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STOCK ABUNDANCE OF THE ATLANTIC BLUEFIN TUNA IN THE GULF OF MEXICO

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SUMMARY

No significant yearly change in the value of the negative binomial parameter k is observed in the frequency distribution of individual set CPUE by the Japanese longliners off the coast of New Orleans in the February-June period between 1975 through 1981.

RESUME

Aucun changement annuel significatif de la valeur du paramètre binomial négatif k n'est observé dans la distribution de fréquence de la CPUE de coups isolés des palangriers japonais au large de la côte de New-Orleans pendant la période février-juin de 1975 à 1981.

RESUMEN

No se observan cambios anuales importantes en el valor del parámetro binómico negativo k en la distribución de frecuencias de la CPUE por lance individual de los palangreros japoneses que faenaron frente a la costa de Nueva Orleans durante los meses de febrero a junio, entre los años 1975 y finales de 1981.

Originally Japanese longliners operating in the Gulf of Mixico had mainly caught yellowfin tuna and white marlins. Interest in the bluefin tuna rose when the Japanese longliners made a catch of more than 1,000 fish for the first time in 1974. The annual catch remained at a stable level of 6,000 to 10,000 fish from 1975 onwards (Honma, Matsumoto and Kono, 1985), when Japanese fishing operation in the Gulf of Mexico was suspended in 1982. The bluefin tuna caught in the Gulf of Mexico are large-sized spawning adult of 2 to 3 m in folk length (Richards, 1976), and much attention has been paid to estimate the abundance of this stock. (Anon., 1985)

Since most of the bluefin fishing grounds lie within the U.S.'s 200-mile zone, Japanese longliners were obligated to have U.S. scientific observers on board their ships. The U.S. scientists who applied the negative binomial distribution to the CPUE data of an individual sets obtained from the observers showed that the value of the negative bionomi parameter k becomes small from year to year. From this they concluded that the stock status of the species in this area is declining every year (NMFS Southeast Fish. Cen., 1984).

However, the number of Japanese fishing operations having U.S. observers on board amounts to only 3 to 35 percent of the entire Japanese operations on the monthly basis. Time and space strata must be considered in studying the annual fluctuation of the parameter k.

The purpose of this paper is to estimate the bluefin tuna stock abundance in the Gulf of Mexico by studying the monthly and annual changes in the value of the parameter k of the negative binomial distribution applied to the Japanese CPUE data.

Materials and Methods

The data used in this study has been compiled from the files prepared by the Far Seas Fisheries Research Laboratory based on the catch records presented by Japanese longliners. Though the reports were collected by most but not all of the fishing vessels, the data derived from these reports have been raised at a single rate to cover the entire Atlantic Ocean (Fisheries Agency, 1977 - 1983).

According to Honma et al. (1985), it is the best time-area of 25°- 30° N and 85°- 95°W off the coast of New Orleans from April through May to measure the stock abundance of the species. As Japanese fishing vessels had shifted their fishing operations to earlier months in recent years, the frequency distribution of those individual set CPUE data in the two 5°-squares above-mentioned were studied for each of the months from February through June. The cases fewer than 20 operations within a month were excluded from this analysis.

The negative binomial distribution is well known to fit the frequency distribution of the individual set tuna longline CPUE (Suda, 1958). The variance to mean ratio was calculated in the analysis below, and negative binominal distribution applied when the ratio was 1.2 or more. The value of 1.2 is merely an emperical figure. The program used was made by Shiyomi (1970).

Results

Table 1 shows the mean values, variances and variance to mean ratios calculated from the monthly frequency distribution of individual set CPUE by Japanese longliners operated off the coast of New Orleans from February through June. The table shows the value of parameter k in the cases where negative binomial distribution is applied.

Analysis was made of a total of 25 months over a seven-year period beginning from March 1975 through April, 1981. Of these, variance to mean ratios for the three months of February, 1977, and February and March, 1979 were less than 1.01, so that negative binomial distribution was not used.

Figure 1 shows the estimated values of k, which are low for February and June of both years. The Value of k exceeds 8 for the March of 1977 and 1978 but is less than 2.3 for the March of 1980 and 1981. Generally speaking, it seems that the value of k is high in March, April and May.

Figure 2 shows the relationship between the mean value and the value of parameter k. It shows no clear relationship in the figure. Except in some extreme cases such as the March of 1975, 1977, 1978 and February of 1980, a linear relationship is rather clear between the mean and the variance.

As is evident from Table 1, it is difficult to examine the annual change in the value of parameter k because the Japanese longlining operations shifted to earlier months year by year. Thus the Generalized Linear Model (Robson, 1966) was used with considering month and year, as main effects, but not the interaction (Table 2).

In this case, the contribution factor R^2 is 0.60, and the value of k estimated on the yearly basis fluctuates between the maximum of 2.38 in 1978 and the minimum of 0.50 in 1980.

Figure 3 shows the estimated values of k listed in Table 2. During the period between 1975 through 1981, the value of k was high in the years between 1977 and 1979 but low in the three years of 1975, 1976 and 1980. However there is no clear upward or downward trend throughout the entire period.

Discussions

According to Bannerot and Austin (1983), increasing the skewness in CPUE distribution, or the lowering of the value of k, indicates a decrease in the stock. The skewness derived from the bluefin CPUE of individual set in the Gulf of Mexico shows an increase from the 1978 to 1979 period to the 1980 to 1981 period (NMFS Southeast Fish. Cen., 1984).

This analysis may not be entirely accurate because it regarded the whole of the Gulf of Mexico as one fishing ground in its calculation. Japanese longliners made big bluefin catches off Key West in the February of 1980 and the January of 1981. But since this fish school was at migrating stage to the waters off New Orleans (Honma et al., 1985), it is not clear if the schooling behavior of this fish group was the same as that at a sojourning stage off New Orleans.

The relationship between the mean and the variance deviates greatly from a straight line in the four months including the March in 1975, those being either in February or March. The fish school has not sufficiently reached the fishing grounds off New Orleans during this period, so that the fishing grounds are assumed to be unstable.

The fishing grounds off New Orleans with high catch rates are quite limited and are more or less the same locations every year. When the longliners are concentrated in these restricted areas, the catch may be small or even nil due to gear conflicts between vessels. This could possibly increase the skewness to appear larger than it actually is.

At any rate no significant yearly change in the value of the negative binomial parameter k is observed in the frequency distribution of individual set CPUE by the Japanese longliners off the coast of New Orleans in the February - June period between 1975 through 1981. These data are not sufficient to support the view that the bluefin resources in the Gulf of Mexico decreased during the seven years from 1975 through 1981.

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Table 1. Mean, variance to mean ratio and the binomial parameter k calculated from the monthly frequency distribution of individual set CPUE in the areas off New Orleans.

Year	Month	No. of sets	Mean	$\frac{\text{Variance}}{\text{Mean}}$	K
1975	Mar.	23	7.21	56.84	0.28
	Apr.	193	4.42	2.98	3.22
	May	267	6.14	4.66	1.89
	June	68	0.69	2.17	0.59
1976	Mar.	366	1.16	3.98	0.32
	Apr.	587	3.19	2.60	1.99
	May	503	5.88	3.07	2.78
	June	109	3.10	3.46	0.87
1977	Feb.	165	1.41	0.97	-
	Mar.	781	1.92	1.37	8.10
	Apr.	717	2.60	2.01	3.72
	May	309	5.30	4.29	2.40
	June	63	2.05	7.24	0.22
1978	Feb.	161	0.95	1.52	1.61
	Mar.	436	3.42	1.42	8.78
	Apr.	376	4.29	1.94	5.93
	May	218	4.56	2.28	4.59
	June	111	0.81	3.60	0.20
1979	Feb.	335	1.47	0.95	-
	Mar.	606	2.39	1.01	-
	Apr.	524	3.81	2.44	4.00
1980	Feb.	212	5.98	21.92	0.19
	Mar.	83	1.77	3.42	1.09
1981	Feb.	195	0.53	1.88	1.15
	Mar.	609	1.70	2.07	2.29
	Apr.	542	2.33	4.05	1.62

Table 2. The parameters estimated by using GLM.

Parameter estimated		
Mean	C(0)= 1.24016	ln(C(0))= .215239
	C(1)= .711813	ln(C(1))=-.33994
	C(2)= .79191	ln(C(2))=-.233308
Year	C(3)= 1.41971	ln(C(3))= .350452
	C(4)= 1.92206	ln(C(4))= .653396
	C(5)= 1.49296	ln(C(5))= .400758
	C(6)= .403828	ln(C(6))=-.906767
	C(7)= .604011	ln(C(7))=-.504163
Month	C(8)= 1.36706	ln(C(8))= .312666
	C(9)= 2.16041	ln(C(9))= .770297
	C(10)=1.99712	ln(C(10))=.691705

Sum of squares = 12.3604
Variance = 1.03003
Standard deviation = 1.01491
Contribution factor (R^2) = 0.60

Year	$\hat{k}$
1975	0.88
1976	0.98
1977	1.76
1978	2.38
1979	1.85
1980	0.50
1981	1.34

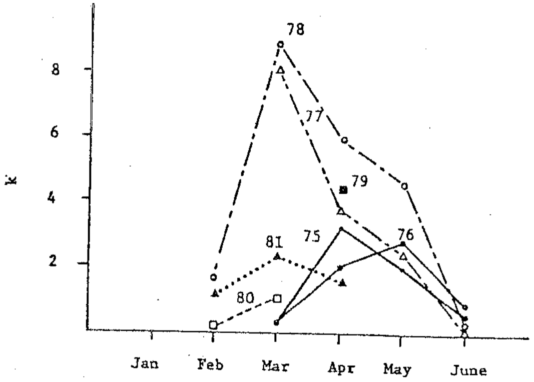

Fig. 1. Graph showing the estimated k values.

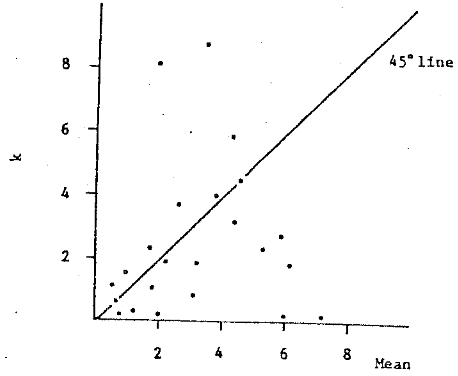

Fig. 2. The relationship between mean and k value.

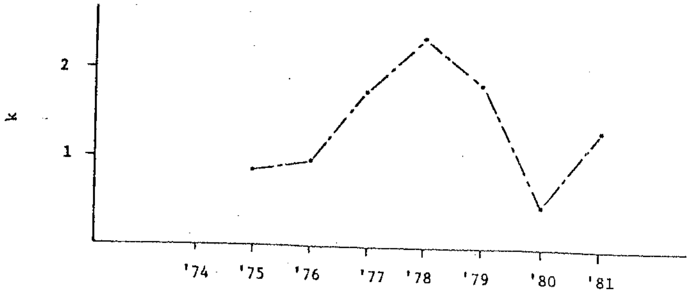

Fig. 3. Year specific k values estimated using GLM.