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Japanese yellowfin tuna fisheries in the western and central Pacific and updated CPUE from those fisheries

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1. Introduction

This paper presents a brief description of the Japanese yellowfin fisheries and fishing condition in 1993. Nominal and standardized CPUEs are updated and given for longline and purse seine fisheries. Yellowfin had been dominating in quantity among the tuna species caught by the Japanese longline fishery in the total WPYF area, but it became the second important species since around 1985. In the purse seine and pole and line fisheries, it has been secondary species following to skipjack. The magnitude of fleet by fishery has been stable for purse seine fishery, slightly decreasing for longline fishery in total WPYF area due to decline of offshore licensed boat for longline and distant water licensed boat for pole and line fishery.

The information on fishing condition and preliminary estimates of catch in 1993 were taken from the internal report of the National Research Institute of Far Seas Fisheries.

2. Catch by fishery and fishing condition in 1993

Longline fishery

The estimate for the catch in 1993 is not yet available. However, about the same catch is expected as in 1992. The geographical distribution of 1992 yellowfin catch for offshore and distant water longliners (>50 GRT) is shown in Fig. 1. This pattern is similar to that of 1991. The average catch was 0.9-1.0 MT/day/boat in gilled and gutted weight in the Micronesian waters west of 150°E. In the east of that (Marshall, Truck and Kiribati), it was about 1.3 MT/day/boat with higher catch rate of bigeye in the northern area (5°-11°N). Around Solomon Islands, Coral Sea to New Caledonia (10°-15°S, 145°-165°E), fairly good catches of yellowfin, including albacore and billfishes by distant water longliners were recorded (4.0 MT/day/boat) especially during the first quarter of the 1993. Stable catch of 2.0 MT/day/boat was reported during the rest of year.

Purse seine fishery

1993 catch by species is estimated to be 56,000 MT and 89,000 MT for yellowfin and skipjack respectively. The catch of yellowfin is the record highest but the catch of skipjack went down below 100,000 MT for the first time since 1983. The fishing area ranged mostly in the waters 8°N-6°S, 130°-170°E (Fig. 2) in the western tropical Pacific.

During the first half of 1993, the sea surface temperature (SST) was low because there were some remaining effect of El Nino. In April, high SST over 29°C started to emerge in part in the waters west of 165°E. Due to a low availability of floating logs, the catch was low for fish schools associated with floating objects. Instead, free swimming schools were targeted during this period. This is apparently one of the reasons of the decline of skipjack catch. Since the ability of fishing devices has improved significantly (i.e., faster fastening of purse, powerful power block, etc), the rate of successful set was increased. The fleet targeted free swimming large yellowfin, and very good catch was recorded especially in June and July. Due to low SST, the distribution of skipjack seemed to be very different from the normal pattern, and there were no formation of fishing ground in the area west of 155°E for skipjack. It was reported the log associated operations has increased during fall.

Pole and line fishery

Pole and line fishery takes considerable amount of yellowfin between 5,000 and 10,000 MT in recent years. The major areas of catch locate temperate waters around Japan and tropical waters in the western Pacific (Fig. 3). In average, 70 to 80 % of total yellowfin catch was made in the former area. During January to April in 1993, the larger boats operated in the area 1°S-9°N, 164°-175°W with very high catch. Medium-sized boat (299-350 GRT) fished in the area 5°-13°N, 140°-162°E, then shifted north in April. In June, the fishing effort was directed towards albacore in the north Pacific. After the albacore fishing was ended in early August, the fleet still stayed in the north Pacific targeting skipjack around Japan and Emperor sea mount area. Accordingly, there were almost no fishing activity in the tropical region until the end of October. After the fleet turned to south, fishing ground was first formed at the waters east of Mariana Islands and then formed in the western side of that area. Larger boats operated in far east (2°S-4°N, 164°-175°W). The fishing was generally good but the catch varied among boats.

3. Nominal CPUE

Nominal CPUE of yellowfin by fishery is shown in Fig. 4. The nominal CPUE of the longline fishery shows stable trend up until 1976 and jumped up during the successive two years. Then it continued to decrease gradually to date. The level in 1992 is slightly less than the pre-1976 level. The nominal CPUE of the purse seine fishery increased steadily except the high peak in 1974 until 1981. After that, it stayed slightly lower level, then it went up again since 1991. 1992 point is the record high. CPUE of pole and line fishery after 1981 showed gradual increase trend through this period.

4. Standardized CPUE

Longline fishery

GLM technique was used for the standardization of CPUE. The model developed here is a similar one used in Tsuji and Okamoto (1993) but modified so as to incorporate more factors such as gear and targeting (by-catch) . Those are :1) WPYF areas 3-5 was divided into 15 subareas (Fig. 4), 2) as a fishing season, month was used rather than quarter of the year, 3) gear effect (deep longlining, i.e., number of hooks between floats) was considered, and 4) by-catch (other than yellowfin, i.e., bigeye and albacore catch rates) was taken into account. Regarding 3), each number of hooks between floats was aggregated to fewer classes (4 classes) by looking at the preliminary run which includes all main effects and one interaction term (month and area). Catch rates of other tunas were also similarly treated, for example, 5 classes for bigeye and 3 classes for albacore, respectively. Another option, which was introduced as well, was that this factor was treated as nominal variable rather than class variable.

Results of ANOVA and estimated parameters were shown in Table 4. It should be noted that adding catch rates of bigeye extremely improved the fit of the model. Inclusion of this factor pushed r-square up to nearly 90 % and 80 % when it was treated as class or nominal variable, respectively. When catch rates of bigeye was not included, r-square was about 40 %. The estimated parameters for this factor as class variable indicate that there are strong positive correlation between catch rates of bigeye and yellowfin. The standardized CPUEs (Fig. 5) are different between the two. The one in which by-catch factor was treated as class variable shows fairly stable trend whilst the other shows decreasing trend after 1981 with some fluctuation. At this point, it is very difficult to judge which CPUE does better reflect the real abundance. It is essential to examine what and how each factor affects CPUE.

Purse seine fishery

The standardized CPUE for purse seine fishery was updated by using same model and same data series as Tsuji and Okamoto (1993). The finally selected model by them was multiplicative and additive models for small and large yellowfin, respectively. In this study, standardized CPUE was also estimated for total yellowfin (small and large together). The CPUE for small yellowfin shows stable trend with 83, 86, 87 being high. That for large yellowfin shows increase after 1987. That of toal yellowfin is slightly increasing showing in-between trend.

5. Sampling of gonad for reproductive biology

In order to perform the reproductive biology for the better understanding spawning activity, sex ratio and size at maturity, the sampling program for yellowfin gonad has started since May 1994. NRIFSF asked sampling of yellowfin gonad to training longline boats of fisheries high school and research vessels of Japan's Marine Resources Research Center. Up to now, about 10 boats made sampling (600 females) and sent them to NRIFSF in frozen condition. More samples are expected to be obtained during this year and next year. The area of sampling is rather limited, approximately from the areas 10°-15°N, 175°E-160°W and 4°S-5° N, 160°-167°E.

References

Tsuji, S. and H. Okamoto. 1993. CPUE analysis of Japanese fisheries for yellowfin tuna in the central and western Pacific. WPYRG3/Working. Paper. No.7. 24pp.

Table 1. Catch in number (in thousand) and fishing effort of the Japanese Longline Fishery in WPYF total area.

Year	Hooks	ALB	BET	YFT	YFT WGT
70	172	1072	694	1149	40970
71	176	786	720	1056	35664
72	174	721	976	1046	38301
73	160	793	684	1134	38094
74	185	641	778	1152	37214
75	158	425	734	995	36685
76	179	762	871	1118	40420
77	169	647	983	1535	47794
78	183	573	839	2213	66576
79	213	669	939	1759	57623
80	222	703	913	2294	69063
81	242	1047	756	1930	56520
82	225	1007	872	1617	47864
83	198	856	815	1627	51808
84	203	717	889	1254	39654
85	211	764	947	1328	46830
86	184	673	752	996	32161
87	182	660	942	901	29237
88	202	789	769	1077	37827
89	185	741	827	859	29878
90	177	793	933	890	32408
91	158	689	680	635	22544
92	140	744	653	684	22983

Table 2. Total catch (MT) by the Japanese purse seine fishery in WPYF area.

Year	Days fishing	SKJ	YFT	BET
70	114	365	164	0
71	2659	7948	2867	129
72	3322	12145	4184	119
73	3364	12356	7281	182
74	2069	4841	9419	294
75	2511	6749	5595	265
76	3136	17719	7649	390
77	2638	18255	6807	302
78	2932	25821	8523	609
79	4219	28298	19013	706
80	4203	41138	19701	564
81	5325	43912	27161	925
82	7159	75016	31035	1131
83	10085	115731	30819	1468
84	12698	128528	38647	697
85	12473	119155	47925	1379
86	11716	130805	44463	1531
87	11189	112924	44504	1602
88	11177	174346	30106	605
89	11273	120495	40872	1527
90	10056	138299	37617	2121
91	9476	142404	46255	1528
92	9156	136690	52889	2561
93*	?	88724	55741	2623

1993 is provisional (NRIFSF internal data)

Table 3. Total catch (MT) by the Japanese pole and line fishery in WPYF area.

Year	Days fishing	SKJ	YFT	BET
81	60768	192625	9050	2337
82	56619	182218	9490	3807
83	48343	209300	9326	3762
84	46531	245243	8690	3192
85	43324	158513	12920	3981
86	40093	222149	8410	2519
87	38657	171754	8464	2810
88	29420	179875	7304	3644
89	31998	172720	7808	3544
90	28927	103259	5867	2659
91	22330	144846	5405	1230
92	21735	109446	6829	1033
93*	?	140627	?	?

Table 4-1. The results of ANOVA and sum of squares explained by factor in the General Linear Model analysis applied for the Japanese longline yellowfin CPUE. Bigeye catch rates are treated as class variable.

Number of observations in data set = 35691

General Linear Models Procedure

Dependent Variable: LCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	181	35688.3427	197.1732	1807.61	0.0001
Error	35509	3873.2980	0.1091		
Corrected Total	35690	39561.6408			

R-Square	C.V.	Root MSE	LCPUE Mean
0.902095	7.669533	0.33027	4.30628

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	17	20.7065	1.2180	11.17	0.0001
MONTH	11	9.1852	0.8350	7.66	0.0001
AREA	12	283.6090	23.6341	216.67	0.0001
ED – hooks/basket	3	2.5597	0.8532	7.82	0.0001
ALB	2	12.7523	6.3762	58.45	0.0001
BET	4	16176.5030	4044.1257	37075.09	0.0001
MONTH*AREA	132	221.7379	1.6798	15.40	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
ED	1	0.022905981 B	3.14	0.0017	0.00729504
	2	-0.008952150 B	-1.06	0.2874	0.00841522
	3	0.002621753 B	0.48	0.6329	0.00548851
	4	0.000000000 B	.	.	.
ALB	1	-0.053585921 B	-10.80	0.0001	0.00496211
	2	-0.037088972 B	-5.36	0.0001	0.00692363
	3	0.000000000 B	.	.	.
BET	1	-2.715728240 B	-365.72	0.0001	0.00742570
	2	-1.685302150 B	-255.52	0.0001	0.00659546
	3	-1.196298074 B	-184.52	0.0001	0.00648315
	4	-0.682626353 B	-126.74	0.0001	0.00538606
	5	0.000000000 B	.	.	.

Table 4-2. The results of ANOVA and sum of squares explained by factor in the General Linear Model analysis applied for the Japanese longline yellowfin CPUE. Bigeye catch rates are treated as nominal variable.

Number of observations in data set = 35691

Dependent Variable: LCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	176	31469.4557	178.8037	784.71	0.0001
Error	35514	8092.1851	0.2279		
Corrected Total	35690	39561.6408			

R-Square	C.V.	Root MSE	LCPUE Mean
0.795454	11.08487	0.47735	4.30628

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	17	150.2787	8.8399	38.80	0.0001
MONTH	11	39.9408	3.6310	15.94	0.0001
AREA	12	2384.0531	198.6711	871.90	0.0001
ED	3	16.5498	5.5166	24.21	0.0001
CBET	1	11969.9991	11969.9991	52532.48	0.0001
MONTH*AREA	132	520.3043	3.9417	17.30	0.0001

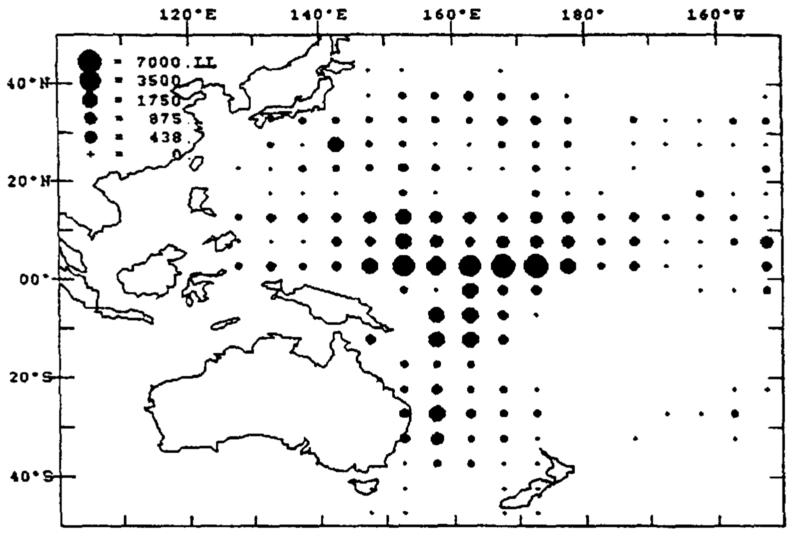

Fig. 1. Geographical distribution of yellowfin catch (in number) by the Japanese longline fishery.

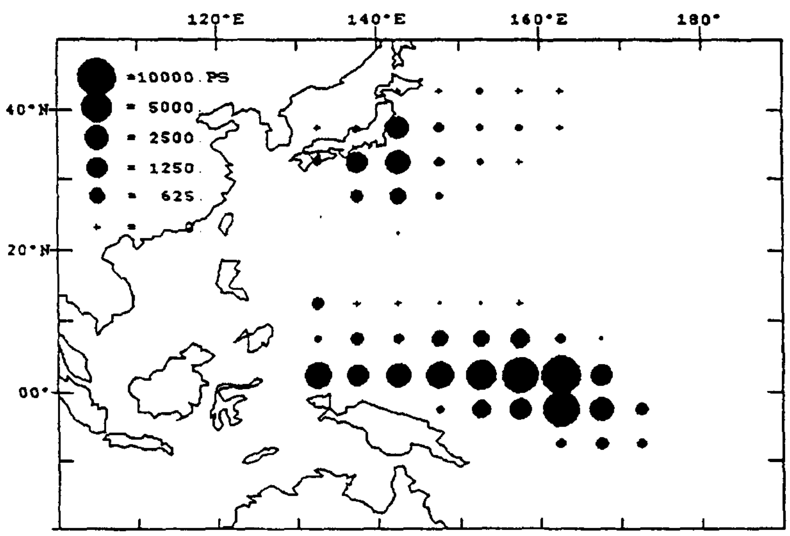

Fig. 2. Geographical distribution of yellowfin catch (MT) by the Japanese purse seine fishery.

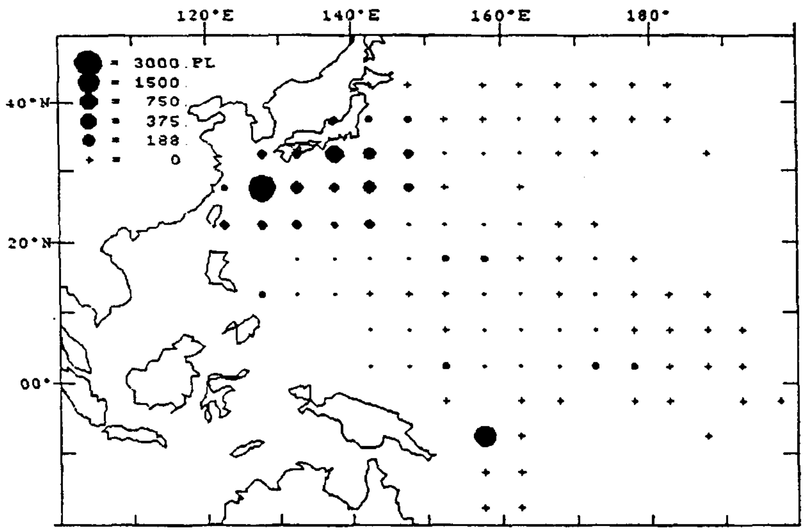

Fig. 3. Geographical distribution of yellowfin catch (MT) by the Japanese pole and line fishery.

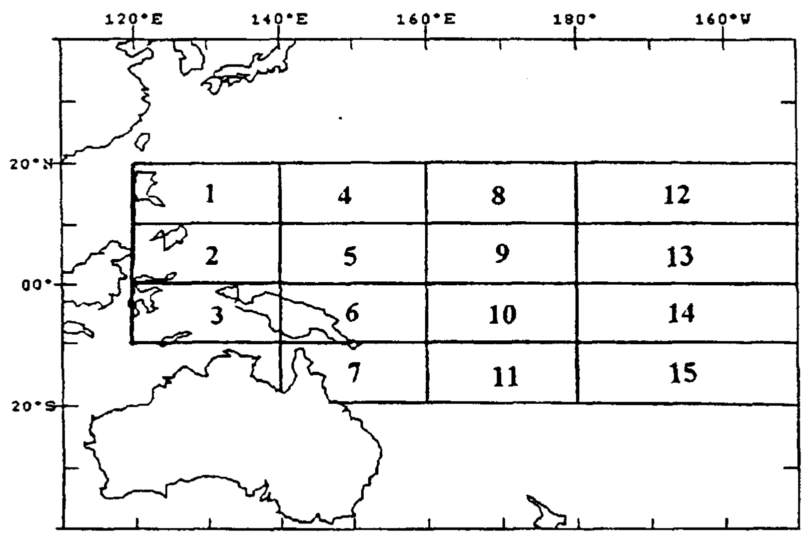

Fig. 4. Area division used for the statdardization of yellowfin CPUE by the Japanese longline fishery.

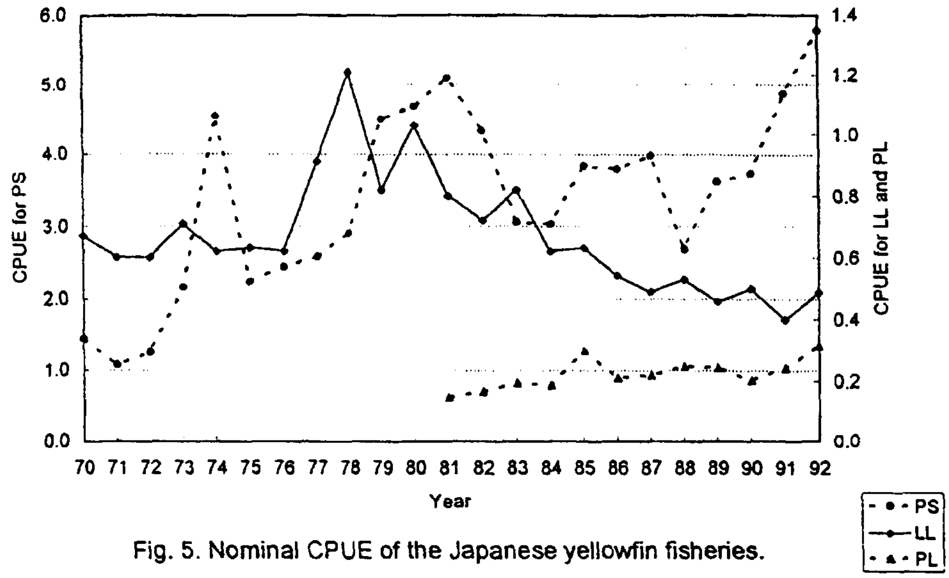

Fig. 5. Nominal CPUE of the Japanese yellowfin fisheries.

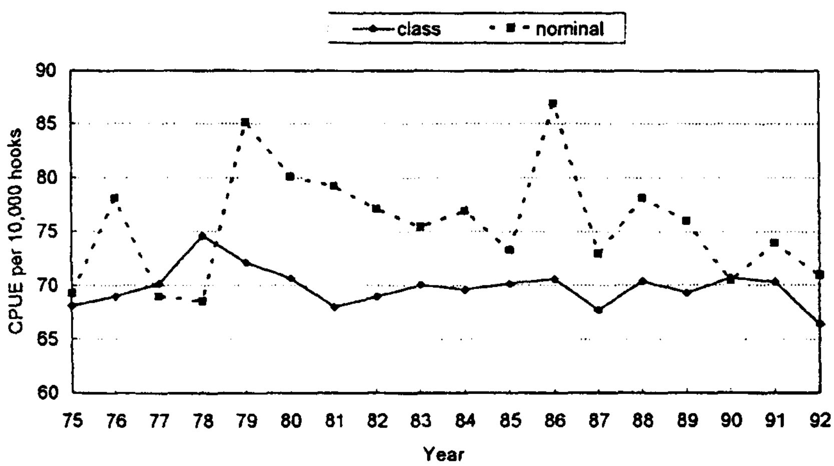

Fig. 6. Standardized CPUE for the Japanese longline fishery.

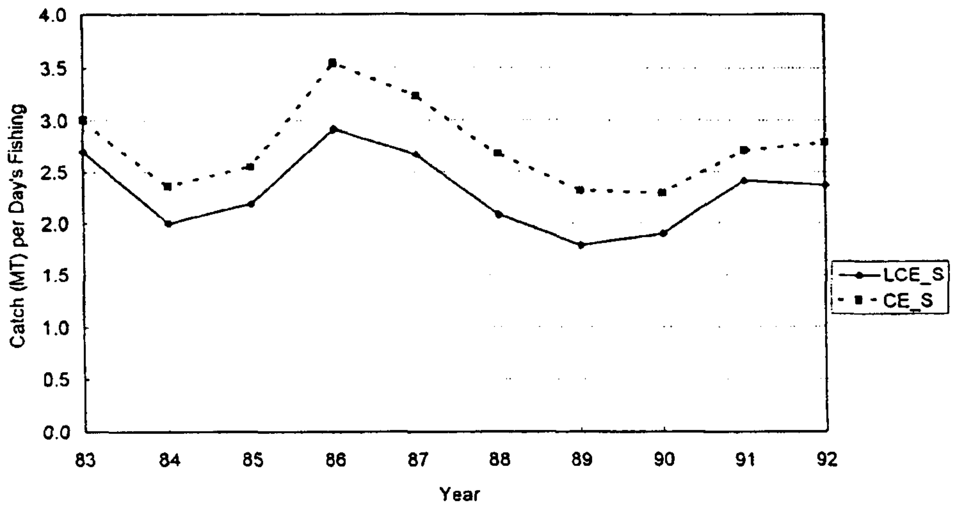

Fig. 7. Standardized CPUE for the Japanese purse seine fishery, small yellowfin.

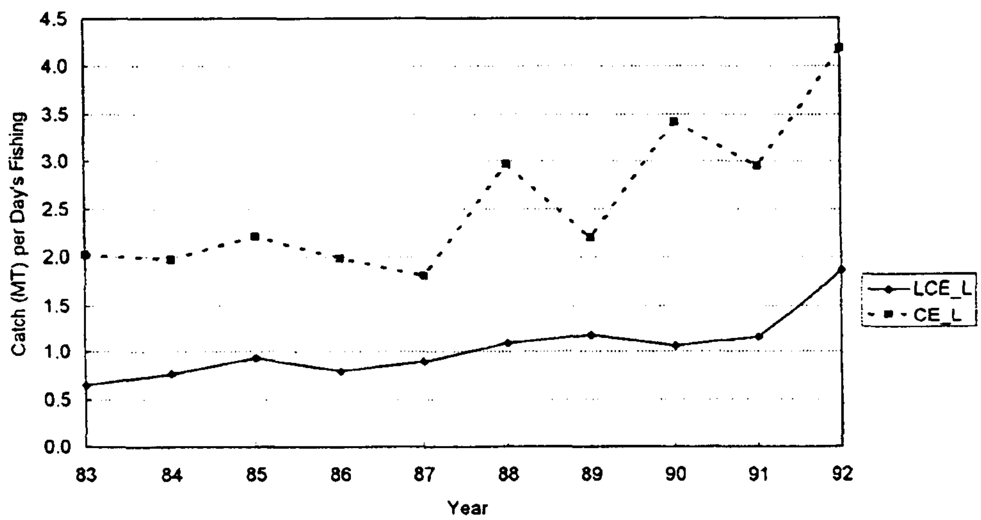

Fig. 8. Standardized CPUE for the Japanese purse seine fishery, large yellowfin.

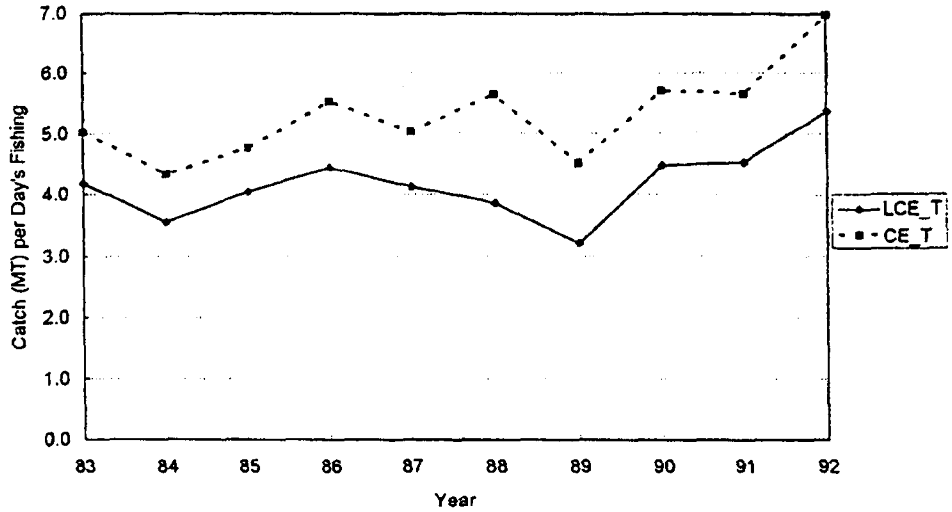

Fig. 9. Standardized CPUE for the Japanese purse seine fishery, small+large yellowfin.