# Comparison of catch-and- effort data of Japanese longline fishery for southern bluefin tuna between shot-by-shot data and raised data in 5x5 degree and month.

# 日本延縄船のミナミマグロ漁獲データにおける L5 データとショット・バイ・ショットデータとの比較

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## 要約

操業ごとのデータ（SbyS データ）と、従来 CCSBT に提出している緯経度 5 度区画･月別に集計したデータ（L5 データ）とを比較した。ニュージーランドとの JV 船データ、オーストラリアとの JV 船データは含まない、日本漁船の日本漁獲枠での 1986-2006 年の操業データを用いた。SbyS データの L5 データに対するカバー率（1986-2006 年の Area4-9 の SBT 尾数で）は全ての年で高く、平均 96%であった。標準化した CPUE のトレンドは SbyS データと L5 データとで互いに類似していた。

## Summary

Comparison was made between shot-by-shot data (SbyS data) and raised data in 5x5 degree and month (L5 data). The data sets used were based on Japanese longline fishery using the Japanese SBT quota during 1986-2006, not including shot-by-shot data fished under the joint ventures with New Zealand or Australia. The coverage of SbyS data to the L5 data was high in all years with an average of 96% in Area 4-9 in number of southern bluefin tuna caught. Trends of standardized CPUE series between SbyS and L5 were rather similar to each other.

## Introduction

In this CPUE Workshop, the fishery data of Japanese longline for southern bluefin tuna (SBT) as well as data from other members, will be analyzed in order to derive the most appropriate CPUE series for SBT stock assessment. This document was prepared to provide information on the Japanese data prepared for the Workshop, especially in comparison to shot-by-shot data (SbyS data) and raised data in 5x5 degree and month (L5 data, submitted to CCSBT).

## General comparison

Four data sets were prepared for comparison for 1986-2006 (Table 1). “SbyS data” is shot-by-shot data for the Japanese longline fishery which was conducted under the Japanese SBT quota. Detailed description of this data set was found in Sakai *et al.* (CCSBT-CPUE/0705/04).

Other three sets of L5 data were made available. One is "L5all data" that contains the Japanese longline fishery data under Japanese quota, the joint venture with New Zealand (1992-2005) and the joint venture with Australia (1989-1995). This data set was made from the CCSBT catch database (CCSBTData_2007_01_25.mdb). This type of dataset is used to derive the standardized CPUE series which were utilized for the stock assessment in the CCSBT.

Another data set "L5J" that contains Japanese longline fishery data under Japanese quota only was made from the same CCSBT catch database. Because SbyS data are prepared from the RTMP data for 2005 and 2006, "L5JR" that replaces L5J for 2005 and 2006 with the RTMP data in 2005 was also made. Data in 2006 used is the dame data submitted to CCSBT on April 2007.

Comparisons were made on the number of hooks used, the number of SBT caught, the nominal CPUE and the standardized CPUE.

Fig.1 shows the number of hooks used, the number of SBT caught and nominal CPUE by year in both all areas south of 20 degree south and for the CCSBT statistical Area 4-9 for four data sets. In the all areas, the number of hooks in different data sets in those strata shows minor differences between SbyS and L5 data sets. This is due to the different criteria was used between SbyS and L5. In the case of SbyS, all data of a vessel that had an experience of fishing in the Area 4-9, was all extracted from the database, while L5 data do not contain data for any month and 5x5 strata where no SBT was caught in the Area 11-15. The numbers of SBT caught in L5 all were almost the same as in L5J and SbyS except 1991-1994. The difference in 1991-1994 is due to the catch by joint ventures with Australia. The difference due to the SBT catch by joint venture with New Zealand was not obvious on the graph.

In Area 4-9, both the number of hooks used and the number of SBT caught was similar among the four data sets except 1991-1994 (due to the catches of joint venture with Australia). The SbyS has high coverage rate in number of SBT caught relative to the L5J being more than 88% with an average of 96%.

**Comparison of standardized CPUE**

In order to check the influence of data resolution on the CPUE index, we compared the year trends of standardized CPUE through the SAS/STAT software (SAS, Ver.9.1.3.) using SbyS data and L5JR.

At first, in terms of the continuity of analysis, we performed the CPUE standardization based on the agreed statistical method and data (See Takahashi *et al.*, 2001 in detail) as follow:

- CPUE-LogNormal model

Log( CPUE + constant ) = Intercept + Year + Area + Month + Quarter + Month*Quarter (nested) + Latitude (5-degree) + Year*Area + Year*Quarter + Area*Quarter + error, error～N(0, $\sigma^2$) (Model-1)

where constant is set to tithe(0.1) of average CPUE (L5JR: 0.2100719, SbyS: 0.2479535), the effect of "Area" shows the statistical area of SBT and area 5 and area 6 are merged.

Remark) All explanatory factors are assumed as fixed effects and categorical variables.

Dataset-A: Year(1986-2006, 1986-2004: logbook, 2005-06: RTMP), Area(4-9), Month(4-9)

Figure 2 shows the year trends of standardized CPUE based on the SbyS and L5JR data. We did not carry out any area-weighting (e.g. constant square, variable square). This two CPUE series are rather similar and it shows extreme high values in 2005. The reason seems there are few observations in area 5 and year 2005 (only one case in L5 data and six records in SbyS data) and there CPUE values are very high as more than 17.

It is expected that the problem of a jump in 2005 is solved after including the data on the joint venture with New Zealand. However, to solve the problem not changing the data (SbyS and L5JR) used, we consider the following model (Model-2: deleting the (Year*Area) effect from our Model-1) and applied this to our analysis. In Model-2, it was not seen the CPUE jump in 2005 and both trends are similar (Figure 3).

- CPUE-LogNormal model without (Year*Area) effect

Log(CPUE + constant) = Intercept + Year + Area + Month + Quarter + Month*Quarter (nested) + Latitude + Year*Quarter + Area*Quarter + error, error～N(0, $\sigma^2$) (Model-2)

Next, we computed the year trends of standardized CPUE by SbyS and L5JR data using another dataset (Dataset-B) and similar formula (Model-3) to Model-1 for the comparison purpose. We used the random effects to the several two-way interactions to overcome the problem of missing data.

Dataset-B: Year(1986-2006,1986-2004:logbook,2005-06:RTMP), Area(2-15), Month(1-12)

- CPUE-LogNormal model with random effects

Log( CPUE + constant ) = Intercept + Year + Area + Month + Quarter + Month*Quarter (nested) + Latitude (5-degree) + Year*Area + Year*Quarter + Area*Quarter + error, error～N(0, $\sigma^2$) (Model-3)

where

constant: 1/10 of average CPUE (L5JR: 0.082554, SbyS: 0.1501656),

Remark) (Year*Area), (Year*Quarter) and (Area*Quarter) are set to the random effects.

In this case, CPUE year trends are rather different from those in the case of the Model-2 and Dataset-A especially after 2004 (although these two trends are similar). However, this seems to be derived from the difference of the covering temporal-spatial pattern between logbook and RTMP data.

The year trends of standardized CPUE seem to be dependent on the statistical method (e.g. probability distribution of response variable, shape of the link function etc.), data range (i.e. Dataset-A or B), explanatory variables included into the model. Therefore, it is necessary and important to select the appropriate model/data (See also the Appendix).

## References

Sakai, O., Shono, H., and Itoh, T. 2007. CPUE comparison of Japanese longline vessels with and without observers. CCSBT-CPUE/0705/04

Takahashi, N., Tsuji, S., Itoh, H. and Shono, H. 2001: Abundance indices of southern bluefin tuna based on the Japanese longline fisheries data, 1969-2000, along the interim approach agreed for the 2001 stock assessment. CCSBT-SC/0108/28, 39p.

Table 1 Four data set prepared

| Data set | Year | Year of RTMP data used | NZ_JV (1992-2005) | AUS_JV (1989-1995) | Used for CPUE standardization |
|---|---|---|---|---|---|
| SbyS | 1986-2006 | 2005, 2006 | × | × | ○ |
| L5all | 1986-2006 | | ○ | ○ | × |
| L5J | 1986-2006 | | × | × | × |
| L5JR | 1986-2006 | 2005, 2006 | × | × | ○ |

All dataset include data of EFP during 1998-2000.

Table 2 ANOVA tables for the finally selected model in the Model-2 and Dataset-A.

(i.e. corresponding to Figure 3)

- Shot-by-shot data (SbyS)

[redacted]

- Aggregated data i.e. 5x5/month (L5JR)

[redacted]

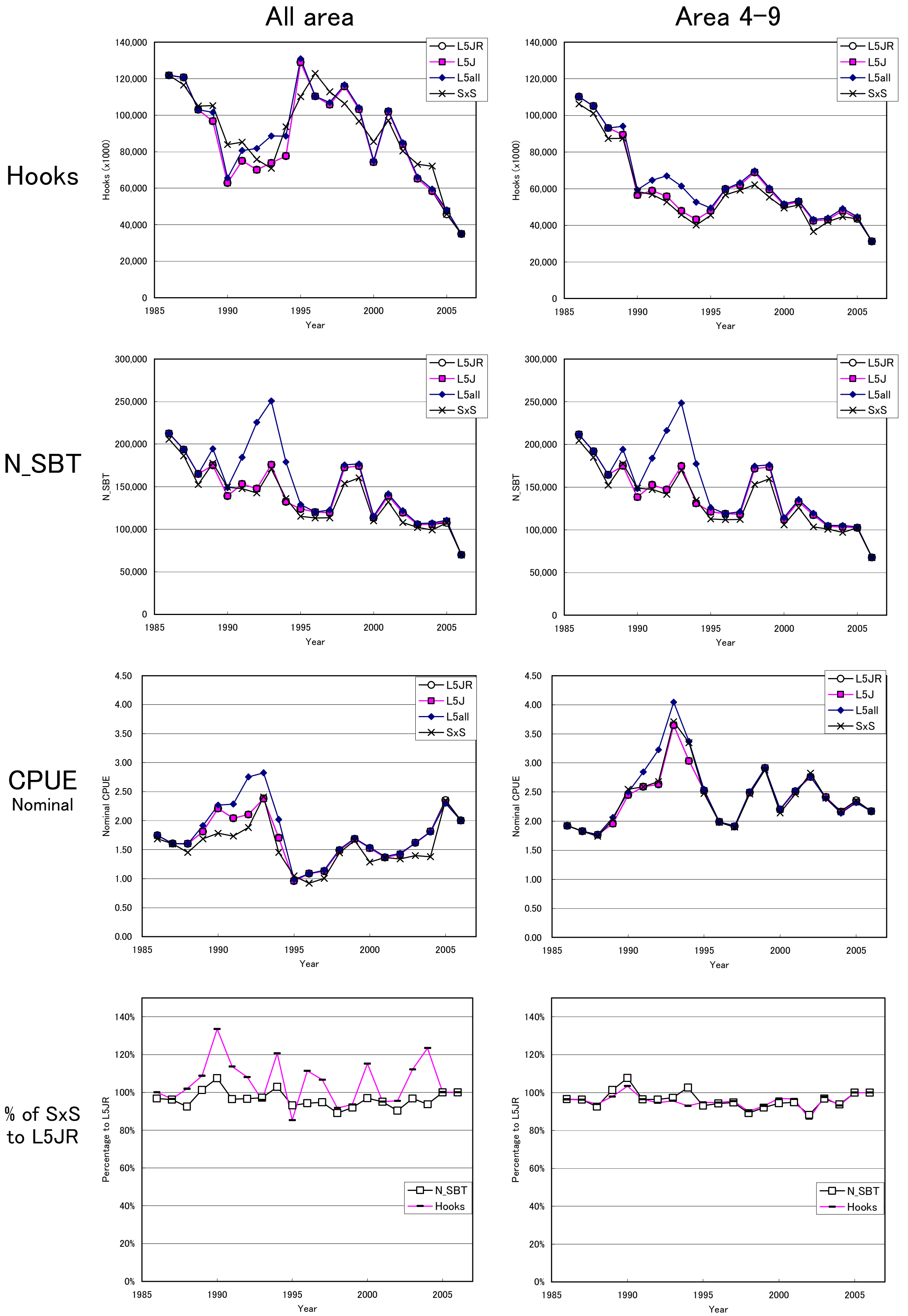


Figure 1 Comparison between L5 data and SbyS data.

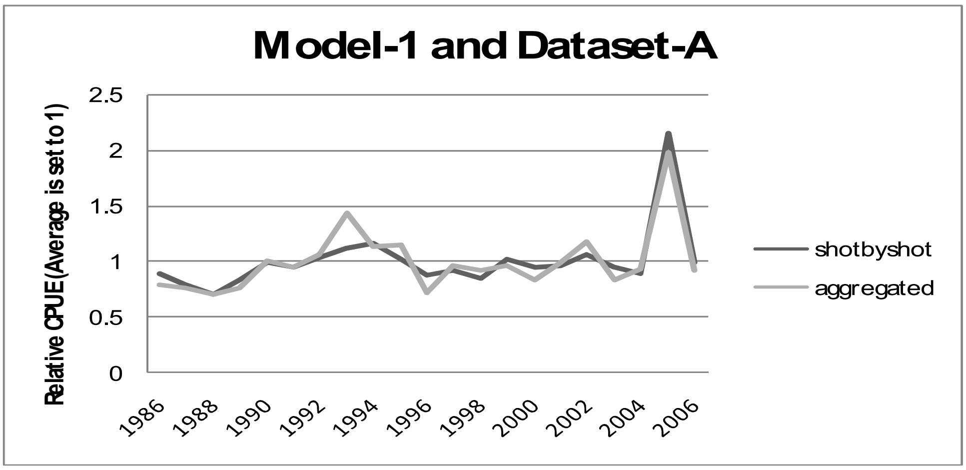


Figure 2 Comparison of standardized CPUE in the Model-1 and dataset-A.

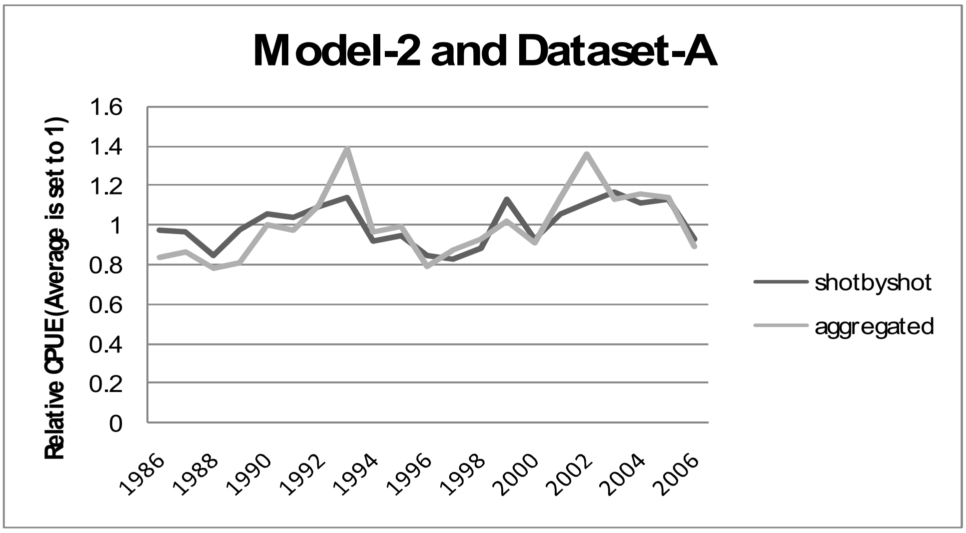


Figure 3 Comparison of standardized CPUE in the Model-2 and dataset-A.

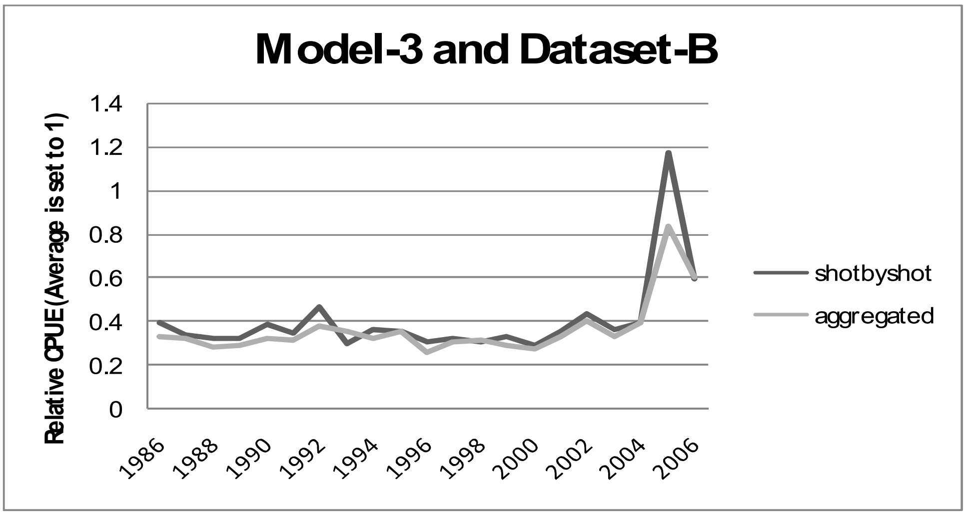


Figure 4 Comparison of standardized CPUE in the Model-3 and dataset-B.

## Appendix

We computed the standardized CPUE using the various statistical models and two dataset (Dataset-A and B) for the comparison between SbyS and L5 data (L5JR).

- Catch Negative-Binomial model

E[ Catch ] = Effort * exp( Intercept + Year + Area + Month ) (Model-4)

where

E: expectation,

Effort: offset,

Area: statistical area 4-9 (area 5 and 6 are not merged),

Catch～NB(a, b).

- Delta-type two-step model (Delta-LogNormal model)

1st step

(Applied to all records)

E[ p / (1-p) ] = Effort * exp( Intercept + Year + Area + Month ),

2nd step

(Applied to the observations with positive SBT catch)

Log( CPUE + 0.05 ) = Intercept + Year + Area + Month + Year*Area + Year*Quarter + Area*Quarter + error, (Model-5)

where

E: expectation,

Effort: offset,

Area: statistical area 4-9 (area 5 and 6 are not merged),

p (zero-catch rate)～Binomial( $\theta$ )

error～N(0, $\sigma^2$)

Year*Area, Year*Quarter, Area*Quarter; random effect.

Because the rate of zero-catch is rather high in the SbyS data, we calculated the standardized CPUE using above two statistical models instead of common CPUE Log-Normal model. In the case of not assuming the normal distribution (Model-4 and 1st step of Model-5), we did not include the two-way interactions as random effects because it takes very long time to operate through the GLIMMIX (or NLMIXED) procedure of SAS/STAT software (SAS, Version. 9.1.3) in large samples. However, if this problem of computation time is improved, the Catch Negative-Binomial model with random effects is expected to be rather effective in the CPUE standardization for SBT.

Figure A1-A4 show the year trends of standardized CPUE by the shot-by-shot and aggregated (i.e. 5x5/month) data using above two models and datasets (Dataset-A & B). Although two CPUE trends in Model-6 are not so similar, the reason seems that the rate of zero-catch is quite different between shot-by-shot (SbyS) and aggregated data (L5JR).

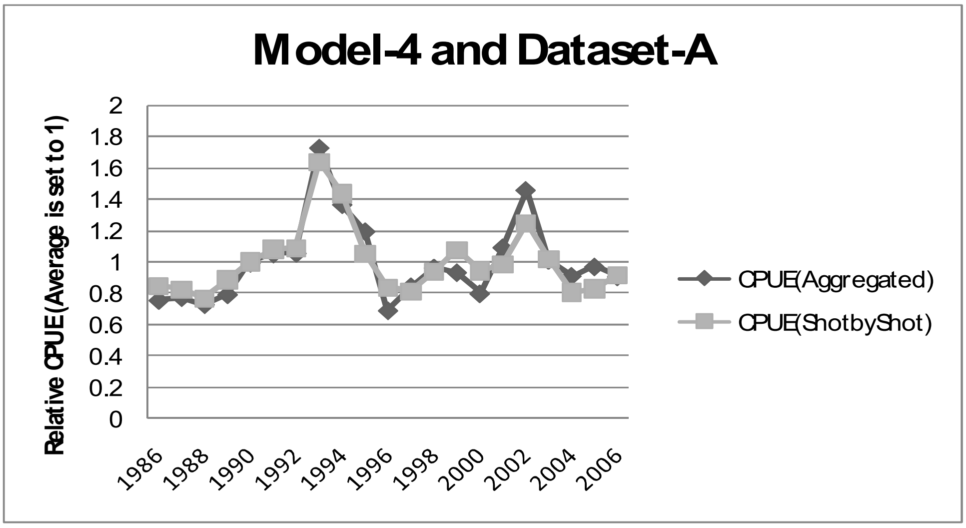


Figure A1 Comparison of standardized CPUE in the Model-4 and dataset-A.

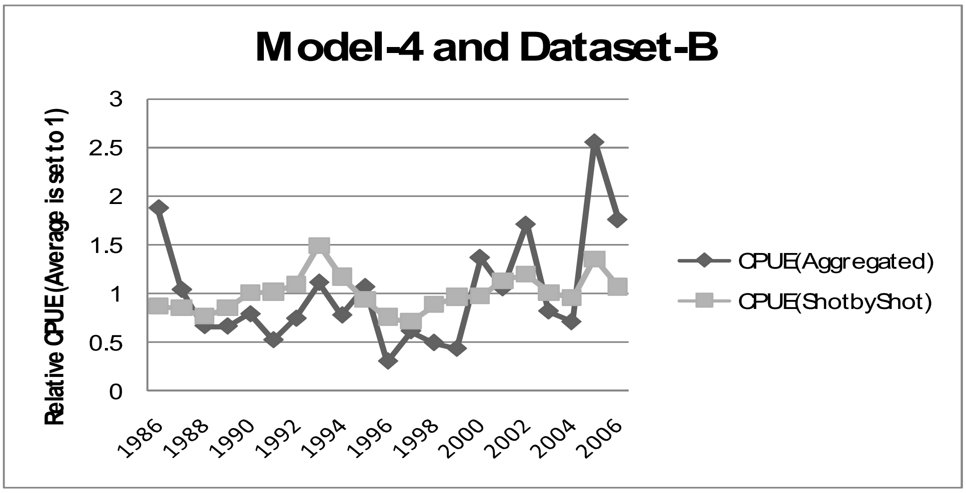


Figure A2 Comparison of standardized CPUE in the Model-4 and dataset-B.

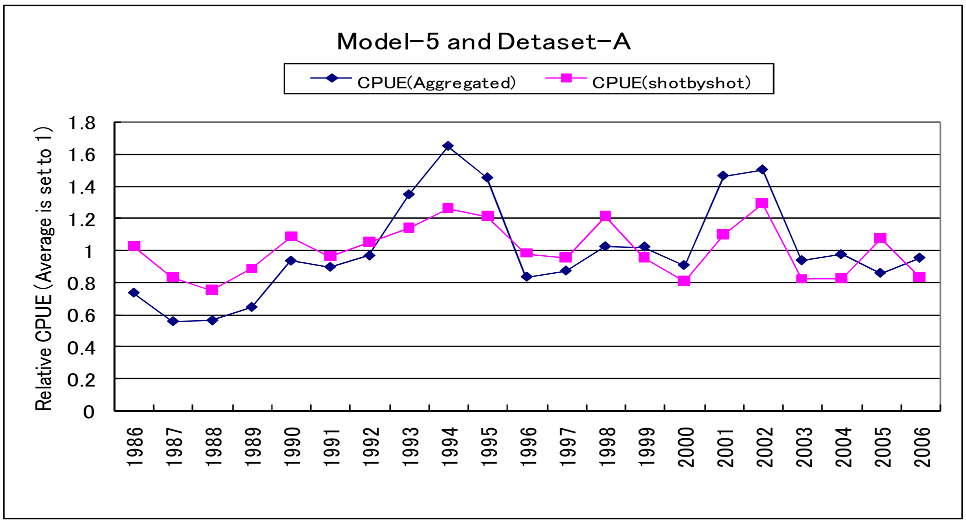


Figure A3 Comparison of standardized CPUE in the Model-5 and dataset-A.

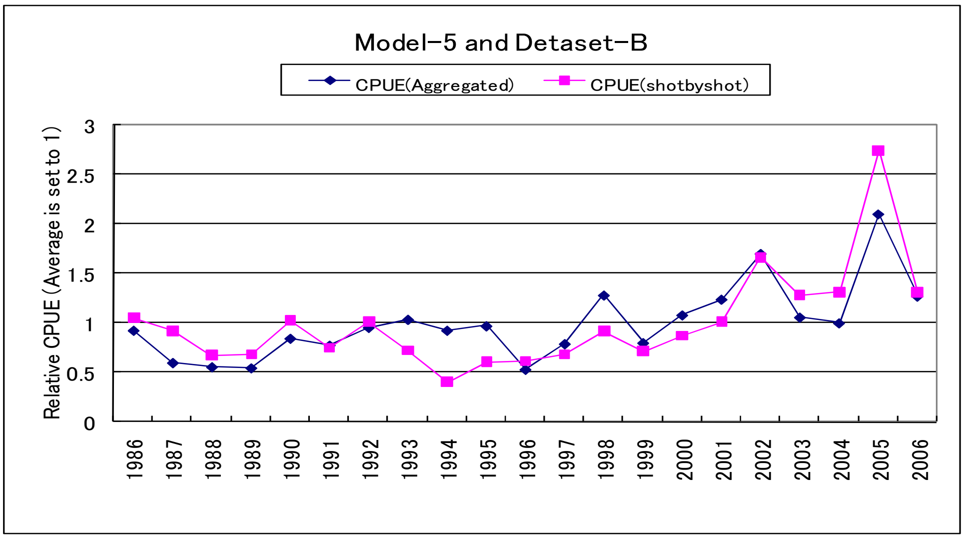


Figure A4 Comparison of standardized CPUE in the Model-5 and dataset-B.