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STANDARDIZED CATCH PER UNIT EFFORT OF BIGEYE TUNA (*Thunnus obesus*) CAUGHT BY TAIWANESE LONGLINE FLEETS IN THE INDIAN OCEAN BY GENERAL LNEAR MIXED MODEL

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SUMMARY

Abundance index of bigeye tuna (*Thunnus obesus*) caught by Taiwanese longline fishery in the Indian Ocean are presented for the period 1968-2004. The index (number caught per 1,000 hooks) was generated from numbers of bigeye tuna caught and reported in the logbooks submitted by commercial fishermen since 1982, and aggregated data from 1968 to 1981. General linear mixed models (GLMM) was applied to both set data, and a step-wise regression procedure was used to select the set of systematic factors and interactions that significantly explained the observed variability, and deviance analysis was used to select the most appropriate factors in the standardization for the observed data. Thus, final selection of explanatory factors was conditional to the relative percentages of deviance explained by adding the factor in evaluation and normally, factors that explained more than 5 or 10% were selected. Variables used in standardization are year, area, season, targets that are represented as quantiles of ratios of albacore and yellowfin tuna in total catches of these three species and their interactions. Consequently, factors of year, season (quarter), area, target on albacore and on yellowfin, and year-area interaction were used in both models. The results of abundance index were obtained from a general linear mixed model with delta-lognormal error structure from 1968 to 2004. In addition, observers' data from 2002 to 2004 were used to verify logbooks' records for the same time and space by GLM, and the observers' information such as the proportion of effort and catch were used to adjust the logbooks' records for the years from 1990 onwards. Consequently, the standardized abundance indices for all Indian Ocean, temperate region and tropical regions were provided from 1968 to 2004.

KEYWORDS

Bigeye tuna (Thunnus obesus), Abundance index, GLMM, Longline, Delta lognormal distribution,

INTRODUCTION

Bigeye tuna, *Thunnus obesus*, is the most valuable and cosmopolitan scombridae, distributing in the tropical and temperate waters between 45°N and 45°S (Collette and Nauen, 1983), respectively. In the Indian Ocean the fish mainly distributes in the tropical regions, which is assumed as one stock in the Indian Ocean for stock assessment and management, and has been targeting by many fisheries. The most important gears used are including Japanese and Taiwanese longline fishery and Spanish purse seine fishery. The production of the entire Indian bigeye tuna stock has exceeded 100,000 MT since 1995, and Taiwanese catches have been accounted to over 30%.

The stock status has been evaluated during several working party for the tropical tunas since Indian Ocean Tuna Commission (IOTC) has established, unfortunately, the standardized catch per unit effort of the Japanese longline fishery is the only available index, which her fishery takes about 25% of the Indian bigeye tuna production. And the biological information of this species is limited. Several assessment models required more biological information cannot be applied. The results obtained showed high uncertainty. .

Among that information, the relative abundance indices from major fisheries is the one which is always necessary to tuna stock assessment models. Frequently, the catch per unit effort (CPUE) from commercial fisheries has been used to derive indices of relative abundance or to estimate fishing effort for many world fisheries (Gulland, 1956; Robson, 1996; Large, 1992; Stefansson, 1996; Griffin *et al.*, 1997; Goni *et al.*, 1999) through an appropriate standardization procedure. That is, the use of catch rates in constructing abundance indices requires standardization to take into account changes in the ability to catch fish, fleet composition, and to adjust catch rate estimates for other factors that may affect the catch rates such as year, month, boat type, or abundance of other target species in the catch (Hilborn and Walters, 1992). The generalized linear mixed modeling (GLMM) technique with delta lognormal error distribution is used because (1) GLMM extends from generalized linear model (GLM) which allows identification of the factors that influence catch rates as well as computation of standardized catch rates, represented by the year effect factor. The factor levels in GLMM are considered as randomly selected from a population of all possible factor levels and the model does not allow only one source of randomness from error structure; and (2) the delta lognormal error distribution avoids problems with contagion by zero data and treats zero and nonzero data separately (Lo *et al.*, 1992).

This study was attempting to address the above two issues in standardizing catch rates of bigeye tuna in the Indian Ocean: (1) to identify factors that have significant effects on catch rates of these two species; and (2) to produce a time series of standardized catch rate estimates that can be used for stock assessment.

2. MATERIALS AND METHODS

2.1 Data used

Two sets of catch data were used from Taiwanese longline fishery. The first set was the time series monthly 5x5 squared catch-effort data aggregated by fishing vessels and areas from 1968 to 1981, and the second is logbook data submitted by fishing vessels in a daily and 5x5 squared area frame from 1982 to 2004. In addition, observers' data from 2002 to 2004 were used to verify the logbooks in the same space and time.

Some points may affect the abundance index standardization must be recalled. First, the compilation of logbooks of Taiwanese longline fleets operated in the Indian Ocean has transferred from the Institute of Oceanography, National Taiwan University (IONTU) to the Oversea Fisheries Development Council (OFDC) in 1994, and the logbooks were then collected and updated by OFDC from 1990. The recognition of logbooks may be changed and may affect the verification of logbooks directly. The fishing behaviors, such as material used, pattern of set line, and targets etc. may be changed and those changes may not be adopted during logbooks' compilation. And the most important, the flag of convenience vessels (FOC) were active, those FOCs or some may over-report their catches and efforts as well not proportionately in logbooks submitted by legal vessels as an alliance. Those characteristics may affect the estimation of dependent variable during abundance index standardization when GLM family was used.

2.2 Stratification of sub-area

Sub-area defined for bigeye tuna (Fig. 1) used in this study is assigned as Okamoto et al. (2006), which was stratified the bigeye tuna fishing area in the Indian Ocean into 7 strata, and s area stratum named 67 in Fig. 1 was not used since the area is not available for bigeye tuna production. Each area is assumed to approximately have homogeneous species density with the investigation of nominal catch per unit effort by 5x5 squared area catch records and those stratified sub-areas were used in the following standardized process as the area factor.

Moreover, the present analysis was aggregate the areas 1 to 5 as the tropical region and 6 and 7 as the temperate region.

2.3 Model used for standardization

Relative indices of abundance for bigeye tuna were generated by Generalized Linear Mixed Model (GLMM) approach assuming a delta-lognormal error distribution for the catch rates. The estimated CPUE rate was assumed to follow a lognormal error distribution (lnCPUE-nominal) of a linear function of fixed factors and random effect interactions, particularly when the *year* effect was within the interaction.

A step-wise regression procedure was used to determine the set of systematic factors and interactions that significantly explained the observed variability. Then the Chi-square (χ^2) distribution was used to test the difference of deviance between two consecutive models, that is, this statistic was used to test significance of an additional factor in the model and the number of additional parameters associated with the added factor minus one corresponds to the number of degree of freedom in the χ^2 test (McCullagh and Nelder, 1989). Deviance analysis tables are presented. Final selection of explanatory factors was conditional to (1) the relative percentage of deviance explained by adding the factor in evaluation (normally factors that explained more than 5 % were selected); (2) significance of the χ^2 test; and (3) the type III test of significance within the final specified model.

Once a set of fixed factors was specified, possible interactions were evaluated, in particular interactions between the *year* effect and other factors. All models using the stepwise approach were fitted with the SAS GEBNOD procedure, whereas the final model was run with the SAS GLIMMIX and MIXED procedures (SAS Inst. Inc.). The detail of GLMM statistical algorithm of standardization for catch per unit effort was described in Lo et al. (1992). The computation was pursued by SAS version 9.02.

2.4 screening the logbooks' data

Two criteria were used in screening the daily record of Taiwanese longline fishery targeting on bigeye tuna. Because the operation of Taiwanese longline fleets in the tropical Indian Ocean (as defined by Fig. 1) was preliminarily observed using observers' records, fishing efforts used in one day can be averaged by 3,000 hooks and the catch of bigeye tuna was averaged about 18 per day. Based on this raw estimated data, I assumed a fishing effort was not over 3000 hooks deployed each day, and the catch was not over this 18 individuals per day, then a screening of the daily fishermen record was made for 1990 to 2004, since the deep longline was much more active during this period than before. Usually a fishing day is 16 hours including set and lift lines and fish processes (gilled and gutted). Then the first criterion is to adjust daily fishing efforts for a vessel by the averaged fishing effort; and daily catches for a vessel by the averaged fishing effort of obtaining from observers.

Besides, if the fishing efforts used were less than 1500 hooks, the test line setting was assumed. The test setting was not used in the current analysis. The records were filtered.

3. RESULTS

3.1 Nominal catch per unit effort

Regional nominal catch per unit effort series (number of fish per 1,000 hooks) of bigeye tuna caught by the Taiwanese longline fleets was estimated by the total number of catch divided the total number of hooks summing up from daily logbooks and is illustrated in Fig. 2. The nominal catch per unit in the temperate region shows high variation with decreasing trend from 1968 to 1986, then increased with fluctuation to 2002 and abruptly declined then after. Both the nominal catch per unit effort in tropical and all Indian Ocean depicts that a flat trend till 1994, an increasing trend from 1995 to 2003, then a sharply declining for the all Indian series, and a slightly increasing trend for tropical series to 2004.

3.2 Deviance analysis of factors chosen

Table 1 shows the results of a step-wised analysis for factor analysis. The result shows that the fixed factor of season (quarter) is not significant to use in the general linear mixed model and all two-way interactions with year factor are not significant (P < 0.0001 for significant χ^2 test but not satisfied the percentage of deviance difference) as well. However, to consider the yearly fishing ground changes of Taiwanese longline vessels, the interaction of year and area was mandatory used in the general linear mixed model on standardizing catch per unit effort of bigeye tuna caught by Taiwanese longline fishery in the Indian Ocean.

The interaction of year and area was also tested by using general linear model with ANOVA tables (Table 2). The variability to explain general linear model was significant (P < 0.0001)

3.3 Standardization of catch per unit effort

As shown in Table 1, the analysis of deviance explains that factors of year, sub-area, catch of albacore and year-sub-area interaction are significant for Chi-square test (p <0.0001) and percentage of deviance on standardizing Indian bigeye tuna. Then, these mentioned factors were selected using in GLMM model to standardize catch per unit effort of bigeye tuna caught by Taiwanese longline fishery in the Indian Ocean from 1968 to 2004 (two different data sets and for three areas stratification). The results are tabulated in Table 3.

The frequency distribution of residuals of GLMM shows that the original logbook data seemed not to obey the log-normal distribution for the temperate Indian region (Fig. 4) and, however, the frequency distribution of residuals were to obey the log-normal distribution error assumption for both tropical and all Indian regions (see Figs. 6 and 8, respectively), and the Q-Q plot of residuals demonstrates that a departure of both ends was found for all the three regions, indicating that there are some observed values out-lied. The suspected outliers were found probably in the early 1980s' data if the detection of frequency distribution of yearly residuals (Fig. 9) was investigated.

As the consequence, using factors selected before analysis, the trend of catch per unit effort for the three defined regions, standardized by GLMM with log-normal error structure with 95% confidence interval are illustrate in Figs. 3, 5 and 7. The results show that the series standardized for the temperate Indian region departed from the other two series during the early times (before 1992) and seemed coincident with each other after then (Fig. 10).

The comparisons of standardized catch per unit effort with the similar definition of area between Japanese (Okamoto and Shono 2006) Taiwanese longline fisheries were illustrated in Figs. 11, 12 and 13 for tropical, temperate and entire Indian Ocean, respectively. The trends more or less are similar in the early period before 1989 and seems opposite after then from the current study.

4. DISCUSSION

There were several trials (e.g., Hsu and Liu 2000, 2001; Okamoto and Miyabe 1993; Okamoto et al. 2004) to standardize bigeye tuna abundance index using Taiwanese longline catch and effort data from Indian Ocean. However, those trials need to verify their fitness to the fishery, and the results are uncertain due to mainly some changes in catch statistics compilation, in particular, those changes but not all may include: (1) Taiwanese longline fleets transferred their target from albacore to bigeye tuna in both the Atlantic and Indian Oceans from 1987 onward (Hsu and Lin 1996), (2) organization responsible for data collection and compilation changed from 1995, this change made new data compilation from 1993 and updated data from 1990; (3) a catch and vessels limit have been set since 1998, and (4) statistical document for bigeye tuna was in effect in Atlantic Ocean and subsequently a catch limit was set. Most of these changes have been addressed by Ma (unpublished thesis), and the data set used were borrowed from Ma.

Further, information of a number of hooks per basket (between two floats, NHPB) was added in the logbooks for all Taiwanese distant waters longline vessels from 1995 onward, however, the percentages of returned logbooks with NHPB information were still very low. So the information seemed not useful in standardization. Lin (1998), Yeh et al. (2001) and Lee et al. (2004) have attempted to use a learning data set, which is built from the returned logbooks with NHPB, to separate the daily set in the returned logbooks without NHPB into either deep or regular longline pattern. The separation result was said about 67.7% being classified correctly in according to Lee-Nishida method (Lee et al. 2004). However, if we do this so by Lin method (Lin 1998) and by Yeh method (Yeh et al. 2001), which almost look like Lee-Nishda method (Lee et al. 2004), the result was still not satisfactory (Hsu and Lee 2002). Consequently, The separation of fishing patterns seems not helpful on the standardization of bigeye tuna for Taiwanese longline fishery in the Indian Ocean too. As the result, a general additive model (GAM) may be used in the future study to avoid separating fishing patterns. Thus, the proportion of positive catch and positive catch rate were applied to daily sets collected from logbooks of Taiwanese longline fishery for GAM. And GAM may solve the problem of fishing patterns.

However, due to unbalance allocation of collection of logbooks, which were from deep longline fleets or regular longline fleets, the estimation of proportion positive catch (a probability to catch at least one bigeye tuna) may be biased. The study is the first run with a dataset that has been screened by using observers' information. The results need to be polished and re-run in near future. However, the procedure in particular for data screening for Taiwanese longline fishery is an improved step, it is worthwhile to be refer and paid attention in further using catch and effort data of Taiwanese longline fishery.

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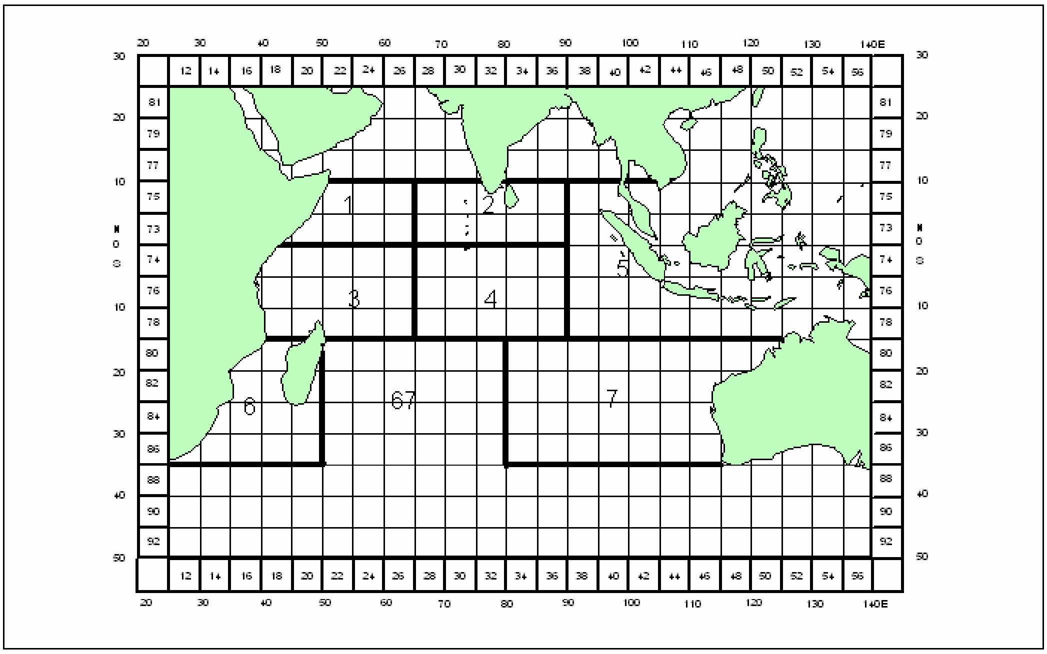

Fig. 1. Area stratification of Indian Ocean for standardizing bigeye tuna catch per unit effort.

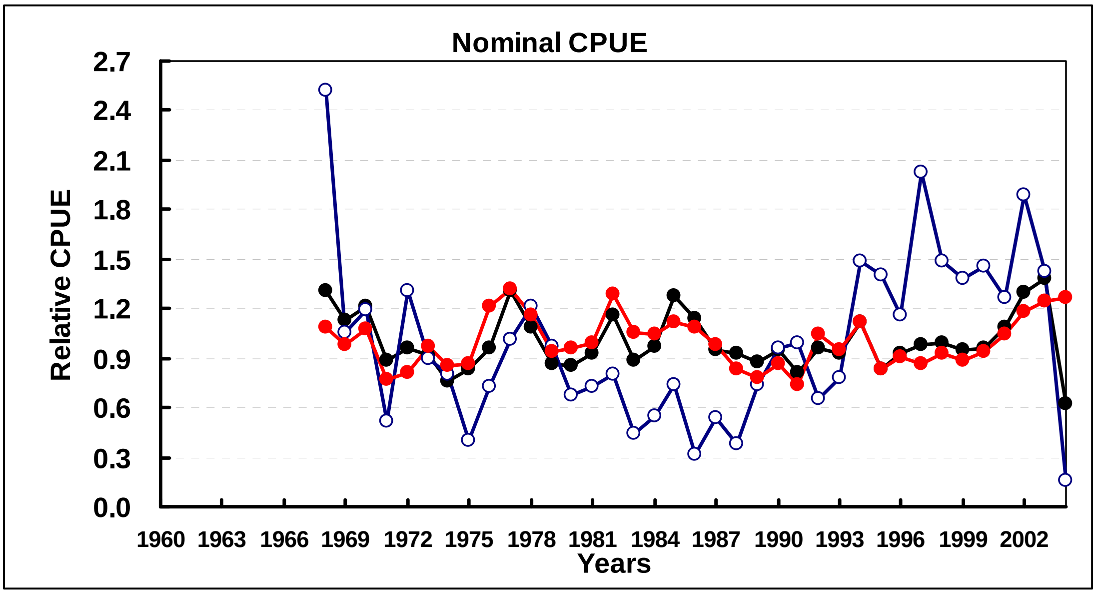

Fig. 2. Nominal CPUE of bigeye tuna for Taiwanese longline fishery in the Indian Ocean from 1968 to 2004, in which blue open circles, black closed circles and red closed circles denote the CPUE of the all Indian region, the temperate region and the tropical region, respectively.

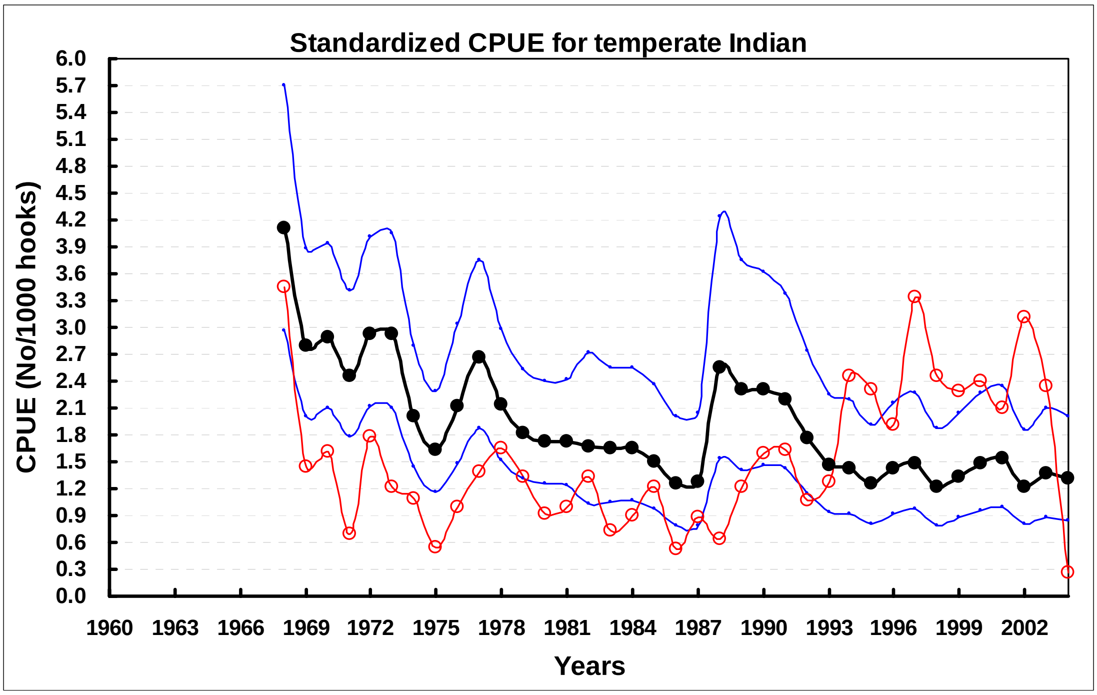

Fig. 3 The standardized CPUE (black closed circles) of the temperate Indian region for bigeye tuna caught by the Taiwanese longline fishery from 1968 to 2004, in which blue curves indicate the 95% confidence interval and red curve with open circles denotes the nominal CPUE from the same region.

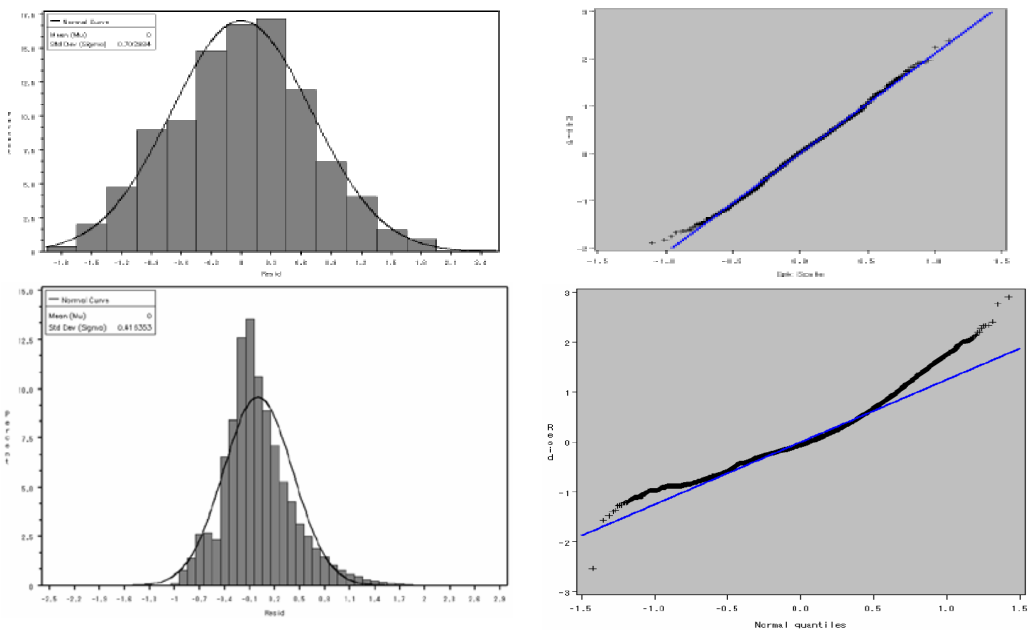

Fig. 4 Residual frequency distributions and Q-Q plots of standardized CPUE of the temperate Indian region for bigeye tuna caught by the Taiwanese longline fishery from 1968 to 1981 (upper panels) and 1982 to 2004 (lower panels), respectively, by GLMM with delta lognormal errors.

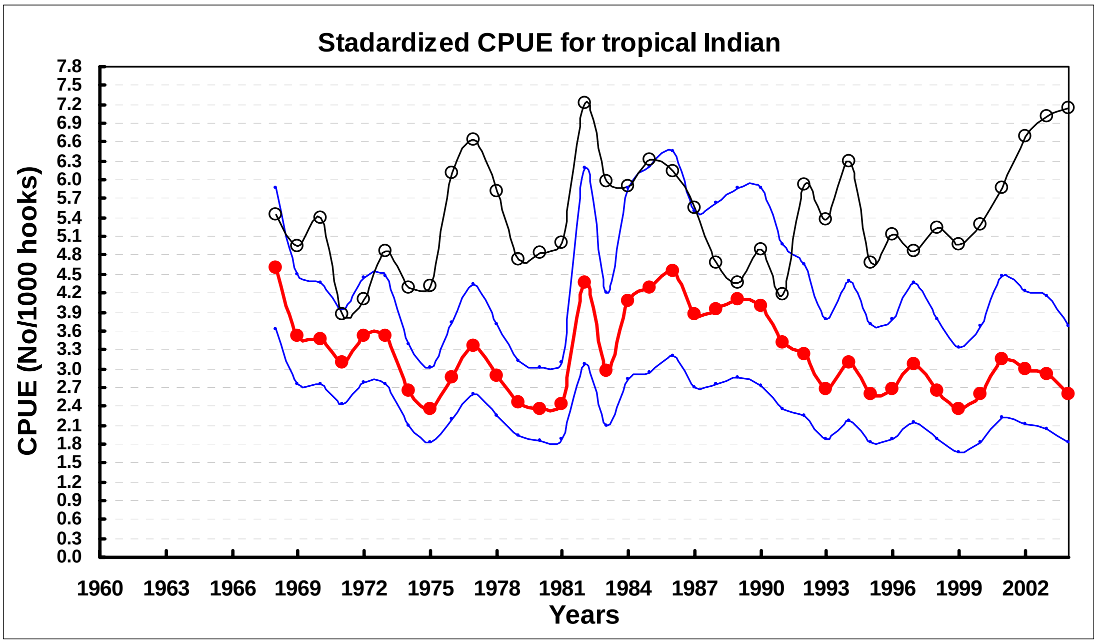

Fig. 5 The standardized CPUE (red curve with closed circles) of the tropical Indian region for bigeye tuna caught by the Taiwanese longline fishery from 1968 to 2004, in which blue curves indicate the 95% confidence interval and black curve with open circles denotes the nominal CPUE from the same region.

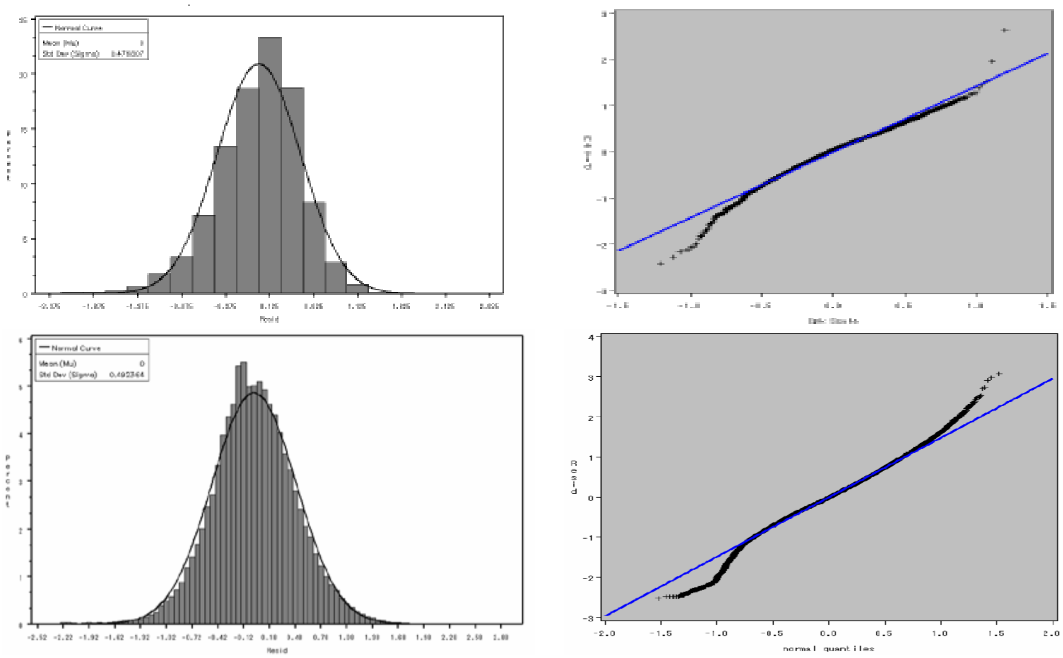

Fig. 6 Residual frequency distributions and Q-Q plots of standardized CPUE of the tropical Indian region for bigeye tuna caught by the Taiwanese longline fishery from 1968 to 1981 (Upper panels) and 1982 to 2004 (lower panels), respectively, by GLMM with delta lognormal errors.

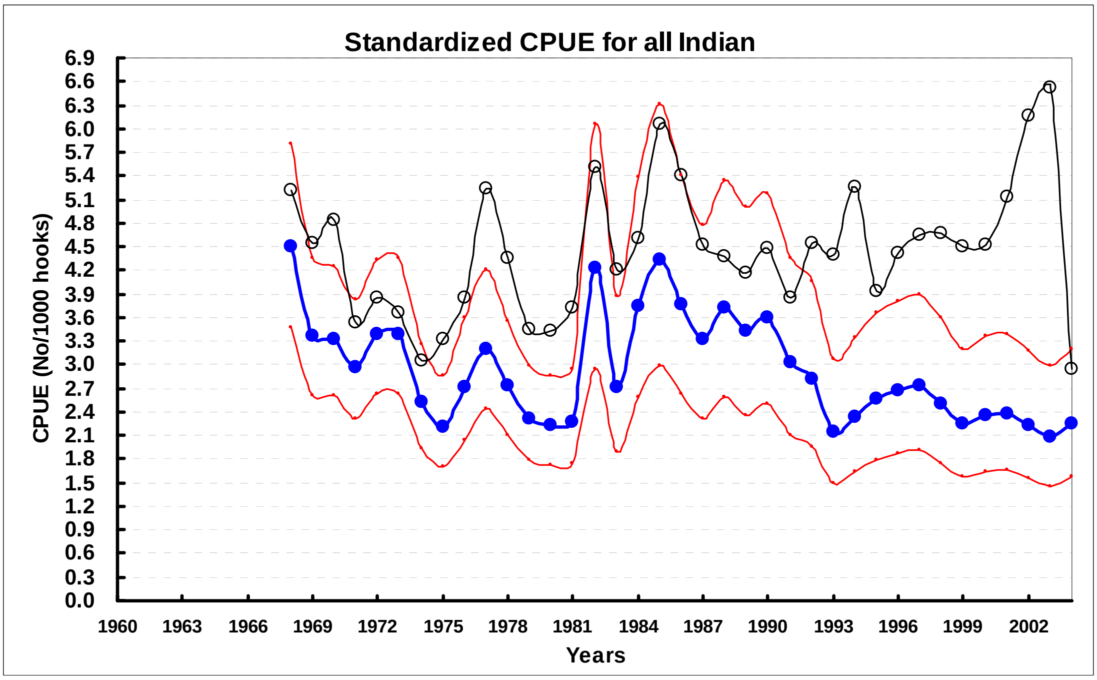

Fig. 7 The standardized CPUE (blue curve with closed circles) of the all Indian region for bigeye tuna caught by the Taiwanese longline fishery from 1968 to 2005, in which red curves indicate the 95% confidence interval and black curve with open circles denotes the nominal CPUE from the same region.

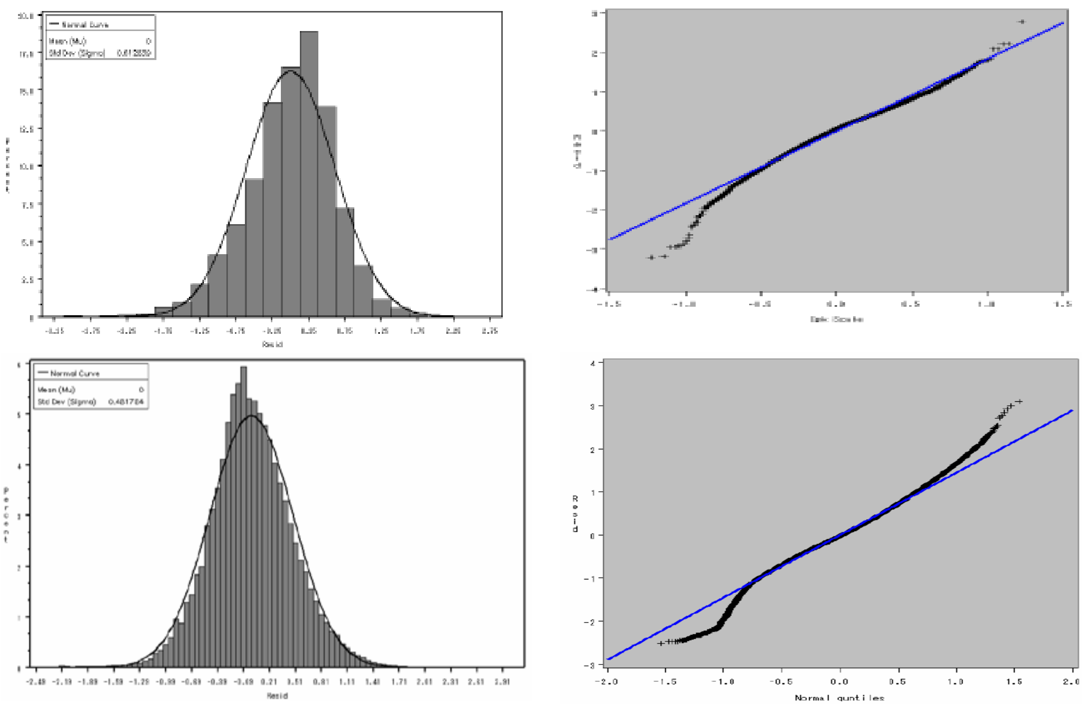

Fig. 8 Residual frequency distributions and Q-Q plots of standardized CPUE of the all Indian region for bigeye tuna caught by the Taiwanese longline fishery from 1968 to 1981 (Upper panels) and 1982 to 2004 (lower panels), respectively, by GLMM with delta lognormal errors.

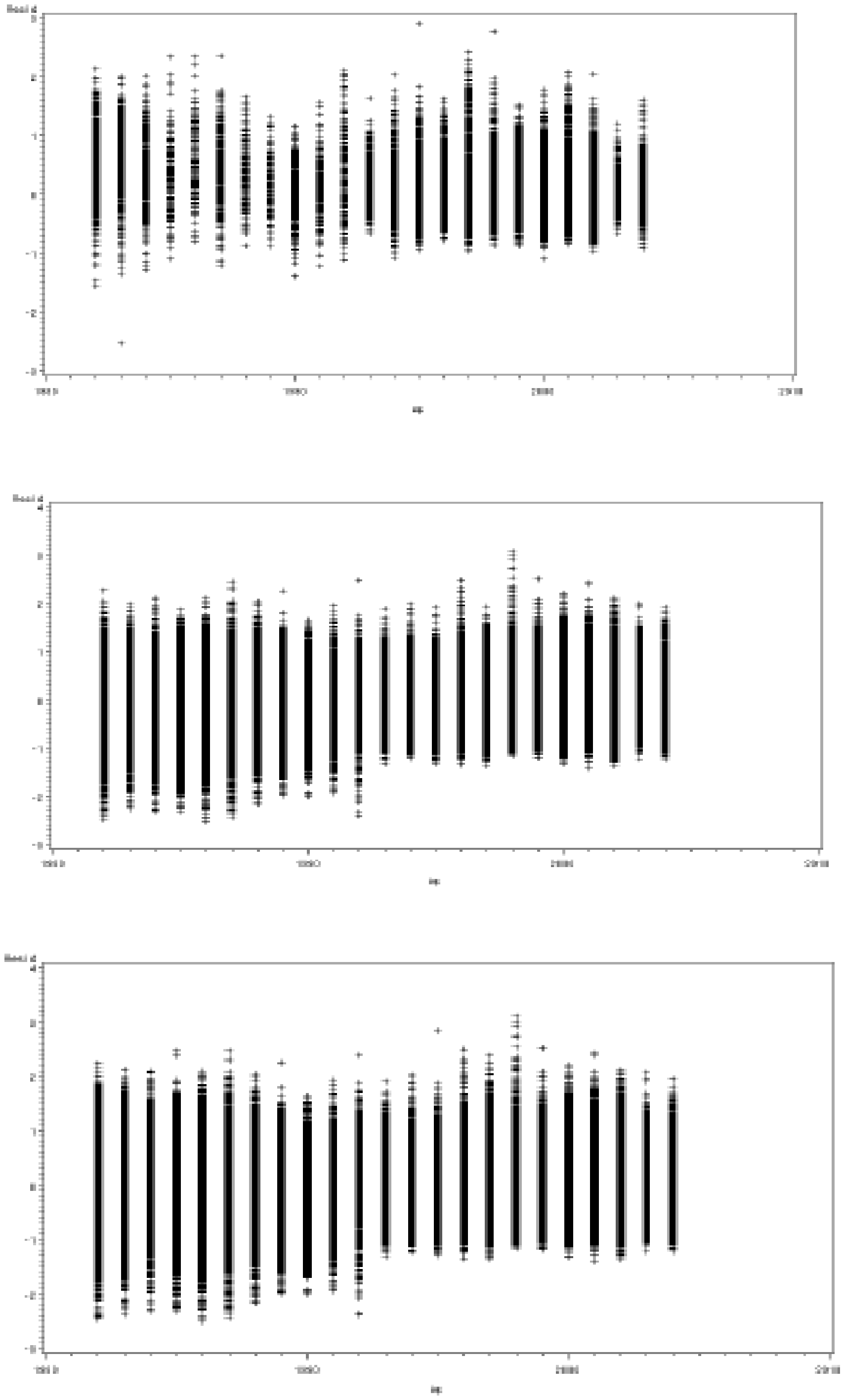

Fig. 9 Yearly residual distributions for temperate Indian region (upper panel), tropical Indian region (middle panel) and all Indian Ocean region (lower panel) by GLMM analysis.

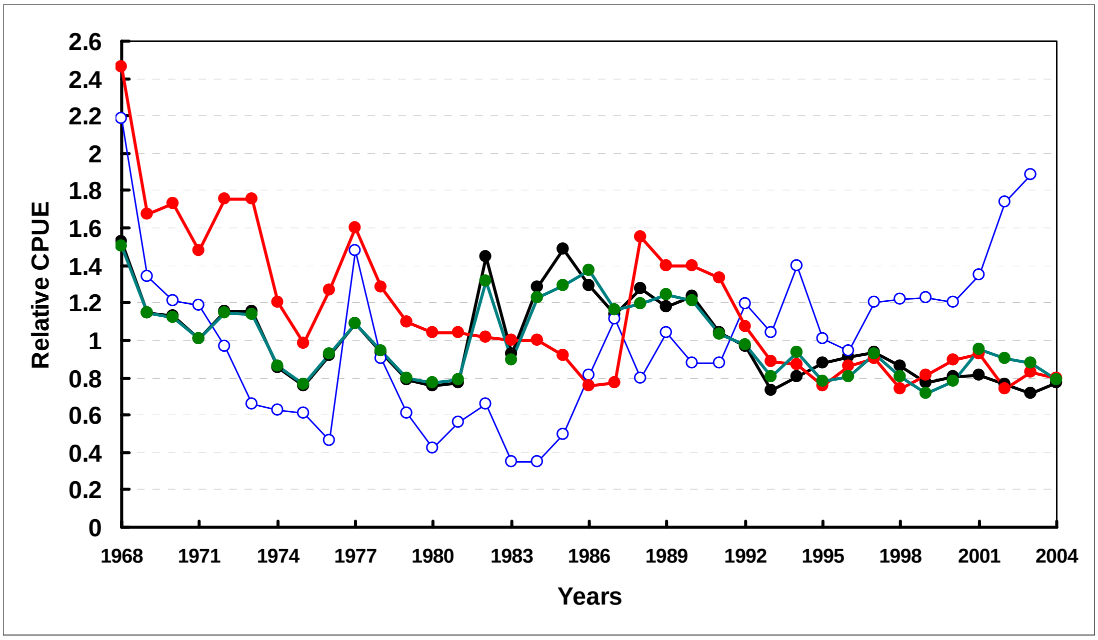

Fig. 10 The comparison among standardized catch per unit effort of bigeye tuna for Taiwanese longline fishery by GLMM from 1968 to 2004 for three defined regions in the Indian Ocean, in which red curve, green curve and black curve with closed circles represent the temperate, all Indian and tropical regions, respectively, and the blue curve with open circles indicates the nominal catch per unit effort time series.

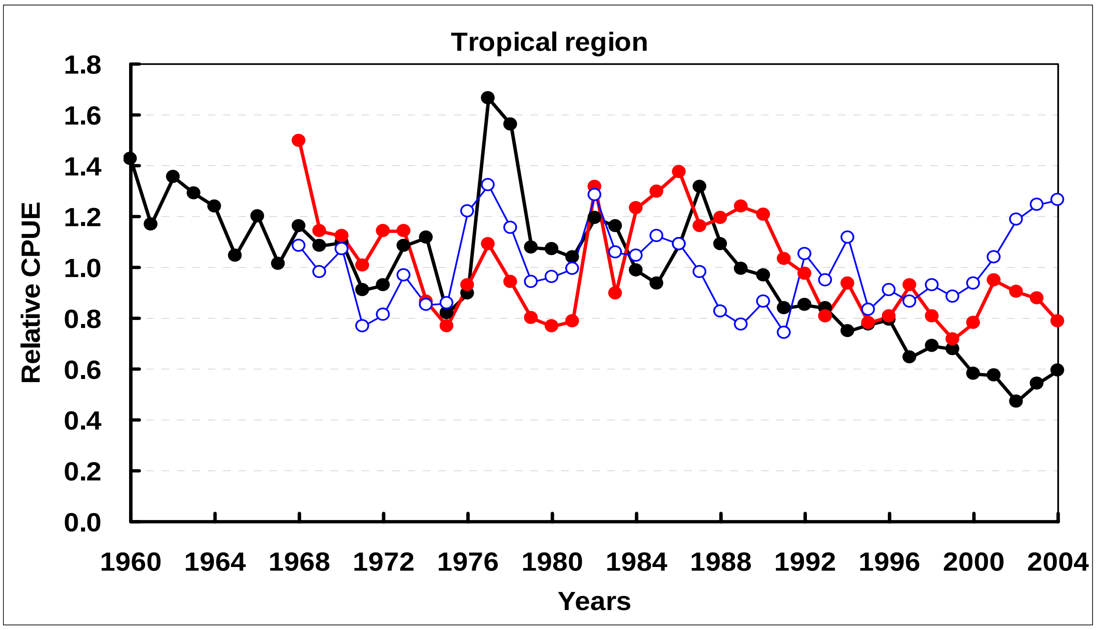

Fig. 11 Comparison of standardized CPUE time series of bigeye tuna in the tropical Indian region caught by Taiwanese (red curve with closed circles, 1968-2004) and Japanese (black curve with closed circles, 1960-2004) longline fisheries, in which blue curve with open circles represents Taiwanese nominal CPUE in the same region. Results shown are rescaled to mean of each series.

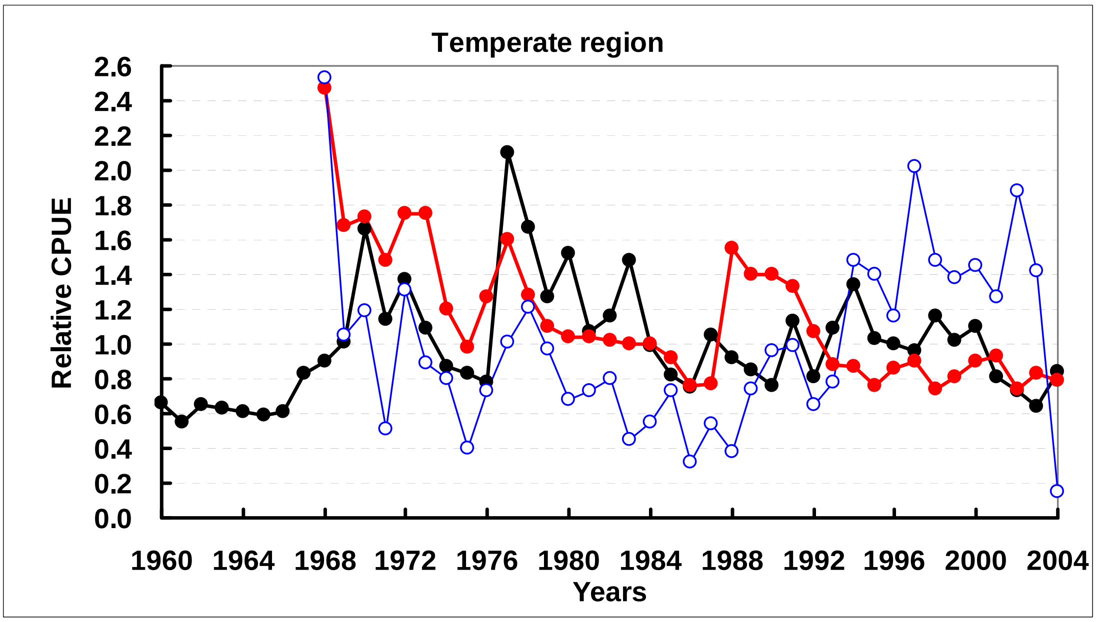

Fig. 12 Comparison of standardized CPUE time series of bigeye tuna in the temperate Indian region caught by Taiwanese (red curve with closed circles, 1968-2004) and Japanese (black curve with closed circles, 1960-2004) longline fisheries, in which blue curve with open circles represents Taiwanese nominal CPUE in the same region. Results shown are rescaled to mean of each series.

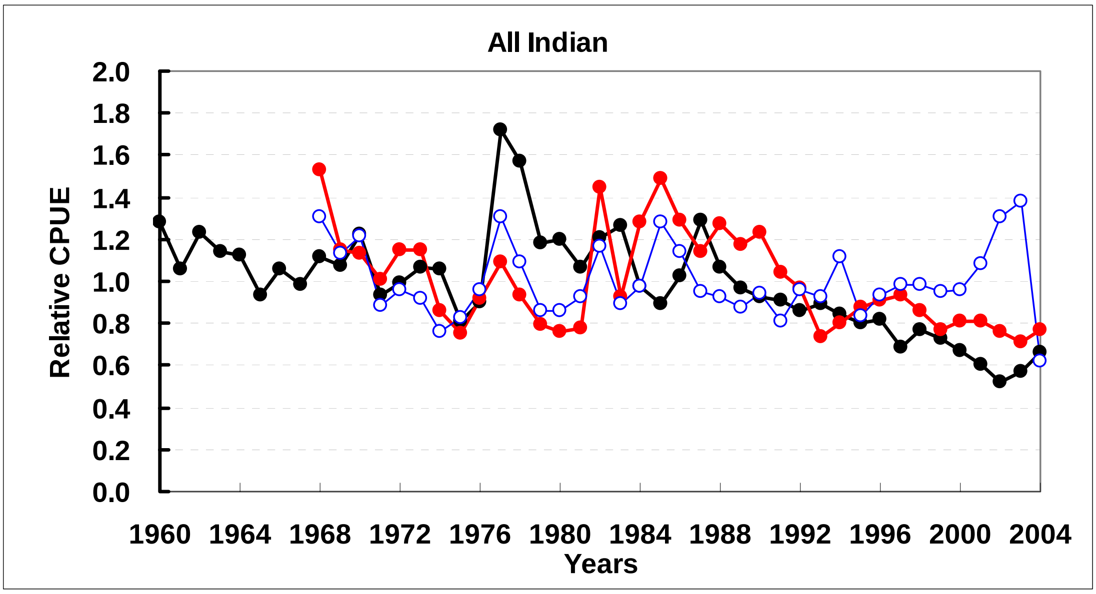

Fig. 13 Comparison of standardized CPUE time series of bigeye tuna in the all Indian region caught by Taiwanese (red curve with closed circles, 1968-2004) and Japanese (black curve with closed circles, 1960-2004) longline fisheries, in which blue curve with open circles represents Taiwanese nominal CPUE in the same region. Results shown are rescaled to mean of each series.

Table 1 Deviance analysis table of explanatory variables in the delta lognormal model for bigeye tuna catch rates (in number per 1,000 hooks) for Taiwanese longline fishery using data from 1982 to 2004. Percentages of total deviance refer to the deviance explained by the full model, and p values indicate the 5% Chi-square probability between consecutive models.

Model factors posotove catch rate values	DF	Deviance	Change devian	%total devian	P
Intercept	322402	187535.2			<.0001
Year	322402	176969.7	10565.5027	5.9702325	<.0001
Year Area	322402	161680.1	15289.5804	9.456685331	<.0001
Year Area Season	322402	160745	935.1322	0.581748893	<.0001
Year Area Season Palbrank	322402	141727.3	19017.6422	13.41847039	<.0001
Year Area Season Palbrank Pyftrank	322402	115524.3	26203.0058	22.68180484	<.0001
Year Area Season Palbrank Pyftrank Year*Area	322402	115265	259.3549	0.22500753	<.0001
Year Area Season Palbrank Pyftrank Year*Area Year*Season	322402	115174.7	90.3287	0.078427582	<.0001
Year Area Season Palbrank Pyftrank Year*Area Year*Season Year*Palbrank	322402	112503.6	2671.0657	2.374204802	<.0001
Year Area Season Palbrank Pyftrank Year*Area Year*Season Year*Palbrank Year*	322402	111322.6	1180.9489	1.0608344	<.0001

Table 2 ANOVA Tables resulted from general linear models (GLM) for standardizing catch per unit effort of bigeye tuna in the Indian Ocean by Taiwanese longline fishery from 1982 to 2004. (1968-1981 missing)

(a) For all Indian Ocean, 1982-2004

Source	DF	Sum of Square	Mean Square	F value	Pr>F
Model	59	64713.7961	1096.844	4266.21	<0.0001
Error	322342	82884.3512	0.2571		
Corrected total	322342	147598.1473			

R^2	Coeff. Variation	RootMSE	Logmean
0.5215	58.7499	0.5071	0.86312

Source	DF	Type III SS	Mean Square	F value	Pr > F
Year	22	29343.3189	1333.7872	5187.18	<0.0001
Season (quarter)	3	95.2752	31.7584	123.51	<0.0001
Area	6	1648.1485	274.6914	1068.29	<0.0001
SST	4	215.2858	53.8215	209.31	<0.0001
Palbrank	3	10594.8398	3531.6133	13734.60	<0.0001
Pyftrank	3	22265.4832	7421.8277	28863.90	<0.0001
Year*area	18	551.4447	30.6358	119.14	<0.0001

(b) For tropical Indian Ocean

Source	DF	Sum of Square	Mean Square	F value	Pr>F
Model	49	587444.7551	1192.7501	4582.21	<0.0001
Error	259782	67622.5073	0.2603		
Corrected total	259831	173231.6930			

R^2	Coeff. Variation	RootMSE	Logmean
0.4914	51.2422	0.5102	0.995665

Source	DF	Type III SS	Mean Square	F value	Pr > F
Year	22	30445.2589	1383.8754	5316.36	<0.0001
Season (quarter)	3	50.6396	16.8799	64.85	<0.0001
Area	4	299.3801	74.8450	287.53	<0.0001
SST	2	41.2397	20.6199	79.21	<0.0001
Palbrank	3	5599.6183	1866.5394	7170.59	<0.0001
Pyftrank	3	21828.1316	7276.0439	27952.00	<0.0001
Year*area	12	180.4869	15.0406	57.78	<0.0001

(c) For temperate Indian Ocean

Source	DF	Sum of Square	Mean Square	F value	Pr>F
Model	38	5287.9269	139.5260	718.04	<0.0001
Error	62531	12119.7571	0.1938		
Corrected total	62569	17407.684			

R^2	Coeff. Variation	RootMSE	Logmean
0.2765	140.7887	0.4403	0.312703

Source	DF	Type III SS	Mean Square	F value	Pr > F
Year	22	1204.4284	54.7467	282.46	<0.0001
Season (quarter)	3	117.6682	39.2227	202.37	<0.0001
Area	1	1.0838	1.0838	5.59	<0.0180
SST	3	172.1036	57.3679	295.99	<0.0001
Palbrank	3	2765.6565	921.8855	4756.40	<0.0001
Pyftrank	3	963.4958	321.1653	1657.03	<0.0001
Year*area	12	63.4906	21.1635	109.19	<0.0001

Table 3 Results of nominal and standardized catch per unit effort of bigey tuna caught by Taiwanese longline fishery in the entire Indian Ocean, the temperate Indian Ocean and tropical Indian Ocean with 95% confidence intervals from 1968 to 2004.

	All Indian			Temperate			Tropical		
year	std CPUE	Lower CI	upper CI	std CPUE	Lower CI	Upper CI	std CPUE	Lower CI	Upper CI
1968	4.494678	3.478781	5.807244	4.105259	2.956526	5.700321	4.611757	3.616293	5.881243
1969	3.363043	2.600625	4.348977	2.791313	2.00806	3.880077	3.513441	2.752724	4.484383
1970	3.325235	2.605399	4.243952	2.881035	2.106706	3.939971	3.454513	2.740774	4.354121
1971	2.96669	2.303522	3.82078	2.461299	1.779309	3.40469	3.105371	2.44259	3.947993
1972	3.38181	2.639479	4.332916	2.918704	2.123788	4.011151	3.514534	2.778116	4.446159
1973	3.380878	2.621157	4.360799	2.918815	2.105803	4.045717	3.510863	2.757626	4.469843
1974	2.515425	1.944419	3.254115	2.002811	1.438931	2.787661	2.653933	2.078811	3.388166
1975	2.207029	1.699249	2.866547	1.637209	1.170745	2.289528	2.354751	1.837384	3.017797
1976	2.705086	2.040015	3.586977	2.115721	1.474	3.036821	2.859962	2.187937	3.7384
1977	3.207278	2.448588	4.201047	2.659997	1.882856	3.757902	3.353508	2.595537	4.33283
1978	2.737366	2.106017	3.557985	2.135565	1.525527	2.989547	2.89331	2.256071	3.710542
1979	2.320097	1.797903	2.993959	1.826627	1.316819	2.533809	2.454637	1.9272	3.126425
1980	2.228917	1.73301	2.866731	1.733883	1.255238	2.395043	2.365908	1.863441	3.003863
1981	2.274412	1.751756	2.953007	1.727312	1.235395	2.415103	2.421639	1.890295	3.102338
1982	4.231073	2.949956	6.068557	1.67587	1.033964	2.716286	4.355447	3.060549	6.198209
1983	2.703963	1.885677	3.877341	1.642665	1.055172	2.557258	2.960849	2.082195	4.210282
1984	3.740807	2.597748	5.386834	1.650795	1.066492	2.555224	4.066076	2.818541	5.86579
1985	4.336433	2.977507	6.315569	1.507935	0.966208	2.353395	4.27716	2.9406	6.221211
1986	3.769484	2.624757	5.413458	1.249606	0.781545	1.997984	4.542073	3.19526	6.456571
1987	3.320527	2.313669	4.765548	1.267795	0.788813	2.037624	3.847556	2.695103	5.492808
1988	3.717972	2.583305	5.351019	2.549921	1.533436	4.240215	3.935416	2.751388	5.628978
1989	3.436836	2.36369	4.997206	2.301172	1.409869	3.755946	4.097711	2.862623	5.865682
1990	3.595897	2.499501	5.173221	2.297068	1.460074	3.613872	3.990309	2.716761	5.860864
1991	3.037488	2.114037	4.364319	2.188942	1.41642	3.3828	3.414341	2.350294	4.960113
1992	2.822695	1.962103	4.060747	1.765157	1.138011	2.737918	3.22217	2.235934	4.643418
1993	2.136984	1.490034	3.06483	1.455214	0.943989	2.243299	2.66152	1.868839	3.790421
1994	2.337925	1.631177	3.350888	1.42581	0.926786	2.19353	3.092331	2.175926	4.394687
1995	2.562951	1.791805	3.665979	1.247202	0.813477	1.912176	2.587709	1.815429	3.688516
1996	2.666017	1.870078	3.800723	1.416147	0.926801	2.163865	2.661065	1.869282	3.788228
1997	2.731557	1.912539	3.901308	1.482748	0.968157	2.270852	3.060642	2.151206	4.354547
1998	2.511208	1.752467	3.598452	1.222433	0.793668	1.882833	2.654839	1.866978	3.775175
1999	2.244725	1.572355	3.204614	1.33571	0.87274	2.044275	2.355997	1.663874	3.336024
2000	2.355064	1.643655	3.374385	1.477026	0.960029	2.272438	2.582232	1.814515	3.674769
2001	2.36993	1.654312	3.395109	1.529605	0.994323	2.35305	3.144192	2.21358	4.466044
2002	2.229441	1.564597	3.176798	1.21886	0.797602	1.862608	2.991023	2.116159	4.227573
2003	2.082746	1.451165	2.989205	1.359766	0.87942	2.10248	2.899372	2.023113	4.155161
2004	2.245328	1.573129	3.204758	1.308104	0.850477	2.01197	2.597145	1.83441	3.677019