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**Japanese longline CPUE for bigeye tuna in the Indian Ocean standardized by GLM**

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**Abstract**

Standardization of Japanese longline CPUE for bigeye tuna was conducted for 1960-2012 by using GLM (generalized linear model, log normal error structured). Methods of standardization are the same as or similar to those used at IOTC WPTT in 2012. The effects of season (month or quarter), subarea or LT5LN5 (five degree latitude-longitude block), SST (sea surface temperature), NHF (number of hooks between floats) and material of main line, and several interactions between them were used for standardization. The trend of CPUE slightly differed by area, but high jump in 1977 and 1978, slight decrease after that, and increasing trend in the recent few years are seen as for each area. Change in fishing gear (material of main line and NHF) was seen especially after 1990s, which may have caused the difference between nominal and standardized CPUE.

## 1. Introduction

Bigeye tuna is one of main target species for Japanese longline fishery in the Indian Ocean. Its abundance indices are very important for stock assessment of this species because they have high spatial and temporal coverage, and detailed information on catch and effort is available through logboods. Assessment of Indian Ocean bigeye tuna is scheduled at 2013 IOTC WPTT meeting held in October. At that time integrated and production models will be used; the former includes multi-region analyses (IOTC, personal communication).

Satoh and Okamoto (2012) reported area aggregated annual standardized Japanese longline CPUE for bigeye tuna based on GLM (generalized linear model, log normal error structured) for the indicator of the stock. Also, area specific CPUE for integrated models was created during 2012 IOTC WPTT meeting (Satoh, personal communication). Methods of standardization in this study are the same as above mentioned studies. In this study, area specific and area aggregated CPUEs have been created for stock assessment of bigeye tuna based on integrated and production models.

## 2. Materials and methods

### Area and sub-area definition:

Sub-area definition for area aggregated CPUE used in this study (Fig. 1), which consists of seven areas, is the same as those used in the IOTC bigeye assessment in 2006 (Okamoto and Shono, 2006) and in

2010 (Okamoto and Shono, 2010), and updated CPUE submitted at 2012 IOTC WPTT meeting (Satoh and Okamoto, 2012). Main fishing ground of Japanese longline fishery for bigeye was divided into seven areas and CPUE standardization was done for three cases of area combinations, tropical (areas 1-5), south (areas 6 & 7) and whole (areas 1-7) Indian Ocean. Area 67 in the south area was not used in this study. Area aggregated CPUE was standardized for each of three area categories, tropical, south and whole Indian Ocean.

Area definition for area specific CPUE used in this study (Fig. 2) was done so that it agrees with areas for stock assessment using integrated models. Fishing ground was divided into three areas: West (tropical area), East (tropical area) and South (subtropical and temperate area).

**Environmental factors:**

As environmental factors, which are available for the analyzed period of 1960-2012, SST (sea surface temperature) was applied. The original SST data, whose resolution is 1-degree latitude and 1-degree longitude by month from 1946 to 2012, were downloaded from NEAR-GOOS Regional Real Time Data Base of Japan Meteorological Agency (JMA) http://goos.kishou.go.jp/rrtdb/database.html. The original data was recompiled into 5-degree latitude and longitude by month from 1960 to 2012 using the procedures described in Okamoto et al. (2001), and was used in the analyses.

**Catch and effort data used:**

The Japanese longline catch (in number) and effort statistics from 1960 up to 2012 were used. The catch and effort data set based on logbook data aggregated by month, 5-degree square, NHF (the number of hooks between floats), and main line material, was used for the analysis. Data in strata in which the number of hooks was less than 5000 were not used for analyses. As the NHF information is not available for the period from 1960 to 1974, NHF was regarded to be 5 in this period. Main line material was categorized into two: 1 = Nylon and 2 = other, which is not available before 1993. The main line material was assumed as ‘other’ from 1975 to 1993 except as NHF was over 18 from 1990 to 1993, in which it was assumed as ‘Nylon’.

**CPUE standardizations by GLM**

CPUEs based on the number of catch were used; (the number of fish caught) / (the number of hooks) * 1000. The model used for GLM analyses (CPUE log normal error structured model) is as follows;

Area aggregated CPUE (annual):

Log [CPUE +const] = μ + year + month + area + NHFC + SST + ML + year*area + month*area + area*NHFC + area*SST + NHFC*ML + error

Area aggregated CPUE (quarterly):

Log [CPUE +const] = μ + year + quarter + area + NHFC + SST + ML + year*quarter *area + area*NHFC

+ area*SST + NHFC*ML + error

Area specific CPUE:

Log [CPUE +const] = μ + year + quarter + NHFC + ML + SST + LT5LN5 + year*quarter + NHFC*ML + error

where

Log: natural logarithm,

CPUE: catch in number of bigeye per 1000 hooks,

const: 10% of overall mean of CPUE,

μ: overall mean (i.e. intercept),

year: effect of year,

month: effect of fishing season (month),

area: effect of sub-area,

NHFC: effect of gear type (class of the number of hooks between floats). The number of hooks between floats (NHF) was divided into 6 classes (NHFC 1: 5-7, NHFC 2: 8-10, NHFC 3: 11-13, NHFC 4: 14-16, NHFC 5: 17-19, NHFC 6: 20-21),

SST: effect of SST (sea surface temperature),

ML: effect of material of main line,

LT5LN5: effect of each latitude 5 degree and longitude 5 degree square,

quarter: effect of fishing season (quarter),

error ~ normal (0, $\sigma^2$).

Variable selection was conducted by a backwards stepwise F-test with a criterion of $P = 0.05$. In the cases in which the factor was not significant as main factor but was significant as interaction with another factor, the main factor was kept in the model.

Effect of year was obtained by the method used in Shono and Ogura (1999) that uses lsmean of Year-Area interaction as the following equation except for area specific CPUE.

$CPUE_i = \Sigma W_j * (\exp(\text{lsmean}(\text{year } i*\text{area }_j)) - \text{constant})$

where $CPUE_i$ = CPUE in year i, $W_j$ = area rate of Area j , ($\Sigma W_j = 1$), lsmean ($\text{year*area}_{ij}$) = least square mean of year-area interaction in year i and area j, constant = 10% of overall mean of CPUE. As for area aggregated CPUE in the tropical and whole Indian Ocean which includes Areas 1 and 3, CPUE in 2010 and 2011 was calculated using area rate without Area 1 and Area 1&3, respectively because no effort was observed in these year and area due to activities of pirates (Fig. 3). Time period of standardization was 1960-2012 for all CPUEs.

## 3. Results and discussion

**Area aggregated CPUE**

Trends of area aggregated CPUE in each region (tropical, south and whole of the Indian Ocean) are shown in Fig. 4. In the tropical Indian Ocean, CPUE slightly decreased from around 9.5 (real scale) in 1960 to 6.5 in 1976. It suddenly jumped up to around 12 in 1977 and 1978 and then it declined and became stable to around 1990 with some fluctuation, after which it had continuously decreased to 3.2 in 2002. CPUE in the last four years was increasing, and was 6.4 in 2012, which is larger than those of the last decade (3.2 – 5.2). The standardized CPUE in the south region also sharply increased (8.2) in 1977 and then showed slightly decreasing trend. It was 2.7 in 2012 which is larger than the average of the last decade (1.3 - 3.2). As a result, CPUE in the whole Indian Ocean, which had been in the same level around 5 to 7 until 1976 and suddenly increased around 10 in 1977 and 1978 and after that showed slightly decreasing trend. It was 4.7 in 2012, which is higher than the values of the last decade (2.5 – 4.0). Results of ANOVA are shown in Table 1, and distributions of the standard residual and QQ-plot for annual and quarterly CPUE are shown in Fig. 5 and Fig. 6, respectively. Distributions of the standard residual did not show remarkable difference from the normal distribution. Annual and quarterly values of standardized CPUE by region are listed in Appendix Table 1 and Appendix Table 2, respectively.

**Area specific CPUE**

Trends of area specific CPUE in each region (east, west and south area) are shown in Fig. 7. Basically the trends for east and west area are similar to that of area aggregated CPUE in the tropical area. CPUE for south area is very close to that of area aggregated CPUE in the south Indian Ocean. Increasing trend is observed for the recent 3 years as for all areas. Results of ANOVA are shown in Table 2, and distributions of the standard residual and QQ-plot are shown in Fig. 8. Distributions of the standard residual did not show remarkable difference from the normal distribution. Quarterly values of standardized CPUE by region are listed in Appendix Table 3.

**Cause of difference between standardized and nominal CPUE**

There was large discrepancy between the nominal and the standardized CPUE in the tropical region from 1977 and 2002, whereas in the same period there was no such difference in the south region (Fig. 4). In order to detect the reason of the difference, we investigated regional difference of effect of each factor (SST, month, NHFC and ML) on the CPUE standardization. The stepwise illustration of the factors influencing this divergence was undertaken. The lsmeans (least square mean) of year effect between the final model and modified model, which is excluding each explanatory variable (SST, month, NHFC and ML) from the final model, were compared.

In first, historical changes of target species, gear setting and material of the main line for Japanese longline in the Indian Ocean were investigated. The proportion of species in catch number for each region (Fig. 9) indicated historical changes of target species. In the tropical area, bigeye tuna was main target species since 1977, whereas in the south region the main target species was yellowfin tuna. The deep gear setting (NHFC 3) was applied in the tropical region from 1977 to around 1990, on the other hand in the south region the shallow gear setting (NHFC 1) had remained to use in the same period (Fig. 10). The extra deep setting (>= NHFC 4) have been put into use in the tropical region after 1990. In the south region the relative shallow setting (NHFC 2) was main gear configuration in the same period, and the deep and the extra deep setting were gradually applied after 1990. Nylon for material of the main line have been used since 1990 in both regions, however the proportion of using for “the other” material of the main line was still high during 1990s in the south region (Fig. 11). These properties of target species, gear setting and material of the main line of three periods (1960-1976, 1977-1993 and 1994-2011) were summarized in **Table 2**.

**Comparison for year-effect between the final model and the modified model**

**NHFC**

In the tropical region, the modified model (without variable for NHFC; Log [CPUE +const] = μ + year + month + area + SST + ML + year*area + month*area + area*SST + error) resulted in lower standardized annual CPUE relative to the final model before 1976, and higher standardized CPUE after 1977, which is coincide with the historical changes of NHFC in the region (Fig. 12). Assuming lower and higher fishing efficiency for bigeye tuna of the shallow and deep setting, respectively, explains well the historical differences of the modified and the final model. In case of same level of biomass, fishing gear with low efficiency leads to lower nominal CPUE rather than using the fishing gear with high fishing efficiency. Although the application of the extra deep setting in early 1990s showed smaller impact on the fishing efficiency rather than the changes from the shallow setting to the deep setting in 1977, the fishing efficiency with the extra deep setting after 1990 have continued to slightly increase.

In the south region, the modified model consistently showed lower standardized CPUE unlike with the tropical region. The consistency is correlated with the fact that the deep setting did not use in 1977 in the south region. The increasing of fishing efficiency with NHFC after 1995 in the south region was partially because of the increasing of the deep setting.

**ML**

In the tropical region, the model without ML resulted in higher standardized CPUE from 1977 to 1990. It is not clear the reason for the higher CPUE because there was only one class (“other than Nylon”) in the period (Fig. 13). However the deep setting was introduced in the period, the higher CPUE may relate to the change of gear configuration. The material of main line used for the shallow setting might be suitable for the deep setting without any alternation. After 1990 the standardized CPUE of the modified model showed slightly low, which may result from the lower fishing efficiency of the extra deep setting with Nylon of the mainline for bigeye tuna.

In the south region, the historical changes of difference between the final model and the modified model without ML were similar to those of NHFC in this region. The increasing of fishing efficiency after 1995 in the south region was related to increasing of Nylon mainline for the deep setting.

**SST, month**

There were no clear historical trends of differences between the modified models (without SST and without month) and the final model in both regions except for large annual changes for the south region (Fig. 14). The large changes may reflect with the relatively large changes of environmental conditions.

The main reasons for the discrepancy between the nominal and the standardized CPUE in the tropical region are related to the historical changes of NHFC and ML. The deep setting put into use from 1977 to early 1990s, and the fishing efficiency for bigeye tuna increased, which resulted in increasing nominal CPUE. On the other hand, in the tropical region the shallow setting was mainly used in the period, therefore there is no increasing of the nominal CPUE. From early 1990s to early 2000s the extra deep setting with Nylon mainline had been used in the tropical region, however the impact of the changing on fishing efficiency for bigeye tuna was relatively small. Simultaneously the proportion of bigeye tuna became gradually small, Japanese fisherman had targeted on yellowfin tuna as well as bigeye tuna in this period. Therefore the discrepancy of the nominal and standardized CPUE became small in this period.

## 4. References

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Table 1. ANOVA tables of GLM for bigeye tuna standardized CPUE (area aggregated) for Japanese longline. CV, the coefficient of variation, which describes the amount of variation in the population, is 100 times the standard deviation estimate of the dependent variable (CPUE), Root MSE (Mean Square for Error), divided by the Mean. Left: annual, right: quarterly.

**Annual — tropical**

| RSquare | CV |
|---|---|
| 0.34 | 31.30 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 352 | 5533.25 | 15.72 | 48 | <.0001 |
| year | 52 | 626.90 | 12.06 | 36.82 | <.0001 |
| month | 11 | 128.20 | 11.65 | 35.59 | <.0001 |
| area | 4 | 156.85 | 39.21 | 119.74 | <.0001 |
| nhfc | 5 | 39.08 | 7.82 | 23.87 | <.0001 |
| sst | 1 | 16.22 | 16.22 | 49.53 | <.0001 |
| ML | 1 | 1.43 | 1.43 | 4.36 | 0.0369 |
| year*area | 205 | 583.95 | 2.85 | 8.7 | <.0001 |
| month*area | 44 | 210.67 | 4.79 | 14.62 | <.0001 |
| area*nhfc | 20 | 62.07 | 3.10 | 9.48 | <.0001 |
| sst*area | 4 | 144.44 | 36.11 | 110.27 | <.0001 |
| nhfc*ML | 5 | 55.98 | 11.20 | 34.19 | <.0001 |

**Quarterly — tropical**

| RSquare | CV |
|---|---|
| 0.39 | 30.50 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 1046 | 6294.89 | 6.02 | 19.36 | <.0001 |
| year | 52 | 411.31 | 7.91 | 25.45 | <.0001 |
| quarter | 3 | 5.45 | 1.82 | 5.84 | 0.0006 |
| area | 4 | 81.86 | 20.46 | 65.85 | <.0001 |
| nhfc | 5 | 33.41 | 6.68 | 21.5 | <.0001 |
| sst | 1 | 1.29 | 1.29 | 4.16 | 0.0413 |
| ML | 1 | 1.93 | 1.93 | 6.22 | 0.0127 |
| year*quarter*area | 951 | 1663.33 | 1.75 | 5.63 | <.0001 |
| area*nhfc | 20 | 50.78 | 2.54 | 8.17 | <.0001 |
| sst*area | 4 | 73.66 | 18.41 | 59.25 | <.0001 |
| nhfc*ML | 5 | 56.16 | 11.23 | 36.14 | <.0001 |

**Annual — south**

| RSquare | CV |
|---|---|
| 0.36 | 76.89 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 145 | 5566.56 | 38.39 | 65.99 | <.0001 |
| year | 52 | 984.43 | 18.93 | 32.54 | <.0001 |
| month | 11 | 604.37 | 54.94 | 94.44 | <.0001 |
| area | 1 | 0.19 | 0.19 | 0.32 | 0.5717 |
| nhfc | 5 | 55.24 | 11.05 | 18.99 | <.0001 |
| sst | 1 | 230.36 | 230.36 | 395.98 | <.0001 |
| ML | 1 | 1.68 | 1.68 | 2.88 | 0.0897 |
| year*area | 52 | 243.37 | 4.68 | 8.04 | <.0001 |
| month*area | 11 | 53.42 | 4.86 | 8.35 | <.0001 |
| area*nhfc | 5 | 30.10 | 6.02 | 10.35 | <.0001 |
| sst*area | 1 | 1.2986317 | 1.2986317 | 2.23 | 0.1352 |
| nhfc*ML | 5 | 17.47 | 3.49 | 6.01 | <.0001 |

**Quarterly — south**

| RSquare | CV |
|---|---|
| 0.42 | 73.95 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 434 | 6450.92 | 14.86 | 27.63 | <.0001 |
| year | 52 | 678.87 | 13.06 | 24.26 | <.0001 |
| quarter | 3 | 260.25 | 86.75 | 161.23 | <.0001 |
| area | 1 | 8.82 | 8.82 | 16.38 | <.0001 |
| nhfc | 5 | 44.87 | 8.97 | 16.68 | <.0001 |
| sst | 1 | 414.24 | 414.24 | 769.89 | <.0001 |
| ML | 1 | 0.31 | 0.31 | 0.58 | 0.4444 |
| year*quarter*area | 360 | 1358.69 | 3.77 | 7.01 | <.0001 |
| area*nhfc | 5 | 13.34 | 2.67 | 4.96 | 0.0002 |
| sst*area | 1 | 21.81 | 21.81 | 40.54 | <.0001 |
| nhfc*ML | 5 | 9.975617 | 1.995123 | 3.71 | 0.0023 |

**Annual — whole**

| RSquare | CV |
|---|---|
| 0.45 | 39.59 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 492 | 15593.42 | 31.69 | 81.95 | <.0001 |
| year | 52 | 956.64 | 18.40 | 47.57 | <.0001 |
| month | 11 | 133.83 | 12.17 | 31.46 | <.0001 |
| area | 6 | 168.00 | 28.00 | 72.4 | <.0001 |
| nhfc | 5 | 62.21 | 12.44 | 32.17 | <.0001 |
| sst | 1 | 6.30 | 6.30 | 16.29 | <.0001 |
| ML | 1 | 0.54 | 0.54 | 1.39 | 0.2384 |
| year*area | 309 | 1469.27 | 4.75 | 12.29 | <.0001 |
| month*area | 66 | 757.55 | 11.48 | 29.68 | <.0001 |
| area*nhfc | 30 | 126.73 | 4.22 | 10.92 | <.0001 |
| sst*area | 6 | 173.49 | 28.92 | 74.76 | <.0001 |
| nhfc*ML | 5 | 44.55 | 8.91 | 23.04 | <.0001 |

**Quarterly — whole**

| RSquare | CV |
|---|---|
| 0.49 | 38.35 |

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 1475 | 17128.42 | 11.61 | 32 | <.0001 |
| year | 52 | 611.15 | 11.75 | 32.38 | <.0001 |
| quarter | 3 | 35.21 | 11.74 | 32.34 | <.0001 |
| area | 6 | 95.44 | 15.91 | 43.83 | <.0001 |
| nhfc | 5 | 51.32 | 10.26 | 28.28 | <.0001 |
| sst | 1 | 1.40 | 1.40 | 3.87 | 0.0493 |
| ML | 1 | 0.34 | 0.34 | 0.93 | 0.3339 |
| year*quarter*area | 1366 | 3826.53 | 2.80 | 7.72 | <.0001 |
| area*nhfc | 30 | 91.29 | 3.04 | 8.39 | <.0001 |
| sst*area | 6 | 119.86 | 19.98 | 55.05 | <.0001 |
| nhfc*ML | 5 | 38.53 | 7.71 | 21.23 | <.0001 |

Table 2. ANOVA tables of GLM for bigeye tuna standardized CPUE (area specific, quarterly) for Japanese longline. CV, the coefficient of variation, which describes the amount of variation in the population, is 100 times the standard deviation estimate of the dependent variable (CPUE), Root MSE (Mean Square for Error), divided by the Mean.

Quarterly

East

| RSquare | CV | | | | |
|---|---|---|---|---|---|
| 0.29 | 26.98 | | | | |
| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
| Model | 262 | 1587.85 | 6.06 | 20.79 | <.0001 |
| year | 52 | 400.30 | 7.70 | 26.41 | <.0001 |
| quarter | 3 | 11.22 | 3.74 | 12.84 | <.0001 |
| nhfc | 5 | 14.88 | 2.98 | 10.21 | <.0001 |
| ML | 1 | 0.10 | 0.10 | 0.33 | 0.5667 |
| sst | 1 | 6.36 | 6.36 | 21.8 | <.0001 |
| LT5LN5 | 39 | 461.38 | 11.83 | 40.59 | <.0001 |
| year*quarter | 156 | 278.63 | 1.79 | 6.13 | <.0001 |
| nhfc*ML | 5 | 10.86 | 2.17 | 7.45 | <.0001 |

West

| RSquare | CV | | | | |
|---|---|---|---|---|---|
| 0.40 | 33.47 | | | | |
| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
| Model | 259 | 4258.21 | 16.44 | 50.77 | <.0001 |
| year | 52 | 479.86 | 9.23 | 28.49 | <.0001 |
| quarter | 3 | 64.43 | 21.48 | 66.31 | <.0001 |
| nhfc | 5 | 5.89 | 1.18 | 3.63 | 0.0027 |
| ML | 1 | 0.62 | 0.62 | 1.92 | 0.1654 |
| sst | 1 | 4.47 | 4.47 | 13.8 | 0.0002 |
| LT5LN5 | 40 | 937.14 | 23.43 | 72.34 | <.0001 |
| year*quarter | 152 | 388.86 | 2.56 | 7.9 | <.0001 |
| nhfc*ML | 5 | 24.67 | 4.93 | 15.24 | <.0001 |

South

| RSquare | CV | | | | |
|---|---|---|---|---|---|
| 0.41 | 74.08 | | | | |
| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
| Model | 269 | 6249.29 | 23.23 | 42.87 | <.0001 |
| year | 52 | 686.07 | 13.19 | 24.35 | <.0001 |
| quarter | 3 | 324.17 | 108.06 | 199.42 | <.0001 |
| nhfc | 5 | 35.94 | 7.19 | 13.27 | <.0001 |
| ML | 1 | 1.18 | 1.18 | 2.17 | 0.1403 |
| sst | 1 | 46.82 | 46.82 | 86.41 | <.0001 |
| LT5LN5 | 46 | 965.38 | 20.99 | 38.73 | <.0001 |
| year*quarter | 156 | 501.74 | 3.22 | 5.94 | <.0001 |
| nhfc*ML | 5 | 14.00 | 2.80 | 5.17 | <.0001 |

Table 3. Summary of target species (from catch proportion by species in number), gear setting depth (judged by NHFC) and material of main line of Japanese longline in the Indian Ocean.

| region | period | target | gear setting | material of main line |
|---|---|---|---|---|
| tropical | 1960-1976 | **YFT**>BET>ALB | shallow | others |
| | 1977-1993 | **BET**>YFT | deep | others |
| | 1994-2011 | **BET**>YFT | extra deep | Nylon |
| south | 1960-1976 | **ALB**>YFT | shallow | others |
| | 1977-1993 | **YFT**>BET | shallow | others |
| | 1994-2011 | **YFT**>BET, ALB | deep | Nylon |

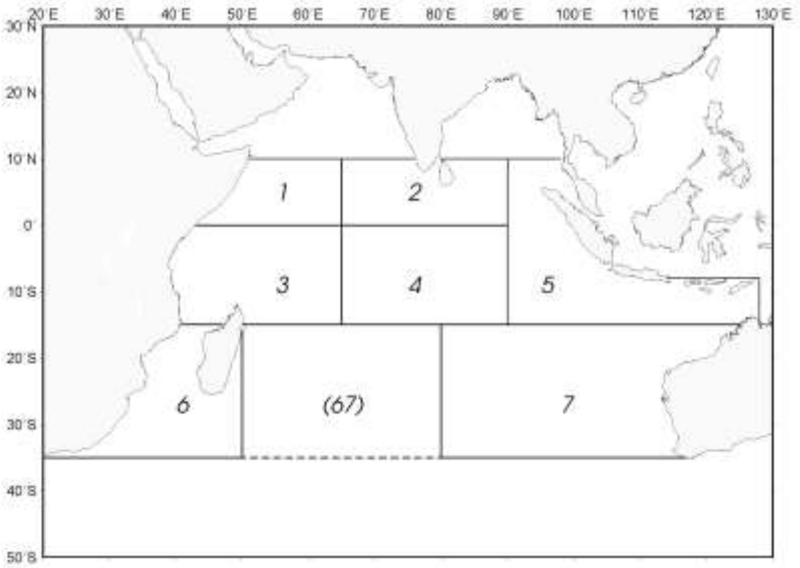



**Fig. 1.** Definition of sub-areas for area aggregated CPUE used in this study. The tropical, south and whole Indian Ocean regions in this paper consist of areas 1-5, areas 6-7 and areas1-7, respectively. Area 67 was not used in this study.

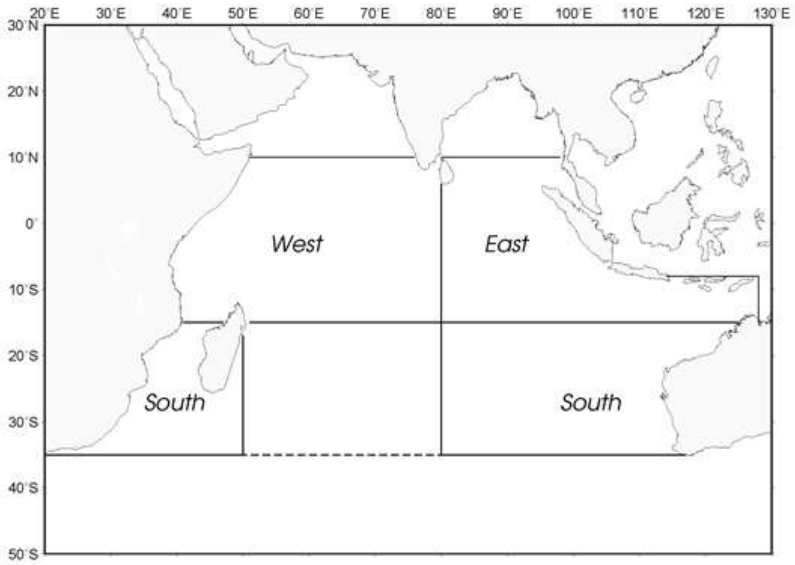



**Fig. 2.** Definition of areas for area specific CPUE used in this study.

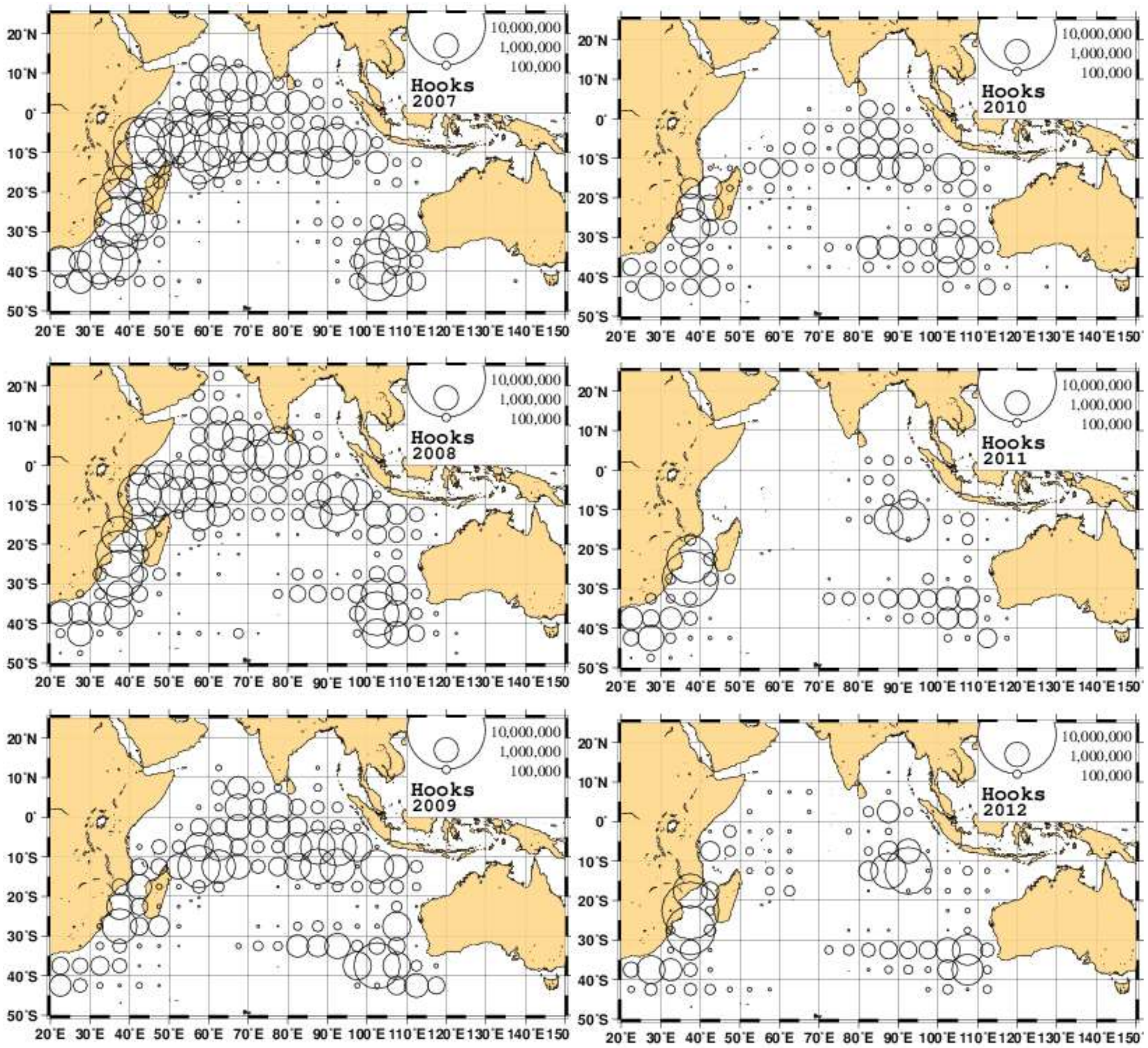



**Fig. 3.** Geographical distribution of fishing effort by Japanese longline in recent years.

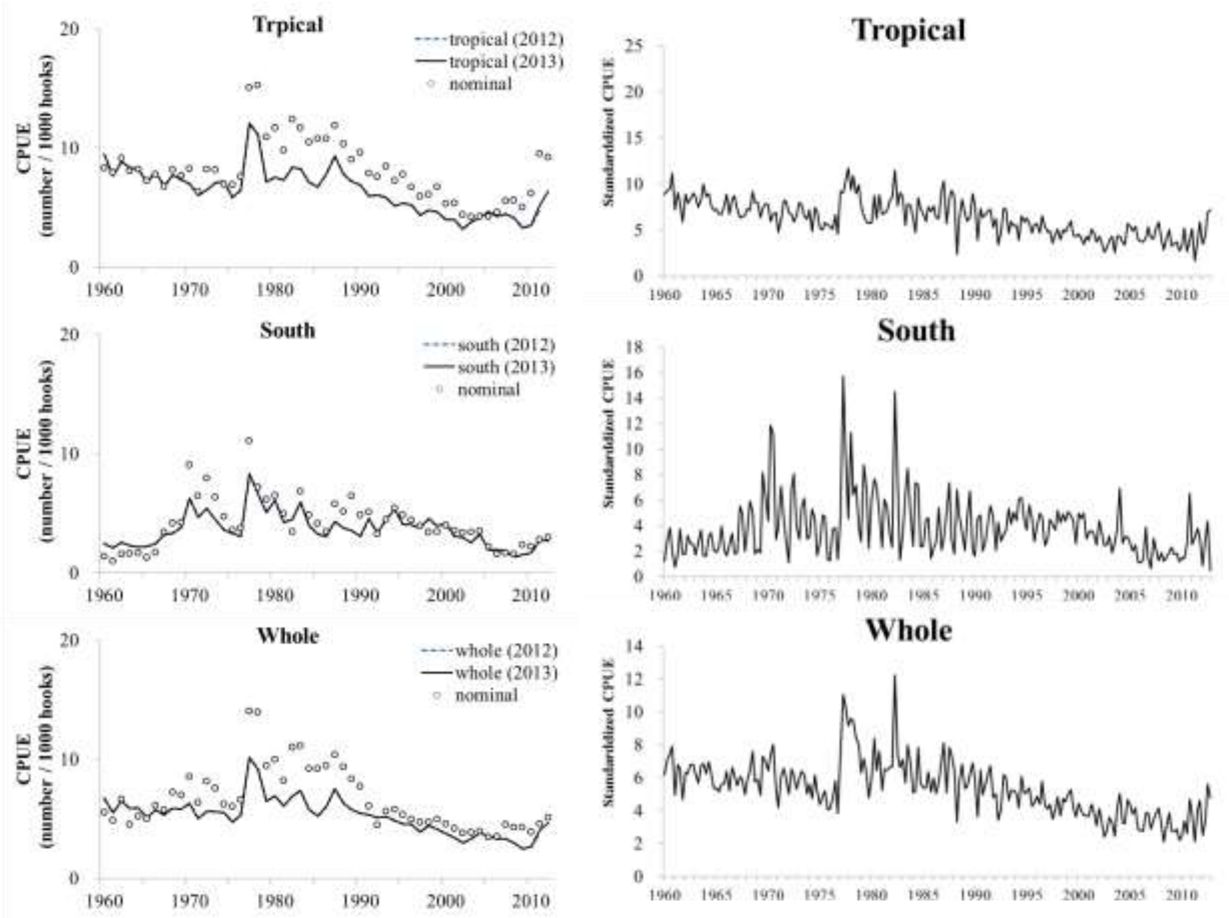
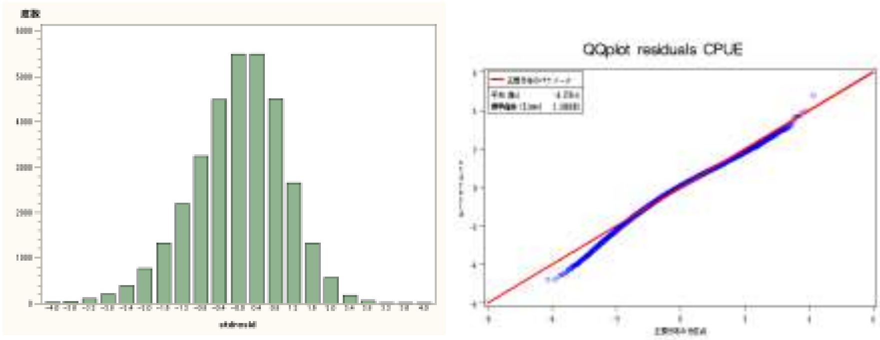
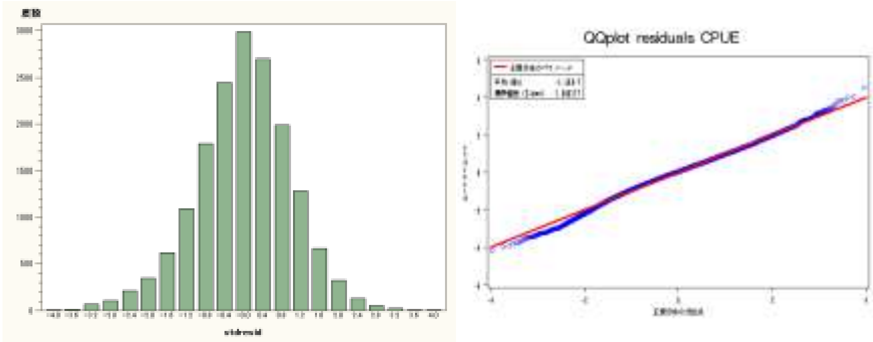



**Fig. 4**. Comparison of area aggregated CPUE series of bigeye. Standardized CPUE in 2013 (solid line), nominal CPUE (open circle), and standardized CPUE in 2012 (dashed line: Satoh and Okamoto, 2012) of Japanese longline for the tropical (top), south (middle) and whole (bottom) Indian Ocean.

1960-2012 Year base
Tropical area




1960-2012 Year base
South area




1960-2012 Year base
Whole Indian

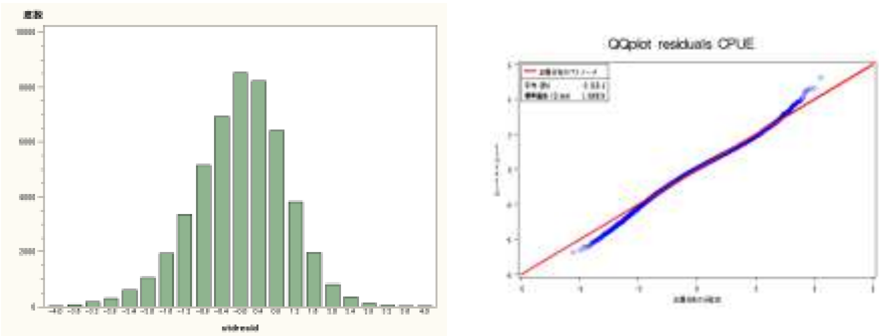
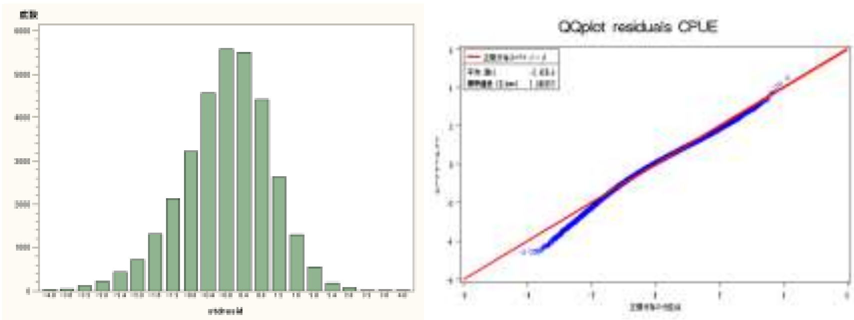
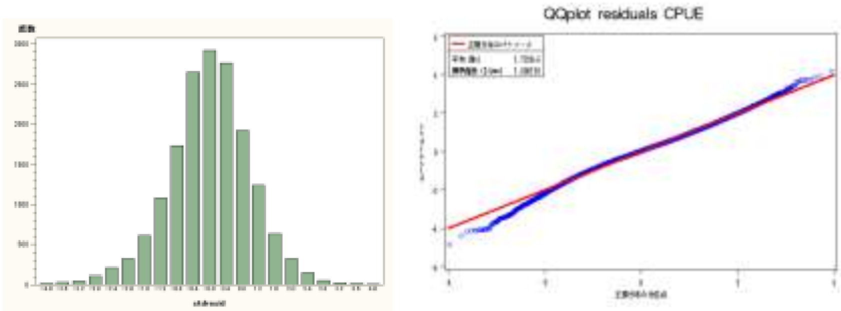



**Fig. 5**. Standardized residuals of area aggregated annual CPUE standardization.

1960-2012 Quarter base
Tropical area




1960-2012 Quarter base
South area




1960-2012 Quarter base
Whole Indian

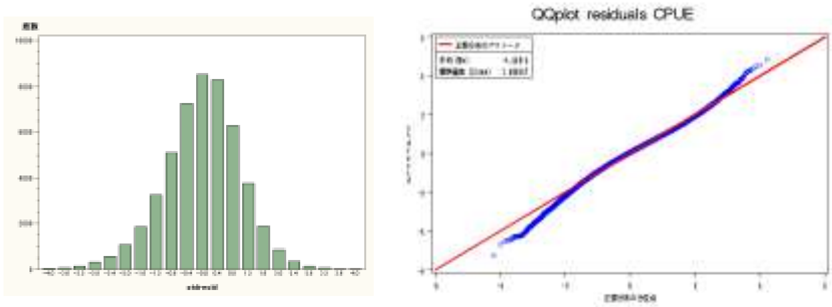



**Fig. 6**. Standardized residuals of area aggregated quarterly CPUE standardization.

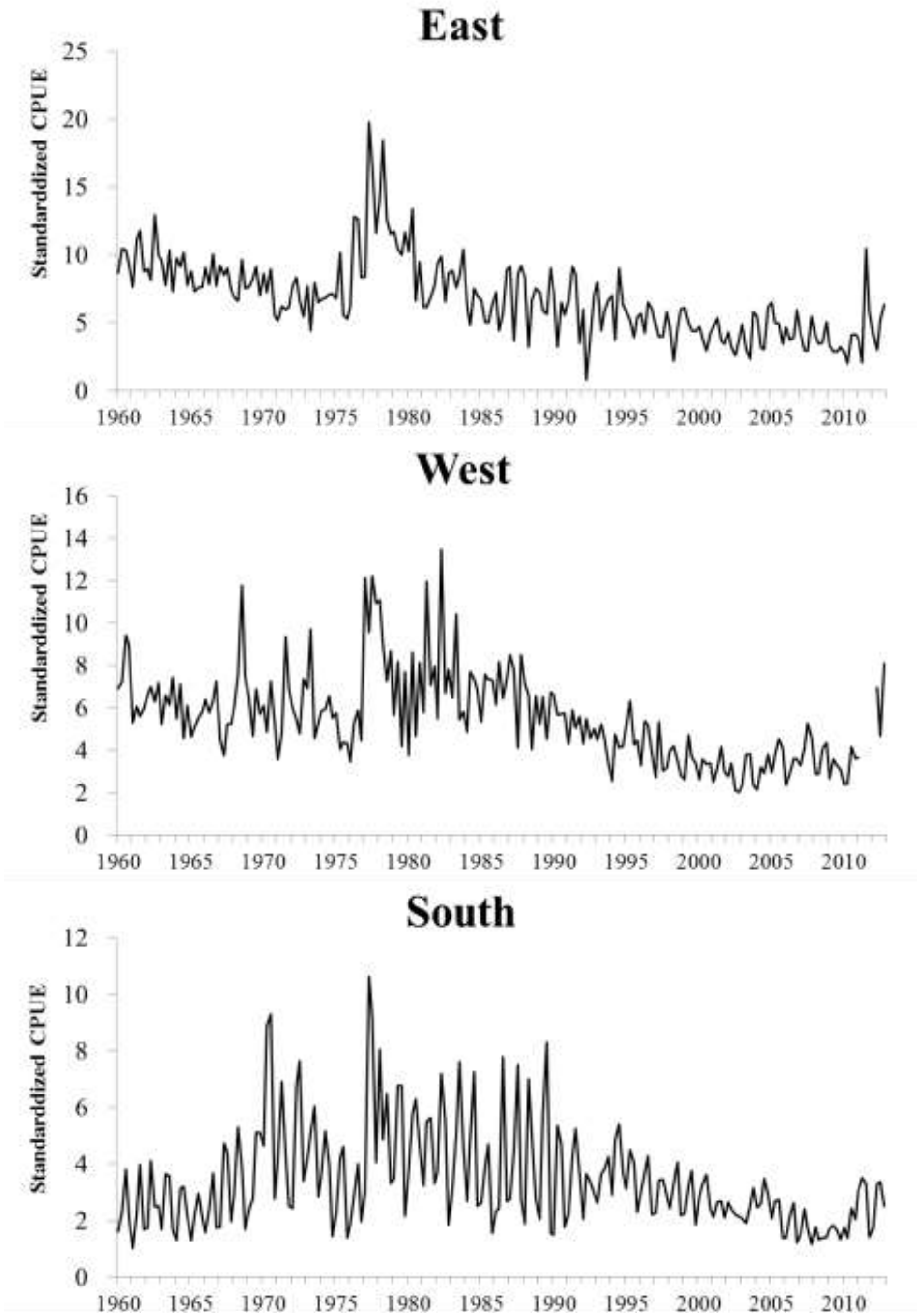
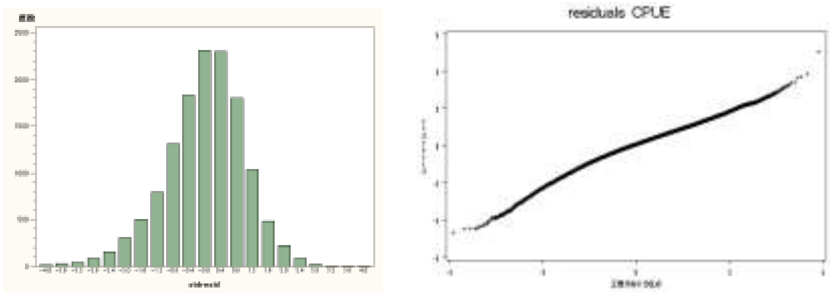
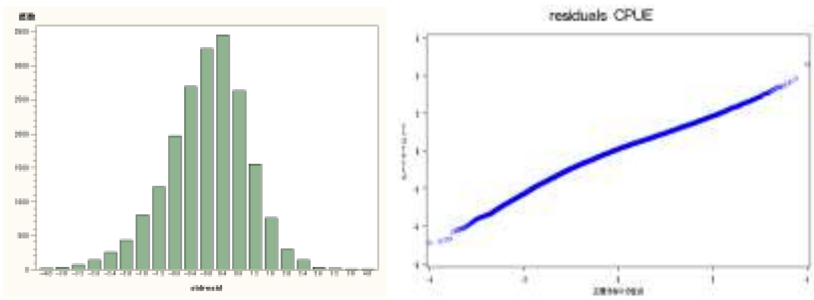



**Fig. 7**. Comparison of area specific CPUE series of bigeye tuna by Japanese longline for the east (top), west (middle) and south (bottom) area.

1960-2012 Quarter base
East area




1960-2012 Quarter base
West area




1960-2012 Quarter base
South Indian

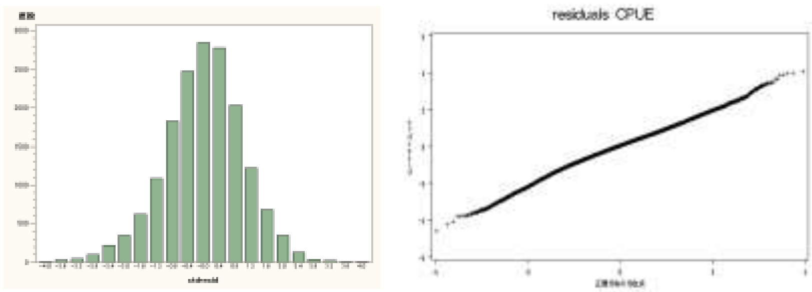



**Fig. 8**. Standardized residuals of area specific quarterly CPUE standardization.

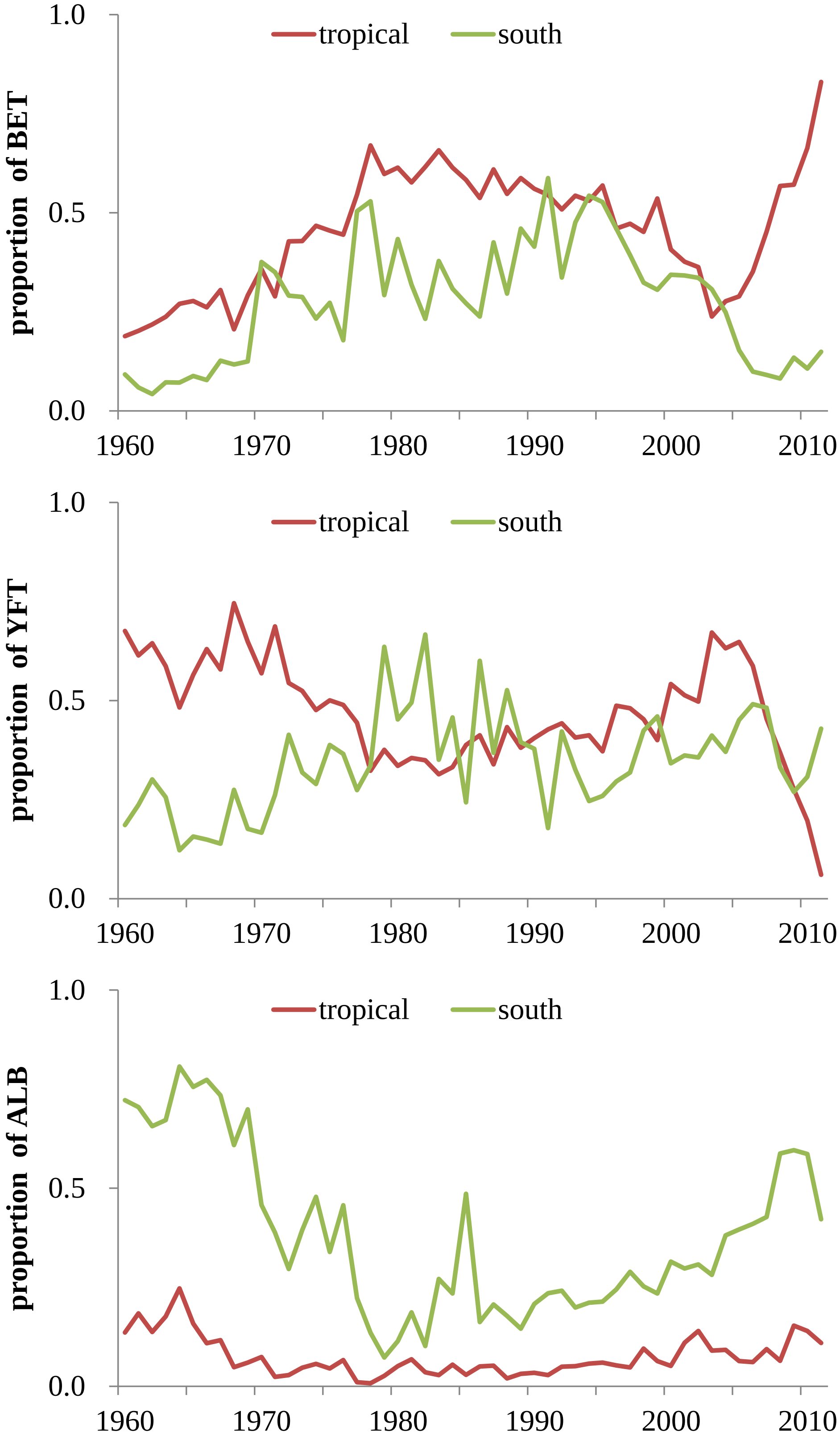



Fig. 9 Annual proportion of BET (bigeye tuna, upper panel), YFT (yellowfin tuna, middle) and ALB (albacore, lower) of Japanese longline in the Indian Ocean from 1960 to 2011. Proportion for BET = BET / (BET +YFT + ALB) in number.

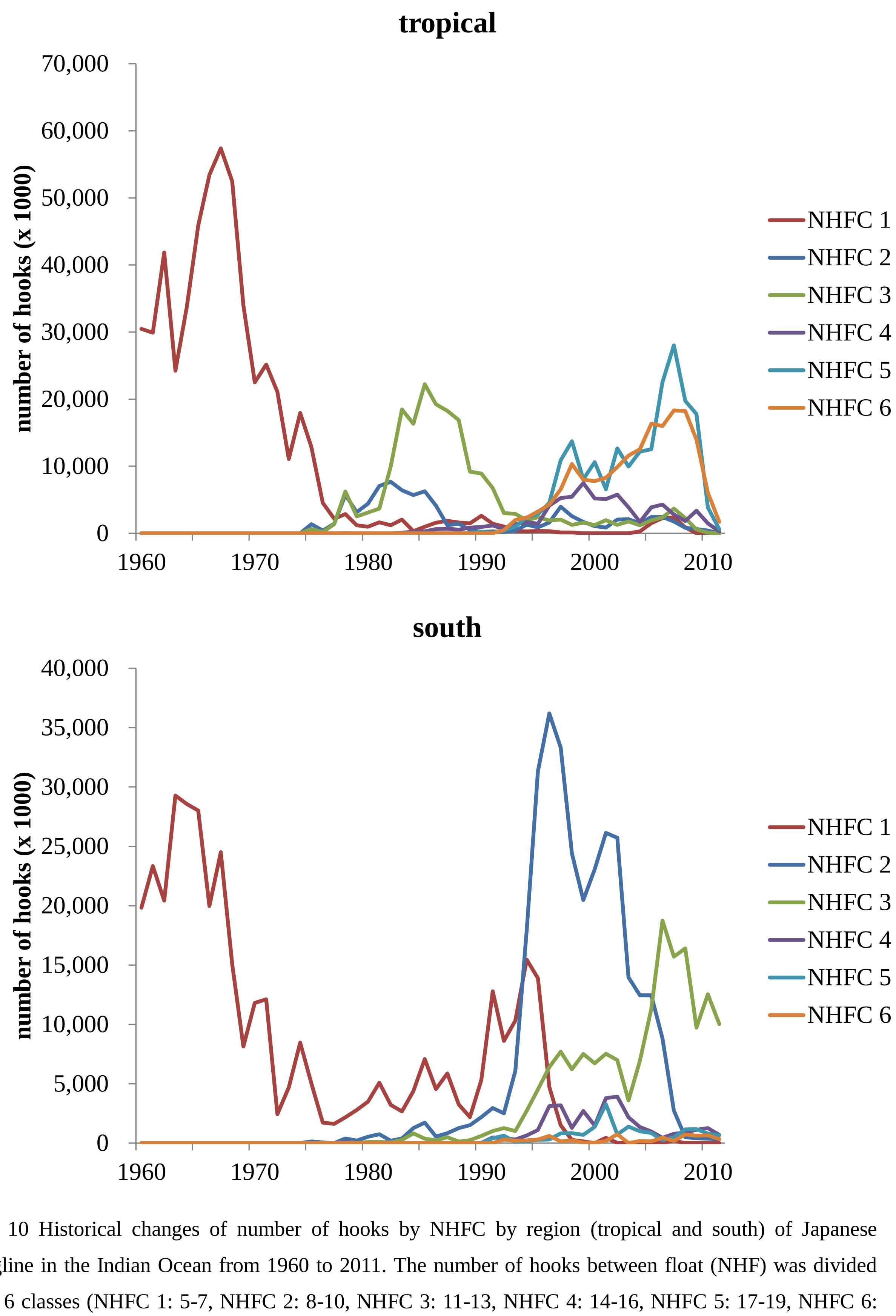



Fig. 10 Historical changes of number of hooks by NHFC by region (tropical and south) of Japanese longline in the Indian Ocean from 1960 to 2011. The number of hooks between float (NHF) was divided into 6 classes (NHFC 1: 5-7, NHFC 2: 8-10, NHFC 3: 11-13, NHFC 4: 14-16, NHFC 5: 17-19, NHFC 6: 20-21).

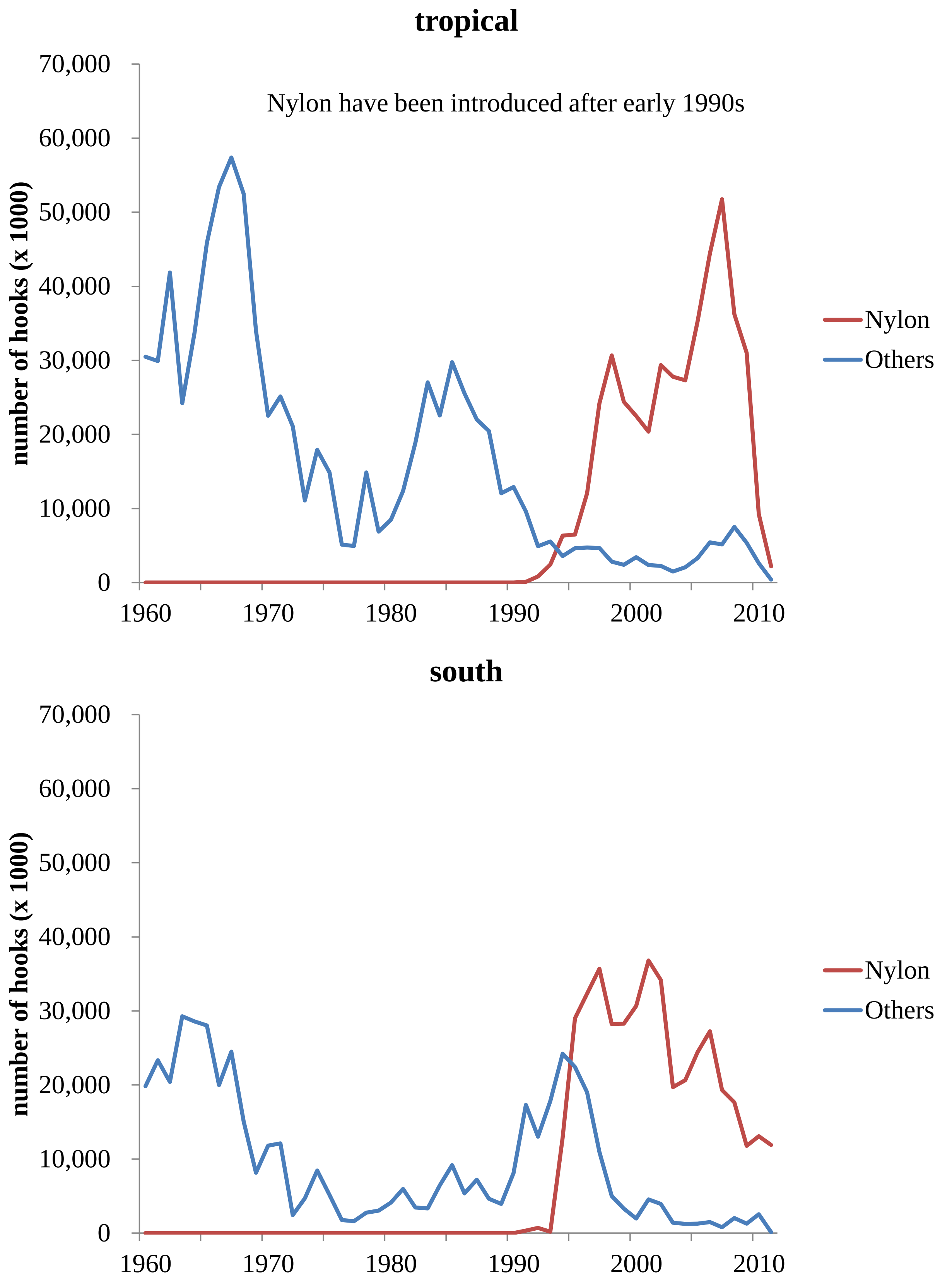



Fig. 11 Historical changes of number of hooks by material of main line (Nylon, others) of Japanese longline in the Indian Ocean from 1960 to 2011.

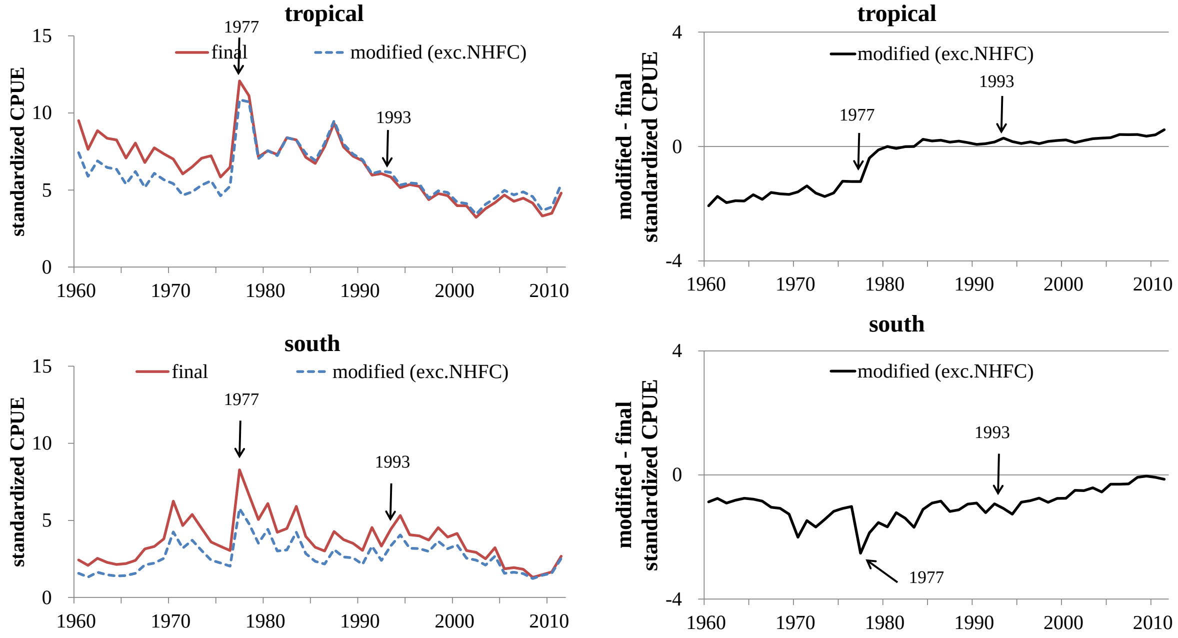



Fig. 12 Historical changes of standardized CPUE of Japanese longline in the Indian Ocean from 1960 to 2011 for the final model and the modified model (excluding variable “NHFC” form the final model) by region in right two panels. Differences between the final model and the modified model by region in left two panels. Tropical region; upper two panels, south region; lower two panels.

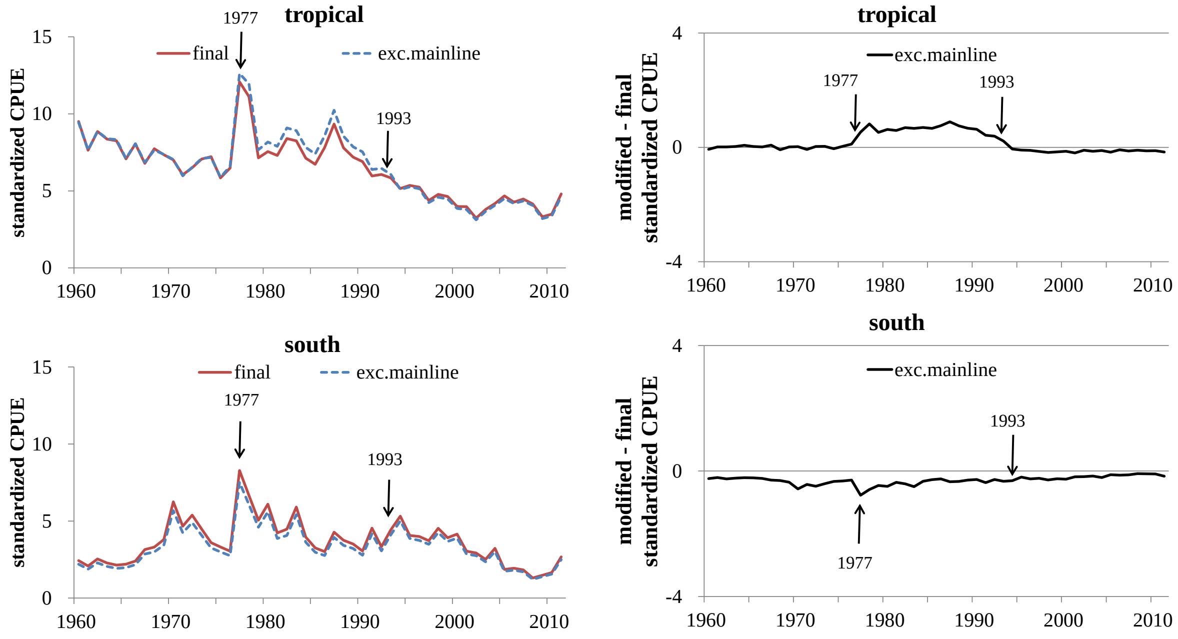



Fig. 13 Historical changes of standardized CPUE of Japanese longline in the Indian Ocean from 1960 to 2011 for the final model and the modified model (excluding variable “main line” form the final model) by region in right two panels. Differences between the final model and the modified model by region in left two panels. Tropical region; upper two panels, south region; lower two panels.

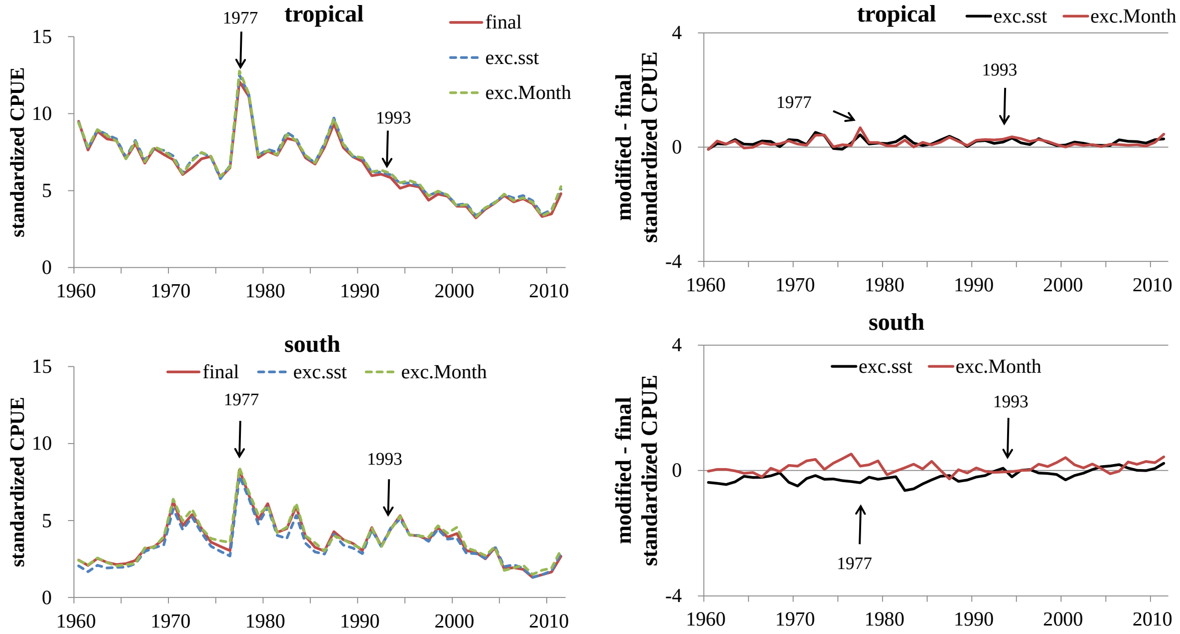



Fig. 14 Historical changes of standardized CPUE of Japanese longline in the Indian Ocean from 1960 to 2011 for the final model and the modified model (excluding variable "SST" (sea surface temperature) and "month" form the final model) by region in right two panels. Differences between the final model and the modified model by region in left two panels. Tropical region; upper two panels, south region; lower two panels.

Appendix Table 1. Annual value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2012 expressed in real and relative scale in which the average from 1960 to 2012 is 1.0, with squared standard error of log CPUE (= CV of CPUE).

| **tropical** | | | | **south** | | | | **whole** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| year | CPUE | dev_t | Relative CPUE | year | CPUE | dev_t | Relative CPUE | year | CPUE | dev_t | Relative CPUE |
| 1960 | 9.5010 | 0.0012 | 1.4684 | 1960 | 2.4400 | 0.0073 | 0.6738 | 1960 | 6.7848 | 0.0012 | 1.2858 |
| 1961 | 7.6365 | 0.0014 | 1.1802 | 1961 | 2.0903 | 0.0052 | 0.5772 | 1961 | 5.5423 | 0.0011 | 1.0503 |
| 1962 | 8.8477 | 0.0009 | 1.3674 | 1962 | 2.5372 | 0.0039 | 0.7006 | 1962 | 6.5263 | 0.0008 | 1.2368 |
| 1963 | 8.3576 | 0.0011 | 1.2917 | 1963 | 2.2820 | 0.0036 | 0.6301 | 1963 | 5.8999 | 0.0009 | 1.1181 |
| 1964 | 8.2457 | 0.0009 | 1.2744 | 1964 | 2.1474 | 0.0036 | 0.5930 | 1964 | 5.9507 | 0.0008 | 1.1277 |
| 1965 | 7.0729 | 0.0007 | 1.0931 | 1965 | 2.2033 | 0.0034 | 0.6084 | 1965 | 5.1154 | 0.0007 | 0.9694 |
| 1966 | 8.0456 | 0.0007 | 1.2435 | 1966 | 2.4112 | 0.0039 | 0.6658 | 1966 | 5.7683 | 0.0007 | 1.0931 |
| 1967 | 6.7761 | 0.0007 | 1.0473 | 1967 | 3.1645 | 0.0025 | 0.8738 | 1967 | 5.3763 | 0.0006 | 1.0189 |
| 1968 | 7.7352 | 0.0009 | 1.1955 | 1968 | 3.3129 | 0.0027 | 0.9148 | 1968 | 5.9164 | 0.0007 | 1.1212 |
| 1969 | 7.3463 | 0.0008 | 1.1354 | 1969 | 3.7959 | 0.0032 | 1.0482 | 1969 | 5.8567 | 0.0007 | 1.1099 |
| 1970 | 7.0024 | 0.0010 | 1.0822 | 1970 | 6.2286 | 0.0030 | 1.7200 | 1970 | 6.3259 | 0.0008 | 1.1988 |
| 1971 | 6.0475 | 0.0009 | 0.9347 | 1971 | 4.6671 | 0.0033 | 1.2888 | 1971 | 5.0578 | 0.0007 | 0.9585 |
| 1972 | 6.5076 | 0.0014 | 1.0058 | 1972 | 5.3888 | 0.0066 | 1.4881 | 1972 | 5.6655 | 0.0013 | 1.0737 |
| 1973 | 7.0640 | 0.0014 | 1.0918 | 1973 | 4.4790 | 0.0053 | 1.2368 | 1973 | 5.6286 | 0.0012 | 1.0667 |
| 1974 | 7.2143 | 0.0013 | 1.1150 | 1974 | 3.5945 | 0.0036 | 0.9926 | 1974 | 5.5603 | 0.0009 | 1.0537 |
| 1975 | 5.8426 | 0.0013 | 0.9030 | 1975 | 3.3047 | 0.0045 | 0.9125 | 1975 | 4.7657 | 0.0010 | 0.9031 |
| 1976 | 6.4789 | 0.0022 | 1.0013 | 1976 | 3.0324 | 0.0113 | 0.8374 | 1976 | 5.3119 | 0.0021 | 1.0067 |
| 1977 | 12.0687 | 0.0029 | 1.8653 | 1977 | 8.2483 | 0.0171 | 2.2777 | 1977 | 10.1624 | 0.0030 | 1.9259 |
| 1978 | 11.1113 | 0.0013 | 1.7173 | 1978 | 6.6297 | 0.0065 | 1.8307 | 1978 | 9.2020 | 0.0013 | 1.7439 |
| 1979 | 7.1484 | 0.0031 | 1.1048 | 1979 | 5.0431 | 0.0063 | 1.3926 | 1979 | 6.4999 | 0.0021 | 1.2318 |
| 1980 | 7.5439 | 0.0017 | 1.1659 | 1980 | 6.0845 | 0.0060 | 1.6802 | 1980 | 6.9505 | 0.0014 | 1.3172 |
| 1981 | 7.2947 | 0.0011 | 1.1274 | 1981 | 4.2352 | 0.0045 | 1.1695 | 1981 | 6.1135 | 0.0010 | 1.1586 |
| 1982 | 8.3869 | 0.0008 | 1.2962 | 1982 | 4.4458 | 0.0073 | 1.2277 | 1982 | 6.9420 | 0.0011 | 1.3156 |
| 1983 | 8.2505 | 0.0011 | 1.2751 | 1983 | 5.8862 | 0.0056 | 1.6254 | 1983 | 7.4120 | 0.0011 | 1.4046 |
| 1984 | 7.1275 | 0.0013 | 1.1016 | 1984 | 3.9452 | 0.0036 | 1.0894 | 1984 | 5.8120 | 0.0010 | 1.1014 |
| 1985 | 6.7287 | 0.0011 | 1.0399 | 1985 | 3.2568 | 0.0038 | 0.8993 | 1985 | 5.2843 | 0.0009 | 1.0014 |
| 1986 | 7.8090 | 0.0007 | 1.2069 | 1986 | 3.0225 | 0.0053 | 0.8346 | 1986 | 6.0370 | 0.0009 | 1.1441 |
| 1987 | 9.3333 | 0.0008 | 1.4425 | 1987 | 4.2887 | 0.0045 | 1.1843 | 1987 | 7.5603 | 0.0009 | 1.4327 |
| 1988 | 7.7947 | 0.0010 | 1.2047 | 1988 | 3.7487 | 0.0071 | 1.0351 | 1988 | 6.3615 | 0.0012 | 1.2056 |
| 1989 | 7.1871 | 0.0011 | 1.1108 | 1989 | 3.5147 | 0.0072 | 0.9705 | 1989 | 5.8099 | 0.0012 | 1.1010 |
| 1990 | 6.8953 | 0.0010 | 1.0657 | 1990 | 3.0568 | 0.0048 | 0.8441 | 1990 | 5.4906 | 0.0010 | 1.0405 |
| 1991 | 5.9691 | 0.0013 | 0.9225 | 1991 | 4.5570 | 0.0023 | 1.2584 | 1991 | 5.3754 | 0.0009 | 1.0187 |
| 1992 | 6.0693 | 0.0017 | 0.9380 | 1992 | 3.3509 | 0.0036 | 0.9253 | 1992 | 5.1427 | 0.0012 | 0.9746 |
| 1993 | 5.8433 | 0.0013 | 0.9031 | 1993 | 4.4497 | 0.0023 | 1.2287 | 1993 | 5.2341 | 0.0009 | 0.9919 |
| 1994 | 5.1545 | 0.0010 | 0.7966 | 1994 | 5.3202 | 0.0013 | 1.4691 | 1994 | 4.8785 | 0.0007 | 0.9245 |
| 1995 | 5.3555 | 0.0008 | 0.8277 | 1995 | 4.0789 | 0.0009 | 1.1263 | 1995 | 4.5870 | 0.0006 | 0.8693 |
| 1996 | 5.2435 | 0.0006 | 0.8104 | 1996 | 4.0136 | 0.0010 | 1.1083 | 1996 | 4.5625 | 0.0005 | 0.8646 |
| 1997 | 4.3752 | 0.0004 | 0.6762 | 1997 | 3.7323 | 0.0012 | 1.0306 | 1997 | 3.9008 | 0.0004 | 0.7392 |
| 1998 | 4.7748 | 0.0005 | 0.7380 | 1998 | 4.5404 | 0.0022 | 1.2538 | 1998 | 4.4761 | 0.0005 | 0.8483 |
| 1999 | 4.6303 | 0.0005 | 0.7156 | 1999 | 3.9254 | 0.0020 | 1.0840 | 1999 | 4.1531 | 0.0005 | 0.7871 |
| 2000 | 3.9942 | 0.0005 | 0.6173 | 2000 | 4.1466 | 0.0015 | 1.1450 | 2000 | 3.7977 | 0.0004 | 0.7197 |
| 2001 | 3.9847 | 0.0006 | 0.6158 | 2001 | 3.0489 | 0.0011 | 0.8419 | 2001 | 3.4535 | 0.0005 | 0.6545 |
| 2002 | 3.2245 | 0.0005 | 0.4984 | 2002 | 2.9391 | 0.0013 | 0.8116 | 2002 | 2.9970 | 0.0004 | 0.5680 |
| 2003 | 3.8008 | 0.0012 | 0.5874 | 2003 | 2.5283 | 0.0027 | 0.6982 | 2003 | 3.3569 | 0.0009 | 0.6362 |
| 2004 | 4.1753 | 0.0008 | 0.6453 | 2004 | 3.2467 | 0.0029 | 0.8965 | 2004 | 3.8412 | 0.0007 | 0.7279 |
| 2005 | 4.6661 | 0.0013 | 0.7212 | 2005 | 1.8844 | 0.0031 | 0.5203 | 2005 | 3.5636 | 0.0010 | 0.6753 |
| 2006 | 4.2620 | 0.0006 | 0.6587 | 2006 | 1.9575 | 0.0029 | 0.5405 | 2006 | 3.3214 | 0.0006 | 0.6294 |
| 2007 | 4.4729 | 0.0004 | 0.6913 | 2007 | 1.8419 | 0.0027 | 0.5086 | 2007 | 3.3629 | 0.0005 | 0.6373 |
| 2008 | 4.1479 | 0.0004 | 0.6411 | 2008 | 1.3119 | 0.0019 | 0.3623 | 2008 | 3.0166 | 0.0005 | 0.5717 |
| 2009 | 3.3141 | 0.0006 | 0.5122 | 2009 | 1.4897 | 0.0022 | 0.4114 | 2009 | 2.5194 | 0.0006 | 0.4774 |
| 2010 | 3.4871 | 0.0014 | 0.5389 | 2010 | 1.6723 | 0.0020 | 0.4618 | 2010 | 2.6721 | 0.0010 | 0.5064 |
| 2011 | 5.2006 | 0.0047 | 0.8038 | 2011 | 2.7353 | 0.0034 | 0.7553 | 2011 | 4.0715 | 0.0022 | 0.7716 |
| 2012 | 6.3754 | 0.0033 | 0.9853 | 2012 | 2.6766 | 0.0035 | 0.7391 | 2012 | 4.6951 | 0.0019 | 0.8898 |

Appendix Table 2. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2012 expressed in real and relative scale in which the average from 1960 to 2012 is 1.0, with squared standard error of log CPUE (= CV of CPUE).

| | | Tropical | | | South | | | Whole | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | quarter | CPUE | dev_t | relative | CPUE | dev_t | relative | CPUE | dev_t | relative |
| 1960 | 1 | 8.831 | 0.003 | 1.408 | 1.211 | 0.009 | 0.313 | 6.185 | 0.002 | 1.156 |
| 1960 | 2 | 9.196 | 0.003 | 1.466 | 2.818 | 0.073 | 0.729 | 7.070 | 0.008 | 1.322 |
| 1960 | 3 | 9.473 | 0.007 | 1.510 | 3.832 | 0.032 | 0.991 | 7.453 | 0.006 | 1.393 |
| 1960 | 4 | 11.124 | 0.004 | 1.773 | 2.029 | 0.016 | 0.525 | 7.894 | 0.003 | 1.476 |
| 1961 | 1 | 7.153 | 0.003 | 1.140 | 0.771 | 0.009 | 0.199 | 4.932 | 0.002 | 0.922 |
| 1961 | 2 | 9.032 | 0.005 | 1.439 | 1.756 | 0.029 | 0.454 | 6.788 | 0.005 | 1.269 |
| 1961 | 3 | 7.929 | 0.007 | 1.264 | 3.738 | 0.029 | 0.967 | 6.546 | 0.006 | 1.224 |
| 1961 | 4 | 5.856 | 0.006 | 0.933 | 1.738 | 0.009 | 0.449 | 4.648 | 0.004 | 0.869 |
| 1962 | 1 | 8.837 | 0.003 | 1.408 | 1.815 | 0.010 | 0.469 | 6.322 | 0.002 | 1.182 |
| 1962 | 2 | 7.921 | 0.002 | 1.262 | 3.252 | 0.031 | 0.841 | 6.259 | 0.004 | 1.170 |
| 1962 | 3 | 8.304 | 0.005 | 1.323 | 2.610 | 0.022 | 0.675 | 6.775 | 0.004 | 1.267 |
| 1962 | 4 | 8.982 | 0.002 | 1.432 | 2.527 | 0.009 | 0.654 | 6.788 | 0.002 | 1.269 |
| 1963 | 1 | 8.553 | 0.002 | 1.363 | 1.724 | 0.007 | 0.446 | 6.196 | 0.002 | 1.158 |
| 1963 | 2 | 7.453 | 0.003 | 1.188 | 2.681 | 0.059 | 0.693 | 5.665 | 0.007 | 1.059 |
| 1963 | 3 | 8.274 | 0.012 | 1.319 | 3.667 | 0.018 | 0.949 | 6.712 | 0.007 | 1.255 |
| 1963 | 4 | 9.968 | 0.009 | 1.589 | 1.664 | 0.008 | 0.431 | 6.857 | 0.005 | 1.282 |
| 1964 | 1 | 8.591 | 0.003 | 1.369 | 1.606 | 0.009 | 0.415 | 6.238 | 0.002 | 1.166 |
| 1964 | 2 | 8.906 | 0.002 | 1.419 | 3.132 | 0.058 | 0.810 | 6.947 | 0.006 | 1.299 |
| 1964 | 3 | 7.634 | 0.006 | 1.217 | 3.448 | 0.033 | 0.892 | 6.282 | 0.006 | 1.174 |
| 1964 | 4 | 7.086 | 0.007 | 1.129 | 2.064 | 0.008 | 0.534 | 5.323 | 0.004 | 0.995 |
| 1965 | 1 | 7.250 | 0.002 | 1.155 | 1.928 | 0.010 | 0.499 | 5.373 | 0.002 | 1.004 |
| 1965 | 2 | 6.663 | 0.002 | 1.062 | 2.285 | 0.026 | 0.591 | 5.128 | 0.003 | 0.959 |
| 1965 | 3 | 6.668 | 0.003 | 1.063 | 3.961 | 0.013 | 1.025 | 5.589 | 0.003 | 1.045 |
| 1965 | 4 | 7.598 | 0.002 | 1.211 | 2.080 | 0.009 | 0.538 | 5.626 | 0.002 | 1.052 |
| 1966 | 1 | 8.865 | 0.002 | 1.413 | 1.686 | 0.012 | 0.436 | 6.386 | 0.002 | 1.194 |
| 1966 | 2 | 6.711 | 0.002 | 1.070 | 2.474 | 0.058 | 0.640 | 5.196 | 0.006 | 0.971 |
| 1966 | 3 | 8.297 | 0.002 | 1.322 | 3.409 | 0.049 | 0.882 | 6.615 | 0.005 | 1.237 |
| 1966 | 4 | 8.657 | 0.002 | 1.380 | 1.822 | 0.007 | 0.471 | 6.162 | 0.001 | 1.152 |
| 1967 | 1 | 7.274 | 0.002 | 1.159 | 1.850 | 0.007 | 0.479 | 5.506 | 0.001 | 1.029 |
| 1967 | 2 | 6.351 | 0.002 | 1.012 | 5.543 | 0.008 | 1.434 | 6.057 | 0.001 | 1.132 |
| 1967 | 3 | 6.361 | 0.003 | 1.014 | 5.040 | 0.008 | 1.304 | 5.898 | 0.002 | 1.103 |
| 1967 | 4 | 6.555 | 0.002 | 1.045 | 1.986 | 0.007 | 0.514 | 4.975 | 0.002 | 0.930 |
| 1968 | 1 | 7.287 | 0.003 | 1.161 | 3.442 | 0.016 | 0.890 | 5.818 | 0.003 | 1.088 |
| 1968 | 2 | 7.132 | 0.003 | 1.137 | 5.943 | 0.011 | 1.537 | 6.434 | 0.002 | 1.203 |
| 1968 | 3 | 9.151 | 0.011 | 1.458 | 5.031 | 0.008 | 1.301 | 7.587 | 0.006 | 1.418 |
| 1968 | 4 | 7.925 | 0.002 | 1.263 | 1.813 | 0.008 | 0.469 | 5.732 | 0.002 | 1.072 |
| 1969 | 1 | 7.926 | 0.002 | 1.263 | 2.159 | 0.009 | 0.558 | 5.867 | 0.002 | 1.097 |
| 1969 | 2 | 6.325 | 0.002 | 1.008 | 1.876 | 0.013 | 0.485 | 4.933 | 0.002 | 0.922 |
| 1969 | 3 | 7.318 | 0.003 | 1.166 | 8.170 | 0.008 | 2.114 | 7.304 | 0.002 | 1.365 |
| 1969 | 4 | 7.804 | 0.002 | 1.244 | 6.296 | 0.018 | 1.629 | 7.006 | 0.003 | 1.310 |
| 1970 | 1 | 7.735 | 0.003 | 1.233 | 4.361 | 0.032 | 1.128 | 6.430 | 0.004 | 1.202 |
| 1970 | 2 | 5.881 | 0.003 | 0.937 | 11.866 | 0.009 | 3.070 | 7.341 | 0.002 | 1.372 |
| 1970 | 3 | 6.689 | 0.007 | 1.066 | 11.227 | 0.008 | 2.904 | 8.004 | 0.004 | 1.496 |
| 1970 | 4 | 6.839 | 0.003 | 1.090 | 2.931 | 0.008 | 0.758 | 5.262 | 0.002 | 0.984 |
| 1971 | 1 | 4.728 | 0.002 | 0.754 | 3.885 | 0.010 | 1.005 | 4.174 | 0.002 | 0.780 |
| 1971 | 2 | 6.066 | 0.002 | 0.967 | 7.110 | 0.011 | 1.839 | 6.064 | 0.002 | 1.134 |
| 1971 | 3 | 8.169 | 0.005 | 1.302 | 4.563 | 0.010 | 1.180 | 6.555 | 0.003 | 1.225 |
| 1971 | 4 | 8.059 | 0.003 | 1.285 | 2.804 | 0.018 | 0.725 | 5.957 | 0.003 | 1.114 |
| 1972 | 1 | 6.896 | 0.004 | 1.099 | 1.104 | 0.146 | 0.285 | 4.983 | 0.015 | 0.932 |
| 1972 | 2 | 6.716 | 0.005 | 1.070 | 6.906 | 0.018 | 1.786 | 6.529 | 0.004 | 1.221 |
| 1972 | 3 | 5.842 | 0.003 | 0.931 | 8.072 | 0.017 | 2.088 | 6.114 | 0.003 | 1.143 |
| 1972 | 4 | 6.548 | 0.022 | 1.044 | 3.991 | 0.021 | 1.032 | 5.299 | 0.012 | 0.991 |
| 1973 | 1 | 7.964 | 0.008 | 1.269 | 2.908 | 0.292 | 0.752 | 5.953 | 0.031 | 1.113 |
| 1973 | 2 | 7.735 | 0.012 | 1.233 | 5.475 | 0.024 | 1.416 | 6.364 | 0.008 | 1.190 |
| 1973 | 3 | 6.536 | 0.004 | 1.042 | 6.162 | 0.013 | 1.594 | 6.165 | 0.003 | 1.152 |
| 1973 | 4 | 6.132 | 0.005 | 0.977 | 2.986 | 0.010 | 0.772 | 4.995 | 0.003 | 0.934 |
| 1974 | 1 | 7.158 | 0.003 | 1.141 | 3.103 | 0.014 | 0.803 | 5.605 | 0.003 | 1.048 |
| 1974 | 2 | 4.794 | 0.004 | 0.764 | 5.348 | 0.011 | 1.384 | 4.728 | 0.003 | 0.884 |
| 1974 | 3 | 7.389 | 0.004 | 1.178 | 4.436 | 0.011 | 1.147 | 6.144 | 0.003 | 1.148 |
| 1974 | 4 | 6.981 | 0.004 | 1.113 | 1.673 | 0.013 | 0.433 | 5.167 | 0.003 | 0.966 |
| 1975 | 1 | 5.191 | 0.007 | 0.827 | 2.660 | 0.024 | 0.688 | 4.350 | 0.006 | 0.813 |
| 1975 | 2 | 4.985 | 0.014 | 0.795 | 4.855 | 0.012 | 1.256 | 4.868 | 0.007 | 0.910 |
| 1975 | 3 | 5.785 | 0.003 | 0.922 | 4.702 | 0.010 | 1.216 | 5.194 | 0.002 | 0.971 |
| 1975 | 4 | 5.519 | 0.004 | 0.880 | 1.353 | 0.022 | 0.350 | 4.057 | 0.004 | 0.758 |
| 1976 | 1 | 5.364 | 0.004 | 0.855 | 1.269 | 0.144 | 0.328 | 4.096 | 0.015 | 0.766 |
| 1976 | 2 | 5.062 | 0.011 | 0.807 | 3.720 | 0.040 | 0.962 | 4.735 | 0.009 | 0.885 |
| 1976 | 3 | 6.601 | 0.018 | 1.052 | 3.847 | 0.035 | 0.995 | 5.813 | 0.011 | 1.087 |
| 1976 | 4 | 4.503 | 0.011 | 0.718 | 1.379 | 0.141 | 0.357 | 3.826 | 0.018 | 0.715 |
| 1977 | 1 | 9.161 | 0.007 | 1.460 | 4.531 | 0.089 | 1.172 | 7.388 | 0.011 | 1.381 |
| 1977 | 2 | 9.054 | 0.026 | 1.443 | 15.751 | 0.050 | 4.075 | 11.050 | 0.017 | 2.066 |
| 1977 | 3 | 10.275 | 0.011 | 1.638 | 10.119 | 0.070 | 2.618 | 10.324 | 0.012 | 1.930 |
| 1977 | 4 | 11.720 | 0.006 | 1.868 | 4.534 | 0.061 | 1.173 | 9.140 | 0.008 | 1.709 |

Appendix Table 2. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2012 expressed in real and relative scale in which the average from 1960 to 2012 is 1.0, with squared standard error of log CPUE (= CV of CPUE).(continued)

| | | Tropical | | | South | | | Whole | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | quarter | CPUE | dev_t | relative | CPUE | dev_t | relative | CPUE | dev_t | relative |
| 1978 | 1 | 9.328 | 0.002 | 1.487 | 11.318 | 0.035 | 2.928 | 9.605 | 0.004 | 1.796 |
| 1978 | 2 | 10.873 | 0.012 | 1.733 | 6.436 | 0.022 | 1.665 | 9.442 | 0.008 | 1.765 |
| 1978 | 3 | 8.929 | 0.008 | 1.423 | 7.185 | 0.030 | 1.859 | 8.415 | 0.007 | 1.573 |
| 1978 | 4 | 9.875 | 0.005 | 1.574 | 3.892 | 0.036 | 1.007 | 7.996 | 0.005 | 1.495 |
| 1979 | 1 | 7.637 | 0.005 | 1.217 | 2.739 | 0.028 | 0.709 | 6.292 | 0.005 | 1.176 |
| 1979 | 2 | 6.525 | 0.005 | 1.040 | 8.784 | 0.018 | 2.272 | 7.171 | 0.004 | 1.341 |
| 1979 | 3 | 5.869 | 0.007 | 0.935 | 6.887 | 0.020 | 1.782 | 6.168 | 0.005 | 1.153 |
| 1979 | 4 | 5.741 | 0.003 | 0.915 | 2.224 | 0.032 | 0.575 | 4.755 | 0.004 | 0.889 |
| 1980 | 1 | 5.722 | 0.020 | 0.912 | 6.005 | 0.049 | 1.553 | 5.908 | 0.014 | 1.104 |
| 1980 | 2 | 8.745 | 0.022 | 1.394 | 7.688 | 0.032 | 1.989 | 8.361 | 0.013 | 1.563 |
| 1980 | 3 | 6.195 | 0.019 | 0.987 | 7.113 | 0.026 | 1.840 | 6.402 | 0.011 | 1.197 |
| 1980 | 4 | 8.827 | 0.004 | 1.407 | 4.931 | 0.015 | 1.276 | 7.606 | 0.003 | 1.422 |
| 1981 | 1 | 6.672 | 0.005 | 1.063 | 2.296 | 0.018 | 0.594 | 5.239 | 0.004 | 0.979 |
| 1981 | 2 | 6.808 | 0.010 | 1.085 | 6.083 | 0.028 | 1.574 | 6.498 | 0.007 | 1.215 |
| 1981 | 3 | 7.072 | 0.006 | 1.127 | 5.473 | 0.014 | 1.416 | 6.440 | 0.004 | 1.204 |
| 1981 | 4 | 8.170 | 0.003 | 1.302 | 3.287 | 0.013 | 0.850 | 6.633 | 0.002 | 1.240 |
| 1982 | 1 | 8.480 | 0.003 | 1.352 | 2.324 | 0.021 | 0.601 | 6.657 | 0.003 | 1.244 |
| 1982 | 2 | 11.462 | 0.010 | 1.827 | 14.505 | 0.036 | 3.752 | 12.221 | 0.008 | 2.285 |
| 1982 | 3 | 7.596 | 0.003 | 1.211 | 7.453 | 0.029 | 1.928 | 7.352 | 0.004 | 1.374 |
| 1982 | 4 | 9.035 | 0.002 | 1.440 | 1.328 | 0.019 | 0.343 | 6.631 | 0.003 | 1.240 |
| 1983 | 1 | 8.573 | 0.002 | 1.366 | 3.264 | 0.025 | 0.844 | 7.105 | 0.003 | 1.328 |
| 1983 | 2 | 5.502 | 0.002 | 0.877 | 6.538 | 0.026 | 1.691 | 5.658 | 0.003 | 1.058 |
| 1983 | 3 | 7.776 | 0.007 | 1.239 | 8.526 | 0.016 | 2.206 | 7.972 | 0.005 | 1.490 |
| 1983 | 4 | 7.681 | 0.004 | 1.224 | 4.921 | 0.016 | 1.273 | 6.885 | 0.003 | 1.287 |
| 1984 | 1 | 6.261 | 0.003 | 0.998 | 2.394 | 0.011 | 0.619 | 5.063 | 0.003 | 0.946 |
| 1984 | 2 | 4.705 | 0.009 | 0.750 | 7.359 | 0.022 | 1.904 | 5.218 | 0.006 | 0.975 |
| 1984 | 3 | 8.476 | 0.004 | 1.351 | 7.184 | 0.018 | 1.858 | 7.836 | 0.004 | 1.465 |
| 1984 | 4 | 7.323 | 0.008 | 1.167 | 2.365 | 0.010 | 0.612 | 5.680 | 0.005 | 1.062 |
| 1985 | 1 | 6.723 | 0.002 | 1.072 | 2.412 | 0.014 | 0.624 | 5.350 | 0.002 | 1.000 |
| 1985 | 2 | 5.921 | 0.012 | 0.944 | 4.472 | 0.010 | 1.157 | 5.382 | 0.006 | 1.006 |
| 1985 | 3 | 7.489 | 0.004 | 1.194 | 4.643 | 0.014 | 1.201 | 6.356 | 0.003 | 1.188 |
| 1985 | 4 | 6.968 | 0.005 | 1.111 | 1.461 | 0.019 | 0.378 | 5.116 | 0.004 | 0.956 |
| 1986 | 1 | 7.566 | 0.001 | 1.206 | 2.304 | 0.008 | 0.596 | 5.962 | 0.001 | 1.114 |
| 1986 | 2 | 6.344 | 0.006 | 1.011 | 2.688 | 0.019 | 0.695 | 5.028 | 0.005 | 0.940 |
| 1986 | 3 | 6.197 | 0.008 | 0.988 | 5.406 | 0.075 | 1.398 | 5.729 | 0.010 | 1.071 |
| 1986 | 4 | 9.269 | 0.002 | 1.477 | 2.079 | 0.026 | 0.538 | 7.049 | 0.003 | 1.318 |
| 1987 | 1 | 10.325 | 0.001 | 1.646 | 2.969 | 0.008 | 0.768 | 8.088 | 0.001 | 1.512 |
| 1987 | 2 | 5.653 | 0.006 | 0.901 | 5.075 | 0.032 | 1.313 | 5.064 | 0.006 | 0.947 |
| 1987 | 3 | 8.298 | 0.027 | 1.323 | 7.372 | 0.031 | 1.907 | 7.835 | 0.015 | 1.465 |
| 1987 | 4 | 9.268 | 0.002 | 1.477 | 2.994 | 0.016 | 0.775 | 7.353 | 0.003 | 1.375 |
| 1988 | 1 | 8.538 | 0.002 | 1.361 | 1.783 | 0.017 | 0.461 | 6.473 | 0.002 | 1.210 |
| 1988 | 2 | 2.344 | 0.004 | 0.374 | 6.816 | 0.024 | 1.763 | 3.291 | 0.004 | 0.615 |
| 1988 | 3 | 6.252 | 0.009 | 0.996 | 4.762 | 0.059 | 1.232 | 5.810 | 0.010 | 1.086 |
| 1988 | 4 | 8.333 | 0.003 | 1.328 | 3.496 | 0.026 | 0.904 | 6.810 | 0.004 | 1.273 |
| 1989 | 1 | 6.834 | 0.002 | 1.089 | 2.044 | 0.017 | 0.529 | 5.332 | 0.003 | 0.997 |
| 1989 | 2 | 5.967 | 0.010 | 0.951 | 4.550 | 0.034 | 1.177 | 5.436 | 0.008 | 1.016 |
| 1989 | 3 | 6.330 | 0.015 | 1.009 | 6.706 | 0.050 | 1.735 | 6.175 | 0.012 | 1.154 |
| 1989 | 4 | 8.920 | 0.004 | 1.422 | 1.993 | 0.022 | 0.516 | 6.882 | 0.004 | 1.286 |
| 1990 | 1 | 7.712 | 0.002 | 1.229 | 1.606 | 0.011 | 0.416 | 5.869 | 0.002 | 1.097 |
| 1990 | 2 | 3.868 | 0.020 | 0.617 | 4.567 | 0.097 | 1.181 | 3.608 | 0.018 | 0.674 |
| 1990 | 3 | 7.263 | 0.012 | 1.158 | 4.828 | 0.009 | 1.249 | 6.436 | 0.006 | 1.203 |
| 1990 | 4 | 6.408 | 0.003 | 1.021 | 1.998 | 0.034 | 0.517 | 4.970 | 0.004 | 0.929 |
| 1991 | 1 | 6.638 | 0.002 | 1.058 | 2.712 | 0.011 | 0.702 | 5.575 | 0.002 | 1.042 |
| 1991 | 2 | 7.033 | 0.014 | 1.121 | 4.378 | 0.016 | 1.133 | 6.250 | 0.008 | 1.168 |
| 1991 | 3 | 7.218 | 0.010 | 1.150 | 5.603 | 0.005 | 1.449 | 6.712 | 0.005 | 1.255 |
| 1991 | 4 | 5.292 | 0.005 | 0.843 | 4.616 | 0.006 | 1.194 | 4.800 | 0.003 | 0.897 |
| 1992 | 1 | 6.200 | 0.004 | 0.988 | 2.057 | 0.014 | 0.532 | 5.011 | 0.003 | 0.937 |
| 1992 | 2 | 3.343 | 0.030 | 0.533 | 4.280 | 0.014 | 1.107 | 3.421 | 0.015 | 0.640 |
| 1992 | 3 | 4.733 | 0.016 | 0.754 | 2.797 | 0.014 | 0.724 | 4.092 | 0.009 | 0.765 |
| 1992 | 4 | 7.368 | 0.004 | 1.174 | 3.324 | 0.013 | 0.860 | 6.168 | 0.003 | 1.153 |
| 1993 | 1 | 7.166 | 0.007 | 1.142 | 3.640 | 0.018 | 0.942 | 5.992 | 0.005 | 1.120 |
| 1993 | 2 | 4.640 | 0.014 | 0.740 | 5.392 | 0.014 | 1.395 | 4.608 | 0.008 | 0.861 |
| 1993 | 3 | 5.891 | 0.008 | 0.939 | 4.163 | 0.005 | 1.077 | 5.212 | 0.004 | 0.974 |
| 1993 | 4 | 5.438 | 0.003 | 0.867 | 5.069 | 0.008 | 1.311 | 5.235 | 0.002 | 0.979 |
| 1994 | 1 | 5.463 | 0.003 | 0.871 | 4.423 | 0.006 | 1.144 | 4.998 | 0.002 | 0.934 |
| 1994 | 2 | 3.847 | 0.018 | 0.613 | 6.052 | 0.005 | 1.566 | 4.142 | 0.009 | 0.774 |
| 1994 | 3 | 6.480 | 0.011 | 1.033 | 6.189 | 0.003 | 1.601 | 6.091 | 0.005 | 1.139 |
| 1994 | 4 | 5.828 | 0.002 | 0.929 | 4.435 | 0.004 | 1.147 | 5.041 | 0.001 | 0.942 |

Appendix Table 2. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2012 expressed in real and relative scale in which the average from 1960 to 2012 is 1.0, with squared standard error of log CPUE (= CV of CPUE).(continued)

| | | Tropical | | | South | | | Whole | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | quarter | CPUE | dev_t | relative | CPUE | dev_t | relative | CPUE | dev_t | relative |
| 1995 | 1 | 6.240 | 0.003 | 0.995 | 3.686 | 0.003 | 0.954 | 5.110 | 0.002 | 0.955 |
| 1995 | 2 | 5.672 | 0.022 | 0.904 | 5.645 | 0.003 | 1.460 | 5.380 | 0.011 | 1.006 |
| 1995 | 3 | 4.658 | 0.008 | 0.742 | 4.604 | 0.002 | 1.191 | 4.267 | 0.004 | 0.798 |
| 1995 | 4 | 5.570 | 0.002 | 0.888 | 2.774 | 0.004 | 0.718 | 4.449 | 0.001 | 0.832 |
| 1996 | 1 | 5.636 | 0.002 | 0.898 | 4.024 | 0.003 | 1.041 | 4.847 | 0.001 | 0.906 |
| 1996 | 2 | 4.631 | 0.008 | 0.738 | 4.996 | 0.003 | 1.292 | 4.398 | 0.004 | 0.822 |
| 1996 | 3 | 6.508 | 0.014 | 1.037 | 4.729 | 0.003 | 1.223 | 5.762 | 0.007 | 1.077 |
| 1996 | 4 | 5.368 | 0.001 | 0.856 | 2.467 | 0.003 | 0.638 | 4.329 | 0.001 | 0.809 |
| 1997 | 1 | 4.785 | 0.001 | 0.763 | 2.975 | 0.012 | 0.770 | 4.069 | 0.002 | 0.761 |
| 1997 | 2 | 4.862 | 0.007 | 0.775 | 4.505 | 0.005 | 1.166 | 4.376 | 0.004 | 0.818 |
| 1997 | 3 | 3.570 | 0.003 | 0.569 | 4.082 | 0.002 | 1.056 | 3.473 | 0.002 | 0.649 |
| 1997 | 4 | 4.591 | 0.001 | 0.732 | 3.658 | 0.003 | 0.946 | 4.066 | 0.001 | 0.760 |
| 1998 | 1 | 5.046 | 0.001 | 0.804 | 5.212 | 0.016 | 1.348 | 4.829 | 0.002 | 0.903 |
| 1998 | 2 | 3.925 | 0.005 | 0.626 | 4.226 | 0.007 | 1.093 | 3.666 | 0.003 | 0.685 |
| 1998 | 3 | 4.970 | 0.004 | 0.792 | 4.940 | 0.007 | 1.278 | 4.719 | 0.002 | 0.882 |
| 1998 | 4 | 4.784 | 0.002 | 0.762 | 4.360 | 0.005 | 1.128 | 4.510 | 0.001 | 0.843 |
| 1999 | 1 | 5.343 | 0.001 | 0.852 | 5.109 | 0.010 | 1.322 | 5.012 | 0.002 | 0.937 |
| 1999 | 2 | 5.980 | 0.004 | 0.953 | 4.799 | 0.006 | 1.241 | 5.256 | 0.003 | 0.983 |
| 1999 | 3 | 4.452 | 0.003 | 0.710 | 4.434 | 0.005 | 1.147 | 4.215 | 0.002 | 0.788 |
| 1999 | 4 | 4.265 | 0.002 | 0.680 | 2.596 | 0.008 | 0.671 | 3.600 | 0.002 | 0.673 |
| 2000 | 1 | 4.509 | 0.001 | 0.719 | 4.978 | 0.007 | 1.288 | 4.436 | 0.001 | 0.829 |
| 2000 | 2 | 4.168 | 0.002 | 0.664 | 4.593 | 0.005 | 1.188 | 4.026 | 0.001 | 0.753 |
| 2000 | 3 | 3.400 | 0.006 | 0.542 | 4.980 | 0.003 | 1.288 | 3.700 | 0.003 | 0.692 |
| 2000 | 4 | 4.294 | 0.002 | 0.684 | 2.962 | 0.006 | 0.766 | 3.691 | 0.002 | 0.690 |
| 2001 | 1 | 3.855 | 0.002 | 0.614 | 3.504 | 0.005 | 0.906 | 3.631 | 0.001 | 0.679 |
| 2001 | 2 | 5.057 | 0.002 | 0.806 | 3.634 | 0.005 | 0.940 | 4.391 | 0.002 | 0.821 |
| 2001 | 3 | 4.599 | 0.004 | 0.733 | 3.286 | 0.003 | 0.850 | 3.821 | 0.002 | 0.714 |
| 2001 | 4 | 3.689 | 0.003 | 0.588 | 2.489 | 0.003 | 0.644 | 3.080 | 0.002 | 0.576 |
| 2002 | 1 | 4.249 | 0.002 | 0.677 | 4.395 | 0.004 | 1.137 | 4.128 | 0.001 | 0.772 |
| 2002 | 2 | 3.669 | 0.003 | 0.585 | 3.544 | 0.007 | 0.917 | 3.417 | 0.002 | 0.639 |
| 2002 | 3 | 2.590 | 0.002 | 0.413 | 2.453 | 0.003 | 0.635 | 2.401 | 0.001 | 0.449 |
| 2002 | 4 | 3.052 | 0.001 | 0.486 | 2.525 | 0.005 | 0.653 | 2.801 | 0.001 | 0.524 |
| 2003 | 1 | 3.833 | 0.002 | 0.611 | 3.200 | 0.023 | 0.828 | 3.584 | 0.003 | 0.670 |
| 2003 | 2 | 4.246 | 0.008 | 0.677 | 1.887 | 0.012 | 0.488 | 3.261 | 0.005 | 0.610 |
| 2003 | 3 | 2.504 | 0.014 | 0.399 | 2.668 | 0.005 | 0.690 | 2.435 | 0.007 | 0.455 |
| 2003 | 4 | 4.253 | 0.005 | 0.678 | 3.726 | 0.011 | 0.964 | 4.082 | 0.003 | 0.763 |
| 2004 | 1 | 4.358 | 0.002 | 0.695 | 6.950 | 0.019 | 1.798 | 5.018 | 0.003 | 0.938 |
| 2004 | 2 | 3.622 | 0.005 | 0.577 | 2.609 | 0.019 | 0.675 | 3.240 | 0.004 | 0.606 |
| 2004 | 3 | 3.367 | 0.003 | 0.537 | 3.124 | 0.006 | 0.808 | 3.214 | 0.002 | 0.601 |
| 2004 | 4 | 5.651 | 0.009 | 0.901 | 3.130 | 0.008 | 0.810 | 4.643 | 0.005 | 0.868 |
| 2005 | 1 | 5.336 | 0.003 | 0.850 | 2.574 | 0.011 | 0.666 | 4.272 | 0.002 | 0.799 |
| 2005 | 2 | 4.863 | 0.009 | 0.775 | 2.020 | 0.041 | 0.522 | 3.764 | 0.008 | 0.704 |
| 2005 | 3 | 5.371 | 0.013 | 0.856 | 2.484 | 0.012 | 0.643 | 4.137 | 0.007 | 0.773 |
| 2005 | 4 | 3.922 | 0.005 | 0.625 | 1.126 | 0.006 | 0.291 | 2.825 | 0.003 | 0.528 |
| 2006 | 1 | 3.798 | 0.002 | 0.605 | 1.107 | 0.007 | 0.286 | 2.784 | 0.002 | 0.520 |
| 2006 | 2 | 3.672 | 0.004 | 0.585 | 1.294 | 0.020 | 0.335 | 2.729 | 0.004 | 0.510 |
| 2006 | 3 | 4.116 | 0.004 | 0.656 | 3.888 | 0.007 | 1.006 | 3.855 | 0.003 | 0.721 |
| 2006 | 4 | 5.279 | 0.001 | 0.841 | 1.443 | 0.019 | 0.373 | 3.859 | 0.002 | 0.721 |
| 2007 | 1 | 4.164 | 0.001 | 0.664 | 0.643 | 0.026 | 0.166 | 2.854 | 0.003 | 0.534 |
| 2007 | 2 | 4.003 | 0.002 | 0.638 | 3.032 | 0.007 | 0.784 | 3.444 | 0.002 | 0.644 |
| 2007 | 3 | 5.136 | 0.004 | 0.819 | 2.205 | 0.005 | 0.570 | 3.801 | 0.002 | 0.711 |
| 2007 | 4 | 5.812 | 0.003 | 0.926 | 1.269 | 0.019 | 0.328 | 4.142 | 0.003 | 0.774 |
| 2008 | 1 | 3.932 | 0.001 | 0.627 | 1.895 | 0.015 | 0.490 | 3.092 | 0.002 | 0.578 |
| 2008 | 2 | 2.844 | 0.005 | 0.453 | 1.225 | 0.004 | 0.317 | 2.091 | 0.003 | 0.391 |
| 2008 | 3 | 4.015 | 0.006 | 0.640 | 1.511 | 0.005 | 0.391 | 3.041 | 0.003 | 0.568 |
| 2008 | 4 | 5.022 | 0.002 | 0.800 | 1.905 | 0.020 | 0.493 | 3.845 | 0.003 | 0.719 |
| 2009 | 1 | 3.245 | 0.001 | 0.517 | 2.334 | 0.026 | 0.604 | 2.809 | 0.003 | 0.525 |
| 2009 | 2 | 3.502 | 0.003 | 0.558 | 1.750 | 0.007 | 0.453 | 2.710 | 0.002 | 0.507 |
| 2009 | 3 | 3.675 | 0.007 | 0.586 | 1.829 | 0.004 | 0.473 | 2.875 | 0.004 | 0.537 |
| 2009 | 4 | 2.708 | 0.008 | 0.432 | 1.171 | 0.025 | 0.303 | 2.178 | 0.006 | 0.407 |
| 2010 | 1 | 3.264 | 0.002 | 0.520 | 1.492 | 0.013 | 0.386 | 2.439 | 0.002 | 0.456 |
| 2010 | 2 | 5.197 | 0.044 | 0.828 | 1.439 | 0.005 | 0.372 | 3.367 | 0.020 | 0.629 |
| 2010 | 3 | 2.652 | 0.009 | 0.423 | 2.570 | 0.005 | 0.665 | 2.601 | 0.005 | 0.486 |
| 2010 | 4 | 3.925 | 0.013 | 0.626 | 6.564 | 0.031 | 1.698 | 4.689 | 0.009 | 0.877 |
| 2011 | 1 | 5.097 | 0.007 | 0.812 | 2.533 | 0.043 | 0.655 | 3.855 | 0.009 | 0.721 |
| 2011 | 2 | 1.630 | 0.043 | 0.260 | 3.054 | 0.008 | 0.790 | 2.104 | 0.016 | 0.393 |
| 2011 | 3 | 3.827 | 0.027 | 0.610 | 3.802 | 0.009 | 0.984 | 4.008 | 0.010 | 0.749 |
| 2011 | 4 | 5.866 | 0.005 | 0.935 | 3.017 | 0.050 | 0.780 | 4.623 | 0.009 | 0.864 |
| 2012 | 1 | 3.437 | 0.004 | 0.548 | 0.858 | 0.048 | 0.222 | 2.487 | 0.006 | 0.465 |
| 2012 | 2 | 4.396 | 0.024 | 0.701 | 3.028 | 0.007 | 0.783 | 3.366 | 0.012 | 0.629 |
| 2012 | 3 | 6.875 | 0.028 | 1.096 | 4.369 | 0.011 | 1.130 | 5.600 | 0.014 | 1.047 |
| 2012 | 4 | 7.194 | 0.006 | 1.147 | 0.473 | 0.003 | 0.122 | 4.763 | 0.003 | 0.890 |

Appendix Table 3. Quarterly value of area specific standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2012 expressed in real and relative scale in which the average from 1960 to 2012 is 1.0, with squared standard error of log CPUE (= CV of CPUE).

| | | East | | | West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | quarter | CPUE | dev_t | relative | CPUE | dev_t | relative | CPUE | dev_t | relative |
| 1960 | 1 | 8.681 | 0.006 | 1.273 | 6.918 | 0.007 | 1.258 | 1.597 | 0.018 | 0.468 |
| 1960 | 2 | 10.454 | 0.006 | 1.533 | 7.229 | 0.007 | 1.314 | 2.286 | 0.055 | 0.670 |
| 1960 | 3 | 10.358 | 0.010 | 1.519 | 9.409 | 0.011 | 1.710 | 3.812 | 0.030 | 1.117 |
| 1960 | 4 | 9.239 | 0.008 | 1.355 | 8.952 | 0.007 | 1.627 | 2.088 | 0.013 | 0.612 |
| 1961 | 1 | 7.655 | 0.008 | 1.122 | 5.287 | 0.007 | 0.961 | 1.037 | 0.016 | 0.304 |
| 1961 | 2 | 11.104 | 0.010 | 1.628 | 6.056 | 0.008 | 1.101 | 2.239 | 0.056 | 0.656 |
| 1961 | 3 | 11.792 | 0.012 | 1.729 | 5.601 | 0.011 | 1.018 | 3.972 | 0.021 | 1.164 |
| 1961 | 4 | 8.774 | 0.007 | 1.287 | 5.944 | 0.008 | 1.081 | 1.699 | 0.010 | 0.498 |
| 1962 | 1 | 8.957 | 0.006 | 1.313 | 6.619 | 0.006 | 1.203 | 1.738 | 0.010 | 0.509 |
| 1962 | 2 | 8.189 | 0.007 | 1.201 | 6.992 | 0.005 | 1.271 | 4.111 | 0.016 | 1.205 |
| 1962 | 3 | 12.917 | 0.006 | 1.894 | 6.292 | 0.011 | 1.144 | 2.498 | 0.010 | 0.732 |
| 1962 | 4 | 9.959 | 0.005 | 1.460 | 7.175 | 0.004 | 1.304 | 2.518 | 0.009 | 0.738 |
| 1963 | 1 | 9.592 | 0.005 | 1.406 | 5.241 | 0.005 | 0.953 | 1.687 | 0.008 | 0.494 |
| 1963 | 2 | 7.769 | 0.007 | 1.139 | 6.582 | 0.006 | 1.196 | 3.639 | 0.022 | 1.067 |
| 1963 | 3 | 10.357 | 0.007 | 1.519 | 6.135 | 0.023 | 1.115 | 3.557 | 0.011 | 1.043 |
| 1963 | 4 | 7.291 | 0.006 | 1.069 | 7.421 | 0.006 | 1.349 | 1.658 | 0.009 | 0.486 |
| 1964 | 1 | 9.791 | 0.007 | 1.436 | 5.495 | 0.005 | 0.999 | 1.303 | 0.009 | 0.382 |
| 1964 | 2 | 9.133 | 0.006 | 1.339 | 7.091 | 0.003 | 1.289 | 3.122 | 0.014 | 0.915 |
| 1964 | 3 | 10.164 | 0.005 | 1.490 | 4.557 | 0.008 | 0.828 | 3.217 | 0.009 | 0.943 |
| 1964 | 4 | 7.748 | 0.005 | 1.136 | 6.122 | 0.004 | 1.113 | 2.131 | 0.008 | 0.625 |
| 1965 | 1 | 8.780 | 0.005 | 1.287 | 4.653 | 0.003 | 0.846 | 1.303 | 0.010 | 0.382 |
| 1965 | 2 | 7.317 | 0.005 | 1.073 | 5.089 | 0.003 | 0.925 | 2.151 | 0.018 | 0.630 |
| 1965 | 3 | 7.604 | 0.005 | 1.115 | 5.509 | 0.005 | 1.001 | 2.952 | 0.008 | 0.865 |
| 1965 | 4 | 7.642 | 0.005 | 1.121 | 5.828 | 0.004 | 1.059 | 2.067 | 0.009 | 0.606 |
| 1966 | 1 | 9.086 | 0.005 | 1.332 | 6.404 | 0.003 | 1.164 | 1.590 | 0.011 | 0.466 |
| 1966 | 2 | 7.800 | 0.006 | 1.144 | 5.764 | 0.003 | 1.048 | 2.419 | 0.014 | 0.709 |
| 1966 | 3 | 10.046 | 0.005 | 1.473 | 6.363 | 0.004 | 1.157 | 3.670 | 0.012 | 1.076 |
| 1966 | 4 | 7.730 | 0.005 | 1.133 | 7.262 | 0.003 | 1.320 | 1.738 | 0.008 | 0.509 |
| 1967 | 1 | 9.181 | 0.005 | 1.346 | 4.497 | 0.003 | 0.817 | 1.776 | 0.007 | 0.521 |
| 1967 | 2 | 8.533 | 0.005 | 1.251 | 3.766 | 0.003 | 0.685 | 4.732 | 0.006 | 1.387 |
| 1967 | 3 | 9.003 | 0.005 | 1.320 | 5.240 | 0.005 | 0.952 | 4.404 | 0.007 | 1.291 |
| 1967 | 4 | 7.437 | 0.006 | 1.091 | 5.213 | 0.004 | 0.948 | 1.955 | 0.008 | 0.573 |
| 1968 | 1 | 6.893 | 0.005 | 1.011 | 6.038 | 0.004 | 1.097 | 2.910 | 0.010 | 0.853 |
| 1968 | 2 | 6.621 | 0.006 | 0.971 | 7.556 | 0.004 | 1.374 | 5.295 | 0.008 | 1.552 |
| 1968 | 3 | 9.679 | 0.005 | 1.419 | 11.756 | 0.005 | 2.137 | 3.839 | 0.007 | 1.125 |
| 1968 | 4 | 7.530 | 0.005 | 1.104 | 7.489 | 0.004 | 1.361 | 1.695 | 0.008 | 0.497 |
| 1969 | 1 | 7.647 | 0.006 | 1.121 | 6.427 | 0.003 | 1.168 | 2.375 | 0.008 | 0.696 |
| 1969 | 2 | 8.264 | 0.005 | 1.212 | 4.689 | 0.004 | 0.852 | 2.805 | 0.008 | 0.822 |
| 1969 | 3 | 9.161 | 0.007 | 1.343 | 6.873 | 0.005 | 1.249 | 5.116 | 0.008 | 1.499 |
| 1969 | 4 | 7.021 | 0.006 | 1.029 | 5.699 | 0.004 | 1.036 | 5.095 | 0.013 | 1.493 |
| 1970 | 1 | 8.611 | 0.006 | 1.263 | 6.106 | 0.004 | 1.110 | 4.623 | 0.030 | 1.355 |
| 1970 | 2 | 7.266 | 0.007 | 1.065 | 4.869 | 0.006 | 0.885 | 8.866 | 0.009 | 2.599 |
| 1970 | 3 | 8.967 | 0.005 | 1.315 | 7.242 | 0.019 | 1.316 | 9.281 | 0.008 | 2.720 |
| 1970 | 4 | 5.547 | 0.005 | 0.813 | 5.300 | 0.005 | 0.963 | 2.769 | 0.007 | 0.812 |
| 1971 | 1 | 5.189 | 0.005 | 0.761 | 3.563 | 0.004 | 0.648 | 4.151 | 0.010 | 1.217 |
| 1971 | 2 | 6.189 | 0.005 | 0.907 | 4.825 | 0.005 | 0.877 | 6.884 | 0.008 | 2.018 |
| 1971 | 3 | 5.973 | 0.006 | 0.876 | 9.349 | 0.007 | 1.699 | 4.290 | 0.008 | 1.257 |
| 1971 | 4 | 6.181 | 0.011 | 0.906 | 6.906 | 0.005 | 1.255 | 2.526 | 0.013 | 0.740 |
| 1972 | 1 | 7.706 | 0.010 | 1.130 | 5.993 | 0.005 | 1.089 | 2.447 | 0.050 | 0.717 |
| 1972 | 2 | 8.361 | 0.008 | 1.226 | 5.447 | 0.006 | 0.990 | 6.719 | 0.018 | 1.969 |
| 1972 | 3 | 6.672 | 0.013 | 0.978 | 4.798 | 0.005 | 0.872 | 7.653 | 0.017 | 2.243 |
| 1972 | 4 | 5.486 | 0.029 | 0.804 | 7.363 | 0.006 | 1.338 | 3.386 | 0.021 | 0.992 |
| 1973 | 1 | 7.729 | 0.010 | 1.133 | 6.899 | 0.007 | 1.254 | 4.186 | 0.110 | 1.227 |
| 1973 | 2 | 4.413 | 0.013 | 0.647 | 9.691 | 0.010 | 1.762 | 5.089 | 0.022 | 1.492 |
| 1973 | 3 | 7.915 | 0.008 | 1.161 | 4.566 | 0.007 | 0.830 | 6.053 | 0.013 | 1.774 |
| 1973 | 4 | 6.519 | 0.007 | 0.956 | 5.290 | 0.008 | 0.962 | 2.857 | 0.010 | 0.837 |
| 1974 | 1 | 6.759 | 0.006 | 0.991 | 5.858 | 0.008 | 1.065 | 3.620 | 0.013 | 1.061 |
| 1974 | 2 | 6.874 | 0.007 | 1.008 | 5.934 | 0.010 | 1.079 | 5.162 | 0.011 | 1.513 |
| 1974 | 3 | 7.087 | 0.006 | 1.039 | 6.566 | 0.007 | 1.193 | 3.943 | 0.010 | 1.156 |
| 1974 | 4 | 7.133 | 0.006 | 1.046 | 5.506 | 0.008 | 1.001 | 1.452 | 0.012 | 0.426 |
| 1975 | 1 | 6.796 | 0.005 | 0.997 | 5.728 | 0.009 | 1.041 | 2.295 | 0.025 | 0.673 |
| 1975 | 2 | 10.197 | 0.005 | 1.495 | 4.066 | 0.011 | 0.739 | 4.233 | 0.011 | 1.241 |
| 1975 | 3 | 5.588 | 0.006 | 0.819 | 4.398 | 0.006 | 0.799 | 4.620 | 0.010 | 1.354 |
| 1975 | 4 | 5.294 | 0.009 | 0.776 | 4.308 | 0.007 | 0.783 | 1.394 | 0.021 | 0.409 |
| 1976 | 1 | 6.176 | 0.010 | 0.906 | 3.466 | 0.007 | 0.630 | 1.859 | 0.030 | 0.545 |
| 1976 | 2 | 12.801 | 0.008 | 1.877 | 5.305 | 0.013 | 0.964 | 2.908 | 0.040 | 0.852 |
| 1976 | 3 | 12.648 | 0.012 | 1.855 | 5.881 | 0.023 | 1.069 | 4.008 | 0.025 | 1.175 |
| 1976 | 4 | 8.330 | 0.018 | 1.221 | 4.449 | 0.034 | 0.809 | 1.969 | 0.273 | 0.577 |
| 1977 | 1 | 8.405 | 0.013 | 1.232 | 12.135 | 0.018 | 2.206 | 3.064 | 0.079 | 0.898 |
| 1977 | 2 | 19.755 | 0.010 | 2.897 | 9.545 | 0.028 | 1.735 | 10.625 | 0.046 | 3.114 |
| 1977 | 3 | 16.691 | 0.007 | 2.447 | 12.220 | 0.022 | 2.221 | 9.207 | 0.051 | 2.699 |
| 1977 | 4 | 11.605 | 0.010 | 1.702 | 10.922 | 0.007 | 1.985 | 4.070 | 0.035 | 1.193 |

Appendix Table 3. Quarterly value of area specific standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2012 expressed in real and relative scale in which the average from 1960 to 2012 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (continued)

| | | East | | | West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | quarter | CPUE | dev_t | relative | CPUE | dev_t | relative | CPUE | dev_t | relative |
| 1978 | 1 | 14.170 | 0.007 | 2.078 | 11.086 | 0.004 | 2.015 | 8.051 | 0.028 | 2.360 |
| 1978 | 2 | 18.466 | 0.007 | 2.708 | 9.008 | 0.004 | 1.637 | 4.859 | 0.022 | 1.424 |
| 1978 | 3 | 12.611 | 0.004 | 1.849 | 7.247 | 0.011 | 1.317 | 6.474 | 0.018 | 1.897 |
| 1978 | 4 | 11.533 | 0.006 | 1.691 | 8.663 | 0.009 | 1.575 | 3.328 | 0.027 | 0.975 |
| 1979 | 1 | 11.721 | 0.007 | 1.719 | 5.678 | 0.007 | 1.032 | 3.492 | 0.018 | 1.023 |
| 1979 | 2 | 10.390 | 0.013 | 1.524 | 8.164 | 0.012 | 1.484 | 6.750 | 0.018 | 1.978 |
| 1979 | 3 | 10.019 | 0.011 | 1.469 | 4.195 | 0.011 | 0.763 | 6.749 | 0.021 | 1.978 |
| 1979 | 4 | 11.662 | 0.005 | 1.710 | 7.697 | 0.033 | 1.399 | 2.165 | 0.025 | 0.635 |
| 1980 | 1 | 10.211 | 0.006 | 1.497 | 3.747 | 0.011 | 0.681 | 3.728 | 0.016 | 1.093 |
| 1980 | 2 | 13.364 | 0.009 | 1.960 | 8.591 | 0.010 | 1.562 | 5.755 | 0.033 | 1.687 |
| 1980 | 3 | 6.611 | 0.007 | 0.969 | 4.659 | 0.028 | 0.847 | 6.296 | 0.027 | 1.846 |
| 1980 | 4 | 9.473 | 0.009 | 1.389 | 8.144 | 0.005 | 1.480 | 4.638 | 0.014 | 1.360 |
| 1981 | 1 | 6.178 | 0.008 | 0.906 | 5.787 | 0.004 | 1.052 | 3.219 | 0.011 | 0.943 |
| 1981 | 2 | 6.186 | 0.012 | 0.907 | 11.965 | 0.010 | 2.175 | 5.496 | 0.024 | 1.611 |
| 1981 | 3 | 6.922 | 0.023 | 1.015 | 7.057 | 0.007 | 1.283 | 5.622 | 0.014 | 1.648 |
| 1981 | 4 | 7.790 | 0.007 | 1.142 | 7.945 | 0.004 | 1.444 | 3.306 | 0.012 | 0.969 |
| 1982 | 1 | 9.372 | 0.008 | 1.374 | 5.484 | 0.003 | 0.997 | 3.703 | 0.011 | 1.085 |
| 1982 | 2 | 9.887 | 0.012 | 1.450 | 13.456 | 0.007 | 2.446 | 7.210 | 0.028 | 2.113 |
| 1982 | 3 | 6.533 | 0.008 | 0.958 | 6.703 | 0.006 | 1.218 | 5.482 | 0.030 | 1.607 |
| 1982 | 4 | 8.649 | 0.006 | 1.268 | 7.795 | 0.003 | 1.417 | 1.842 | 0.037 | 0.540 |
| 1983 | 1 | 8.880 | 0.005 | 1.302 | 6.490 | 0.002 | 1.180 | 3.134 | 0.025 | 0.918 |
| 1983 | 2 | 7.602 | 0.015 | 1.115 | 10.399 | 0.005 | 1.890 | 5.082 | 0.026 | 1.490 |
| 1983 | 3 | 8.458 | 0.005 | 1.240 | 5.439 | 0.007 | 0.989 | 7.607 | 0.016 | 2.230 |
| 1983 | 4 | 10.423 | 0.006 | 1.528 | 5.828 | 0.005 | 1.059 | 4.558 | 0.016 | 1.336 |
| 1984 | 1 | 6.251 | 0.006 | 0.917 | 4.845 | 0.004 | 0.881 | 2.679 | 0.011 | 0.785 |
| 1984 | 2 | 4.857 | 0.009 | 0.712 | 7.705 | 0.006 | 1.401 | 4.889 | 0.014 | 1.433 |
| 1984 | 3 | 7.553 | 0.006 | 1.108 | 7.367 | 0.008 | 1.339 | 7.250 | 0.016 | 2.125 |
| 1984 | 4 | 7.027 | 0.007 | 1.030 | 6.829 | 0.007 | 1.241 | 2.503 | 0.010 | 0.734 |
| 1985 | 1 | 6.689 | 0.005 | 0.981 | 5.354 | 0.004 | 0.973 | 2.615 | 0.014 | 0.766 |
| 1985 | 2 | 5.082 | 0.008 | 0.745 | 7.567 | 0.006 | 1.376 | 3.909 | 0.010 | 1.146 |
| 1985 | 3 | 5.034 | 0.006 | 0.738 | 7.307 | 0.005 | 1.328 | 4.690 | 0.012 | 1.375 |
| 1985 | 4 | 6.321 | 0.010 | 0.927 | 7.323 | 0.004 | 1.331 | 1.552 | 0.020 | 0.455 |
| 1986 | 1 | 7.222 | 0.004 | 1.059 | 6.132 | 0.002 | 1.115 | 2.324 | 0.008 | 0.681 |
| 1986 | 2 | 4.411 | 0.019 | 0.647 | 8.182 | 0.004 | 1.487 | 2.435 | 0.019 | 0.714 |
| 1986 | 3 | 5.705 | 0.009 | 0.837 | 6.431 | 0.007 | 1.169 | 7.789 | 0.037 | 2.283 |
| 1986 | 4 | 8.895 | 0.007 | 1.304 | 7.391 | 0.003 | 1.343 | 2.677 | 0.050 | 0.785 |
| 1987 | 1 | 9.165 | 0.004 | 1.344 | 8.501 | 0.003 | 1.545 | 2.758 | 0.008 | 0.808 |
| 1987 | 2 | 3.719 | 0.061 | 0.545 | 7.747 | 0.005 | 1.408 | 4.467 | 0.033 | 1.309 |
| 1987 | 3 | 8.545 | 0.028 | 1.253 | 4.142 | 0.013 | 0.753 | 7.490 | 0.022 | 2.195 |
| 1987 | 4 | 9.211 | 0.006 | 1.351 | 8.492 | 0.004 | 1.544 | 2.772 | 0.016 | 0.812 |
| 1988 | 1 | 8.382 | 0.006 | 1.229 | 7.178 | 0.003 | 1.305 | 1.892 | 0.015 | 0.555 |
| 1988 | 2 | 3.260 | 0.100 | 0.478 | 6.576 | 0.006 | 1.195 | 7.005 | 0.021 | 2.053 |
| 1988 | 3 | 6.614 | 0.015 | 0.970 | 4.069 | 0.009 | 0.740 | 5.002 | 0.018 | 1.466 |
| 1988 | 4 | 7.561 | 0.006 | 1.109 | 6.559 | 0.004 | 1.192 | 2.772 | 0.025 | 0.812 |
| 1989 | 1 | 7.224 | 0.007 | 1.059 | 5.216 | 0.003 | 0.948 | 2.040 | 0.017 | 0.598 |
| 1989 | 2 | 5.932 | 0.023 | 0.870 | 6.524 | 0.006 | 1.186 | 5.742 | 0.022 | 1.683 |
| 1989 | 3 | 5.663 | 0.013 | 0.830 | 4.526 | 0.025 | 0.823 | 8.297 | 0.025 | 2.432 |
| 1989 | 4 | 9.035 | 0.010 | 1.325 | 6.738 | 0.007 | 1.225 | 1.561 | 0.022 | 0.457 |
| 1990 | 1 | 7.364 | 0.005 | 1.080 | 6.617 | 0.004 | 1.203 | 1.489 | 0.010 | 0.436 |
| 1990 | 2 | 3.211 | 0.295 | 0.471 | 5.666 | 0.007 | 1.030 | 5.355 | 0.033 | 1.569 |
| 1990 | 3 | 6.527 | 0.018 | 0.957 | 5.718 | 0.014 | 1.039 | 4.667 | 0.007 | 1.368 |
| 1990 | 4 | 5.591 | 0.006 | 0.820 | 5.728 | 0.006 | 1.041 | 1.758 | 0.022 | 0.515 |
| 1991 | 1 | 6.620 | 0.005 | 0.971 | 4.316 | 0.004 | 0.785 | 2.247 | 0.010 | 0.659 |
| 1991 | 2 | 9.169 | 0.031 | 1.344 | 5.878 | 0.013 | 1.068 | 4.273 | 0.012 | 1.252 |
| 1991 | 3 | 8.597 | 0.044 | 1.261 | 5.059 | 0.012 | 0.920 | 5.244 | 0.004 | 1.537 |
| 1991 | 4 | 3.507 | 0.009 | 0.514 | 5.586 | 0.009 | 1.015 | 3.624 | 0.005 | 1.062 |
| 1992 | 1 | 5.976 | 0.010 | 0.876 | 4.317 | 0.007 | 0.785 | 2.050 | 0.008 | 0.601 |
| 1992 | 2 | 0.847 | 0.294 | 0.124 | 5.488 | 0.009 | 0.998 | 3.645 | 0.008 | 1.068 |
| 1992 | 3 | 3.859 | 0.051 | 0.566 | 4.579 | 0.028 | 0.832 | 3.358 | 0.006 | 0.984 |
| 1992 | 4 | 7.005 | 0.014 | 1.027 | 5.006 | 0.007 | 0.910 | 2.946 | 0.011 | 0.863 |
| 1993 | 1 | 8.020 | 0.007 | 1.176 | 4.481 | 0.008 | 0.815 | 2.619 | 0.011 | 0.768 |
| 1993 | 2 | 4.461 | 0.038 | 0.654 | 5.215 | 0.007 | 0.948 | 3.646 | 0.008 | 1.069 |
| 1993 | 3 | 5.862 | 0.014 | 0.860 | 4.553 | 0.011 | 0.828 | 3.812 | 0.005 | 1.117 |
| 1993 | 4 | 6.677 | 0.012 | 0.979 | 3.403 | 0.004 | 0.619 | 4.250 | 0.007 | 1.246 |
| 1994 | 1 | 7.002 | 0.006 | 1.027 | 2.529 | 0.004 | 0.460 | 2.897 | 0.004 | 0.849 |
| 1994 | 2 | 3.767 | 0.148 | 0.552 | 4.751 | 0.005 | 0.864 | 4.863 | 0.003 | 1.425 |
| 1994 | 3 | 9.008 | 0.023 | 1.321 | 4.121 | 0.014 | 0.749 | 5.408 | 0.003 | 1.585 |
| 1994 | 4 | 6.339 | 0.008 | 0.930 | 4.184 | 0.003 | 0.760 | 3.681 | 0.003 | 1.079 |

Appendix Table 3. Quarterly value of area specific standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2012 expressed in real and relative scale in which the average from 1960 to 2012 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (continued)

| | | East | | | West | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | quarter | CPUE | dev_t | relative | CPUE | dev_t | relative | CPUE | dev_t | relative |
| 1995 | 1 | 5.894 | 0.005 | 0.864 | 5.134 | 0.005 | 0.933 | 3.130 | 0.003 | 0.917 |
| 1995 | 2 | 5.201 | 0.020 | 0.763 | 6.342 | 0.010 | 1.153 | 4.499 | 0.003 | 1.319 |
| 1995 | 3 | 3.898 | 0.011 | 0.572 | 4.283 | 0.014 | 0.779 | 4.026 | 0.002 | 1.180 |
| 1995 | 4 | 5.386 | 0.005 | 0.790 | 4.450 | 0.003 | 0.809 | 2.298 | 0.003 | 0.674 |
| 1996 | 1 | 5.719 | 0.005 | 0.839 | 3.270 | 0.003 | 0.594 | 3.024 | 0.003 | 0.886 |
| 1996 | 2 | 4.253 | 0.020 | 0.624 | 5.359 | 0.005 | 0.974 | 3.695 | 0.002 | 1.083 |
| 1996 | 3 | 6.481 | 0.026 | 0.950 | 5.179 | 0.005 | 0.941 | 4.291 | 0.002 | 1.258 |
| 1996 | 4 | 6.033 | 0.005 | 0.885 | 3.869 | 0.002 | 0.703 | 2.222 | 0.003 | 0.651 |
| 1997 | 1 | 4.809 | 0.003 | 0.705 | 2.736 | 0.002 | 0.497 | 2.264 | 0.003 | 0.664 |
| 1997 | 2 | 3.975 | 0.034 | 0.583 | 5.340 | 0.003 | 0.971 | 3.412 | 0.003 | 1.000 |
| 1997 | 3 | 3.986 | 0.010 | 0.585 | 3.017 | 0.004 | 0.548 | 3.451 | 0.003 | 1.012 |
| 1997 | 4 | 5.830 | 0.004 | 0.855 | 3.172 | 0.002 | 0.577 | 2.862 | 0.003 | 0.839 |
| 1998 | 1 | 4.657 | 0.004 | 0.683 | 3.986 | 0.001 | 0.725 | 2.436 | 0.004 | 0.714 |
| 1998 | 2 | 2.186 | 0.014 | 0.321 | 4.213 | 0.002 | 0.766 | 3.281 | 0.004 | 0.962 |
| 1998 | 3 | 4.584 | 0.013 | 0.672 | 3.515 | 0.004 | 0.639 | 4.045 | 0.004 | 1.186 |
| 1998 | 4 | 6.010 | 0.005 | 0.881 | 2.856 | 0.003 | 0.519 | 2.185 | 0.004 | 0.640 |
| 1999 | 1 | 6.076 | 0.004 | 0.891 | 2.626 | 0.003 | 0.477 | 2.246 | 0.004 | 0.658 |
| 1999 | 2 | 5.002 | 0.011 | 0.733 | 4.704 | 0.007 | 0.855 | 3.222 | 0.004 | 0.945 |
| 1999 | 3 | 4.454 | 0.005 | 0.653 | 3.693 | 0.006 | 0.671 | 3.766 | 0.004 | 1.104 |
| 1999 | 4 | 4.393 | 0.004 | 0.644 | 3.376 | 0.002 | 0.614 | 1.868 | 0.005 | 0.548 |
| 2000 | 1 | 4.733 | 0.004 | 0.694 | 2.626 | 0.002 | 0.477 | 2.880 | 0.005 | 0.844 |
| 2000 | 2 | 3.862 | 0.004 | 0.566 | 3.567 | 0.004 | 0.648 | 3.294 | 0.004 | 0.966 |
| 2000 | 3 | 2.917 | 0.007 | 0.428 | 3.357 | 0.005 | 0.610 | 3.606 | 0.004 | 1.057 |
| 2000 | 4 | 4.231 | 0.007 | 0.620 | 3.397 | 0.003 | 0.617 | 2.393 | 0.005 | 0.701 |
| 2001 | 1 | 4.749 | 0.004 | 0.696 | 2.505 | 0.003 | 0.455 | 2.138 | 0.004 | 0.627 |
| 2001 | 2 | 5.355 | 0.006 | 0.785 | 3.154 | 0.004 | 0.573 | 2.667 | 0.005 | 0.782 |
| 2001 | 3 | 3.668 | 0.006 | 0.538 | 4.169 | 0.005 | 0.758 | 2.682 | 0.003 | 0.786 |
| 2001 | 4 | 3.452 | 0.006 | 0.506 | 2.970 | 0.004 | 0.540 | 2.115 | 0.004 | 0.620 |
| 2002 | 1 | 4.343 | 0.006 | 0.637 | 2.769 | 0.002 | 0.503 | 2.663 | 0.004 | 0.781 |
| 2002 | 2 | 3.221 | 0.010 | 0.472 | 3.378 | 0.003 | 0.614 | 2.414 | 0.006 | 0.707 |
| 2002 | 3 | 2.616 | 0.007 | 0.384 | 2.092 | 0.003 | 0.380 | 2.208 | 0.003 | 0.647 |
| 2002 | 4 | 3.821 | 0.003 | 0.560 | 2.050 | 0.002 | 0.373 | 2.117 | 0.005 | 0.621 |
| 2003 | 1 | 4.871 | 0.005 | 0.714 | 2.361 | 0.002 | 0.429 | 2.079 | 0.008 | 0.609 |
| 2003 | 2 | 3.101 | 0.028 | 0.455 | 3.808 | 0.004 | 0.692 | 1.918 | 0.010 | 0.562 |
| 2003 | 3 | 2.343 | 0.013 | 0.344 | 3.826 | 0.006 | 0.695 | 2.523 | 0.005 | 0.739 |
| 2003 | 4 | 5.813 | 0.006 | 0.852 | 2.350 | 0.002 | 0.427 | 3.153 | 0.011 | 0.924 |
| 2004 | 1 | 5.478 | 0.007 | 0.803 | 2.138 | 0.002 | 0.389 | 2.460 | 0.007 | 0.721 |
| 2004 | 2 | 3.189 | 0.017 | 0.468 | 3.218 | 0.003 | 0.585 | 2.611 | 0.011 | 0.765 |
| 2004 | 3 | 3.075 | 0.008 | 0.451 | 2.929 | 0.003 | 0.532 | 3.480 | 0.004 | 1.020 |
| 2004 | 4 | 6.181 | 0.005 | 0.906 | 3.806 | 0.002 | 0.692 | 2.925 | 0.007 | 0.857 |
| 2005 | 1 | 6.484 | 0.008 | 0.951 | 2.964 | 0.001 | 0.539 | 2.063 | 0.006 | 0.605 |
| 2005 | 2 | 5.030 | 0.018 | 0.738 | 3.794 | 0.002 | 0.690 | 2.670 | 0.009 | 0.783 |
| 2005 | 3 | 4.981 | 0.028 | 0.730 | 4.545 | 0.002 | 0.826 | 2.736 | 0.006 | 0.802 |
| 2005 | 4 | 3.489 | 0.013 | 0.512 | 4.089 | 0.001 | 0.743 | 1.393 | 0.005 | 0.408 |
| 2006 | 1 | 4.662 | 0.005 | 0.684 | 2.357 | 0.001 | 0.428 | 1.379 | 0.004 | 0.404 |
| 2006 | 2 | 3.722 | 0.008 | 0.546 | 2.912 | 0.001 | 0.529 | 2.153 | 0.006 | 0.631 |
| 2006 | 3 | 3.918 | 0.006 | 0.575 | 3.603 | 0.003 | 0.655 | 2.626 | 0.006 | 0.770 |
| 2006 | 4 | 5.905 | 0.005 | 0.866 | 3.582 | 0.001 | 0.651 | 1.215 | 0.007 | 0.356 |
| 2007 | 1 | 4.223 | 0.004 | 0.619 | 3.283 | 0.001 | 0.597 | 1.513 | 0.006 | 0.443 |
| 2007 | 2 | 3.022 | 0.007 | 0.443 | 4.074 | 0.001 | 0.741 | 2.405 | 0.005 | 0.705 |
| 2007 | 3 | 2.936 | 0.008 | 0.431 | 5.263 | 0.002 | 0.957 | 1.723 | 0.005 | 0.505 |
| 2007 | 4 | 5.443 | 0.005 | 0.798 | 4.590 | 0.002 | 0.834 | 1.158 | 0.010 | 0.339 |
| 2008 | 1 | 3.999 | 0.005 | 0.586 | 2.861 | 0.002 | 0.520 | 1.764 | 0.006 | 0.517 |
| 2008 | 2 | 3.470 | 0.011 | 0.509 | 2.886 | 0.002 | 0.525 | 1.321 | 0.005 | 0.387 |
| 2008 | 3 | 3.571 | 0.010 | 0.524 | 4.104 | 0.002 | 0.746 | 1.389 | 0.006 | 0.407 |
| 2008 | 4 | 5.060 | 0.004 | 0.742 | 4.352 | 0.002 | 0.791 | 1.427 | 0.006 | 0.418 |
| 2009 | 1 | 3.343 | 0.004 | 0.490 | 2.652 | 0.001 | 0.482 | 1.711 | 0.008 | 0.502 |
| 2009 | 2 | 2.899 | 0.008 | 0.425 | 3.558 | 0.002 | 0.647 | 1.828 | 0.007 | 0.536 |
| 2009 | 3 | 2.913 | 0.007 | 0.427 | 3.289 | 0.007 | 0.598 | 1.642 | 0.005 | 0.481 |
| 2009 | 4 | 3.234 | 0.004 | 0.474 | 3.114 | 0.006 | 0.566 | 1.324 | 0.013 | 0.388 |
| 2010 | 1 | 2.826 | 0.004 | 0.414 | 2.394 | 0.004 | 0.435 | 1.739 | 0.008 | 0.510 |
| 2010 | 2 | 2.019 | 0.020 | 0.296 | 2.447 | 0.010 | 0.445 | 1.395 | 0.006 | 0.409 |
| 2010 | 3 | 4.070 | 0.021 | 0.597 | 4.157 | 0.041 | 0.756 | 2.442 | 0.005 | 0.716 |
| 2010 | 4 | 4.126 | 0.006 | 0.605 | 3.611 | 0.024 | 0.656 | 2.041 | 0.011 | 0.598 |
| 2011 | 1 | 3.843 | 0.007 | 0.563 | 3.647 | 0.163 | 0.663 | 3.059 | 0.020 | 0.897 |
| 2011 | 2 | 2.099 | 0.100 | 0.308 | 0.000 | 0.000 | 0.000 | 3.507 | 0.008 | 1.028 |
| 2011 | 3 | 10.486 | 0.149 | 1.538 | 0.000 | 0.000 | 0.000 | 3.298 | 0.009 | 0.967 |
| 2011 | 4 | 5.900 | 0.009 | 0.865 | 0.000 | 0.000 | 0.000 | 1.411 | 0.019 | 0.414 |
| 2012 | 1 | 4.143 | 0.009 | 0.608 | 0.000 | 0.000 | 0.000 | 1.711 | 0.014 | 0.502 |
| 2012 | 2 | 2.990 | 0.148 | 0.438 | 6.965 | 0.054 | 1.266 | 3.301 | 0.007 | 0.967 |
| 2012 | 3 | 5.213 | 0.034 | 0.764 | 4.686 | 0.025 | 0.852 | 3.364 | 0.011 | 0.986 |
| 2012 | 4 | 6.309 | 0.007 | 0.925 | 8.078 | 0.017 | 1.468 | 2.527 | 0.037 | 0.741 |