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The preliminary analysis of standardized CPUE for the catch data of blue shark by Japanese longliner using the finite mixture model[1]

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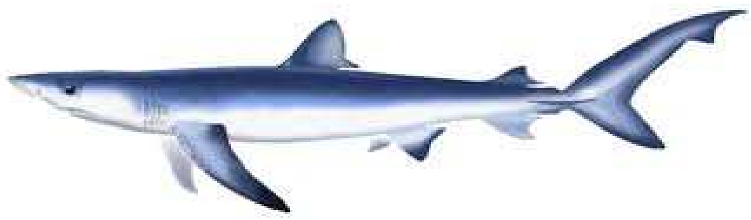

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Abstract

The target effect, which is a problem in CPUE standardization, was addressed in latent variable estimation using a finite mixture model, and the stock indices of blue shark in the Northwest Pacific Ocean were estimated from Japanese longline fishery data. As a result, the models with latent variables 2-8 converged, and the trend of the stock index was similar in that there were peaks in 2005, 2017 and 2018, although there were minor differences among the models.

Introduction

CPUE standardization aims to remove the effects that affect catch rates and to represent the stock trends. For observed factors, changes in catch rates can be averaged out by incorporating them into the model's explanatory variables. However, some factors are not observed in the logbook data, such as what is targeting fished for, that need to be removed when standardizing, but are difficult to remove. Shibano et al. (2021) showed that a finite mixture model could estimate and standardize not-recorded effects with good performance. This study attempts to standardize nominal CPUE using this model for the logbook data of blue shark caught by Japanese offshore and distant water longliners in the western and central North Pacific Ocean.

Material and Methods

Data source

Set by set Japanese logbook data from offshore and distant water longline fishery were used to standardize CPUE between 1994 and 2020. The catch number of blue shark, swordfish, and tunas (bigeye, albacore, yellowfin, and bluefin tuna), number of hooks, hooks per baskets (HPB), longitude and latitude of a set by 1x1 degree resolution, the prefecture of vessels and operating month were used for this analysis.

Data filtering

The data was filtered to ensure a certain degree of homogeneity and avoid the effects of discarding blue sharks followed by Kai (2021). The data were filtered based on that the number of HPB is between 3 and 5, reporting rates is equivalent to 94.6% or higher, latitudes of operational location is between 25 and 45 degrees, longitudes of operational location is between 130-200 degrees, other than government ships (Japanese research and training vessels), and ships registered in Tohoku, Hokkaido and Toyama prefectures. This data filtering reduces the set-by-set data from 724,466 to 103,856.

Models

The finite mixture model was used for this analysis. The finite mixture model could have multiple response variables simultaneously, and the optimal category could be estimated as a categorical factor of the unobserved latent variable. In the present study, we used the number of caught fish for blue shark, swordfish and tunas as response variables with Poisson distribution and season (Season 1 from January to March, Season 2 from April to June, Season 3 from July to September, and Season 4 from October to December), area (30-43 degrees latitude and 130-179 degrees longitude as area 1, 30-43 degrees latitude and 180-200 degrees longitude as area 2, 25-29 degrees latitude and 130-179 degrees longitude as area 3, 25-29 degrees latitude and 180-200 degrees longitude as area 4) fishery type (coastal, offshore and distant water) and year as response variables. The categories estimated as latent variables are treated as factors affecting unobserved catch rates, including the target effect. Only the year effect was assumed to be species-specific, with a common trend regardless of the latent variable. The number of categories for the latent variable ranged from 2-9 and were rated by BIC.

Results and Discussion

The models with less than 8 latent variables converged and there was no significant problem with the residuals. On the number of latent variables was 9, the model did not converge. The BIC was the smallest when the number of latent variables was 8, as shown in Figure 1. The standardized CPUE estimated for each number of latent variables is shown in Figure 2. Although the detailed trends differ, the peaks in 2005 and 2017-18 are common, with a decrease in 2020 but a slight increase in the overall trend.

References

Kai, M. 2021. Spatio-temporal model for CPUE standardization: Application of blue shark caught by Japanese offshore and distant water shallow-set longliner in the western North Pacific. ISC/21/SHARKWG-2/xx

Shibano, A., M. Kanaiwa and M. Kai. 2021 Performance of a finite mixture model in CPUE standardization for a longline fishery with target change. Fisheries Science 87: 465-477.

Tables and Figures

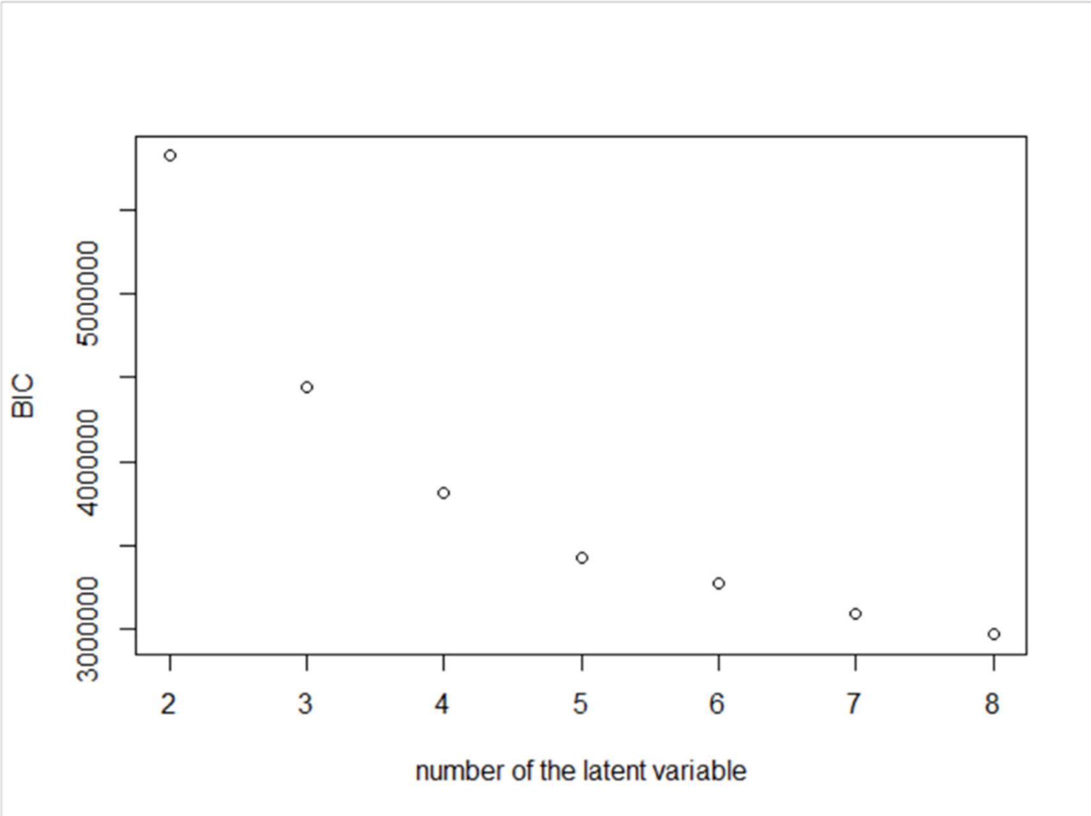

Fig. 1 The BIC vs the number of the latent variable

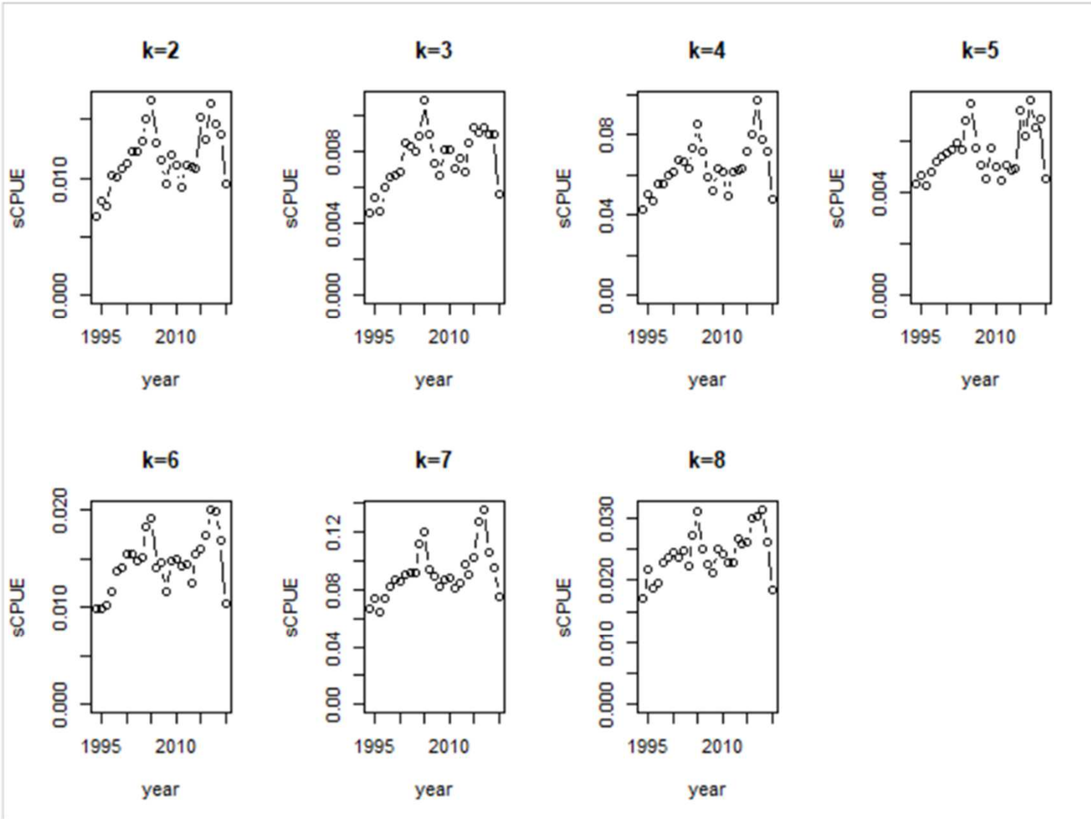

Fig. 2 Standardized CPUE by the number of latent variable