

OVERALL FISHING INTENSITY OF ATLANTIC FISHERY
FOR BIGEYE TUNA, 1956-1975

by

S. Kume

SUMMARY

Summarized and estimated in this report are amounts of catch, effort and fishing intensity on bigeye tuna exploited by Atlantic longline fleet. Standardization of effort was made on the basis of Japanese catch and effort data. In relation to possibly two stocks in the Atlantic, an attempt was made to separate statistics between the North and South Atlantic.

The high Concentration Indices of the Japanese longline fleet in recent years indicate the concentration of the fleet on bigeye tuna. The sharp increase of effort without corresponding catch increase in 1975 seems to imply that fishing is approaching an asymptote of the allowable catch.

RESUME

Le présent rapport fait état des données de prise, effort et intensité de pêche, résumées et estimées pour le thon obèse pris par la flottille palangrière dans l'Atlantique. L'effort a été standardisé à partir des données japonaises de prise et effort. Pour ce qui est de l'hypothèse de deux stocks atlantiques, on a tenté de séparer les statistiques entre Atlantique Nord et Sud. Les indices élevés de concentration de la flottille japonaise pour ces dernières années indiquent que cette flottille concentre ses efforts sur le thon obèse. Le fait qu'en 1975 l'augmentation accusée de l'effort n'ait pas été accompagnée d'un accroissement correspondant des prises semblerait indiquer que la pêche approche d'une asymptote de la production équilibrée.

RESUMEN

Este informe presenta estimaciones y resumen de las cifras de captura, esfuerzo, e intensidad de pesca referentes a la explotación del patudo por la flota palangrera del Atlántico. La normalización del esfuerzo se hizo en base a los datos japoneses de captura y esfuerzo. En relación con la existencia eventual de dos stocks en el Atlántico, se intentó separar las estadísticas correspondientes al norte y al sur del océano.

Los altos "índices de concentración" de la flota palangrera japonesa en los últimos años, señalan su concentración sobre el patudo. El brusco incremento del esfuerzo, sin un aumento correspondiente en la captura de 1975, podría denotar que la pesquería se acerca a un asintota de captura admisible.

Figures 1 to 4 reproduced in Data Record Vol. 11.

Figures 1 à 4 reproduits dans le Vol. 11 du Recueil de Données.

Figuras 1 á 4 reproducidos en Vol. 11 de la Colección de Datos Estadísticos.

1. Recent longline fishery for bigeye tuna in the Atlantic.

There are several countries in the Atlantic engaging in harvesting bigeye tuna by longline fishing (Table 1). Among them, Japan, Korea and Taiwan have been taking the species substantially. Bigeye fishing grounds in 1975 by countries are shown in Figs. 1-4. Catch distribution of bigeye is different by countries. In brief, Japanese and Taiwanese fleet are taking more bigeye in temperate waters than in tropical waters, while catches of Korean and Cuban fleet are centered in low latitudes. This information is useful to separate catch and effort data into north and south Atlantic.

2. Standardization of nominal effort to effective effort.

Distribution of certain fish is generally not uniform, so that 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, 5 degree square in this study, is the same as the average density of the stock, the unit of effort, in terms of hooks in this study, invested on such area will take constant rate (q) of amount from the fishable stock. Then, when the density of i-th unit 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, fishing effort, nominal one, invested on i-th area (h_i) will take the amount of fish of $h_i \times q \times r_i$, and $h_i \times r_i$ is defined as effective effort. Details of technique of calculation for effective effort and fishing intensity were already explained by Honma (1973). The average density distribution for the calculation of effective hooks was selected eleven years of Japanese data from 1965 to 1975. Japanese and Taiwanese catch and effort data, for which historical statistics by 5 degree square are available, were processed up to 1975 data by the above method.

3. Estimation of overall fishing intensity.

Since detailed catch and effort statistics, Task 2 in SCRS, have not been made available historically for all longline fleet except Japanese and Taiwanese longliners, the overall fishing intensity of the whole Atlantic longline fleet was estimated by extrapolation based on "basic data", Japanese and Taiwanese data combined. The estimated overall fishing intensity and relevant data are tabulated in Table 2. Japanese annual yield in weight in years up to 1970 and those of non-Japanese longline fleet have been expressed by amount of landing, which do not correspond exactly to the effort statistics dealt with in this study. There seems no appropriate way to adjust them.

4. North-south separation of catch-effort statistics.

Considering the possibility of two separate stocks in the Atlantic (Kume and Morita 1977), catch and effort data of whole Atlantic were divided into two general areas, north Atlantic (ICCAT bigeye areas 1-4) and south Atlantic (ICCAT bigeye areas 5-8). Compared with the previous separation by Kume (1977), minor revision was made in this text.

Yield in weight (Table 3)

Japan and Taiwan.....all annual catches in weight were proportionated by catches in number in respective area of north and south obtained from detailed catch statistics.

Korea.....1966-72, proportionated by 25:75 = north:south; rounded ratio obtained from catch statistics by area (Anonymous 1970).

1973, the average ratio of 1974 and 1975 was applied.

1974 and 75, annual ratios were obtained from catch statistics by area (ICCAT 1976a and 1977).

Panama.....the same ratios of Korean data were applied.

Argentina and Brazil.....assigned to south Atlantic.

Cuba.....1975 ratio obtained from catch-effort data (ICCAT 1976b) was used. Effective effort and fishing intensity (Tables 4 and 5)

To calculate effective effort, the same procedure given to the whole Atlantic was applied to the Japanese and Taiwanese data for north and south Atlantic separately. Then, overall fishing intensity and relevant data were estimated based on "basic data", Japanese and Taiwanese data combined, and north and south catches in Table 3.

5. Brief comments on catch and effort relations.

Value of annual number of effective hooks divided by the corresponding number of nominal hooks, "Concentration Index", will indicate relative convergence of effort how the fleet concentrated on the bigeye grounds. The Index on Atlantic bigeye for Japanese longline fleet has increased remarkably since 1971 and remained at high level (Fig. 5). Such trend is reflected by the continuous greater concern of recent Japanese fleet on bigeye tuna. On the other hand, the trend in the index of Taiwanese fleet has been remained on low level less than 1.0.

Hook rate (CPUE), annual catch in number divided by the corresponding number of effective hooks, was calculated based on Japanese and Taiwanese data combined. Since 1961 when longline fishery expanded to cover nearly entire bigeye distribution, the annual hook rate of whole Atlantic bigeye tuna has been on the decrease, hook rate of recent years being about 2/3 of those in best years (Fig. 6). Annual change in both hook rates in north and south Atlantic indicates almost similar trend. The fair uprise of hook rate observed in whole Atlantic in 1974 was attributed to the increased hook rate in the north Atlantic.

In Figs. 7 and 8, shown are relations between catch and effort of bigeye tuna for entire Atlantic and north and south areas. In the whole Atlantic (Fig. 7), recent amount of longline catch since 1971 has been maintained on high level and sharp increase in effort was observed in 1975, suggesting an asymptotic approach to the allowable catch. It appears that productivity of bigeye tuna may be larger in the north Atlantic than in the south, and that southern bigeye has been harvested recently heavier than northern one. |

References.

- Anonymous 1970: Yearbook of catch and effort statistics on Korean tuna longline fishery, Vol. 1 for 1966-1970.
- 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. 1; 59-77.
- ICCAT 1976a: Data Record Vol. 7.
- 1976b: Data Record Vol. 8.
- 1977: Statistical Series-2.
- 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.

Table 1. Annual catch of bigeye tuna caught by longline fishery by countries in the Atlantic Ocean, 1965-1975, in 1,000 tons.

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Argentina	0.4	0.2	0.1	0.3	0.2	0.1			0.0	0.0	0.1
Brazil									0.1	0.2	0.1
Cuba							3.2	2.0	2.6	2.4	1.9
Korea		0.3	0.3	0.3	1.9	4.7	7.4	5.7	5.8	7.4	10.2
Japan	28.5	17.6	8.5	10.3	10.3	9.0	20.8	18.5	20.2	21.4	17.7
Panama								0.1	2.7	1.8	
Taiwan		0.6	2.2	5.3	7.5	7.6	5.5	5.0	3.8	3.1	4.0
Longline total	28.9	18.7	11.2	16.2	19.8	21.4	36.8	31.3	35.3	36.2	33.9
Surface total	0.2	0.3	0.8	2.0	4.3	6.8	8.3	3.9	7.2	16.1	17.1
Grand total	29.2	19.0	12.0	18.2	24.1	28.2	45.1	35.2	42.5	52.4	51.0

Table 2. Catch, effective effort and fishing intensity of bigeye tuna caught by the longline fleet in the whole Atlantic Ocean, 1956-1975.

Year	Basic data (Japan and Taiwan combined)*					Whole longline fleet		
	Catch in number (10 ³) (A)	Yield in weight (10 ³ tons) (B)	Effective hooks (10 ⁶) (C)	Intensity per 5 th square (10 ³ hooks) (D)	Hook rate 100x(A)/(C)	Yield in weight (10 ³ tons) (E)	Effective hooks (10 ⁶) (C)x(E)/(B)	Intensity per 5 th square (10 ³ hooks) (D)x(E)/(B)
1956	0.2	0.0	0.1	0.5	0.228	0.0	0.1	0.5
1957	8.7	0.5	2.7	17.5	0.320	0.5	2.7	17.5
1958	14.8	0.5	5.9	38.2	0.251	0.5	5.9	38.2
1959	44.8	1.5	11.4	74.0	0.394	1.5	11.4	74.0
1960	70.6	2.9	15.5	102.3	0.454	3.0	16.0	105.8
1961	243.7	11.0	29.8	196.2	0.818	11.2	30.3	199.8
1962	367.9	15.7	54.0	357.3	0.682	15.9	54.7	361.9
1963	285.3	14.5	47.4	316.3	0.602	14.7	48.1	320.7
1964	343.7	17.3	61.1	406.0	0.563	17.6	62.2	413.0
1965	648.3	28.5	117.9	787.8	0.550	28.9	119.6	798.9
1966	232.1	17.6	48.1	323.9	0.482	18.7	51.1	344.1
1967	188.3	10.8	33.1	217.7	0.569	11.2	34.3	225.8
1968	341.4	15.6	63.1	414.6	0.541	16.2	65.5	430.5
1969	430.2	17.7	71.6	473.1	0.601	19.8	80.1	529.2
1970	332.2	16.5	65.9	436.5	0.504	21.4	85.5	566.1
1971	533.2	26.3	128.1	850.9	0.416	36.8	179.2	1190.6
1972	430.4	23.5	115.6	772.2	0.372	31.3	154.0	1028.5
1973	475.6	24.1	117.1	769.6	0.406	35.3	171.5	1127.3
1974	551.2	24.4	103.2	679.8	0.534	36.2	153.1	1008.6
1975	556.5	21.6	151.0	1009.9	0.369	33.9	237.0	1585.0

* Taiwanese data are included since 1967

Table 3. North-south division of bigeye catch caught by longline fishery in the Atlantic Ocean, 1957-75 (in M/T).

Year	North Atlantic				South Atlantic							
	Japan	Taiwan	Korea*	Cuba	Total	Japan	Taiwan	Korea*	Cuba	Argentina	Brazil	Total
1957	381				381	73						73
1958	399				399	54						54
1959	1,316				1,316	162						162
1960	2,061				2,061	843						843
1961	3,065				3,065	7,979						7,979
1962	8,506	3			8,509	7,214	15					7,229
1963	8,430	6			8,436	6,060	35					6,095
1964	10,904	6			10,910	6,432	35					6,467
1965	14,669				14,669	13,869						13,869
1966	8,753	88	72		8,913	8,823	507	217				9,547
1967	3,394	330	80		3,804	5,155	1,901	240				7,396
1968	4,042	1,529	66		5,637	6,244	3,815	197				10,556
1969	2,402	2,969	464		5,835	7,864	4,514	1,393				13,971
1970	4,705	5,117	1,183		11,003	4,290	2,438	3,549				10,377
1971	13,149	2,365	1,838	1,248	18,600	7,623	3,114	5,515	1,952			18,204
1972	11,263	792	1,449	780	14,284	6,762	4,198	4,345	1,220			16,525
1973	11,113	1,270	5,704	1,014	19,101	9,130	2,548	2,809	1,586	25	68	16,166
1974	17,640	1,107	5,868	936	25,510	3,716	1,990	3,300	1,464	17	175	10,662
1975	12,376	1,474	7,113	741	21,704	5,288	2,476	3,049	1,159	100	129	12,201

* Panamanian Catch is included.

Table 4. Catch, effective effort and fishing intensity of bigeye tuna caught by the longline fleet in the north Atlantic Ocean, 1956-1975.

Year	Basic data (Japan and Taiwan combined)*					Whole longline fleet		
	Catch in number (10 ³) (A)	Yield in weight (10 ³ tons) (B)	Effective hooks (10 ⁶) (C)	Intensity per 5 th square (10 ³ hooks) (D)	Hook rate 100x(A)/(C)	Yield in weight (10 ³ tons) (E)	Effective hooks (10 ⁶) (C)x(E)/(B)	Intensity per 5 th square (10 ³ hooks) (D)x(E)/(B)
1956	0.1	0.0	0.1	0.8	0.366	0.0	0.1	0.8
1957	7.3	0.4	2.0	24.0	0.369	0.4	2.0	24.0
1958	13.0	0.4	5.1	60.0	0.256	0.4	5.1	60.0
1959	39.9	1.3	9.6	112.7	0.417	1.3	9.6	112.7
1960	50.1	2.1	10.3	115.6	0.488	2.1	10.3	115.6
1961	67.6	3.1	9.1	100.5	0.742	3.1	9.1	100.5
1962	199.1	8.5	29.1	325.5	0.684	8.5	29.1	325.5
1963	166.0	8.4	26.2	299.4	0.635	8.4	26.2	299.4
1964	219.2	10.9	37.4	453.8	0.586	10.9	37.4	453.8
1965	339.1	14.7	56.5	683.9	0.601	14.7	56.5	683.9
1966	121.6	8.8	25.0	304.4	0.486	8.9	25.3	307.9
1967	76.4	3.7	15.1	179.7	0.507	3.8	15.5	184.8
1968	125.2	5.6	23.4	268.0	0.536	5.6	23.4	268.0
1969	131.3	5.4	24.9	287.8	0.528	5.8	26.7	309.1
1970	202.1	9.8	37.1	443.8	0.545	11.0	41.6	498.1
1971	318.1	15.5	81.5	969.6	0.390	18.6	97.8	1163.5
1972	241.2	12.1	64.0	794.2	0.377	14.3	75.6	958.6
1973	247.4	12.4	52.7	654.9	0.469	19.1	81.2	1008.8
1974	422.5	18.7	67.8	836.4	0.623	25.5	92.5	1140.5
1975	360.1	13.9	99.2	1236.7	0.363	21.7	154.9	1930.7

* Taiwanese data are included since 1967

Table 5. Catch, effective effort and fishing intensity of bigeye tuna caught by the longline fleet in the south Atlantic Ocean, 1956-1975.

Year	Basic data (Japan and Taiwan combined)*					Whole longline fleet		
	Catch in number (10 ³) (A)	Yield in weight (10 ³ tons) (B)	Effective hooks (10 ⁶) (C)	Intensity per 5 th square (10 ³ hooks) (D)	Hook rate 100x(A)/(C)	Yield in weight (10 ³ tons) (E)	Effective hooks (10 ⁶) (C)x(E)/(B)	Intensity per 5 th square (10 ³ hooks) (D)x(E)/(B)
1956	0.0	0.0	0.0	0.2	0.364	0.0	0.0	0.2
1957	1.4	0.1	0.6	10.0	0.218	0.1	0.6	10.0
1958	1.8	0.1	0.8	12.9	0.219	0.1	0.8	12.9
1959	4.9	0.2	1.8	29.1	0.266	0.2	1.8	29.1
1960	20.5	0.8	6.2	86.8	0.333	0.9	7.0	97.7
1961	176.0	8.0	21.1	307.4	0.833	8.2	21.6	315.1
1962	168.8	7.2	26.9	394.2	0.627	7.4	27.6	405.1
1963	119.3	6.1	23.0	335.9	0.519	6.3	23.8	346.9
1964	124.6	6.4	25.0	350.6	0.498	6.7	26.2	367.0
1965	309.2	13.9	61.6	908.4	0.502	14.3	63.4	934.5
1966	110.5	8.8	23.0	346.6	0.480	9.7	25.4	382.0
1967	111.8	7.1	18.7	261.7	0.598	7.4	19.5	272.8
1968	216.2	10.1	39.9	584.8	0.541	10.6	41.9	613.8
1969	298.9	12.4	46.4	688.3	0.644	14.0	52.4	777.1
1970	130.2	6.7	29.1	428.1	0.447	10.4	45.2	664.5
1971	215.1	10.7	48.6	713.0	0.442	18.2	82.7	1121.8
1972	189.2	11.0	51.2	746.7	0.369	16.5	76.8	1120.1
1973	228.2	11.7	61.6	902.7	0.370	16.2	85.3	1249.9
1974	128.7	5.7	33.8	497.8	0.380	10.7	63.4	934.5
1975	196.4	7.8	51.9	746.4	0.379	12.2	81.2	1167.4

* Taiwanese data are included since 1967

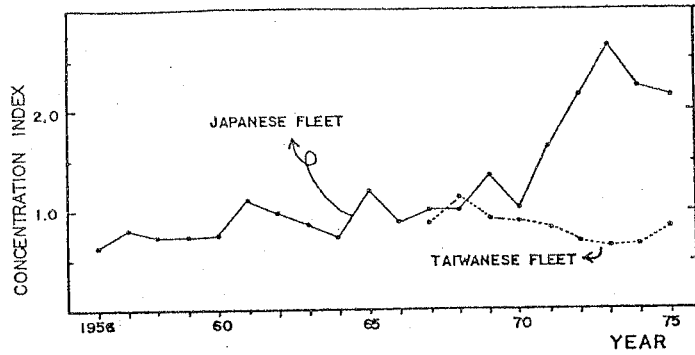


Fig. 5. Annual change in Concentration Index of Japanese and Taiwanese longline fleet on bigeye tuna in the Atlantic Ocean.

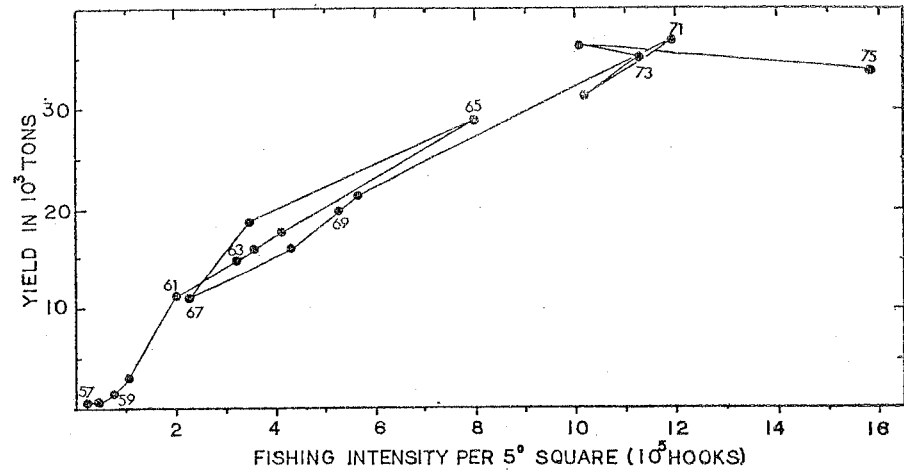


Fig. 7. Annual change in catch in weight of bigeye tuna against overall fishing intensity of the whole longline fleet in the Atlantic Ocean.

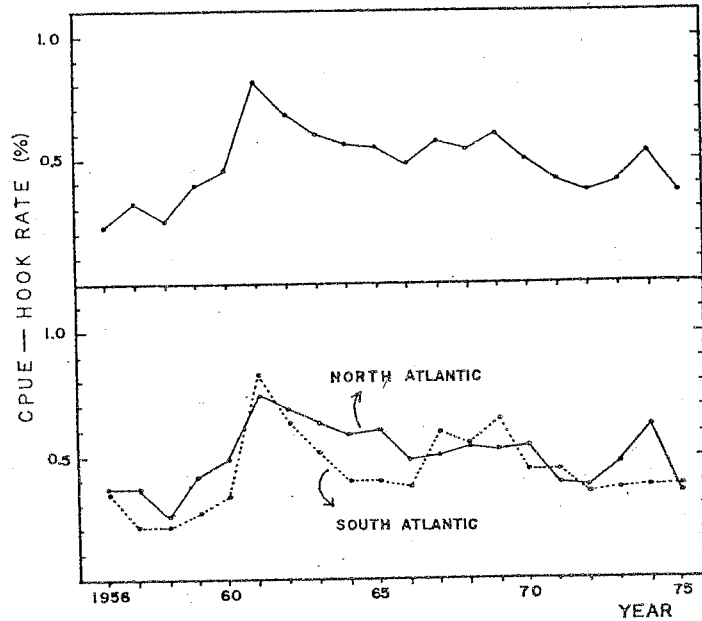


Fig. 6. Annual change in hook rate of bigeye tuna in the whole Atlantic (upper panel) and north and south Atlantic (lower panel), based on data of Japanese and Taiwanese longline fisheries combined.

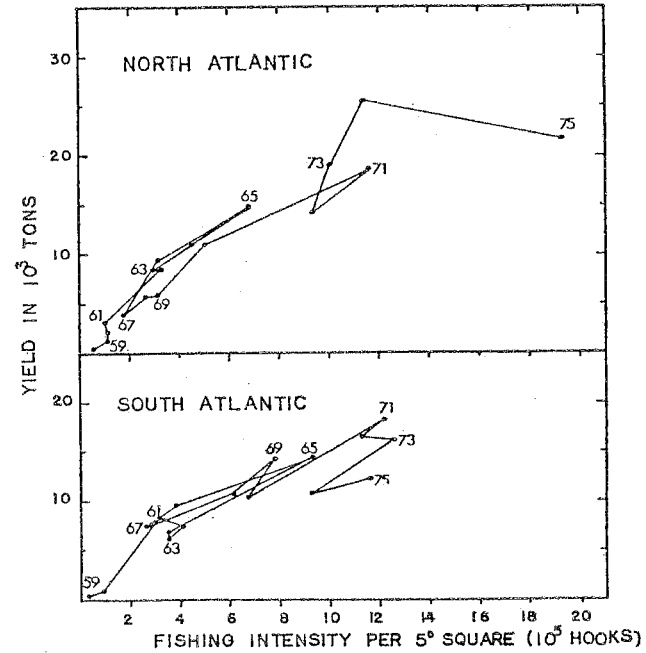


Fig. 8. Relationship between yield and fishing intensity on bigeye tuna caught by longline fishery in the north and south Atlantic.