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STANDARDIZED CPUE OF BLUEFIN TUNA IN THE WESTERN ATLANTIC CAUGHT BY JAPANESE LONGLINE FISHERY

N. Miyabe
National Research Institute of Far Seas Fisheries, 7-1 Orido, 5-chome, Shimizu-shi, Shizuoka 424, Japan

SUMMARY

In order to supply abundance indices as inputs to the VPA analysis, standardized CPUEs for the western Atlantic bluefin from the Japanese longline fishery were estimated using the so-called General Linear Model. Size specific CPUEs for the 3 to 5 age group and the 6 to 8 age group were developed to better tune the VPA. Both indices showed similar stable trends and moderate fluctuations in recent years.

RESUME

Dans le but de donner des indices d'abondance comme entrées aux analyses de VPA, les CPUE standardisées pour le thon rouge de l'Atlantique ouest de la pêcherie palangrière japonaise ont été estimées en utilisant le modèle linéaire généralisé. Des CPUE spécifiques de taille pour les groupes d'âge 3 à 5 et 6 à 8, ont été développées pour obtenir le meilleur ajustement des VPA. Ces dernières années, les deux indices montrent une tendance stable similaire et des fluctuations modérées.

RESUMEN

Para facilitar índices de abundancia como inputs para análisis de VPA, se calcularon CPUE estandarizadas para el atún rojo del Atlántico Oeste de la pesquería de palangre de Japón, utilizando el denominado Modelo Lineal Generalizado. Se desarrollaron las CPUE específicas de la talla para el grupo de 3 a 5 años y de 6 a 8 años para un mejor calibración del VPA. Ambos índices mostraron la misma tendencia estable y fluctuaciones moderadas en años recientes.

1. Introduction

Japanese longline fishery has covered the widest distributional area of the west Atlantic bluefin and the longest time series among major fisheries. Because of this, CPUE from this fishery has been used in the stock assessment of this species to tune the VPA.

Two sets of the CPUE were available; one is age specific CPUEs (3 to 5, 6 to 7 and 8 to 9 years old) obtained from observer data within US 200 mile zone (Davis and Turner 1989), the other age specific CPUEs (3 to 5 and 6 to 8 years old) for the whole west Atlantic stock. Since US observer data cover only short period of recent years and localized area, the CPUE series seem to be less informative. In fact, the former CPUE series were not used in the VPA tuning because of this reason (ICCAT 1989).

In this study, the Japanese longline CPUE series from the entire western Atlantic were updated using the revised 1987 data and newly added 1988 data.

2. Material and Method

Japanese longline catch and effort data during 1975-1988 with codes for 5° square, month and kind of bait were used. Data for 1988 were preliminary.

As a fishing season, which is incorporated to the model, each month from November to February was selected since the

Japanese longline fleet targeted bluefin tuna only in the northern winter in the northwestern Atlantic since the implimentation of current regulation in 1982. It is thought the CPUE of the fishing season(November to February) represents abundance index at the beginning of the latter calender year of the fishing season. For example, CPUE of 1985-1986 fishing season represents the abundance of year 1986.

To obtain better CPUE series as an input for the purpose of tuning VPA, size specific CPUE indices were developed. After the examination of available size data, it was thought that the matching of catch and size data was impossible by each 5 square and by month. So length frequency (Fig. 2) was built by two months interval (e.g. Nov.- Dec. and Jan.-Feb.) and inshore-offshore water (divided by 65° W). Then catch data for areas 1-3 were matched with the length frequency in the inshore water and the areas 4-9 were matched with that of offshore water.

Needless to say, it is better to have ages included in the index as few as possible. However, considering the nature and the availability of the size data, it was thought better to estimate CPUEs for two age groups (3 to 5 years old and 6 to 8 years old). Actually what was done is that nominal CPUE was split into two age specific indices based on the percentage of each age group in the size data.

Catch and effort data were aggregated to each area delineated in Fig. 1 and the CPUE was calculated per 1,000 hooks. The histgram of nominal CPUE was shown in Fig. 3. Number of observations by year, month and area were tabulated in Table 1.

Then GLM was applied to obtain annual trend of the CPUE. The multiplicative model was used as were the cases of last year' works for this fishery (Miyabe and Suzuki 1989, Davis and Turner 1989):

$$LOG\ (\ CPUE + 1.0\ ) = \mu + Y_i + M_j + A_k + MA_{jk} + e_{ijk}$$

where LOG : natural logarithm,
CPUE : catch in number of bluefin per 1,000 hooks,
μ : overall mean,
Y_i : effect of year (November to February),
M_j : effect of month,
A_k : effect of area,
MA_{jk} : interaction term between M_j and A_k,
e_{ijk} : error term with $N(0,\sigma)$.

Constraints ($\Sigma Y_i=0.0$, $\Sigma M_j=0.0$, $\Sigma A_k=0.0$) were set to reduce the number of parameters to be estimated. Design matrix was prepared using dammy variable with 1, 0, -1 codes.

3.Result and Discussion

The distributions of normalized residual at each main effect are shown in Fig. 4. Although in some cases the distribution is different from normal, it seemed acceptable. The overall distribution of residual (Fig. 5) is very close to normal curve. The results of ANOVA are listed in Table 2. R^2 is 0.51 and 0.41 for 3-5 and 6-8 age group, respectively.

In Fig. 6 and Table 3 standardized CPUE and its 95 % confident limits are shown. CPUE for 3-5 age group was fairly high in 1977 and 1978 indicating that 1973 year class was dominant. This trend can be followed in the length frequency histogram in Fig. 2. After 1978 it has been stable with moderate fluctuations. CPUE for 6-8 age groups showed consistently stable trend with low CPUE in 1976 and 1983. During 1977-1981 and in 1985 and 1987 CPUE was high and at about the same level. Similar trend in CPUE was observed in both CPUEs. This might mean fishing success was affected by oceanographic condition, such as water temperature.

References

Davis K. S. and S. C. Turner 1989: Standardized catch rates of bluefin tuna from the Japanese longline fishery in the United States Exclusive Economic Zone for 1983-1987, ICCAT, CVSP. Vol. 30(2), 311-317.

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Miyabe, N. and Z. Suzuki 1989: Problems in the stock assessment of west Atlantic bluefin tuna, ICCAT, CVSP. Vol. 30(2), 276-282.

Table 1. Number of observations for CPUE analysis by month and area.

Year	Nov	Dec	Jan	Feb	A1	A2	A3	A4	A5	A6	A7	A8	A9	Total
75-76	9	12	7	5	8	7	4	2	1	6	5	0	0	33
76-77	13	16	11	8	6	7	8	9	4	4	4	6	0	48
77-78	15	14	13	4	4	7	10	9	4	7	1	4	0	46
78-79	17	15	21	5	5	8	9	10	4	8	5	6	3	58
79-80	17	11	17	7	6	3	8	9	8	8	2	5	3	52
80-81	17	28	20	13	7	11	10	11	9	8	5	8	9	78
81-82	19	21	11	5	4	9	6	6	6	6	6	8	5	56
82-83	12	13	10	14	5	4	9	9	6	6	4	5	1	49
83-84	10	12	13	8	3	3	7	8	6	5	5	4	2	43
84-85	11	12	15	11	6	4	6	8	6	8	5	5	1	49
85-86	0	0	15	6	4	2	2	4	1	2	2	3	1	21
86-87	14	15	12	0	6	2	6	6	6	6	4	5	0	41
87-88	12	15	8	8	12	3	4	8	8	4	2	2	0	43
Total	166	184	173	94	76	70	89	99	69	78	50	61	25	617

Table 2. Results of ANOVA from the General Linear Model for western Atlantic bluefin.

Age group	Source of variation	Sum of square	Degree of freedom	Mean Square	F statistics	R^2
3 - 5	Regression	186.0483	47	3.9585	12.80	0.51
	Residual	175.9551	569	0.3092		
	Total	362.0034	616			
6 - 8	Regression	61.4972	47	1.3085	8.46	0.41
	Residual	87.9679	569	0.1546		
	Total	149.4651	616			

Table 3. Annual CPUE for western Atlantic bluefin tuna.

Year	3-5 age	6-8 age
76	0.7743	0.0750
77	2.6794	0.5998
78	1.6812	0.7917
79	0.3749	0.6314
80	0.8683	0.6760
81	0.9266	0.5859
82	0.4311	0.3457
83	0.1131	0.0960
84	0.5116	0.3790
85	0.8948	0.6551
86	0.1875	0.2623
87	0.8743	0.5688
88	0.6679	0.6087

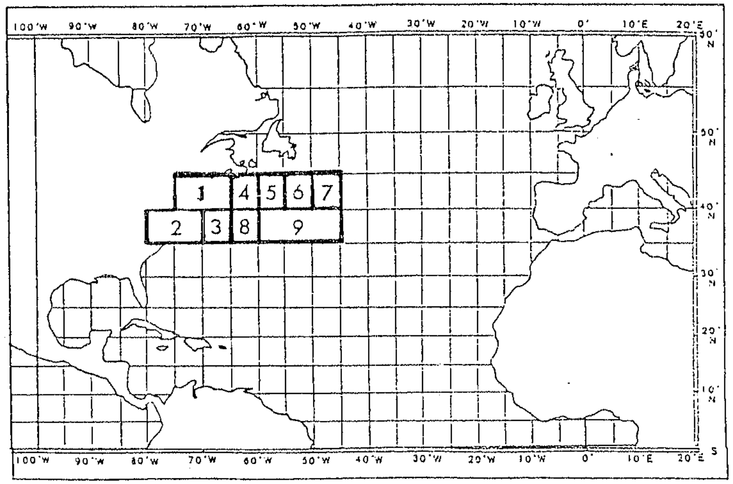

Fig. 1 Area division used in this study.

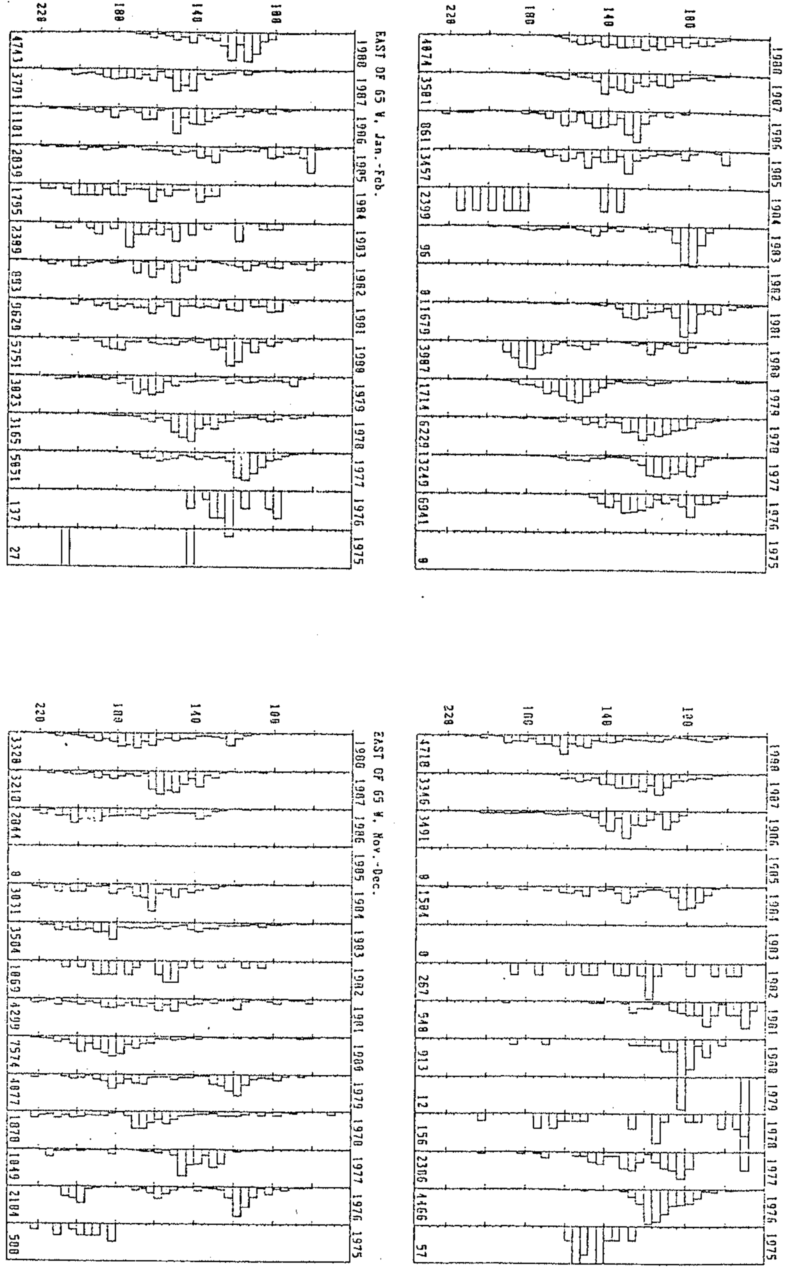

Fig. 2 Length frequency of bluefin in the western Atlantic caught by the Japanese longline fishery by area (east and west of 65 W) and two months interval (Nov.-Dec. and Jan.-Feb.).

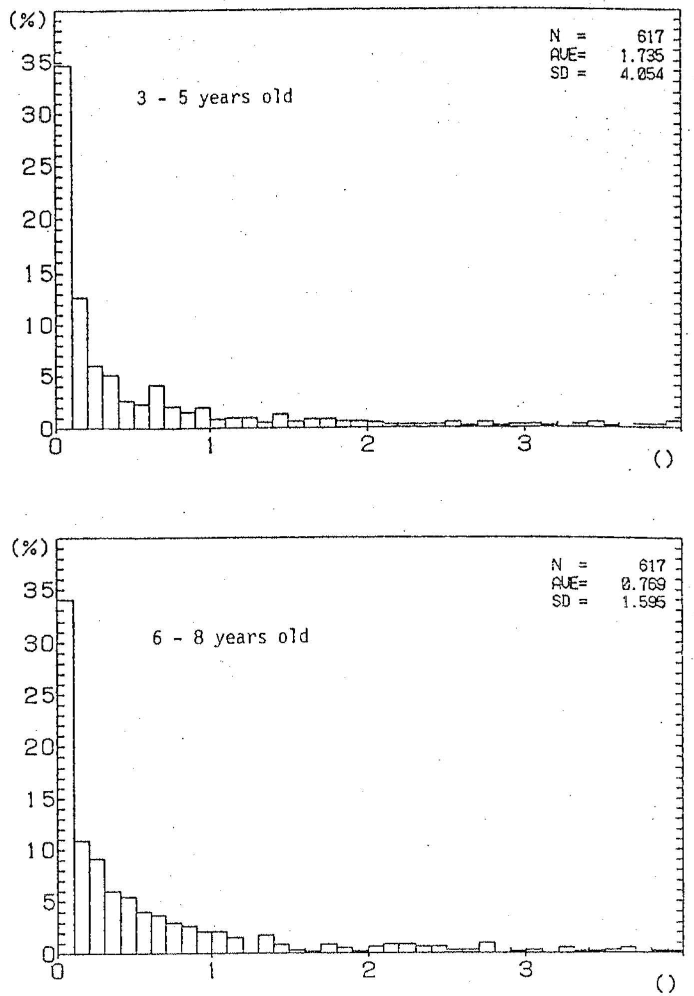

Fig. 3 Histogram of nominal bluefin CPUE for 3-5 and 6-8 age group.

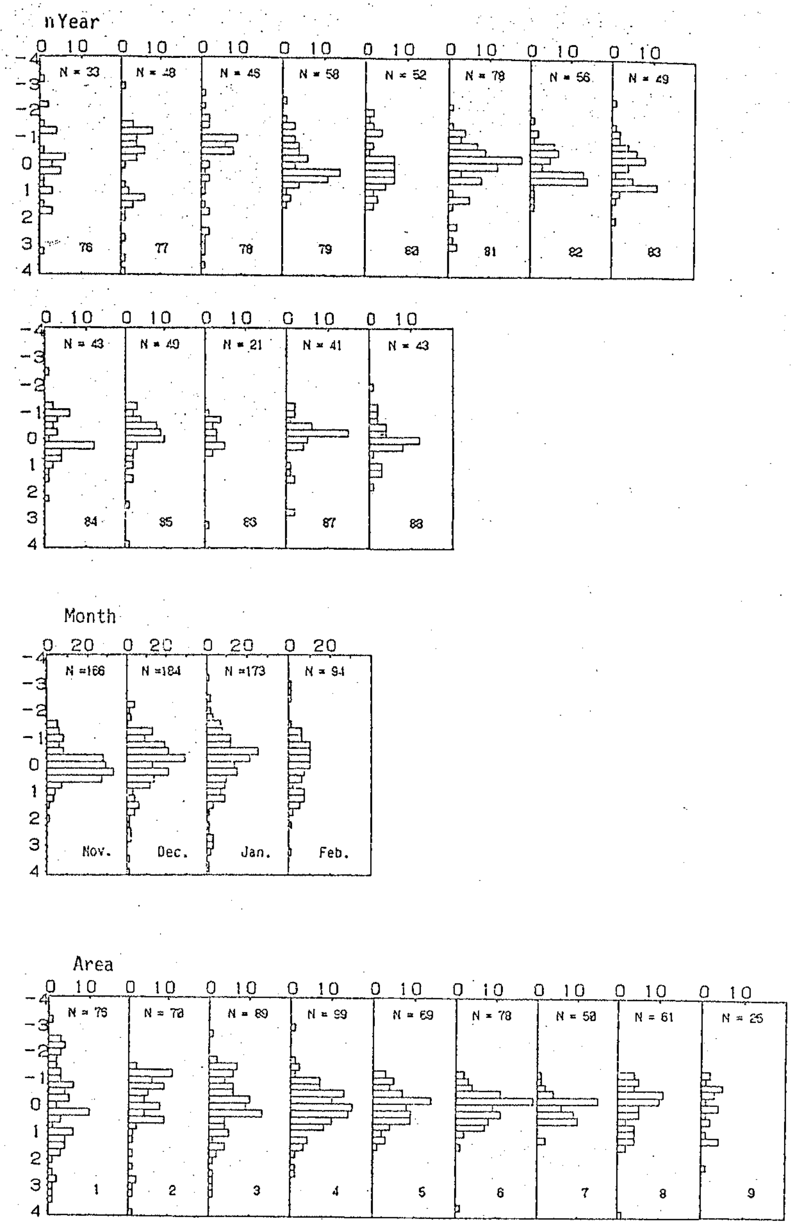

Fig. 4 Frequency distribution of the normalized residual plotted at each main effect, 3 - 5 years old.

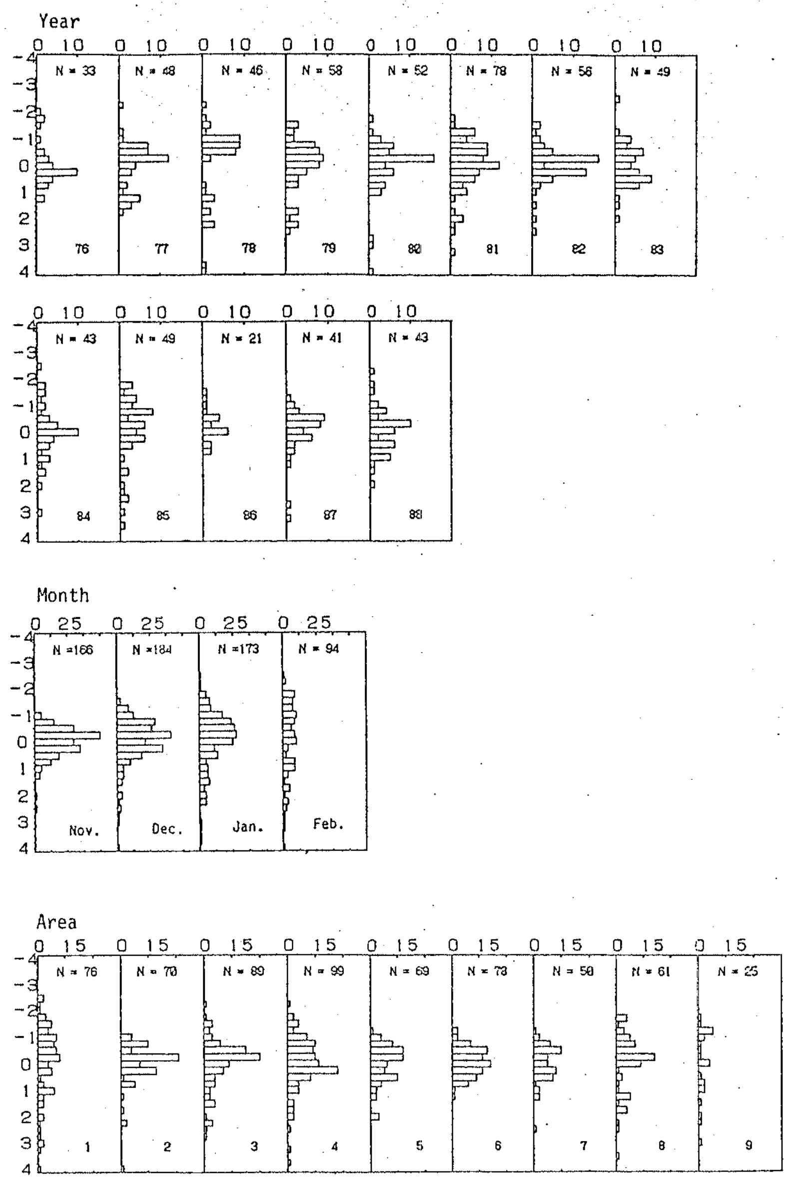

Fig. 4 Continued, 6 - 8 years old.

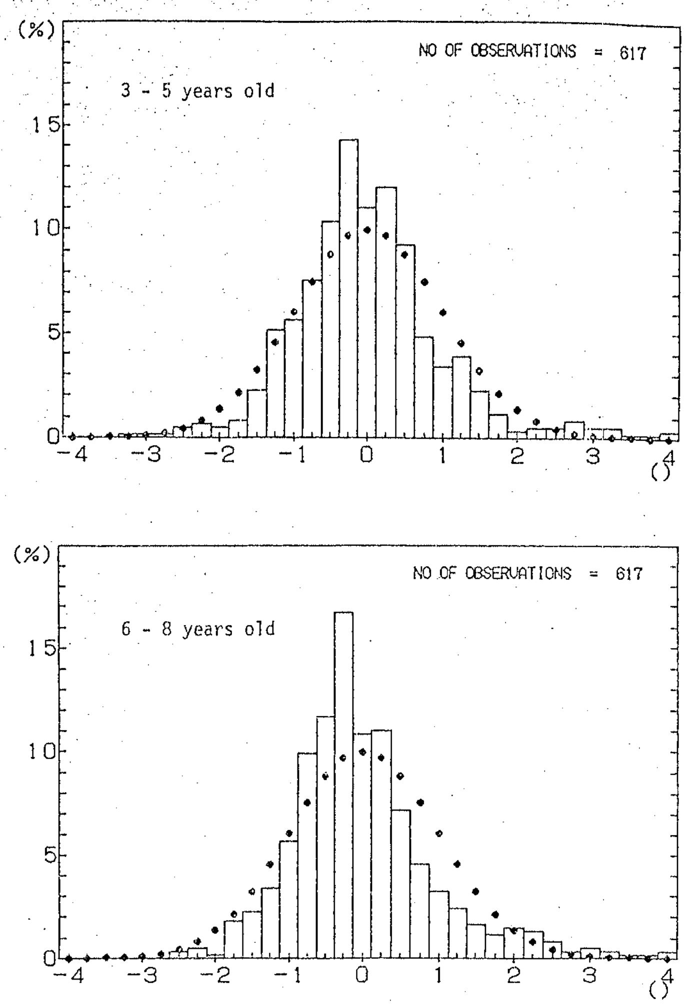

Fig. 5 Histogram of normalized residual. Bars show frequency of residual and solid circles show expected one from normal distribution.

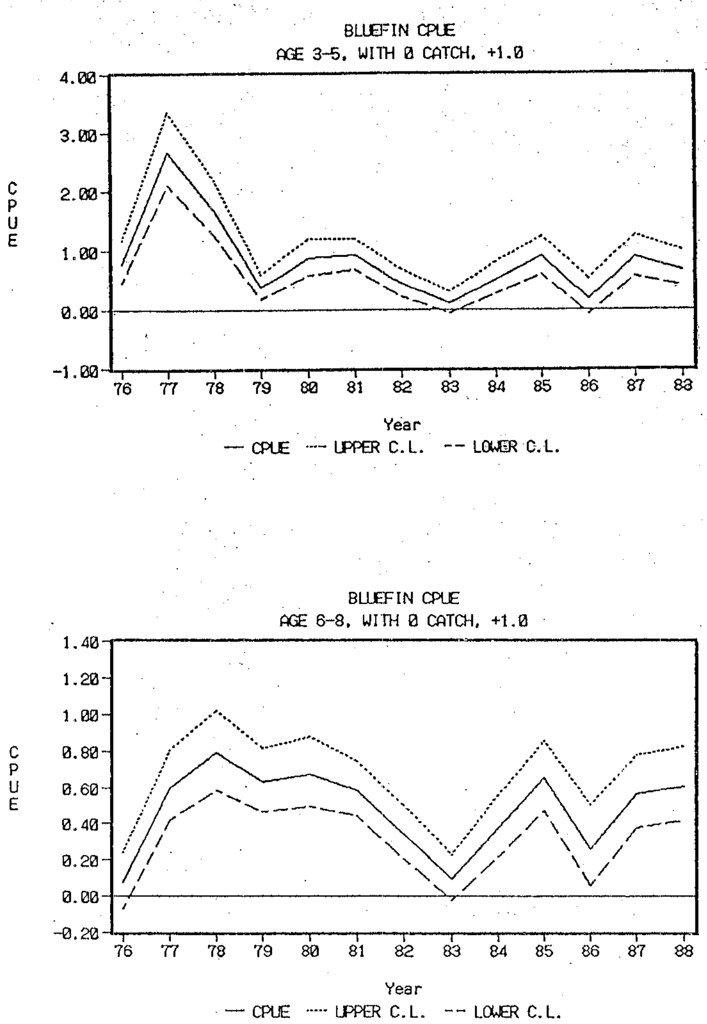

Fig. 6 Standardized CPUE for west Atlantic bluefin based on Japanese longline fishery. Solid line and dotted lines show CPUE and its upper and lower 95% confidence limits.