022)	2 stanza (Eveson et al, 2012)
Specification					
Uncertainties (9 combined values)	h (steepness)	3 different values (0.7, 0.8 & 0.9)			
	σ_R (recruitment deviation)	3 different values (0.5, 0.6 and 0.7)			
fixed parameters	CV (CPUE)	0.2			
	CV (Growth eq.)	0.2			
	Relative weight to CAS against CPUE	0.1 for 12 fleets			
	Depression	100 % (no depletion) in 1950			

3. Stock assessment : Results

No convergences were obtained for all 36 runs

(4 scenarios x 9 combined values of σ_R & steepness)

No results (Stock status in 2021 is unknown)

*Initially, we thought to **withdraw** our document at this point…*

But there is an additional story …..may be worth to inform

3. Stock assessment: Results
However, there were **9 plausible results** in the 36 runs without convergences

M	Growth equation	# of runs produced plausible results (out of 36 runs) (but not converged)
Base case M used in the 2019 assessment	Modified (age 0-1) Farley vB eq. (2021) (per. comm., Eveson & Farley, 2022)	7
	2 stanza (Eveson et al, 2012)	0
Lorenzen based M (Hoyle, 2022)	Modified (age 0-1) Farley vB eq. (2021) (per. comm., Eveson & Farley, 2022)	2
	2 stanza (Eveson et al, 2012)	0

3. Stock assessment: Results

code	parameters	meanings
EF	Growth eq.	Modified (age 0-1) Farley vB (2021) (per. comm. **E**veson & **F**arley, 2022)
9M	Mortality	**M** (base case in the 201**9** stock assessment)
LM		**L**orenzen based **M** (Hoyle, 2022)

9 plausible runs suggest

(***perceptional view only*** *as no convergences)*

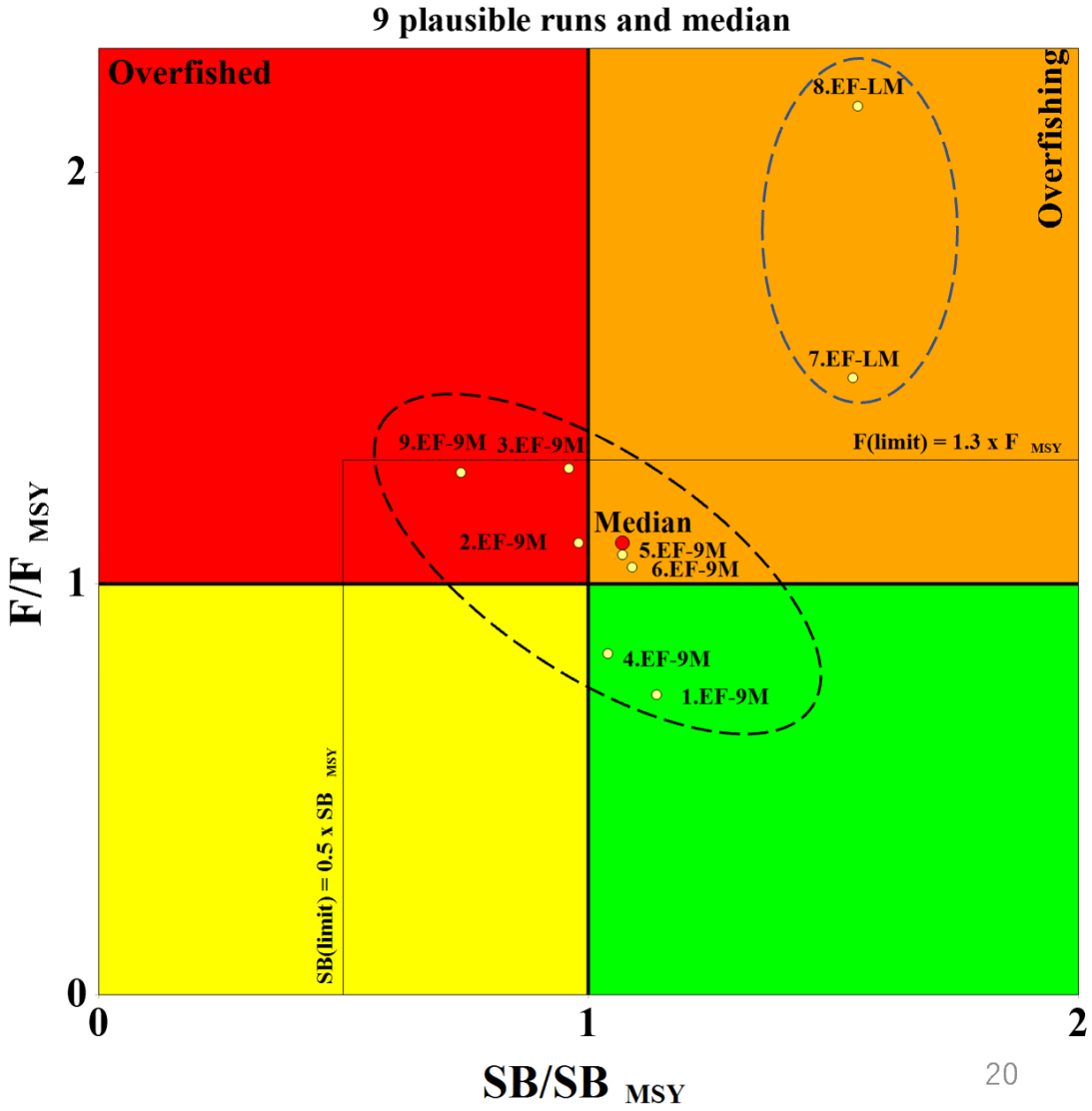
- High uncertainties (stock statuses)
- 7 runs are based on the scenario (9M+EF)

  ➔ *within both limit reference points*
- 2 runs are based on the scenario (LM+EF)

  ➔ *above limit reference point (F)*
- Scenario (9M+EF) (7 runs) likely produce plausible stock statuses
- Stock status based on 9 runs:

  - Bratio (0.74~1.55) and Fratio (0.73~2.16)

  - Median: Bratio(1.07) and Fratio (1.10) (orange zone)



4. Discussion & future works

Difficult to get convergences. Why ? May be 3 reasons:

(a) We did not attempt other relevant & important parameters in the grid search, i.e.,

CV for growth, relative weight to CAS against CPUE, CV for CPUE etc. (fixed)

➔ need to incorporate these in the grid search.

(b) We used the limited number of the guess values for initial population size (SSB, N0 and N1)

➔ need to explore more

(c) Poor fitting to length compositions for some fisheries (BB, OT1, OT2, PSFS2)

because limited selectivity functions in the current SCAS software (logistic & double logistic)

➔ need cubic spline.

5. Summary

- 4 scenarios (2 types of growth eq. and 2 types of M)

  with 9 variants (3-σ_R and 3-steepness) (36 runs)

- 2 types of growth eq.

  (a) Eveson *et al (*2012) and (b) Eveson & Fraley (2022) age 0-1 modified Farley vB eq. (2021)

- 2 types of M : (a) base case M (2019) & (b) Lorenzen based M by Hoyle (2022)
- Results: No convergences, but there are 9 plausible runs.
- Stock status (2021) based on the 9 plausible runs suggest :

  (**perceptional view only** as no convergences)

  Bratio (0.74~1.55) and Fratio (0.73~2.16)

  Median point : Bratio(1.07) and Fratio (1.10) (orange zone close both MSYs)

- Base case M (2019) with Eveson & Fraley growth eq. (2022) likely produce plausible results.

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Great appreciations to :

- Fabio Fiorellato and his powerful data team (IOTC Secretariat) providing fisheries information;
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- Sheng-Ping Wang (National Taiwan Ocean Univ.) to provide technical references.
- Kazuharu Iwasaki (Environmental Simulation Laboratory) to develop the user interface & graphical outputs of the SCAS software; and
- Funding agency (Fisheries Resources Institute, Japan Fisheries Research and Education Agency) to provide the financial assistances to develop the SCAS software.

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- **IOTC**-2022-WPTT24(AS)-DATA03 Nominal catches by fleet, year, gear, IOTC area and species
- **IOTC**-2022-WPTT24(AS)-DATA14 Bigeye tuna - stock assessment input data
- **Kitakado**, T., et al 2022 Joint CPUE indices for the bigeye tuna in the Indian Ocean based on Japanese, Korean and Taiwanese longline fisheries data up to 2020. IOTC–2022–WPM13–14
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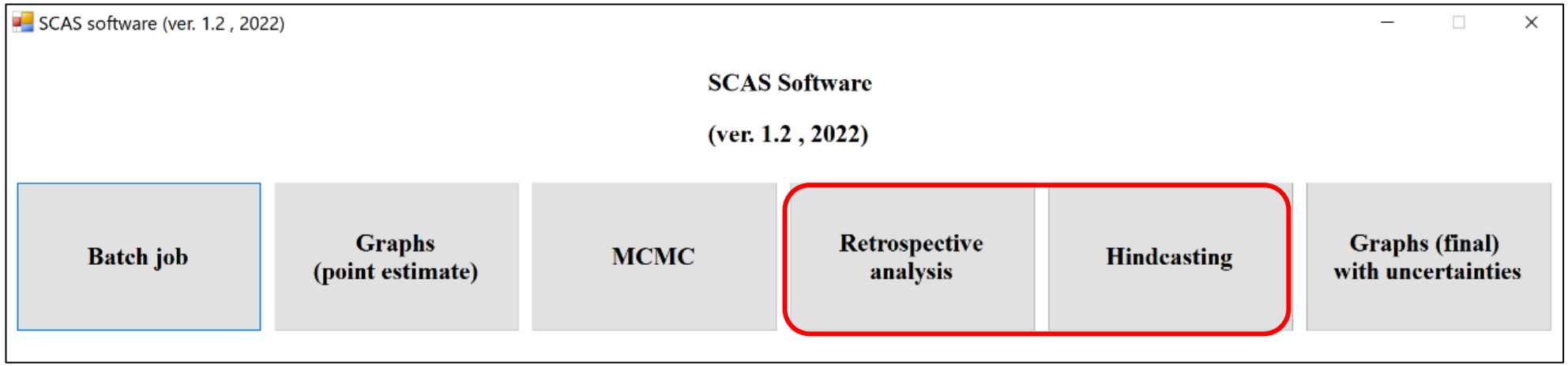
Appendix A: Progress of the menu-driven SCAS software development

A bit of history: ASPM(2008) ➔SCAA ➔SCAS (2022) 15 years of development

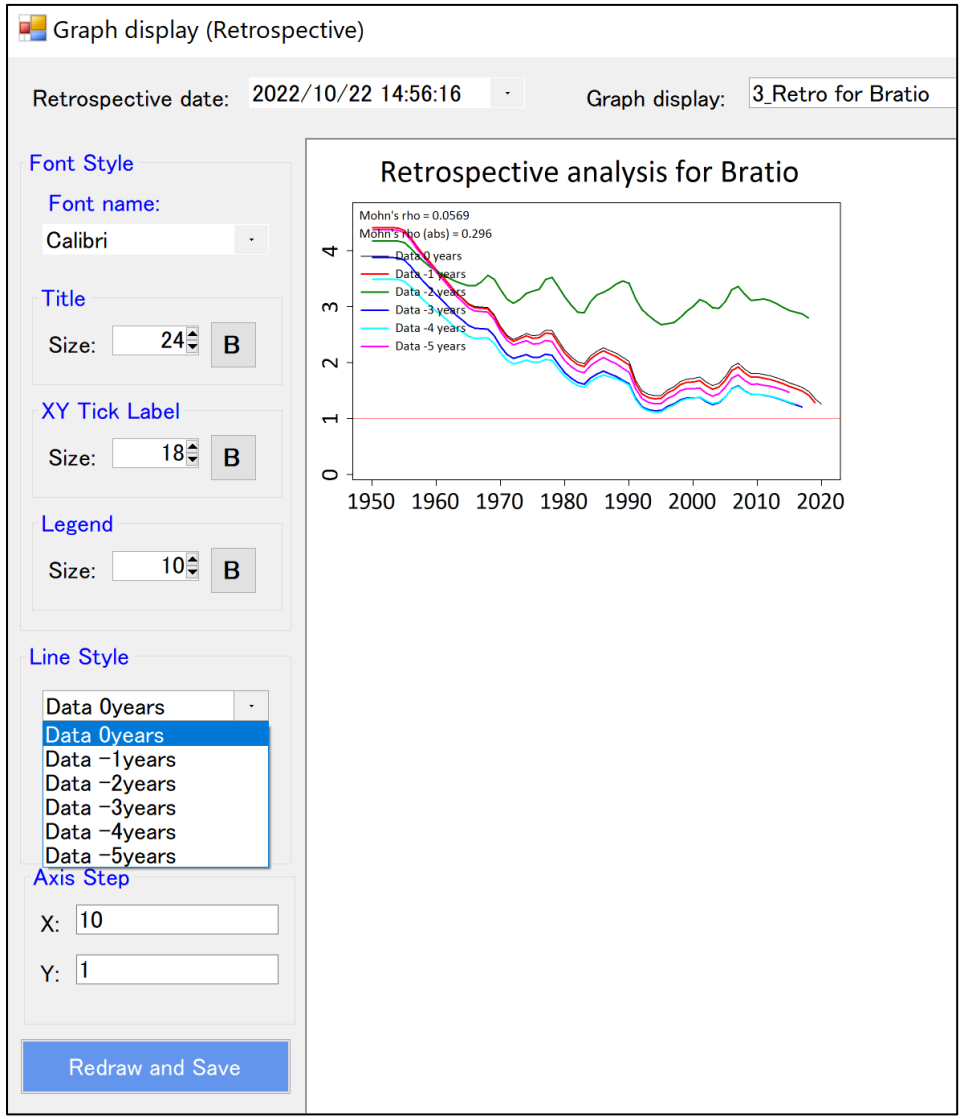
Available menus (6) in the current SCAS software (ver.1.2, 2022) *(see Nishida et al., 2021 for details)*

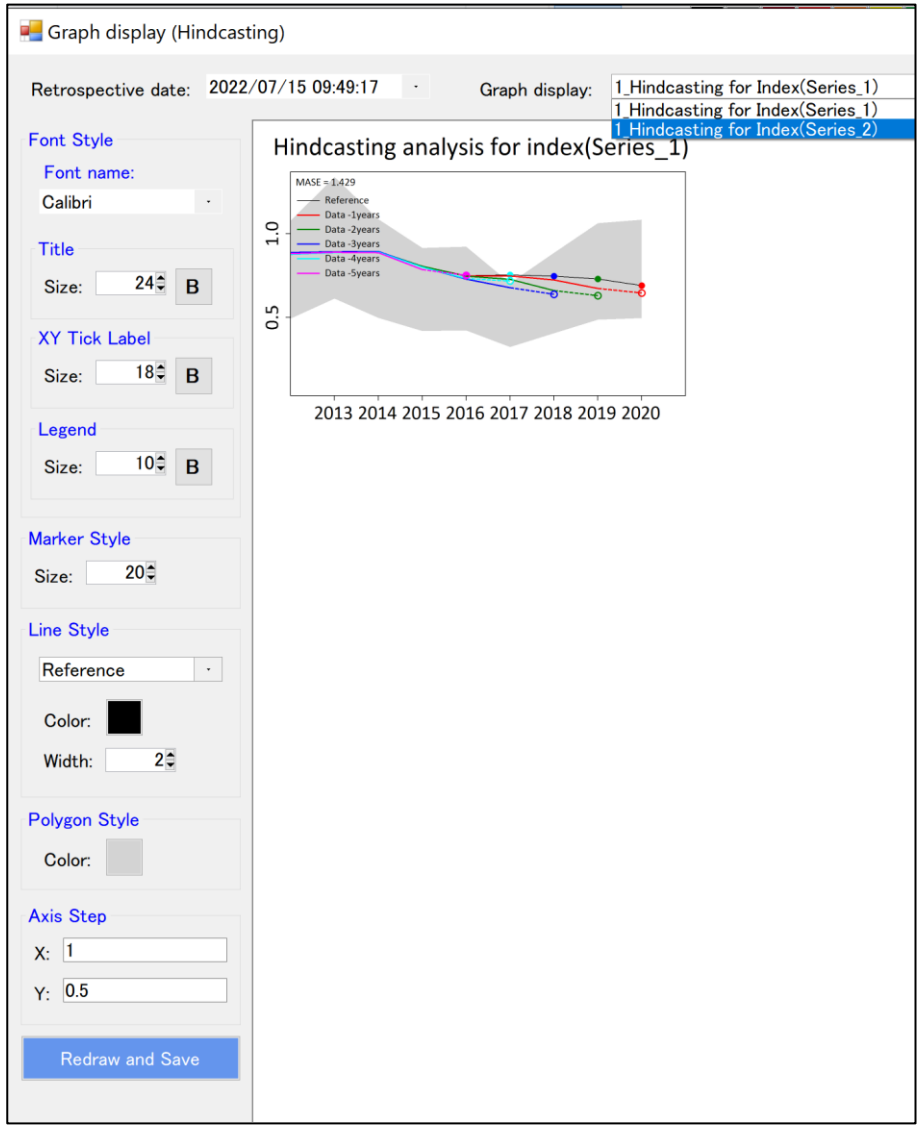


Recently 2 menus (retrospective analyses & hindcasting) were added (see examples, next slide) .

2 more menus on diagnostics (Jitter & ASPM analyses) can be added if the fund is available.

Examples: Process of retrospective and hindcasting analyses by menus from IO albacore SCAS assessment in WPTmT08(AS) (2022)





Thank you !