ADJUSTED INDIAN OCEAN ALBACORE CPUE SERIES OF TAIWANESE LONGLINE AND DRIFT NET FISHERIES

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ABSTRACT

Catch and effort data series of Taiwanese longline (1968-1992) and driftnet (1986-1992) fisheries were used in the present study for standardization of historic albacore CPUE trend in the Indian Ocean by applying Generalized Linear Model (GLM) technique with: (1) fishing year; (2) fishing season; (3) fishing area; and (4) the bigeye and yellowfin tuna catch rate as major factors. The results thus obtained show that (1) the adjusted CPUE trend derived from driftnet data series seemed to fluctuate around a long-term average; (2) those derived from longline data set indicated: (i) there was an increasing trend from 1968 to early 1980s; and (ii) although there was a decline trend from early 1980 to 1990, an increment of CPUE since early 1990 was also observed.

INTRODUCTION

Variations in the catch statistics make the standardization of fishing effort essential to properly evaluate the CPUE series of albacore. To this purpose, standardisations by GLM procedure were performed on the possible variations, including fishing year, fishing season, fishing area and the fishing operation's target species, for both the Taiwanese longline and driftnet fisheries. Ever since some of the Taiwanese longliner shifted their target species from albacore to bigeye or yellowfin tunas (Chang *et al*., 1993; Nakano, 1994), the effect of the fishing operation's target species has been considered more and more important in the evaluation of an albacore abundance index. Therefore, a target species index (namely, the nominal CPUE of bigeye and yellowfin tunas) was designed in the GLM procedure (Chang and Hsu, 1994) to reduce the risks of misleading estimates of albacore abundance.

MATERIALS AND METHODS

Data used were the 1968-1992 time series catch-and-effort data compiled by the Tuna Research Center, National Taiwan University. The catch data were in units of numbers of fish, and the fishing effort in units of deployed hooks for the longline fishery and operating days for the driftnet fishery.

Four factors were designed in the GLM model to obtain the adjusted CPUE of the longline fishery: fishing year (denoted as *YEAR* in the GLM model), fishing season (*QUAT*), fishing area (*AREA*) and "target species index" (*TARGET*). Three sub-areas were defined by latitude for the fishing area factor: area north of 10ºS, south of 25ºS, and between 10ºS and 25ºS.

Figure 1. *The adjusted CPUE trends of longline and drift net fisheries.*

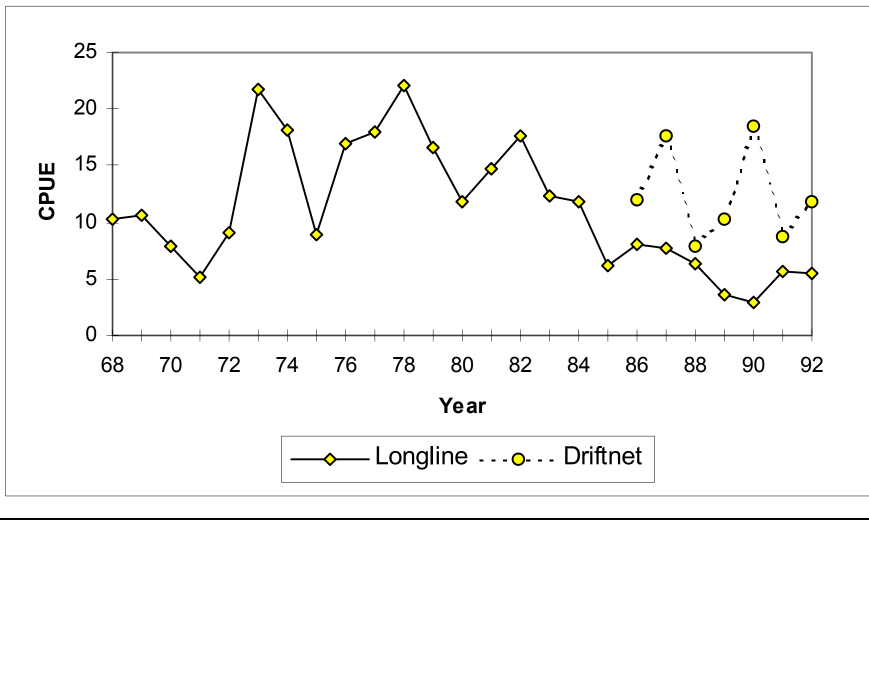

Table 1. **ANOVA tables of the GLM model of Taiwanese longline and driftnet fisheries**.

Source	DF	Type III SS	Mean Square	F Value	Pr>F
A. LONGLINE FISHERY					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Model	42	1531.2939	36.4594	72.25	0.0001
Error	1071	518.9189	0.4845		
Total	1113	2050.2128			
R-Square: 0.8126			C.V. 32.02456		
YEAR	25	87.1188	3.4848	8.36	0.0001
QUAT	3	4.175	1.3917	3.34	0.0188
AREA	2	859.2405	429.6202	1030.99	0.0001
TARGET	4	26.0718	6.5179	15.64	0.0001
*AREA*TARGET*	8	35.227	4.4034	10.57	0.0001
B. DRIFTNET FISHERY					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Model	7	4160.914	594.4163	992.85	0.0001
Error	794	475.3673	0.5987		
Total	801	4636.281			
R-Square: 0.8975			C.V.: 23.14047		
YEAR	6	60.0864	10.0144	16.73	0.0001
QUAT	1	3552.523	3552.523	5933.73	0.0001

The target species index was expressed by the class of natural logarithm (*LN*) of nominal CPUE of bigeye and yellowfin tunas together ($LN[(N_{BET}+N_{YFT}) / f]$, where N_{BET} is the number of bigeye tuna caught and N_{YFT} the number of yellowfin tuna caught, and f the nominal fishing effort). Five categories were classified by 0.5, 1.0, 1.5, 2.0.

Thus, the GLM model for the longline fishery was built as:

$$LN(U_{ALB} + 1) = \mu + YEAR + QUAT + AREA + TARGET + (INTERACTION) + \xi$$

where U_{ALB} is albacore catch in number per 1,000 hooks, μ is overall mean, ξ is the error term with $N(0,\sigma)$, and *(INTERACTION)* is the interactions term of every two of the variables.

Same factors except the target species index were included in the GLM model for the driftnet fishery. Thus the model for the driftnet fishery was:

$$LN(U_{ALB} + 1) = \mu + YEAR + QUAT + AREA + (INTERACTION) + \xi$$

Since no data have been reported from the area between 10ºS and 25ºS, only two sub-areas were applied to the GLM model for the driftnet fishery.

F-tests were conducted on all main factors and interaction terms of both models to determine whether each contributed significantly to the models.

Table 2. **Adjusted CPUE and catches in number of Indian Ocean albacore made by the Taiwanese longline and driftnet fisheries**

	Longline		*Driftnet*	
Year	*CPUE*	*Catch*	*CPUE*	*Catch*
68	10.269	400,810	-	-
69	10.531	556,384	-	-
70	7.948	373,104	-	-
71	5.077	227,676	-	-
72	9.141	359,109	-	-
73	21.712	707,727	-	-
74	18.116	957,443	-	-
75	8.895	331,606	-	-
76	16.911	556,306	-	-
77	17.963	608,865	-	-
78	22.154	811,900	-	-
79	16.667	963,858	-	-
80	11.785	702,094	-	-
81	14.71	763,413	-	-
82	17.557	1.394,275	-	-
83	12.255	1.057,207	-	-
84	11.765	969,064	-	-
85	6.161	400,271	-	-
86	8.077	697,715	12.024	308,991
87	7.729	842,985	17.709	1.266,009
88	6.313	774,667	7.933	1.471,682
89	3.636	484,659	10.248	1.463,511
90	2.889	362,299	18.578	2.300,421
91	5.62	823,613	8.699	1.347,398
92	5.497	771,143	11.892	815,763

RESULTS

Table 1 shows the ANOVA tables of the final GLM models for the longline and driftnet fisheries. For the longline fishery, all four main factors (*YEAR*, *QUAT*, *AREA* and *TARGET*) are statistically significant. The interactions between the factors of year, fishing area and "target species" are also significant. Among the significant factors, the fishing area factor accounts most of the model variance. The "target species" factor, however, does not explain as much model variance as expected. It was likely that, since the bigeye and yellowfin tuna are much more abundant in the area north of 10ºS than south of 10ºS, the definition of sub-area in this paper has already implied the effect of shifting of target species from albacore to bigeye or yellowfin tuna for longline fishery.

For the driftnet fishery, only main factors of year (*YEAR*) and fishing season (*QUAT*) are statistically significant.

Figure 1 shows the adjusted CPUE trends for Taiwanese longline and driftnet fisheries. There is a significant declining trend for the longline fishery during 1983-1990. After that, the trend rose in 1991 and 1992. For the driftnet fishery, the trend fluctuated and no continuous decline could be found. Table 2 lists the numerical value of the adjusted CPUE and the catches of albacore made by the Taiwanese longline and drift net fisheries.

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