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

Daisuke Ochi, Takayuki Matsumoto, Keisuke Satoh and Hiroaki Okamoto

National Research Institute of Far Seas Fisheries
5 chome 7-1, Orido, Shimizu-Ku, Shizuoka-City, 424-8633, Japan

Abstract

Standardization of Japanese longline CPUE for bigeye tuna was conducted for 1960-2013 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 2013 or before. 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, but slightly decrease in the latest year are seen as for each area.

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 logbooks.

Satoh and Okamoto (2012) and Matsumoto et al. (2013) reported area aggregated annual standardized Japanese longline CPUE for bigeye tuna based on GLM (generalized linear model, log normal error structured) for an indicator of the stock. Also, area specific CPUE for integrated models was reported at the last IOTC WPTT-15 meeting (Matsumoto et al. 2013). Methods of standardization in this study are the same as above mentioned studies. In this study, area specific and area aggregated CPUEs have been updated for consideration for future stock assessment of bigeye tuna (scheduled in 2016) as well as to provide an indicator of the stock. In addition, an alternative method was also examined for area aggregated CPUE to consider if the trend of CPUE differs depending on standardization methods.

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 and 2013 IOTC WPTT meetings (Satoh and Okamoto 2012, Matsumoto et al. 2013). 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 central 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 1960-2013, 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 2013, 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 x 5 degrees latitude and longitude by month from 1960 to 2013 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 2013 were used. The catch and effort data set based on logbook data aggregated by month, 5 x 5 degree square, NHF (the number of hooks between floats), and main line material, were used for the analysis. Data in the 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: 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, σ^2).

Input variables for the model was selected 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 (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 piracy activities (Fig. 3). Time period of standardization was 1960-2013 for all CPUEs.

As for alternative method, area aggregated CPUE (annual base) was standardized using the effect of LT5LN5 instead of subarea. The model is as follows.

Area aggregated CPUE (annual, with LT5LN5):

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

In this model, SST (integer value) was incorporated as categorical value. The results were compared with those with the effect of subarea. In this model, effect of year was obtained using the following equation.

$CPUE_i$ = exp(lsmean(year i)) - constant

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 during 2009-2012 was increasing, and was 6.4 in 2012, but decreased to 5.0 in 2013. The standardized CPUE in the south region also sharply increased (8.3) in 1977 and then showed slightly decreasing trend. It was increasing trend during 2009-2012 (from 1.7 to 2.7) but slightly decreased to 2.3 in 2013. 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). However, CPUE was slightly decreased to 3.9 in 2013. Comparatively large difference between standardized and nominal CPUE is seen in the tropical area, though not apparent in the south area. This is considered to be due to the development of fishing gear (deep longline and nylon material) which was pronounced in the tropical area (Satoh and Okamoto, 2012). Results of ANOVA are shown in Table 1, and distributions of the standardized residual and QQ-plot for annual and quarterly CPUE are shown in Fig. 5 and Fig. 6, respectively. Distributions of the standardized 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. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE)., respectively.

Results of ANOVA for annual CPUE with the effect of LT5LN5 in each area are shown in Table 2. ANOVA table indicates that the effect of LT5LN5 was the largest in the tropical and the whole area and the second largest in the south area, indicating that the effect of fishing ground is important. Comparison of CPUE trend with the model for each subarea (Fig. 4) indicates that there is not large difference of the trend of CPUE except for a part of the period. This is different trend from the case of yellowfin tuna CPUE by Japanese longline (Ochi et al., 2014). Possible cause of the difference is that subareas for bigeye tuna CPUE are smaller than those for yellowfin tuna hence the effect of fishing ground was well incorporated by using subareas.

Area specific CPUE

Trends of area specific CPUE in each region (east, west and south area) are shown in Fig. 8. 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. Similar CPUE trend is observed for the recent 3 years as for all areas. Results of ANOVA are shown in Table 3, and distributions of the standardized residual and QQ-plot are shown in Fig. 9. Distributions of the standardized residual did not show remarkable difference from the normal distribution. Quarterly values of standardized CPUE by region are listed in Appendix Table 2.

4. References

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Okamoto, H. (2011): Updated Japanese longline CPUE for bigeye tuna in the Indian Ocean standardized by GLM for the period from 1960 to 2010. IOTC-2011/WPTT13/52, p. 9.

Satoh, K. and Okamoto, H. (2012): Updated Japanese longline CPUE for bigeye tuna in the Indian Ocean standardized by GLM. IOTC-2012/WPTT14/26, p. 18.

Shono, H. and M. Ogura, M. (1999): The standardized skipjack CPUE including the effect of searching devices, of the Japanese distant water pole and line fishery in the Western Central Pacific Ocean. ICCAT-SCRS/99/59, p.18

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

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	357	5553.8	15.6	47.5	<.0001	0.340
						CV
year	53	626.5	11.8	36.1	<.0001	31.297
month	11	129.3	11.8	35.9	<.0001	
area	4	161.3	40.3	123.1	<.0001	
nhfc	5	38.7	7.7	23.6	<.0001	
sst	1	16.3	16.3	49.8	<.0001	
ML	1	1.9	1.9	5.8	0.0158	
year*area	209	588.3	2.8	8.6	<.0001	
month*area	44	211.3	4.8	14.7	<.0001	
area*nhfc	20	61.0	3.1	9.3	<.0001	
sst*area	4	148.6	37.1	113.4	<.0001	
nhfc*ML	5	55.3	11.1	33.8	<.0001	

South

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	147	5627.2	38.3	66.1	<.0001	0.365
						CV
year	53	986.2	18.6	32.1	<.0001	76.929
month	11	612.7	55.7	96.1	<.0001	
area	1	0.2	0.2	0.3	0.5745	
nhfc	5	57.9	11.6	20.0	<.0001	
sst	1	234.1	234.1	403.9	<.0001	
ML	1	2.1	2.1	3.7	0.0550	
year*area	53	245.6	4.6	8.0	<.0001	
month*area	11	53.9	4.9	8.5	<.0001	
area*nhfc	5	29.0	5.8	10.0	<.0001	
sst*area	1	1.3	1.3	2.2	0.1371	
nhfc*ML	5	18.7	3.7	6.5	<.0001	

Whole

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	499	15755.7	31.6	81.7	<.0001	0.450
						CV
year	53	959.6	18.1	46.9	<.0001	39.599
month	11	133.1	12.1	31.3	<.0001	
area	6	172.5	28.7	74.4	<.0001	
nhfc	5	63.6	12.7	33.0	<.0001	
sst	1	6.4	6.4	16.5	<.0001	
ML	1	0.3	0.3	0.7	0.4017	
year*area	315	1479.1	4.7	12.2	<.0001	
month*area	66	767.6	11.6	30.1	<.0001	
area*nhfc	30	126.3	4.2	10.9	<.0001	
sst*area	6	177.3	29.5	76.5	<.0001	
nhfc*ML	5	44.1	8.8	22.9	<.0001	

Quarter

Tropical

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	1060	6329.9	6.0	19.2	<.0001	0.387
						CV
year	53	411.0	7.8	25.0	<.0001	30.478
quarter	3	7.3	2.4	7.8	<.0001	
area	4	83.7	20.9	67.4	<.0001	
nhfc	5	33.2	6.6	21.4	<.0001	
sst	1	1.2	1.2	3.9	0.0472	
ML	1	2.3	2.3	7.5	0.0062	
year*quarter*area	964	1681.5	1.7	5.6	<.0001	
area*nhfc	20	50.0	2.5	8.1	<.0001	
sst*area	4	75.4	18.8	60.7	<.0001	
nhfc*ML	5	56.0	11.2	36.0	<.0001	

South

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	441	6522.7	14.8	27.6	<.0001	0.423
						CV
year	53	690.3	13.0	24.3	<.0001	73.972
quarter	3	264.6	88.2	164.6	<.0001	
area	1	8.4	8.4	15.6	<.0001	
nhfc	5	47.4	9.5	17.7	<.0001	
sst	1	417.4	417.4	778.9	<.0001	
ML	1	0.7	0.7	1.3	0.2548	
year*quarter*area	366	1377.3	3.8	7.0	<.0001	
area*nhfc	5	13.2	2.6	4.9	0.0002	
sst*area	1	21.0	21.0	39.3	<.0001	
nhfc*ML	5	10.7	2.1	4.0	0.0013	

Whole

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	1496	17313.7	11.6	31.9	<.0001	0.495
						CV
year	53	615.0	11.6	32.0	<.0001	38.349
quarter	3	33.8	11.3	31.1	<.0001	
area	6	96.7	16.1	44.5	<.0001	
nhfc	5	52.5	10.5	29.0	<.0001	
sst	1	1.5	1.5	4.1	0.0440	
ML	1	0.2	0.2	0.5	0.4894	
year*quarter*area	1386	3868.1	2.8	7.7	<.0001	
area*nhfc	30	91.4	3.0	8.4	<.0001	
sst*area	6	120.5	20.1	55.4	<.0001	
nhfc*ML	5	37.8	7.6	20.9	<.0001	

Table 2. ANOVA tables of GLM for bigeye tuna standardized CPUE (area aggregated, with LT5LN5 instead of subareas) 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.

Annual with LT5LN5

tropical

RSquare	CV				
0.34	31.30				
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Model	162	5486.65	33.87	103.38	<.0001
year	53	847.53	15.99	48.81	<.0001
month	11	104.81	9.53	29.09	<.0001
LT5LN5	80	2289.69	28.62	87.37	<.0001
nhfc	5	11.09	2.22	6.77	<.0001
sst	7	72.96	10.42	31.82	<.0001
ML	1	0.39	0.39	1.2	0.273
nhfc*ML	5	47.16	9.43	28.79	<.0001

south

RSquare	CV				
0.39	75.33				
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Model	137	6023.39	43.97	79.1	<.0001
year	53	834.98	15.75	28.35	<.0001
month	11	554.18	50.38	90.64	<.0001
LT5LN5	46	893.46	19.42	34.95	<.0001
nhfc	5	33.52	6.70	12.06	<.0001
sst	16	34.50	2.16	3.88	<.0001
ML	1	2.38	2.38	4.28	0.0386
nhfc*ML	5	15.67	3.13	5.64	<.0001

whole

RSquare	CV				
0.43	40.35				
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Model	218	14905.42	68.37	170.46	<.0001
year	53	1190.17	22.46	55.98	<.0001
month	11	195.40	17.76	44.29	<.0001
LT5LN5	127	6706.25	52.81	131.65	<.0001
nhfc	5	7.49	1.50	3.73	0.0022
sst	16	264.93	16.56	41.28	<.0001
ML	1	0.43	0.43	1.07	0.3011
nhfc*ML	5	60.09	12.02	29.96	<.0001

Table 3. 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.

West

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	262	4267.1	16.3	50.2	<.0001	0.403
						CV
year	53	481.7	9.1	28.0	<.0001	33.514
quarter	3	67.1	22.4	69.0	<.0001	
nhfc	5	5.9	1.2	3.6	0.0029	
ML	1	0.6	0.6	1.9	0.1702	
sst	1	4.6	4.6	14.3	0.0002	
LT5LN5	40	935.7	23.4	72.1	<.0001	
year*quarter	154	391.2	2.5	7.8	<.0001	
nhfc*ML	5	24.3	4.9	15.0	<.0001	

East

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	273	6315.2	23.1	42.8	<.0001	0.411
						CV
year	53	688.5	13.0	24.1	<.0001	74.123
quarter	3	329.1	109.7	203.2	<.0001	
nhfc	5	37.0	7.4	13.7	<.0001	
ML	1	1.6	1.6	3.0	0.0842	
sst	1	45.8	45.8	84.9	<.0001	
LT5LN5	46	966.2	21.0	38.9	<.0001	
year*quarter	159	506.5	3.2	5.9	<.0001	
nhfc*ML	5	14.9	3.0	5.5	<.0001	

South

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square
Model	273	6315.2	23.1	42.8	<.0001	0.411
						CV
year	53	688.5	13.0	24.1	<.0001	74.123
quarter	3	329.1	109.7	203.2	<.0001	
nhfc	5	37.0	7.4	13.7	<.0001	
ML	1	1.6	1.6	3.0	0.0842	
sst	1	45.8	45.8	84.9	<.0001	
LT5LN5	46	966.2	21.0	38.9	<.0001	
year*quarter	159	506.5	3.2	5.9	<.0001	
nhfc*ML	5	14.9	3.0	5.5	<.0001	

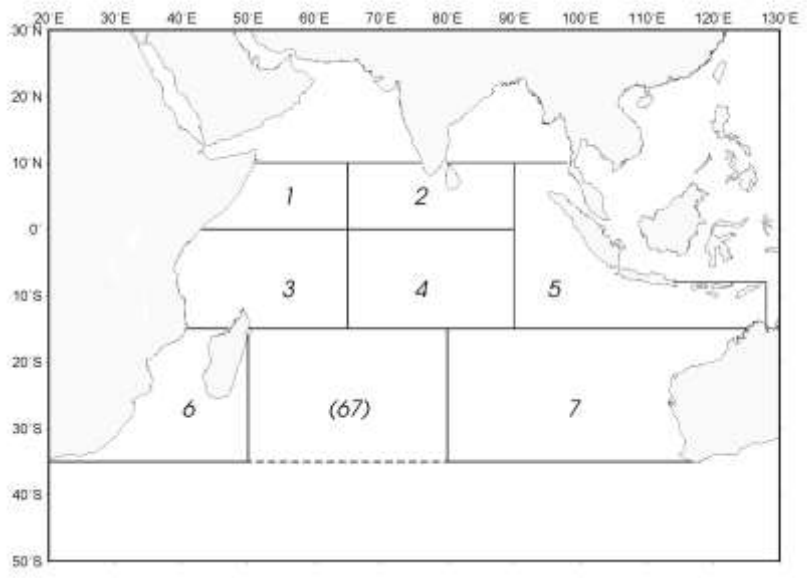


Fig. 1. Definition of sub-areas for area aggregated CPUE used in this study. The tropical, south and whole Indian Ocean regions in this paper consist of areas 1-5, areas 6-7 and areas1-7, respectively. Area 67 was not used in this study.

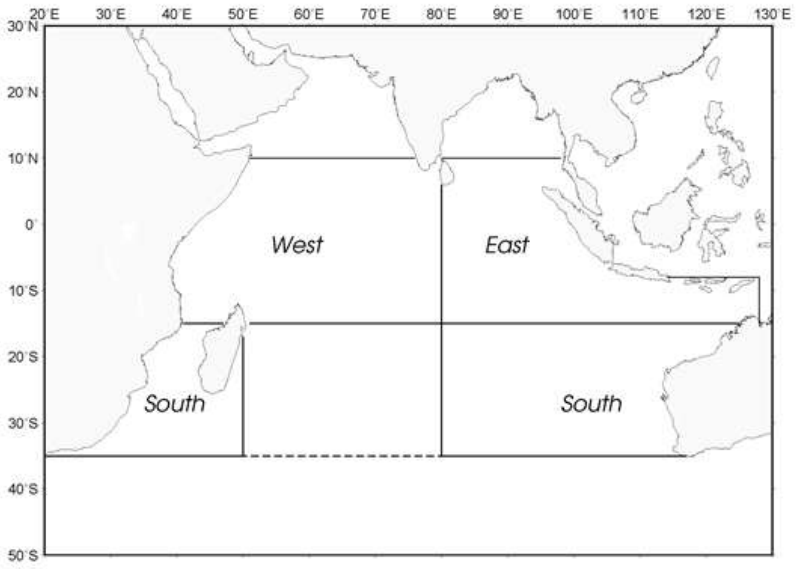


Fig. 2. Another definition of areas for area specific CPUE formatted for integrated model.

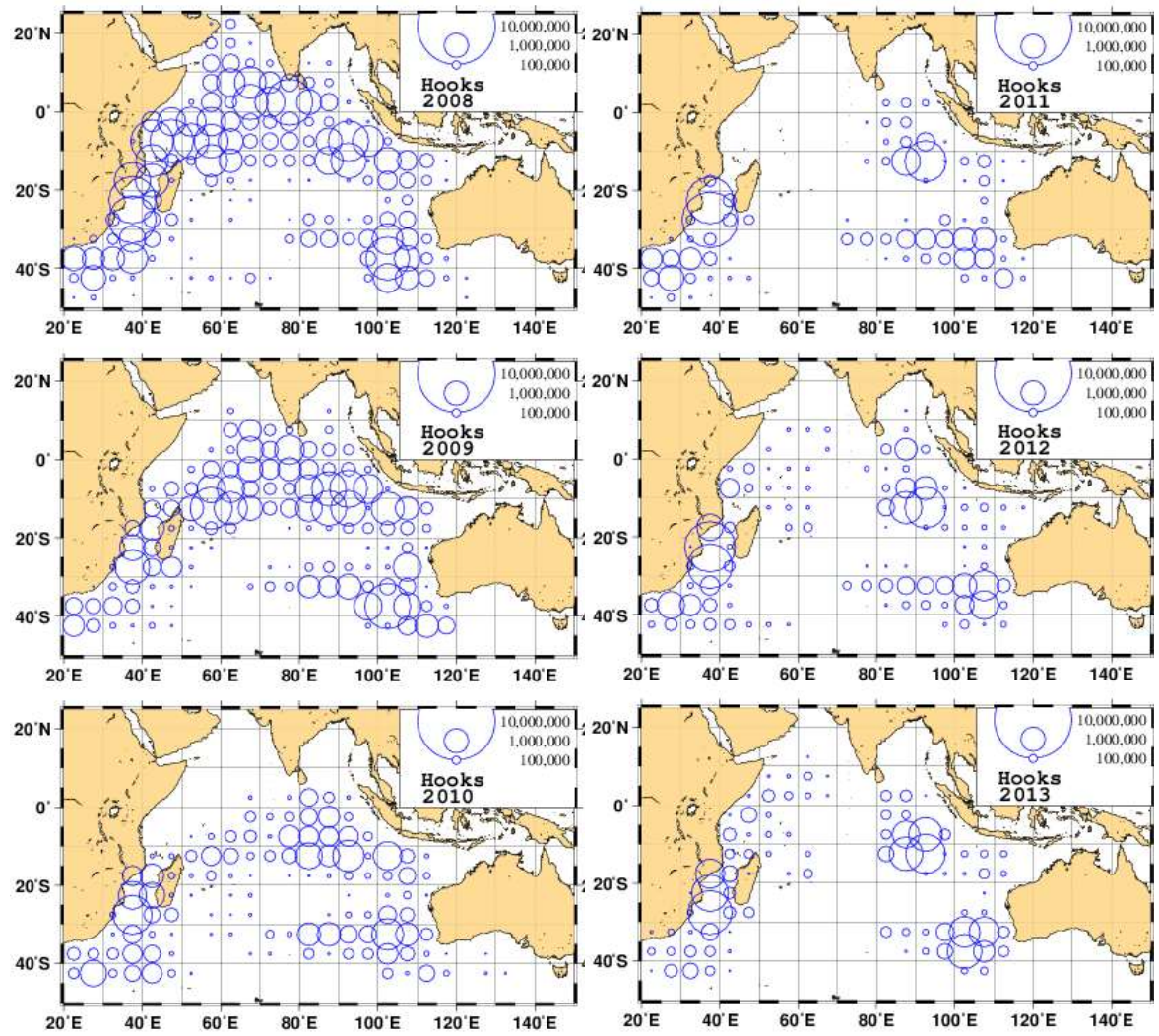


Fig. 3. Geographical distribution of fishing effort by Japanese longline in recent years.

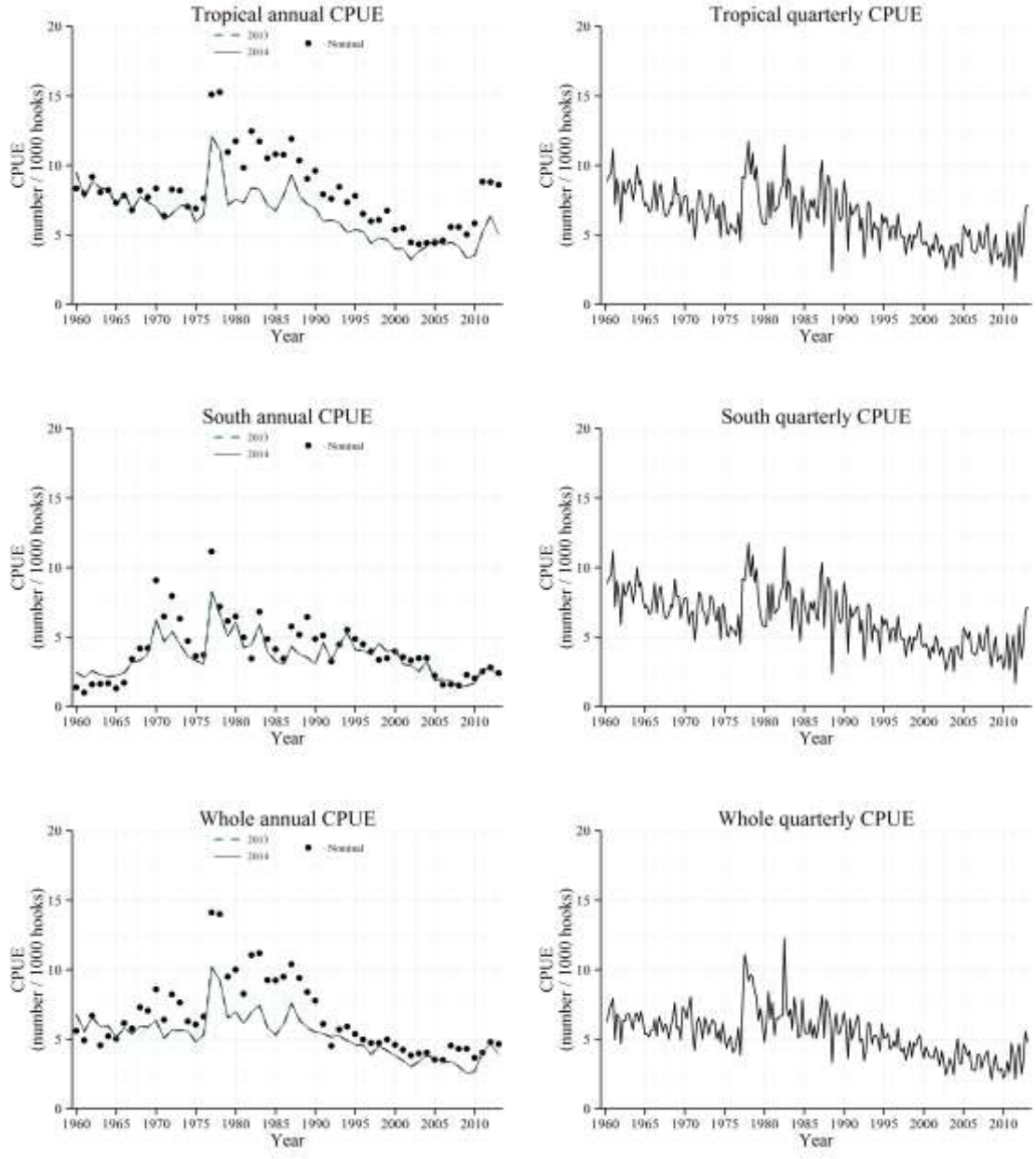
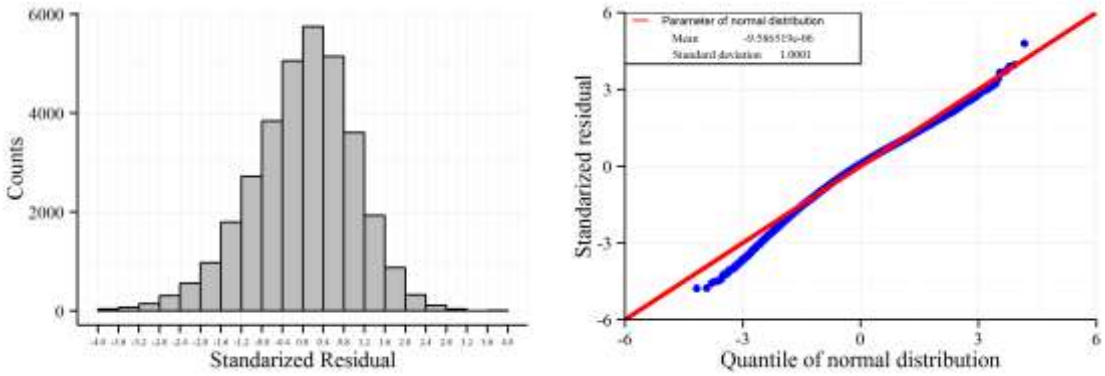


Fig. 4. Comparison of area aggregated annual (left) and quarterly (right) CPUE series of bigeye. Standardized CPUE created in 2014 (solid line), nominal CPUE (open circle), and standardized CPUE created in 2013 (dashed line: Matsumoto el al., 2013) of Japanese longline for the tropical (top), south (middle) and whole (bottom) Indian Ocean.

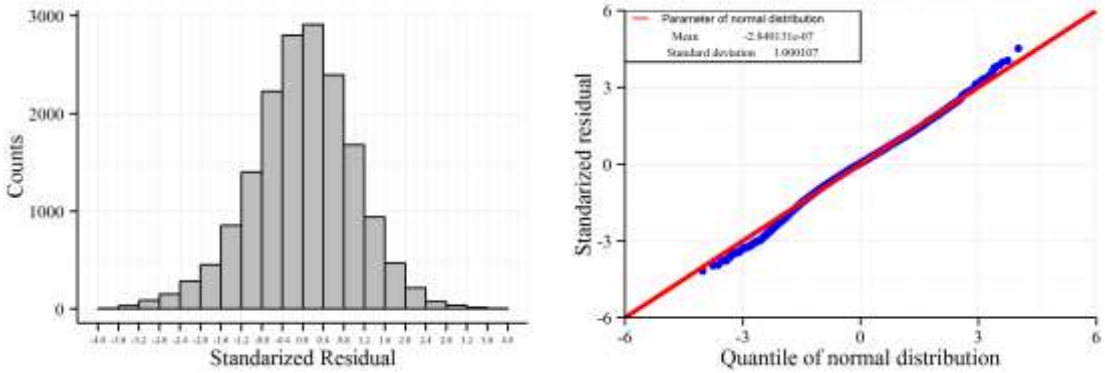
1960-2013 Year based

Tropical area



1960-2013 Year based

South area



1960-2013 Year based

Whole area

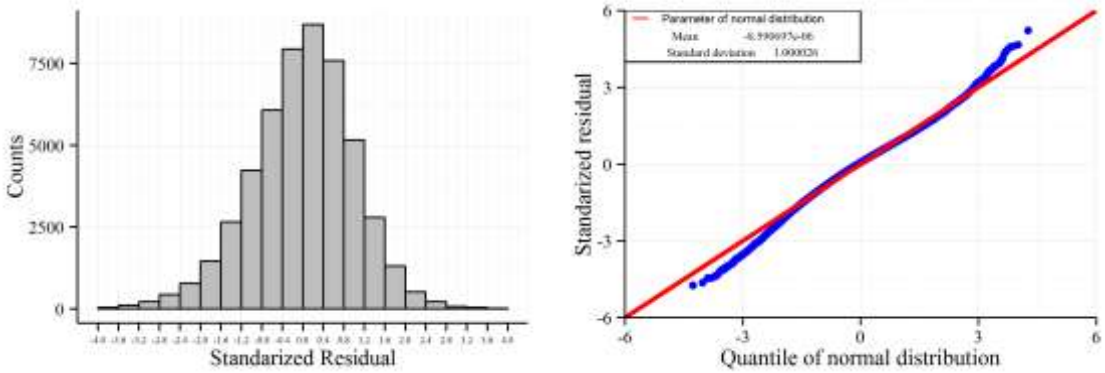
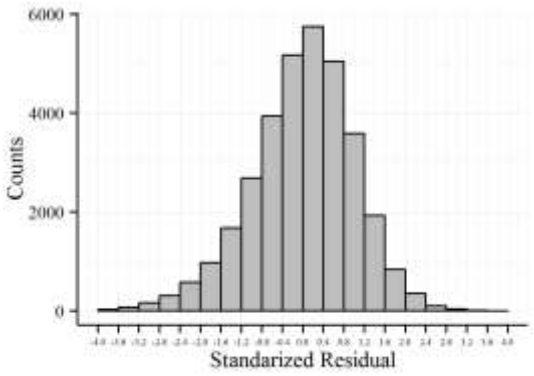
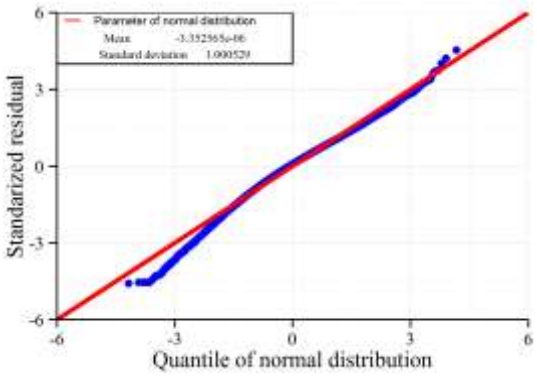


Fig. 5. Standardized residuals of area aggregated annual CPUE standardization.

1960-2013 quarter based

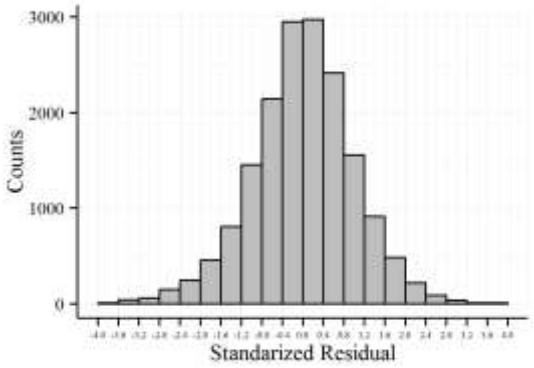
Tropical area

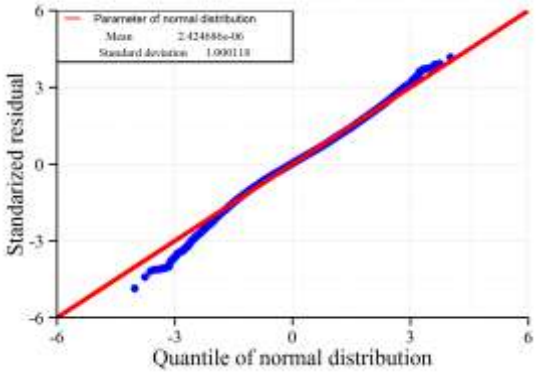




1960-2013 quarter based

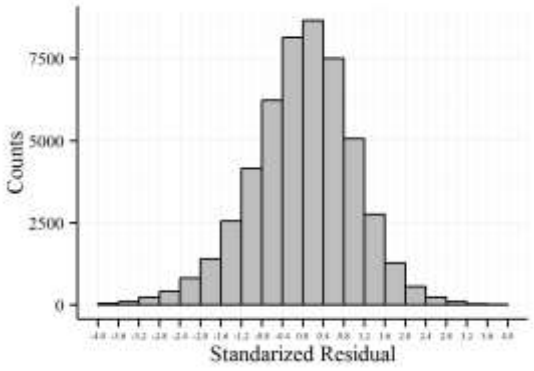
South area





1960-2013 quarter based

Whole area



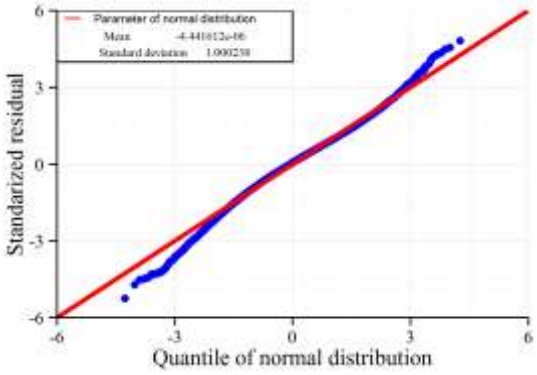


Fig. 6. Standardized residuals of area aggregated quarterly CPUE standardization.

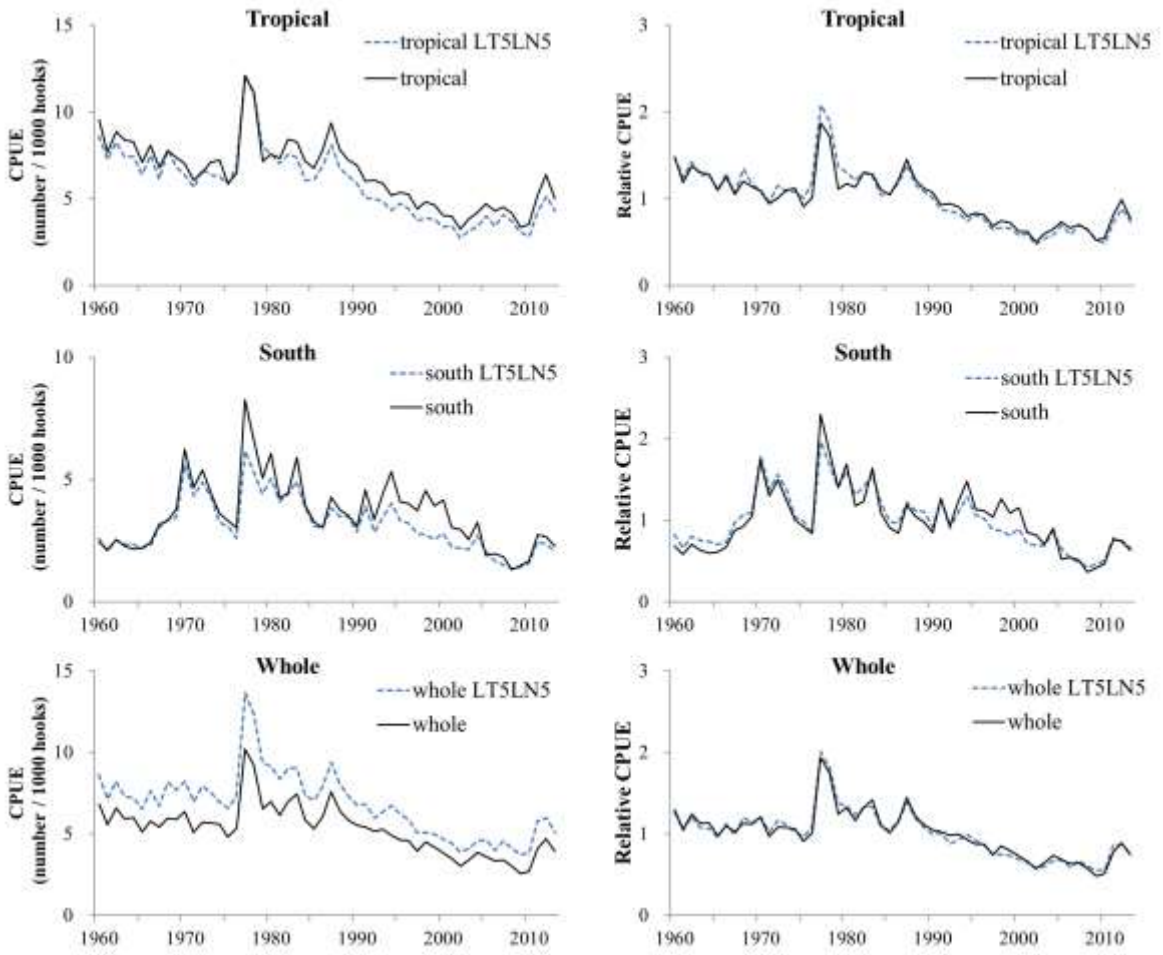


Fig. 7. Comparison of area aggregated CPUE series of bigeye between the model including subarea effect and that including LT5LN5 effect. Left: real scale, right: relative scale.

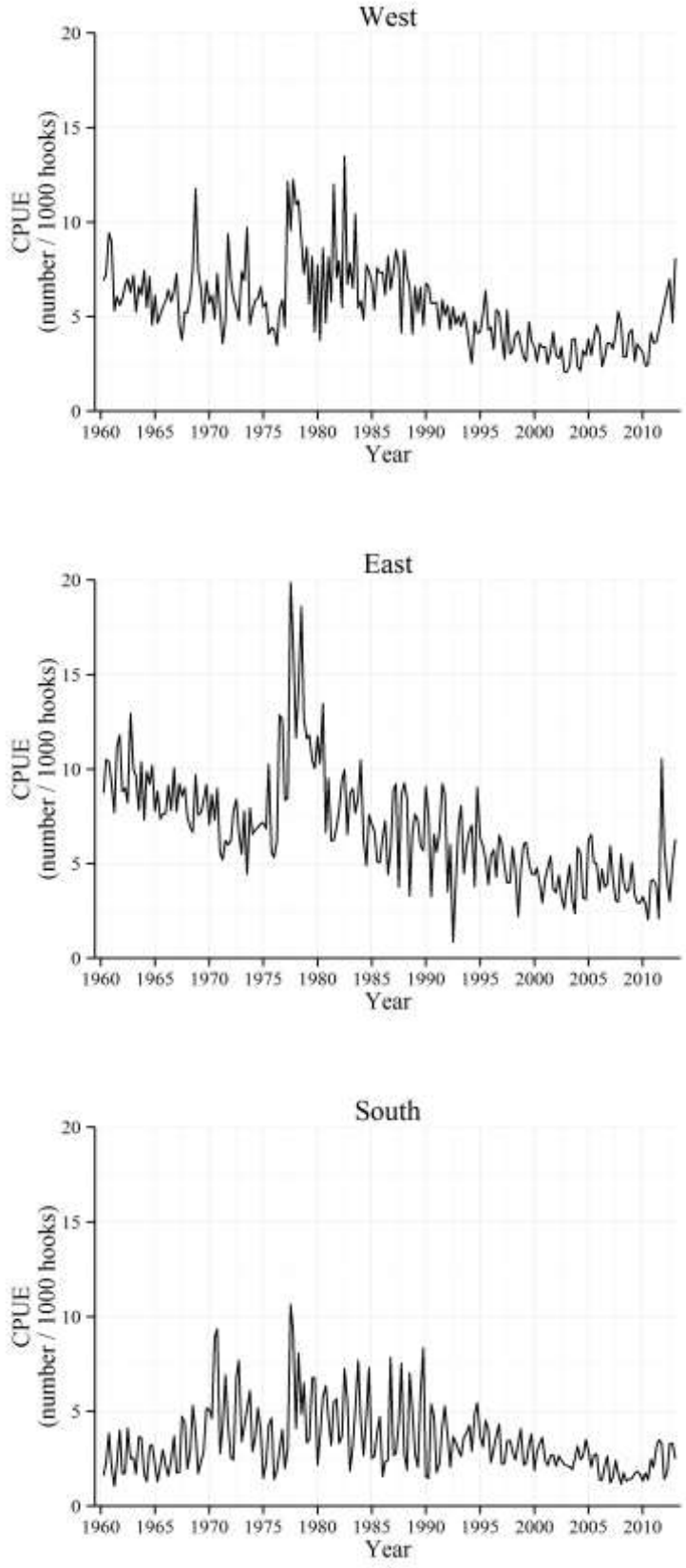
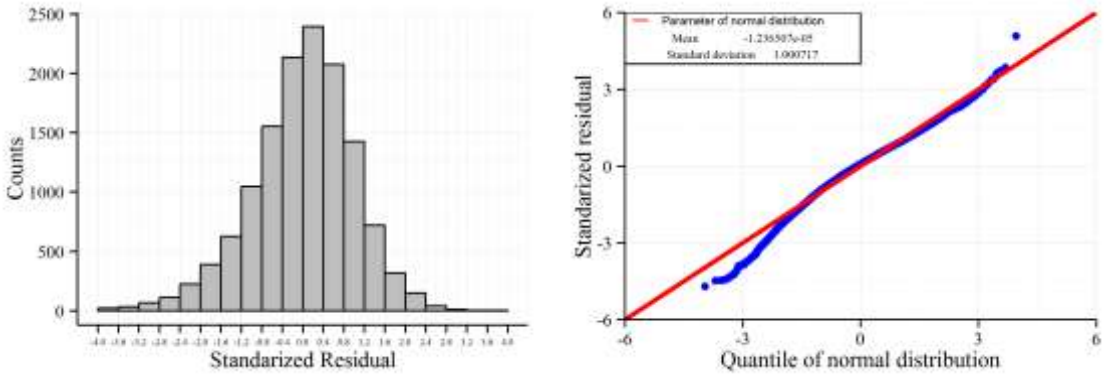


Fig. 8. Comparison of area specific quarterly CPUE series of bigeye tuna by Japanese longline for the east (top), west (middle) and south (bottom) area.

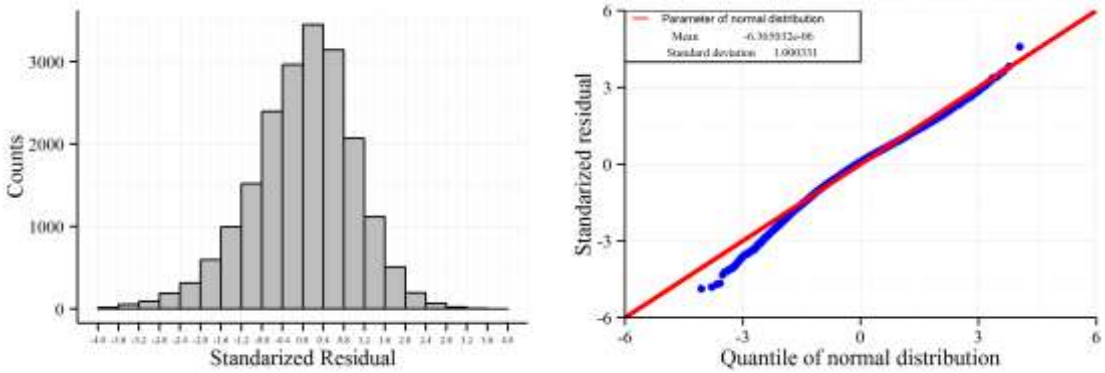
1960-2013 quarter based

East area



1960-2013 quarter based

West area



1960-2013 quarter based

South area

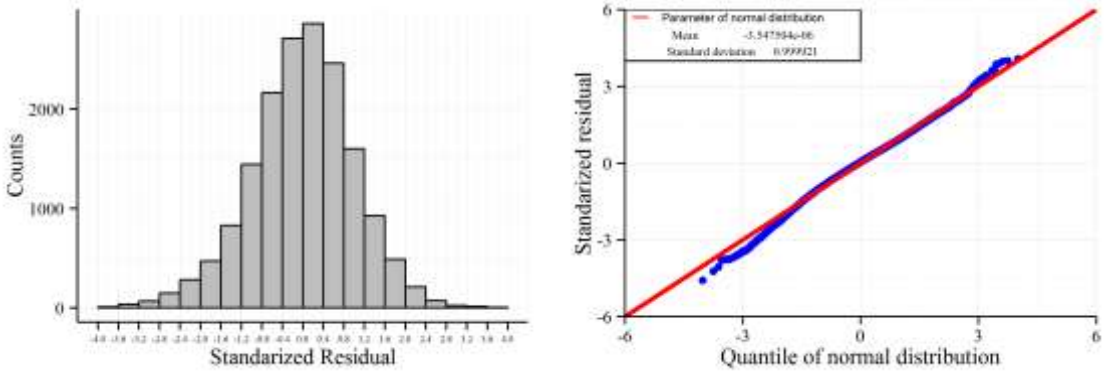


Fig. 9. Standardized residuals of area specific quarterly CPUE standardization.

Appendix Table 1. Annual value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 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	9.522	0.001	1.475	1960	2.446	0.007	0.680	1960	6.811	0.001	1.293
1961	7.651	0.001	1.185	1961	2.097	0.005	0.583	1961	5.563	0.001	1.056
1962	8.860	0.001	1.373	1962	2.543	0.004	0.707	1962	6.548	0.001	1.243
1963	8.373	0.001	1.297	1963	2.287	0.004	0.636	1963	5.920	0.001	1.123
1964	8.258	0.001	1.279	1964	2.153	0.004	0.598	1964	5.971	0.001	1.133
1965	7.087	0.001	1.098	1965	2.208	0.003	0.614	1965	5.133	0.001	0.974
1966	8.058	0.001	1.248	1966	2.417	0.004	0.672	1966	5.785	0.001	1.098
1967	6.785	0.001	1.051	1967	3.168	0.003	0.880	1967	5.393	0.001	1.023
1968	7.754	0.001	1.201	1968	3.317	0.003	0.922	1968	5.938	0.001	1.127
1969	7.359	0.001	1.140	1969	3.798	0.003	1.056	1969	5.875	0.001	1.115
1970	7.013	0.001	1.086	1970	6.230	0.003	1.731	1970	6.342	0.001	1.204
1971	6.061	0.001	0.939	1971	4.667	0.003	1.297	1971	5.071	0.001	0.962
1972	6.518	0.001	1.010	1972	5.389	0.007	1.497	1972	5.679	0.001	1.078
1973	7.075	0.001	1.096	1973	4.481	0.005	1.245	1973	5.643	0.001	1.071
1974	7.224	0.001	1.119	1974	3.596	0.004	0.999	1974	5.573	0.001	1.058
1975	5.853	0.001	0.907	1975	3.307	0.004	0.919	1975	4.781	0.001	0.907
1976	6.484	0.002	1.005	1976	3.028	0.011	0.841	1976	5.326	0.002	1.011
1977	12.080	0.003	1.872	1977	8.258	0.017	2.295	1977	10.185	0.003	1.933
1978	11.126	0.001	1.724	1978	6.632	0.007	1.843	1978	9.228	0.001	1.751
1979	7.157	0.003	1.109	1979	5.043	0.006	1.401	1979	6.521	0.002	1.238
1980	7.549	0.002	1.170	1980	6.077	0.006	1.689	1980	6.967	0.001	1.322
1981	7.303	0.001	1.131	1981	4.239	0.004	1.178	1981	6.130	0.001	1.163
1982	8.395	0.001	1.301	1982	4.444	0.007	1.235	1982	6.960	0.001	1.321
1983	8.264	0.001	1.280	1983	5.890	0.006	1.637	1983	7.441	0.001	1.412
1984	7.142	0.001	1.106	1984	3.949	0.004	1.097	1984	5.833	0.001	1.107
1985	6.745	0.001	1.045	1985	3.261	0.004	0.906	1985	5.305	0.001	1.007
1986	7.824	0.001	1.212	1986	3.025	0.005	0.841	1986	6.060	0.001	1.150
1987	9.352	0.001	1.449	1987	4.291	0.005	1.192	1987	7.591	0.001	1.441
1988	7.808	0.001	1.210	1988	3.752	0.007	1.042	1988	6.386	0.001	1.212
1989	7.204	0.001	1.116	1989	3.520	0.007	0.978	1989	5.835	0.001	1.107
1990	6.905	0.001	1.070	1990	3.061	0.005	0.851	1990	5.510	0.001	1.046
1991	5.978	0.001	0.926	1991	4.563	0.002	1.268	1991	5.395	0.001	1.024
1992	6.076	0.002	0.941	1992	3.353	0.004	0.932	1992	5.160	0.001	0.979
1993	5.851	0.001	0.906	1993	4.452	0.002	1.237	1993	5.252	0.001	0.997
1994	5.165	0.001	0.800	1994	5.324	0.001	1.479	1994	4.894	0.001	0.929
1995	5.355	0.001	0.830	1995	4.079	0.001	1.134	1995	4.594	0.001	0.872
1996	5.248	0.001	0.813	1996	4.015	0.001	1.116	1996	4.572	0.000	0.868
1997	4.378	0.000	0.678	1997	3.730	0.001	1.037	1997	3.907	0.000	0.742
1998	4.790	0.000	0.742	1998	4.539	0.002	1.261	1998	4.494	0.001	0.853
1999	4.640	0.000	0.719	1999	3.926	0.002	1.091	1999	4.166	0.000	0.791
2000	4.008	0.000	0.621	2000	4.152	0.002	1.154	2000	3.814	0.000	0.724
2001	3.999	0.001	0.619	2001	3.055	0.001	0.849	2001	3.470	0.000	0.659
2002	3.232	0.000	0.501	2002	2.942	0.001	0.817	2002	3.008	0.000	0.571
2003	3.817	0.001	0.591	2003	2.530	0.003	0.703	2003	3.378	0.001	0.641
2004	4.192	0.001	0.649	2004	3.248	0.003	0.902	2004	3.863	0.001	0.733
2005	4.694	0.001	0.727	2005	1.885	0.003	0.524	2005	3.593	0.001	0.682
2006	4.281	0.001	0.663	2006	1.959	0.003	0.544	2006	3.343	0.001	0.634
2007	4.492	0.000	0.696	2007	1.838	0.003	0.511	2007	3.382	0.001	0.642
2008	4.157	0.000	0.644	2008	1.317	0.002	0.366	2008	3.032	0.000	0.575
2009	3.332	0.001	0.516	2009	1.491	0.002	0.414	2009	2.537	0.001	0.482
2010	3.508	0.001	0.543	2010	1.673	0.002	0.465	2010	2.694	0.001	0.511
2011	5.225	0.005	0.809	2011	2.742	0.003	0.762	2011	4.103	0.002	0.779
2012	6.360	0.003	0.985	2012	2.664	0.003	0.740	2012	4.686	0.002	0.889
2013	4.991	0.002	0.773	2013	2.277	0.004	0.633	2013	3.906	0.001	0.741

Appendix Table 2. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (= CV of CPUE).

		Tropical			South			Whole		
year	quarte	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
1960	1	8.849	0.003	1.418	1.221	0.009	0.317	6.213	0.002	1.165
1960	2	9.215	0.003	1.477	2.836	0.073	0.736	7.105	0.008	1.333
1960	3	9.485	0.007	1.520	3.860	0.031	1.002	7.481	0.006	1.403
1960	4	11.147	0.004	1.786	2.043	0.016	0.531	7.931	0.003	1.488
1961	1	7.169	0.003	1.149	0.777	0.009	0.202	4.955	0.002	0.929
1961	2	9.051	0.005	1.450	1.770	0.029	0.459	6.825	0.005	1.280
1961	3	7.940	0.007	1.272	3.763	0.029	0.977	6.575	0.006	1.233
1961	4	5.866	0.006	0.940	1.750	0.009	0.454	4.673	0.004	0.877
1962	1	8.856	0.003	1.419	1.827	0.010	0.474	6.351	0.002	1.191
1962	2	7.938	0.002	1.272	3.275	0.030	0.850	6.291	0.004	1.180
1962	3	8.310	0.005	1.332	2.630	0.022	0.683	6.806	0.004	1.277
1962	4	8.999	0.002	1.442	2.545	0.009	0.661	6.820	0.002	1.279
1963	1	8.570	0.002	1.373	1.736	0.007	0.451	6.225	0.002	1.168
1963	2	7.469	0.003	1.197	2.701	0.059	0.701	5.691	0.007	1.068
1963	3	8.284	0.012	1.327	3.695	0.017	0.959	6.741	0.007	1.265
1963	4	9.988	0.009	1.601	1.677	0.008	0.435	6.886	0.005	1.292
1964	1	8.611	0.003	1.380	1.616	0.009	0.419	6.271	0.002	1.176
1964	2	8.924	0.002	1.430	3.155	0.058	0.819	6.983	0.006	1.310
1964	3	7.644	0.006	1.225	3.474	0.033	0.902	6.310	0.006	1.184
1964	4	7.098	0.007	1.137	2.079	0.007	0.540	5.347	0.004	1.003
1965	1	7.263	0.002	1.164	1.940	0.010	0.504	5.398	0.002	1.013
1965	2	6.675	0.002	1.070	2.302	0.026	0.598	5.152	0.003	0.966
1965	3	6.677	0.003	1.070	3.990	0.013	1.036	5.611	0.003	1.053
1965	4	7.613	0.002	1.220	2.096	0.009	0.544	5.652	0.002	1.060
1966	1	8.883	0.002	1.423	1.698	0.012	0.441	6.417	0.002	1.204
1966	2	6.721	0.002	1.077	2.492	0.058	0.647	5.218	0.006	0.979
1966	3	8.307	0.002	1.331	3.433	0.048	0.891	6.642	0.005	1.246
1966	4	8.674	0.002	1.390	1.835	0.007	0.477	6.188	0.001	1.161
1967	1	7.287	0.002	1.168	1.862	0.007	0.484	5.532	0.001	1.038
1967	2	6.361	0.002	1.019	5.578	0.008	1.448	6.085	0.001	1.141
1967	3	6.367	0.003	1.020	5.069	0.008	1.316	5.919	0.002	1.110
1967	4	6.567	0.002	1.052	1.999	0.007	0.519	4.998	0.002	0.938
1968	1	7.302	0.003	1.170	3.463	0.016	0.899	5.846	0.003	1.097
1968	2	7.147	0.003	1.145	5.980	0.011	1.553	6.463	0.002	1.212
1968	3	9.166	0.011	1.469	5.059	0.008	1.314	7.615	0.006	1.429
1968	4	7.941	0.002	1.272	1.826	0.008	0.474	5.758	0.002	1.080
1969	1	7.942	0.002	1.273	2.173	0.009	0.564	5.895	0.002	1.106
1969	2	6.338	0.002	1.016	1.889	0.013	0.491	4.959	0.002	0.930
1969	3	7.329	0.003	1.174	8.218	0.008	2.134	7.331	0.002	1.375
1969	4	7.820	0.002	1.253	6.337	0.018	1.645	7.039	0.003	1.321
1970	1	7.754	0.003	1.243	4.392	0.032	1.140	6.467	0.004	1.213
1970	2	5.893	0.003	0.944	11.939	0.009	3.100	7.371	0.002	1.383
1970	3	6.696	0.007	1.073	11.291	0.007	2.932	8.033	0.004	1.507
1970	4	6.853	0.003	1.098	2.951	0.008	0.766	5.284	0.002	0.991
1971	1	4.738	0.002	0.759	3.911	0.010	1.015	4.192	0.002	0.786
1971	2	6.079	0.002	0.974	7.153	0.011	1.857	6.090	0.002	1.142
1971	3	8.186	0.005	1.312	4.593	0.010	1.192	6.581	0.003	1.235
1971	4	8.077	0.003	1.294	2.826	0.018	0.734	5.982	0.003	1.122
1972	1	6.907	0.004	1.107	1.111	0.145	0.288	5.005	0.015	0.939
1972	2	6.726	0.005	1.078	6.951	0.018	1.805	6.556	0.004	1.230
1972	3	5.850	0.003	0.937	8.124	0.017	2.109	6.137	0.003	1.151
1972	4	6.561	0.022	1.051	4.017	0.021	1.043	5.316	0.012	0.997
1973	1	7.983	0.008	1.279	2.926	0.291	0.760	5.981	0.031	1.122
1973	2	7.752	0.012	1.242	5.510	0.024	1.431	6.390	0.008	1.199
1973	3	6.548	0.004	1.049	6.199	0.013	1.609	6.191	0.003	1.161
1973	4	6.143	0.005	0.984	3.005	0.010	0.780	5.016	0.003	0.941
1974	1	7.171	0.003	1.149	3.124	0.014	0.811	5.630	0.003	1.056
1974	2	4.800	0.004	0.769	5.382	0.011	1.397	4.744	0.003	0.890
1974	3	7.403	0.004	1.186	4.462	0.011	1.159	6.168	0.003	1.157
1974	4	6.993	0.004	1.120	1.685	0.013	0.438	5.190	0.003	0.974
1975	1	5.201	0.007	0.833	2.680	0.024	0.696	4.373	0.005	0.820
1975	2	4.991	0.014	0.800	4.890	0.012	1.270	4.890	0.007	0.917
1975	3	5.793	0.003	0.928	4.734	0.010	1.229	5.214	0.002	0.978
1975	4	5.528	0.004	0.886	1.363	0.022	0.354	4.075	0.004	0.764
1976	1	5.372	0.004	0.861	1.279	0.144	0.332	4.116	0.015	0.772
1976	2	5.063	0.011	0.811	3.741	0.040	0.971	4.751	0.009	0.891
1976	3	6.601	0.018	1.058	3.873	0.035	1.006	5.834	0.011	1.094
1976	4	4.504	0.011	0.722	1.391	0.141	0.361	3.845	0.018	0.721
1977	1	9.178	0.007	1.471	4.565	0.089	1.185	7.425	0.011	1.393
1977	2	9.065	0.026	1.453	15.852	0.049	4.116	11.104	0.017	2.083
1977	3	10.277	0.011	1.647	10.180	0.070	2.643	10.359	0.012	1.943
1977	4	11.740	0.006	1.881	4.566	0.061	1.186	9.174	0.008	1.721

Appendix Table 2. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (= CV of CPUE).(continued)

		Tropical			South			Whole		
year	quarte	CPUE	dev_t	relativ	CPUE	dev_t	relative	CPUE	dev_t	relative
1978	1	9.341	0.002	1.497	11.392	0.035	2.958	9.641	0.004	1.809
1978	2	10.889	0.012	1.745	6.476	0.022	1.682	9.481	0.008	1.779
1978	3	8.935	0.008	1.432	7.233	0.030	1.878	8.448	0.007	1.585
1978	4	9.889	0.005	1.585	3.923	0.036	1.019	8.032	0.005	1.507
1979	1	7.652	0.005	1.226	2.758	0.028	0.716	6.329	0.005	1.187
1979	2	6.534	0.005	1.047	8.838	0.018	2.295	7.205	0.004	1.352
1979	3	5.871	0.007	0.941	6.934	0.020	1.800	6.192	0.005	1.162
1979	4	5.746	0.003	0.921	2.240	0.032	0.582	4.774	0.004	0.896
1980	1	5.731	0.020	0.918	6.042	0.049	1.569	5.935	0.014	1.113
1980	2	8.759	0.022	1.404	7.738	0.032	2.009	8.398	0.013	1.575
1980	3	6.202	0.019	0.994	7.160	0.026	1.859	6.429	0.011	1.206
1980	4	8.838	0.004	1.416	4.961	0.015	1.288	7.635	0.003	1.432
1981	1	6.685	0.005	1.071	2.311	0.018	0.600	5.265	0.004	0.988
1981	2	6.818	0.010	1.092	6.121	0.028	1.589	6.525	0.007	1.224
1981	3	7.082	0.006	1.135	5.510	0.014	1.431	6.466	0.004	1.213
1981	4	8.184	0.003	1.311	3.308	0.013	0.859	6.663	0.002	1.250
1982	1	8.494	0.003	1.361	2.341	0.021	0.608	6.692	0.003	1.255
1982	2	11.485	0.010	1.840	14.588	0.036	3.788	12.272	0.008	2.302
1982	3	7.607	0.003	1.219	7.498	0.029	1.947	7.381	0.004	1.385
1982	4	9.048	0.002	1.450	1.338	0.019	0.347	6.660	0.003	1.249
1983	1	8.595	0.002	1.377	3.288	0.025	0.854	7.148	0.003	1.341
1983	2	5.509	0.002	0.883	6.578	0.025	1.708	5.681	0.003	1.066
1983	3	7.788	0.007	1.248	8.585	0.016	2.229	8.011	0.005	1.503
1983	4	7.689	0.004	1.232	4.957	0.016	1.287	6.915	0.003	1.297
1984	1	6.273	0.003	1.005	2.411	0.011	0.626	5.090	0.003	0.955
1984	2	4.713	0.009	0.755	7.412	0.021	1.924	5.239	0.006	0.983
1984	3	8.488	0.004	1.360	7.237	0.018	1.879	7.872	0.004	1.477
1984	4	7.337	0.008	1.176	2.385	0.010	0.619	5.705	0.005	1.070
1985	1	6.736	0.002	1.079	2.430	0.014	0.631	5.379	0.002	1.009
1985	2	5.933	0.012	0.951	4.501	0.010	1.169	5.411	0.006	1.015
1985	3	7.506	0.004	1.203	4.675	0.014	1.214	6.389	0.003	1.198
1985	4	6.981	0.005	1.119	1.473	0.019	0.382	5.141	0.004	0.964
1986	1	7.581	0.001	1.215	2.321	0.008	0.603	5.994	0.001	1.124
1986	2	6.358	0.006	1.019	2.707	0.019	0.703	5.053	0.005	0.948
1986	3	6.202	0.008	0.994	5.444	0.074	1.413	5.753	0.010	1.079
1986	4	9.283	0.002	1.487	2.092	0.026	0.543	7.079	0.003	1.328
1987	1	10.346	0.001	1.658	2.988	0.008	0.776	8.131	0.001	1.525
1987	2	5.670	0.006	0.909	5.108	0.032	1.326	5.093	0.006	0.955
1987	3	8.312	0.027	1.332	7.423	0.031	1.927	7.873	0.015	1.477
1987	4	9.286	0.002	1.488	3.016	0.016	0.783	7.393	0.003	1.387
1988	1	8.558	0.002	1.371	1.797	0.017	0.467	6.511	0.002	1.221
1988	2	2.349	0.004	0.376	6.860	0.024	1.781	3.302	0.004	0.619
1988	3	6.262	0.009	1.003	4.792	0.058	1.244	5.839	0.010	1.095
1988	4	8.347	0.003	1.338	3.520	0.026	0.914	6.843	0.004	1.284
1989	1	6.848	0.002	1.097	2.060	0.017	0.535	5.363	0.003	1.006
1989	2	5.980	0.010	0.958	4.581	0.034	1.189	5.467	0.008	1.026
1989	3	6.341	0.015	1.016	6.752	0.050	1.753	6.205	0.012	1.164
1989	4	8.936	0.004	1.432	2.008	0.022	0.521	6.918	0.004	1.298
1990	1	7.728	0.002	1.238	1.618	0.011	0.420	5.902	0.002	1.107
1990	2	3.876	0.020	0.621	4.596	0.097	1.193	3.620	0.018	0.679
1990	3	7.279	0.012	1.166	4.860	0.009	1.262	6.469	0.006	1.213
1990	4	6.417	0.003	1.028	2.014	0.034	0.523	4.993	0.004	0.937
1991	1	6.651	0.002	1.066	2.730	0.011	0.709	5.606	0.002	1.052
1991	2	7.043	0.014	1.129	4.409	0.016	1.145	6.280	0.008	1.178
1991	3	7.227	0.010	1.158	5.637	0.005	1.464	6.741	0.005	1.265
1991	4	5.300	0.005	0.849	4.645	0.006	1.206	4.818	0.003	0.904
1992	1	6.209	0.004	0.995	2.072	0.014	0.538	5.036	0.003	0.945
1992	2	3.354	0.030	0.537	4.309	0.014	1.119	3.442	0.015	0.646
1992	3	4.743	0.016	0.760	2.815	0.014	0.731	4.112	0.009	0.771
1992	4	7.371	0.004	1.181	3.345	0.013	0.868	6.189	0.003	1.161
1993	1	7.176	0.007	1.150	3.664	0.018	0.951	6.020	0.005	1.129
1993	2	4.653	0.014	0.746	5.424	0.013	1.408	4.631	0.008	0.869
1993	3	5.898	0.008	0.945	4.191	0.005	1.088	5.234	0.004	0.982
1993	4	5.444	0.003	0.872	5.101	0.008	1.325	5.256	0.002	0.986
1994	1	5.475	0.003	0.877	4.452	0.006	1.156	5.021	0.002	0.942
1994	2	3.854	0.018	0.618	6.091	0.005	1.581	4.156	0.009	0.780
1994	3	6.493	0.011	1.040	6.226	0.003	1.616	6.115	0.005	1.147
1994	4	5.837	0.002	0.935	4.463	0.004	1.159	5.058	0.001	0.949

Appendix Table 2. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (= CV of CPUE).(continued)

		Tropical			South			Whole		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
1995	1	6.253	0.003	1.002	3.709	0.003	0.963	5.130	0.002	0.962
1995	2	5.681	0.022	0.910	5.679	0.003	1.474	5.400	0.010	1.013
1995	3	4.643	0.008	0.744	4.629	0.002	1.202	4.265	0.004	0.800
1995	4	5.565	0.002	0.892	2.789	0.004	0.724	4.454	0.001	0.836
1996	1	5.643	0.002	0.904	4.048	0.003	1.051	4.862	0.001	0.912
1996	2	4.638	0.008	0.743	5.025	0.003	1.305	4.411	0.004	0.828
1996	3	6.515	0.014	1.044	4.756	0.002	1.235	5.779	0.007	1.084
1996	4	5.372	0.001	0.861	2.482	0.003	0.644	4.343	0.001	0.815
1997	1	4.793	0.001	0.768	2.993	0.012	0.777	4.086	0.002	0.766
1997	2	4.866	0.007	0.780	4.530	0.005	1.176	4.388	0.004	0.823
1997	3	3.574	0.003	0.573	4.105	0.002	1.066	3.484	0.002	0.654
1997	4	4.594	0.001	0.736	3.681	0.003	0.956	4.077	0.001	0.765
1998	1	5.058	0.001	0.810	5.246	0.016	1.362	4.850	0.002	0.910
1998	2	3.939	0.005	0.631	4.251	0.007	1.104	3.682	0.003	0.691
1998	3	4.983	0.004	0.798	4.967	0.007	1.290	4.740	0.002	0.889
1998	4	4.791	0.002	0.768	4.382	0.005	1.138	4.526	0.001	0.849
1999	1	5.355	0.001	0.858	5.139	0.009	1.334	5.032	0.002	0.944
1999	2	5.995	0.004	0.961	4.826	0.006	1.253	5.279	0.003	0.990
1999	3	4.454	0.003	0.714	4.458	0.005	1.157	4.226	0.002	0.793
1999	4	4.273	0.002	0.685	2.612	0.008	0.678	3.615	0.002	0.678
2000	1	4.522	0.001	0.725	5.012	0.007	1.301	4.457	0.001	0.836
2000	2	4.179	0.002	0.670	4.623	0.005	1.200	4.042	0.001	0.758
2000	3	3.404	0.006	0.545	5.011	0.003	1.301	3.712	0.003	0.696
2000	4	4.302	0.002	0.689	2.983	0.006	0.775	3.706	0.002	0.695
2001	1	3.867	0.002	0.620	3.531	0.005	0.917	3.650	0.001	0.685
2001	2	5.074	0.002	0.813	3.660	0.004	0.950	4.413	0.002	0.828
2001	3	4.605	0.004	0.738	3.308	0.003	0.859	3.831	0.002	0.719
2001	4	3.698	0.003	0.592	2.508	0.003	0.651	3.093	0.002	0.580
2002	1	4.263	0.002	0.683	4.421	0.004	1.148	4.147	0.001	0.778
2002	2	3.679	0.003	0.590	3.568	0.007	0.926	3.432	0.002	0.644
2002	3	2.593	0.002	0.416	2.469	0.003	0.641	2.409	0.001	0.452
2002	4	3.059	0.001	0.490	2.539	0.005	0.659	2.813	0.001	0.528
2003	1	3.846	0.002	0.616	3.219	0.023	0.836	3.603	0.003	0.676
2003	2	4.254	0.008	0.682	1.900	0.012	0.493	3.273	0.005	0.614
2003	3	2.509	0.014	0.402	2.686	0.005	0.697	2.444	0.007	0.459
2003	4	4.266	0.005	0.684	3.743	0.011	0.972	4.104	0.003	0.770
2004	1	4.371	0.002	0.700	6.991	0.018	1.815	5.040	0.003	0.946
2004	2	3.630	0.005	0.582	2.629	0.019	0.682	3.257	0.004	0.611
2004	3	3.377	0.003	0.541	3.140	0.006	0.815	3.230	0.002	0.606
2004	4	5.667	0.009	0.908	3.145	0.008	0.817	4.665	0.005	0.875
2005	1	5.366	0.003	0.860	2.586	0.011	0.672	4.306	0.002	0.808
2005	2	4.891	0.009	0.784	2.032	0.041	0.527	3.795	0.008	0.712
2005	3	5.372	0.013	0.861	2.498	0.012	0.649	4.149	0.007	0.778
2005	4	3.934	0.005	0.630	1.132	0.006	0.294	2.839	0.003	0.533
2006	1	3.815	0.002	0.611	1.114	0.007	0.289	2.803	0.002	0.526
2006	2	3.693	0.004	0.592	1.301	0.019	0.338	2.750	0.004	0.516
2006	3	4.129	0.004	0.662	3.905	0.007	1.014	3.871	0.003	0.726
2006	4	5.292	0.001	0.848	1.453	0.018	0.377	3.878	0.002	0.727
2007	1	4.179	0.001	0.670	0.647	0.026	0.168	2.872	0.003	0.539
2007	2	4.018	0.002	0.644	3.045	0.007	0.791	3.460	0.002	0.649
2007	3	5.146	0.004	0.825	2.216	0.005	0.575	3.813	0.002	0.715
2007	4	5.824	0.003	0.933	1.277	0.019	0.332	4.160	0.003	0.780
2008	1	3.942	0.001	0.632	1.909	0.015	0.496	3.108	0.002	0.583
2008	2	2.851	0.005	0.457	1.235	0.004	0.321	2.101	0.003	0.394
2008	3	4.024	0.006	0.645	1.524	0.005	0.396	3.055	0.003	0.573
2008	4	5.018	0.002	0.804	1.905	0.019	0.495	3.852	0.003	0.723
2009	1	3.257	0.001	0.522	2.296	0.025	0.596	2.817	0.003	0.529
2009	2	3.516	0.003	0.563	1.762	0.007	0.457	2.725	0.002	0.511
2009	3	3.686	0.007	0.591	1.841	0.004	0.478	2.890	0.004	0.542
2009	4	2.722	0.008	0.436	1.166	0.025	0.303	2.193	0.006	0.411
2010	1	3.280	0.002	0.526	1.504	0.013	0.390	2.455	0.002	0.461
2010	2	5.218	0.044	0.836	1.448	0.005	0.376	3.387	0.020	0.635
2010	3	2.665	0.009	0.427	2.573	0.005	0.668	2.615	0.005	0.491
2010	4	3.938	0.013	0.631	6.554	0.030	1.702	4.695	0.009	0.881

Appendix Table 2. Quarterly value of area aggregated standardized bigeye tuna CPUE in the tropical, south and whole Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (= CV of CPUE).(continued)

		Tropical			South			Whole		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
2011	1	5.111	0.007	0.819	2.555	0.042	0.663	3.878	0.009	0.727
2011	2	1.649	0.043	0.264	3.072	0.008	0.798	2.122	0.016	0.398
2011	3	3.867	0.027	0.620	3.830	0.009	0.994	4.053	0.010	0.760
2011	4	5.887	0.005	0.943	3.043	0.049	0.790	4.652	0.009	0.873
2012	1	3.443	0.004	0.552	0.865	0.048	0.225	2.499	0.006	0.469
2012	2	4.398	0.024	0.705	3.045	0.007	0.791	3.369	0.012	0.632
2012	3	6.841	0.027	1.096	4.268	0.010	1.108	5.541	0.014	1.039
2012	4	7.177	0.006	1.150	0.473	0.003	0.123	4.765	0.003	0.894
2013	1	4.025	0.004	0.645	1.458	0.037	0.379	2.959	0.005	0.555
2013	2	2.362	0.033	0.378	2.829	0.007	0.734	2.317	0.016	0.435
2013	3	3.332	0.008	0.534	2.796	0.011	0.726	3.170	0.005	0.595
2013	4	5.728	0.004	0.918	0.264	0.001	0.069	3.975	0.002	0.746

Appendix Table 2. Quarterly value of area specific standardized bigeye tuna CPUE in the east, west and south Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE).

		East			West			South		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
1960	1	8.728	0.006	1.284	6.927	0.007	1.260	1.603	0.018	0.472
1960	2	10.510	0.006	1.546	7.238	0.007	1.316	2.308	0.055	0.679
1960	3	10.378	0.010	1.527	9.423	0.011	1.714	3.847	0.030	1.132
1960	4	9.290	0.008	1.367	8.961	0.007	1.630	2.097	0.013	0.617
1961	1	7.704	0.008	1.134	5.295	0.007	0.963	1.039	0.016	0.306
1961	2	11.165	0.010	1.643	6.061	0.008	1.102	2.248	0.055	0.661
1961	3	11.798	0.012	1.736	5.611	0.011	1.020	3.988	0.021	1.173
1961	4	8.819	0.007	1.298	5.945	0.008	1.081	1.709	0.010	0.503
1962	1	8.994	0.006	1.323	6.625	0.006	1.205	1.740	0.010	0.512
1962	2	8.238	0.006	1.212	6.996	0.005	1.272	4.111	0.016	1.210
1962	3	12.945	0.006	1.905	6.292	0.011	1.144	2.514	0.010	0.740
1962	4	10.006	0.005	1.472	7.181	0.004	1.306	2.530	0.009	0.744
1963	1	9.643	0.005	1.419	5.245	0.005	0.954	1.688	0.008	0.497
1963	2	7.816	0.007	1.150	6.589	0.006	1.198	3.646	0.022	1.073
1963	3	10.373	0.007	1.526	6.138	0.023	1.116	3.586	0.011	1.055
1963	4	7.324	0.006	1.078	7.422	0.006	1.350	1.666	0.008	0.490
1964	1	9.859	0.007	1.451	5.496	0.005	0.999	1.303	0.009	0.383
1964	2	9.190	0.006	1.352	7.100	0.003	1.291	3.130	0.014	0.921
1964	3	10.189	0.005	1.499	4.559	0.008	0.829	3.240	0.008	0.953
1964	4	7.778	0.005	1.144	6.123	0.004	1.114	2.141	0.008	0.630
1965	1	8.818	0.005	1.297	4.656	0.003	0.847	1.303	0.010	0.383
1965	2	7.349	0.005	1.081	5.095	0.003	0.927	2.156	0.018	0.634
1965	3	7.613	0.005	1.120	5.518	0.005	1.003	2.975	0.008	0.875
1965	4	7.668	0.005	1.128	5.833	0.004	1.061	2.079	0.009	0.612
1966	1	9.137	0.005	1.344	6.411	0.003	1.166	1.592	0.010	0.468
1966	2	7.837	0.006	1.153	5.771	0.003	1.050	2.426	0.014	0.714
1966	3	10.059	0.005	1.480	6.372	0.004	1.159	3.691	0.012	1.086
1966	4	7.761	0.005	1.142	7.269	0.003	1.322	1.747	0.007	0.514
1967	1	9.226	0.005	1.357	4.503	0.003	0.819	1.780	0.007	0.524
1967	2	8.576	0.005	1.262	3.768	0.003	0.685	4.737	0.006	1.394
1967	3	9.005	0.005	1.325	5.245	0.005	0.954	4.429	0.007	1.303
1967	4	7.469	0.006	1.099	5.215	0.004	0.948	1.963	0.008	0.577
1968	1	6.925	0.005	1.019	6.042	0.004	1.099	2.916	0.010	0.858
1968	2	6.660	0.006	0.980	7.563	0.004	1.375	5.307	0.008	1.562
1968	3	9.700	0.005	1.427	11.768	0.005	2.140	3.863	0.007	1.137
1968	4	7.572	0.005	1.114	7.498	0.004	1.364	1.704	0.008	0.501
1969	1	7.688	0.006	1.131	6.435	0.003	1.170	2.374	0.008	0.699
1969	2	8.312	0.005	1.223	4.693	0.004	0.854	2.807	0.008	0.826
1969	3	9.172	0.007	1.349	6.886	0.005	1.252	5.144	0.008	1.513
1969	4	7.049	0.006	1.037	5.708	0.004	1.038	5.109	0.013	1.503
1970	1	8.663	0.006	1.275	6.113	0.004	1.112	4.622	0.030	1.360
1970	2	7.303	0.007	1.074	4.872	0.006	0.886	8.889	0.009	2.615
1970	3	8.982	0.005	1.322	7.253	0.019	1.319	9.323	0.008	2.743
1970	4	5.579	0.005	0.821	5.306	0.005	0.965	2.786	0.007	0.820
1971	1	5.213	0.005	0.767	3.567	0.004	0.649	4.148	0.010	1.220
1971	2	6.219	0.005	0.915	4.832	0.005	0.879	6.897	0.008	2.029
1971	3	5.988	0.006	0.881	9.368	0.007	1.704	4.307	0.008	1.267
1971	4	6.212	0.011	0.914	6.914	0.005	1.257	2.540	0.013	0.747
1972	1	7.727	0.010	1.137	6.003	0.005	1.092	2.439	0.050	0.718
1972	2	8.402	0.008	1.236	5.457	0.006	0.992	6.724	0.018	1.978
1972	3	6.680	0.013	0.983	4.806	0.005	0.874	7.680	0.017	2.260
1972	4	5.513	0.029	0.811	7.374	0.006	1.341	3.400	0.021	1.000
1973	1	7.782	0.010	1.145	6.909	0.007	1.256	4.177	0.110	1.229
1973	2	4.445	0.013	0.654	9.706	0.010	1.765	5.095	0.022	1.499
1973	3	7.939	0.008	1.168	4.576	0.007	0.832	6.084	0.013	1.790
1973	4	6.554	0.007	0.964	5.294	0.008	0.963	2.867	0.010	0.844
1974	1	6.785	0.006	0.998	5.867	0.008	1.067	3.624	0.012	1.066
1974	2	6.910	0.007	1.017	5.944	0.010	1.081	5.171	0.011	1.521
1974	3	7.102	0.006	1.045	6.579	0.007	1.196	3.957	0.010	1.164
1974	4	7.165	0.006	1.054	5.514	0.008	1.003	1.460	0.012	0.429
1975	1	6.837	0.005	1.006	5.740	0.009	1.044	2.291	0.025	0.674
1975	2	10.246	0.005	1.508	4.075	0.011	0.741	4.240	0.011	1.248
1975	3	5.603	0.006	0.824	4.405	0.006	0.801	4.646	0.010	1.367
1975	4	5.324	0.009	0.783	4.314	0.007	0.785	1.401	0.021	0.412
1976	1	6.209	0.010	0.914	3.471	0.007	0.631	1.859	0.030	0.547
1976	2	12.856	0.008	1.891	5.319	0.013	0.967	2.902	0.039	0.854
1976	3	12.647	0.012	1.861	5.888	0.023	1.071	4.028	0.025	1.185
1976	4	8.372	0.017	1.232	4.452	0.034	0.810	1.982	0.273	0.583
1977	1	8.451	0.013	1.243	12.152	0.018	2.210	3.070	0.078	0.903
1977	2	19.853	0.010	2.921	9.564	0.028	1.739	10.625	0.046	3.126
1977	3	16.684	0.007	2.455	12.241	0.022	2.226	9.248	0.051	2.721
1977	4	11.653	0.009	1.715	10.932	0.007	1.988	4.092	0.035	1.204

		Tropical			South			Whole		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
2011	1	5.111	0.007	0.819	2.555	0.042	0.663	3.878	0.009	0.727
2011	2	1.649	0.043	0.264	3.072	0.008	0.798	2.122	0.016	0.398
2011	3	3.867	0.027	0.620	3.830	0.009	0.994	4.053	0.010	0.760
2011	4	5.887	0.005	0.943	3.043	0.049	0.790	4.652	0.009	0.873
2012	1	3.443	0.004	0.552	0.865	0.048	0.225	2.499	0.006	0.469
2012	2	4.398	0.024	0.705	3.045	0.007	0.791	3.369	0.012	0.632
2012	3	6.841	0.027	1.096	4.268	0.010	1.108	5.541	0.014	1.039
2012	4	7.177	0.006	1.150	0.473	0.003	0.123	4.765	0.003	0.894
2013	1	4.025	0.004	0.645	1.458	0.037	0.379	2.959	0.005	0.555
2013	2	2.362	0.033	0.378	2.829	0.007	0.734	2.317	0.016	0.435
2013	3	3.332	0.008	0.534	2.796	0.011	0.726	3.170	0.005	0.595
2013	4	5.728	0.004	0.918	0.264	0.001	0.069	3.975	0.002	0.746

Appendix Table **2**. Quarterly value of area specific standardized bigeye tuna CPUE in the east, west and south Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (continued)

		East			West			South		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
1978	1	14.265	0.007	2.099	11.111	0.004	2.021	8.049	0.028	2.368
1978	2	18.578	0.007	2.733	9.020	0.004	1.640	4.856	0.022	1.429
1978	3	12.644	0.004	1.860	7.256	0.011	1.320	6.503	0.018	1.913
1978	4	11.604	0.006	1.707	8.670	0.009	1.577	3.338	0.027	0.982
1979	1	11.795	0.007	1.735	5.692	0.007	1.035	3.504	0.018	1.031
1979	2	10.464	0.013	1.540	8.173	0.012	1.486	6.749	0.018	1.986
1979	3	10.032	0.011	1.476	4.205	0.011	0.765	6.781	0.020	1.995
1979	4	11.722	0.005	1.725	7.710	0.033	1.402	2.176	0.025	0.640
1980	1	10.273	0.006	1.511	3.751	0.011	0.682	3.735	0.016	1.099
1980	2	13.456	0.009	1.980	8.609	0.010	1.566	5.756	0.033	1.694
1980	3	6.646	0.007	0.978	4.670	0.028	0.849	6.346	0.027	1.867
1980	4	9.510	0.009	1.399	8.152	0.005	1.483	4.655	0.014	1.370
1981	1	6.211	0.008	0.914	5.793	0.004	1.053	3.216	0.011	0.946
1981	2	6.229	0.012	0.917	11.984	0.010	2.179	5.501	0.024	1.619
1981	3	6.936	0.023	1.020	7.062	0.007	1.284	5.651	0.014	1.663
1981	4	7.828	0.007	1.152	7.950	0.004	1.446	3.315	0.012	0.975
1982	1	9.431	0.008	1.388	5.492	0.003	0.999	3.706	0.011	1.090
1982	2	9.951	0.012	1.464	13.483	0.007	2.452	7.240	0.028	2.130
1982	3	6.546	0.008	0.963	6.713	0.006	1.221	5.512	0.029	1.622
1982	4	8.692	0.006	1.279	7.804	0.003	1.419	1.848	0.037	0.544
1983	1	8.961	0.005	1.319	6.502	0.002	1.182	3.137	0.025	0.923
1983	2	7.671	0.015	1.129	10.420	0.005	1.895	5.085	0.026	1.496
1983	3	8.487	0.005	1.249	5.447	0.007	0.991	7.673	0.016	2.258
1983	4	10.476	0.006	1.541	5.836	0.005	1.061	4.576	0.016	1.346
1984	1	6.295	0.006	0.926	4.854	0.004	0.883	2.678	0.010	0.788
1984	2	4.893	0.009	0.720	7.719	0.006	1.404	4.886	0.014	1.437
1984	3	7.577	0.006	1.115	7.377	0.008	1.342	7.302	0.016	2.148
1984	4	7.074	0.007	1.041	6.840	0.007	1.244	2.520	0.010	0.741
1985	1	6.727	0.005	0.990	5.364	0.004	0.976	2.623	0.014	0.772
1985	2	5.121	0.008	0.753	7.582	0.006	1.379	3.907	0.010	1.149
1985	3	5.050	0.006	0.743	7.320	0.005	1.331	4.713	0.012	1.387
1985	4	6.355	0.010	0.935	7.338	0.004	1.335	1.560	0.020	0.459
1986	1	7.257	0.004	1.068	6.139	0.002	1.116	2.326	0.008	0.684
1986	2	4.436	0.019	0.653	8.192	0.004	1.490	2.438	0.019	0.717
1986	3	5.719	0.009	0.841	6.440	0.007	1.171	7.829	0.037	2.303
1986	4	8.936	0.007	1.315	7.399	0.003	1.346	2.686	0.050	0.790
1987	1	9.208	0.004	1.355	8.511	0.003	1.548	2.754	0.008	0.810
1987	2	3.758	0.060	0.553	7.758	0.005	1.411	4.463	0.033	1.313
1987	3	8.572	0.028	1.261	4.148	0.013	0.754	7.518	0.022	2.212
1987	4	9.257	0.006	1.362	8.495	0.004	1.545	2.784	0.016	0.819
1988	1	8.436	0.006	1.241	7.185	0.003	1.307	1.895	0.015	0.558
1988	2	3.282	0.099	0.483	6.586	0.006	1.198	7.021	0.021	2.066
1988	3	6.635	0.015	0.976	4.075	0.009	0.741	5.028	0.018	1.479
1988	4	7.600	0.006	1.118	6.568	0.004	1.194	2.778	0.025	0.817
1989	1	7.259	0.007	1.068	5.222	0.003	0.950	2.050	0.017	0.603
1989	2	5.961	0.023	0.877	6.537	0.006	1.189	5.764	0.022	1.696
1989	3	5.682	0.013	0.836	4.532	0.025	0.824	8.338	0.025	2.453
1989	4	9.079	0.010	1.336	6.746	0.007	1.227	1.566	0.022	0.461
1990	1	7.408	0.005	1.090	6.624	0.004	1.205	1.490	0.010	0.438
1990	2	3.243	0.294	0.477	5.675	0.007	1.032	5.375	0.033	1.582
1990	3	6.546	0.018	0.963	5.726	0.014	1.041	4.693	0.007	1.381
1990	4	5.618	0.006	0.827	5.738	0.006	1.043	1.765	0.022	0.519
1991	1	6.658	0.005	0.980	4.322	0.004	0.786	2.247	0.010	0.661
1991	2	9.216	0.031	1.356	5.891	0.013	1.071	4.284	0.012	1.260
1991	3	8.640	0.044	1.271	5.066	0.012	0.921	5.273	0.004	1.551
1991	4	3.520	0.009	0.518	5.591	0.009	1.017	3.639	0.005	1.071
1992	1	6.013	0.010	0.885	4.323	0.007	0.786	2.052	0.008	0.604
1992	2	0.862	0.293	0.127	5.498	0.009	1.000	3.654	0.008	1.075
1992	3	3.870	0.050	0.569	4.585	0.028	0.834	3.374	0.006	0.993
1992	4	7.025	0.014	1.034	5.013	0.007	0.912	2.957	0.011	0.870
1993	1	8.059	0.007	1.186	4.489	0.008	0.816	2.619	0.011	0.771
1993	2	4.472	0.038	0.658	5.222	0.007	0.950	3.650	0.008	1.074
1993	3	5.873	0.014	0.864	4.559	0.012	0.829	3.827	0.005	1.126
1993	4	6.695	0.012	0.985	3.408	0.004	0.620	4.261	0.007	1.254
1994	1	7.039	0.006	1.036	2.531	0.004	0.460	2.896	0.004	0.852
1994	2	3.791	0.148	0.558	4.759	0.005	0.865	4.870	0.003	1.433
1994	3	9.031	0.023	1.329	4.131	0.014	0.751	5.434	0.003	1.599
1994	4	6.361	0.008	0.936	4.191	0.003	0.762	3.687	0.003	1.085

		Tropical			South			Whole		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
2011	1	5.111	0.007	0.819	2.555	0.042	0.663	3.878	0.009	0.727
2011	2	1.649	0.043	0.264	3.072	0.008	0.798	2.122	0.016	0.398
2011	3	3.867	0.027	0.620	3.830	0.009	0.994	4.053	0.010	0.760
2011	4	5.887	0.005	0.943	3.043	0.049	0.790	4.652	0.009	0.873
2012	1	3.443	0.004	0.552	0.865	0.048	0.225	2.499	0.006	0.469
2012	2	4.398	0.024	0.705	3.045	0.007	0.791	3.369	0.012	0.632
2012	3	6.841	0.027	1.096	4.268	0.010	1.108	5.541	0.014	1.039
2012	4	7.177	0.006	1.150	0.473	0.003	0.123	4.765	0.003	0.894
2013	1	4.025	0.004	0.645	1.458	0.037	0.379	2.959	0.005	0.555
2013	2	2.362	0.033	0.378	2.829	0.007	0.734	2.317	0.016	0.435
2013	3	3.332	0.008	0.534	2.796	0.011	0.726	3.170	0.005	0.595
2013	4	5.728	0.004	0.918	0.264	0.001	0.069	3.975	0.002	0.746

Appendix Table **2**. Quarterly value of area specific standardized bigeye tuna CPUE in the east, west and south Indian Ocean for 1960-2013 expressed in real and relative scale in which the average from 1960 to 2013 is 1.0, with squared standard error of log CPUE (= CV of CPUE). (continued)

		East			West			South		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
1995	1	5.922	0.005	0.871	5.142	0.005	0.935	3.125	0.003	0.920
1995	2	5.240	0.020	0.771	6.359	0.010	1.156	4.502	0.003	1.325
1995	3	3.900	0.011	0.574	4.285	0.014	0.779	4.039	0.002	1.188
1995	4	5.399	0.005	0.794	4.455	0.003	0.810	2.302	0.003	0.677
1996	1	5.749	0.005	0.846	3.275	0.003	0.596	3.019	0.003	0.888
1996	2	4.282	0.020	0.630	5.366	0.005	0.976	3.698	0.002	1.088
1996	3	6.496	0.026	0.956	5.187	0.005	0.943	4.309	0.002	1.268
1996	4	6.058	0.005	0.891	3.874	0.002	0.705	2.223	0.003	0.654
1997	1	4.834	0.003	0.711	2.739	0.002	0.498	2.257	0.003	0.664
1997	2	4.001	0.034	0.589	5.349	0.003	0.973	3.414	0.003	1.005
1997	3	3.995	0.010	0.588	3.023	0.004	0.550	3.463	0.002	1.019
1997	4	5.852	0.004	0.861	3.176	0.002	0.578	2.864	0.003	0.843
1998	1	4.691	0.004	0.690	3.989	0.001	0.725	2.428	0.004	0.714
1998	2	2.207	0.013	0.325	4.218	0.002	0.767	3.282	0.004	0.966
1998	3	4.602	0.013	0.677	3.521	0.004	0.640	4.061	0.004	1.195
1998	4	6.035	0.005	0.888	2.860	0.003	0.520	2.185	0.004	0.643
1999	1	6.117	0.004	0.900	2.629	0.003	0.478	2.238	0.004	0.658
1999	2	5.037	0.011	0.741	4.707	0.007	0.856	3.227	0.004	0.950
1999	3	4.467	0.005	0.657	3.700	0.006	0.673	3.780	0.004	1.112
1999	4	4.419	0.004	0.650	3.380	0.002	0.615	1.869	0.005	0.550
2000	1	4.767	0.004	0.701	2.630	0.002	0.478	2.872	0.005	0.845
2000	2	3.884	0.004	0.572	3.573	0.004	0.650	3.299	0.004	0.971
2000	3	2.933	0.007	0.432	3.362	0.005	0.611	3.621	0.003	1.065
2000	4	4.241	0.007	0.624	3.401	0.003	0.619	2.397	0.005	0.705
2001	1	4.773	0.004	0.702	2.505	0.004	0.456	2.137	0.004	0.629
2001	2	5.393	0.006	0.794	3.158	0.004	0.574	2.672	0.005	0.786
2001	3	3.679	0.006	0.541	4.174	0.005	0.759	2.693	0.003	0.792
2001	4	3.470	0.006	0.510	2.971	0.004	0.540	2.121	0.004	0.624
2002	1	4.381	0.006	0.645	2.772	0.002	0.504	2.652	0.004	0.780
2002	2	3.249	0.010	0.478	3.383	0.003	0.615	2.414	0.006	0.710
2002	3	2.627	0.007	0.387	2.096	0.003	0.381	2.215	0.003	0.652
2002	4	3.844	0.003	0.566	2.051	0.002	0.373	2.122	0.005	0.624
2003	1	4.910	0.005	0.722	2.361	0.002	0.429	2.071	0.008	0.609
2003	2	3.122	0.028	0.459	3.810	0.004	0.693	1.919	0.010	0.565
2003	3	2.358	0.013	0.347	3.829	0.006	0.696	2.535	0.005	0.746
2003	4	5.848	0.006	0.860	2.352	0.002	0.428	3.151	0.011	0.927
2004	1	5.522	0.007	0.812	2.138	0.002	0.389	2.446	0.007	0.720
2004	2	3.218	0.017	0.474	3.222	0.003	0.586	2.616	0.011	0.770
2004	3	3.093	0.008	0.455	2.932	0.003	0.533	3.492	0.004	1.027
2004	4	6.225	0.005	0.916	3.806	0.002	0.692	2.928	0.007	0.862
2005	1	6.544	0.008	0.963	2.964	0.002	0.539	2.054	0.006	0.604
2005	2	5.059	0.018	0.744	3.799	0.002	0.691	2.671	0.009	0.786
2005	3	4.996	0.028	0.735	4.551	0.002	0.828	2.747	0.006	0.808
2005	4	3.510	0.013	0.516	4.089	0.001	0.744	1.393	0.005	0.410
2006	1	4.704	0.005	0.692	2.358	0.001	0.429	1.372	0.004	0.404
2006	2	3.752	0.008	0.552	2.914	0.001	0.530	2.149	0.006	0.632
2006	3	3.941	0.006	0.580	3.608	0.003	0.656	2.631	0.006	0.774
2006	4	5.940	0.005	0.874	3.584	0.001	0.652	1.213	0.007	0.357
2007	1	4.263	0.004	0.627	3.284	0.001	0.597	1.503	0.006	0.442
2007	2	3.053	0.007	0.449	4.077	0.001	0.741	2.397	0.005	0.705
2007	3	2.962	0.008	0.436	5.267	0.002	0.958	1.726	0.005	0.508
2007	4	5.478	0.005	0.806	4.595	0.002	0.836	1.162	0.010	0.342
2008	1	4.026	0.005	0.592	2.861	0.002	0.520	1.758	0.006	0.517
2008	2	3.501	0.011	0.515	2.889	0.002	0.525	1.322	0.005	0.389
2008	3	3.586	0.010	0.528	4.108	0.002	0.747	1.399	0.006	0.412
2008	4	5.061	0.004	0.745	4.323	0.002	0.786	1.446	0.006	0.425
2009	1	3.351	0.004	0.493	2.651	0.001	0.482	1.705	0.008	0.502
2009	2	2.924	0.008	0.430	3.559	0.002	0.647	1.828	0.007	0.538
2009	3	2.934	0.007	0.432	3.293	0.007	0.599	1.655	0.005	0.487
2009	4	3.258	0.004	0.479	3.112	0.006	0.566	1.328	0.013	0.391
2010	1	5.922	0.005	0.871	5.142	0.005	0.935	1.738	0.008	0.511
2010	2	5.240	0.020	0.771	6.359	0.010	1.156	1.390	0.006	0.409
2010	3	3.900	0.011	0.574	4.285	0.014	0.779	2.455	0.005	0.722
2010	4	5.399	0.005	0.794	4.455	0.003	0.810	2.035	0.011	0.599

		Tropical			South			Whole		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
2011	1	5.111	0.007	0.819	2.555	0.042	0.663	3.878	0.009	0.727
2011	2	1.649	0.043	0.264	3.072	0.008	0.798	2.122	0.016	0.398
2011	3	3.867	0.027	0.620	3.830	0.009	0.994	4.053	0.010	0.760
2011	4	5.887	0.005	0.943	3.043	0.049	0.790	4.652	0.009	0.873
2012	1	3.443	0.004	0.552	0.865	0.048	0.225	2.499	0.006	0.469
2012	2	4.398	0.024	0.705	3.045	0.007	0.791	3.369	0.012	0.632
2012	3	6.841	0.027	1.096	4.268	0.010	1.108	5.541	0.014	1.039
2012	4	7.177	0.006	1.150	0.473	0.003	0.123	4.765	0.003	0.894
2013	1	4.025	0.004	0.645	1.458	0.037	0.379	2.959	0.005	0.555
2013	2	2.362	0.033	0.378	2.829	0.007	0.734	2.317	0.016	0.435
2013	3	3.332	0.008	0.534	2.796	0.011	0.726	3.170	0.005	0.595
2013	4	5.728	0.004	0.918	0.264	0.001	0.069	3.975	0.002	0.746

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		East			West			South		
year	quarter	CPUE	dev_t	relative	CPUE	dev_t	relative	CPUE	dev_t	relative
2011	1	2.856	0.004	0.420	3.65	0.163	0.664	3.056	0.020	0.899
2011	2	2.044	0.020	0.301				3.501	0.008	1.030
2011	3	4.104	0.021	0.604				3.310	0.009	0.974
2011	4	4.123	0.006	0.607				1.418	0.019	0.417
2012	1	3.838	0.007	0.565				1.704	0.014	0.501
2012	2	2.098	0.099	0.309	6.976	0.054	1.269	3.290	0.006	0.968
2012	3	10.525	0.148	1.549	4.699	0.025	0.855	3.300	0.010	0.971
2012	4	5.899	0.009	0.868	8.071	0.017	1.468	2.499	0.037	0.735
2013	1	4.140	0.009	0.609	2.894	0.013	0.526	2.554	0.014	0.751
2013	2	3.000	0.148	0.441	3.897	0.013	0.709	2.688	0.007	0.791
2013	3	4.957	0.031	0.729				2.572	0.011	0.757
2013	4	6.284	0.007	0.925	7.765	0.066	1.412	1.321	0.019	0.389