SOME CONSIDERATION ON THE FISHING ABILITY OF INDIVIDUAL JAPANESE PURSE SEINE VESSELS AND STANDARDIZED CPUE ON THEIR FISHERY DATA

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ABSTRACT

Survey on devices equipped on the purse seine vessels was conducted for Japanese vessels operated in the Indian Ocean. Each vessel had have already most of devices and scarcely changed. ANOVA showed significant difference in vessel effect on CPUEs (catch per a fishing (searching and operation) day and catch per an operation) between vessels. However younger vessel with new and powerful devices did not always have a better ability. Taking this vessel effect into account, trend of standardized CPUE with the effort of fishing day was different from nominal one, showing increasing trends. Trend of standardized CPUE with the effort of the number of operation was higher at early 1990s and lower after 1995. Japanese vessels had conducted FADs set operation mainly but we don't have detail information about FADs usage. To obtain further and precise estimate abundance trend in this region, we should be watching the on-going fishery's information on FADs usage

INTRODUCTION

It was pointed out that several devices were equipped on the purse seine vessels which are considered to improve fishing efficiency and many of these have developed during the course of time (Matsumoto et al., 2000, Soto et al., 2000). Japanese purse seine fishery in the Indian Ocean was, in fact, the past fishery (Ogura and Matsumoto 2003). Earnest fishing by commercial vessels was conducted only from 1989 to 2001 and maximum number of Japanese vessels entering the fishery was 10. In this paper, available supplemental information on fishing devices of Japanese purse seine vessels operated in this region was presented. Catch variation among vessels and among devices equipment of vessels were discussed. Although Japanese data was too limited to watch the trend and to represent the skipjack resources because of covering short time period and small number of vessels, some standardization of CPUEs were conducted using Japanese data.

SURVEY OF THE FISHING DEVICES

Matsumoto et al. (2000) prepared a questionnaire and distributed to the each fishing company who owns and had owned purse seine vessels. The items included in the questionnaire were listed in Table 1. Then commercial vessel logbook data was merged with the device database. We used the merged data including the cruises in the Indian Ocean. These data covered from 1991 to 1999.

It was assumed that each item surveyed has their own effect in a specific way. Maximum speed influences school chasing and net throwing, contributing to the success of catch. Capacity of well in tonnage may affect the total cruise tactics. Ability of power block may influence the time of whole operation. Ability of purse winch controls the speed of winding up the tow line and the purse ring and influencing the success of school catch. Net length and depth also affect the success of catch but influencing the operation time. Mesh size is also. Bird radar is used to find the bird associated school and that power (in W) influences the detecting range. By using the sonar system, they can find the school in water (especially at the temperate water of the Pacific Ocean). Also they can observe the school size and behavior to decide the operation tactics. Low frequency sonar can observe wider range but lower resolution than high frequency sonar dose. Tele-sounder transmits the image of the sonar equipped on the skiff boat to the vessel and enable operator to observe the school behavior.

DEVICES EQUIPMENT AND EFFECTS ON FISHING

Most of the devices had been developed and introduced during 1980s to the purse seine vessels. In general, Japanese vessels already had many of these devices in 1990. The ability of operating had reached a level that was thought to be enough (Matsumoto et al. 2000).

The percentage of data covered by the devices information on the logbook data was 60 % or less (Figure 1), although there was still some discrepancies between the information based on this questioner and the information by other independent source (device maker's sales data). The total number of vessels that we could obtain the information by questionnaire was 9 for the Indian Ocean. Of these, only two vessels renewed the bird radar, from that of 30 W output power to 60 W during 1990s. Except these, there was no change in vessel devices during 1990s. Some vessels did not equip the high frequency sonar and tele-sounder. The maximum speed ranged from 13.9 to 16.5 kt and other value of operation devices showed some ranges. Particularly relatively young vessels built in 1989 and 1990 had higher maximum speed, larger carrying capacity, higher powered power block and purse winch, larger net, all electronics and ultrasonic devices, and smaller mesh size (Table 2).

Japanese purse seine vessels operated in the Indian Ocean seemed to have stable abilities on fishing devices. There were no changes on the ability of each vessel but total ability of Japanese vessels operated in this region had changed year by year because the number of vessels operated were not same every year.

DIFFERENCES IN CPUE AMONG VESSELS AND STANDARDIZATION

To compare the ability of each vessel, two indices were prepared and conducted ANOVA by using GLM procedure on SAS. CPUE1 was the catch per a fishing day which included both operation days and searching days. CPUE2 was the catch per an operation. CPUE2 might be a better index of operation to specify the ability than CPUE1. Trends of these indices of FADs sets by area using logbook data without devices information from 1989 to 2001 were shown in Figures 2 and 3. Trends of these indices were similar between CPUE1 and CPUE2, relatively high level in the early 1990s in the western Indian Ocean and decreasing at late 1990s in the eastern.

The ANOVA model is as follows;

Log(CPUE*+1.0)=intercept + YEAR + QUARTER + AREA + VESSEL + error (1)

CPUE*: CPUE1 or CPUE2

YEAR: effect of year

QUARTER: effect of quarter of the year

AREA: effect of two areas divided in 70E

Vessel: effect of individual vessel

For both of CPUE1 and CPUE2, vessel effects were significant (Tables 3 and 4). The value of CPUE* in certain vessel ($CPUE^*_v$) was given as the Least Squared Mean (LSMEANS) of Vessel effect in GLM procedure of SAS package.

$$CPUE^*_v=\exp(\text{intercept} + VESSEL_v + \overline{YEAR} + QUARTER + AREA)-1.0 \quad (2)$$

The relative CPUE* (smallest CPUE* was set to 1.0) were shown in Table 5. Younger vessels mentioned above showed less CPUE values (Table 2 Vessels A and F).

Trends of standardized CPUE1 and CPUE2 were given as the LSMEANS of Year effect

$$CPUE^*_i=\exp(\text{intercept} + YEAR_i + \overline{QUARTER} + AREA + VESSEL)-1.0 \quad (3)$$

Trend of standardized CPUE1, value in 1991 set as 1.0, increased during the period and relative value in 1997 was 2.5 times higher than that in 1991 (Figure 4). On the other hand, standardized CPUE2 showed higher in early 1990s and lower after 1995 (Figure 5).

For further consideration on these differences between vessels, we evaluated the effect of each device on the vessel. ANOVA was conducted with replacing the effect of vessel with effects of devices in the model (1). Significant factors were purse winch, bird radar and high frequency sonar for CPUE1 and maximum speed and net length for CPUE2 (Tables 6 and 7). Effects of these factors were also shown by the relative CPUE* (average CPUE was set to 1.0) calculated by same manner as done for vessel effect (equation (2)). Larger power purse winch reduces the CPUE1 compared to the smaller power one and higher power bird radar also reduced the CPUE (Table 8). High frequency sonar showed a positive effect for CPUE1. On CPUE2, higher maximum speed showed positive effect but the effect of net length was negative.

DISCUSSION

There seemed to be significant differences in fishing ability among the vessels operated in the Indian Ocean but this is not consistent with the expectation from devices equipped. There might be other factors (such as fishing master personality etc.) affecting the ability of fishing.

CPUE2 is assumed more pure index focused in operation than CPUE1. There might be plausible explanations of significant effects for CPUE2. In general, high speed vessel could set net quickly and relatively small net in length could be treated easily and quickly. But on CPUE1, it was hard to explain the negative effects of purse winch and bird radar. CPUE1 includes the day of searching in addition to operating days. In the Indian Ocean, the duration of the searching day depends on the time needed for moving from one FADs to another. The duration was affected by the distance of each FADs, density of available FADs seeded, and seeding pattern of FADs as well as ship speed.

If skipjack abundance is assumed to be related with school density and each school size (in fish number or weight), CPUE2 can measure school size information. Depending on the annual trend of the standardized CPUE2, the school size of FADs might be becoming to be small. In order to know the density of school, FADs density etc. is an important index rather than CPUE1 of here.

Japanese vessels had conducted FADs set operation mainly and brought 20 to 30 FADs per a vessel per a cruise throughout the active fishing period in the Indian Ocean. But we don’t have detail information of the number of FADs actually used cruise by cruise and how Japanese vessels communicated within the group of vessels about the FADs usage. To obtain further and precise estimate abundance trend in this region, we should be watching the on-going fishery’s information on FADs usage.

References

MATSUMOTO, T., M. OGURA, N. MITABE, AND H. SHONO (2000): Creation of a database to identify factors affecting CPUE of the Japanese equatorial purse seine fishery. SCTB13/RG-7. 7p.

OGURA, M. AND T. MATSUMOTO (2003): Japanese skipjack fishery and research activities in the Indian Ocean. IOTC/WPYY/03/**. 11p

SOTO, M., J. MORON, AND P. PALLARES (2000): Standardized catch rates for yellowfin (Thunnus albacares) from the Spanish purse seine fleet (1984 - 1995). IOTC/WPTT00/04. 10p.

Table 1: Items covered in the questionnaire distributed to the purse seine vessels (from Matsumoto et al. 2000)

Item	Content
Ship speed	Cruise and maximum (kt)
Gross tonnage of vessel (domestic measure)	Tonnage (t)
Capacity of well	Tonnage
Power block	Power (Force and velocity), maker and model
Purse winch	Power (Force and velocity), maker and model
Fishing net	Total size (width and depth), mesh size and maker
Bird radar	Power (kw), maker and model
Sonar	Frequency (KHZ), maker and model
Telesouder	Maker and model
GPS	Maker and model
Satellite weather display	Maker and model
Name of fishing master	Full name
Another comment	Comments which fishermen consider to improve fishing efficiency

Table 2. Fishing devices and vessel information of Japanese purse seine vessels operated in the Indian Ocean. For high frequency sonar and tele-sounder, 1 means equipped and 0 means absence.

Vessel	Launching year	Maximum speed (kt)	carrying capacity (mt)	Power block power (mt)	Power block speed (m/s)	Purse winch power (mt)	Purse winch speed (m/s)	Net length (m)	Net depth (m)	Mesh size (mm)	Bird Radar (power in W)	High frequency sonar	Tele-sounder
A	1989	16.5	700	7.0	80	14.0	45	1640	351	210	60	1	1
B	1981	15.1	660	7.0	80	11.0	32	1580	320	-	60	0	0
C	1978	15.1	806	5.5		12.5	24	1600	300	240	30	0	0
D	1981	14.9	479	5.0	72	12.5	27.5	1800	270	-	30	0	1
E	1982	13.5	768	7.0	80	12.0	30	1660	322	210	30	1	0
F	1990	16.5	800	7.0	80	12.0	45	2000	340	210	60	1	1
G	1981	13.7	700	7.0	80	12.5	27.5	1600	350	220	30	0	1
H	1981	15.6	650	5.0	80	12.0	30	1555	306	360	30	0	1
I	1981	15.2	680	5.0	72	12.0	27.5	1650	270	-	60	0	1

Table 3. Result of ANOVA for CPUE1 with vessel effect.

CPUE1

Source	DF	Sum of Squares	Mean Squares	F Value	Pr > F
Model	18	232.3346	12.9075	5.68	<.0001
Error	4782	10861.9982	2.2714		
Corrected	4800	11094.3328			

Source	DF	Type III SS	Mean	F Value	Pr > F
YR	6	43.9831	7.3305	3.2300	0.0036
AREA	1	16.8881	16.8881	7.4300	0.0064
mon	3	26.1156	8.7052	3.8300	0.0094
Vessel	8	127.6333	15.9542	7.0200	<.0001

Table 4. Result of ANOVA for CPUE2 with vessel effect.

CPUE2

Source	DF	Sum of Squares	Mean Squares	F Value	Pr > F
Model	18	439.8842	24.4380	19.46	<.0001
Error	3246	4076.1185	1.2557		
Corrected	3264	4516.0027			

Source	DF	Type III SS	Mean	F Value	Pr > F
YR	6	69.1579	11.5263	9.1800	<.0001
AREA	1	7.8440	7.8440	6.2500	0.0125
mon	3	5.4598	1.8199	1.4500	0.2265
Vessel	8	73.8727	9.2341	7.3500	<.0001

Table 5. Standardized CPUEs with vessel. Average CPUEs were set to 1.0. Figures in shadow mean figures lower than average. Vessel codes were same as Table 2.

Vessel	Relative CPUE1	Relative CPUE2
A	0.90	0.75
B	0.69	0.84
C	1.06	1.10
D	1.26	0.96
E	1.35	1.12
F	0.68	0.87
G	1.13	0.82
H	0.82	1.18
I	1.11	1.36

Table 6. Result of ANOVA for CPUE1 with devices effects.

CPUE1

Source	DF	Sum of Squares	Mean Squares	F Value	Pr > F
Model	17	200.0862	15.3913	6.76	<.0001
Error	4787	10894.2466	2.2758		
Corrected	4800	11094.3328			

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	6	47.3705	7.8951	3.4700	0.0020
AREA	1	20.4624	20.4624	8.9900	0.0027
mon	3	27.1416	9.0472	3.9800	0.0077
PW	1	71.9935	71.9935	31.6300	<.0001
BIRDR	1	23.3515	23.3515	10.2600	0.0014
SONH	1	17.0817	17.0817	7.5100	0.0062

Table 7. Result of ANOVA for CPUE2 with devices effects.

CPUE2

Source	DF	Sum of Squares	Mean Squares	F Value	Pr > F
Model	15	390.2768	32.5231	25.64	<.0001
Error	3252	4125.7259	1.2687		
Corrected	3264	4516.0027			

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	6	68.0083	11.3347	8.9300	<.0001
AREA	1	12.2098	12.2098	9.6200	0.0019
MON	3	9.3107	3.1036	2.4500	0.0620
SPEED	1	17.4670	17.4670	13.7700	0.0002
NET	1	14.8128	14.8128	11.6800	0.0006

Table 8. Standardized CPUEs with effective devices. CPUEs in case of the category with low performance or without equipment were adjusted 1.0.

CPUE1

facter	level	LSMEANS	CPUE	Ratio
PW	<350 txm/s	1.8581	5.4118	
	>=350	1.5366	3.6486	0.67
BIRDR	2(30W)	1.7814	4.9384	
	3(60W)	1.6132	4.0191	0.81
SONH	absent	1.5891	3.8993	
	equiped	1.8056	5.0836	1.30

CPUE2

facter	level	LSMEANS	CPUE	
SPEED	<14.5kt	2.1491	7.5768	
	>=14.5kt	2.3627	9.6196	1.27
NET	<1700m	2.3384	9.3645	
	>=1700m	2.1734	7.7878	0.83

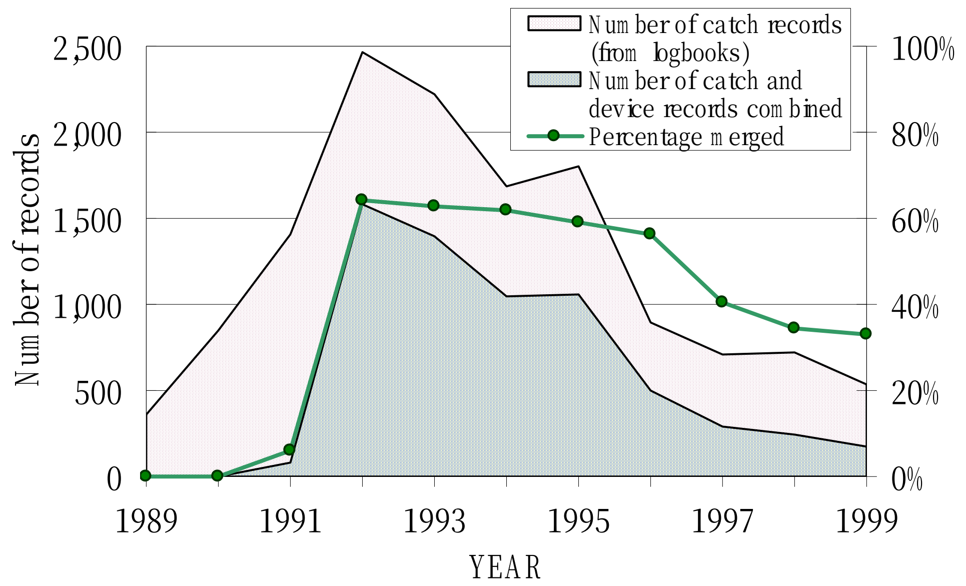

Figure 1: Annual trends of the number of logbook record, the number of records merged, and percentage merged.

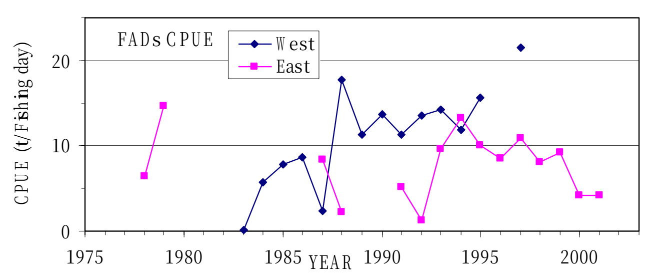

Figure 2. Trends of nominal CPUE1s (catch per a fishing day) of FADs set by area (70E forms the boundary between west and east).

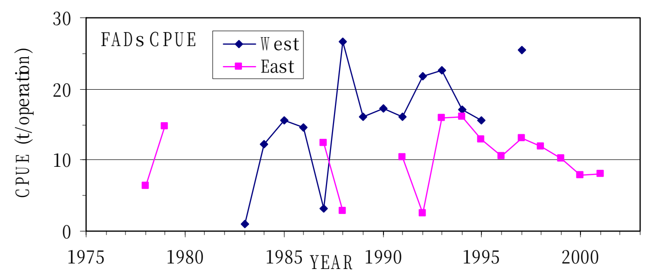

Figure 3. Trends of nominal CPUE2s (catch per an operation) of FADs set by area (70E forms the boundary between west and east).

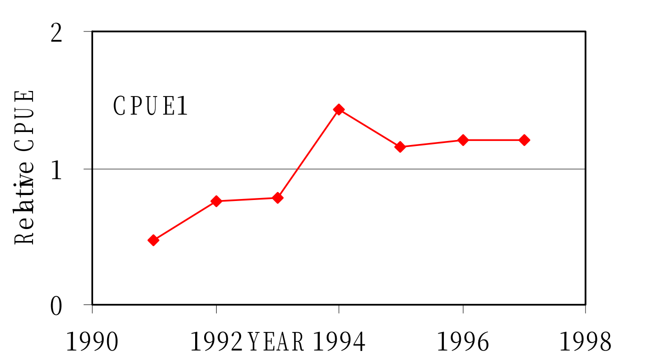

Figure 4. Annual trend of standardized CPUE1. Average CPUE1 was set 1.0.

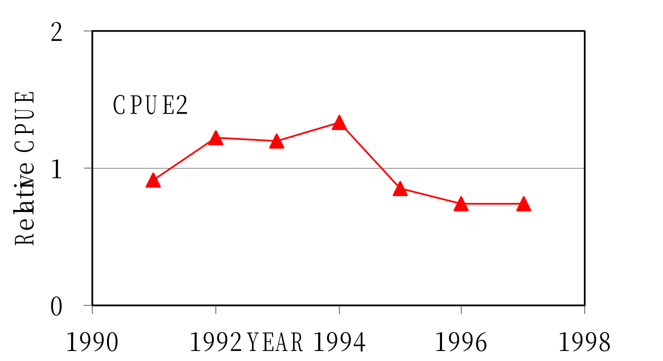

Figure 5. Annual trend of standardized CPUE2. Average CPUE1 was set 1.0.