CPUE standardization of blue marlin caught by Taiwanese large scale longline fishery in the Indian Ocean

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ABSTRACT

This paper described the historical patterns of blue marlin catches of Taiwanese large scale longline fishery in the Indian Ocean. The cluster analysis was adopted to explore the targeting of fishing operations. In addition, the CPUE standardizations were conducted using delta-gamma generalized linear models because blue marlin were the bycatch of Taiwanese longline fishery and large amount zero catch existed in the data sets. The results indicate that the effects of targeting (clusters) provided most significant contributions to the explanation of the variance of CPUEs of blue marlin for the models with positive catches, but the catch probability of blue marlin might be mainly influenced by temporal and spatial effects.

1. INTRODUCTION

Blue marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Longline catches6 account for around 70% of total catches in the Indian Ocean, followed by gillnets (24%), with remaining catches recorded under troll and handlines. Based on the catches data from 2012 to 2015, main fleets consisted of Taiwan (longline, 34%), Indonesia (fresh longline, 31%), Pakistan (gillnet, 12%), I.R. Iran (gillnet, 9%), and Sri Lanka (6%). Catches reported by drifting longliners were more or less stable until the late-70’s, at around 3,000 t to 4,000 t, and have steadily increased since then to reach values between 8,000 t and to over 10,000 t since the early 1990’s. The highest catches reported by longliners have been recorded since 2012, and are likely to be the consequence of higher catch rates by some longline fleets which appear to have resumed operations in the western tropical Indian Ocean. (IOTC, 2018).

This report briefly describes temporal and spatial patterns of fishing operations and blue marlin catches caught by Taiwanese longliners in the Indian Ocean. The cluster analysis (He et al., 1997; Hoyle et al., 2014) was adopted to explore the targeting of fishing operations and to produce the data filter for selecting the data for

CPUE standardization.

2. MATERIALS AND METHODS

2.1. Catch and Effort data

In this study, daily operational catch and effort data (logbook) with 5x5 degree longitude and latitude grid for Taiwanese longline fishery during 1979-2018 were provided by Oversea Fisheries Development Council of Taiwan (OFDC). It should be noted that the data in 2018 is preliminary.

2.2. Cluster analysis

Cluster analysis was performed based on species composition of the catches of albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO), blue marlin (BUM), striped marlin (MLS), black marlin (BLM) and other species (OTH). However, clustering operational set-by-set data might include large amount noise because most of billfishes were caught by Taiwanese vessels as bycatches. Therefore, the cluster analysis was performed based weekly-aggregated data and then merged the clusters with set-by-set operational data to identify the targeting fishing operations.

He et al. (1997) suggested a cluster analysis with two steps to classify the data sets because the large number of data sets precluded direct hierarchical cluster analysis. First, a non-hierarchical cluster analysis (K-means method) was used to group the species composition from all data sets into 64 clusters for taking the mixture of fishing operations into account (P_2^6 which means 2 species can be chosen with priority from 8 species). Second, a hierarchical cluster analysis with Ward minimum variance method was applied to the squared Euclidean distances calculated based on the species composition from 64 non-hierarchical clusters. Non-hierarchical and hierarchical cluster analyses were conducted using R functions kmeans and hclust (The R Foundation for Statistical Computing Platform, 2018).

The choice for the number of clusters to produce was largely subjective. At least two clusters were expected. In this study, the number of clusters was selected based on the basic concept of cluster analysis approach that is to produce clusters with high similarity within a cluster and low similarity between clusters. In this study, the number of clusters was selected when the difference in the relative variance between groups and the relative variance within the group was more than 50~60%. In addition, cluster analyses were performed by four fishing areas separately (Fig. 1).

2.3. CPUE Standardization

Because blue marlin was bycatch species of Taiwanese lognline fishery, large amount of zero-catches was recorded in the operational catch and effort data sets of Taiwanese longline fishery. In recent decades, the annual proportions of zero-catch were about 50-80% of total data sets (Fig. 2). In previous study (Wang, 2016), the delta-lognormal GLM (Pennington, 1983; Lo et. al., 1992; Pennington, 1996) was applied to conduct CPUE standardization of blue marlin in the Indian Ocean but the model with lognormal assumption for the residuals might not appropriate for fitting to the data. Therefore, a delta-gamma GLM was adopted in this study. In addition, the targeting of fishing operation was identified from the cluster analyses as recommended by the Fifth IOTC CPUE Workshop.

The vessel ID was incorporated into the CPUE standardizations as an effect for albacore tuna (Wang, 2019). However, the vessels operated in the Indian Ocean varied over time and space and they did not operate all the time and space. In addition, vessel ID effect did not provide explanatory power for the CPUE standardizations and thus this study did not attempt to conduct the CPUE standardization by incorporating the effect of vessel ID.

As the approach of Wang (2017), the models were simply conducted with the main effects considered in this analysis were year, month, 5x5 longitude-latitude grid, and the effects related to the fishing configurations (clusters), while interactions between main effects were not incorporated into the models. In addition, CPUE standardizations were also performed by four fishing areas separately. The gamma and delta models were conducted as follows:

Gamma model for CPUE of positive catch:

$$\log(CPUE) = \mu + Y + M + G + T + \varepsilon^{\text{gamma}}$$

Delta model for presence and absence of catch:

$$PA = \mu + Y + M + CT + G + T + \varepsilon^{del}$$

where	*CPUE*	is the nominal CPUE of positive catch of blue marlin (catch in number/1,000 hooks),
	PA	is the nominal presence and absence of catch,
	μ	is the intercept,
	Y	is the effect of year,
	M	is the effect of month,
	G	is the effect of 5x5 longitude-latitude grid,

T	is the effect of targeting (cluster),
ε^{gamma}	is the error term, ε^{gamma} ~ Gamma distribution with log link function,
ε^{del}	is the error term, ε^{del} ~ Binomial distribution.

The models performed by stepwise search ("both" direction, i.e. "backward" and "forward") and selected based on the Akaike information criterion (AIC) using the glm function of R (R Core Team, 2019). The standardized CPUE series were calculated based on the estimates of least square means of the effects of year using the function of emmeans of R.

The area-specific standardized CPUE trends were estimated based on the exponentiations of the adjust means (least square means) of the year effects (Butterworth, 1996; Maunder and Punt, 2004). The standardized relative abundance index was calculated by the product of the standardized CPUE of positive catches and the standardized probability of positive catches:

$$index = e^{\log(CPUE)} \times \left(\frac{e^{\tilde{P}}}{1+e^{\tilde{P}}} \right)$$

where	$CPUE$	is the adjust means (least square means) of the year effect of the gamma model,
	$\tilde{P}$	is the adjust means (least square means) of the year effect of the delta model.

1.1. Area-aggregated CPUE series

The area-aggregated standardized CPUE series were calculated from the weighted average of the area indices (Punt et al., 2000):

$$U_y = \sum_a S_a^1 U_{y,a}$$

Where	U_y	is CPUE for year y,
	$U_{y,a}$	is CPUE for year y and area a,
	S_a^1	is the relative size of the area a.

The relative sizes of nine IOTC statistics areas for swordfish in the Indian Ocean (Nishida and Wang et al., 2006) were used to be aggregated into four areas used in this study.

Area	NW	NE	SW	SE
Relative area size	0.2478	0.2577	0.1638	0.3307

As suggested by the previous meeting of WPB, area-specific standardized CPUE series were also aggregated by the proportions of annual area-specific catch and effort data:

$$U_y = \sum_a S^2_{y,a} U_{y,a}$$

Where $S^2_{y,a}$ is the proportion of the catch or hooks in year *y* and area *a*.

3. RESULTS AND DISCUSSION

3.1. Historical fishing trends

Figs. 3 to 5 show the distributions of catch and CPUE of blue marlin and fishing effort (hooks) of Taiwanese large scale longline fishery in the Indian Ocean. The catches of blue marlin were mainly made in the northern water of 20°S before the 1990s; expanded to the entire Indian Ocean thereafter due to the expansion of the efforts; concentrated in the tropical area since the mid-2000s when the efforts substantially decreased in part of the temperate waters. High CPUEs were mainly occurred in the northern water of 20°S, even for the period from the early 1990s to the mid-2000s when high catches appeared in the entire Indian Ocean.

The blue marlin catches were mainly caught in the Area NE before the 1990s and most of the catches were made in the Area NW thereafter due to the substantial increase of the fishing efforts (Fig. 6).

The fishing operation of the vessels in the Indian Ocean also tended to use deep sets since early 2000s (Figs. 7 and 8). High CPUEs of blue marlin generally occurred with the NHBF between 13 to 18 hooks (Fig. 9), which were often used for catching tropical tunas, and this may be the reason that high CPUEs mainly observed in the tropical waters during the early 1990s to the mid-2000s (Fig. 4).

3.2. Cluster analysis

For Area 1 (NW), 5 clusters were selected (Fig. 10). Annual catches and catch proportion by species for each cluster were shown in Fig. 11, which indicated that Cluster 1 was operations for mixed species, Cluster 2 was targeting BET with YFT, Cluster 3 was targeting SWO with BET, Cluster 4 was targeting YFT, and Cluster was mainly targeting ALB with more BET and YFT in the later years. The catch proportions by clusters for each species (Fig. 12) show similar results with Fig. 11. The operations of Cluster 4 (YFT cluster) mainly consisted of the shallow sets and concentrated in the waters of 0-20°N and 55°E-65°E; operations of Cluster 5 (ALB cluster) mainly occurred in the waters with relatively higher latitude in the second half-year; fishing characteristics for other clusters were relatively similar but operations of Cluster 3 (SWO cluster) concentrated in the waters between 5°S and 10°N after early 2000s (Fig. 13). The catches of blue marlin and fishing efforts of Cluster 1 and 2 were obviously higher than those of other clusters, while Cluster 4 also contained more blue marlin catches in some years due to relatively higher fishing efforts (Fig. 14). The proportions of blue marlin catches were generally low for all clusters except for high catch proportion occurred in coastal areas for Clusters 3 and 5 (Fig. 15).

For Area 2 (NE), 5 clusters were selected (Fig. 16). Annual catches and catch proportion by species for each cluster were shown in Fig. 17, which indicated that Cluster 1 was operations for targeting BET, Cluster 2 was targeting BET with YFT, Cluster 3 was targeting YFT, Cluster 4 mainly caught OTH with some YFT and BET, and Cluster was mainly targeting ALB with more BET in the later years. The catch proportions by clusters for each species (Fig. 18) show similar results with Fig. 16. The operations of Cluster 3 (YFT cluster) mainly consisted of the shallow sets and concentrated in the waters of 0-15°N in the first-half year; operations of Cluster 5 (ALB cluster) mainly occurred in the waters with relatively higher latitude; fishing characteristics for other clusters were relatively similar but operations of Cluster 4 (OTH cluster) mainly occurred in later years (Fig. 19). Cluster 1, 2 and 3 obviously contained more catches of blue marlin and fishing efforts than those of other clusters, while more blue marlin catches also occurred in Cluster 4 in the later years due to relatively higher fishing efforts (Fig. 20). The proportions of blue marlin catches were generally low for all clusters but relatively higher catch proportion can be observed in coastal areas for all clusters (Fig. 21).

For Area 3 (SW), 3 clusters were selected (Fig. 22). Annual catches and catch proportion by species for each cluster were shown in Fig. 23, which indicated that Cluster 1 was operations for targeting ALB, Cluster 2 was operations for catching mixed species, and Cluster 3 was targeting OTH. The catch proportions by clusters for each species (Fig. 24) show similar results with Fig. 23. Cluster 1 (ALB cluster) mainly consisted of the operations in eastern part of this area and in years before 2000; Cluster 3 (OTH cluster) consisted of the operations with more deep sets, concentrated in the high latitude and western part of this area, and in the years after 2000 (Fig. 25). Cluster 1 and 2 obviously contained more catches of blue marlin and fishing efforts before the late 2000s, while Cluster 2 contained more blue marlin catches in the later years due to substantial increase of fishing efforts (Fig. 26). The proportions of blue marlin catches were generally low for all clusters but relatively higher catch proportion can be observed in coastal areas for Cluster 1 (Fig. 27).

For Area 4 (SE), 5 clusters were selected (Fig. 28). Annual catches and catch proportion by species for each cluster were shown in Fig. 29, which indicated that Cluster 1 was the operations for targeting ALB, Cluster 2 was also the operations for targeting ALB but with more OTH, Cluster 3 was the operations for catching BET and ALB and also OTH in the later years, Cluster 4 was the operations for catching mixed species, and Cluster 5 was targeting OTH with ALB. The catch proportions by clusters for each species (Fig. 30) show similar results with Fig. 29. Both Clusters 1 and 2 were targeting ALB but Cluster 1 consisted of the operations in years before 2000, while Cluster 2 consisted of the operations in the years after 2000; Cluster 5 (OTH cluster) consisted of the operations concentrated in the waters of 80°E-90°E, and in the years after the late 2000s (Fig. 31). Except Cluster 5, catches of blue marlin were contained in different Clusters accompanied the occurrences of fishing efforts (Fig. 32). The proportions of blue marlin catches were generally low for all clusters but relatively higher catch proportion can be observed in the waters for Cluster 5 (Fig. 33).

3.3. CPUE standardization

The clusters contained very few catches of blue marlin were excluded when doing the CPUE standardizations. Except for Area 3 (SW), the data of Cluster 5 were excluded for all other areas.

Based on the model selections for the gamma models incorporated clusters as the effects related to targeting of operations, all of main effects were statistically significant and remained in the models for all areas. The ANOVA tables for selected gamma models are shown in the Table 1. The results indicate that the effects of *T* (clusters) provided most significant contributions to the explanation of variance of CPUEs for the models for all of four areas. Thus, the targeting of fishing operation might influence the CPUE derived from the positive catch of blue marlin.

For the delta models, all of the effects were also statistically significant and remained in the models for all areas. The ANOVA tables for selected delta models are shown in the Table 2. Comparing to the gamma models for positive catches, the effect of *T* (clusters) were less influential for the catch probability although this effect still significant in the models for all of four areas. The results indicated that the catch probability of blue marlin in the Indian Ocean might be mainly influenced by temporal (Year, Y) and spatial (5x5 longitude-latitude grid, G) effects.

The area-specific standardized CPUE are shown in Fig. 34. The trends of CPUE series in the northern areas (NW and NE) reveal similar trends before the early 2000s. The standardized CPUE series in the northern areas obviously declined since the mid-1980 although CPUEs obviously fluctuated in early years, gradually increased in the 1990s, and declined again from the late 1990s to the late 2000s. However, the CPUE series continuously increased after the early 2000s for area NE but a substantial decline of CPUE can be observed in area NW for recent years. The CPUE series in the southern areas (SW and SE) generally fluctuated without apparent trends, but some spikes occurred between the late 1990s and early 2010s. In addition, the ranges of confidence intervals of standardized CPUE in the southern areas are much wider than those in the northern areas, and this may indicate the high uncertainty in CPUE standardizations for blue marlin in the southern areas.

Because very few blue marlin catches were made in the southern areas (SW and SE) and the CPUE standardizations may remain uncertainties, the CPUE series in the northern areas (NW and NE) were only used when calculating the area-aggregated CPUE series. Fig. 35 shows the area-aggregated standardized CPUE series of blue marlin in the Indian Ocean. The area-aggregated CPUE series calculated by different weightings generally revealed similar trends, but apparent difference can be observed for recent years although they all revealed decline trends.

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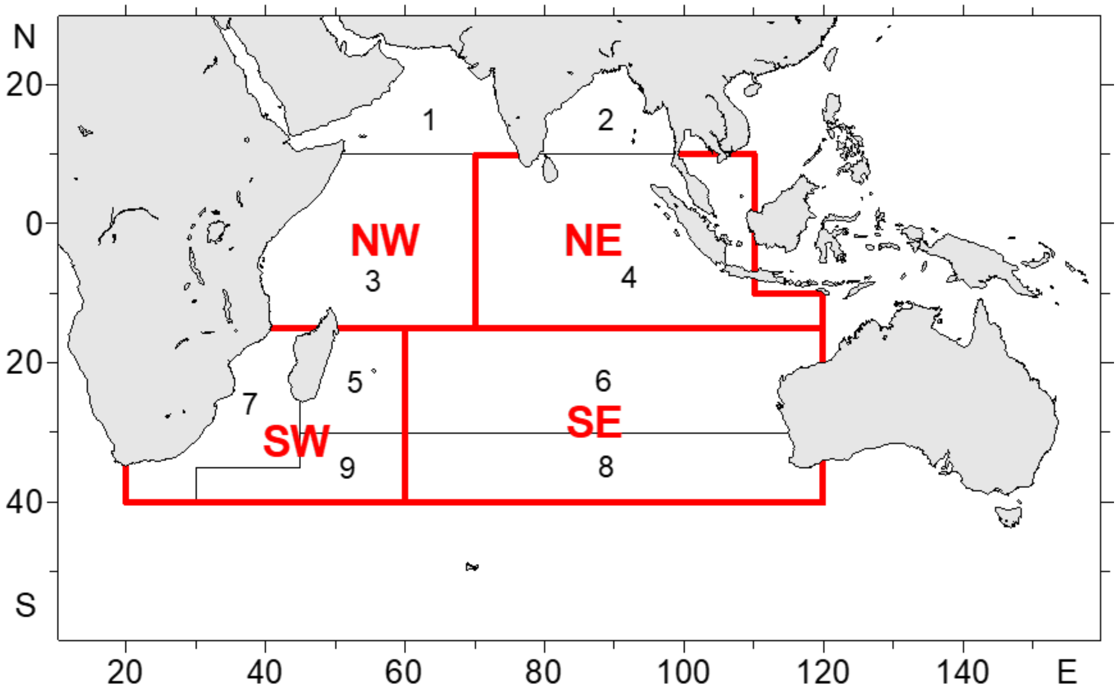


Fig. 1. Area stratification for blue marlin in the Indian Ocean.

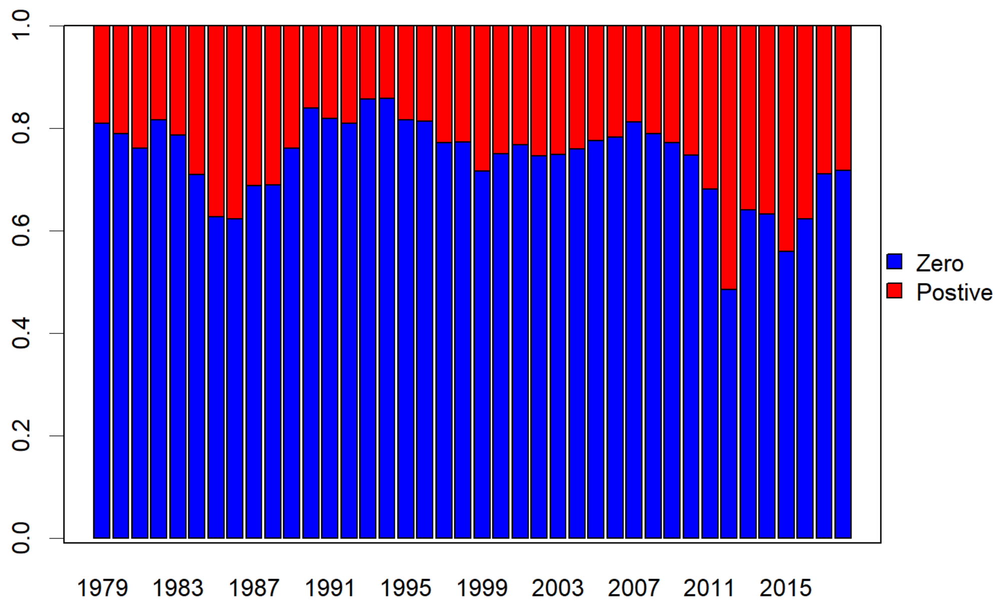


Fig. 2. Annual proportions of positive and zero catches of blue marlin caught by Taiwanese large scale longline fishery in the Indian Ocean.

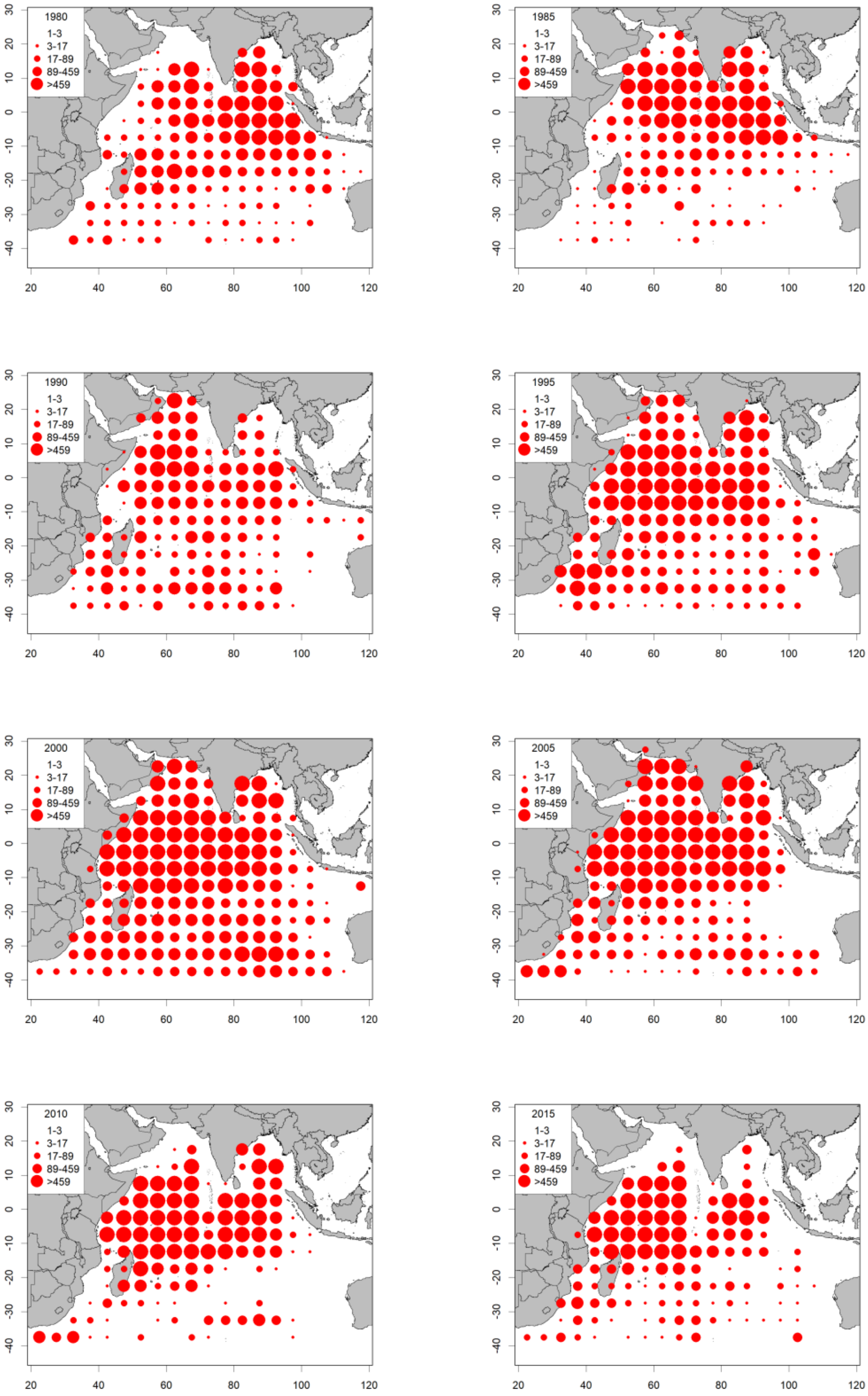


Fig. 3. Blue marlin catches distributions of Taiwanese large scale longline fishery in the Indian Ocean.

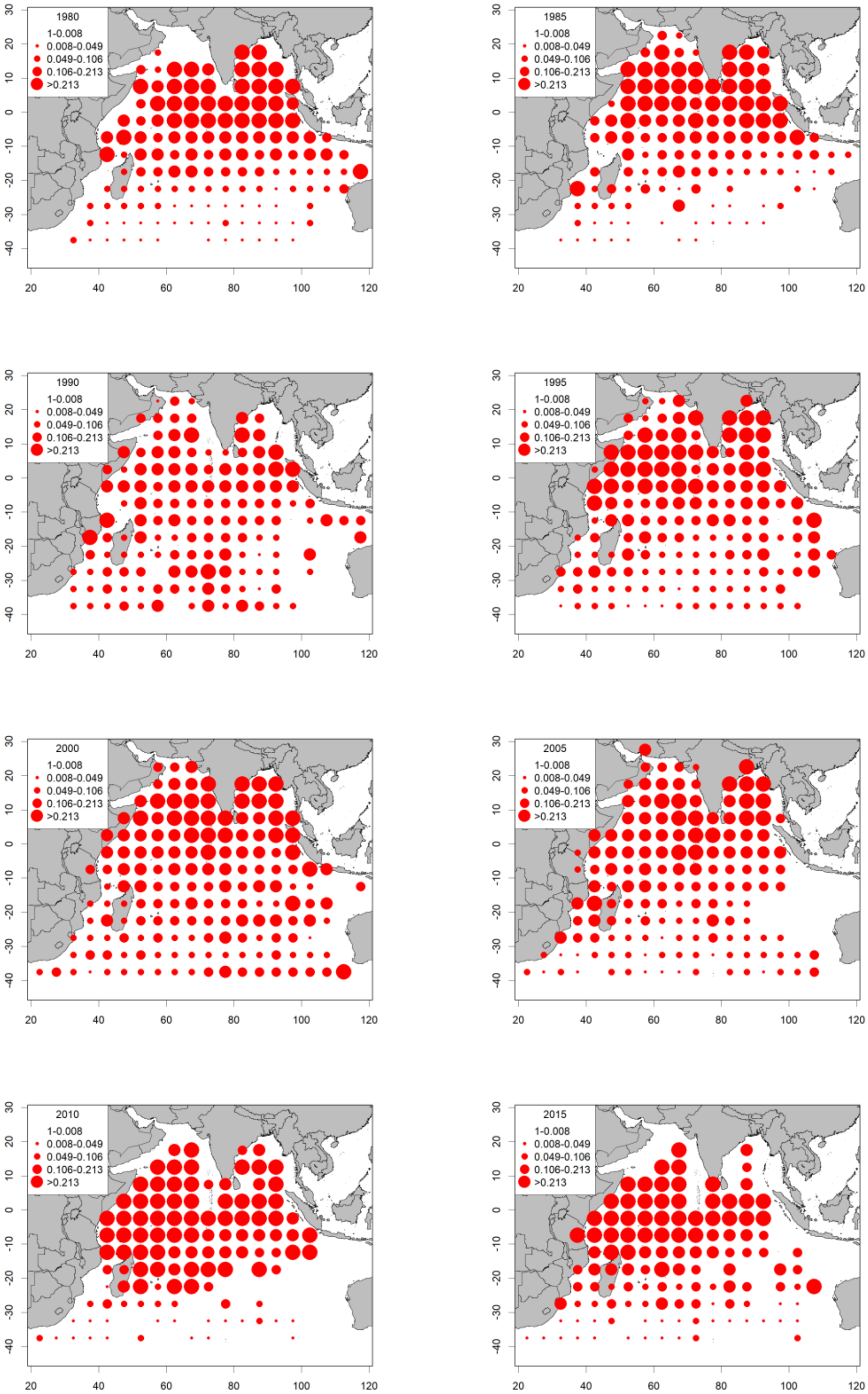


Fig. 4. Blue marlin CPUE distributions of Taiwanese large scale longline fishery in the Indian Ocean.

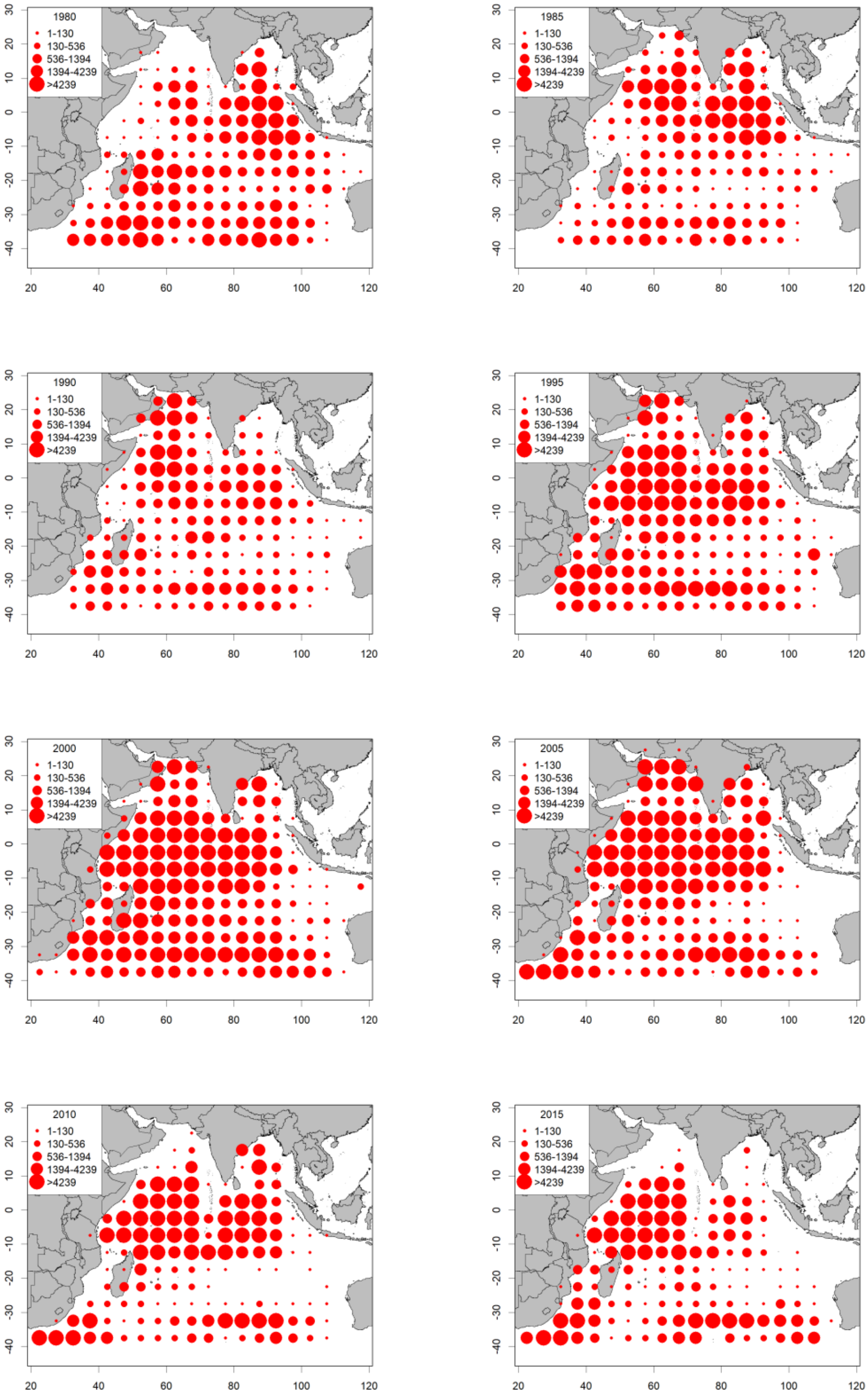


Fig. 5. Effort distributions of Taiwanese large scale longline fishery in the Indian Ocean.

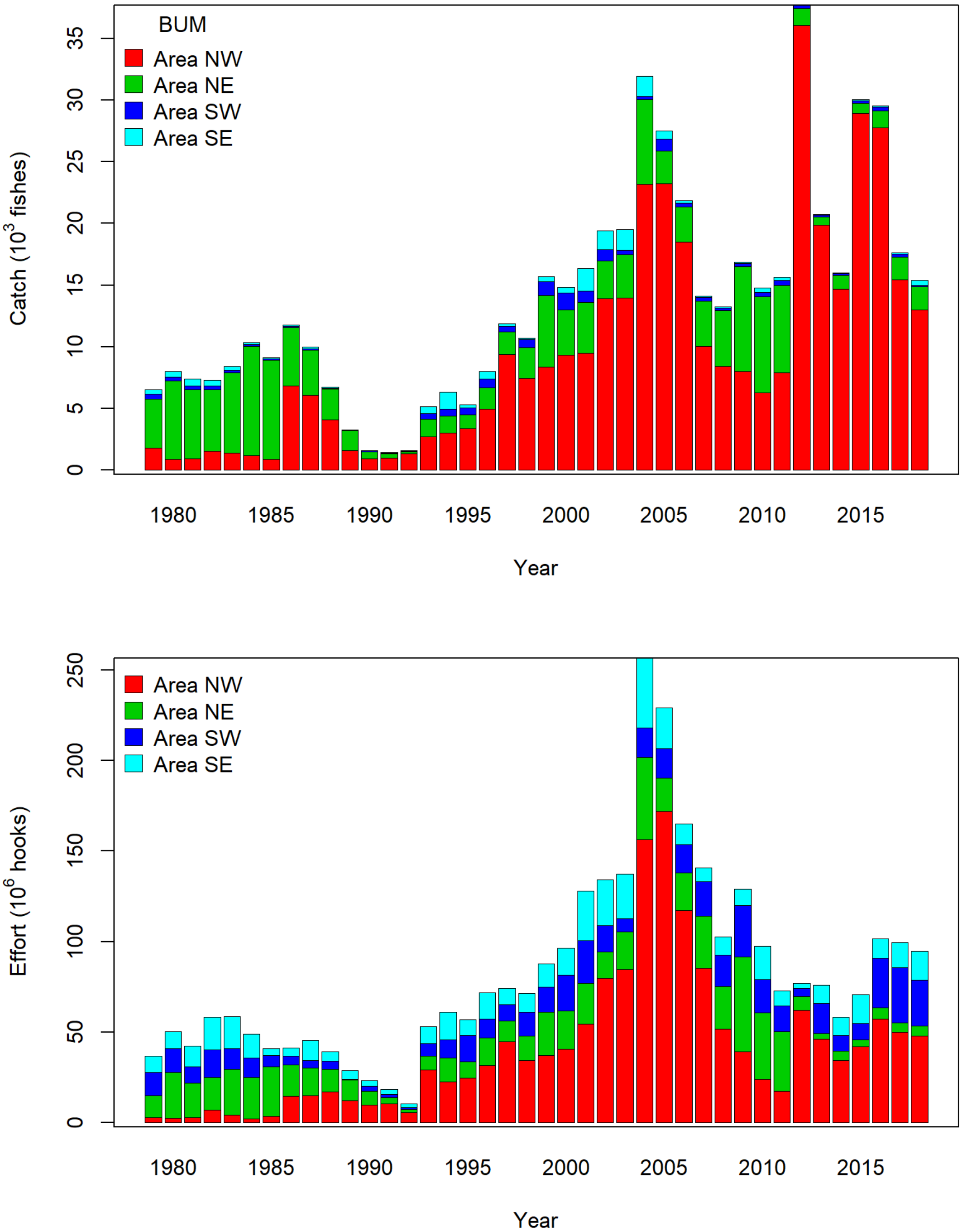


Fig. 6. Annual blue marlin catches and fishing efforts of Taiwanese large scale longline fishery in the Indian Ocean.

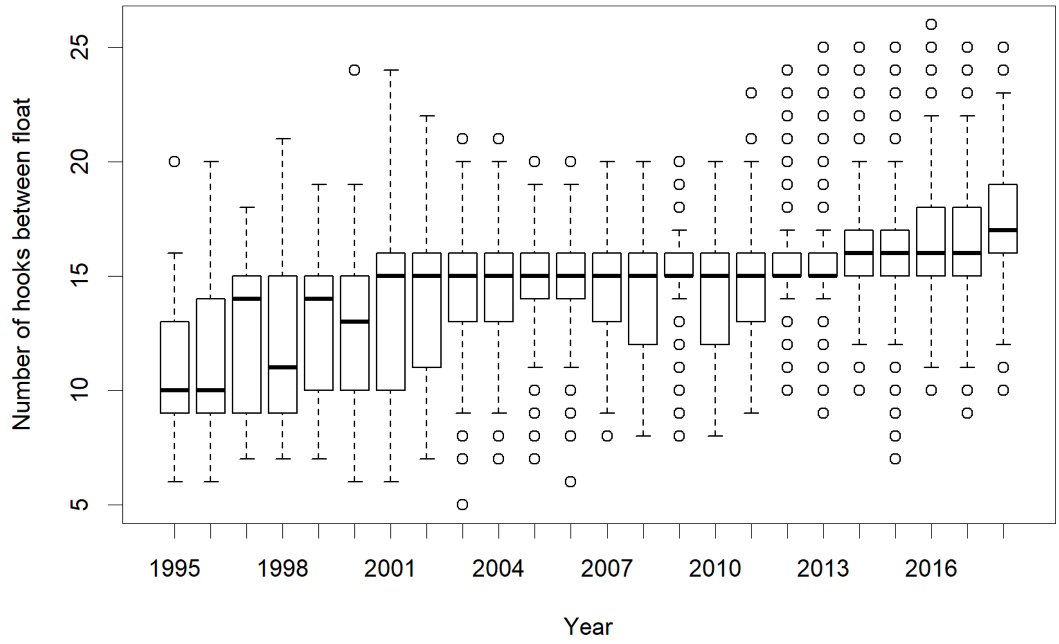


Fig. 7. Annual trend of the boxplot for the number of hooks between float of Taiwanese large scale longline fishery in the Indian Ocean.

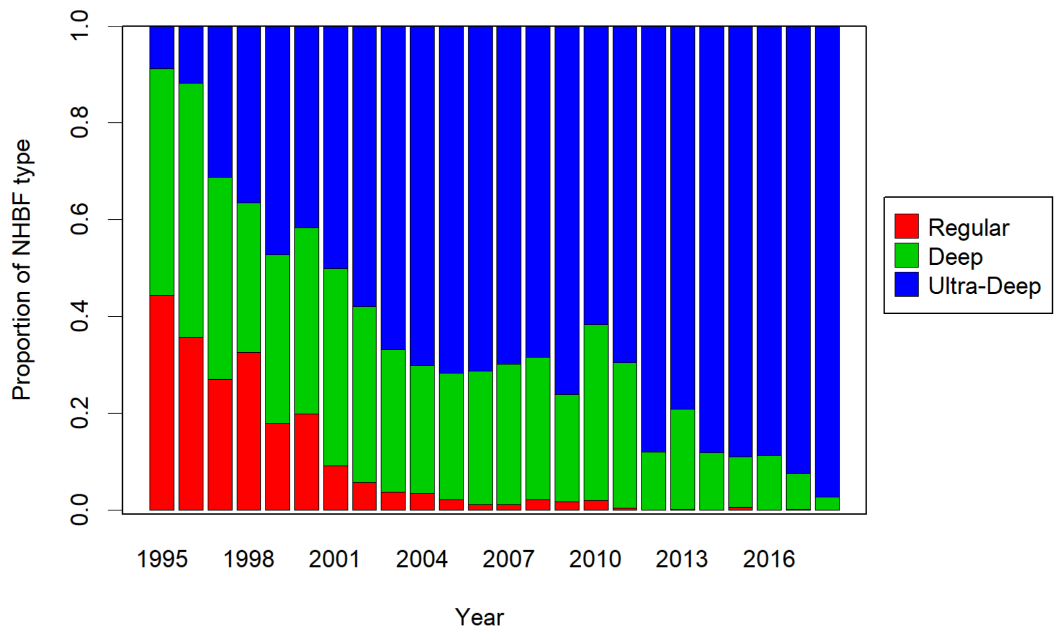


Fig. 8. Annual trend of the proportion of set type of Taiwanese large scale longline fishery in the Indian Ocean. Regular set: number of hooks between float (NHBF) < 10 hooks; Deep set: 10 hooks ≤ NHBF < 15 hooks; Ultra-deep: NHBF ≥ 15 hooks.

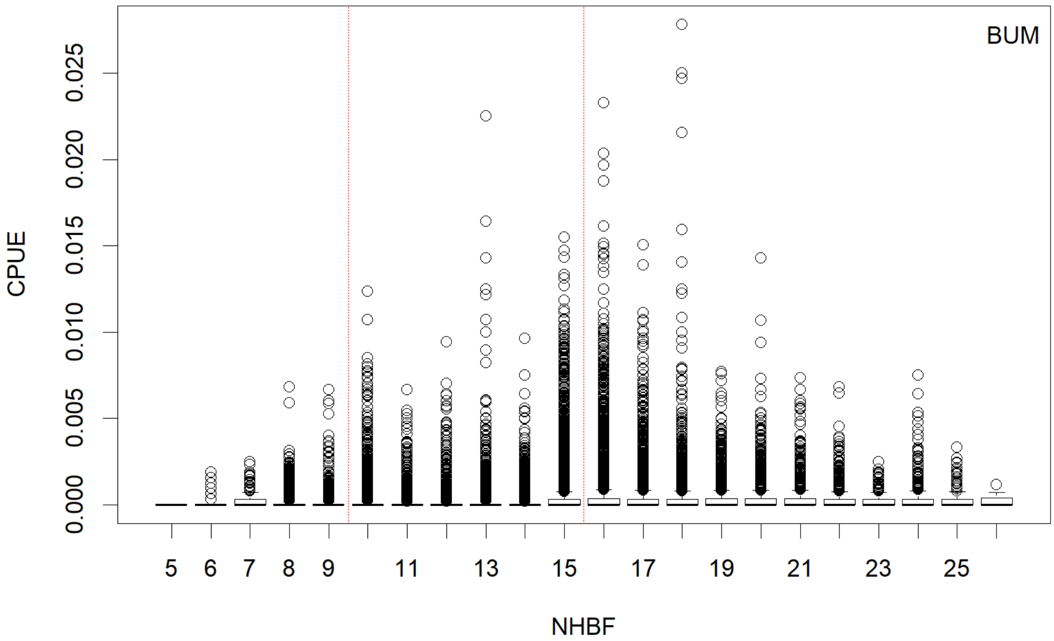


Fig. 9. Nominal CPUEs of blue marlin of Taiwanese large scale longline fishery grouped by number of hooks between float (NHBF).

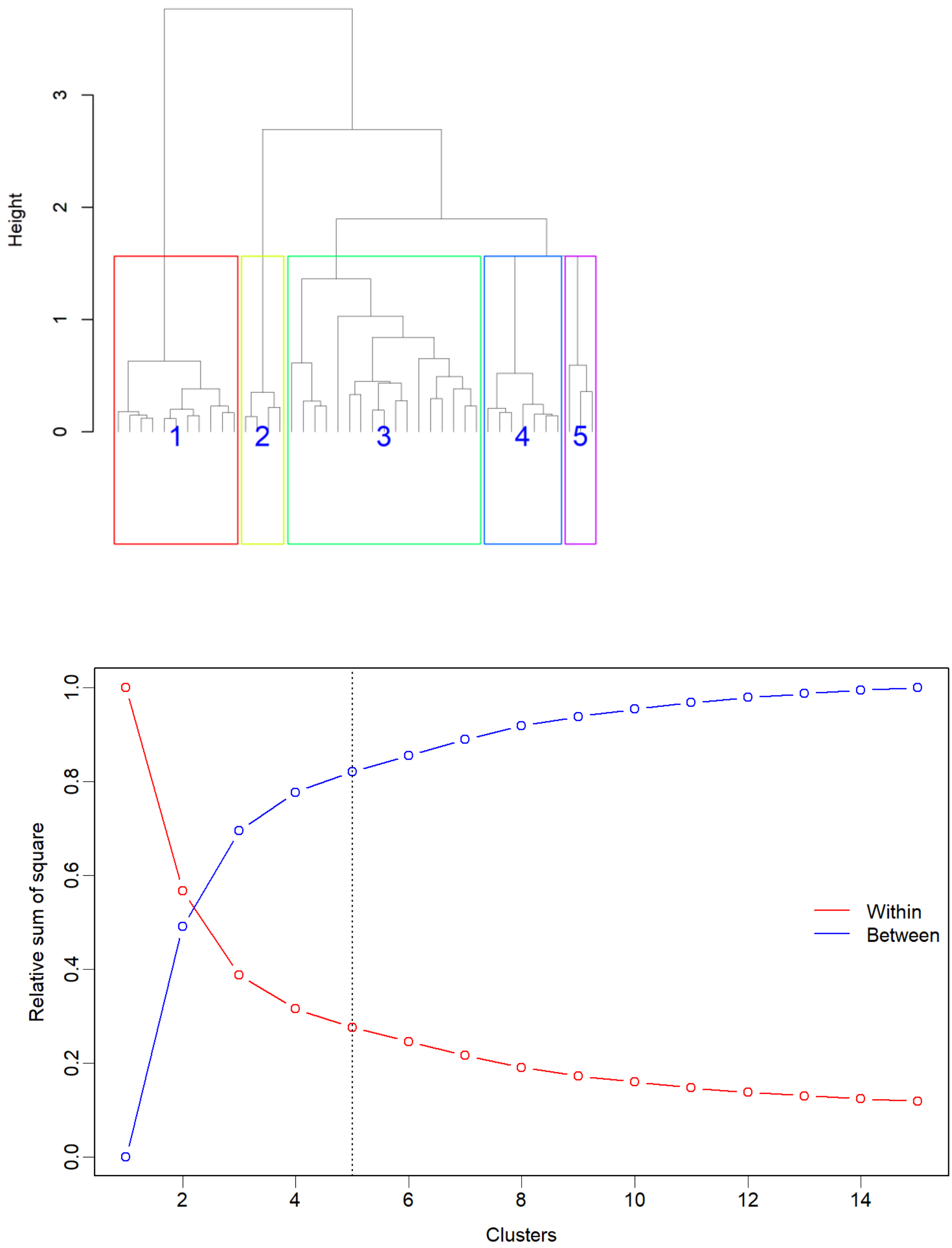


Fig. 10. Cluster tree and sum of squares within and between clusters for the data of Taiwanese large scale longline fishery in Area 1 (NW) of the Indian Ocean.

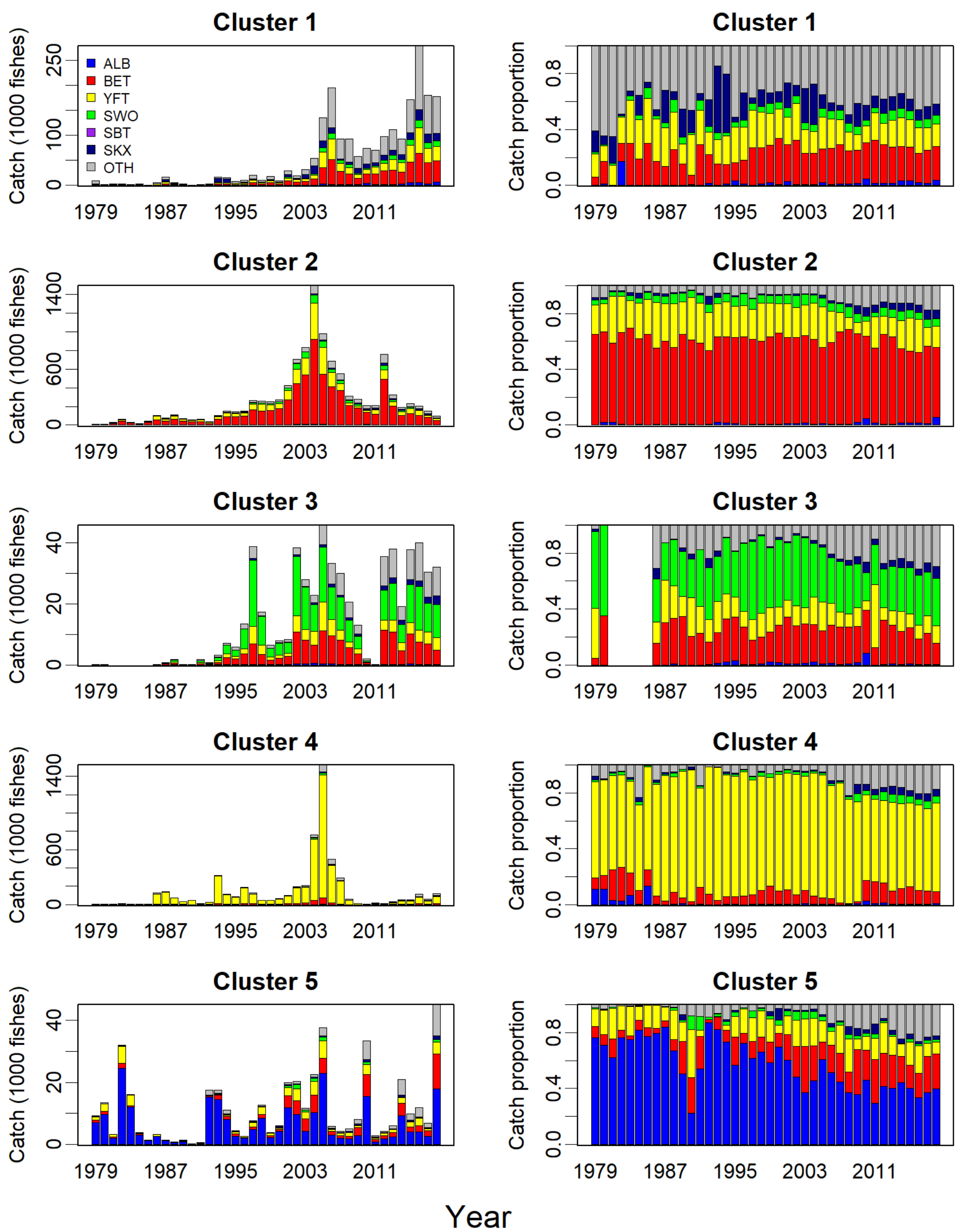


Fig. 11. Annual catches and catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 1 (NW) of the Indian Ocean.

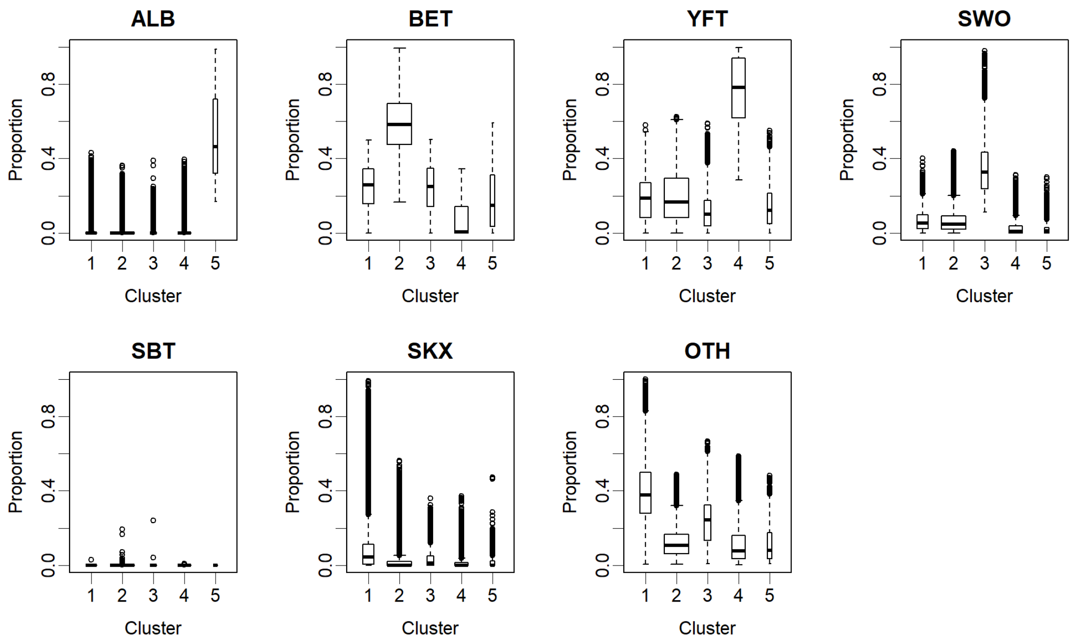


Fig. 12. Catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 1 (NW) of the Indian Ocean.

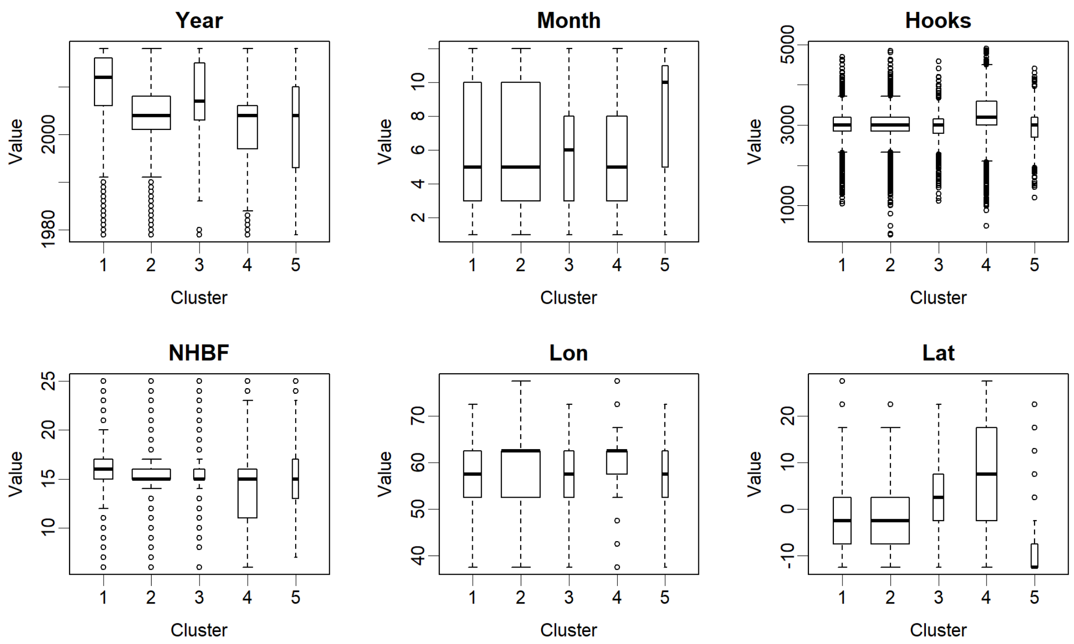
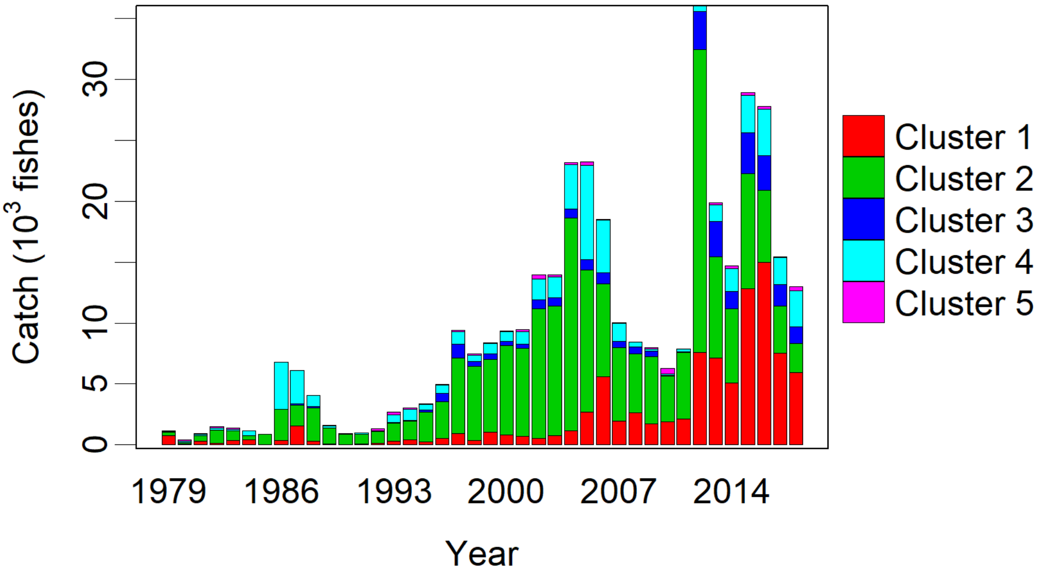


Fig. 13. Data composition by factors for each cluster of Taiwanese large scale longline fishery in Area 1 (NW) of the Indian Ocean.



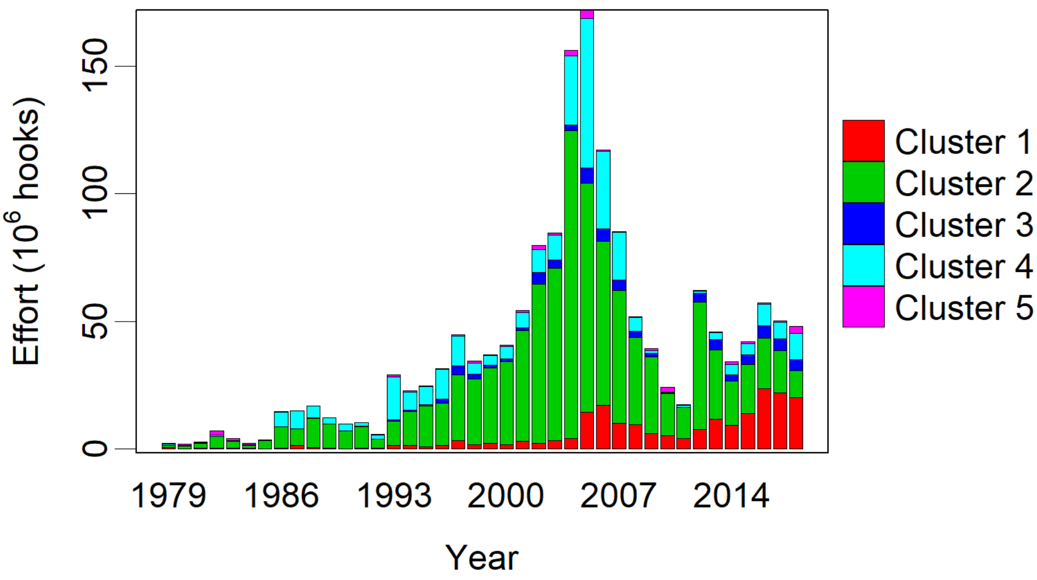


Fig. 14. Annual blue marlin catches for each cluster of Taiwanese large scale longline fishery in Area 1 (NW) of the Indian Ocean.

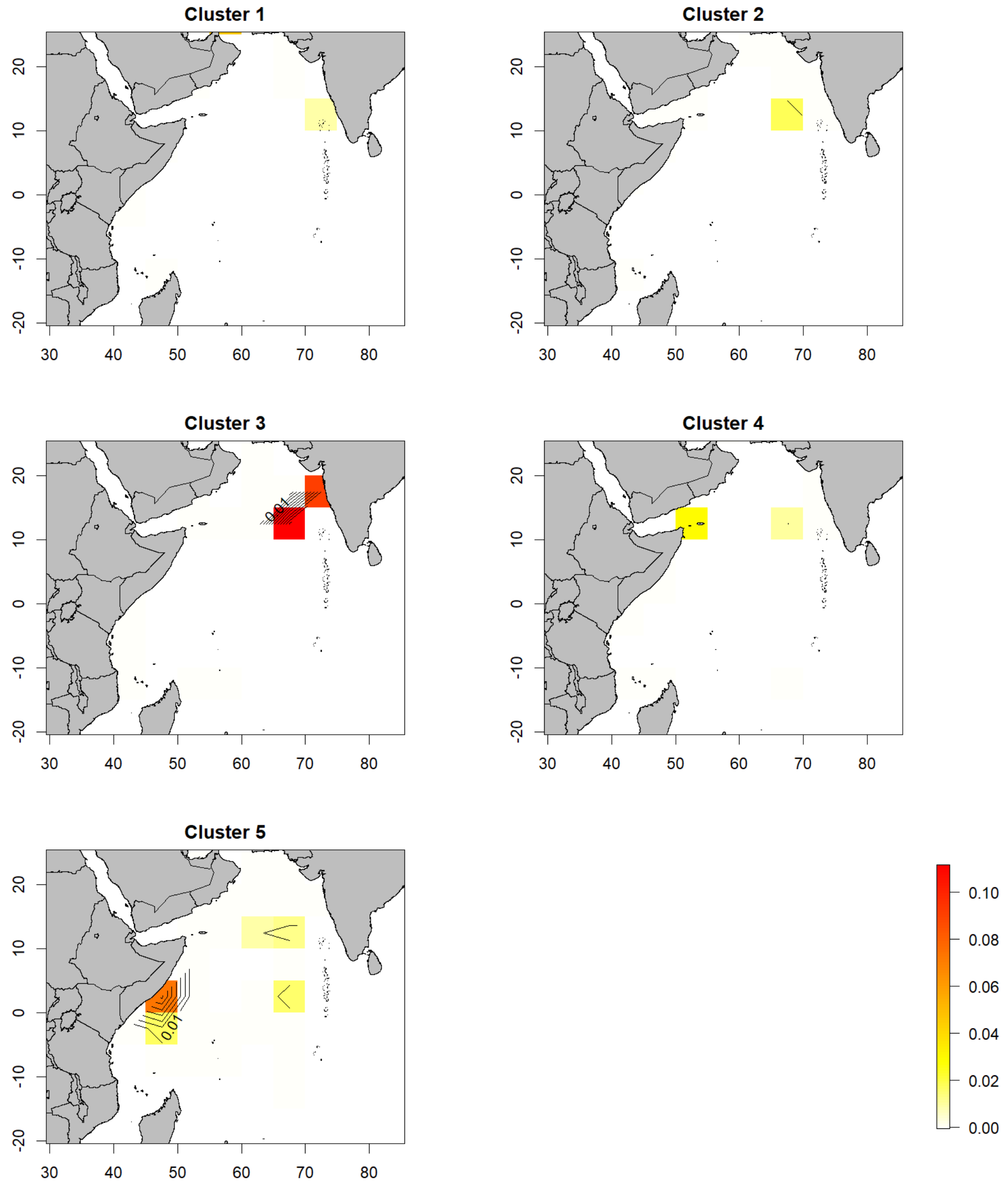


Fig. 15. Blue marlin catch distribution for each cluster of Taiwanese large scale longline fishery in Area 1 (NW) of the Indian Ocean. Yellow is high catch and red is low catch.

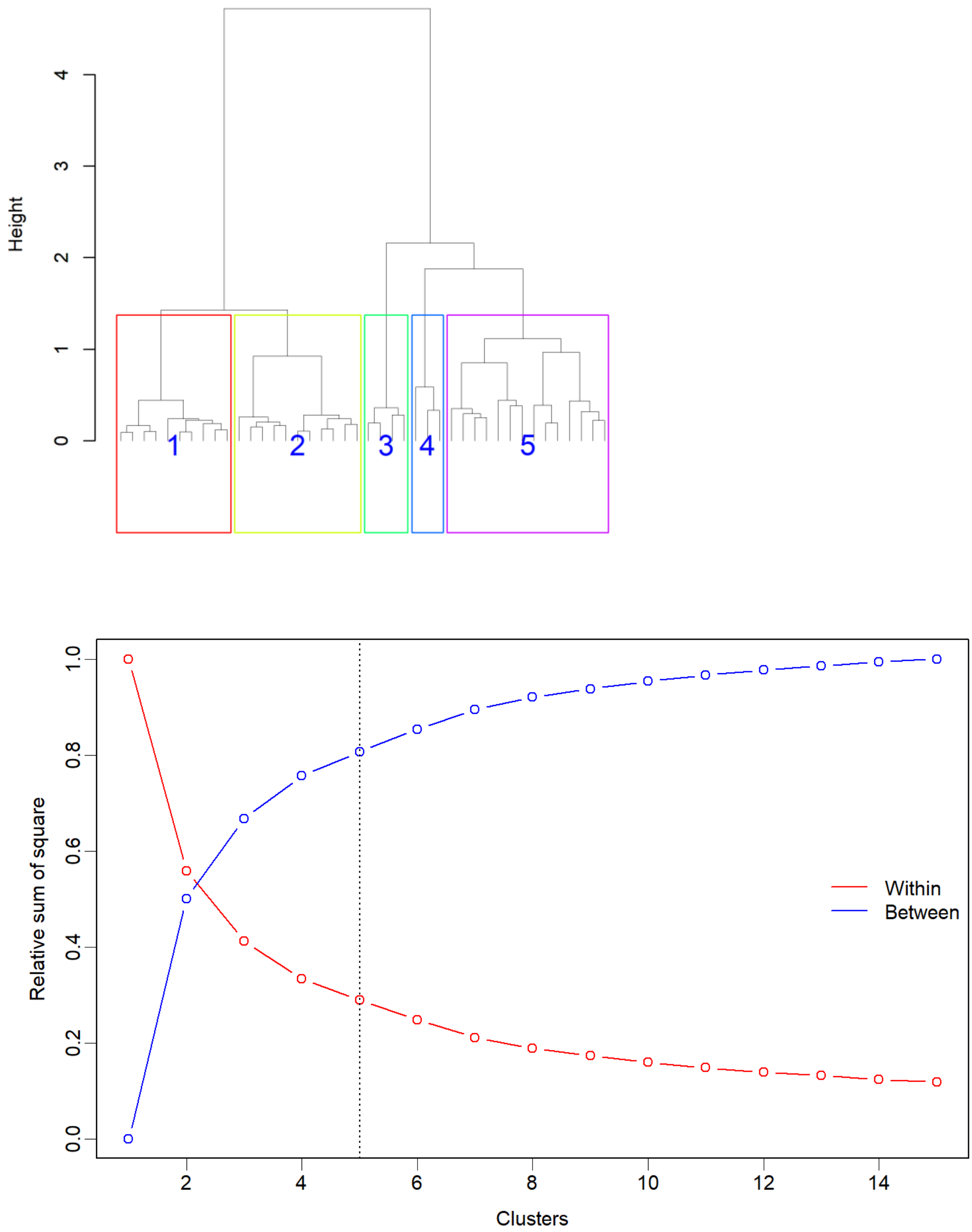


Fig. 16. Cluster tree and sum of squares within and between clusters for the data of Taiwanese large scale longline fishery in Area 2 (NE) of the Indian Ocean.

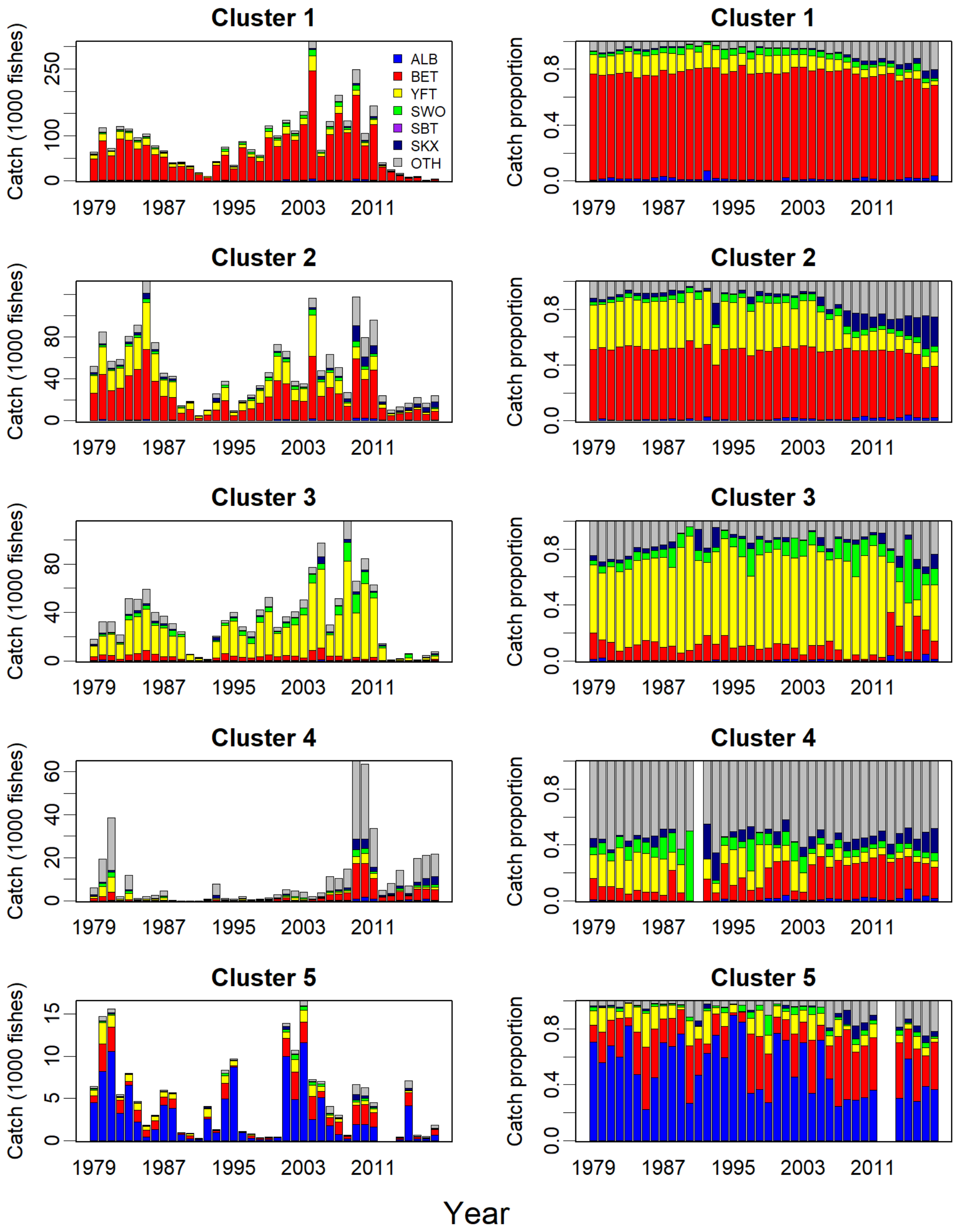


Fig. 17. Annual and catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 2 (NE) of the Indian Ocean.

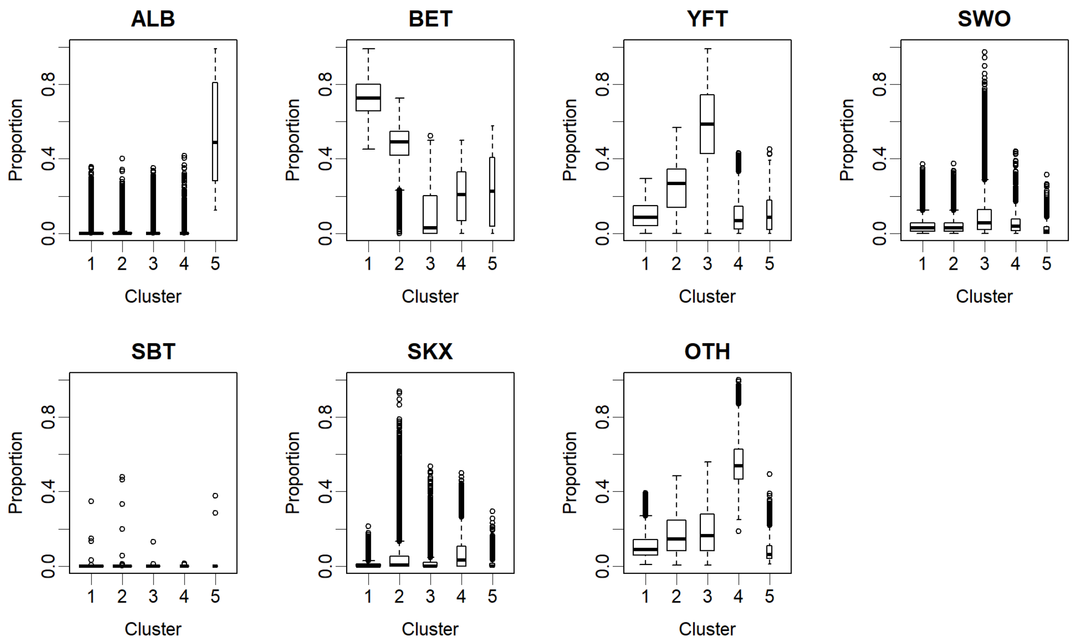


Fig. 18. Catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 2 (NE) of the Indian Ocean.

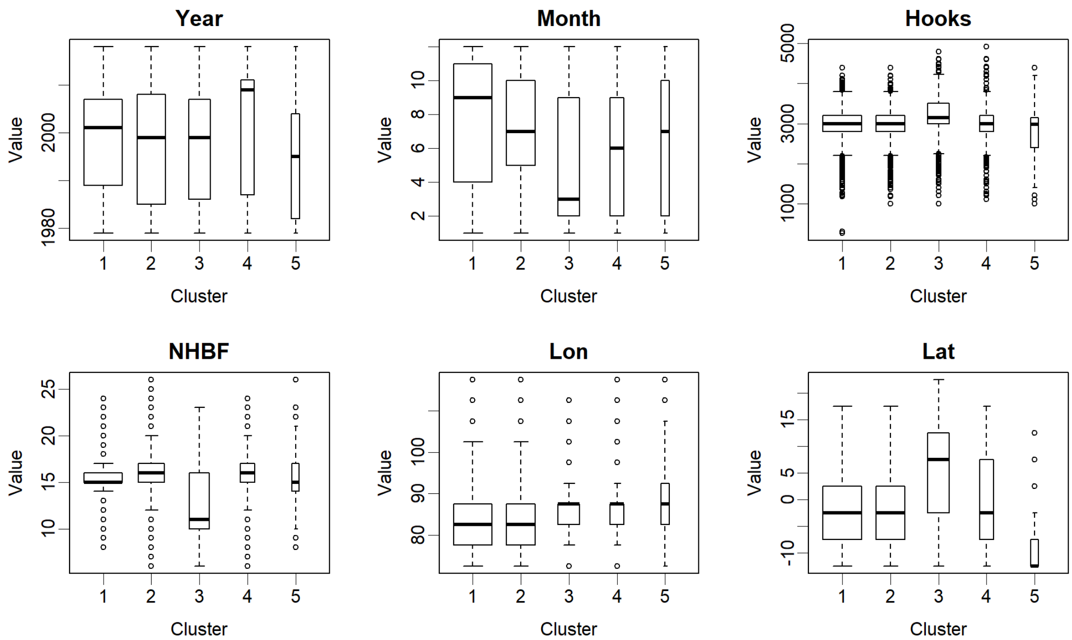


Fig. 19. Data composition by factors for each cluster of Taiwanese large scale longline fishery in Area 2 (NE) of the Indian Ocean.

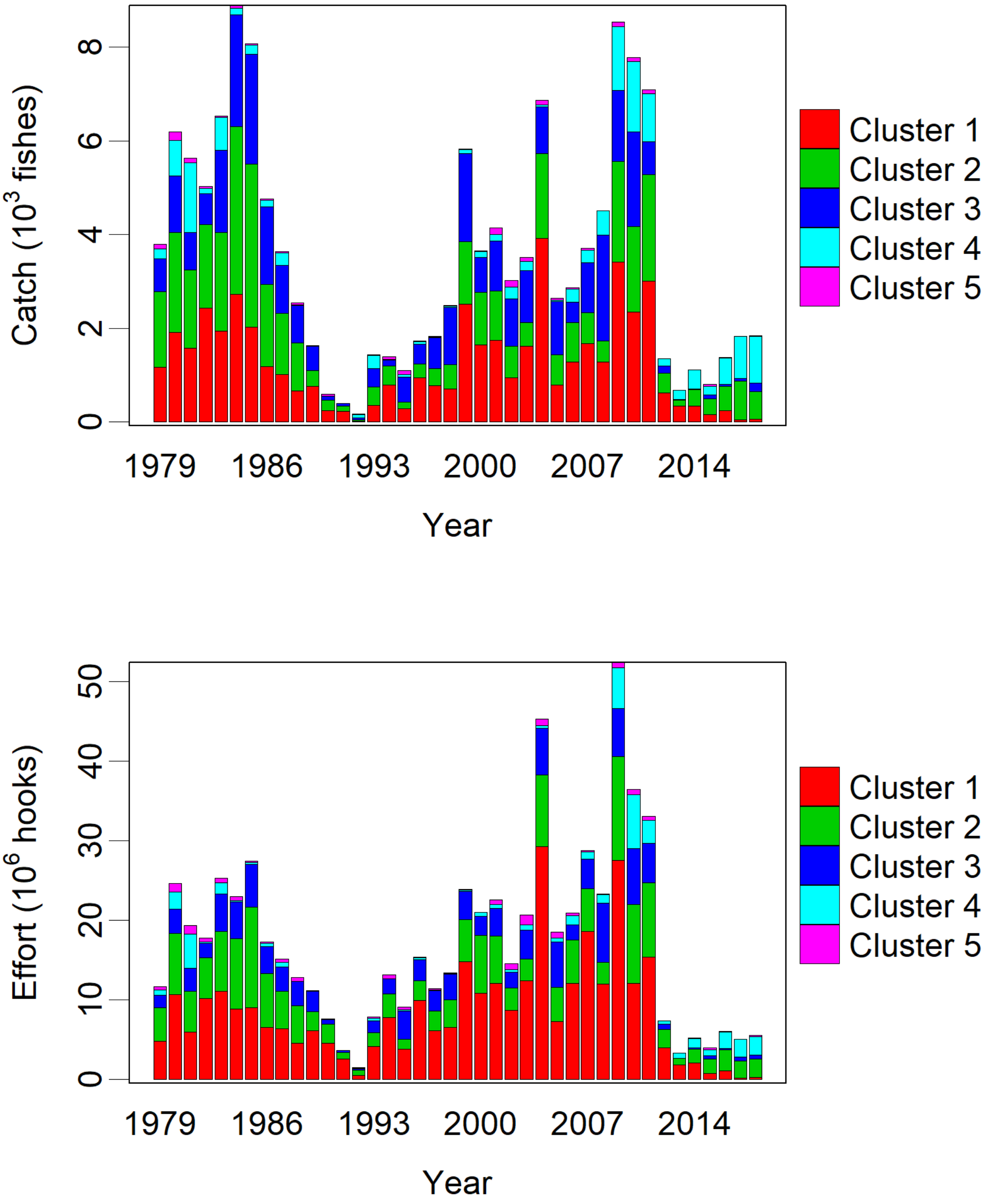


Fig. 20. Annual blue marlin catches for each cluster of Taiwanese large scale longline fishery in Area 2 (NE) of the Indian Ocean.

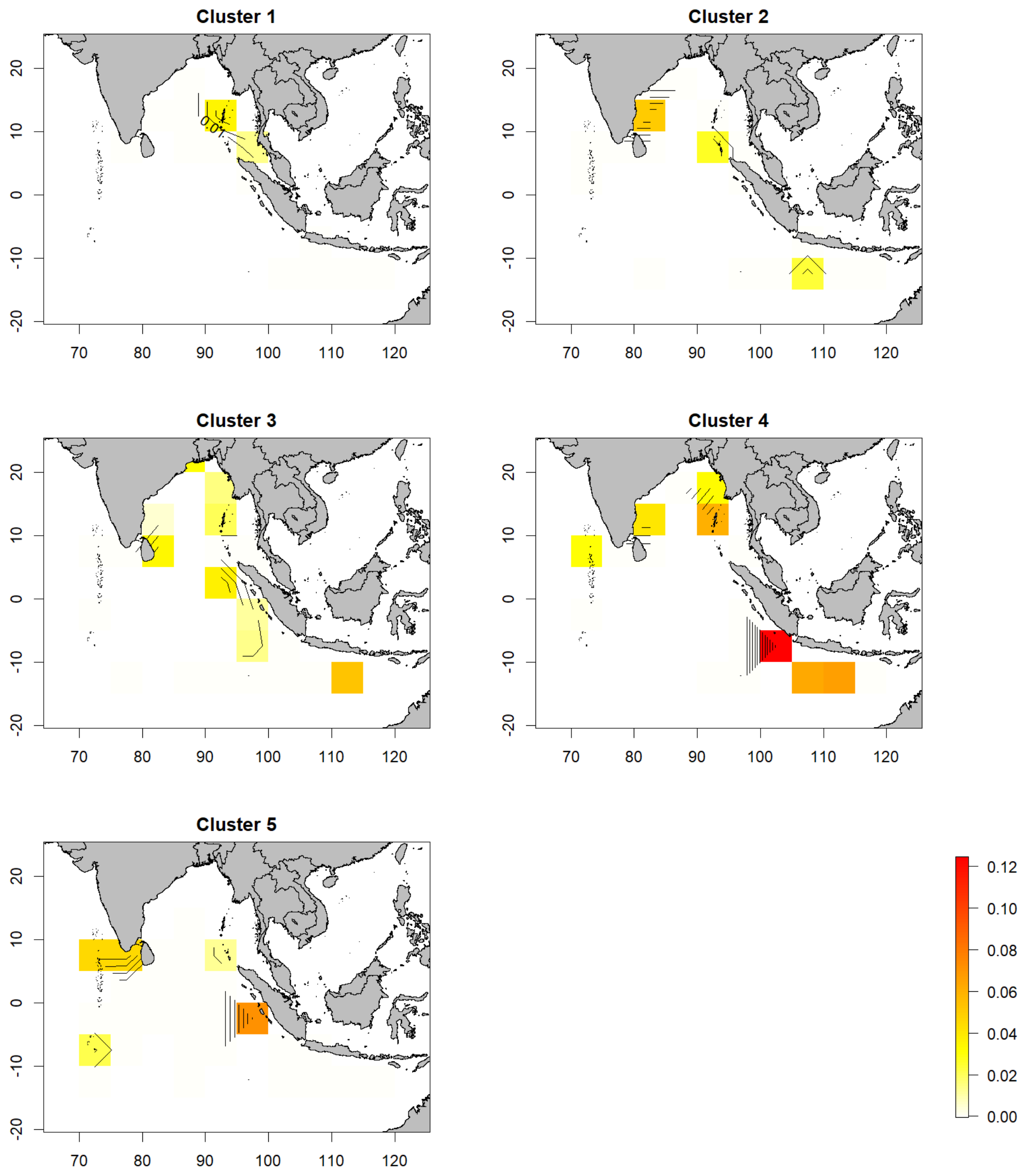


Fig. 21. Blue marlin catch distribution for each cluster of Taiwanese large scale longline fishery in Area 2 (NE) of the Indian Ocean. Yellow is high catch and red is low catch.

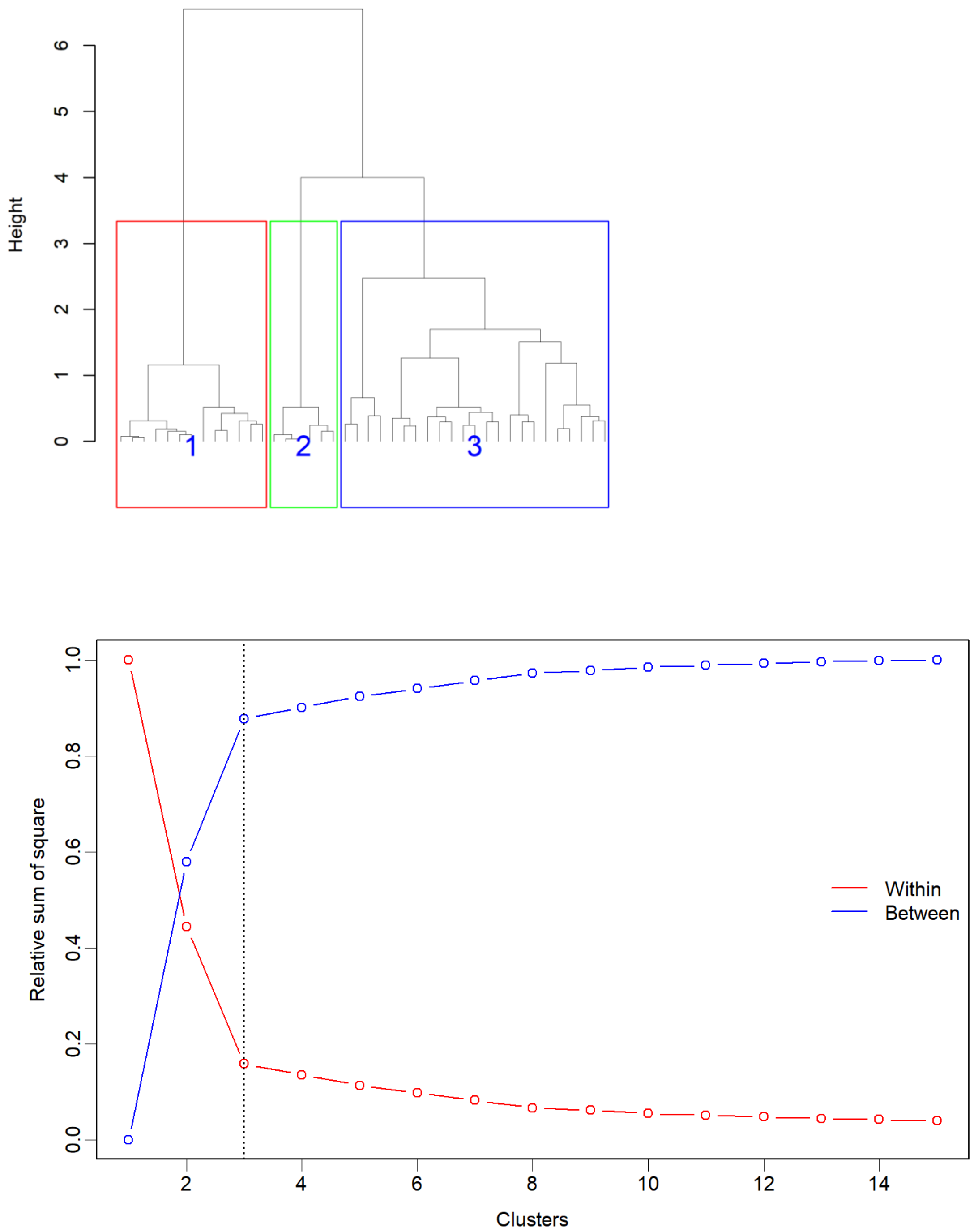


Fig. 22. Cluster tree and sum of squares within and between clusters for the data of Taiwanese large scale longline fishery in Area 3 (SW) of the Indian Ocean.

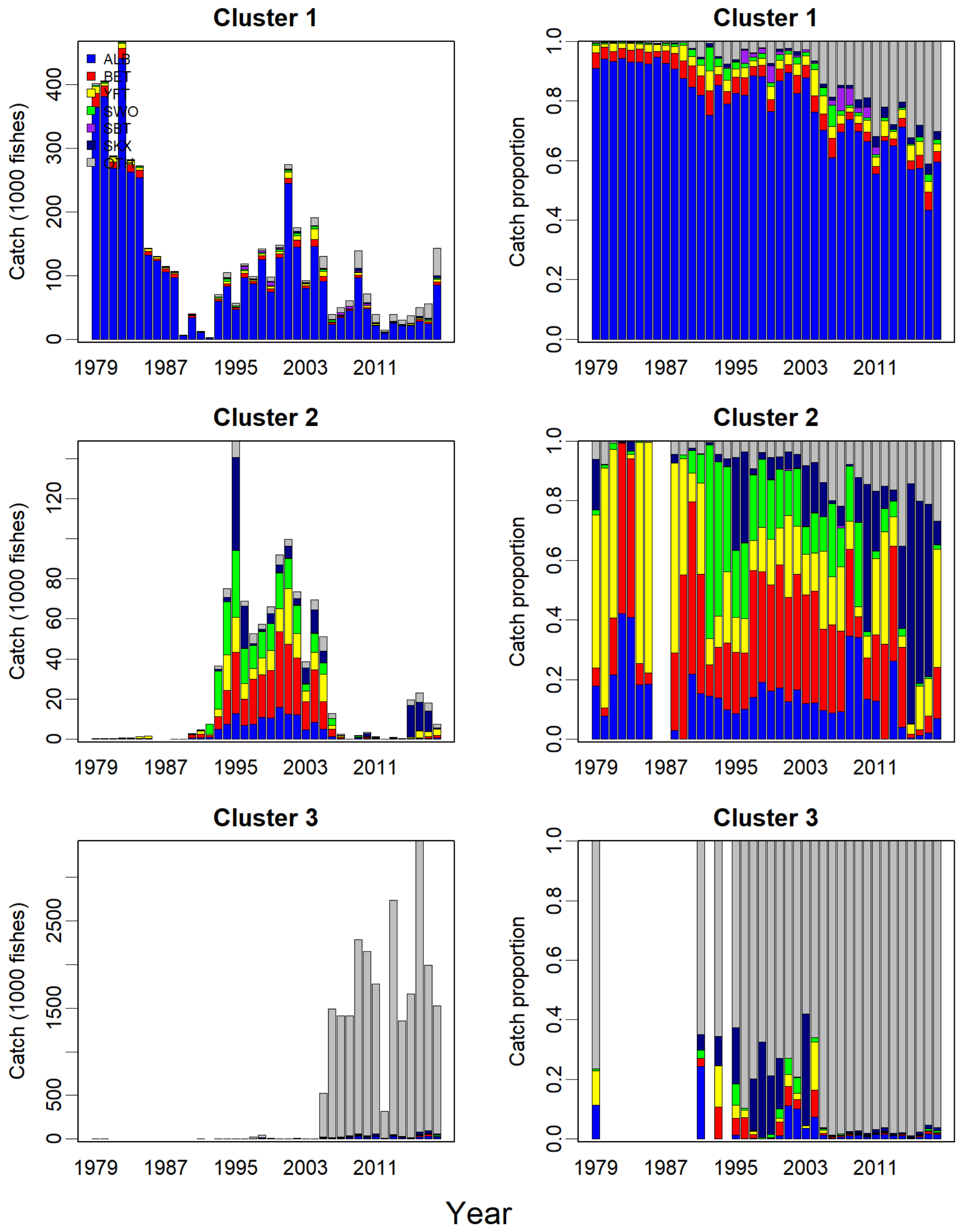


Fig. 23. Annual and catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 3 (SW) of the Indian Ocean.

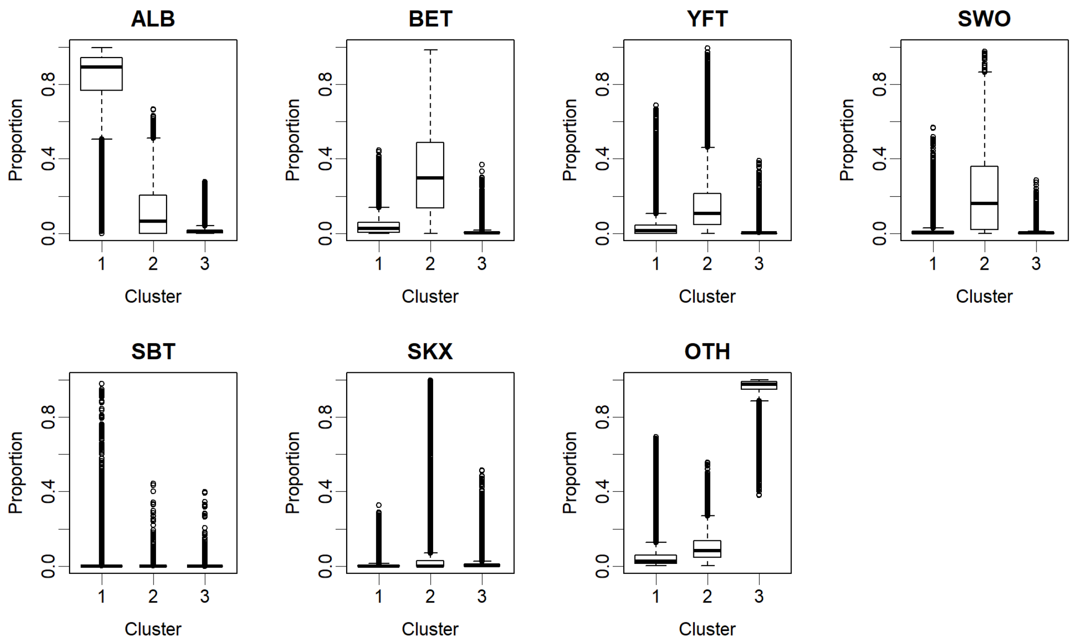


Fig. 24. Catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 3 (SW) of the Indian Ocean.

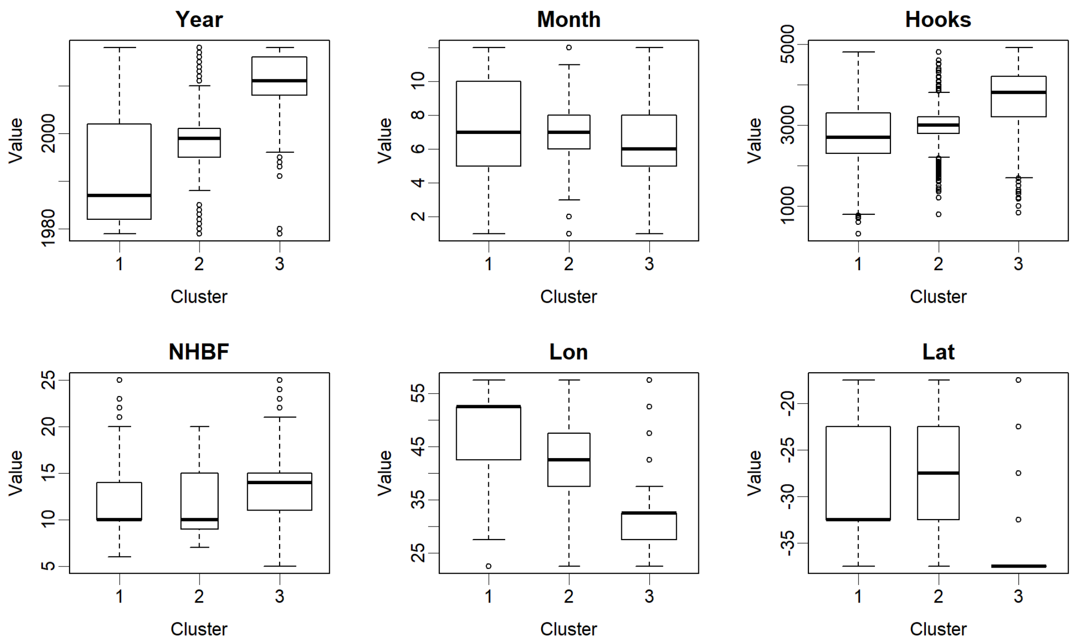


Fig. 25. Data composition by factors for each cluster of Taiwanese large scale longline fishery in Area 3 (SW) of the Indian Ocean.

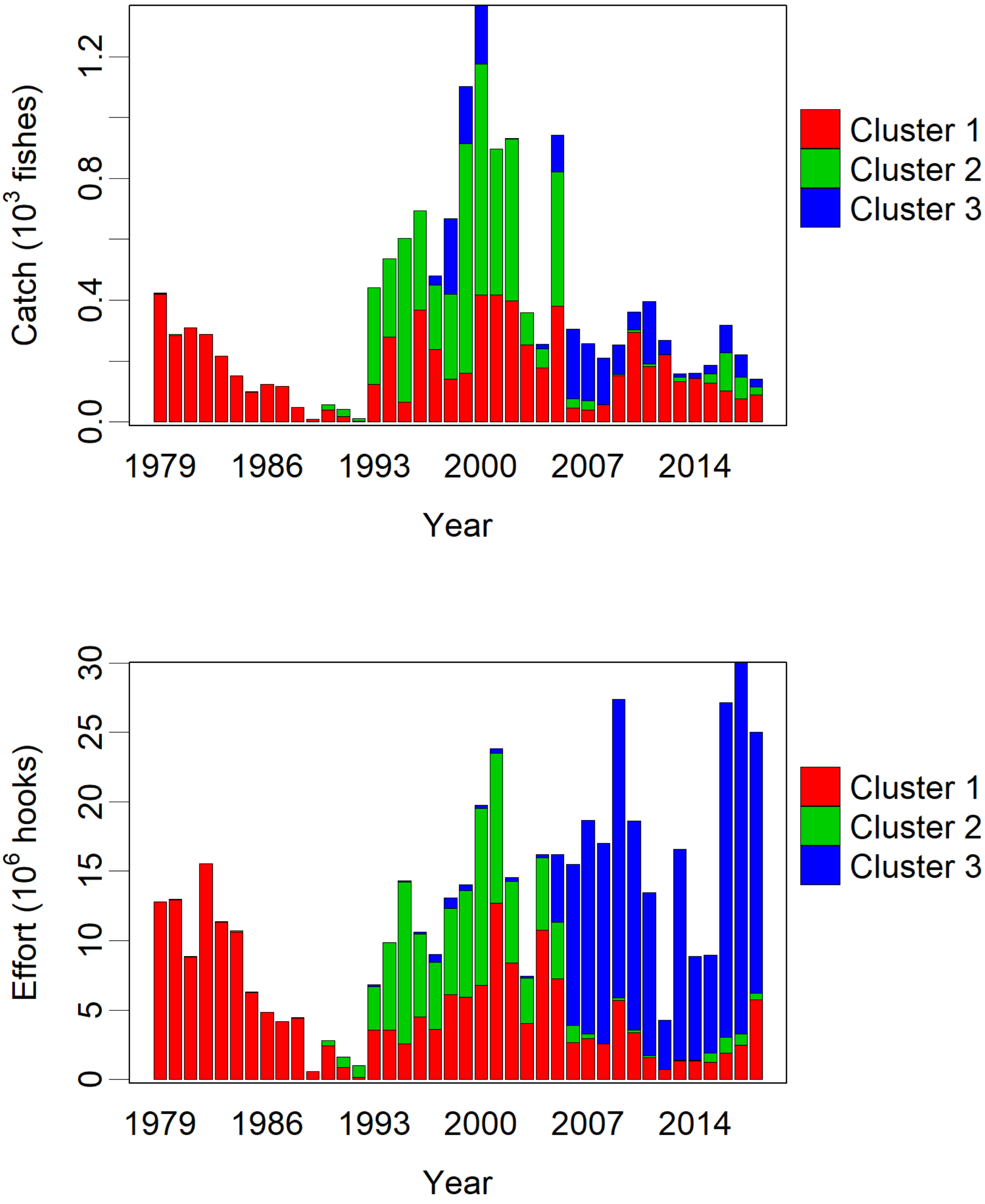


Fig. 26. Annual blue marlin catches for each cluster of Taiwanese large scale longline fishery in Area 3 (SW) of the Indian Ocean.

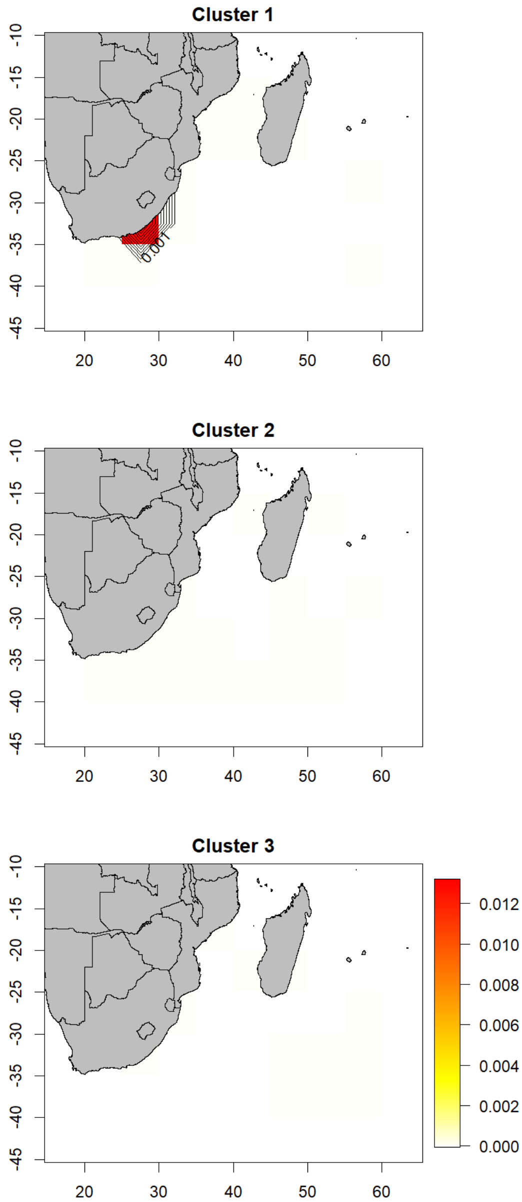


Fig. 27. Blue marlin catch distribution for each cluster of Taiwanese large scale longline fishery in Area 3 (SW) of the Indian Ocean. Yellow is high catch and red is low catch.

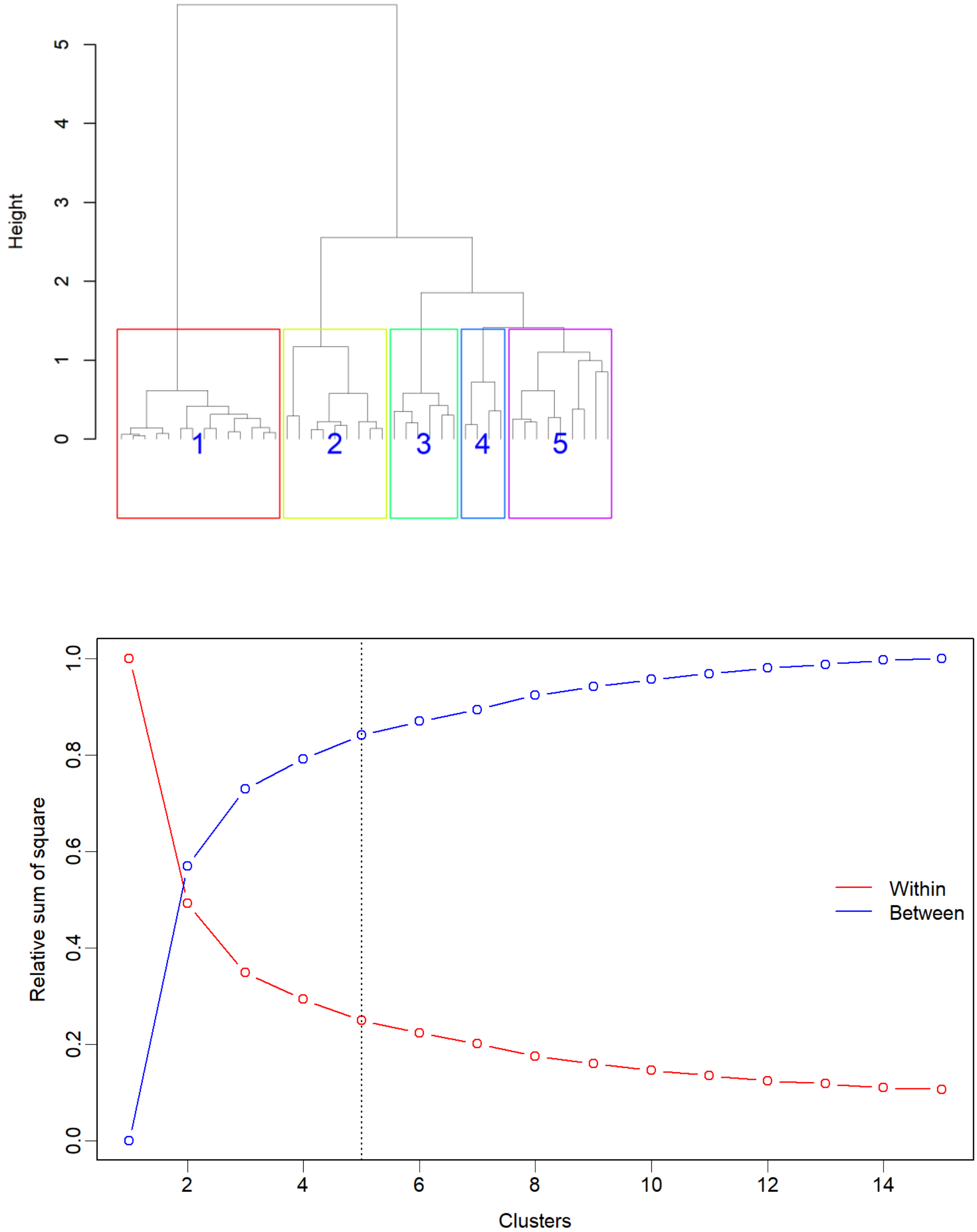


Fig. 28. Cluster tree and sum of squares within and between clusters for the data of Taiwanese large scale longline fishery in Area 4 (SE) of the Indian Ocean.

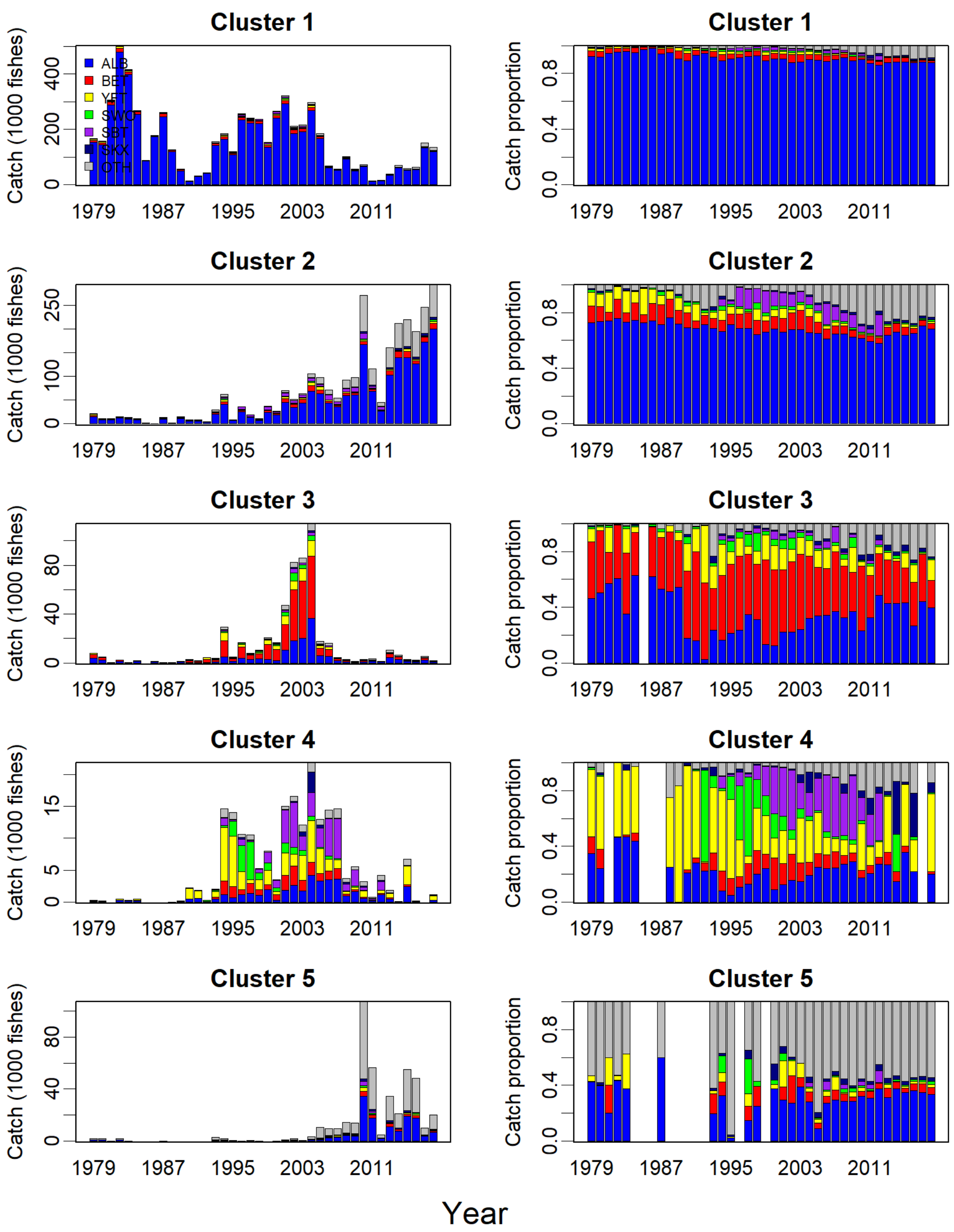


Fig. 29. Annual and catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 4 (SE) of the Indian Ocean.

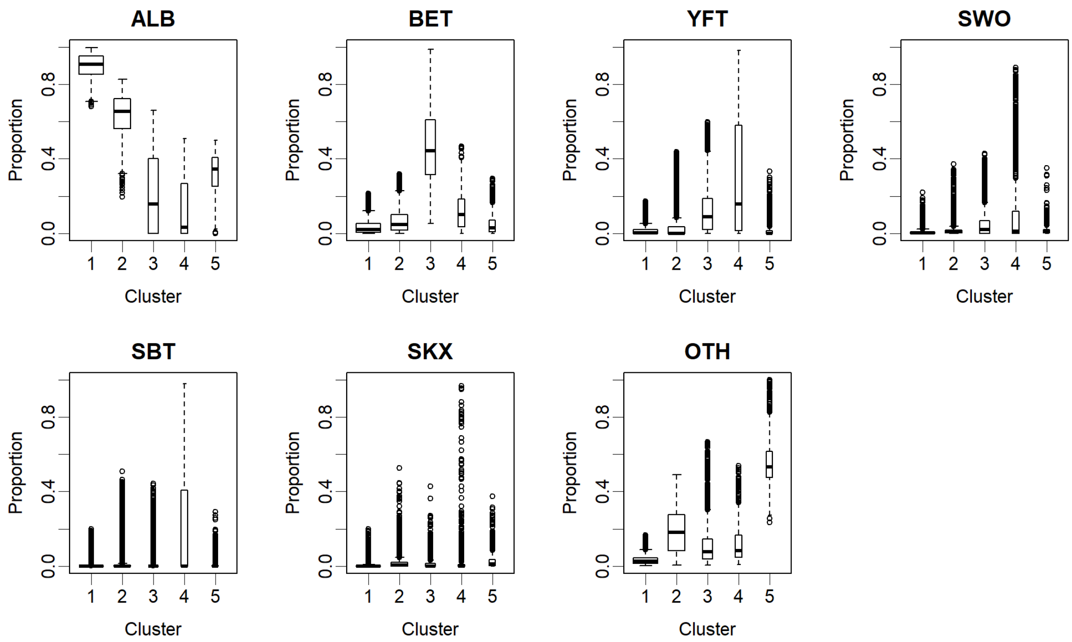


Fig. 30. Catch proportion by species for each cluster of Taiwanese large scale longline fishery in Area 4 (SE) of the Indian Ocean.

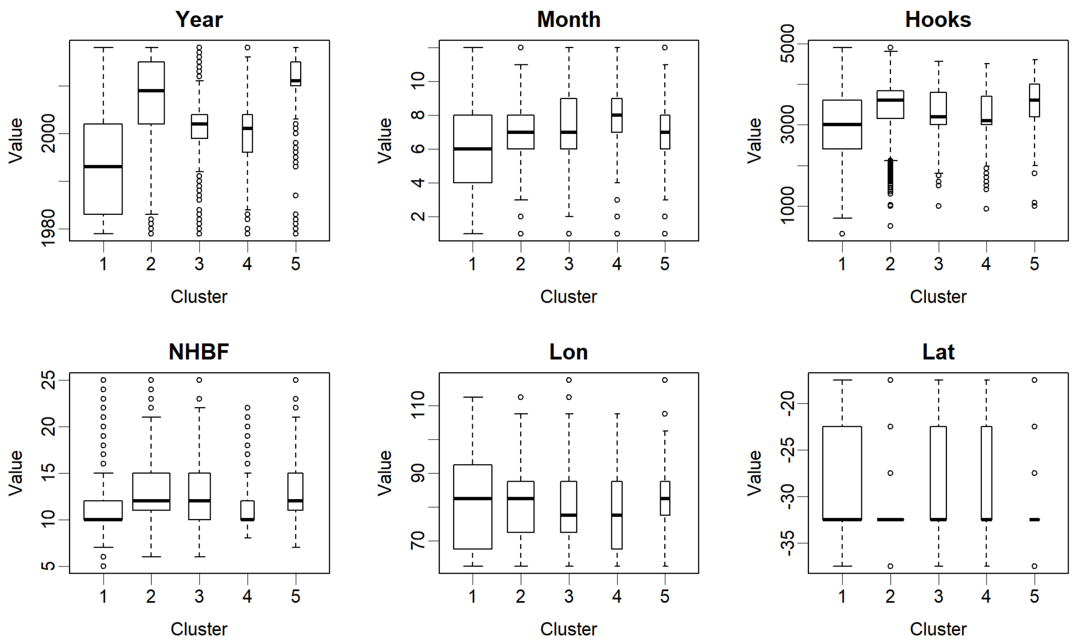


Fig. 31. Data composition by factors for each cluster of Taiwanese large scale longline fishery in Area 4 (SE) of the Indian Ocean.

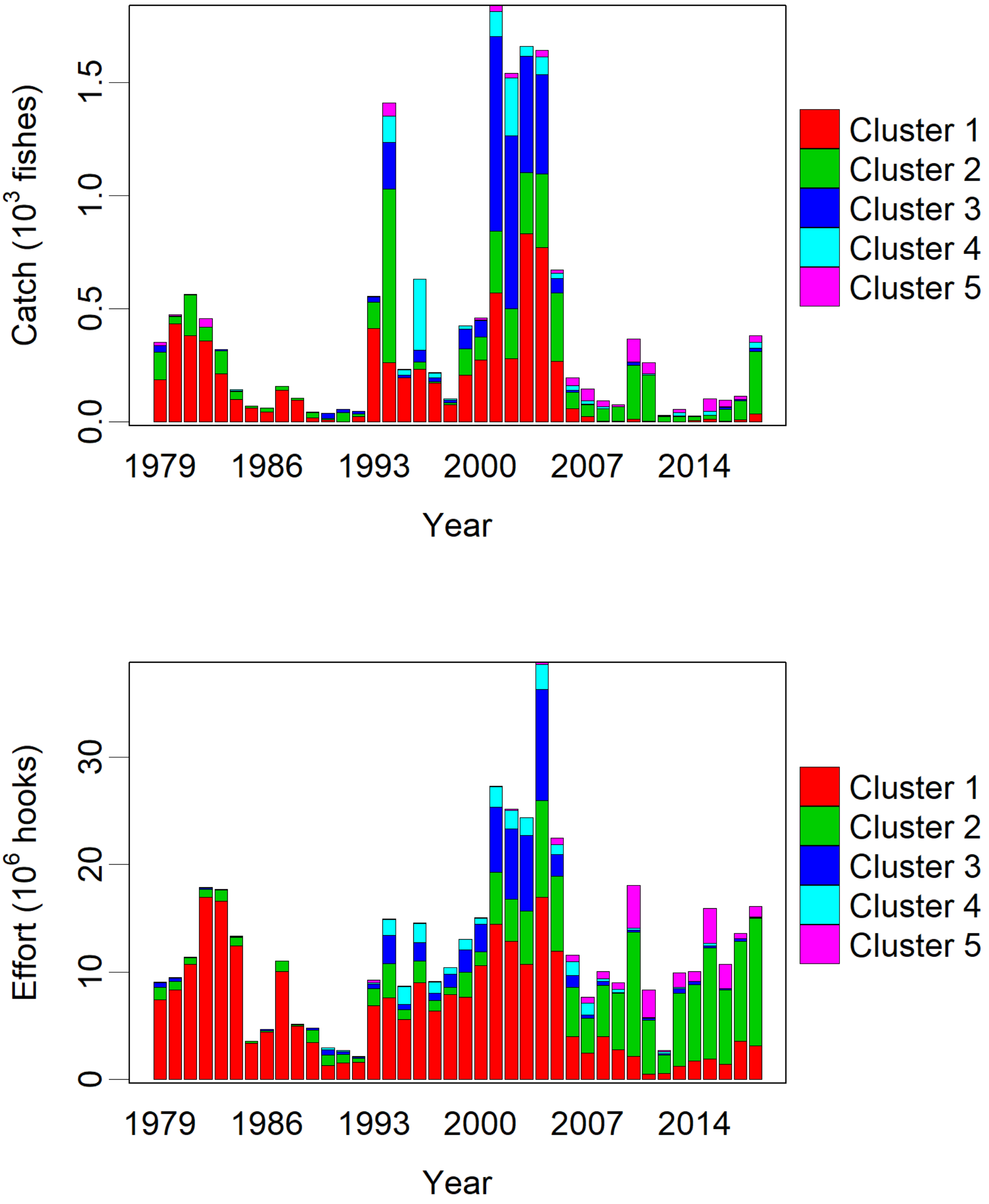


Fig. 32. Annual blue marlin catches for each cluster of Taiwanese large scale longline fishery in Area 4 (SE) of the Indian Ocean.

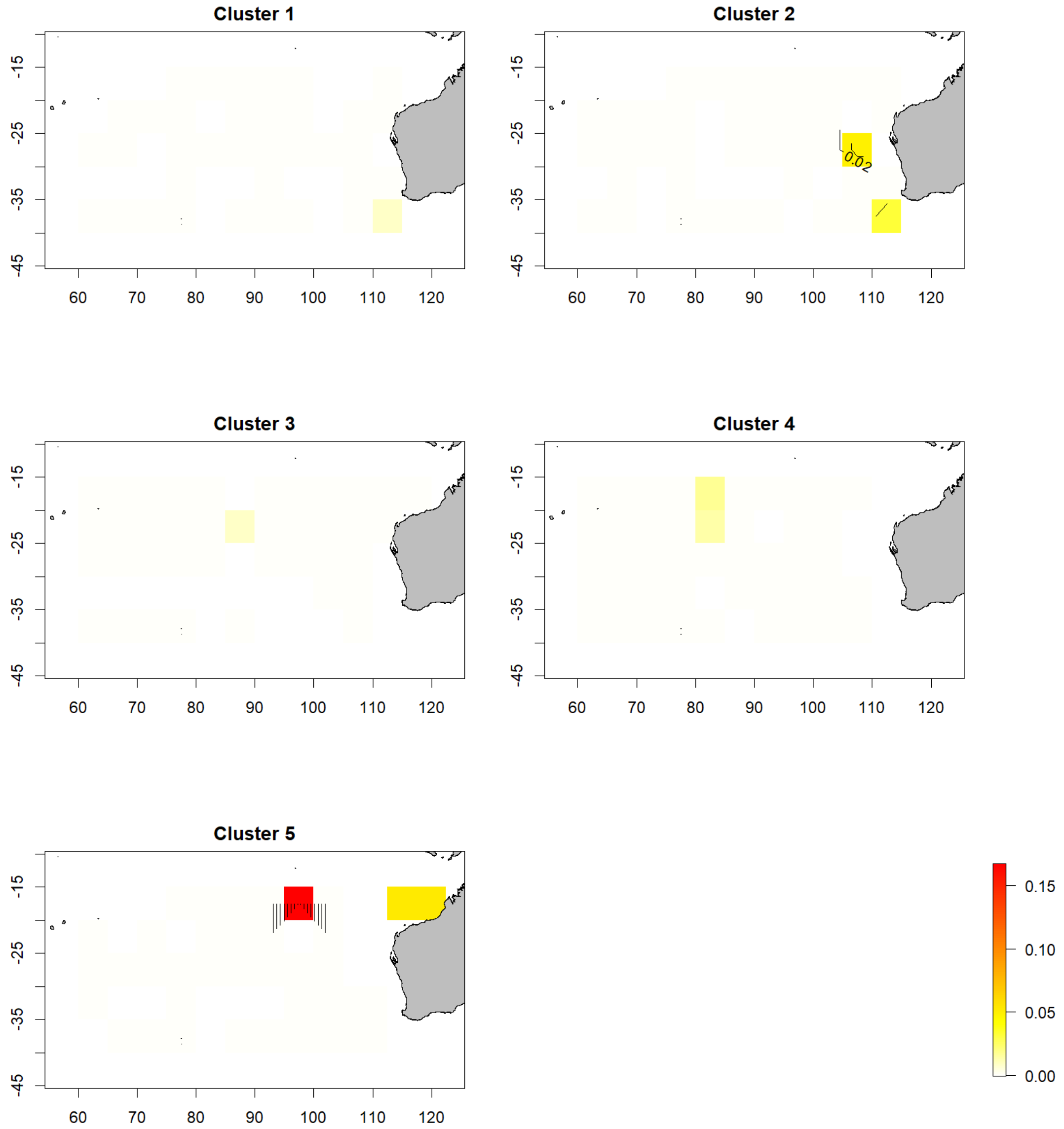


Fig. 33. Blue marlin catch distribution for each cluster of Taiwanese large scale longline fishery in Area 4 (SE) of the Indian Ocean. Yellow is high catch and red is low catch.

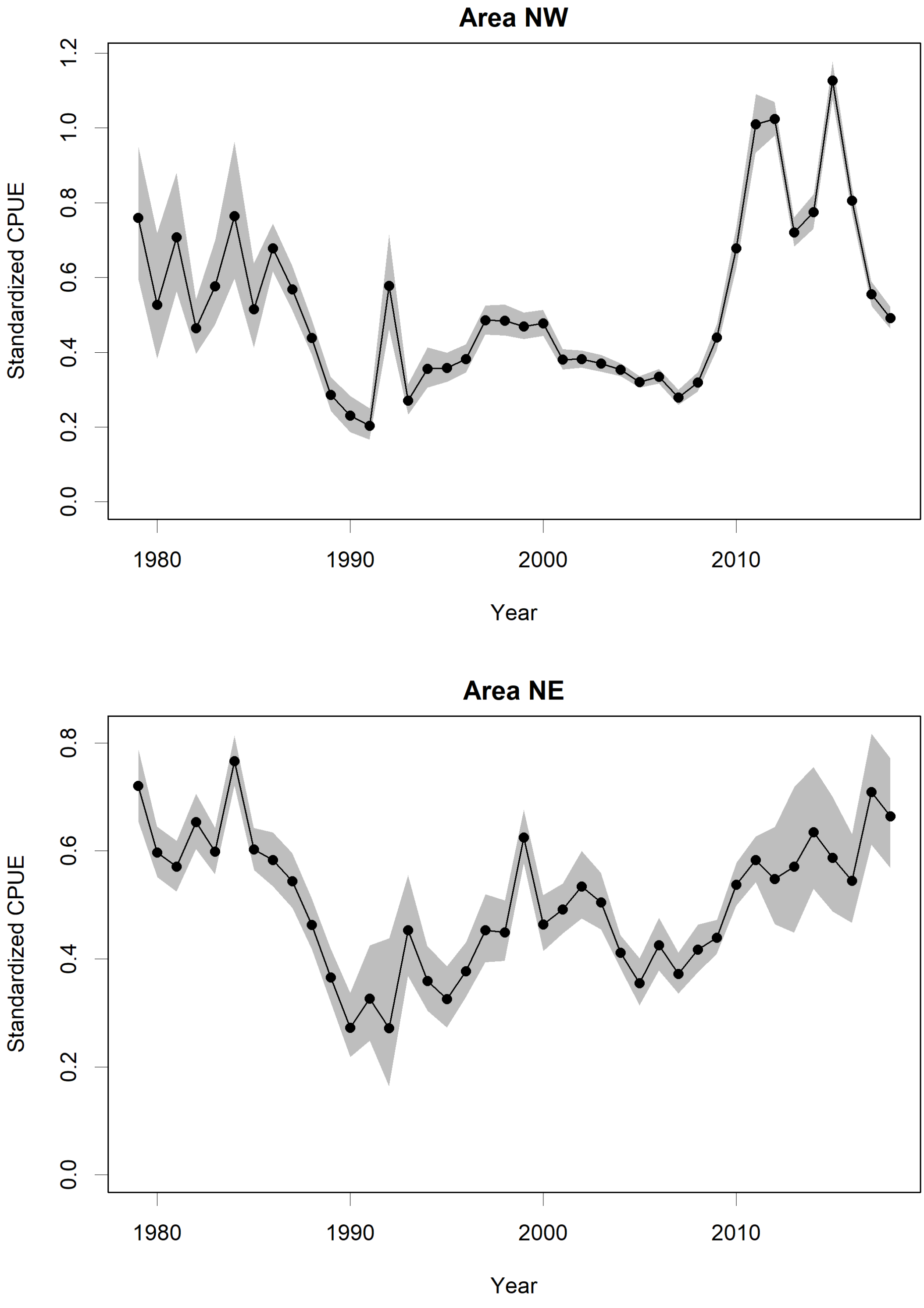
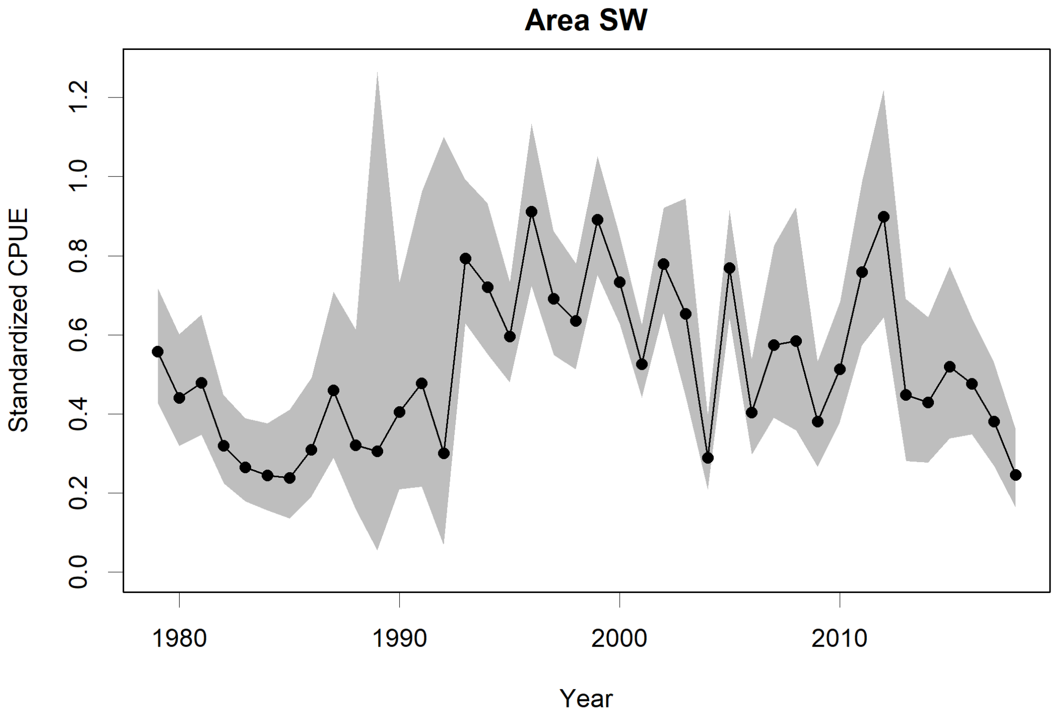


Fig. 34. Annual trends of standardized CPUE series for blue marlin caught by Taiwanese large scale longline fishery in the Indian Ocean.



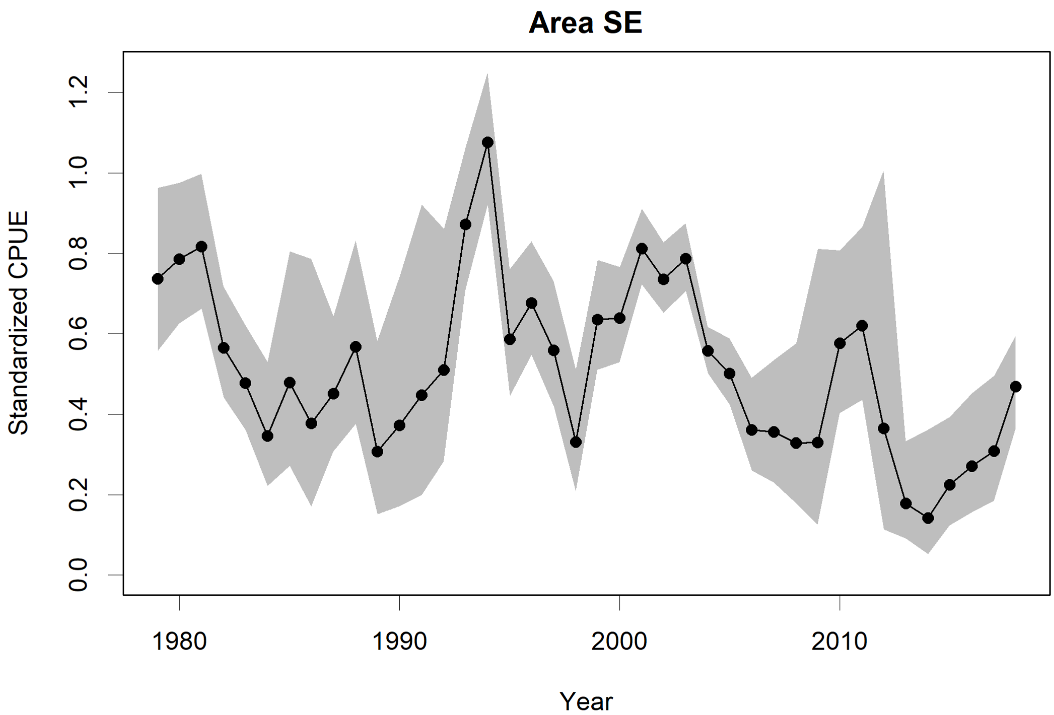


Fig. 34. (Continued).

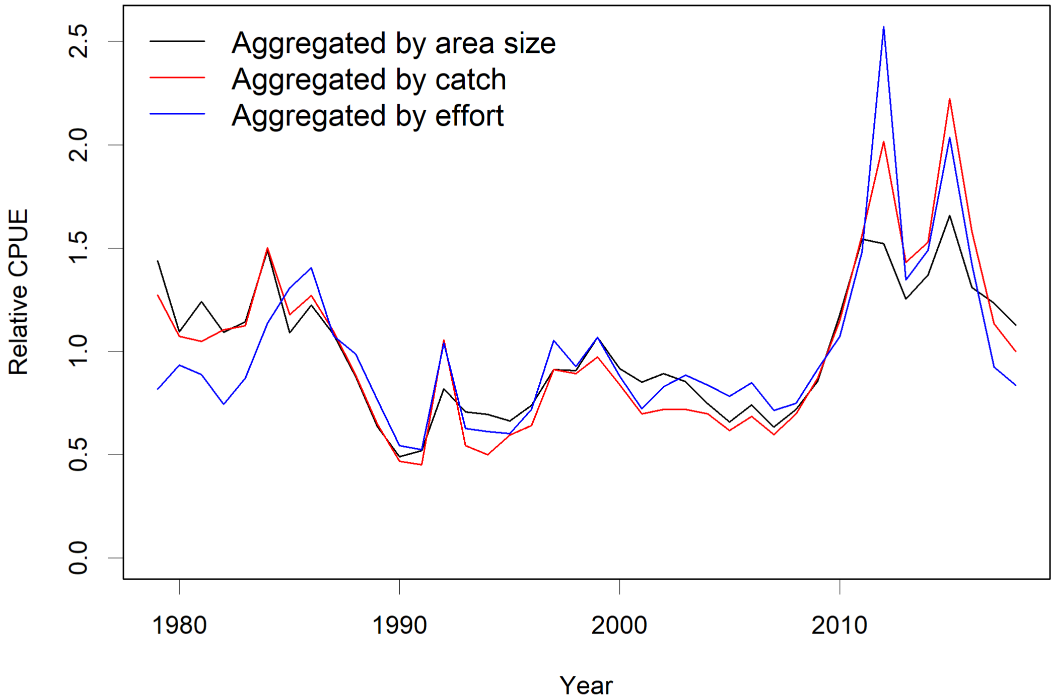


Fig. 35. Annual trends of area-aggregated standardized CPUE series for blue marlin caught by Taiwanese large scale longline fishery in the Indian Ocean.

Table 1. ANOVA tables for selected gamma models for CPUE standardizations for blue marlin caught by Taiwanese large scale longline fishery in the Indian Ocean.

Area NW

Variable	SS	Df	F	Pr(>F)
Y	6175	39	193.02	< 2.2e-16 ***
M	498	11	55.23	< 2.2e-16 ***
CT	21	2	12.70	3.05E-06 ***
G	1712	45	46.39	< 2.2e-16 ***
T	2313	3	939.80	< 2.2e-16 ***
Residuals	143789	175295		

Area NE

Variable	SS	Df	F	Pr(>F)
Y	668	39	31.54	< 2.2e-16 ***
M	220	11	36.90	< 2.2e-16 ***
CT	34	3	20.96	1.44E-13 ***
G	641	42	28.11	< 2.2e-16 ***
T	663	3	407.37	< 2.2e-16 ***
Residuals	40893	75340		

Area SW

Variable	SS	Df	F	Pr(>F)
Y	250	39	11.04	< 2.2e-16 ***
M	17	11	2.65	2.15E-03 ***
CT	12	2	10.29	3.45E-05 ***
G	128	30	7.34	< 2.2e-16 ***
T	158	2	136.24	< 2.2e-16 ***
Residuals	5333	9179		

Area SE

Variable	SS	Df	F	Pr(>F)
Y	412	39	24.65	< 2.2e-16 ***
M	28	11	5.89	1.29E-09
CT	11	2	13.30	1.71E-06 ***
G	122	53	5.37	< 2.2e-16 ***
T	85	3	65.91	< 2.2e-16 ***
Residuals	4167	9731		

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 2. ANOVA tables for selected delta models for CPUE standardizations for blue marlin caught by Taiwanese large scale longline fishery in the Indian Ocean.

Area NW

Variable	LR Chisq	Df	Pr(>Chisq)
Y	26516	39	< 2.2e-16 ***
M	209	11	< 2.2e-16 ***
CT	980	3	< 2.2e-16 ***
G	10472	48	< 2.2e-16 ***
T	1864	3	< 2.2e-16 ***

Area NE

Variable	LR Chisq	Df	Pr(>Chisq)
Y	5795	39	< 2.2e-16 ***
M	823	11	< 2.2e-16 ***
CT	388	4	< 2.2e-16 ***
G	5359	42	< 2.2e-16 ***
T	813	3	< 2.2e-16 ***

Area SW

Variable	LR Chisq	Df	Pr(>Chisq)
Y	1665	39	< 2.2e-16 ***
M	1659	11	< 2.2e-16 ***
CT	84	3	< 2.2e-16 ***
G	2802	32	< 2.2e-16 ***
T	294	2	< 2.2e-16 ***

Area SE

Variable	LR Chisq	Df	Pr(>Chisq)
Y	3312	39	< 2.2e-16 ***
M	875	11	< 2.2e-16 ***
CT	16	4	2.68E-03 ***
G	1096	54	< 2.2e-16 ***
T	185	3	< 2.2e-16 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1