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Standardized CPUE of striped marlin caught by Japanese large-mesh drift fishery in the north Pacific for the periods between 1977 and 1993 [1]

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Introduction

Striped marlin is one of the major target species for the Japanese large-mesh drift net fishery between early 1970's and 1992 when the moratorium on large scale drift-net fishery in the open sea was implemented several thousands tons of striped marlin caught annually. This document reports the results of CPUE standardization of striped marlin caught by the Japanese large-mesh drift net fishery, using reported log-book data for the period between 1977 and 1993.

Materials and methods

Catch and fishing effort data used in this analysis were obtained from the Japanese large-mesh driftnet fishery statistics. The statistics for 1977-1993 were compiled by the National Research Institute of Far Seas Fisheries, based on logbooks. These data include date, position (1x1 degree), mesh size of net (cm), length of net, and catch number by species for each set. Although log-book coverage is unknown, it is believed that the amount of data is sufficient to estimate the historical change of abundance of striped marlin in the main fishing ground of this fishery (Uosaki,1998).

Logbook data were aggregated by year, month, and 1 degree square block. Mesh size of the net is classified into three strata; <17cm, 17-19cm, and >19cm in the analysis of CPUE. Among the aggregated data, ones with less than four operations are excluded from this analysis. CPUE is calculated as catch in number per 10 km net length.

The standardization of CPUE was conducted using the GLM method and the following model;

$$\ln(CPUE_{ijkl}+const)=\ln(\mu)+\ln(YR_i)+\ln(QT_j)+\ln(AR_k)+\ln(GE_l)+\ln(INTER)+\varepsilon_{ijkl}$$

where ln: natural logarithm, $CPUE_{ijk}$: nominal CPUE (catch in number per 10km of net, in year i, quarter j, area k), const: 1/20 of overall mean, μ: overall mean, YR_i: effect of year i, QT_j: effect of quarter j, AR_k: effect of area k, GE_l: effect of mesh size category, INTER: interaction terms between YR*QT and AR*QT, and ε: normal error term. Analysis was made using the GLM procedure of software, SAS (Ver. 9.1).

Results and Discussion

Figures 1-3 show the seasonal distribution pattern of CPUE, catch, and effort for the main fishing grounds of the Japanese large-mesh driftnet fishery in the north Pacific for the periods between 1977 and 1993. Based on these distribution patterns, five areas are designated (Fig. 4) for the analysis of CPUE of striped marlin: west of Kyushu area (area 1); off northeast of Honshu area (area 2); a temperate area in the northwest Pacific (area 3); a subtropical area in the north-west Pacific (area 4); and a temperate area in the north-central Pacific. Higher CPUEs are observed in the 3rd and 4th quarters in areas 2 and 3, and also area 1 all year round. Effort is distributed in all four quarters in areas 1 – 3, while most of effort in areas 4 and 5 are concentrated in the 1st and the 2nd quarters (fig. 3).

Figure 5 shows the annual catch number of striped marlin by area, and the annual amount of effort by area. More than half of all striped marlins are caught in areas 2 and 3 throughout the periods analyzed, while the amount of effort in these two areas is about 30-40% in 1984-1992. In 1993, 96% of effort is recorded in area 2, which is the results of introduction of moratorium of large scale drift net fishery in the open sea area. This drastic decrease of coverage of data observed in 1992-1993 may affect the results of the CPUE standardization.

Figure 6 shows nominal CPUE trends of striped marlin by area. Generally, higher CPUEs are observed in areas 1, 2, and 3. In the period between 1977 and 1982, decreasing trends of CPUE are observed more or less in all areas except for area 1.

Figure 7 shows the standardized CPUEs (number/10km) of striped marlin caught by the Japanese large mesh drift net fishery for the period between 1977-1992 and 1977-1993. CPUE decreased from 1977 to 1983, and then, it showed a gradual increasing trend. Figure 8 shows the residual patterns obtained in the results of CPUE standardization. Generally, the pattern of residuals approximate a normal distribution, although skewed patterns are observed in some strata. Increase in CPUE from 1992 to 1993 might be an artifact of the introduction of the moratorium on operations in the open sea, because most of operations in 1993 are found in area 2 where historically higher CPUE are observed. The peak of mode of the distribution pattern of residuals in 1993 shifted toward the positive side (Fig. 8, left top), which would support this.

Figure 9 shows the standardized CPUE of striped marlin by area, quarter, and mesh size class. Mesh size does not have significant impact on the CPUE of striped marlin. Higher CPUEs tend to be observed in the coastal areas of Japan (areas 1 and 2) than in offshore areas (areas 3-5). Clear seasonal patterns in CPUE are observed. Figure 10 shows seasonal pattern of CPUE by area. In areas 2, 3, and 4, the highest CPUE is observed in the 3rd quarter, while in the 1st quarter is highest in areas 1 and 5. Generally, the lowest CPUE is observed in the 2nd quarter except for in area 1 where the 4th quarter is the lowest.

In CPUE analysis of tunas and billfishes by GLM, differences in historical trend of CPUE by area are usually observed, and introduction of these differences to the estimation of an overall abundance index is an important issue. In the data set for the Japanese large scale drift net fishery for the period 1977-1993, areas 2 and 3 have a relatively large number of data available throughout the period analyzed (Fig. 5). Figure 11 shows standardized CPUE in areas 2 and 3. Trends in CPUE are different between the two areas. Figure 12 shows a comparison between the combined CPUE for areas 2 and 3, and CPUEs standardized in the original model which are shown in Figure 7. Standardized CPUEs in areas 2 and 3 are combined in two different ways: CPUE in each area is weighted by the approximate size of each area (the relative value of size of area 2 is 3.5, and area 3 is 18.0); CPUE in each area is weighted by the catch number in each area. General trend of these four estimated abundance indices are similar, but there are some differences in the values of the estimated indices at the beginning and end of the periods (1977-1978, and 1991-1993).

Conclusion

Uosaki (1998) reported that major target species of the Japanese drift net fishery in 1977-1993 were swordfish, albacore, skipjack, and striped marlin. He also reported that target species generally changed by season and area. Effect of these changes of target species was not introduced into the model of CPUE standardization used in this study because there is no information about target species in the logbook. The influence of a change in target species would be at least partly covered by the inclusion of effects for area and quarter, but because area stratification is determined arbitrary based on the average distribution of catch number and CPUE of striped marlin, the effect of change of target species would not be fully accounted for in the model used in this study. Further analysis of data is necessary to obtain better estimation of abundance indices for striped marlin in the north Pacific.

This is the first trial of CPUE standardization of striped marlin in the north Pacific caught by the Japanese large mesh drift-net fishery in the period between 1977 and 1993. Results of CPUE analysis shown in this document should be compared with the results of other studies using data from other fishery such as longline, to check its appropriateness as input to stock assessment models. Analysis of size data of striped marlin caught by the Japanese large mesh drift-net fishery would also be useful for better evaluation of the results of this study. These analyses could be effective in selecting the best method for estimating abundance indices as shown in Figure 12.

References

Uosaki, K. (1998); Standardized CPUE of north Pacific swordfish, *Xiphias gladius*, in the Japanese large-mesh driftnet fishery. NOAA Tech. Rep. NMSF 142, 125-131pp.

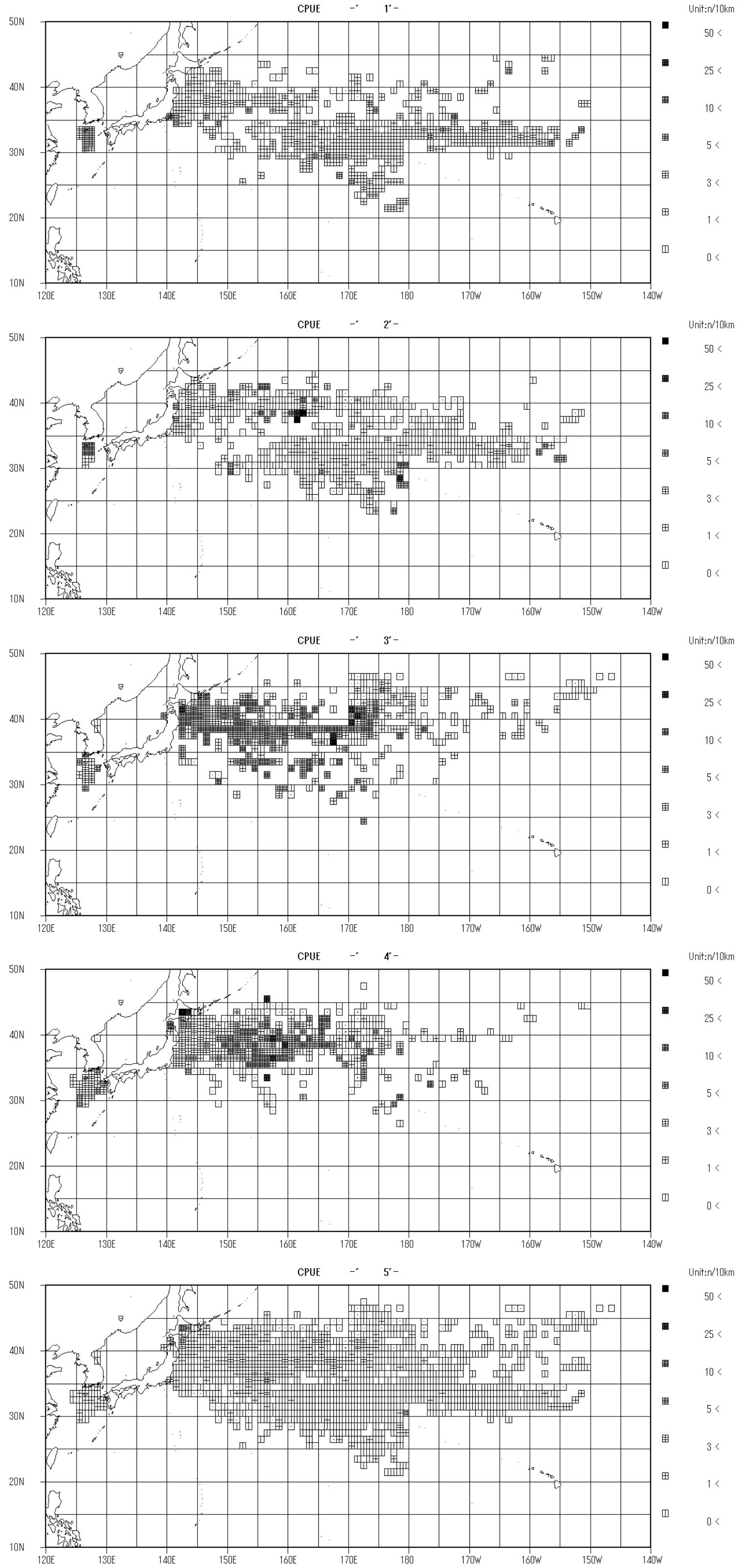

Fig. 1. Seasonal average distribution pattern of CPUE (number/10km) of striped marlin caught by large-mesh driftnet fishery. Average values for 1977-1993 are used, and data with less than four operations are omitted. Distributions of the 1st, the 2nd, the 3rd, and the 4th quarters are shown in 1st, 2nd, 3rd, and 4th top panels. Bottom panel shows the overall average pattern.

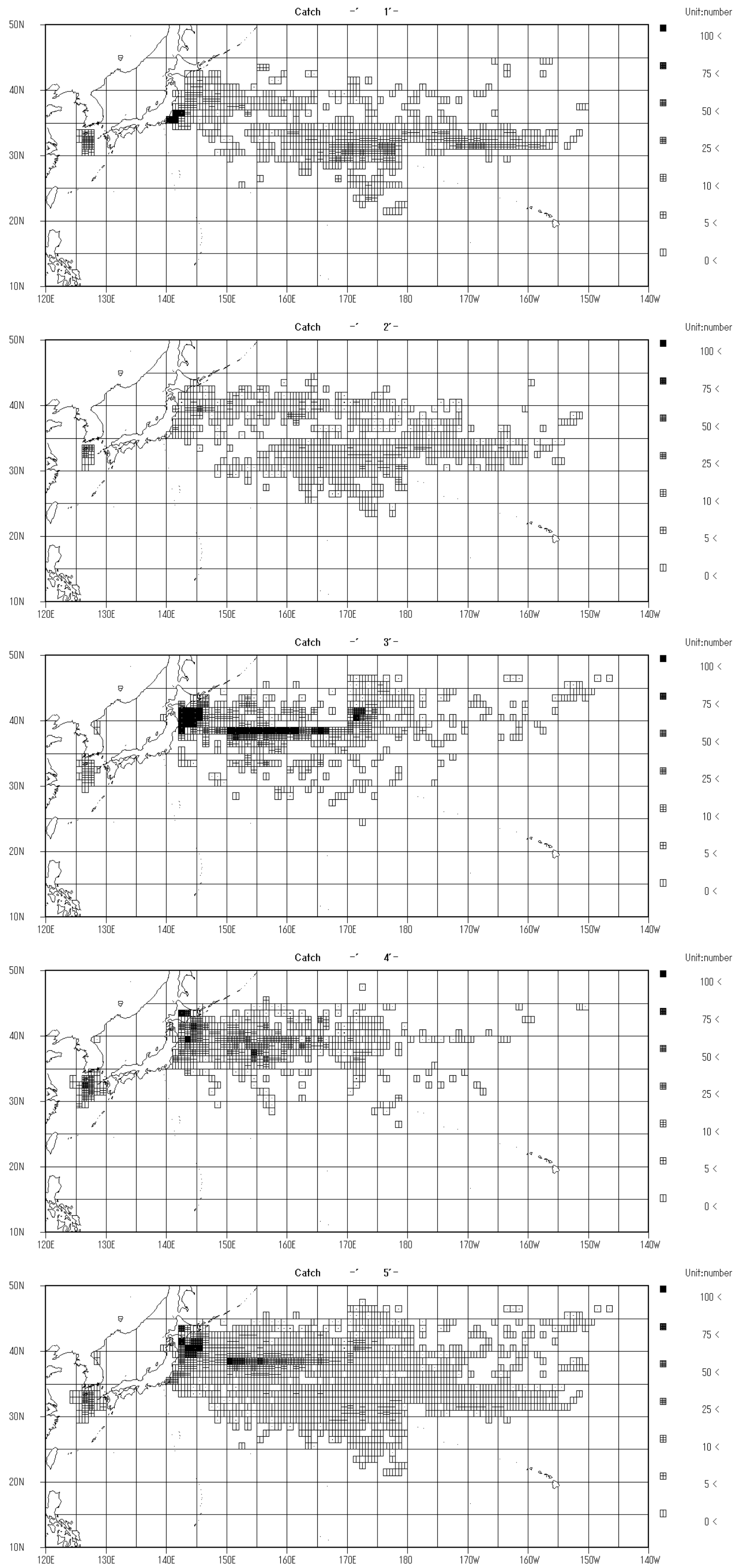

Fig. 2. Seasonal average distribution pattern of catch number of striped marlin caught by large-mesh driftnet fishery. Average values for 1977-1993 are used, and data with less than four operations are omitted. Distributions of the 1st, the 2nd, the 3rd, and the 4th quarters are shown in 1st, 2nd, 3rd, and 4th top panels. Bottom panel shows the overall average pattern.

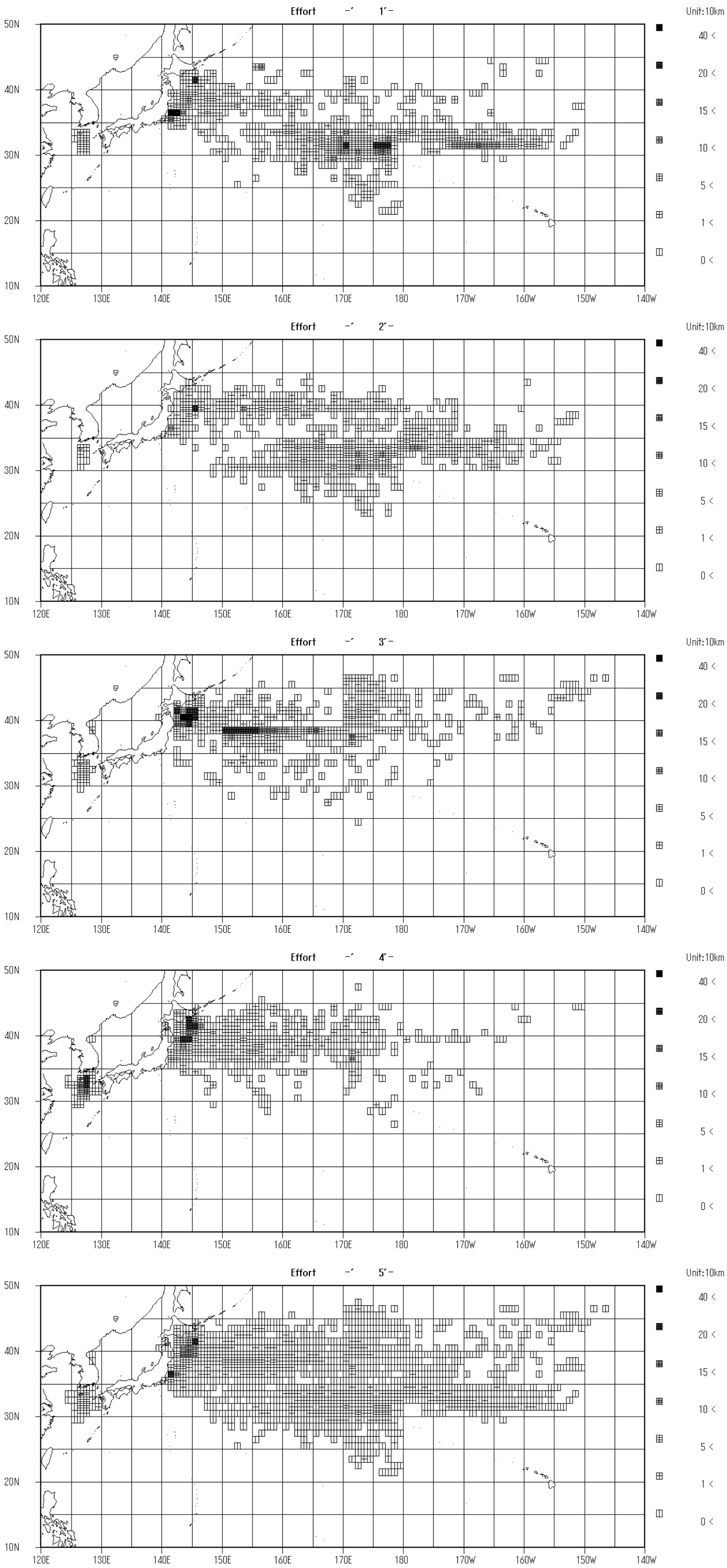

Fig. 3. Seasonal average distribution pattern of effort (10km) of Japanese large-mesh driftnet fishery. Average values for 1977-1993 are used, and data with less than four operations are omitted. Distributions of the 1st, the 2nd, the 3rd, and the 4th quarters are shown in 1st, 2nd, 3rd, and 4th top panels. Bottom panel shows the overall average pattern.

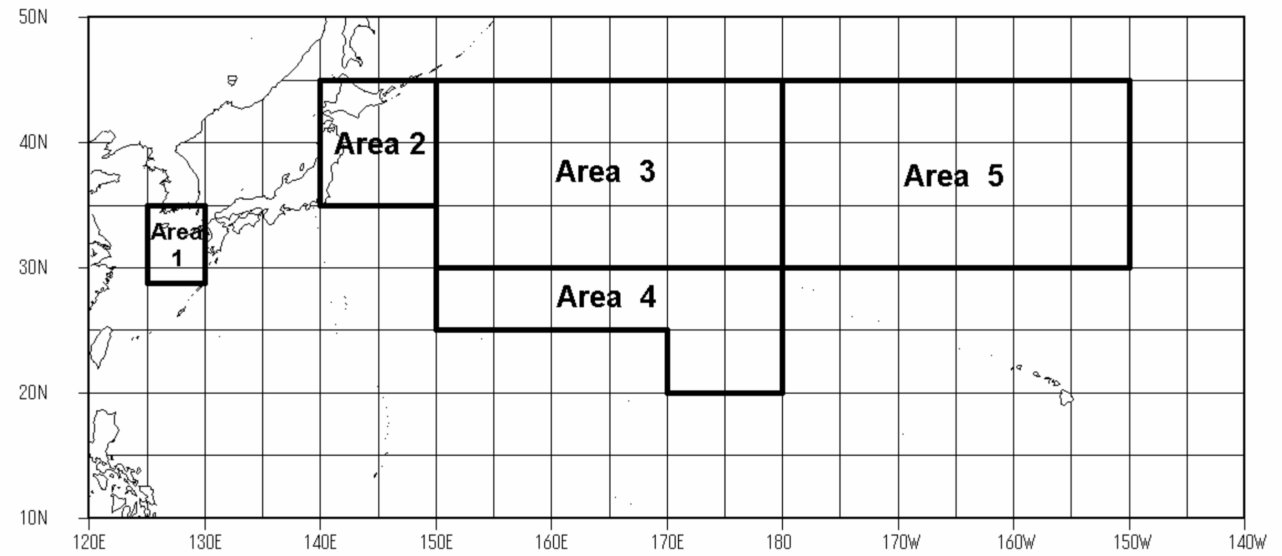

Fig. 4. Area stratification used in this study.

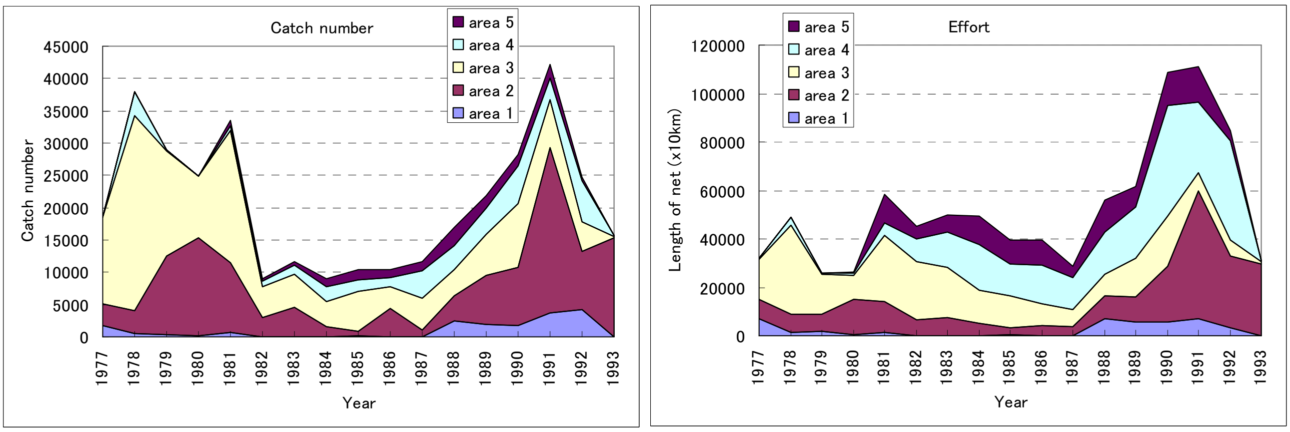

Fig. 5. Annual catch number (left) and annual amount of effort (right) by area.

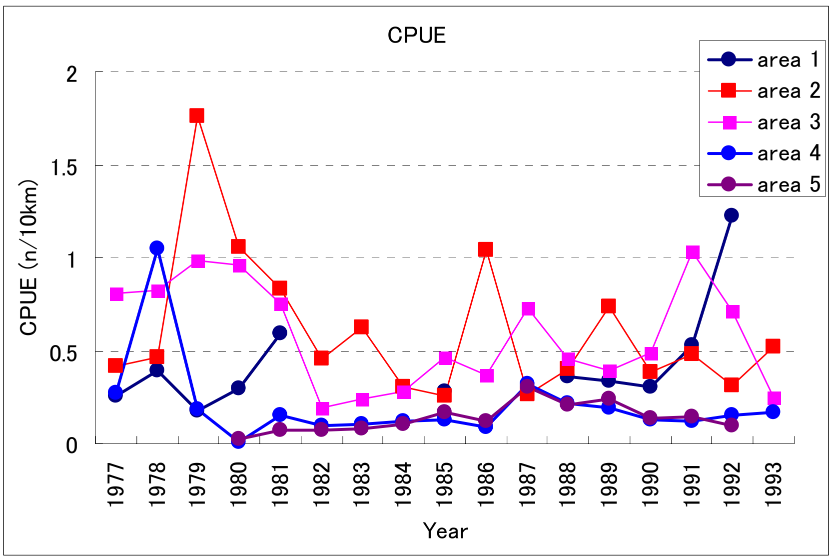

Fig. 6. Nominal CPUE (number/10km) by area.

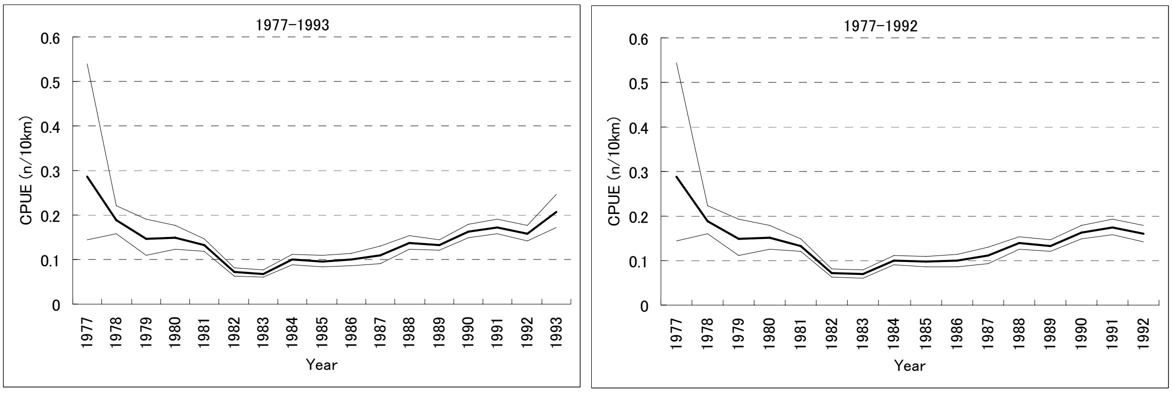

Fig. 7. Standardized CPUE (number/10km) of striped marlin and its confidence interval caught by Japanese large mesh drift net fishery for the period between 1977-1993 (left) and 1977-1992 (right).

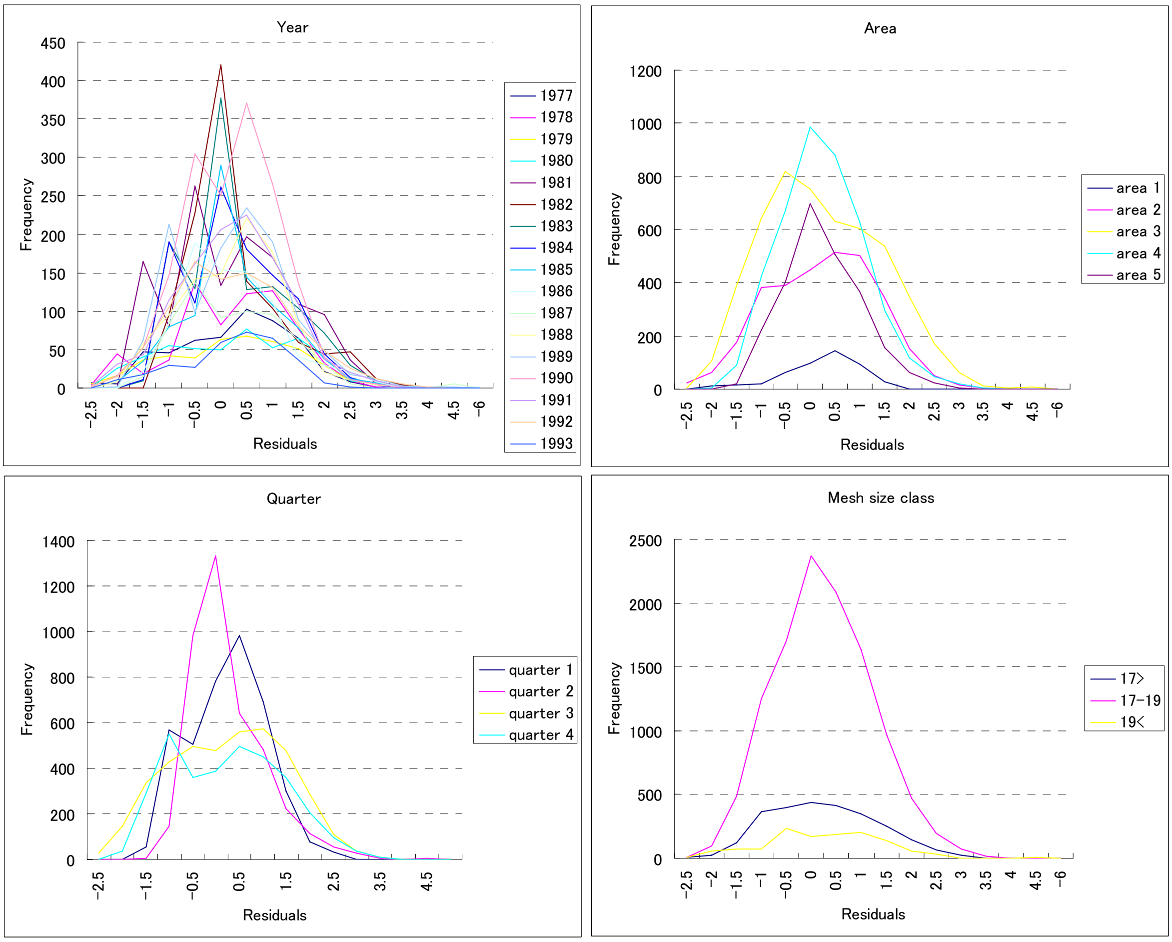

Fig. 8. Plot of residuals by year (left top), by area (right top), by quarter (left bottom), and by class of mesh size (right bottom).

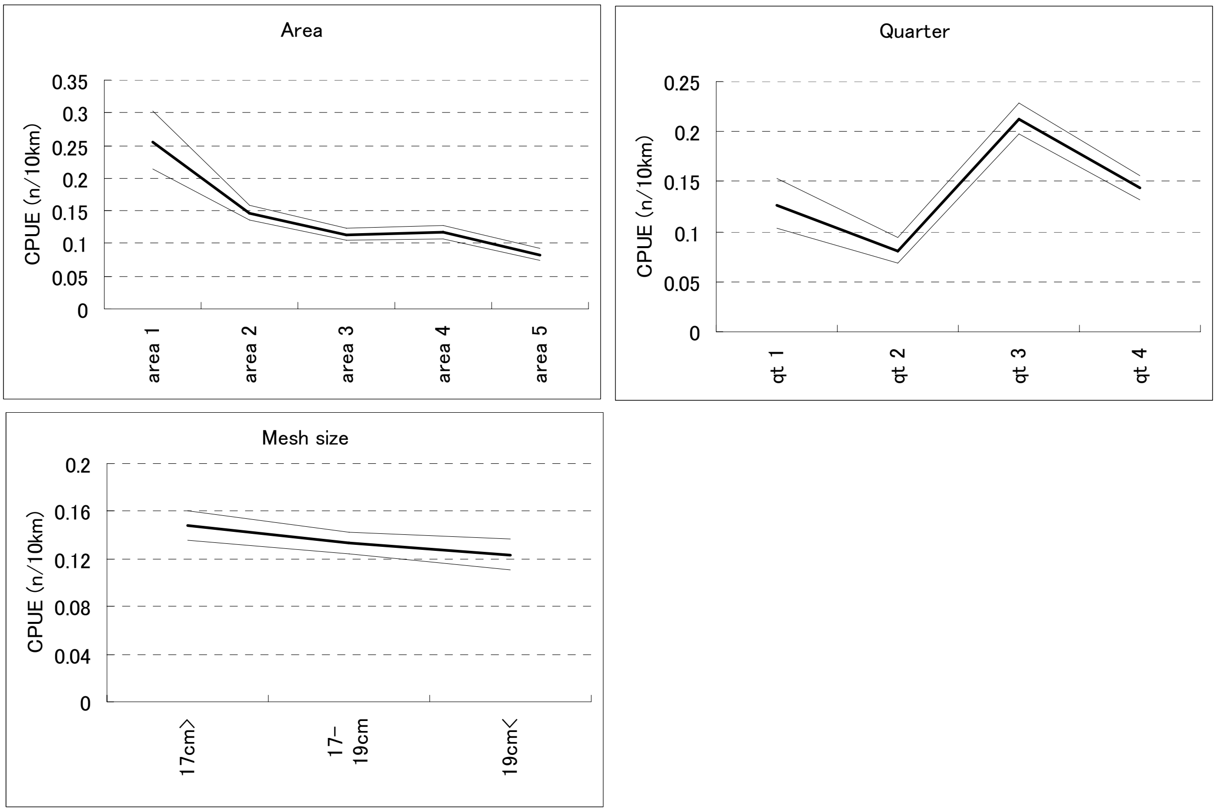

Fig. 9. Standardized CPUE of striped marlin and its confidence interval by area (left top), quarter (right top), and mesh size class (left bottom).

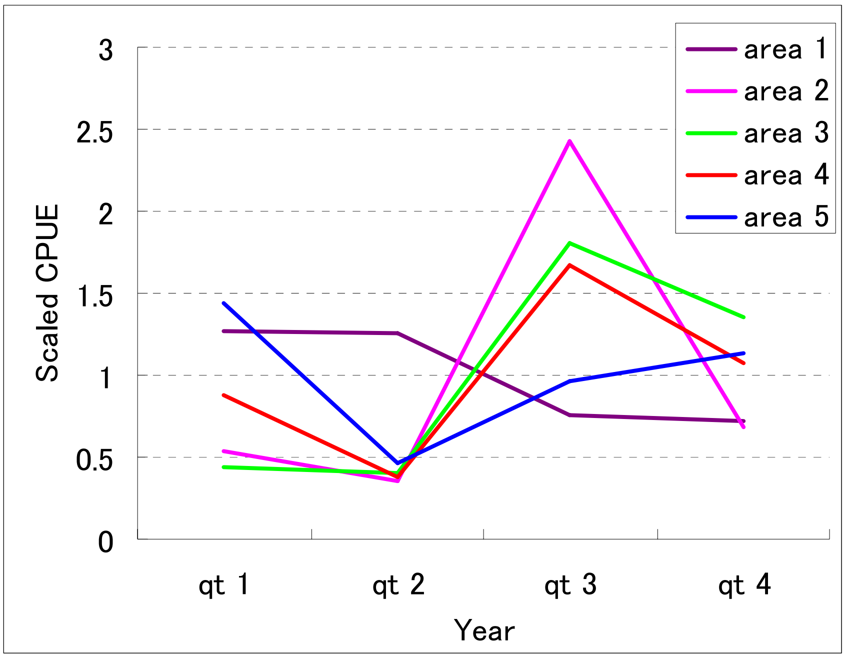

Fig. 10. Standardized CPUE of striped marlin by area and quarter.

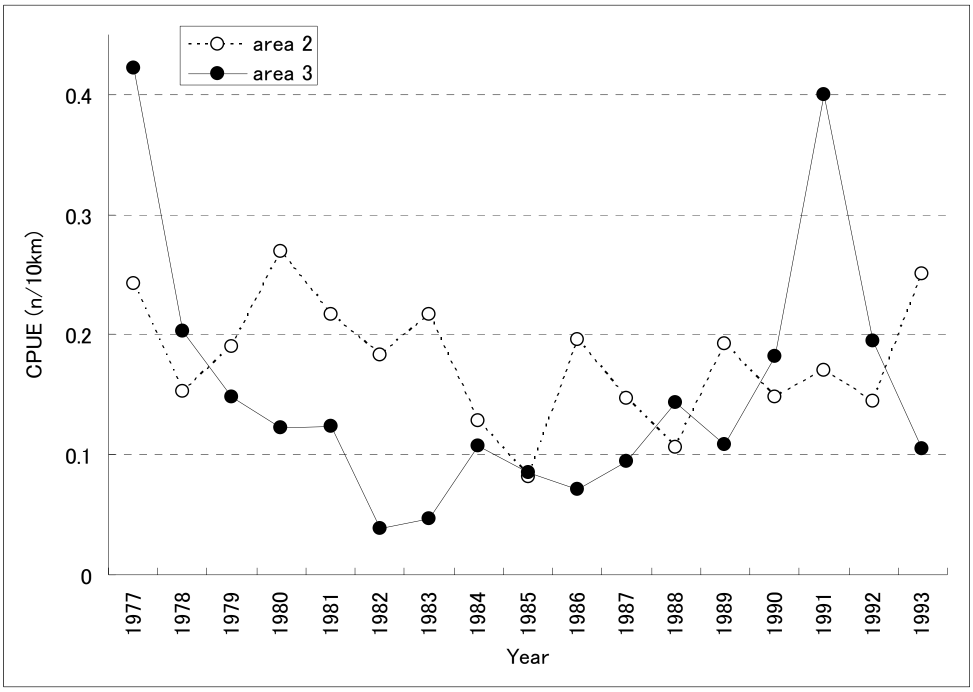

Fig. 11. Standardized CPUE of areas 2 and 3.

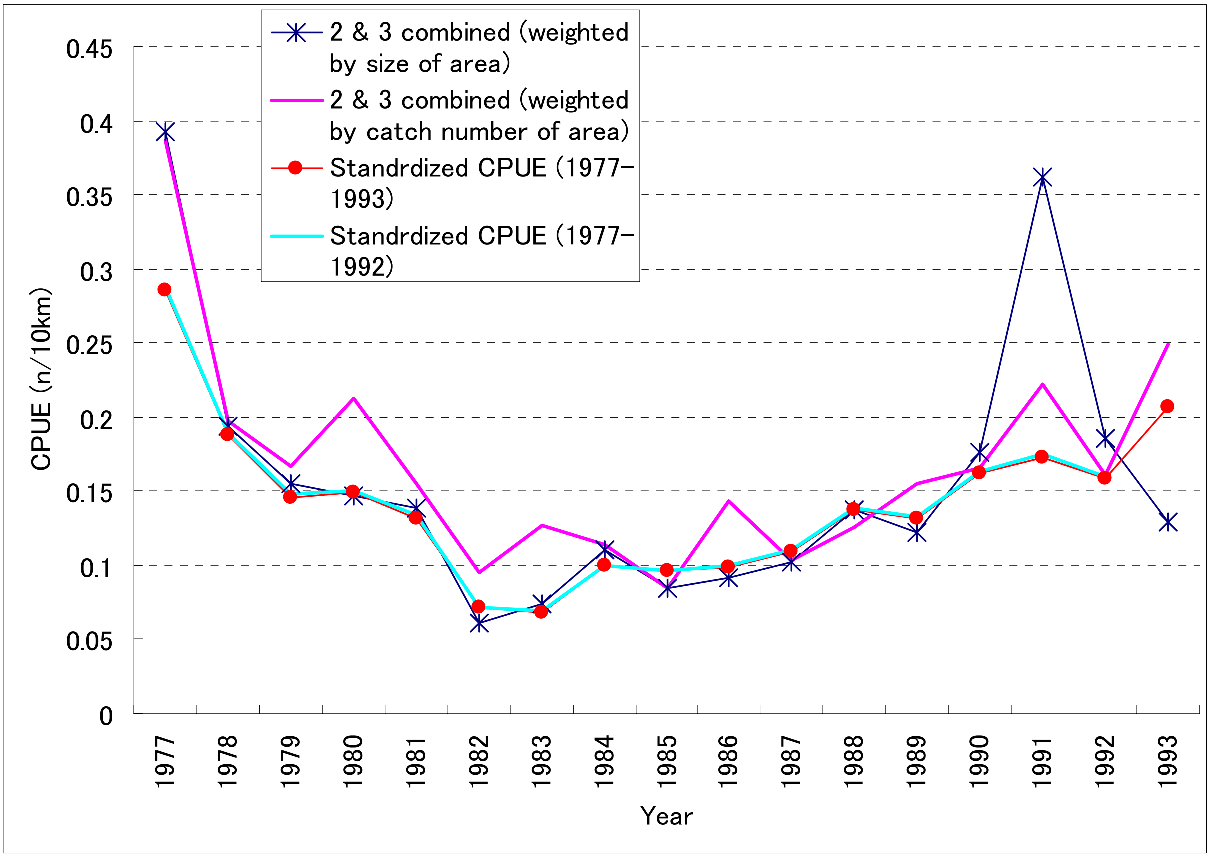

Fig. 12. Standardized CPUEs (1977-1993, and 1977-1992), areas 2 & 3 combined (CPUE value of each area is weighted by the approximated size of each area), and areas 2 & 3 combined (CPUE value of each area is weighted by the catch number of each area).