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Standardization of swordfish (*Xiphias gladius*) CPUE of the Japanese tuna longline fisheries in the Indian Ocean (1975-2004)

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Abstract

We starndaeuzed nominal swordfish CPUE of the Japanese tuna longline fisheries in the Indian Oceans for 30 years from 1975-2003.

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1. Introduction

In this paper, we attempted to standardize the swordfish (*Xiphias gladius*) (SWO) Catch-Per-Unit-Effort (CPUE) or hooking rate of the Japanese tuna longline fisheries (LL) in the Indian Ocean from 1975-2004 using the GLM to be used for the its stock assessment by the ASPIC (Nishida et al, 2006).

2. Data

2.1 Fisheries

We use the SWO catch and effort data (1975-2004) including the information of number of hooks per basket, which have been stored in the database of the National Research Institute of Far Seas Fisheries (NRIFSF). As for the 2004 catch and effort data, about 70% of the whole operations have been entered into that database.

2.2 Environment

For the environmental data, Sea Surface Temperature (SST) is from the SAGE, Thermocline Depth (TD) or mixed layer depth from JEDAC. For details of these data refer to Okamoto *et al* (2001). In addition we used the Indian Oscillation Index (IOI) which is the difference of the standardized anomalies of Sea Level Pressure between Seychelles and Darwin (Marsac and Le Blanc, 1998). IOI is the same concept for the Southern Oscillation Index (SOI) but is adjusted for the Indian Ocean.

3. Method and Results

3.1 Period analyzed

Data for 30 years from 1975-2004 will be analyzed as the number hook per basket information (NHB) are available from 1975 in the Japanese longline data, which is important factor to standardize the SWO CPUE.

3.2 Data screenings

In order to conduct the reliable GLM analyses we eliminated the catch & effort data if hook is less than 5,000 in particular month and 5x5 area.

3.3 Sub-area

We use nine areas agreed by the 2004 WPB meeting is used (Fig. 1).

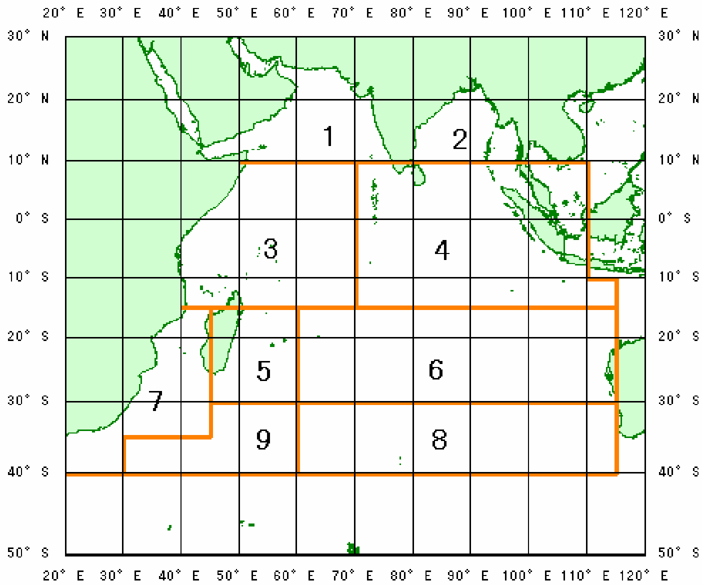

Fig. 1 Nine sub-areas used for the GLM analyses.

Note : relative sub-area size

Sub area	1	2	3	4	5	6	7	8	9
Relative size	0.67	0.40	1.81	2.18	0.48	2.07	0.66	1.24	0.50

3.4 Gear

Same class of the hook per basket as for Taiwan in 2004 and this time is used as indicated in Table 1.

Table 1 Classification of gear

Class	NHB number of hooks per between basket
1	5- 9
2	10-12
3	13-14
4	14-21

3.5 GLM

(1) Selection of sub areas

In order to perform reliable GLM analyses, we examined availability of the catch, effort and nominal CPUE by area for 1975-2004(Fig. 2). We consider that catch, effort and nominal CPUE in sub area 1,2, 5 and 9 are not sufficient to perform the GLM analyses, thus we exclude these sub areas from the GLM analyses. Same observations were noticed in case for Taiwan (Fig. 3), Taiwan also used the same sub areas (3,4, 6, 7 and 8) ‘Fig. 4)

(2) GLM runs

As a first step, we attempted the full model as follow:

ln (cpue+ x) = mean + Y + Q + A + G + SST + TD + IOI
+ interaction tems(Y*Q+ Y*A+A*Q+A*G+Q*G+Y*G) + error

where	cpue	: catch *1000/hooks
	Y	: year effect
	Q	: Quarter effect
	A	: sub area effect
	G	: gear effect
	SST	: SST effect
	TD	: thermo cline effect
	IOI	: Indian Ocean index effect (Marsac and Le Blanc, 1998)
	x	: 10% of the average cpue (Campbell et al, 1996)

As a result of the full model run, we could not get the satisfactory results as TD has too many missing values and no data in 2004 and Y*G did not provide the least square mean for Y. In addition after we excluded these two terms IOI and SST were resulted as statistically non-significant. Thus we further excluded these two terms. Then the final model became as below and Box 1 shows the SAS output.

ln (cpue+ x) = mean + Y + Q + A + G + interaction (Y*Q+ Y*A+A*Q+A*G+Q*G) + error

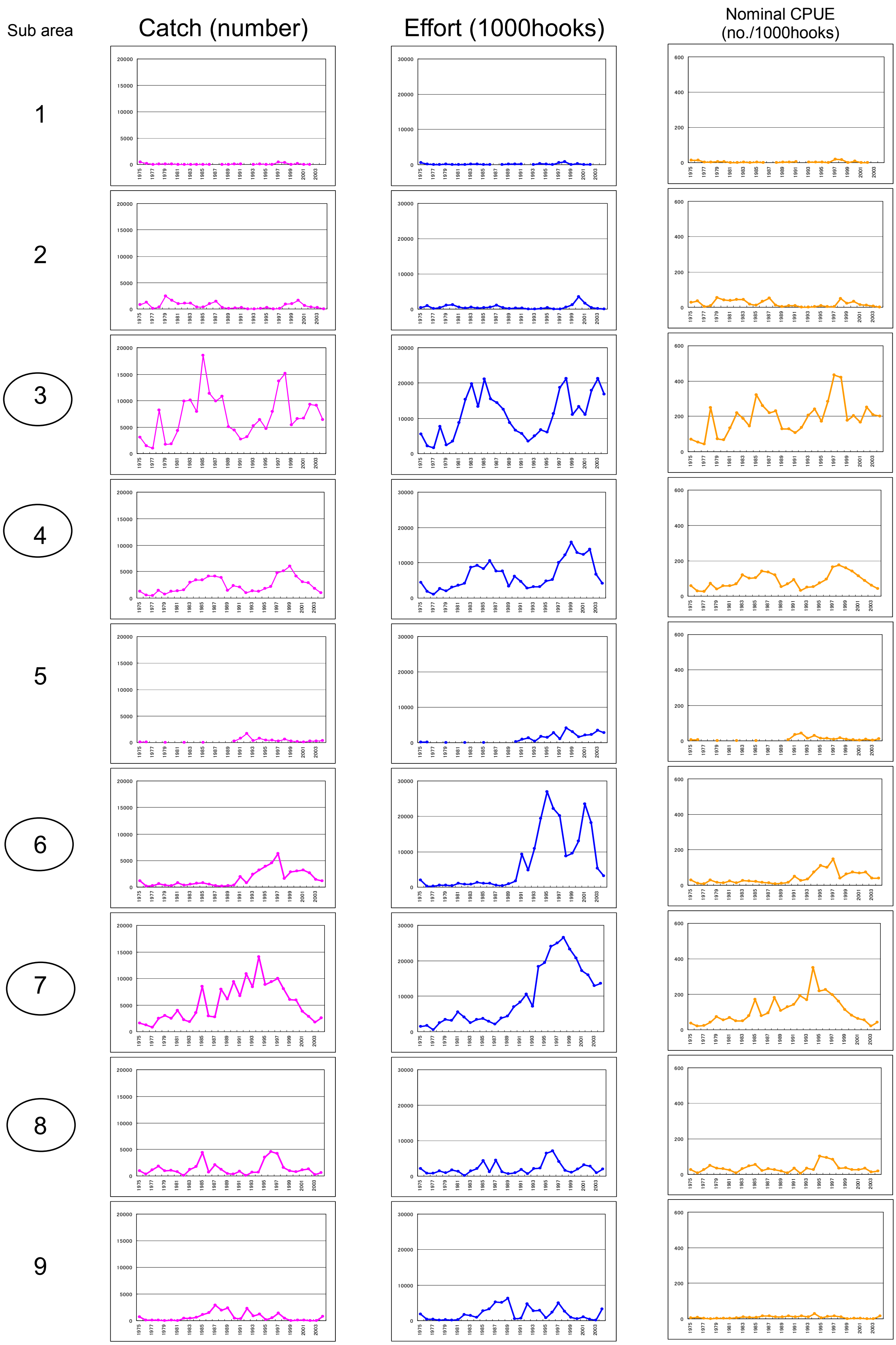

Fig. 2 Trends of catch, effort and nominal CPUE by sub-area (Japan) (1975-2004)

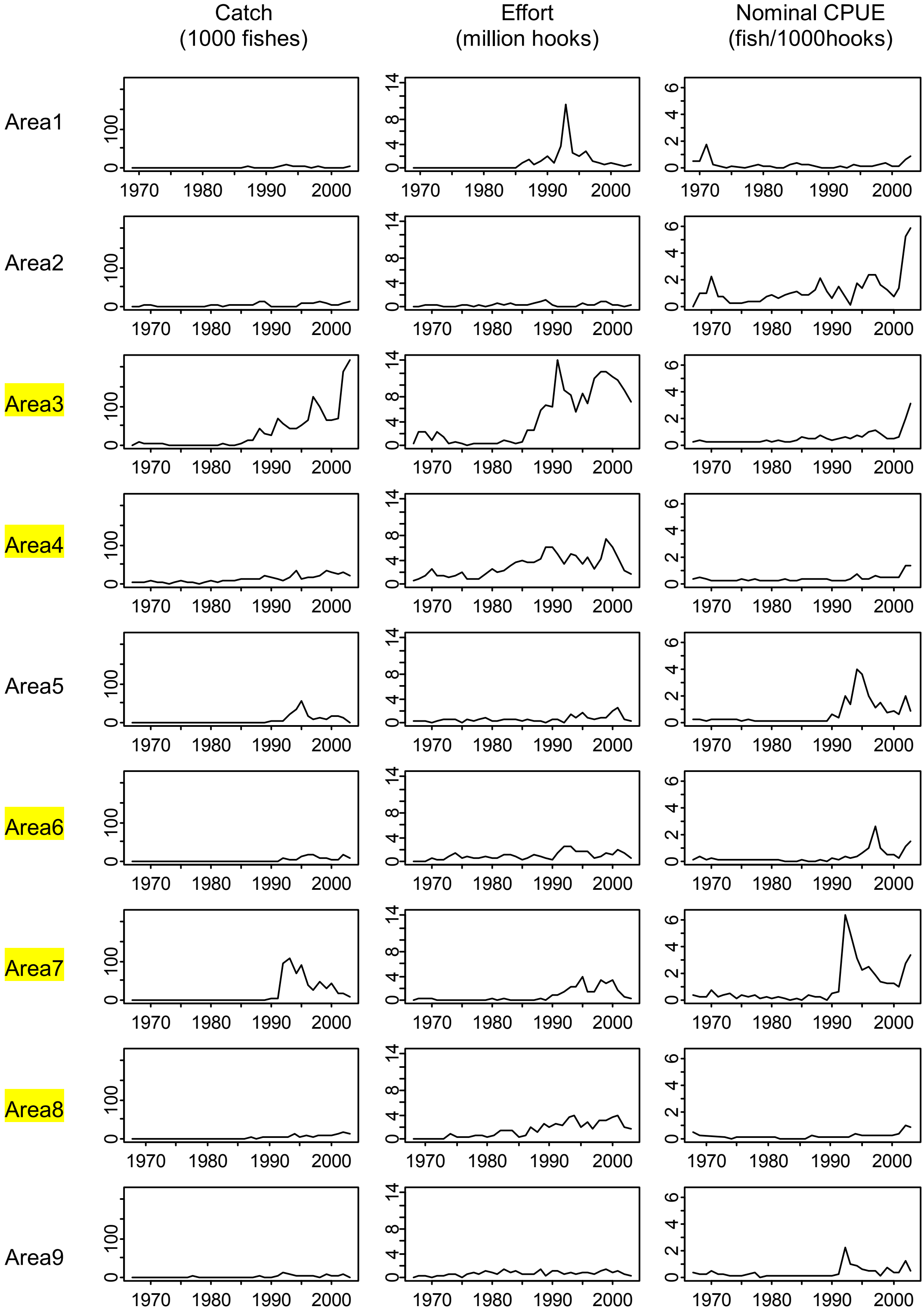

Fig. 3 Trends of catch, effort and nominal CPUE by sub-area (Taiwan LL) (1968-2003)

Box 1 SAS output of the final GLM model (1975-2004)

The GLM Procedure

Class Level Information

Class	Levels	Values
yr	30	1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
a	5	3 4 6 7 8
q	4	1 2 3 4
g	4	1 2 3 4

Dependent Variable: lcpue

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	275	8663.76186	31.50459	36.88	<.0001
Error	27358	23367.82368	0.85415		
Corrected Total	27633	32031.58554			

R-Square	Coeff Var	Root MSE	lcpue Mean
0.270476	-82.65043	0.924202	-1.118206

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	4	773.917003	193.479251	226.52	<.0001
yr	29	1201.321143	41.424867	48.50	<.0001
q	3	198.013541	66.004514	77.28	<.0001
g	3	43.786209	14.595403	17.09	<.0001
a*q	12	334.358302	27.863192	32.62	<.0001
yr*a	116	1298.630323	11.195089	13.11	<.0001
yr*q	87	353.529473	4.063557	4.76	<.0001
a*g	12	217.218684	18.101557	21.19	<.0001
q*g	9	36.895770	4.099530	4.80	<.0001

(3) Estimation of standardized annual CPUE

Using the SAS results we estimated annual standardized (STD) CPUE by applying the weighted average of the area index (Chang and Wang, 2004) as below:

Standardized CPUE = $\Sigma\ (\text{CPUE})_{ya} \times (\text{area index})a / \Sigma\ (\text{area index})_a$

Figs. 4-7 show results.

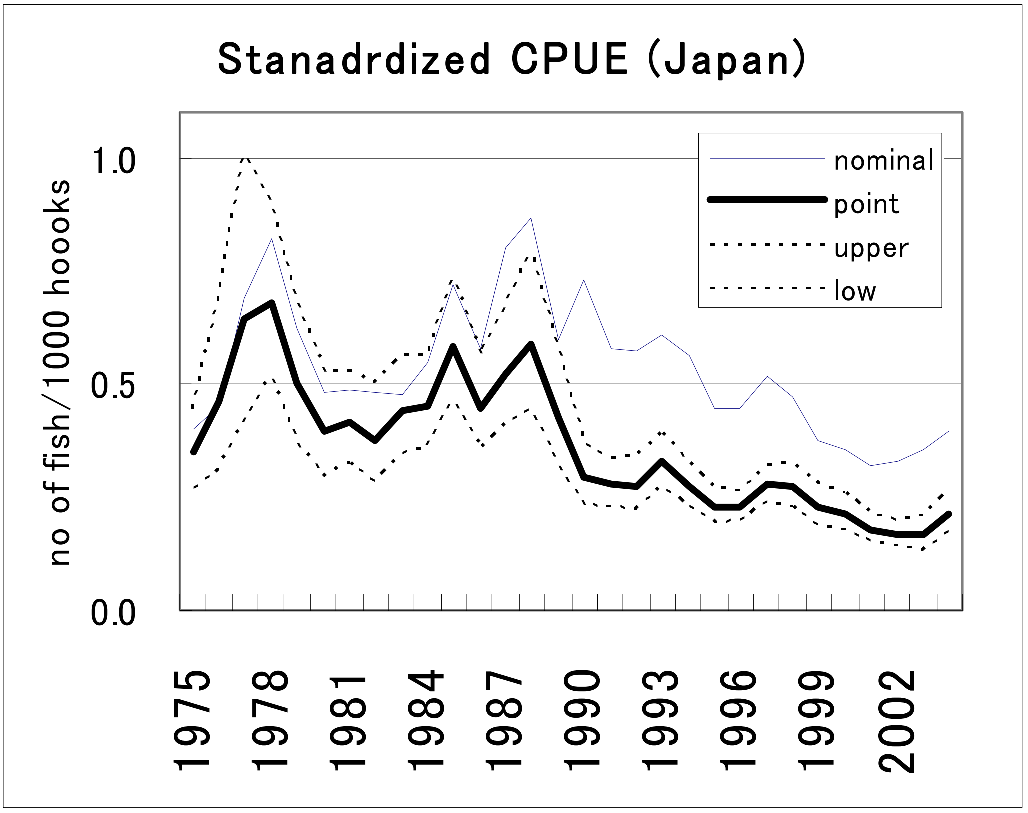

Fig. 4 Trends of the nominal CPUE bad estimated STD CPUE with 95% confidence intervals.

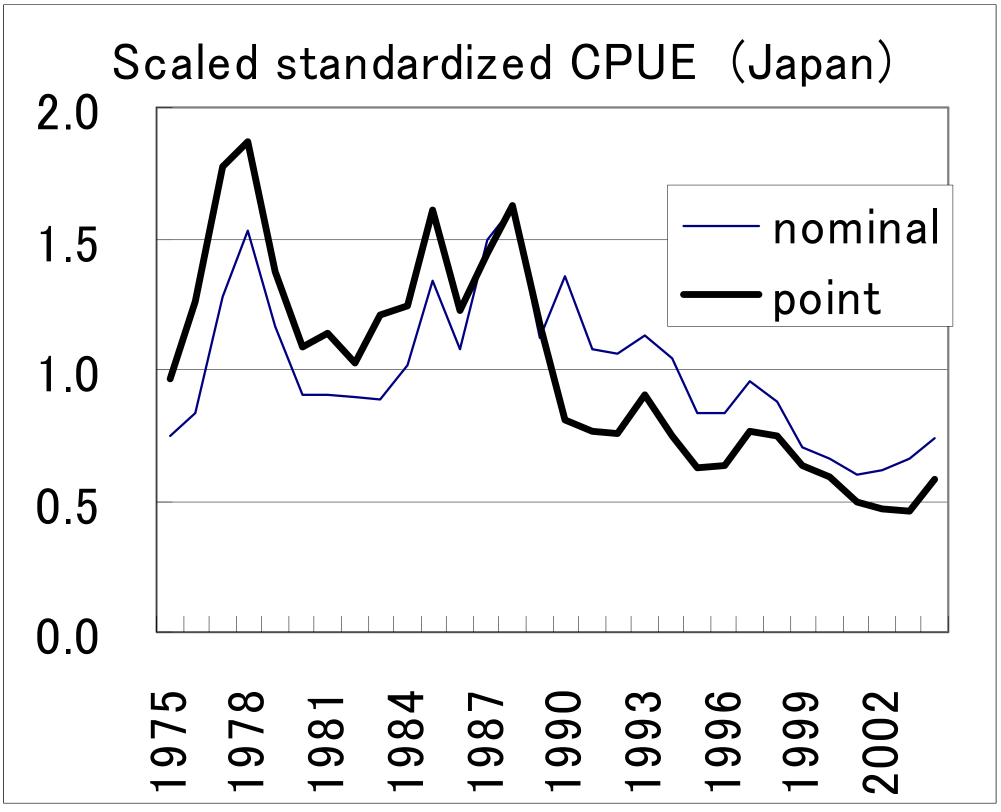

Fig. 5 Scaled trends of the nominal CPUE bad estimated STD CPUE by setting average=1.

```
                             Histogram                           #             Boxplot
  4.75+*                                                         1                *
      .*                                                         8                0
      .*                                                        21                0
      .*                                                        55                0
      .**                                                      132                0
      .***                                                     337                |
      .********                                                949                |
      .*******************                                    2361                |
      .***********************************                    4580             +-----+
      .************************************************       6262             *-----*
      .***************************************                5032             |  +  |
      .***************************                            3529             +-----+
      .*****************                                      2189                |
      .**********                                             1235                |
      .******                                                  714                |
      .**                                                      205                0
      .*                                                        22                0
 -3.75+*                                                         2                0
       ----+----+----+----+----+----+----+----+----+---
       * may represent up to 131 counts
```

Fig. 6 Residual plots

```
                     Normal Probability Plot
  4.75+                                                 *
      |                                                 *
      |                                                 *
      |                                                 *
      |                                                **
      |                                            +****
      |                                       +******
      |                                  +******
      |                             *******
      |                       *******
      |                  ******+
      |              *****+
      |          *****
      |     +*****
      | *******
      |**
      |*
 -3.75+*
       +----+----+----+----+----+----+----+----+----+----+
           -2        -1         0        +1        +2
```

Fig. 7 Normal Probability Plot

Acknowledgements

We very much appreciate Kataro Yokawa, Horoaki Okamoto and Eric Chang (Taiwan) for providing constructive suggestions to improve this paper.

References

MARSAC, F. and J-L. LE BLANC, 1998 Interannual and Enso-associated variability of the coupled ocean-atmosphere system with possible impacts on the yellowfin tuna fisheries of the Indian and Atlantic Oceans. Tuna Symposium, Pta Delgada, Acores, 10-18 Juin 1996. Coll. Vol. Scient. Papers, Vol L(2): 345

Okamoto, H., Miyabe, N. and Matsumoto. (2001): GLM analyses for standardization of Japanese longline CPUE for bigeye tuna in the Indian Ocean. IOTC/WPTT/01/21, 38p.-377

Other references are provided upon requested.