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AN UPDATED PRODUCTION MODEL ANALYSIS ON ATLANTIC BIGEYE TUNA

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SUMMARY

Production model analysis was conducted for bigeye tuna in whole Atlantic on the basis of CPUE calculated from Japanese longline statistics for the years 1961-1985. The CPUE was estimated by the Honma method with adjustments of deep longline operations. Result of the analysis confirmed the Atlantic bigeye tuna stock has been under high exploitation, but is still in healthy condition in recent years.

RESUME

L'analyse du modèle de production a été effectuée pour le thon obèse de l'Atlantique entier au moyen de la CPUE calculée à partir des statistiques palangrières japonaises pour les années 1961-85. La CPUE a été estimée par la méthode de Honma, en l'ajustant pour les opérations de palangre de profondeur. Les résultats de l'analyse confirment que le stock de thon obèse atlantique a été soumis à une forte exploitation, mais était encore en bon état ces dernières années.

RESUMEN

Se hizo un análisis del modelo de producción para el patudo en todo el Atlántico, partiendo de la CPUE calculada en base a las estadísticas japonesas de palangre de los años 1961 a 1985. La CPUE se estimó aplicando el método Honma, con ajuste de las operaciones de palangre profundo. El resultado del análisis confirmó que el stock atlántico de patudo ha sufrido una fuerte explotación, pero que se encuentra en buen estado.

1. Introduction

Bigeye tuna has been the most important species for the Japanese longline fishery in terms of amount of the catches as well as of the values. Besides, this is an only species with which the Japanese longline fishery has a largest catch share, except a few years, in single gear-country category in the Atlantic. Trend of the Atlantic bigeye catch, categorized by major fishery, which also roughly accounts for the size of the fish taken is shown in Figure 1. The catches by longline and bait boat fisheries in Canary-Azores-Madeira islands represent adult large sized fish mostly bigger than 90 cm while purse seine and other baitboat fisheries capture juvenile small fish less than 90 cm (Cayre et al. 1986). Except the Canary-Azores-Madeira baitboat fishery, both large fish and small fish fisheries appear to have been increasing their catch consistently with respect to time series. Therefore, the impact of the fisheries to bigeye stock must have increased for all sizes of the species. The facts that the Japanese longline fishery dominates in the Atlantic bigeye catches and targets this species over the almost entire areas of the distribution of the species have qualified the use of the Japanese statistics as a base of production model analysis to assess the status of stock of this species. The present study updates the previous one (Kume and Miyabe 1987) covering the period from 1961 to 1985.

2. Materials and Methods

Recent studies (e.g. Pereira and Bard 1986) on tagging results, distribution by size and spawning activities imply the bigeye tuna in the whole Atlantic Ocean forms a unit stock. Therefore, single stock hypothesis was adopted in this report for production model analysis. However, taking into account a possible separated stock hypothesis, trend of CPUE for the Japanese longline divided by north and south Atlantic at 5° N was monitored as before.

Materials and methods used in this study is essentially the same with the previous work (Kume and Miyabe 1987). The procedure used to estimate the total effective effort and catch of the Atlantic bigeye tuna is outlined as follows.

Step 1. The Japanese longline Task II data were used to compute the effective effort of the species, converting the nominal fishing efforts by deep longline operations to those by conventional longline operations on the basis of efficiency and deployment rates described by Kume (1985). Tables 1 and 2 and Figure 2 give the relevant information mentioned in this step.

Step 2. The Japanese nominal fishing effort thus calculated forms a base to compute effective effort by Honma method (Honma 1973). Average year period to obtain average density index by month and 5 degree squares covers the years from 1967 to 1972. The area south of 45 N and north of 40° S was chosen for the computation of the effective effort.

Step 3. The effective effort on bigeye by the Japanese longline fleet was raised to the total effective effort of all fishing gears multiplying the ratio of the total to the Japanese catches (Table 3).

Most of the relevant processed statistics previously described were adopted from the work of Kume and Miyabe (1986) for the years 1961-1984. The present study adds the values for 1985.

Production model analysis (Fox 1975) was conducted by the same procedure as the previous work i.e., four cases of shape parameter m, m=0, 1, 2 and variable, parameter K (number of year classes that mainly contribute to the fishery) equals to 4.

3. Results

CPUE trends

Figure 3 shows bigeye CPUE calculated from the effective fishing effort of the Japanese longline statistics computed by the procedure described in the previous section. Three sets of the CPUE, i.e., for whole, north and south Atlantic Oceans show a similar trend which might be an indication of single stock hypothesis. Despite of the increased catch in the recent years, the CPUE appears stable or even shows slight increasing trend especially for the south Atlantic Ocean due to significantly high value in 1985. Average CPUE for the recent five years from 1981 to 1985 is 73% of that for the early five years from 1961 to 1964.

4. Production model analysis

Addition of the high 1985 CPUE in the analysis resulted in higher MSYs than those estimated in the previous work for all cases of parameter m (Table 4 and Fig. 4). The MSY ranges from 73.6 to 174.6 thousand tons with minor differences in degree of fit index. Since the recent level of the fishing efforts are smaller than the optinum level which gives the MSY, namely, no observations appear in the right hand rim of the production curves, it is difficult to decide which one of the MSYs presently estimated would be most likely. However, it could be concluded that the stock of the Atlantic bigeye tuna is in a healthy condition despite the increased level of the exploitation in the recent year.

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Table 1. Annual rate of deployment of deep longline operation and its gear efficiency factor over conventional longline for 1980-85.

Year		Area 1	Area 2	Area 3	Area 4
1980	Rate(%)	5	41	75	29
	Efficiency	1.35	1.24	1.32	1.22
1981	Rate(%)	25	49	68	22
	Efficiency	1.78	1.51	1.11	1.21
1982	Rate(%)	29	67	85	38
	Efficiency	1.31	1.14	1.19	0.95
1983	Rate(%)	11	68	82	37
	Efficiency	1.75	1.25	1.16	1.07
1984	Rate(%)	10	63	90	50
	Efficiency	1.59	1.58	1.16	0.98
1985	Rate(%)	12	85	95	59
	Efficiency	1.82	1.62	1.17	0.86

Table 2. Catch, effort and CPUE (hook rate) on Atlantic bigeye tuna by the Japanese longline fleet, 1961-85. For 1981-85, deep longline efficiency is adjusted.

Year	Catch in number (1,000)	Yield in weight (1,000 MT)	Effective effort (million)	Hook rate
1961	243.7	11.0	29.8	0.818
1962	367.9	15.7	54.0	0.681
1963	285.3	14.5	47.4	0.602
1964	343.7	17.3	61.1	0.563
1965	648.3	28.5	117.9	0.550
1966	232.1	17.6	48.1	0.483
1967	180.9	8.5	31.5	0.574
1968	204.6	10.3	31.2	0.656
1969	263.6	10.3	38.1	0.692
1970	187.3	9.0	33.5	0.559
1971	394.9	20.3	85.7	0.461
1972	346.0	18.1	79.5	0.435
1973	391.3	20.0	77.1	0.508
1974	457.3	20.9	69.0	0.663
1975	449.1	17.4	113.5	0.396
1976	171.0	7.3	50.6	0.338
1977	189.6	9.2	36.5	0.519
1978	209.2	9.3	48.9	0.428
1979	270.4	12.0	62.1	0.435
1980	451.3	20.5	98.6	0.458
1981	469.0	21.0	127.3	0.368
1982	698.7	32.9	149.1	0.469
1983	351.4	15.1	77.5	0.453
1984	524.3	24.3	107.7	0.487
1985	674.7	31.6	119.2	0.566

Table 3. Input fishery data in the production model analyses for Atlantic bigeye tuna, 1961-85. Deep longline effort was adjusted for 1980-85.

Year	Japan L.L. fishery Yield in weight (1,000 MT)	Japan L.L. fishery Effective effort (million)	Atlantic total Yield in weight (1,000 MT)	Atlantic total Effective effort (million)
1961	11.0	29.8	17.0	46.2
1962	15.7	54.0	23.1	78.9
1963	14.5	47.4	26.0	84.7
1964	17.3	61.1	23.5	83.3
1965	28.5	117.9	39.2	142.5
1966	17.6	48.1	25.0	108.3
1967	8.5	31.5	21.7	87.1
1968	10.3	31.2	23.0	73.3
1969	10.3	38.1	35.4	116.4
1970	9.0	33.5	41.5	151.5
1971	20.3	85.7	54.9	252.8
1972	18.1	79.5	46.3	242.5
1973	20.0	77.1	56.3	277.1
1974	20.9	69.0	63.5	203.5
1975	17.4	113.5	60.6	306.1
1976	7.3	50.6	44.6	280.8
1977	9.2	36.5	54.1	212.7
1978	9.3	48.9	51.7	268.4
1979	12.0	62.1	45.1	235.6
1980	20.5	98.6	62.7	304.2
1981	21.0	127.3	67.1	405.2
1982	32.9	149.1	73.0	331.2
1983	15.1	77.5	62.2	319.3
1984	24.3	107.7	64.7	288.8
1985	31.6	119.2	72.6	273.7

Table 4. Estimated population parameters obtained from production model analyses for Atlantic bigeye tuna, 1961-85.

m (shape parameter)	Degree of fit index	F-optimum (million hooks)	Y-max (1,000 MT)	1981-85 catch (1,000 MT)
variable	0.421	-	174.6	62.2-73.0
0	0.421	-	174.8	
1.001	0.417	737.7	86.6	
2	0.411	473.8	73.6	

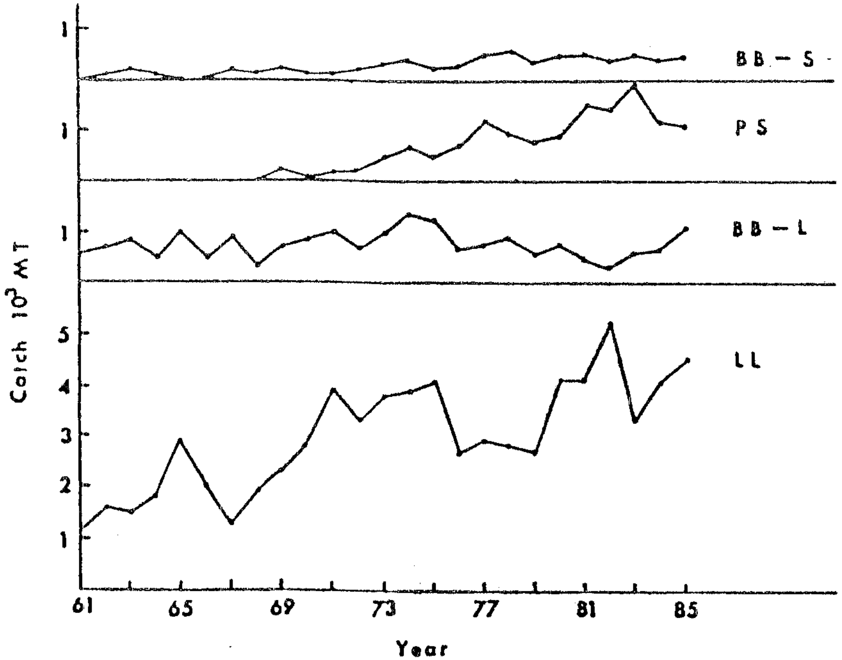

Fig. 1 Bigeye tuna catch in the Atlantic by major fisheries. Data sources are ICCAT 1982, 1985 and 1986.

BB-S : baitboat fishery for small fish.
PS : purse seine fishery.
BB-L : baitboat fishery for large fish.
LL : longline fishery.

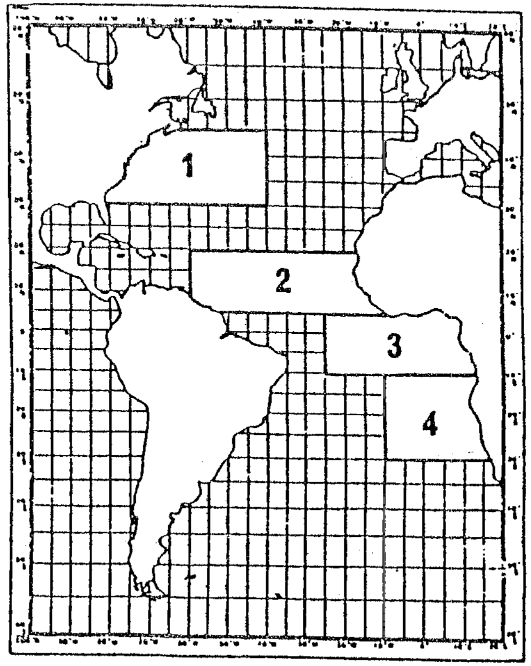

Fig. 2 Area division used for the adjustment of deep longline effort.

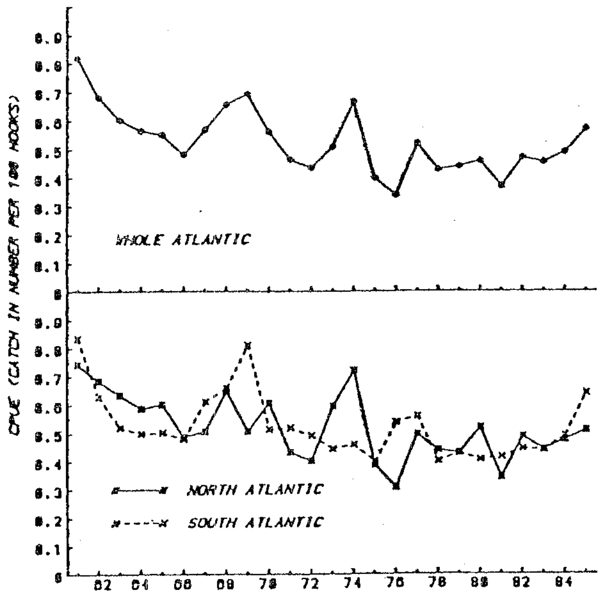

Fig. 3 Trend of annual cpue of bigeye tuna caught by Japanese longline fishery in the whole Atlantic(upper panel) and in the north and south Atlantic(lower panel), 1961-85.

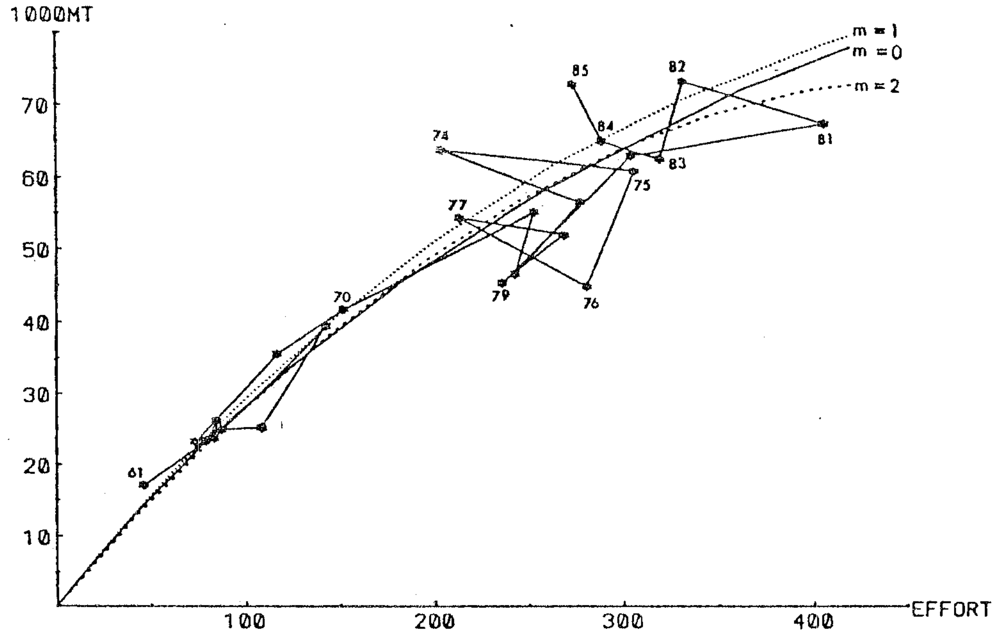

Fig. 4 Yield curves of the production model analysis for bigeye tuna in the whole Atlantic, 1961-85.