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Yellowfin tuna CPUE standardization of the Korean tuna longline fisheries In the Indian Ocean (1980-2009)

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Abstract

We attempted to standardize the Korean tuna longline fisheries yellowfin tuna CPUE using the improved database as a first time in the IPTP and IOTC. The results suggested that standardized Korean CPUE were similar to those of Japan and Taiwan unlike in the past. This suggested that the improved catch and effort database can be used to make STD_CPUE for YFT and other species.

1. Introduction

Recently the Korean catch and effort data have been revised because in the past there are problems in the data quality. By taking advantage of this revise, we attempted to standardize yellowfin tuna CPUE of the Korean tuna longline fisheries as a first time in the IPTP and IOTC.

2. Data (1980-2009)

2.1 Catch and effort (CE)

Catch and effort data (5x5 and month) were used which available in the new database in National Fisheries Research and Development Institute (NFRDI), Busan, Korea.

2.2 Number of hooks between floats (NHF)

Number of hooks between floats was also used which was also available in the logbook data in the same database.

2.3 Environmental (ENV) data

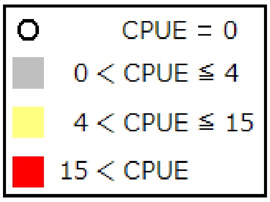
5 ENV data were used, i.e., (1) IOI, (2) Indian Ocean Di Pole Index (DP), (3) sea temperature and (4) salinity at 155m, the average depth where YFT caught by LL and (5) Shear current and its amplitudes. (1) and (2) were obtained through Dr Francis Marsac (IRD, France) and (3)-(5) from NCEP, NOAA, USA. For details on the data (3)-(5), refer to Nishida and Wang (IOTC WPB8 doc #__, 2010).

2.4 Data process

Using the all the data (CE, NHB and ENV), all data are merged into one data set by year, Q and 5x5 area.

3. Distribution of average nominal CPUE

Using the CE data, we made quarterly maps for average CPUE approximately in each operation (number of fish/3000 hooks) (Fig. 1) which were overlaid on the YFT sub area developed by Okamoto (IOTC WPTT11 report, 2009). From these maps we considered that major YFT fishing grounds were area 2, 3 and 5.



Unit: number of fish / 3000 hooks

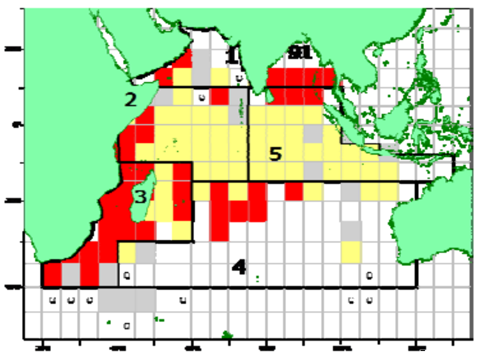
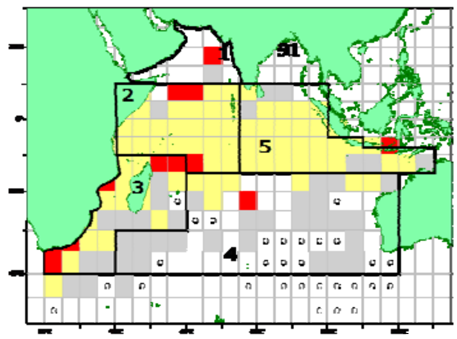
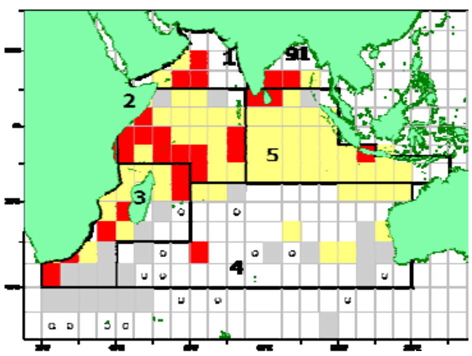
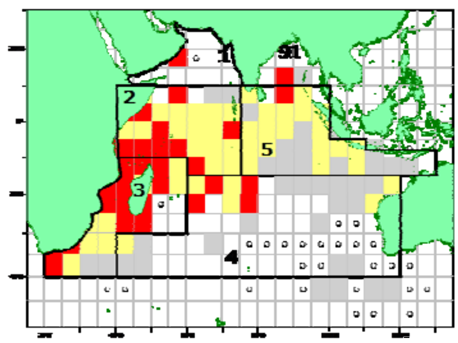
Q1	Q3
	
Q2	Q4
	

Fig. 1 Distribution of average nominal CPUEs (number of fish/3000 hooks, i.e., approximate catch rate in one operation) by quarter.

4. Trends of nominal CPUE (N_CPUE)

We plotted the trends of Korean N_CPUE in 3 areas (2, 3 and 5). Korean N_CPUE trend in area 3 shows strange the sharp pulses after 2000.

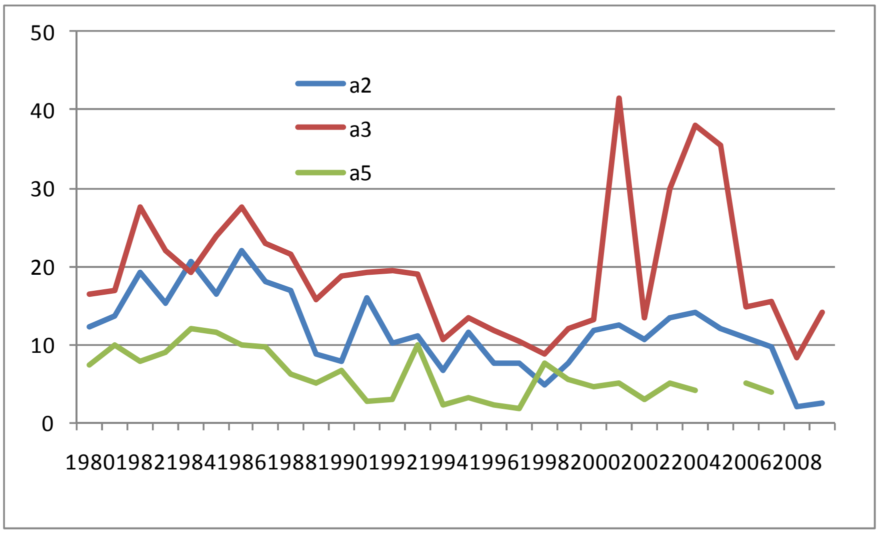


Fig. 2 Trends of nominal Korean CPUE in 3 areas
(scaled as mean CPUE=1) (based on 5x5/mo data)

5. CPUE standardization

We attempted to make 2 STD CPUE with 2 types of areas, i.e., Main FG (area 2+3+5) and tropical FG (area 2+5).

The following GLM is used:

log(natural) log+ 10% of average nominal CPUE
= (mean) + Y + Q + A + Q*A + NHF + NHF*A + NHF*Q + ENV + (error) -- (A)

where

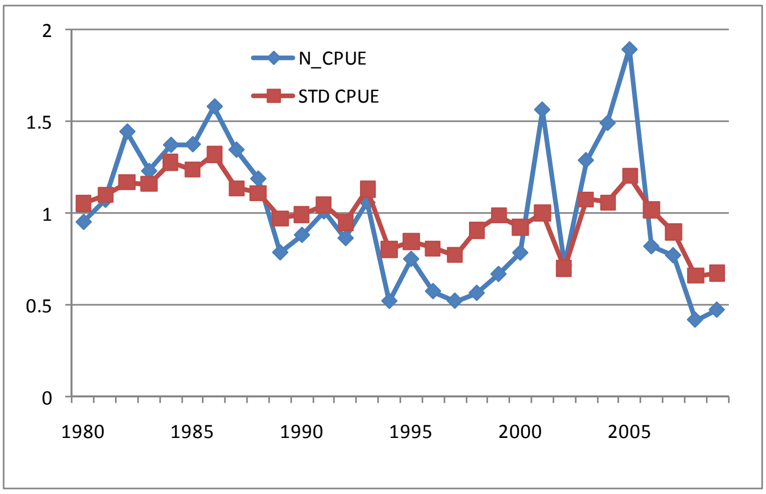
Y	:	*year*
Q	:	*quarter*
A	:	*Area 2 and 5*
NHF	:	*no of hooks between floats*
ENV	:	*IOI+DP+TD+SC+AM+T155+S155+MP*

, where

IOI	:	*Indian Ocean Index*
DP	:	*Dipole index*
TD	:	*Thermocline depth*
SC	:	*Shear current*
AM	:	*Amplitude of SC*
T155	:	*Temperature at 155 m depth*
S155	:	*Salinity at 155m depth*

5.1 STD CPUE for the major FG (Area 2+3+5)

Fig 3 shows results of STD CPUE with N_CPUE. After 2000 there were large jumps due to high YFT catch in area 3 in 2003-2005. But STD CPUE smoothed out them very well because such high YFT catch were caused mainly by ENV factors such as shallow thermo-cline depths, warm temperature and shear currents. ANOVA indicated that such factors showed high statistical significant.



ANOVA

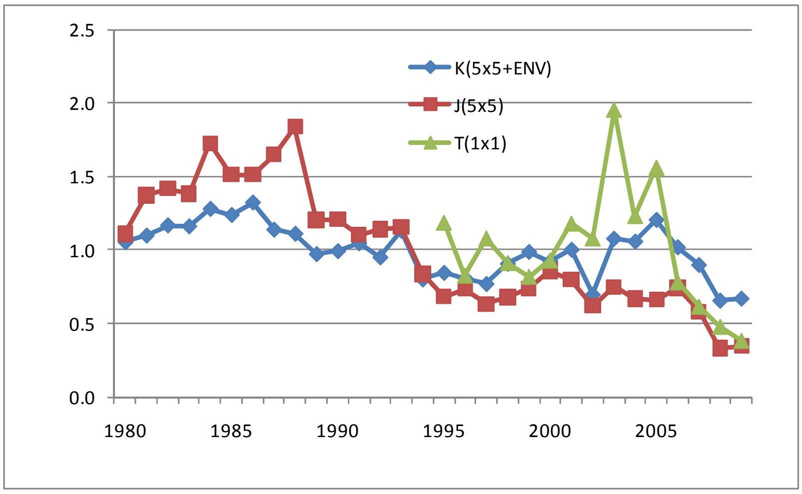
factor	df	SS	MSS	F	Pr > F
Model	53	1489.567228	28.105042	43.39	<.0001
Error	5083	3292.707089	0.647788		
Corrected Total	5136	4782.274318			

R2	CV	Root MSE	mean lcpue
0.311477	37.77079	0.804853	2.130887

factor	df	Type III SS	MSS	F	yellow Pr < 0.05 level
Yr	29	455.1038752	15.6932371	24.23	<.0001
q	3	11.9316078	3.9772026	6.14	0.0004
a	2	61.0427683	30.5213841	47.12	<.0001
q*a	6	164.0406894	27.3401149	42.21	<.0001
nhb	1	2.2132810	2.2132810	3.42	0.0646
nhb*a	2	2.6661984	1.3330992	2.06	0.1278
nhb*q	3	7.4318256	2.4772752	3.82	0.0095
t	1	23.2976760	23.2976760	35.96	<.0001
s	1	40.3888684	40.3888684	62.35	<.0001
IOI	1	0.0176811	0.0176811	0.03	0.8688
DP	1	0.2331271	0.2331271	0.36	0.5486
td	1	31.5873584	31.5873584	48.76	<.0001
sc	1	20.1691775	20.1691775	31.14	<.0001
am	1	0.0000107	0.0000107	0.00	0.996

Fig 3. Trends of STD_CPUE in the major FG (area 2+3+5) and N_CPUE and ANOVA table

We further compared with STD_CPUE of Japan (WPTT12 Doc#___ by Okamoto and Shono, 2010) and Taiwan (WPTT12 Doc #__ by Yu min and Change) (Fig. 4). Three STD_CPUE show different behaviors probably due to the different conditions of GLM, i.e., ENV in high YFT catch years (2003-2005) may be needed to reduce biases.

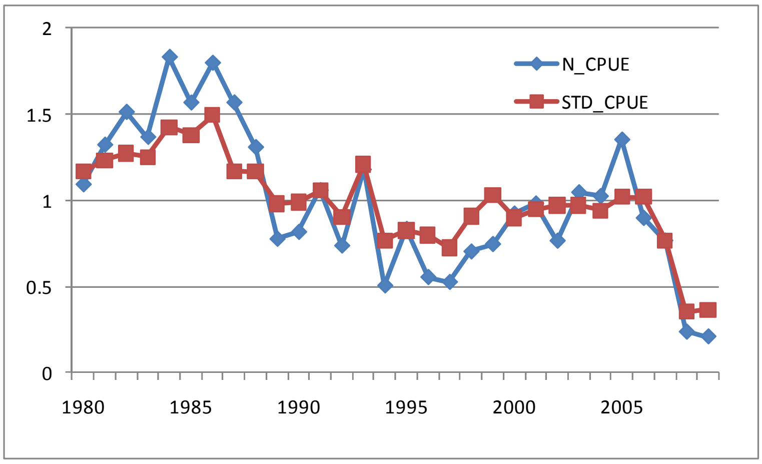


<table>
<tr><th></th><th>Grid</th><th>ENV</th><th>NHF</th></tr>
<tr><td>Japan</td><td rowspan="2">5x5</td><td>No</td><td rowspan="3">Yes</td></tr>
<tr><td>Korea</td><td rowspan="2">Yes</td></tr>
<tr><td>Taiwan</td><td>1x1</td></tr>
</table>

Fig. 4 Comparisons among 3 STD_CPUE (Japan, Korea and Taiwan) in major FG (area 2+3+5)

5.2 STD CPUE for the tropical FG (Area 2+5)

Fig 5 shows results of STD CPUE with N_CPUE. For this case, unlike the previous case (main FG), N_CPUE and STD_CPUE showed similar trends. In this large tropical area, large YFT catch was observed only in the western end tropical areas. Thus N_CPUE showed only one jump in 2005. Thus ANOVA indicated that much less ENV factors affected N_CPUE comparing to the one in the major FG (area 2+3+5). Such ENV are shallow thermo-cline depths, warm temperature and shear currents.



ANOVA

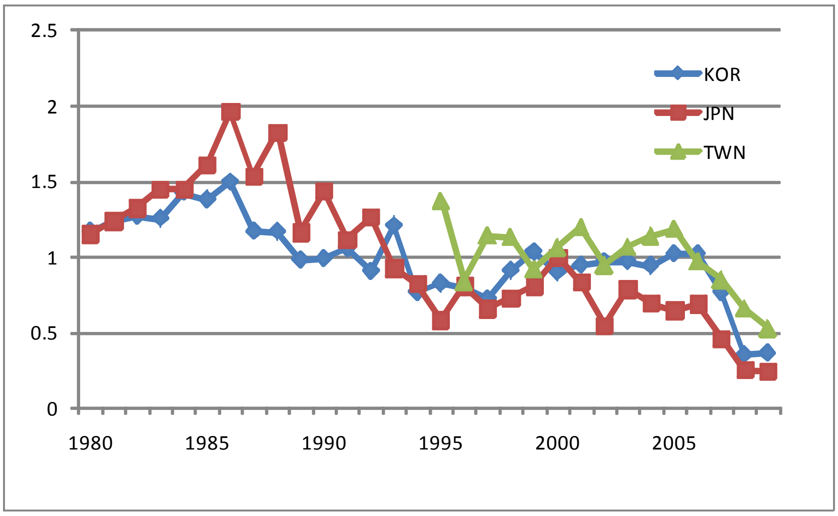
factor	df	SS	MSS	F	Pr > F
Model	48	951.278116	19.818294	30.72	<.0001
Error	3935	2538.654197	0.645147		
Corrected Total	3983	3489.932312			

R2	CV	Root MSE	mean lcpue
0.272578	40.85586	0.803211	1.965962

factor	df	Type III SS	MSS	F	yellow Pr < 0.05 level
Yr	29	414.2994052	14.2861864	22.14	<.0001
q	3	19.3019408	6.4339803	9.97	<.0001
a	1	20.5755690	20.5755690	31.89	<.0001
q*a	3	29.0282283	9.6760761	15.00	<.0001
nhb	1	4.2622891	4.2622891	6.61	0.0102
nhb*a	1	1.2573114	1.2573114	1.95	0.1628
nhb*q	3	10.1173712	3.3724571	5.23	0.0013
t	1	1.5700842	1.5700842	2.43	0.1188
s	1	25.4164765	25.4164765	39.40	<.0001
IOI	1	1.9018275	1.9018275	2.95	0.0861
DP	1	0.3616831	0.3616831	0.56	0.4541
td	1	3.4214888	3.4214888	5.30	0.0213
sc	1	8.9921496	8.9921496	13.94	0.0002
am	1	0.0590675	0.0590675	0.09	0.7622

Fig 5. Trends of STD_CPUE in the tropical FG (area 2+5) and N_CPUE and ANOVA table

We further compared with STD_CPUE of Japan (WPTT12 Doc#___ by Okamoto and Shono, 2010) and Taiwan (WPTT12 Doc #__ by Yu min and Change) (Fig. 6). Three STD_CPUE show very similar trends probably because the large tropical areas were not affected by high YFT catch (2003-2005). Thus even without ENV data, the trends were not affected.



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</table>

Fig. 6 Comparisons among 3 STD_CPUE (Japan, Korea and Taiwan) in tropical FG (area 2+5)

6. Discussion

Through this paper, we recognized that Korean catch and effort database now improved by revised database works. This is because the Korean CPUE trends showed similar as for Japan and Taiwan unlike in the past, i.e., for example, PhD dissertation (Nishida, 1991) and (WTPP reports in the past, IOTC). But we need to check more the database carefully as we found errors through this time.

We recognized that ENV data played important roles, i.e., especially apparent high N_CPUE due to high YFT catch periods (2003-2005) were well smoothed out by STD_CPUE. In such case, ENV factors such as sea temperature at 155m (mean depth at YFT exploited by LL), thermo-cline depth and shear currents suggested to play important roles to smooth the jumps by the high YFT catch in area 3 (western tropical IO).