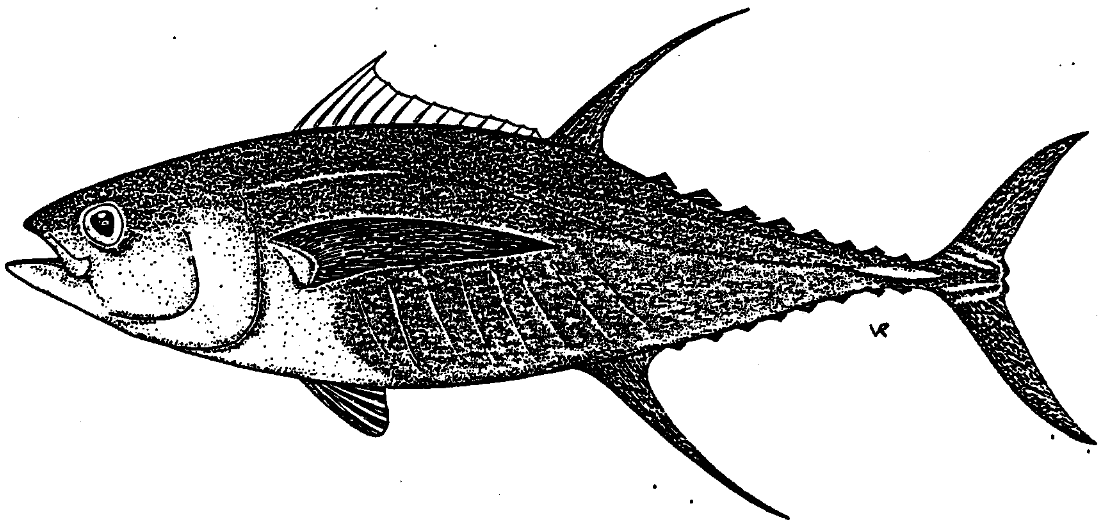
THIRD STANDING COMMITTEE ON TUNA AND BILLFISH

6-8 June 1990
Noumea, New Caledonia

WORKING PAPERS 9 AND 10

SPC/NFSFRL COLLABORATIVE STUDY



Tuna and Billfish Assessment Programme
South Pacific Commission
Noumea, New Caledonia

June 1990

COLLABORATIVE STUDY BETWEEN SPC AND JAPAN NATIONAL RESEARCH INSTITUTE OF FAR SEAS FISHERIES: GENERAL REPORT

1. INTRODUCTION

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The first phase of the study began in Noumea with the three-month visit to SPC headquarters of NRIFSF scientist Dr Sachiko Tsuji. During the visit, Dr Tsuji worked closely with SPC Principal Fisheries Scientist Dr John Hampton.

Because of the short period of the visit, it was decided to restrict the initial work to the purse seine fishery. The specific objectives in relation to the initial work were:

(i) Comparison of Japanese and U.S. purse seine size and species composition data;
(ii) Comparison of catch, effort, CPUE, gear efficiency and areas of operation of the different purse seine fleets operating in the western Pacific;
(iii) Construction of preliminary abundance and concentration indices for the Japanese purse seine fishery, in particular comparing results using complete Japanese statistics and relevent data held on the SPC Regional Tuna Fisheries Database.

2. REVIEW OF RESULTS TO DATE

2.1 Comparison of Japanese and U.S. size and species composition data

Because of the short time series of the U.S. data and the low coverage of Japanese data, direct comparisons of size composition from similar area-time strata were not possible. In general, similar features relating to size composition were indicated. The main findings were:

- Log sets captured yellowfin and skipjack mainly in the 40-70 cm length range.
- School sets captured pure skipjack and yellowfin schools as well as mixed schools.
- Larger yellowfin (80-150 cm) tend to be caught in school sets.
- The proportion of the catch reported as yellowfin was generally around 20-25% for Japanese purse seiners, although higher proportions were caught in 1981-82 and 1987.
- The proportion of bigeye in the U.S. purse seine catch reported as yellowfin was 29% (by number) during 1988. Further investigations are planned with Japanese purse seine data.

2.2 Comparison of catch, effort, CPUE, gear efficiency and areas of operation

CPUEs, as calculated from SPC data, for the Japanese, U.S., Taiwanese and Korean fleets, are shown in Table 1.

TABLE 1. Effort (days fishing and searching) and CPUE for the major purse seine fleets of the western Pacific.

Year	Japan		U.S.		Taiwan		Korea	
	Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE
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1984	5,555	4.89	624	11.10	528	1.63	623	1.89
1985	4,657	4.93	774	7.17	1,086	1.82	631	0.94
1986	4,715	6.50	535	9.23	1,136	1.41	546	4.40
1987	4,717	6.51	502	13.06	2,750	0.78	1,520	4.74
1988	4,895	3.26	3,919	2.88	3,706	0.77	1,706	2.91
1989	4,142	5.11	2,828	5.20	4,205	0.87	1,774	1.27

Further analyses indicated different gear efficiencies (as measured by catch per successful set), operational patterns and target species among the fleets. The following points were highlighted:

- The Japanese fleet operated in the most westerly area, with the Taiwanese, Korean and U.S. fleets generally more to the east, but with some overlap with the Japanese fleet. The operating area of all fleets, and the extent of overlap, varied considerably from year to year.
- The U.S. fleet has the highest gear efficiency (about 40 mt per successful set) and tended to catch large, free-swimming yellowfin more than the other fleets. Sets on free-swimming schools accounted for 55-65% of the total successful sets by U.S. purse seiners.
- The Japanese fleet had the largest average number of sets per day with a total catch per successful set of 30 mt. Sets on logs accounted fo 60-70% of successful sets by Japanese purse seiners.
- The gear efficiency of the Korean fleet showed an apparent increase since 1987, resulting from a decrease in the percentage of sets on logs (60%) as well as a drop in the success rate for log sets. The low success rate for log sets would appear to be unreasonable and

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- The Taiwanese fleet appears to target log-associated skipjack almost exclusively and has the lowest gear efficiency of 20 mt per successful set. A very high percentage of successful sets suggests that unsuccesful operations are not being consistently recorded.

2.3 Construction of preliminary abundance and concentration indices

Preliminary abundance and concentration indices, based on SPC holdings of Japanese purse seine data, were constructed. Similar calculations were then made in Japan after the completion of Dr Tsuji's visit using the entire Japanese purse seine data set. This was done to test whether the incomplete coverage of Japanese purse seiners in the SPC database (60-80% in recent years) affects such analyses. Prior to 1983, days in which searching took place but no sets were made were not recorded on Japanese logbooks, therefore comparable calculations with the Japanese data could only be made with data from 1983 onwards.

The analyses were performed using purse seine sets from the area 10°N-6°S, 130°E-165°E. The data were stratified into areas of 2° latitude by 5° longitude and either monthly or quarterly time periods. The abundance index was estimated as the CPUE averaged across strata on an annual basis. The concentration index, also calculated annually, is the correlation coefficient between stratified CPUE and effort. If CPUE accurately reflects relative fish abundance, the concentration index a measure of the degree to which effort is concentrated in areas where the fish are concentrated.

Raw CPUE (total catch/total effort) showed a very close correspondence between the SPC and Japanese data sets (Figure 1). Larger discrepancies occured with the calculated abundance indices (Figure 2), particularly those stratified by quarter. Although the trends were similar, it appears that some bias may be introduced by assuming that the SPC data set is a random sample of all Japanese purse seine sets.

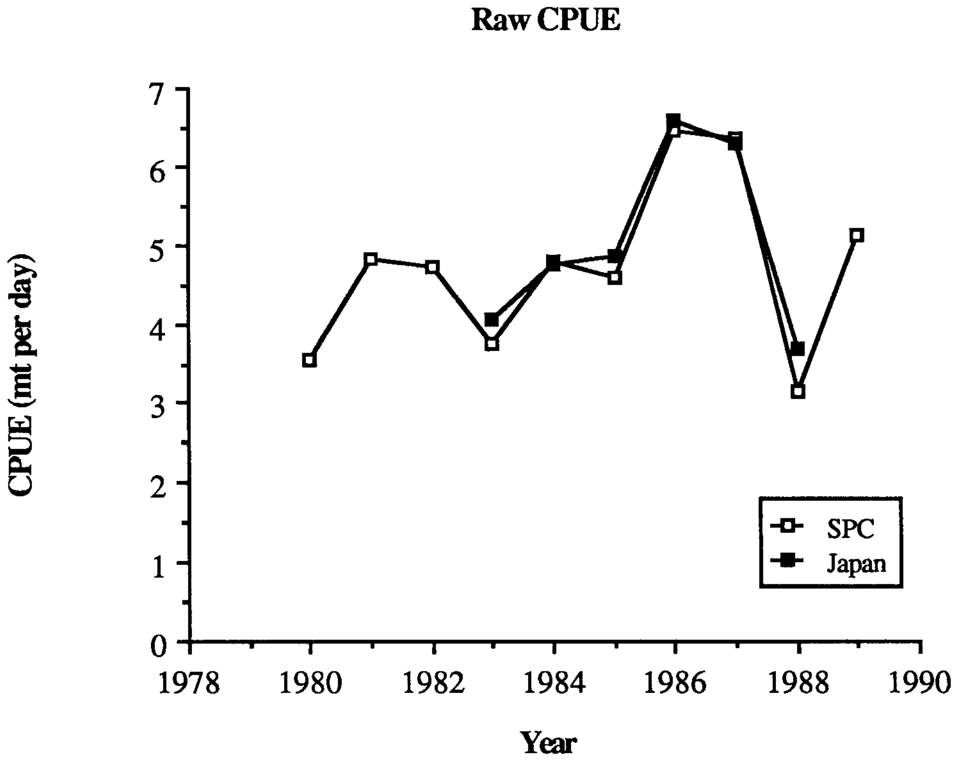
Comparisons of the calculated concentration indices appear in Figure 3. There are substantial differences between the two data sets, suggesting that the SPC data is a biased sample for analyses that include area stratification. It is interesting to note that, for both data sets, the concentration indices for skipjack are higher than those for yellowfin. This suggests that the distribution of the Japanese purse seine fleet is determined more by the distribution of skipjack than by that of yellowfin.

3. CONCLUSIONS

The collaborative study has made good progress towards its objectives, but there is clearly much work to be done. The study has been hindered to a large extent by the continued unavailability of U.S. purse seine data prior to June 1988. Clearly, this large amount of fishing effort should be taken into account in the estimation of abundance indices, and subsequently in estimating purse seine-longline interaction. The following points are highlighted for future collaborative study:

- Calculation of yellowfin abundance indices from purse seine catch and effort data, including effects such as vessel size and gear characteristics, vessel nationality, set type, skipjack catch and environmental effects, as appropriate.
- Estimation of size and species composition of Japanese and U.S. purse seine catches, by area and time strata.
- Compare coverage of SPC data holdings of Japanese longliners with complete data held in Japan.
- Develop abundance indices for yellowfin based on Japanese longline catch and effort statistics, including effects relating to the environment, differences in setting techniques, etc, as is appropriate.
- Compare CPUE trends between longline and purse seine free-school sets on adult yellowfin.

FIGURE 1 **Comparison of raw Japanese purse seine CPUE for yellowfin in the area 10°N-10°S, 130°E-180° as indicated by complete Japanese statistics and statistics held for Japanese purse seiners on the SPC Regional Tuna Fisheries Database.**



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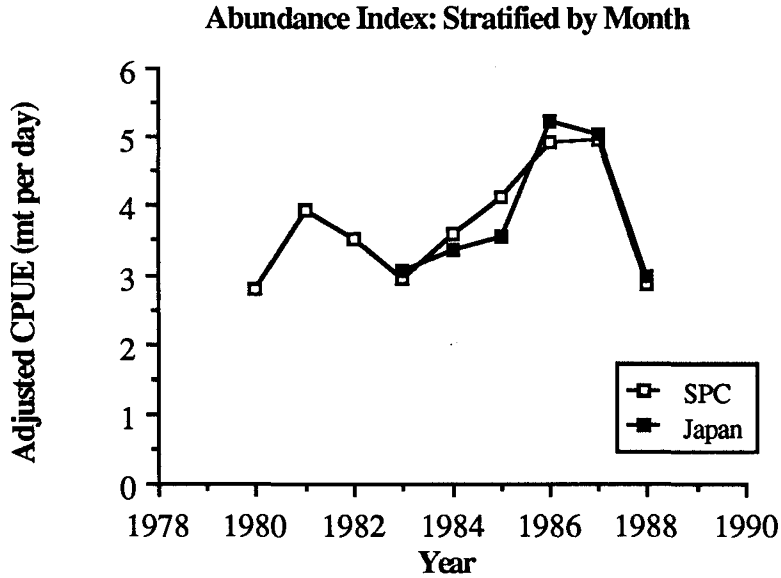

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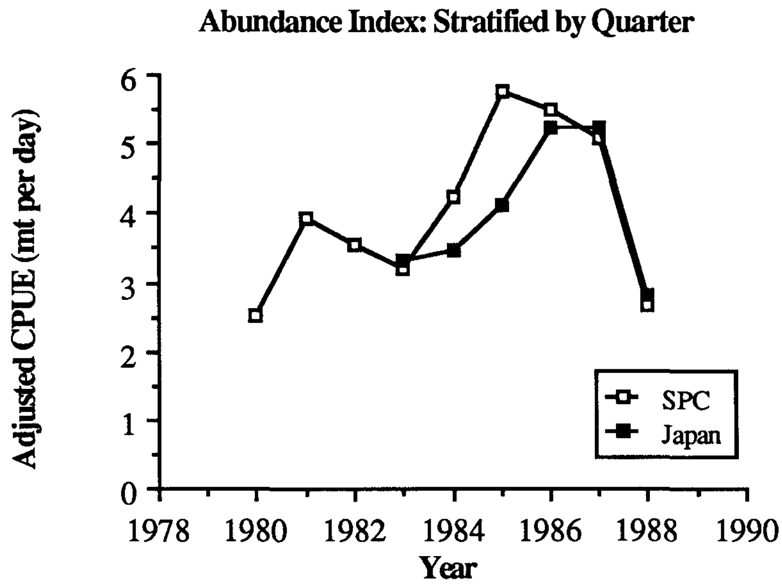

FIGURE 3 **Comparison of concentration indices for the Japanese purse seine fishery for yellowfin in the area 10°N-10°S, 130°E-180° as indicated by complete Japanese statistics and statistics held for Japanese purse seiners on the SPC Regional Tuna Fisheries Database.**

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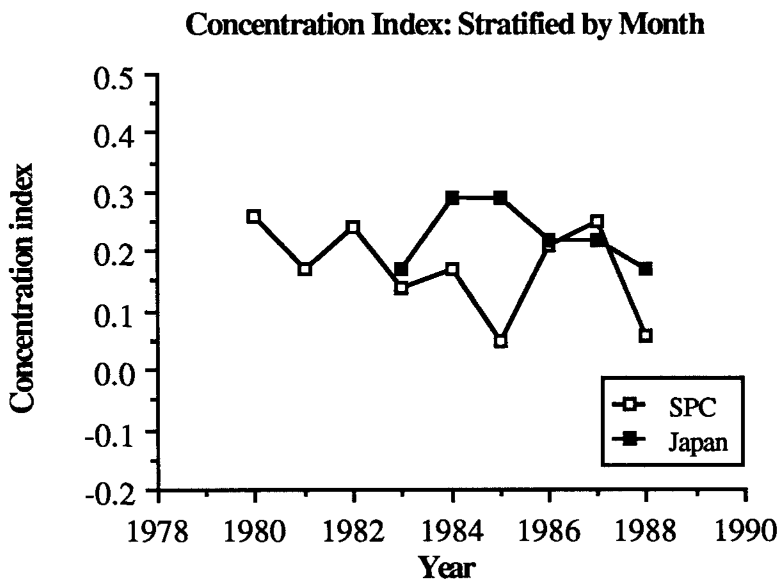

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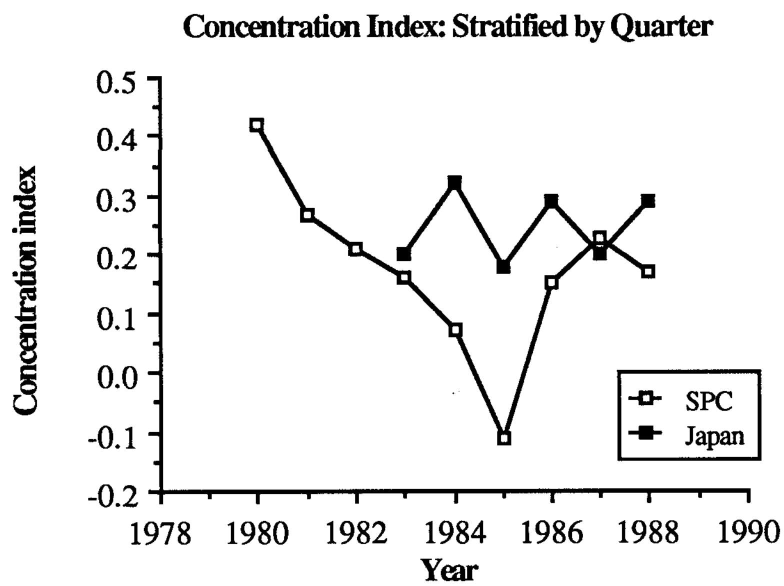

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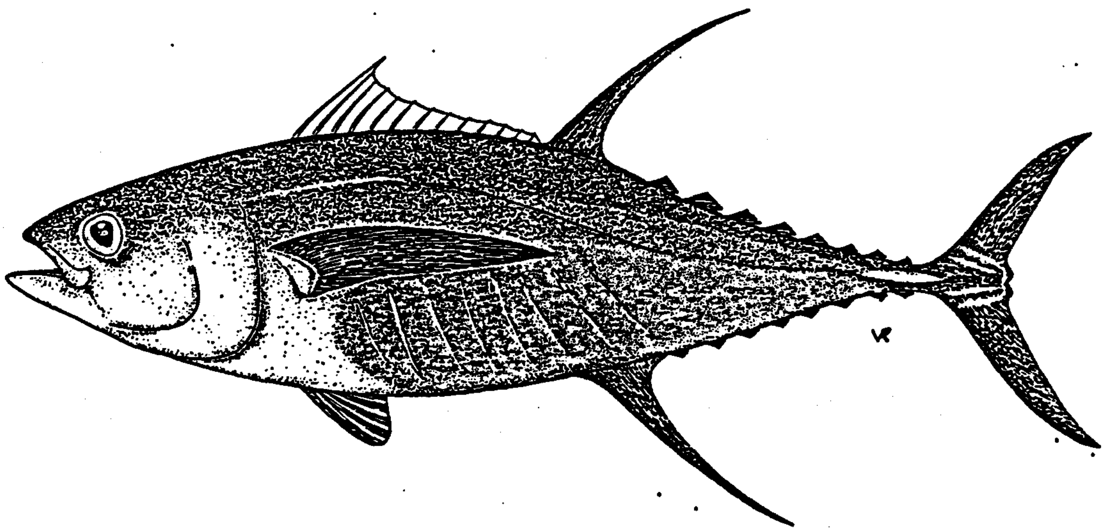

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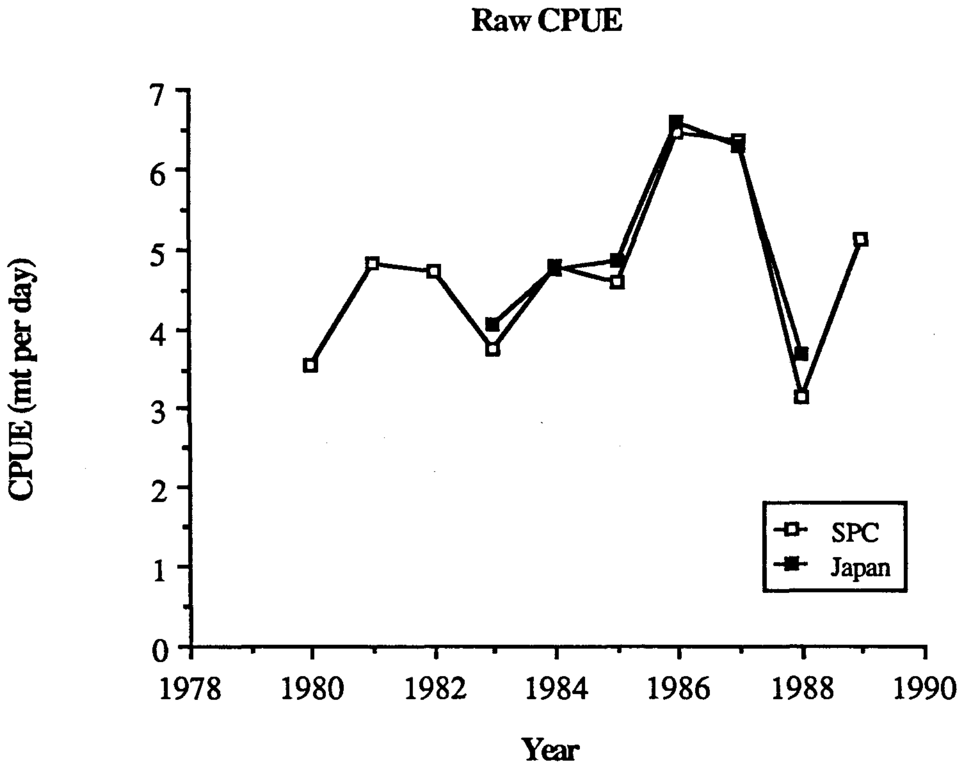

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(a)

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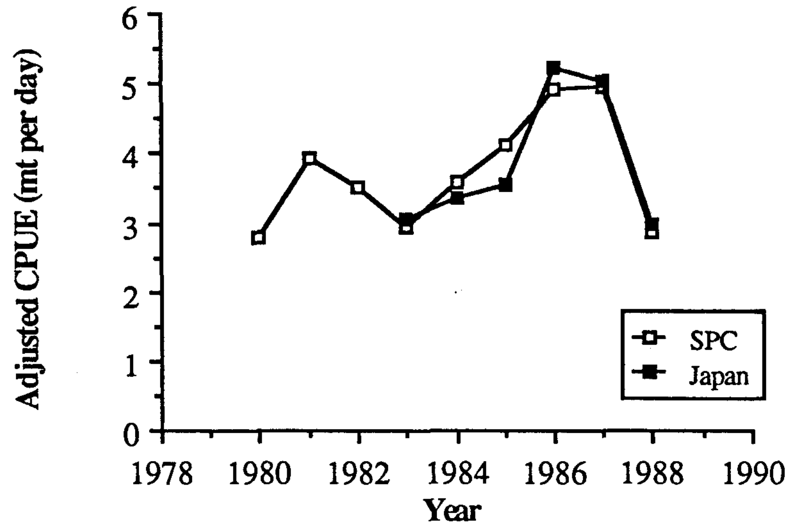

(b)

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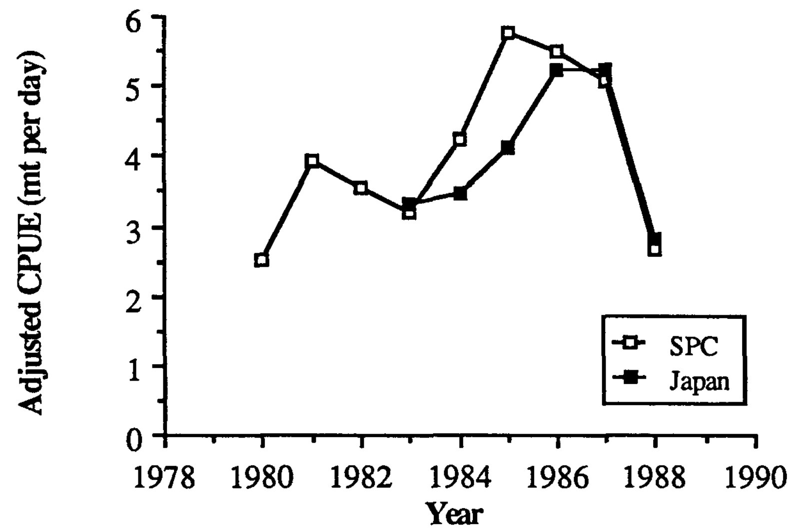

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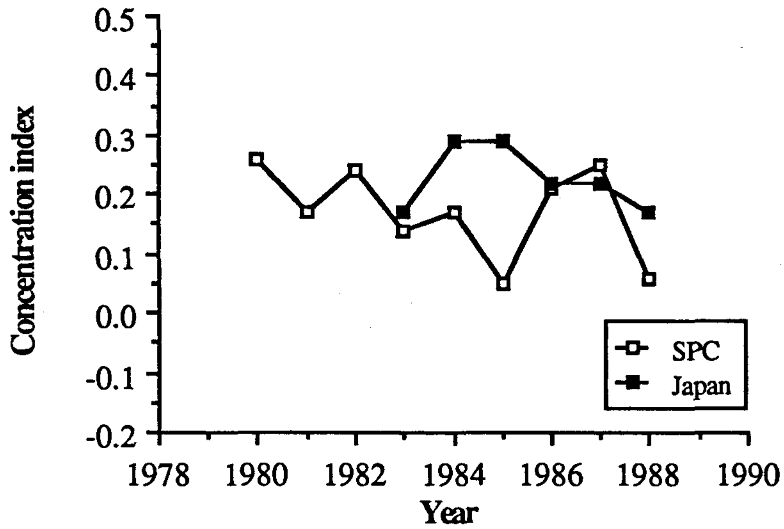

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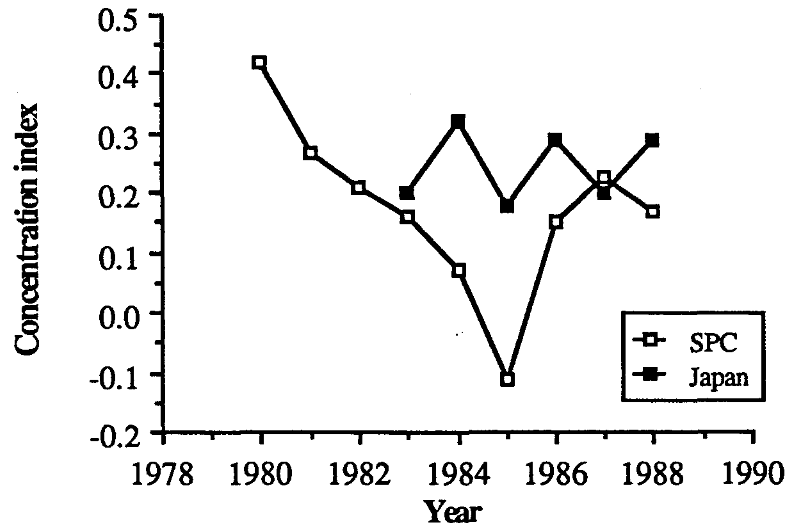

DRAFT

Operation and CPUE of Japanese Purse Seine in the Western Tropical Pacific

Sachiko Tsuji

National Research Institute of Far Seas Fisheries

Introduction

Based on the Action Sheet Item 4 of the 1988 Standing Committee on Tuna and Billfish, a collaborative study between the Tuna and Billfish Program of South Pacific Commission and the National Research Institute of Far Seas Fisheries (NRIFSF) in Japan was held from September 21 to December 21 of 1989.

The study was originally planned to work on the interaction between surface and longline fisheries in the western Pacific with a particular reference to yellowfin tuna. But the objective of study was shifted to the development of more reliable and practical abundance index for purse seine fishery. This will serve as the basis for investigations of interaction between fisheries. The shift in study objectives was mainly caused from data problems including the availability of Japanese longline data and the absence of historical U.S. purse seine data. The interaction between longline and surface fisheries was hoped to be analyzed after current data problems are cleared during a continuation of the collaborative project.

This report reviews the activity and characteristics of the Japanese purse seiners operating in the western tropical Pacific (WTP) and presents some analysis and adjustments of CPUE estimates. Log book data from 20°S-20°N and 130-180°E was used for the description of fishery and a detailed analysis was made for the area of 5°S-10°N and 130-160°E. The CPUE defined as catch-per-day in fishing activity was investigated only for 1983-1988 period, because of the absence of information on searching days before 1983.

The History of Japanese purse seine fishery

The Japanese purse seine fishery in the western tropical Pacific was started around 1965 on an experimental basis to develop a supplemental fishery for Japanese coastal operations during winter. During the first phase, there were no good prospects obtained to signal a shift to commercial operation. However, after operations associated with floating objects was established around 1970, the fishery expanded to a year-around commercial operation.

The number of vessels operating in this WTP increased from 9 in 1974 to 31 in 1983 and has remained at the same level since then. The group seiners started their operations with three units in 1974 and seven units are currently permitted to operate in this area during February to May. The actual activity of group seiners seemed to contract in recent years.

The total WTP catch increased steadily from the beginning of the fishery until 1983 and stayed about the same level of 130,000 metric tons since then (Figure 1). On the average, the catch was composed of about 25% yellowfin and 75% skipjack tunas but the actual species composition varied year to year.

The effort, shown by total number of sets with catch, displayed the same pattern as the total catch; constant increase through the beginning to 1983 and more or less leveling off after that (Figure 2). Total annual number of positive sets varied around 4,500 sets in recent years.

The group seiners accounted for about 10% of total number of sets and 8.5% of total catch. Though the proportion of sets associated with floating objects was about the same between single seiners and group seiners, group seiners caught less amount of yellowfin tuna than single seiners, 10.6% and 24.1% of total catch, respectively. Only data from single seiners were used for further analysis mainly because of the lack of appropriate searching information for group seiners.

The Japanese catch statistics covered all activity held under the Japanese flag from the beginning of the fishery and does not include activities under joint venture with other nations. The information collected included date, location of each set, type of set such as log associated or free swimming, and catch of skipjack, yellowfin, bigeye, bluefin and albacore tunas and other species. The log book format was improved at 1983 to include activity code, searching or fishing, and to record the location at noon even no set was made.

Set types

Operations were categorized into two groups, log set and school set, according to whether or not the school targeted was associated with floating objects. Operations associated with large marine animals such as whales and basking sharks were classified as a school set in this analysis, based on the similarity of size of fish caught and seasonality in occurrence.

Log sets were usually made once a day starting just before dawn after gathering fish with a light during night. School sets were made almost exclusively in daytime. The success rate was about 93% for log sets and 45% for school sets and showed little year to year variation.

The distribution of total catch-per-set was skewed to the lower side with a mode between 5-10 tons per set for both log and school sets. There was no difference in the shape of distributions according to set type except that school sets showed longer tail, with the possibility of higher catch-per-set, than log sets. Since these distributions can be approximated with log-normal distributions, the maximum likelihood estimates of total catch-per-set were obtained for 1975-1988 (Figure 3), which showed a very clear linear increasing trend. Total catch-per-set was considered to reflect size of schools available as well as capability of vessels to hold fish during the fishing operation. However, in the case of purse seine fishery in the WTP, school size in log sets is also partly results of using night light to aggregate fish. Therefore, the linear increase in total catch-per-set is considered to correspond with improvements in fishing technique and is used to adjust CPUE (catch-per-day) later.

The log sets accounted for about 85% of total number of sets and 90% of positive sets until 1982, then the proportion shifted to 60-65% of total sets and around 75% of positive sets (Figure 4). While the yearly average of set type ratio showed little variation, the ratio greatly fluctuated by month. Figure 5 showed the percent of occurrence of log set ratio (more than 90%, 80-90%, 70-80%, 60-70%, 50-60% and less than 50%) by month for all years during 1975-1988. The observation of more than 90% log sets was lower through January to March than the other months but that of less than 50% log set was scattered whole year. In total, the proportion of school sets tended to increase during the first quarter of year, but a very high school set ratio could be expected at any time of the year depending on environmental or any other conditions.

Figure 6 showed proportions of yellowfin and skipjack catches caught in pure and mixed schools for both log and school sets. Log sets mostly utilized mixed schools of yellowfin and skipjack and proportion of yellowfin and skipjack did not vary among years. In contrast, school sets depended on catches from pure schools and the proportion of yellowfin and skipjack varied year to year. This fluctuation explained most of the variation of yellowfin ratio in total catch and also suggested good correspondence with depth of thermocline in the area. Although it seemed like the availability of yellowfin pure schools to the fishery determined the yellowfin ratio in total catch, more detailed investigation is needed before drawing some conclusions about environmental effects on fishery.

Operation pattern and CPUE adjustment

Since all Japanese boats shared fishing information as a single code group, concentration of effort into small area with high density of fish could be expected. These concentrations not only jeopardized the assumption of random sampling but also changed the meaning of effort defined as searching time, because those boats using coded information did not search before fishing.

In order to describe the relationship between concentration of vessels and catch, the occurrences of days with no catch, with positive catch but no catch for the following day, and with positive catch two days in sequence (within a unit square), were shown in Figure 7 by the number of boats operating in a unit square (1°x 1° square). The area with only one boat operating showed the highest possibility of zero catch and the lowest possibility to obtain continuous positive catch. As the number of boats operating in an area increased, the possibility of zero catch decreased dramatically and that of continuous catch increased.

Figure 8 showed the relationship of number of boats and occurrence of high CPUE in positive catch within an area. High CPUE defined here, more than 50 tons catch per day or more than 15 tons yellowfin catch-per-day, roughly corresponded with upper 15% occurrence, respectively. Judging from these figures, high catch rate for both total and yellowfin catch could be expected when searching and operating individually which also had highly risk of zero catch.

Based on these information, searching days were adjusted by subtracting number of days operating in the area where catch was reported on the previous day, from total fishing and searching days. Adjustment by linear increase of total catch-per-set was also applied to catch-per-adjusted searching time.

The effects of these adjustment were shown in Figure 9. All catch rate in Figure 9 was shown in relative value to the year, when the highest nominal catch-per-day was observed, 1988 for skipjack and 1986 for yellowfin tunas. Both adjustments had the effect of raising the estimates of earlier years and lowering those of recent years. Most importantly is that the adjustment for concentration of efforts changed the overall trend observed.

The reduction of concentration of efforts, which was expressed with the small effects by the adjustment on CPUE estimates of recent years, was derived from two major possibilities: the expansion of searching area stimulated by improvement of searching ability including use of bird-radar, and the disappearance of large patches of fish which could support fishing several days. Both possibilities could have serious effects on stock assessments of tunas utilized by purse seine fisheries and needed more investigations. Another factors which should be taken into account are environmental factors which control the availability and distribution of fish. It is desired to develop more plausible abundance index for purse seiners based on these information.

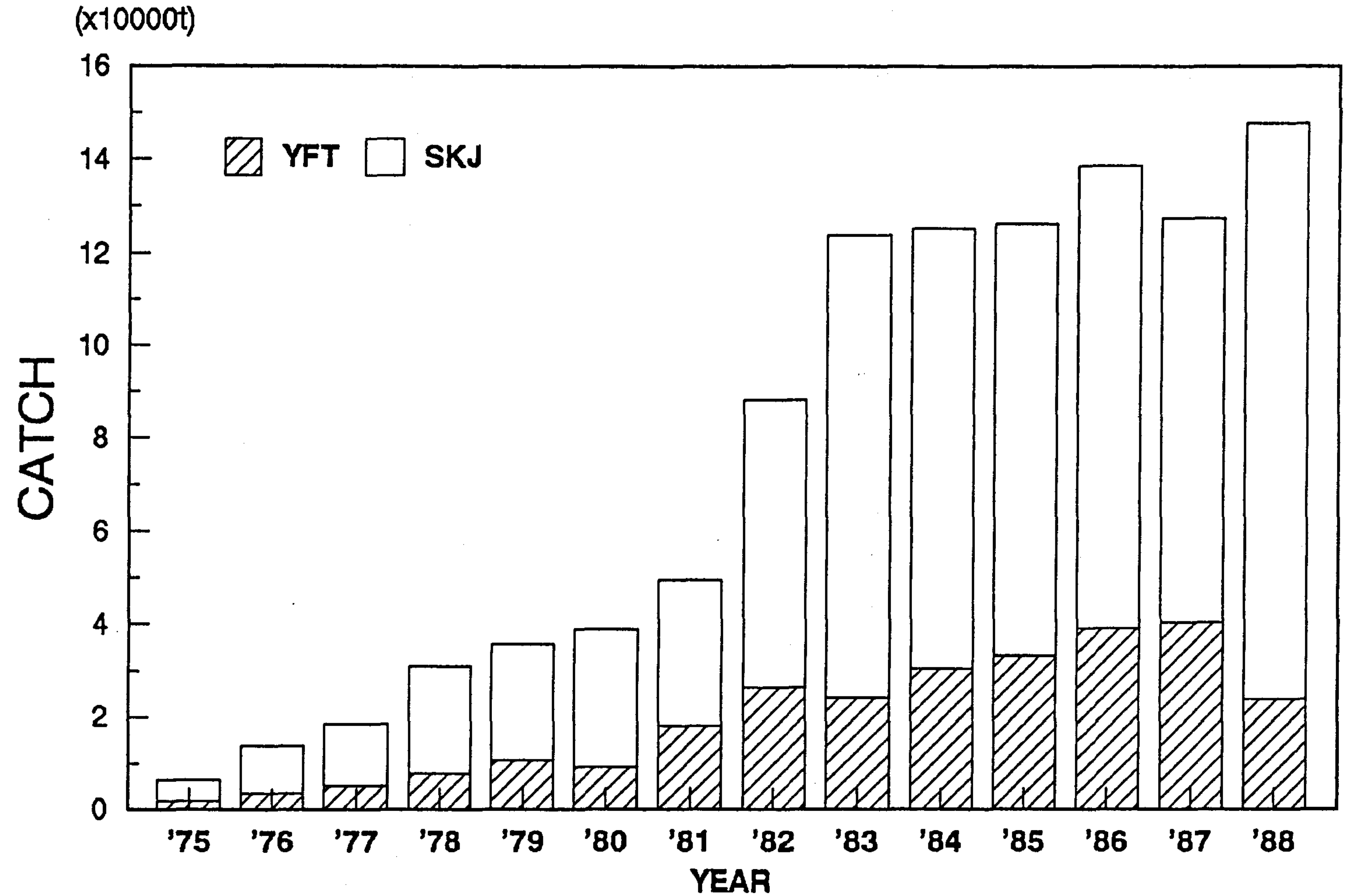

Figure 1. Total catch of Japanese purse seine fishery in the western tropical Pacific.

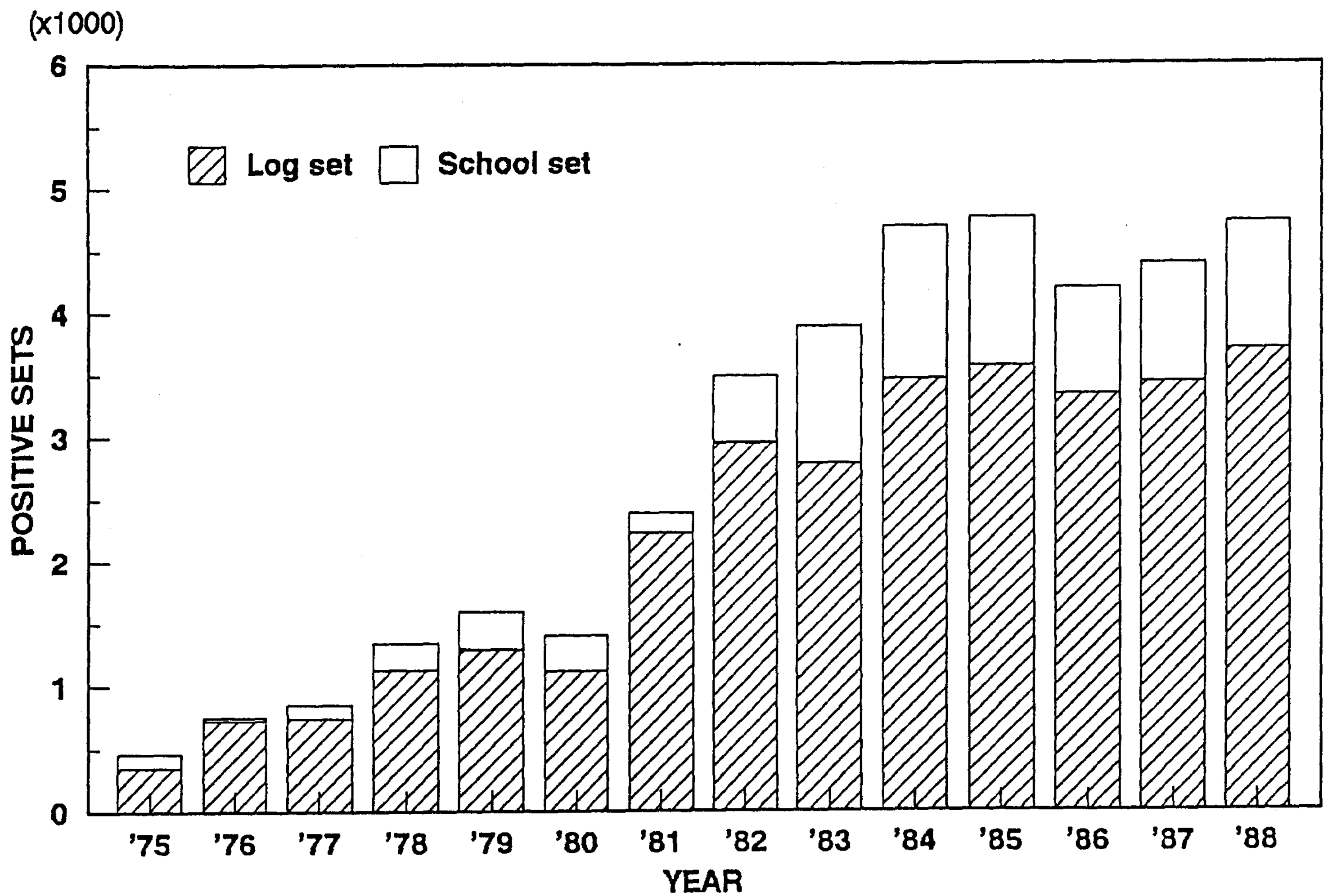

Figure 2. Total effort of Japanese purse seine fishery in the western tropical Pacific. Effort was shown as total number of positive sets.

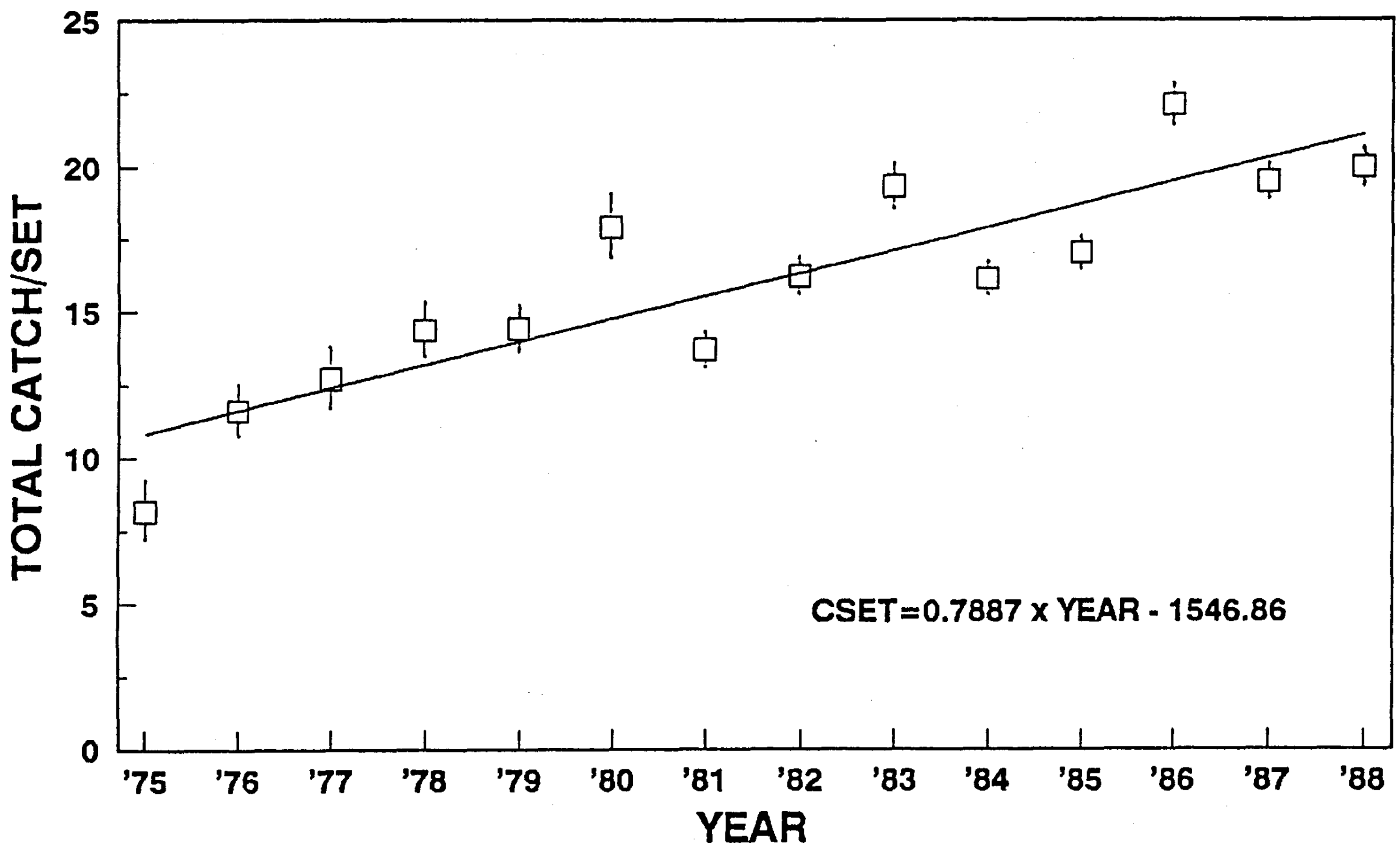

Figure 3. Change of total catch-per-positive set of Japanese purse seine fishery. Squares and bars showed the maximum likelihood estimates and its 95% confiden~~tial~~ce limits.

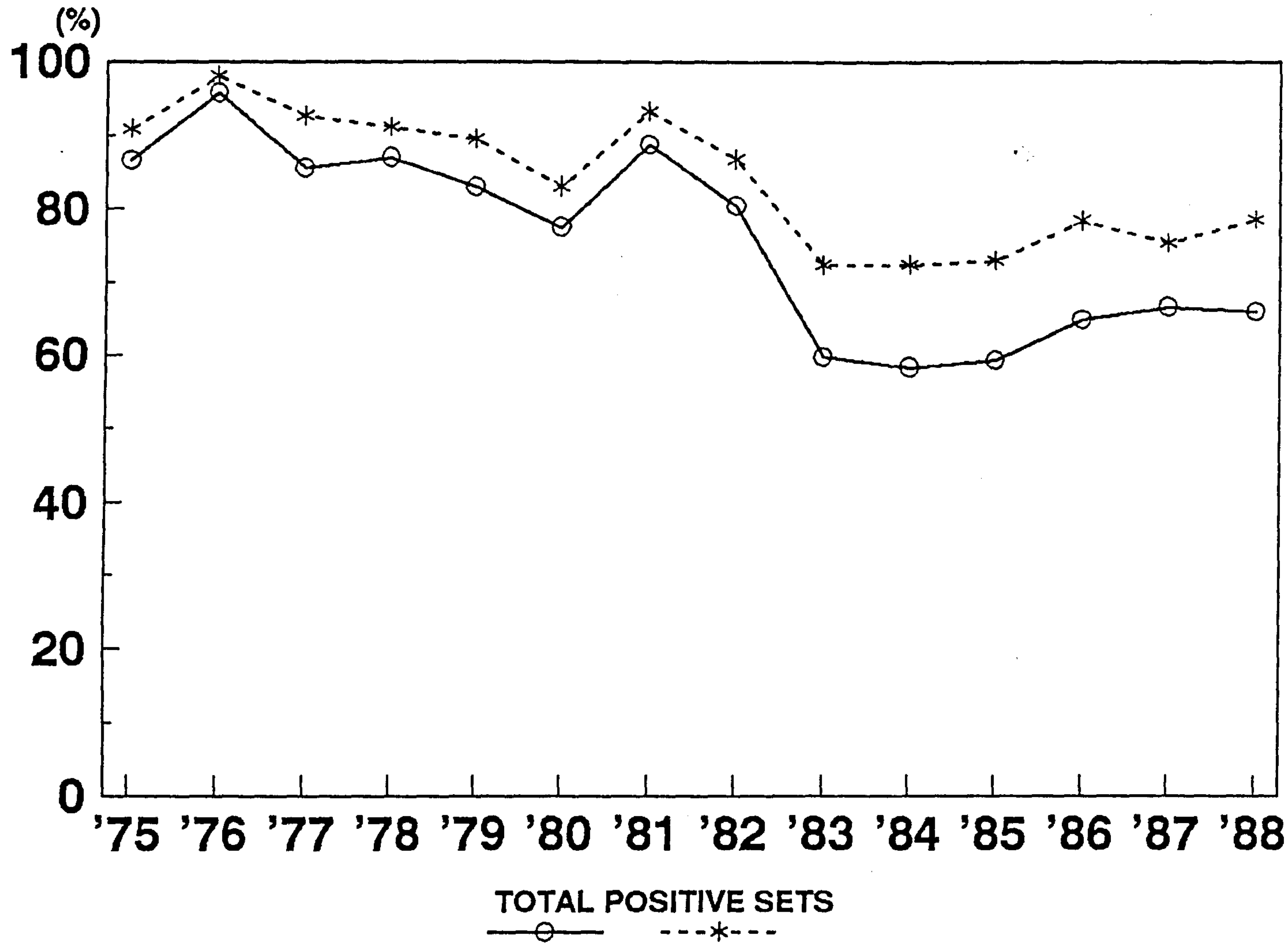

Figure 4. Annual log set ratio of Japanese purse seine fishery.

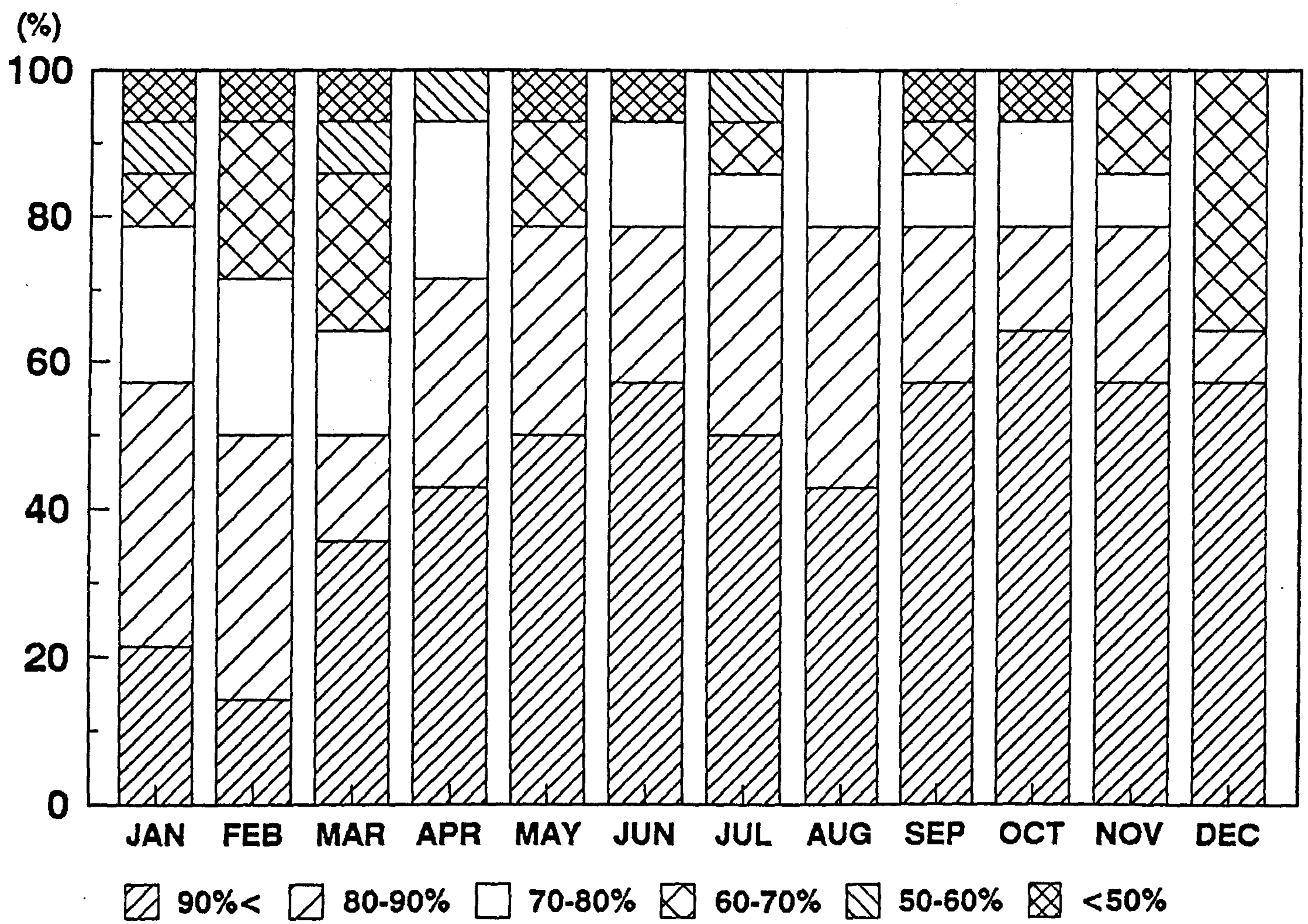

Figure 5. Log set ratio of by month for all years of 1975-1988.

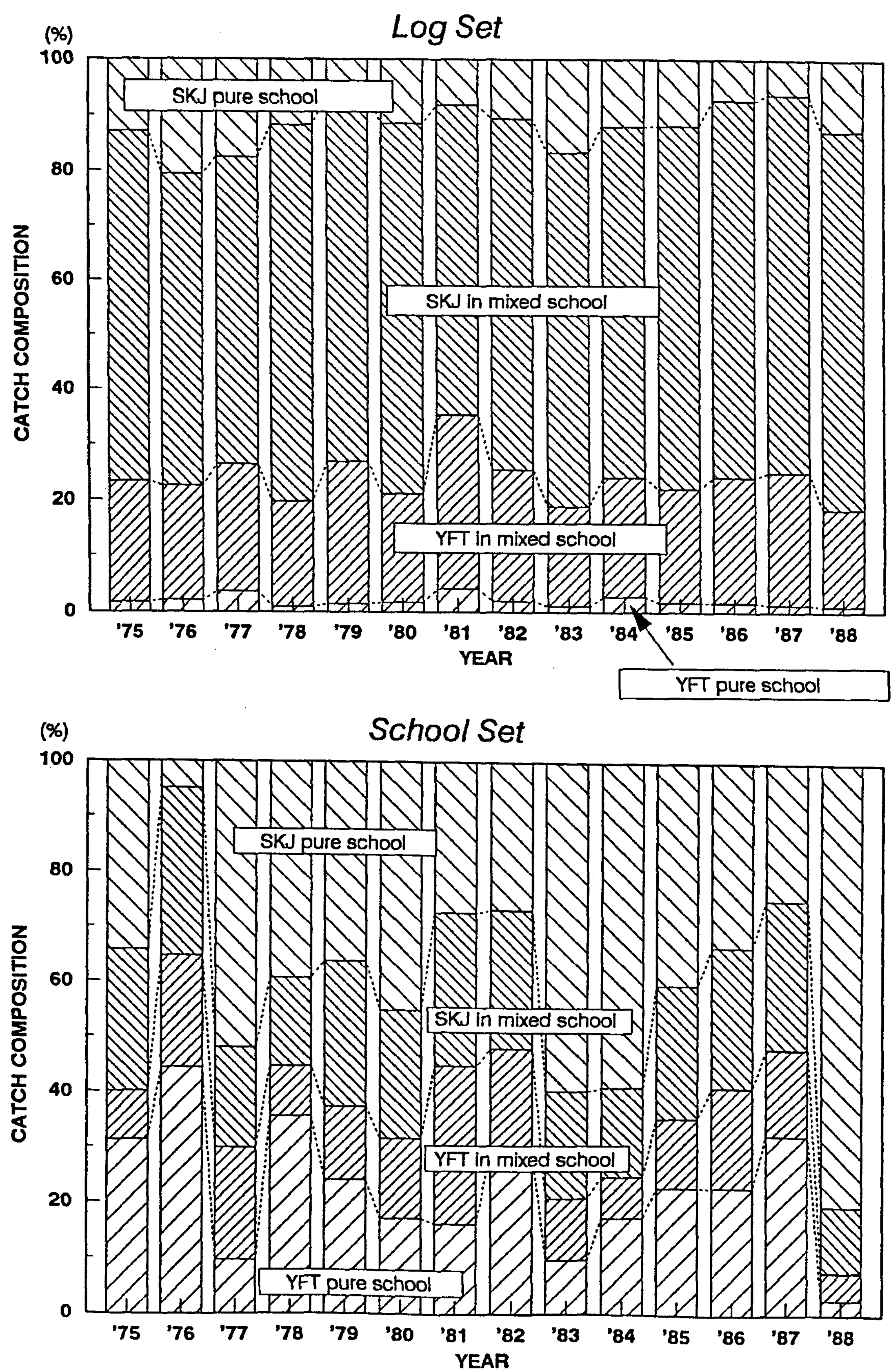

Figure 6. Proportions of yellowfin and skipjack tunas caught in pure and mixed schools by set type.

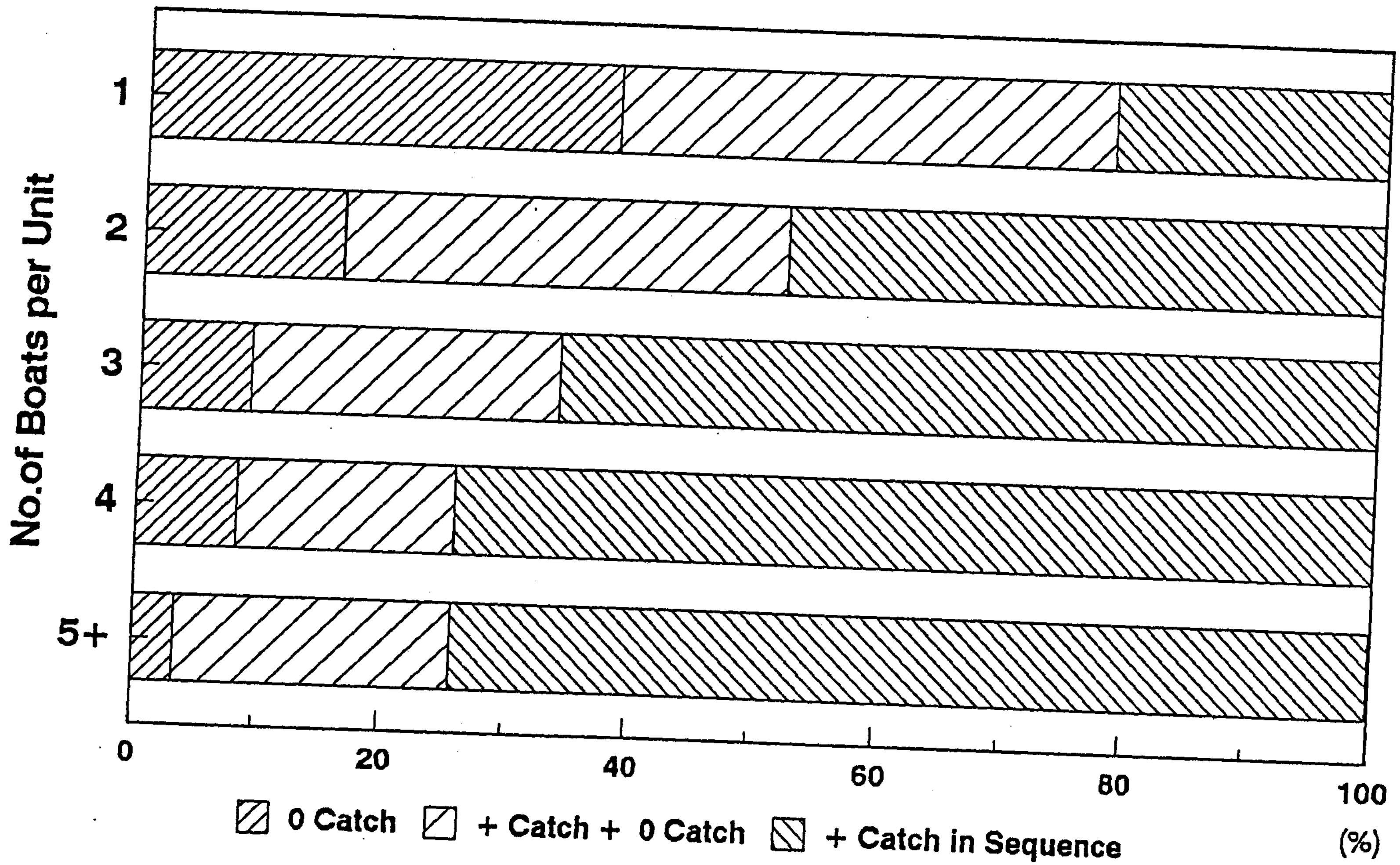

Figure 7. The relationship between catch and concentration of boats. Catch patterns were grouped into three; no catch, positive catch but no catch for the following day, and positive catch two days in sequence.

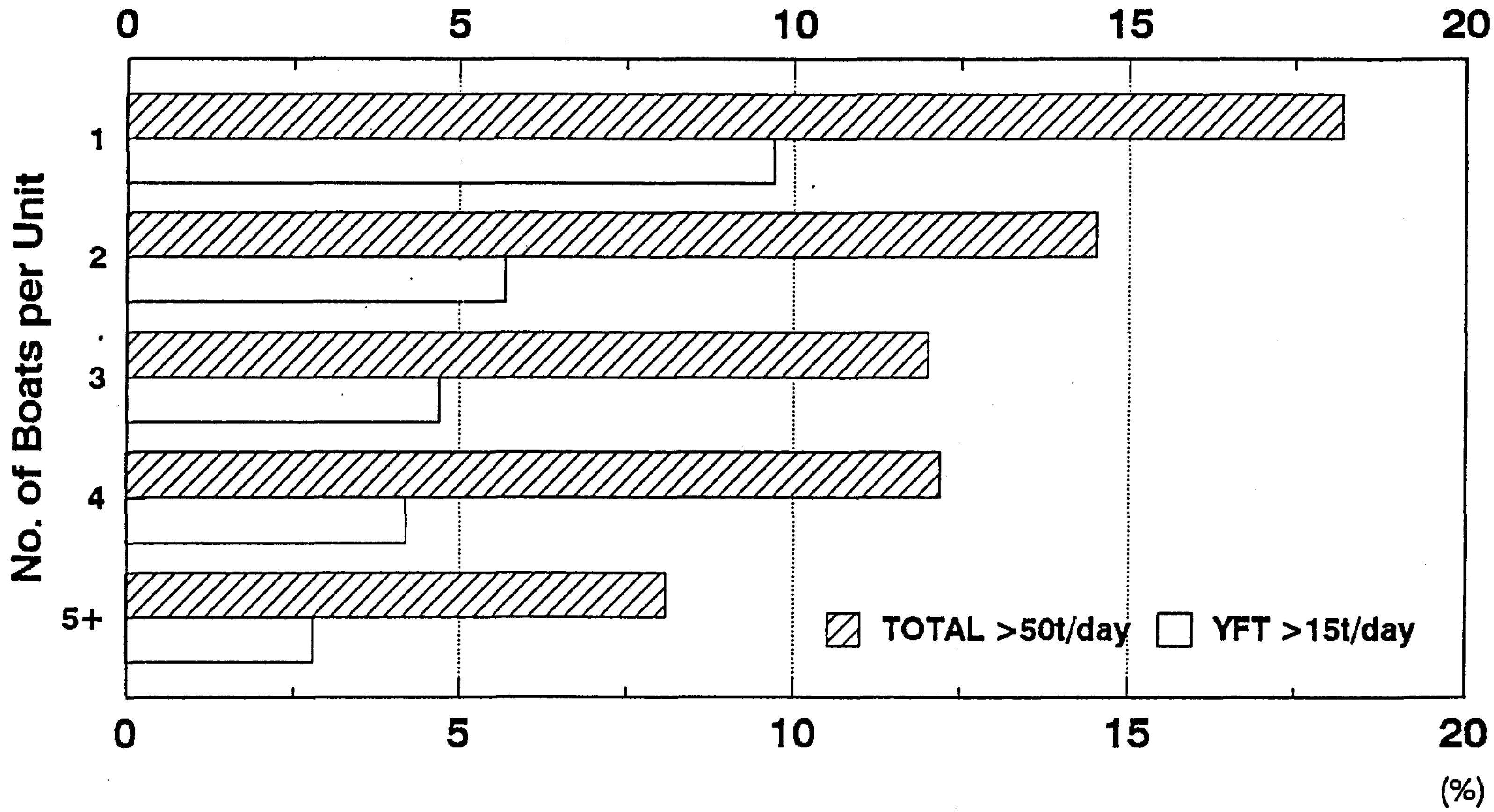

Figure 8. The relationship between occurrence of high CPUE and concentration of boats within an area. High CPUE defined here roughly corresponded with upper 15% occurrence.

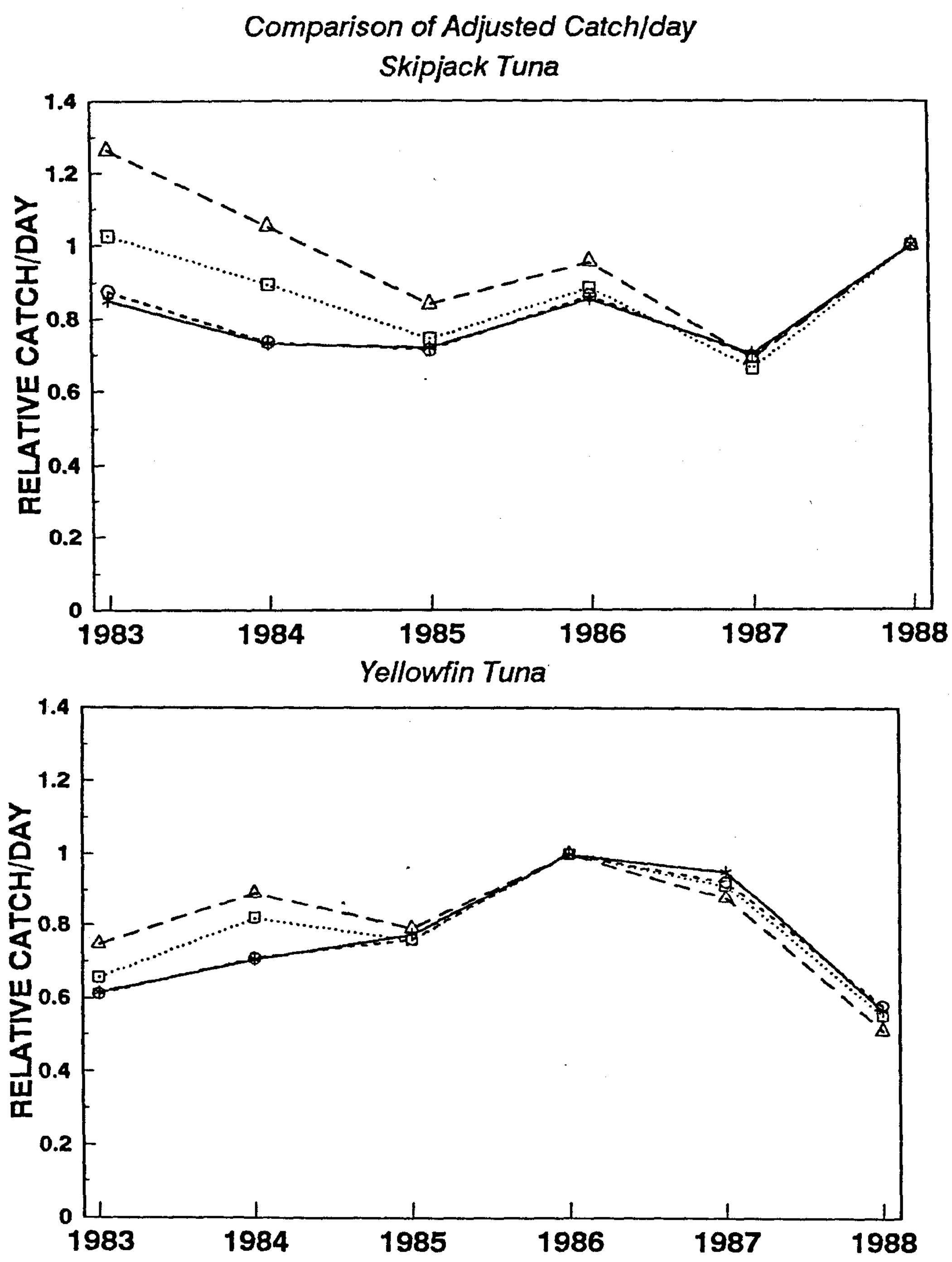

Figure 9. Comparison of several adjustments of catch-per-day. All estimates were shown as relative to the year with highest nominal catch rate. Solid line with stars -- nominal catch-per-day, broken line with circles -- average of monthly nominal catch-per-day, dotted line with squares -- catch-per-adjusted searching day by concentration of efforts and broken line with triangles -- adjusted catch by technical improvements per adjusted searching day by concentration of efforts.