

OVERALL FISHING INTENSITY AND CATCH BY LENGTH CLASS OF YELLOWFIN TUN.  
IN JAPANESE ATLANTIC LONGLINE FISHERY, 1956-1971 \*

by

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SUMMARY

Catch and sampling data for 1971 were added to previous calculations on fishing intensity and length composition of catch in Japanese and other longline fisheries in the Atlantic Ocean (Honma 1973). In 1971, the whole longline intensity reached its highest, but hook-rate dropped to the lowest ever recorded. The catch remained at the recent low level. The modal size of the catch showed a further decline in the "CARIB" area, while there was a remarkable recovery in "GUINEA" area. A preliminary estimate of the spawning index showed a substantial decline in the latter three years.

\* Data to be partially reproduced in Data Record, Vol. 4

RESUME

Des données de capture et d'échantillonnage pour 1971 ont été incorporées aux calculs antérieurs de l'intensité de pêche et de la composition par taille de la pêcherie japonaise et autres pêcheries palangrières dans l'Atlantique (Honma, 1973). L'intensité totale palangrière a atteint son maximum en 1971, mais le taux par hameçon est passé au niveau le plus bas jamais enregistré. Les prises se sont maintenues au niveau médiocre de ces derniers temps. La taille modale de la prise a indiqué une baisse encore plus importante dans la zone des Caraïbes, alors que la zone guinéenne s'est remarquablement rétablie. Une première estimation de l'indice de ponte a indiqué une baisse sensible ces trois dernières années.

\* Ces données seront partiellement reproduites dans le "Recueil de Données Statistiques" Vol.4

RESUMEN

Los datos de capturas y muestreo de 1971 fueron añadidos a los cálculos anteriores sobre intensidad pesquera y composición de tallas de capturas en las pesquerías japonesas y otras con palangre en el Océano Atlántico (Honma 1973). 1971 fué el año que registró la cota máxima de intensidad pesquera total con palangre, siendo, sin embargo, el índice de capturas por anzuelo el más bajo. La captura permaneció al nivel bajo reciente. La talla modal de la captura mostró otro nuevo descenso en la zona del "CARIB", en tanto que la situación mejoró notablemente en la zona de "GUINEA". Una estimación preliminar de la tasa de reproducción reflejó un descenso sustancial en los últimos tres años.

\* Estos datos serán parcialmente reproducidos en la "Colección de Datos Estadísticos" Vol. 4.

This is the second issue of a series of fishing intensity and length composition of catch of yellowfin tuna exploited by Japanese and other longline fleets in the Atlantic Ocean. In addition, the present paper contains a brief examination of spawning index of the stock.

### 1. Fishing intensity, 1956-1971

Procedures of calculations are already described in the first issue of this series (Honma 1973). The newly added data for 1971 are those provided by ICCAT (1973) on yields and by Fishery Agency (1973) on Japanese catch and effort statistics. The "average years" in the present calculations extend from 1963 to 1971.

Recent change of strategy of Japanese fleet (e.g. Hayasi 1973) resulted in shift of fishing ground, and then addition of 1971 data widens "area of distribution range" (Appendix table 1). The apparent expansion of area causes slight reduction of estimates of fishing intensity in 1956 through 1970 from those calculated at the previous occasion. As to the 1971 data, it is noted that the fishing intensity showed the first recovery since the peak of 1965, but the hook rate, yearly catch divided by yearly sum of effective effort, showed the lowest record in the Atlantic Ocean (Table 1).

Fishing intensity of the whole longline fleet including non-Japanese boats is roughly estimated on the basis of the Japanese estimates and yields of all the participating nationals. Relations between the whole intensity and either one of hook rate, catch and yield indicate that, as already pointed, that the longline depleted the stock by the early 1960's, but that reduction of the fishery did not result in recovery of the stock probably due to rapid expansion of surface fishery since then (Fig. 1). Korean and Taiwanese boats seem to have operated out of major fishing area of Japanese boats (Shiohama ms). And the discrepancy in operating range might have caused biases of the estimates of fishing intensity. It is urgently required to collect Task 2 statistics from non-Japanese longline boats.

### 2. Length composition of catch, 1971

In 1971 sampling program of Japanese longline catch covered 13,625 yellowfin tuna in the Atlantic Ocean (Shingu and Hisada ms), 12,886 of which from CARIB area and 1,232 from GUINEA area (Table 2). Catch in these two areas were 280,000 fish comprising 96 percent of total Japanese catch. Number of samples in the whole Atlantic do not agree with sum of the regional samples because fish taken in quadrangles extending between Long. 20°W and 40°W were used for both areas. The sample length composition was converted to catch by length class through the methods described in the first issue.

Appendix table 2 gives catch in number of fish for each 2-cm interval of body length compiled by area and by quarter. Yearly total figures in CARIB area indicate drastic change of size distribution from a moderate mode extending between 104 and 122 cm and another in 132-148 cm in 1970 to a sharp mode of 108-116 cm and two large sized groups of 124-132 cm and 144-152 cm in 1971. Size of dominant mode in 1971 was substantially smaller than those in the past over 120 cm. Such change might have been partly due to concentration of fishing activity in the warm waters. Modal size in GUINEA area recovered to 148-152 cm in 1971 after a decrease from 140-148 cm in 1965 to 112-132 cm in 1970. Another feature of 1971 composition is occurrence of very small fish of 64-72 cm (Fig. 2).

## 3. Spawning index, 1965-1971

Orange (1961) showed the biological minimum of about 60 cm in yellowfin tuna taken by bait boats in the eastern tropical Pacific. According to Kikawa (1966), data from catch by longline in various parts of the Pacific Ocean indicate significant rise of gonad index for specimens over 120 cm in body length. Both authors noted remarkable variation in seasonal change of maturation depending on size of fish and on area of capture. Basing on the aforementioned papers, ratio of matured fish in  $l$ -th length interval,  $p_l$ , is assumed as 40 percent for 60-100 cm classes, 50 percent for 100-120 cm classes, and 100 percent for fish over 120 cm. Joseph (1963) showed a relation of expected number of ova to be discharge,  $E_l'$  (millions), on body length of the fish,  $l$  (mm), by  $E_l' = 8.955 l^{2.791} \times 10^{-9}$ . Table 3 shows average number of eggs produced for  $l$ -th length class,  $E_l = p_l \times E_l'$ .

Honma (1973) and present calculation give catch by length class,  $C_l$ , for CARIB and GUINEA areas. The hook rate in each area,  $d$ , is obtained in the course of preparing Table 1. These figures provide the spawning index,

$$S = d \times \sum_l \frac{C_l \cdot E_l}{C} \text{ for each year and area. This estimate is of preliminary}$$

nature, e.g. maturation of different sized groups must be re-examined with use of the materials taken from the Atlantic Ocean. In spite of such defects of basic data, it must still be noted, in both the CARIB and GUINEA areas, that the spawning index decreased in 1969 and onward, having lowered to about a half of the level in 1966 (Fig. 3).

## References

- Fishery Agency of Japan 1973. "Annual report of effort and catch statistics by area on Japanese tuna longline fishery, 1971". 319 p.
- Hayasi, S. 1973. "Japanese fisheries and research activities on tunas and tuna-like fishes in the Atlantic Ocean, 1970-1972". ICCAT Rept. 1972-1973, Part 1, 126-136.
- Honma, M. 1973. "Overall fishing intensity and catch by length class of yellowfin tuna in Japanese Atlantic longline fishery, 1956-1970". Col. Vol. Sci. Pap. vol. 1, 59-77.
- International Commission for the Conservation of Atlantic Tunas 1973. "Statistical Bulletin". vol. 3.
- Joseph, J. 1963. "Fecundity of yellowfin tuna (Thunnus albacares) and skipjack (Katsuwonus pelamis) from the eastern Pacific Ocean". Bull. Inter-Amer. Trop. Tuna Comm. 7 (4), 257-292.
- Kikawa, S. 1966. "The distribution of maturing bigeye and yellowfin and an evaluation of their spawning potential in different areas in the tuna longline grounds in the Pacific". Rept. Nankai Reg. Fish. Res. Lab. (23), 131-208.
- Orange, J. C. 1961. "Spawning of yellowfin tuna and skipjack in the eastern tropical Pacific, as inferred from studies of gonad development". Bull. Inter-Amer. Trop. Tuna Comm. 5 (6), 459-526.
- Shingu, C. and K. Hisada ms. "Size composition of tuna and billfish samples from Japanese longline fishery in the Atlantic Ocean, 1971, including supplemental data for 1970".
- Shiohama, T. ms. "Overall fishing intensity and catch by length class of albacore in Japanese Atlantic longline fishery, 1956-1971".

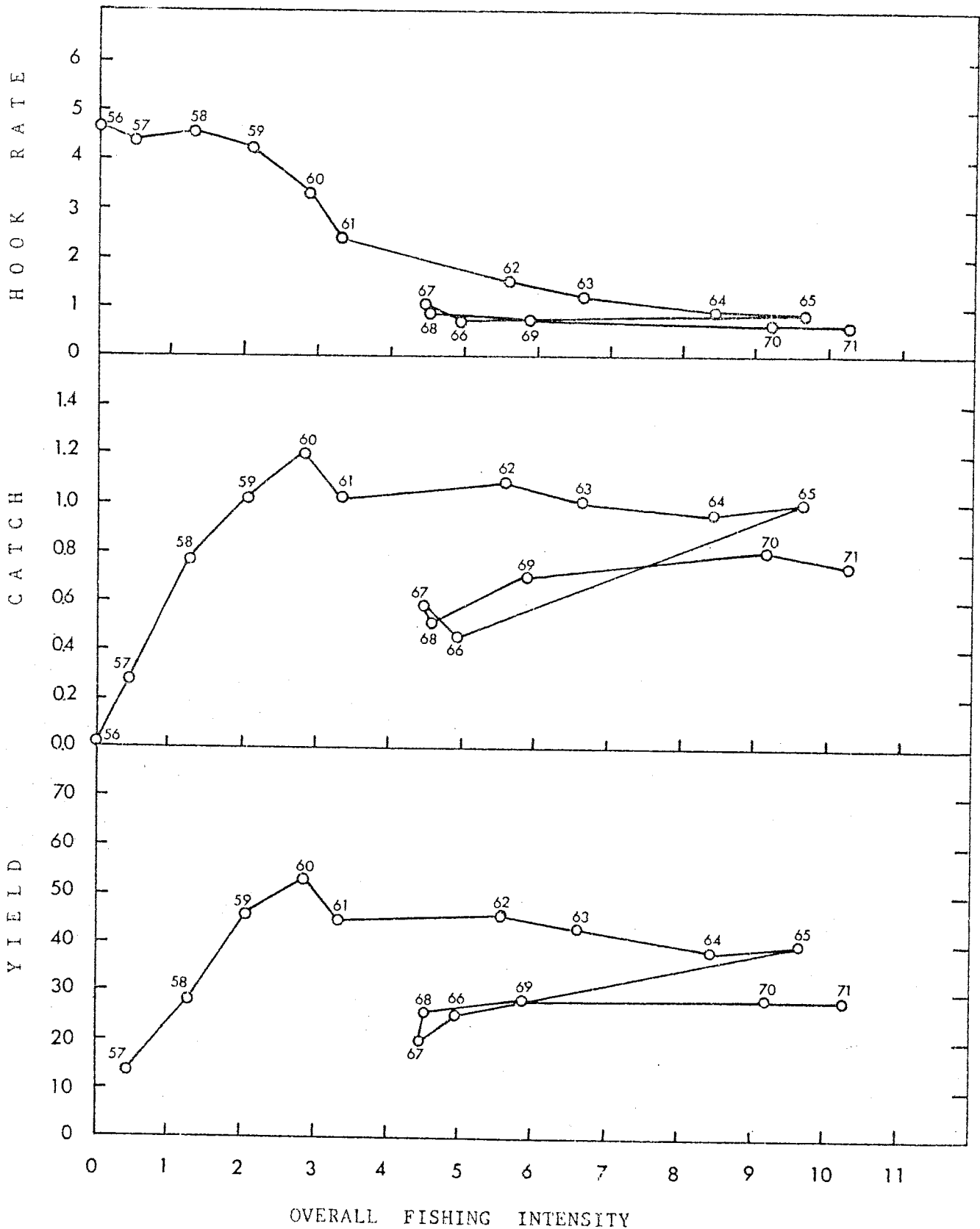


Fig. 1. Hook rate in percent (upper panel), catch in million fish (central panel), and yield in thousand tons (lower panel) of yellowfin tuna against overall fishing intensity in hundred thousand hooks per 5° square in the Atlantic longline fishery, 1956-1971.

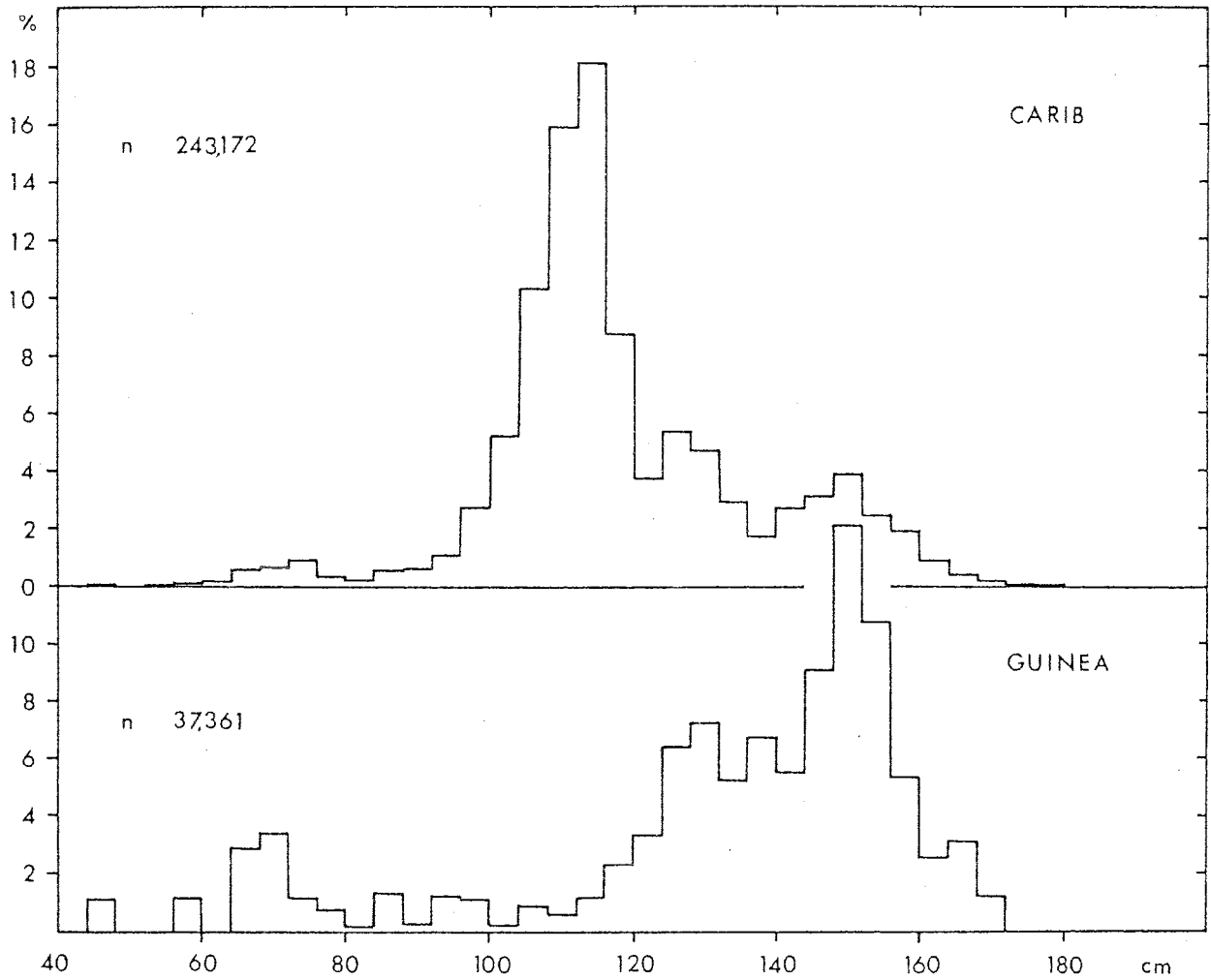


Fig. 2. Percentage length composition of yellowfin tuna caught by Japanese longline fishery in the Atlantic Ocean, 1971.

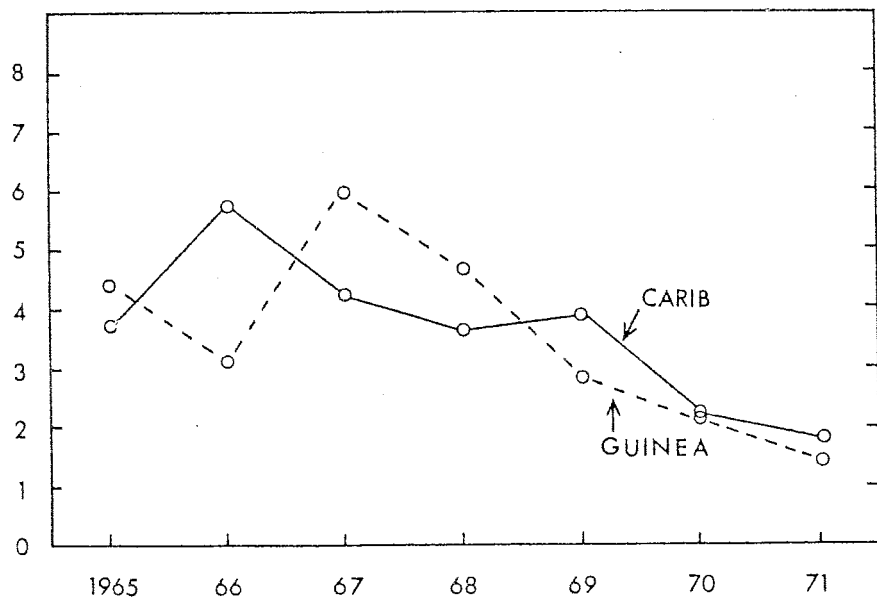


Fig. 3. Spawning index of yellowfin tuna in Atlantic longline fishery, 1965-1971.

Table 1. Hook rate, catch in number, yield in weight and overall fishing intensity of yellowfin tuna in Japanese longline fishery, and catch, yield and overall fishing intensity in the whole longline fishery in the Atlantic Ocean, 1956-1971.

Year	Hook rate in percent	Japanese fleet			Catch in number of fish	Yield in tons	Intensity in 1,000 hooks per 5 <sup>0</sup> -square
		Catch in number of fish	Yield in tons	Intensity in 1,000 hooks per 5 <sup>0</sup> -square			
1956	4.65	12,028	..	2.0	..	..	2.0
1957	4.38	258,544	13,198	45.1	270,337	13,798	47.2
1958	4.54	746,400	27,159	126.2	772,354	28,059	130.6
1959	4.24	1,097,535	44,071	200.7	1,138,103	45,671	208.1
1960	3.30	1,158,534	50,822	274.6	1,205,903	52,822	285.8
1961	2.40	980,399	42,609	320.9	1,026,147	44,709	335.6
1962	1.53	990,472	41,973	512.8	1,080,780	45,919	559.6
1963	1.22	885,796	37,717	582.0	1,009,869	42,970	663.5
1964	0.89	879,188	35,106	772.6	959,177	38,308	842.9
1965	0.82	927,267	36,619	897.4	997,687	39,459	965.6
1966	0.74	394,538	22,123	427.8	456,546	25,971	495.0
1967	1.03	366,046	12,809	282.4	577,260	20,313	445.3
1968	0.87	274,181	13,857	244.6	512,469	25,887	457.2
1969	0.77	241,832	9,823	204.6	696,716	28,260	589.5
1970	0.66	189,569	6,674	216.3	806,677	28,336	920.4
1971	0.57	291,532	11,026	397.0	753,552	28,114	1,026.2

Table 2. Sample size and substitution of data for calculating catch by length class

Area	Quarter			
	I	II	III	IV
CARIB	78	407	8,164	4,242
GUINEA	603	593	126	(III)

Arabic numerals without parentheses denote number of individuals determined by either body length or body weight.

Roman numerals in parentheses denote substituted data of the given quarters.

Table 3. Average fecundity of individual yellowfin tuna by length class.

Length cm	Fecundity 10 <sup>0</sup> ova	Length cm	Fecundity 10 <sup>0</sup> ova	Length cm	Fecundity 10 <sup>0</sup> ova
60-62	0.21	120-122	3.60	180-182	11.07
62-64	0.23	122-124	3.77	182-184	11.41
64-66	0.25	124-126	3.94	184-186	11.77
66-68	0.28	126-128	4.12	186-188	12.13
68-70	0.30	128-130	4.30	188-190	12.49
70-72	0.33	130-132	4.49		
72-74	0.35	132-134	4.69		
74-76	0.38	134-136	4.88		
76-78	0.41	136-138	5.09		
78-80	0.44	138-140			
80-82	0.47	140-142	5.51		
82-84	0.50	142-144	5.74		
84-86	0.54	144-146	5.96		
86-88	0.57	146-148	6.20		
88-90	0.61	148-150	6.43		
90-92	0.65	150-152	6.68		
92-94	0.69	152-154	6.93		
94-96	0.73	154-156	7.18		
96-98	0.78	156-158	7.44		
98-100	0.82	158-160	7.71		
100-102	1.09	160-162	7.98		
102-104	1.15	163-164	8.27		
104-106	1.21	164-166	8.55		
106-108	1.28	166-168	8.84		
108-110	1.34	168-170	9.15		
110-112	1.41	170-172	9.45		
112-114	1.49	172-174	9.75		
114-116	1.56	174-176	10.08		
116-118	1.64	176-178	10.40		
118-120	1.72	178-180	10.73		

Appendix table 1. Extent of distribution range of yellowfin tuna in 5-degree square in the average years, and amount of effective effort in thousand hooks and overall fishing intensity in thousand hooks per 5-degree square of Japanese longline fishery, 1956-1971.

Month	Area	1956		1957		1958		1959		1960		1961	
		X	f	X	f	X	f	X	f	X	f	X	f
Total	-	(258)	2.0	(5,898)	45.1	(16,425)	126.2	(25,879)	200.7	(35,156)	274.6	(40,816)	320.6
1	135.06	-	-	-	-	1,769	13.1	1,374	10.2	1,883	13.9	4,150	30.7
2	131.86	-	-	86.0	0.7	1,153	8.7	1,258	9.5	3,507	26.6	5,847	44.3
3	108.17	-	-	65.2	0.6	961	8.9	1,594	14.7	2,403	22.2	3,883	35.9
4	119.48	-	-	167.8	1.4	684	5.7	2,325	19.5	3,807	31.9	4,759	39.8
5	130.63	-	-	604.3	4.6	1,020	7.8	2,290	17.5	2,742	21.0	4,962	38.0
6	134.05	41.4	0.3	216.8	1.6	1,930	14.4	2,593	19.3	3,095	23.1	3,799	28.3
7	125.86	19.3	0.2	726.4	5.8	1,707	13.6	2,619	20.8	4,214	33.5	3,256	25.9
8	128.79	89.9	0.7	694.9	5.4	947	7.4	2,899	22.5	4,470	34.7	3,552	27.6
9	131.46	34.3	0.3	633.3	4.8	1,799	13.7	1,944	14.8	2,581	19.6	887	6.8
10	141.62	35.0	0.2	927.3	6.5	2,248	15.9	3,222	22.7	2,627	18.5	1,330	9.5
11	127.46	8.0	0.1	845.1	6.6	1,240	9.7	2,158	16.9	1,929	15.1	2,181	17.1
12	131.64	30.6	0.2	930.6	7.1	968	7.4	1,602	12.2	1,897	14.4	2,190	16.6

Month	1962		1963		1964		1965		1966	
	X	f	X	f	X	f	X	f	X	f
Total	(64,905)	512.8	(72,707)	582.0	(98,284)	773.1	(113,255)	898.8	(53,322)	428.6
1	3,136	23.2	2,885	21.4	7,245	53.6	10,740	79.5	4,056	30.0
2	6,663	50.5	9,862	74.8	11,846	89.8	20,694	156.9	6,813	51.7
3	7,527	69.6	12,039	111.3	11,081	102.4	17,572	162.5	10,638	98.3
4	10,292	86.1	13,110	109.7	9,700	81.2	12,266	102.7	7,010	58.7
5	6,153	47.1	6,171	47.2	4,312	33.0	6,445	49.3	3,228	24.7
6	7,048	52.6	2,336	17.4	3,574	26.7	4,487	33.5	2,539	18.9
7	3,862	30.7	2,271	18.0	8,231	65.4	6,446	51.2	4,438	35.3
8	6,365	49.4	6,075	47.2	13,386	103.9	11,148	86.6	6,740	52.3
9	5,653	43.0	4,441	33.8	9,677	73.6	7,547	57.4	4,343	33.0
10	4,226	29.8	4,543	32.1	7,503	53.0	5,459	38.5	2,419	17.1
11	2,029	15.9	3,792	29.7	5,356	42.0	5,254	41.2	631	5.0
12	1,951	14.8	5,181	39.4	6,373	48.4	5,196	39.5	467	3.5
Month	1967		1968		1969		1970		1971	
	X	f	X	f	X	f	X	f	X	f
Total	(35,586)	283.1	(31,229)	246.7	(28,380)	225.1	(28,128)	220.7	(50,747)	397.7
1	1,256	9.3	4,649	34.4	1,623	12.0	1,826	13.5	1,625	12.0
2	4,809	36.5	3,343	25.3	3,047	23.1	2,703	20.5	2,689	20.4
3	5,399	49.9	4,904	45.3	4,203	38.9	3,015	27.9	4,928	45.6
4	4,942	41.4	2,074	17.4	2,673	22.4	2,040	17.1	3,809	31.9
5	2,328	17.8	1,710	13.1	2,775	21.2	1,472	11.3	2,703	20.7
6	1,412	10.5	3,071	22.9	3,076	22.9	4,517	33.7	5,603	41.8
7	2,500	19.9	3,056	24.3	2,534	20.1	4,254	33.8	6,431	51.1
8	2,586	20.1	3,489	27.1	3,430	26.6	3,077	23.9	9,962	77.4
9	2,460	18.7	1,963	14.9	1,644	12.5	2,148	16.3	7,099	54.7
10	2,716	19.2	1,560	11.0	1,205	8.5	1,570	11.1	4,159	29.4
11	1,984	15.6	819	6.4	1,076	8.4	1,046	8.2	1,347	10.6
12	3,195	24.3	594	4.5	1,095	8.3	460	3.5	390	3.0

Appendix table 2. Catch of yellowfin tuna by length class in Japanese Atlantic longline fishery, 1971.  
A. CARIB area.

Length class	Jan.-Mar.	Apr.-June	July-Sep.	Oct.-Dec.	Total
46- 48	191	-	-	-	191
50- 52	-	-	-	-	-
52- 54	-	-	-	4	4
54- 56	-	-	15	12	27
56- 58	191	-	15	16	31
58- 60	-	-	31	28	250
60- 62	-	-	92	37	129
62- 64	-	-	245	73	318
64- 66	-	-	107	118	225
66- 68	287	-	291	264	842
68- 70	191	-	214	277	682
70- 72	287	-	138	355	780
72- 74	287	-	184	347	818
74- 76	-	4	642	375	1,308
76- 78	95	55	550	277	882
78- 80	-	46	107	228	476
80- 82	-	-	184	212	396
82- 84	-	38	122	130	290
84- 86	-	80	122	89	291
86- 88	95	219	322	20	656
88- 90	95	126	398	45	664
90- 92	-	134	412	41	587
92- 94	287	244	276	61	868
94- 96	287	177	429	85	978
96- 98	573	97	780	102	1,552
98-100	383	420	1,682	260	2,745
100-102	191	433	2,937	322	3,883
102-104	95	97	4,374	680	5,246
104-106	-	269	6,118	1,100	7,487
106-108	95	42	8,519	1,801	10,457
108-110	191	429	11,272	2,799	14,691
110-112	95	164	12,557	4,465	17,281
112-114	191	454	15,157	5,695	21,497
114-116	191	290	17,007	6,461	23,949
116-118	95	240	14,683	5,268	20,286
118-120	191	509	9,957	3,231	13,888
120-122	191	252	5,399	1,535	7,377
122-124	191	618	3,457	627	4,893
124-126	95	765	3,075	387	4,322
126-128	573	1,887	4,129	273	6,862
128-130	-	2,135	3,824	187	6,146
130-132	287	2,614	3,518	179	6,598
132-134	-	1,383	3,150	228	4,761
134-136	-	1,664	1,989	179	4,761
136-138	-	1,584	1,529	175	3,832
138-140	287	1,126	627	175	3,288
140-142	191	437	1,345	114	2,154
142-144	-	1,017	1,178	175	2,148
144-146	95	1,324	1,117	106	2,301
146-148	-	2,244	1,453	207	2,743
148-150	-	2,433	1,101	171	3,868
150-152	95	3,194	1,437	138	3,672
152-154	191	2,782	1,376	81	4,807
154-156	191	1,265	1,025	150	4,499
156-158	191	2,295	780	98	2,579
158-160	-	2,072	443	73	3,339
160-162	-	1,446	398	77	2,592
162-164	-	1,131	230	61	1,905
164-166	-	458	122	85	1,446
166-168	-	378	92	57	637
168-170	-	387	61	57	527
170-172	-	387	-	12	460
172-174	-	189	15	8	395
174-176	-	-	31	-	204
176-178	-	-	61	-	31
178-180	-	-	15	-	61
Total	7,457	42,029	152,945	40,741	243,172

Appendix table 2 (continued). B. GUINEA area.

Length class	Jan.-Mar.	Apr.-June	July-Sep.	Oct.-Dec.	Total
46- 48	423	-	-	-	423
56- 58	423	-	-	-	423
64- 66	636	-	-	-	636
66- 68	423	-	-	-	423
68- 70	636	-	-	-	636
70- 72	636	-	-	-	636
72- 74	423	1	-	-	424
74- 76	-	19	-	-	19
76- 78	213	20	-	-	233
78- 80	-	21	-	-	21
80- 82	-	29	-	-	29
82- 84	10	36	-	-	46
84- 86	360	49	6	5	420
86- 88	53	34	2	2	91
88- 90	-	32	-	-	32
90- 92	-	41	1	1	43
92- 94	-	30	8	6	44
94- 96	391	17	-	-	408
96- 98	245	70	-	-	315
98-100	-	72	-	-	72
100-102	-	17	-	-	17
102-104	-	45	8	6	59
104-106	213	7	10	8	238
106-108	-	72	1	1	74
108-110	-	28	15	11	54
110-112	-	76	41	31	148
112-114	-	49	17	13	79
114-116	213	40	52	39	344
116-118	423	86	13	10	532
118-120	255	42	29	22	348
120-122	593	104	71	53	821
122-124	213	129	53	40	435
124-126	1,259	318	22	16	1,615
126-128	360	360	28	21	769
128-130	1,432	448	46	34	1,960
130-132	386	244	64	48	742
132-134	203	322	77	58	660
134-136	819	399	54	41	1,313
136-138	641	261	9	7	918
138-140	1,264	290	21	16	1,591
140-142	258	361	44	33	696
142-144	981	325	25	19	1,350
144-146	606	614	46	35	1,301
146-148	1,359	677	21	16	2,073
148-150	2,163	777	49	37	3,026
150-152	1,382	804	51	38	2,275
152-154	986	519	82	62	1,649
154-156	1,617	627	60	45	2,349
156-158	198	628	42	32	900
158-160	636	409	25	19	1,089
160-162	213	314	13	10	550
162-164	213	161	18	14	406
164-166	493	69	3	2	567
166-168	443	111	6	5	565
168-170	123	75	-	-	198
170-172	213	39	9	7	268
Total	25,934	10,320	1,143	864	37,361