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International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

Analysis of Blue Marlin catches by Japanese training vessels

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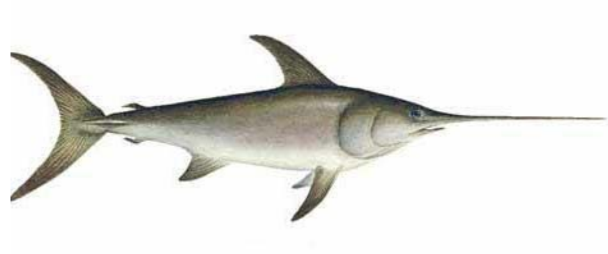

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Summary

Data from Japanese training vessels was used for the consideration whether HPB can distinguish effective fishing effort for each gear. Simple GLM and statHBS was applied on this analysis. A part of estimated standardized CPUE per each HPB does not fit biological prediction, i.e. smaller HPB, whose gear is deployed in shallower layers than larger HPB, does not provide higher standardized CPUE. This unnatural result caused mainly due to the difference of operation area by the HPB, i.e. the vessels which use smaller HPB are only operating around Japan, where not suitable for catching blue marlin, and other vessels which use larger HPB are operating wider area including tropical area where blue marlin is abundant. The area where the vessels with smaller HPB are operating has lower temperature. In such a situation, HPB cannot become good indicator of gear effects on blue marlin. So additional area factors and interaction of HPB*year to the GLM are included would produce closer result with statHBS. The fact that result of GLM which includes the effect of small scale area effect, such as effect of latitude or longitude, was closer to the result of statHBS than simpler GLM may indicates that statHBS has better ability to adjust the effect of annual change of environmental conditions of fishing ground than the simpler GLM. However such a complicate model is probably exceptional for such as blue marlin stock assessment by using commercial fishery data because of the shortage of the coverage of data. More consideration to distinguish effective gear effect is required.

Introduction

Data from the Japanese training vessels represent one of the most reliable data in the tropical and sub-tropical Pacific Ocean. Different from commercial fishery data, detailed data are available such as the position of hooks between the floats where catches were hooked and depth at which hooks were set. These data base has the information of the hook's number (number of branch line) of each fish caught as well as the information of the set depth of hooks monitored by the time-depth recorder (TDR) attached on the branch line. Because the detailed information about the operation are available in the data of the Japanese training vessel, all these data are very useful in evaluating the methodology such as CPUE standardization that takes into consideration of swimming depth of the catches. The purposes of this paper are to compare the results of GLM and statistical habitat based standardization (statHBS) for blue marlin and to evaluate whether the consideration of habitat preferences are effective or not.

Material and Methods

Data set

Japanese training vessels have been reported the detailed information about their longline operation since 2000, such as detailed gear configuration (number of hooks per basket (HPB), length of branch line, length of float line etc.) catch by species, number of branch line for fish caught, and the set depth of hook monitored by TDR. These were compiled by NRIFSF as the training vessel database. In the present study, the data of training vessels operated in the central North Pacific from 2000 to 2006 were used.

This fleet had a spatial geographical extent (0−45ºN, 140ºE−140ºW) and there largely occurs around the Hawaii. In this analysis, data are used from the area north of 20ºN, because in this area the catenary curve (the shape of the mainline in the water) can be estimated by Kanaiwa *et al.* (2008a). All other detail of fishery data should be referred to Kanaiwa et al. (2008b).

Environmental covariates of ambient temperature and thermocline gradient were obtained from the Global Ocean Data Assimilation System (GODAS, *http://cfs.ncep.noaa.gov/cfs/godas/*) and processed according to Bigelow and Maunder (2007). This is the same as in Kanaiwa *et al.* (2008 a), also.

Model of statHBS

The entire parameter setting and model definition of the statHBS are the same as Kanaiwa *et. al.* (2008a) which followed Maunder *et al.* (2006) and we used 68º as catenary angle for this analysis because it was adopted by the analysis by statHBS with multiple species in Kanaiwa et al. (2008a).

Model of GLM

The simple model of GLM was used. The GLM equation is:

$$\log(CPUE + const) = \alpha_{year} \cdot year + \alpha_{quarter} \cdot quarter + \alpha_{HPB} \cdot HPB + \varepsilon$$

Here, year, quarter and HPB are categorical factors and α s are coefficient for each factors. ε shows error factor and is followed to normal distribution. $const$ is the constant calculated as 10% of minimum CPUE except zero catch.

Result and discussion

Figure 1 show a nominal CPUE par ambient temperature by calculating from the observation data of number of branch line for fish caught, TDR and GODAS data. Figure 2 shows relative standardized CPUE by statHBS par ambient temperature. These values are estimated independently but these figures mean that statHBS can estimate the habitat preference well even if statHBS does not use the number of branch line for fish caught and TDR data, directly. Figure 3 is the box plot of logarithm of nominal CPUE excluding zero catch data and ratio of zero catch. The ratio of zero catch is high and almost similar among different HPB.

The nominal CPUE is largely fluctuated depending on HPB and their medians are higher in fewer HPB and lower in larger HPB. However, there is a higher point when HPB is 14. The standardized CPUE (shown as relative values) for each HPB by GLM is shown in Fig. 4 and there is a peak when HPB is 10. The standardized CPUE by statHBS, which is expressed as the amount of effective effort, is shown in Fig. 5 and there is a peak when HPB is 11. Figure 6 shows logarithm of nominal CPUE in each year as box plot and ratio of zero catch as gray line. There are small peaks of nominal CPUE in 2001 and 2002 and almost no trend in ratio of zero catch. Relative standardized CPUEs by GLM and statHBS are shown in Fig. 7. There is a high peak in 2001 by statHBS but not by GLM.

The reason why higher HPB produce larger standardized CPUE is the characteristic of habitat and number of data. Figure 8 shows box plots of latitude, longitude and surface temperature and bar plot of number of data sets for each HPB. This clearly shows when HPB is smaller (<10), fishing ground is close from Japan (roughly equal to the northern limit of blue marlin habitat) and when HPB is larger (>7), they spread around Hawaii. This difference of operational area make causes difference in surface temperature (Fig. 8 c), and the fishing ground when HPB is small, the habitat is not good for blue marlin.

The training vessels mostly operated in area where the surface temperature is lower than the temperature of higher estimated habitat preference (24 – 27 degree Celsius, Fig. 1) when they operate in around Japan with shallower gear configuration. This should be the reason why the training vessels could not obtain higher catch ratio with shallow sets. In such a situation, HPB cannot become good indicator of gear effects on blue marlin.

The consideration of habitat preference is effective for blue marlin, and lack of them may make different in results of GLM and statHBS (e.g. in 2001 in Fig. 7). Because the fishermen's behaviors could be different in each year in response to the annual change of environmental condition of the fishing ground and this affect on the estimation of the effective effort, it may be difficult to distinguish the effective effort for each vessel by the currently used GLM framework which only consider the effect of the relatively large scale of area, season, year, HPB and some two way interactions of them. Because the effectiveness is considered to relate with not only HPB but also HPB's interaction factors and/or independent factors of areas, years, seasons and/or fishermen’s ability. More small scale area stratification such as 5x5 blocks and the three or four way interactions such as year*area*gear*season could produce reasonable results, but the shortage of the coverage of data hampers this. Especially, it may affect more so for the fish like blue marlin whose favorite habitat is quite limited to warmer and shallower layer in the ocean because the environmental variability of shallower layer can be much more variable than deeper layer. Preliminary result of GLM with additional factors of latitude, longitude and interaction between HPB and year is provided in Fig. 9, and this fit produced the

CPUE trend closer to the result of statHBS than former simpler GLM models. It cannot be said that statHBS's result is close to true dynamics and fitting closer is better, but at least consideration of small scale area effect (latitude and longitude) in GLM make closer result to statHBS.

The fact that result of GLM which includes the effect of small scale area effect was closer to the result of statHBS than simpler GLM may indicates that statHBS has better ability to adjust the effect of annual change of environmental conditions of fishing ground than the simpler GLM. However such a complicate model is probably exceptional for such as blue marlin stock assessment by using commercial fishery data.

In conclusion, effects of habitat preferences of blue marlin should be adequately adjusted in the process of CPUE standardization but it would not be easy for the currently used GLM framework when it is applied on the complicated Japanese longline data set. While this study utilized the data from training vessels, the commercial longline fisheries may have different characteristics such as trip schedule, gear materials, gear setting, and/or etc. Implementation of such analysis with commercial fishery data is required as a next step.

References

Bigelow, K.A. and Maunder, M.N. (2007). Does habitat or depth influence catch rates of pelagic species?, Can. J. Fish. Aqu. Sci. 64:1581−1594.

Kanaiwa, M, K. Bigelow and K. Yokawa. (2008a). .A comparison of observed catenary angles and estimated angles with a statistical habitat-based standardization model with a multiple species approach. ISC/BILLWG/2008/04

Kanaiwa, M, K. Bigelow and K. Yokawa. (2008b). A comparison of gear configuration and capture by hook, depth and habitat for Japanese training vessel and Hawaii-based tuna longline fisheries. ISC/BILLWG/2008/03

Maunder, M.N., Hinton, M.G., Bigelow, K.A. and Langley, A.D. (2006). Developing indices of abundance using habitat data in a statistical framework. Bull. Mar. Sci. 79: 545−559.

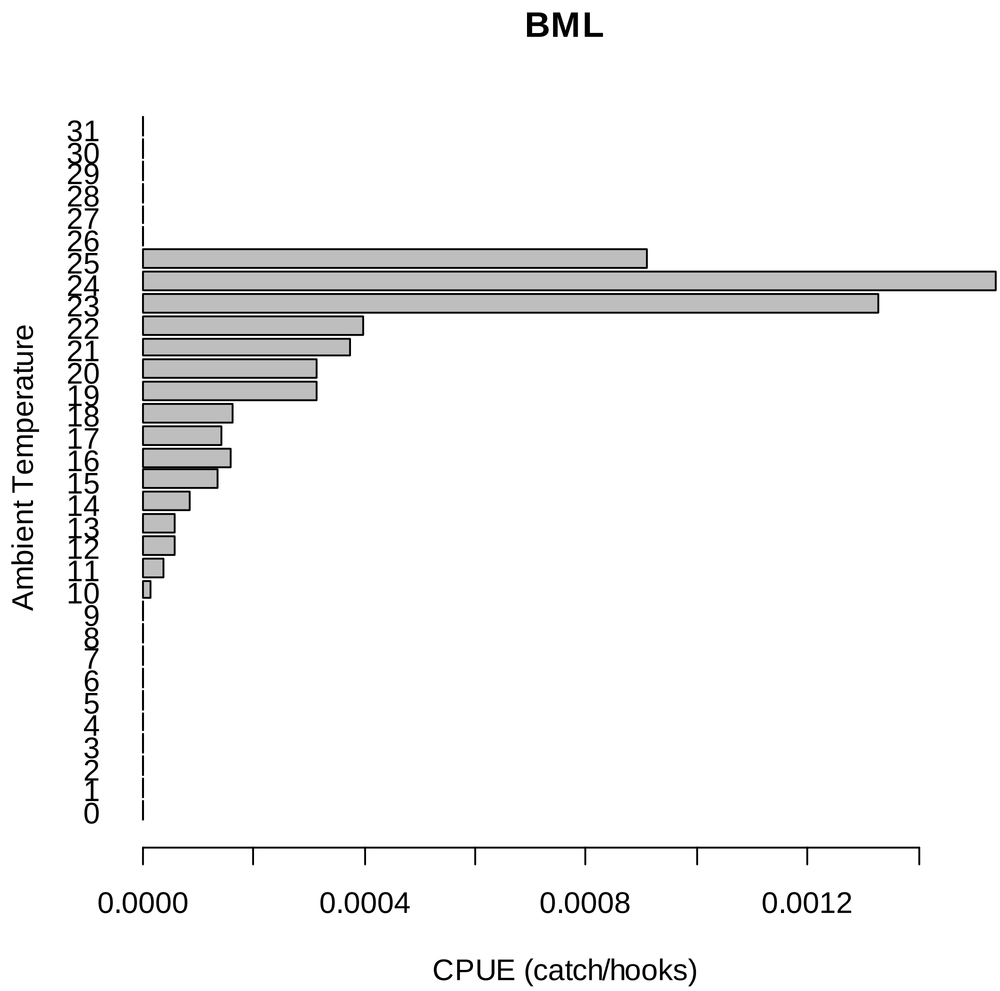

Fig. 1 Estimated Nominal CPUE of blue marlin by ambient temperature.

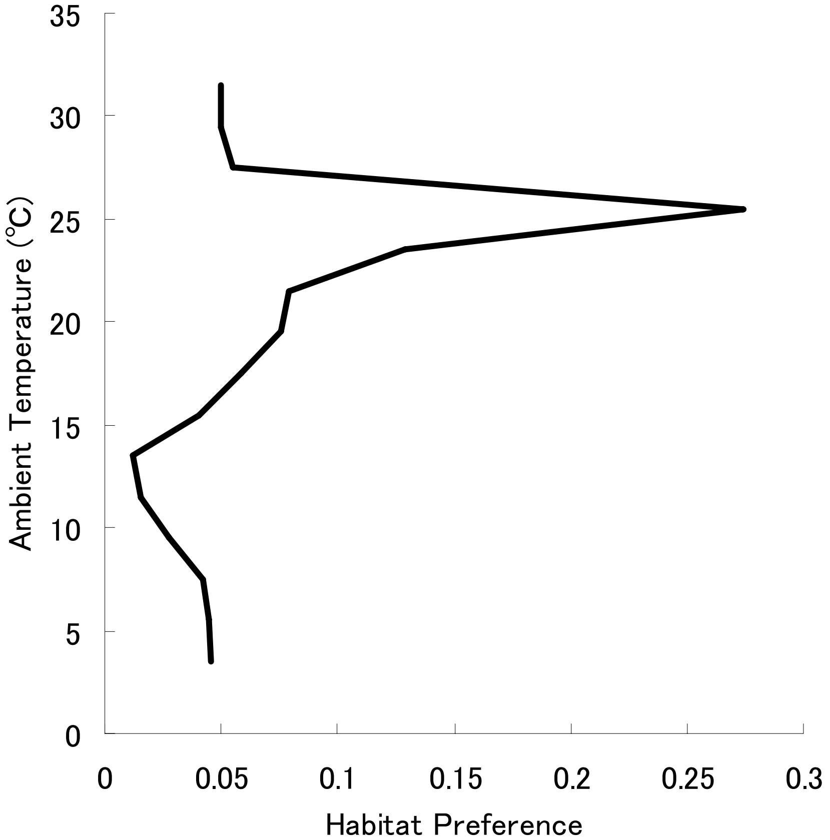

Fig. 2 Estimated habitat preference by statHBS

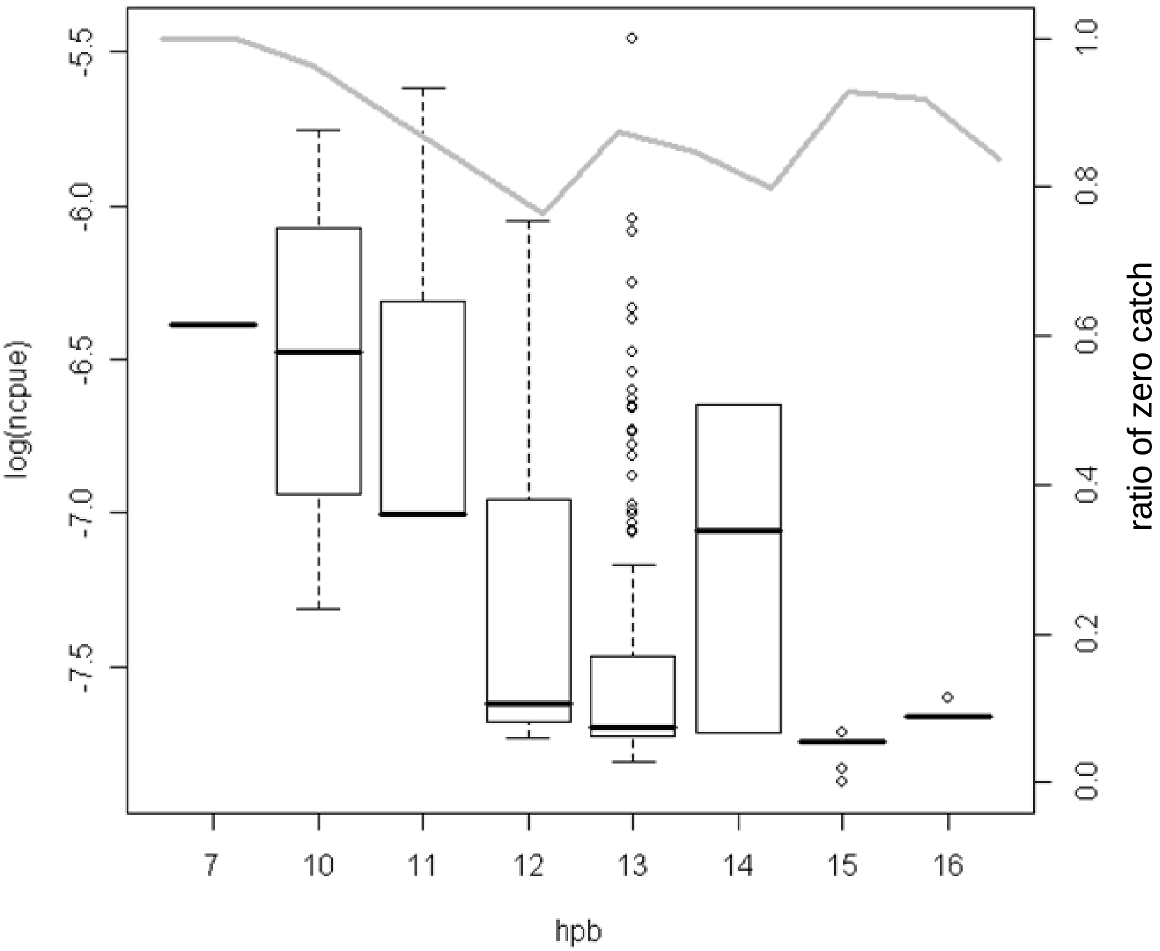

Fig. 3 Logarithm of nominal CPUE without zero catch (box plot) and ratio of zero catch (gray line) by different hooks per basket. *HPB=7 has only 1 observation with catch.

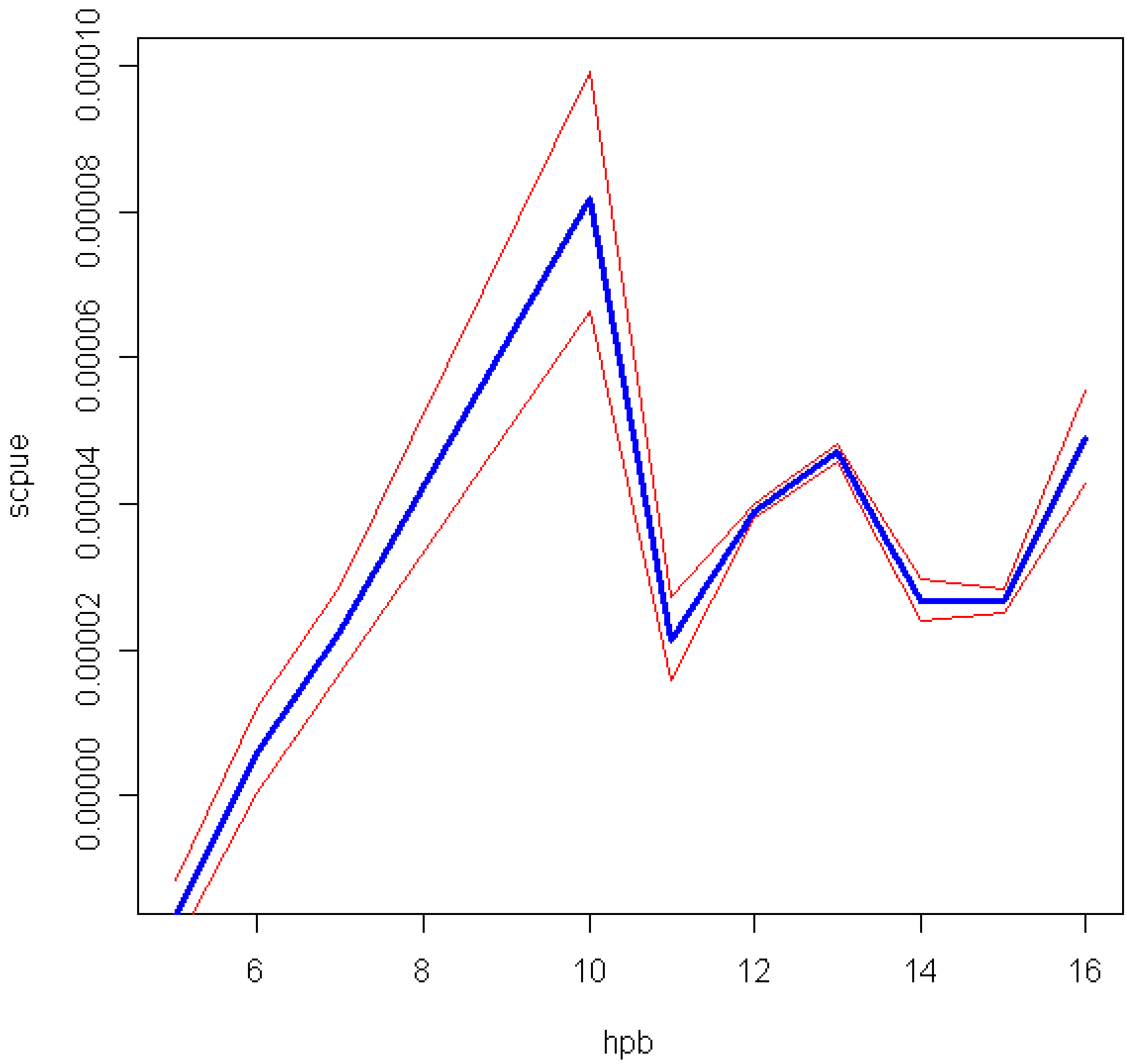

Fig. 4 Standardized CPUE by hooks per basket by GLM

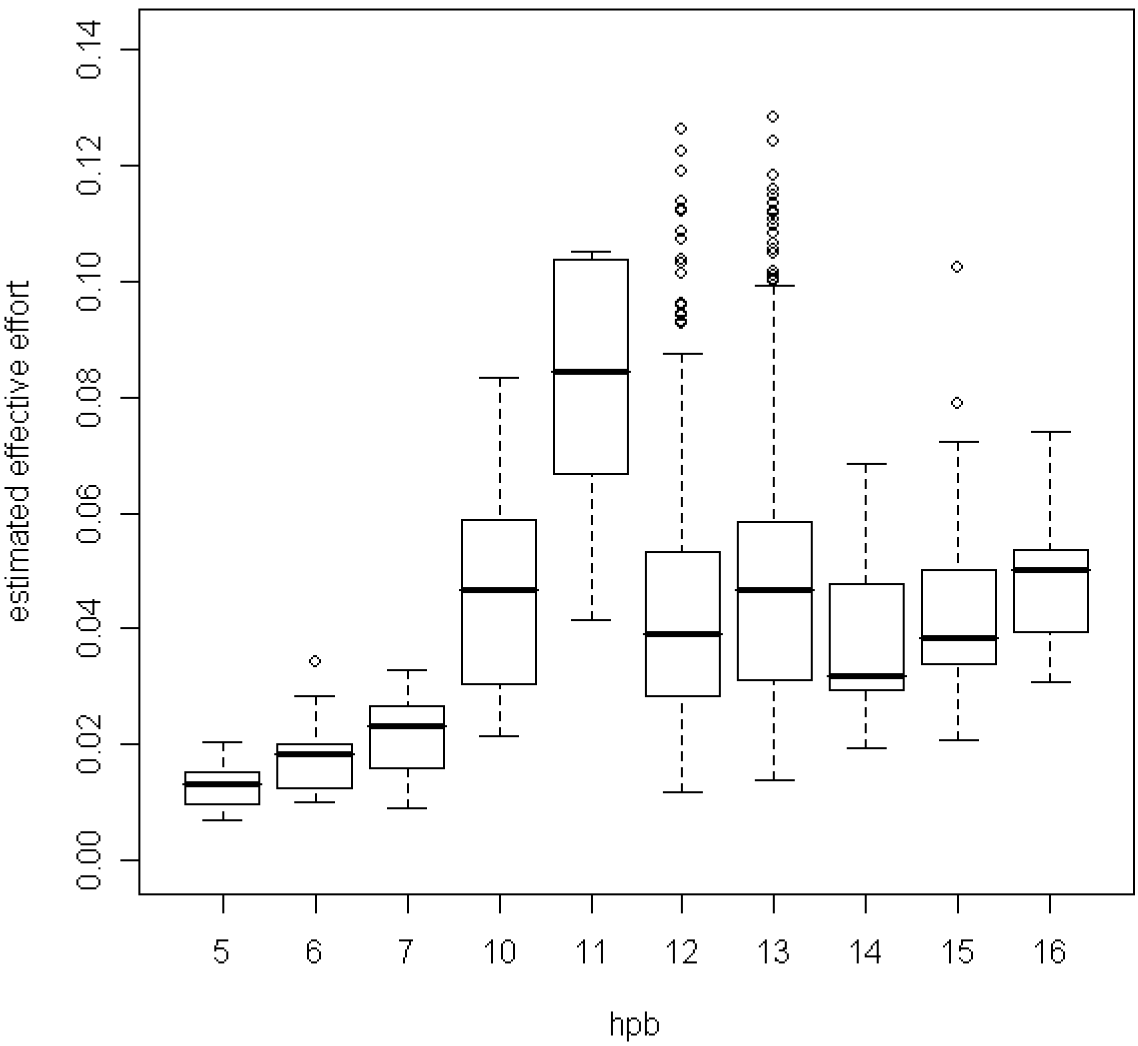

Fig. 5 Estimated effective effort for each HPB by statHBS

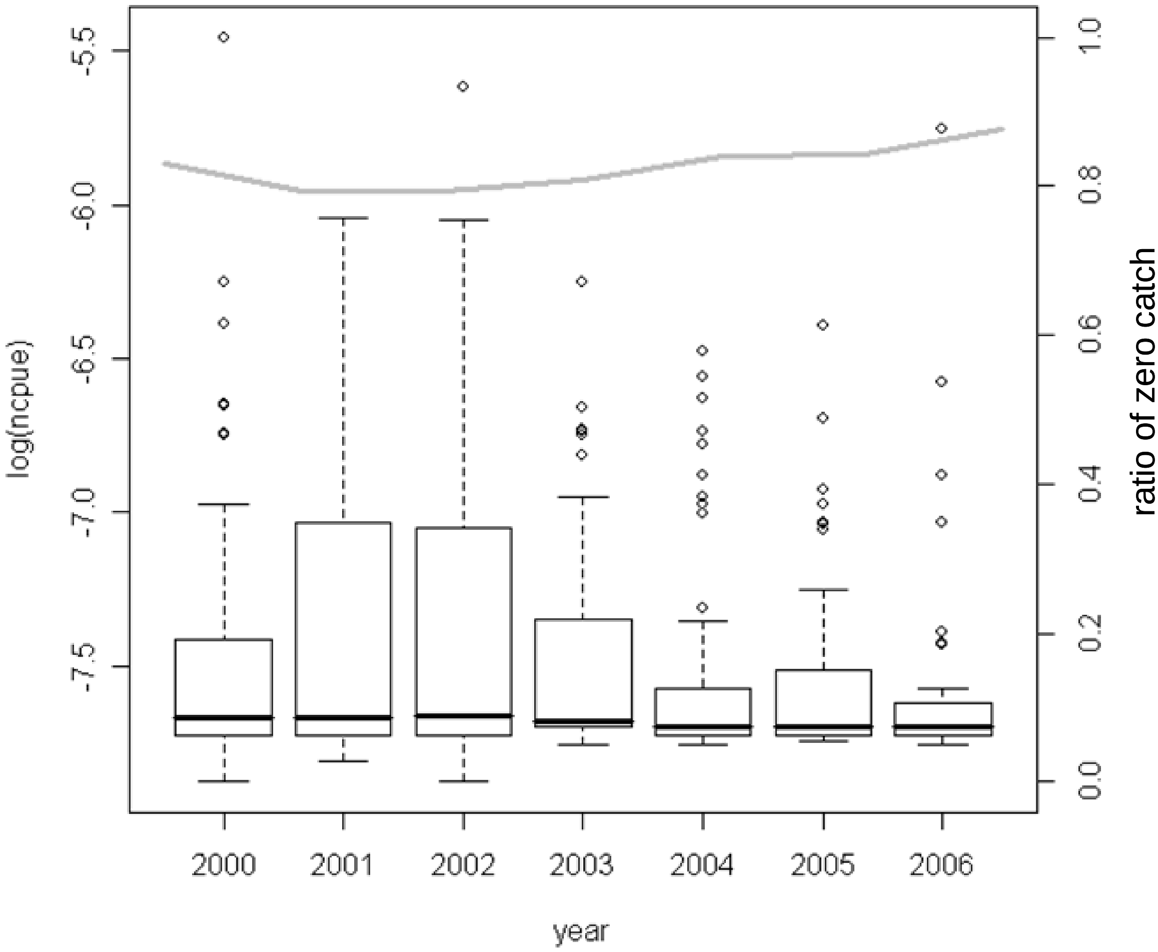

Fig. 6 Logarithm of nominal CPUE in each year (box plot) and ratio of zero catch (gray line)

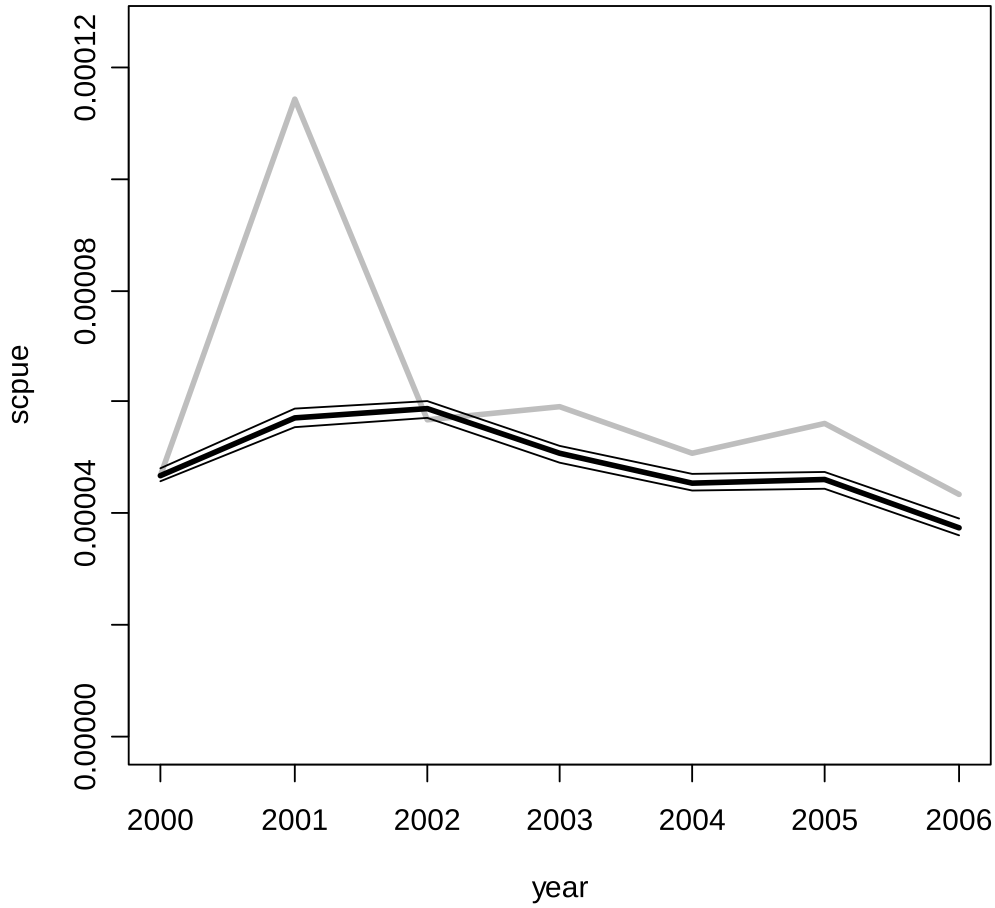

Fig. 7 Standardized CPUE in each year by statHBS (gray line) and simple GLM (black line)

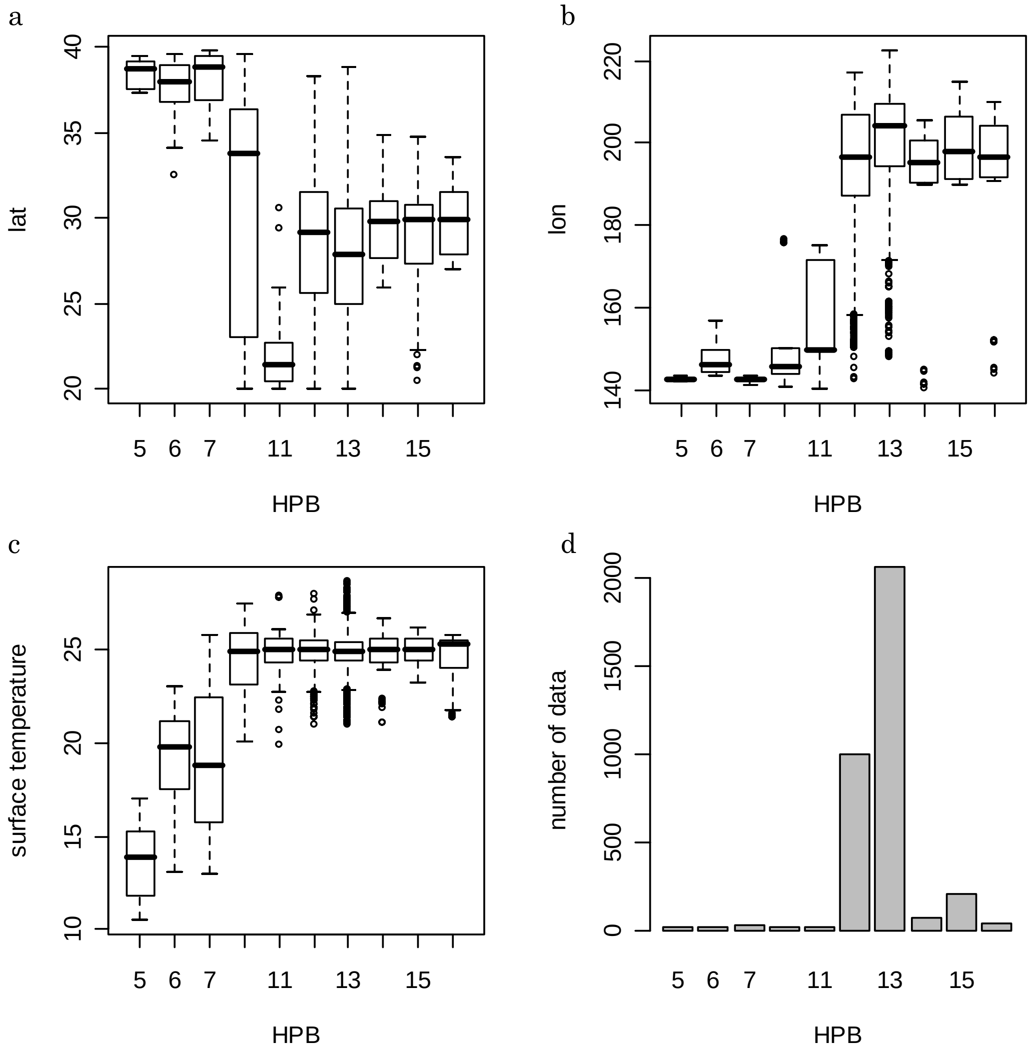

Fig. 8 a) Box plot of latitude for each HPB, b) box plot of longitude for each HPB, c) box plot of surface temperature for each HPB and d) number of data points.

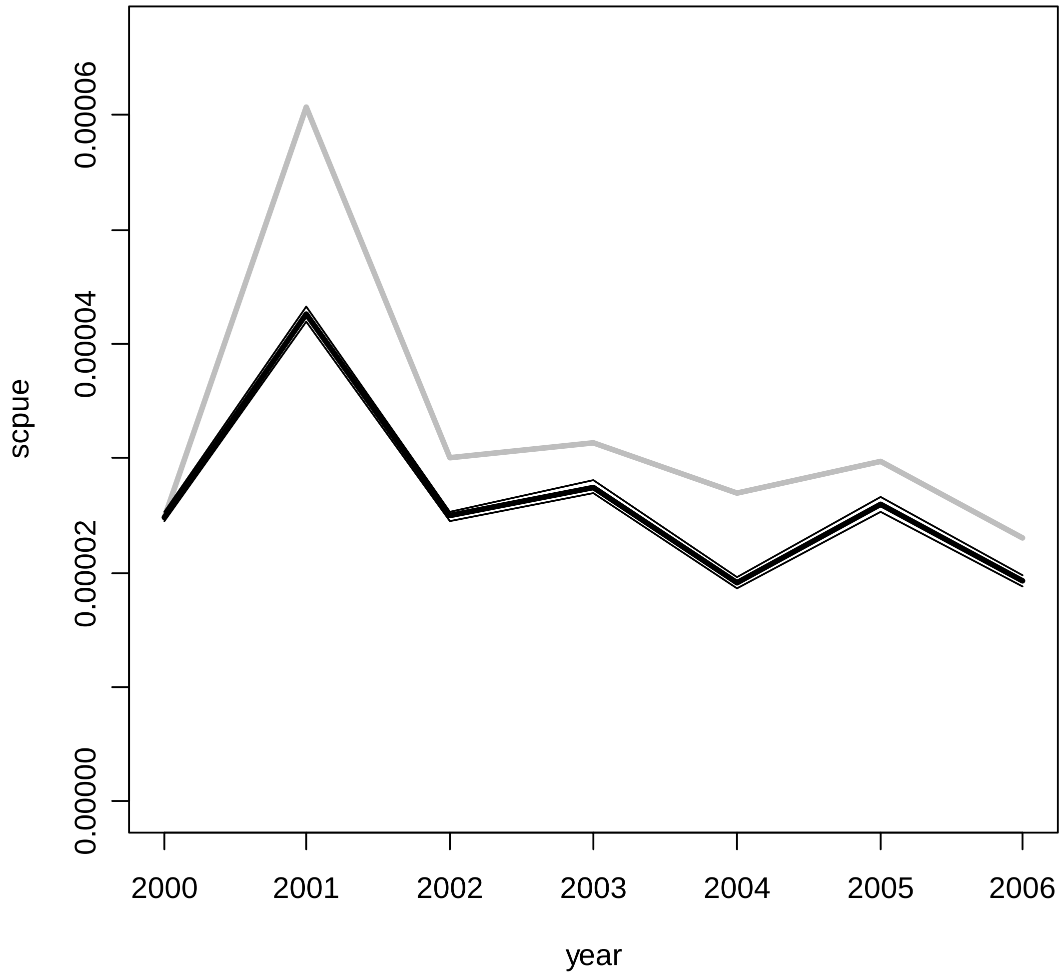

Fig. 9 Standardized CPUE in each year by statHBS (gray line) and GLM with additional factors of area and HPBxYear effects (black line)