Sayonara ASPIC and Welcome JABBA to SEAFDEC

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Sayonara ASPIC and welcome JABBA
A Stock Production Model Incorporating Covariates (ASPIC) is one of the surplus production models (SPMs). It has been used in SEAFDEC over the past decade primarily for neritic and oceanic tuna but has recently become outdated theoretically and practically. In contrast, Just Another Bayesian Biomass Assessment (JABBA) is a more recent SPM that can offer more reliable, robust and plausible results. For this reason, the authors strongly recommend that fish stock practitioners switch from ASPIC to JABBA.

Routine assessments using the JABBA-HCR approach
Based on past experience, it has been observed that participants, during and especially after stock assessment training sessions organized by SEAFDEC, require the assistance of resource persons to carry out proper, reliable and plausible stock assessments. This situation will continue even if JABBA is introduced. In addition, in previous SEAFDEC meetings, recommendations were made to conduct routine stock assessments for important species (neritic tuna), which are still pending. To address these issues, the introduction of routine stock assessments using the JABBA-Harvest Control Rule (HCR) approach needs to be considered. A simple HCR can derive catch limits or Total Allowable Catch (TAC) using only catch or CPUE without conducting full stock assessments. Hence, this approach can be implemented by stock assessment practitioners in the SEAFDEC Member Countries without the assistance of resource persons.

Implementing the JABBA-HCR approach
The initial stage of implementing the JABBA-HCR approach should prioritize the unhealthy stocks in the most important species. As an example, it can be carried out as follows: (1) JABBA will be conducted with the assistance of resource persons every three years; and (2) during the two years between these assessments, SEAFDEC can independently implement annual HCRs to derive the TAC without the assistance by resource persons (refer to the text for the healthy stock case). This will enable routine assessments in a timely and cost-effective manner while complying with pending recommendations. This effort is vital for SEAFDEC to fulfil its mission of securing sustainable food sources and livelihoods for its Member Countries.

Sustainable capacity building framework
This framework is designed to supervise trainees' stock assessment work continuously, especially after the training, to ensure that they achieve satisfactory proficiency. In this regard, Thailand, Indonesia, Sri Lanka and the Republic of Korea have shown strong interest in this approach and have requested to carry it out. Between 2024 and 2026, eight face-to-face training sessions were conducted with 49 participants. The initial sessions mainly comprised lectures and practices for the newly developed menu driven JABBA software. This software makes it possible to implement proper, transparent and reliable assessments smoothly. During the initial training sessions, a few important species were selected in each country and preliminary assessments were carried out. Afterwards, online training and discussion sessions have been implemented for 1–3 years to complete the full assessment work. In addition, to demonstrate their proficiency, they were asked to write scientific papers to submit to international peer-reviewed journals. Unlike the normal snapshot-type training, this approach enables continuous collaboration between stock assessment practitioners and resource persons, ensuring its sustainability. Some of their achievements are introduced and referenced in this article. Implementing this approach in SEAFDEC will be quite challenging or impossible under its current structure.

Two main issues with JABBA
In summary, the authors address two important issues to initiate JABBA-related activities: (1) routine assessments by the JABBA-HCR approach under the current SEAFDEC structure; and (2) sustainable capacity building framework with JABBA and other models through long-term supervision. It includes follow-up online training and discussion sessions as well as publication support to ensure assessments conducted are proper, reliable and plausible.

Introduction

This article reviews past stock assessment activities in SEAFDEC and proposes a future direction based on the perspective of the authors experienced with conducting these initiatives. One of proposals is to introduce JABBA (Just Another Bayesian Biomass Assessment) (Winker *et al.* 2018), one of the most advanced and powerful surplus production models (SPMs). While ASPIC (A Stock Production Model Incorporating Covariates) has been the standard SPM within SEAFDEC for the past decade, it is now technically and theoretically outdated. To facilitate the efficient implementation of JABBA, Nishida and Iwasaki (2024) developed the menu driven JABBA software without using R (engine of JABBA).

Regarding JABBA, two important issues are raised in this article, *i.e.* the routine stock assessments and sustainable capacity building. For the first issue, the JABBA-Harvest Control Rule (HCR) is introduced. This will enable routine assessments in a timely and cost-effective manner, while at the same time, its recommendations can be complied with. This effort is vital for SEAFDEC to fulfil its mission of securing sustainable food sources and livelihoods for its Member Countries. Derived catch limits or TAC should only serve as a reference since SEAFDEC does not function as a Regional Fisheries Management Organization (RFMO); hence, compliance is not mandatory. Nevertheless, Member Countries are encouraged not to exceed the recommended catch limits.

For the second issue, the authors introduce the sustainable capacity building framework by the following reasons. Based on past experience, it has been observed that participants were unable to carry out proper, reliable and plausible stock assessments after training sessions. This is because resource persons cannot supervise their own assessment work after the training as this is beyond the scope of their contracts. This can be solved through the sustainable (continuous) capacity-building framework. The actual activities carried out in Thailand, Indonesia, Sri Lanka and the Republic of Korea are introduced.

In summary, the author addresses to initiate two JABBA-related activities in SEAFDEC: (1) routine assessments by the JABBA-HCR approach under the current SEAFDEC structure and (2) sustainable capacity building framework by JABBA or other models under a special arrangement.

Review of Stock Assessment Practices Within SEAFDEC

Table 1 shows the three types of fish stock assessment models. This section reviews SEAFDEC's use of these models in the past and suggests future directions, with a particular focus on the implementation of JABBA.

Table 1. Summary of the three types of fish stock assessment models

Type	Data characteristics	Information (data type)	Data volume (actual data)	Data period	Reference point (RP) (MSY, F_{MSY}, TB_{MSY}, target & limit RP)	Models and application (examples)	Implementation methods
TYPE 1	Qualitative	✓Parameters ✓Attributes				• ERA • PSA	✓R ✓SRAplus
TYPE 2	Quantitative	✓Real data ✓Parameter values	(a) Data limited (length)	Short (< a few years)	Temporal & relative [snap shot type]	• Length or age based models (ELEFAN, FiSAT, Y/R (YPR), S/R (SPR), LBSPR, Thompson & Bell, TropFishR)	✓Software ✓Shiny ✓Others
			(b) Data limited (catch)	Long (> 10 years)	Available [Relative, less reliable and less robust]	• Depletion rate assumed (CMSY & OCOM) • Depletion rate not assumed (ORCS & SSCOM) • Robin-hood methods	✓Excel ✓R ✓Others
TYPE 3		✓Real data ✓Parameter values ✓Priors (Bayesian approach)	(a) Data moderate (catch + CPUE + priors)		Available [reliable, robust and objective]	• Surplus Production models (SPM) (ASPIC, SPiCT, **JABBA**)	✓Own codes ✓R ✓[MENU]
			(b) Data rich (catch + CPUE + biology + priors + life history)			• Age/size structured model (VPA, ASPM, SCAA, SCAS) • Integrated models (SS, CASAL)	

ASPM Age-structured Production Model
CASAL C++ Algorithmic Stock Assessment Laboratory
CMSY Catch MSY (advanced state-space Bayesian method)
ELEFAN Electronic length frequency analysis
ERA Ecological Risk Assessment
FiSAT FAO-iCLARM Stock Assessment Tools
LBSPR Length-based Spawning Potential Ration
[MENU] Menu driven fish stock assessment software development team (Japan)
OCOM Optimized Catch-Only Model
ORSC Only Reliable Catch Stocks
PSA Productivity Susceptibility Analysis
SCAA Statistical-catch-at-age Model
SCAS Statistical-catch-at-size Model
SPiCT Stochastic surPlus Reduction Model in Continuous Time
SPM Surplus Production Model
S/R (SPR) Spawner per Recruit Analysis
SRA Stock Reduction Analysis (catch only SA)
SS Stock Synthesis
SSCOM State-space Catch-only Model
VPA Virtual Population Analysis
Y/R (YPR) Yield per Recruit Analysis

Type 1 (qualitative) assessments

Type 1 assessments are qualitative approaches using parameters and attributes such as Ecological Risk Assessment (ERA) and Productivity Susceptibility Analysis (PSA). Type 1 assessments have not yet been conducted in SEAFDEC. FAO is currently preparing PSA for specific species in Southeast Asia, with the second author of this article participating in the project. In addition, a technical workshop on PSA was held in SEAFDEC/TD in 2025 to build the capacities of the participants (SEAFDEC/TD, 2025). These activities will eventually pave the way for its gradual implementation in SEAFDEC Member Countries.

Type 2 (data limited) stock assessments: (a) length and (b) catch

Outline
Type 2 (data-limited) assessments are classified into two types: Type 2(a), which is based on short-term length-frequency data, and Type 2(b), which is based solely on catch data over a longer period. Since SEAFDEC Member Countries generally do not have long-term catch, CPUE nor biological data, Type 2(a) assessments have been mainly implemented. Type 2(a) assessments provide only a **snapshot** evaluation of stock status based on relative and temporary assessments over a short period. Hence, Type 2(a) cannot produce robust or reliable MSY, stock status and reference points compared to Type 3 assessments (see next section). While Type 2(b) uses a longer period of catch data and thus provides slightly more reliable results, its application in Member Countries has been limited.

Application in SEAFDEC
Software for Type 2(a) fish stock assessments, such as ELEFAN, FiSAT, LBSPR, and Thomson and Bell, have been developed by organizations such as FAO and ICLARM as well as by various universities and research institutes. These organizations have been providing extensive training worldwide, including for SEAFDEC Member Countries. Because of their user-friendly design, they can be accessed by a wide range of users. SEAFDEC Member Countries apply these tools to waters mainly within their own countries because (1) application in a closed area is a basic assumption under these models; and (2) the input data (length) can be easily obtained over a short period in these small regions.

Training within SEAFDEC
SEAFDEC/TD conducted a training session in 2023 at the SEAFDEC/TD facility in Samut Prakan, Thailand titled "Regional Training Course on Data-Limited Fish Stock Assessments Using R-Statistical Program" to encourage Member Countries to apply Type 2(a) assessments using the R computer language (SEAFDEC/TD, 2023). The second co-author of this article was the resource person for the session.

Type 3 (a) data moderate and (b) data rich

Outline
Type 3 assessments are based on a longer period of data (ideally more than ten years). There are two subtypes based on data availability. For Type 3(a) (data moderate), assessments use catch and CPUE. Representative approaches include surplus production models such as ASPIC and JABBA. For Type 3(b) (data rich), assessments include additional biological data. Representative approaches include integrated models such as SS (*stock synthesis*) and CASAL (*C++ Algorithmic Stock Assessment Laboratory*).

The ASPIC model has served as the primary tool for Type 3(a) assessments in SEAFDEC over the last decade and its relevant activities are summarized in **Table 2**. There is no documented application of Type 3(b) data rich assessments in SEAFDEC Member Countries.

Advantages
Type 3 assessment results are based on long-term population dynamics (ideally spanning more than 10 years) which can provide reliable MSY, F_{MSY},TB_{MSY}, target and limit reference points and can therefore provide more reliable and robust results than Type 2 assessments.

ASPIC in SEAFDEC
ASPIC has been the primary stock assessment tool used in SEAFDEC over the last ten years primarily for neritic and oceanic tuna. To consider future stock assessment efforts in SEAFDEC, it is important to understand the ASPIC-related activities conducted in SEAFDEC as summarized in **Table 2**. During the same period, SPMs after ASPIC have evolved and improved concurrently. These advancements will be discussed in the next section.

ASPIC and JABBA

Evolution of SPMs

Table 3 shows the evolution of surplus production models (SPMs), tracing their trajectory from the original equilibrium SPMs in the 1950s to the most recent Bayesian state-space SPMs developed in the 2010s. The three original SPMs, which have been the standard for almost six decades (1950s–2000s), were based on an assumption of an equilibrium condition (biomass unchanging), which rarely occurs. The emergence of non-equilibrium models, including ASPIC, represented a significant shift in the 2000s. They were actively used for almost two decades (2000s–2010s). Afterwards, the (three) Bayesian state-space SPMs have served as the primary standard over the last decade.

Table 2. ASPIC and JABBA related activities in SEAFDEC and Member Countries (2016–2026)

Year	Activities	Funded by	Programming language or software	Resource persons and/or assistants	Reference
Neritic Tuna (ASPIC)					
2016	Neritic tuna projects (training & publication)	SIDA	Menu driven software	Dr. Nishida (FRA) Dr. Supapong (TD) Dr. Taki (MFRDMD)	SEAFDEC (2026)
2017					
2018					
2019					
2020					
2021		JTF			MFRDMD (2021)
2024	Training and Publication (seerfish)	JTF	ASPIC 5 (Prager, 2013) (original language)	Dr. Matsumoto (FRA) Dr. Supapong (TD)	MFRDMD (2024)
Other Species (ASPIC & JABBA)					
2016	SSS (Sulu and Sulawesi Seas) project. Assessment of Oceanic tuna & publication	JTF	Menu-driven software	Dr. Nishida (FRA) Dr. Supapong (TD)	Nishida (2017) Pangsorn & Nishida (2020)
2017					
2018					
2019					
2020	Training (Vietnam)				
2022	2nd Regional Training Workshop	FAO	Original JABBA	Dr. Rishi Sharm (FAO) Others	FAO (2022)
2023	Seminar	SEAFDEC & [MENU]	Updated ASPIC menu driven software	Dr. Nishida [MENU] Dr. Supapong (TD)	SEAFDEC (2024)
2024	1st joint workshop Thailand (DOF) & [MENU] (training & publication) (*)	DOF & [MENU]	Menu driven software (ASPIC)	Dr. Nishida [MENU] Dr. Supapong (TD) Mr. Weerapol (DOF)	DOF & [MENU] (2024)
	1st joint workshop BRIN (Indonesia) & [MENU]	BRIN & [MENU]	Menu driven software (JABBA)	Dr. Nishida [MENU]	
2025	2nd joint workshop Thailand (DOF) & [MENU] (training & publication) (*)	DOF & [MENU]		Dr. Nishida [MENU] Dr. Supapong (TD) Mr. Weerapol (DOF)	DOF & [MENU] (2025)
2026	2nd joint workshop BRIN (Indonesia) & [MENU] (training & publication) (plan)	BRIN & [MENU]		Dr. Nishida [MENU] Dr. Supapong (TD)	

SIDA: Swedish International Development Cooperation Agency
JTF : Japan Trust Fund
BRIN: National Research and Innovation Agency (Indonesia)

(*) *Dr. Supapong* (TD) was officially invited as a resource person upon the approval by the SEAFDEC SG
[MENU] Menu driven fish stock assessment software development team (Japan)

Table 3. Evolution of SPMs (Surplus Production Models)

Type	Authors	Features				Remarks
		Non-equilibrium condition (biomass changing over time)	Bayesian approach	Error type		
				Observation error (CPUE)	Process error (Model)	
Original SPM	Schaefer (1954), Pella & Tomlinson (1969) and Fox (1970)					Original SPM
ASPIC (ver2~5)	Prager (2004-2013)					Non-equilibrium SPM
ASPIC (ver7)	Prager (2014~)					
SPiCT (Stochastic surplus production model in continuous time)	Pedersen & Berg (2017)	*incorporated*	*incorporated*	*incorporated*	*incorporated*	Bayesian state space SPM
JABBA (Just Another Bayesian Biomass Assessment)	Winker *et al.* (2018)					
JABBA-Select	Winker *et al.* (2020)					

(Note) Representative SPMs are listed. For others, refer to Cousido-Rocha et al. *(2022)*

Problems with ASPIC

ASPIC has three main limitations: (1) ASPIC accounts only for observation errors, whereas statistical models incorporate both observation errors (the variance between observed and predicted values) and process errors (difference between actual and predicted biomass changes); (2) ASPIC relies on the Root Mean Squared Error (RMSE) estimation method, which produces biased results when parameters are selected at the local minimum due to incomplete searches; and (3) the RMSE cannot estimate uncertainties precisely as in the Bayesian approach; as a result, it cannot generate reliable uncertainties and forecasts required for Kobe I (Kobe plot) and Kobe II (Risk assessment).

Bayesian state-space SPM and JABBA

Over the past decade, the development of the Bayesian state-space SPMs has addressed the limitations of earlier assessment methods such as ASPIC. This coincides with the duration of ASPIC utilization in SEAFDEC (**Table 4**). The three key Bayesian state-space models currently in use are SPiCT (Pedersen and Berg, 2017), JABBA (Winker *et al.*, 2018), and JABBA-Select (Winker *et al.*, 2020). JABBA is suggested as the preferred successor to ASPIC in SEAFDEC for three practical reasons: (1) it is an annual-based and discrete-time model like ASPIC; (2) it accepts the coarse-scale data mainly available in SEAFDEC Member Countries; and (3) JABBA is a user-friendly application that provides ready-made figures and tables. These three factors can facilitate a more seamless transition from ASPIC to JABBA for users.

Table 4. Timeline of the transition from ASPIC to JABBA within SEAFDEC

Year	ASPIC	JABBA	Publication of three key Bayesian state-space SPMs
2016	Training, application and publication (SEAFDEC)		
2017			SPiCT (2017)
2018			JABBA (2018)
2019			
2020		Welcome!	JABBA-select (2020)
2021			
2022		2nd Regional training workshop (FAO)	
2023		1st joint workshop by BRIN (Indonesia) and [MENU] (JAPAN)	
2024			
2025	Sayonara!	2nd joint workshop by DOF (Thailand) and [MENU] (Japan) (Lizardfish & short mackerel)	
2026		2nd joint workshop by BRIN (Indonesia) and [MENU] (plan)	

Comparison summary (ASPIC vs. JABBA)

Table 5 compares features between ASPIC and JABBA, highlighting the benefits of transitioning to JABBA.

Table 5. Comparison between ASPIC and JABBA

Specification	ASPIC	JABBA
Equilibrium condition (biomass unchanging)	*Incorporated*	*Incorporated*
Estimation method	*RMSE*	*Bayesian state-space approach*
Optimum results	*Problem of apparent results*	*Robust*
Observation error	*Incorporated*	*Incorporated*
Process error	*Not incorporated*	*Incorporated*
Estimation of uncertainties	*Less accurate*	*Accurate*

(advantage; disadvantage)

JABBA in SEAFDEC

As detailed in **Table 4**, JABBA has been introduced through four training sessions conducted in SEAFDEC and its Member Countries.

Sayonara ASPIC and Welcome JABBA

What is the future direction for stock assessment practices within SEADEC?

Figure 1 illustrates the frequency of stock assessment activities for Types 1, 2 and 3 based on a comprehensive review of past stock assessment practices within SEAFDEC in this article. Type 2 (data limited) accounted for approximately 80 percent of the total, followed by Type 3(a) (data moderate) assessments at almost 20 percent; Type 1 (qualitative) and Type 3(b) (data rich) contribution is almost nil.

Table 6 shows a summary of the future directions for the three stock assessment models also based on this review. Future Type 3 (data moderate) assessment models, particularly JABBA, will be discussed in more detail in the next section.

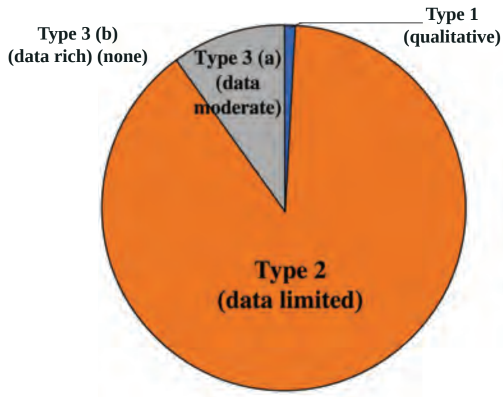


Figure 1. The frequencies of Types 1, 2 and 3 stock assessment models used within SEAFDEC to date

Table 6. Future direction of stock assessments for SEAFDEC based on the review in this article

Type	Data Type	To Date	Future
Type 1	Qualitative (parameter)	• FAO is preparing PSA for SEAFDEC species Workshop on PSA (SEAFDEC, 2025)	• Continue this initiative and apply other approaches, such as ERA
Type 2	Quantitative (data limited)	• Length-based models and catch only methods have been conducted using software	• Continue to apply
Type 3	Quantitative (data moderate)	• SPM: ASPIC has been used	• Change to JABBA
	Quantitative (data rich)	• No age-structured models (integrated models) were used	• Simple age structured model ASPM (*) can be initiated

(Note) (*) Menu driven ASPM (Age Structured Production Model) software is available in [MENU], which has been used many times in the IOTC

The challenges in implementing Type 3 stock assessment

Type 3 stock assessment models are essential for providing reliable and robust MSY-based reference points based on long-term population dynamics, which cannot be obtained by Type 2 (data limited) nor Type 1 (qualitative) assessments. In this regard, if catch and CPUE data gathered over a long period are available, SEAFDEC should apply Type 3(a) data moderate assessments (JABBA), especially for species deemed important in the livelihoods in Member Countries. In addition, the first application of a simple Type 3(b) (data-rich) assessment model with biological data in SEAFDEC can be initiated. For example, the Age Structured Production Model (ASPM) could be implemented using the ASPM software with a menu driven interface developed by [MENU]. To ensure proper and reliable assessments, resource persons must supervise participants' work even after the training sessions through a special arrangement to be discussed later.

JABBA-HCR Approach

To address these challenges and provide management advice such as setting catch limits (TAC) without access to resource persons, the harvest control rule (HCR) can be a useful and effective solution for SEAFDEC. HCR has been developed over many years and is used globally. Some model-free HCRs are simple and effective, relying solely on catch or CPUE data to derive catch limits. These HCRs can allow stock assessment practitioners in SEAFDEC Member Countries by themselves to derive catch limits without any assistance from the resource persons.

Two examples of simple models include: (1) TAC derived from the average catch in the most recent three years (data limited case) (ICES, 2022); and (2) TAC derived from the slope of the CPUE against time over the last five years. The second HCR was originally developed by *Professor Doug Butterworth* (University of Cape Town; the technical reviewer of this article) and has been applied in Regional Fisheries Management Organization (RFMOs), which included the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Northwest Atlantic Fisheries Organization (NAFO), and the South East Atlantic Fisheries Organization (SEAFO) **(Figure 2)**.

The JABBA-HCR approach should be implemented only for important species in SEAFDEC. This approach can be conducted by two ways by the stock status: (1) (top priority) for unhealthy stocks, JABBA can be implemented every three years with the support of resource persons. During the two intervening years, stock assessment practitioners can apply HCRs to derive the annual TAC. (2) (less priority) for healthy stocks For healthy stocks, JABBA can be implemented every five years without using HCR in collaboration between resource persons and SEAFDEC stock assessment practitioners. In this way, effective routine assessments can be implemented in a timely and budget-friendly manner as shown in **Figure 3.**

Based on comprehensive and in-depth discussions presented thus far, the main theme of this article, *"Sayonara ASPIC and Welcome JABBA to SEAFDEC,"* has now been clearly addressed.

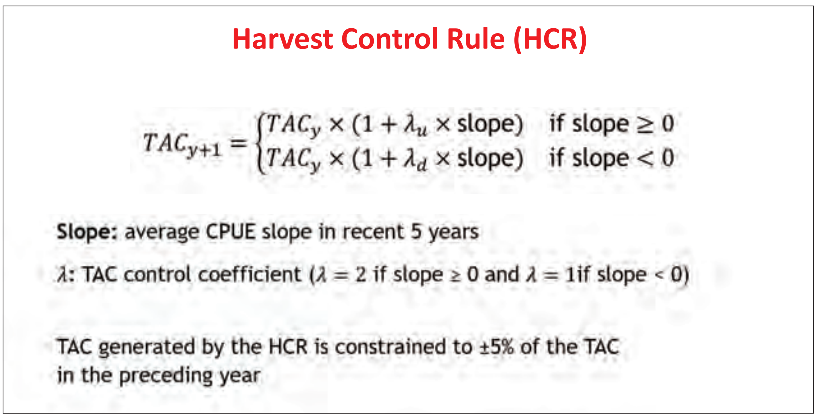


Figure 2. HCR to derive TAC using average CPUE slopes from the last five years (SEAFO, 2014)

Preparation			(1) Unhealthy stock (3 years cycle) (JABBA-HCR approach)													
			Phase		1st			2nd			3rd			4th		
2027	2028	2029	Methods	Responsibility	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
(1) Decide on a simple HCR method (2) Identify stock status by JABBA To be implemented by resource persons and stock assessment practitioners in SEAFDEC			HCR	SEAFDEC		update	update		update	update		update	update		update	update
			JABBA	Resource persons & SEAFDEC	update			update			update			update		
			(2) Healthy stock (5 years cycle) (only JABBA)													
			Phase		1st					2nd					3rd	
			JABBA (no HCR)	Resource persons & SEAFDEC	update					update					update	

Figure 3. Example of schedules of routine stock assessments for the most important species in SEAFDEC, designed to comply with the recommendations of previous consultative meetings: (1) 3-year cycle using the JABBA-HCR approach for unhealthy stocks and (2) 5-year cycle using only JABBA (without using HCR) for healthy stocks

Note: Since SEAFDEC is not an RFMO, any derived TAC or catch limits are non-mandatory. These figures serve as references and management targets for Member Countries

Menu driven JABBA software

Outline

While the original JABBA software is based on the R statistical computer programming language, its direct application depends on users who know how to code. In developing countries, few users can apply programming languages such as R. To bridge this gap, [MENU] has been developing various menu driven fish stock assessment-related software that does not require any programming nor application-specific languages. In addition, this software was designed for beginners/non-experts using fewer technical terms and is as easy to operate as standard applications such as Windows, MS Word and Excel. **Figure 4** illustrates this concept.

The menu driven JABBA software was developed by Nishida and Iwasaki (2025), with technical assistance from article co-author *Professor Wang* (National Taiwan Ocean University) and article reviewer *Professor Emeritus Butterworth* (University of Cape Town). It is based on the original paper by Winker *et al.* (2018), with the practical section referring to 'Good Practices for SPMs' by Kokkalis et al. (2024). **Figure 5** shows a schematic diagram of the original JABBA application.

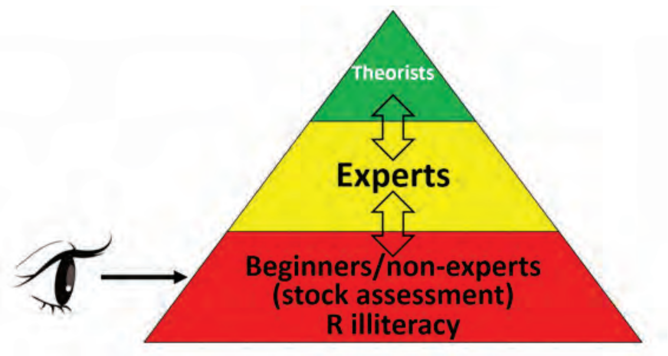


Figure 4. Types of stock assessment specialists and their composition. Target users for menu driven software are at the bottom

Professor Wang linked the original JABBA R source codes into a menu-driven software that implements two standard SPMs (Schaefer, 1954 and Fox, 1970). While the original JABBA application includes the general model with four parameters developed by Pella and Tomlinson (1969), it is not included in the menu driven JABBA software because its results tend to be similar to those of the Schaefer or Fox models. This also keeps the software simple. The entire process runs automatically through the menu interface making it easy, consistent and transparent for anyone to use.

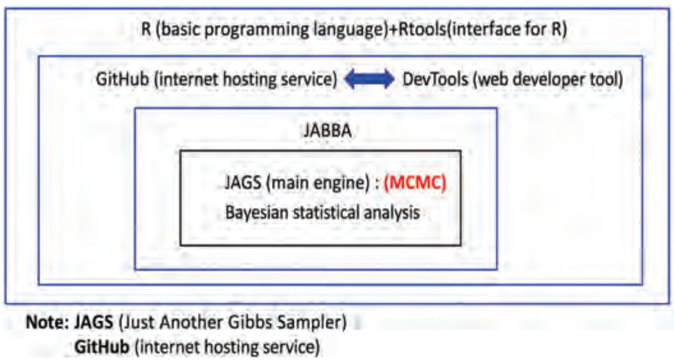


Figure 5. Schematic diagram of JABBA components and their relationships

Grid search approach

JABBA uses six parameters **(Table 7)**. When no information on depletion levels is available, the software employs a grid search approach with three default prior configurations: (1) observation and process variances, where priors are defined in the original paper; (2) r and K, where empirical priors based on prior knowledge form the accumulated information as stated in **Table 7**; and (3) q, which follows the original JABBA protocol and is estimated during optimization using Markov Chain Monte Carlo (MCMC).

Table 7. Six parameters/priors and SPMs in JABBA; Original vs. Grid search approach

No.	Parameters	Meanings	Priors	Original	Grid search approach	
1	r	Intrinsic population growth rate	Log normal model	• Mean • SE=1		
			Uniform model	• Mini and max	• Min~max: median & 95% CI by species available in FishBase (FAO). 95% CI (upper & lower border) is used for mini & max	empirical priors
2	K	Carrying capacity	Log normal model	• Mean • SE=1		
			Uniform model	• Mini and max	• 2*Max (Catch)~10*Max (Catch) (*)	empirical priors
3	q	Catchability	Uniform model	• Parameters will be estimated during the JABBA optimization		default
4	ψ (psi)	Depletion	Log normal model	• Mean value (0~1) • SE=0.2	• Inspection of the full range (0~1) by 0.2 (base case) (8 grids) & 0.1 (sensitivities) (4 grids)	grid search
5	σ^2_{η}	Process variance	Inverse gamma model (fixed)	• Shape=4 • Scale=0.01	$\sigma^2_{\eta} \sim 1/gamma(4,\ 0.01)$	
6	$\sigma^2_{\varepsilon,y,i} = \hat{\sigma}^2_{SE,y,i} + \sigma^2_{fix} + \sigma^2_{est,i}$	Observation variances	(1) Basic variance $\sigma^2_{SE,y,i}$	• Estimated CV by fleet in standardized CPUE		
			(2) Additional variance (fixed) σ^2_{fix}	• $(0.2)^2$		default
			(3) Additional variance $\sigma^2_{est,i}$.	• Inverse gamma model (shape parameter=0.001 and scale parameter=0.001 fixed) $\sigma^2_{est,i} \sim 1/gamma(0.001,\ 0.001)$		
	SPMs (Surplus Production Models)			• Schaefer, Fox and Pella Tomlinson	• Schaefer and Fox	

(*) Personal communication with Prof. Seng-Ping Wang (National Taiwan Ocean University) (based on expert knowledge)

In the first step (base case), the grid search approach inspects the full depletion range (0~1) by a 0.2 interval grid (0.2, 0.4, 0.6 and 0.8) to select the best depletion level to produce the optimum results based on diagnostics. In the second step for sensitivities, the finer grid (0.1) before and after the depletion level in the best base case will be inspected to identify the final best depletion level to produce the optimum JABBA results. The grid search approach prevents selecting apparent optimum results produced when the limited range of the depletion rates are searched.

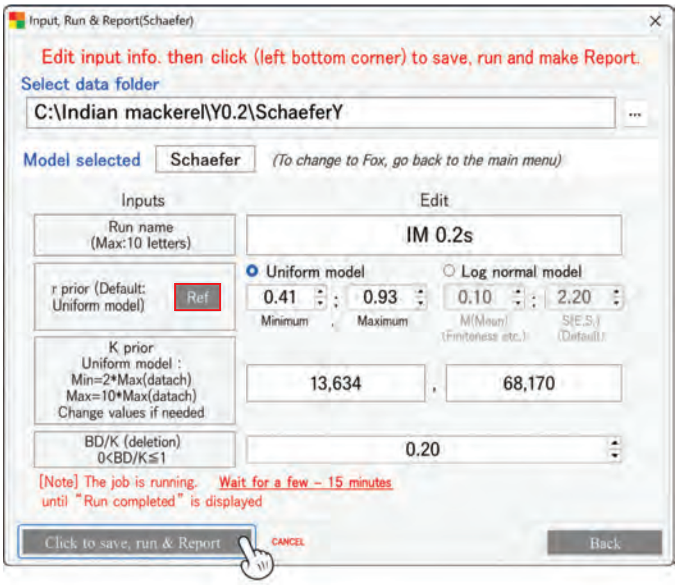
In case pre-knowledge on the depletion level is available, there is no need to search the full range (0~1); instead, only a few numbers of grids around such levels can be inspected. In addition, in case pre-knowledge of prior values for other parameters are available, the grid search and sensitivities around these prior values will be conducted to identify the optimum priors and depletion level that produce the best results.

Running the software

After installing the software, its icon will appear on the desktop (**Figure 6,** *left*). The first main menu will appear after clicking the icon (**Figure 6,** *right*). Another window will appear (**Figure 7,** *top*) after clicking the sub-menu for model selection (*e.g.* Schaefer). In this window, four inputs need to be entered: (1) run ID name; (2) prior values for r which can be selected from the popup Excel (**Figure 7,** *bottom*); If there are no values, get the data from FishBASE (FAO) and enter values to the popup Excel and save; (3) prior values for K; and (4) the depletion rate based on the grid search.

(Note for K) the software will automatically calculate and provide the minimum and maximum K values using the formula displayed in the window; manual entry is not required.

Figure 6. Software icon (*left*) and the first window (*right*)



Reference of Mini & Max for r by species. Users can add. Min~Max is based on the 95% CI						
species			Mini	Max	Median	Source
code	English name	area				
SWO	Swordfish	all ocean	0.30	0.69	0.46	FishBASE
IM	Indian mackerel	Sri Lanka	0.41	0.93	0.62	FishBASE
SM	Short mackerel	G.of Thailand	0.79	1.79	1.19	FishBASE
SU	brushtooth lizardfish	G.of Thailand	0.37	0.85	0.57	FishBASE
KAW	Kawakawa	World	0.57	0.45	0.95	FishBASE

Figure 7. (*top*) Input window for the Schaefer run (example) (*bottom*) Pop-up Excel file for r values by species. It will appear if Ref (red box on *top*) is clicked. If there are no values, obtain the data from FishBASE (FAO) and enter values in the popup Excel and save

The JABBA run will begin once the 'Save, Run & Report' button in the bottom left-hand corner is clicked. Depending on PC performance and the volume of data (number of years and number of fleets/CPUE), processing time could take up to 20 minutes. Once the run has finished, a 19-page standardized report will be automatically provided. An example of the first page is shown in **Figure 8.**

Report_IM 0.2s (Schaefer)

Contents

Input (catch, standardized CPUE, parameters and priors)

Summary of key results and diagnostics

1. Convergence
   Heidelberger and Welch Statistical test (MCMC)
2. Model fit
   2.1 CPUE Residuals (Randomness & Outliers)
   2.2 RMSE (Root Mean Square Error)
   2.3 Prior to Posterior Median/Variance Ratio (PPMR/PPVR)
   2.4 Posterior Predictive Check (PPC)
3. Retrospective analyses (Model mis-specification)
4. Future projections and Hindcast analyses
5. Estimated parameter values
6. Stock status (Kobe plot & Surplus production phase plot)
7. Next step

Figure 8. First page of the standardized report on the results of the menu driven JABBA software (19 pages)

Selection forms to determine the optimum result

Evaluation of the JABBA results is conducted using the Selection form composed of 11 diagnostics. Visual inspections for the Kobe plot and retrospective patterns are the top two priorities, followed by nine equally weighted diagnostics. Only when the two top diagnostics are satisfied, the other nine can then be conducted. The nine diagnostics are: convergences (2 types), model fits (3), retrospective analyses (1) and hindcast analyses (3). Although this is the default setup, users can customize it. Details of how to select the final optimum results using the Selection form will be described in the next section.

Sustainable Capacity Building Framework Using JABBA Software

This framework is designed to continuously supervise the stock assessment work of trainees especially after the training sessions because it is the only way to ensure that they can be implemented in a proper, reliable and plausible manner. This requires a long-term continuous effort; hence, it will not be possible to achieve this goal through traditional snapshot-type training.

Thailand, Indonesia, Sri Lanka and the Republic of Korea have shown strong interest in this framework to be implemented. Between 2024 and 2026, eight face-to-face training sessions were conducted with 49 participants. The initial sessions mainly comprised lectures and practical exercises for the newly developed, menu driven JABBA software. This software facilitates the smooth implementation of proper, transparent and reliable stock assessments.

During the initial training sessions, a few important species were selected in each country and preliminary assessments were carried out. Afterwards, online training and discussion sessions were conducted. In addition, to reinforce their learning, they were asked to write scientific papers for submission to international journals. Unlike conventional snapshot-type training, this approach enables continuous collaboration between stock assessment practitioners and resource persons, ensuring its sustainability. For reference, some of their key achievements are highlighted below.

Thailand

The second joint workshop to implement stock assessment for important species in Thailand was co-organized by the Department of Fisheries (DOF) and [MENU] (Japan). Twelve participants took part in the workshop which was held at the DOF Bangkok office in May 2025 **(Figure 9)**.

Figure 9. Participants in the second joint workshop by DOF (Thailand) and [MENU] (Japan) to implement stock assessments for important species in Thailand using the menu driven JABBA and CPUE software (May 2025)

Figure 11. Participants in the first joint workshop co-organized by BRIN (Indonesia) and [MENU] (Japan) to implement stock assessments for important species in Indonesia (April 2024)

The menu driven JABBA and CPUE standardization software was applied in two species working groups (WG): brushtooth lizardfish (*Saurida undosquamis*) (SU WG) and short mackerel (*Rastrelliger brachysoma*) (SM WG). After three days of hands-on PC training with technical assistance by SEAFDEC/TD resource person *Dr. Pattarapongpan* (the second author of this article), all participants could use the software independently and produce plausible results. A selection of the standardized report produced by the SM-WG using the menu driven JABBA software is shown in **Figure 10.**

Indonesia

The menu driven JABBA software was introduced during the inaugural joint workshop organized by the National Research and Innovation Agency (Badan Riset dan Inovasi Nasional or BRIN) (Indonesia) and [MENU] (Japan) in April 2024. The workshop was attended by 19 participants **(Figure 11)** and resulted in the formation of two dedicated working groups focusing on squid and mackerel. A second workshop is planned in 2026 and will focus on the practical application of JABBA using real-world data on these two species.

Sri Lanka

The second joint workshop on the assessment of important species in Sri Lanka was co-organized by NARA (National Aquatic Resources Research and Development Agency) and [MENU] (Japan). It was conducted at the NARA office in October 2024. A total of eight participants attended the workshop (**Figure 12**).

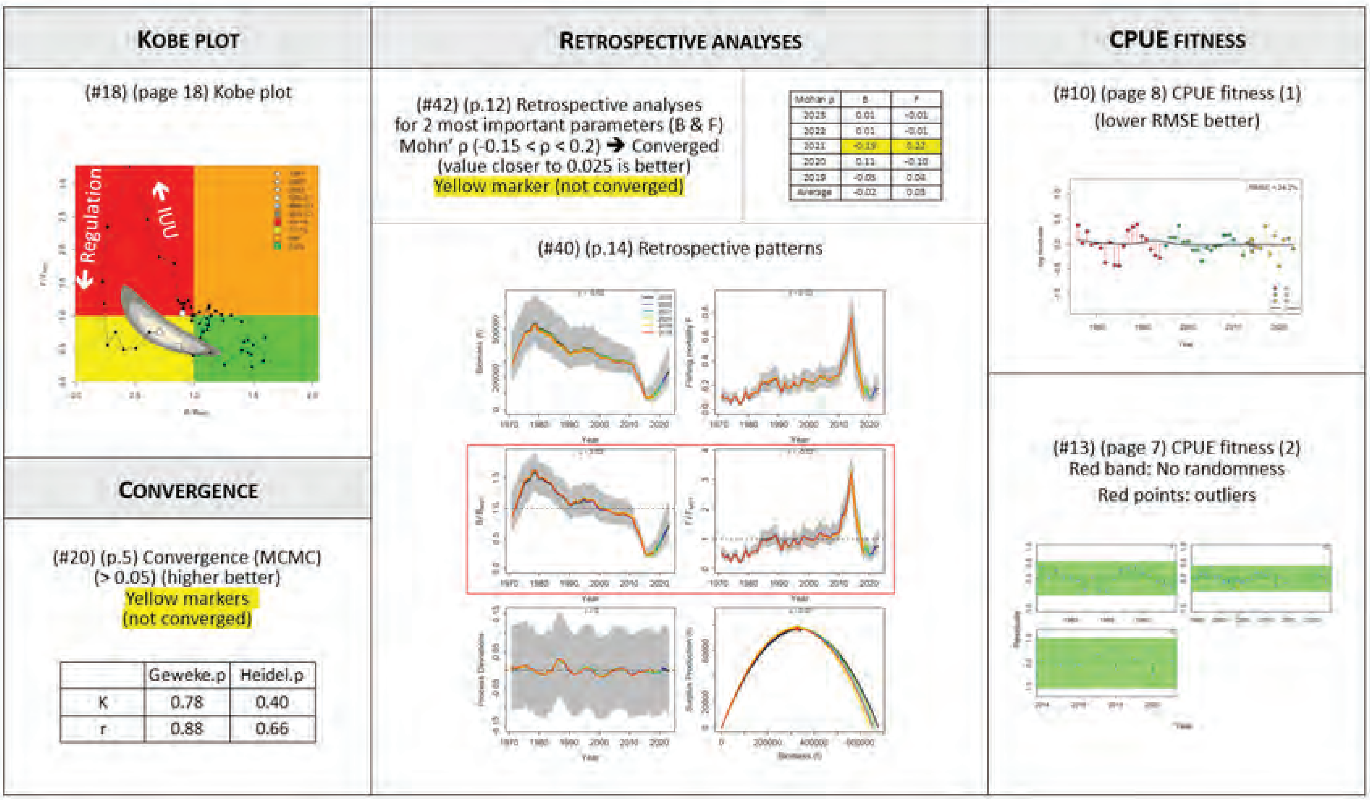


Figure 10. Part of the results of the short mackerel stock assessments (Gulf of Thailand) by the menu driven JABBA software. The results from the standardized report were provided by the SM-WG (short mackerel working group)

Figure 12. Participants in the second joint workshop co-organized by NARA (Sri Lanka) and [MENU] (Japan) to implement stock assessment for important species in Sri Lanka (October 2024)

Although Sri Lanka is not a SEAFDEC Member Country, the progress on case studies by the menu driven JABBA and CPUE software was introduced for reference. JABBA software was used for two working group species: Indian mackerel (*Rastrelliger kanagurta*) (IM-WG) and kawakawa (*Euthynnus affinis*) (KAW-WG). All the participants were able to use the software independently and produced plausible results after three days of hands-on PC training. **Figure 13** shows a part of the result, *i.e.* Kobe II (Risk assessments) for Indian mackerel produced by the IM working group.

Republic of Korea

The first joint workshop, co-organized by Pukyong National University (Republic of Korea) and [MENU] (Japan), was held at the Ocean and Fisheries Development International Cooperation Institute in the University (Busan) in January 2026. Convened at the request of Professor Jung Hwa Choi, the workshop provided lectures and practical training on menu driven software (JABBA and CPUE standardization). The first session, which was attended by ten participants (**Figure 14**), was designed to enable graduate students to apply these software for their master's theses or doctoral dissertations. A second progress joint workshop is scheduled for later in 2026.

Figure 14. Graduate students participating in the first joint workshop co-organized by Pukyong National University (Busan, Republic of Korea) and [MENU] (Japan). This workshop aimed to apply the menu driven JABBA and CPUE software to their master's theses or doctoral dissertations (January 2026)

Kobe II (Risk assessment) (TB & F combined)

Probabilities (%) violating MSY levels (both TB and F combined) within 10 years by catch level.

Color legend

Green: Probability < 50% (lower risk) — Yellow ≥50% (higher risk)

% of the current catch (*)	Catch (tons)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
40%	1,870	42	40	38	28	22	18	16	14	13	12	12	11
60%	2,805	42	40	38	30	25	22	19	18	16	16	15	14
80%	3,739	42	40	38	33	29	27	24	23	22	21	20	19
100%	4,674	42	40	38	36	34	33	32	31	30	29	29	28
118%(MSY)	5,560	42	40	41	42	43	44	45	46	47	47	48	48
120%	5,609	42	40	41	42	43	44	45	46	47	47	48	49
140%	6,544	42	40	51	55	59	63	65	67	69	71	72	73
160%	7,479	42	40	61	68	74	78	81	83	85	86	87	88

(*) The current catch is the average catch over the recent three years.

MSY (t)	Median	Lower (80%)	Upper (80%)
	5,560	4,665	8,747

Figure 13. Part of the results of Kobe II (risk assessments) on the Indian mackerel (Sri Lanka) based on the menu driven JABBA software (Standardized Report is provided in each JABBA run). This was provided by the IM WG (Indian mackerel working group)

Way Forward

The authors suggest two issues related to the application of JABBA to be addressed and initiated in SEAFDEC together with the resource person and stock assessment researcher in SEAFDEC/TD (the second author of this article).

(1) Routine assessments by the JABBA-HCR (Harvest Control Rule) approach under the current SEAFDEC structure

The initial stage of this new approach should prioritize a few unhealthy stocks in the most important species which are the main sources of livelihood in SEAFDEC Member Countries before gradually expanding to other limited important species. This effort is vital for SEAFDEC to fulfill its mission of ensuring food security in the region.

(2) Sustainable capacity building framework under a special arrangement

It is ideal to enable the continuous supervision of stock assessment practitioners' work in SEAFDEC especially after training. This is the only way to ensure that they can implement proper, reliable and plausible stock assessments. This requires long-term commitment; hence, it will not be possible to achieve this goal through conventional snapshot-type training. Therefore, it will be quite challenging or impossible to initiate this framework under the current SEAFDEC structure, especially when it comes to finding dedicated resource persons and budgets. One possible option is to engage retired experts or consultants who can supervise on a semivoluntary basis for extended periods after training sessions. In any case, this is the only way to achieve satisfactory proficiency and comprehensive capacity building in the long term.

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