THE VERTICAL DISTRIBUTION OF TUNAS AND BILLFISHES, AND FISHING EFFICIENCY BETWEEN KOREAN REGULAR AND DEEP LONGLINES IN THE ATLANTIC OCEAN

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SUMMARY

The Korean deep longline tuna fishery in the Atlantic Ocean began in 1980. The vertical distribution of tunas and billfishes was analyzed by catch per unit of effort from deep longlining as an index of abundance. Yellowfin, albacore and billfishes were chiefly distributed in shallow layers less than 200 m, while bigeye tuna were distributed in the depth of 300 m. In comparing the fishing efficiency between the two methods used on yellowfin and bigeye tunas, the regular gear was more efficient on yellowfin tuna than on bigeye and deep longlining was more efficient on bigeye tuna.

RESUME

La pêche coréenne à la palangre de profondeur dans l'Atlantique a débuté en 1980. La distribution verticale des thonidés et poissons porte-épée a été analysée au moyen de la CPUE de la palangre de profondeur en tant qu'indice de l'abondance. L'albacore, le germon et les poissons porte-épée étaient surtout distribués dans une couche fine à moins de 200 m, alors que le thon obèse se trouvait à une profondeur d'environ 300 m. En comparant l'efficacité de pêche entre les deux méthodes en ce qui concerne l'albacore et le thon obèse, on observe que l'engin traditionnel est plus efficace pour l'albacore, et la palangre de profondeur pour le thon obèse.

RESUMEN

La pesquería coreana de túnidos atlánticos con palangre profundo se inició en 1980. La distribución vertical de túnidos y marlines se analizó por medio de la CPUE del palangre profundo como índice de abundancia. El rabil, el atún blanco y los marlines se encontraban distribuídos principalmente en los 200 metros mientras que el patudo se encontraba a 300 metros. Comparando la eficacia de dos métodos en la pesca de rabil y patudo, se observó que el arte regular era más eficaz para el rabil y el palangre profundo tenía más éxito con el patudo.

INTRODUCTION

There are various types of fishing gears and methods to catch tunas and tuna-like species. It is commonly known, the tuna longline gear has been used as a main fishing gear to target large yellowfin and bigeye tunas, albacore tuna, and billfishes incidentally. Korean tuna longline fishery has been initiated in the Atlantic Ocean since 1964. According to the year book of fisheries statistics by the Ministry of Agriculture and Fisheries, Republic of Korea (1971-1985), annual total catch had maintained a level of over 30,000 MT until 1978, thereafter it shows a continuous decrease.

Yellowfin tuna was a major target fish which had a 25 to 45 percent of the total catch until 1979. However, it has been changed to bigeye as target species since 1980, which shows a 50 percent of the total catch. From this it can be inferred that the deep longline gear has been main fishing gear since 1980 (Fig. 1).

The purpose of this study is to analyse the abundance index of tunas and fishing efficiency from catch per unit effort(CPUE).

DATA SOURCES AND METHODS

The tuna longline gear, called a basket, is made of floats, float lines, mainline and branch lines. It has been taken with 6 to 9 branch lines in a unit of basket for the regular gear and with 10 to 16 branch lines for deep gear in the Atlantic Ocean.

The data used in this study were the catch and effort which were collected from 11 vessels of regular gear and 6 vessels of deep gear in 1983, and catch and effort by branch lines gathered 16,195 baskets in 1985. The former was used to compare the fishing efficiency on yellowfin and bigeye tunas between regular (RL) and deep longline (DL) gears in the simultaneous fishing area in which both gears had been operated at the same time in 1983 (Fig. 2), the latter was used to analysis the vertical distribution by species and hanging depth of hooks.

Catch per unit of effort (number/100 hooks) was used as an abundance index of tunas. The fishing efficiency between two gears was calculated by dividing CPUE of the deep longline by that of the regular one as follows :

$$\text{CPUE} = \text{Catch in number/100 hooks}$$

$$\overline{\text{CPUE}} = \frac{1}{n} \sum_{i=1}^{n} \text{CPUE}$$

$$\text{FE} = \text{CPUE of } DL_i / \text{CPUE of RL}$$

$$\overline{\text{FE}} = \frac{1}{n} \sum_{i=1}^{n} FE_i$$

Where, CPUE of DL_i : Catch per unit of effort of the deep longline in i unit area (5° x 5° squares)

CPUE of RL_i : Catch per unit of effort of the regular longline in i unit area

FE_i : Fishing efficiency in i unit area

$\overline{FE}$: Average fishing efficiency

Theoretical catenary equation described by Yoshihara (1951, 1954) was fitted to determine the vertical distribution of tunas from hanging depth of hooks under the assumption that mainline makes a catenary curve in water (Fig. 3). In this equation, the angle between horizontal line and tangental line of the mainline at the connecting points of mainline and float lines was chosen $\varphi° = 72$ (when sagging rate is 0.6) as a representative for the calculation, using the results from relevant studies (Hanamoto, 1974 ; Fujii and Okamoto, 1971 ; Suzuki et. al., 1977). According to the interviews with fishermen and informations on the deep longline gear, they have mostly used the length of lines in a basket as follows : half of length of mainline (L)=340 m ; length of float line (Ha)=25 m ; length of branch line (Hb)=30 m.

RESULTS AND DISCUSSIONS

1. Fishing efficiency between the regular and deep longline gears

Suzuki et al. (1977), Kume (1984) and Koido (1985) reported that the RL has less than 7 branch lines and more than 9 or 10 branch for DL. In our study, 10 to 16 branch lines were hung in DL and 6 to 9 branch lines in RL.

It is known that bigeye tuna is a deeper swimmer than yellowfin and other tunas (Kume, 1984), so it is worthwhile to review fishing efficiency for yellowfin tuna between the two fishing gears.

In table 1, average of CPUE, coefficient of variation, standard error of CPUE and fishing efficiency are summarized. Fishing efficiency between the two gears on yellowfin was about 0.95 and that on bigeye tunas was as high as 1.87. It was pointed out that almost similar trends in the fishing efficiency were reported by Suzuki (1977) while there was a slight difference in the report by Kume(1984). Consequently, the deep longline could be considered more efficient on bigeye tuna, while the regular one to be more efficient on yellowfin tuna.

2. Vertical distribution of tunas and billfishes for deep longline gear

Catch per unit of effort by vertical depth of branch lines for the deep longline gear was analysised by species in Atlantic Ocean. The CPUE of albacore and yellowfin tunas were high at the hanging depth of hooks of 150 to 230 m (No. 2 to 4 and 10 to 12 branch line), and the highest CPUE of albacore was at the layer around 150 m (No. 2) and that of yellowfin around 190 m (No. 3 and 11). The CPUE of bigeye tuna was high at the 260 to 300 m layer (No. 5 to 9) which is the deepest among other tunas and billfishes. Swordfish, blue marlin, white marlin and sailfish were high at the shallow layer of 100 to 190 m, however, white marlin and sailfish were not caught at 190 to 300 m (Fig. 4). Therefore, it can be inferred that yellowfin, albacore and billfishes are chiefly distribute at the shallow layers and bigeye tuna mostly at the deepest layer (Saito, 1975; Kume, 1984;Koido, 1985).

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Table 1. The comparison of fishing effiency between regular (RL) and deep longline (DL) on yellowfin and bigeye tunas in the Atlantic Ocean for 1983

	Yellowfin		Bigeye	
	RL	DL	RL	DL
Average of CPUE (CPUE)	0.717	0.532	0.565	0.776
Standard deviation	0.330	0.220	0.290	0.218
Coefficient of variation of CPUE (%)	46.0	41.4	51.3	28.1
Standard error of CPUE	0.095	0.064	0.084	0.063
Fishing efficiency ($\overline{FE}$)	0.954		1.874	

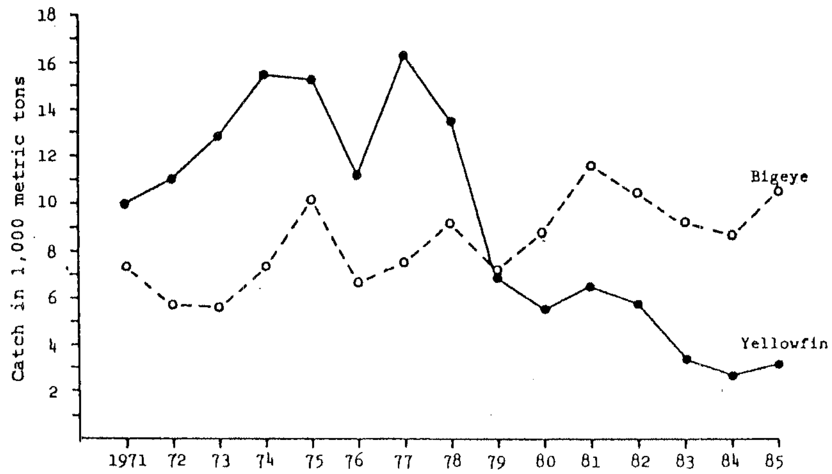

Fig. 1. Nominal catch of yellowfin and bigeye tunas taken by Korean longline fishery in the Atlantic Ocean, 1971-1985.

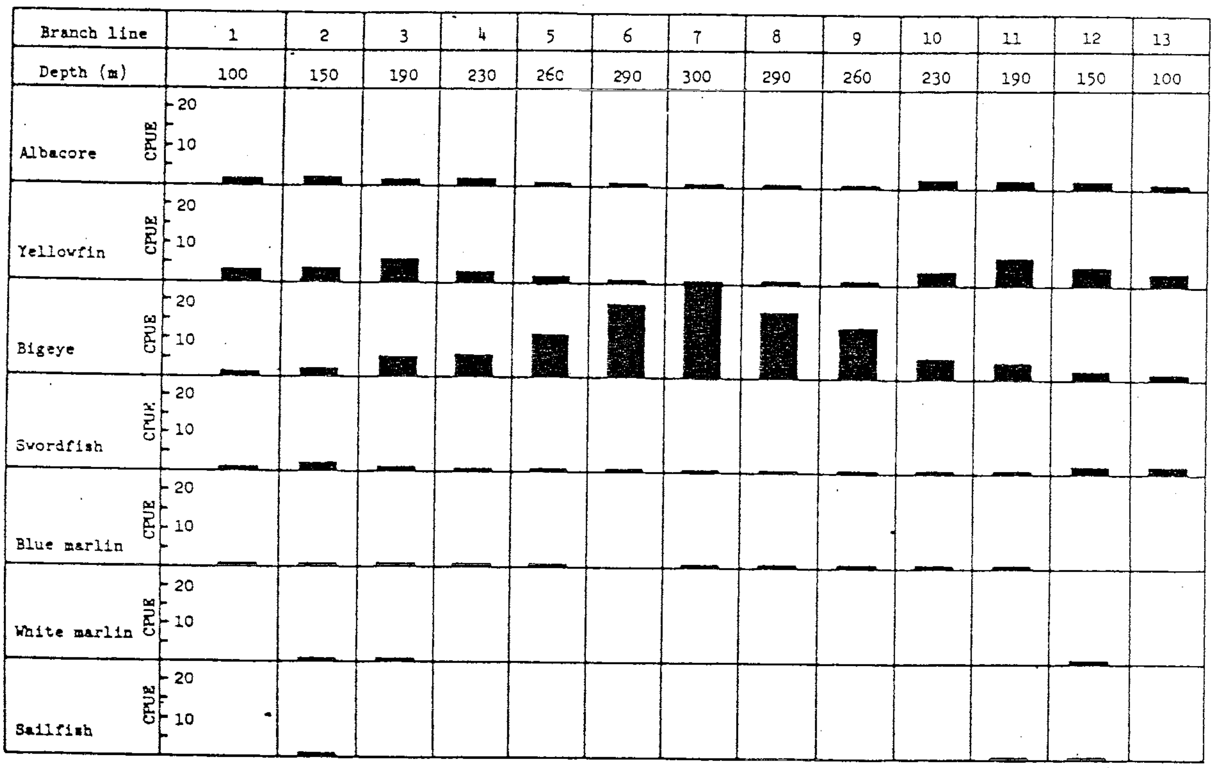

Fig. 4. CPUE (No. of fish per 10,000 hooks) by species and hanging depth of branch lines in 1985.

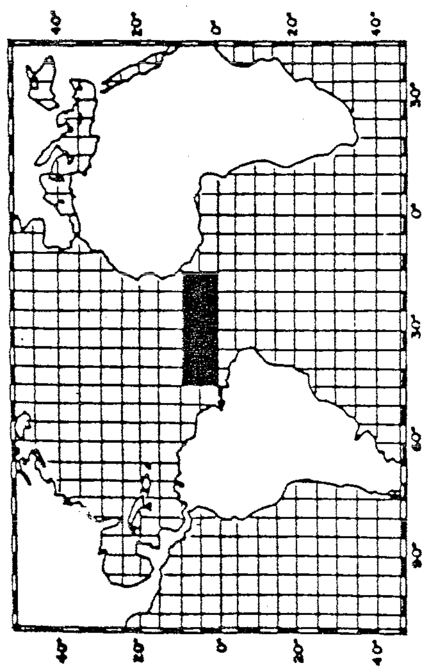

Fig. 2. The area for comparison of gear efficiency between regular and deep longline on yellowfin and bigeye tunas in 1983.

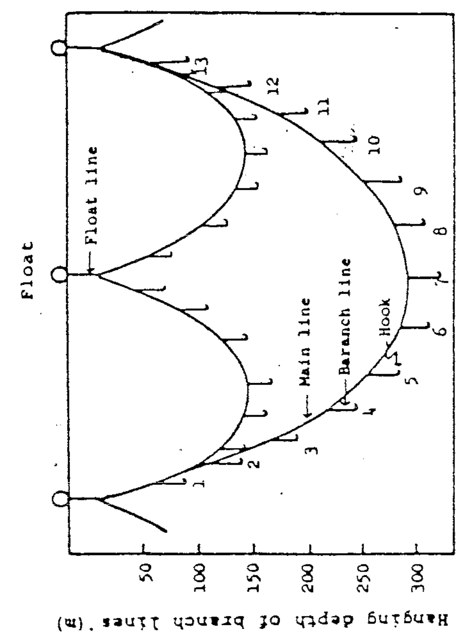

Fig. 3. Gear constructions of regular (above) and deep longlines (below)
The hanging depth of branch lines was calculated by the catenary method of Yoshihara (1951)

$$D_j = H_a + H_b + L\left\{(1+\cot^2\varphi^\circ)^{\frac{1}{2}} - \left(\left(1-2\frac{j}{n+1}\right)^2 + \cot^2\varphi^\circ\right)^{\frac{1}{2}}\right\}$$

* L = 340 m, Ha = 25 m, Hb = 30 m