Col.Vol.Sci.Pap. ICCAT, 34 : 123-127 (1991)

STUDIES ON SELECTION OF STANDARD YEARS AND ABUNDANCE TRENDS OF THE SOUTH ATLANTIC ALBACORE BASED ON 1967-1988 TAIWANESE LONGLINE FISHERY DATA

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SUMMARY

Using Honma's algorithm to justify Taiwanese 1967-1988 longline fishing effort on South Atlantic albacore, results obtained from analyses of various chosen time frames as "standard years" show that: (1) selection of "standard years" with larger fishing area coverage tends to have higher adjusted CPUE; (2) seasonal, as compared to monthly, stratum as a time unit tends to have higher adjusted CPUE; and (3) there were no significant differences among adjusted CPUE trends derived from various time frames of "standard years".

RESUME

En utilisant l'algorithme de Honma pour justifier l'effort des palangriers taiwanais portant en 1967-88 sur le germon sud-atlantique, les résultats obtenus par l'analyse de diverses structures temporelles, telles que les "années standards", montrent que: (1) la sélection des "années standards" avec une couverture plus étendue de la zone de pêche tend à donner une CPUE ajustée plus élevée; (2) la strate saisonnière, plutôt que mensuelle, en tant qu'unité temporelle tend à donner une CPUE ajustée plus forte; et (3) il n'y pas de différence significative entre les tendances de la CPUE ajustée calculées à partir de différentes structures temporelles d'"années standards".

RESUMEN

Aplicando el algoritmo de Honma para justificar los esfuerzos de pesca de los palangreros taiwaneses sobre el atún blanco del Atlántico sur, en el período 1967-1988, los resultados obtenidos del análisis de varias unidades de tiempo seleccionadas como "años estandar" muestran que: (1) la selección de "años estandar" con una zona de pesca más amplia tiende a dar una CPUE más ajustada, (2) que el estrato temporal como unidad de tiempo, en contraposición al mensual, da una CPUE más ajustada, y (3) no se observan grandes diferencias entre las tendencias de CPUE ajustada derivada de los diversos "años estandar".

INTRODUCTION

Honma (1974) has proposed an algorithm to justify annual fishing efforts in compatible with a preset "standard years" period. This method has been well acknowledged and used as an essential assessment technology for the south Atlantic albacore stock (Shiohama 1976; Kume 1977; Sun and Yang 1982).

Although a selection on the "standard years" is a must when Honma's algorithm is employed, the algorithm lacks definite guidelines to determine the exact "standard years". This uncertainty in selection of "standard years" also invited criticisms on the methodology (Conser 1984). The main purpose of this study are thus to compare (1) the difference in adjusted CPUE values and (2) the trends of adjusted CPUEs derived from various time frames of "standard years".

MATERIALS AND METHODS

Yearly catch (in number of fish) and effort (in number of hooks) statistics compiled from Taiwanese longliners, dating from 1967 to 1988, are the major source of data to be used in this study (Anon. 1967-1988). All catch and effort data were compiled by months and by 5-degree-square fishing blocks.

The basic equation in Honma's algorithm is:

$$Xij = aij \sum_{k} rijk \; fijk$$

where Xij is effective effort fished in the jth month of year i;

aij is the availability index during month j of year i;

rijk is the density index in subarea k during month j of year i;

fijk is the nominal effort fished in subarea k during month j of year i.

Let

$$aij = \frac{\sum_k \frac{Aijk\ Cijk}{fijk}}{\frac{1}{n}\sum_j\sum_k \frac{Aijk\ Cijk}{fijk}}$$

$$rij = \frac{\frac{Cijk}{fijk}}{\left(\sum_k \frac{Cijk}{fijk}\ Aijk\right) / \sum_k Aijk}$$

where Aijk is the population area in subarea k during month j of year i;

Cijk is the catch in subarea k during month j of year i;

n is the number of months fished during year i.

Under the assumptions that: (1) fishes are uniformly distributed over the entire stock area; (2) stock area is constant and is fished entirely during the course of a year; (3) catchability to be constant over all subareas and month (Conser 1984); and if further assumed that:

$$a11 = a21 = .. = ai1 = a'1$$
$$a12 = a22 = .. = ai2 = a'2$$
$$..$$
$$arj = a'j$$

$$r111 = r211 = .. = ri11$$
$$r121 = r221 = .. = ri21$$
$$..$$
$$rijk = r'jk$$

Therefore, the effective effort Xij can be obtained as:

$$Xij = a'j \sum_k r'jk\ fijk$$

Honma (1974) suggested to estimate a'j and r'jk from the "standard years", then use them to estimate annual effective efforts and its corresponding abundance index for all years. The abundance index can be derived as:

$$\frac{Ci}{Fi} = \frac{Ci}{\sum_j Fij} = \frac{Ci}{\sum_j (Xij / Fij)}$$

where Fij is the fishing intensity (efforts per area) of month j in year i; and $Fi = \sum_j Fij$.

There are seven sets of "standard years": 1967-1988; 1967-1977; 1978-1988; 1967-1972; 1973-1977; 1978-1982; and 1983-1988 to be compared in this study. Each set further re-grouped into two time frames (monthly ane seasonal). The differences among various adjusted abundance trends were thus tested by using either analyses of variance or correlation analyses.

RESULTS AND DISCUSSIONS

Figure 1 shows the catch rate (catch in number per nominal fishing efforts of hundred hooks) trend of south Atlantic albacore caught by Taiwanese longline fishery. As shown in Figure 1, there appeared two periods (years of 1967-1977 and 1978-1988) of catch rate fluctuation and were thus employed as the empirical criterium to define "standard years".

Seven sets of "standard years" were used in this study. They are: periods of (1) 1967-1988; (2) 1967-1977; (3) 1978-1988; (4) 1967-1972; (5) 1973-1977; (6) 1978-1982; and (7) 1983-1988. The availability index and the population area thus derived by using Honma's algorithm were shown in Table 1. It is noticeable that (1) availability index in the standard years of 1967-1988 appeared higher from January to July, while those of 1967-1977 were higher from May to August and those of 1978-1988 were higher from January to July; (2) population area in the standard years of 1967-1988 appeared always higher than those derived from the 1967-1977 and the 1978-1988 "standard years". The coverage areas

of fishing deployed by Taiwanese longliners are shown in Figure 2. It is noticed that the coverage of fishing areas in period of 1967-1977 were more extensive toward northward as compared to those of 1978-1988 period.

The adjusted CPUE trends obtained by using Honma's methods are shown in Figure 3 with 7 sets of "standard years" at two levels of time frame, i.e., monthly and seasonal stratum. It is noticed that (1) adjusted CPUE values tend to be higher in the "standard years" set of 1967-1988 as compared to those from the rest sets of "standard years"; (2) adjusted CPUE values tend to be higher in seasonal stratum as compared to those from monthly stratum; and (3) similarities among adjusted CPUE trends derived from all sets were highly significant (Table 2).

Honma (1984) pointed out that conditions as (1) fishing operations covered the entire area of the stock; and (2) distribution pattern of hooking rates were homogenious are the two important criteria to be awared of when a proper standard years can be determined. Unfortunately, neither of the two can be fully satisfied in the fishing reality. The straight forward solution to it is to include all the years within the fishing history were used as the utimate "standard years" (Yeh et. al. 1989) and the experiences show it worked well.

The historical abundance index curves estimated from monthly and quarterly time strata got similar trends with different mean values (Fig.3). Suzuki and Kikawa (1982) had the same conclusion. Seasonal movement in fishing efforts was one of the characters revealed by Taiwanese longline fleet in south Atlantic. As seasonal stratum was employed which may increase "population area" value (A'j) and may consequently resulted in an increase of abundance indices. It is thus recommended that careful consideration should be given in seleting time stratum, preferably as small a stratum as possible within the scope of available data in addition to the "standard years" period in applying this method.

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Table 1. Availability index and population area of South Atlantic albacore estimated from 3 sets of standard years.

(a) Availability index.

STDYR	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
6788	1.03	1.00	1.06	1.11	1.12	1.04	1.28	.96	.80	.82	.84	.94
6777	.90	.90	.89	.91	1.28	1.17	1.35	1.17	.93	.86	.76	.88
7888	1.13	1.17	1.23	1.22	1.07	1.07	1.13	.86	.83	.72	.74	.82

(b) Population areas

STDYR	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
6788	78.10	87.38	80.81	63.54	64.54	56.31	57.99	61.03	69.38	82.57	74.97	64.16
6777	62.69	69.11	57.55	49.24	55.44	47.08	47.51	50.82	60.58	78.53	70.30	54.81
7888	61.45	69.81	55.97	38.54	39.35	37.96	39.38	44.07	61.29	47.92	40.93	42.43

Table 2. ANOVA of adjusted CPUE gradients (CPUE differences between any two consecutive years) by time-stratum and by sets of standard years of south Atlantic albacore resource.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	26	7.586	0.292	41.84	0.0001
STDYR	6	0.061	0.010	1.46	0.1992
SLOPE	20	7.525	0.376	53.95	0.0001
Error	120	0.837	0.007		
Total	146	8.423			

Time stratum: Month

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	26	14.492	0.557	77.55	0.0001
STDYR	6	0.075	0.013	1.75	0.1152
SLOPE	20	14.416	0.721	100.29	0.0001
Error	120	0.862	0.007		
Total	146	15.354			

Time stratum: Quarter

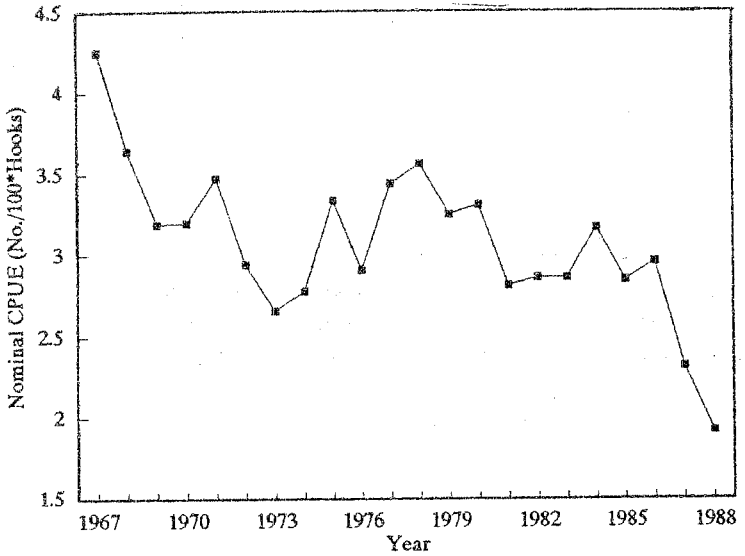

Fig. 1. Catch rate (number of fish per 100 hooks) trend of south Atlantic albacore caught by Taiwanese longliners dating from 1967 to 1988.

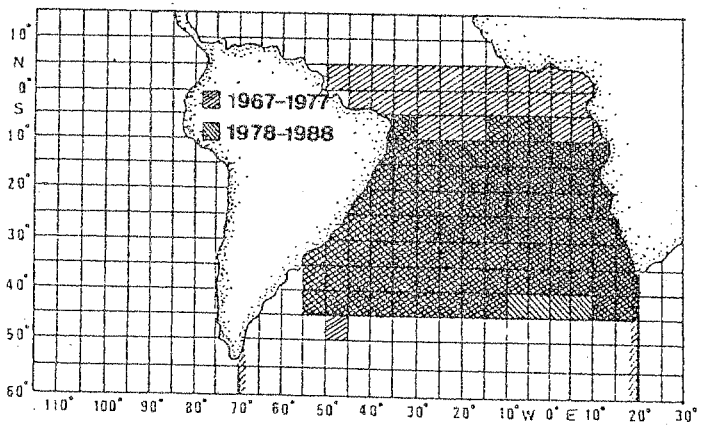

Fig. 2. Shadowed regions indicate the areas of fishing by Taiwanese longliners in the south Atlantic dating from 1967 to 1988.

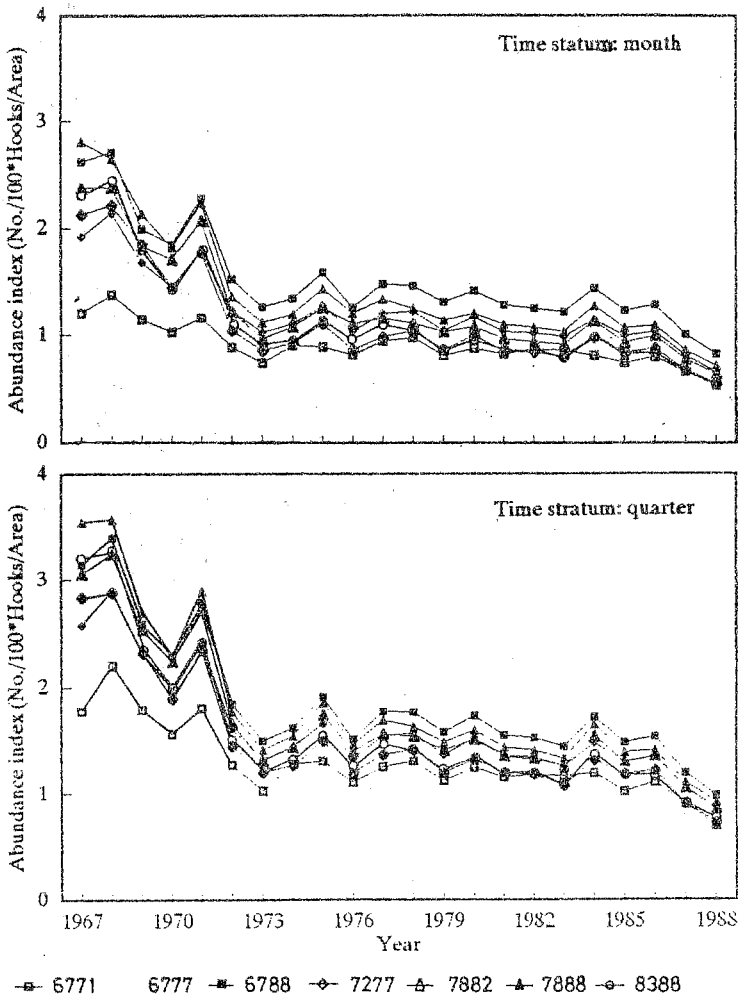

Fig. 3. Trends of abundance index, by time-stratum and by sets of standard years, of south Atlantic albacore stock obtained by using Honma's algorithm.