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Standardization of annual and quarterly CPUE for yellowfin tuna caught by Japanese longline fishery in the Indian Ocean up to 2007 using general linear model

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Abstract

Japanese longline CPUE for yellowfin tuna was standardized up to 2007 by GLM (CPUE-LogNormal error structured model) which SST (Sea Surface Temperature) was included in the model as oceanographic factor. Number of hooks between float (NHF) and material of main line and branch line were applied in the model to standardize the change of the catchability which has been derived by fishing gear configuration. Quarterly and annual CPUEs in the tropical Indian Ocean were standardized to provide abundance index for yellowfin assessment using standard models, such as ASPM and SS2, in the IOTC WPTT in 2008. Additionally, quarterly CPUE in each area in the whole Indian Ocean was also standardized for the assessment using Multifan-CL which would be newly tried to be applied to yellowfin assessment in this Ocean.

In the tropical Indian Ocean, annual CPUE continuously decreased from around 23.0 (real scale: catch in number per 1000 hooks) in 1960 to .5 in 1972, and was kept in same level until 1988. Thereafter, it declined to about 4.0 in 1991 and has been kept in the low level with fluctuation between 2.9 and 4.2. Although the data in the latest year 2007 is preliminary, CPUE in this year was estimated to be about 2.7, the lowest record in the period analyzed.

1. Introduction

In the CPUE standardization of longline CPUE, targeting is regarded to be an important factor to standardize the change in the catchability for the tuna species, although the term, “target” is difficult to define and is apt to be simply interpreted as that higher CPUE or higher ratio in species composition should mean higher probability of target. In the case that the change in the main target species happens accompanied by shift of fishing ground and/or fishing season, it would be relatively easy to account these change in the CPUE standardization by applying adequate area definition and/or season factors in the model.

However, if the distribution of original target species and that of changed target species are same or broadly duplicated, time and space factors can not be effective targeting indicators. If change in the targeting without shift of fishing ground and/or season brings the change of CPUE level of one species, it is supposed that some fishing method should have been introduced into the fishery depending to the difference in biological characteristics between both species such as vertical distribution pattern, food, etc . It is well known that the target species in the tropical ocean for Japanese longliners shifted in the middle of 1970s from yellowfin as mainly material for processed food to bigeye as material of “sashimi”. This target change was accompanied with the shift of gear configuration from regular longline (NHF 5-6) to deep longline (NHF 10 or more, Suzuki 1977, Okamoto et al, 2004) to catch bigeye which distribute at deeper water than yellowfin effectively. Therefore, NHF has been applied in the model to standardize the change of the catchability brought by change in the fishing gear configuration derived mainly from targeting change. Although it is apt to be supposed that larger NHF means deeper gear depth, it is not necessarily correct and it is not necessary to assume that (Okamoto 2005).

Target change is not only factor that affect on the gear configuration. In the end of

1980s through early 1990s, increase in the number of hooks between floats (NHF) was observed in tropical and temperate areas, that is, from NHF=13 to NHF=20 in the tropical and from NHF=7 to NHF=10 in the temperate (Okamoto et al., 2004). This big shift in the gear configuration in this time, however, seems not to be brought by target shifting but by the introduction of new material, Nylon mono-filament, for longline gear (Okamoto, 2005, Okamoto and Shono 2006). It is naturally supposed that the different gear material may cause the difference in catch ability, and that CPUE may be different between same NHF of different material. Therefore, in the last stock assessment of bigeye in 2006 (Okamoto and Shono, 2006), gear material information was applied into model to standardize the difference in catch rate brought by targeting more appropriately. In this paper, the same approach using gear material information combined with that of gear configuration is applied to the yellowfin CPUE standardization.

Since the late 1990s, yellowfin ratio in the total of bigeye and yellowfin catch has been increased in the Indian Ocean. This increasing trend of yellowfin ratio is obvious in the western Indian Ocean where this trend started around early 1990s (Okamoto, 2005). This increasing in yellowfin ratio seems to have been brought mainly by shift of fishing ground (distribution of effort concentration) to yellowfin dominant region in the western Indian Ocean. Although the period of this shift in effort concentration is overlapped with that of the change in gear material, the relation between them is not clear.

2. Materials and methods

Principally, the model used for the standardization in this paper is the same as that used in the yellowfin assessment last year (Okamoto et al, 2007, Okamoto, 2007).

Area definition:

Basic area definition used in this study was the same as that agreed in the IOTC WPTT meeting in 2002 (Fig. 1). Since the assessment meeting in 2007 held in July, it was agreed to use only tropical areas (area2, area 5 and north of 30 degree south in area 3) for CPUE standardization, these tropical areas were used in this paper for standard analyses. Because north part of area 3 is very small, if this area is treated as a separated area, it cause missing data. Then in this analysis, this small area was treated a part of area 2. Therefore, two areas, area 2 (including north part of area 3) and Area 5 were used in the standardization of CPUE in the tropical Indian Ocean.

For Multifan-CL analysis. CPUE was standardized for each of five areas which cover whole Indian Ocean, except for the areas east of India (north of area 5) and south part of area 3. Although CPUE standardization was conducted for all five sub-areas, CPUE in sub-area 1 is not reliable and should not be used in the assessment since this sub-area is historically not major fishing ground for Japanese longliners and fishing effort in this sub-area is very sparse. Because of that, there are so many missing data in this sub-area.

Environmental factors:

As environmental factors, which are available for the analyzed period from 1960 to 2007, 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 2004, was downloaded from NEAR-GOOS Regional Real Time Data Base of Japan Meteorological Agency (JMA).

http://goos.kishou.go.jp/rrtdb/database.html

It is necessary to get password to access the data retrieving system. The original data was recompiled into 5-degree latitude and 5-latitude longitude by month from 1960 to 2007 using the procedures described in Okamoto et al. (2001), and used in the analyses.

Catch and effort data used:

The Japanese longline catch (in number) and effort statistics from 1960 up to 2007 were used. 2007 data is preliminary. The catch and effort data set aggregated by month, 5-degree square, NHF (the number of hooks between floats), and main and branch 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 does not available for the period from 1960 to 1974, NHF was regarded to be 5 in this period. Main and branch line material was classified into two categories, 1 = Nylon and 2 = other. Although this information on the materials has been collected since 1994, the nylon material was started to be used by distant water longliner in the tropical Indian Ocean in around the late 1980s and spread quickly in the early 1990s (Okamoto 2005). And it seems that the larger number of NHF than 17 or 18 would become possible to be used as a result of introduction of the new material. Therefore, the material of NHF 17 or larger was assumed to be nylon since 1990.

GLM (Generalized Linear Model):

CPUE based on the catch in number was used. CPUE is calculated as "the number of caught fish / the number of hooks * 1000"

As the model for standardizing CPUE, CPUE-LogNormal error structured model was used. The followings was the initial model for each analysis. Basing on the result of ANOVA (type III SS), non-significant effects were removed in step-wise from the initial model based on the F-value ($p<0.05$).

- Initial Model for Year based CPUE standardization in the tropical Indian Ocean for 1960 (or 1968 or 1980) through 2007

Log (CPUE+const)= μ +YR +QT +AREA +NHFCL +ML +BL +SST +SST2 +SST3 +YR*QT +QT*AREA +YR*AREA +AREA*NHFCL +NHFCL*ML +NHFCL*BL +AREA*SST +YR*SST

- Initial Model for Quarter based CPUE standardization in the tropical Indian Ocean for 1960 (or 1968 or 1980) through 2007

Log (CPUE+const)= μ +YR +QT +AREA +NHFCL +ML +BL +SST +SST2 +SST3 +YR*QT*AREA +AREA*NHFCL +NHFCL*ML +NHFCL*BL +AREA*SST +YR*SST

- Initial Model for quarter based CPUE standardization in each area for whole Indian Ocean from 1960 through 2007

Log (CPUE+const)= μ +YR +QT +AREA +NHFCL +ML +BL +SST +SST2 +SST3 +YR*QT +NHFCL*ML +NHFCL*BL +YR*SST

Where Log : natural logarithm,
CPUE : catch in number of bigeye per 1000 hooks,
Const : 10% of overall mean of CPUE
μ : overall mean,
YR : effect of year,
QT : effect of fishing season (quarter)
Area: effect of area,
NHFCL : effect of gear type (category of the number of hooks between floats),
SST : effect of SST (as a continuous variable),
SST2 : effect of SST2 (=SST x SST, as a continuous variable),
SST3 : effect of SST3 (=SST x SST x SST, as a continuous variable),
MLD: effect of MLD (mixing layer depth),

ML： effect of material of main line,
BL： effect of material of branch line,
YR*QT：interaction term between year and quarter,
QT*Area: interaction term between quarter and area,
YR*Area: interaction term between year and area,
Area*NHFCL: interaction term between area and gear type,
NHFCL*ML: interaction term between material of gear type and main line,
NHFCL*BL: interaction term between material of gear type and branch line,
Area*SST：interaction term between area and SST,
YR*SST：interaction term between year and SST,
YR*QT*Area：interaction term between year, quarter and Area,
e： error term.

The number of hooks between float (NHF) was divided into 6 classes (NHFCL 1: 5-7, NHFCL 2: 8-10, NHFCL 3: 11-13, NHFCL 4: 14-16, NHFCL 5: 17-19, NHFCL 6: 20-21) as later explanation.

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

$$CPUE_i = \Sigma\ W_j * (\exp(\mathrm{lsmean}(Year\ i*Area\ j))-constant)$$

Where $CPUE_i$ = CPUE in year i,
W_j = Area rate of Area j , ($\Sigma W_j = 1$),
lsmean(Year*Areaij) = least square mean of Year-Area interaction in Year i and Area j (As for the quarter based CPUE, least square mean of Year*Quarter*Area was used instead),
constant = 10% of overall mean of CPUE.

3. Results and discussion

CPUE standardizations by GLM:

The yellowfin CPUE (catch in number per 1000 hooks) was standardized by GLM (CPUE-LogNormal error structured model) for both of area categories, Tropical (sub-area 2 and 5) and each of five sub-areas in whole Indian Ocean (sub-areas 1 – 5), as described in the materials and method section.

Trends of annual CPUE for tropical Indian Ocean (sub-area 2, 3 and 5) from 1960 through 2007 was shown in Fig. 2 in real scale overlaying nominal CPUE and in relative scale. In the tropical Indian Ocean, CPUE continuously decreased from around 23.0 (real scale) in 1960 to .5 in 1972, and was kept in same level until 1988. Thereafter, it declined to about 4.0 in 1991 and has been kept in the low level with fluctuation between 2.9 and 4.2. Although the data in the latest year 2007 is preliminary, CPUE in this year was estimated to be about 2.7, the lowest record in the period analyzed. Looking at the trend of nominal CPUE, however, CPUE was kept in high level after 1999. This different trend between nominal and standardized CPUE should be interpreted as that the high nominal CPUE was caused by shift of Japanese longline effort into the yellowfin abundant area and yellowfin CPUE did not necessarily increased in the all tropical area in the Indian Ocean. Quarterly CPUE trend for tropical area is basically similar to that of all Indian Ocean (Fig. 3). Distributions of the standard residual for both of annual and quarterly CPUE did not show remarkable difference from the normal distribution (Figs. 4 and 5).

Quarterly CPUEs for each of five sub-areas in the whole Indian Ocean were shown in Fig. 6

in real and relative scale overlaid with nominal CPUE. The CPUE trend in which CPUE declined from the beginning year of analysis until around 1978 and kept in the low level thereafter, is basically similar among all sub-areas with miner difference between them. Quarter based standardized CPUE in all sub-areas, distributions of the standard residual did not show remarkable difference from the normal distribution (Fig. 7).

Annual values of standardized CPUE in number for tropical area was listed in Appendix Table 1 for three kind of periods, 1960-2007, 1968-2007 and 1980-2007, in real and relative scales with variation. Quarterly CPUEs in number standardized for tropical area was also listed in Appendix Table 2 in the same manner as year based CPUEs.

4. Recerences

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Table 1. ANOVA table of GLM for year based CPUE from 1960 (top), 1968 (middle) and 1980 (bottom) to 2007 in the tropical Indian Ocean

All Tropical (Area 2 (&3) &5) 1960-2007 Year base

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	315	10639.264	33.775	63.860	<.0001	R-Square= 0.403119
						CV =
yr	47	277.364	5.901	11.160	<.0001	40.9488
qt	3	5.451	1.817	3.440	0.0161	
area	1	26.508	26.508	50.120	<.0001	
nhfcl	5	89.811	17.962	33.960	<.0001	
bl	1	0.710	0.710	1.340	0.2466	
ml	1	12.638	12.638	23.900	<.0001	
sst	1	12.505	12.505	23.640	<.0001	
sst2	1	40.220	40.220	76.050	<.0001	
sst3	1	46.132	46.132	87.230	<.0001	
yr*qt	141	815.907	5.787	10.940	<.0001	
qt*area	3	166.173	55.391	104.740	<.0001	
yr*area	47	473.308	10.070	19.040	<.0001	
area*nhfcl	5	21.408	4.282	8.100	<.0001	
nhfcl*ml	5	29.929	5.986	11.320	<.0001	
nhfcl*bl	5	19.685	3.937	7.440	<.0001	
sst*area	1	17.668	17.668	33.410	<.0001	
sst*yr	47	255.842	5.443	10.290	<.0001	

All Tropical (Area 2 (&3) &5) 1968-2007 Year base

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	267	7374.455	27.620	46.660	<.0001	R-Square= 0.323544
						CV =
yr	39	282.805	7.251	12.250	<.0001	47.50373
qt	3	5.627	1.876	3.170	0.0233	
area	1	10.102	10.102	17.060	<.0001	
nhfcl	5	92.097	18.419	31.120	<.0001	
bl	1	0.717	0.717	1.210	0.271	
ml	1	13.989	13.989	23.630	<.0001	
sst	1	5.340	5.340	9.020	0.0027	
sst2	1	41.707	41.707	70.450	<.0001	
sst3	1	46.745	46.745	78.970	<.0001	
yr*qt	117	825.402	7.055	11.920	<.0001	
qt*area	3	217.912	72.637	122.710	<.0001	
yr*area	39	461.020	11.821	19.970	<.0001	
area*nhfcl	5	24.524	4.905	8.290	<.0001	
nhfcl*ml	5	31.691	6.338	10.710	<.0001	
nhfcl*bl	5	21.541	4.308	7.280	<.0001	
sst*area	1	5.270	5.270	8.900	0.0029	
sst*yr	39	264.549	6.783	11.460	<.0001	

All Tropical (Area 2 (&3) &5) 1980-2007 Year base

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	194	5693.922	29.350	46.090	<.0001	R-Square= 0.287753
						CV =
yr	27	239.329	8.864	13.920	<.0001	52.53461
qt	3	25.031	8.344	13.100	<.0001	
area	1	660.185	660.185	1036.820	<.0001	
nhfcl	5	92.479	18.496	29.050	<.0001	
bl	1	0.688	0.688	1.080	0.2988	
ml	1	15.117	15.117	23.740	<.0001	
sst	1	5.997	5.997	9.420	0.0022	
sst2	1	33.335	33.335	52.350	<.0001	
sst3	1	39.228	39.228	61.610	<.0001	
yr*qt	81	691.864	8.542	13.410	<.0001	
qt*area	3	252.371	84.124	132.120	<.0001	
yr*area	27	347.080	12.855	20.190	<.0001	
area*nhfcl	5	25.999	5.200	8.170	<.0001	
nhfcl*ml	5	34.133	6.827	10.720	<.0001	
nhfcl*bl	5	22.945	4.589	7.210	<.0001	
sst*area						
sst*yr	27	232.914	8.626	13.550	<.0001	

Table 2. ANOVA table of GLM for quarter based CPUE from 1960 (top), 1968 (middle) and 1980 (bottom) to 2007 in the tropical Indian Ocean

All Tropical (Area 2 (&3)&5) 1960-2007 Quarter base

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square=
Model	456	11018.611	24.164	46.600	<.0001	0.417492
						CV =
yr	47	269.721	5.739	11.070	<.0001	40.54884
qt	3	4.150	1.383	2.670	0.046	
area	1	27.505	27.505	53.040	<.0001	
nhfcl	5	85.866	17.173	33.120	<.0001	
bl	1	0.585	0.585	1.130	0.2881	
ml	1	12.720	12.720	24.530	<.0001	
sst	1	12.055	12.055	23.250	<.0001	
sst2	1	38.457	38.457	74.160	<.0001	
sst3	1	43.804	43.804	84.470	<.0001	
yr*qt*area	332	1912.886	5.762	11.110	<.0001	
area*nhfcl	5	21.509	4.302	8.300	<.0001	
nhfcl*ml	5	28.699	5.740	11.070	<.0001	
nhfcl*bl	5	19.153	3.831	7.390	<.0001	
sst*area	1	18.878	18.878	36.400	<.0001	
sst*yr	47	251.081	5.342	10.300	<.0001	

All Tropical (Area 2 (&3)&5) 1968-2007 Quarter base

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square=
Model	384	7717.669	20.098	34.570	<.0001	0.338602
						CV =
yr	47	269.721	5.739	11.070	<.0001	47.07789
qt	3	4.150	1.383	2.670	0.046	
area	1	27.505	27.505	53.040	<.0001	
nhfcl	5	85.866	17.173	33.120	<.0001	
bl	1	0.585	0.585	1.130	0.2881	
ml	1	12.720	12.720	24.530	<.0001	
sst	1	12.055	12.055	23.250	<.0001	
sst2	1	38.457	38.457	74.160	<.0001	
sst3	1	43.804	43.804	84.470	<.0001	
yr*qt*area	332	1912.886	5.762	11.110	<.0001	
area*nhfcl	5	21.509	4.302	8.300	<.0001	
nhfcl*ml	5	28.699	5.740	11.070	<.0001	
nhfcl*bl	5	19.153	3.831	7.390	<.0001	
sst*area	1	18.878	18.878	36.400	<.0001	
sst*yr	47	251.081	5.342	10.300	<.0001	

All Tropical (Area 2 (&3)&5) 1980-2007 Quarter base

Source	DF	Type III SS	Mean Square	F Value	Pr > F	R-Square=
Model	276	5941.835	21.528	34.290	<.0001	0.300281
						CV =
yr	27	244.354	9.050	14.410	<.0001	52.16723
qt	3	16.985	5.662	9.020	<.0001	
area	1	7.929	7.929	12.630	0.0004	
nhfcl	5	91.914	18.383	29.280	<.0001	
bl	1	0.686	0.686	1.090	0.2959	
ml	1	15.028	15.028	23.940	<.0001	
sst	1	7.437	7.437	11.850	0.0006	
sst2	1	36.482	36.482	58.100	<.0001	
sst3	1	42.096	42.096	67.050	<.0001	
yr*qt*area	192	1554.069	8.094	12.890	<.0001	
area*nhfcl	5	24.487	4.897	7.800	<.0001	
nhfcl*ml	5	32.688	6.538	10.410	<.0001	
nhfcl*bl	5	22.588	4.518	7.200	<.0001	
sst*area	1	3.256	3.256	5.190	0.0228	
sst*yr	27	236.662	8.765	13.960	<.0001	

Table 3. ANOVA table of GLM for quarter based CPUE for each of five sub-area 1-5 in whole Indian Ocean from 1960 to 2007

Area 1

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	79	343.593	4.349	10.300	<.0001	R-Square= 0.687
						CV =
yr	41	183.476	4.475	10.600	<.0001	52.439
qt	3	3.803	1.268	3.000	0.031	
nhfcl						
bl						
ml	1	1.902	1.902	4.500	0.035	
sst						
sst2	1	5.881	5.881	13.920	0.000	
sst3						
yr*qt	33	43.845	1.329	3.150	<.0001	
nhfcl*ml						
nhfcl*bl						
sst*yr						

Area 2

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	256	3786.530	14.791	29.570	<.0001	R-Square= 0.345
						CV =
yr	47	2584.630	54.992	109.920	<.0001	34.985
qt	3	86.674	28.891	57.750	<.0001	
nhfcl	5	100.681	20.136	40.250	<.0001	
bl	1	1.815	1.815	3.630	0.057	
ml						
sst						
sst2						
sst3						
yr*qt	141	763.081	5.412	10.820	<.0001	
nhfcl*ml	6	106.578	17.763	35.510	<.0001	
nhfcl*bl	5	7.338	1.468	2.930	0.012	
sst*yr	48	135.733	2.828	5.650	<.0001	

Area 3

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	184	2758.848	14.994	24.710	<.0001	R-Square= 0.486
						CV =
yr	46	337.377	7.334	12.090	<.0001	44.424
qt						
nhfcl	5	34.027	6.805	11.220	<.0001	
bl						
ml						
sst	1	28.992	28.992	47.780	<.0001	
sst2	1	49.206	49.206	81.090	<.0001	
sst3	1	56.213	56.213	92.640	<.0001	
yr*qt	124	462.849	3.733	6.150	<.0001	
nhfcl*ml	6	43.323	7.221	11.900	<.0001	
nhfcl*bl						
sst*yr						

Area 4

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	257	12401.132	48.253	55.070	<.0001	R-Square= 0.568
						CV =
yr	47	298.270	6.346	7.240	<.0001	-186.709
qt	3	335.712	111.904	127.720	<.0001	
nhfcl	5	73.129	14.626	16.690	<.0001	
bl	1	6.024	6.024	6.880	0.009	
ml	1	22.645	22.645	25.840	<.0001	
sst	1	217.492	217.492	248.230	<.0001	
sst2						
sst3	1	40.699	40.699	46.450	<.0001	
yr*qt	141	631.270	4.477	5.110	<.0001	
nhfcl*ml	5	50.521	10.104	11.530	<.0001	
nhfcl*bl	5	89.468	17.894	20.420	<.0001	
sst*yr	47	562.586	11.970	13.660	<.0001	

Area 5

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	258	4583.705	17.766	44.910	<.0001	R-Square= 0.531
						CV =
yr	47	88.931	1.892	4.780	<.0001	44.563
qt	3	27.446	9.149	23.130	<.0001	
nhfcl	5	18.387	3.677	9.300	<.0001	
bl	1	8.776	8.776	22.180	<.0001	
ml						
sst	1	8.219	8.219	20.770	<.0001	
sst2	1	3.795	3.795	9.590	0.002	
sst3	1	3.796	3.796	9.600	0.002	
yr*qt	141	309.621	2.196	5.550	<.0001	
nhfcl*ml	6	20.010	3.335	8.430	<.0001	
nhfcl*bl	5	13.837	2.767	7.000	<.0001	
sst*yr	47	101.538	2.160	5.460	<.0001	

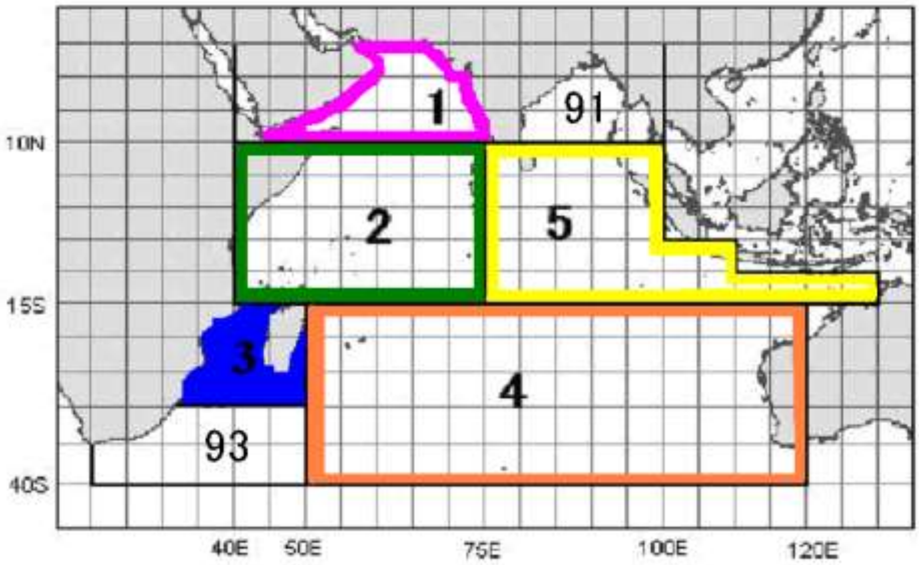


Fig. 1. Definition of sub-areas used in this study. Tropical (sub-areas 2, 3 and 5) and whole Indian area (sub-areas 1-5) categories in this paper.

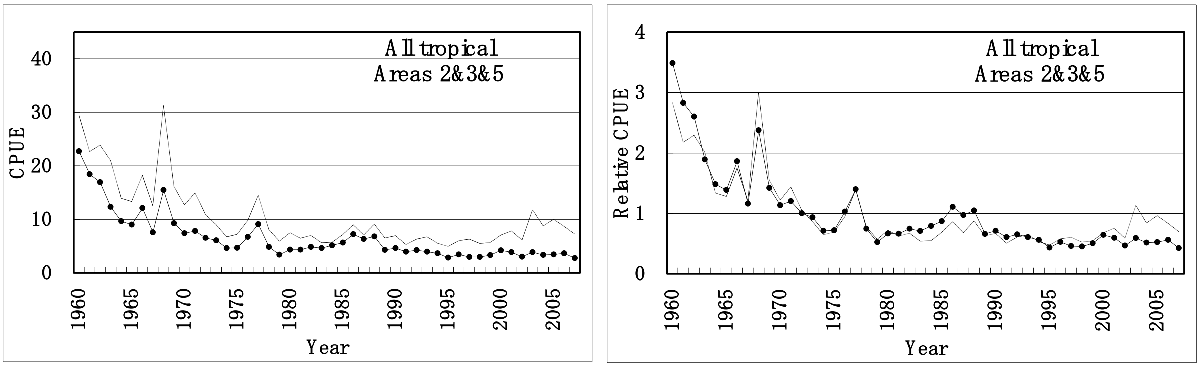


Fig. 2. Standardized annual based CPUE in number from 1960 to 2007 for tropical area expressed in relative (left figure) and real (right figure) scale overlaid with nominal CPUE.

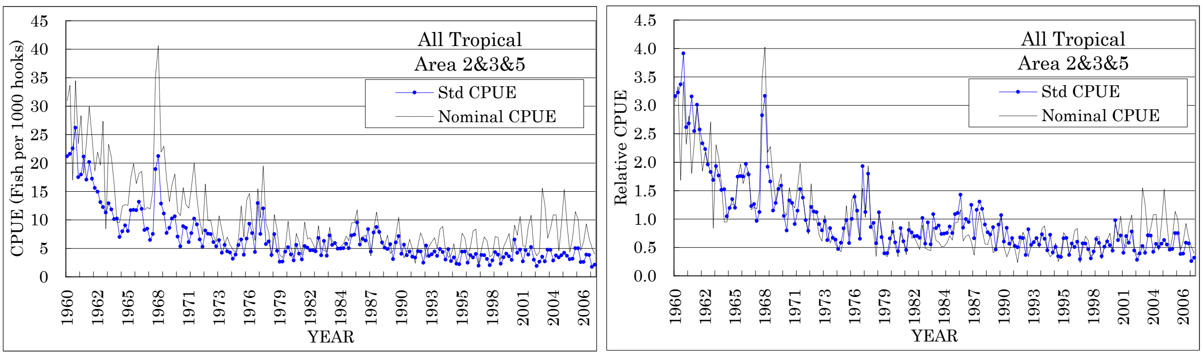


Fig. 3. Standardized quarter based CPUE in number from 1960 to 2007 for tropical area expressed in relative (left figure) and real (right figure) scale overlaid with nominal CPUE.

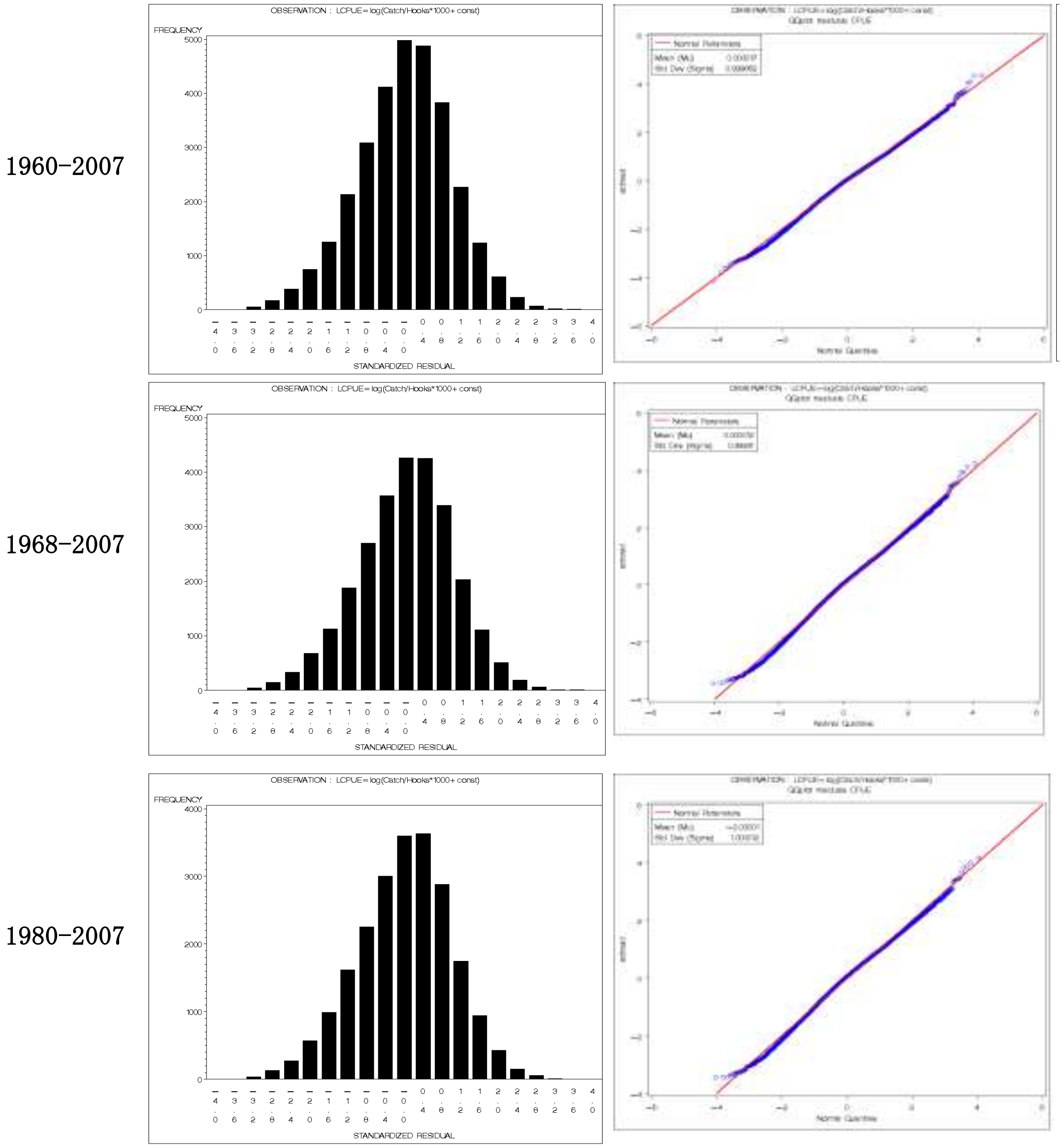
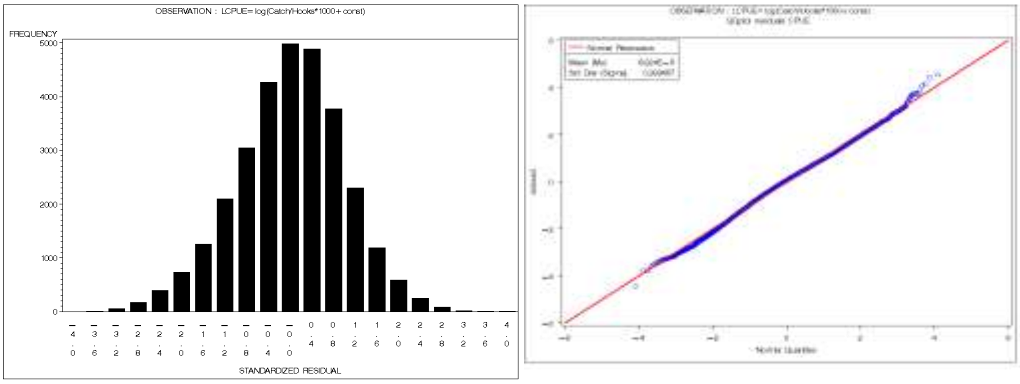
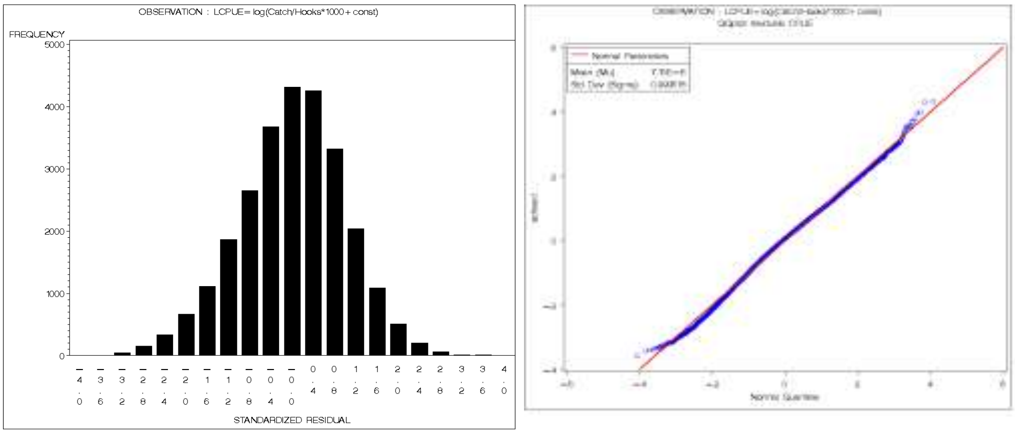


Fig. 4　Standardized residuals of annual based CPUE standardization for three kind of analyzed period for tropical area expressed as histograms and QQ plots.

1960–2007



1960–2007



1980–2007

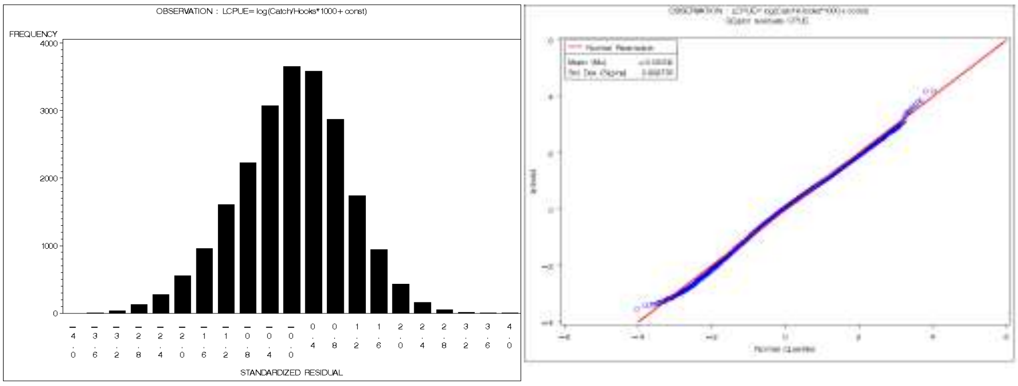


Fig. 5. Standardized residuals of quarter based CPUE standardization for three kind of analyzed period for tropical area expressed as histograms and QQ plots.

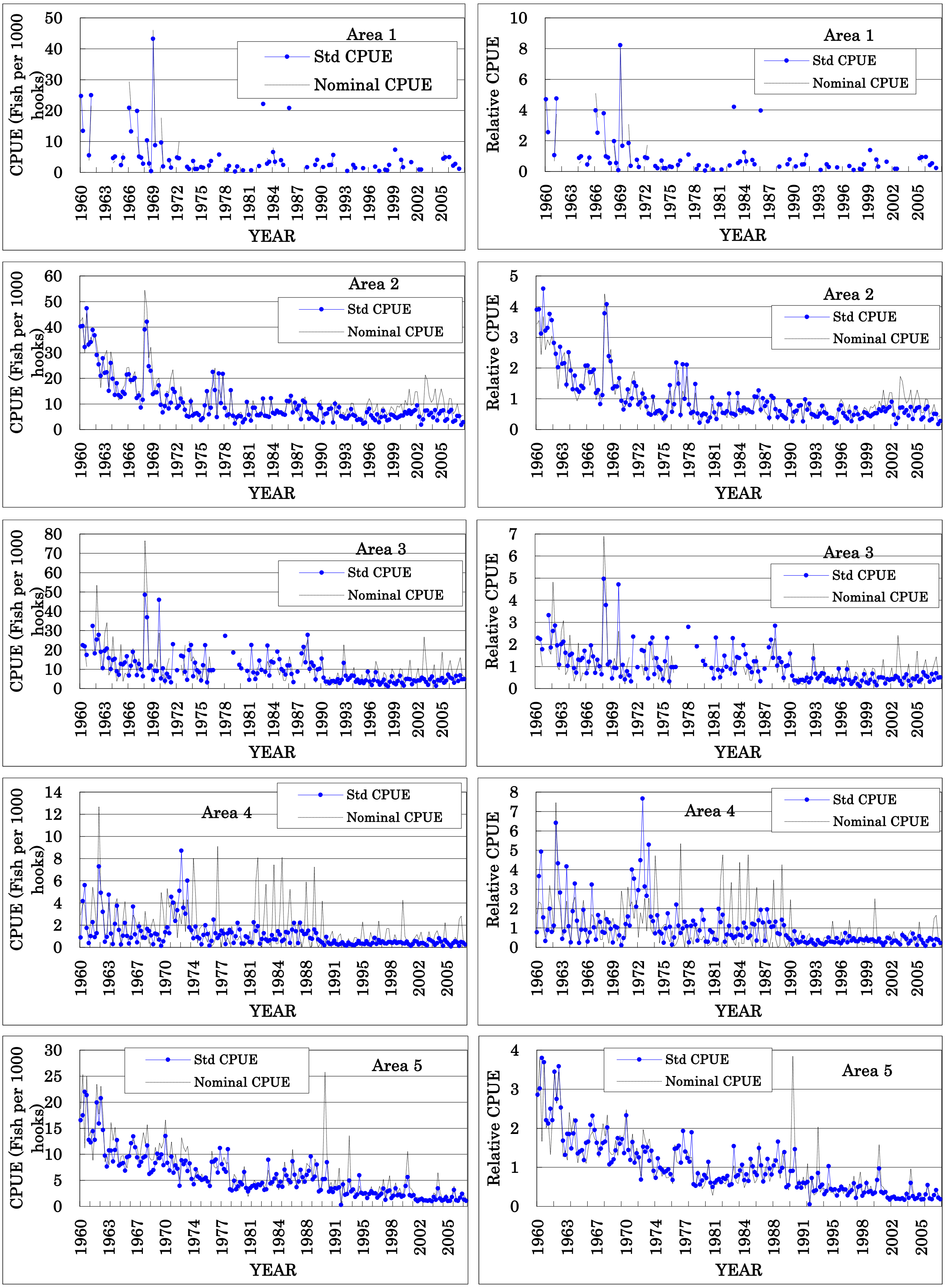


Fig. 6. Standardized quarter based CPUE in number from 1960 to 2007 for each five sub-areas in whole Indian Ocean expressed in relative (left figure) and real (right figure) scale overlaid with nominal CPUE.

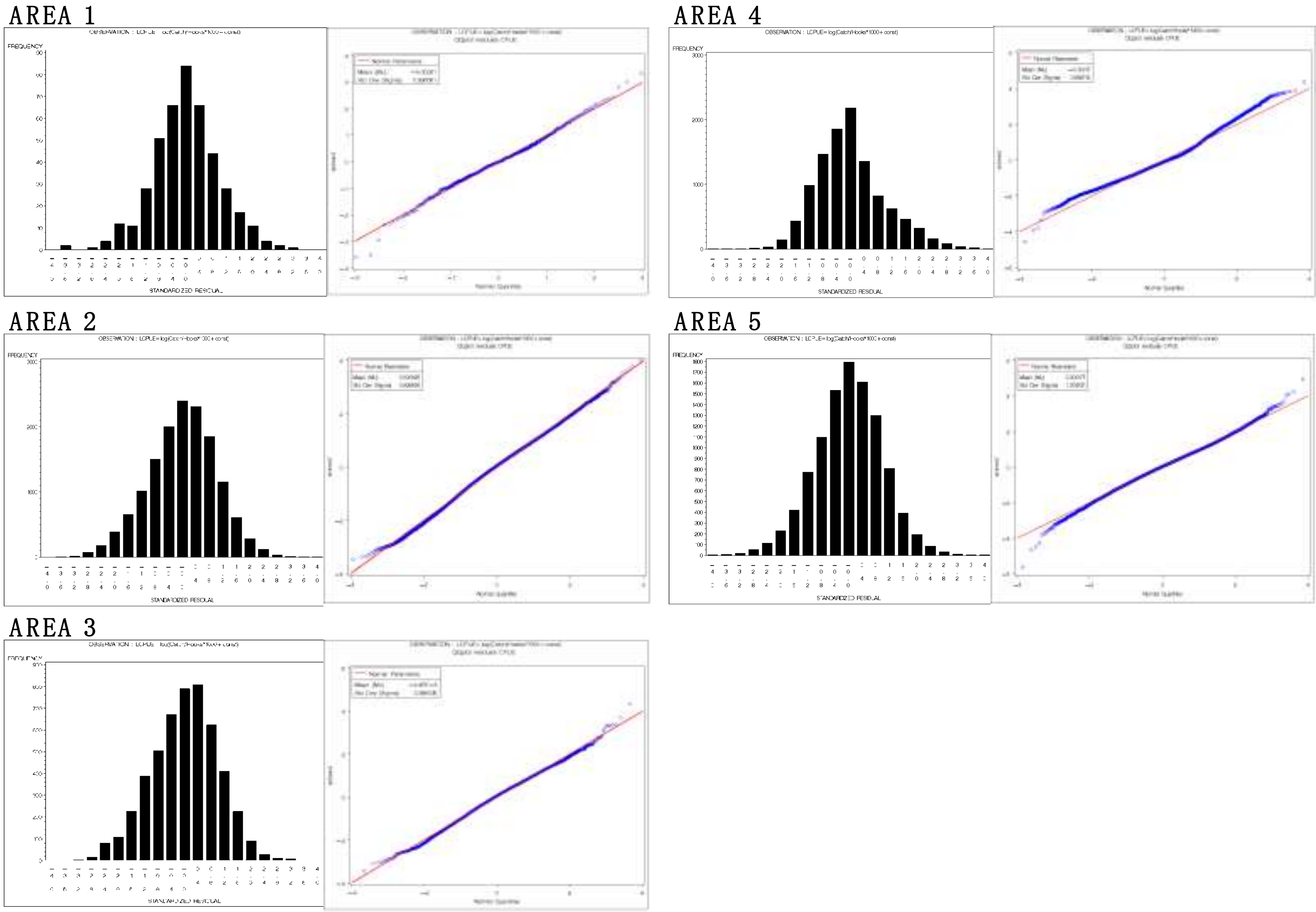


Fig. 7. Standardized residuals of quarter based CPUE standardization for each area in whole Indian Ocean expressed as histograms and QQ plots.

Appendix table 1. Annual value of standardized yellowfin CPUE in tropical Indian Ocean for three kind of period (1960-2007, 1968-2007 and 1980-2007) expressed in real and relative scale in which the average of each period is 1.0, and variance.

All tropical (Area2(&3)&5) 1960-2007				All tropical (Area2(&3)&5) 1968-2007				All tropical (Area2(&3)&5) 1980-2007			
	LSMEAN		Relative		LSMEAN		Relative		LSMEAN		Relative
year	cpue_p	dev_t	CPUE	year	cpue_p	dev_t	CPUE	year	cpue_p	dev_t	CPUE
1960	22.7287	0.0022	3.4870	1960				1960			
1961	18.4265	0.0023	2.8270	1961				1961			
1962	16.9436	0.0016	2.5995	1962				1962			
1963	12.3399	0.0019	1.8932	1963				1963			
1964	9.6673	0.0019	1.4831	1964				1964			
1965	9.0379	0.0016	1.3866	1965				1965			
1966	12.1292	0.0015	1.8608	1966				1966			
1967	7.5687	0.0014	1.1612	1967				1967			
1968	15.4836	0.0018	2.3755	1968	15.4804	0.0020	3.0372	1968			
1969	9.2623	0.0017	1.4210	1969	9.2989	0.0019	1.8244	1969			
1970	7.4066	0.0021	1.1363	1970	7.4076	0.0023	1.4533	1970			
1971	7.8357	0.0020	1.2021	1971	7.7704	0.0023	1.5245	1971			
1972	6.5482	0.0028	1.0046	1972	6.4930	0.0031	1.2739	1972			
1973	6.1037	0.0030	0.9364	1973	6.1208	0.0033	1.2009	1973			
1974	4.6562	0.0023	0.7143	1974	4.6514	0.0026	0.9126	1974			
1975	4.6813	0.0019	0.7182	1975	4.6763	0.0022	0.9175	1975			
1976	6.7099	0.0038	1.0294	1976	6.7224	0.0043	1.3189	1976			
1977	9.1249	0.0057	1.3999	1977	9.1342	0.0064	1.7921	1977			
1978	4.8741	0.0019	0.7478	1978	4.8771	0.0021	0.9569	1978			
1979	3.4229	0.0027	0.5251	1979	3.4195	0.0030	0.6709	1979			
1980	4.3376	0.0021	0.6655	1980	4.2850	0.0023	0.8407	1980	4.2130	0.0025	0.9988
1981	4.3298	0.0015	0.6643	1981	4.3037	0.0017	0.8444	1981	4.2894	0.0018	1.0169
1982	4.8739	0.0014	0.7477	1982	4.8468	0.0016	0.9509	1982	4.8283	0.0017	1.1446
1983	4.6304	0.0014	0.7104	1983	4.6359	0.0015	0.9095	1983	4.6137	0.0016	1.0938
1984	5.1639	0.0013	0.7922	1984	5.1731	0.0015	1.0149	1984	5.1968	0.0016	1.2320
1985	5.6803	0.0011	0.8715	1985	5.6676	0.0013	1.1120	1985	5.7061	0.0013	1.3527
1986	7.2220	0.0011	1.1080	1986	7.2231	0.0012	1.4171	1986	7.2460	0.0013	1.7178
1987	6.3295	0.0019	0.9711	1987	6.3793	0.0021	1.2516	1987	6.4694	0.0022	1.5337
1988	6.8313	0.0018	1.0481	1988	6.9432	0.0020	1.3622	1988	7.1042	0.0021	1.6842
1989	4.2925	0.0019	0.6586	1989	4.3271	0.0021	0.8490	1989	4.4060	0.0022	1.0445
1990	4.6533	0.0017	0.7139	1990	4.7161	0.0019	0.9253	1990	4.8138	0.0020	1.1412
1991	3.9543	0.0018	0.6067	1991	3.9748	0.0020	0.7798	1991	4.0303	0.0022	0.9555
1992	4.2447	0.0027	0.6512	1992	4.2821	0.0030	0.8401	1992	4.3522	0.0032	1.0318
1993	3.9466	0.0017	0.6055	1993	3.9333	0.0019	0.7717	1993	3.9374	0.0020	0.9334
1994	3.6714	0.0014	0.5633	1994	3.6728	0.0016	0.7206	1994	3.6752	0.0017	0.8713
1995	2.8382	0.0011	0.4354	1995	2.8127	0.0012	0.5518	1995	2.7936	0.0013	0.6623
1996	3.4523	0.0009	0.5296	1996	3.4507	0.0010	0.6770	1996	3.4554	0.0011	0.8192

1997	2.9870	0.0006	0.4583	1997	2.9747	0.0007	0.5836	1997	2.9644	0.0007	0.7028
1998	2.9593	0.0006	0.4540	1998	2.9577	0.0007	0.5803	1998	2.9617	0.0007	0.7021
1999	3.2995	0.0007	0.5062	1999	3.2815	0.0008	0.6438	1999	3.2688	0.0008	0.7749
2000	4.1938	0.0006	0.6434	2000	4.1464	0.0007	0.8135	2000	4.1059	0.0008	0.9734
2001	3.8789	0.0007	0.5951	2001	3.8395	0.0008	0.7533	2001	3.7983	0.0009	0.9005
2002	3.0394	0.0006	0.4663	2002	2.9988	0.0007	0.5884	2002	2.9640	0.0008	0.7027
2003	3.8622	0.0009	0.5925	2003	3.8377	0.0011	0.7529	2003	3.8097	0.0011	0.9032
2004	3.3761	0.0008	0.5180	2004	3.3545	0.0009	0.6581	2004	3.3346	0.0010	0.7905
2005	3.4278	0.0010	0.5259	2005	3.4105	0.0011	0.6691	2005	3.4006	0.0012	0.8062
2006	3.6530	0.0006	0.5604	2006	3.6286	0.0006	0.7119	2006	3.6113	0.0007	0.8561
2007	2.7885	0.0006	0.4278	2007	2.7685	0.0007	0.5432	2007	2.7589	0.0008	0.6540

Appendix table 2. Quartely value of standardized yellowfin CPUE in the tropical Indian Ocean for three kind of period (1960-2007, 1968-2007 and 1980-2007) expressed in real and relative scale in which the average of each period is 1.0, and variance.

All tropical (Area2 (&3)&5)

		1960-2005			1968-2007			1980-2007		
Year	Quarter	CPUE	t-dev	Relative CPUE	Tropical CPUE	t-dev	Relative CPUE	Tropical CPUE	t-dev	Relative CPUE
1960	1	21.1707	0.0061	3.1601						
1960	2	21.5962	0.0067	3.2236						
1960	3	22.5547	0.0108	3.3667						
1960	4	26.2076	0.0072	3.9119						
1961	1	17.5096	0.0066	2.6136						
1961	2	17.9643	0.0082	2.6815						
1961	3	21.1338	0.0111	3.1546						
1961	4	17.0571	0.0065	2.5460						
1962	1	20.1709	0.0044	3.0108						
1962	2	17.2442	0.0043	2.5740						
1962	3	15.5996	0.0076	2.3285						
1962	4	14.9374	0.0043	2.2296						
1963	1	13.1163	0.0040	1.9578						
1963	2	12.2338	0.0052	1.8261						
1963	3	11.2955	0.0112	1.6860						
1963	4	12.9233	0.0061	1.9290						
1964	1	11.8235	0.0061	1.7648						
1964	2	10.1248	0.0046	1.5113						
1964	3	10.2049	0.0079	1.5232						
1964	4	7.0012	0.0051	1.0450						
1965	1	7.9781	0.0039	1.1909						
1965	2	9.0364	0.0043	1.3488						
1965	3	8.0229	0.0059	1.1975						
1965	4	11.6831	0.0053	1.7439						
1966	1	11.7609	0.0042	1.7555						
1966	2	11.6892	0.0045	1.7448						
1966	3	13.1855	0.0053	1.9681						
1966	4	11.9262	0.0042	1.7802						
1967	1	8.2221	0.0035	1.2273						
1967	2	8.4413	0.0035	1.2600						
1967	3	6.4561	0.0051	0.9637						
1967	4	7.5218	0.0045	1.1227						
1968	1	18.9268	0.0046	2.8251	18.8717	0.0046	3.5675			
1968	2	21.2038	0.0052	3.1650	21.2394	0.0052	4.0151			
1968	3	12.8450	0.0083	1.9173	12.8261	0.0083	2.4246			
1968	4	11.1102	0.0047	1.6584	11.0727	0.0047	2.0932			
1969	1	7.6925	0.0040	1.1482	7.7100	0.0040	1.4575			
1969	2	8.5821	0.0053	1.2810	8.6823	0.0053	1.6413			
1969	3	10.2438	0.0068	1.5291	10.2431	0.0068	1.9364			
1969	4	10.6188	0.0055	1.5850	10.6054	0.0055	2.0048			
1970	1	7.0531	0.0054	1.0528	7.0737	0.0054	1.3372			
1970	2	5.3373	0.0070	0.7967	5.3579	0.0070	1.0129			
1970	3	8.8687	0.0127	1.3238	8.8481	0.0127	1.6726			
1970	4	8.5923	0.0057	1.2825	8.5576	0.0057	1.6177			
1971	1	6.0866	0.0044	0.9085	6.0633	0.0044	1.1462			
1971	2	7.6628	0.0070	1.1438	7.6680	0.0070	1.4496			
1971	3	10.2233	0.0104	1.5260	10.2562	0.0104	1.9388			
1971	4	9.2013	0.0074	1.3734	9.1440	0.0074	1.7286			
1972	1	6.5623	0.0068	0.9795	6.5399	0.0068	1.2363			
1972	2	5.2858	0.0106	0.7890	5.2880	0.0106	0.9996			
1972	3	8.1125	0.0090	1.2109	8.0376	0.0090	1.5194			
1972	4	7.5779	0.0132	1.1311	7.6129	0.0132	1.4391			
1973	1	7.4913	0.0093	1.1182	7.5419	0.0093	1.4257			
1973	2	6.0983	0.0144	0.9103	6.1929	0.0144	1.1707			
1973	3	5.3525	0.0102	0.7989	5.3492	0.0102	1.0112			
1973	4	6.4474	0.0075	0.9624	6.4100	0.0075	1.2117			
1974	1	4.2102	0.0058	0.6284	4.1724	0.0058	0.7887			
1974	2	5.6092	0.0110	0.8373	5.6292	0.0110	1.0641			
1974	3	4.4713	0.0075	0.6674	4.4250	0.0075	0.8365			
1974	4	4.2585	0.0064	0.6356	4.2272	0.0064	0.7991			

Appendix table 2. Continued.

		1960-2005			1968-2007			1980-2007		
Year	Quarter	Indian CPUE	t-dev	Relative CPUE	Tropical CPUE	t-dev	Relative CPUE	Tropical CPUE	t-dev	Relative CPUE
1975	1	3.1582	0.0058	0.4714	3.1831	0.0058	0.6017			
1975	2	3.8914	0.0084	0.5809	3.8775	0.0084	0.7330			
1975	3	5.5850	0.0049	0.8337	5.5635	0.0049	1.0517			
1975	4	6.5586	0.0061	0.9790	6.5231	0.0061	1.2331			
1976	1	3.8530	0.0054	0.5751	3.8123	0.0054	0.7207			
1976	2	6.7019	0.0124	1.0004	6.6603	0.0124	1.2591			
1976	3	9.3113	0.0245	1.3899	9.3850	0.0245	1.7741			
1976	4	7.6636	0.0332	1.1439	7.6148	0.0332	1.4395			
1977	1	4.3606	0.0161	0.6509	4.3588	0.0161	0.8240			
1977	2	12.9287	0.0713	1.9298	12.8390	0.0713	2.4271			
1977	3	7.5132	0.0265	1.1215	7.4991	0.0265	1.4176			
1977	4	12.0259	0.0151	1.7951	11.9333	0.0151	2.2559			
1978	1	5.7429	0.0054	0.8572	5.7465	0.0054	1.0863			
1978	2	6.2194	0.0144	0.9283	6.2448	0.0144	1.1805			
1978	3	3.8301	0.0097	0.5717	3.7866	0.0097	0.7158			
1978	4	7.4779	0.0078	1.1162	7.4650	0.0078	1.4112			
1979	1	4.5446	0.0062	0.6784	4.5398	0.0062	0.8582			
1979	2	2.6483	0.0146	0.3953	2.6430	0.0146	0.4996			
1979	3	2.6593	0.0111	0.3969	2.6160	0.0111	0.4945			
1979	4	4.3962	0.0148	0.6562	4.4117	0.0148	0.8340			
1980	1	5.2029	0.0064	0.7766	5.1912	0.0064	0.9813	5.1637	0.0078	1.1613
1980	2	3.9220	0.0118	0.5854	3.8913	0.0118	0.7356	3.8257	0.0143	0.8604
1980	3	2.8813	0.0154	0.4301	2.8419	0.0154	0.5372	2.8142	0.0187	0.6329
1980	4	5.6012	0.0049	0.8361	5.5790	0.0049	1.0547	5.5501	0.0059	1.2482
1981	1	4.0591	0.0035	0.6059	4.0418	0.0035	0.7641	4.0194	0.0043	0.9039
1981	2	3.0421	0.0092	0.4541	3.0472	0.0092	0.5760	3.0242	0.0111	0.6801
1981	3	5.3940	0.0105	0.8051	5.3509	0.0105	1.0115	5.2817	0.0127	1.1878
1981	4	5.1053	0.0038	0.7620	5.0828	0.0038	0.9609	5.0570	0.0045	1.1373
1982	1	4.6547	0.0033	0.6948	4.6146	0.0033	0.8723	4.5868	0.0040	1.0315
1982	2	4.6827	0.0084	0.6990	4.6866	0.0084	0.8860	4.6743	0.0102	1.0512
1982	3	4.4782	0.0049	0.6684	4.4425	0.0049	0.8398	4.4161	0.0060	0.9931
1982	4	6.8119	0.0034	1.0168	6.7576	0.0034	1.2775	6.7430	0.0040	1.5164
1983	1	3.7717	0.0029	0.5630	3.7823	0.0029	0.7150	3.7877	0.0035	0.8518
1983	2	6.2902	0.0085	0.9389	6.3214	0.0085	1.1950	6.3724	0.0102	1.4331
1983	3	3.6896	0.0050	0.5507	3.6406	0.0050	0.6882	3.6232	0.0061	0.8148
1983	4	7.2502	0.0038	1.0822	7.2330	0.0038	1.3673	7.2308	0.0045	1.6261
1984	1	5.6032	0.0030	0.8364	5.6259	0.0030	1.0635	5.6455	0.0036	1.2696
1984	2	5.9172	0.0066	0.8832	5.9335	0.0066	1.1217	5.9174	0.0079	1.3308
1984	3	4.9196	0.0056	0.7343	4.9258	0.0056	0.9312	4.9530	0.0068	1.1139
1984	4	4.9549	0.0048	0.7396	4.9586	0.0048	0.9374	4.9808	0.0058	1.1201
1985	1	5.0332	0.0027	0.7513	5.0356	0.0027	0.9519	5.0459	0.0033	1.1348
1985	2	5.8031	0.0053	0.8662	5.8569	0.0053	1.1072	5.8779	0.0064	1.3219
1985	3	5.0201	0.0040	0.7493	4.9848	0.0040	0.9423	4.9936	0.0048	1.1230
1985	4	7.2534	0.0045	1.0827	7.2344	0.0045	1.3676	7.2478	0.0055	1.6299
1986	1	7.3971	0.0018	1.1041	7.3595	0.0018	1.3912	7.3707	0.0022	1.6576
1986	2	9.5580	0.0076	1.4267	9.5446	0.0076	1.8043	9.5430	0.0091	2.1461
1986	3	5.6567	0.0056	0.8444	5.6375	0.0056	1.0657	5.6544	0.0068	1.2716
1986	4	6.6719	0.0029	0.9959	6.6257	0.0029	1.2525	6.6531	0.0035	1.4962
1987	1	6.3504	0.0021	0.9479	6.3146	0.0021	1.1937	6.3297	0.0026	1.4235
1987	2	8.3572	0.0255	1.2474	8.4616	0.0255	1.5996	8.5395	0.0308	1.9204
1987	3	4.4122	0.0139	0.6586	4.4028	0.0139	0.8323	4.4330	0.0169	0.9969
1987	4	7.7668	0.0034	1.1593	7.7437	0.0034	1.4639	7.7957	0.0041	1.7532
1988	1	8.7341	0.0029	1.3037	8.7464	0.0029	1.6534	8.7913	0.0035	1.9771
1988	2	7.8735	0.0308	1.1752	7.9781	0.0308	1.5082	8.0619	0.0373	1.8130
1988	3	6.0313	0.0082	0.9003	6.0459	0.0082	1.1429	6.1052	0.0099	1.3730
1988	4	5.1159	0.0038	0.7636	5.1076	0.0038	0.9655	5.1434	0.0046	1.1567
1989	1	4.8697	0.0030	0.7269	4.8763	0.0030	0.9218	4.9060	0.0036	1.1033
1989	2	5.7249	0.0106	0.8545	5.8560	0.0106	1.1070	5.9536	0.0128	1.3389
1989	3	3.0989	0.0153	0.4626	3.0868	0.0153	0.5835	3.0984	0.0186	0.6968
1989	4	6.0352	0.0063	0.9009	6.0200	0.0063	1.1380	6.0765	0.0076	1.3666

Appendix table 2. Continued.

Year	Quarter	1960-2005 CPUE	t-dev	Relative CPUE	1968-2007 Tropical CPUE	t-dev	Relative CPUE	1980-2007 Tropical CPUE	t-dev	Relative CPUE
1990	1	7.1386	0.0033	1.0656	7.1581	0.0033	1.3532	7.1907	0.0040	1.6171
1990	2	4.0310	0.0390	0.6017	4.0216	0.0390	0.7602	4.0344	0.0472	0.9073
1990	3	5.6365	0.0105	0.8413	5.7005	0.0105	1.0776	5.7810	0.0128	1.3001
1990	4	3.7831	0.0039	0.5647	3.7768	0.0039	0.7140	3.8038	0.0047	0.8554
1991	1	4.4318	0.0031	0.6615	4.4467	0.0031	0.8406	4.4737	0.0038	1.0061
1991	2	3.5210	0.0137	0.5256	3.5427	0.0137	0.6697	3.5509	0.0165	0.7986
1991	3	3.3703	0.0126	0.5031	3.3228	0.0126	0.6281	3.3111	0.0153	0.7446
1991	4	4.5058	0.0062	0.6726	4.4615	0.0062	0.8434	4.4523	0.0076	1.0013
1992	1	4.4356	0.0044	0.6621	4.4069	0.0044	0.8331	4.4087	0.0054	0.9915
1992	2	2.4574	0.1085	0.3668	2.4422	0.1085	0.4617	2.4364	0.1314	0.5479
1992	3	5.4694	0.0200	0.8164	5.5008	0.0200	1.0399	5.5591	0.0243	1.2502
1992	4	3.6424	0.0073	0.5437	3.6131	0.0073	0.6830	3.6038	0.0089	0.8104
1993	1	3.9418	0.0044	0.5884	3.9052	0.0044	0.7382	3.8838	0.0053	0.8734
1993	2	4.4410	0.0141	0.6629	4.4159	0.0141	0.8348	4.3912	0.0170	0.9875
1993	3	3.6539	0.0085	0.5454	3.6340	0.0085	0.6870	3.6194	0.0103	0.8140
1993	4	4.8756	0.0051	0.7278	4.8222	0.0051	0.9116	4.7963	0.0062	1.0786
1994	1	4.3652	0.0028	0.6516	4.3206	0.0028	0.8168	4.2905	0.0034	0.9649
1994	2	3.0061	0.0277	0.4487	2.9679	0.0277	0.5611	2.9307	0.0336	0.6591
1994	3	4.8355	0.0104	0.7218	4.8505	0.0104	0.9169	4.8371	0.0126	1.0878
1994	4	2.7421	0.0033	0.4093	2.6993	0.0033	0.5103	2.6616	0.0040	0.5986
1995	1	3.4047	0.0022	0.5082	3.3626	0.0022	0.6357	3.3272	0.0027	0.7482
1995	2	2.2871	0.0079	0.3414	2.2985	0.0079	0.4345	2.2948	0.0096	0.5161
1995	3	2.2105	0.0065	0.3300	2.1727	0.0065	0.4107	2.1400	0.0079	0.4813
1995	4	4.4213	0.0025	0.6599	4.3701	0.0025	0.8261	4.3349	0.0031	0.9749
1996	1	4.4518	0.0018	0.6645	4.4049	0.0018	0.8327	4.3567	0.0022	0.9798
1996	2	2.4581	0.0099	0.3669	2.4391	0.0099	0.4611	2.4042	0.0119	0.5407
1996	3	3.7915	0.0079	0.5659	3.8047	0.0079	0.7192	3.7899	0.0095	0.8523
1996	4	3.3817	0.0020	0.5048	3.3463	0.0020	0.6326	3.3142	0.0024	0.7453
1997	1	4.0014	0.0012	0.5973	3.9565	0.0012	0.7479	3.9055	0.0014	0.8783
1997	2	1.9515	0.0114	0.2913	1.9706	0.0114	0.3725	1.9575	0.0139	0.4402
1997	3	3.8214	0.0038	0.5704	3.7811	0.0038	0.7148	3.7386	0.0046	0.8408
1997	4	3.7938	0.0014	0.5663	3.7602	0.0014	0.7108	3.7263	0.0017	0.8380
1998	1	3.1431	0.0012	0.4692	3.1232	0.0012	0.5904	3.0893	0.0014	0.6947
1998	2	2.0434	0.0038	0.3050	2.0443	0.0038	0.3865	2.0217	0.0046	0.4547
1998	3	2.8670	0.0039	0.4279	2.8698	0.0039	0.5425	2.8514	0.0047	0.6412
1998	4	4.3277	0.0019	0.6460	4.3033	0.0019	0.8135	4.2772	0.0023	0.9619
1999	1	3.8735	0.0017	0.5782	3.8379	0.0017	0.7255	3.8005	0.0021	0.8547
1999	2	2.2987	0.0046	0.3431	2.2869	0.0046	0.4323	2.2645	0.0056	0.5093
1999	3	3.4324	0.0032	0.5123	3.4078	0.0032	0.6442	3.3828	0.0039	0.7607
1999	4	4.0526	0.0014	0.6049	4.0263	0.0014	0.7611	3.9950	0.0017	0.8984
2000	1	3.6071	0.0014	0.5384	3.5777	0.0014	0.6763	3.5447	0.0017	0.7972
2000	2	2.9635	0.0021	0.4423	2.9525	0.0021	0.5581	2.9228	0.0026	0.6573
2000	3	6.5365	0.0035	0.9757	6.5345	0.0035	1.2353	6.5032	0.0042	1.4625
2000	4	4.2117	0.0026	0.6287	4.1905	0.0026	0.7922	4.1680	0.0032	0.9373
2001	1	4.7525	0.0017	0.7094	4.6977	0.0017	0.8881	4.6438	0.0020	1.0443
2001	2	2.6996	0.0028	0.4030	2.6862	0.0028	0.5078	2.6567	0.0034	0.5975
2001	3	4.6616	0.0039	0.6958	4.6808	0.0039	0.8849	4.6554	0.0047	1.0469
2001	4	3.8957	0.0028	0.5815	3.8546	0.0028	0.7287	3.8116	0.0034	0.8572
2002	1	5.2115	0.0023	0.7779	5.1687	0.0023	0.9771	5.1211	0.0028	1.1517
2002	2	2.9779	0.0039	0.4445	2.9632	0.0039	0.5602	2.9321	0.0047	0.6594
2002	3	1.8945	0.0032	0.2828	1.8547	0.0032	0.3506	1.8183	0.0039	0.4089
2002	4	2.6368	0.0014	0.3936	2.5889	0.0014	0.4894	2.5524	0.0017	0.5740
2003	1	3.5069	0.0019	0.5235	3.4696	0.0019	0.6559	3.4247	0.0023	0.7702
2003	2	2.7003	0.0112	0.4031	2.6779	0.0112	0.5062	2.6409	0.0136	0.5939
2003	3	4.7619	0.0065	0.7108	4.7628	0.0065	0.9004	4.7297	0.0079	1.0637
2003	4	4.7222	0.0023	0.7049	4.6798	0.0023	0.8847	4.6392	0.0028	1.0433
2004	1	2.8292	0.0025	0.4223	2.8032	0.0025	0.5299	2.7713	0.0030	0.6232
2004	2	3.7466	0.0065	0.5592	3.7380	0.0065	0.7066	3.7009	0.0079	0.8323
2004	3	3.3890	0.0035	0.5059	3.3714	0.0035	0.6373	3.3478	0.0043	0.7529
2004	4	3.7806	0.0020	0.5643	3.7369	0.0020	0.7064	3.6971	0.0025	0.8314
2005	1	4.2126	0.0022	0.6288	4.1849	0.0022	0.7911	4.1508	0.0027	0.9335
2005	2	3.6807	0.0048	0.5494	3.6645	0.0048	0.6927	3.6329	0.0058	0.8170
2005	3	3.0772	0.0071	0.4593	3.0466	0.0071	0.5759	3.0166	0.0086	0.6784
2005	4	3.1561	0.0032	0.4711	3.1219	0.0032	0.5902	3.0909	0.0039	0.6951
2006	1	5.0243	0.0015	0.7500	4.9815	0.0015	0.9417	4.9400	0.0018	1.1110
2006	2	5.0189	0.0024	0.7492	5.0252	0.0024	0.9500	5.0058	0.0029	1.1258
2006	3	2.5743	0.0029	0.3843	2.5512	0.0029	0.4823	2.5247	0.0035	0.5678
2006	4	2.6161	0.0017	0.3905	2.5771	0.0017	0.4872	2.5507	0.0020	0.5736
2007	1	3.8891	0.0013	0.5805	3.8360	0.0013	0.7252	3.8003	0.0016	0.8547
2007	2	3.8243	0.0024	0.5708	3.8185	0.0024	0.7218	3.7985	0.0029	0.8542
2007	3	1.7324	0.0040	0.2586	1.7108	0.0040	0.3234	1.6912	0.0049	0.3803
2007	4	2.1208	0.0029	0.3166	2.0835	0.0029	0.3939	2.0589	0.0035	0.4630

Appendix table 3. Quarterly value of standardized yellowfin CPUE for each of five sub-area in whole Indian Ocean from 1960-2007 expressed in real scale and relative scale with variance.

Whole Indian Ocean

Year	Quarter	AREA 1 CPUE	AREA 1 Dev	AREA 1 Relative CPUE	AREA 2 Tropical CPUE	AREA 2 Dev	AREA 2 Relative CPUE	AREA 3 Tropical CPUE	AREA 3 Dev	AREA 3 Relative CPUE	AREA 4 Tropical CPUE	AREA 4 Dev	AREA 4 Relative CPUE	AREA 5 Tropical CPUE	AREA 5 Dev	AREA 5 Relative CPUE
1960	1	24.7092	0.0660	4.6955	40.2568	0.0127	3.8979				0.8746	0.0626	0.7698	16.5115	0.0102	2.8534
1960	2	13.3905	0.4307	2.5446	40.4008	0.0144	3.9119	22.3543	0.6117	2.2924	4.1577	0.0773	3.6594	17.4519	0.0112	3.0160
1960	3				32.1859	0.0365	3.1164	21.7146	0.0913	2.2268	5.5942	0.0322	4.9238	21.9739	0.0188	3.7974
1960	4				47.3181	0.0175	4.5816	17.2969	0.1258	1.7737	1.7438	0.0317	1.5348	21.3392	0.0142	3.6877
1961	1	5.5031	0.2188	1.0457	33.1896	0.0131	3.2136				0.3653	0.0716	0.3216	12.7478	0.0118	2.2030
1961	2	24.9676	0.2161	4.7446	34.0749	0.0160	3.2993				0.9973	0.1446	0.8778	12.2548	0.0164	2.1178
1961	3				38.8287	0.0342	3.7596	32.3554	0.0423	3.3179	2.2606	0.0722	1.9897	14.4360	0.0254	2.4948
1961	4				36.7114	0.0149	3.5546	18.0947	0.0423	1.8555	0.9054	0.0424	0.7969	12.7505	0.0139	2.2035
1962	1				29.0456	0.0107	2.8124	25.3204	0.0515	2.5965	1.2646	0.0605	1.1131	19.9275	0.0083	3.4438
1962	2				25.4120	0.0100	2.4605	27.7417	0.0363	2.8448	7.2731	0.0816	6.4015	15.8757	0.0101	2.7436
1962	3				20.9027	0.0271	2.0239	18.9783	0.0348	1.9462	4.9139	0.0365	4.3250	20.7306	0.0120	3.5826
1962	4				27.7360	0.0097	2.6856	10.5006	0.0595	1.0768	3.1993	0.0370	2.8159	14.6266	0.0089	2.5277
1963	1				22.0480	0.0098	2.1348	19.4778	0.0367	1.9974	0.4904	0.0450	0.4317	9.7176	0.0081	1.6793
1963	2				22.2566	0.0121	2.1550	20.6638	0.0379	2.1190	0.9289	0.1708	0.8175	7.6078	0.0116	1.3147
1963	3				15.0382	0.0494	1.4561	15.7148	0.0453	1.6115	4.7315	0.0328	4.1644	10.7284	0.0155	1.8540
1963	4				25.9284	0.0136	2.5105	9.9434	0.0651	1.0197	1.2260	0.0348	1.0791	10.6883	0.0126	1.8471
1964	1	4.5780	0.1107	0.8700	19.7693	0.0121	1.9142	14.6842	0.0916	1.5058	0.2891	0.0382	0.2544	8.5750	0.0143	1.4819
1964	2	5.1175	0.1110	0.9725	13.4819	0.0100	1.3054	15.3441	0.0476	1.5735	2.1117	0.0921	1.8586	10.7898	0.0109	1.8646
1964	3				18.0505	0.0343	1.7478	8.9144	0.0395	0.9141	3.7295	0.0373	3.2826	12.6868	0.0106	2.1925
1964	4				13.4081	0.0158	1.2983	7.0065	0.0380	0.7185	1.5547	0.0235	1.3684	7.8189	0.0106	1.3512
1965	1	2.3614	0.0908	0.4487	12.6432	0.0086	1.2242	12.6884	0.1262	1.3011	0.2500	0.0314	0.2200	8.0984	0.0080	1.3995
1965	2	4.6994	0.0897	0.8930	14.6670	0.0100	1.4201	12.4347	0.0803	1.2751	1.0287	0.0798	0.9055	8.3062	0.0083	1.4354
1965	3				13.8502	0.0165	1.3411	13.3852	0.0312	1.3726	2.1848	0.0351	1.9230	6.8451	0.0138	1.1829
1965	4				21.3894	0.0119	2.0711	16.6318	0.1063	1.7055	1.0182	0.0198	0.8962	9.4082	0.0107	1.6259
1966	1	20.8505	0.0604	3.9622	21.4997	0.0091	2.0817	6.6751	0.1568	0.6845	0.3336	0.0308	0.2936	9.5840	0.0084	1.6563
1966	2	13.2386	0.0431	2.5157	19.2111	0.0087	1.8601	11.7367	0.0447	1.2036	0.8682	0.1313	0.7641	12.0891	0.0106	2.0892
1966	3				19.3211	0.0157	1.8708	18.9773	0.0384	1.9461	3.6643	0.0309	3.2251	13.4044	0.0123	2.3165
1966	4				20.0661	0.0096	1.9429	14.1043	0.0476	1.4463	1.1636	0.0184	1.0241	11.3051	0.0095	1.9537
1967	1	19.8542	0.0409	3.7729	12.2210	0.0087	1.1833	6.8558	0.0350	0.7030	0.4466	0.0210	0.3931	9.3937	0.0074	1.6234
1967	2	5.1213	0.0261	0.9732	13.2006	0.0084	1.2782	12.6787	0.0286	1.3002	1.8779	0.0191	1.6528	7.7891	0.0082	1.3461
1967	3	4.7049	0.4409	0.8941	8.5308	0.0147	0.8260	9.7842	0.0430	1.0033	1.4792	0.0155	1.3020	8.5297	0.0133	1.4741
1967	4	2.7791	0.2169	0.5281	11.5345	0.0093	1.1168	6.2060	0.0549	0.6364	0.9028	0.0126	0.7946	9.3567	0.0104	1.6170
1968	1				39.0091	0.0103	3.7771	48.4321	0.3083	4.9665	0.8392	0.0205	0.7386	9.5780	0.0083	1.6552
1968	2	10.3338	0.0431	1.9637	42.0816	0.0104	4.0746	36.7973	0.0399	3.7734	1.6457	0.0208	1.4485	11.6693	0.0124	2.0166
1968	3	2.8437	0.4409	0.5404	24.6391	0.0283	2.3857	10.5471	0.0491	1.0816	1.4532	0.0160	1.2791	6.1881	0.0202	1.0694
1968	4	0.3818	0.4281	0.0726	22.9068	0.0103	2.2180	11.7979	0.0650	1.2098	1.0764	0.0136	0.9474	6.4891	0.0107	1.1214
1969	1	43.2131	0.0441	8.2117	13.7317	0.0084	1.3296	4.3858	0.0428	0.4497	0.2701	0.0276	0.2377	6.9338	0.0093	1.1983
1969	2	8.7448	0.0227	1.6618	14.4519	0.0134	1.3993	9.1235	0.0381	0.9356	1.2233	0.0202	1.0767	8.2767	0.0147	1.4303
1969	3				14.4290	0.0190	1.3971	8.9375	0.0482	0.9165	1.1538	0.0142	1.0155	10.0827	0.0153	1.7424
1969	4				17.2152	0.0116	1.6669	45.8813	0.2068	4.7050	0.6912	0.0166	0.6083	9.2420	0.0104	1.5972
1970	1	9.6383	0.0493	1.8316	9.6004	0.0122	0.9296	5.1863	0.1563	0.5318	0.1181	0.0456	0.1039	9.9318	0.0097	1.7164
1970	2	1.8727	0.0253	0.3559	6.6505	0.0192	0.6439	10.3717	0.1561	1.0636	0.5336	0.0245	0.4696	7.8819	0.0120	1.3621
1970	3				9.0460	0.0565	0.8759	3.9779	0.0805	0.4079	1.3567	0.0188	1.1941	13.4709	0.0137	2.3280
1970	4				13.3966	0.0139	1.2971	7.5900	0.0911	0.7783	1.7957	0.0184	1.5805	8.3238	0.0113	1.4385

Appendix table 3.　Continued.

		AREA 1			AREA 2			AREA 3			AREA 4			AREA 5		
Year	Quarter	CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE
1971	1	3.9173	0.0976	0.7444	8.1666	0.0096	0.7907	5.7921	0.0514	0.5940	1.2628	0.0329	1.1115	6.8622	0.0093	1.1859
1971	2	1.4892	0.0431	0.2830	10.4047	0.0148	1.0074	3.0998	0.3080	0.3179	4.5390	0.0223	3.9950	9.5101	0.0123	1.6435
1971	3				15.7870	0.0358	1.5286	22.8925	0.1572	2.3475	4.0097	0.0152	3.5291	6.4437	0.0162	1.1136
1971	4				14.5996	0.0131	1.4136				2.3649	0.0312	2.0815	7.8410	0.0184	1.3550
1972	1	4.7702	0.0936	0.9065	8.3717	0.0135	0.8106	9.3511	0.1061	0.9589	3.3389	0.4407	2.9387	7.2243	0.0135	1.2485
1972	2	4.5313	0.0404	0.8611	9.2211	0.0219	0.8928				5.0944	0.0436	4.4839	3.9365	0.0198	0.6803
1972	3				12.0234	0.0141	1.1642	16.9502	0.1055	1.7382	8.6993	0.0360	7.6568	8.8318	0.0310	1.5263
1972	4				10.4879	0.0161	1.0155	16.5421	0.3077	1.6963	3.5588	0.0544	3.1323	8.0602	0.0360	1.3929
1973	1				7.6477	0.0191	0.7405	8.5863	0.2075	0.8805	3.0089	0.2216	2.6483	8.7410	0.0192	1.5106
1973	2	1.7928	0.0652	0.3407	5.2720	0.0276	0.5105	4.4251	0.6118	0.4538	6.0082	0.0377	5.2882	6.7515	0.0373	1.1668
1973	3	1.0745	0.1562	0.2042	4.9090	0.0177	0.4753	19.8589	0.0911	2.0365	1.7845	0.0271	1.5706	8.2243	0.0241	1.4213
1973	4				10.9760	0.0176	1.0628	22.4226	0.0802	2.2994	1.5230	0.0216	1.3405	5.2341	0.0138	0.9045
1974	1	3.6434	0.2216	0.6924	5.3809	0.0184	0.5210	6.2918	0.0514	0.6452	0.8116	0.0471	0.7143	4.2148	0.0105	0.7284
1974	2	1.0834	0.0470	0.2059	6.0985	0.0236	0.5905	13.2882	0.1257	1.3627	1.8640	0.0208	1.6406	7.0972	0.0221	1.2265
1974	3	1.0866	0.1562	0.2065	6.3272	0.0244	0.6126	9.4070	0.1058	0.9647	0.9104	0.0214	0.8013	5.7121	0.0161	0.9871
1974	4				5.5924	0.0225	0.5415	8.3632	0.0548	0.8576	0.7956	0.0396	0.7003	5.4295	0.0110	0.9383
1975	1	1.6933	0.0949	0.3218	3.5681	0.0188	0.3455	4.1301	0.1563	0.4235	0.2579	0.0475	0.2270	5.0261	0.0075	0.8686
1975	2	1.4952	0.0349	0.2841	4.3723	0.0184	0.4234	11.9783	0.2067	1.2283	1.1072	0.0206	0.9745	5.1995	0.0146	0.8986
1975	3				9.3189	0.0159	0.9023	22.3679	0.0814	2.2937	1.9839	0.0165	1.7462	5.4900	0.0098	0.9488
1975	4				14.8769	0.0174	1.4405	3.1266	0.2067	0.3206	1.1963	0.0282	1.0530	4.7613	0.0112	0.8228
1976	1	2.2084	0.4328	0.4197	5.8760	0.0158	0.5690	9.3670	0.0451	0.9606	0.1444	0.1829	0.1271	3.8961	0.0121	0.6733
1976	2	3.6617	0.0470	0.6958	8.4294	0.0258	0.8162	9.3757	0.6115	0.9614	0.5642	0.0602	0.4966	8.5065	0.0207	1.4701
1976	3				22.4470	0.0761	2.1735	9.4496	0.6138	0.9690	2.4959	0.0261	2.1968	8.5801	0.0411	1.4828
1976	4				15.3788	0.0963	1.4891				1.2610	0.0597	1.1099	8.9587	0.0307	1.5482
1977	1				4.8274	0.0390	0.4674				0.8314	0.1421	0.7318	6.4476	0.0177	1.1142
1977	2	5.7437	0.2161	1.0915	21.8602	0.0530	2.1166				1.0943	0.0837	0.9632	11.1564	0.2022	1.9280
1977	3				10.3019	0.0765	0.9975				1.4946	0.0529	1.3155	8.0883	0.0402	1.3978
1977	4				21.6991	0.0122	2.1010				1.2328	0.0333	1.0851	7.1519	0.0535	1.2360
1978	1				8.3831	0.0062	0.8117	27.1649	0.6117	2.7857	0.2844	0.0707	0.2504	6.6035	0.0153	1.1412
1978	2	0.8221	0.1465	0.1562	5.4307	0.0071	0.5258				1.2524	0.0325	1.1023	10.9505	0.0458	1.8924
1978	3	2.0891	0.4409	0.3970	5.8613	0.0281	0.5675				1.5535	0.0240	1.3673	3.2655	0.0188	0.5643
1978	4				15.2773	0.0156	1.4792				1.3257	0.0325	1.1668	3.0397	0.0165	0.5253
1979	1				5.3520	0.0130	0.5182	18.5878	0.0650	1.9061	0.3831	0.0672	0.3372	4.8838	0.0140	0.8440
1979	2	0.2388	0.1475	0.0454	2.2476	0.0287	0.2176				0.9746	0.0375	0.8578	3.2334	0.0253	0.5588
1979	3	1.9175	0.4409	0.3644	4.7210	0.0283	0.4571				2.1896	0.0274	1.9271	3.8056	0.0277	0.6577
1979	4				5.3057	0.0512	0.5137	12.1511	0.1561	1.2461	1.6026	0.0389	1.4105	4.6333	0.0153	0.8007
1980	1				5.0973	0.0184	0.4936	10.4232	0.0271	1.0689	0.3297	0.1491	0.2901	4.1729	0.0136	0.7211
1980	2	0.6062	0.1464	0.1152	2.7088	0.0271	0.2623				0.3211	0.0663	0.2826	6.5700	0.0173	1.1354
1980	3				3.9716	0.0458	0.3846				0.9911	0.0321	0.8723	3.5014	0.0114	0.6051
1980	4				10.6921	0.0103	1.0353	9.0672	0.1260	0.9298	0.8798	0.0195	0.7744	2.8570	0.0118	0.4937

Appendix table 3. Continued.

		AREA 1			AREA 2			AREA 3			AREA 4			AREA 5		
Year	Quarter	CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE
1981	1				5.6924	0.0060	0.5512	4.3856	0.0278	0.4497	0.4679	0.0411	0.4118	3.4763	0.0090	0.6008
1981	2	0.6160	0.2160	0.1171	3.4512	0.0206	0.3342	22.4695	0.6114	2.3042	0.4376	0.0695	0.3851	3.8350	0.0158	0.6627
1981	3				8.4077	0.0166	0.8141	8.2408	0.0805	0.8451	2.2453	0.0269	1.9762	4.0419	0.0327	0.6985
1981	4				8.4078	0.0080	0.8141	4.8708	0.1058	0.4995	1.4664	0.0208	1.2907	3.5656	0.0077	0.6162
1982	1				5.5324	0.0055	0.5357	7.7929	0.0226	0.7991	1.8991	0.0952	1.6715	4.1687	0.0088	0.7204
1982	2	2.0013	0.2161	0.3803	5.4598	0.0156	0.5287	14.4108	0.3078	1.4778	0.3231	0.1008	0.2844	4.0311	0.0185	0.6966
1982	3				6.1001	0.0098	0.5906	9.5606	0.6127	0.9804	0.7423	0.0438	0.6533	4.4976	0.0112	0.7773
1982	4	22.1052	0.4281	4.2006	12.0447	0.0056	1.1662				1.2548	0.0348	1.1044	3.1247	0.0075	0.5400
1983	1				5.3384	0.0042	0.5169	8.5416	0.3072	0.8759	0.7066	0.0678	0.6219	3.2645	0.0080	0.5642
1983	2	2.7968	0.1139	0.5315	5.2059	0.0127	0.5041	22.1504	0.3083	2.2714	0.5367	0.0462	0.4724	8.9180	0.0217	1.5412
1983	3	3.3774	0.2169	0.6418	4.8416	0.0146	0.4688	6.6117	0.3082	0.6780	0.6292	0.0215	0.5538	4.3672	0.0050	0.7547
1983	4				12.1458	0.0078	1.1760	13.8717	0.6103	1.4225	1.0810	0.0217	0.9515	4.6226	0.0071	0.7989
1984	1	6.5286	0.2160	1.2406	6.4614	0.0074	0.6256	13.4247	0.0381	1.3767	0.7265	0.0243	0.6394	5.3051	0.0065	0.9168
1984	2	3.3723	0.1455	0.6408	6.0752	0.0134	0.5882				0.6874	0.0197	0.6050	6.1514	0.0118	1.0631
1984	3				7.3022	0.0166	0.7070	19.0857	0.1254	1.9572	1.4299	0.0252	1.2585	3.8729	0.0085	0.6693
1984	4				6.6490	0.0108	0.6438	15.1509	0.3080	1.5537	1.1486	0.0197	1.0109	4.7162	0.0079	0.8150
1985	1	3.8925	0.4328	0.7397	6.5957	0.0068	0.6386	9.9495	0.0505	1.0203	0.5486	0.0439	0.4829	3.7334	0.0052	0.6452
1985	2	2.3830	0.2161	0.4528	5.9375	0.0112	0.5749	9.0898	0.2054	0.9321	0.6757	0.0189	0.5947	7.0102	0.0103	1.2115
1985	3				5.6681	0.0097	0.5488	7.1527	0.0794	0.7335	1.3757	0.0227	1.2108	5.9163	0.0084	1.0224
1985	4				11.0825	0.0059	1.0731	11.9270	0.1259	1.2231	1.3166	0.0257	1.1588	5.0424	0.0124	0.8714
1986	1	20.7945	0.1512	3.9516	10.9330	0.0046	1.0586	11.9288	0.0290	1.2233	0.3918	0.0269	0.3448	4.6028	0.0037	0.7954
1986	2				13.0881	0.0100	1.2673	7.4558	0.2054	0.7646	1.5774	0.0443	1.3883	8.6173	0.0199	1.4892
1986	3				6.5993	0.0125	0.6390	3.1786	0.3068	0.3260	2.1868	0.0433	1.9247	6.0401	0.0111	1.0438
1986	4				10.4488	0.0055	1.0117				1.4427	0.0316	1.2698	3.6664	0.0064	0.6336
1987	1				7.8288	0.0049	0.7580	8.6604	0.0321	0.8881	0.3754	0.0223	0.3304	4.7384	0.0042	0.8189
1987	2				9.2664	0.0131	0.8972				2.2068	0.0762	1.9423	7.0007	0.0889	1.2098
1987	3				3.9468	0.0253	0.3822	18.1365	0.3074	1.8598	1.4765	0.0327	1.2995	5.5796	0.0277	0.9642
1987	4				11.2436	0.0076	1.0887	21.4662	0.1551	2.2013	1.1799	0.0190	1.0385	4.7114	0.0056	0.8142
1988	1				10.5352	0.0073	1.0201	13.4879	0.0421	1.3831	1.2178	0.0799	1.0719	6.0307	0.0074	1.0422
1988	2	1.6328	0.4307	0.3103	6.8298	0.0185	0.6613	27.6808	0.2055	2.8386	1.4884	0.0658	1.3100	6.7829	0.1089	1.1722
1988	3				4.1080	0.0178	0.3978	10.0744	0.1547	1.0331	0.8222	0.0567	0.7237	9.5657	0.0138	1.6531
1988	4				6.1815	0.0089	0.5985	13.4235	0.3065	1.3765	0.7583	0.0345	0.6674	5.1432	0.0057	0.8888
1989	1				4.7504	0.0048	0.4600	11.6393	0.0545	1.1936	1.6024	0.0776	1.4104	5.6807	0.0076	0.9817
1989	2	2.4167	0.1465	0.4592	4.1828	0.0152	0.4050	4.6600	0.1547	0.4779	1.2847	0.1019	1.1308	8.0026	0.0351	1.3830
1989	3	4.0581	0.4281	0.7712	3.5723	0.0521	0.3459	9.7679	0.1245	1.0017	0.6995	0.0626	0.6156	2.8252	0.0168	0.4882
1989	4				9.4696	0.0120	0.9169	10.1520	0.3064	1.0411	0.5464	0.0305	0.4809	3.0998	0.0113	0.5357
1990	1				8.3238	0.0099	0.8060	15.3714	0.0441	1.5763	0.4277	0.0331	0.3764	5.2095	0.0060	0.9003
1990	2	1.6817	0.0653	0.3196	2.6647	0.0213	0.2580	5.5774	0.1548	0.5719	0.1787	0.2957	0.1573	5.2448	0.1344	0.9064
1990	3				5.9210	0.0278	0.5733	3.5309	0.0413	0.3621	0.9316	0.0216	0.8199	8.4371	0.0193	1.4581
1990	4				6.2548	0.0100	0.6056	3.4405	0.0640	0.3528	0.4175	0.0608	0.3675	2.7975	0.0062	0.4835

Appendix table 3. Continued.

		AREA 1			AREA 2			AREA 3			AREA 4			AREA 5		
Year	Quarter	CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE
1991	1	2.3294	0.1477	0.4427	7.9347	0.0084	0.7683	2.6355	0.0596	0.2703	0.2761	0.0300	0.2430	3.4018	0.0066	0.5879
1991	2	2.4099	0.0928	0.4580	8.1038	0.0420	0.7847	3.7308	0.0382	0.3826	0.3317	0.0410	0.2919	2.7342	0.0397	0.4725
1991	3	5.5901	0.4328	1.0623	2.6788	0.0226	0.2594	3.7963	0.0148	0.3893	0.5945	0.0120	0.5233	3.4837	0.0364	0.6020
1991	4				10.0672	0.0208	0.9748	3.3542	0.0430	0.3440	0.2974	0.0093	0.2618	3.4128	0.0095	0.5898
1992	1				6.6371	0.0121	0.6426	4.7224	0.0191	0.4843	0.2255	0.0363	0.1985	3.6122	0.0103	0.6242
1992	2				8.6648	0.0241	0.8390	2.6790	0.0196	0.2747	0.3065	0.0268	0.2698	0.2751	0.4038	0.0475
1992	3				5.1776	0.0713	0.5013	4.4702	0.0178	0.4584	0.4439	0.0185	0.3907	4.1841	0.0565	0.7231
1992	4				4.9362	0.0102	0.4780	13.2019	0.1546	1.3538	0.2236	0.0184	0.1968	2.2227	0.0202	0.3841
1993	1				4.2877	0.0129	0.4152	6.5633	0.0253	0.6730	0.1416	0.0559	0.1247	2.3679	0.0084	0.4092
1993	2	0.4416	0.4307	0.0839	4.2611	0.0236	0.4126	4.4261	0.0289	0.4539	0.4230	0.0334	0.3723	4.9337	0.0454	0.8526
1993	3				5.3205	0.0184	0.5152	5.4383	0.0412	0.5577	0.2570	0.0153	0.2262	2.8547	0.0195	0.4933
1993	4				7.9141	0.0069	0.7663	6.6910	0.0894	0.6861	0.2102	0.0133	0.1850	3.2078	0.0144	0.5544
1994	1	2.3681	0.4328	0.4500	5.7324	0.0057	0.5550	6.5327	0.0103	0.6699	0.1707	0.0177	0.1502	1.7956	0.0075	0.3103
1994	2	1.4571	0.0555	0.2769	5.2810	0.0146	0.5113	3.4011	0.0078	0.3488	0.2968	0.0116	0.2612	2.2542	0.1026	0.3896
1994	3				3.6350	0.0214	0.3520	4.5603	0.0121	0.4676	0.5682	0.0079	0.5001	5.9363	0.0313	1.0259
1994	4				3.9451	0.0055	0.3820	2.8217	0.0327	0.2894	0.3341	0.0060	0.2941	2.5703	0.0110	0.4442
1995	1				3.7197	0.0085	0.3602	3.8774	0.0079	0.3976	0.3215	0.0095	0.2830	2.3840	0.0055	0.4120
1995	2	1.3102	0.0729	0.2490	2.1758	0.0285	0.2107	2.7025	0.0083	0.2771	0.2860	0.0087	0.2517	2.5206	0.0257	0.4356
1995	3				2.6271	0.0242	0.2544	4.0897	0.0132	0.4194	0.5393	0.0050	0.4747	1.5813	0.0154	0.2733
1995	4				6.6629	0.0048	0.6451	8.6553	0.0529	0.8876	0.2821	0.0047	0.2483	2.3568	0.0061	0.4073
1996	1				8.0373	0.0051	0.7782	3.5382	0.0071	0.3628	0.2283	0.0083	0.2009	2.8770	0.0051	0.4972
1996	2				5.4856	0.0111	0.5311	1.7037	0.0073	0.1747	0.3868	0.0077	0.3405	2.5149	0.0354	0.4346
1996	3				4.4130	0.0081	0.4273	4.2291	0.0112	0.4337	0.8350	0.0072	0.7350	2.4700	0.0247	0.4269
1996	4	1.7974	0.4282	0.3416	3.5983	0.0033	0.3484	8.3896	0.0119	0.8603	0.2902	0.0062	0.2555	1.6273	0.0062	0.2812
1997	1				5.8832	0.0034	0.5696	3.6676	0.0063	0.3761	0.6549	0.0276	0.5764	2.0530	0.0033	0.3548
1997	2	0.4514	0.0172	0.0858	2.7396	0.0065	0.2653	1.9374	0.0088	0.1987	0.3846	0.0131	0.3385	2.3727	0.0429	0.4100
1997	3				4.8154	0.0060	0.4663	3.0872	0.0167	0.3166	0.5228	0.0057	0.4602	3.3983	0.0104	0.5873
1997	4				7.3158	0.0028	0.7084	4.5601	0.0103	0.4676	0.3505	0.0066	0.3085	1.2515	0.0046	0.2163
1998	1	0.8023	0.0486	0.1525	5.0096	0.0045	0.4851	1.9267	0.0072	0.1976	0.3414	0.0333	0.3005	2.8565	0.0040	0.4936
1998	2	0.6289	0.0237	0.1195	3.4697	0.0072	0.3360	0.9779	0.0096	0.1003	0.4793	0.0118	0.4219	3.0306	0.0146	0.5237
1998	3	2.3716	0.2142	0.4507	3.7750	0.0064	0.3655	3.4335	0.0137	0.3521	0.4494	0.0109	0.3955	1.5698	0.0105	0.2713
1998	4				5.7604	0.0047	0.5578	6.2759	0.0109	0.6436	0.3967	0.0093	0.3492	2.0098	0.0049	0.3473
1999	1				5.4966	0.0054	0.5322	2.6801	0.0086	0.2748	0.5262	0.0209	0.4632	3.4300	0.0044	0.5928
1999	2	7.2748	0.4272	1.3824	4.7776	0.0117	0.4626	2.1481	0.0087	0.2203	0.3637	0.0124	0.3201	2.1076	0.0132	0.3642
1999	3				4.4106	0.0099	0.4271	3.8100	0.0146	0.3907	0.4453	0.0101	0.3920	2.2495	0.0070	0.3887
1999	4				4.9611	0.0040	0.4804	6.5069	0.0104	0.6673	0.4571	0.0161	0.4024	1.8141	0.0036	0.3135
2000	1	4.0109	0.2142	0.7622	5.4298	0.0028	0.5257	2.9619	0.0097	0.3037	0.3537	0.0195	0.3113	2.0203	0.0039	0.3491
2000	2	1.6142	0.0479	0.3067	5.4208	0.0086	0.5249	1.4136	0.0141	0.1450	0.3349	0.0118	0.2947	3.8797	0.0041	0.6705
2000	3				6.7717	0.0103	0.6557	4.8509	0.0181	0.4974	0.5066	0.0079	0.4459	5.5962	0.0071	0.9671
2000	4				6.1875	0.0049	0.5991	4.9360	0.0142	0.5062	0.2690	0.0120	0.2368	2.1394	0.0067	0.3697

Appendix table 3.　Continued.

		AREA 1			AREA 2			AREA 3			AREA 4			AREA 5		
Year	Quarter	CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE	Tropical CPUE	Dev	Relative CPUE
2001	1				7.4068	0.0069	0.7172	4.7274	0.0094	0.4848	0.1166	0.0146	0.1026	1.9299	0.0033	0.3335
2001	2	3.2962	0.1462	0.6264	6.0170	0.0090	0.5826	2.1103	0.0155	0.2164	0.2892	0.0115	0.2546	2.1166	0.0072	0.3658
2001	3				6.9880	0.0126	0.6766	4.1131	0.0150	0.4218	0.5582	0.0053	0.4913	1.2794	0.0077	0.2211
2001	4				7.5171	0.0056	0.7279	3.6576	0.0180	0.3751	0.5133	0.0060	0.4518	0.9830	0.0067	0.1699
2002	1				9.3264	0.0038	0.9030	4.1144	0.0086	0.4219	0.2528	0.0125	0.2225	1.2857	0.0074	0.2222
2002	2	0.8767	0.2160	0.1666	4.9392	0.0061	0.4782	4.1429	0.0162	0.4248	0.3736	0.0149	0.3288	1.4051	0.0123	0.2428
2002	3	0.8768	0.4331	0.1666	1.8295	0.0071	0.1771	5.5356	0.0130	0.5677	0.3879	0.0058	0.3414	1.1056	0.0087	0.1911
2002	4				3.8644	0.0028	0.3742	4.8040	0.0311	0.4926	0.2787	0.0068	0.2453	1.1170	0.0034	0.1930
2003	1				7.2953	0.0037	0.7064	3.3304	0.0120	0.3415	0.1586	0.0358	0.1395	1.0536	0.0071	0.1821
2003	2				7.3767	0.0072	0.7143	1.8419	0.0209	0.1889	0.7155	0.0204	0.6297	1.1706	0.0417	0.2023
2003	3				5.5956	0.0132	0.5418	4.7218	0.0154	0.4842	0.6155	0.0109	0.5417	0.9599	0.0191	0.1659
2003	4				6.4859	0.0039	0.6280	6.1891	0.0343	0.6347	0.4852	0.0150	0.4270	1.8077	0.0074	0.3124
2004	1				4.6226	0.0028	0.4476	3.3528	0.0107	0.3438	0.2168	0.0377	0.1908	1.2436	0.0085	0.2149
2004	2				7.5012	0.0054	0.7263	1.3097	0.0205	0.1343	0.3766	0.0300	0.3315	3.4488	0.0241	0.5960
2004	3				3.4949	0.0068	0.3384	4.3574	0.0119	0.4468	0.8021	0.0103	0.7059	1.4861	0.0094	0.2568
2004	4				6.1873	0.0036	0.5991	4.0509	0.0167	0.4154	0.5165	0.0140	0.4546	1.0764	0.0055	0.1860
2005	1				7.1705	0.0025	0.6943	5.3791	0.0107	0.5516	0.1279	0.0265	0.1126	1.2192	0.0098	0.2107
2005	2	4.4369	0.0598	0.8431	7.4720	0.0038	0.7235	2.9712	0.0164	0.3047	0.6436	0.0250	0.5665	1.7255	0.0170	0.2982
2005	3	4.8535	0.4414	0.9223	3.3179	0.0064	0.3213	3.9840	0.0152	0.4085	0.4412	0.0212	0.3883	1.0150	0.0289	0.1754
2005	4				3.9634	0.0025	0.3838	7.1597	0.0126	0.7342	0.2487	0.0148	0.2189	1.0348	0.0123	0.1788
2006	1	4.9049	0.2252	0.9321	6.8229	0.0022	0.6606	5.6436	0.0087	0.5787	0.0779	0.0199	0.0686	1.7694	0.0048	0.3058
2006	2				7.6406	0.0022	0.7398	5.0683	0.0112	0.5197	0.3692	0.0433	0.3250	3.1453	0.0089	0.5436
2006	3	2.1304	0.2256	0.4048	2.9817	0.0062	0.2887	2.9444	0.0304	0.3019	0.5385	0.0124	0.4740	1.1657	0.0072	0.2015
2006	4	2.7025	0.1467	0.5136	3.4366	0.0024	0.3328	6.3982	0.0134	0.6561	0.4398	0.0237	0.3871	1.0305	0.0057	0.1781
2007	1				5.2609	0.0024	0.5094	3.8040	0.0089	0.3901	0.1215	0.0624	0.1070	1.6388	0.0042	0.2832
2007	2	1.1029	0.0215	0.2096	5.1817	0.0031	0.5017	6.7344	0.0137	0.6906	0.4740	0.0205	0.4172	2.3858	0.0093	0.4123
2007	3				1.7436	0.0083	0.1688	4.7515	0.0180	0.4872	0.4252	0.0130	0.3743	1.2796	0.0097	0.2211
2007	4				2.8191	0.0073	0.2730	4.8848	0.0268	0.5009	0.2491	0.0307	0.2192	1.0304	0.0062	0.1781