

OVERALL FISHING INTENSITY OF ATLANTIC LONGLINE FISHERY
FOR BIGEYE TUNA, 1956-77

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SUMMARY

The purpose of this study is to estimate the effective effort and fishing intensity on bigeye tuna exploited by the Atlantic longline fishery up to 1977. The standardization of effort was done by following Honma's method (1973) for the Japanese and Taiwanese catch and effort data and then extrapolated to the whole longline fishery. The calculation was done for three cases of the stock structure; the entire Atlantic and North and South Atlantic. The 1977 hook rates of the longline fishery continued to indicate recent low values, but recovered to some extent compared to those in 1976 for all cases.

RESUME

Le but de cette étude est d'estimer l'effort effectif et l'intensité de pêche portant sur le thon obèse exploité par la pêche palangrière de l'Atlantique jusqu'en 1977. La standardisation de l'effort a tout d'abord été effectuée en suivant la méthode de Honma (1973) pour ce qui est des données japonaises et de Taiwan de prises et effort, et a ensuite été étendue à

toute la pêche palangrière. Le calcul a été fait pour trois hypothèses de structure des stocks: Atlantique entier, Atlantique nord et Atlantique sud. En 1977, le taux par hameçon de la pêche palangrière est demeuré médiocre en 1977, tout en montrant une amélioration par rapport à 1976.

RESUMEN

El propósito de este estudio, es estimar el esfuerzo efectivo y la intensidad de pesca del patudo explotado por la pesquería de palangre en el Atlántico hasta 1977. La normalización del esfuerzo fue hecho siguiendo el método de Honma (1973) para los datos de captura y esfuerzo de Japón y Taiwan y posteriormente se amplió al conjunto de la pesquería de palangre. El cómputo fue llevado a cabo para tres casos de estructura del stock; conjunto del Atlántico y Norte y Sur. En 1977 las tasas de anzuelos de la pesquería de palangre continuó indicando un valor bajo, pero se recuperaron en todos los casos, si se compara con los de 1976.

1. Longline fishery for bigeye tuna in the Atlantic in 1977.

According to the catch statistics by country (ICCAT 1978), nine nations participated in catching bigeye tuna by longline fishery. The total longline catch increased by less than 10 % from 26 thousand tons in 1976 to 28 thousand tons in 1977. Two thirds of the catch were taken by Japan and Korea (with Panama) the former of which exceeded by about 650 tons, and then USSR, Taiwan and Cuba follow them in descending order of the catch. In recent years, Japanese and Taiwanese fleet are taking more bigeye tuna in temperate waters than in tropical waters, whereas catches of Korean and Cuban fleet are centered in low latitudes (Kume 1979).

2. North-south separation of catch data.

It was suggested by Kume and Morita (1977) that there is a possibility of two separate stocks in the Atlantic, north and south. The whole Atlantic bigeye catch in 1977 was partitioned into two general areas: north Atlantic (ICCAT areas 41-44, 49 and 50) and south Atlantic (ICCAT areas 44-48), using ICCAT summarized Task II data (ICCAT 1979). Historical N-S separated catch data are tabulated in Table 1.

3. Estimation of effective effort and fishing intensity.

In general, fishing effort invested on the area of higher density will be more effective in the catchability than that invested on the area of lower density. If the density of the fish in certain small unit area (eg. 5° square) is the same as the average density of the fishable stock, the unit of effort invested on such area will take constant rate (q) of amount from the stock. When the density of i -th area is r_i times as much as the average density, the catchability in i -th area will become the product of r_i multiplied by q . Thus nominal fishing effort invested on i -th area (h_i) will take the amount of fish of $h_i \times q \times r_i$ from the fishable stock, and $h_i \times r_i$ is defined as effective effort. Since the longline fishery is a multi-species gear and it changes its main target species from one to another, this procedure is also operational to eliminating the effect of the concentration on other species. Details of the technique for calculation was explained by Honma (1973). The average density distribution for the calculation in this report was taken from eleven years' data of Japanese longline fishery from 1965 to 1975, during which years bigeye fishing ground was totally covered by the fishery. Japanese and

Taiwanese catch and effort data, for which historical catch-effort data are available, were processed up to 1977 data.

The annual fishing intensity defined here is the summation of monthly fishing intensity in terms of effective hooks per 5° square which is obtained by taking into account of the monthly change of the range of population area. The overall fishing intensity was calculated first on Basic Data, which are the combined data of Japanese and Taiwanese fleet, and then fishing intensity on whole longline fleet was estimated by extrapolating by the ratio of catch of Basic Data to the catch of whole longline fleet. The results including effective effort are tabulated in Tables 2-4 for three stock units.

3. Hook rate and catch-effort relation.

In the case of whole Atlantic unit, the annual hook rate was the highest in 1961 when longline fishery covered nearly entire bigeye distribution. Since then, the hook rate has been on the decreasing trend and recorded the lowest in 1976, but it recovered upward a little in 1977 (Fig. 1). The average hook rate of recent three years is approximately one half of that during 1961-63 when the hook rates were highest. Both hook rates in north and south Atlantic indicate almost similar decreasing trend on a long term basis (Figs. 2 and 3). Recent levels of hook rate in both areas are about a half of the early 1960's, showing higher values in the southern area. It is also pointed out that since 1972 hook rates of southern area have been stable but those of northern area fluctuated with the highest in 1974 and the lowest in 1976.

In Figs. 4-6, shown are relations between catch and effort of bigeye tuna for entire Atlantic and north and south sub-areas. In all cases, fishing intensities in 1977 decreased and the catch-effort relationship appears to approaching to the 1971-73 situation.

References.

- Honma, M. 1973 Overall fishing intensity and catch by length class of yellowfin tuna in Japanese Atlantic longline fishery, 1961-1971. Col. Vol. Sci. Pap., Vol. 1: 59-77.
- ICCAT 1978 Statistical Bulletin, Vol. 8 - 1977 (FINAL).
- ICCAT 1979 Data Record, Vol. 12.
- Kume, S. and Y. Morita 1977 On the stock structure of bigeye tuna in the Atlantic Ocean. Col. Vol. Sci. Pap., Vol. VI (SCRS-1976): 149-155.

Kume, S. 1979 Overall fishing intensity of Atlantic longline fishery for bigeye tuna, 1956-76. Col. Vol. Sci. Pap., Vol. VIII (SCRS-1978):230-235.

Table 1. Catch statistics of Atlantic bigeye tuna caught by longline fishery by north and south Atlantic and by country, 1957-77 (mt).

Year	North Atlantic					South Atlantic					Whole Atlantic		
	Japan	Taiwan	Korea-Panama	Cuba	Venezuela	Japan	Taiwan	Korea-Panama	Cuba	Argen-Brazil line	USSR	Total-1	Total-2
1957	381	-	-	-	-	381	73	-	-	-	-	73	454
1958	399	-	-	-	-	399	54	-	-	-	-	54	453
1959	1,316	-	-	-	-	1,316	162	-	-	-	-	162	1,478
1960	2,061	-	-	-	-	2,061	843	-	-	100	-	943	3,004
1961	3,065	-	-	-	-	3,065	7,979	-	-	200	-	8,179	11,235
1962	8,506	3	-	-	-	8,509	7,214	15	-	200	-	7,429	15,938
1963	8,430	6	-	-	-	8,436	6,060	35	-	200	-	6,295	14,731
1964	10,904	6	-	-	-	10,910	6,432	35	-	200	-	6,667	17,577
1965	14,669	-	-	-	-	14,669	13,869	-	-	400	-	14,269	28,938
1966	8,753	80	72	-	-	8,913	8,023	507	217	-	-	9,747	18,660
1967	3,394	330	80	-	-	3,804	5,155	1,901	240	-	100	7,396	11,200
1968	4,042	1,529	66	-	-	5,637	6,244	3,815	197	-	300	10,556	16,193
1969	2,402	2,969	464	-	-	5,835	7,864	4,514	1,393	-	200	13,971	19,806
1970	4,703	5,127	1,183	-	-	11,003	4,290	2,438	3,549	-	100	10,377	21,380
1971	13,149	2,365	1,838	1,248	-	18,600	7,109	3,114	5,515	1,952	-	17,690	36,290
1972	11,763	792	1,449	780	-	14,784	6,315	4,198	4,345	1,220	-	16,078	30,862
1973	11,113	1,270	5,706	1,014	-	19,101	8,841	2,548	2,809	1,586	25	15,877	34,978
1974	17,440	1,107	5,868	936	-	25,510	3,222	1,990	3,300	1,464	17	10,168	35,678
1975	12,376	1,474	8,504	741	-	23,095	5,015	2,476	3,645	1,159	100	12,524	35,619
1976	5,940	360	5,003	788	21	12,032	1,438	2,914	3,627	512	176	161,490	13,735
1977	5,301	300	4,368	1,350	875	14,194	3,836	2,678	2,123	450	84	333,406	13,390

* Total-1 is North and South combined.
 ** Total-2 is from the Table provided by ICCAT Secretariat as of September 1979.

Table 2. Catch, effective effort and fishing intensity on bigeye tuna caught by the longline fleet in the whole Atlantic Ocean, 1956-77.

Year	Basic data (Japan and Taiwan combined)					Whole longline fleet			
	Catch in number (10 ³) (A)	Yield in weight (10 ³ MT) (B)	Effective hooks (10 ⁵) (C)	Intensity per 5x5 square (10 ³ hooks) (D)	Hook rate 100 x(A)/(C) (E)	Yield in weight (10 ³ MT) (F)	Effective hooks (10 ⁵) (G)	Intensity per 5x5 square (10 ³ hooks) (H)	Hook rate 100 x(F)/(G) (I)
1956	0.2	0.0	0.1	0.5	0.228	0.0	0.1	0.5	0.5
1957	8.7	0.5	2.7	17.5	0.320	0.5	2.7	17.5	0.5
1958	14.8	0.5	5.9	38.2	0.251	0.5	5.9	38.2	0.5
1959	44.8	1.5	11.4	74.0	0.394	1.5	11.4	74.0	0.5
1960	70.6	2.9	15.5	102.3	0.454	3.0	16.0	105.8	0.5
1961	243.7	11.0	29.8	196.2	0.818	11.2	30.7	199.8	0.5
1962	367.9	15.7	54.0	357.3	0.682	15.9	54.7	361.9	0.5
1963	285.3	14.5	47.4	316.3	0.602	14.7	48.1	320.7	0.5
1964	343.7	17.3	61.1	406.0	0.563	17.6	62.2	413.0	0.5
1965	648.3	28.5	117.9	787.8	0.550	28.9	119.6	790.9	0.5
1966	232.1	17.6	48.1	323.9	0.482	18.7	51.1	344.1	0.5
1967	188.3	10.8	33.1	217.7	0.569	13.6	41.7	274.1	0.5
1968	341.4	15.6	63.1	414.6	0.541	17.9	72.4	475.7	0.5
1969	430.2	17.7	71.6	673.1	0.601	22.0	89.0	588.0	0.5
1970	332.2	16.5	65.9	436.5	0.504	21.4	85.5	566.1	0.5
1971	533.2	25.7	128.1	850.9	0.416	36.3	181.0	1201.9	0.5
1972	430.4	23.1	115.6	722.2	0.372	32.5	162.6	1038.4	0.5
1973	475.6	23.8	117.1	769.6	0.406	35.0	172.2	1131.6	0.5
1974	551.2	24.0	103.2	679.8	0.534	35.7	153.5	1011.2	0.5
1975	556.5	21.3	151.0	1039.9	0.369	35.6	252.4	1487.9	0.5
1976	259.2	10.6	89.3	594.0	0.290	25.8	217.4	1445.8	0.5
1977	268.1	12.1	75.0	491.7	0.357	29.1	181.0	1186.6	0.5

* Taiwanese data are included since 1967.

Table 3. Catch, effective effort and fishing intensity on bigeye tuna caught by the longline fleet in the north Atlantic Ocean, 1956-77.

Year	Basic data (Japan and Taiwan combined)					Whole longline fleet			
	Catch in number (10 ³) (A)	Yield in weight (10 ³ MT) (B)	Effective hooks (10 ⁵) (C)	Intensity per 5x5 square (10 ³ hooks) (D)	Hook rate 100 x(A)/(C) (E)	Yield in weight (10 ³ MT) (F)	Effective hooks (10 ⁵) (G)	Intensity per 5x5 square (10 ³ hooks) (H)	Hook rate 100 x(F)/(G) (I)
1956	0.1	0.0	0.1	0.8	0.366	0.0	0.1	0.8	0.8
1957	7.3	0.4	2.0	24.0	0.369	0.4	2.0	24.0	0.8
1958	13.0	0.4	5.1	60.0	0.256	0.4	5.1	60.0	0.8
1959	39.9	1.3	9.6	112.7	0.417	1.3	9.6	112.7	0.8
1960	50.1	2.1	10.3	115.6	0.488	2.1	10.3	115.6	0.8
1961	67.6	3.1	9.1	100.5	0.742	3.1	9.1	100.5	0.8
1962	199.1	8.5	29.1	325.5	0.604	8.5	29.1	325.5	0.8
1963	166.0	8.4	26.2	299.4	0.635	8.4	26.2	299.4	0.8
1964	219.2	10.9	37.4	453.8	0.586	10.9	37.4	453.8	0.8
1965	339.1	14.7	56.5	603.9	0.601	14.7	56.5	603.9	0.8
1966	121.6	6.8	25.0	304.4	0.486	6.8	25.3	307.9	0.8
1967	76.4	3.7	15.1	179.7	0.507	3.8	15.5	184.8	0.8
1968	125.2	5.6	23.4	268.0	0.536	5.6	23.4	268.0	0.8
1969	131.5	5.4	24.9	287.8	0.528	5.8	26.7	301.0	0.8
1970	202.1	9.8	37.1	443.8	0.545	11.0	41.6	498.1	0.8
1971	318.1	15.5	81.5	969.6	0.390	16.6	97.8	1163.5	0.8
1972	241.2	12.6	64.0	794.2	0.377	14.8	75.2	932.9	0.8
1973	247.4	12.4	52.7	654.9	0.469	19.1	81.2	1038.8	0.8
1974	422.5	16.7	67.8	836.4	0.623	25.5	92.5	1110.5	0.8
1975	360.1	13.9	99.2	1236.7	0.363	23.1	166.9	2055.2	0.8
1976	147.3	6.2	57.7	721.4	0.255	12.0	111.7	1394.3	0.8
1977	116.3	5.6	33.4	420.6	0.349	14.2	84.7	1244.4	0.8

* Taiwanese data are included since 1967.

Table 4. Catch, effective effort and fishing intensity on bigeye tuna caught by the longline fleet in the south Atlantic Ocean, 1956-77.

Year	Basic data (Japan and Taiwan combined)					Whole longline fleet			
	Catch in number (10 ³) (A)	Yield in weight (10 ³ MT) (B)	Effective hooks (10 ⁵) (C)	Intensity per 5x5 square (10 ³ hooks) (D)	Hook rate 100 x(A)/(C) (E)	Yield in weight (10 ³ MT) (F)	Effective hooks (10 ⁵) (G)	Intensity per 5x5 square (10 ³ hooks) (H)	Hook rate 100 x(F)/(G) (I)
1956	0.0	0.0	0.0	0.2	0.364	0.0	0.0	0.2	0.2
1957	1.4	0.1	0.6	10.0	0.218	0.1	0.6	10.0	0.2
1958	1.8	0.1	0.8	12.9	0.219	0.1	0.8	12.9	0.2
1959	4.9	0.2	1.8	29.1	0.266	0.2	1.8	29.1	0.2
1960	20.5	0.8	6.2	86.8	0.333	0.9	7.0	97.7	0.2
1961	176.0	8.0	21.1	307.4	0.833	8.2	21.6	405.1	0.2
1962	168.8	7.2	26.9	394.2	0.627	7.4	27.6	405.1	0.2
1963	119.3	6.1	25.0	335.9	0.519	6.3	23.8	346.9	0.2
1964	124.6	6.4	25.0	350.6	0.498	6.7	26.2	367.0	0.2
1965	309.2	13.9	61.6	908.4	0.502	14.3	63.4	934.5	0.2
1966	110.5	8.0	23.0	346.4	0.480	9.7	25.4	382.0	0.2
1967	111.8	7.1	18.7	261.7	0.598	7.4	19.5	272.8	0.2
1968	216.2	10.1	39.9	584.8	0.541	10.6	41.9	613.8	0.2
1969	296.9	12.4	46.4	688.3	0.644	14.0	52.4	777.1	0.2
1970	130.2	6.7	29.1	428.1	0.447	10.4	45.2	664.5	0.2
1971	215.1	10.2	48.6	713.0	0.442	17.7	84.3	1237.3	0.2
1972	189.2	10.5	51.2	746.7	0.369	16.1	78.5	1144.9	0.2
1973	228.2	11.4	61.6	902.7	0.370	15.9	85.9	1259.0	0.2
1974	128.7	5.2	33.8	497.8	0.380	10.2	66.3	976.5	0.2
1975	196.4	7.5	51.9	746.4	0.379	12.5	86.5	1244.0	0.2
1976	111.9	4.4	30.1	446.0	0.372	13.7	93.7	1388.7	0.2
1977	151.0	6.5	39.0	574.2	0.389	13.4	80.4	1183.7	0.2

* Taiwanese data are included since 1967.



Fig. 1. Annual change in hook rate of bigeye tuna in the whole Atlantic, based on data of Japanese and Taiwanese longline fisheries combined, 1960-77.

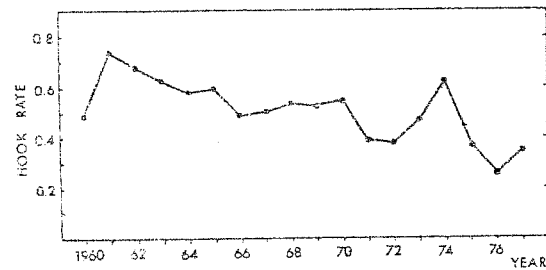


Fig. 2. Annual change in hook rate of bigeye tuna in the north Atlantic, based on data of Japanese and Taiwanese longline fisheries combined, 1960-77.

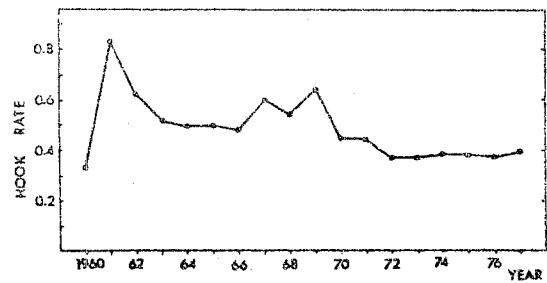


Fig. 3. Annual change in hook rate of bigeye tuna in the south Atlantic, based on data of Japanese and Taiwanese longline fisheries combined, 1960-77.

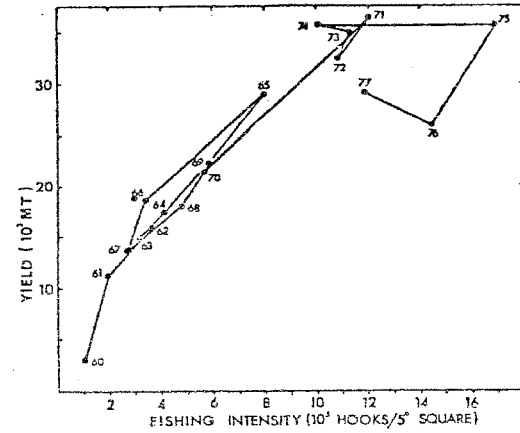


Fig. 4. Catch-effort relationship of bigeye tuna caught by the whole longline fleet in the Atlantic Ocean, 1960-77.

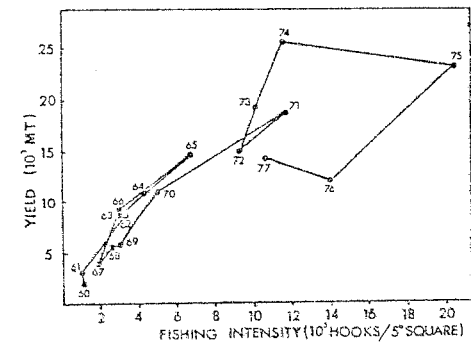


Fig. 5. Catch-effort relationship of bigeye tuna caught by the longline fishery in the north Atlantic, 1960-77.

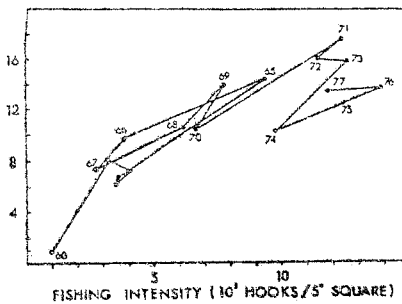


Fig. 6. Catch-effort relationship of bigeye tuna caught by the longline fishery in the south Atlantic, 1960-77.