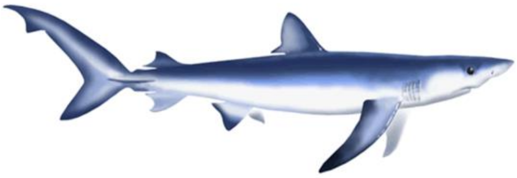
ISC/22/SHARKWG-3/1

Discussions on the issues of composite CPUE and the model ensemble approach for blue shark in the North Pacific Ocean [1]

Mikihiko Kai[2],

[2] Fisheries Resources Institute, Japan Fisheries and Education Agency,
5-7-1 Orido, Shimizu, Shizuoka, 424-8633, Japan

Email: kai_mikihiko61@fra.go.jp



[1] Working document submitted to the ISC Shark Working Group Workshop, 8-12 December 2022 (JST), Hybrid-meeting. **Document not to be cited without author's permission.**

Summary
This working paper shortly reviews composite CPUE and model ensemble approach used in the stock assessment for blue sharks in the North Pacific Ocean in 2022, and to raise the discussion points about the issues of them. These discussions will expedite our understanding of the new approach and justify the usage of the approach in the stock assessment.

Review of composite CPUE and model ensemble approach
The stock assessment of blue shark, *Prionace glauca*, in the North Pacific Ocean was completed in 2022 (ISC, 2022a). In the data preparatory meeting, the SHARK working group (SHARKWG or WG) agreed to use standardized CPUEs of blue shark caught by Japanese Kinkai shallow fishery (i.e., Japanese offshore and distant-water longline shallow-set fishery) for early (1975-1993; S5: JPN_EARLY) and late (1994-2021; S6: JPN_LATE) periods as representative of the abundance indices for the stock assessment of blue shark (ISC, 2022b). These abundance indices (**Fig. 1**) were derived from Japanese logbook data after filtering and, the data covers a long operational period and wide operational area in the main distribution area (i.e., temperate water) of blue sharks where they were seasonally targeted and encountered across a large size range (Kai, 2021a; 2021b). Meanwhile, a composite CPUE for late period (S11: Composite CPUE) was proposed as alternative abundance index (Ducharme-Barth et al. 2022; **Fig. 2**). The composite-CPUE was derived using a Dynamic Factor Analysis (DFA; Peterson et al., 2021) which combined three standardized CPUEs: Hawaii deep-set longline index (S1: US_HW_DP); Taiwanese large-scale longline index (S3: TAIW_LG); Japanese research and training vessel deep-set longline index (S7: JPN_RTV) (**Fig. 3**). The DFA is a state space multivariate auto-regressive model which estimates a common temporal trend as a combination of the input time series and their associated variances. The DFA is therefore able to account for missing observations and time series of different lengths.

Model diagnostics could not conclusively identify a *single best* model from the two alternative CPUE scenarios and as a result the WG agreed to present the stock status using a model ensemble (ISC, 2022a). Although the model ensemble approach has been used in the stock assessments for other pelagic species such as a blue marline (*Makaira mazara*) in the Pacific Ocean (ISC, 2021), it was the first time to apply the model ensemble to the assessment of North Pacific blue shark. However, the WG had not enough time to discuss an appropriateness of the composite CPUE as well as the model ensemble approach.

Discussions
1) When is the time limitation to conduct the model ensemble approach?

The CPUE data is commonly fixed at the data preparatory meeting, however, the use of model ensemble approach was determined during the full stock assessment meeting. The WG therefore need to discuss the time-schedule for model ensemble approach.

2) What is the condition to conduct the model ensemble approach?

In the stock assessment for blue shark in 2022, the model ensemble approach was conducted as the Model diagnostics could not conclusively identify a *single best* model from the two alternative CPUE scenarios (S6, S11). If the model diagnostics can determine the best model in terms with the CPUE, how does the WG deal with the two alternative CPUE? In addition, if the three CPUEs (S1, S3, and S7) showed inconsistent trends, how does the WG deal with the composite CPUE?

3) What kind of uncertainties should be considered in the model ensemble approach?

"SC18 noted that the model ensemble did not consider some key uncertainties, in particular natural mortality or stock-recruitment steepness". The WG need to determine the procedure of the model ensemble approach for these parameters in the next stock assessment for blue shark in 2027.

4) Was it reasonable to separate the composite-CPUE (S11) into two?

Both models (S6, S11) showed retrospective bias in the estimation of absolute biomass and fishing mortality. This issue was improved in the composite-CPUE model by down weighting the large input sample sizes for the Taiwanese small scale longline length composition data in 2018 and 2020. Accordingly, the composite-CPUE model was separated into two hypotheses with and without the down-weighting of the Taiwanese size data from small scale longline fishery in 2018 and 2020. Further research is necessary to address the retrospective issue.

References

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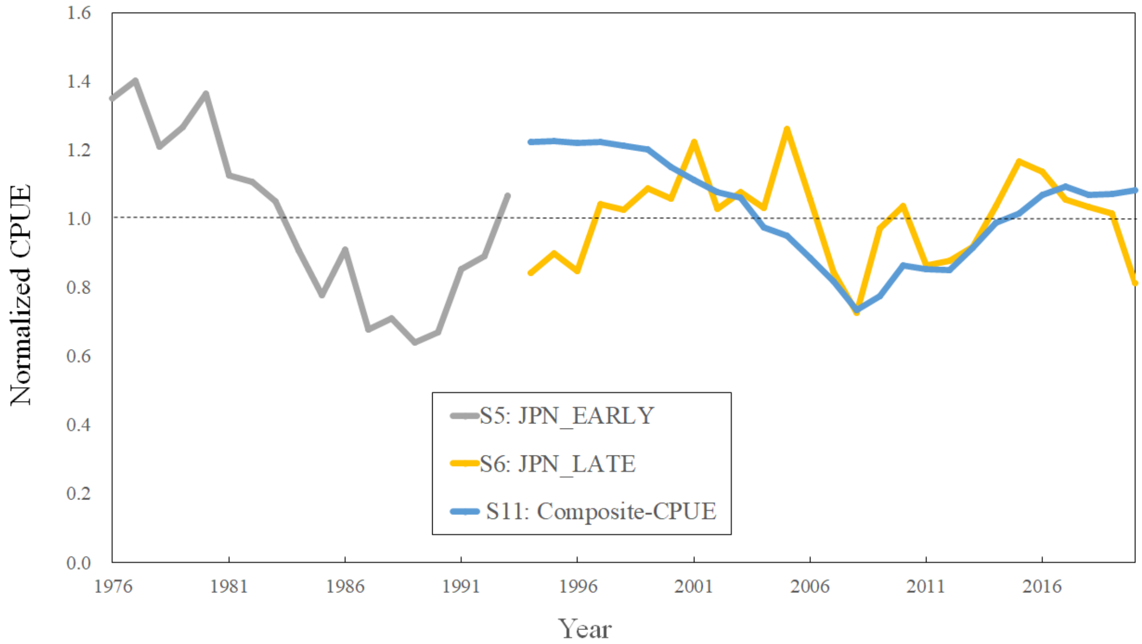

Fig. 1. Annual standardized CPUE of North Pacific BSH during 1976 through 1993 (Japanese offshore and distant water shallow-set longline: S5: JPN_EARLY), and two standardized CPUEs of blue shark between 1993 and 2020 (S6: JPN_LATE and S11: Composite-CPUE). The horizontal broken line denotes the mean value (1.0) of each CPUE.

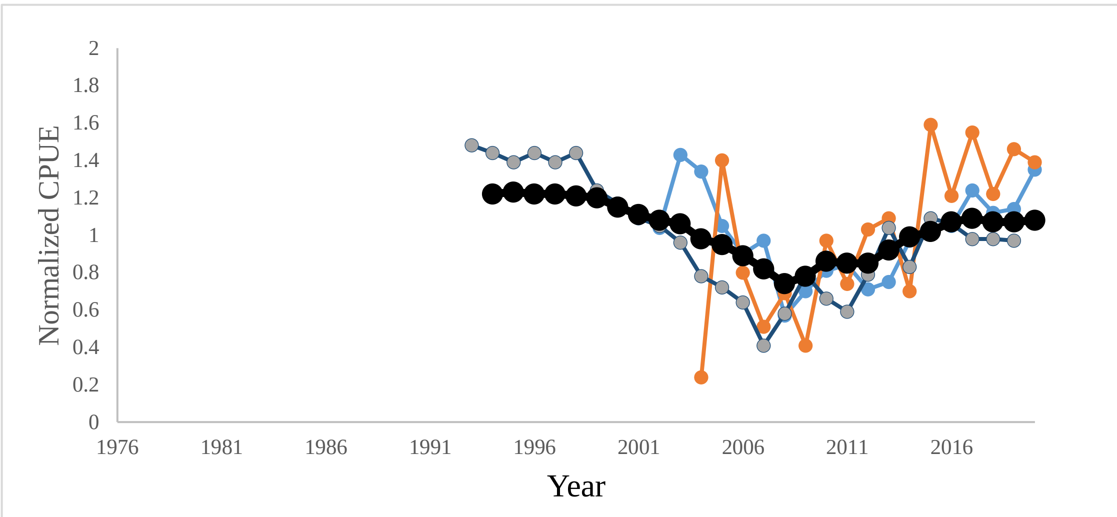

Fig. 2. Composite CPUE (S11, black) and three standardized CPUEs (S1: US_HW_DP, blue; S3: TAIW_LG, orange; S7: JPN_RTV, grey) of North Pacific blue shark for 1993-2020. The horizontal broken line denotes the mean value (1.0) of each CPUE. The time series were normalized by mean value of each CPUE and the horizontal broken line denotes the mean value (1.0) of each CPUE.

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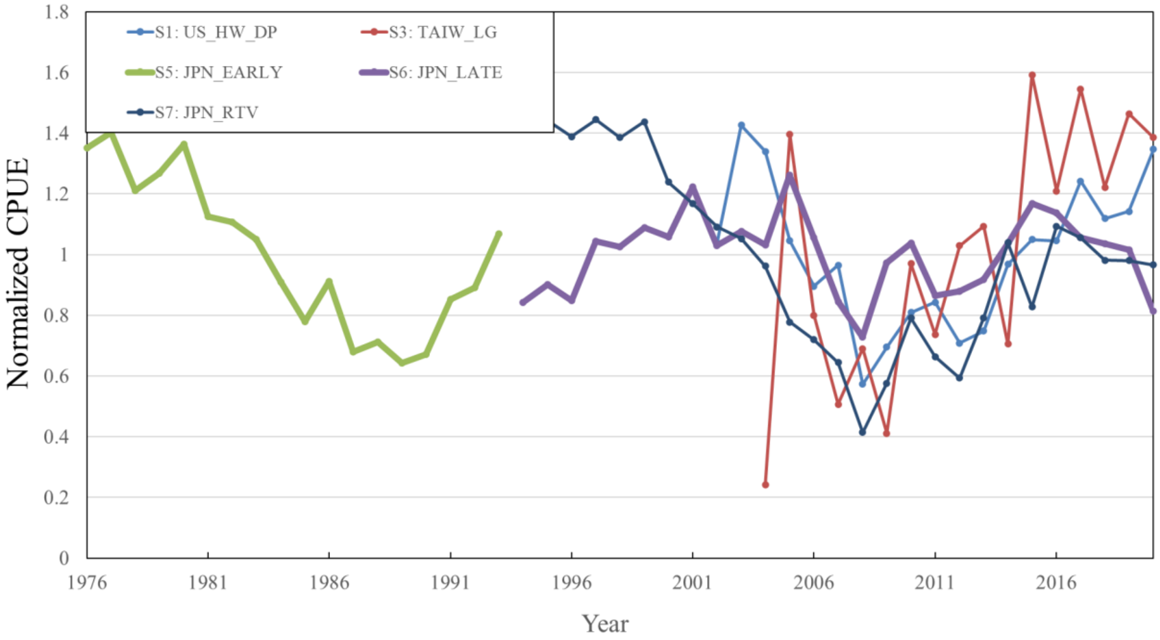

Fig. 3. Annual standardized CPUE of North Pacific blue shark during 1976 through 1993 (S5: JPN_EARLY), and five standardized CPUEs of blue shark between 1993 and 2020 (S1: US_HW_DP; S3: TAIW_LG; S6: JPN_LATE; S7: JPN_RTV).