Workshop on

INTRODUCTION TO MENU-DRIVEN FISH STOCK ASSESSMENT AND MANAGEMENT DECISION MAKING (KOBE I+II) SOFTWARE

Conducted by

Dr. Tom Nishida
Stock Assessment Software Developing Team, Japan

VENUE - NARA AUDITORIUM

10.00 AM - 12.00 Noon
June 12th Monday 2023

Jointly organised by National Aquatic Resources Research and Development Agency (NARA) & Sri Lanka Association for Fisheries and Aquatic Resources (SLAFAR)

More info
https://slafar.lk/

3 species working groups (WG) established and WG members

(1) Small tuna
(2) Sardine
(3) Kawakawa

(1) Small tuna WG

NARA scientists			Species	Stock structure (assumption)	Data		Note
Name	Pictures	Specialty			Catch	CPUE	
Kasun Randika (leader)		Small tuna (Matara U) MS	Will work on one most important species (2024)	Sri Lankan water	SLNS IOTC	Sampling data, database & others	• Kasun is responsible for 3 small tuna species (Kawakawa, Bullet and frigate tuna) in NARA. • TropfishR
Sujeewa Hemanthi		Demersal Shrimp Survey					• No data available for demersal species.
Thejani Balawardhana		Shark Biology (Matara U)					• Thejani is responsible for Blue and Silky shark in NARA

(2) Sardine WG

NARA scientists			Species	Stock structure (assumption)	Data		Note
Name	Pictures	Specialty			Catch	CPUE	
Kishara Bandaranayake (leader)		Small Pelagic (Reproductive Biology) (Univ. of Sri Jayewardenepura)	Will work on one most important species (2024) (Need to decide species in this time)	Sri Lankan water	SLNS	Sampling data, database & others	• Kishara is responsible for 4 Sardine species and spotted sardine in NARA. • Data are available for Spotted sardine and 2 other species.
L.D. **Gayathry**		Small pelagic (Badulla U) Nuwara Eliya					• LBSPA method (Length-Based Spawning Potential Ratio)
Thanushan (Kalpitiya) Thanusanth Santhalingam		Shrimp Trawl survey Demersal/Lagoon (Eastern U) (Kelaniya U)					• STOX (Norway)

(3) Indian mackerel WG

NARA scientists			Species	Stock structure (assumption)	Data		Note
Name	Pictures	Specialty			Catch	CPUE	
Udari **Ayeshya** (leader)		Yellowfin tuna	Indian mackerel	Sri Lankan water	SLNS	Sampling data, database & others	• Ayesha is responsible for Indian mackerel in NARA.
Acini Fernando		Plankton Anchovy (Kelaniya U)					• Achini has Anchovy data (only 2 years), thus cannot conduct SA.

Menu driven software
“CPUE standardization”, “Stock & Risk assessments” and “Management decision making (Kobe I+II)”

Stock assessments for ALL

Tom Nishida (PhD)
Representative
STOCK ASSESSMENT SOFTWARE DEVELOPING TEAM

Welcome aboard

June 12 (Mon) NARA, Sri Lanka

10-12 AM

Part 1 Presentation & discussion (All)

Part 2 Future collaborative works

(*small group for those interested in*)

➔ *may be extended if more time needed*

Captain FV

Tom Nishida

STOCK ASSESSMENT
SOFTWARE DEVELOPING TEAM

Important Abbreviation

SA : Stock Assessment

RFMO : Regional Fisheries Management Organizations (example ➔ IOTC)

F : Fishing mortality

SSB (SB) : Spawning Stock Biomass

TB : Total Biomass

PM : Production Model

Self-Introduction

Stock assessments (<u>practical</u>)

Fish GIS (http://www.esl.co.jp/Sympo/)

Hokkaido University (BS)

University of Washington (BS+MS)

Tokyo University (PhD)

Work (38 years)

FAO (BOBP+IPTP)(Sri Lanka) (1985-1990)

(NARA➔ Back to home now !!)

\+

National Research Institute of Far Seas Fisheries (Japan) (IOTC + 4 RFMO)

(Extra work)

Stock assessment software developing team (Japan)

(assist 104 users in 24 countries)

Before starting presentation…..

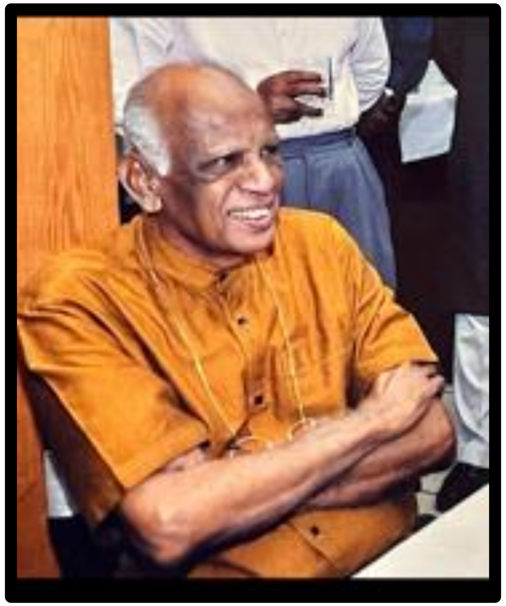
We would like to have a minute of silent prayer to Dr Sivasubramanian.

Dr Siva passed away last October.

Dr Siva & I worked BOBP together (NARA).

He was a great scientist and leader

for NARA, Sri Lanka and World !



Contents

(1) Outline

(2) Menu-driven software

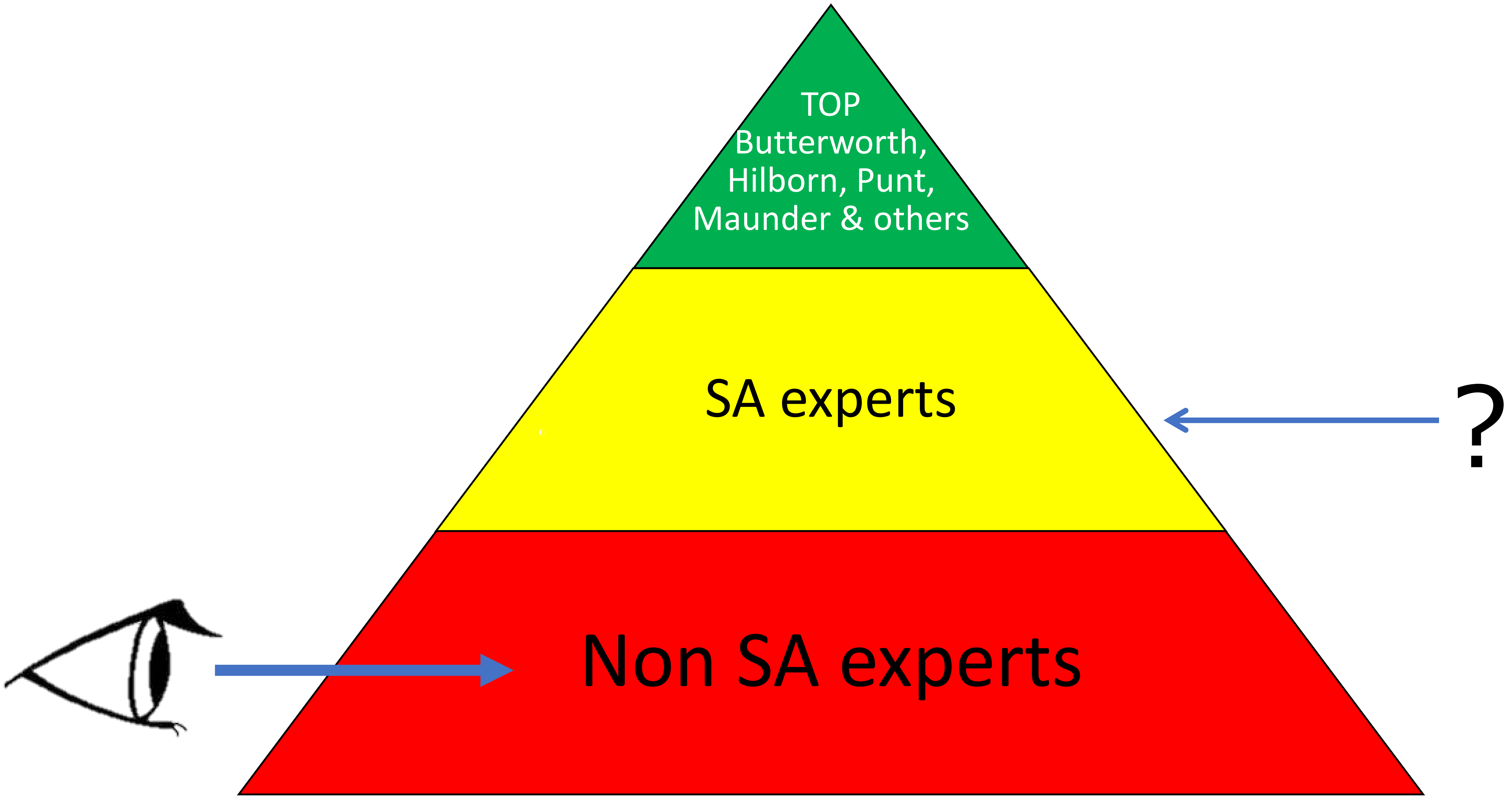
- CPUE standardization
- Stock and Risk assessment
  - Overview
  - Production model (ASPIC and JABBA)
  - Age structured production model (ASPM)
- Management decision making tool (Kobe I+II)

(3) Summary

Informal seminar

Please ask any questions,

make comments & discussion anytime…


TOP
Butterworth,
Hilborn, Punt,
Maunder & others
SA experts
?
Non SA experts

Outline (Menu-driven software) OBJECTIVES

- To develop menu-driven software for ALL

  especially for non-SA professionals & for those not good at programming.

- Total 8 = 「CPUE standardization (1)」+「SA models (5)」

  + 「management decision making tools (Kobe I+II) (2)」

- Easy: Anyone can do (short time) by **menu** (NO programming)

Policy I

- **We don't recommend** to use our menu-driven software?? Why???

- The most appropriate way ➔ develop own programs (R, C++).
  - ➔ Users can learn how application works, what Input/Output means
- Past Capacity Buildings (15 years)
  - ➔ most users using our software find it **difficult** to do so.
  - ➔ OK to use

Policy II

- Users **need** understand mechanism & Input/Output.
- In the **past** Capacity Building, we fully explained these points to users.

  ➔ we will continue to do SO…

- **Important point**

We protect users against <u>Auto-operating syndrome</u>.

➔we don’t want users

to be <u>easy-going & lazy persons.</u>

POLICY III : SIMPLE METHODS

SIMPLE → QUICK & DIRTY

Professor Steve Mathews
(University of Washington)

↓

Even simple/approximate method is OK

≈ Theoretically best methods

↓

This philosophy is applied for our menu-driven software

Comparisons: "Theoretical Best" vs "Quick & Dirty(simple)" approaches

	[A]	[B]
Approach	Theoretically good	Quick & Dirty (simpler)
Users	Limited (highly skillful) experts	Non expert (more people)
Method	Theoretically best but highly complicated	Simpler
Data requirements	Many	Minimum
Time	Highly time consuming	less
Results	Probably best, but not necessarily so, due to too many data by complicated methods	Appriximate thus not best, but close to [A] or better than [A] sometimes

some example

	[A]	[B]
Approach	Theoretically good	Quick & Dirty (simpler)
Results	Best	Approximate thus not best, but close to [A] sometimes
Example (some parameter estimation in SA)	$P_y = \begin{cases} \varphi\, e^{\eta_y} & \text{for} y = 1 \\ \left(P_{y-1} + \frac{r}{(m-1)} P_{y-1}\left(1 - P_{y-1}{}^{m-1}\right) - \frac{\sum_f C_{f,y-1}}{K} \right) e^{\eta_y} & \text{for} P_{y-1} \geq P_{\lim} \ \& \ y = 2, 3, \ldots, \text{n} \\ \left(P_{y-1} + \frac{r}{(m-1)} P_{y-1}\left(1 - P_{y-1}{}^{m-1}\right) \frac{P_{y-1}}{P_{\lim}} - \frac{\sum_f C_{f,y-1}}{K} \right) e^{\eta_y} & \text{for} P_{y-1} < P_{\lim} \ \& \ y = 2, 3, \ldots, \text{n} \end{cases}$	$Py \approx \Phi 2$
results	both produce almost identical estimates.	

Based on this philosophy

8 menu driven software

6 developed and 2 under development

3 types
(8 software)

Updated

Types		Level	Name	Icon to start	Features
CPUE standardization		*Basic to Intermediate*	(1) GLM based CPUE Standardization	CPUE standardization	Basic CPUE Standardization
Stock assessment (SA)	**Production model (PM)**		(2) ASPIC (A Stock-Production model Incorporating Covariates)	ASPIC batch job	Standard PM incorporating observation (OBS) errors
		Advanced	(3) JABBA (Just Another Bayesian Biomass Assessment)		Theoretically best PM incorporating both OBS and process errors
	Age structured (integrated) model		(4) ASPM (Age Structured Production Model)	BatchASPM *(for both ASPM and SCAA)*	In-between PM & age-structured model (selectivity: fixed)
			(5) SCAA (Statistical-Catch-At-Age)		Catch-At-Age based age-structured model
			(6) SCAS (Statistical-Catch-At-Size)	SCAS	Catch-At-Size based age-structured model
Management decision tools		*Basic to Intermediate*	(7) <u>Kobe I</u> : Kobe plot and <u>Kobe II</u>: Strategy matrix (risk assessment)	Kobe plot I_II	<u>Kobe I</u> : Standard stock status trajectory plot <u>Kobe II</u>: Evaluation of the optimum catch level (TAC)
		Intermediate	(8) <u>Kobe II</u> for (2) ASPIC	Kobe II Risk matrix (for ASPIC) (ver.2...	<u>Kobe II:</u> Special version suitable for (2) ASPIC

INPUT DATA

Types		Name	Input information				
			Catch	CPUE	Biology	SA results (B/Bmsy and F/Fmsy) Projection	Prior (Bayesian Approach)
CPUE standardization		(1) GLM based CPUE Standardization					
Stock assessment (SA)	Production model (PM)	(2) ASPIC (A Stock-Production model Incorporating Covariates)					
		(3) JABBA (Just Another Bayesian Biomass Assessment)					
	Age structured (integrated) model	(4) ASPM (Age Structured Production Model)					
		(5) SCAA (Statistical-Catch-At-Age)					
		(6) SCAS (Statistical-Catch-At-Size)					
Management decision tools		(7) Kobe I and II					
		(8) Kobe II for (2) ASPIC					

Warning

Complicated methods
are not necessarily good methods
nor provide good results

same for the simple methods

So we don't have any good methods..
what is the best solution ? (important)

5 tuna RFMO (Regional Fisheries Management Organizations) meeting (2009) recommended

Need to compare results among a few SA models(*)

to evaluate as each model has pros & cons

(*) 'Simple', 'intermediate' & 'advanced' model

(different structures & data sets)

If results are similar → certain & confident

So we (menu-soft) can contribute 'Simple', and 'Intermediate',

while SA expert for 'Advanced (SS3)' SA

Win-win situation

UTILIZATION

- All software : FREE of charge for anyone to utilize.
- If you want to use the software, please contact us.
- We will provide the on-site free training.

  (funded by ODA and others)
- We will release software and manual after we make sure that users understand the software (theory & input/output) and can handle software properly.

→ Our responsibility

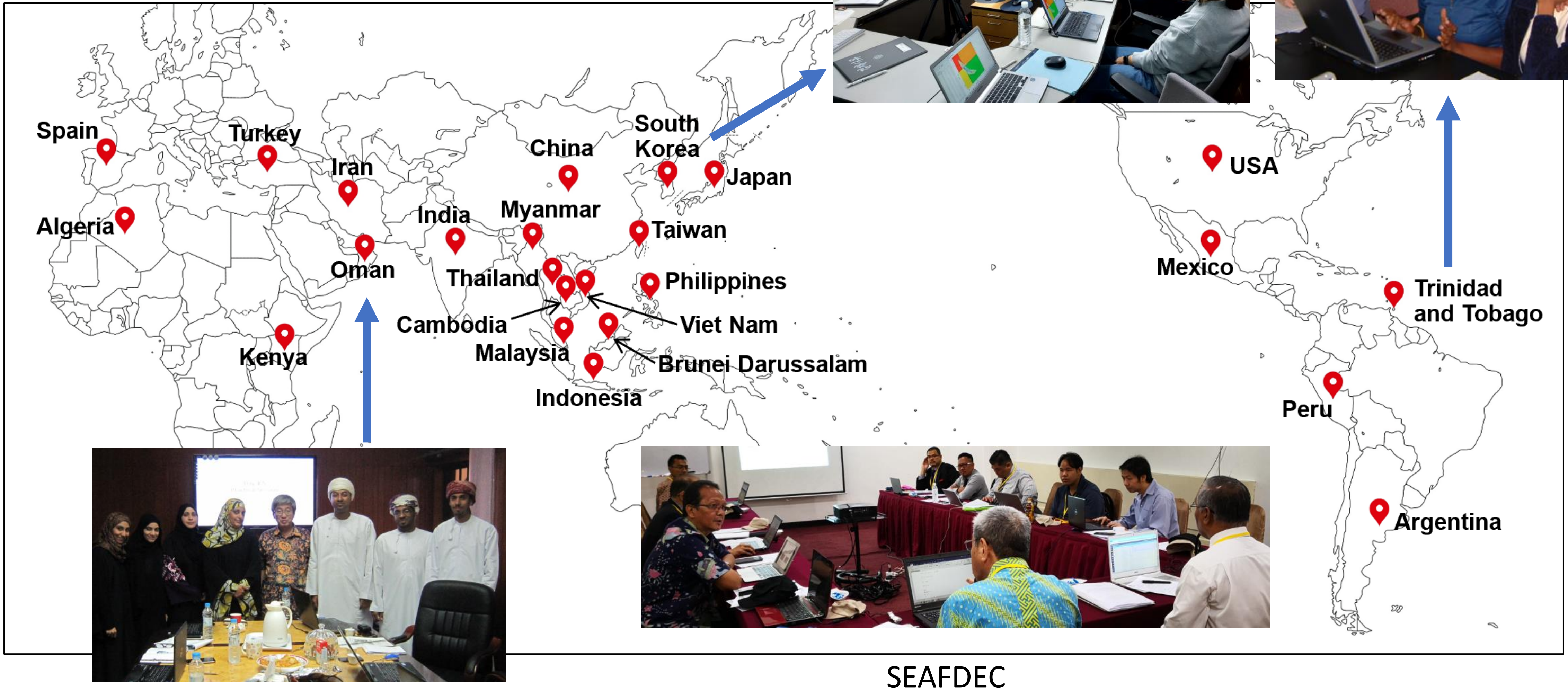
USERS: 104 USERS (24 COUNTRIES)

Sri Lanka (not yet), but will start…

Algeria, Argentina, Brunei Darussalam*, Cambodia*, China, Indonesia*, India, Iran, Japan*, Rep. Korea, Kenya, Malaysia*, Mexico, Myanmar*, Oman, Peru, Philippines*, Spain, Thailand*, Trinidad and Tobago, USA, Viet Nam*, Taiwan and Turkey.

(*) Southeast Asian Fisheries Development Center (SEAFDEC) member countries

Mainly Southeast Asia

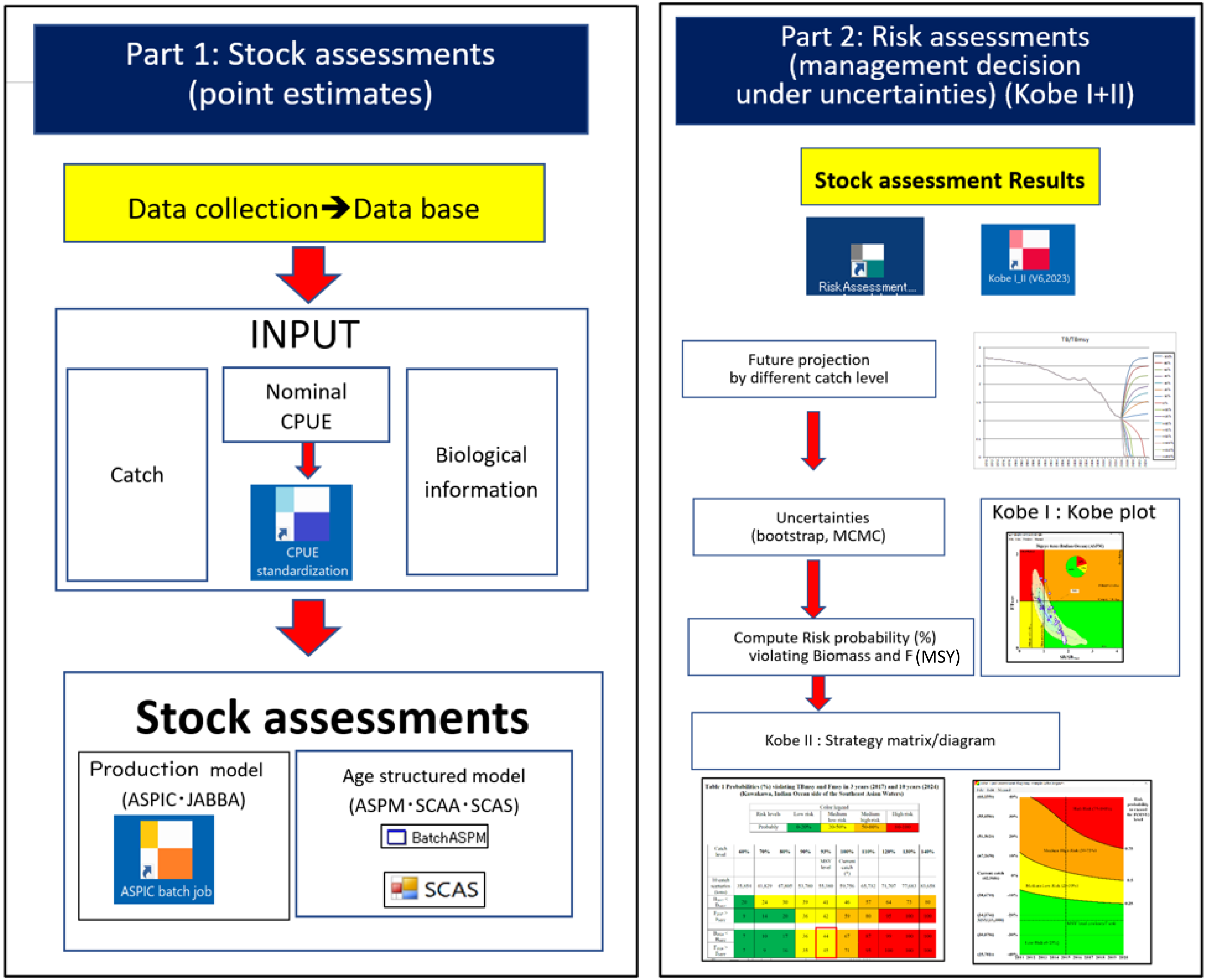


SEAFDEC

Structure (Outline)

Menu driven software

will be fully explained



Our ultimate goal

Stock assessments (SA) for ALL ☺

No more

- struggling with SA
- only for SA experts (5~10%)

↓

for a happy & better life for ALL

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(3) Summary

CPUE standardization by year

To be used as one of most important inputs for stock assessment as abundance index (year based)

Menu-driven
CPUE standardization software

Policy → <u>for non technical users</u> → Simple (quick & dirty)

GLM → standard. No complicated ones (VAST, regression tree, NN etc.)

Covariates (factors affecting nominal CPUE)

→ Minimum (year, season, area) (3)

→If users want to use more complicated methods

and more covariates, use R, SAS etc..

Why we need CPUE standardization?

- Nominal (raw) CPUE

  ➔ Bias➔ not real abundance index ➔ not good for SA

- Major bias by ➔ Y(Year), S(Season) & A(Area)

  Other bias by ➔ target, ENV, gear, vessel, skipper etc.

  ➔Could be explained by YSA because biases are reflected by time & area

- Thus, 3 Covariates (=factors) (Year, Season & Area) ➔ OK

  ➔ if you want to use more covariates ➔ use R, SAS etc.

Model: GLM (Generalized Linear Model) *standard approach*

GLM is a flexible generalization linear regression

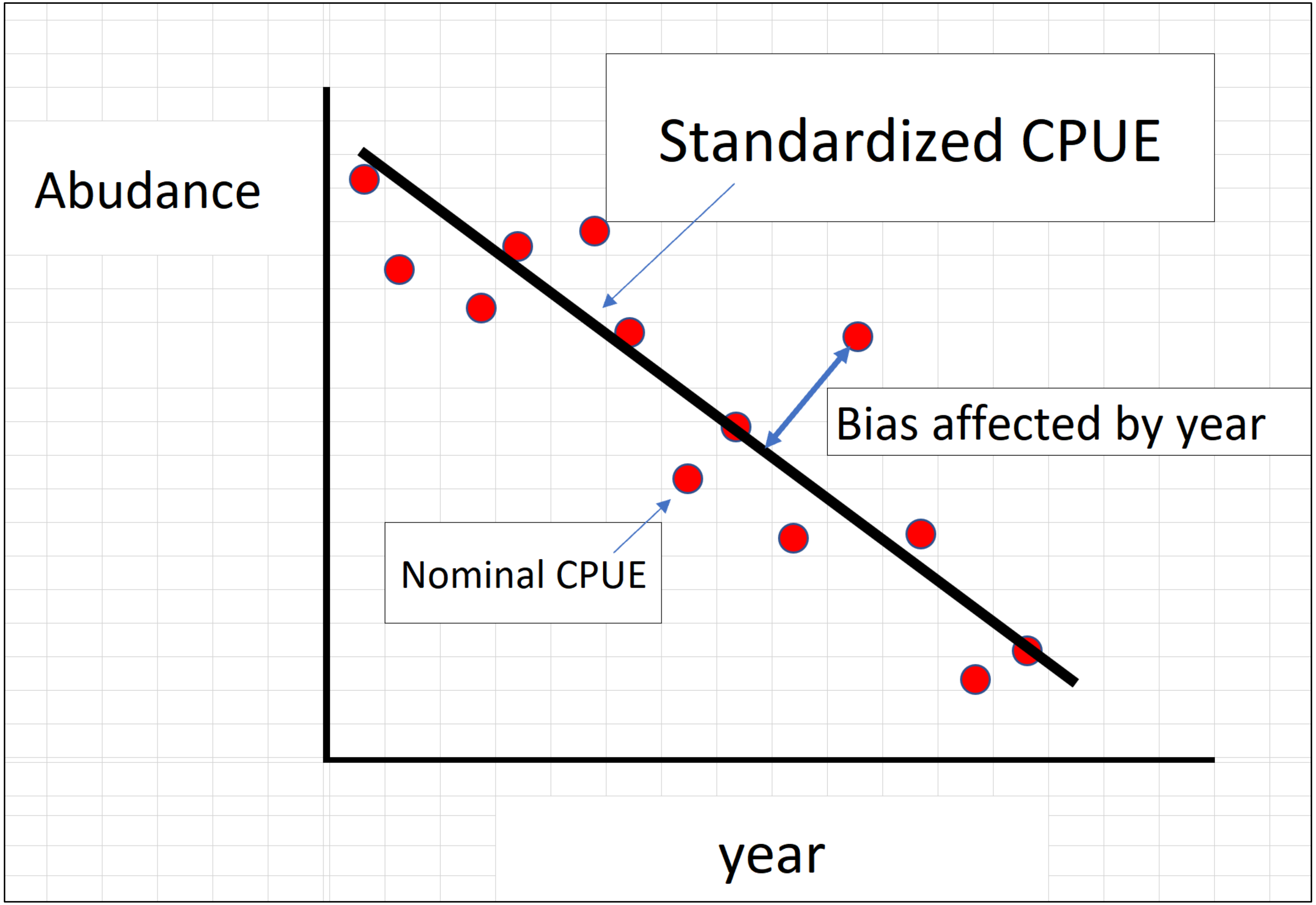
Error distribution ➔ Normal (Bell shape) distribution

Simple linear regression (high school math textbook) is the simplest GLM

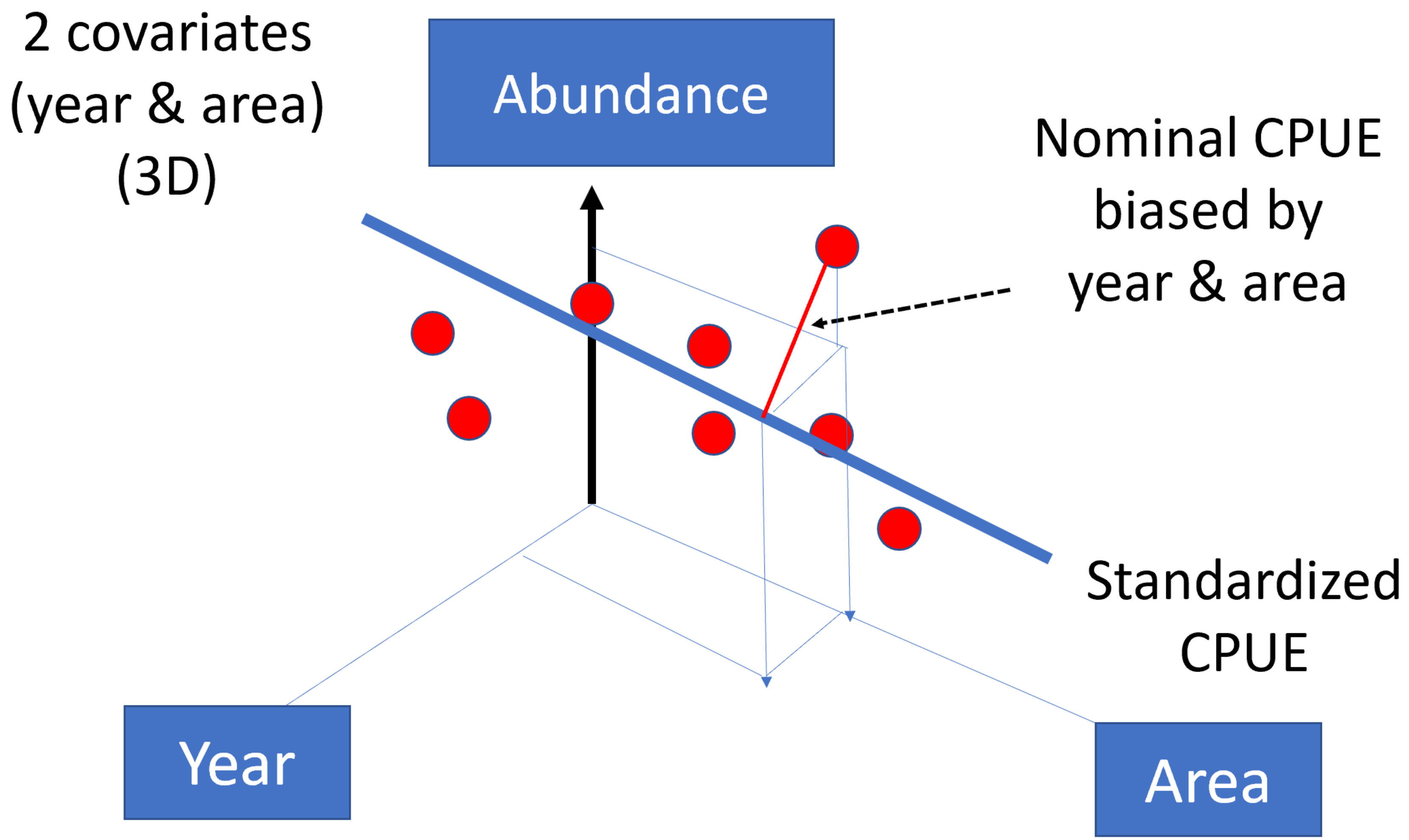
Simple way to explain CPUE standardization by GLM
(1 covariate → year)

Simple linear regression

You can calculate standardized CPUE



Simple way to explain GLM (2 covariates: year & area)
➔Still you can calculate, but bit complicated



No simple way to explain GLM (3 or more covariates)

Can not draw images …

More complicated to compute standardized CPUE

So need **R, SAS** etc.,

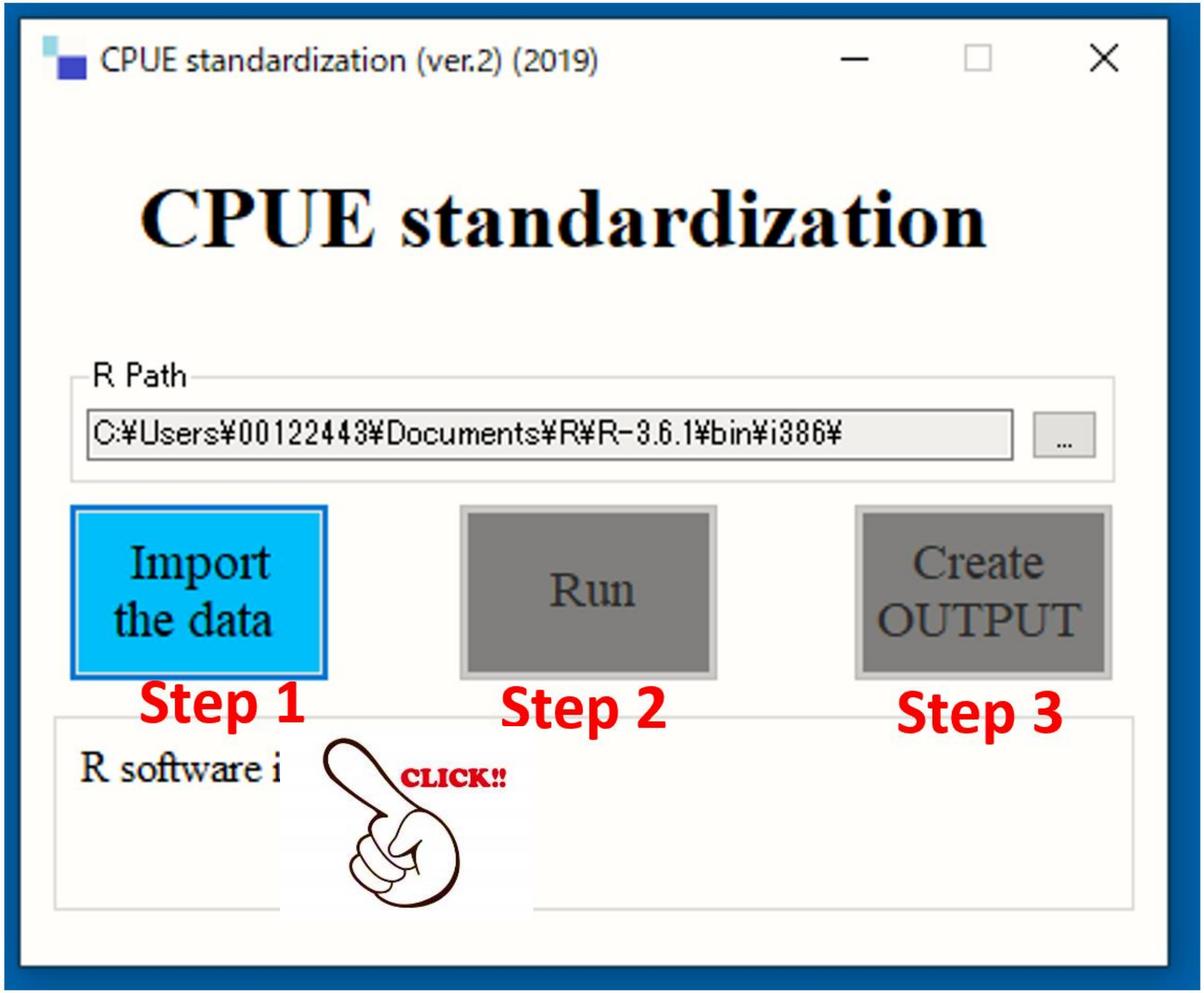
But we use **menu-driven GLM** software

(actually we use R behind)

(Simple) Input data : Example
Year (1986-2006)(21), Season(4), Area(7) and Nominal CPUE

YR	Q	area	KAW CPUE (KG/HAUL)
2006	1	6	26.88
2006	1	6	0.00
2006	1	6	0.00
2006	2	6	163.35
2006	2	6	314.64
2006	2	6	37.69
2006	3	6	237.87
2006	3	6	429.18
2006	3	6	18.69
2006	4	6	29.62
2007	1	6	0.00
2007	1	6	0.00

3 steps to complete



1st window ➔

Check
① Sample size
② 0 catch rate

Selection
③ Model
④ Covariates

Information on 0(Zero) Catch

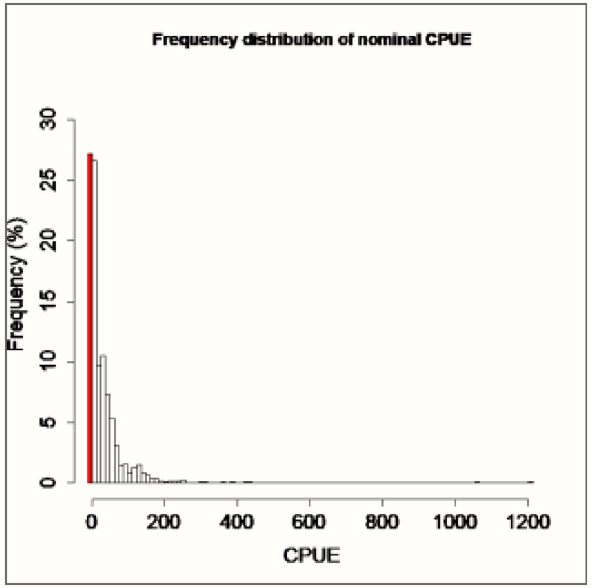
① Sample size (n=)

	area 1	area 2	area 3	area 4	area 5
1995	4	12	12	11	12
1996	1	12	10	12	3
1997	1	12	10	12	3
1998	12	12	12	12	.
1999	5	12	12	12	10
2000	3	12	12	11	10
2001	3	12	12	11	4
2002	8	12	12	12	4
2003	12	12	12	12	4
2004	12	12	12	12	4
2005	12	12	12	12	9
2006	3	12	12	12	12
2007	12	12	12	12	12
2008	12	12	12	12	12
2009	12	12	12	12	12
2010	12	12	12	12	12
2011	12	12	12	12	12
2012	12	12	12	12	12
2013	12	12	10	12	12
2014	12	12	10	12	12
2015	12	12	10	12	12

	Q 1	Q 2	Q 3	Q 4
1995	18	19	19	19
1996	16	15	16	15
1997	16	15	16	15
1998	18	18	18	18

② 0 (zero) CPUE (catch) rate (red bar)= 27%

% frequency distribution of nominal CPUE



③ Select model

- ◉ Log normal GLM: 0 (zero) CPUE (catch) rate < around 30%
- ○ Delta type 2 steps log-normal model: 0 (zero) CPUE (catch) rate > around 30%

④ Select covariates (factors)

- ☑ Y (Year)
- ☐ S (Season: Month, Quarter etc.)
- ☐ A (sub-Area)
- ☐ Y * A
- ☐ Y * S
- ☐ S * A
- ☐ Y * S * A

OK Cancel

1[st] window ➔

check
① Sample size

why ? If sample size too small, results will be no reliable.

Information on 0(Zero) Catch

① Sample size (n=)

	area 1	area 2	area 3	area 4	area 5
1995	4	12	12	11	12
1996	1	12	10	12	3
1997	1	12	10	12	3
1998	12	12	12	12	.
1999	5	12	12	12	10
2000	3	12	12	11	10
2001	3	12	12	11	4
2002	8	12	12	12	4
2003	12	12	12	12	4
2004	12	12	12	12	4
2005	12	12	12	12	9
2006	3	12	12	12	12
2007	12	12	12	12	12
2008	12	12	12	12	12
2009	12	12	12	12	12
2010	12	12	12	12	12
2011	12	12	12	12	12
2012	12	12	12	12	12
2013	12	12	10	12	12
2014	12	12	10	12	12
2015	12	12	10	12	12

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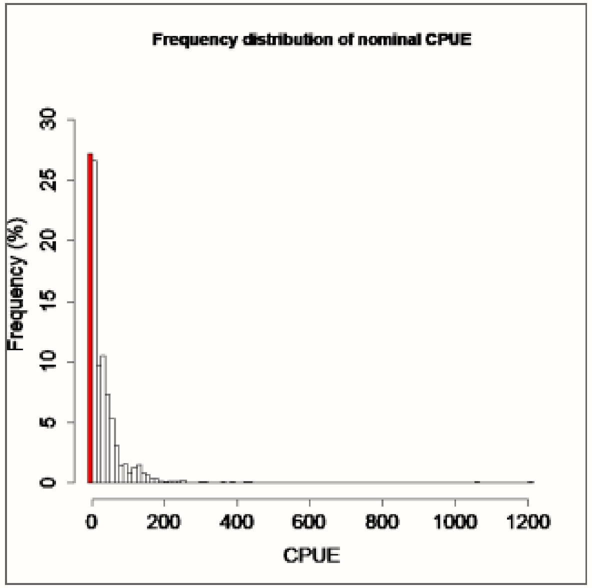

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- ☑ Y (Year)
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- ☐ Y * A
- ☐ Y * S
- ☐ S * A
- ☐ Y * S * A

OK Cancel

1st window ➔

check

② 0 catch rate

⬇

Why ?

If there are too many 0 (zero) catch

⬇

results (bias)

⬇

Need to use theoretically appropriate GLM model

Information on 0(Zero) Catch

① Sample size (n=)

	area 1	area 2	area 3	area 4	area 5
1995	4	12	12	11	12
1996	1	12	10	12	3
1997	1	12	10	12	3
1998	12	12	12	12	.
1999	5	12	12	12	10
2000	3	12	12	11	10
2001	3	12	12	11	4
2002	8	12	12	12	4
2003	12	12	12	12	4
2004	12	12	12	12	4
2005	12	12	12	12	9
2006	3	12	12	12	12
2007	12	12	12	12	12
2008	12	12	12	12	12
2009	12	12	12	12	12
2010	12	12	12	12	12
2011	12	12	12	12	12
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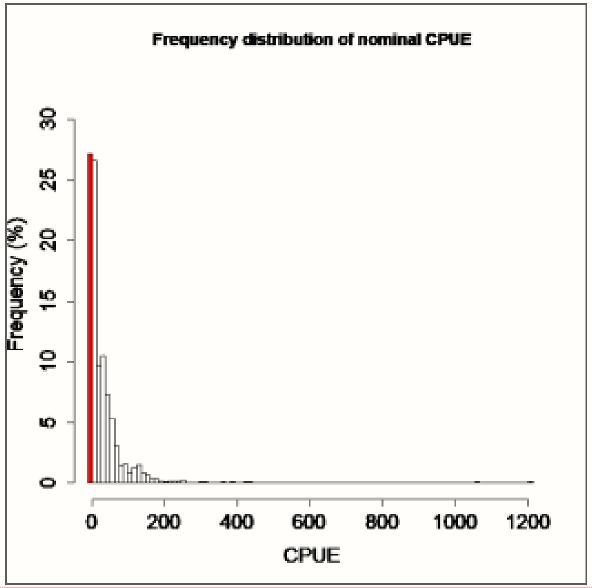
% frequency distribution of nominal CPUE



③ Select model

- (●) Log normal GLM: 0 (zero) CPUE (catch) rate < around 30%
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- ☑ Y (Year)
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- ☐ A (sub-Area)
- ☐ Y * A
- ☐ Y * S
- ☐ S * A
- ☐ Y * S * A

OK Cancel

What is the theoretically appropriate GLM model

If 0 catch rate < 30% ➔ GLM (OK)

But if 0 catch rate > 30 %

⬇

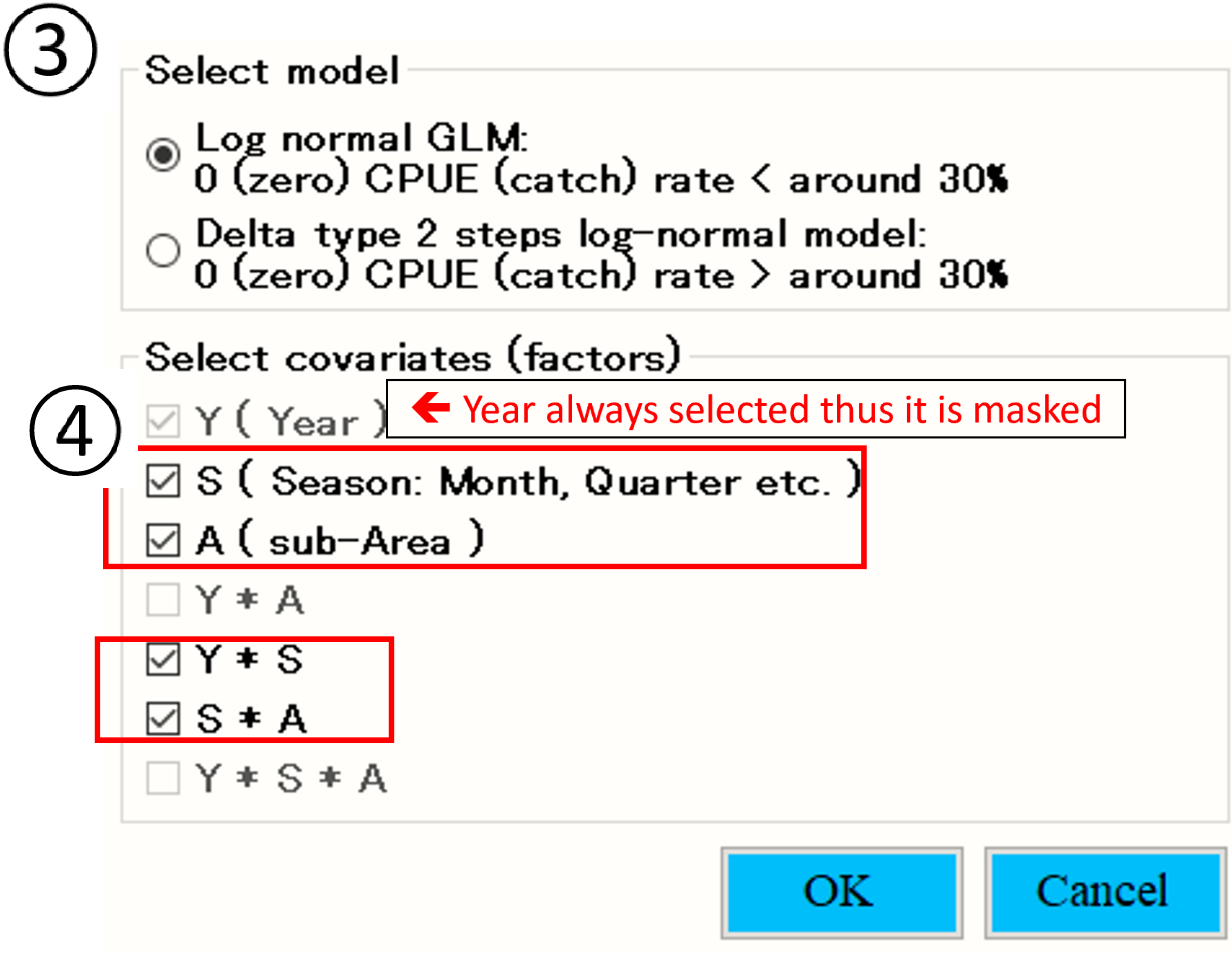
0 (zero) inflated Delta type 2 step log-normal GLM (2 step GLM)

(1) Estimate 0 catch rate (logistic regression)

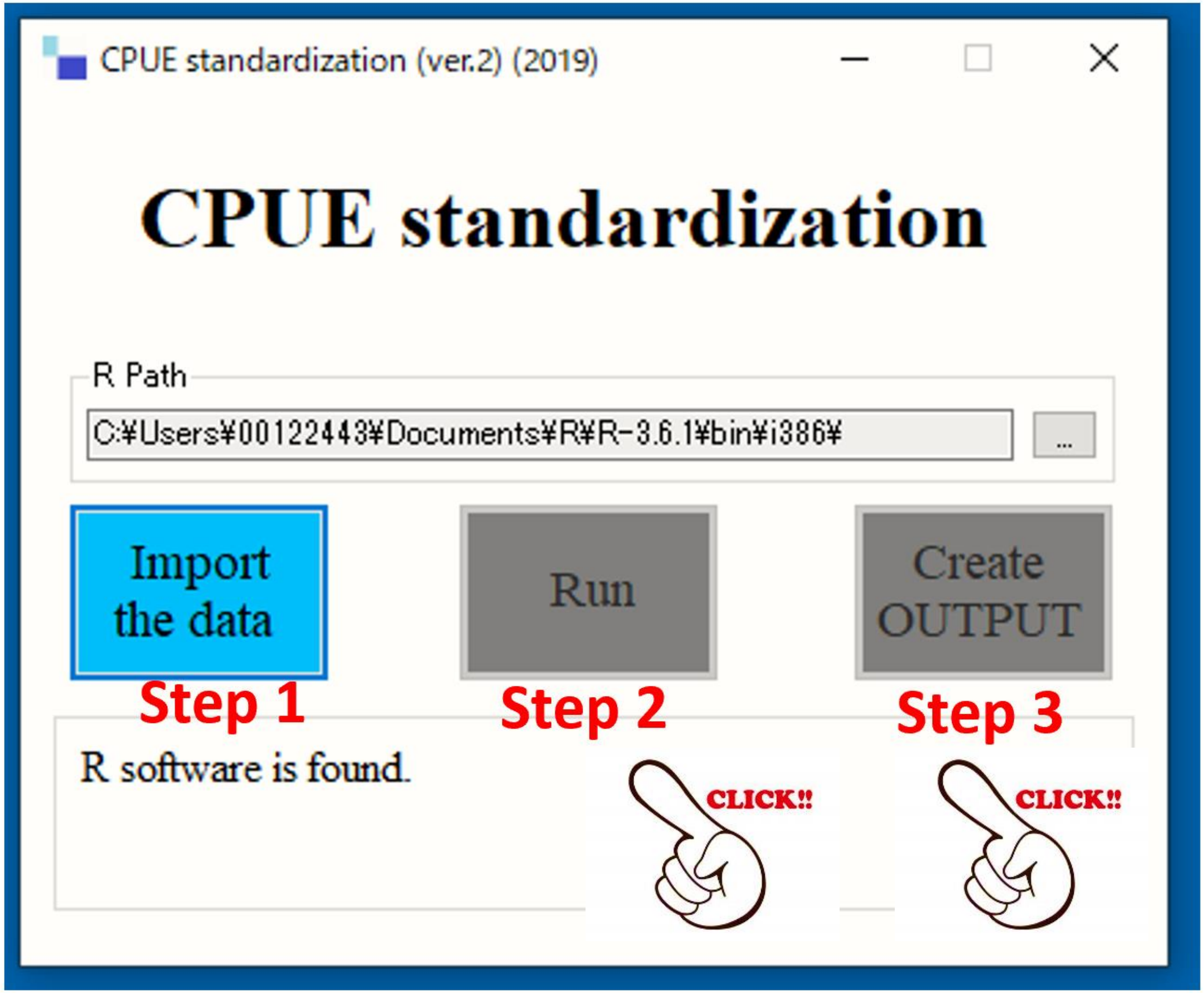
(2) Standardized CPUE for non-0 catch

➔ Standardized CPUE=(1)*(2)

(Prof. Shono)


③
Select model
Log normal GLM:
0 (zero) CPUE (catch) rate < around 30%
Delta type 2 steps log-normal model:
0 (zero) CPUE (catch) rate > around 30%
Select covariates (factors)
④
Y (Year)
Year always selected thus it is masked
S (Season: Month, Quarter etc.)
A (sub-Area)
Y * A
Y * S
S * A
Y * S * A
OK
Cancel

3 steps to complete



2 Outputs will be provided

(1) Numerical results (excel file) ➔ Users can do further analyses

	Observed (nominal) CPUE	Estimated (standardized) CPUE	Lower boundary of 95% CI (2.5%)	Upper boundary of 95% CI (97.5%)
1996	96.64	73.82	46.41	116.05
1997	87.21	67.21	42.13	105.86
1998	46.38	22.69	10.34	45.49
1999	49.75	38.05	24.28	58.45
2000	65.33	72.53	47.55	109.56
2001	60.73	68.77	45.01	103.98
2002	66.14	77.39	50.83	116.76
2003	77.64	90.49	59.67	136.17
2004	62.06	55.99	36.39	85.04
2005	20.66	18.84	11.32	29.98
2006	18.74	22.88	14.05	35.97
2007	10.60	14.02	8.07	22.84
2008	16.48	19.44	11.72	30.87
2009	13.54	17.75	10.59	28.37
2010	34.11	24.09	14.86	37.76
2011	37.47	36.87	23.49	56.71
2012	28.94	34.38	21.80	53.01
2013	29.49	24.67	15.25	38.63
2014	30.92	26.29	16.35	41.03
2015	22.04	21.07	12.83	33.30

2 Outputs will be provided

(2) Summary of results (word file)➔ Your report is ready !

- ANOVA ➔ to check if model and COV are significant.
- Graphs ➔ Estimated standardized CPUE by year overlaid with 95% CI + Nominal CPUE
- Diagnosis (residual analyses) (model evaluation)

  ➔ Histogram (Residuals) to check errors are normal distribution

  ➔ QQ plots to check the model is OK

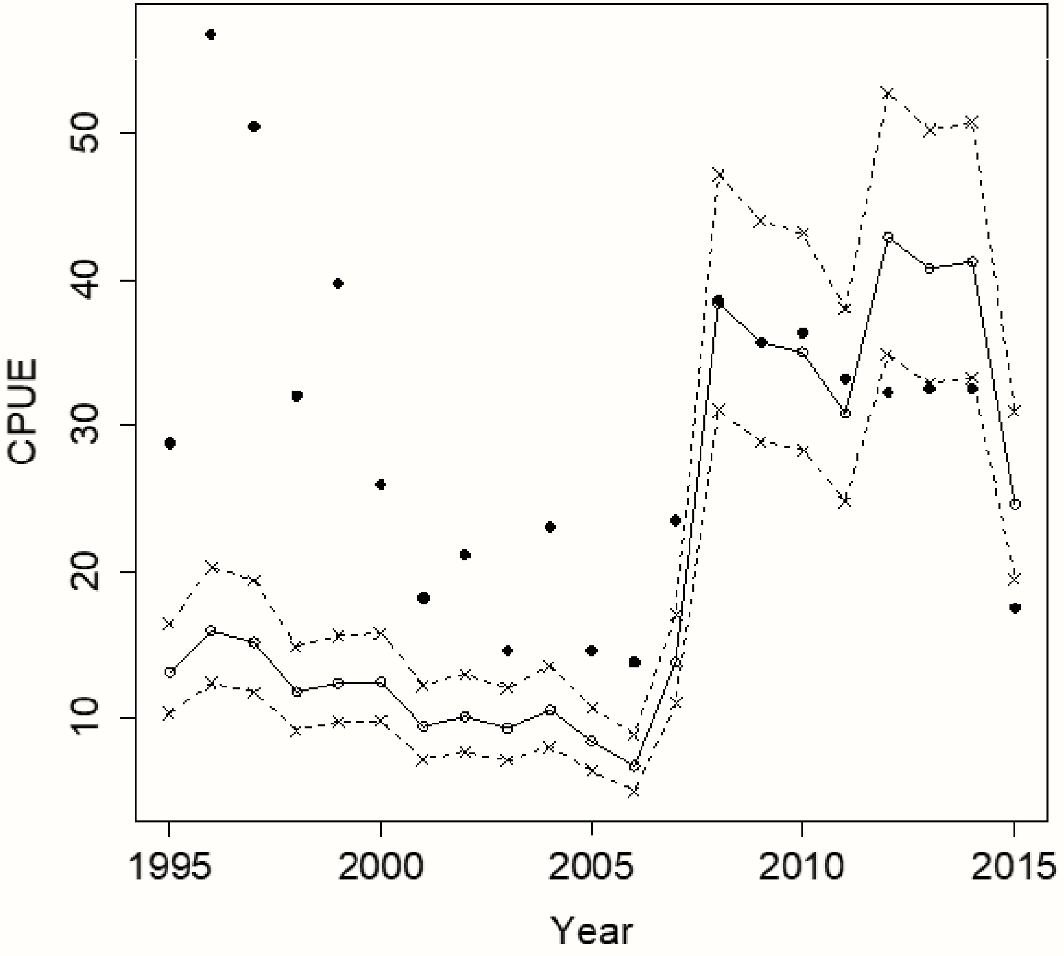
ANOVA to check if model (GLM) is OK & Covariates affect nominal CPUE (5%)

ANOVA (Analysis Of Variance) Table for log normal GLM to test statistical significances				
Adjusted R2 = 0.60				
Factors	DF (Degrees of Freedom)	Type III SS (Sum of Squares)	F value	Pr(>F)
Model	107	636.67	8.53	0.00
YR	20	89.01	6.38	0
Q	3	3.42	1.64	0.18
area	6	429.09	102.49	0
YR*Q	60	64.59	1.54	0.01
YR*area				
Q*area	18	50.55	4.02	0

- Model is OK (significant to Covariates ➔ effective model) < 5%
- Covariates are OK (significant to nominal CPUE➔ affected) <5%

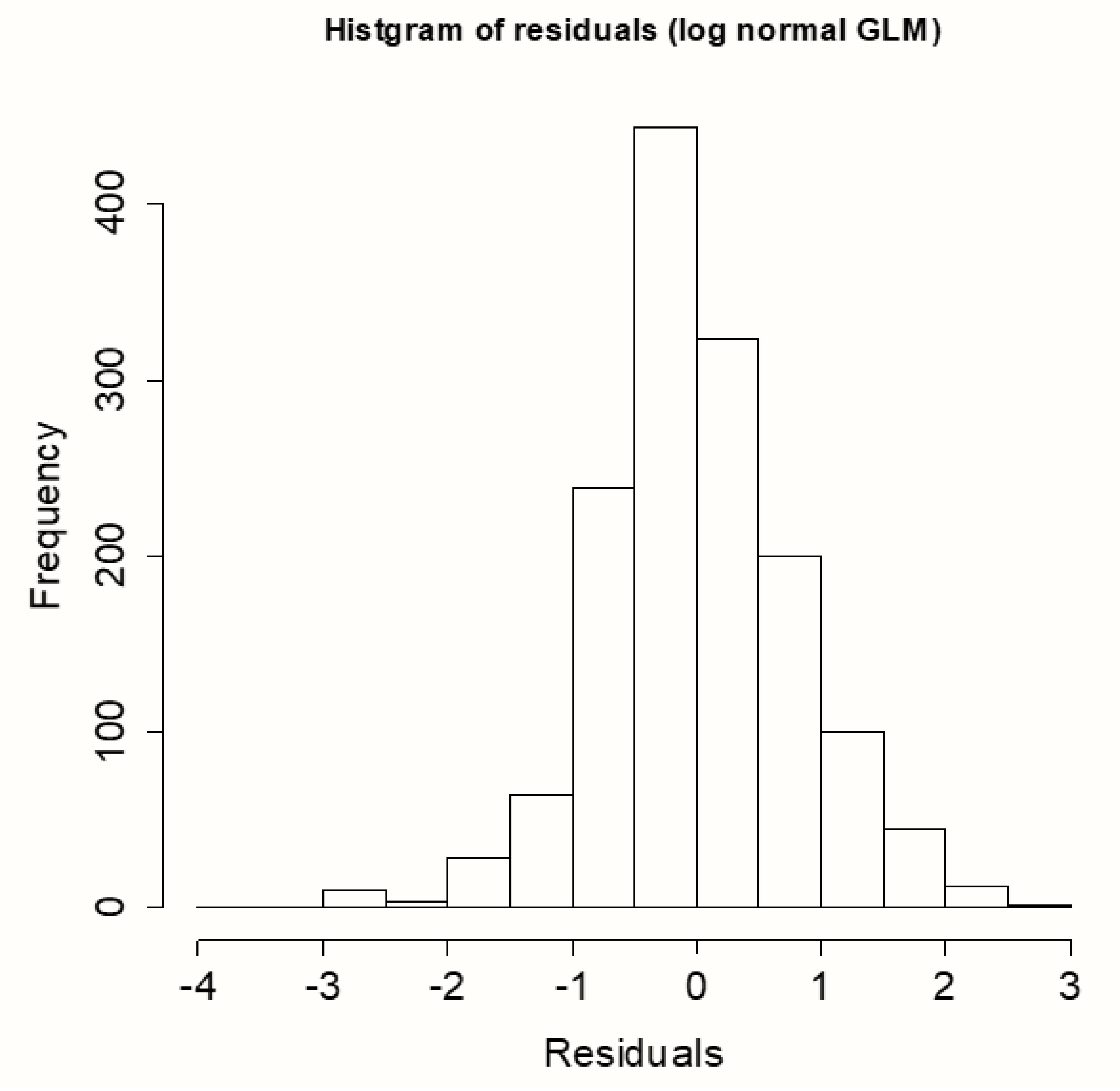
except Q (> 5%)➔ non significant to nominal CPUE ➔ not affected

Trends of nominal CPUE, standardized CPUE
and 95% confidence intervals



Legend

Point (•) : Nominal CPUE
Line (——) : Standardized CPUE (point estimate)
Broken line (-----) : 95% Confidence intervals



Model suitability

Error distributions

(Bell chape)

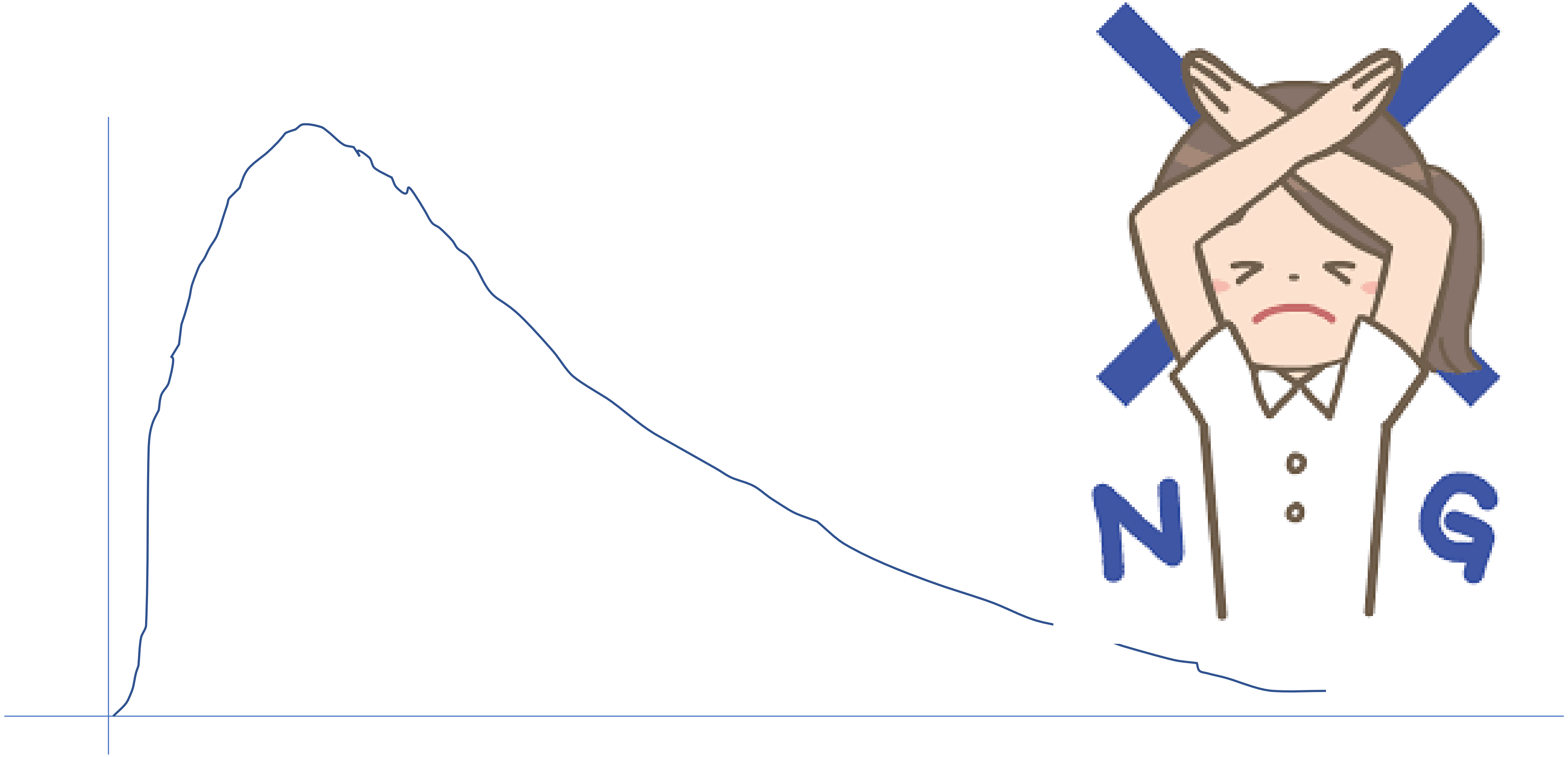
↓

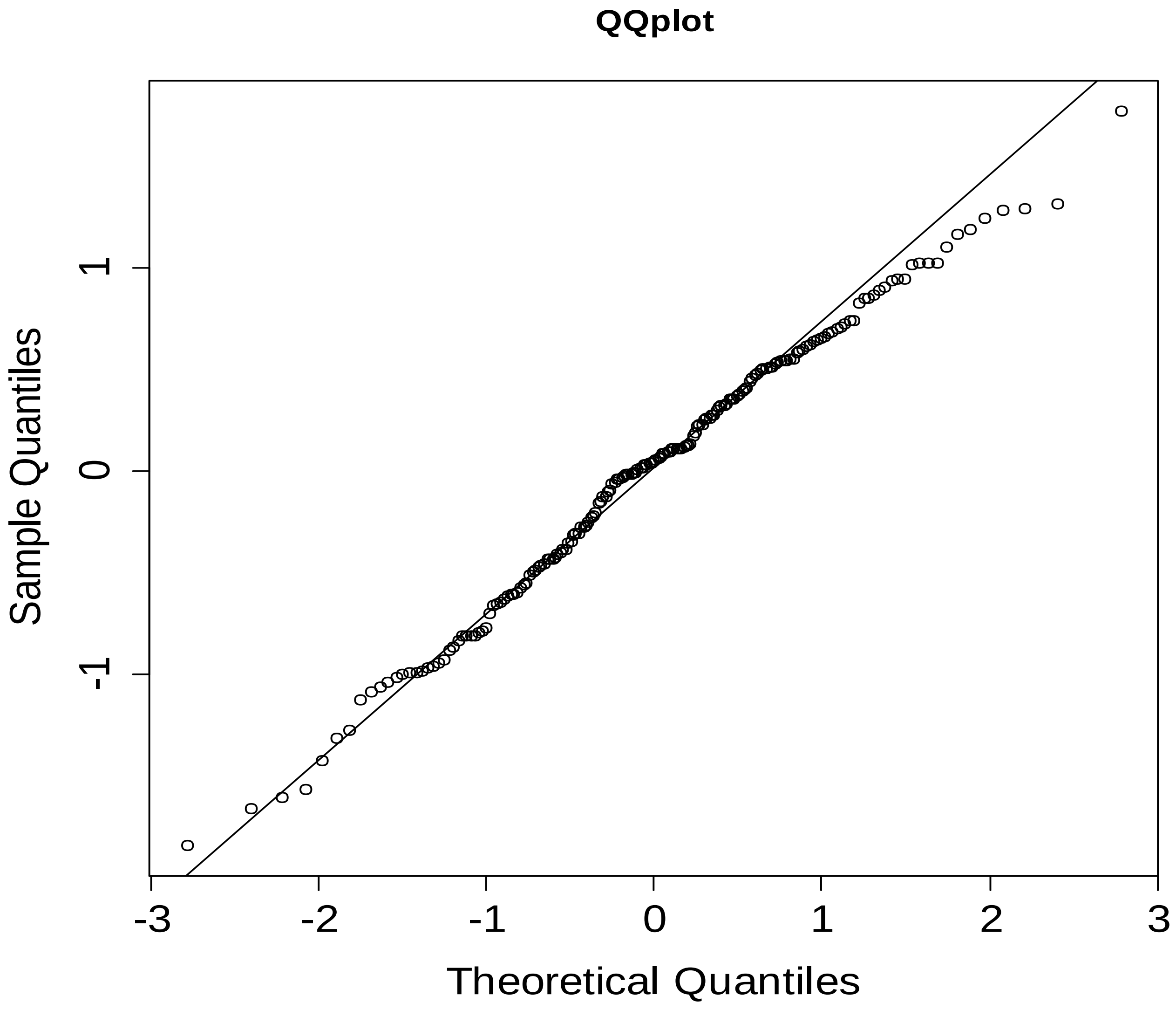
Log normal GLM

↓

Model OK

If NG,
you need to try 2 steps GLM or other models





QQ (quantile-quantile) plot

Another method to evaluate Model if errors (observation) follow normal distribution

Straight line (perfect normality)

This case (GLM) is OK

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    - Kobe I+II
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Overview: Stock & Risk assessments

Let’s start from stock assessment overview

- Quiz

  How many stock assessment models ?

How many SA models ? More than 50 (IOTC, 2015) (a list and not classified)

Method	Data Requirements		Reference Points	Management Advice	Pros	Cons
	Biology	Fishery				
PSA	Qualitative	Qualitative	No	Qualitative	Easy to use if LH parameters available	Difficult to relate to current abundances and fishing mortality.
Demographic Models/Elasticity Analysis	Age & growth, Fecundity, Natural Mortality	Several fishery characteristics	No	Mostly qualitative (change of gear) and F	Easy to use if LH Parameters available. Can provide guidance on gear usage/ selectivity	Must assume that LH parameters are correct, but uncertainties can be introduced. Difficult to relate to current abundances and fishing mortality.
Catch free LH Based	M, growth curve parameters, and Age at full Maturity or Max Age	Selectivity	Yes (F_{MSY})	F_{MSY}	Easy to get LH parameters if available. Zhou et. al. (2011) provides equations that are relevant to species. Could run a meta-analysis and run as well using a Bayesian Hierarchical Model Approach. Provides a Target F.	Guidelines provided for Fishing Mortality, but no specifics on current status. No idea what current Biomass and F are. However some guidelines could be provided based on theoretical carrying capacity, current depletion levels, and whether current take are meeting or exceeding targets.
Catch free CPUE Based	M, growth curve parameters, and Age at full Maturity or Max Age & recruitment	Selectivity and CPUE Series	Yes (F_{MSY} & B_{MSY})	F_{MSY} & B_{MSY}	Easy to parameterize with LH data. Estimate recruitment, F and selectivity to tune to the CPUE series. Provides target F, Yield levels and where we are with regards to these rates. Provides target B as well and where we are with regards to that.	LH based assumptions could be misleading. CPUE series may not be representative of abundance series if from a limited fleet and area. Catch at size should be estimated from the viewpoint of the operational patterns
Catch Based SRA	r & K	Catch series	Yes (F_{MSY} & B_{MSY})	F_{MSY} & B_{MSY}	Set of data that currently exist (but may not be too good). Tried and tested approach in ICES, Walters, etc. Easy to run, provides Yield targets and FMSY & BMSY	Uncertainty in catch series can give misleading results. Based on assumptions of depletion range in current years that may give misleading results. May not be very accurate in terms of FMSY and BMSY
Surplus Production (Bayesian or Otherwise)	r & K	Catch series & CPUE series	Yes (F_{MSY} & B_{MSY})	F_{MSY} & B_{MSY}	Traditional approaches. Used extensively in literature. Provides yield targets and FMSY and BMSY	Length of time-series and uncertainty in catch series and CPUE series can bias results. Models may have problems converging to a solution if there is no contrasting information.
Integrated assessments	Recruitment, M by age, growth paramters, maturation schedule, fecundity, recruitment	Catch series, Length based samples, CPUE data (and or have tagging data), fishery selectivity	Yes (F_{MSY} & B_{MSY})	F_{MSY} & B_{MSY}	Most robust approach. Incorporates all information in a dynamic model. Provides most representative yield targets and FMSY and BMSY	Highly data dependent. Models can have problems converging. Learning curve steep.

50 approaches →3 major categories(Nishida, 2015)

Type No.	Type	Information	Data period	Important for management Reference point (MSY, Fmsy, SSBmsy etc.)	Models (examples)
1	Demography (Qualitative)	Parameters			● ERS ● PSA Productivity-Susceptibility Analysis
2	Standard stock assessments (Quantitative)	Real data	Short term (Snap shot)	Partially available, but only for the short term (temporary)	● ELEFAN ● FiSTAT ● Y/R 
3			Long term historical fisheries data (preferably 10 years or longer)	Available (more objective due to a longer-term data)	(1) SRA(CMSY) (Catch only method) (2) Production model (ASPIC etc.) (3) Age (size) structured models (VPA, SCAA, ASPM etc.) (4) Integrated models (SS3, MULTIFAN-CL etc.)

Type 3 (important) : Summary

Models		Example	Data and parameters required							
			Stock structure	Global catch	Abundance indices (CPUE or fisheries in depend indices such as acoustic/areal survey data)	size/age	M (natural mortlity)	LW relation + growth eq	Maturity + fecundity	Space and movement
Data limit approach		SRA(CMSY) (Catch only)								
Production model		ASPIC								
		JABBA								
Age/size structure model	(without abundance indices)	VPA								
	(with abundance indices)	ADAPT—VPA								
	Simpler integrated model (I)	ASPM SCAA								
	Integrated model (II)	CASAL and SS3								(option)

+ Priors r, K

Based on the summary

We considered which models should be used
for menu-driven software

Basic philosophy
Quick & dirty=Simpler (easier) model
but we still need effective stock assessments
(for non-SA professionals)

So we selected

Simple : Production model→ ASPIC

Intermediate: Age structured model → ASPM

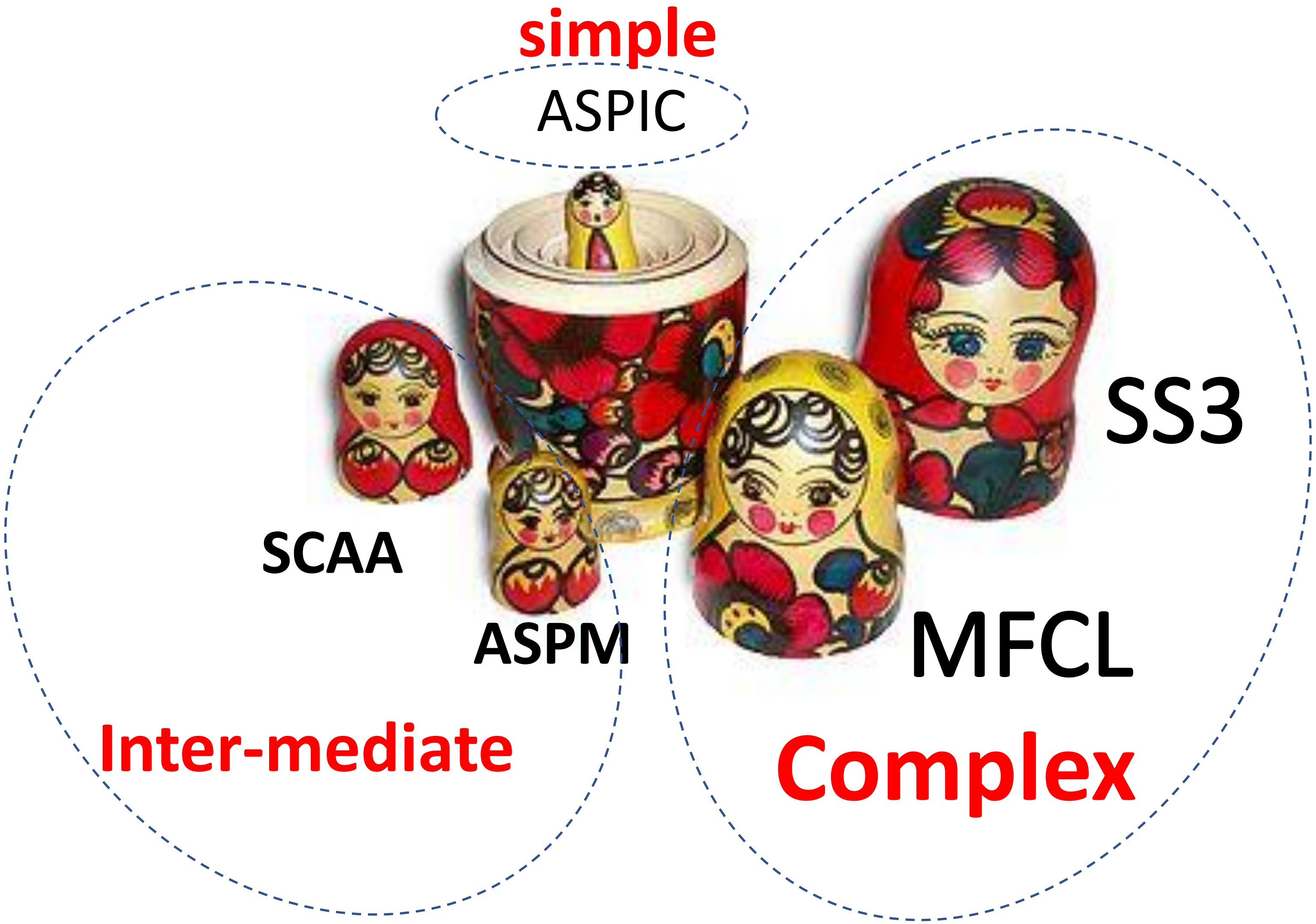
Please note that ASPM and SCAA are similar

ASPM fixes selectivity and SCAA estimates selectivity

We suggest to use ASPM

as estimation of selectivity (SCAA) is sometimes difficult

(especially when sample size of length are small)



simple
ASPIC
SS3
SCAA
ASPM
MFCL
Inter-mediate
Complex

We further review
Production models in details …

Evolution of Production Model

Evolution	Type	Authors	Features				Comments
			Equilibrium Condition (EC) (death=increase) (never happen)	Error type		Bayesian (better) Approach	
				Observation (data) error	Process (model) error		
old	Original PM	Shaeffer(1954), PT(1969) & Fox (1970)	YES				Classical (Not recommended to use due to EC)
	ASPIC (Ver5)	Prager (2004)					Basic, standard & common (RFMOs & fishing countries)
	ASPIC (ver7.5)	Prager (2017)	NO				
new	JABBA (Just Another Bayesian Biomass Assessment)	Winker (2018)					Best but high standard (slowly expanding) Recommended

So we decided to develop the additional menu driven software : JABBA

Fisheries Research 204 (2018) 275–288

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Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

JABBA: Just Another Bayesian Biomass Assessment

Henning Winker[a,b,*], Felipe Carvalho[c], Maia Kapur[c,d]

[a] Department of Agriculture, Forestry and Fisheries, Private Bag X2, Vlaeberg, 8018, South Africa
[b] Centre for Statistics in Ecology, Environment and Conservation (SEEC), Department of Statistical Sciences, University of Cape Town, South Africa
[c] NOAA Pacific Islands Fisheries Science Center, 1845 Wasp Boulevard, Building 176, Honolulu, HI, 96818, United States
[d] Joint Institute for Marine and Atmospheric Research, University of Hawaii, 1845 Wasp Boulevard, Building 176, Honolulu, HI, 96818, United States

JABBA (<u>Complicated</u>)

<u>State space(many sub-models incorporated)</u>

Process & OBS error, Bayesian, MCMC and Diagnostics

But basic idea is the production model (catch and CPUE)(**<u>simple</u>**)

JABBA has 2 opposite aspects

➔ Complicated but simple (quick & dirty)

(new type!! for us➔ 2 opposite philosophy)

We recently started development. It will take 1 year…

*Hope we can show you **<u>next year</u>** !*

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Overview: Risk assessment

Why we need to do Risk assessment ?
Stock assessments are not enough ?

Stock assessments are enough to the some extent

We know the stock status

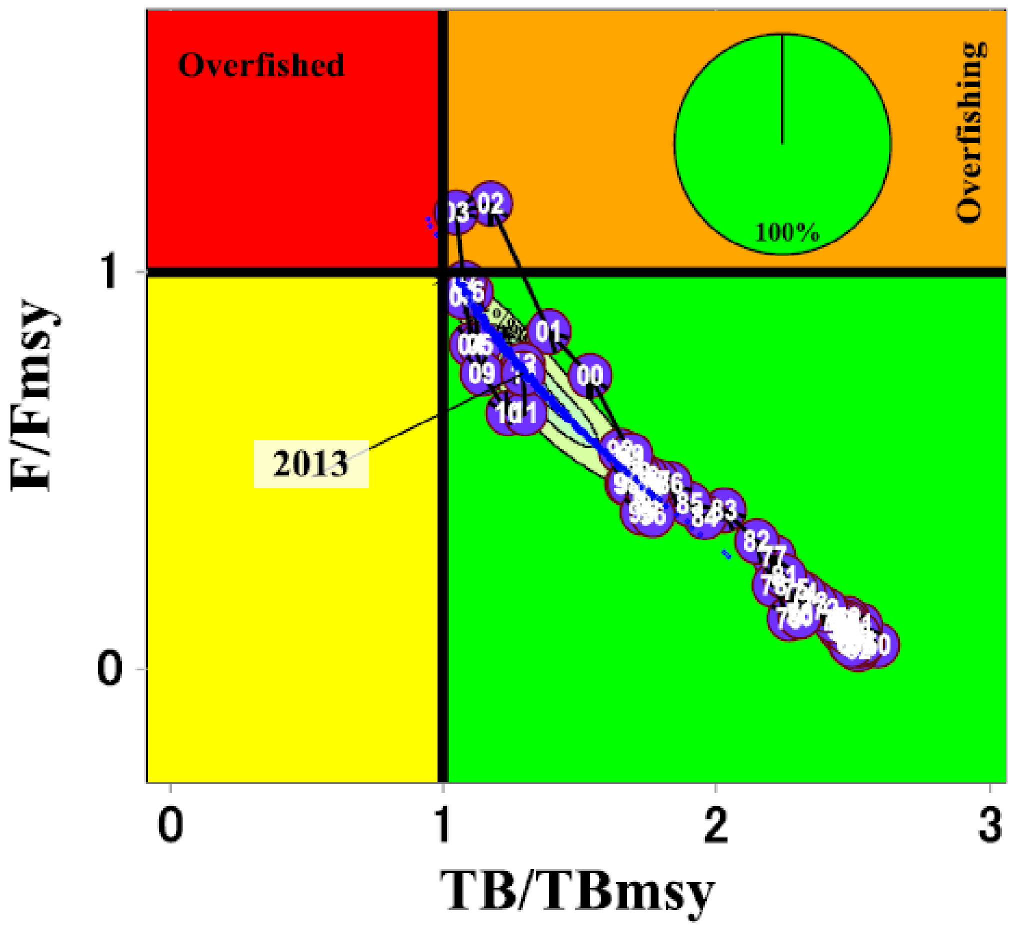
We can set up TAC (e.g. MSY)

Maybe that is enough and OK??

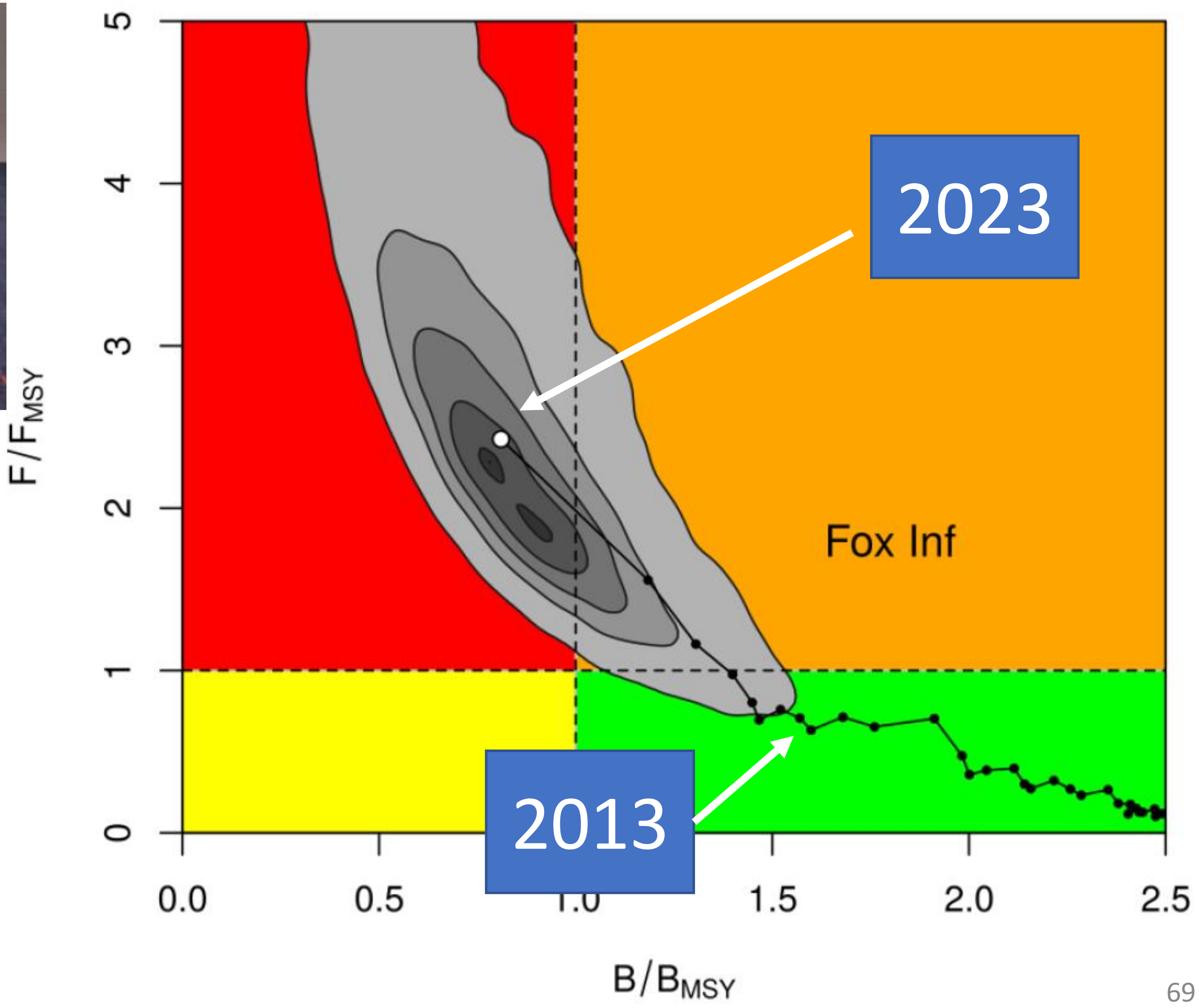
Not OK…thus we need Risk assessment..

We know the current stock status ➔ green (happy) zone ☺

So, we are OK, finish our work and we can relax …



But if the current catch level were continued…
then we may end up the RED ZONE in 10 years !



How do we know the future stock status?

For example stock assessments➔current stock status (red zone)

<u>what happens the stock status</u>

<u>10 years later ?</u>

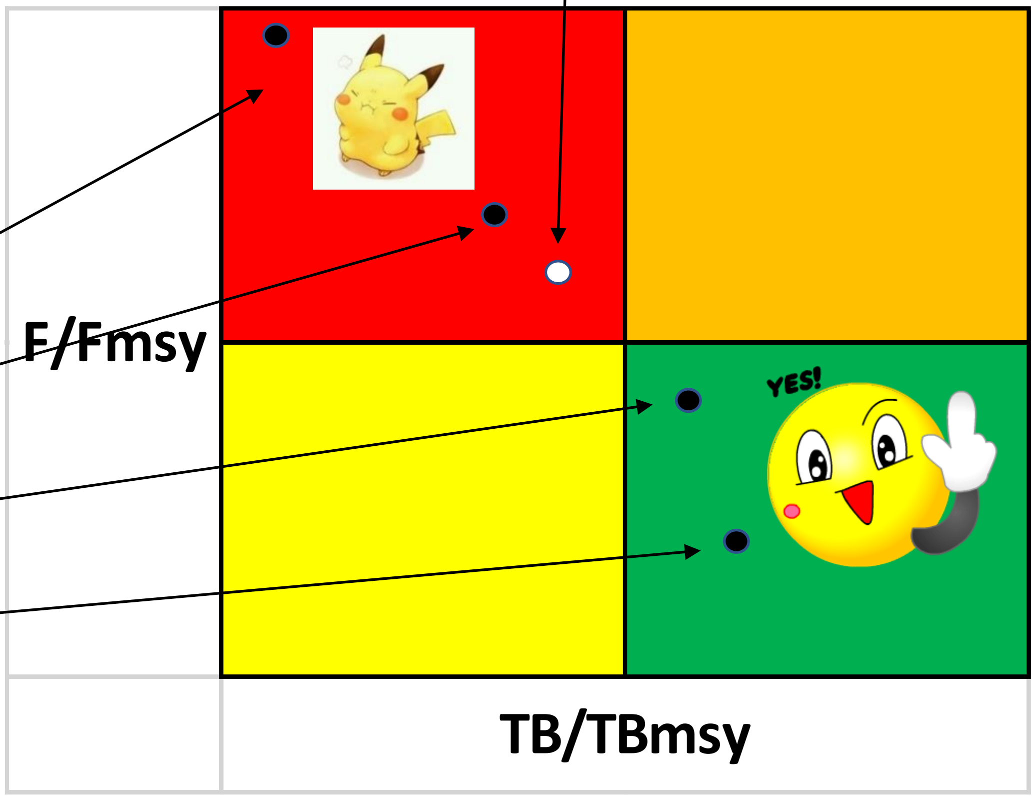
<u>Depending on the catch levels</u>

Higher catch (20,000 t)

Current catch (10,000 t)

<u>MSY level (8,000 t)</u>

Lower catch (5,000)



- Simply if catch level is higher

    ➔ more RISK to violate MSY levels

- And vice versa

  lower catch ➔ less risk to violate MSY level

We should certainly avoid HIGH RISK

➔ We need to select **OPTIMUM CATCH level**

to maintain MSY level in the future (Pr>50%)

For this purpose, we need to do Risk assessment, i.e.,

To determine the optimum catch

⬇

Kobe II : Strategy matrix & diagram

⬇

We can secure sustainable resources and Fisheries

What are Kobe II : Strategy matrix & diagram?

Matrix or Diagram showing
Probability of risk (%)
violating MSY levels (Biomass & F)
by different catch level
in the future (10 years)

Will show real ones ..

Kobe II
strategy matrix
(TB+F)
(3 & 10 years later)
(IOTC)

to decide
optimum catch level
(TAC)

criteria
50% < Pr (risk)
(10 years later)

a little less than MSY

21,000 ton

Probabilities(%) violating TBmsy and Fmsy in 3 and 10 years.

Color legend				
Risk levels	Low risk	Medium low risk	Medium high risk	High risk
Probably	0 – 20%	20 – 50%	50 – 80%	80 – 100

		Catch level →	60%	70%	80%	90%	100%	110%	115%	120%	130%	140%
							Current catch (*)		MSY level			
		10 catch scenarios (tons)	11,231	13,103	14,975	16,847	18,719	20,591	21,500	22,463	24,335	26,207
3 years later		TB2019 < TBmsy	1	2	3	5	8	12	14	16	23	30
		F2019 > FMSY	0	0	0	0	3	11	20	29	63	97
10 years later		TB2026 < TBmsy	0	0	0	1	8	34	52	70	96	100
		F2026 > FMSY	0	0	0	0	5	31	53	76	100	100

(*)The current catch levelis the average catch in 3 recent years(2014–2016).

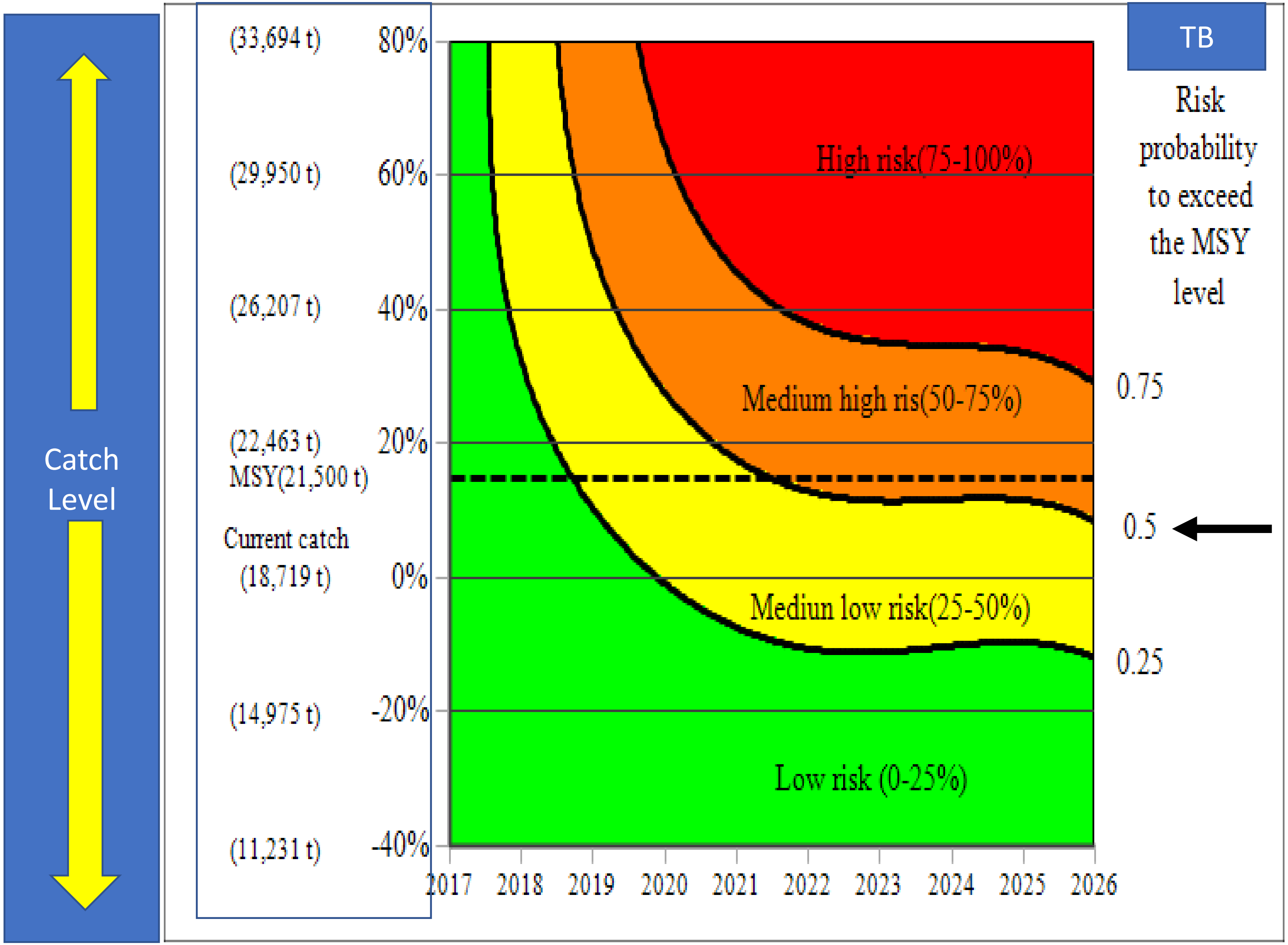
Kobe II
strategy diagram
(more general)
(by TB and F)
(10 years)

to decide
optimum catch level
(TAC)

criteria
50% < Pr (risk)
(10 years later)

a little less than MSY

21,000 ton



Summary

Stock assessments <u>not enough</u> → Risk assessment

Stock assessments → Current stock status (MSY)

We don't know the **future stock status**

↕

Depending upon **catch levels**

↓

Risk assessment will provide **future stock status**

(by various catch levels)

↓

We will find out Optimum catch level (TAC)

to sustain SAFE stock status → < 50% Risk violating MSY (future)

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new	JABBA (Just Another Bayesian Biomass Assessment)	Winker (2018)					Best but high standard (slowly expanding) Recommended

ASPIC

A Stock Production Model Incorporating Covariates

Outline

INPUT
Catch &
CPUE

Need to estimate
4 parameters

- B1/K
- q
- MSY
- K

OUTPUT (Estimation)
MSY, F,
r (intrinsic pop growth rate),
K (Carrying capacity),
q (catchability)
B1/K (depletion)
Population size

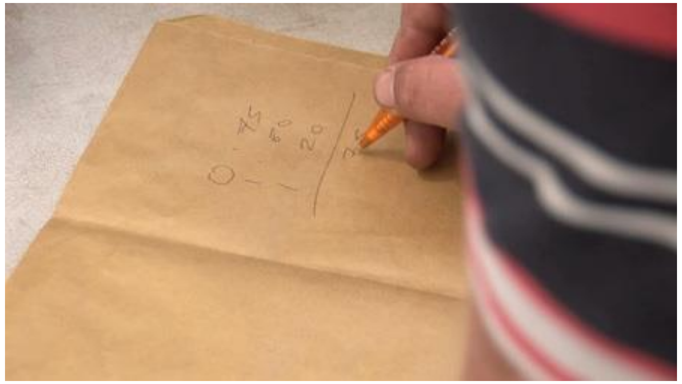
how to estimate 4 parameters ?

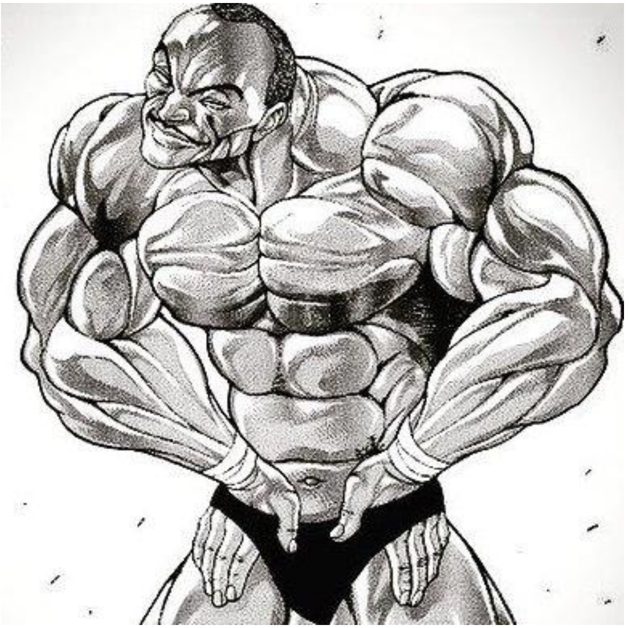
Original ASPIC：A Single run/time

```
コマンド プロンプト
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:¥Users¥TN4>cd C:¥TN¥Neritic(SEAFDEC)¥マニュアル¥4 software (109MB)¥(2) ASPIC (
original soft) (v 5.05) Prager (2004) (1.3MB)

C:¥TN¥Neritic(SEAFDEC)¥マニュアル¥4 software (109MB)¥(2) ASPIC (original soft) (
v 5.05) Prager (2004) (1.3MB)>dir
 ドライブ C のボリューム ラベルは Windows7_OS です
 ボリューム シリアル番号は 5CE1-2062 です

 C:¥TN¥Neritic(SEAFDEC)¥マニュアル¥4 software (109MB)¥(2) ASPIC (original soft)
(v 5.05) Prager (2004) (1.3MB) のディレクトリ

2016/04/18  23:34    <DIR>          .
2016/04/18  23:34    <DIR>          ..
2005/05/17  05:50           939,220 aspic.exe
2011/06/23  14:56           240,313 aspic5_05(manual).pdf
2004/08/18  08:31           132,431 ASPIC5_05.pdf
2006/11/02  21:54             1,659 Command Prompt.lnk
2014/01/24  10:23             2,656 s14.inp
2013/05/28  16:56             4,963 test.inp
               6 個のファイル           1,321,242 バイト
               2 個のディレクトリ  101,927,071,744 バイトの空き領域
```

If you have several scenarios on K, B1/K, q and MSY for example 3 each

- 4^{3}= 256
- With 2 models (Schaefer and FOX)
- Then Total 512 combinations
- Too much to do by hand (one by one) (Pencil and Paper method)





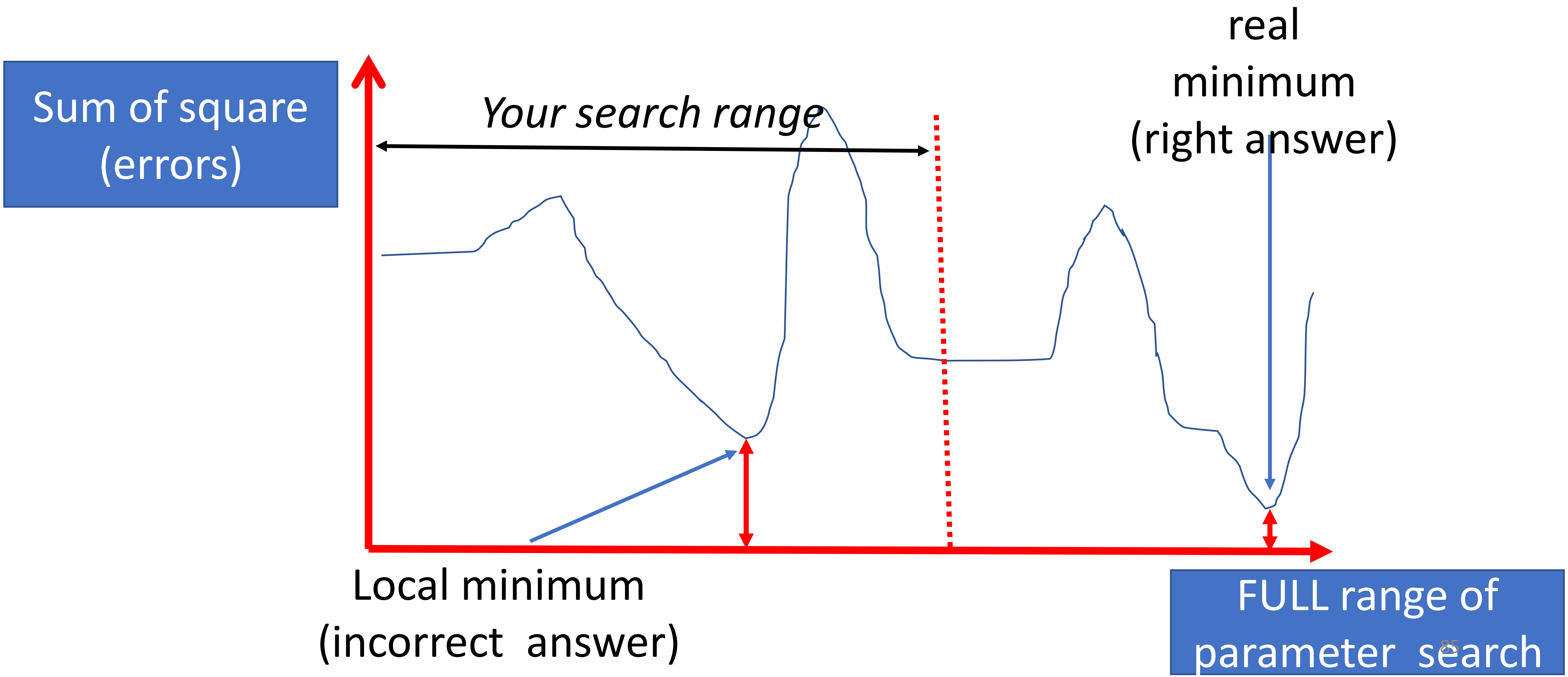
➔you will be tired

you need strong muscle!

But danger is the local minimum

- False convergences (answers)
  (incorrect estimated parameters)

What is the local minimum?
We select optimum parameters when SSE (errors) is minimum.
You might find the incorrect SSE (➔parameters) if your search range is limited.



To protect damages of your muscle and to avoid local minimum we develop special software

ASPIC Grid search software (menu driven)

This automatically run

combination of plausible parameters ranges

No need pencil and paper method

↓

Software works for you (you can rest)

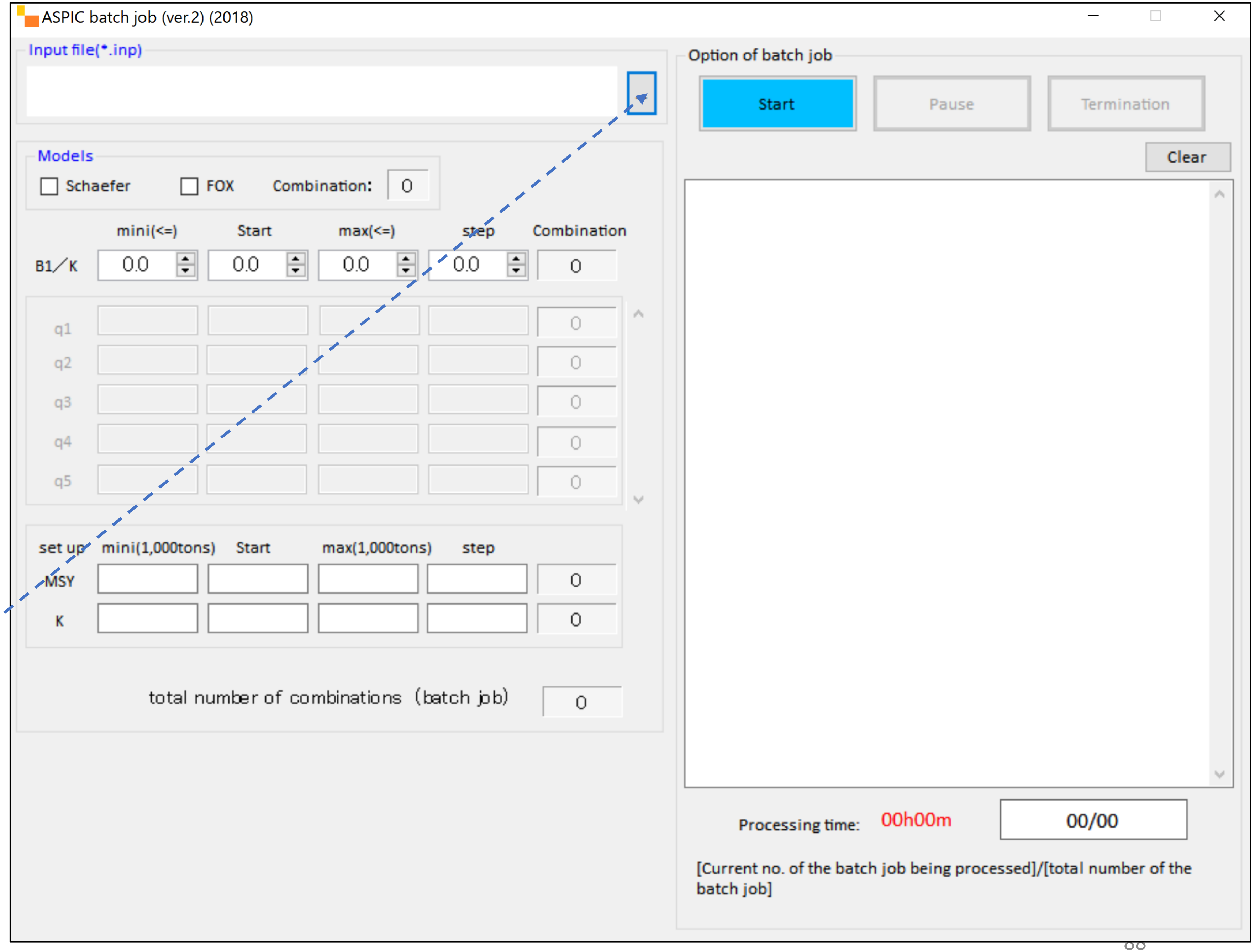
No worry about the local minimum

Starting
ASPIC Batch job

DOUBLECLICK

You will see the 1^{st} window (menu)

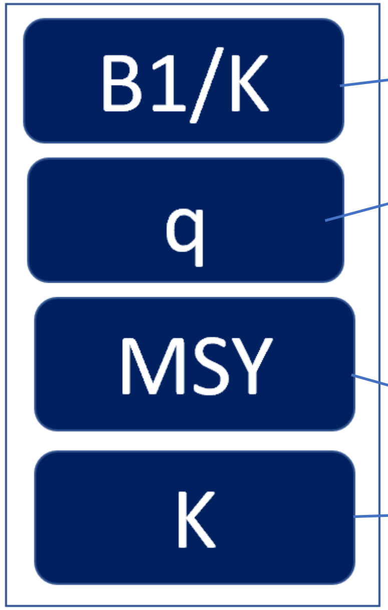
then import input data.

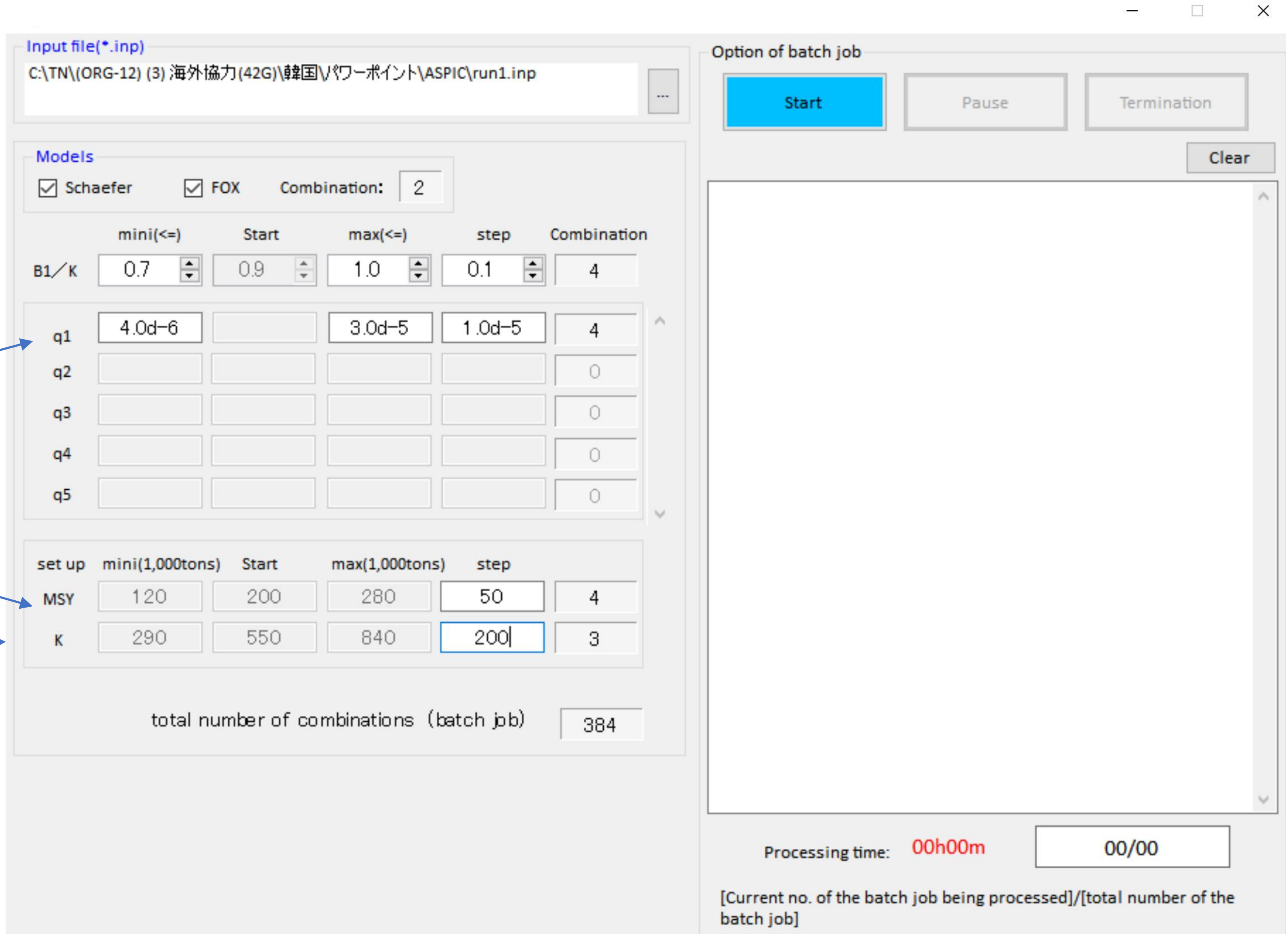


Setting up the grid search (range & step)

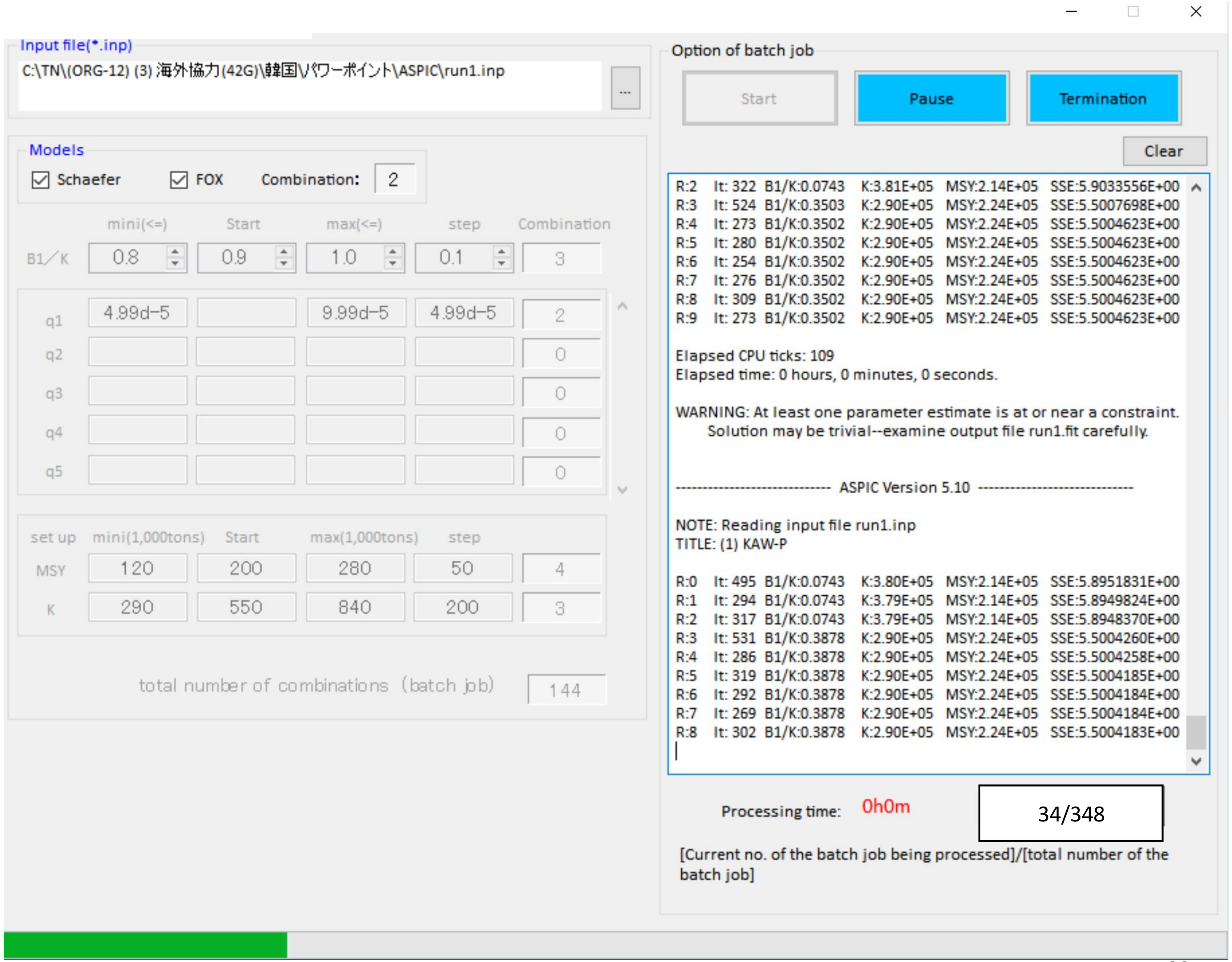
input file

Selection of PM

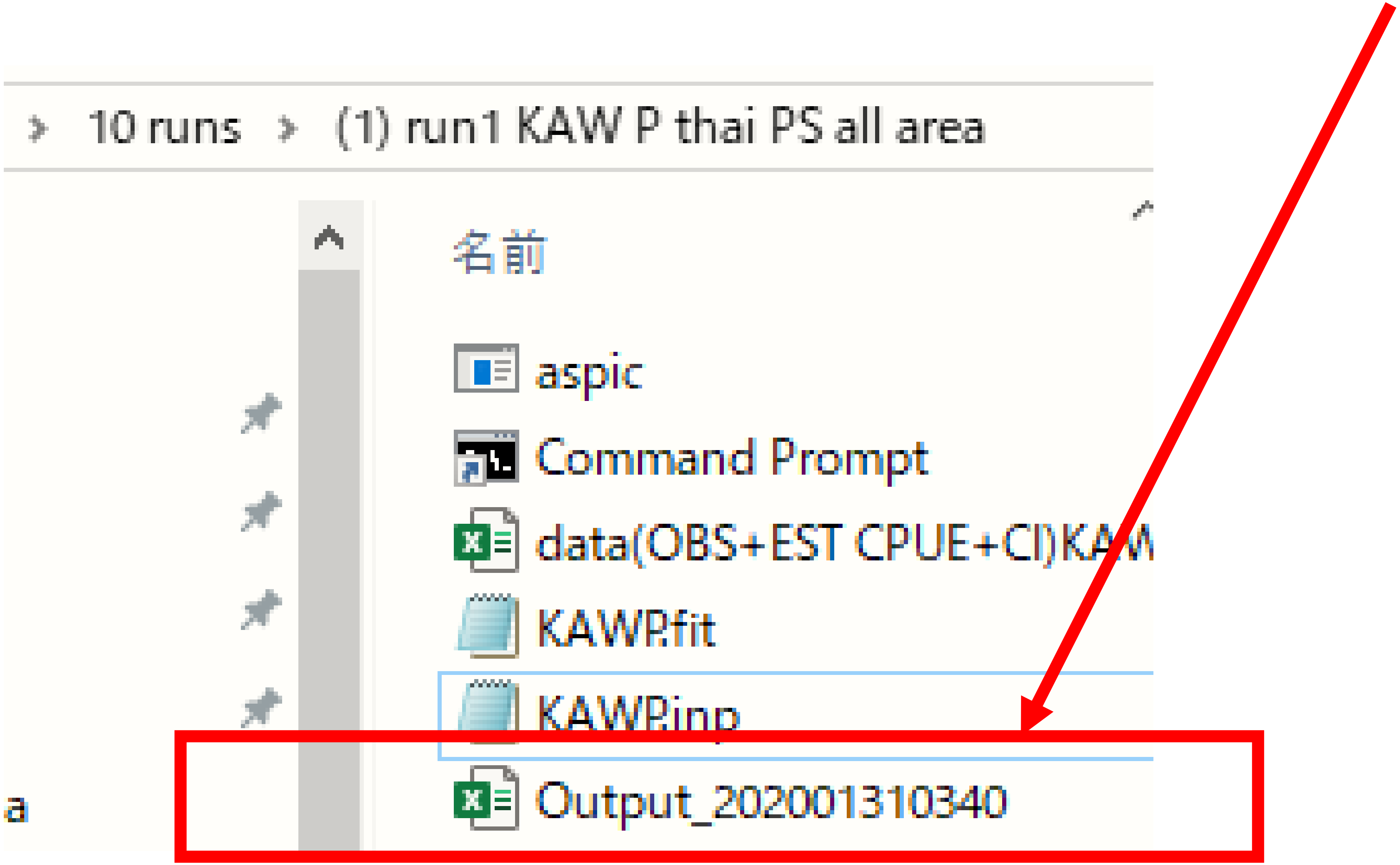




Now software working for you 348 combo.



Results (output) will be stored in the excel file with time stamp



List of results of 1st 25 runs (excel file)

Time	0h2m	No of jobs	60	Average	0.0388	Min/job	Sec/job	2.33														
Parameters	Model	B1/K	q(LOT-PI)	MSY	K																	
Range (step)	Fox and Schaefer	0.1-1 by 0.2	2.3d-6-2.3d-6 by 2.3d-6-1	120-280 by 30	900																	
Flag (0: fixed / 1: estimate)		1	1	1	0																	
Biomass unit in 1,000 tons																						
No	Model	B1/K	q	MSY(min)	MSY(start)	MSY(max)	K(min)	K(start)	K(max)	B1/K[Est]	R2	q(LOT-	RMS	r	K[Est]	MSY	Bmsy	Fmsy	B/Bmsy	F/Fmsy	TB	note
1	Schaefer	0.1	2.3d-6	120	120	280	290	900	1200													FATAL: MSY bounds do not include starting guess.
2	Schaefer	0.1	2.3d-6	120	150	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
3	Schaefer	0.1	2.3d-6	120	180	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
4	Schaefer	0.1	2.3d-6	120	210	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
5	Schaefer	0.1	2.3d-6	120	240	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
6	Schaefer	0.1	2.3d-6	120	270	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
7	Schaefer	0.3	2.3d-6	120	120	280	290	900	1200													FATAL: MSY bounds do not include starting guess.
8	Schaefer	0.3	2.3d-6	120	150	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
9	Schaefer	0.3	2.3d-6	120	180	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
10	Schaefer	0.3	2.3d-6	120	210	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
11	Schaefer	0.3	2.3d-6	120	240	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
12	Schaefer	0.3	2.3d-6	120	270	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
13	Schaefer	0.5	2.3d-6	120	120	280	290	900	1200													FATAL: MSY bounds do not include starting guess.
14	Schaefer	0.5	2.3d-6	120	150	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
15	Schaefer	0.5	2.3d-6	120	180	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
16	Schaefer	0.5	2.3d-6	120	210	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
17	Schaefer	0.5	2.3d-6	120	240	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
18	Schaefer	0.5	2.3d-6	120	270	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
19	Schaefer	0.7	2.3d-6	120	120	280	290	900	1200													FATAL: MSY bounds do not include starting guess.
20	Schaefer	0.7	2.3d-6	120	150	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
21	Schaefer	0.7	2.3d-6	120	180	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
22	Schaefer	0.7	2.3d-6	120	210	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
23	Schaefer	0.7	2.3d-6	120	240	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
24	Schaefer	0.7	2.3d-6	120	270	280	290	900	1200	1.006	0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit
25	Schaefer	0.9	2.3d-6	120	120	280	290	900	1200													FATAL: MSY bounds do not include starting guess.

Combinations (scenarios)

Results
(estimated parameters)

How to select the most optimum parameters?

(1) Select runs with "ASPIC ended normally (converged)"

F/Fmsy	TB	note	
		~~FATAL: MSY bounds do not include starting guess.~~	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
		~~FATAL: MSY bounds do not include starting guess.~~	NG
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	
		~~FATAL: MSY bounds do not include starting guess.~~	NG
0.6388	649.3	NOTE: ASPIC ended normally. The output file is lot.fit	

How to select the most optimum parameters?

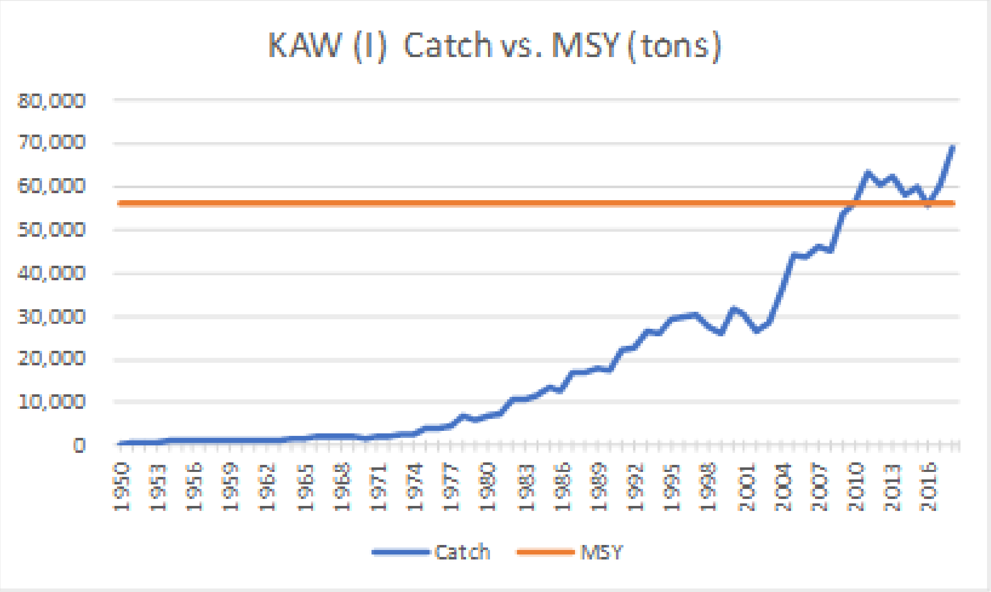
(2) Sort by RMS (ascending) & R2(descending)

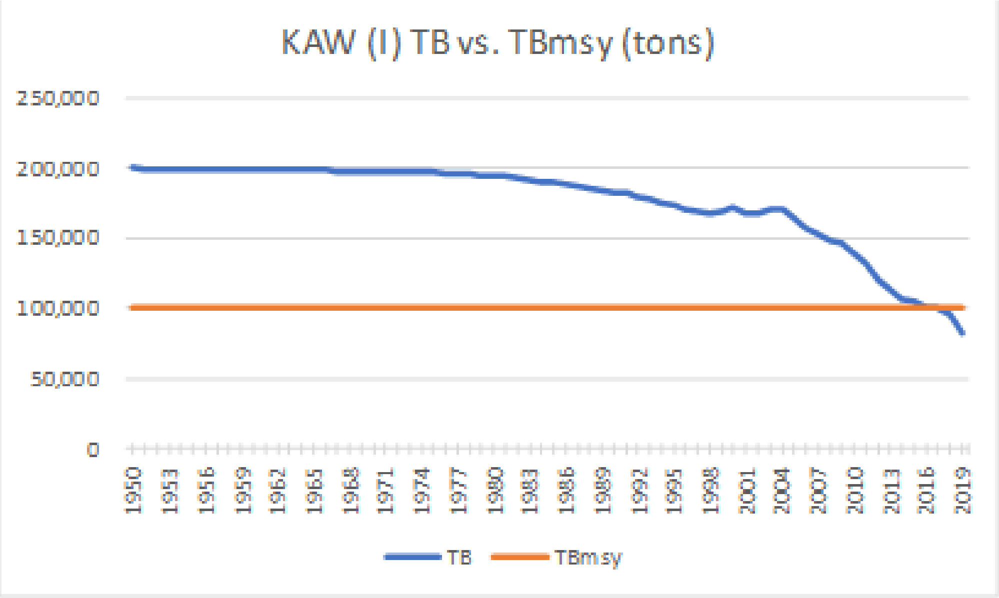
Select the run with smallest and largest value, respectively.

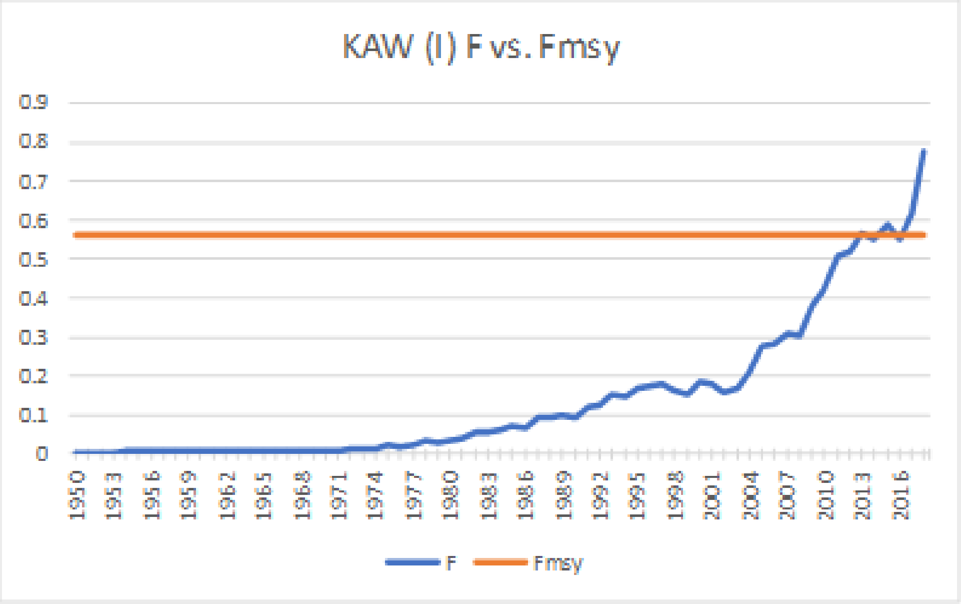
R2	q(LOT-	RMS	r	K[Est]	MSY	Bmsy	Fmsy	B/Bmsy	F/Fmsy	TB
0.36	2.109E-06	0.4877	0.569933	900	188.7	331.1	0.5701	1.661	0.5338	567.7
0.36	2.109E-06	0.4877	0.569933	900	188.7	331.1	0.5701	1.661	0.5338	567.7
0.36	2.109E-06	0.4877	0.569933	900	188.7	331.1	0.5701	1.661	0.5338	567.7
0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3
0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3
0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3
0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3
0.28	1.779E-06	0.5066	0.830222	900	186.8	450	0.4151	1.406	0.6388	649.3

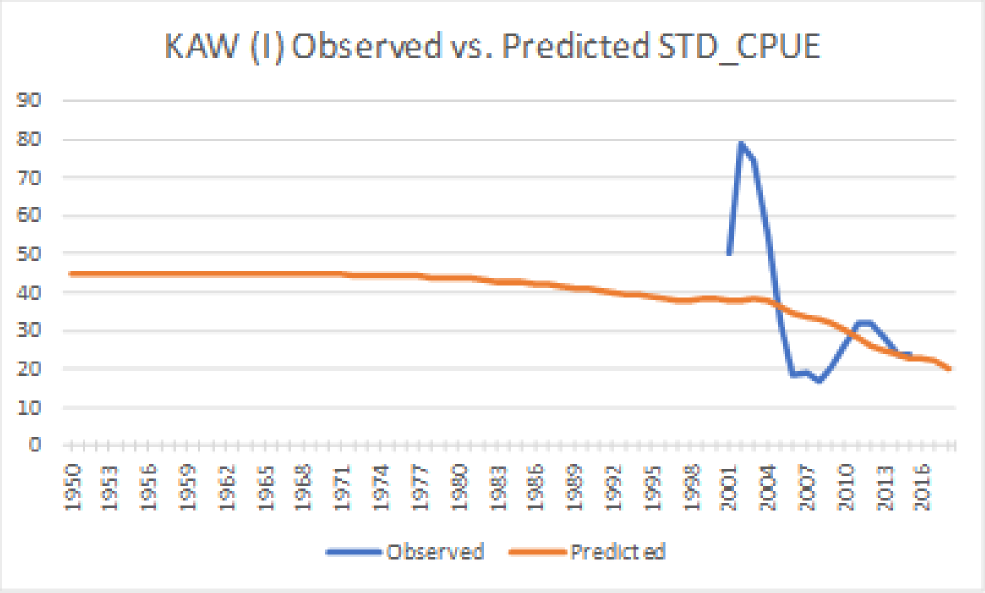
RMS: Root Mean Square

Results Point estimates (Graphs)

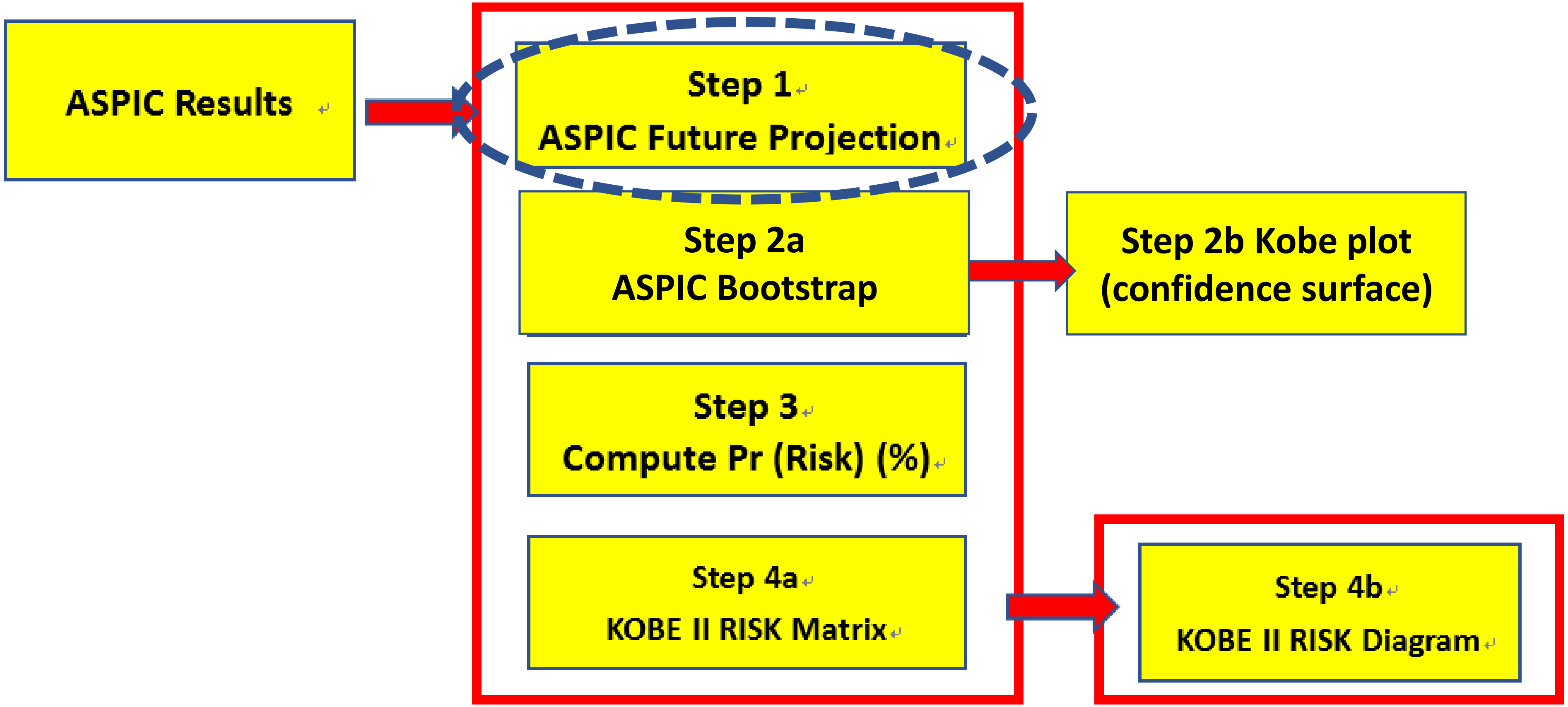






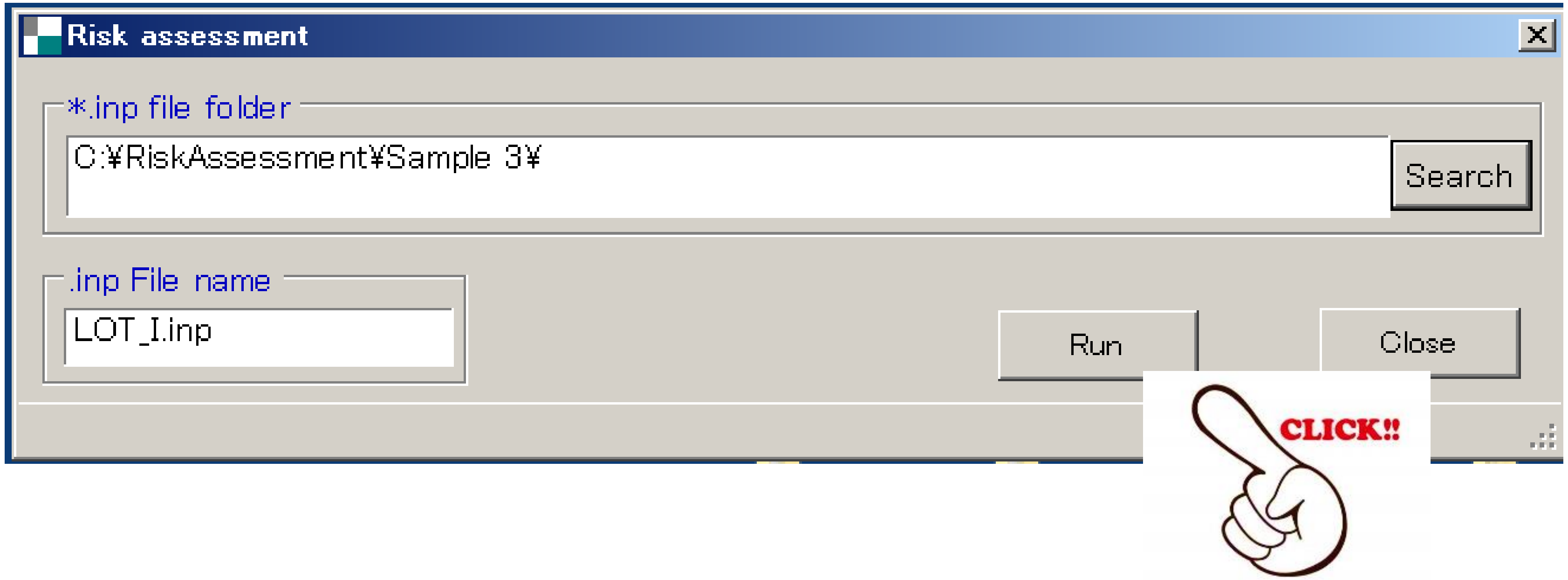


Uncertainties, projection, risk assessment and Kobe I+II



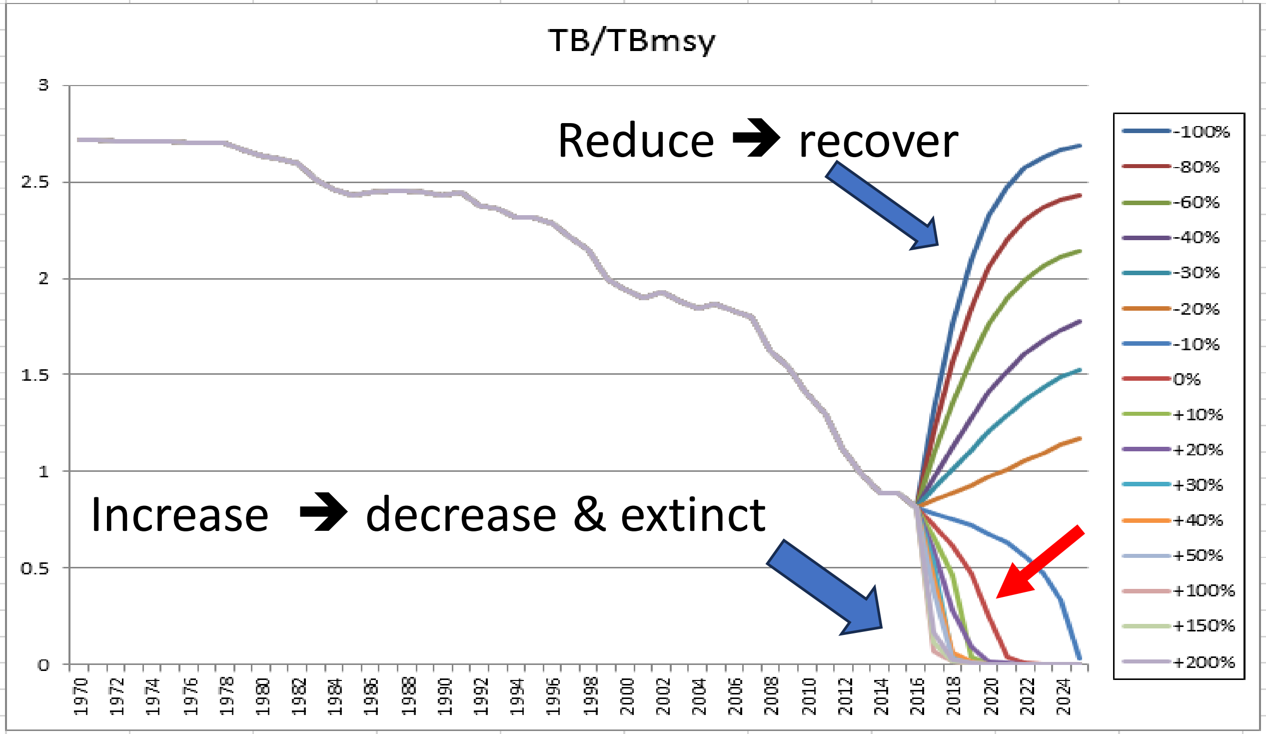
Step 1: Future projection by different catch level from the current catch (1)

Import the input file



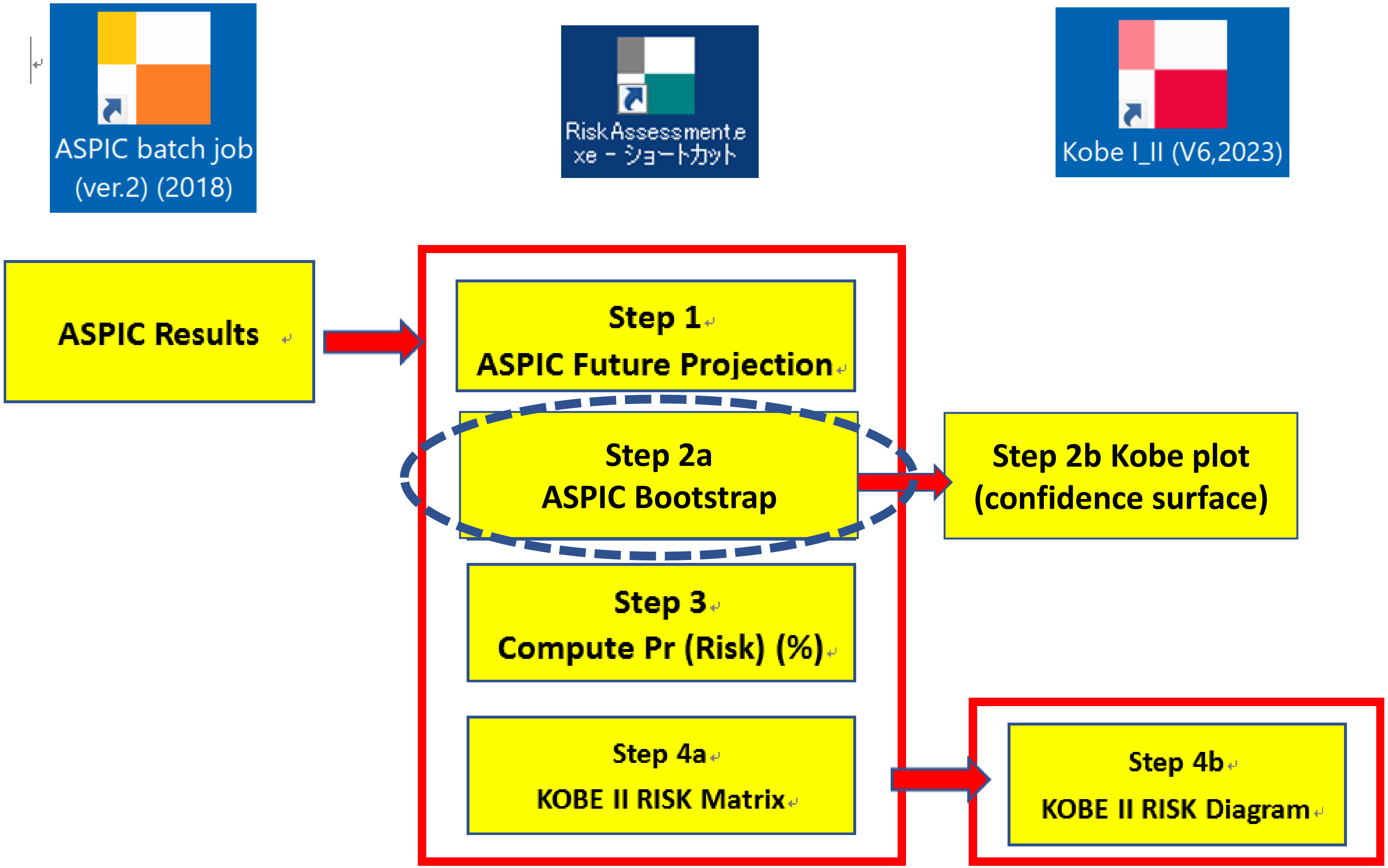
Step 1
Future projection TB (MSY) & F (MSY) by different catch level from the current catch 0%

A	AW	AX	AY	AZ	BA	BB	BC	BD	BE
	2017	2018	2019	2020	2021	2022	2023	2024	2025
−100%	1.008	0.9609	0.8235	0.7384	1.283	1.691	1.887	1.962	1.987
−80%	1.008	0.9609	0.8235	0.7384	1.164	1.522	1.728	1.821	1.859
−60%	1.008	0.9609	0.8235	0.7384	1.04	1.327	1.53	1.644	1.701
−40%	1.008	0.9609	0.8235	0.7384	0.9096	1.097	1.265	1.391	1.473
−30%	1.008	0.9609	0.8235	0.7384	0.8415	0.9635	1.09	1.204	1.295
−20%	1.008	0.9609	0.8235	0.7384	0.7712	0.8134	0.8652	0.9252	0.9902
−10%	1.008	0.9609	0.8235	0.7384	0.6981	0.6406	0.5523	0.3972	0.01309
0%	1.008	0.9609	0.8235	0.7384	0.6217	0.4329	0.01419	0.000496	1.74E−05
+10%	1.008	0.9609	0.8235	0.7384	0.5413	0.1254	0.004308	0.000151	5.29E−06
+20%	1.008	0.9609	0.8235	0.7384	0.4554	0.01487	0.00052	1.82E−05	6.39E−07
+30%	1.008	0.9609	0.8235	0.7384	0.3612	0.01197	0.000419	1.47E−05	5.14E−07
+40%	1.008	0.9609	0.8235	0.7384	0.2514	0.008469	0.000297	1.04E−05	3.64E−07
+50%	1.008	0.9609	0.8235	0.7384	0.02314	0.000808	2.83E−05	9.92E−07	3.48E−08
+100%	1.008	0.9609	0.8235	0.7384	0.02314	0.000808	2.83E−05	9.92E−07	3.48E−08
+150%	1.008	0.9609	0.8235	0.7384	0.02314	0.000808	2.83E−05	9.92E−07	3.48E−08
+200%	1.008	0.9609	0.8235	0.7384	0.02314	0.000808	2.83E−05	9.92E−07	3.48E−08



Kobe II Matrix | TB_Projection | F_Projection

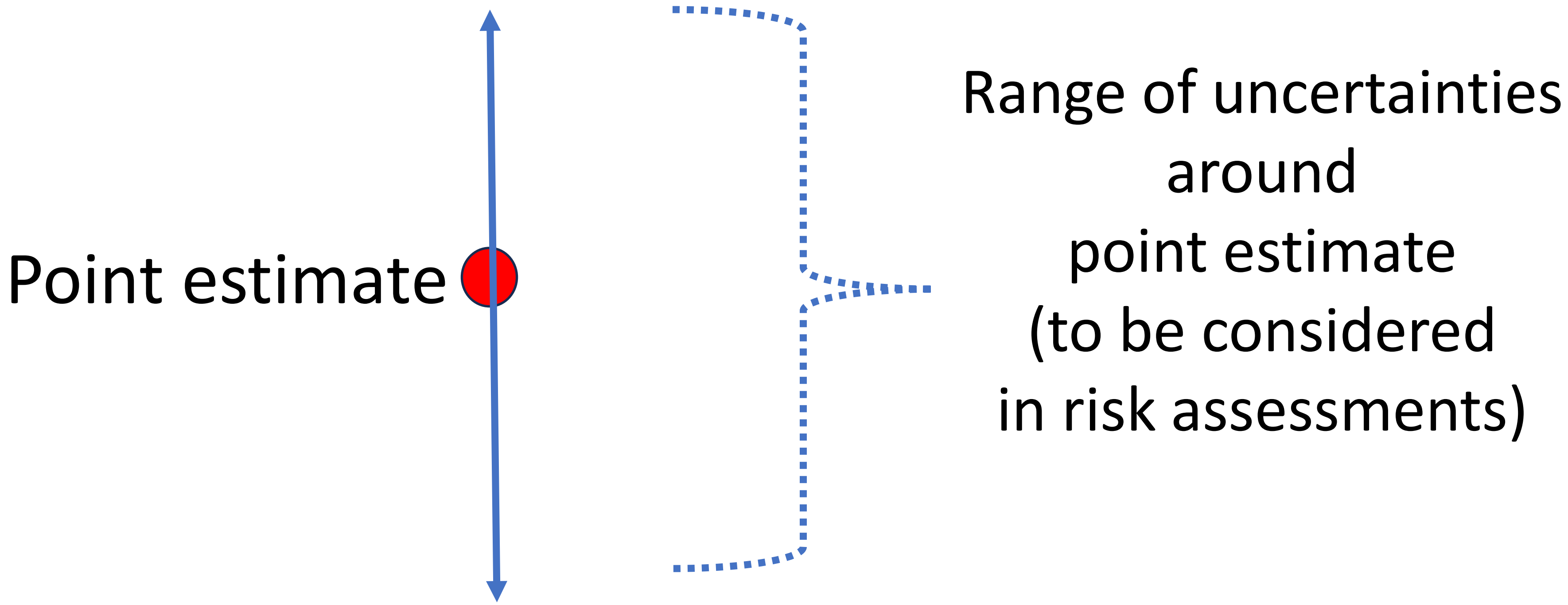
Uncertainties, projection, risk assessment and Kobe I+II



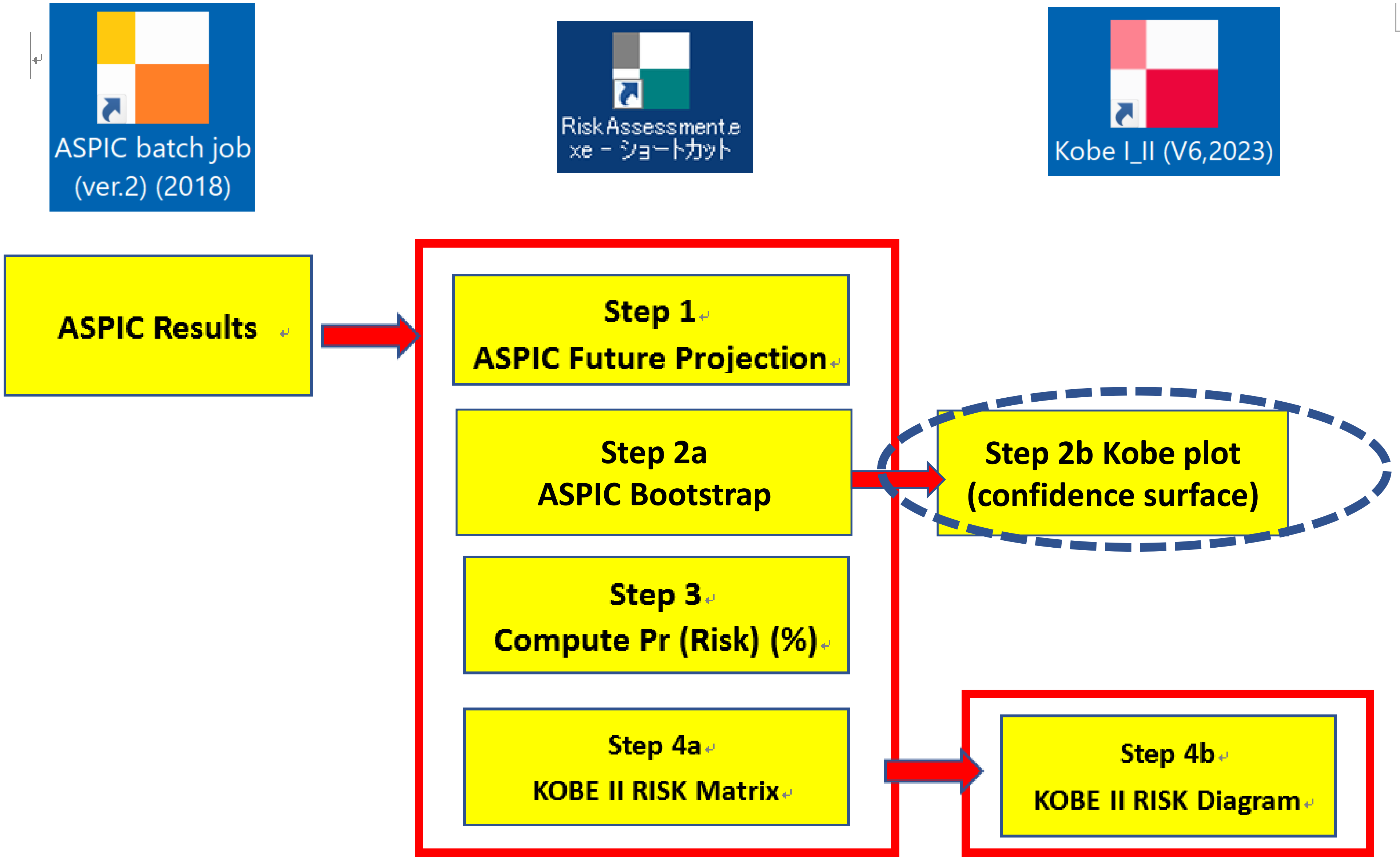
Step 2a ASPIC bootstrap

- Re-sample data 1,000 times to estimate Uncertainties.

  ➔ different catch levels (e.g. 0%, ±20%, ±40%)

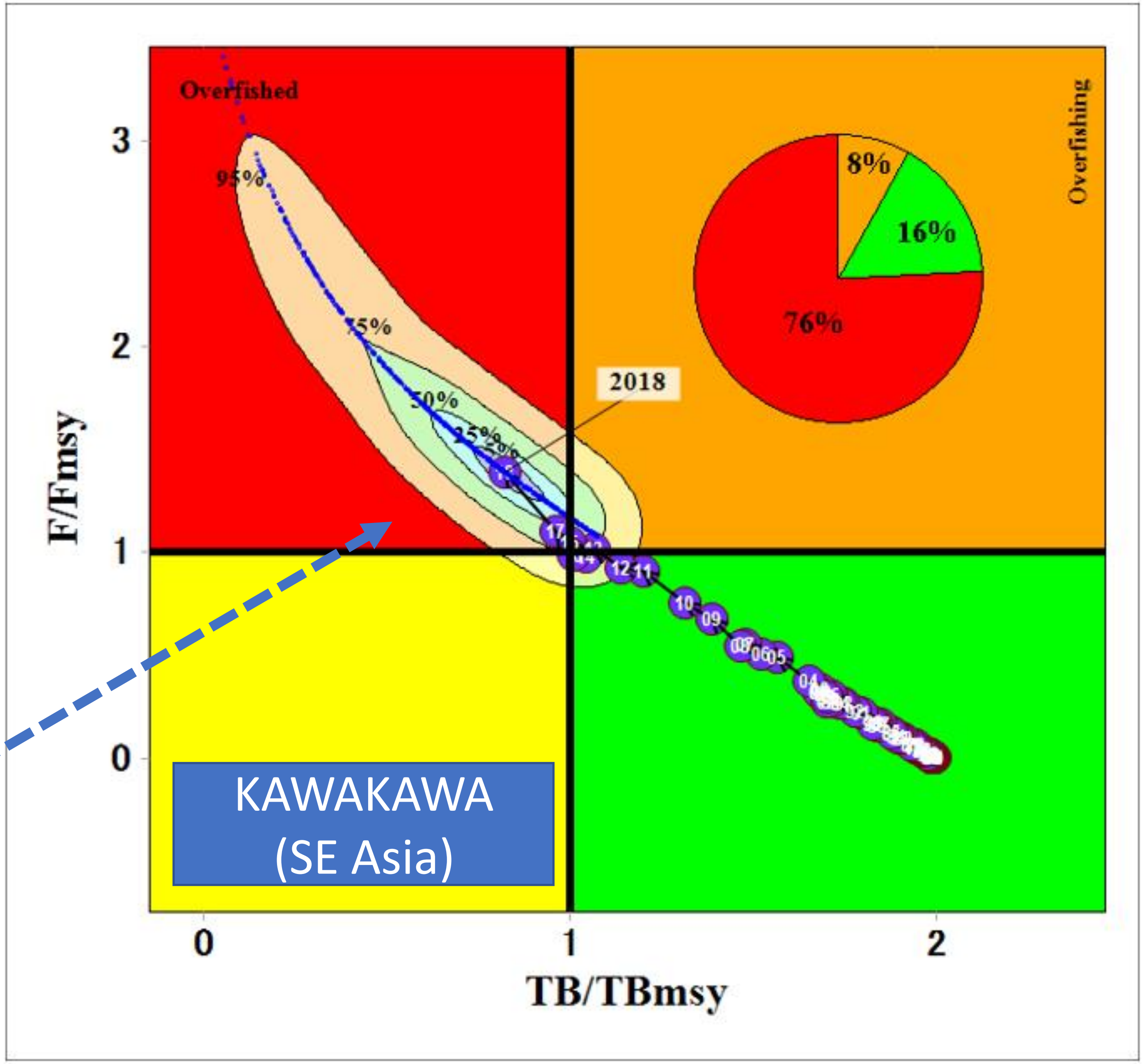


Uncertainties, projection, risk assessment and Kobe I+II

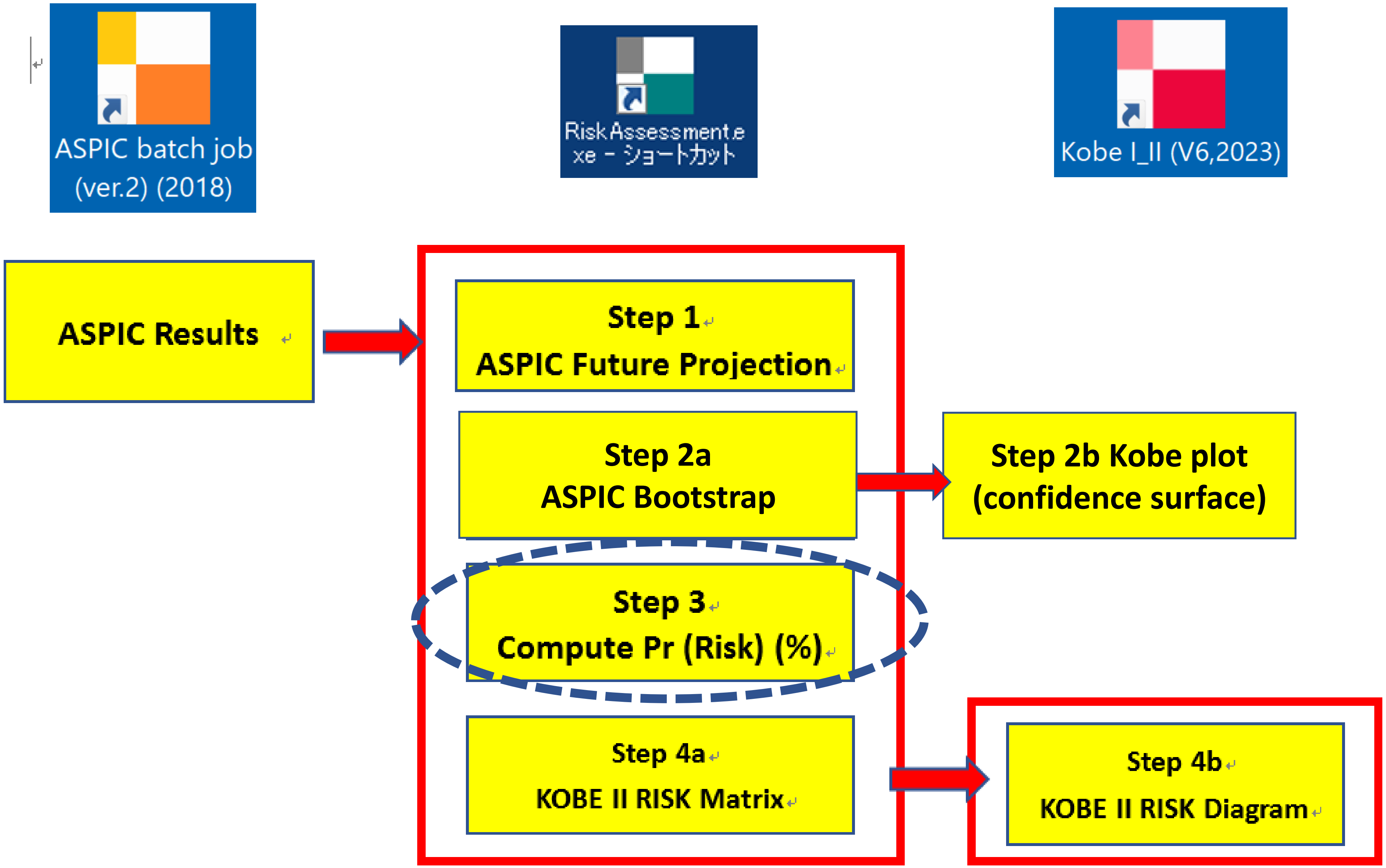


Step 2b Kobe plot (confidence surface)

Using the bootstrap results (0% catch), **Uncertainties** around the last SA year are estimated and depicted **(confidence surface).**



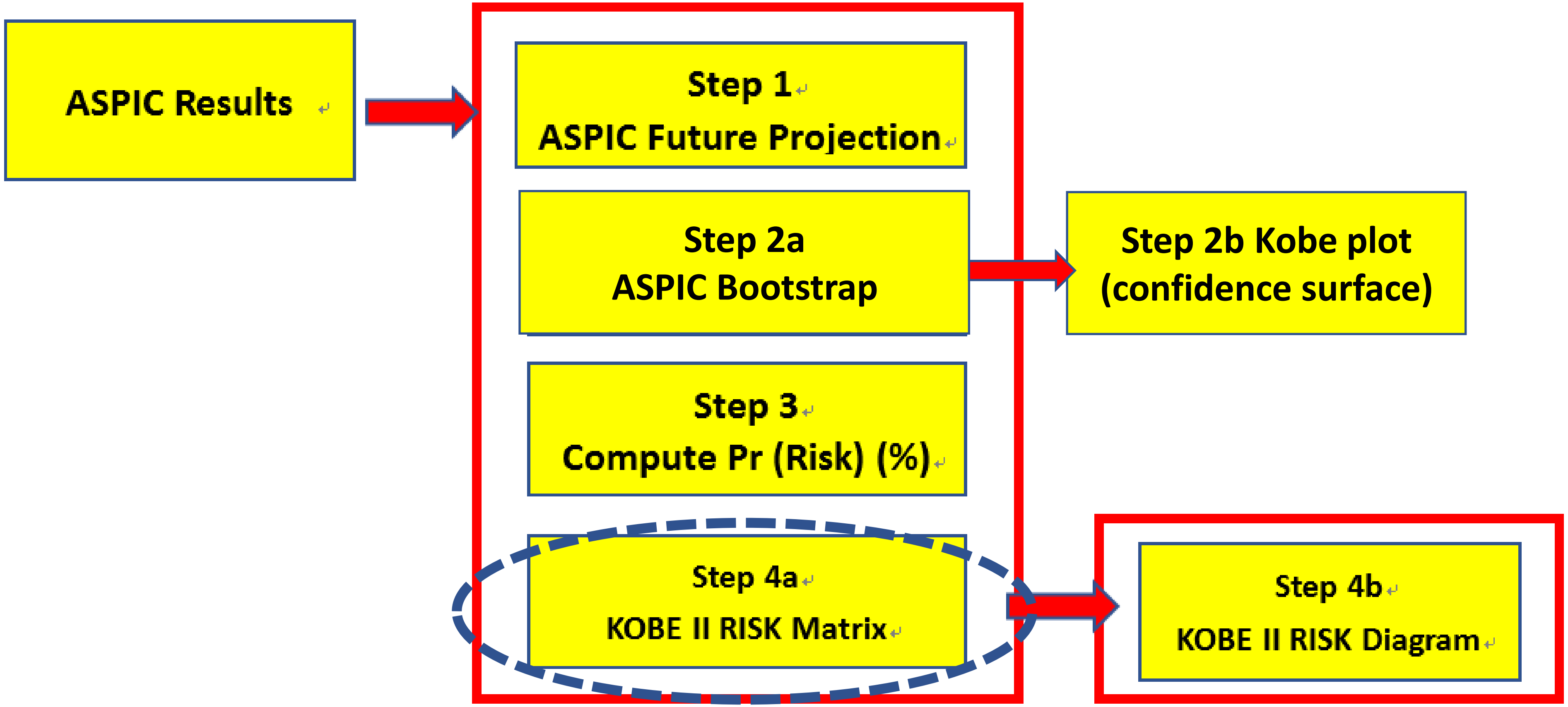
Uncertainties, projection, risk assessment and Kobe I+II



What is “Compute Pr (Risk) (%)” ?

To compute “Risk Probability” violating MSY levels (TB & F) by catch level and year incorporating uncertainties.

Uncertainties, projection, risk assessment and Kobe I+II



Step 4a Kobe II Strategy matrix based on Risk Probability

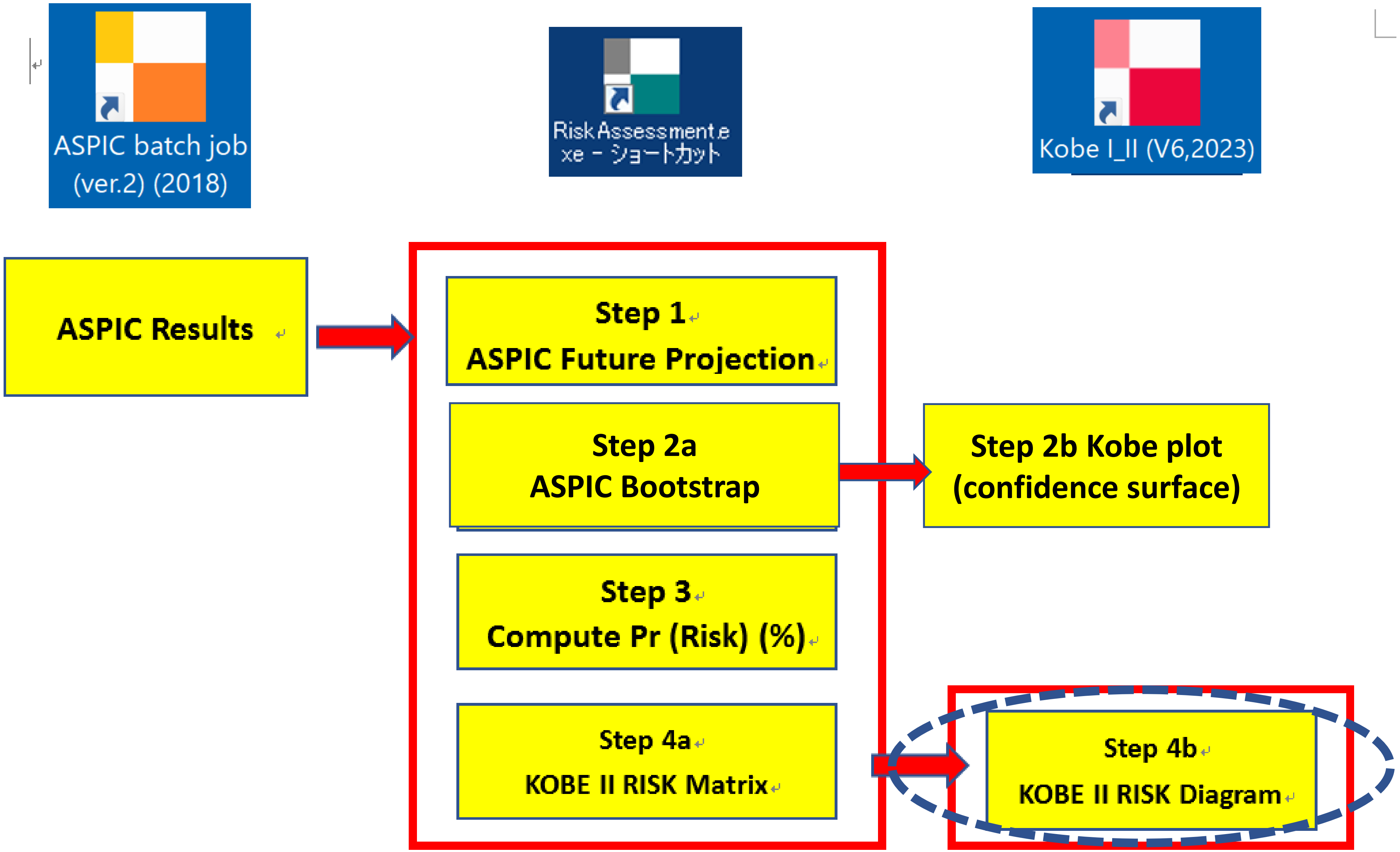
Probabilities(%) violating TBmsy and Fmsy in 3 and 10 years.

Color legend				
Risk levels	Low risk	Medium low risk	Medium high risk	High risk
Probability	0 – 25%	25 – 50%	50 – 75%	75 – 100

	Catch level →	0% (−100%)	20% (−80%)	40% (−60%)	60% (−40%)	70% (−30%)	80% (−20%)	90% (−10%)	91% (−9%)	100%	110%	120%
									MSY level	Current catch (*)		
	11 catch scenarios (tons)	0	12,312	24,624	36,936	43,092	49,248	55,404	55,850	61,560	67,716	73,872
3 years later	TB2021 < TBmsy	56	58	61	67	70	73	76	76	80	84	87
	F2021 > Fmsy	0	48	51	56	60	66	75	76	86	98	100
10 years later	TB2028 < TBmsy	41	48	50	54	57	61	71	72	84	95	100
	F2028 > Fmsy	0	48	50	54	57	60	70	72	88	100	100

(*)The current catch levelis the average catch in 3 recent years(2016–2018).

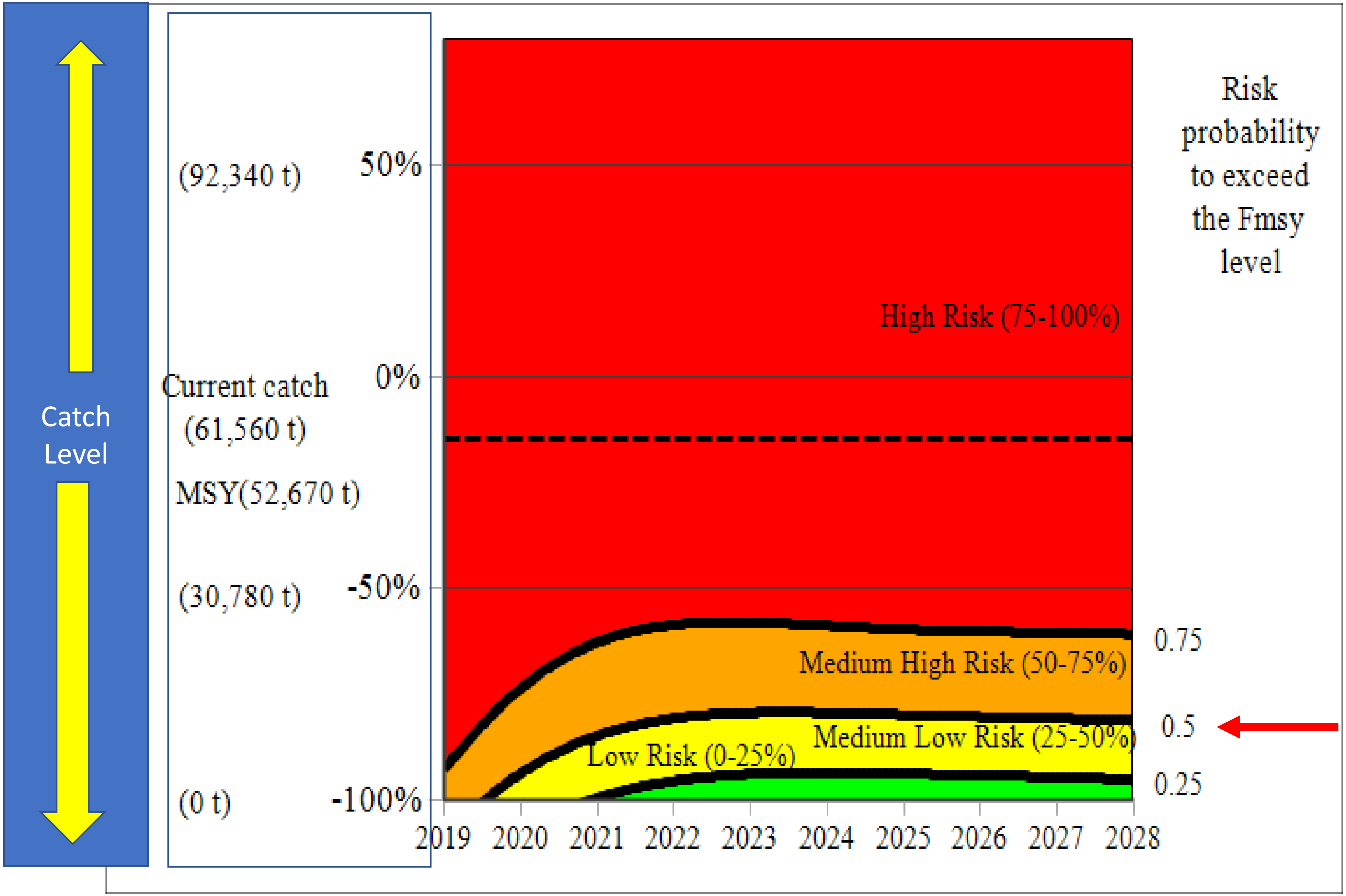
Uncertainties, projection, risk assessment and Kobe I+II



Step 4b

Kobe II Strategy diagram based on risk Probability

Easier to see risk situation



Contents

(1) Outline

(2) Menu-driven software

- CPUE standardization
- Stock and Risk assessment
    - Overview
    - Production model (ASPIC and JABBA)
    - Age structured production model (ASPM)
- Management decision making tool (Kobe I+II)

(3) Summary

JABBA
Just Another Bayesian Biomass Assessment
Under contraction

Theoretically Best Production model

There are several similar hand-made models

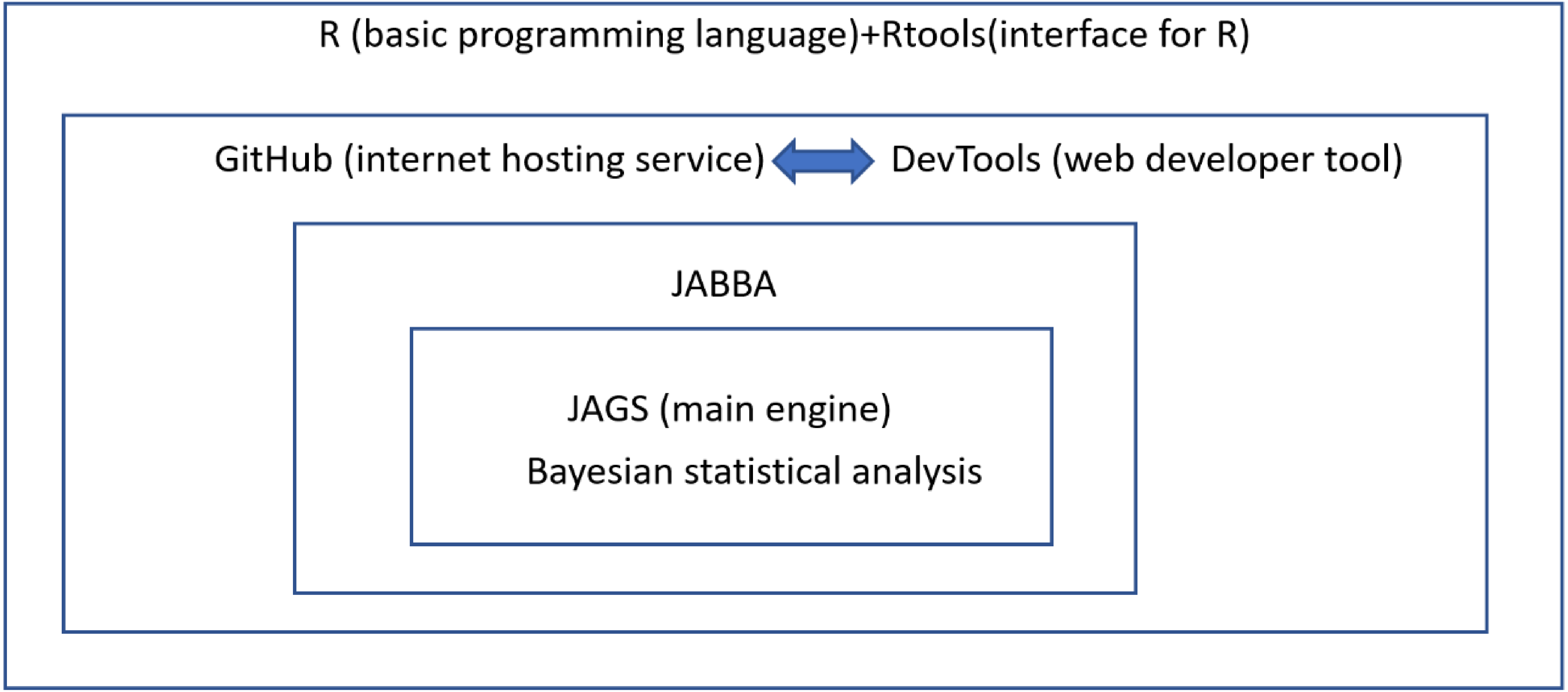
JABBA : best ➔ General (standardized) for anyone

RE: Bayesian, Graphics, Diagnosis, MCMC,

Evolution of Production Model

Evolution	Type	Authors	Features				Comments
			Equilibrium Condition (EC) (death=increase) (never happen)	Error type		Bayesian (better) Approach	
				Observation (data) error	Process (model) error		
old	Original PM	Shaeffer(1954), PT(1969) & Fox (1970)	YES				Classical (Not recommended to use due to EC)
	ASPIC (Ver5)	Prager (2004)	NO				Basic, standard & common (RFMOs & fishing countries)
	ASPIC (ver7.5)	Prager (2017)					
new	JABBA (Just Another Bayesian Biomass Assessment)	Winker (2018)					Best but high standard (slowly expanding) Recommended

Outline (Nishida & Wang 2023)
JABBA composed of recent internet & computing technologies

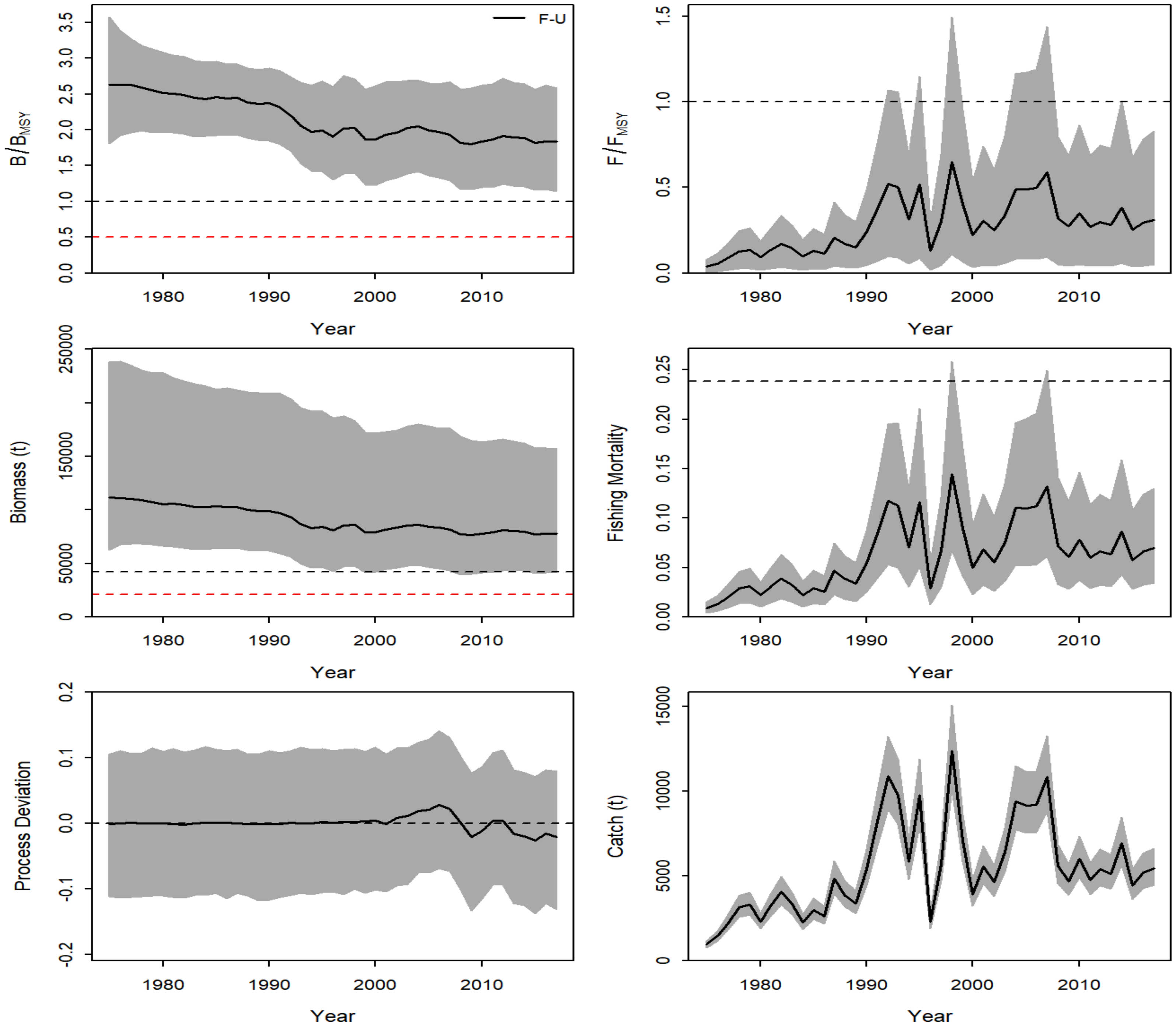


JAGS : **J**ust **A**nother **G**ibbs (MCMC) **S**ampler

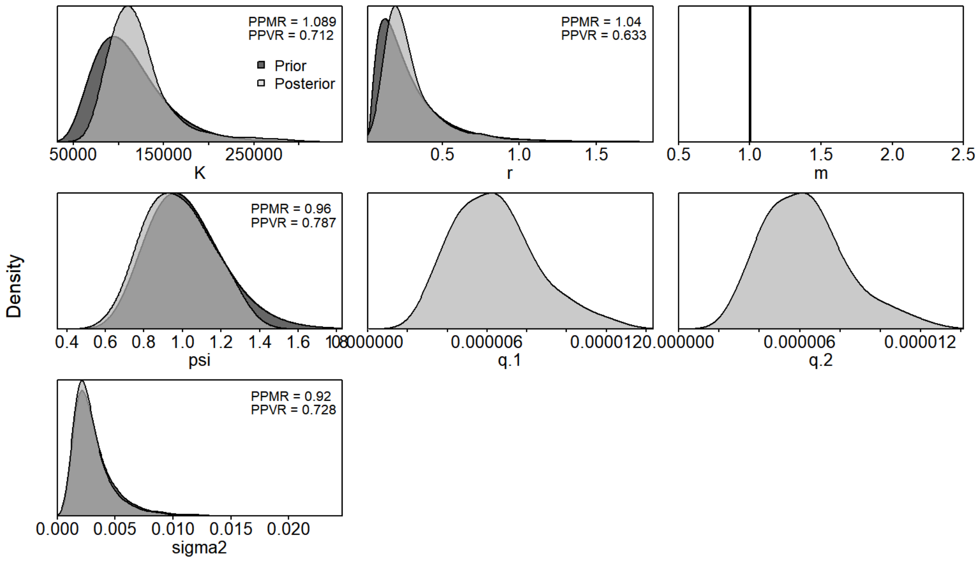
Sample outputs (many useful graphs)

To be explained in the users manual
when the software is completed (2024)

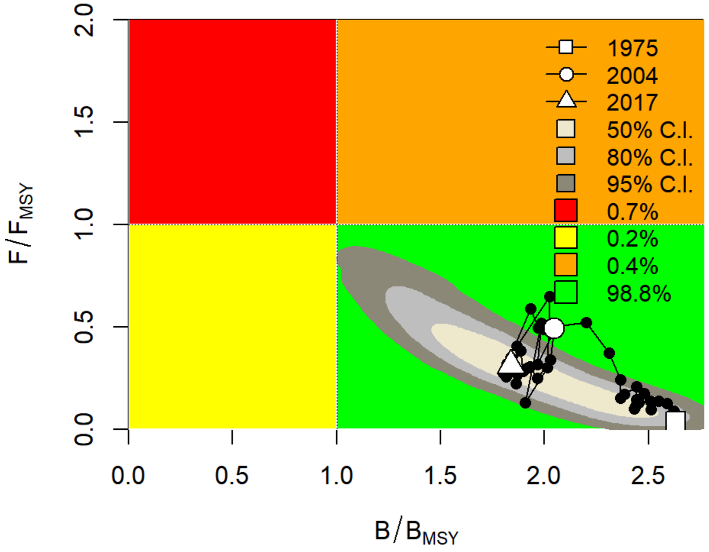
Estimated parameters with Uncertainties (JAGS MCMC)

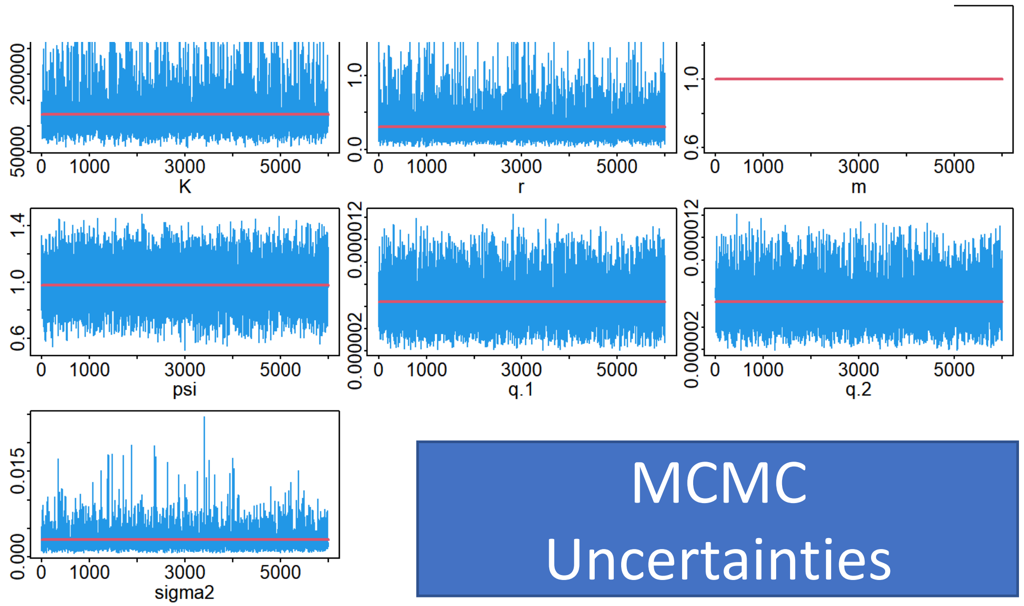


Bayesian (Priors and Posteriors)



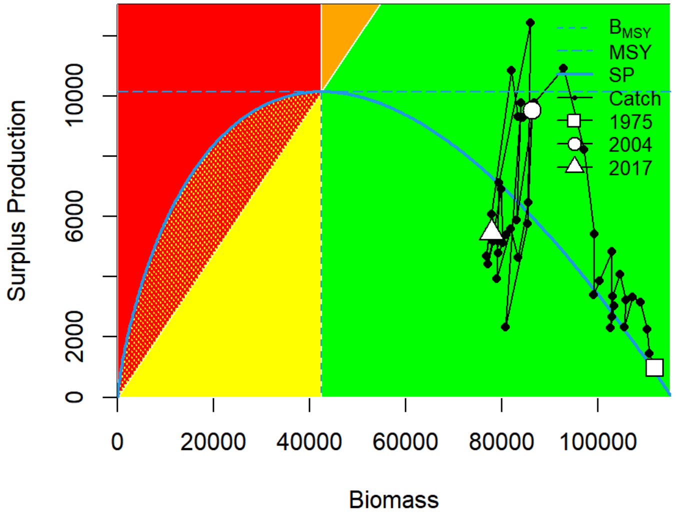
Kobe plot





MCMC Uncertainties

Surplus production phase plot



One weak point : JABBA

No Risk assessment ➔ <u>We will add Risk assessment to JABBA</u>

Menu-driven JABBA software (2024) ➔ Most Powerful PM

JABBA

\+

Probabilities(%) violating TBmsy and Fmsy in 3 and 10 years.

Color legend				
Risk levels	Low risk	Medium low risk	Medium high risk	High risk
Probability	0 – 25%	25 – 50%	50 – 75%	75 – 100

	0% (−100%)	20% (−80%)	40% (−60%)	60% (−40%)	70% (−30%)	80% (−20%)	90% (−10%)	91% (−9%) MSY level	100% Current catch (*)	110%	120%
11 catch scenarios (tons)	0	12,312	24,624	36,936	43,092	49,248	55,404	55,850	61,560	67,716	73,872
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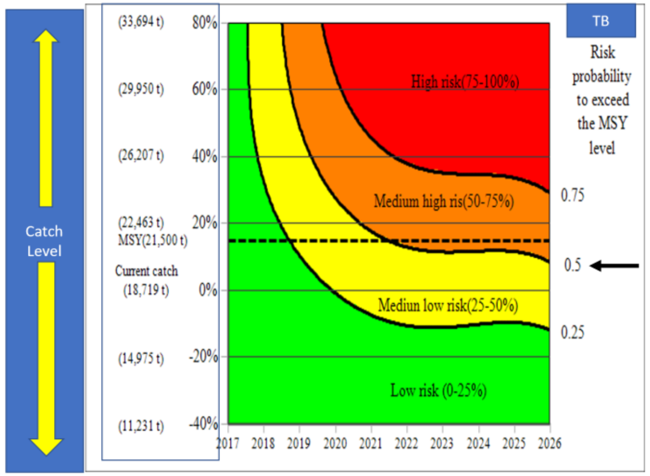
(*)The current catch levelis the average catch in 3 recent years(2016–2018).



Risk assessment

Contents

Models		Example	Data and parameters required							
			Stock structure	Global catch	Abundance indices (CPUE or fisheries in depend indices such as acoustic/areal survey data)	size/age	M (natural mortlity)	LW relation + growth eq	Maturity + fecundity	Space and movement
Data limit approach		SRA(CMSY) (Catch only)								
Production model		ASPIC								
		JABBA								
Age/size structure model	(without abundance indices)	VPA								
	(with abundance indices)	ADAPT—VPA								
	Simpler integrated model (I)	ASPM	Inter-mediate model							
	Integrated model (II)	CASAL and SS3								(option)

ADMB Implemented
ASPM software

Tom Nishida
(Stock assessment software developing team)

Rebecca Rademeyer + Doug Butterworth
(Univ of Cape Town, South Africa)

(2010-2015)

ADMB: Automatic Differentiation Model Builder

Non-linear statistical modeling

Original ASPM (ICCAT)

Restorep (1997) FORTAN (outdated)

↓

Re-coded by AD Model Builder

↓

We developed the user's friendly software

(menu-driven)

6 years

Why ASPM was selected as one of our menu-driven software ?

5 RFMO meeting (2007 and 2009) recommended

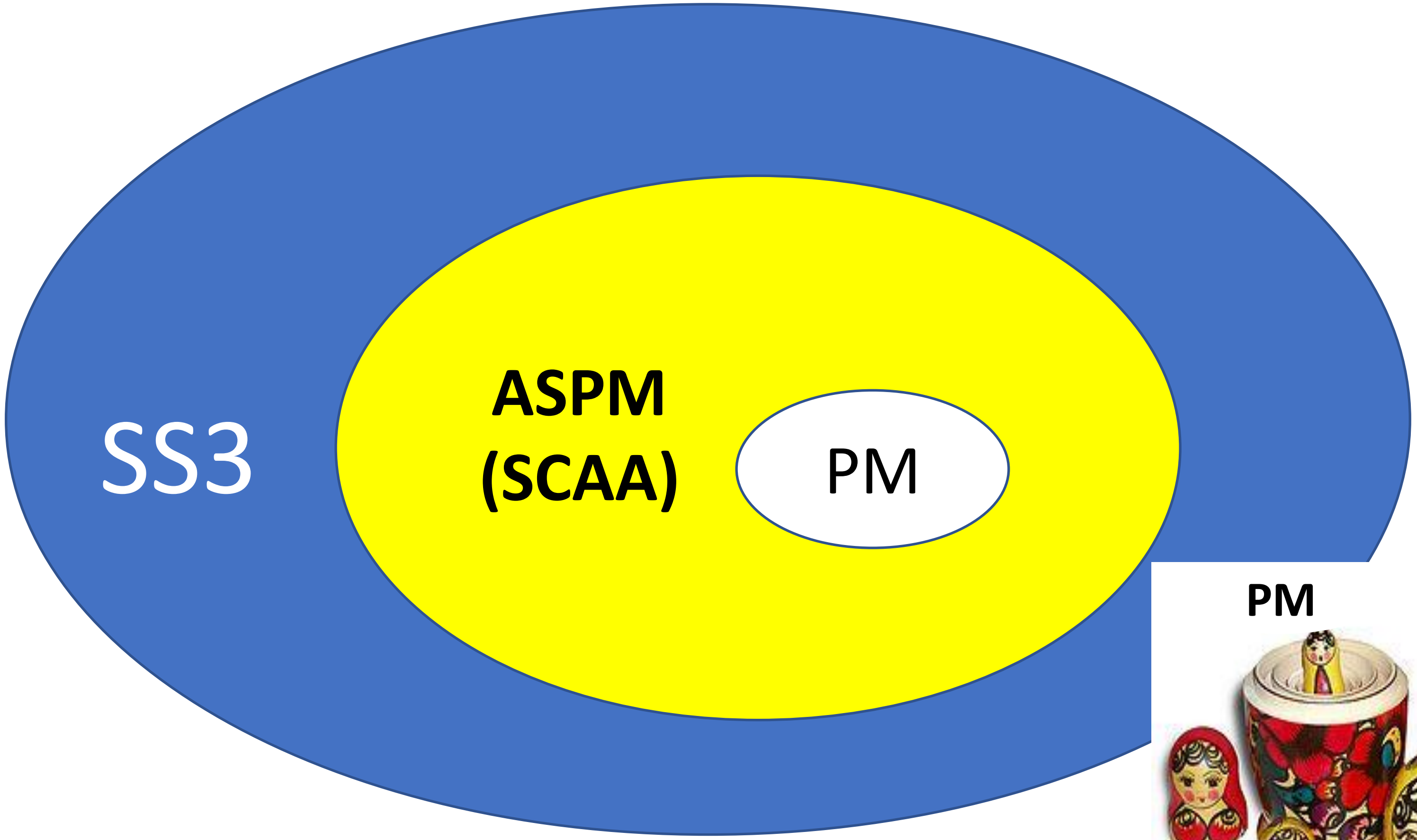
Need to compare & evaluate results among a few SA models(*)

as each model has pros & cons

(*) 'Simple', **'intermediate'** & 'advanced(integrated)' model

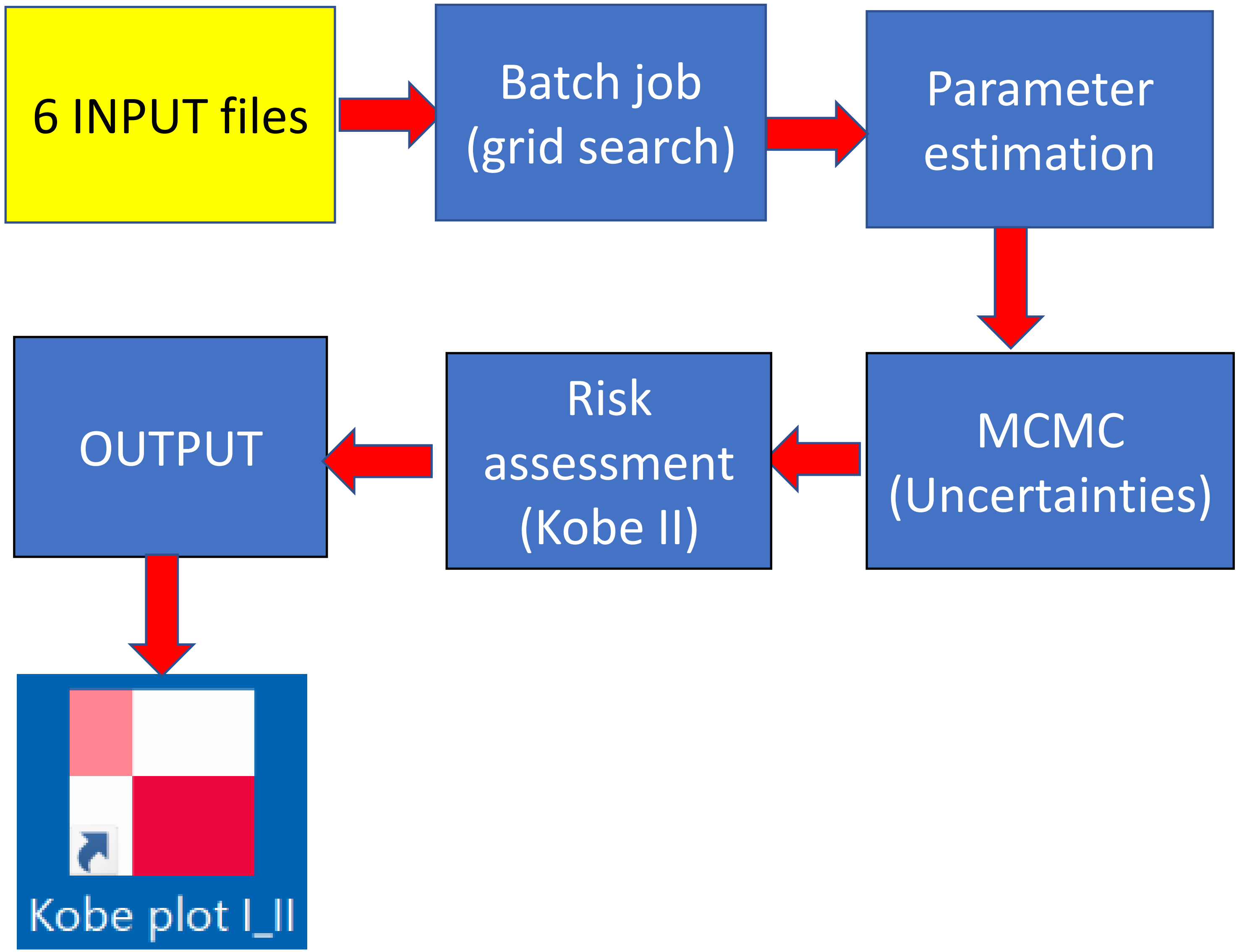
(different structures & data sets)

PM is the subset of ASPM
ASPM is the subset of SS3/MFCL
a big family !



Like Russian matorpshika??➔

ASPM flow


6 INPUT files
Batch job (grid search)
Parameter estimation
MCMC (Uncertainties)
Risk assessment (Kobe II)
OUTPUT
Kobe plot I_II

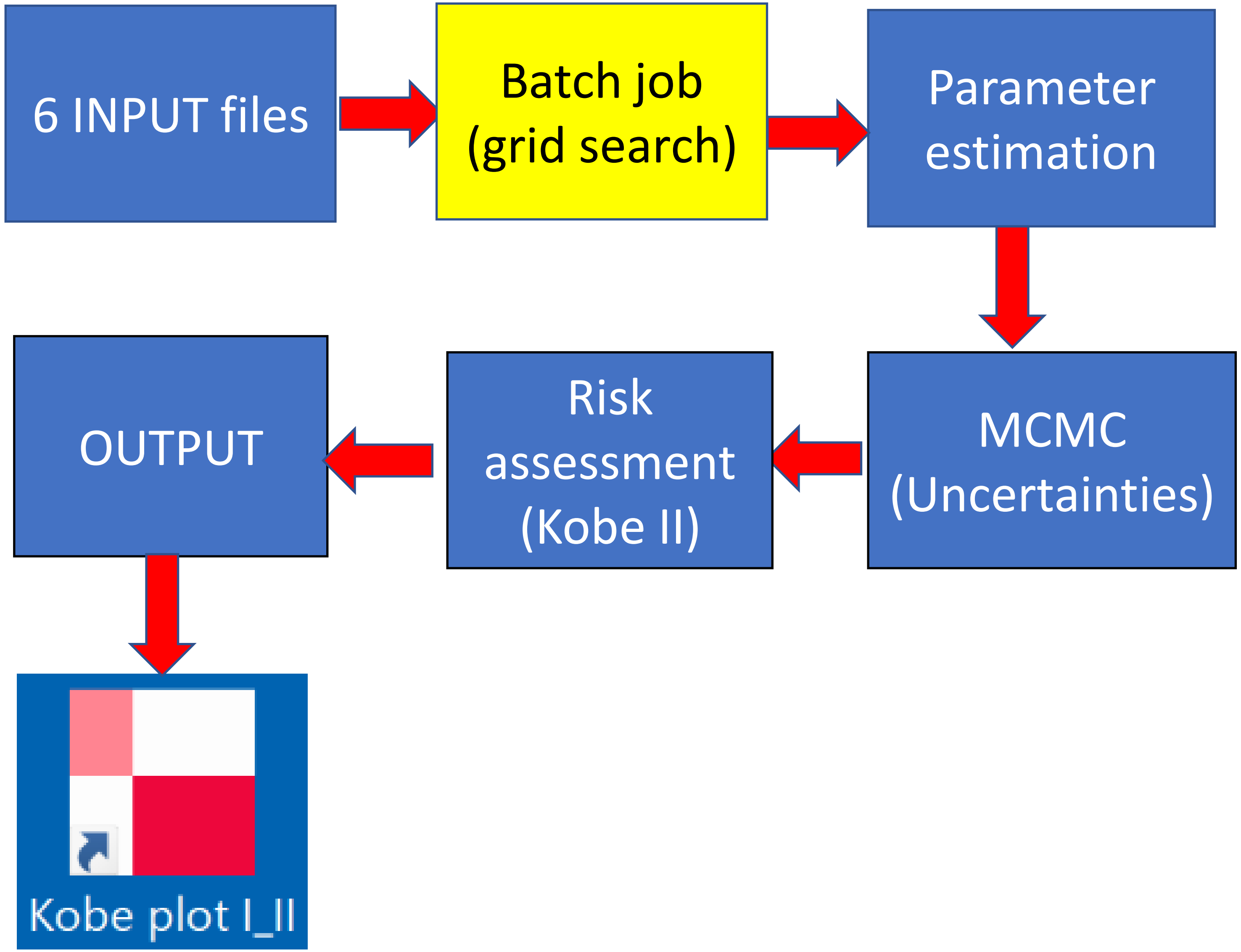
ASPM: 6 input files

- ***Control.inp*** *(basic settings)*

  years, fleet, area SR, σR,
- ***aspm.par*** *(guess for SB0 and steepness)*
- ***Biological.inp***

  (Age specific M+WT+Maturity+Fecundity)
- ***index.inp*** *(STD CPUE by fleet)*
- ***Fishery.inp*** *(Catch and CAA by fleet)*
- ***Projection.inp*** *(Catch or F scenario)*

ASPM flow


6 INPUT files
Batch job (grid search)
Parameter estimation
MCMC (Uncertainties)
Risk assessment (Kobe II)
OUTPUT
Kobe plot I_II

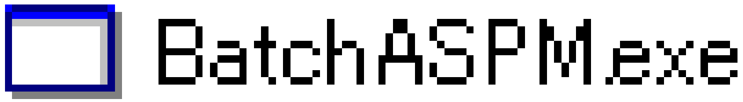
BATCH JOB

(GRID SEARCH)

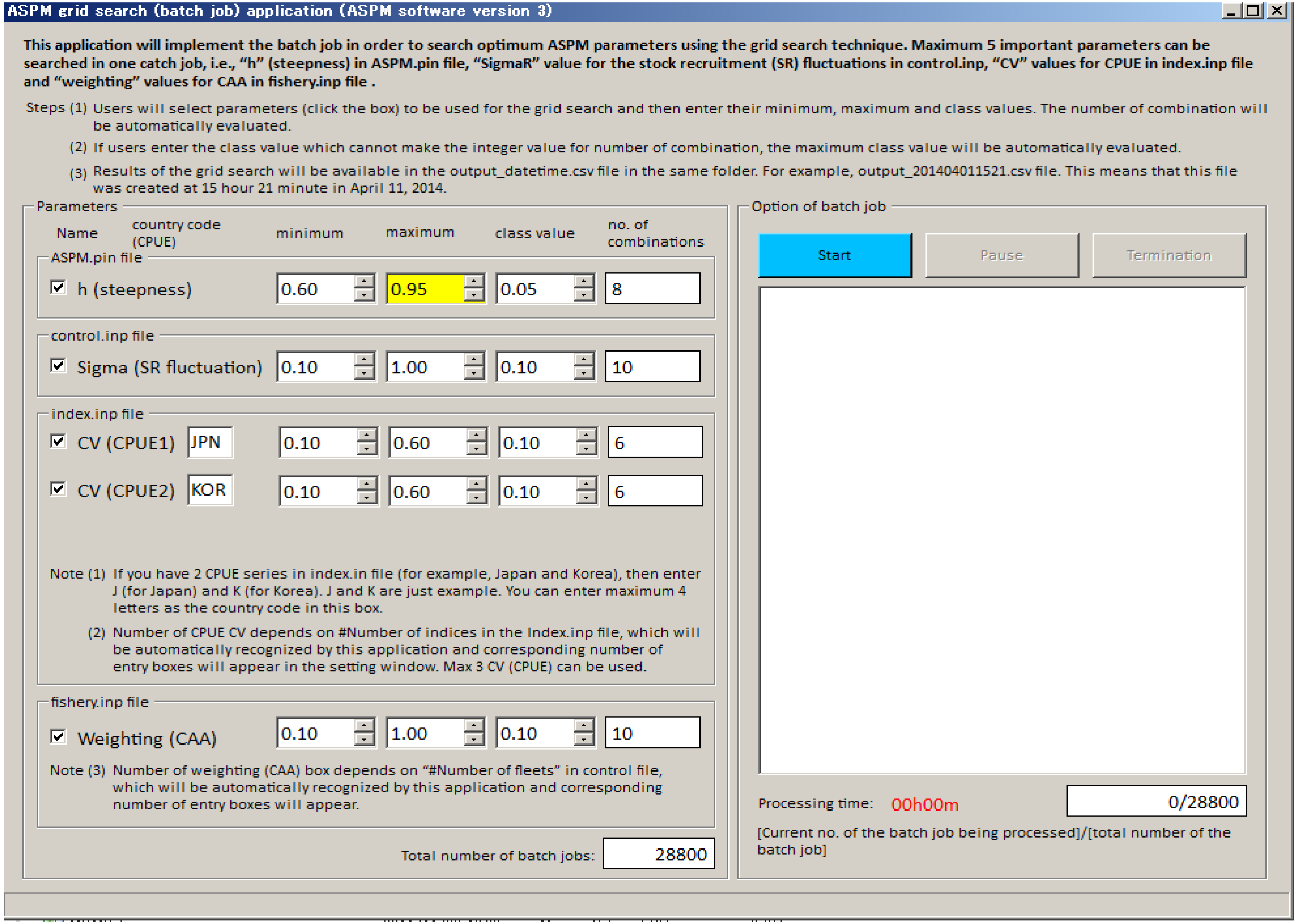
To search optimum parameters while avoiding local minimum problem (i.e. to select incorrect parameters)

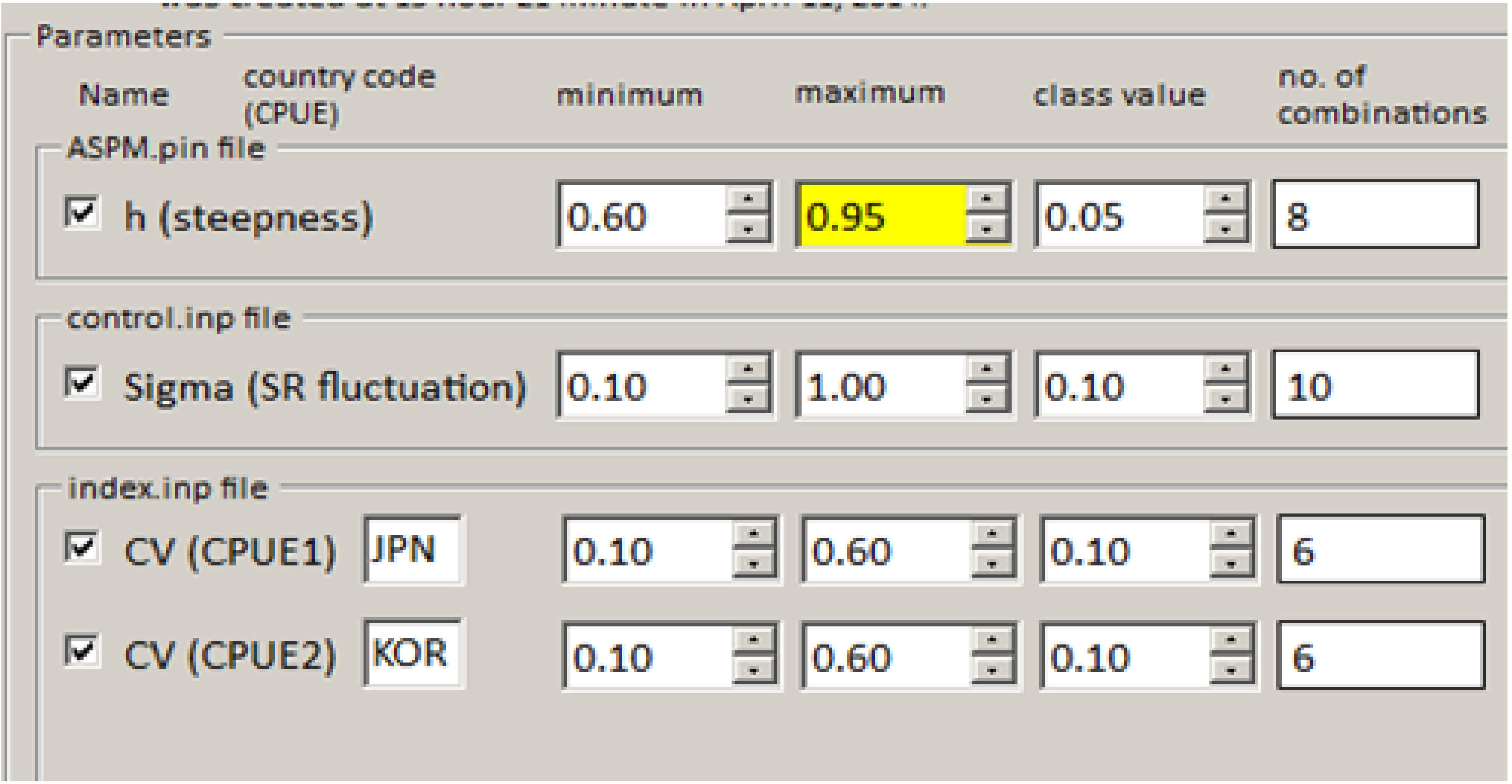
Batch job procedure

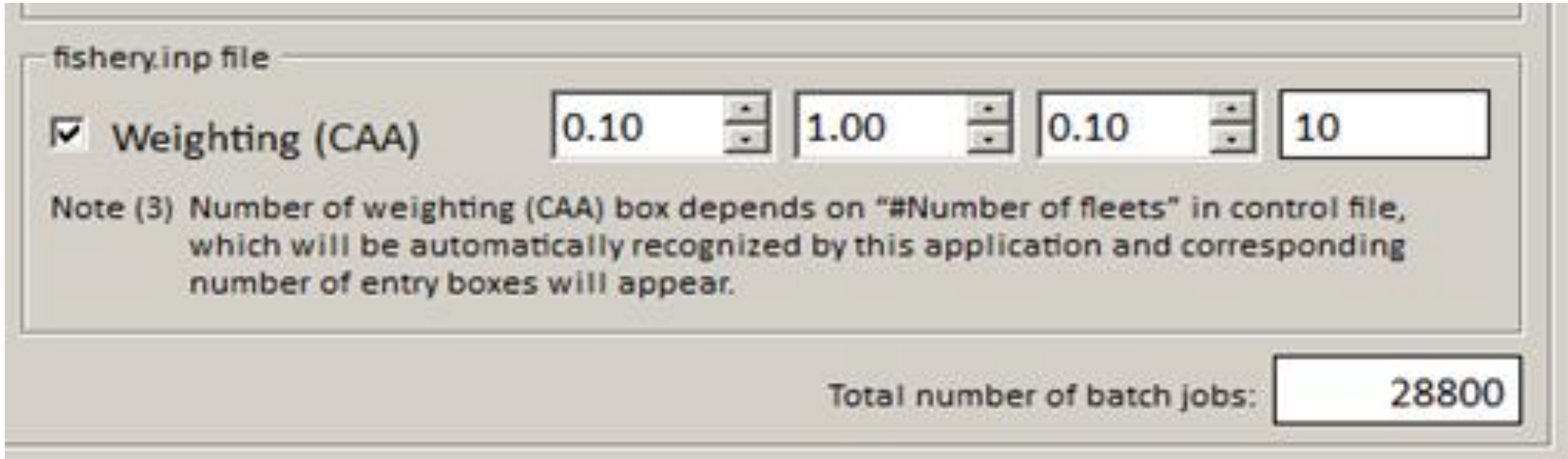
BatchASPM.exe file



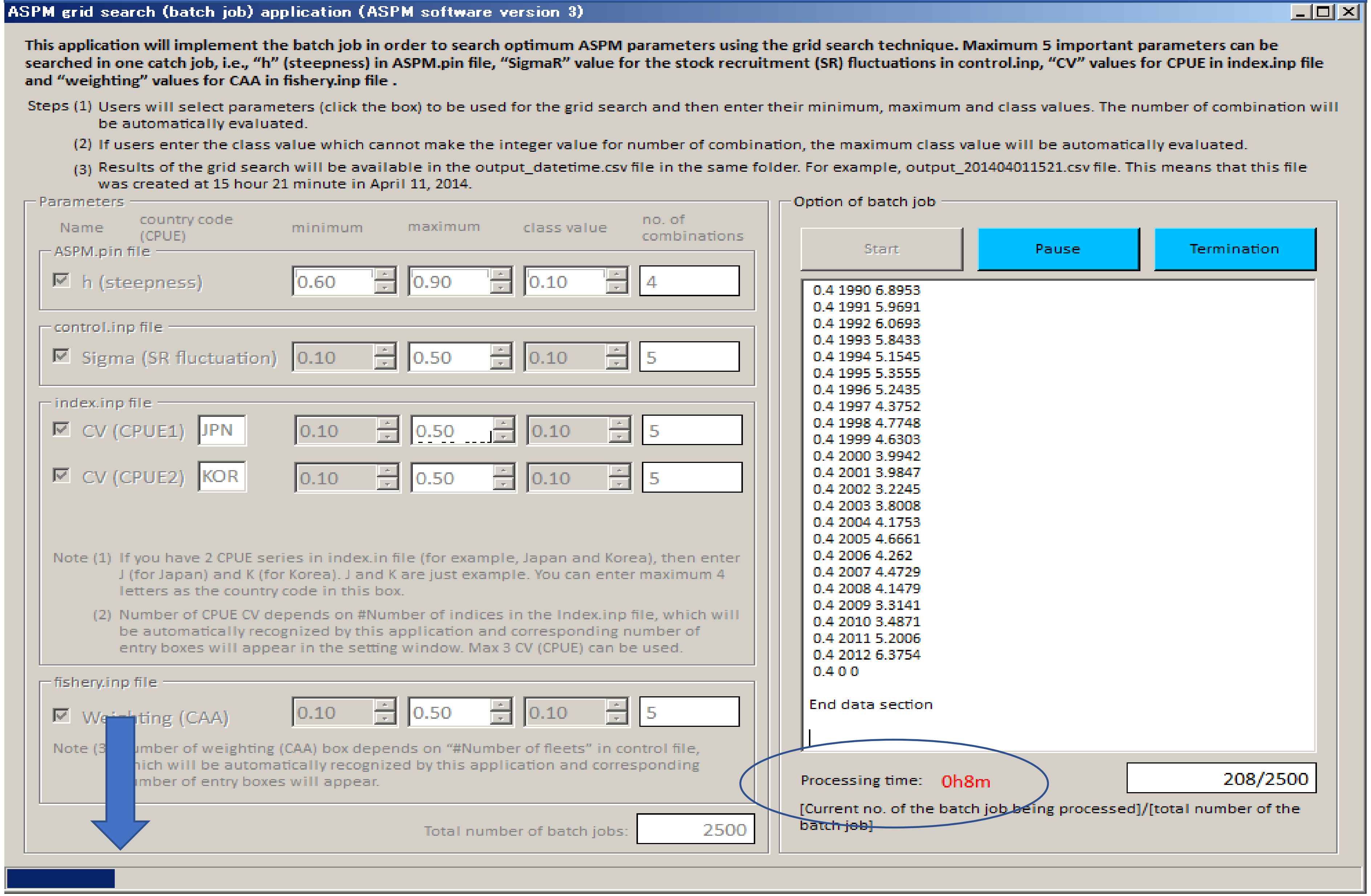
Batch job menu : Setting 4 parameter search ranges




Parameters
Name
country code (CPUE)
minimum
maximum
class value
no. of combinations
ASPM.pin file
h (steepness)
0.60
0.95
0.05
8
control.inp file
Sigma (SR fluctuation)
0.10
1.00
0.10
10
index.inp file
CV (CPUE1)
JPN
0.10
0.60
0.10
6
CV (CPUE2)
KOR
0.10
0.60
0.10
6


fishery.inp file
Weighting (CAA)
0.10
1.00
0.10
10
Note (3) Number of weighting (CAA) box depends on "#Number of fleets" in control file, which will be automatically recognized by this application and corresponding number of entry boxes will appear.
Total number of batch jobs:
28800

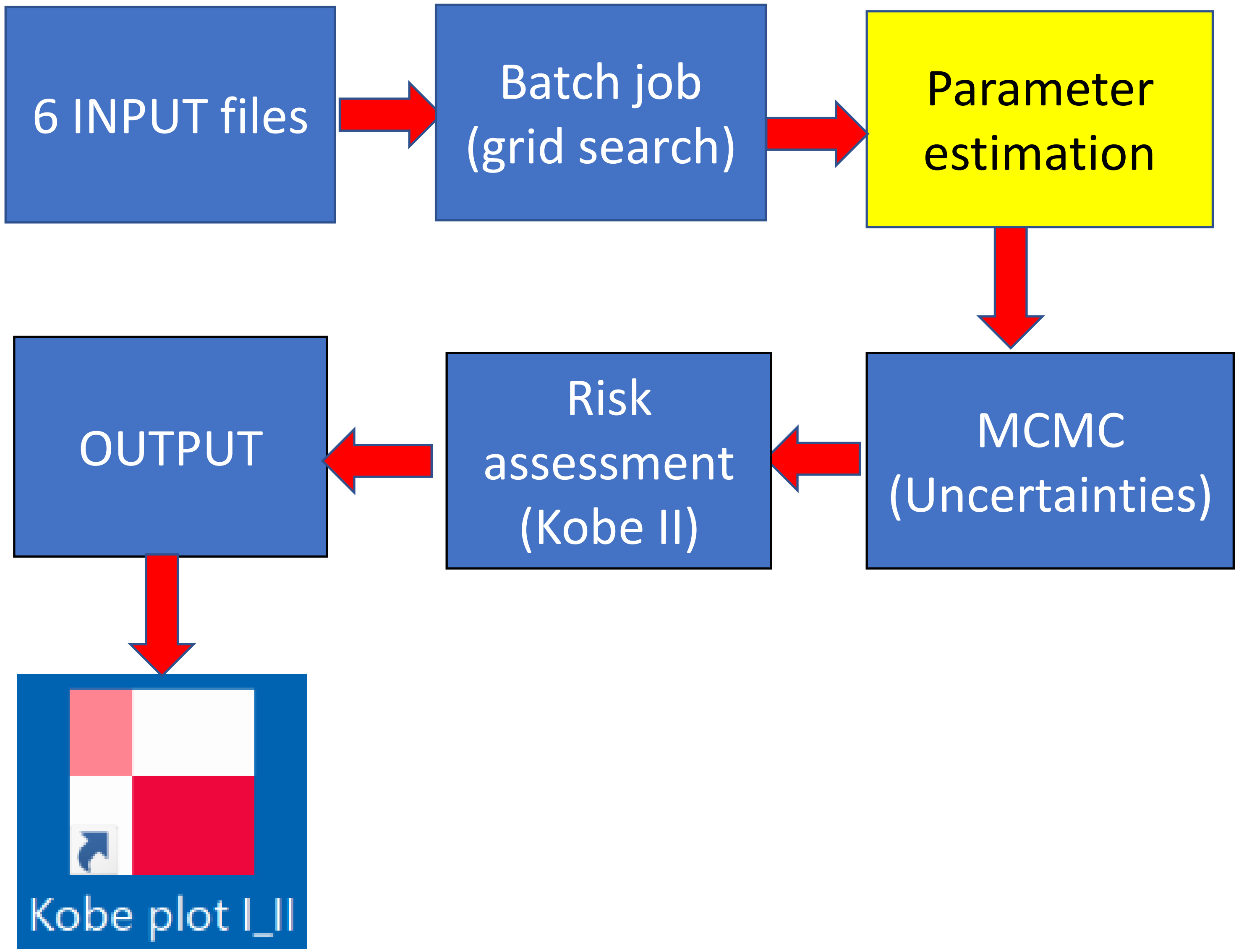
Snap shot during processing



Output (excel): All results are recorded.
(No pen & paper methods)
Beginning part (run # 1-10)

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Processing time:	4h36m											
2		0.6-0.9 by 0.1	0.1-0.4 by 0.1	J0.1-J0.4 by 0.1	0.1-0.4 by 0.1								
3													
4	No	h (steepness)	Sigma (SR)	CPUE	Weighting (CAA)	SSB0	Total likelihood	R2	SSB	MSY	SSB/SSBmsy	F/Fmsy	Error Message
5	1	0.6	0.1	J0.1	0.1	394	-14.481	0.498	135	30	1.07	1.4	
6	2	0.6	0.1	J0.1	0.2	400	2.901	0.484	141	30	1.11	1.33	
7	3	0.6	0.1	J0.1	0.3	413	20.075	0.463	156	31	2.14	0.54	
8	4	0.6	0.1	J0.1	0.4	785	63.918	0.233	539	61	2.11	0.33	Warning -- Hessian does not appear to be positive definite
9	5	0.6	0.1	J0.2	0.1	394	-14.481	0.498	135	30	1.07	1.4	
10	6	0.6	0.1	J0.2	0.2	400	2.901	0.484	141	30	1.11	1.33	
11	7	0.6	0.1	J0.2	0.3	413	20.075	0.463	156	31	2.14	0.54	
12	8	0.6	0.1	J0.2	0.4	785	63.918	0.233	539	61	2.11	0.33	Warning -- Hessian does not appear to be positive definite
13	9	0.6	0.1	J0.3	0.1	394	-14.481	0.498	135	30	1.07	1.4	
14	10	0.6	0.1	J0.3	0.2	400	2.901	0.484	141	30	1.11	1.33	

ASPM flow


6 INPUT files
Batch job (grid search)
Parameter estimation
MCMC (Uncertainties)
Risk assessment (Kobe II)
OUTPUT
Kobe plot I_II

How to select the most optimum parameters?

Sort by

total likelihood (ascending)

(smaller value better)

and

R2(descending)

(higher value better)

Sorted results

and

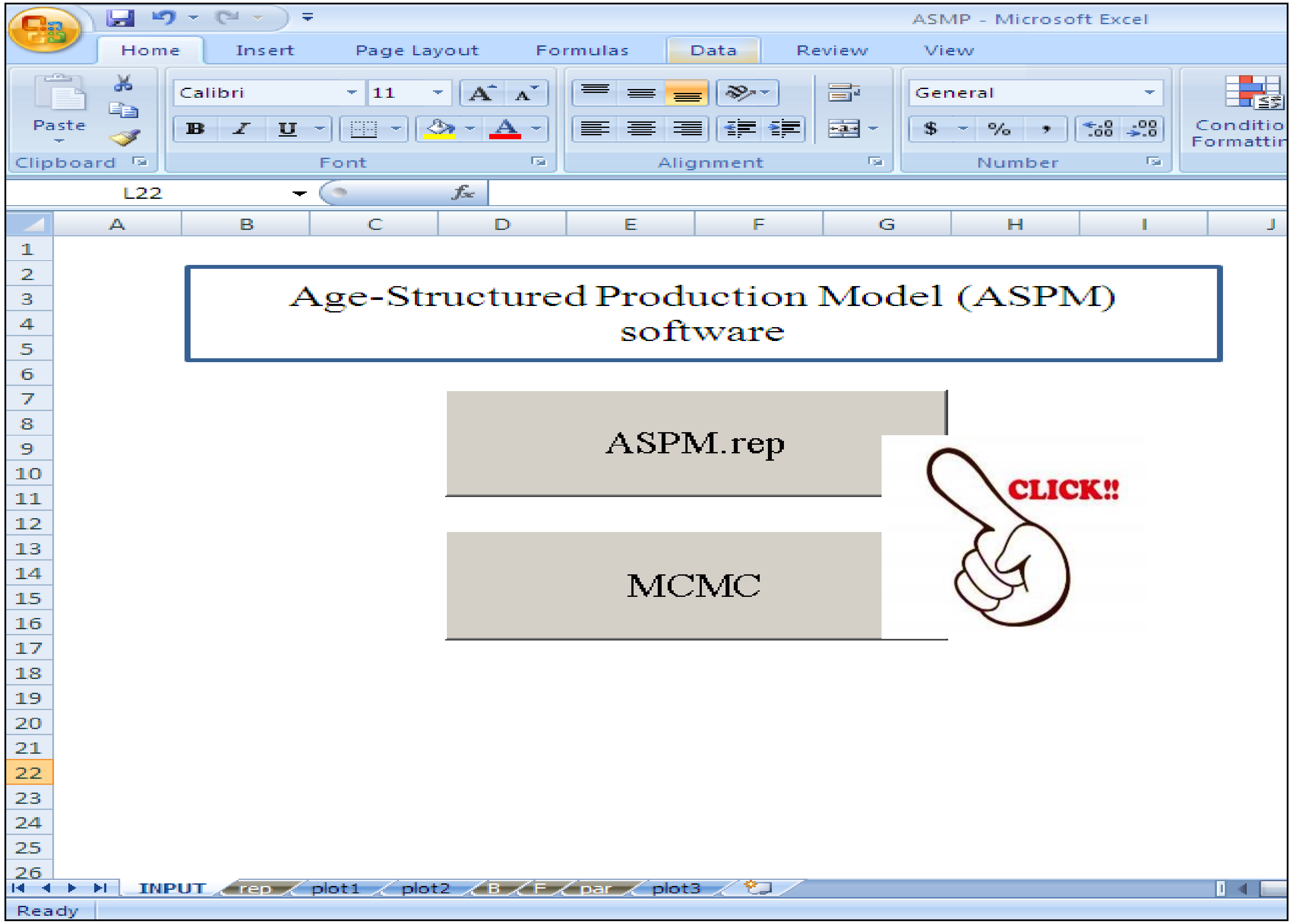
selection of optimum parameters

Low → High (Total likelihood)

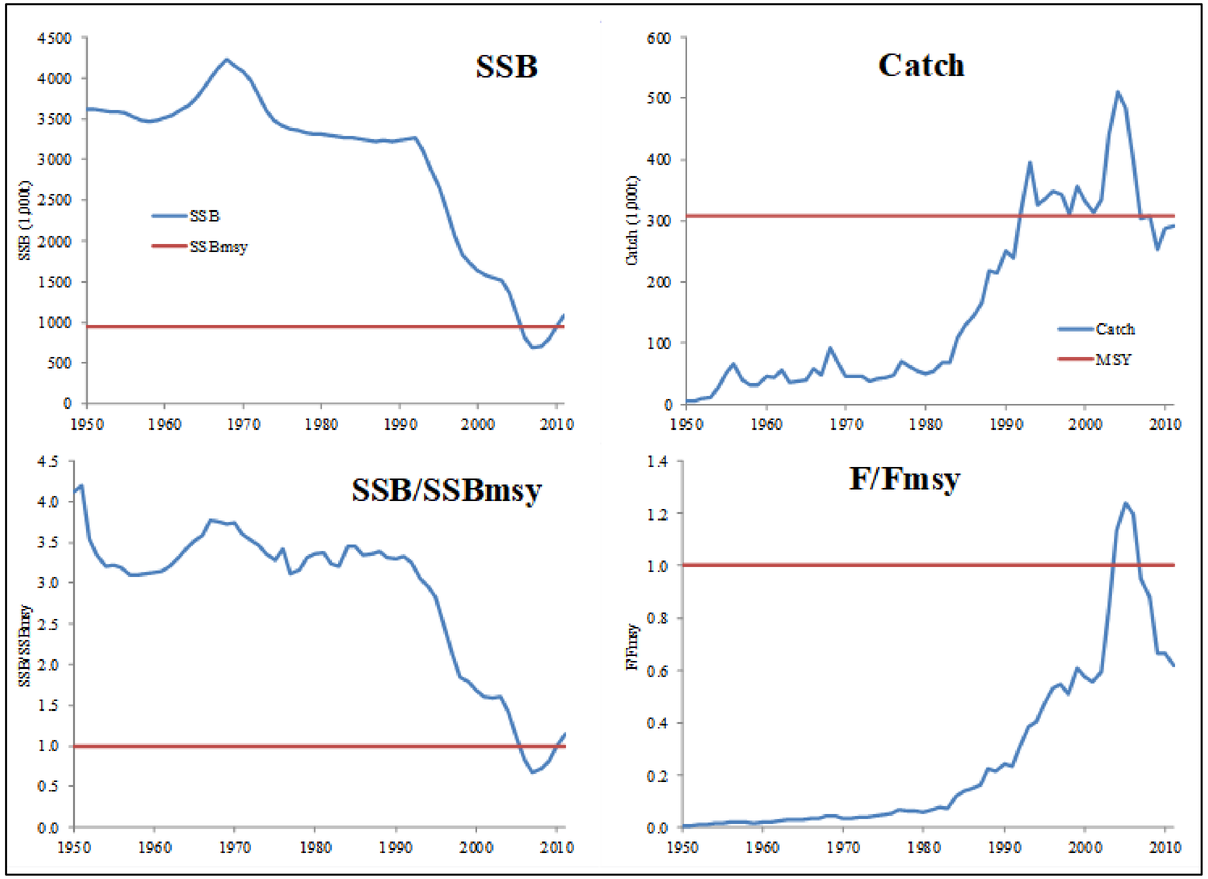
High → Low (R2)

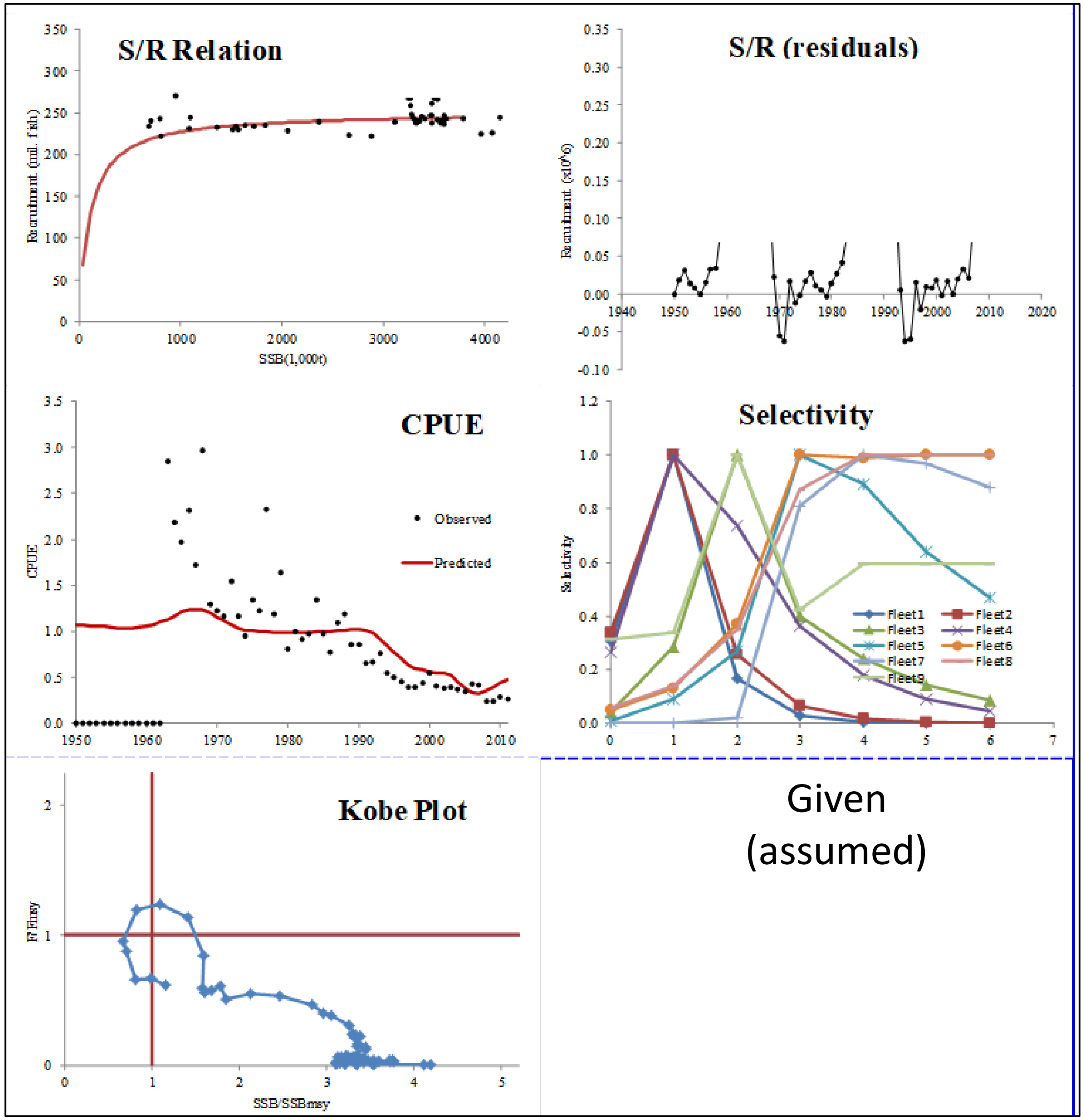
Run No	h (steepness)	Sigma (SR)	CPUE	Weighting (CAA)	SSB0	Total likelihood	R2	SSBmsy	MSY (1000 tons)	SSB/SSB msy	F/Fmsy	Error Message
49	0.6	0.4	J0.1	0.1	536	-21.959	0.907	213	41	1.29	0.88	
53	0.6	0.4	J0.2	0.1	536	-21.959	0.907	213	41	1.29	0.88	
57	0.6	0.4	J0.3	0.1	536	-21.959	0.907	213	41	1.29	0.88	
61	0.6	0.4	J0.4	0.1	536	-21.959	0.907	213	41	1.29	0.88	
177	0.8	0.4	J0.1	0.1	476	-21.853	0.907	193	50	1.78	0.47	
181	0.8	0.4	J0.2	0.1	476	-21.853	0.907	193	50	1.78	0.47	
185	0.8	0.4	J0.3	0.1	476	-21.853	0.907	193	50	1.78	0.47	
189	0.8	0.4	J0.4	0.1	476	-21.853	0.907	193	50	1.78	0.47	
241	0.9	0.4	J0.1	0.1	460	-21.802	0.907	189	55	1.77	0.4	
245	0.9	0.4	J0.2	0.1	460	-21.802	0.907	189	55	1.77	0.4	
17	0.6	0.2	J0.1	0.1	404	-16.003	0.597	133	31	1.03	1.43	Warning -- Hessian does not appear to be positive definite
21	0.6	0.2	J0.2	0.1	404	-16.003	0.597	133	31	1.03	1.43	Warning -- Hessian does not appear to be positive definite

To produce graphs (point estimates), click ASPM.rep (numerical results)

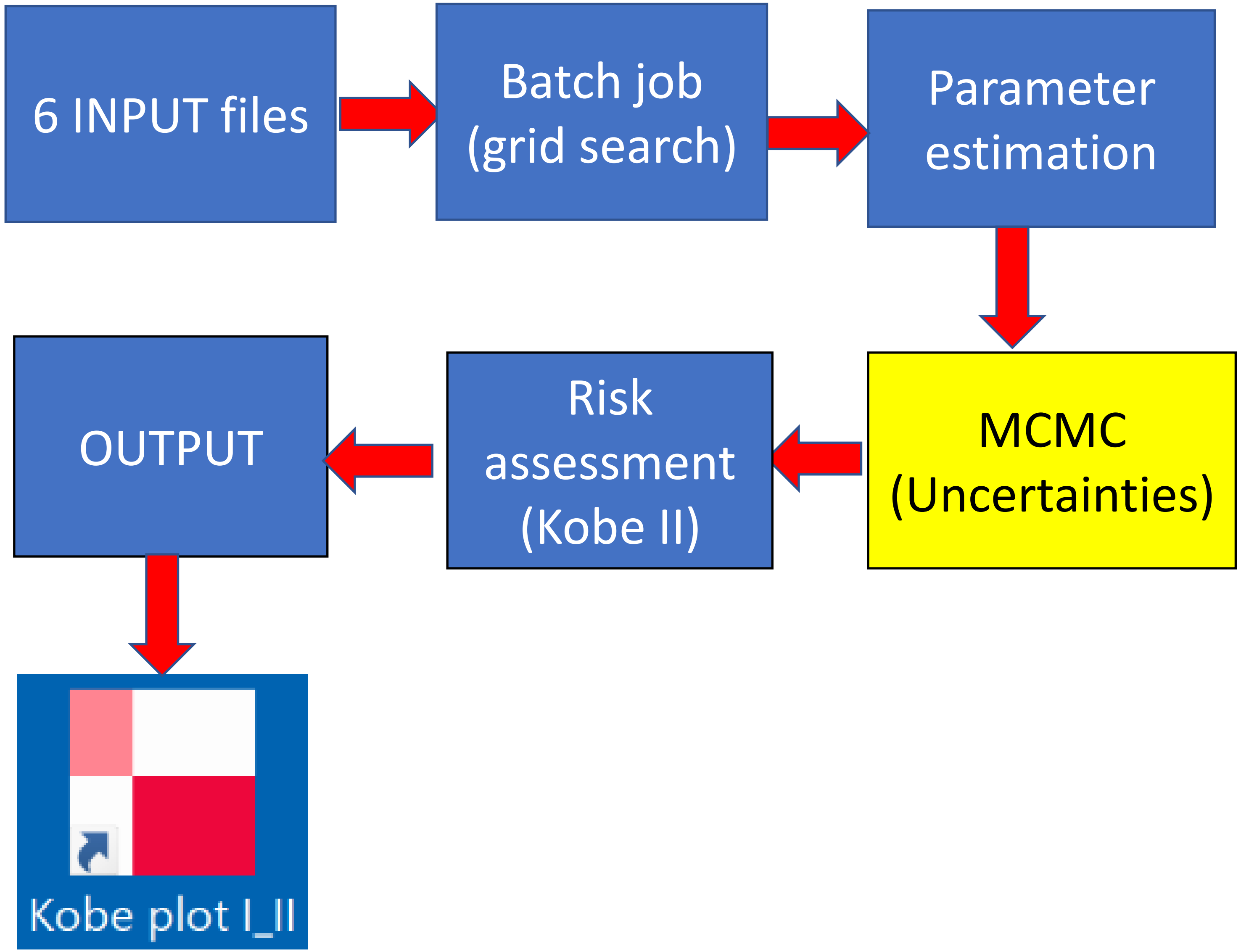


Point Estimates



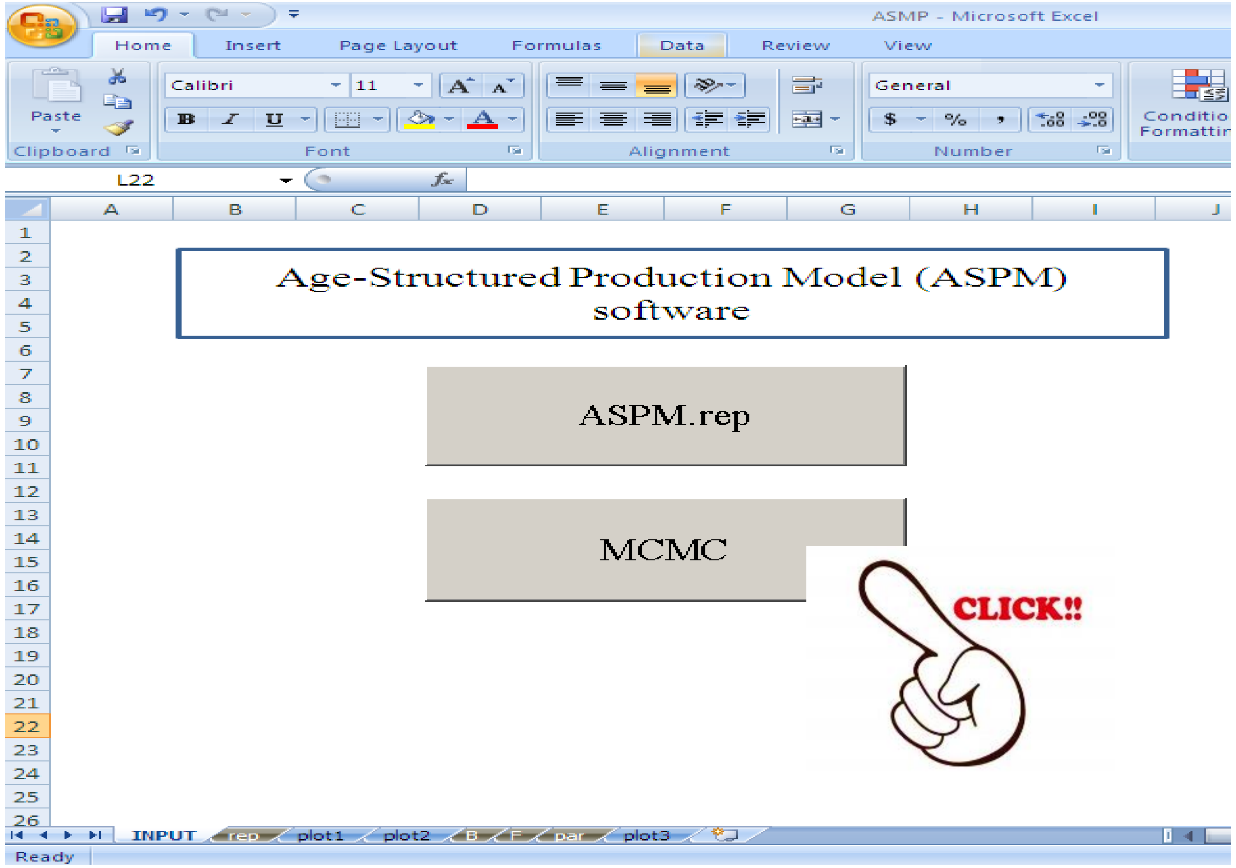


ASPM flow


6 INPUT files
Batch job (grid search)
Parameter estimation
MCMC (Uncertainties)
Risk assessment (Kobe II)
OUTPUT
Kobe plot I_II

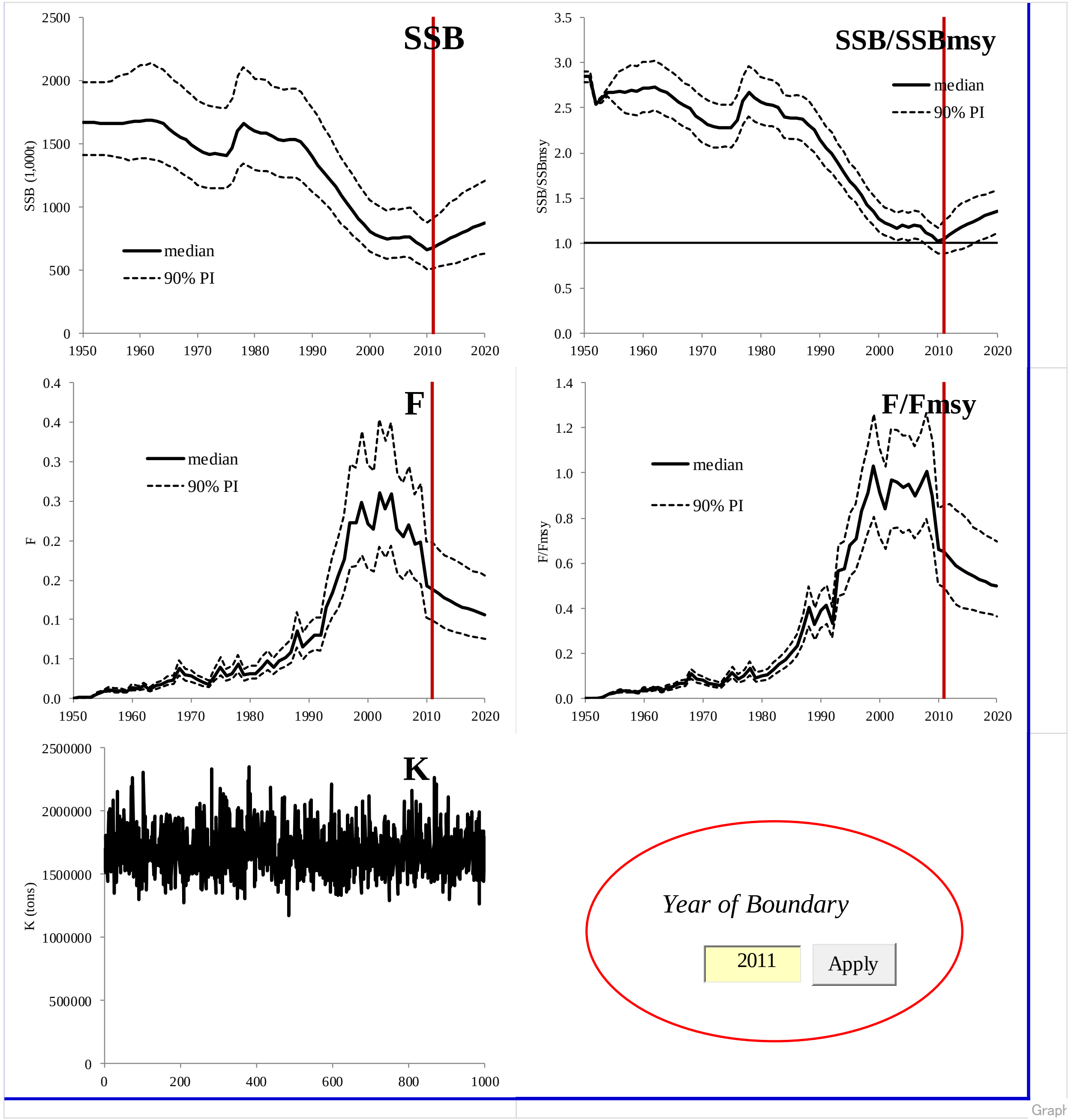
Menu : MCMC (Markov Chain Monte Carlo)

To evaluate uncertainties by re-samplings

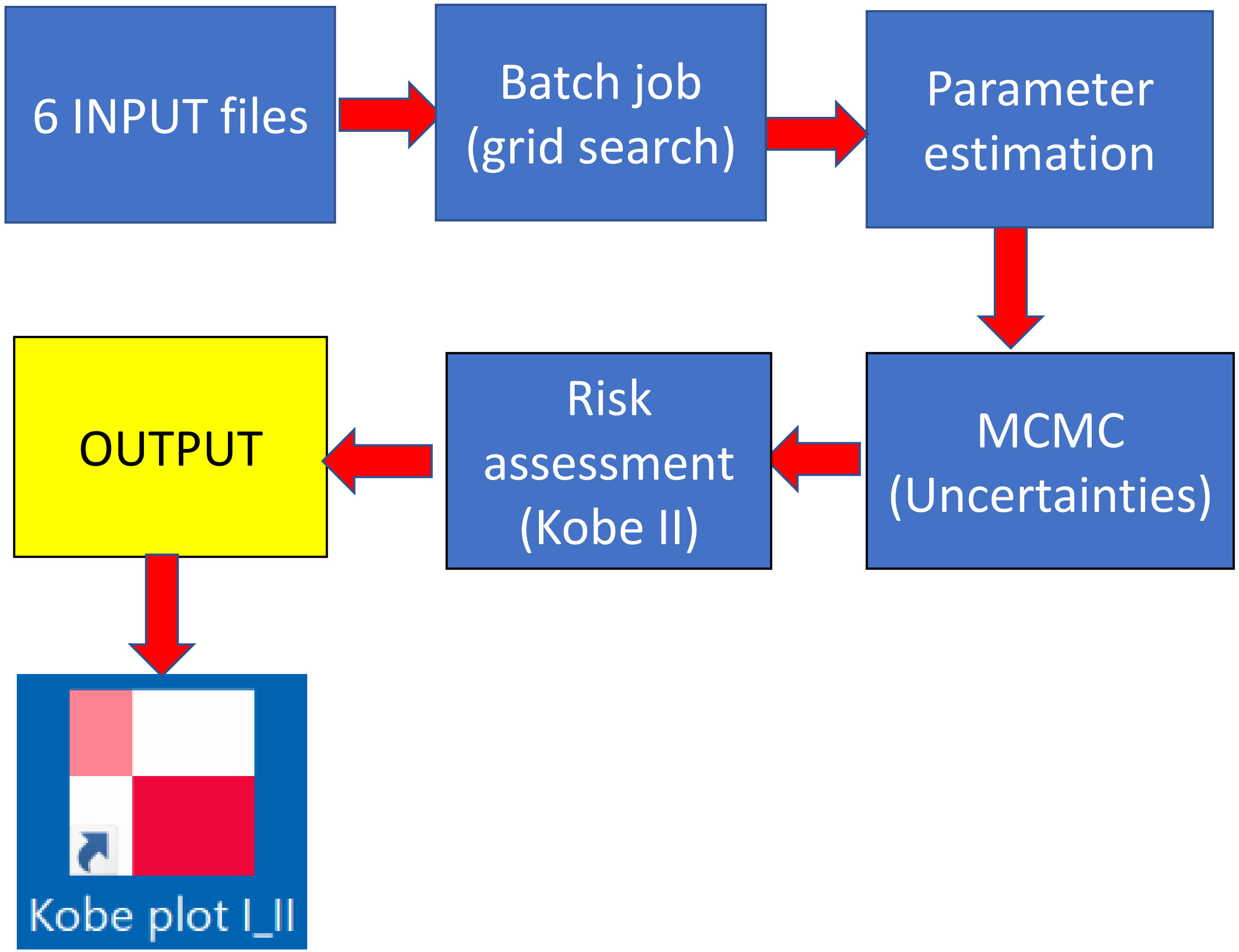


MCMC

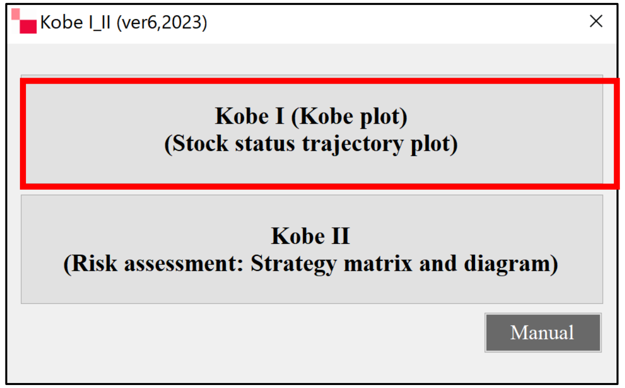
Confidence Intervals + Projections

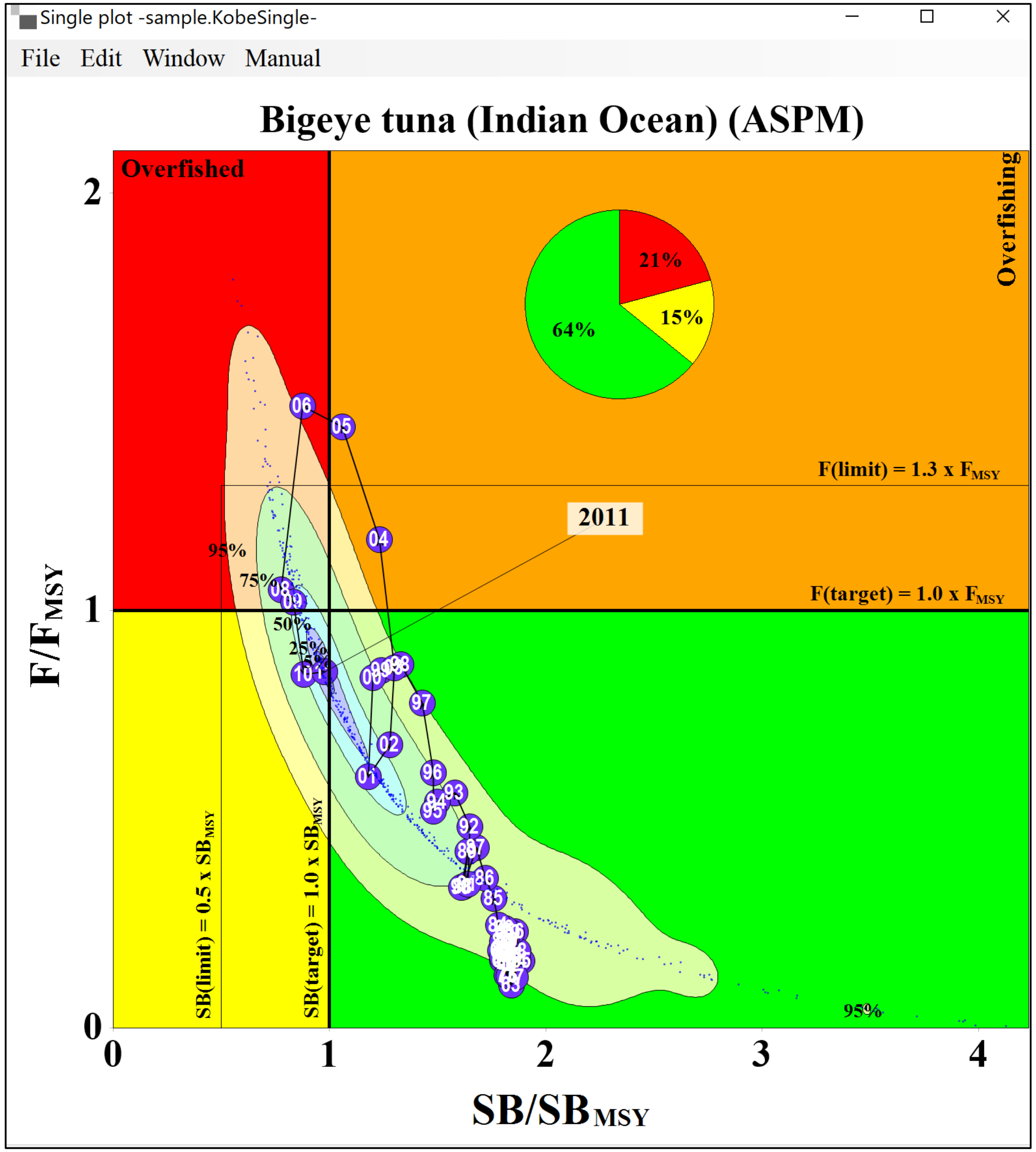


ASPM flow

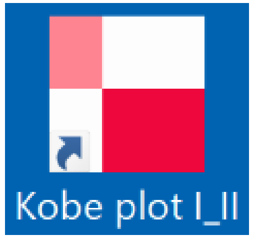

6 INPUT files
Batch job (grid search)
Parameter estimation
MCMC (Uncertainties)
Risk assessment (Kobe II)
OUTPUT
Kobe plot I_II

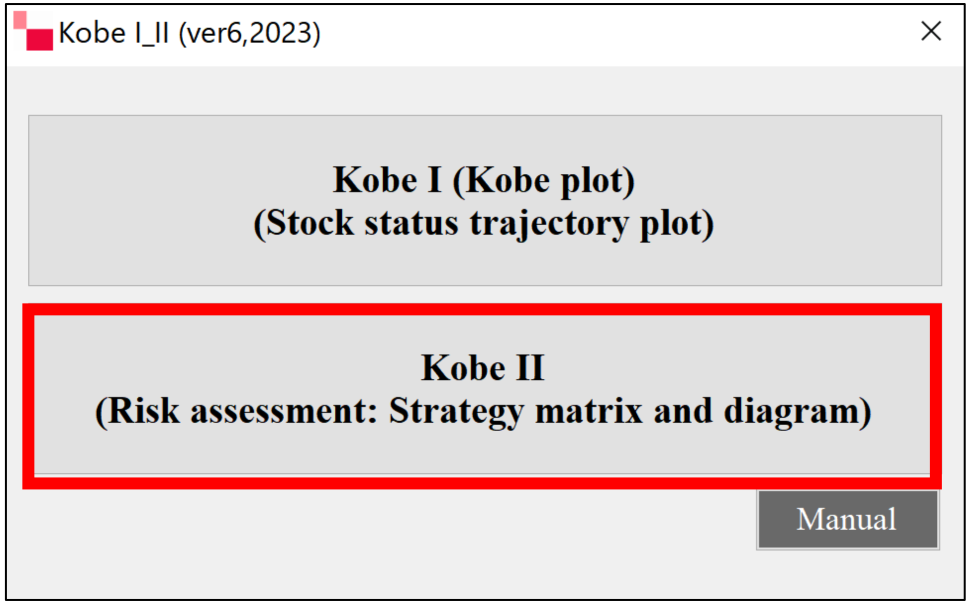

Kobe plot I_II

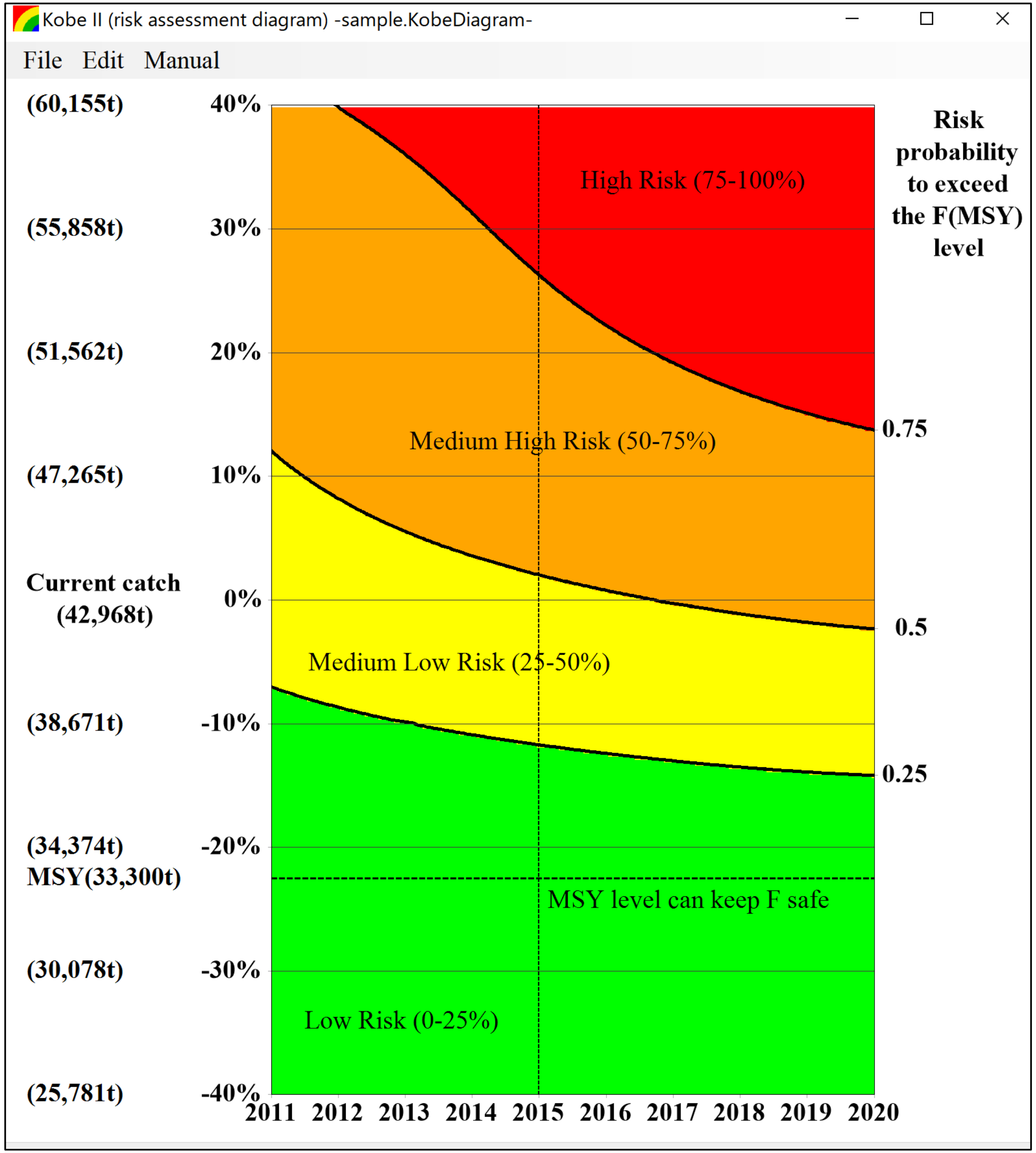

Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
(Stock status trajectory plot)
Kobe II
(Risk assessment: Strategy matrix and diagram)
Manual


Single plot -sample.KobeSingle-
File Edit Window Manual
Bigeye tuna (Indian Ocean) (ASPM)
Overfished
Overfishing
21%
15%
64%
F(limit) = 1.3 x F_MSY
F(target) = 1.0 x F_MSY
2011
95%
75%
50%
25%
SB(limit) = 0.5 x SB_MSY
SB(target) = 1.0 x SB_MSY
F/F_MSY
SB/SB_MSY
0
1
2
3
4

Kobe II (strategy diagram)
Bigeye tuna (Indian Ocean)







Contents

(1) Outline

(2) Menu-driven software

- CPUE standardization
- Stock and Risk assessment
  - Overview
  - Production model (ASPIC and JABBA)
  - Age structured production model (ASPM)
- Management decision making tools (Kobe I+II)

(3) Summary

Kobe I+II :
Important Management decision making tools

Kobe I (Kobe plot) (stock status trajectory)

- Effective tool to understand changes of historical status of stock
- Recent stock status ➔ important for management advice

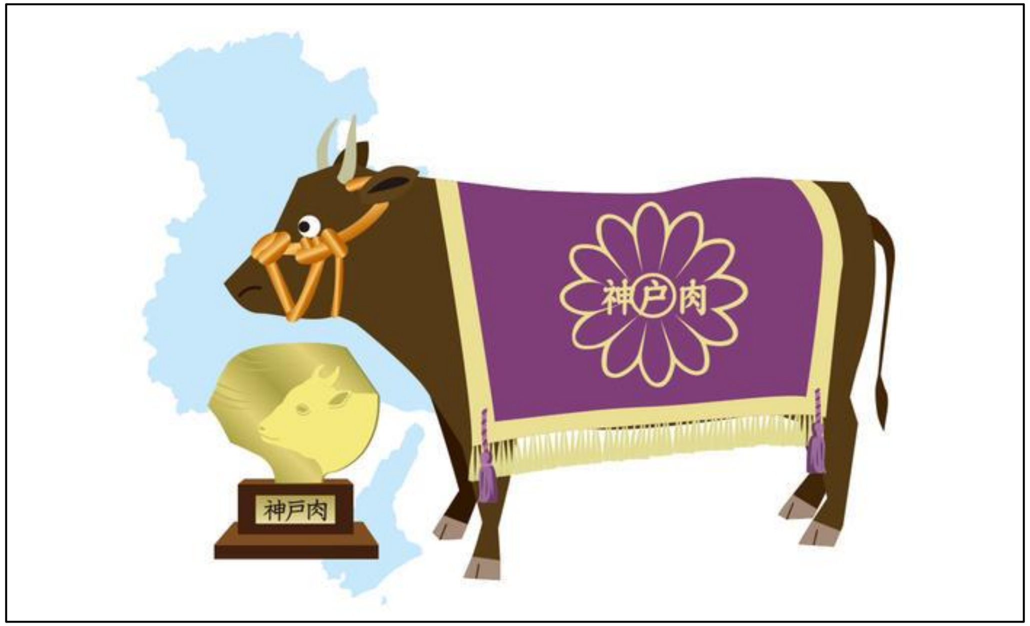
Kobe II (Strategy matrix/diagram) (Risk assessment)

- Effective tool to understand Probabilities of risks to violate MSY for F and Biomass in the future by different catch level ➔ advice for TAC

Kobe I+II : Visualization is important

Comprehensive tool: to bridge scientists ➔ managers/industry

Why we call KOBE （神戸）？
Any relation to the Kobe beef?



Kobe I (Kobe plot) + II (strategy matrix) agreed by 5 tuna RFMO meetings (IOTC+4)

Kobe I (Kobe plot) Stock status trajectory plot

First meeting in 2007 (**Kobe**, Japan)

Second meeting in2009 (Barcelona, Spain)

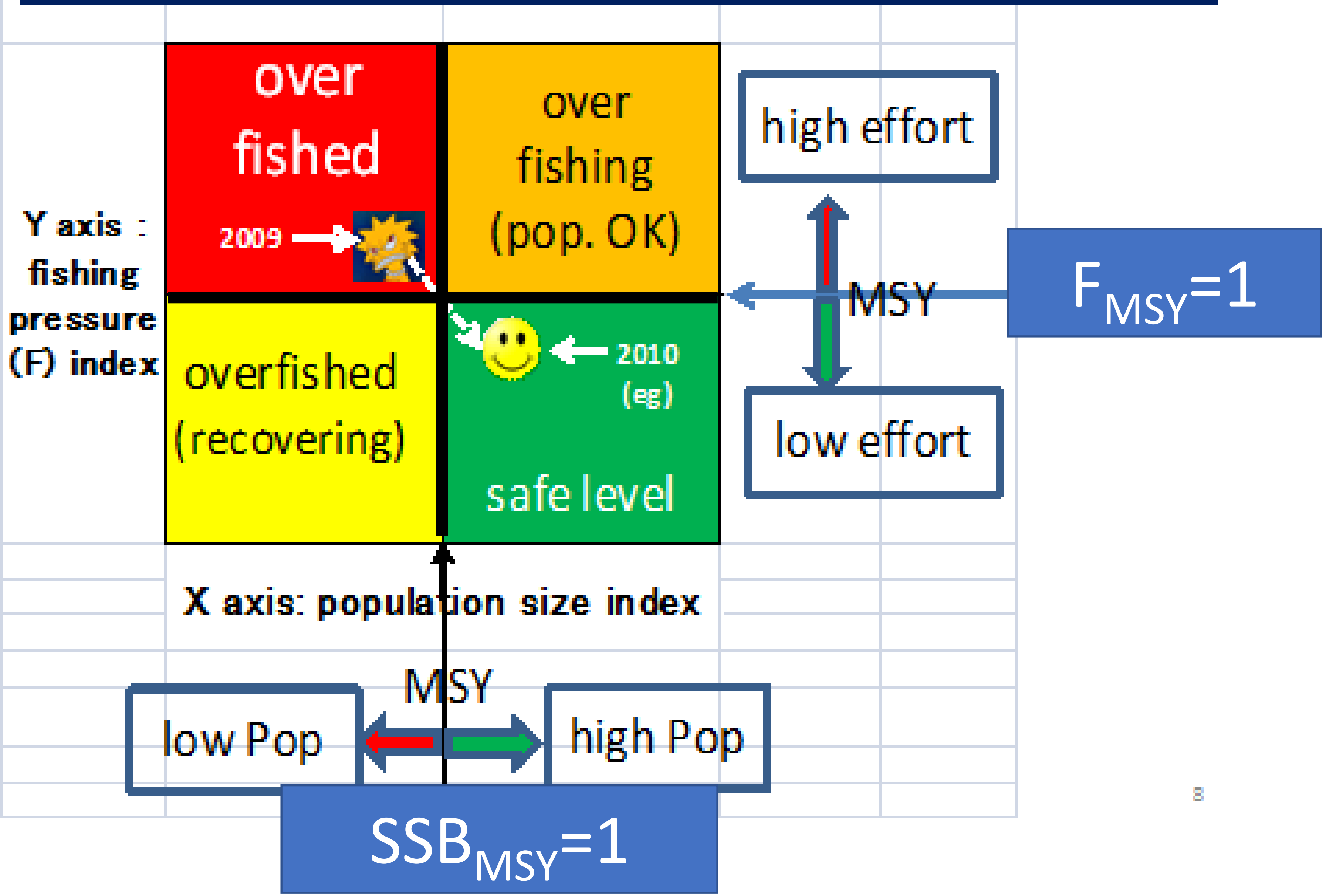
Kobe II (strategy matrix)

↓

Spreading also to demersal RFMOs and others

(e.g. NAFO, SEAFO, NPFC……)

Status of stock : Kobe plot to represent stock status in 4 phases



Introduction :Kobe I+II
Most recent version(2023)

STOCK ASSESSMENT
SOFTWARE DEVELOPING TEAM

MENU-DRIVEN SOFTWARE SERIES (NO. 7)

KOBE I (KOBE PLOT) AND KOBE II (STRATEGY DIAGRAM)

[management decision tools]

(Version 6, 2023)

User manual

Tom NISHIDA (PhD) (Representative)

aco20320@par.odn.ne.jp

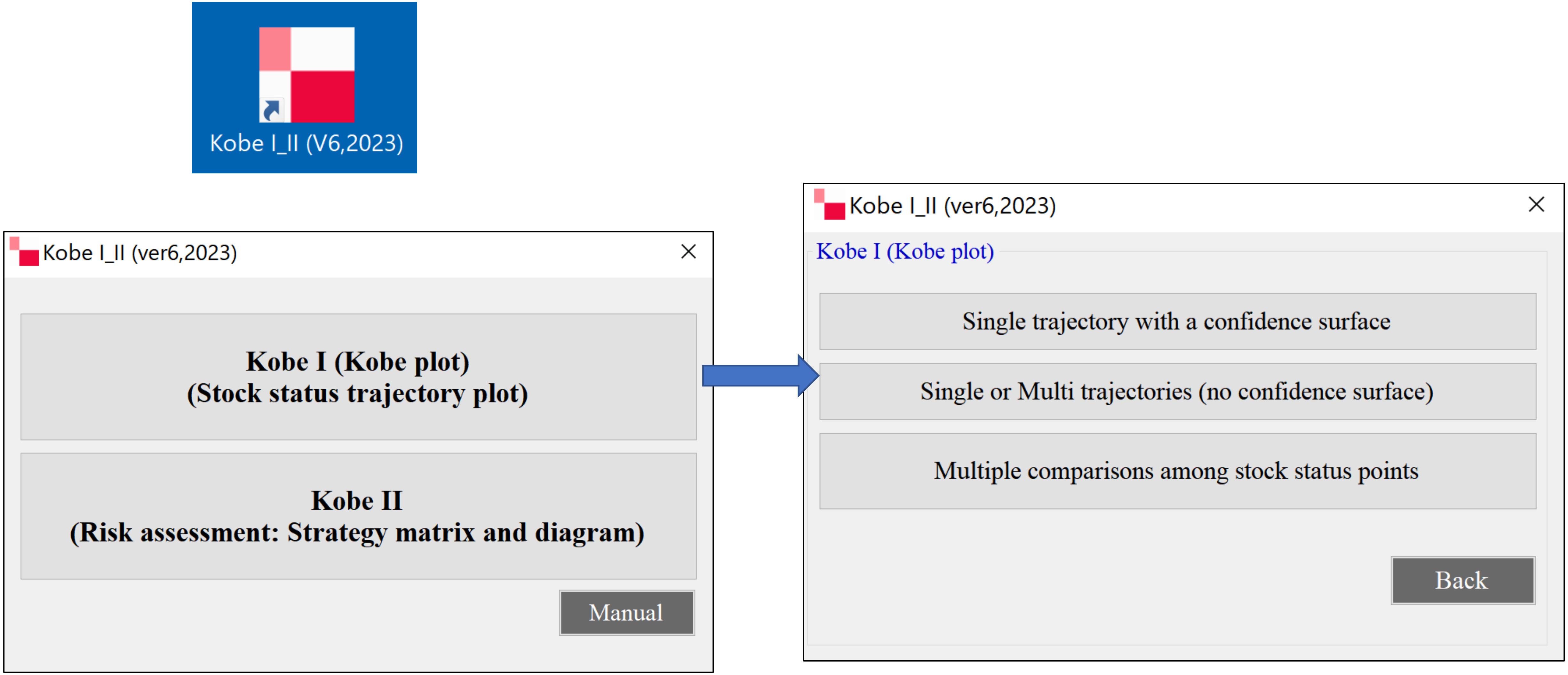
Kazuharu Iwasaki (Software Engineer)

Stock assessment software developing team

www.esl.co.jp/stock_assessment_software_developing_team.pdf

Kobe I_II (V6,2023)

Contents


Kobe I_II (V6,2023)
Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
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Kobe II
(Risk assessment: Strategy matrix and diagram)
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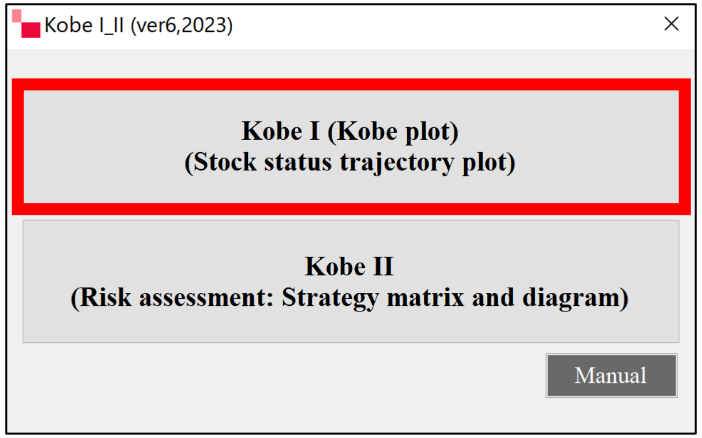
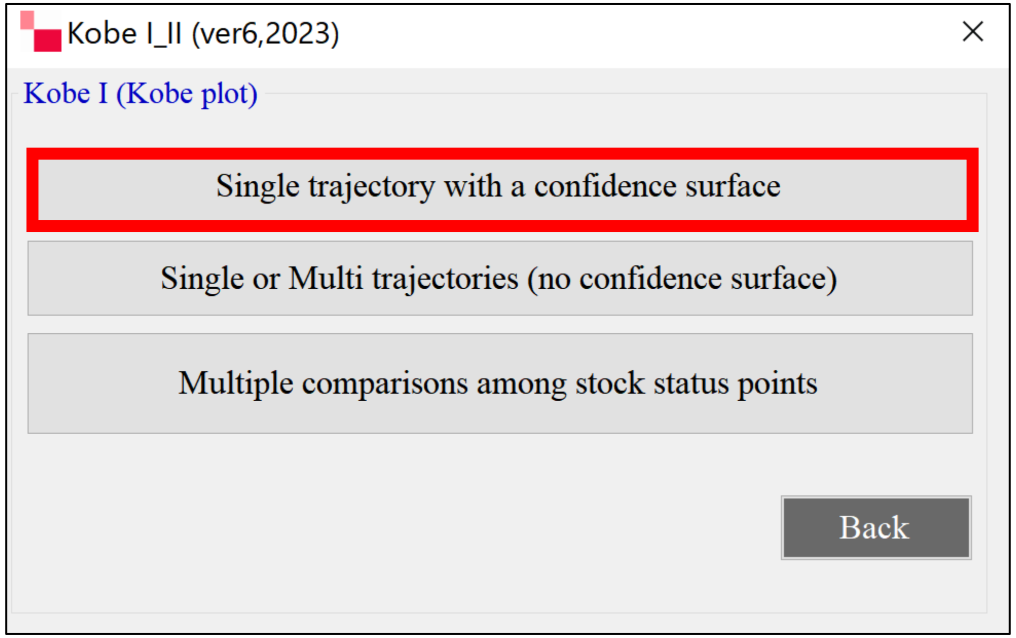
Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
Single trajectory with a confidence surface
Single or Multi trajectories (no confidence surface)
Multiple comparisons among stock status points
Back


Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
(Stock status trajectory plot)
Kobe II
(Risk assessment: Strategy matrix and diagram)
Manual


Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
Single trajectory with a confidence surface
Single or Multi trajectories (no confidence surface)
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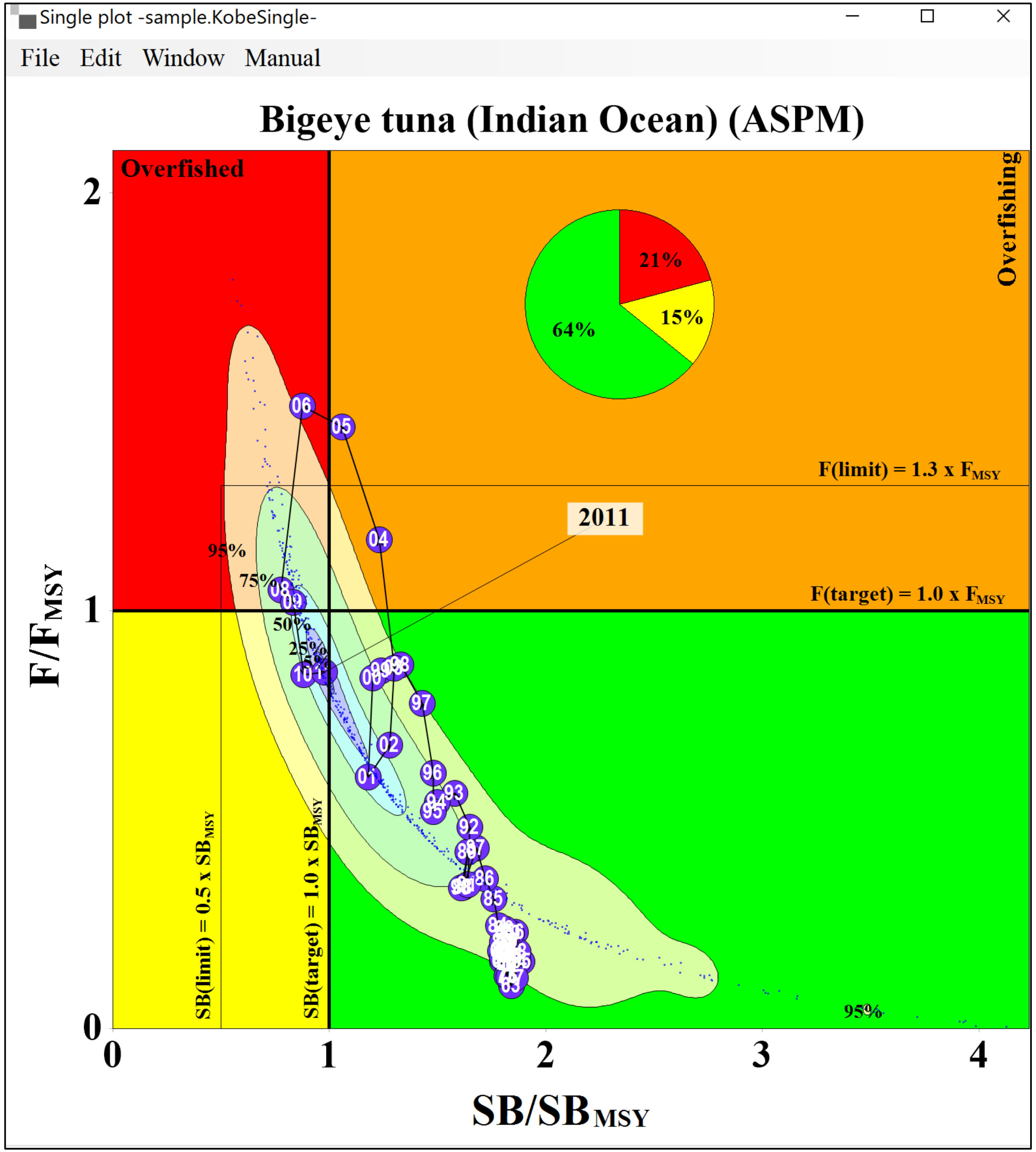

Single plot -sample.KobeSingle-
File
Edit
Window
Manual
Bigeye tuna (Indian Ocean) (ASPM)
Overfished
Overfishing
21%
15%
64%
F(limit) = 1.3 x FMSY
F(target) = 1.0 x FMSY
2011
95%
75%
50%
25%
SB(limit) = 0.5 x SBMSY
SB(target) = 1.0 x SBMSY
F/FMSY
SB/SBMSY
0
1
2
3
4

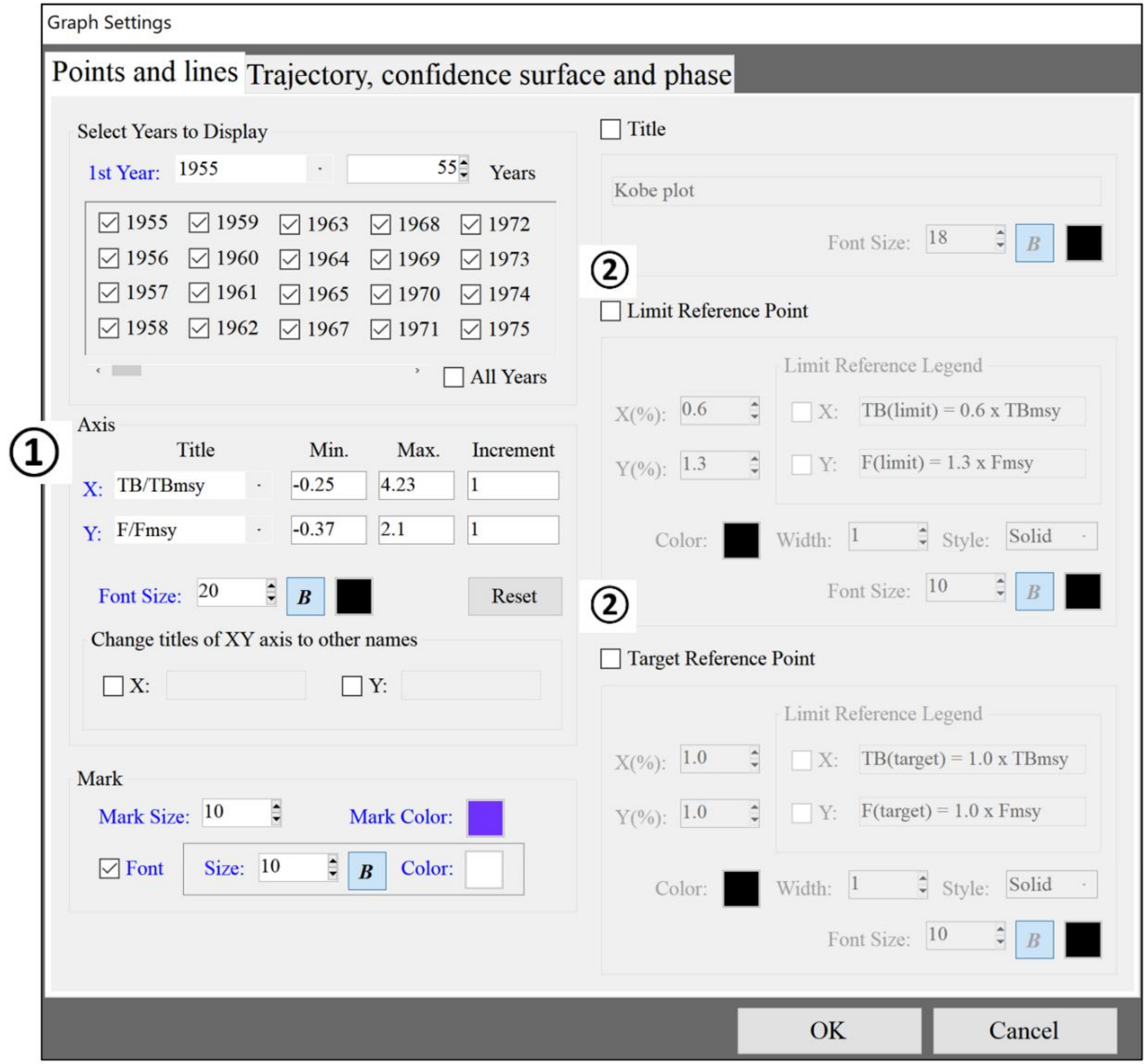
INPUT

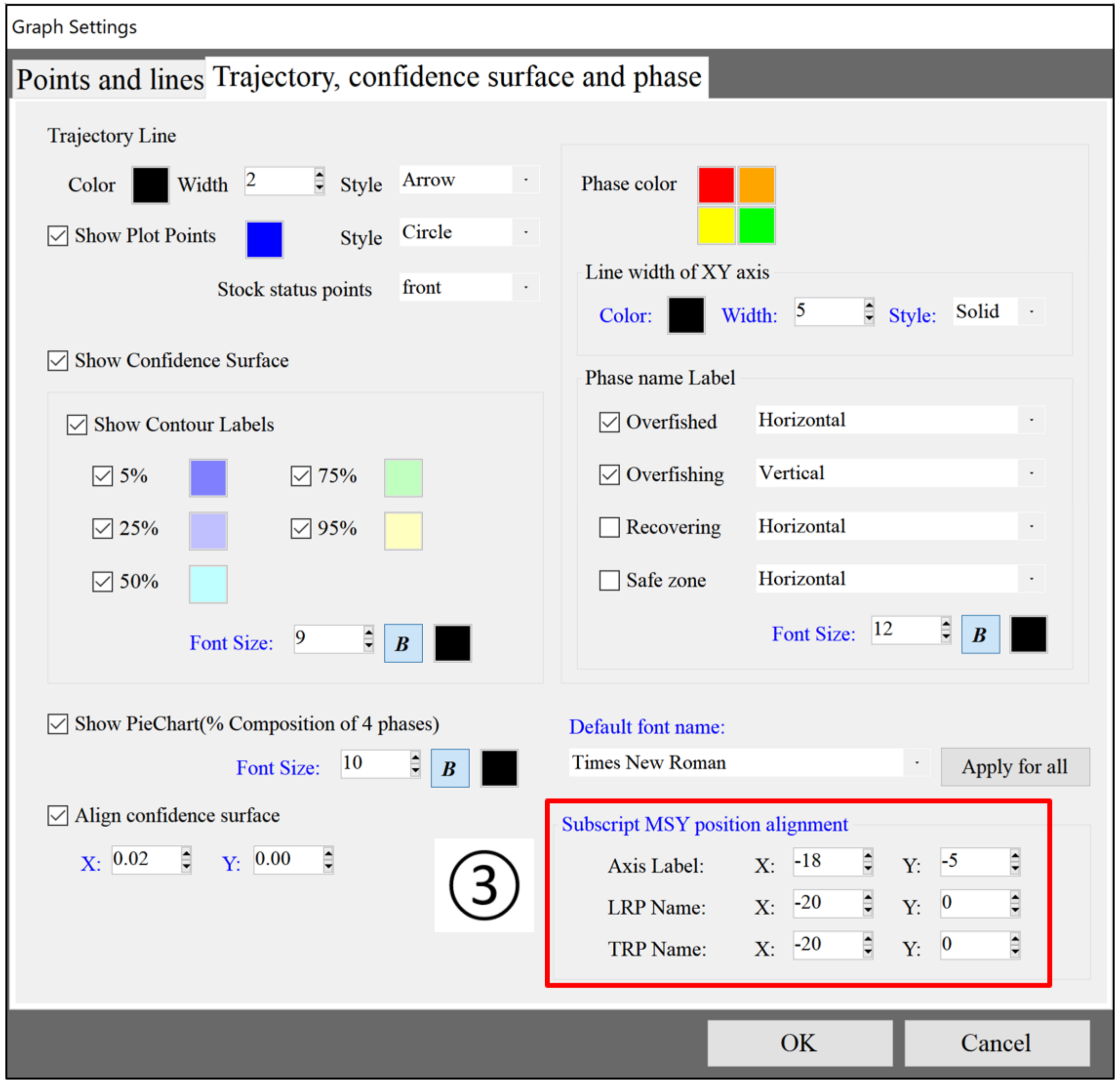
	Column 1	Column 2	Column 3	Column 4	Column 5
row 1	year	Biomass ratio	F ratio	Bratio (Uncertainties)	F(ratio) (Uncertainties)
row 2	1955	1.89	0.16	0.81	1.06
row 3	1956	1.86	0.23	1.01	0.79
row 4	1957	1.81	0.18	1.31	0.55
row 5	1958	1.81	0.20	1.25	0.57
row 6	1959	1.81	0.22	1.51	0.42
row 7	1960	1.79	0.19	1.08	0.70
row 8	1961	1.80	0.16	1.39	0.49
row 9	1962	1.82	0.16	0.80	1.13
row 10	1963	1.84	0.10	0.92	0.88
row 11	1964	1.87	0.16	1.53	0.41
row 12	1965	1.85	0.17	1.06	0.75
			(omitted)		
row 56	2009	0.83	1.02	0.74	1.32
row 57	2010	0.88	0.85	1.42	0.46
row 58	2011	0.98	0.85	0.96	0.84
			(omitted)		
row 59				0.88	1.02
row 60				0.91	0.90
row 61				0.99	0.80
row 62				0.77	1.14
row 63				0.84	1.09
row 64				3.01	0.09
row 65				1.23	0.60
row 66				2.32	0.18
row 67				0.88	0.98
row 68				1.58	0.39
row 69				0.93	0.87
			(omitted)		
row 495				1.05	0.74
row 496				1.23	0.58

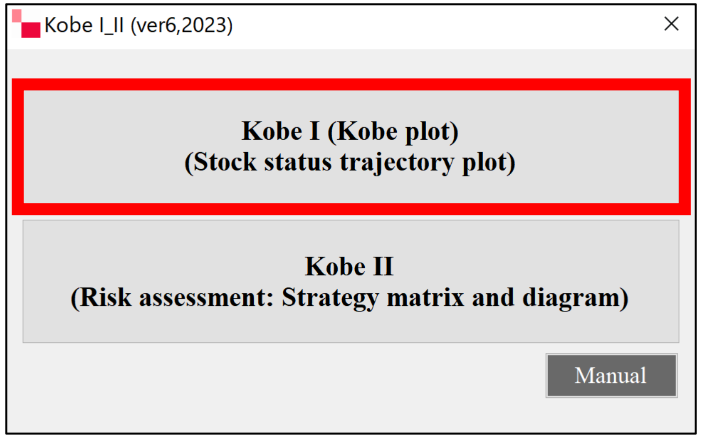
Point estimates (1955-20211)

Uncertainties (500 times bootstrap)

Graph settings to adjust formats of the Plot (many functions to produce users' desired plot)






Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
(Stock status trajectory plot)
Kobe II
(Risk assessment: Strategy matrix and diagram)
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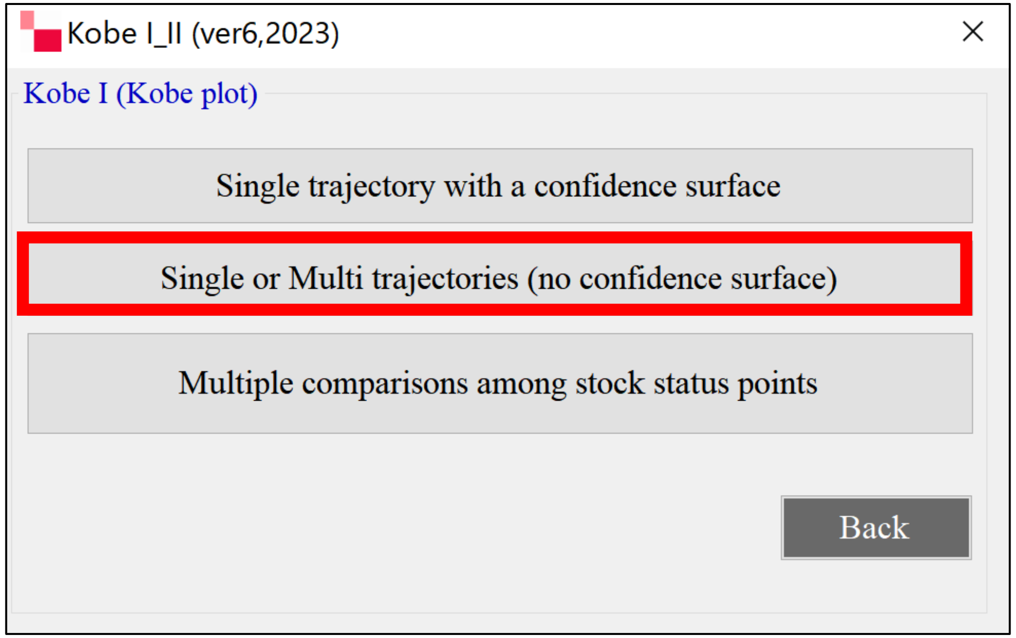
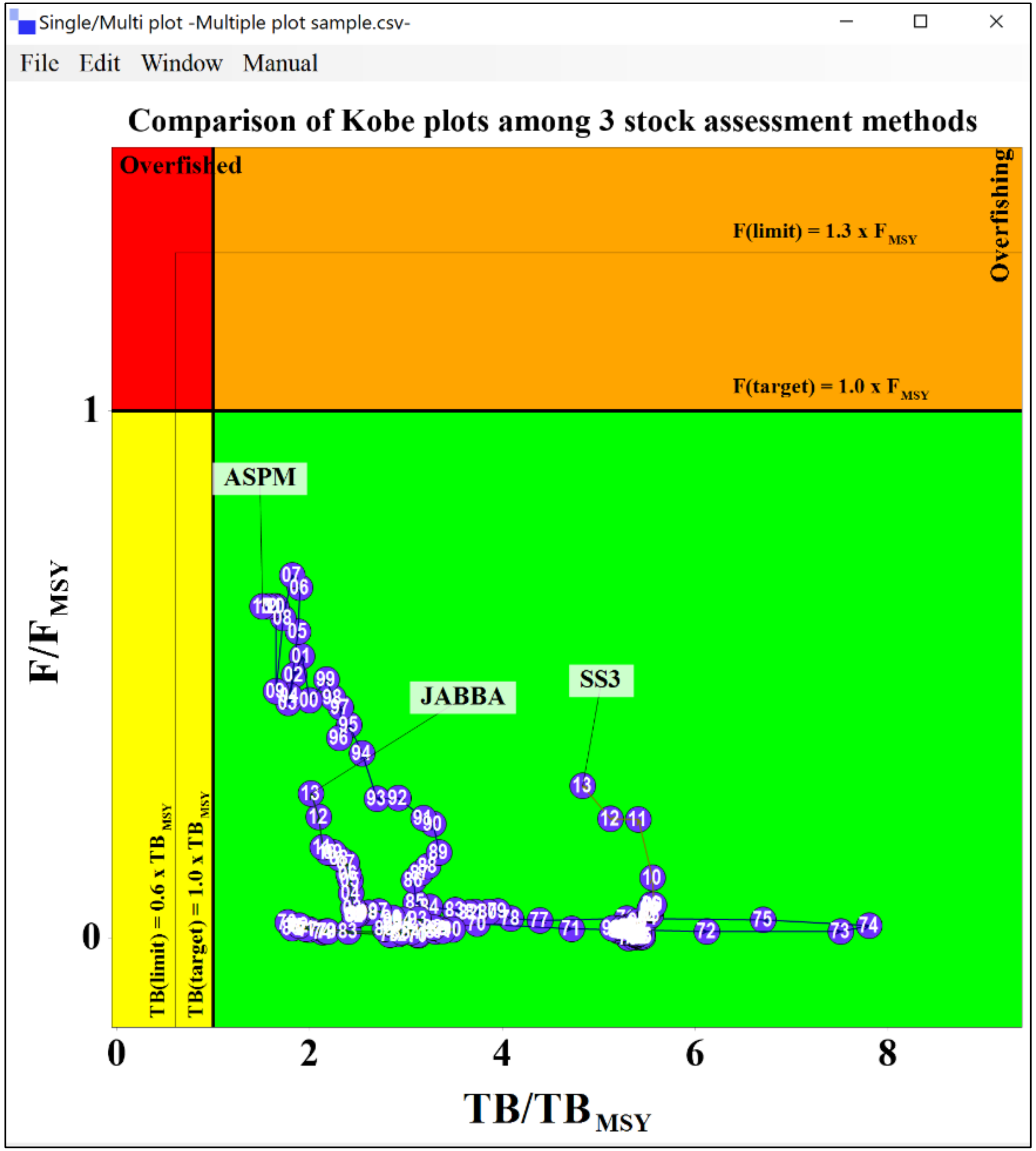

Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
Single trajectory with a confidence surface
Single or Multi trajectories (no confidence surface)
Multiple comparisons among stock status points
Back


Single/Multi plot -Multiple plot sample.csv-
File
Edit
Window
Manual
Comparison of Kobe plots among 3 stock assessment methods
Overfished
Overfishing
F(limit) = 1.3 x F MSY
F(target) = 1.0 x F MSY
ASPM
JABBA
SS3
TB(limit) = 0.6 x TB MSY
TB(target) = 1.0 x TB MSY
F/F MSY
TB/TB MSY
0
1
0
2
4
6
8

Input data for multiple (3) Kobe plots (example)

INPUT

		Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Row 1		Year	Biomass ratio (1)	Fratio(1)	Biomass ratio (2)	Fratio(2)	Biomass ratio (3)	Fratio(3)
Row 2		1970	3.74	0.03	3.13	0.01	5.31	0.00
Row 3		1971	4.72	0.02	3.12	0.01	5.31	0.00
Row 4		1972	6.12	0.01	2.92	0.01	5.37	0.00
Row 5		1973	7.51	0.01	2.83	0.01	5.44	0.00
Row 6		1974	7.81	0.02	2.13	0.01	5.41	0.00
Row 7		1975	6.71	0.04	1.86	0.02	5.46	0.00
Row 8		1976	5.29	0.04	1.77	0.03	5.41	0.00
Row 9		1977	4.39	0.03	1.99	0.02	5.45	0.01
Row 10		1978	4.09	0.04	2.17	0.01	5.39	0.01
Row 11		1979	3.95	0.05	2.19	0.01	5.38	0.01
					omitted			
Row 40		2008	1.72	0.61	2.31	0.15	5.53	0.06
Row 41		2009	1.65	0.47	2.25	0.16	5.57	0.06
Row 42		2010	1.65	0.63	2.19	0.16	5.56	0.11
Row 43		2011	1.62	0.63	2.13	0.17	5.41	0.23
Row 44		2012	1.57	0.63	2.09	0.23	5.12	0.23
Row 45		2013	1.51	0.63	2.01	0.27	4.83	0.29

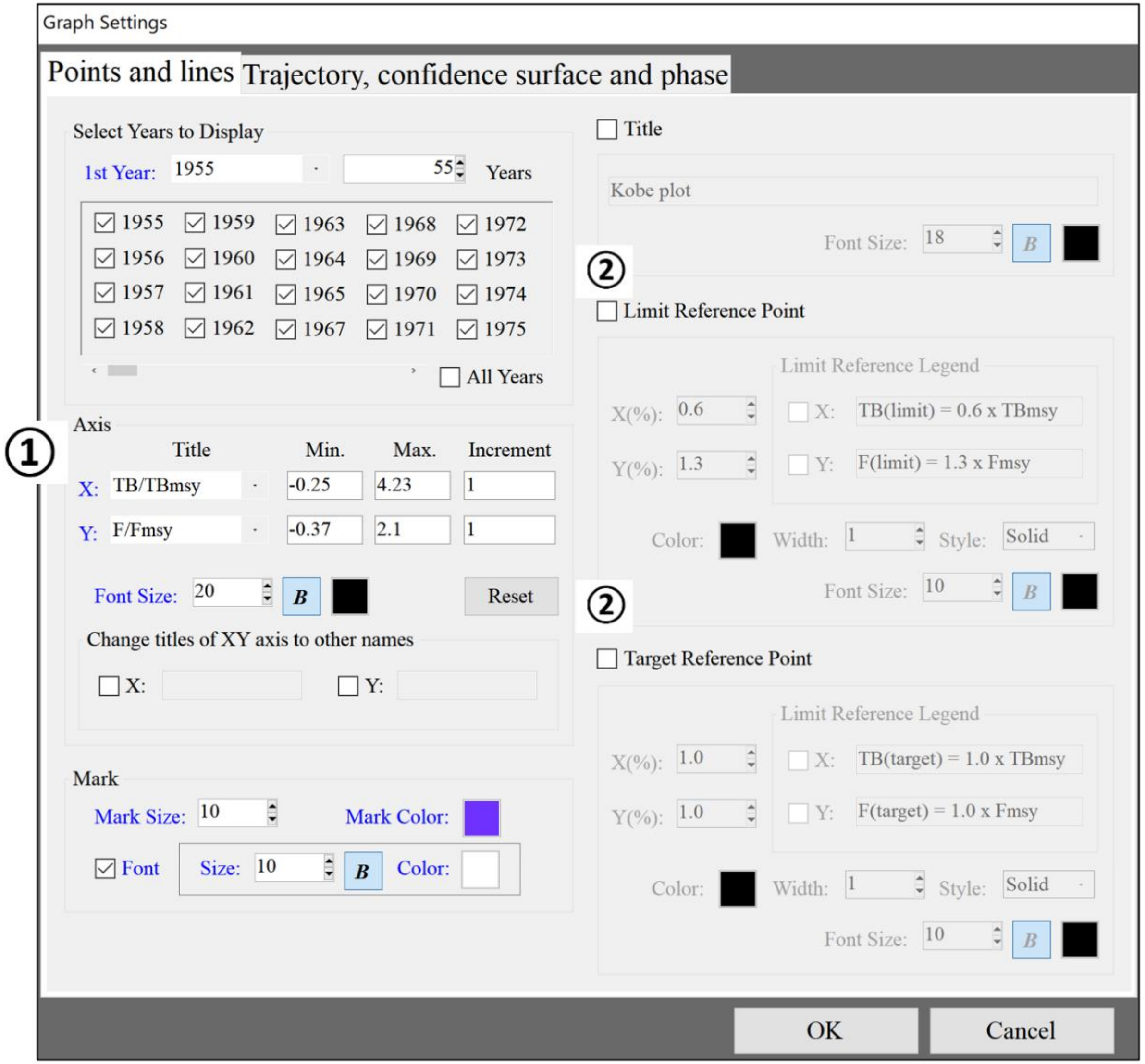
1st data set (ASPM)

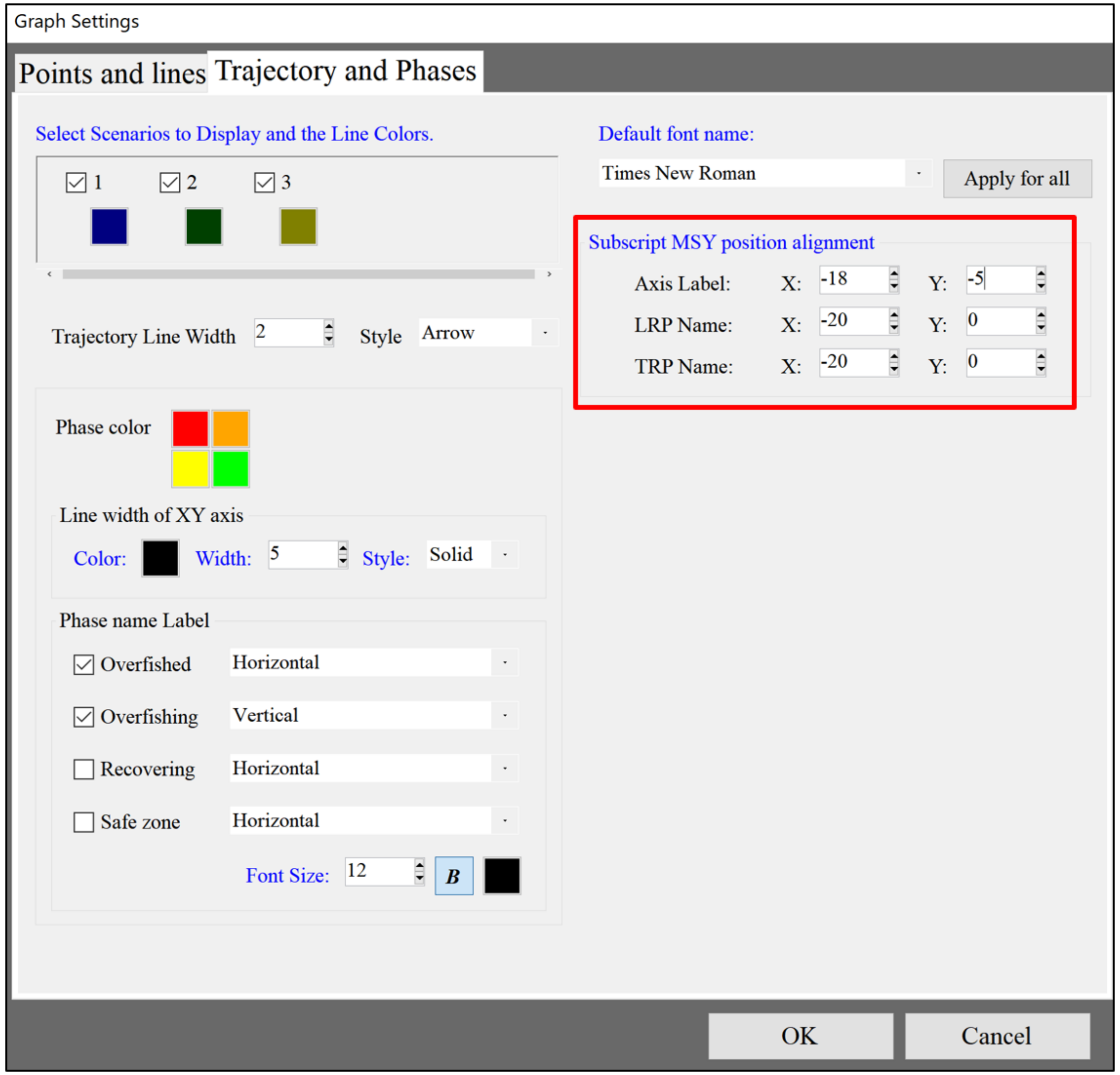
2nd data set (JABBA)

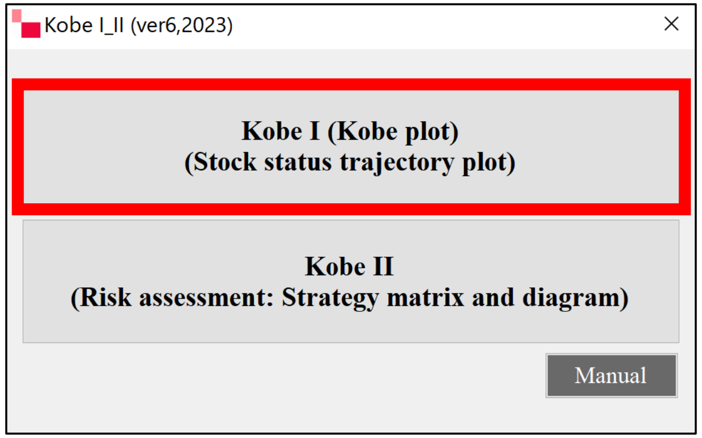
3rd data set (SS3)

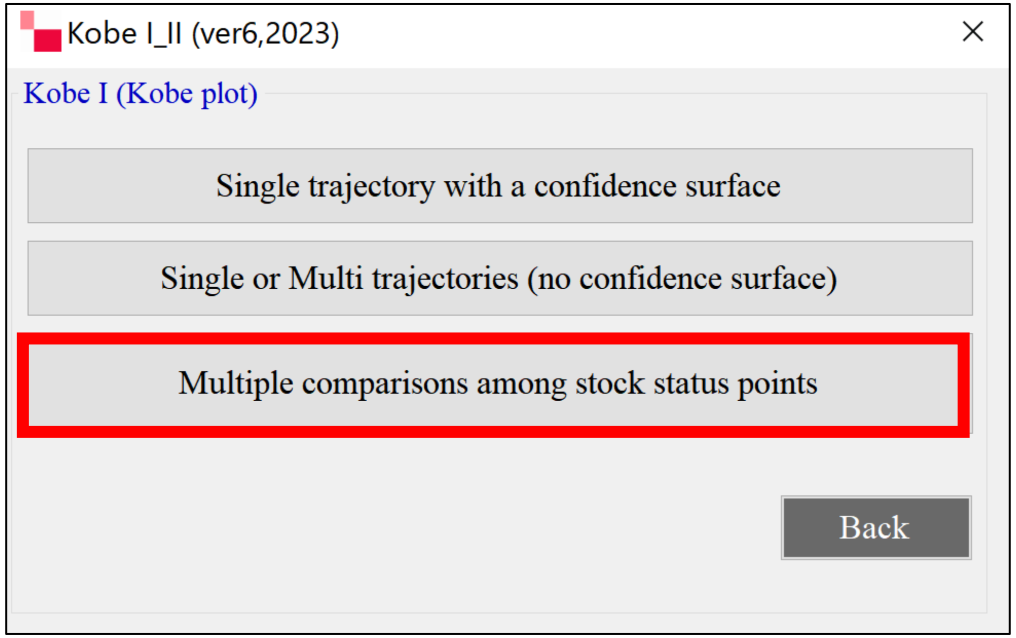
Graph settings to adjust formats of the Plot

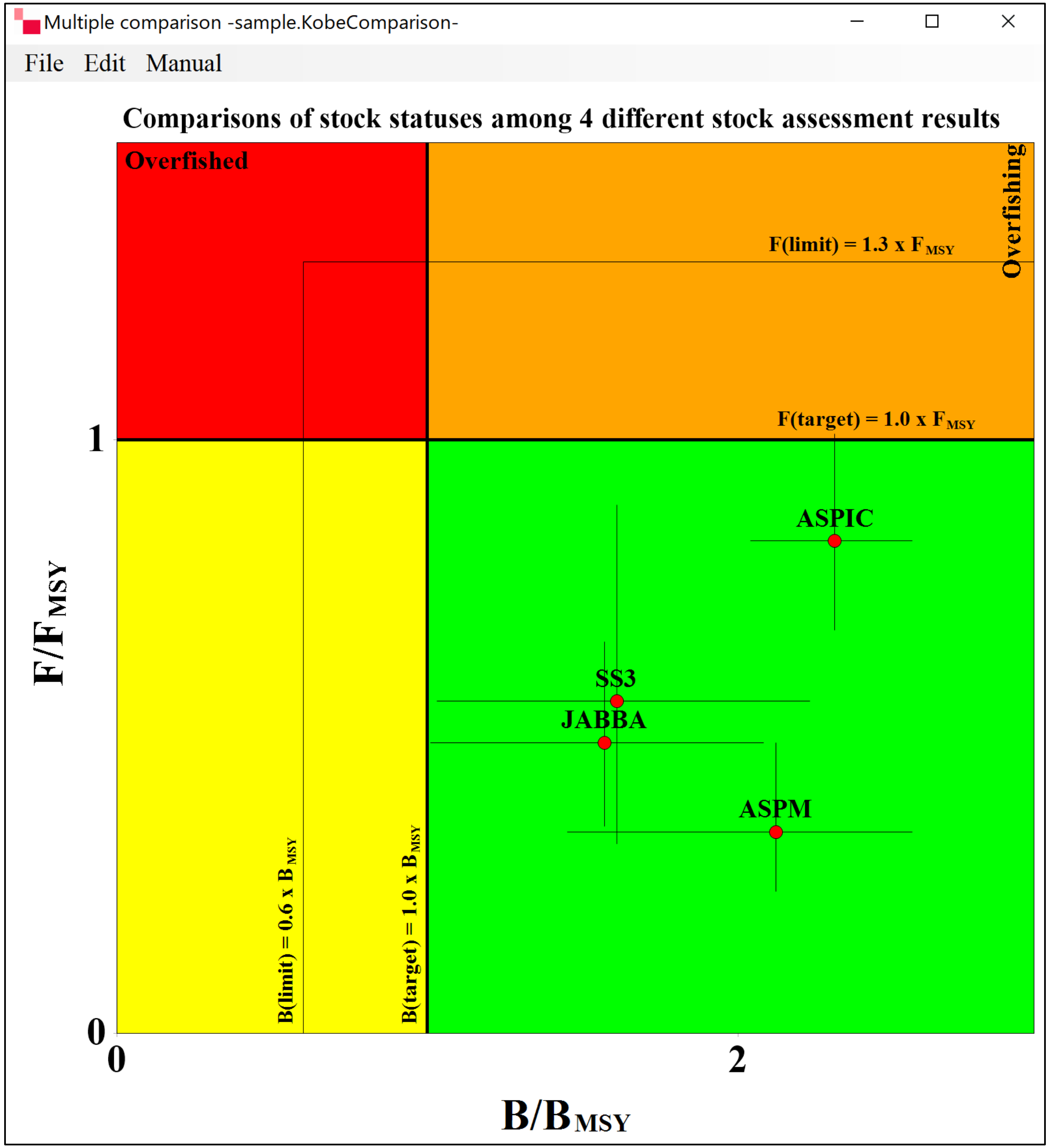
(many functions are available to produce users' desired plot)






Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
(Stock status trajectory plot)
Kobe II
(Risk assessment: Strategy matrix and diagram)
Manual


Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
Single trajectory with a confidence surface
Single or Multi trajectories (no confidence surface)
Multiple comparisons among stock status points
Back


Multiple comparison -sample.KobeComparison-
File
Edit
Manual
Comparisons of stock statuses among 4 different stock assessment results
Overfished
Overfishing
F(limit) = 1.3 x F MSY
F(target) = 1.0 x F MSY
ASPIC
SS3
JABBA
ASPM
B(limit) = 0.6 x B MSY
B(target) = 1.0 x B MSY
F/F MSY
B/B MSY
1
0
0
2

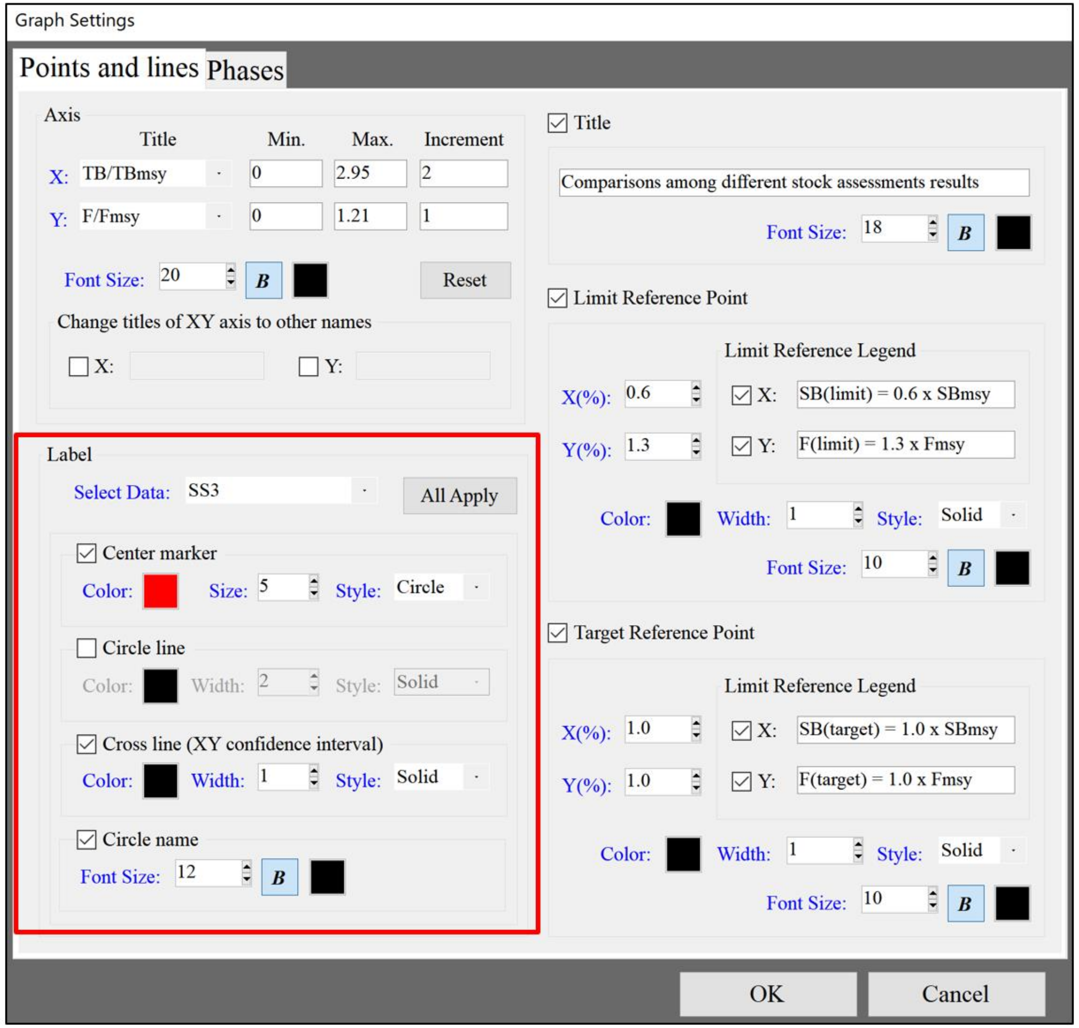
INPUT

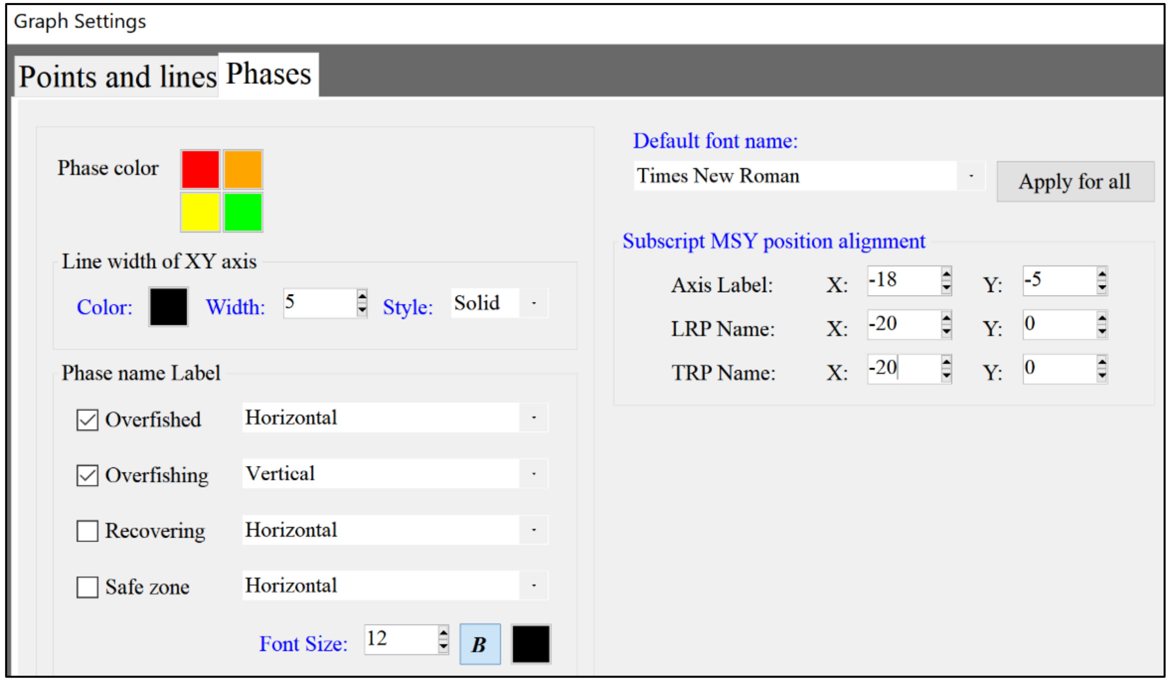
		Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Row 1		stock assessment model	Biomass ratio(point)	Biomass ratio(lower)	Biomass ratio(upper)	F/F_{MSY} (point)	F/F_{MSY} (lower)	F/F_{MSY} (upper)
Row 2		SS3	1.61	1.03	2.23	0.56	0.32	0.89
Row 3		ASPIC	2.31	2.04	2.56	0.83	0.68	1.01
Row 4		JABBA	1.57	1.01	2.08	0.49	0.35	0.66
Row 5		ASPM	2.12	1.45	2.56	0.34	0.24	0.49

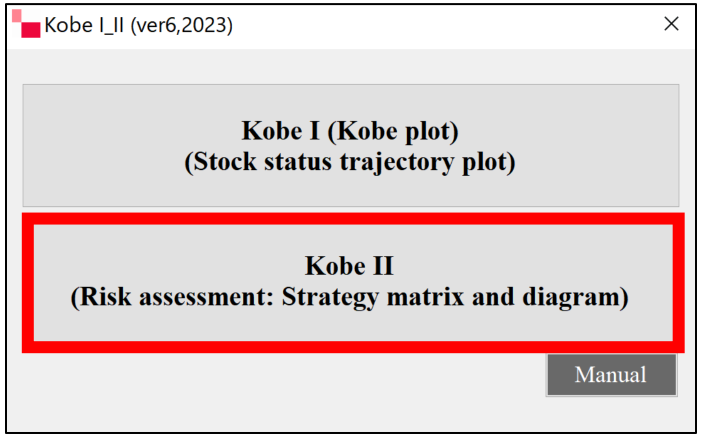
Graph settings to adjust formats of the Plot

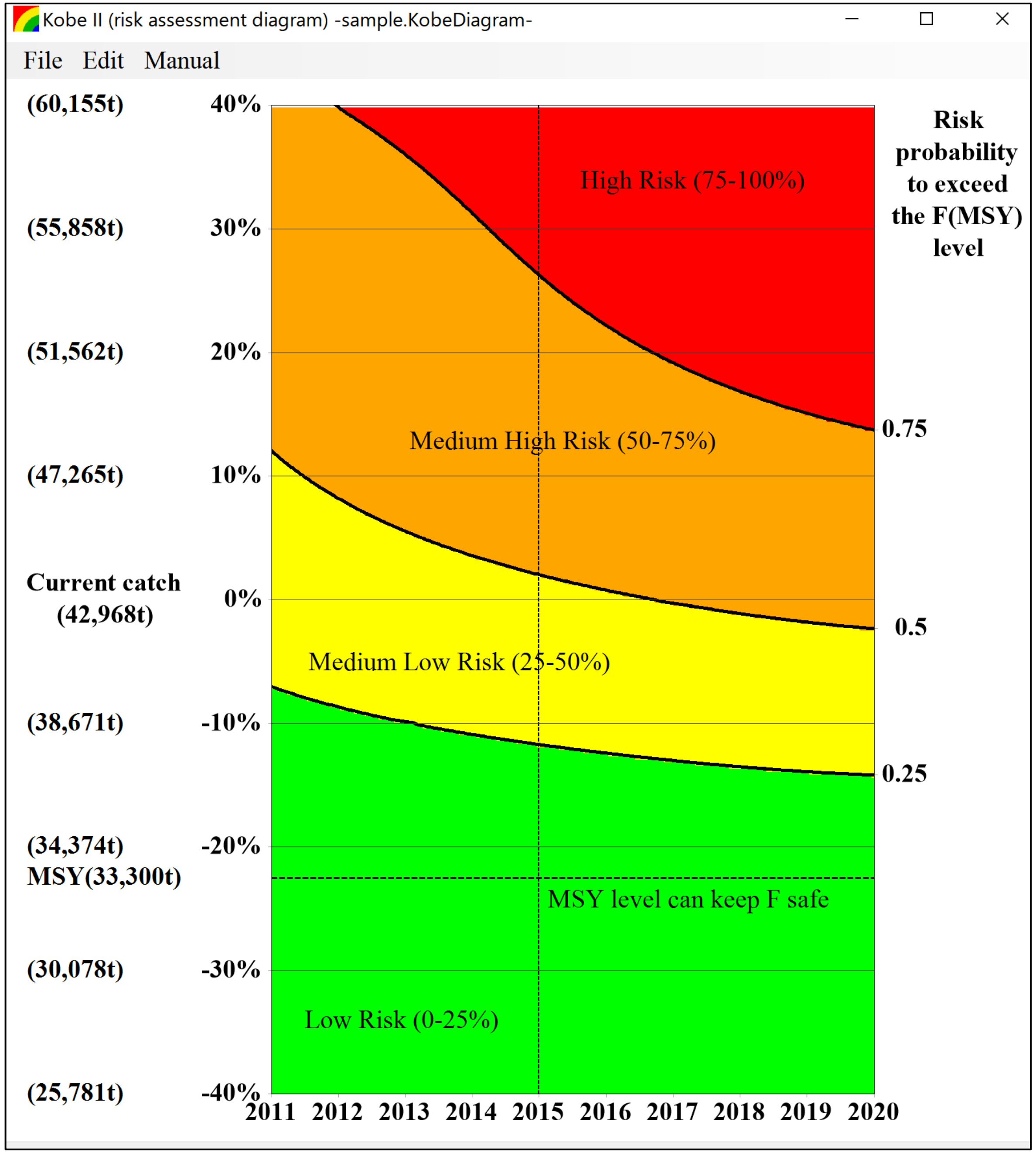
(many functions available to produce users' desired plot)

④






Kobe I_II (ver6,2023)
Kobe I (Kobe plot)
(Stock status trajectory plot)
Kobe II
(Risk assessment: Strategy matrix and diagram)
Manual

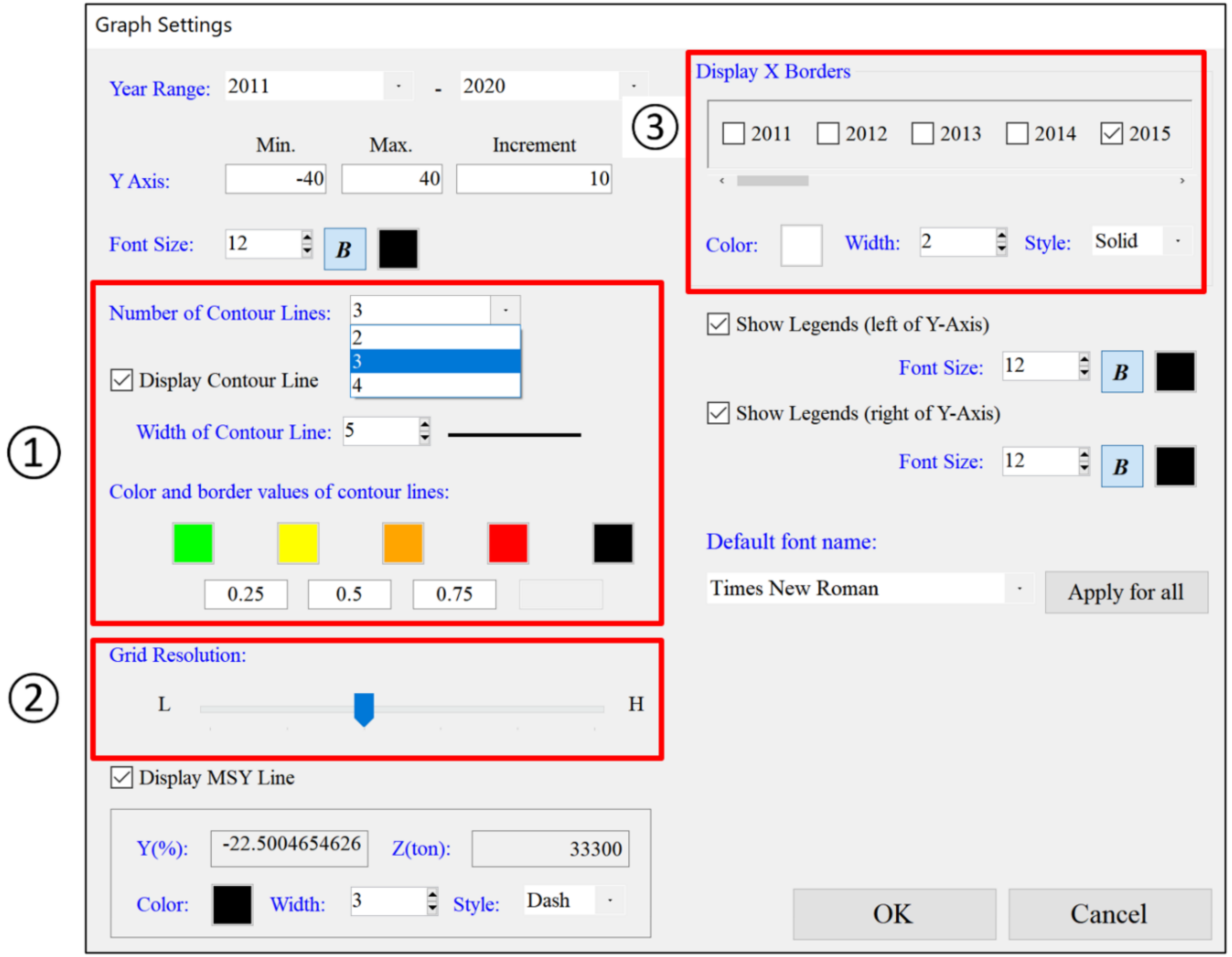

Kobe II (risk assessment diagram) -sample.KobeDiagram-
File Edit Manual
(60,155t) 40%
(55,858t) 30%
(51,562t) 20%
(47,265t) 10%
Current catch (42,968t) 0%
(38,671t) -10%
(34,374t) -20%
MSY(33,300t)
(30,078t) -30%
(25,781t) -40%
High Risk (75-100%)
Medium High Risk (50-75%)
Medium Low Risk (25-50%)
MSY level can keep F safe
Low Risk (0-25%)
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Risk probability to exceed the F(MSY) level
0.75
0.5
0.25

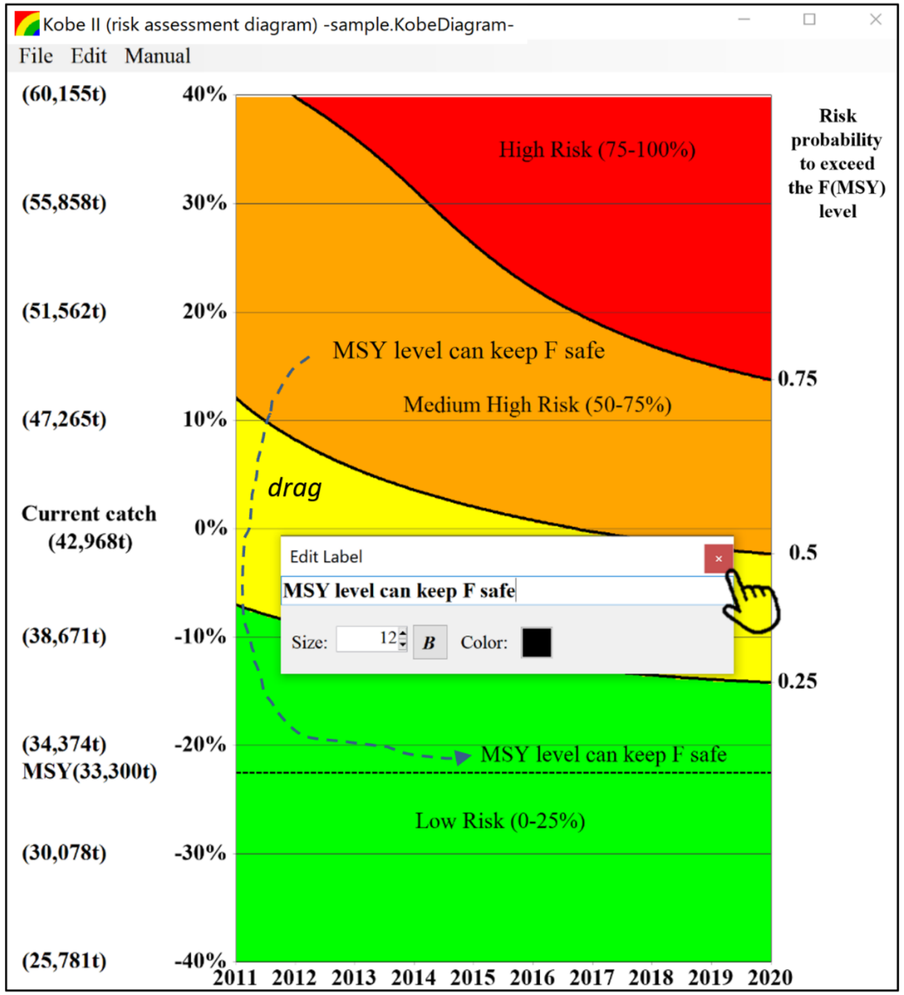
INPUT

		Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12
Row 1			Catch	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Row 2		-40%	25,781	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Row 3		-30%	30,078	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Row 4		MSY	33,300	0.07	0.06	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06
Row 5		-20%	34,374	0.09	0.08	0.07	0.06	0.07	0.07	0.08	0.08	0.08	0.09
Row 6		-10%	38,671	0.21	0.22	0.23	0.25	0.28	0.30	0.31	0.33	0.35	0.37
Row 7		0%	42,968	0.32	0.37	0.41	0.45	0.47	0.50	0.53	0.55	0.57	0.58
Row 8		10%	47,265	0.45	0.51	0.56	0.59	0.62	0.66	0.68	0.69	0.69	0.70
Row 9		20%	51,562	0.57	0.64	0.67	0.70	0.71	0.73	0.74	0.75	0.76	0.78
Row 10		30%	55,858	0.66	0.70	0.73	0.74	0.76	0.78	0.79	0.80	0.81	0.81
Row 11		40%	60,155	0.71	0.74	0.76	0.79	0.80	0.82	0.83	0.83	0.84	0.84

Graph settings & editorial function to change formats of the diagram

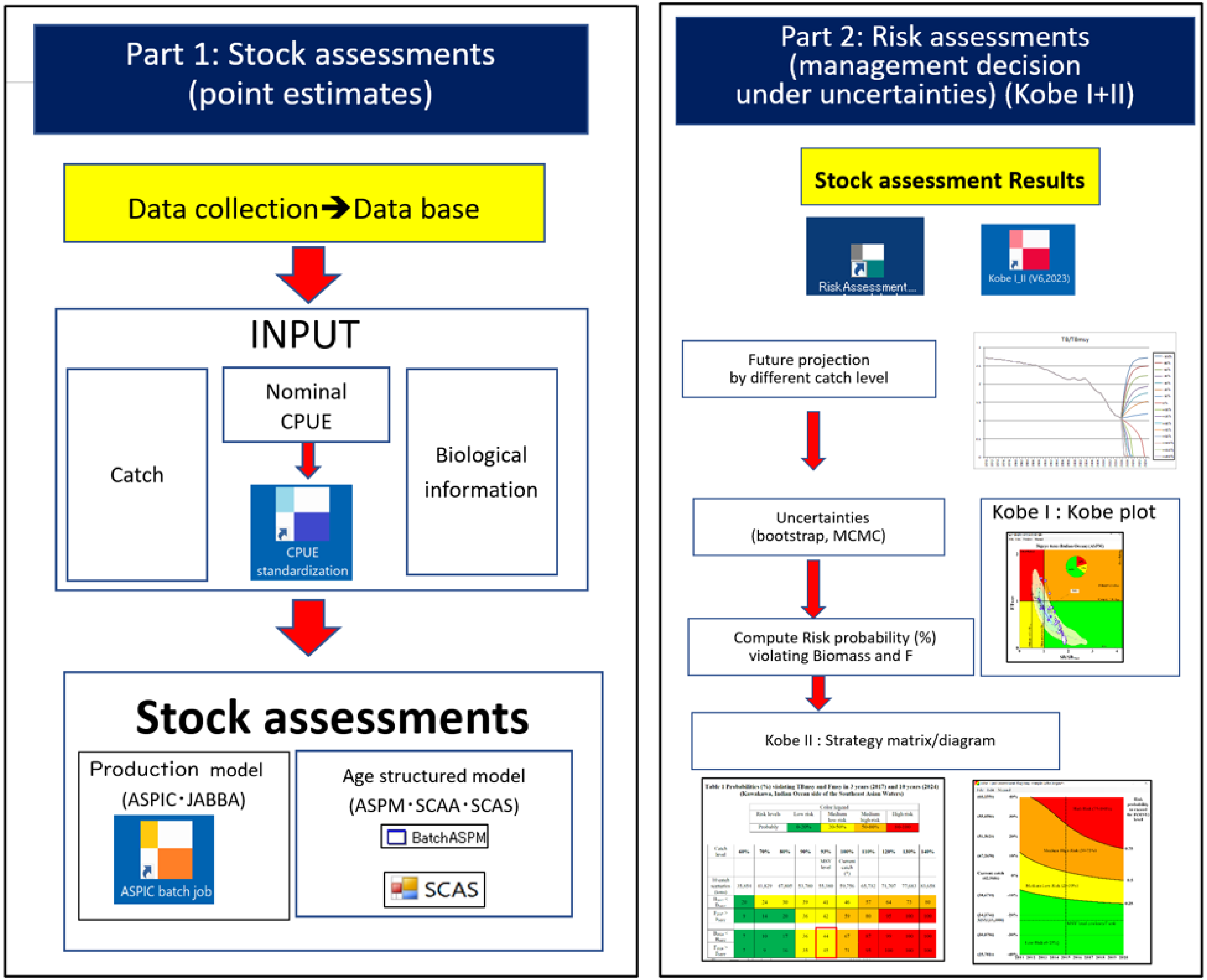
(many functions available to produce users' desirable plot)





Contents

Summary (1)


Part 1: Stock assessments
(point estimates)
Data collection➔Data base
INPUT
Catch
Nominal
CPUE
CPUE
standardization
Biological
information
Stock assessments
Production model
(ASPIC･JABBA)
ASPIC batch job
Age structured model
(ASPM･SCAA･SCAS)
BatchASPM
SCAS
Part 2: Risk assessments
(management decision
under uncertainties) (Kobe I+II)
Stock assessment Results
Risk Assessment...
Kobe I_II (V6,2023)
Future projection
by different catch level
Uncertainties
(bootstrap, MCMC)
Compute Risk probability (%)
violating Biomass and F
Kobe I : Kobe plot
Kobe II : Strategy matrix/diagram

Summary (2)

Different types of menu-drive software (simple & intermediate)

are available to suite different objectives

If users want to utilize our software, we will offer free on-site training

including theory and explanation of Input/Output.

After we will make sure that users can use software properly & understand theory & Input/Output, then software & manuals will be provided.

This is our responsibility.

Our ultimate goal

Stock assessments (SA) <u>for ALL</u> ☺
(no more struggling nor only for SA experts)
for a happy & better life

Questions, Comments, ?

Part II Future collaborative works

(1) Training
(2) Joint works using real data (important species)

No cost are needed as we are funded

by Japanese government, ODA (Official Development Assistance) and other funding agencies.

What is “Compute Pr (Risk) (%)” ?

To compute “Risk Probability” violating MSY levels (TB: Total Biomass and F)

in each catch level using Uncertainties (Bootstrap, MCMC)

For example

If +20% catch from the current catch level continued next 10 years (2033), and if risk probability (F) is 30%,

➔ It means that risk violating the MSY level(F) is 30%.

Step 3: How to compute Pr (Risk) (%) by catch level (future year)?

Re-sample the data

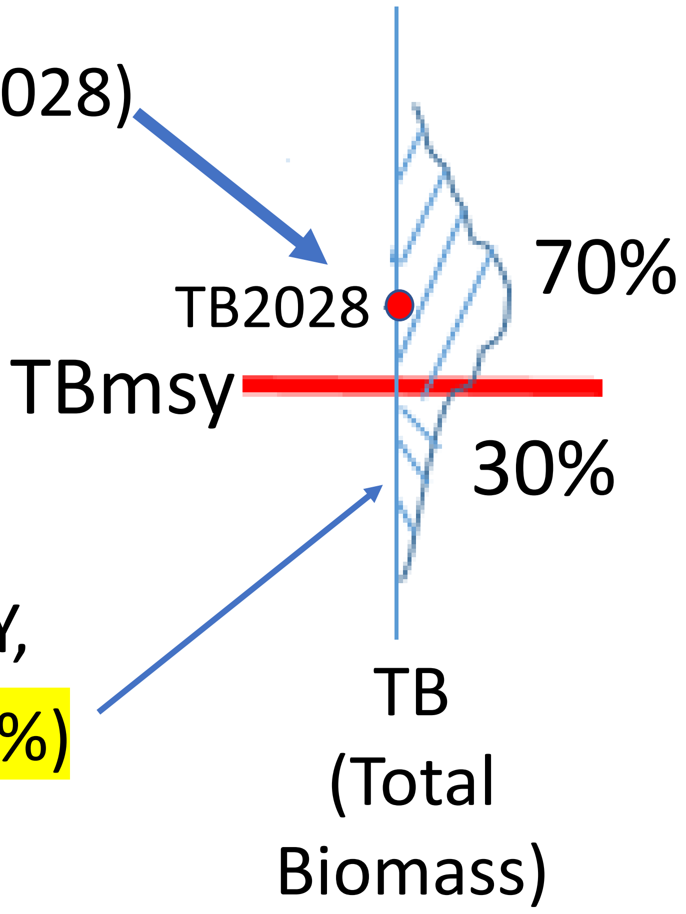
(e.g. TB at +20% from the current catch in 2028)

➔ estimate "error distribution"

In 1,000 times re-sampling trials

if 300 points out of 1,000 are below MSY,

➔ Pr (violating MSY for TB2033) =0.3 (30%)



If N.G., then you need to change other models ➔ 2 step GLM (available in our soft)

But still NG ➔ try other models

GAM, Regression tree, VAST, Negative binomial…

But they are not available in our soft

➔You need to use SAS, R etc.

But no worry from past 15 years experiences,

There were No NG case ! So our soft & your data should be OK !

5 RFMO meeting (2007 and 2009) recommended

Need to compare & evaluate results among a few SA models(*)

as each model has pros & cons

(*) **'Simple', 'intermediate'** & 'advanced(integrated)' model

(different structures & data sets)

If results are similar → certain & confident (e.g. IOTC)

So we can contribute for 'Simple', and 'intermediate',

,while SA expert by SS3 (Advanced).

Win-win situation

Note : we don’t recommend SRA (data poor : catch only method)

- Many assumptions
- Simple but need complex computation due to many assumptions

    ➔ actually not quick & dirty (simple) method

- Relative assessment affected by assumptions
- If catch is regulated (e.g. TAC)

    ➔ will not work (violation of assumption)

- It is much better to use stock assessment models with CPUE

Risk Prob (%) are computed
in each catch level (ASPIC folder)
for all projected years .
(TB and F)

Kobe I+II

Reference Point: F_{MSY}, SSB_{MSY}, TB_{MSY}…

➔ important for management decision making

(population size)

SSB: Spawning Stock Biomass

TB: Total Biomass

(fishing pressure)

F: Fishing mortality

Another Quiz

Kobe Bryant famous US NBA passed away (Jan 27, 2020)

Why his 1st name is Kobe?

Answer

His father (NBA player)

Loves Kobe beef

Kobe Steak House (USA)

That is why his father makes his first name Kobe !!