Col.Vol.Sci.Pap. ICCAT, 23 (2): 248-253 (1985)

AN ANALYSIS ON THE STOCK ABUNDANCE OF ATLANTIC BIGEYE TUNA CAUGHT BY JAPANESE LONGLINE FISHERY

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SUMMARY

The recently developing deep longline operation exhibits different gear efficiency, especially for catching bigeye tuna, from conventional longlining. To obtain the overall fishing effort, standardization of effort was conducted for catch and effort data of the Japanese longline fishery in the Atlantic, 1980-82. Using resultant effort data and calculating the CPUE as an index of abundance, it is shown that the recent level of the adult bigeye stock could be regarded at 60-65 percent of the initial exploitation. In addition, a change in relative abundance of the age group of bigeye tuna caught by Japanese longline fishery, 1975-82 was examined. It is unlikely that there has been any trend in the relative abundance in the major age groups (ages 4-6) of the catch.

RESUME

La palangre de profondeur qui s'est développée récemment diffère de la palangre conventionnelle en ce qui concerne le degré d'efficacité, surtout pour la capture du thon obèse. Pour calculer l'effort de pêche global, une standardisation de l'effort a été effectuée sur les données de capture et d'effort des palangriers japonais dans l'Atlantique pour les années 1980-82. Les données d'effort qui en résultent et la CPUE calculée comme indice de l'abondance permettent d'observer que le niveau récent du stock adulte de thon obèse peut être estimé à 60-65 % de celui du début de l'exploitation. En outre, un changement a été noté dans l'abondance relative du groupe d'âge de thon obèse capturé par les palangriers japonais en 1975-82. Il est peu probable qu'il y ait eu une tendance quelconque dans l'abondance relative des groupes plus âgés dans la prise, ceux d'âge 4-6.

RESUMEN

El reciente desarrollo de las operaciones de palangre profundo muestra una distintas eficacia de los artes de pesca, especialmente para la pesca del patudo, con respecto al palangre convencional. Para obtener el esfuerzo de pesca total, se llevó a cabo estandarización del esfuerzo de los datos de captura y esfuerzo de la pesquería japonesa de palangre en el Atlántico, 1980-82. Utilizando los datos de esfuerzo resultantes y calculando la CPUE como índice de abundancia, se muestra que el nivel reciente de la población de patudo adulto podría considerarse a 60-65% de la explotación inicial. Además, se estudió un cambio de la abundancia relativa del grupo de edad del patudo capturado por la pesquería japonesa de palangre, 1975-82. Es improbable que haya existido alguna tendencia en la abundancia relativa, en los grupos de mayor edad de la captura, edades 4-6.

1. Introduction

The longline catch of bigeye tuna in the Atlantic has constituted major portion of the total Atlantic bigeye catch, being more than 62 % during the past decade. The bigeye catch by Japanese longline fishery has been predominant in the total longline catch, and its fisheries data have been used as basic data base for assessment of the stock status (e.g. Kume 1984).

Deep longline operation directing to the catch of bigeye tuna has become prevailing in the Atlantic Japanese fleet since 1980. A biological background for adoption of such operation was explained referring to the instances in the Pacific and Indian Oceans (Suzuki and Kume 1982). To estimate cpue as an index of abundance of the stock, its specific gear efficiency should be taken into account, with respect to obtaining amount of effort as standardized. In addition, examined is a change in age structure of the Japanese longline catch.

2. Standardization of effort

Deep longline operation (DL) can be differentiated from conventional or regular longline operation (CL) by the number of hooks per basket, being more than 10 hooks and 5-7 hooks, respectively. By employing more hooks per basket, hooks can attain in the deeper layer, where bigeye tuna, deeper swimmer than other tunas in general, could be caught more efficiently.

From 1977 on, all original logbook sheets of Japanese longline fishery were investigated as to the number of basket used, by which number of hooks used was calculated. DL is defined as an operation with more than 10 hooks per basket in this study. In Table 1, annual deployment of DL is shown by main bigeye fishing grounds (Fig. 1) for 1978-82. It is noted that overall deployment of DL of the Japanese fleet in the Atlantic has become noticeable in increasing trend since 1980, and that DL is more prevailing in tropical waters, such as areas 2 and 3 in Fig. 1. The same spatial pattern of DL deployment was also observed in the Pacific and Indian Oceans, reflecting ecological feature in the vertical distribution of bigeye tuna as explained by Suzuki and Kume op. cit.

Nominal hook rates, in terms of catch in number per 100 hooks, were calculated for both DL and CL catch and effort data, by main bigeye fishing grounds for the years 1980-82. Amount of effort invested in 1-4 areas accounted for more than 80 % of the total longline effort in the area covering all bigeye distribution. It is observed in expectation that DL is more efficient than CL for catching bigeye tuna as being indicated by higher hook rates of DL over those of CL, except in the area 4 in 1982 (Table 2). A factor of gear efficiency between DL and CL was calculated as a ratio of a hook rate of DL against that of CL (F in Table 2), to adjust DL effort into CL effort. Using F-factors (Table 2) and deployment rates (Table 1), effort data in the main bigeye fishing grounds for 1980-82 were re-calculated as standardized in terms of CL effort. After this treatment, estimation of overall effective effort was made using a method developed by Honma (1973). The resultant estimated effort statistics and cpue are shown in Table 3.

3. Trend in cpue of the longline fishery

As mentioned above, since the Japanese longline fishery has been covering almost entire bigeye distribution and the share of the catch has been large, its cpue based on standardized effective effort is representative of relative abundance of the stock. The annual changes in cpue for the whole Atlantic and for the north and south Atlantic for the years 1961 through 1982 are shown in Fig. 2. Since 1961 when the longline fishery expanded substantially over the range of the bigeye distribution, the cpue in three areas has been decreasing gradually in the same fashion, although there is a difference in a peak year of the cpue between north and south Atlantic during 1965-75. The level of the cpues in recent years has been rather stable but declined at about 60-65 % of the initial exploitation (0.70 for 1961-63 average and 0.43 for 1980-82 average in the case of whole Atlantic). It is considered that this relative abundance is indicative of the recent level of adult or spawning stock, because the longline catch has been composed of medium- and large- sized individuals as shown in the next section.

4. Change in age structure of the longline catch

Since on-board size sampling scheme has been initiated by the Japanese longline fleet in 1975, amount of sampling increased greatly. In the case of bigeye tuna, as indicated in Fig. 3, annual number of fish measured ranged from 26,000 to 60,000, accounting for 5.6-21.7 % of the fish caught, during 1975-82. Using the growth equation (Cayre and Diouf 1984), these size data were transformed into age data. Then summarized annual age frequencies were converted into index of abundance by multiplying with the cpue in Table 3 (Fig. 3). During the period, the most predominant age group has been age 4 or 5, being followed by age 6. Although the relative abundance of age group among ages 4-6 has changed year-to-year, it is unlikely that there has been any trend in the relative abundance.

References

Cayre, P. and T. Diouf 1984: Croissance du thon obese (Thunnus obesus) de l'Atlantique d'apres les resultate de marquage. Col. Vol. Sci. Pap., Vol. XX(1), 180-187.

Honma, M. 1973: Overall fishing intensity and catch by length class of yellowfin tuna in Japanese Atlantic longline fishery, 1956-1971. Col. Vol. Sci. Pap., Vol. I, 59-77.

Kume, S. 1984: On the stock status of Atlantic bigeye tuna evaluated by production model analysis. Col. Vol. Sci. Pap., Vol. XX(1),192-200.

Suzuki, Z. and S. Kume 1982: Fishing efficiency of deep longline for bigeye tuna in the Atlantic as inferred from the operations in the Pacific and Indian Oceans. Col. Vol. Sci. Pap., Vol. XVII(2), 471-486.

Table 1 Annual rate of deployment of deep longline operation, expressed in 1,000 hooks, in the Atlantic Japanese longline fleet, 1977-82.

Year		Fishing area 1	2	3	4	Others	Total
1982	Total	6,804	17,069	18,648	7,799	5,879	56,199
	DL	1,963	11,489	15,889	2,936	436	32,713
	%	28.9	67.3	85.2	37.6	7.4	58.2
1981	Total	18,792	8,712	6,017	5,864	9,881	49,266
	DL	4,776	4,238	4,062	1,261	165	14,502
	%	25.4	48.6	67.5	21.5	1.7	29.4
1980	Total	12,348	6,670	7,635	5,316	6,538	38,507
	DL	663	2,726	5,735	1,533	116	10,773
	%	5.4	40.9	75.1	28.8	1.8	28.0
1979	Total	10,544	1,751	4,143	5,936	7,170	29,544
	DL	0	727	99	12	0	838
	%	0	41.5	2.4	0.2	0	2.8
1978	Total	6,563	3,355	125	5,032	6,321	21,396
	DL	74	157	0	0	421	652
	%	1.1	4.7	0	0	6.7	3.0
1977		--- No deep longline operation reported ---					

* Fishing area designation is given in Fig. 1.
** DL is deep longline operation which employed more than 10 branch lines per basket.

Table 2 Comparison of gear efficiency between conventional longline (CL) and deep longline (DL) of the Japanese longline fleet in the main bigeye fishing grounds, 1980-82.

Year		Fishing area 1 CL	1 DL	2 CL	2 DL	3 CL	3 DL	4 CL	4 DL
1982	Hook rate	0.59	0.77	1.15	1.31	1.07	1.27	1.04	0.99
	F	1.31		1.14		1.19		0.95	
1981	Hook rate	0.46	0.82	0.97	1.46	1.31	1.46	1.11	1.34
	F	1.78		1.51		1.11		1.21	
1980	Hook rate	0.81	1.09	1.43	1.77	0.91	1.20	0.98	1.20
	F	1.35		1.24		1.32		1.22	

* F is a factor of DL efficiency against CL.

Table 3. Catch, effective effort and CPUE (hook rate) on Atlantic bigeye tuna by the Japanese longline fleet, 1961-82. For the data 1980-82, deep longline efficiency is adjusted.

WHOLE ATLANTIC

YEAR	CATCH IN NUMBER (1000)	YIELD IN WEIGHT (1000 MT)	EFFECTIVE HOOKS (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	64.4	0.420
1980	451.3	20.5	99.6	0.453
1981	469.0	21.0	125.4	0.374
1982	698.7	32.9	151.8	0.460

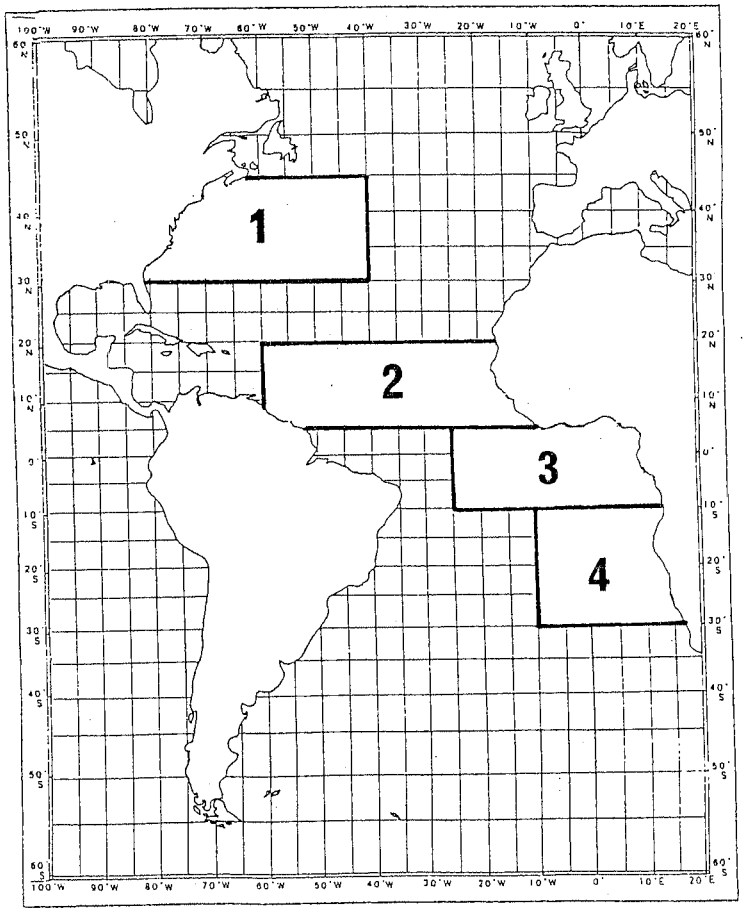
NORTH ATLANTIC

YEAR	CATCH IN NUMBER (1000)	YIELD IN WEIGHT (1000 MT)	EFFECTIVE HOOKS (MILLION)	HOOK RATE
1961	67.6	3.1	9.1	0.743
1962	199.1	8.5	29.1	0.684
1963	166.0	8.4	26.2	0.634
1964	219.2	10.9	37.4	0.586
1965	339.1	14.7	56.5	0.600
1966	121.6	8.8	25.0	0.486
1967	75.3	3.4	14.9	0.505
1968	86.1	4.0	13.3	0.647
1969	65.2	2.4	12.9	0.505
1970	103.9	4.7	17.2	0.604
1971	258.5	13.1	60.0	0.431
1972	227.8	11.8	56.9	0.400
1973	219.4	11.1	37.0	0.593
1974	388.9	17.6	54.0	0.720
1975	320.0	12.4	83.0	0.386
1976	137.2	5.9	44.7	0.307
1977	107.5	5.3	21.7	0.495
1978	126.8	5.8	28.8	0.440
1979	127.4	5.1	30.9	0.412
1980	268.2	11.1	51.8	0.518
1981	275.5	11.4	77.9	0.354
1982	342.1	14.7	70.7	0.484

SOUTH ATLANTIC

YEAR	CATCH IN NUMBER (1000)	YIELD IN WEIGHT (1000 MT)	EFFECTIVE HOOKS (MILLION)	HOOK RATE
1961	176.0	8.0	21.1	0.834
1962	168.8	7.2	26.9	0.628
1963	119.3	6.1	23.0	0.519
1964	124.6	6.4	25.0	0.498
1965	309.2	13.9	61.6	0.502
1966	110.5	8.8	23.0	0.480
1967	105.6	5.2	17.3	0.610
1968	118.5	6.2	18.0	0.658
1969	198.4	7.9	24.5	0.810
1970	83.4	4.3	16.3	0.512
1971	136.5	7.1	26.4	0.517
1972	118.2	6.3	24.1	0.490
1973	171.9	8.8	38.7	0.444
1974	68.4	3.2	14.9	0.459
1975	129.0	5.0	32.4	0.398
1976	33.8	1.4	6.3	0.537
1977	82.2	3.8	14.7	0.559
1978	82.5	3.5	20.5	0.402
1979	143.0	6.8	34.3	0.417
1980	183.1	9.4	46.1	0.397
1981	193.5	9.6	47.4	0.408
1982	356.6	18.2	82.7	0.431

Table 3. cont.



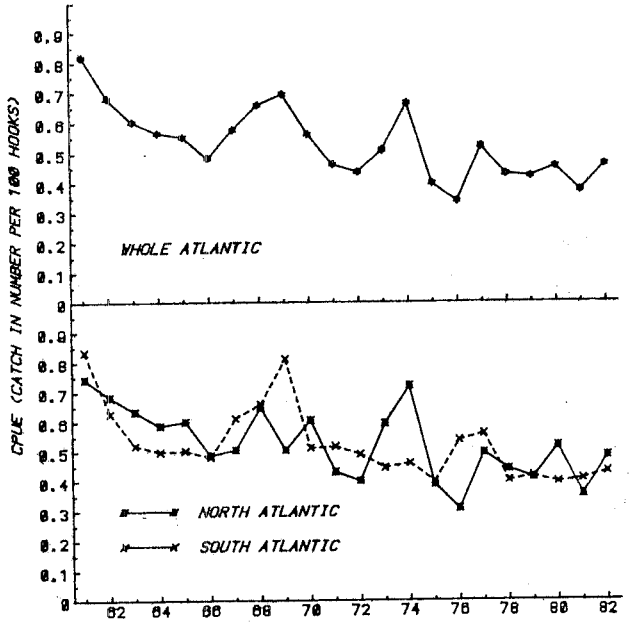


Figure 1 Designation of bigeye fishing grounds of Japanese longline fishery in the Atlantic.

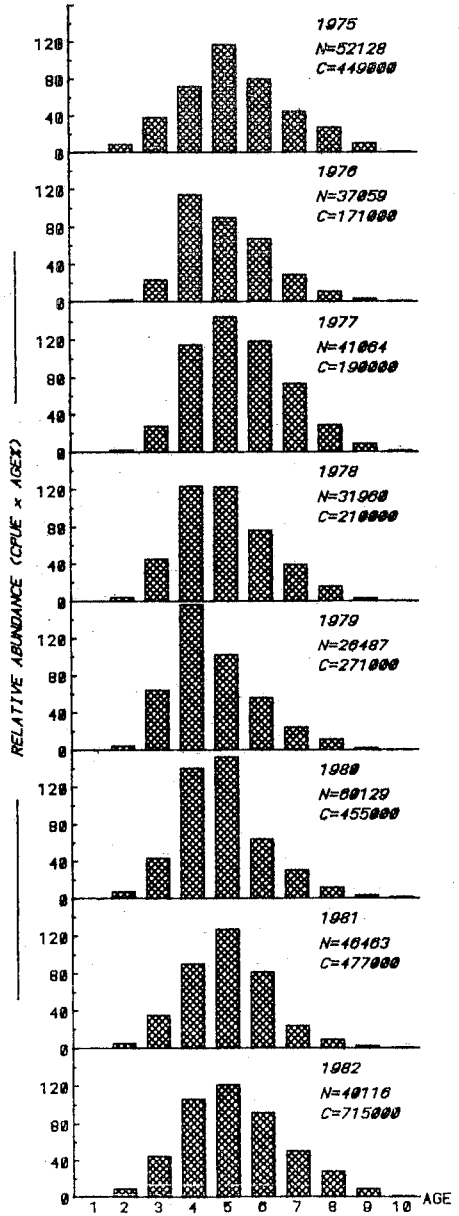


Figure 3 Annual change in relative abundance by age in the Japanese longline catch, 1975-82.
N=number of fish measured.
C=number of fish caught.