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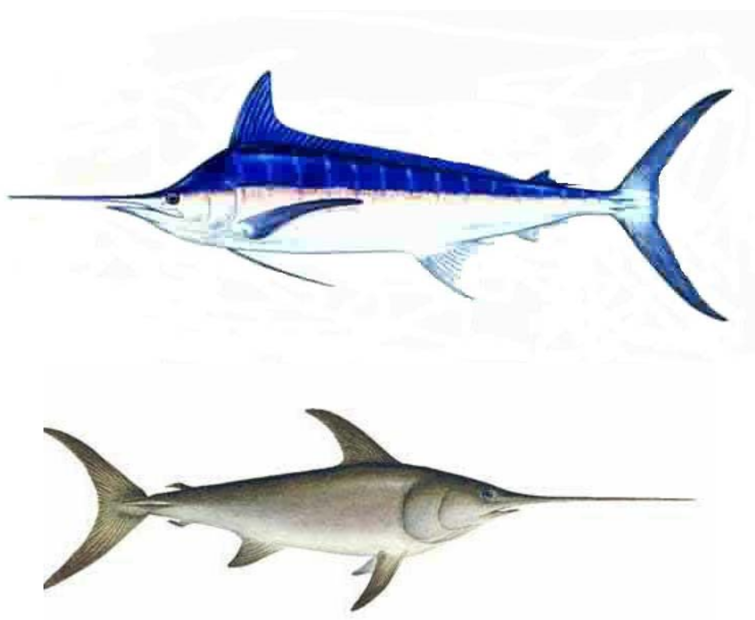
Preliminary analysis of area boundary to standardize CPUE of striped marlin in the North Pacific Ocean

Minoru Kanaiwa
Tokyo University of Agriculture
196 Yasaka, Abashiri, Hokkaido, Japan 099-2493

Kotaro Yokawa
National Research Institute of Far Seas Fisheries
5-7-1 Orido, Shimizu, Shizuoka, Japan 424-8633



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Summary

The trial of possible area boundary to standardize CPUE in west side from 140W of the North Pacific Ocean was provided. Spatial pattern was clarified using delta-type two-step method describing abundance index. We search optimal boundary for latitude and longitude and got two results from two models used in delta-type two-step method. The result from sum of AIC by both steps select same model with second step on delta-type two-step method. We conclude to choose time series of data to make standardize model if we will use GLM to standardize CPUE or to apply another model like statHBS.

Introduction

The stock structure of striped marlin in the North Pacific Ocean was discussed and 140W longitude was accepted as stock boundary. In this study, we investigated the possibilities of the further structure of the separated stock in the northwest and central Pacific.

Data set

Catch and effort data used in this analysis was provided from the Japanese longline fishery statics compiled at the National Research Institute of Far Seas Fisheries for 1982-1986 because HPB pattern is stable and include various gear types (Fig. 1; Kanaiwa and Yokawa 2009). This data has the information of catch number and number of hooks and aggregated by month, 5x5 degree blocks area and gear configuration, i.e. the number of branch lines between floats (hooks par baskets: HPB).

Area separation

To define the stock structure to manage striped marlin in the North Pacific Ocean, we check this spatial distribution by using GLM method. The caught data of striped marlin in North Pacific Ocean has many zero catch data. Delta-type two-step method (Lo et al. 1992) was used for estimating standardized CPUE of striped marlin. The formula of the first step model is following:

p ~ year * sarea+ gear + hooks + qt * sarea + binomial error.

Here p is the ratio of non-zero catch, year is the year, gear is the category of HPB (same with Ichinokawa and Yokawa 2006), qt is the quarter of season, hooks is the number of hooks, poly(variable, n) is a fitting polynomial equation of n-th order for variable, sarea is area separation (including only two separated area) by setting of latitude and longitude. The formula of the second step model is following:

pCPUE ~ year * sarea+ gear + hooks + qt * sarea + Gaussian error.

Here pCPUE is the catch per each hook of positive catch. Standardized CPUE was calculated from the product of estimated values of least squared means derived from the two models as (ratios of non-zero catch) * (CPUE of positive catch). To define sarea, we change both northern (larger target latitude) and southern (smaller than target latitude) separation lines of longitude by 5 degree step, respectively and calculate AIC each by each step.

The number of sarea was fixed at two in this study. The range of each area was decided by following method;

1) The position of the boundary assumed to be the same as the line running along the 5x5 blocks.
2) For each 5 degree unit of latitude (10N – 35N), the longitudinal position of boundary changed by 5 degree unit to calculate the value of AIC using the both steps written above. Longitudinal position of boundary was change from 120E-125E to 145W-140W for the northern boundary, and from 115E-120E to 145W-140W for the southern boundary.
3) Among all combinations of northern and southern boundaries, the one produced smallest AIC value was selected as the optimal boundary between two sareas.

Result and Discussion

In the result, we can get two separation lines from these two steps the analysis of the ratio of positive catch and the ones of CPUE of positive catch drew the different lines (Fig. 2 and 3), and both results seems to indicates that catch pattern of striped marlin was different between western and eastern side of the area analyzed And sum of both step's AIC for each scenario, step2's optimal model was selected (Fig. 3) so we recognize this as optimal boundary.

AIC values are similar for each longitude of northern boundary between 120 and 160 (Figs. 6 and 8). In contrast, southern boundary has distinct minimum point (Fig. 7 and 9). So the northern boundary is not so robust but southern boundary is robust. This indicates that the catch pattern of striped marlin in the south western side of the area analyzed apparently different from the one in the north eastern side, while the difference between the north eastern side and north western side is not so large as the former one. These findings should be reflected in the analysis of CPUE of striped marlin in the northwestern and central Pacific.

The estimated gear effect is reasonable (Fig. 4 and 5) in the light of the vertical distribution pattern of striped marlins which spend most of their time at the surface, and it partly means this model is reasonable. The estimated effect of gear configuration became rather different when it was calculated with data obtained by the period when the set of different gear configuration distributed no so evenly (1995 - 2003) as the selected period (1882 – 1886) (Fig. 10). And the estimated CPUE trend by the gear configuration calculated from the data in the period between 1995 and 2003 showed unrealistic one when it was compared with the vertical distribution pattern of striped marlin. In the similar study using data in the whole north Pacific since the 1970s to the 2000s produced similar unrealistic effect of gear configuration (Ichinokawa et al 2006).

The results obtained in this study clearly indicates that the effect of gear configuration on CPUE of by-catch species such as striped marlin, whose vertical distribution pattern is largely different from the target species like bigeye tuna, can only be estimated with data selected in the appropriate way. The effect of gear configuration should give large effect on the estimation of the historical trend of standardized CPUE when the set depth of gear change rapidly and consistently into deeper strata like the case of Japanese offshore and distant-water longliners in the north Pacific. Thus, the method of CPUE standardization of the striped marlin in the north Pacific should be revisited in the next stock assessment.

References

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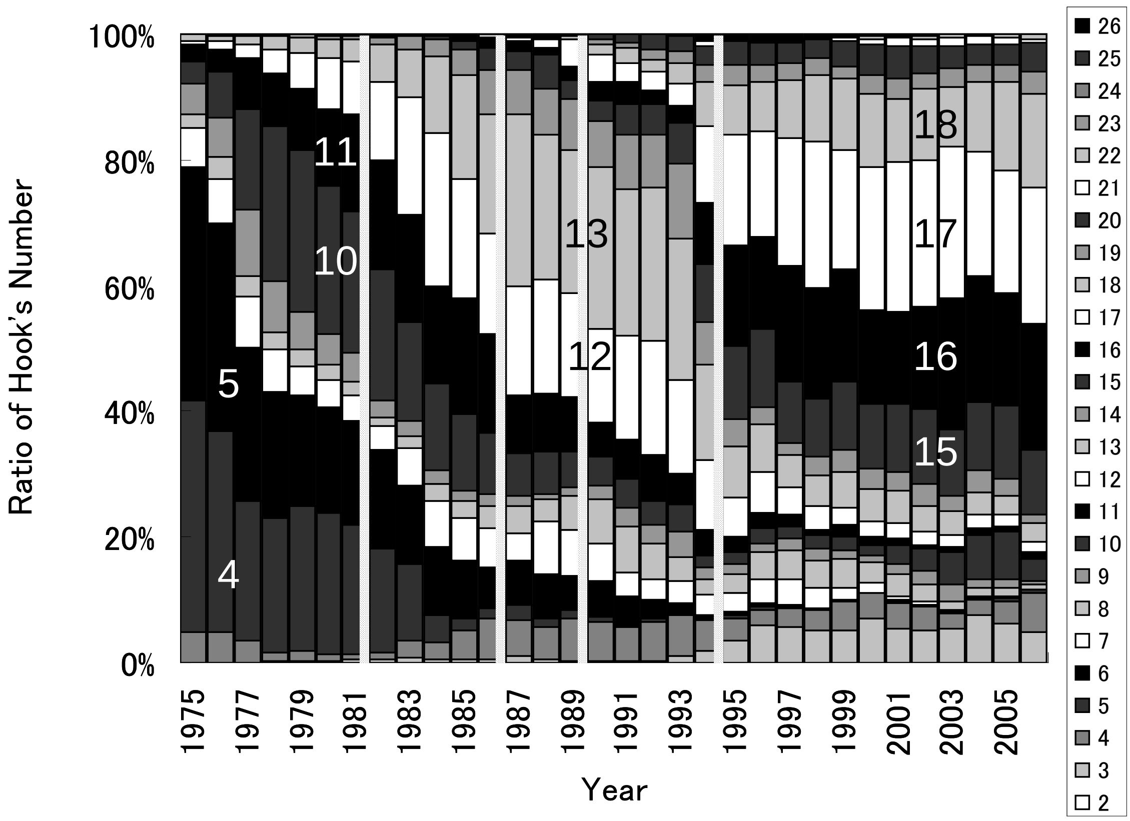

Figure 1

Yearly change of HPB pattern. Dashed line means optimal separation year to cluster years.

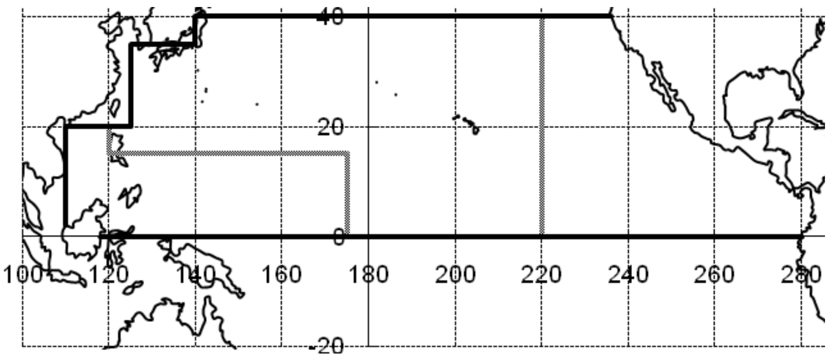

Fig. 2 Optimal boundary by step 1 model

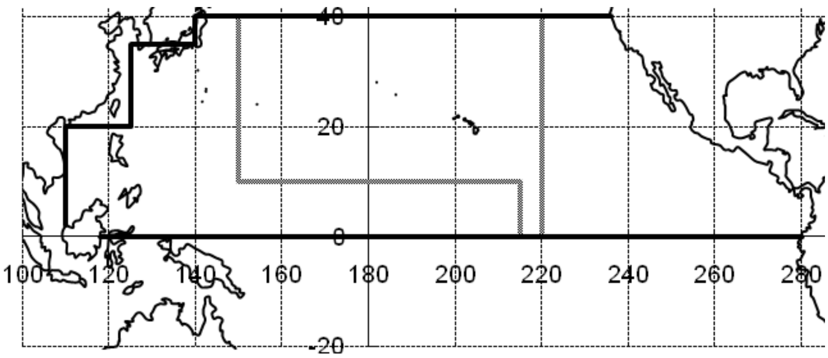

Fig. 3 Optimal boundary by step 2 model and sum of step 1 and step 2

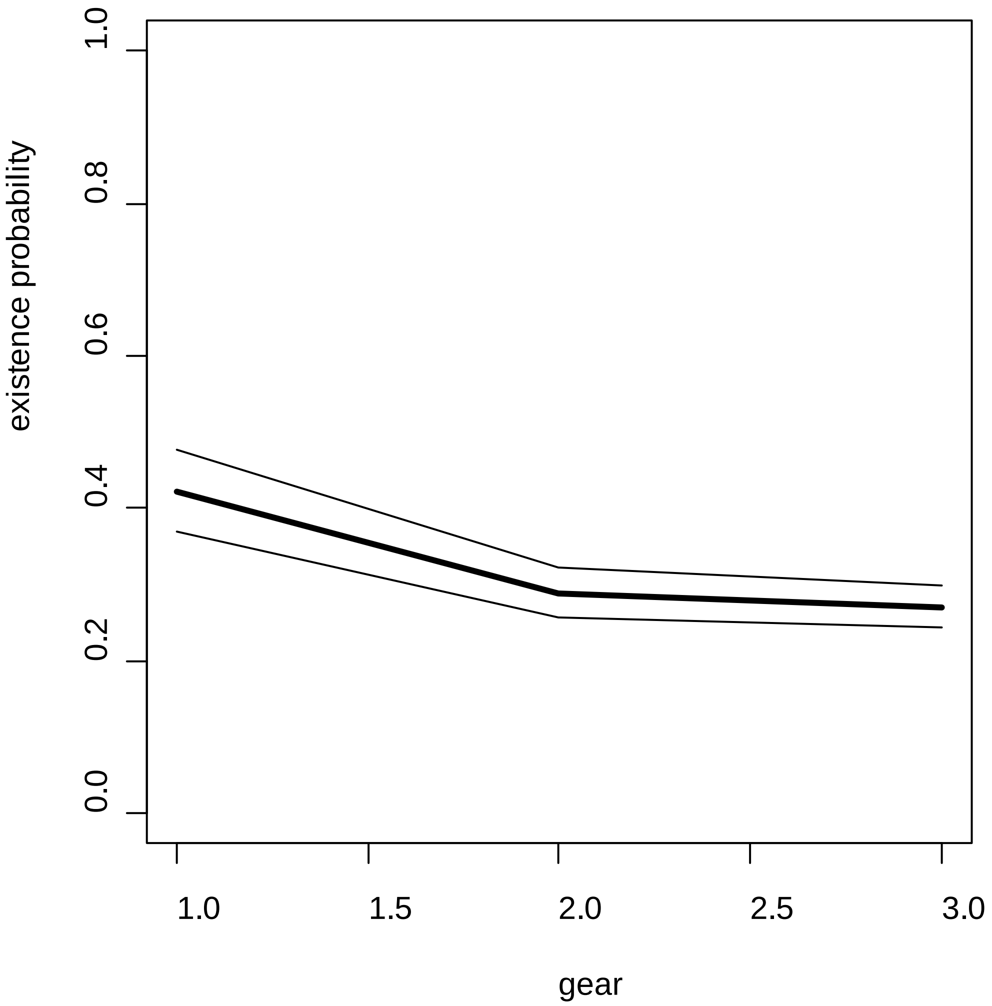

Fig. 4 Estimated gear effect by step 1

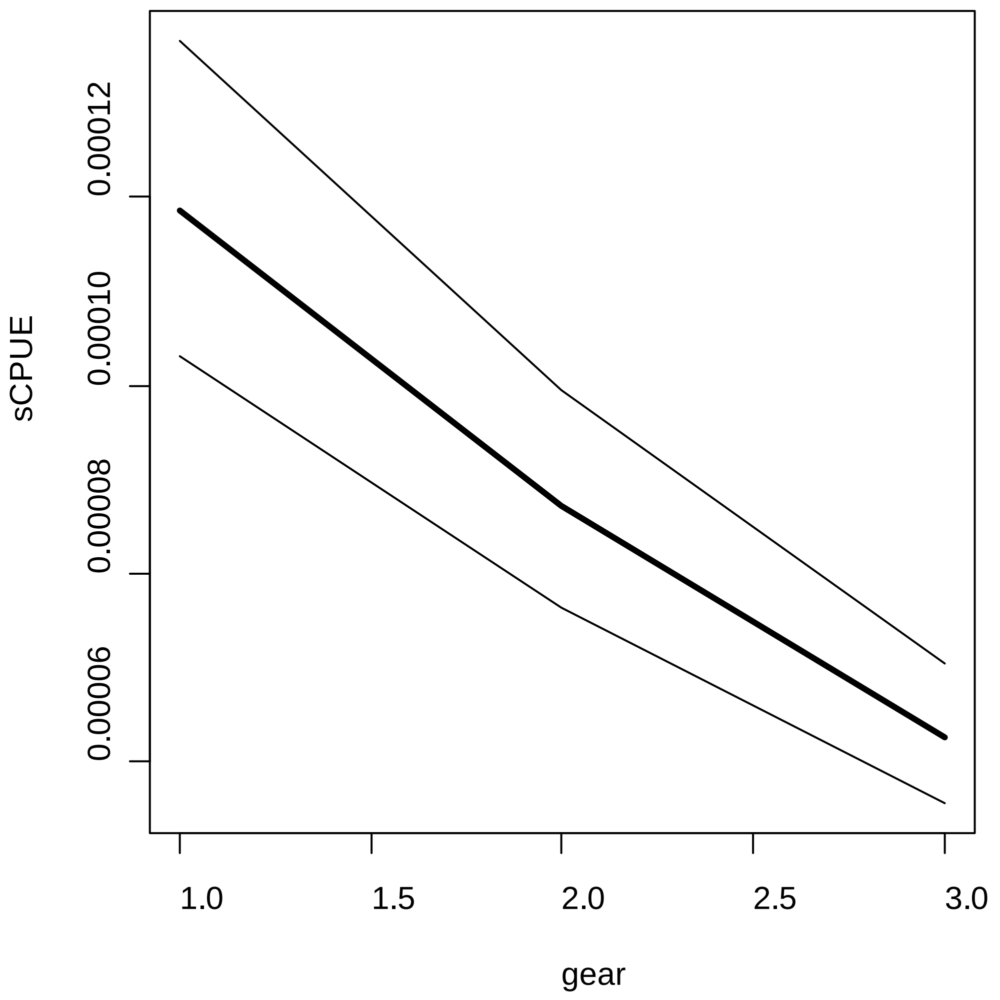

Fig. 5 Estimated gear effect by step 2

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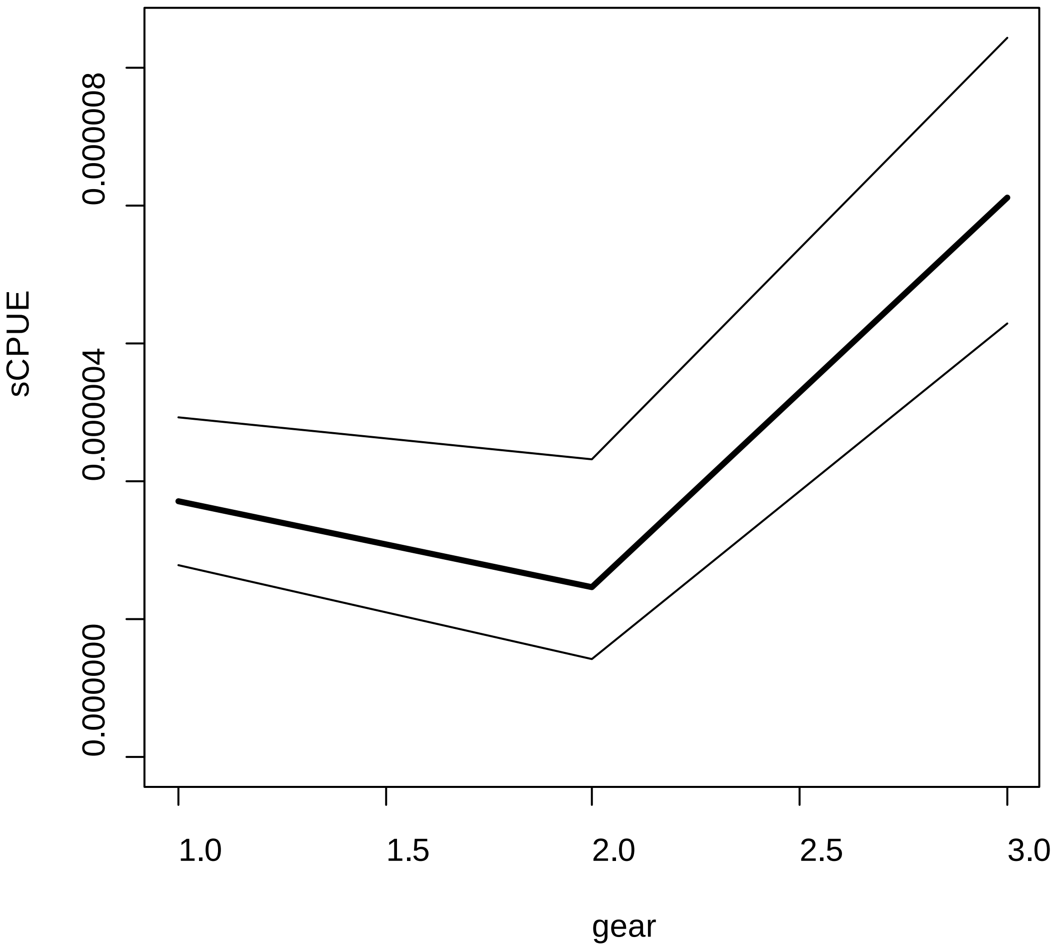

Fig. 10 Estimated gear effect (step 1 x step 2) by using the data between 1995 and 2003