PRODUCTION MODEL ANALYSIS ON ATLANTIC BIGEYE TUNA AS OF 1988

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SUMMARY

A production model analysis was conducted for the Atlantic stock of bigeye tuna, on the basis of CPUE from the Japanese longline fishery, for the years 1961-1988. The fishing intensity estimated by the Honma method was adjusted for the deep longline operation, for 1980-88. MSY estimated values are 66,700 MT for m=2 and 74,900 MT for m=1. Results shows that the stock is in a healthy condition and that present catches are below the estimated values of MSY. The model also indicates that current fishing effort is at a level below the estimated F_{opt}.

RESUME

Cet article analyse l'état du stock de patudo atlantique par le modèle global, en utilisant les CPUE de la pêcherie palangrière japonaise pour les années 1961-1988. Des valeurs révisées pour la CPUE de 1974 ont été utilisées. L'intensité de pêche a été estimée par la méthode de Honma en ajustant pour l'utilisation de la palangre profonde, pour la période 1980-88. Les valeurs estimées pour la PME sont de 66.700 TM pour m = 2 et de 74.900 TM pour m = 1. Les résultats montrent que le stock est en bon état et que les prises actuelles sont à un niveau inférieur à ceux estimés pour la PME. L'analyse indique aussi que l'effort de pêche actuel est à un niveau inférieur au Fopt estimé par le modèle.

RESUMEN

Este artículo analiza el estado del stock de patudo atlántico mediante el modelo global, utilizando las CPUE de la pesquería palangrera de Japón para los años 1961-1988. Se han utilizado los valores revisados para la CPUE de 1974. La intensidad de pesca ha sido estimada mediante el método de Honma ajustado a la utilización del palangre profundo, para el período 1980-88. Los valores estimados para el RMS son de 66.700 t para m=2 y de 74.900 t para m=1. Los resultados muestran que el stock se encuentra en buen estado y que las capturas actuales están a un nivel inferior a las estimadas para el RMS. El análisis indica también que el esfuerzo de pesca actual se encuentra a un nivel inferior al Fopt estimado por el modelo.

1. The Atlantic bigeye fishery

Bigeye tuna are widely distributed in the tropical and temperate waters of the Atlantic Ocean, between approximately 45º N and 45º S. Small bigeye have been observed in the only known nursery, wich is located in the Gulf of Guinea

The stock is exploited in the entire area of distribution by different fleets and gears, such as longline, purse seine and baitboats.

The main bigeye fishery is the longline, which operates throughout the year in the entire distribution area. The longline fishery directly targets large fish, and since 1980, Japanese and Korean longliners have targeted bigeye using deep longline and concentrating the effort in the time-area strata where the density of bigeye is high.

Bigeye tuna is also target seasonally by some local baitboat fisheries in the areas of the Azores, Madeira, Canary Islands. These fisheries of the Northeastern Atlantic islands exploit mainly medium and adult bigeye tuna.

Dakar based baitboats, operating off Senagal and Mauritania, also target seasonaly on medium size bigeye.

The eastern tropical surface fleets also catches an important amount of juvenile bigeye tuna, in mixed schools with young yellowfin and skipjack. Those fisheries do not target directly on bigeye tuna, but the catches of small bigeye are important in terms of number of fish.

Figure 1 shows the historical catch series for the Atlantic bigeye tuna stock, from 1960 up to 1988, by major fishing gear. In recent years the catch increased to a maximum of 74.300 MT in 1985, then decreased in the folowing years until 1987. In 1988 the catch level increased up to 56.500 MT. The observed changes in annual catches of bigeye are mainly due to a decline in the longline catch, but a decrease is also observed in surface gears.

2. Materials and methods

It is presently accepted the hypothesis that the bigeye tuna forms a unique stock in the Atlantic Ocean. A study by Pereira and Bard (1985) analyzing the available information on tagging experiments, distribution by areas and sizes and spawning activities has shown evidence to support the present hypothesis; which is adopted in the present study.

The Japanese longline fishery dominates in the Atlantic bigeye catch and targets this species over the entire area of distribution. This facts and the absence of an abundance index from the surface fisheries, qualified the use of Japanese statistics as a base of production model analysis to access the status of stock of this species.

The catch data are taken from the most recent ICCAT statistical publications (ICCAT, 1988) and those available at the ICCAT secretariat. The procedure used to estimate the total effective effort and catch of the Atlantic bigeye tuna is described by Miyabe (1988) and 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 effort of deep longline operation to that of conventional longline operation on the basis of gear efficiency and deployment rate of deep longline, as described by Kume (1985). Tables 1 and 2 and Figures 2 and 3, 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 5º x 5º squares, covers the years from 1967 to 1972. The area south of 45º N and north of 40º S, except Mediterranean was chosen for the whole Atlantic 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 catch to the Japanese catch.

The method described in Step 3, was not used in the calculation of the total Atlantic effort for the year 1974. For this particular year, the cpue value used was an average of those observed in 1973 and 1975. In fact, the 1974 cpue value deduced from the Japanese statistics, appears unrealistic high which induces a bias in the estimation of bigeye abundance. A detailed analysis of bigeye abundance in the period 1973-75 is presented by Pereira (1990).

A production model analysis was conducted using the program "PRODFIT" (Fox, 1975), for four cases of the shape parameter m, m=0 , m=1 , m=2 and m variable . The k parameter, corresponding to the number of year classes that mainly contribute to the fishery, was chosen as 4.

The input data used for Prodfit estimations are listed in table 3.

The present study updates the previous one by Pereira and Miyabe (1990), and covers the period from 1961 to 1988.

3. Results and discussions

3.1. CPUE trends

The annual trend of bigeye CPUE for the Japanese longline fishery, calculated based on standardized effort and catch in number of fish (catch in number per 100 hooks) is shown in figure 4. This longline CPUE is a good index of abundance of the adult stock, since the catch of the longline fishery is composed of medium and large size fish. This trend indicates that the CPUE has been relatively stable in the recent period, with a slightly increasing trend when compared to the period before the introduction of deep longline.

Average CPUE for the last five years period (1984-88) is at 81.8% of the CPUE calculated for the beginning of the fishery, period 1961-1965. The CPUE values shown an increasing trend in the recent years, when compared to the CPUE in previous years.

3.2. Production model analysis

The results of the adjustment of the model to the input data, for each case of the m parameter are given in table 4 and in figure 5.

The MSY estimated values, depending on the value of the m parameter, are 66700 MT for m=2, 74.900 MT for m=1 and 140.000MT for m= 0. The optimum effort levels estimated for each case range from 385 to 563 millions hooks, for m=2 and m=1 respectively. The estimated values for Fopt are higher than those observed in the recent period. This has been the case in previous analysis, where the current fishing effort has been at a level lower than the optimal estimated by production model analysis.

The observed total catches of bigeye tuna in the Atlantic have decreased since 1986, mainly due to a decline in the longline effort, and the MSY estimated values indicates that the present catches are at a level below the lowest estimation of the MSY.

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YEAR		AREA 1	2	3	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
1986	Rate (%)	8	91	96	35
	Efficiency	3.11	1.53	1.72	1.38
1987	Rate (%)	14	93	98	40
	Efficiency	1.59	1.27	1.48	0.89
1988	Rate (%)	8	96	96	64
	Efficiency	1.47	1.76	1.11	0.84

Table 1. Annual deployment rate of deep longline operation and gear efficiency factor over conventional longline for 1980-88.

Year	Catch in number (1,000)	Yield in weight (1,000 MT)	Effective effort (million)	Hook rate
1961	243.7	11.0	27.3	0.892
1962	367.9	15.7	51.7	0.712
1963	285.3	14.5	45.8	0.623
1964	343.7	17.3	58.0	0.593
1965	648.3	28.5	113.8	0.570
1966	232.1	17.6	46.8	0.496
1967	180.9	8.5	30.5	0.593
1968	204.6	10.3	30.0	0.682
1969	263.3	10.3	36.8	0.717
1970	187.3	9.0	32.4	0.578
1971	394.9	20.3	83.0	0.476
1972	346.0	18.1	77.6	0.446
1973	391.3	20.0	74.7	0.524
1974	457.4	20.9	66.9	0.683
1975	449.1	17.4	110.4	0.407
1976	171.0	7.3	49.2	0.348
1977	190.0	9.2	35.2	0.540
1978	209.2	9.3	47.3	0.442
1979	270.4	12.0	62.2	0.435
1980	451.7	20.5	101.4	0.446
1981	469.2	21.0	130.8	0.359
1982	699.8	32.9	144.0	0.486
1983	351.6	15.1	77.7	0.452
1984	524.3	24.3	108.3	0.484
1985	674.8	31.6	119.4	0.565
1986	499.3	22.8	115.4	0.433
1987	404.5	18.6	73.4	0.547
1988	681.0	31.7	107.9	0.631

Table 2. Catch, effort and CPUE on Atlantic bigeye tuna by the japanese longline fleet, 1961 - 1988. For 1980-88, deep longline efficiency was adjusted.

Year	Yield in weight (1,000 MT)	Effective effort (million)	CPUE
1961	17.0	46.2	0.368
1962	23.1	76.1	0.304
1963	26.0	82.1	0.317
1964	23.5	78.8	0.298
1965	39.2	156.5	0.250
1966	25.0	66.5	0.376
1967	24.7	88.6	0.279
1968	23.0	67.0	0.343
1969	35.7	126.5	0.282
1970	41.3	149.4	0.276
1971	55.0	224.5	0.245
1972	46.4	198.9	0.233
1973	56.4	210.7	0.268
1974	63.6	299.1	0.213
1975	60.7	385.1	0.158
1976	44.6	300.6	0.148
1977	54.1	207.2	0.261
1978	51.7	262.9	0.197
1979	45.1	233.8	0.193
1980	62.7	310.1	0.202
1981	67.1	417.9	0.161
1982	72.9	319.1	0.228
1983	58.4	300.5	0.194
1984	68.8	306.6	0.224
1985	74.3	280.7	0.265
1986	58.7	297.1	0.198
1987	47.1	185.9	0.253
1988	56.5	192.2	0.294

Table 3. Catch, effort and CPUE on bigeye tuna for the entire Atlantic Ocean, 1961 - 1988.

m	Degree of fit index	Y - max 1000 MT	F-optimum million hooks	1983-88 catch (1000 MT)
variable (m=0.89)	.5611	75.4	591.0	
0	.5598	140.0	--	
1	.5609	74.9	563.6	47.1- 74.3
2	.5595	66.7	667.6	

Table 4. Estimated population parameters obtained from production model analysis for Atlantic bigeye tuna, 1961-88.

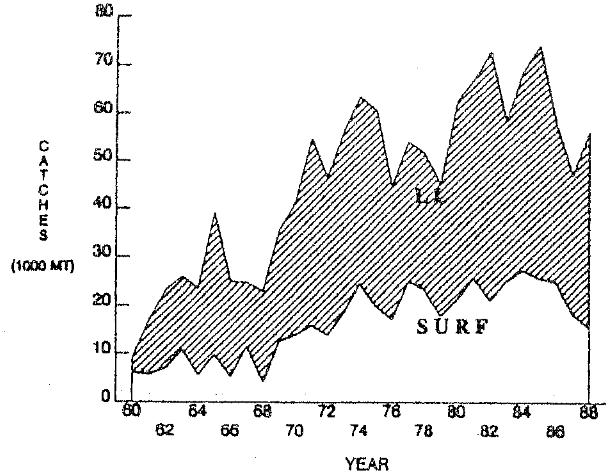

Figure 1. Atlantic bigeye tuna catches (cumulative), by surface and longline gears, 1960 - 88.

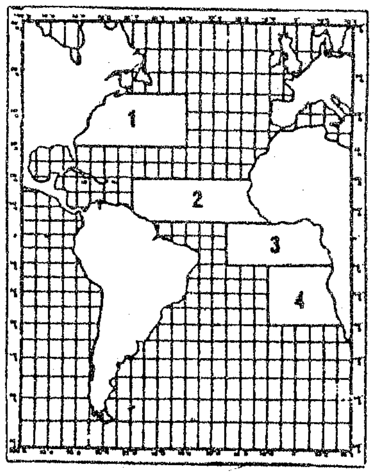

Figure 2. Area division used for the adjustment of deep longline effort.

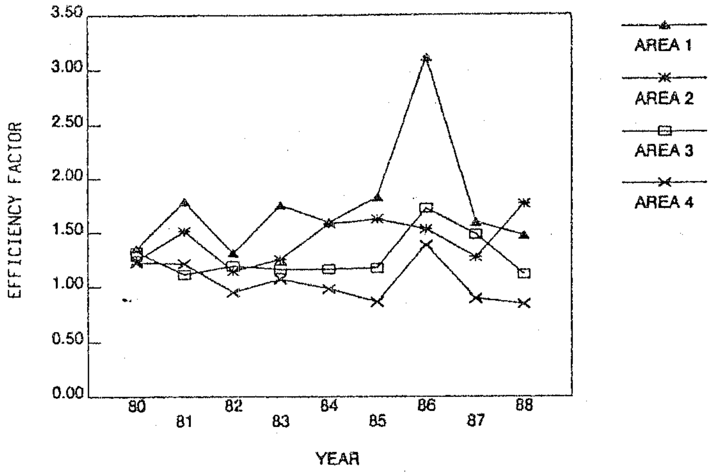

Figure 3. Efficiency factor of deep longline operation over conventional longline, in 1980-1988, in the four areas used for the adjustment of deep longline.

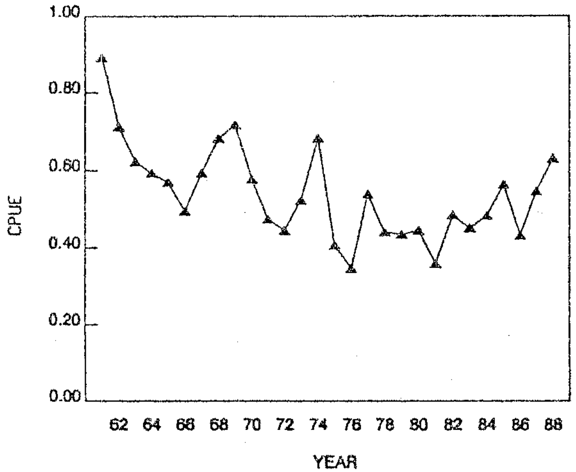

Figure 4. Trend of annual CPUE of bigeye tuna caugth by japanese longline fishery in the Atlantic Ocean, 1961-88.

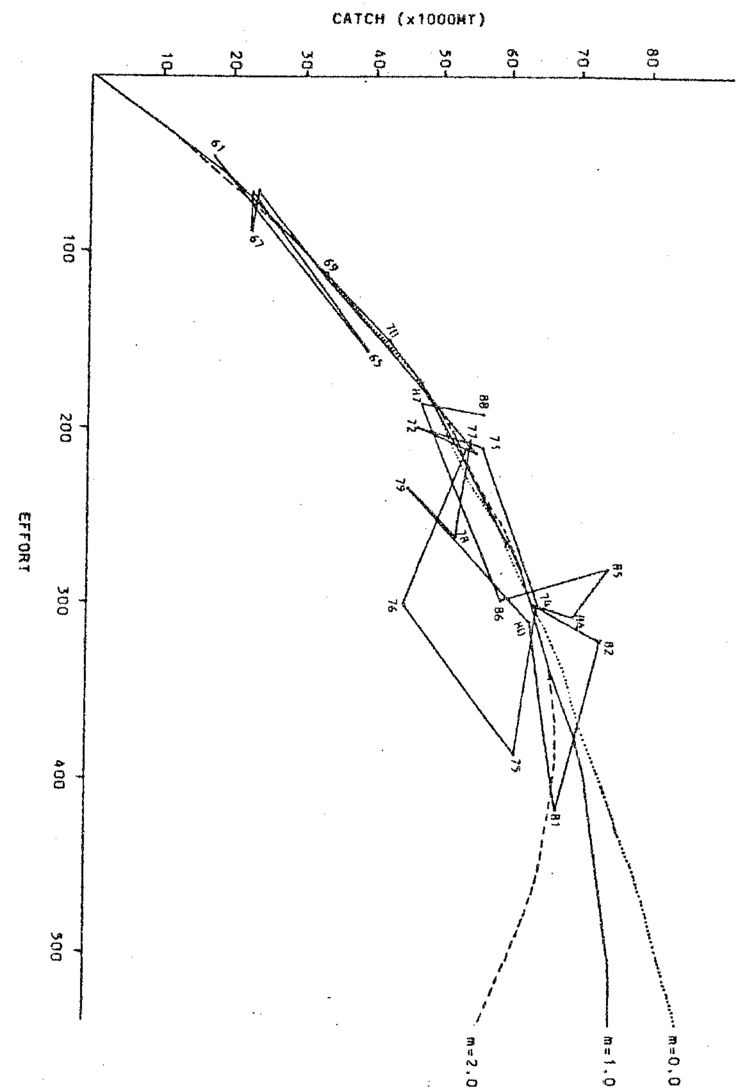

Figure 5. Yield curves of the production model analysis for bigeye in the whole Atlantic, 1961-88.