Fishery Indicators from the Japanese Tuna Fisheries in the Western Central Pacific

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1. Length frequency

Length frequencies of skipjack, yellowfin and bigeye tunas caught by the Japanese purse seine fishery (equatorial fishery) were estimated by landing and port sampling data. Overall length frequencies of each species caught in 1996 and 1997 are shown in Fig. 1. For yellowfin, most fish ranged between 30 and 140 cm in fork length (FL). In 1997, more large (> 60 cm) fish and less small fish (<50cm) were observed compared with 1996 data. It is noteworthy that the catch for medium fish between 60 and 80 cm were significant possibly for the first time. Similarly considerable amount of medium bigeye (60-80 cm) was also caught in addition to the regular size of this species. Skipjack catch also indicates much larger size in 1997 than in 1996 with dominant mode at 51cm.

Length frequency distributions of those three species by quarter are shown in Fig.2. For skipjack dominant mode was at around 50 cm until the third quarter of 1997, but smaller fish (about 40cm FL) appeared in the fourth quarter and far dominated in the catch at the first quarter of 1998. Bigeye and yellowfin tunas indicate similar seasonal changes with respect to the size range and position of modes, although yellowfin size is slightly larger than bigeye. During the first half of the 1997, length frequencies were bimodal (modes at 43 cm and 64 cm), but the modes became obscure in the following quarter. In the following quarters, much larger size was caught and smaller size (40-50 cm) recruited the fishery.

2. Species composition in the purse seine fishery

As is well known, some of bigeye tuna are not accurately separated from yellowfin tuna, so we re-estimated the catch composition of three species. Landing statistics, which were divided into market categories, and port sampling data were used. Table 1 indicates the results of comparison between landing figures and corrected ones for 1996 and 1997. It is clear that the catch of bigeye was underestimated in the landing statistics.

Compared the estimated annual catch of 1996 with 1997, the amount of skipjack reduced by nearly 50,000 MT, while that of yellowfin and bigeye was drastically increased. These changes are probably due to the changes in oceanography, caused by the strong El Niño event. As it is indicated in the Japan's country report, the Japanese purse seine fleet operated, for the first time, in the waters east of 170 E extending from Marshall to Gilbert and Phoenix Islands. At the same time, extensive use of fish aggregating devices (FADS) is reported. The fact that about 10 boats left the equatorial fishing ground targeting fresh skipjack in nearshore water of Japan during summer is also contributed to the decline of skipjack catch.

The composition of sets and catches containing yellowfin and bigeye is shown in Table 2. The sets and catches containing yellowfin and bigeye were almost constant during 1991-1993, declined during 1994-1996, and increased again in 1997. In the mixed catches with skipjack, catches dominated by yellowfin+bigeye (more than 60 % of total catch) was over 60% of total yellowfin+bigeye catch during 1991-1993, went down below 60% during 1994-1996, and again over 60% in 1997.

3. Catch per unit of fishing effort

Yellowfin

Standardized CPUEs for purse seine fishery were calculated from following formula:

$\log(CPUE)=Year_i+Set+SKJ+\varepsilon$

where Set and SKJ are rations of school set and skipjack catch, respectively.

Standardized relative and nominal CPUEs for yellowfin caught by purse seine fishery are shown in Fig.3. For both small (<10kg) and large (>10kg) fish, CPUE decreased in 1996, and that of small fish increased in 1997. As mentioned before, that may due to El Niño. Compared with nominal CPUE, standardized CPUE indicated similar trends of change except for large fish in 1997.

CPUE for longline fishery, which was calculated as follows, is shown in Fig.4.

$\log(HR+1.0)=Year_i+Month_j+Area_k+Main_l+Branch_m+HPB_n+Month_j*Area_k+\varepsilon_{ijklm}$

where,

log:	natural logarithm,
Main:	main line material,
Branch:	branch line material,
HPB:	hooks per basket,
ε_{ijklm}:	error term N(0, σ).

The trend has hardly gone with that of purse seiners. CPUE for longliners had a peak in 1978, had fluctuated and declined since then, and has been stable since 1989 except for 1994.

Skipjack

Nominal CPUE for skipjack is shown in Fig.5. CPUE for skipjack has fluctuated since 1983, and CPUE of 1997 was lower than that of previous year.

4. Trend of some future of Japanese purse seine fishery in the Pacific

Purse seine sets by Ocean based on logbook data

Annual changes in the number of sets by Japanese purse seiners in the Pacific Ocean were shown in Fig. 6. Equatorial purse seine set started around 1975. The number of sets, which was about 7000 in the early 1980s in the Pacific, reduced to 5000-6000 recently.

In the Pacific Ocean, about a half of total sets are log sets and most of the rest are free sets (Fig. 7). Floating objects such as natural logs, fishing nets and broken boats are abundant. Although 'logs' include several forms of logs, that is, natural logs as they are, logs with radio buoy, and logs with radio buoy and FADS (net and bamboo or other wooden material), it is impossible now to distinguish them in the logbook data.

Frequencies of catch per set calculated by the data from 1989 through 1996 are compared between set types (Fig. 8).

The frequencies of catch per set showed similar distribution between log and free school sets, although that in lower catch is rather higher for log school set than that for free school set. Annual change in average catch per set is shown in Fig. 9. Total catch per set of log and free school sets showed similar trend, and increased after 1990, though they show wide fluctuation.

Fig. 10 shows annual change in the number of fishing days (searching days + days with sets). Basically, the trend is similar to that of the number of sets shown in Fig. 6. Fishing days is somewhat declining. Searching days in the total fishing days (Fig. 11) has slightly increasing through the time. Though the reason of increase in searching time can not be interpreted simply, it is now taking longer time to find fish school which may suggest the decline of fish stock.

Change in distance between operations

Increase in searching ability would surely affect on catch efficiency. And actually it is almost certain this has occurred. In this sense, the distance between successive sets might be indicative of fish density.

Fig. 12 shows annual change in distance between continuous log sets and free sets. Average distance for free sets, which was about 70-80km in the 1980s, increased to 80-100km in the early 1990s. However, those in 1995 and 1997 were lower at about 70km, and the trend doesn't seem to be consistent. On the other hand, the average distance between log sets, which was around 110km during the first half of the 1980s, increased to about 150 km in the second half, and further increased to 160-170 km in the most recent three years. Although decrease in natural logs is also possible reason for this increasing trend, there is no information on log density. In any case, this trend in distance between operations seems to link with increasing trend in searching days described above, and might suggest decrease in school density if the distance between operations reflects the change in distance between schools.

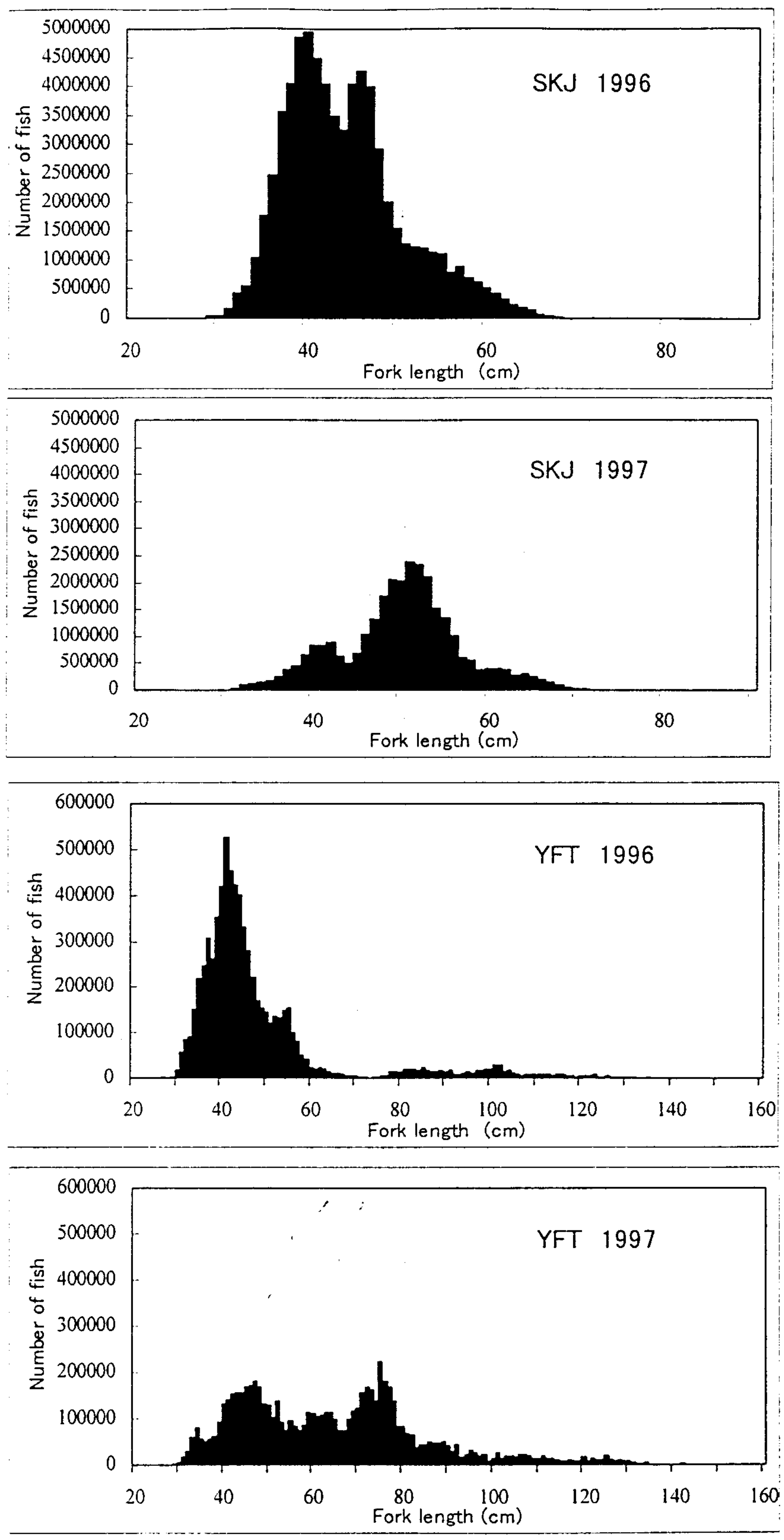


Fig. 1 Length frequency of all the purse seine (equatorial fishery) catch.

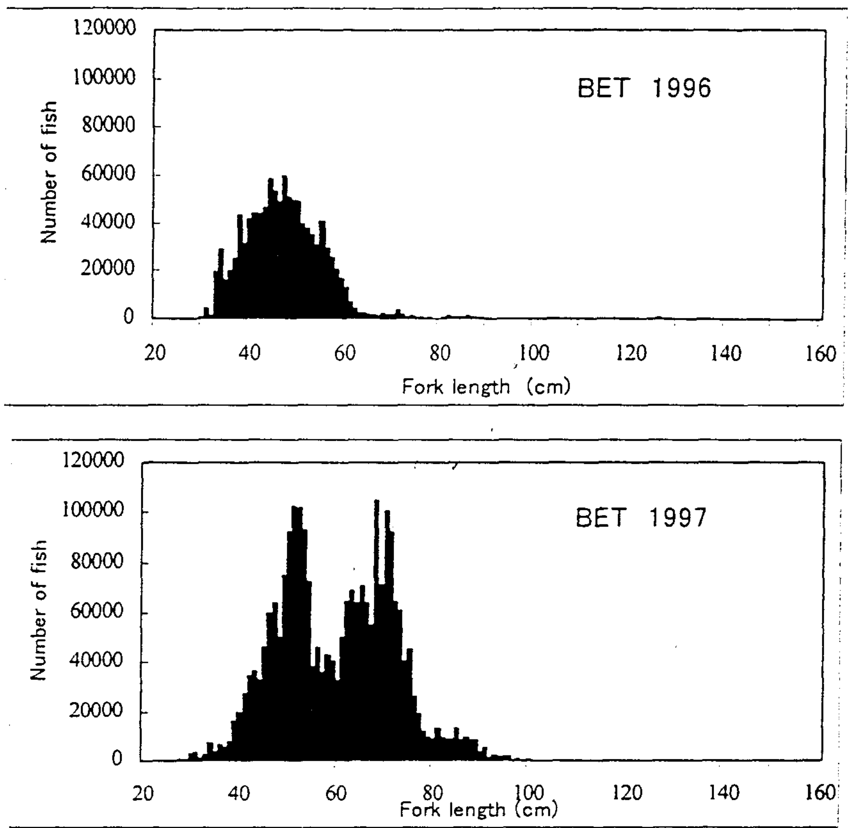


Fig.1 Length frequency of all the purse seine (equatorial fishery) catch (continued).

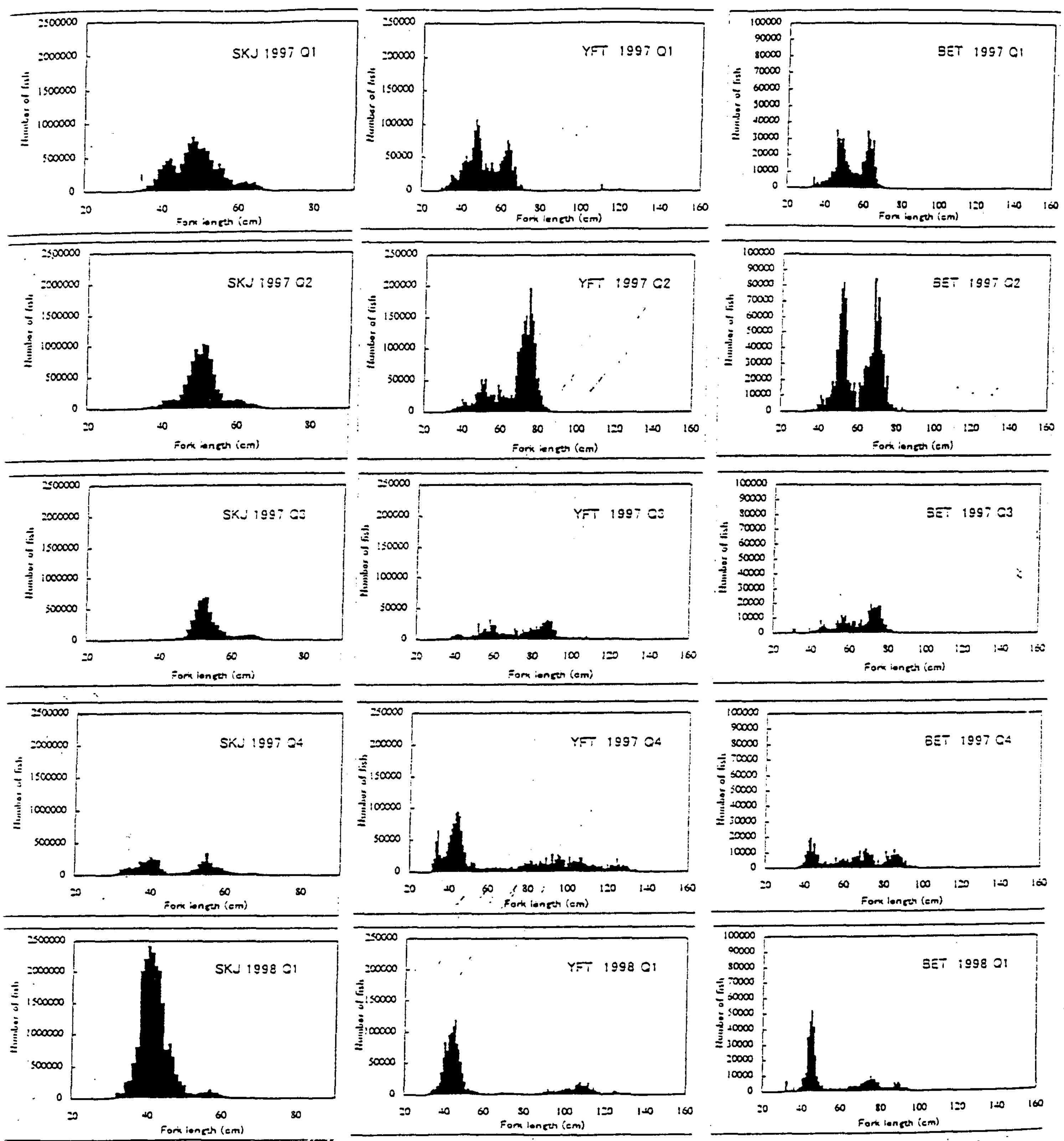
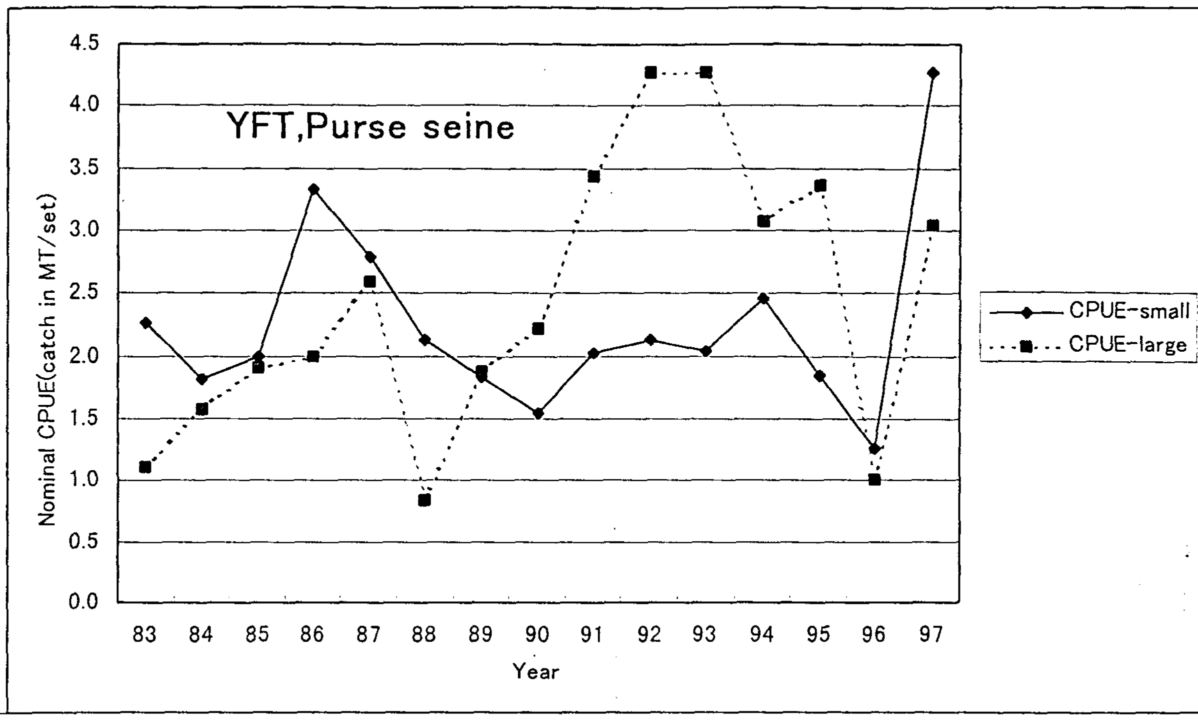


Fig.2 Length frequency of purse seine catch by quarter.



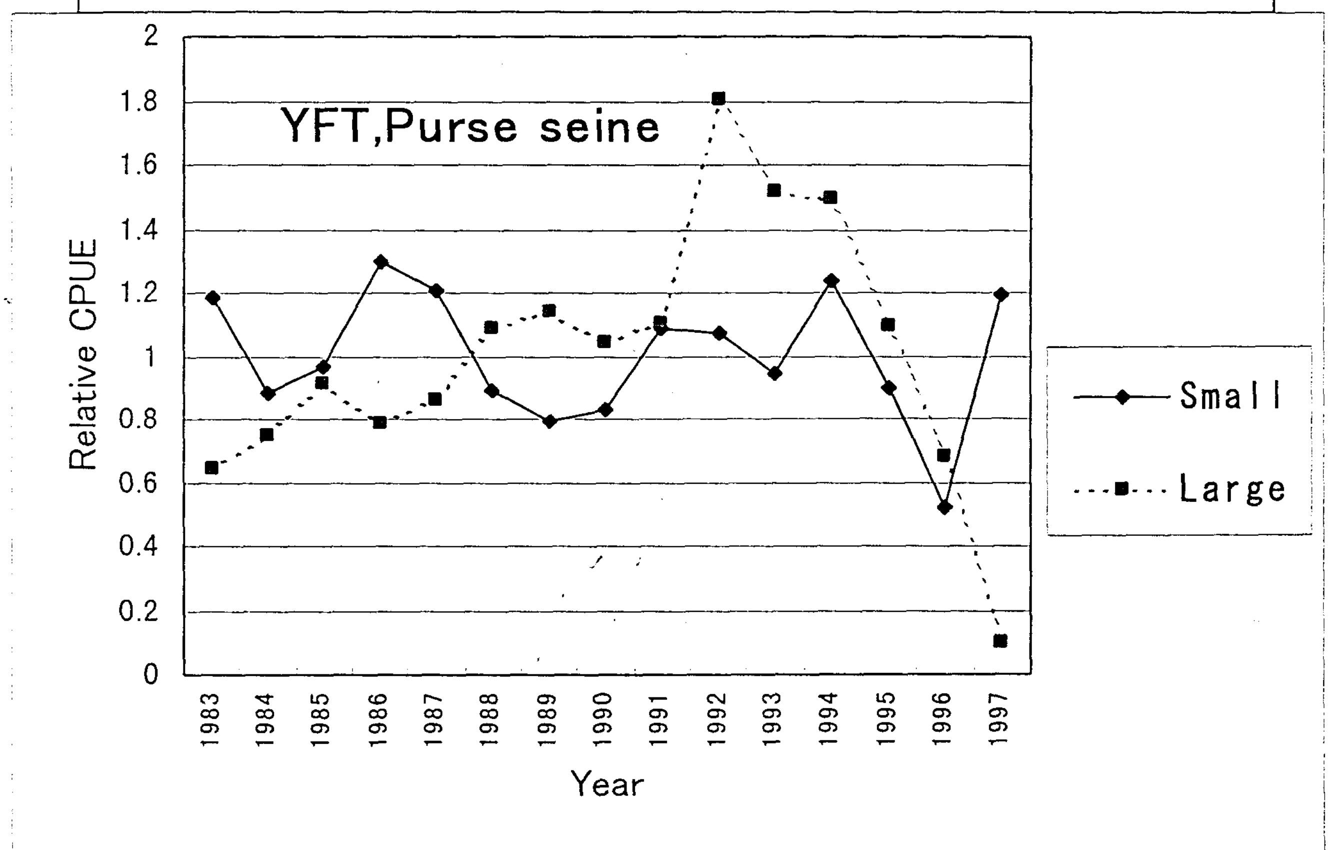


Fig.3 Trend of nominal and standardized (relative) CPUEs for yellowfin tuna of purse seine catch.

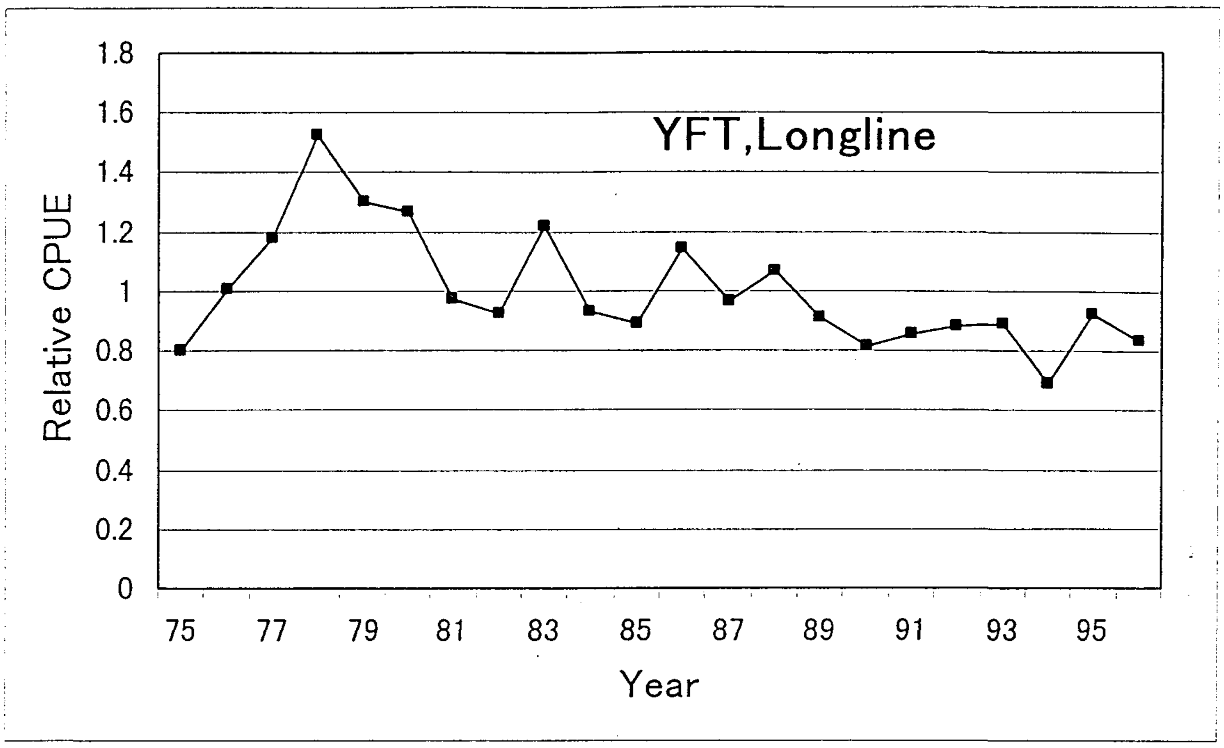


Fig.4 Trend of nominal CPUE for yellowfin tuna of longline catch.

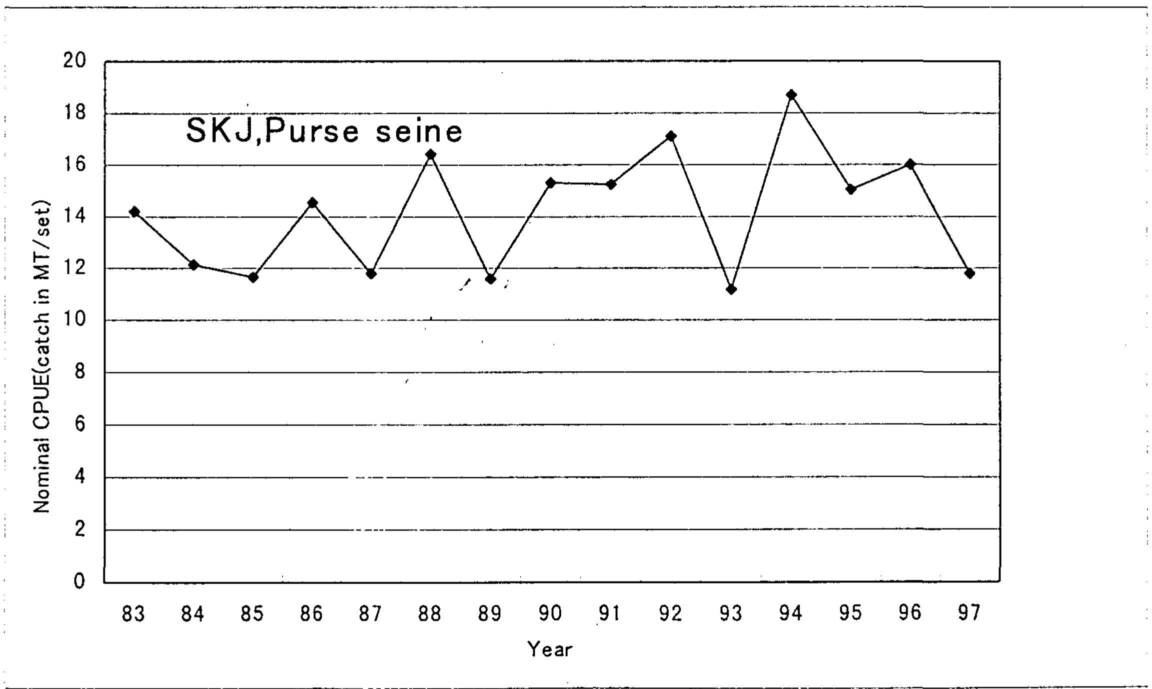


Fig.5 Trends of nominal CPUE for skipjack tuna of purse seine catch.

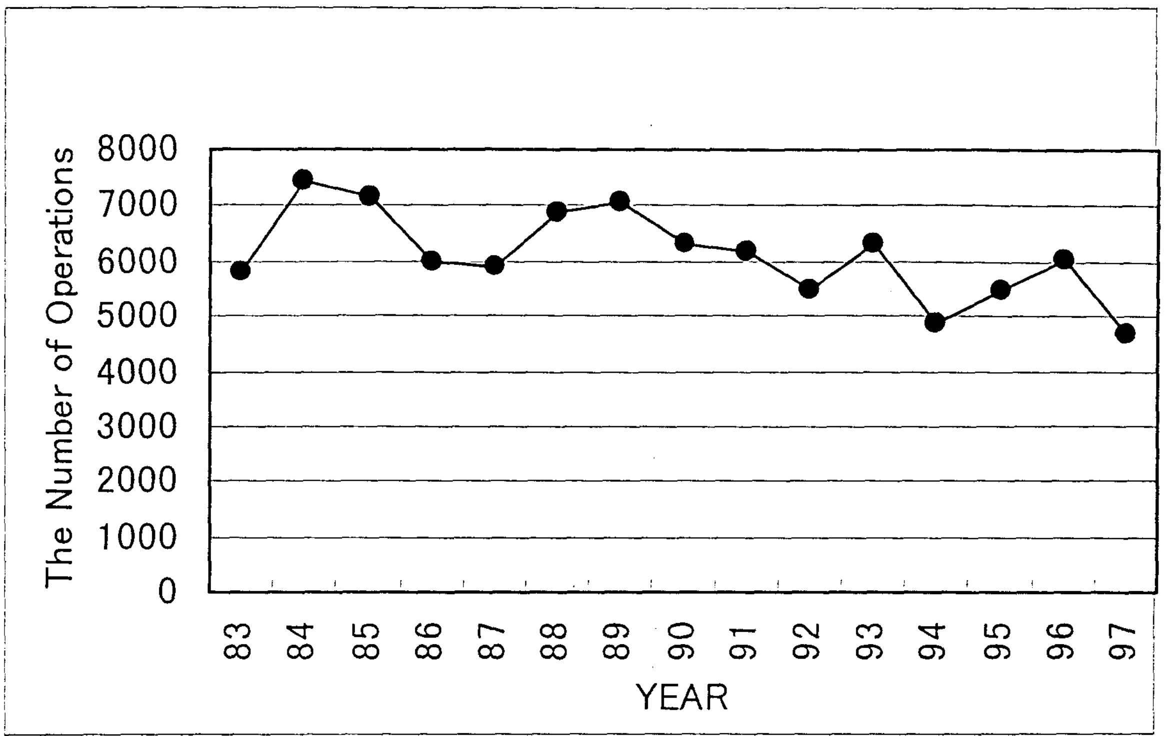


Fig. 6 Annual change in the number of purse seine operations in the Pacific ocean.

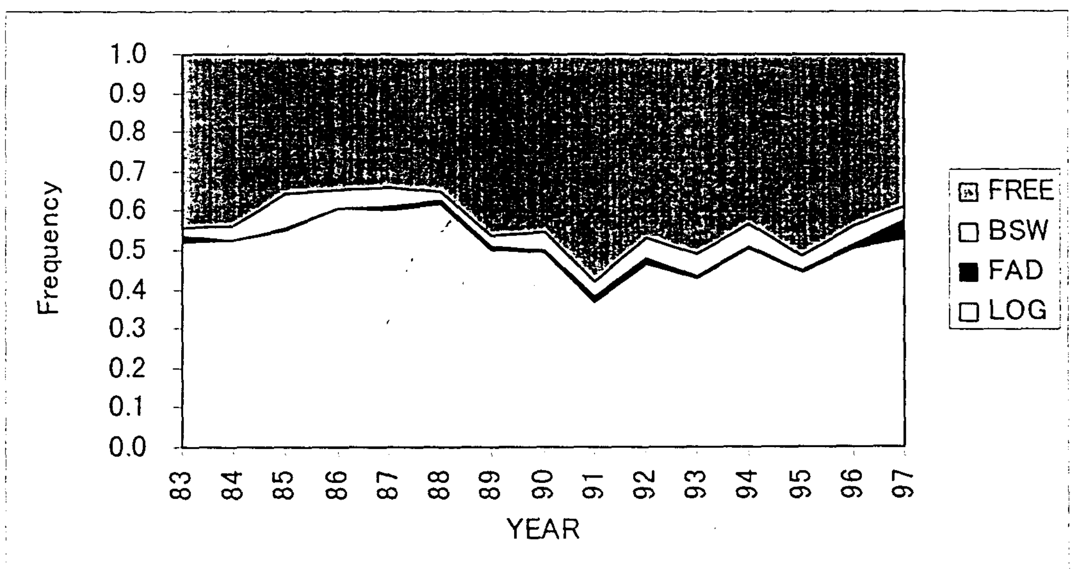


Fig. 7 Annual change in the school type rate in total operations in the Pacific Ocean.

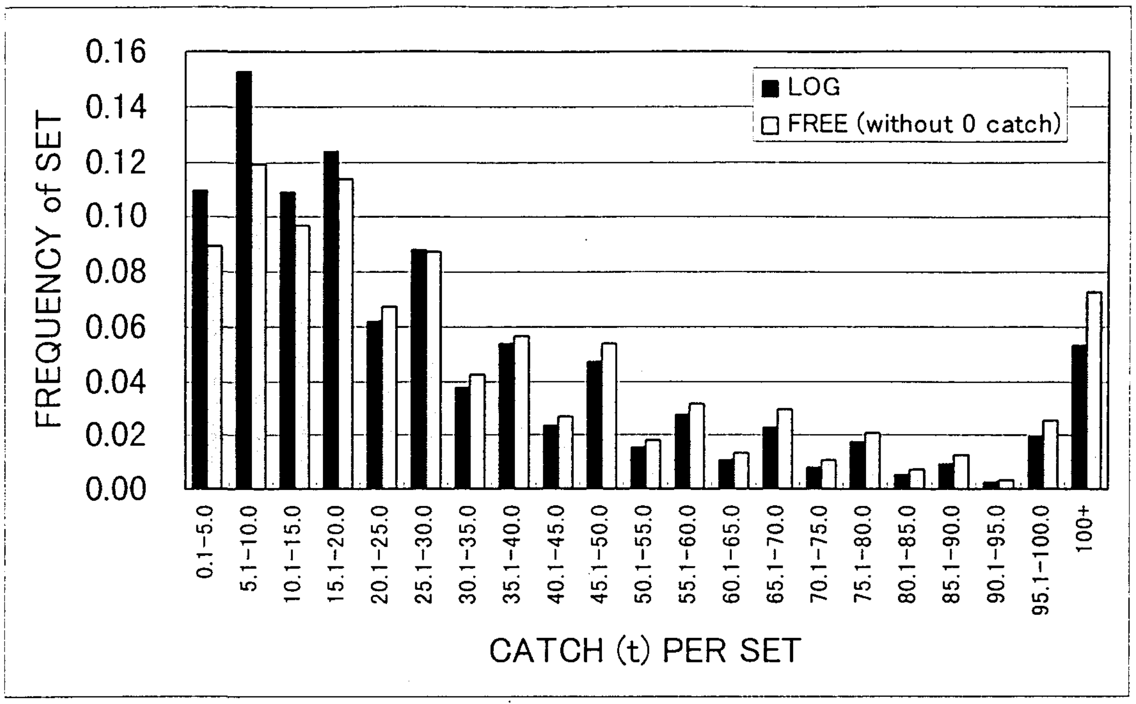


Fig. 8 Frequency distribution of catches for successful free school sets and successful log school sets made by Japanese purse seiners in the Pacific Ocean.

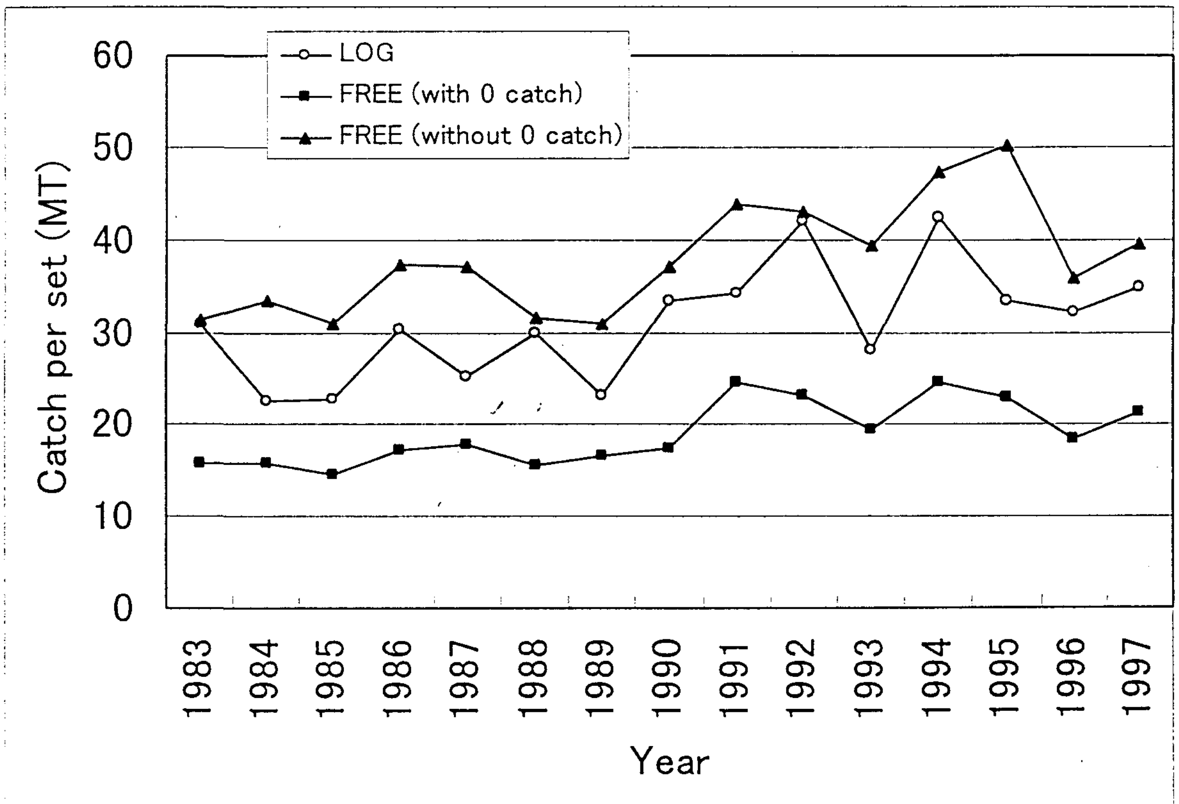


Fig. 9 Annual change in average catch per set for log school sets and free school sets including 0 catch and that without 0 catch.

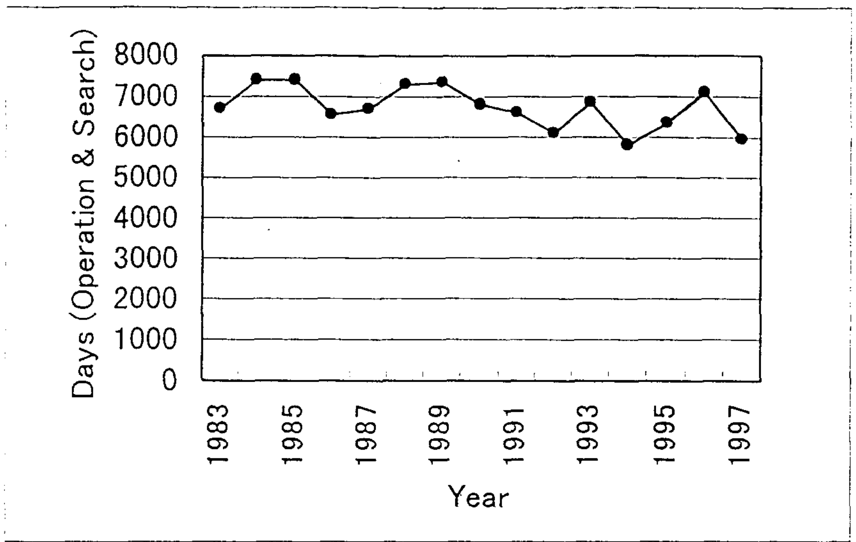


Fig.10 Annual change in the number of fishing days (operation days + search days) in the Pacific Ocean.

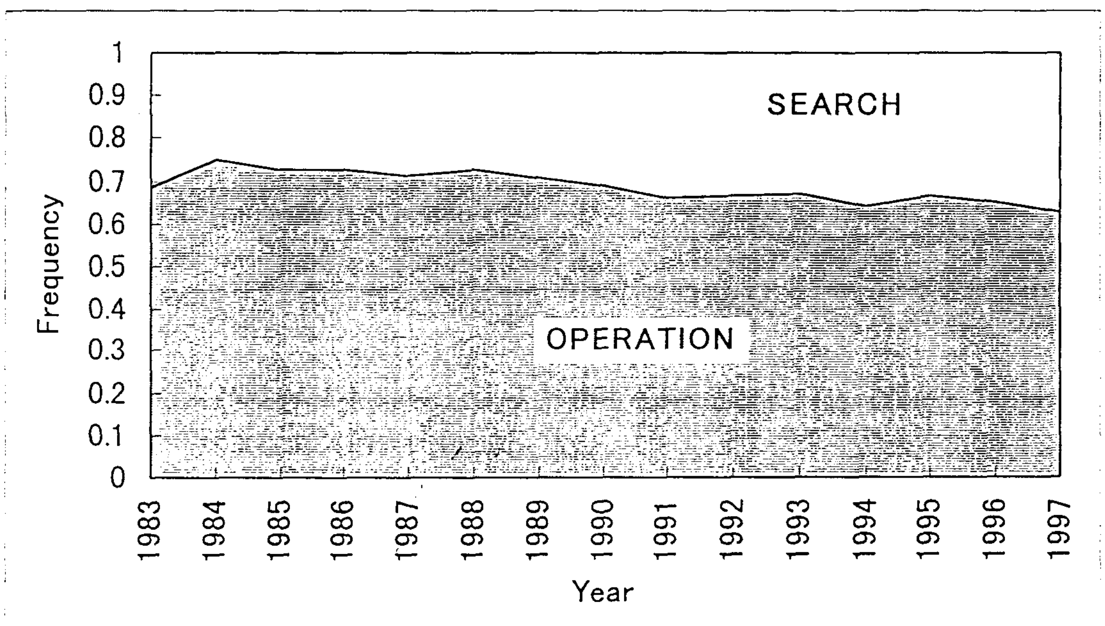


Fig.11 Change in the rate of the number of search and operation days in total fishing days.

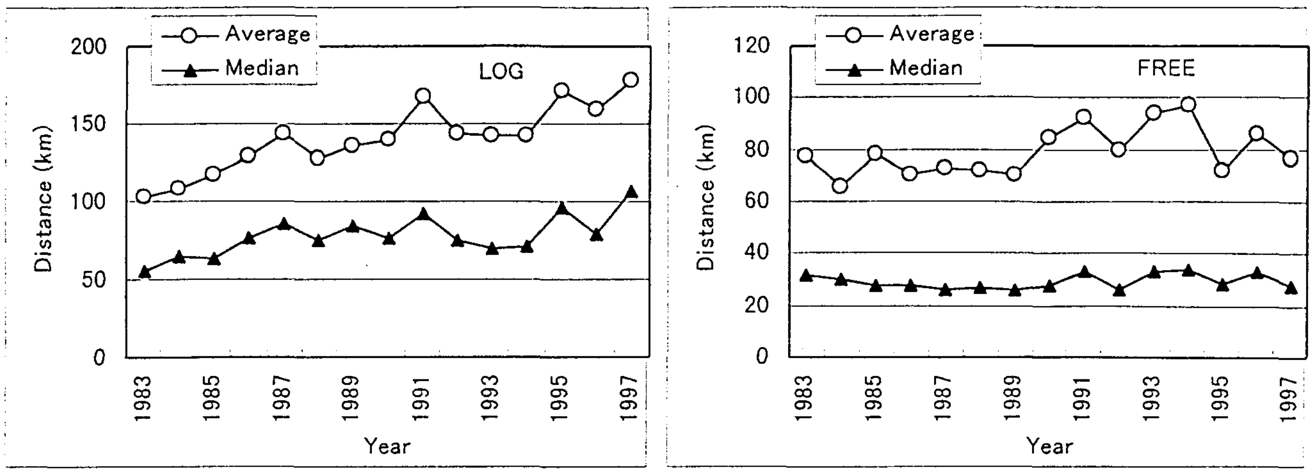


Fig. 12 Annual change in the distance between purse seine operations in the Pacific Ocean. Left and right figures present LOG associated and FREE school respectively.

Table 1. Comparison between landed and estimated catch of Japanese purse seine fishery (equatorial fishery) for 1996 and 1997 (unit=MT).

	Landed catch				Estimation by landing and port sampling			
Year	**SKJ**	**YFT**	**BET**	**Total**	**SKJ**	**YFT**	**BET**	**Total**
1996	137047	26889	1947	165882	132050	25750	2836	160636
1997	84805	49665	11638	146109	84732	49745	13082	147559

Table.2. Sets and catches which contain different level of yellowfin+bigeye for the Japanese purse seine fishery. Data were extracted from logbook.

Year	Sets(%)		Catches(MT)		Rate of pure catch(%)	<40%		40-60%		>60%	
	Pure	Mix	Pure	Mix		Set	Catch	Set	Catch	Set	Catch
91	23.8	76.2	19154	26428	42.0	51.4	24.5	9.3	8.7	39.3	66.8
92	22.3	77.7	23023	25901	47.1	59.0	30.4	8.0	7.0	33.0	62.6
93	21.4	78.6	23330	28113	45.4	59.5	31.4	8.2	7.2	32.3	61.4
94	14.5	85.5	12288	26090	32.0	67.1	41.0	9.7	8.7	23.2	50.3
95	17.7	82.3	16714	23247	41.8	66.4	35.8	7.9	8.1	25.7	56.1
96	8.7	91.3	4979	14979	24.9	74.7	48.5	11.5	12.9	13.8	38.6
97	18.9	81.1	15950	41843	27.6	41.8	20.1	16.9	15.8	41.3	64.1