Abundance indices of albacore tuna by Japanese longline fishery in the north Pacific Ocean. [1]

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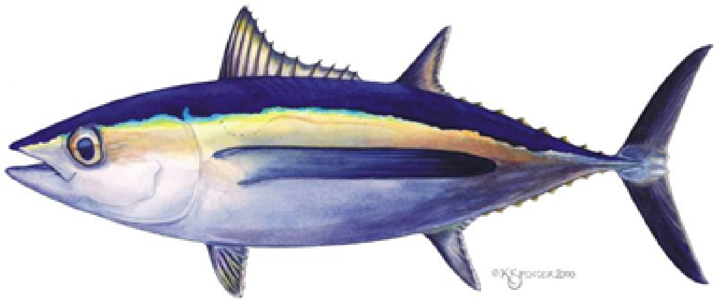

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Summary
To apply abundance indices of albacore tuna to Stock Synthesis 3, we redefined Japanese albacore longline fisheries that were considered catch at length and change of main fishing ground by year. In this analysis, We used catch and effort data, and Generalized linear models. As a consequence, we could improve Japanese longline CPUE in the North West Pacific: (1) there is time lag between CPUE of small size albacore and CPUE of large size albacore, (2)unrealistic increasing would be down in large size albacore CPUE. (3) we could pick up 1970 's CPUE decreasing.

Introduction

In the previous ISC albacore working group in Shanghai, We attempted abundance indices analysis for Japanese albacore longline fishery in the north West Pacific Ocean(Ijima et al., 2013(a) (b); Okamoto et al., 2013). In these papers, We used catch and effort data and assumed simple fishery definition that depend on Japanese log book and last stock assessment fishery definition. To apply these abundance indices to the length base stock assessment model such as a stock synthesis 3 (SS3)(Methot and Wetzel, 2012), it needs to define a relationship between length data and abundance indices. However, these previous document did not enough consider these difficulties. In this paper, we addressed abundance indices analysis using new fishery definitions that were considering a relationship between length data and abundance indices.

Data and Methods

Fisheries Data

In this analysis, we used three type longline fishery operational data sets given by Japanese logbooks as: Offshore fishery, Distant water fishery and Coastal fishery. These data set inculde catch, effort (hooks) and hooks per basket with 1 °× 1° grid cells. We picked up data set between 1975 and 2012, because hooks per basket data is available after 1975. Hooks per basket data shows fishing gear effect and that effectiveness is significantly large. **Fisheries definition**

In north West Pacific Ocean (WPO), Japanese longline fishery have caught small size and large size albacore. Japanese longline fishery ground was changed in 1990's (Figure 1). Hence, we summed up three type operational data and redefined four type fishing category that was considering catch at length, change of fishing ground by year as follows;

- JPNLL small:This fishery covers small area from 25°N to 35°N and 130°E to 140°E(Figure8-10). In this area, coastal and offshore fishery have targeted small size albacore (about 80cm) and main fishery season is first and second quarter.
- JPNLL large7592:During 1975 and 1992, Japanese longline fleets operated high-latitude area in WPO (from 25°N to 35°N and 140°E to 180°E)(Figure8-10). In this area, large size albacore (over 100cm) has been caught by offshore and distant water fishery. Main fishery season is first and 4th quarter.
- JPNLL large9312:After 1993, Japanese longline fishery ground expanded south area in the north Pacific Ocean (from 10°N to 35°N and 130°E to 180°E exclude JPNLL small

area)(Figure8-10). In this area, large size albacore (over 100cm) has been caught by offshore, distant water and coastal fishery.

- JPNLL EPO:Until early 2000's, distant water fishery caught albacore in north East Pacific Ocean (EPO)(from 25°N to 35°N and 140°W to 180°W)(Figure8-10). We choose data set between 1975 and 2000. In this area, albacore size was different by a year.

Generalized linear models

Generalized linear models (GLMs) was widely used tools to standardize catch per unit effort (CPUE) (Maunder and Punt, 2004; Walters,2003). We assumed CPUE as albacore abundance indices. We analyzed Japanese longline albacore CPUE that based on four fishery definitions above. We used negative binominal model because: (1)these catch data is count data that shows Negative Binomial distribution, (2)total zero catch ratio is approximately low (under 25%). We chose five main effects a combination of year, quarter, a fishing gear effect (hooks per basket), 5 °× 5° fishing area effect and fishery fleet type. We did not use interaction term. The model examined for standardization of CPUE was:

$$\begin{aligned}
Catch_i &\sim NB(\mu_i, k) \\
E(Catch_i) &= \mu_i \\
\log(\mu_i) &= \alpha + \beta_1 yr_i + \beta_2 qtr_i + \beta_3 latlon_i + \beta_4 hpb_i + \beta_5 fleet_i + \log(hooks)
\end{aligned}$$

where $Catch_{\ i}$ is the albacore catch number in condition i. μ_i is expected value and k is variance of Negative Binomial distribution. α is an intercept. β_x are coefficients. $yr_{\ i}$ is year effect in the condition i. $qtr_{\ i}$ is quarterly effect in the condition i. $latlon_{\ i}$ is 5 °× 5° area effect in the condition i. $hpb_{\ i}$ is fishing gear effect in the condition i and $\log(hooks)$ is offset term of fishing effort respectively. In this GLMs, we treated all explanatory variables as categorical data. A standardized annual CPUE was obtained by calculating the least squares means. All statistical analysis results were provided by R-2.15.2.

Result and Discussion

Summary of result in this analysis shows Figure 4 to 7. To compare with this analysis and ISC/13ALBWG/07 result using previous stock assessment method, we could get three improvements of Japanese longline CPUE in the WPO (Figure 2). First, there is time lag between small size albacore CPUE and large size albacore CPUE. Secondly, unrealistic increasing would be down in the large size albacore CPUE. Finally, we could pick up 1970 's CPUE decreasing.
To compare with standardized and nominal CPUE, standardized CPUE trend is approximately same as nominal CPUE. However, in JPNLL large7592, standardized CPUE trend shows different trend as nominal CPUE (Figure 3). This reason is thought fishing gear effect.

References

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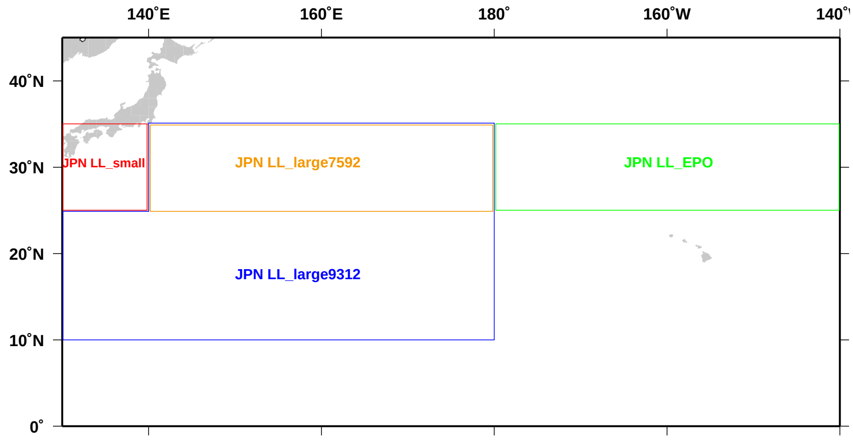

Figure 1: Areas for CPUE analysis.

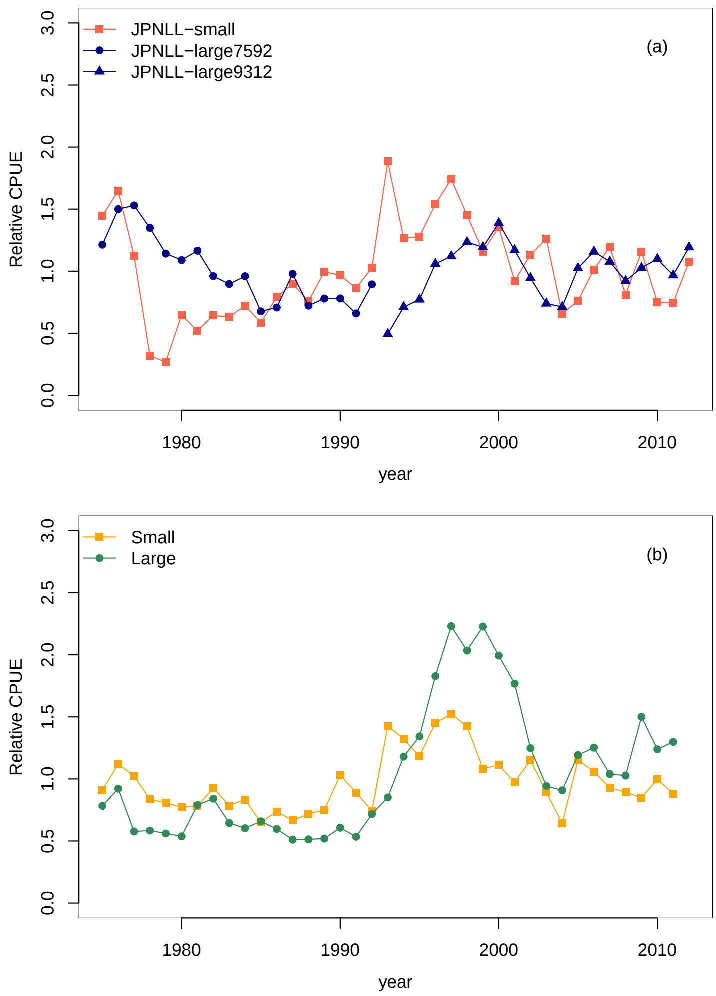

Figure 2: Comparison (a)this document result and (b)ISC/13ALBWG/07 result using previous stock assessment method.

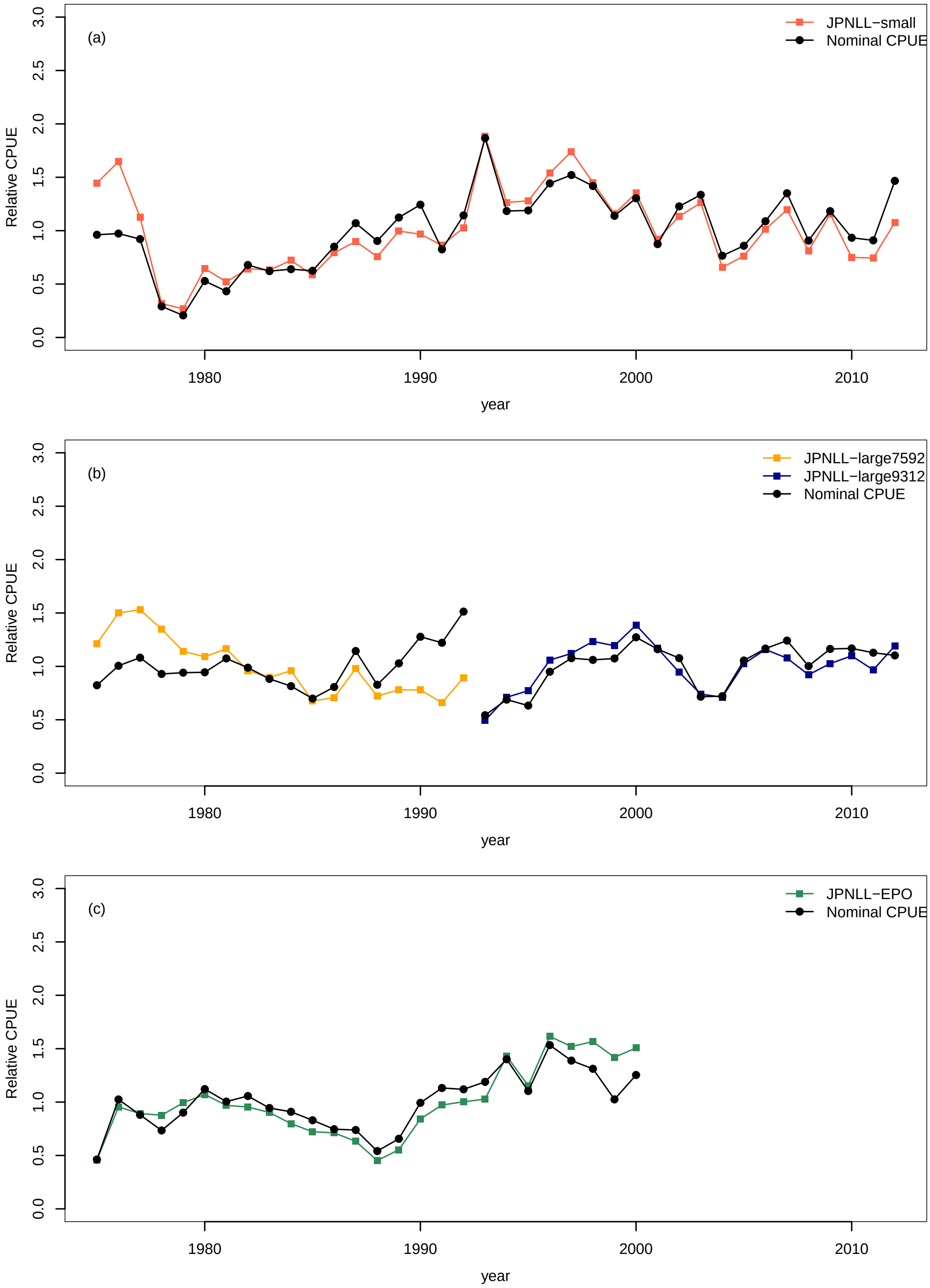

Figure 3: Relative CPUE (a) Small size albacore fishery in north West Pacific, (b) Large size albacore fishery in north West Pacific and (c) Albacore fishery in north East Pacific.

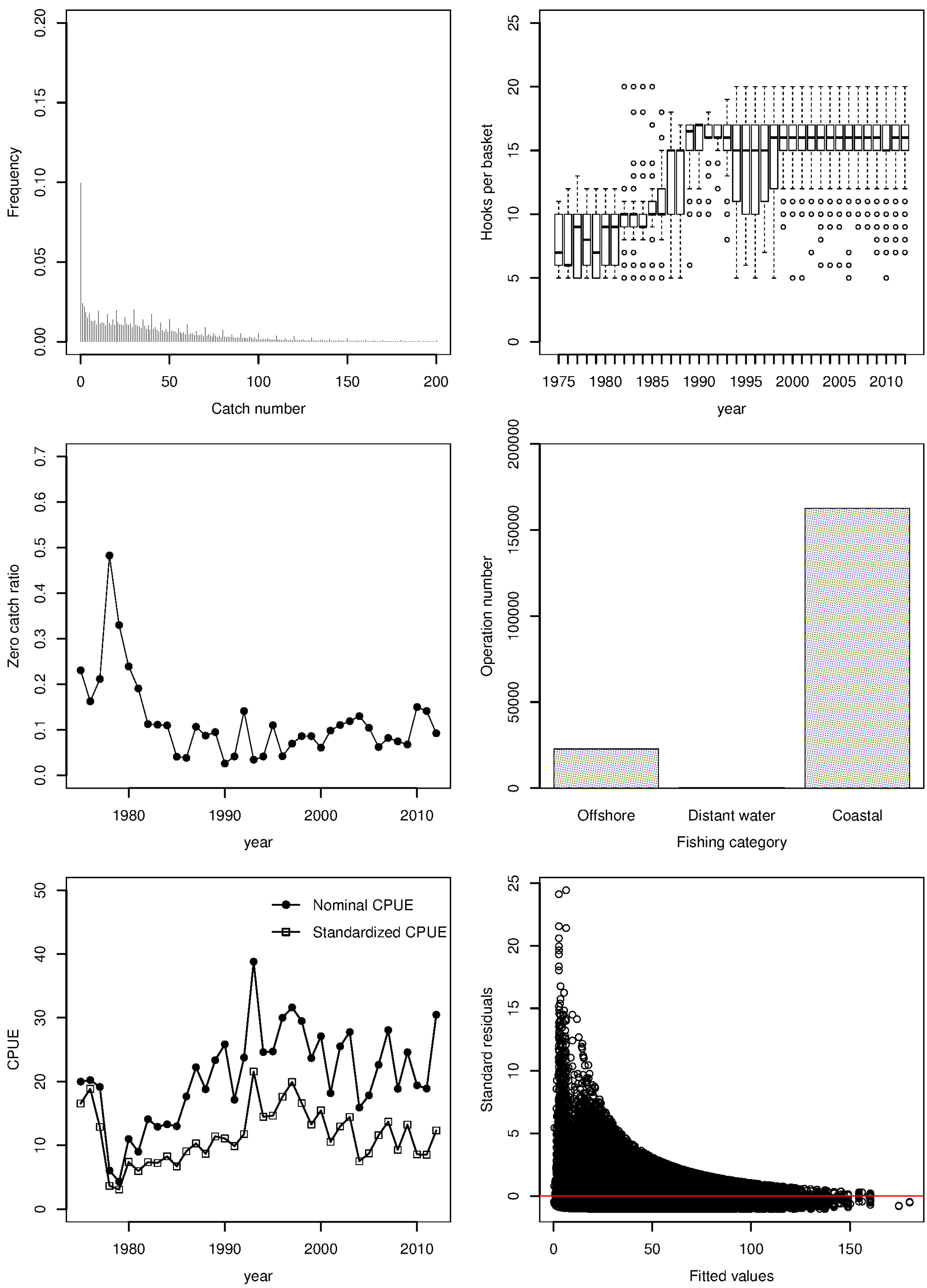

Figure 4: Analysis results of JPNLL small.

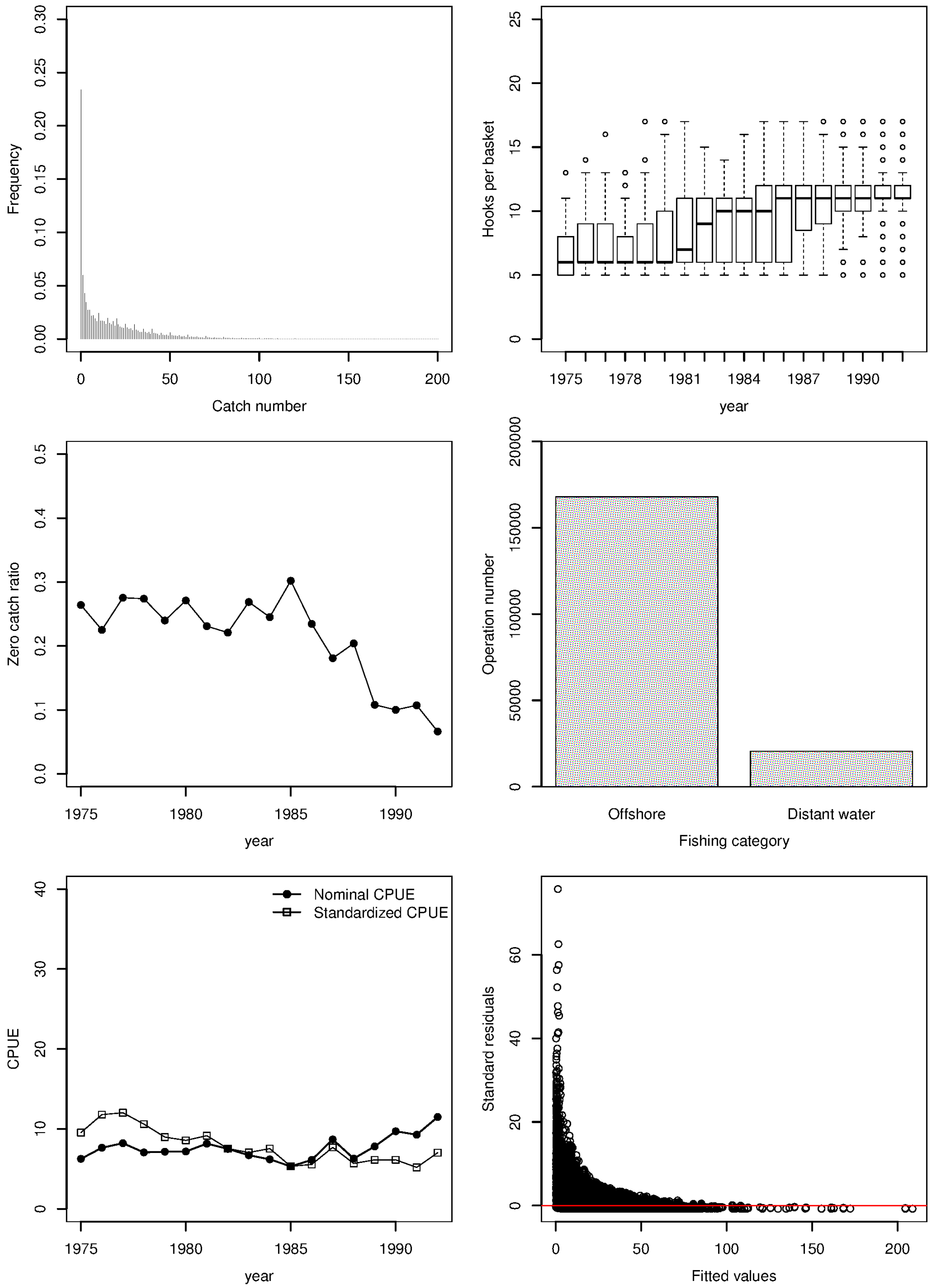

Figure 5: Analysis results of JPNLL large7592.

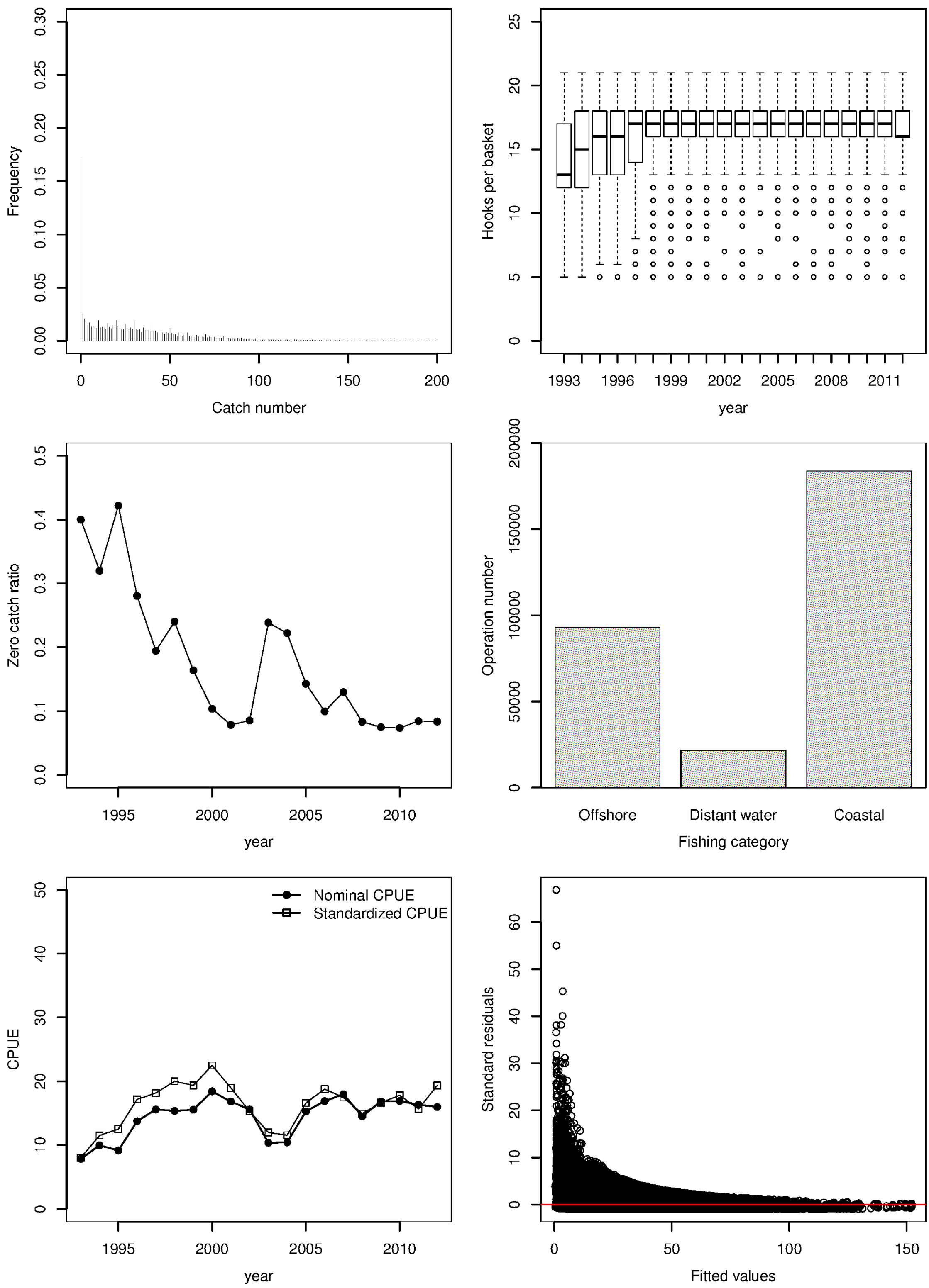

Figure 6: Analysis results of JPNLL large9312.

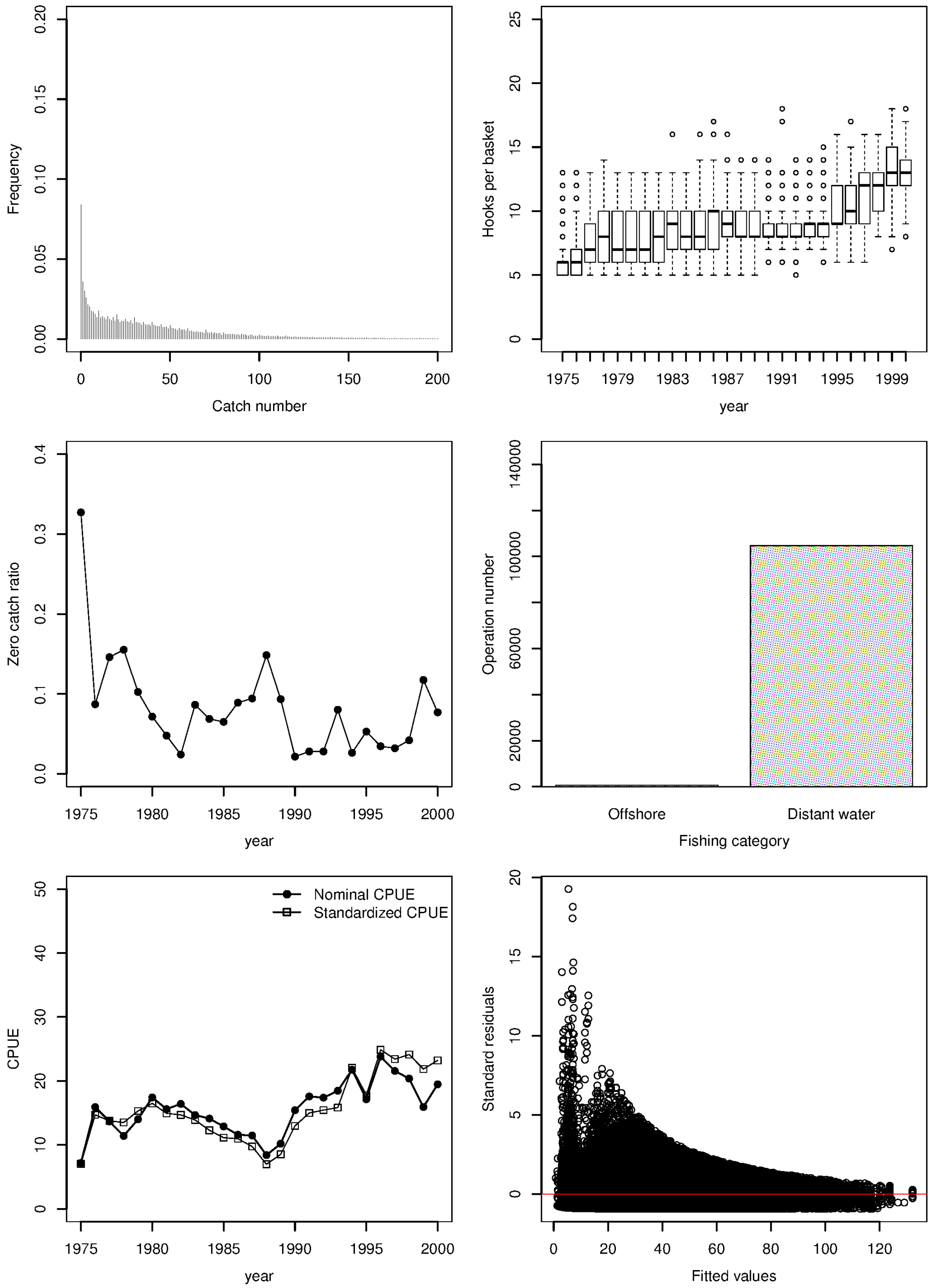

Figure 7: Analysis results of JPNLL EPO.

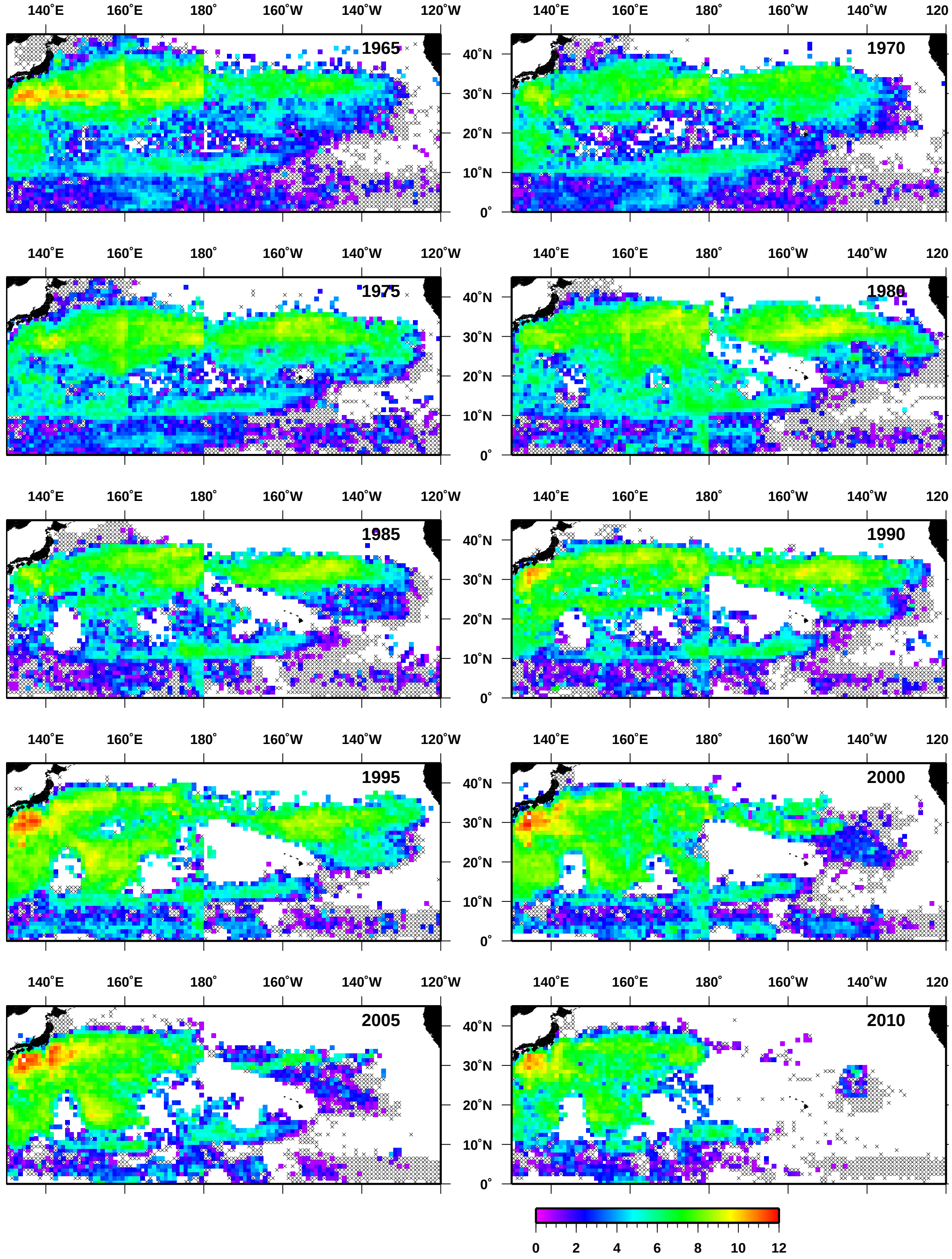

Figure 8: Spatial distribution of albacore catch(log scale).

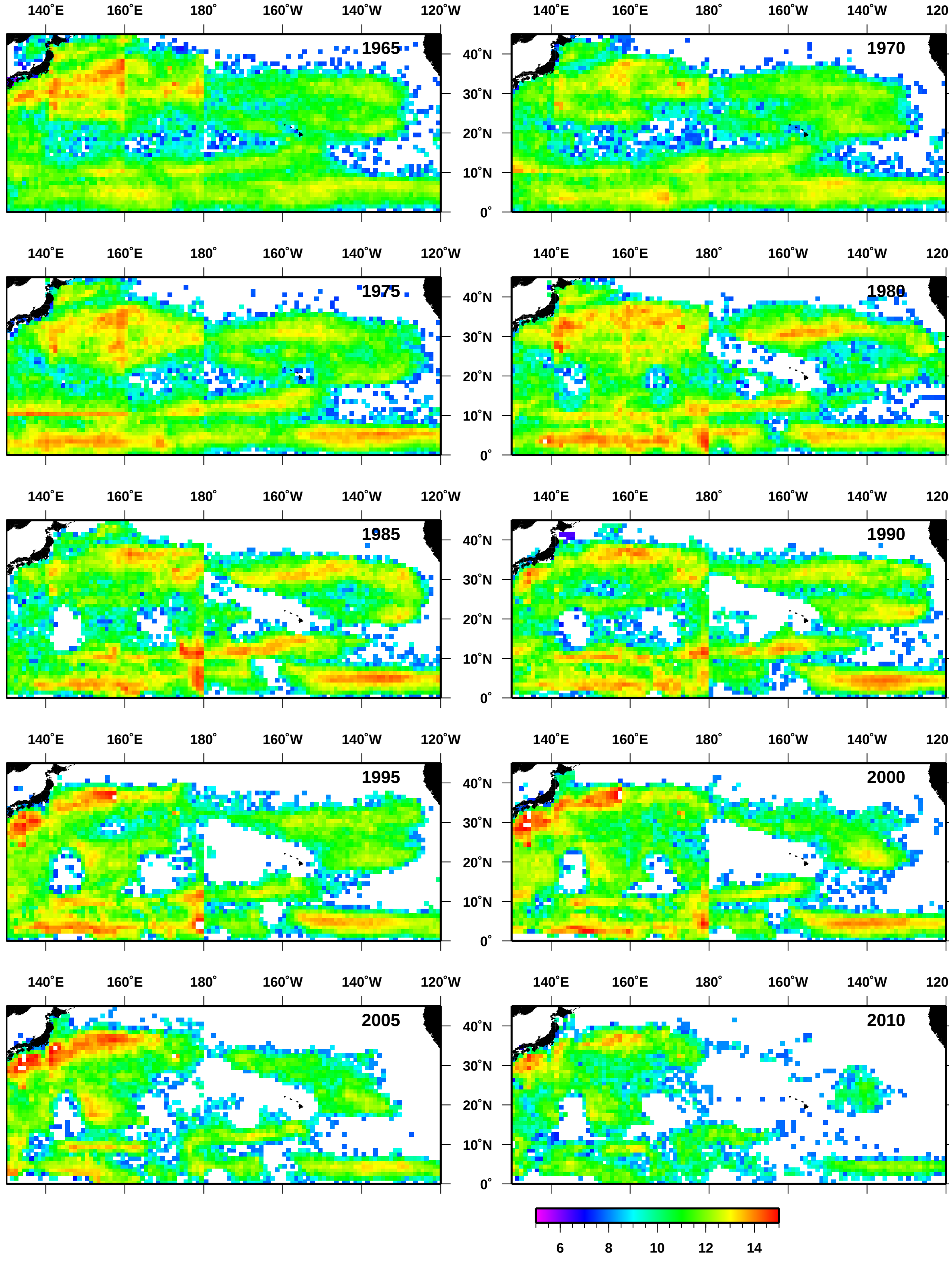

Figure 9: Spatial distribution of effort by longline fishery(log scale).

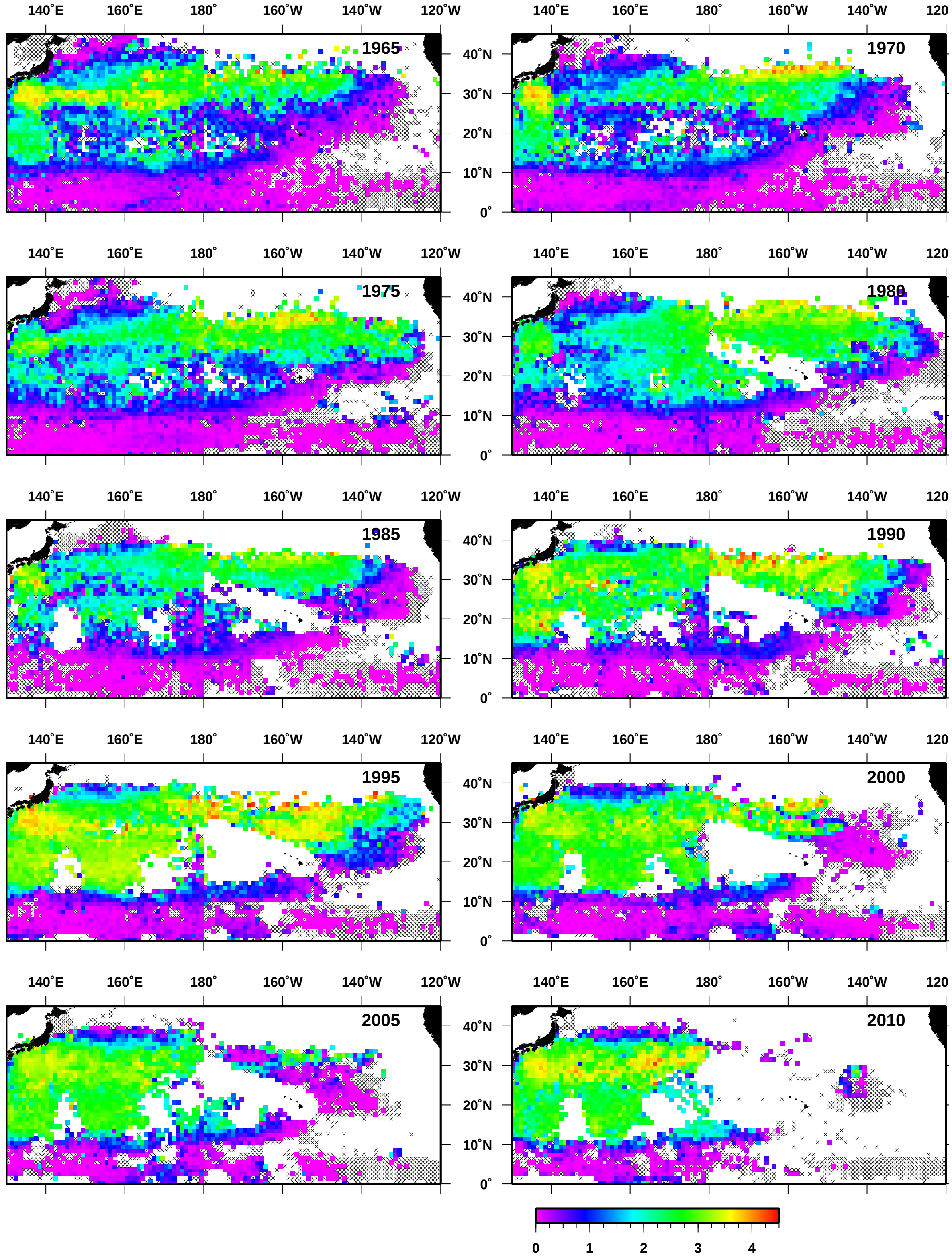

Figure 10: Spatial distribution of albacore CPUE(log scale).