REVIEW ON "CPUE STANDARDIZATION OF THE INDUSTRIAL LONGLINE TUNA FISHERIES" AND "PRODUCTION MODEL ANALYSES" FOR YELLOWFIN TUNA (*THUNNUS ALBACARES*) AND BIGEYE TUNA (*THUNUS OBESUS*) RESOURCES IN THE INDIAN OCEAN

(Information document)

edited by

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ABSTRACT

In the past IPTP and IOTC meetings, sizable amounts of papers on "catch rates standardization of the industrial longline tuna fisheries (LL)" and "Production model analyses" for yellowfin tuna (Thunnus albacares) (YFT) and bigeye tuna (Thunnus obesus) (BET) resources have been reported. This document is prepared to review such papers and summarizes outlines, problems and suggestions made during the meetings in the past.

INTRODUCTION

In the past IPTP and IOTC meetings, sizable amounts of papers on "catch rates standardization of the industrial longline tuna fisheries (LL)" and "Production model analyses" for yellowfin tuna (*Thunnus albacares*) (YFT) and bigeye tuna (*Thunnus obesus*) (BET) resources have been reported. This document is prepared to review such papers and summarizes outlines, problems and suggestions made during the meetings in the past.

INFORMATION

Information used in this document were taken from papers submitted in the past five IPTP and IOTC meetings as below:

1 Second WPTT (2000), Victoria, Seychelles
2 First WPTT (1999), Victoria, Seychelles
3 Seventh expert consultation meeting (1998), Victoria, Seychelles
4 Sixth expert consultation meeting (1995), Colombo, Sri lanka
5 Fifth expert consultation meeting (1993), Victoria, Seychelles

3. REVIEWS

Tables 1-3 summariuze the re view of the relevant papers presented in the recent five IPTC and IOTC meetigs, i.e.,

(1) Table 1 : Review of LL CPUE standardization (YFT: yellowfin tuna)
(2) Table 2 : Review of LL CPUE standardization (BET: bigeye tuna)
(3) Table 3 : Review of production model analyses (BET: bigeye tuna)

2 4. Problems

3 Details of problems in these anlasyes are discussed in the working papers prepared for this workshop by Shono

(WPM/01/_____), Okamoto *et al*(WPM/01____), and Nishida and Suzuki (WPM/01/______).

Table 1 : Review of YFT LL CPUE standardization						
Meeting	**Author**	**Data**	**Stock**	**Factor**	**Model**	**Problems, Comments and Suggestions**
2nd WPTT (2000)	Nishida (#10)	5x5, month 1975-98 (Japan)	West (two stocks Hypo.)	Y, M, A (4 sub-areas), NHF(1), M*A, A*NHF(1)	(GLM) CPUE model (Error) normal	• Lack of coherence between the trends in nominal catches and the standardized CPUEs. During the first part of the period, when catches were low, both nominal and standardized CPUES fell sharply, while during the most recent years, when catches have increased sharply, the standardized CPUEs have been relatively stable. • Two possible reasons: (a) the standardization may not yet adequately deal with changes in target species which have occurred over the years and (b) the standardization method does not take account of additional environmental factors that may affect abundance and recruitment.
	Lee & Liu (#26)	5x5, Q, 1967-98 (Taiwan)(2)	Single Stock	Y, Q, A (5 sub-areas), ALB(3) ,BET(3)	(GLM) CPUE (Error) normal	• Similar results to Japanese one (above) • Deep & regular LL data are combined and should be seprated.Taiwan starts to collect such data from 1995.
	[Overall comments for two papers]					• standardized CPUE forYFT for both the Taiwanese and Japanese longline fleets showed some similarities. In both fisheries, there are remarkable peaks in 1977 and 1993. It was also suggested that the peaks in CPUE might be related to ENSO events, although further analysis would be needed to corroborate this. • The apparent stability of recent standardized CPUEs contrasts with the recent rapid increase in total catches. This suggests that the current methods of CPUE standardization might not yet be producing reliable measures of relative abundance. • Strong need to take account of environmental factors during the standardization of CPUE, and other factors, such as market price of the target species , may also to play an important role.
1st WPTT	(2000) No papers					
7th Expert consulatation (1998)	Lee (#21)	5x5, Q, 1967-98 (Taiwan)(2)	1 & 2 stocks	Y, Q, A(8 sub-area), ALB(3), BET(3)	(GLM) CPUE model (Error) normal	• Information on the temporal trends in the average size of fish caught could provide some additional insights for interpreting the CPUE trends. Testing for significant year/area and year/season interaction is important, as variability in the spatial and temporal distribution is common in large pelagic species. • If such interactions occur, they can confuse the interpretation of the year effects as estimated in a GLM analysis. • Limitations in using % of catch composed of other species as a measure of targeting. For

						example, a decline in the abundance of the species of interest could easily be misinterpreted in this case as a change in targeting.
6th Expert consulatation (1995)	Nishida (#13)	5x5, M, 1970-92 1x1 & 5x5 (J, K, T)(5)	West (two stocks hypo.)	Y, M, A(4 sub-area), SOI, SST, by-catch(4)	(GLM) Catch model (Error) Poisson	• Environmental parameters (SOI and SST) and by-catch are significant factors affecting the nominal catch rates. • LL CPUE, as it has been the case in other YFT fisheries in the world, does not seem to measure well changes in relative abundance.
5th Expert consulatation (1993)	Nishida (#19)	5X5, month, 1980-91 (Japan)	West (two stocks hypo)	Y, Q, A(4 sub areas), SOI, SST, by-catch(4)	(GLM) CPUE model (Error) normal	• Age specific analyses. • Environmental parameters (SOI and SST) and by-catch are significant factors affecting the nominal catch rates.

(note)
(1) NHF: number of hooks between floats (3 classes) ; (2) Deep & regular LL combined; (3) 5 classes of % of catch rates; (4) SBT, BET, ALB, SWO, BLM, BUM (5 classes)
(5) Coarse scale analyses (5x5) (for Korea, Japana & tawain) and FINE SCALE analyses(1x1) (for Japan)

Table 2 Review of BET LL CPUE standardization

Meeting	Author	Data	Stock	Factor	Model	Problems, Comments and Suggestions
WPM (2001)	Angannuzi					(Discussion paper to evaluate various standardization models including the regression tree model)
2nd WPTT (2000)	Matsumoto (#8)	5x5, month 1975-99 (Japan)	Single	Y, M, A (7 sub-areas), NHF[(2)], M*A, A*NHF[(1)]	(GLM) CPUE model (Error) normal	• Considerable jump in both the nominal and the standardized BET CPUE between 1976 and 1977 is unlikely to reflect a change in biomass of that magnitude in such a short time. Increases in the biomass of the YFT ranging from 10 to 30% over a single year have been reported in other oceans. However, given that fewer age classes can be expected in LL caches of YFT than of BET, it would be far more difficult for these changes to have occurred in the biomass of BET over a single year. • this jump in CPUE resulted from some factor associated with the gear or targeting that has not been accounted for in the standardization process➔ additional factors should be incorporated into future standardizations, such as changes in environmental conditions.
	Hsu (#25)	5x5, Q, 1967-98 (J,K,T[(2)])	Single	Y, Q, A(5 sub-areas), ALB[(3)] BET[(3)] & interaction	(GLM) catch & CPUE model (Error) Poisson & normal	• strong need to take account of environmental factors during the standardization of CPUE, and other factors, such as market price of the target species, may also to play an important role. • Deep & regular LL data are combined and should be seprated.Taiwan starts to collect such data from 1995.
1st WPTT (1999)	Okamoto & Miyabe (#6)	5x5, M, 1975-97 (Japan)	single	Y, M, A (7 sub-areas), NHF[(1)] , M*A	(GLM) CPUE model (Error) normal	• GLM taking into account the considerable change in numbers of hooks per basket during 1952-98. In the southern part of the Indian Ocean, BET CPUE fluctuated erratically, probably because of changes in fishing activity by Japanese fishermen in response to quota restrictions and time-space regulation on SBT catch. In the western and eastern tropical Indian Ocean, CPUE patterns were similar, both showing a general downward trend. • Considerable jump in both nominal and standardized BET CPUE between 1976 and 1977 that appears to reflect and increase in Japanese LL catchability in the western tropical Indian Ocean at that time. This effect is also seen in YFT and striped marlin nominal CPUE data, but not in data for other species. The effects of changes in materials used in LL construction are might be the one of causes.
7th Expert consulatation (1998)	Okamoto & Miyabe (#26)	5x5, M, 1952-97 1975-97 (Japan)	single	Y, M, A (7 sub-areas), NHF[(1)] , M*A, A*G	(GLM) CPUE model (Error) normal	• Effects of the area and gear configuration significantly affect CPUE. • A substantial difference in the trend of CPUE between the tropical and southern areas. In the latter area, where the main fishing ground for SBT is located, BET catch increased substantially after 1990. The historical changes in the relationship between the nominal CPUE and the gear configuration in the South area suggested a shift in targeting by LL in this area. As this was not accounted for, the standardized CPUE for the tropical region was recognised as a better index of

						BET abundance.
6th Expert consulatation (1995)	Okamoto & Miyabe (#17)	5x5, Q, 1952-76 & 1975-94 (Japan)	single	Y, Q A (6 sub-areas), Gear type, CPUE (YFT, SWO, SBT, BIL), Q*A	(GLM) CPUE model (Error) normal	• Quicker drop than the one by Hsu and Chang (1993) • 1st period:YFT, SWO and BIL showed large effects. 2nd period : Area, Gear, SBT, SWO and BIL • negative correlation(BET vs SBT) & positive correlations(YFT, SWO & BIL) • Taiwanese LL data showed a doubling of the catches between 1992 and 1993, which may be in accurate. In this respect, it was noted that 1993 was the first year in which estimates of Taiwanese LL catch involved weighting on the basis of Japanese tuna imports from Taiwanese vessels.
5th Expert consulatation (1993)	Hsu & Chang (#12)	5x5, Q, 1975-90 (K, J, T(2))	single	Y, Q, A (2 Sub-areas) int (Y*Q, Y*A and Q*A)	(GLM) CPUE model (Error) normal	• gear type (deep & regular) included, which should be considered. • Japan and Korean CPUE trends ➔ statsisticaly non-significat, but they are significant to Tawianese CPUE.

(1) NHF: number of hooks between floats(3 classes) ; (2) Deep & regular LL combined; (3) 5 classes of % of catch rates

<table>
<tr><th colspan="8">Table 3 Review of PRODUCTION MODEL analyses (BET) (I)</th></tr>
<tr><th>Meeting</th><th>Authors</th><th>Data (CPUE)</th><th>Data (catch)</th><th>Stock</th><th>Model</th><th>MSY (1000tons)</th><th>Problems, Comments and Suggestions</th></tr>
<tr><td rowspan="3">2nd WPTT (2000)</td><td>Matsumoto #9</td><td>5x5, month 1975-99 (Japan)</td><td>Global LL & PS catch</td><td>Single</td><td>ASPIC</td><td>45-74</td><td>• necessary to include PS catches. The age composition of PS catches is quite different from that of LL catches, and the increase in PS catches changes the selectivity of the entire fishery ➔ large bias in a simple stock assessment such as in PM. ➔ age-structured PM.
• adequacy of a Schaefer model for the dynamics of the population ?</td></tr>
<tr><td>Hsu #25</td><td>5x5, Q, 1967-98 (J, K, T)</td><td>Global(LL & PS)</td><td>Single</td><td>Stochastic age structured PM (ASPM)</td><td>116</td><td>• Assumed selectivity of PS fishery ➔ catch by PS assumed to be composed of ages 1 and 2.
• Value of the steepness parameter of the stock recruitment relationship ➔ relationship is not very strong.</td></tr>
<tr><td colspan="6">[Overall comments for two papers]</td><td>• large differences between two papers ➔ Further research to clarify the reasons for discrepancies.
• Application of PM➔a change in selectivity-at-age patterns would result in changes in the apparent productivity that cannot be well estimated by a standard PM. Such changes, which occurred as a consequence of the expansion of the FAD fishery on BET, mean that the results of fitting simple PM should be interpreted cautiously.
• suggestions to improve the analyses:
  • <u>Environmental</u> variables should be included as factors in the standardization procedure.
  • As targeting of BET by LL seems to be affected by <u>market prices</u>, the effect of including price information in the effort standardization procedure should be explored.
  • Use of an <u>age- or size-structured PM</u> which might better account for changing selectivity, could result in an improvement in the assessments.</td></tr>
<tr><td>1st WPTT (1999)</td><td colspan="7">No papers</td></tr>
<tr><td>7th Expert consulatation (1998)</td><td colspan="7">No papers. One paper was prepared by Hsu, but it was not presented. This paper will be published soon.</td></tr>
</table>

Table 3 (contimued) Review of PRODUCTION MODEL analyses (BET) (II)							
Meeting	**Authors**	**Data (CPUE)**	**Data (catch)**	**Stock**	**Model**	**MSY (1000 tons)**	**Problems, Comments and Suggestions**
6th Expert consulatation (1995)	Okamoto & Miyabe (#17)	5x5, Q, 1952-94 & 1961-94 (Japan)	LL(J) & ALL	single	ASPIC	55-68	• ratio of current fishing mortality at MSY exceeded 1.0 when a penalty term was applied where estimates of initial biomass exceeded the estimated carrying capacity. • use only LL catch data ➔ caution as significant PS catches in the past. • Problem ➔Taiwanese LL, a doubling of the catches between 1992 and 1993. • No decline in the catch with increases of effort ➔ impossible to estimate accurate MSY ➔ large CI • In general, it is not until the population has been over-exploited that there will be information in the data to better identify the MSY range. Furthermore, PM assume an age-specific pattern of exploitation that is constant over time. The recent increases in the catches from the surface fishery, where BET caught are smaller than in LL, suggest this is not the case. • pattern of the catch and effort data, where catches approach an asymptotic value as effort increases, is quite typical of the various BET worldwide; similar patterns have been observed in the Atlantic, Pacific and Indian Oceans.
	During the meeting	Same as above			PRODFIT	52-60	• MSY was re-estimated. the population will reach an equilibrium when the level of fishing effort mortality is kept constant, and tries to estimate this equilibrium curve of the stock productivity, using the duration of the exploited life of the fish. • PRODFIT can estimate the parameters of a Fox model, which assumes that the CPUE (at equilibrium) declines exponentially with increasing effort. By contrast, the Schaefer model assumes that such relationship is linear.
5th Expert consulatation (1993)	Hsu & Chang (#12)	5x5, Q, 1975-90	LL (K,J,T)	Single	ASPIC	38	• 1975 to 1990 ➔ during which time CPUE has not varied greatly, particularly since 1979. ➔ there may not be enough information in the data to obtain reliable estimates of MSY. • analysis did not take surface catches into account, which were low until 1990, but which accounted for half of the total catch in 1991. • Unrecorded LL catches ➔ significant in recent years ➔ MSY may has even been exceeded.