ISC/08/BILLWG-2/05

Preliminary analysis of Blue Marlin's fishery by Japanese offshore and distant-water longliners

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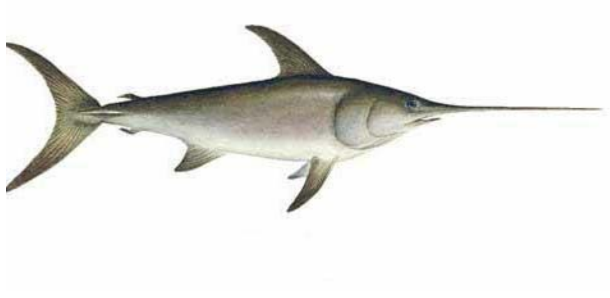

[1]Working document submitted to the ISC Billfish Working Group Workshop, June 11-19, 2008, Abashiri, Hokkaido, Japan. Document not to be cited without authors' written permission.

Summary

Simple GLM is applied on the commercial fishery data of blue marlin by Japanese longline fishery in Pacific Ocean to examine the existence of difficulties in the CPUE standardization caused by the complexity of the data to standardize CPUE because of the complexity of Japanese longline fishery. The annual trend of standardized CPUE is decline when the traditional GLM model was applied. At same time the standardized CPUE per each HPB indicate unrealistic result, i.e. smaller HPB (shallower sets) obtains higher catch rates than the larger HBP (deeper sets), whose gear is positioned in shallower layers than larger HPB, does not provide higher standardized CPUE.

To explore the reason of this unrealistic result, operation patterns of Japanese longliners analyzed by latitude, longitude, gear configurations and periods. The data of Japanese longliners in 1975 – 2006 was divided into 3 periods arbitrarily based on the historical patterns of the ratio of sets with different gear configuration, and effects of latitude and longitude on the operation pattern was examined by the period. Though both shallower and deeper sets were observed all over the Pacific, the apparent tendency that ratio shallower sets become larger as the latitude become higher, and this tendency turn out to be more noticeable in the recent years. After 1993, majority of shallow sets obtained in offshore area of Japan where blue marlin is less abundant, and almost of all sets are occupied by the sets deeper that 10 HPB in the tropical area. This unbalanced distribution pattern of efforts of Japanese longliners in periods of their gear configuration would be one of the main reasons of the calculated sharp declining of standardized CPUE of blue marlin caught by Japanese longliners.

The observed strong effects of area and gear configuration could only be adjusted by introducing the interaction periods among year, area, gear configuration as well as season into the traditional GLM framework. The statHBS would be one of alternatives but may have some problems i.e. assumption that habitat preferences of blue marlin regulated by ambient temperature, quality and quantity of habitat information as well as the method to estimate vertical distribution pattern of longline efforts definition of catenary curve. More consideration about standardized methods is required.

Introduction

The CPUE standardization is required to distinguish the change of stock abundance from variety of hidden biases mainly caused by the skewed operational pattern of commercial fleets. For this purpose, there are several methods are provided so far. The commonness of these methods demands to choose appropriate factors which will distinguish stock abundance. However the commercial fishery data is skewed often and it make difficulty to define key factors to distinguish it. Yokawa (2004) showed the difficulty to standardize CPUE for marlins by Atlantic Japanese longline fishery and it suggested the complexity of Japanese longline fishery. In this paper, we apply simple GLM to the fishery data of blue marlin by Japanese longline fishery in Pacific Ocean to examine if there are similar problem occurred in the Japanese longline data in the Pacific blue marlin.

Material and Methods

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 1975-2006. 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).

The standardization of CPUE is conducted by the GLM method with the model as following equation.

$$\log(CPUE_{i,j,k} + const) = Intercept + \alpha_{Year} \cdot Year_i + \alpha_{quarter} \cdot quarter_j + \alpha_{HPB} \cdot HPB_k + \varepsilon$$

Here, $\log$ is natural logarithm, $CPUE_{i,j,k}$ is nominal CPUE (catch in number per hooks in Year i, quarter j and HPB k), $const$ is 10% of minimum CPUE except zero catch, $Year_i$ is the factor of year i, $quarter_j$ is the factor of quarter j, HPB_k is the factor of HPB k, α s are coefficients for each factors and ε is error factor followed by normal distribution.

Pacific blue marlin was caught all of Pacific Ocean and mainly was caught in the tropical Pacific between 20˚N and 25˚S (Figure 1). Even through the annually and seasonally effects are included in the model, effects of area are not included in this study as no significant spatial partition is recognized.

Result and Discussion

Figure 2 is the box plot of logarithm of nominal CPUE excluding zero and gray line is ratio of zero catch in all over the Pacific Ocean for blue marlin in each year. The median of nominal CPUE does not fluctuate much and ratio of zero catch is relatively stable also. Figure 3 shows logarithm of nominal CPUE in each HPB and gray line shows ratio of zero catch.

There is a high peak when HPB is 1 and 2, however these HPB is unrealistic and remaining the probability of inputting error. Except these two points, there is no significant difference in nominal CPUE. The ratio of zero catch fluctuates. When HPB is larger than 10, the ratio is stable in lower probability.

Figure 4 shows standardized CPUE by year. It looks being on decreasing trend significantly and quite different from the one of the nominal CPUE. Figure 5 shows standardized CPUE in each HPB. There are big fluctuations and there is high peak around HPB is 17. This result is different with Kanaiwa et al. 2008. Kanaiwa et al. (2008) shows the standardized CPUE of blue marlin shows the apparent decreasing trend when HPB larger than 10 when they analyzed data of Japanese training longline vessels. The pattern of standardized CPUE can be separated to three blocks, i.e. smaller than 10, between 10 and 15, and larger than 15. When HPB is smaller than 10, the standardized CPUEs are low, when HPB is between 10 and 15, the standardized CPUEs are increasing and when HPB is larger than 15, the standardized CPUEs are staying at high values.

Block et al. (1992) shows the depth and temperature distribution of blue marlin around Hawaiian waters. They showed that blue marlin is staying mostly around 10m depth and 26˚C. This result suggests that the shallower sets should have higher efficiency in catching blue marlin than the deeper sets. If HPB factor can distinguish the effective effort of different gear configurations designed to target different depth layer properly, smaller HPB should provide larger standardized CPUE.

To explore the reason of this calculated unrealistic pattern of CPUE by HPB, the historical change of HPB is focused (Figure 6). The ratio of sets with smaller HPB than 10 is decreasing historically, and on the other side, the ratio of sets with larger HPB than 15 is increasing.

For the further analysis, we separate years as 3 periods arbitrarily by this HPB distribution. First period is from 1975 to 1982, 2nd is from 1983 to 1992, and 3rd is from 1993 to 2006 (Fig. 6 white dashed line). Figure 7 shows the number of operations by longitude and by the period, and Figure 8 shows the ones by latitude and by the period. Through the all periods, the shallow sets (HPB; 1 - 10) occurred in latitudinally wider range than the deep sets (HPB; 11 – 15) and the super deep sets (HPB; 16 -)(Fig. 8). The deep and super deep sets occurred in around the equator. After 1993, most of shallow sets obtained in around 150E. The super deep sets are also obtained in around 150E in the second period (1983 – 1992). Except for these two cases, all longline set distribute widely by longitude.

It is summarized that in early period many sets centers around equator and spread to east and west, but recently the shallow sets spread to north and south. But in recent years, the shallow sets become more abundant in the higher latitude area where blue marlin is less abundant than the lower latitude area.

Figure 9 shows the standardized CPUEs which are estimated by using the data of shallow sets (black line), deep sets (dark gray line) and super deep sets (light gray line). The CPUE by shallow sets shows the rapid decreasing trend while the one by deep and super deep sets shows more stable trend. The calculated rapid decreasing trend of the CPUE by shallow sets would represent the shift of operational area of shallow sets to higher latitude. Though the number of observation in early period is limited, relatively stable trend of the CPUE by deep and deeper sets would reflects true track of abundance of blue marlin.

Total trend of CPUE may be shifted by that black line's trend but we doubt this trend show the trend of stock abundance. This comes from the change of operating areas by each HPB. In other word, it has high probability that HPB is not a sufficient indicator of gear effects on blue marlin in commercial fishery.

To solve this problem, at least the consideration of interaction among HPB, year and area would be required, but the shortage of data coverage would obstruct the introduction of sufficient interaction terms into the GLM model for the CPUE standardization. In such case, the statHBS may be one of the alternative methods to consider these effects but this may have problems, i.e. assuredness of habitat preference in each area and year, quality of habitat information and/or the definition of catenary curve. More consideration about standardized methods is required.

References

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Block, B. A., D. T. Booth and F. G. Carey (1992). Depth and temperature of the blue marlin, *Makaira nigricans*, observed by acoustic telemetry. Marine Biology 114: 175-183.

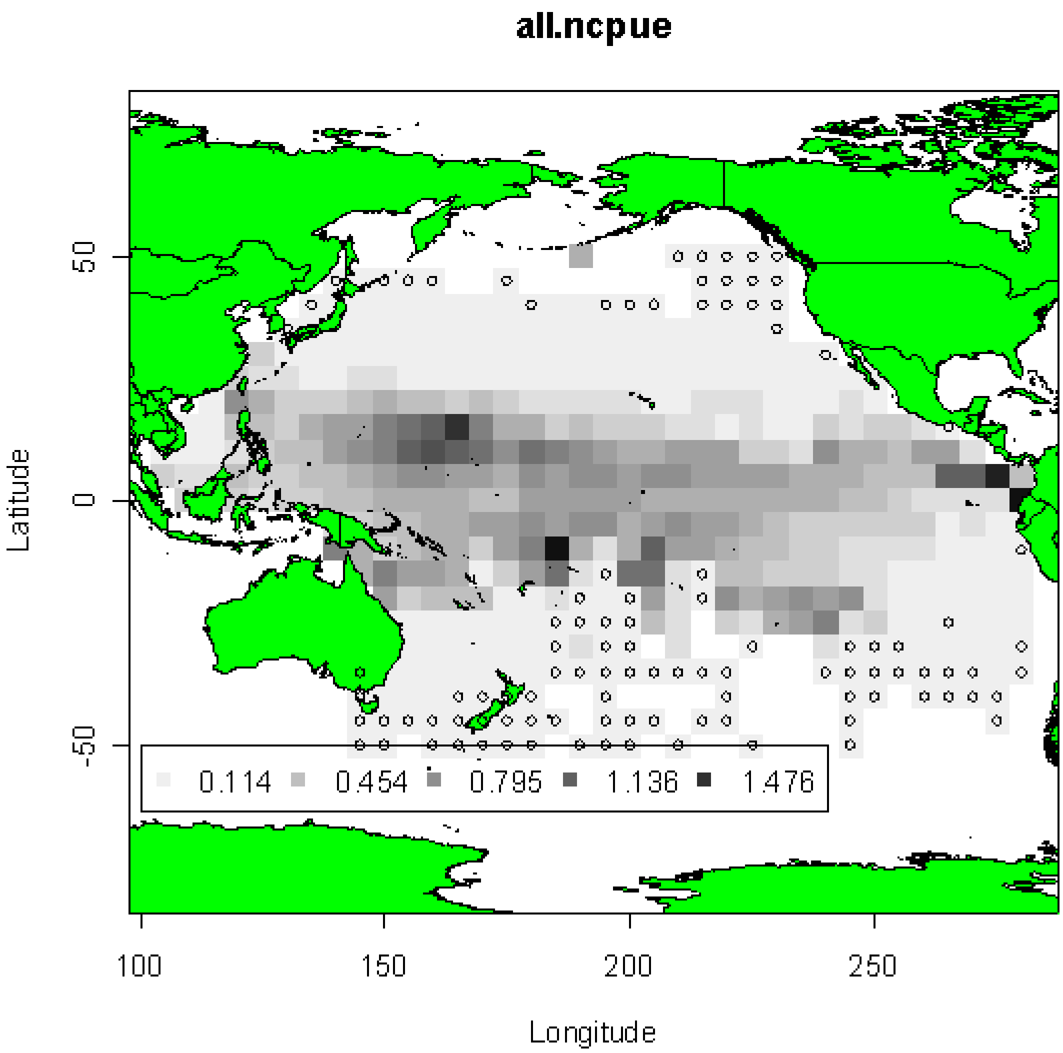

Fig. 1 The average of nominal CPUE*1000 for whole years.　The circle shows zero catch.

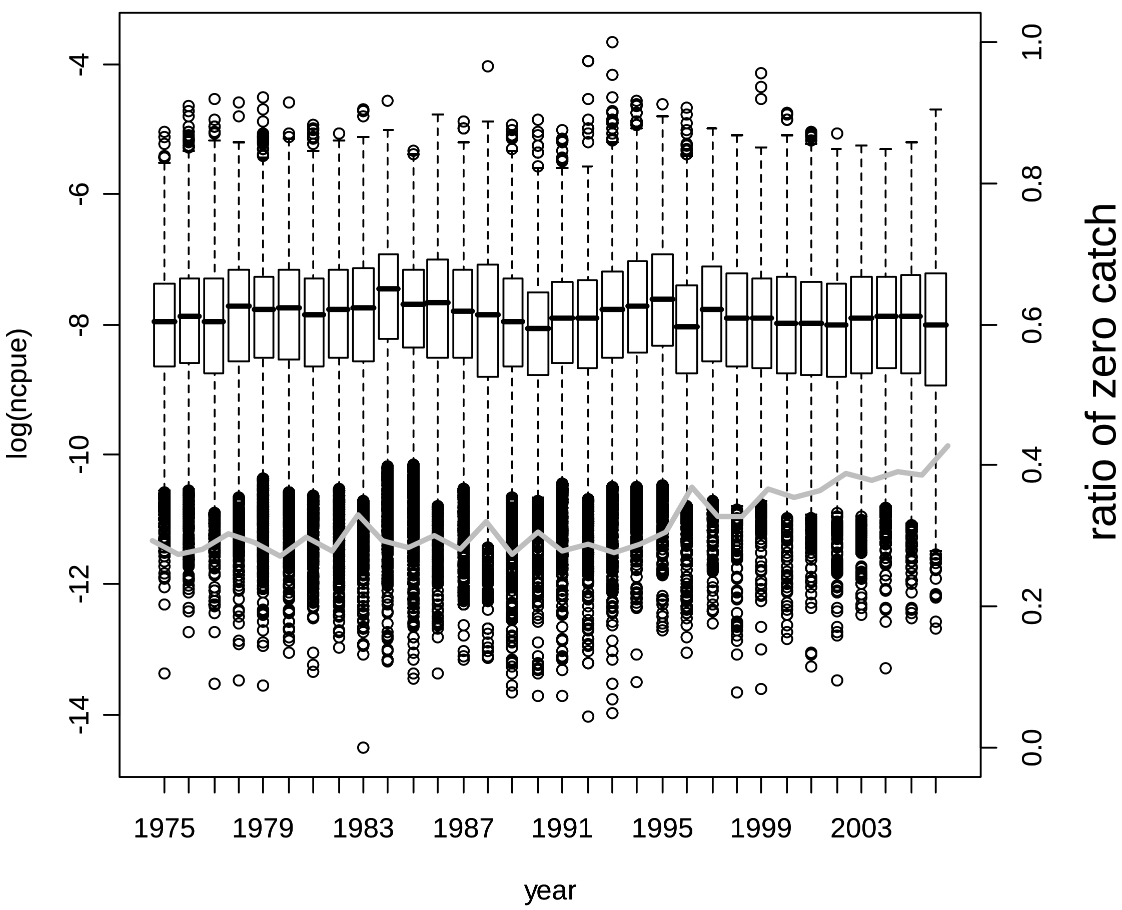

Fig. 2 Logarithm of nominal CPUE in each year (box plot) and ratio of zero catch (gray line)

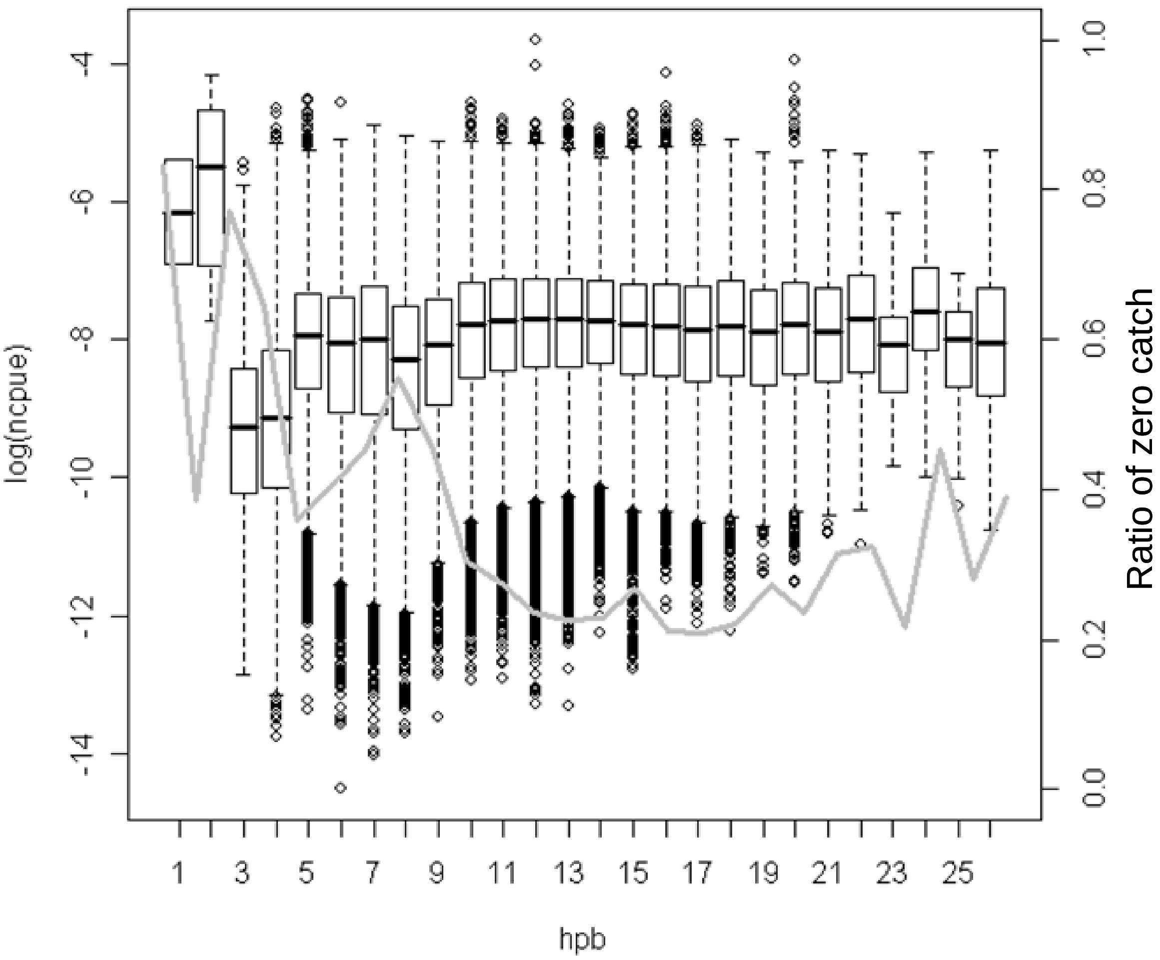

Fig. 3 Logarithm of nominal CPUE in each HPB (box plot) and ratio of zero catch (gray line)

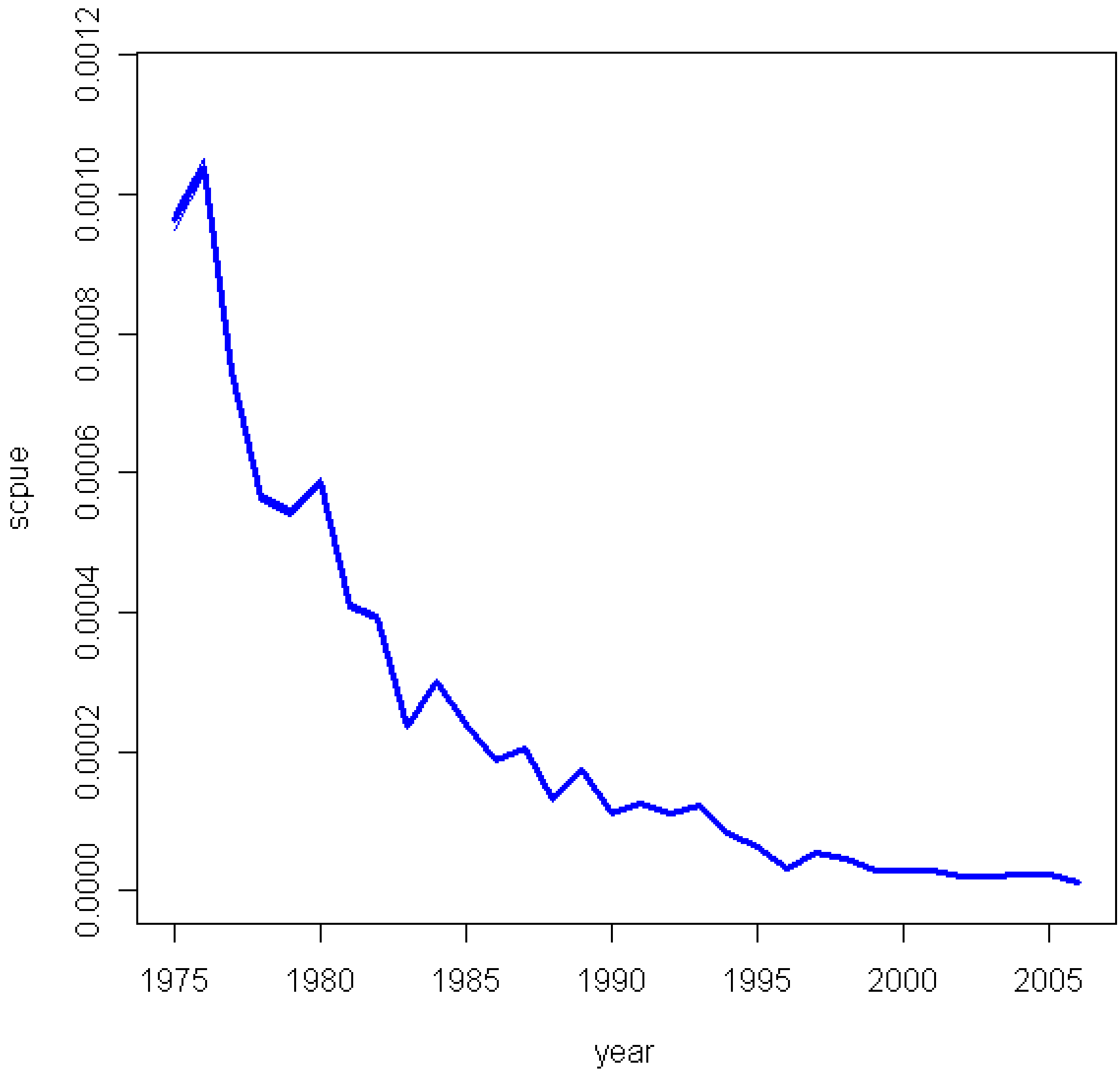

Fig. 4 standardized CPUE in each year.

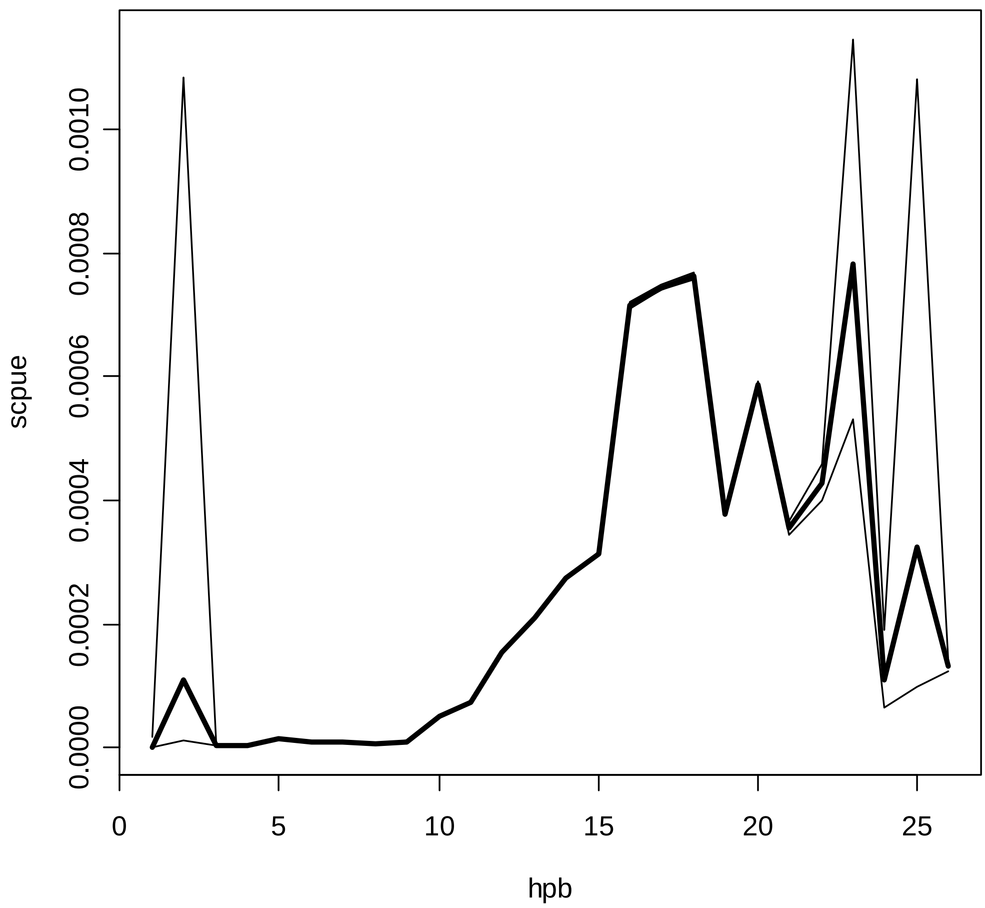

Fig. 5 Standardized CPUE in each HPB

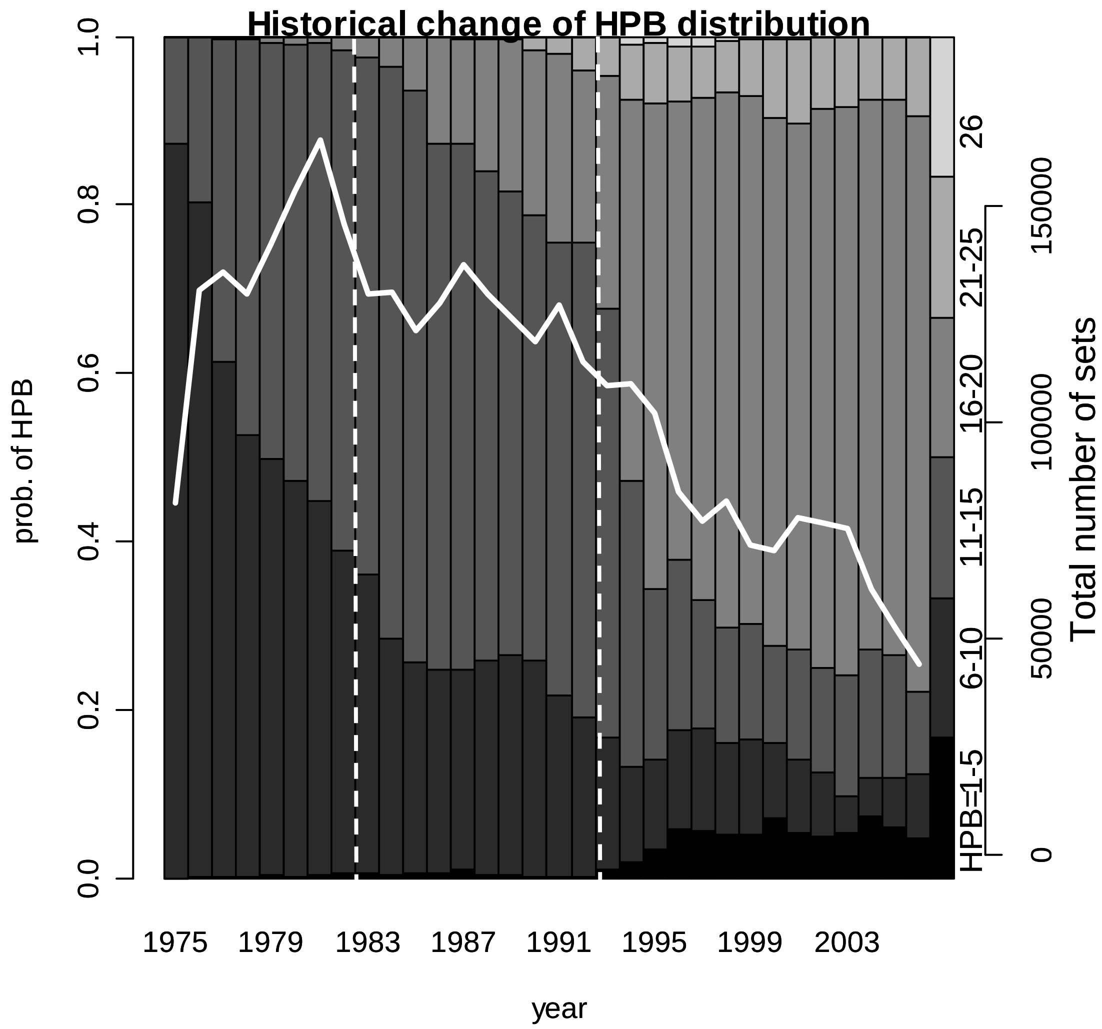

Fig. 6 HPB distribution in each year (bar plots), total number of sets (white solid line) and white solid lines show the age separation.

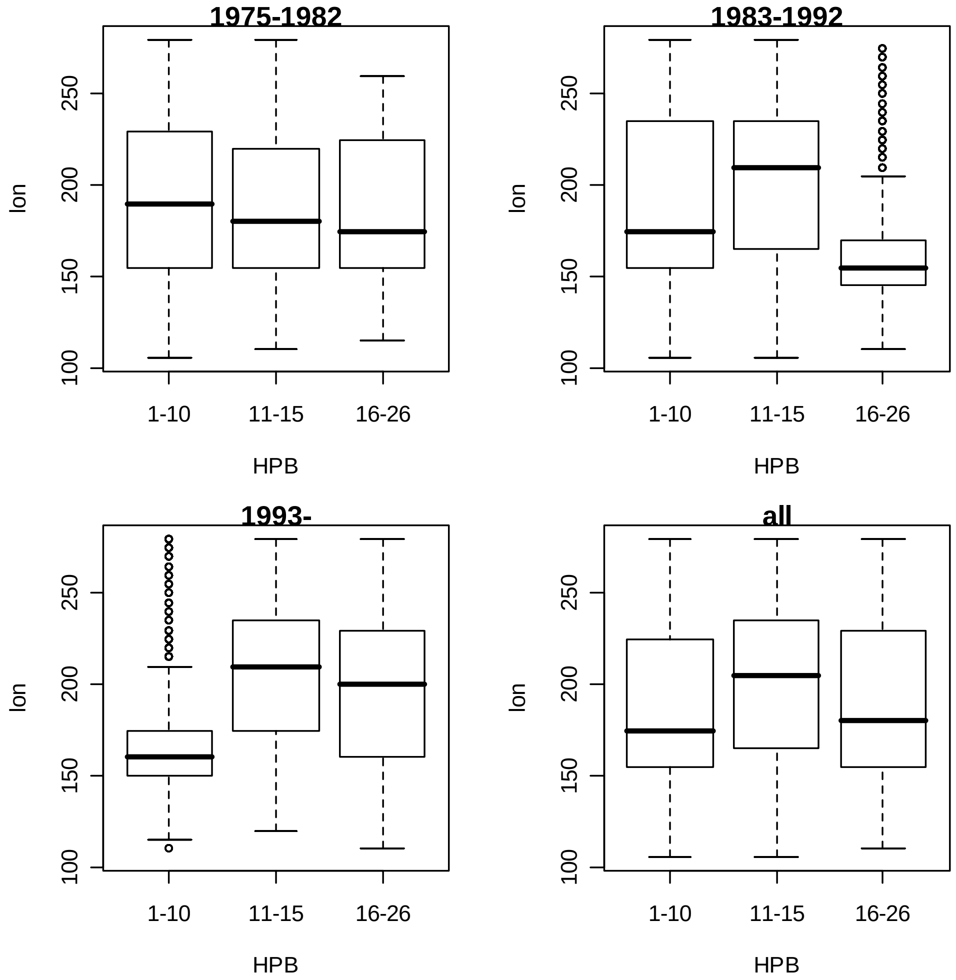

Fig. 7 Longitude distribution fro each HPB by three periods.

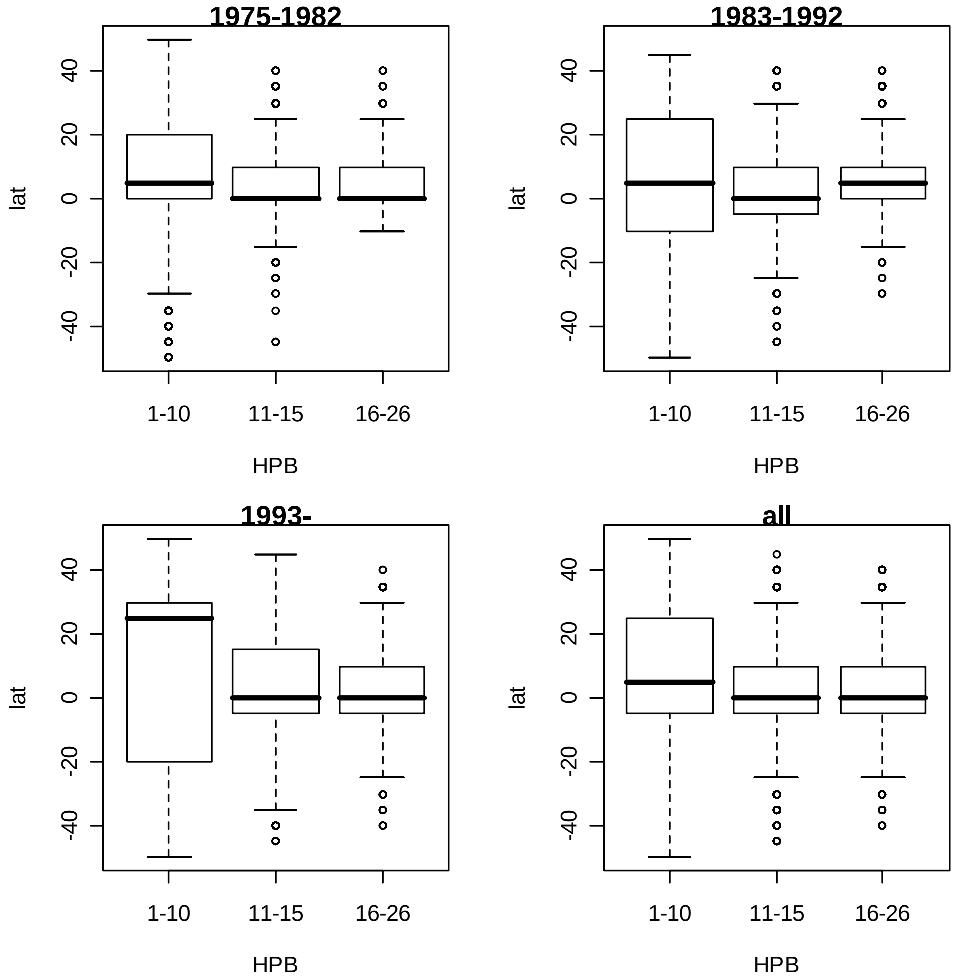

Fig. 8 Latitude distribution in each HPB for yearly ages.

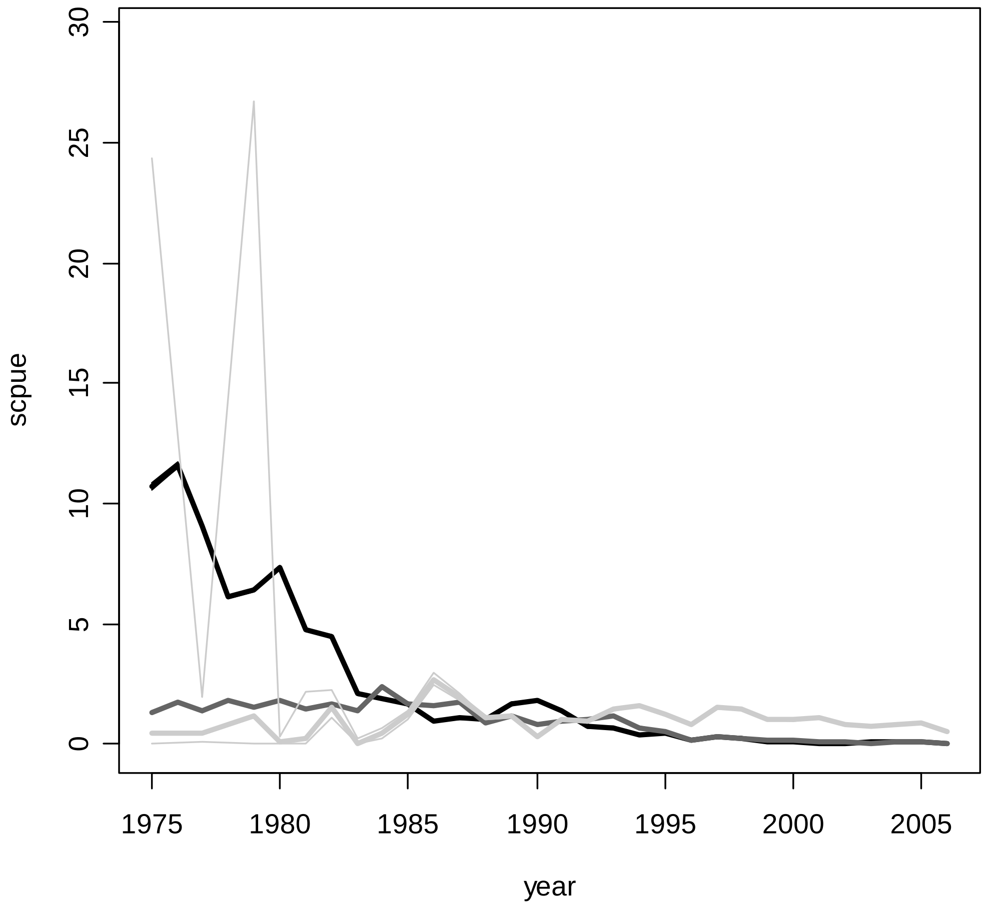

Fig. 9 Standardized CPUE for each HPB classes. Black: HPB=1-10, Dark gray: HPB=11-15 and Light gray: HPB>15.