IOTC-2008-WPB-03

Preliminary results of standardization of swordfish CPUE of Taiwanese and Japanese tuna longline fisheries in the Indian Ocean (1980- 2006 and 1990-2006) (*)

- Preliminary report for the IOTC WPB6 (July, 2008) -

June 10, 2008

Contents

1/ National Research Institute of Far Seas Fisheries (NRIFSF) Fisheries Agency of Japan

2/ Dept. of Environmental Biology and Fisheries Science, National Taiwan Ocean Univ., Keelung, Taiwan.

(*) Reasons to choose 1980-2006

- To improve and solve the problems on the discrepancies in STD CPUE between Taiwan and Japan.
- Various ENV data by depth are available since 1980
- To reduce the regime shift effect (see the WPB5 report)
- To use more accurate and consistent quality in q of the data

Part 1: Results (Japan)

Standardization of swordfish CPUE of the Japanese tuna longline fisheries in the Indian Ocean (1980- 2006)

- Preliminary report for the IOTC WPB6 (July, 2008) -

Yasuko Semba and Tom Nishida
National Research Institute of Far Seas Fisheries (NRIFSF)
Fisheries Agency of Japan

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This is the preliminary report of the standardized (STD) CPUE (Catch Per Unit Effort) of swordfish (SWO) exploited by Japanese tuna longline fisheries (LL) in the Indian Ocean (1980-2006).

1. Data

(1) CPUE

We used the NRIFSF's database of tuna longline fisheries (LL). From this database we extracted the $5^o x 5^o$ and month based swordfish catch and effort data including the number of hooks between floats (NFBF) information.

(2) Environment (ENV)

We used temperature and salinity data at 15m depth as SWO inhabits in that depth in average (source?) when exploited by the tuna LL. In addition we used the thermocline depth (TD) and IOI. The source of the environmental data is NCEP, NOAA (USA).

2. Methods

(1) Period of the analyses

As the NCEP data are available since 1980 we used CPUE and ENV data for 27 years from 1980-2006. In addition based on the discussion in the last WPB5, we also estimated STD CPUE for 17 years from 1990-2006 to evaluate the performances of stock assessments between these two periods.

(2) Sub areas (Fig. 1)

We re-grouped nine sub-areas used in the past work (Nishida and Wang 2006) into four sub -areas (Fig. 1). The reason of this regrouping is to reduce the non conversion problems in the GLM analyses caused by too many missing values when small (nine) sub areas were used.

New area	compositions of the previous sub areas
NW:	area1 and area 3
NE	area2 and area 4
SW	area 5 and area 7 and area 9
SE	area 6 and area 8

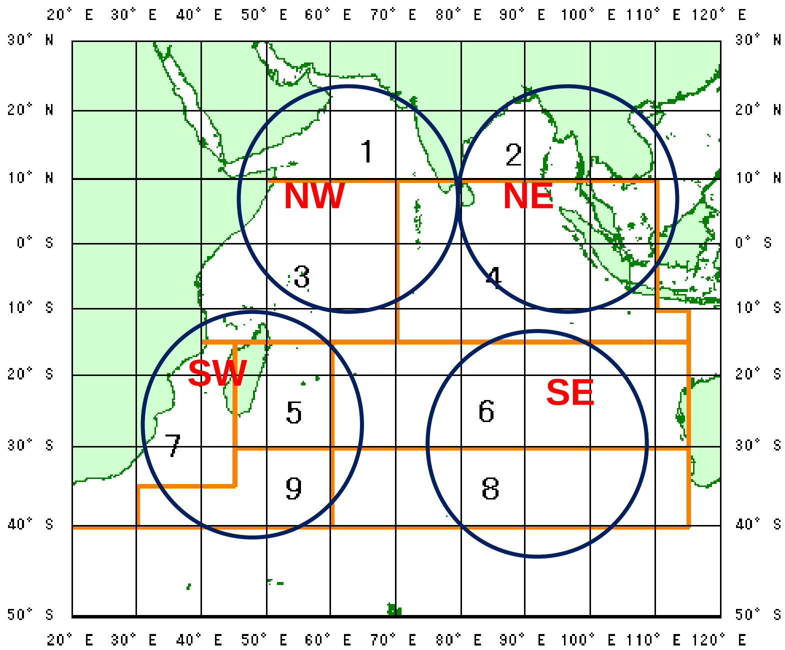


Figure 1 Nine sub areas (1-9) used in the last WPB5 (2006) and the new sub areas (NE, NW, SW and SE)

(3) Gear: Number of hooks between float (NHBF)

We used the same classification as in the WPB5 (2006) as below:

Category	number of hook between floats (NHBF)
1	NHBF <=9
2	10<= NFBF <=12
3	13<= NFBF<=14
4	15<= NHBF

(4) GLM

We used GLM (Generalized Linear Model) to standardize nominal CPUE. We transformed nominal CPUE by the natural logarithm and we assume that the error structure of this GLM model follows the normal distribution. We initially attempted the full models using all the factors and their interactions as many as possible as below:

Full model

Lcpue = log (nominal CPUE + 0.1*average nominal CPUE)
= (mean) + Y + Q + A + G + T + S + TD +IOI
+ Y*Q+ Y*A + Q*A + G*Y+ G*Q + G*A
+ T*Y + T*Q + T*A + S*Y+ S*Q + S*A
+ IOI*Y + IOI*Q+IOI*A

Y: year, Q: season, A: sub area, G: NFBF, TD: Thermocline depth, IOI:Indian Ocean Index
T: sea temperature at15m depth, S: Salinity at 15m depth

Reduced model

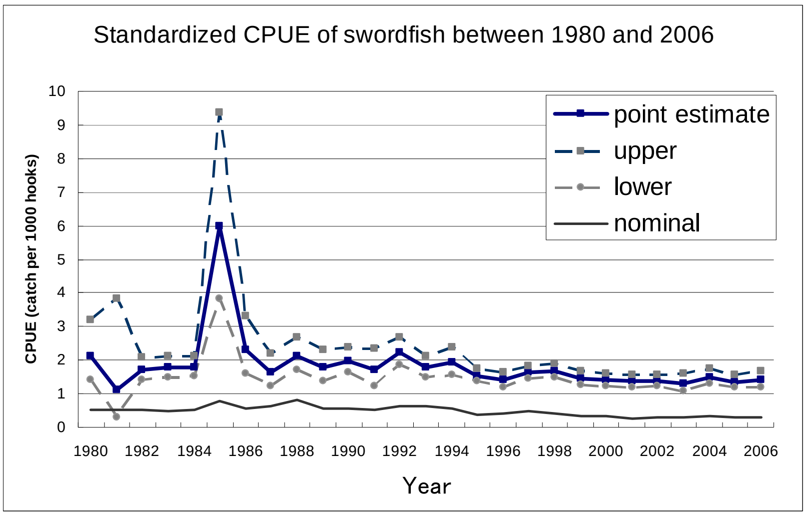
As four factors (T, S, IOI, TD) did not provide statistical significances in the full model we omitted these factors in the reduced model. In addition we omitted G*Y because if it were included in the GLM, not all of the annual STD CPUE could not be estimated due to missing values.

Lcpue = log (nominal CPUE + 0.1*average nominal CPUE)
= (mean) + Y + Q + A + G ~~+ T + S + TD +IOI~~
+ Y*Q+ Y*A + Q*A ~~+ G*Y~~+ G*Q + G*A
+ T*Y + T*Q + T*A + S*Y+ S*Q + S*A
+ IOI*Y + IOI*Q+IOI*A

3. Results

(1) 1980-2006 (Fig. 2)

In the preliminary trial for the period between 1980 and 2006, standardized CPUE (or abundance index) of the point estimate was almost between 0.4-1.2 except for 1985(1.8). In 1985, STD CPUE was extraordinarily higher than in other years. We will investigate its cause. Except for 1985, the STD CPUE generally shows the decreasing trend. The residual plots show the normal distribution (Figure is omitted).



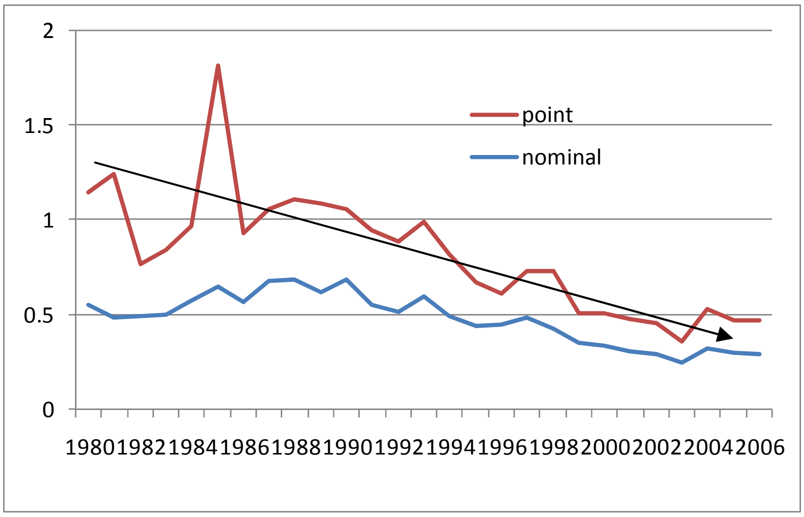


Fig. 2 Trend of the estimated STD CPUE (abundance) index (1980-2006)

Upper: with 95% CI. Lower: showing only point estimate & nominal CPUE

NB: STD CPUE in the upper graph shows APPARENTLY constant trend due to the effect of the large 1985 value of the upper 95%CI. However the lower shows the INTRINSIC trend of the point STD CPUE without 95% CI. We need to be careful for this type of apparent trend caused by the different scaling.

(2) 1990-2006 (Fig. 3)

The estimated STD CPUE shows gentle decreasing trend until 1999.Afterwards it shows the constant trend. The residual plots show the normal distribution (Figure is omitted).

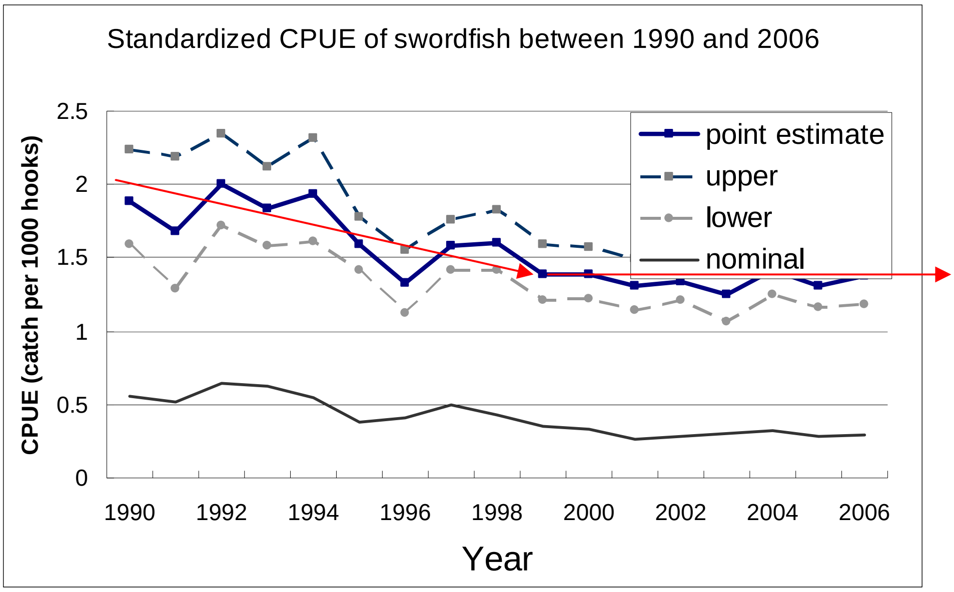


Fig. 3 Trend of the estimated STD CPUE (abundance) index (1990-2006)

4. Note

If time is allowed, in the GLM analyses we plan to add the Shear current (Bigelow et al, 2005 and Marsac and Nishida, 2008) and the ocean fronts effect caused by sea temperature (Bigelow et al.,) and salinity (Bo and Nishida, 2006?)

Reference

The complete referees will be provided in the final paper to be submitted to the WPB6.

Part 2: Results (Taiwan)

CPUE standardization of swordfish caught by Taiwanese longline fishery in the Indian Ocean (preliminary report for IOTC WPB6)

Sheng-Ping Wang
Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, Keelung, Taiwan.

Catch and Effort data

- Logbook data (daily shot-by-shot data) of Taiwanese longline fishery from 1980-2006.
- Data of Hooks Per Basket (HPB) are only available since 1995.
- The percentage of data with HPB is about 62%.

Environmental data

Temperature and salinity data at 15m depth, thermocline depth (TD) and Indian Oscillation Index (IOI) are from NCEP, NOAA (USA). However, TD is not used in this study due to large number of missing data.

GLM Model

$$\log(CPUE + c) = \mu + Y + Q + A + T + Temp + Sal + IOI + \text{interactions} + \varepsilon$$

where
CPUE is the nominal CPUE of swordfish,
c is the constant value (i.e. 10% of the average nominal CPUE),
μ is the intercept,
Y is the effect of year,
Q is the effect of quarter,
A is the effect of fishing area,
T is the effect of target,
Temp is the effect of sea surface temperature,
Sal is the effect of Salinity ,
IOI is the effect of Indian Oscillation Index,
Interactions is the interactions between main effects,
ε is the error term, $\varepsilon \sim N(0, \sigma^2)$.

Fishing areas are redefined by four new areas (Fig. 1):

1. NW: IOTC SWO area 1 and 3;
2. SW: IOTC SWO area 5, 7 and 9;
3. NE: IOTC SWO area 2 and 4;
4. SE: IOTC SWO area 6 and 8.

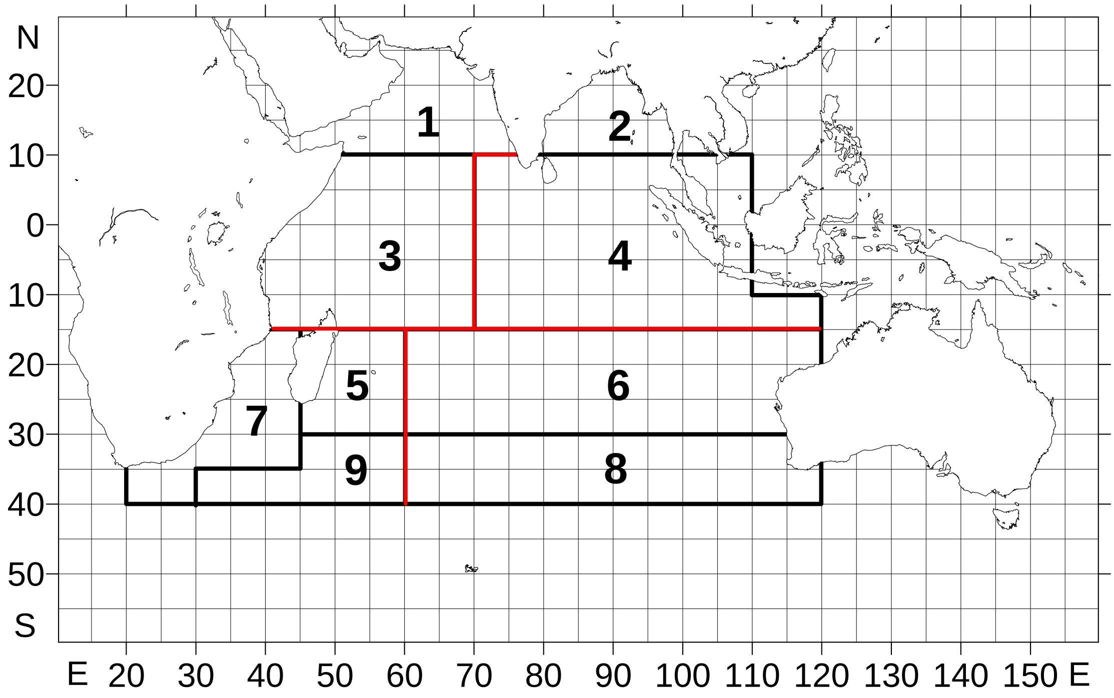


Fig. 1. Area stratification for swordfish in the Indian Ocean.

Two indices are used to express the target effects:

1. Three categories of swordfish catch composition defined based on the information of hooks per basket (1: <8%; 2: 8-15%; 3: >15%).
2. Four categories of HPB used by Nishida and Wang (2006)(1: <9; 2: 10-12; 3: 13-14; 4: >14).

In this study, three data series are used for standardizing the CPUE:

Case 1: Data of 1980-2006 are used to standardize CPUE and swordfish catch composition is used as target effect.

Case 2: Data of 1990-2006 are used to standardize CPUE and swordfish catch composition is used as target effect.

Case 3: Data of 1995-2006 are used to standardize CPUE and HPB is used as target effect.

Adjustment by area size

The estimation of annual nominal and standardized CPUE is calculated from the weighted average of the area indices.

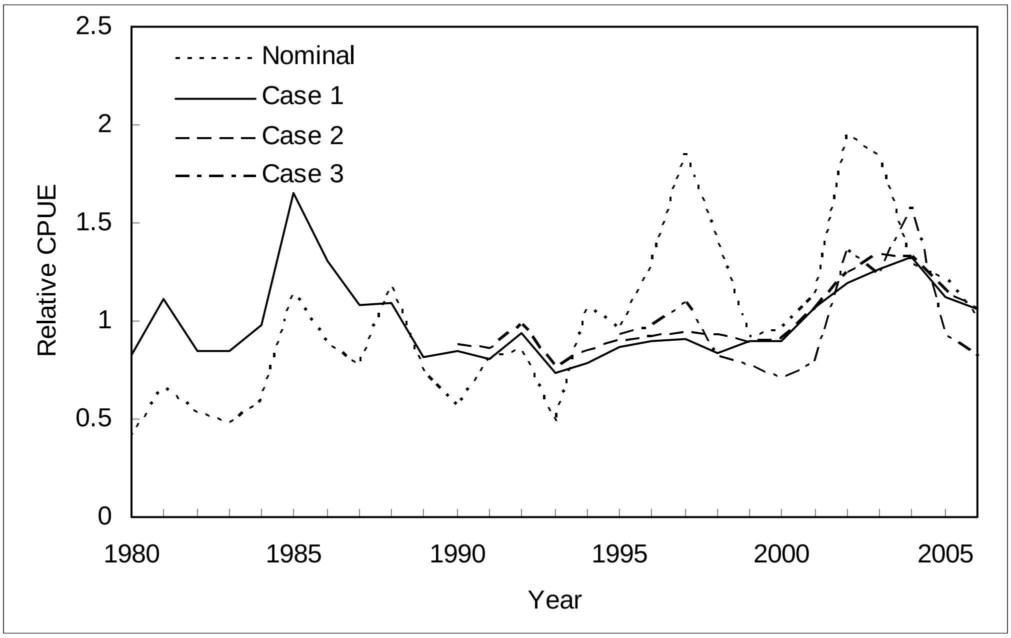
$$U_y = \sum_a S_a U_{y,a}$$

Where U_y is CPUE for year y,
$U_{y,a}$ is CPUE for year y and area a,
S_a is the relative size of the area a to the four new areas.

Results

For Case 1, The interactions of *A***IOI* and *Temp***IOI* are excluded from the full model because these effects are not statistically significant. For Case 2 and Case 3, The main effect of *IOI* and interactions related to *IOI* are excluded from the full model because these effects are not statistically significant. Nominal and standardized CPUE for each fishing area is shown in Fig. 2. Nominal and standardized CPUE aggregated by area size is shown in Fig. 3.

New Area 1



New Area 2

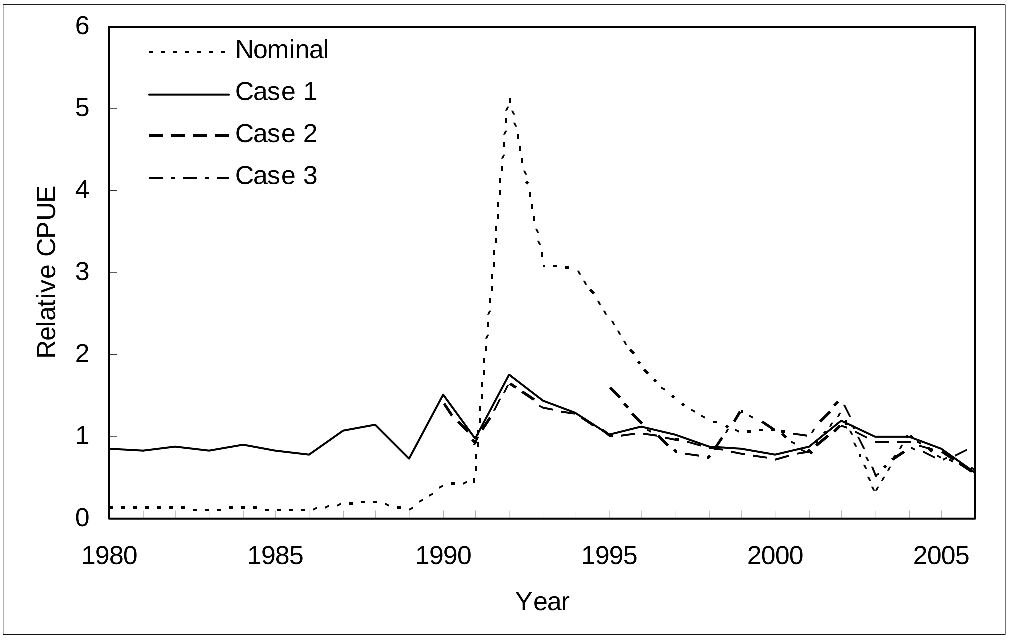
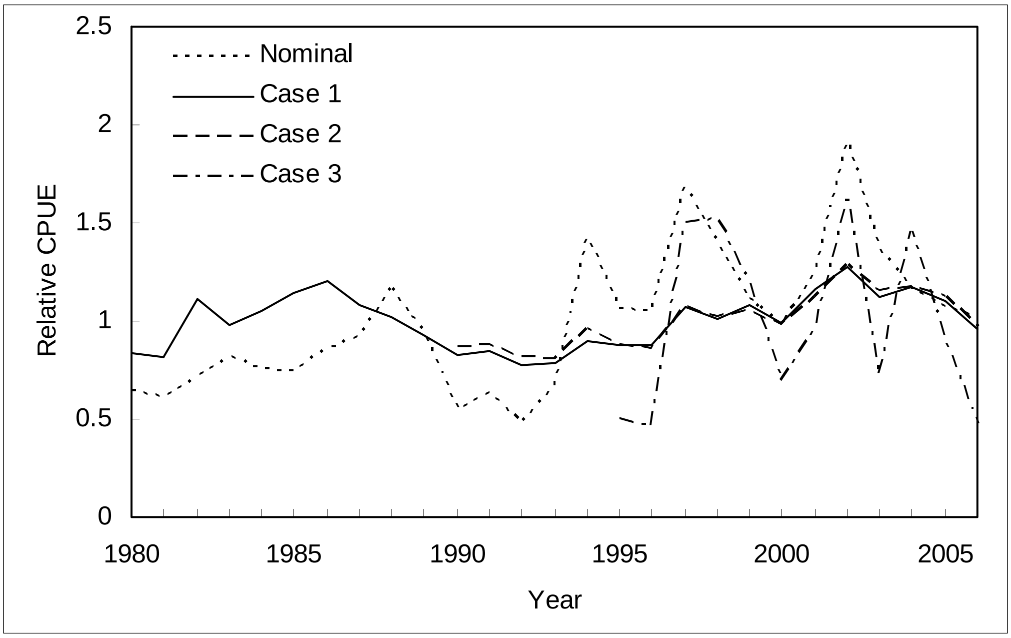


Fig. 2. Nominal and standardized CPUE for four areas (scaled to the average estimates).

New Area 3



New Area 4

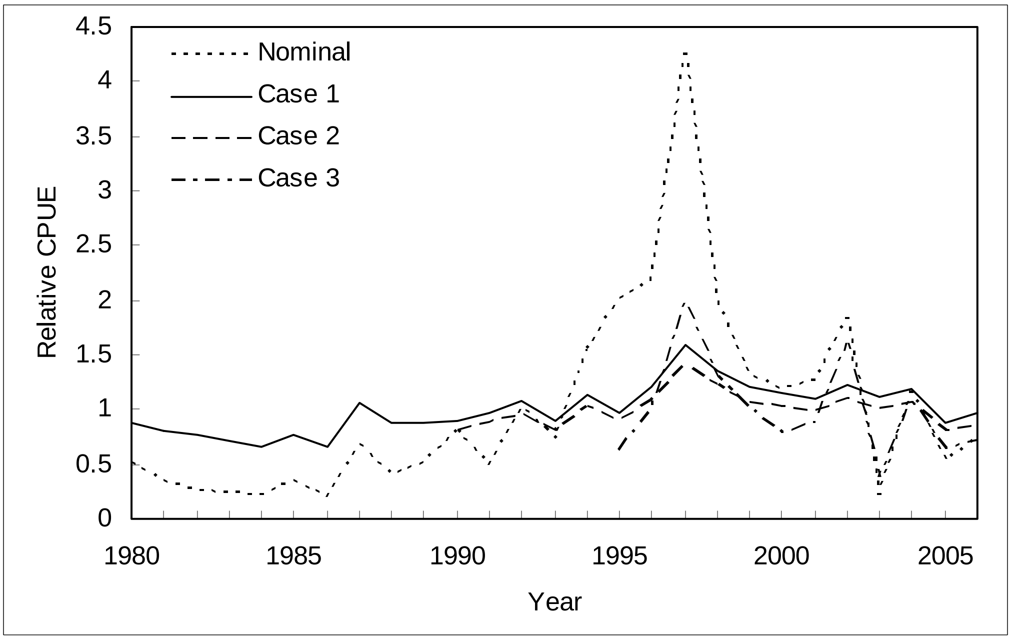


Fig. 2. (continued).

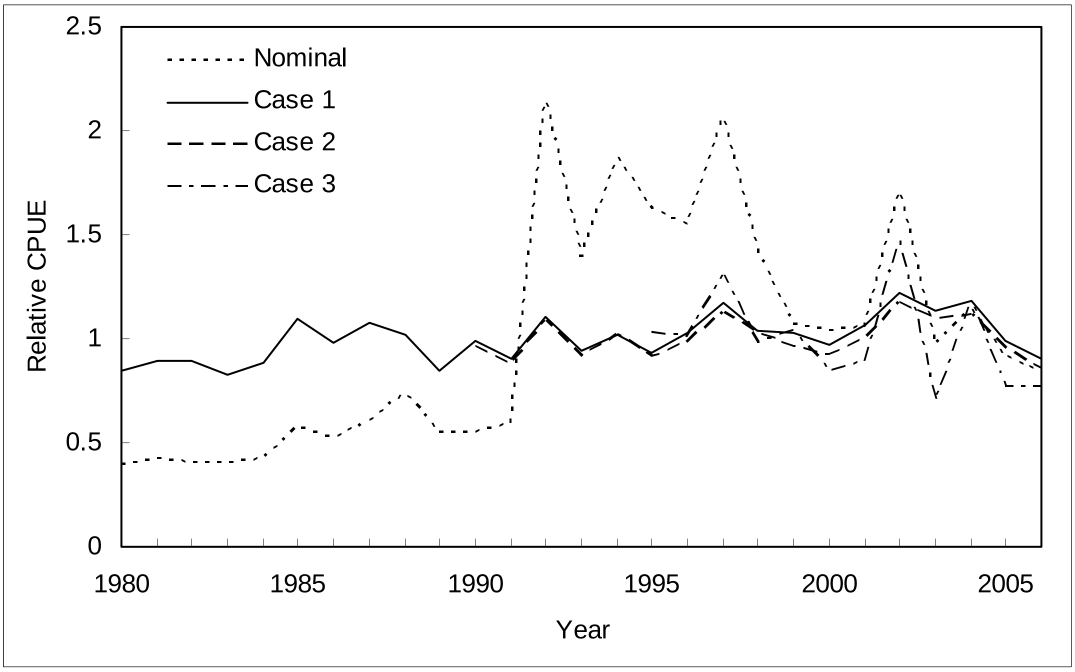


Fig. 3. Nominal and standardized CPUE aggregated by area size (scaled to the average estimates).

Part 3: Comparisons

1. 1980-2006

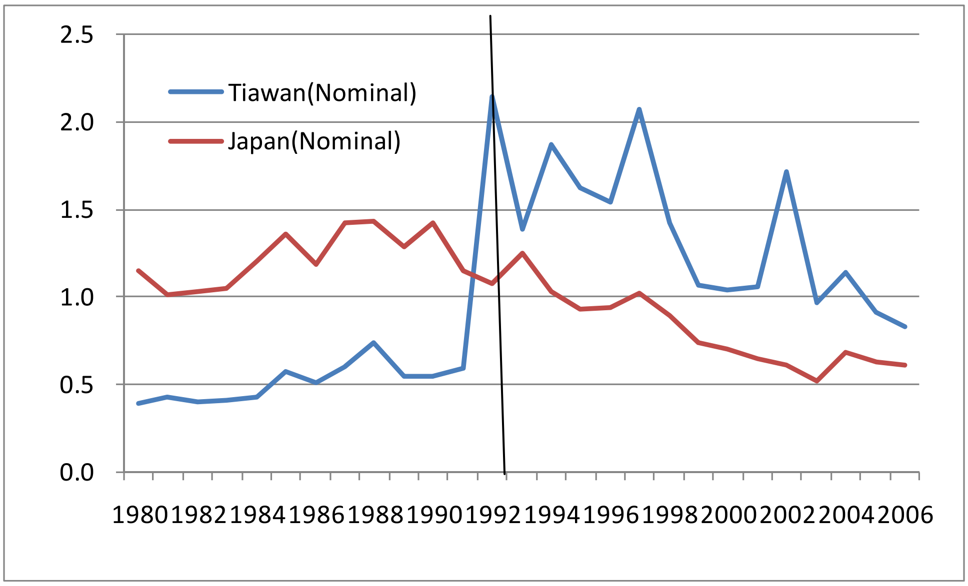


Fig. 1 Nominal CPUE (Taiwan and Japan) (scaled as mean CPUE = 1)

- Significant regime shift after 1992 (Taiwan)
- Before 1992 Japan shows the constant trend while Taiwan slight increasing trend

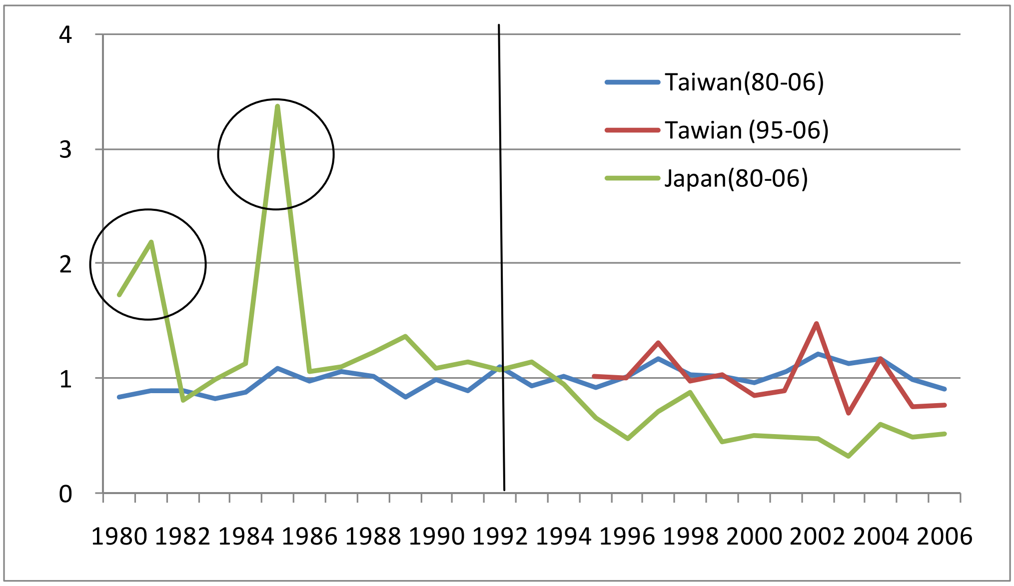


Fig 2. STD CPUE (Taiwan and Japan) (scaled as mean CPUE = 1)

- Japan: there are three outliers in 1980-1981 and 1985. Except these three points, Japan STD CPUE shows the gentle decreasing trend.
- Taiwan(1980-06) shows the constant trends while Taiwan (95-06) shows the slight decreasing trends.

Note: Differences in GLM among three STD CPUE series are that Taiwan (80-06) is based on the SA model (Wang et al, 2007) while Taiwan (95-06) & Japan (80-06) based on the number hook between floats.

2. 1990-2006

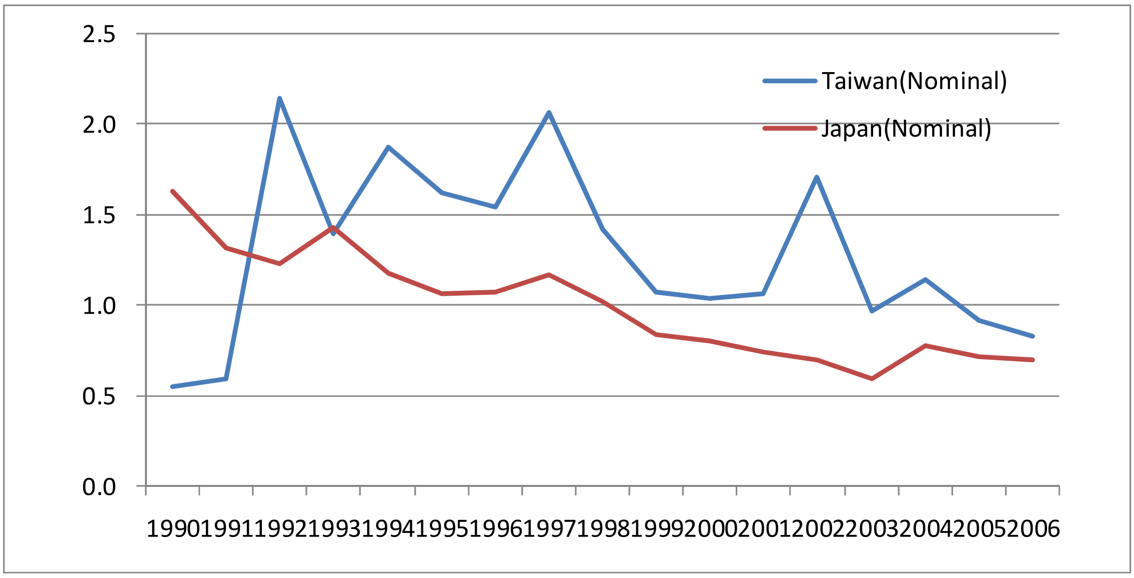


Fig. 3 Nominal CPUE (Taiwan and Japan) (scaled as mean CPUE = 1)

- Both shows the decreasing trends except Taiwan (1990-91)

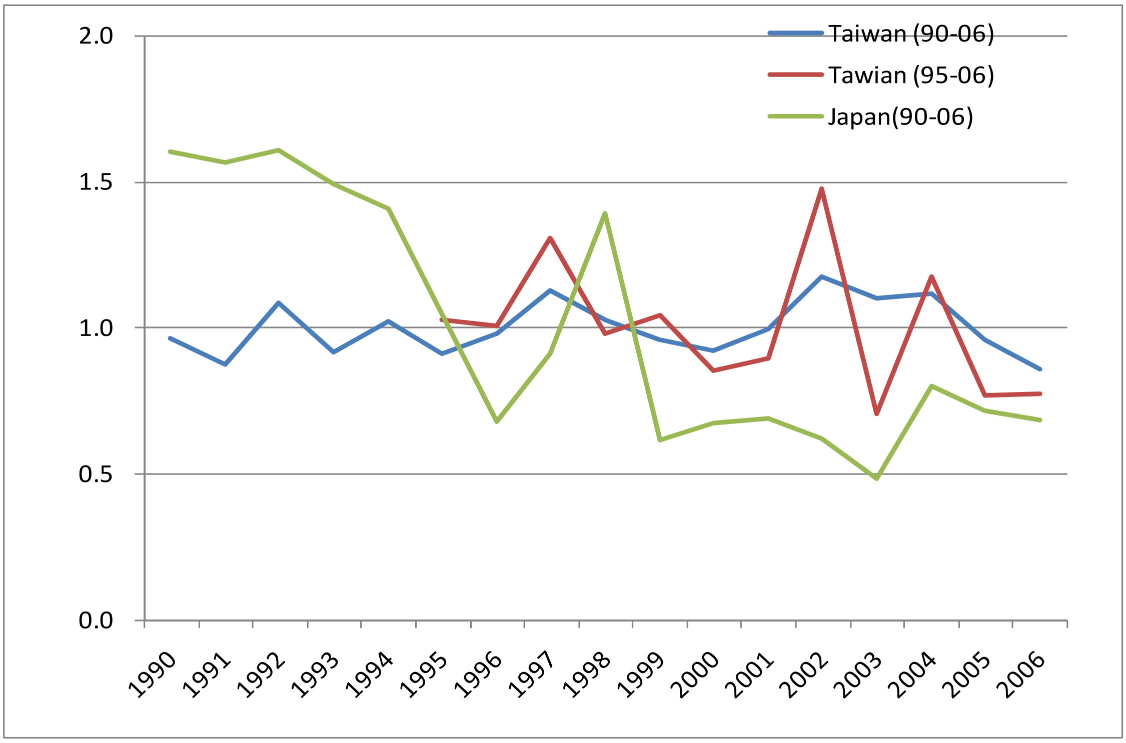


Fig 4. STD CPUE (Taiwan and Japan) (scaled as mean CPUE = 1)

- Japan shows the gentle decreasing trend.
- Taiwan shows the constant trends except Taiwan (95-06) shows the slight decreasing trends with large fluctuation.

Note: Differences in GLM among three STD CPUE series are that nominal CPUE of Taiwan (80-06) isbased on the SA model (Wang et al, 2007) while Taiwan (95-06) & Japan (80-06) based on the number hook between floats.

2. 1992-2006

As both Japan and Taiwan nominal CPUE (1990-2006) (Fig. 3) shows consistent decreasing trend except two points in Taiwan (1990-1991), the nominal CPUE (1992-2006) are re-depicted (Fig 5)

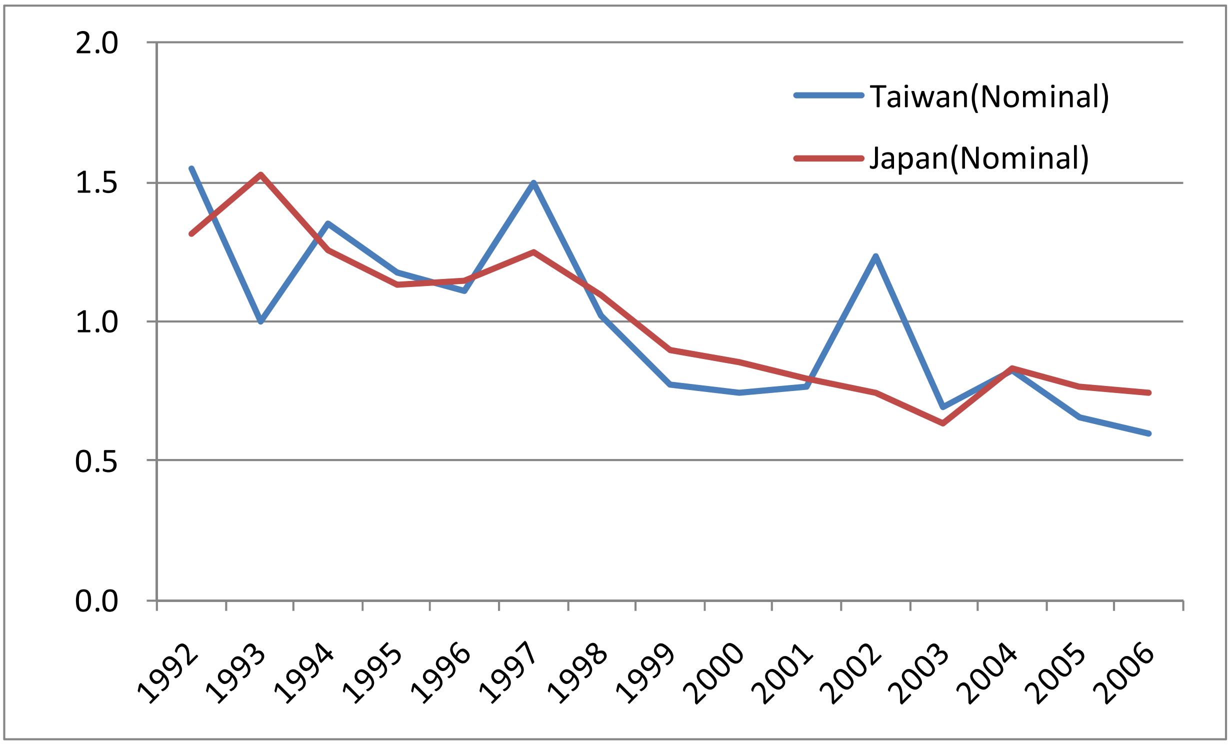


Fig.5 Nominal CPUE (Taiwan and Japan) (scaled as mean CPUE = 1)

- Both nominal CPUE show the very similar decreasing trends

As this is the first time to see such very similar trends in the nominal CPUE between Japan and Taiwan, we further need to attempt to evaluate the STD CPUE in this period.