CPUE analysis in intercessional period
Working Paper for c.1 & e.1

オブザーバー有無の CPUE 比較

CPUE comparison between with and without observer

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[Introduction]

本文書は、CPUE 解析におけるオブザーバーの存在の効果について記述するものである。

オブザーバーが乗船した操業としなかった操業とのCPUEの比較は、これまでにも実施されてきた。2006年9月に開催されたESC11に日本は、日本延縄データにおいてオブザーバー有無のCPUEを比較した文書（CCSBT-ESC/0609/39）を提出した。この時使用したデータは、1995－2005年のRTMPデータであり、4,7,8,9海区についてデータの多い5－7月、9－11月のものを抽出した。この解析において、オブザーバーが乗船した同一操業に対する船からの報告CPUEと観察時間を補正したオブザーバーからの報告CPUEとに矛盾が無いことが確認された。標準化は、小型魚の放流もなかった1997-2005年のデータに対して、HPBを考慮し、メバチ、キハダの漁獲は含めないモデルで実施した。その結果、オブザーバー有無によるCPUEの差は小さかった。この結果に対してSAG7は"SAG noted that analyses of the available data for observed versus non-observed fishing by longline vessels did not indicate any consistent pattern of appreciable under-reporting of catch."と解釈した(SAG7レポート)。

2007年5月に清水で開催された第2回CPUEモデリングワークショップに日本は、Logbookの操業毎データに基づく解析結果を提出した(CCSBT-CPUW/0705/06)。データは1992－2005年のLogbookデータ（2005年はRTMPデータ）の4,7,8,9海区のものを使用した。時期は、ミナミマグロ以外を対象とした操業を可能な限り排除するため、ミナミマグロ漁期に限定した。標準化モデルにはHPB、船ID、船サイズを含んでいた。その結果、オブザーバーの有無によって標準化したCPUEに大きな差は認められなかった。この結果に対してワーキンググループは"The group noted that the figure did not show large differences in the CPUE time series with and without observers"としながらも"the ANOVA showed statistical significance of both the observer and observer*year effects."(Report of 2nd CPUEWG)とした。

2008年9月までの7回のweb-meetingを通じて、豪州、NZの操業毎延縄データを加えたデータセットが形成され、CPUE標準化のベースモデルも決まった（CCSBT-ESC/0809/09）。2008年9月に開催されたESC13に日本はCCSBT-ESC/0809/38を提出し、要請された年･月･海区別のオブザーバーカバー率を提示すると共に、オブザーバー種類別（元漁業者とそれ以外）のCPUEを示した。オブザーバータイプ別に明白で実質的なCPUEの差は見られなかった。この解析結果の解釈において、

豪州、NZのEEZにおいて高いCPUEが記録された可能性が指摘され、豪州、NZのオブザーバーが専らEEZで乗船するためにオブザーバーのCPUEが高くなった可能性が指摘された。また、1995、1996年の小型魚放流に伴うオブザーバーCPUEの高まりが問題視された。この結果に対してSAG9はCPUEワーキンググループの作業計画（Attachment5 of SAG9 Report）を承認した。そこでは、"Evaluate GLMs with data from observed and unobserved sets for SBT separately for SBT larger and smaller than 25kg"および"Include appropriate factors for sets within and outside national EEZ's"が謳われている。

よって、本文書はオブザーバー有無によるCPUEの差への、(1)1995年1996年の小型魚放流の影響および(2)EEZ内外の影響を扱うものである。

This working paper describes comparison of CPUE between with and without observers. Analyses for this issue have been carried out for years. In ESC11 held in September 2006, Japan submitted CCSBT-ESC/0609/39. The data used for the analysis were from RTMP of Japanese longline data between 1995 and 2005 and chosen areas (Area 4, 7, 8, and 9) and months (May-July and September-November) where data records were many. The result showed agreement of CPUEs between reported from observer and reported from fishermen of which the observer was on board. Standardization of CPUE was conducted for data in 1997-2005 when small fish were not released using a model including hooks-per-basket (HPB) in addition to basic items (e.g. month, Area, etc.) but not including by-catch tuna species. The result showed little difference among the two CPUE series. SAG noted that "analyses of the available data for observed versus non-observed fishing by longline vessels did not indicate any consistent pattern of appreciable under-reporting of catch." (Report of SAG7)

In the second CPUE Modeling Workshop held in May 2007 in Shimizu, Japan submitted CCSBT-CPUW/0705/06. The data used were from logbook of Japanese longline (including RTMP in 2005) between 1992 and 2005 in Area 4, 7, 8 and 9. Data were chosen in Japanese SBT fishing season to exclude operations targeting for other tuna species as much as possible. The model for CPUE standardization included HPB, vessel ID and vessel size in addition to the basic items. The result showed little difference among two CPUE series again. The working group noted that "the figure did not show large differences in the CPUE time series with and without observers", though it also noted that "the ANOVA showed statistical significance of both the observer and observer*year effects." (Report of 2nd CPUEWG)

Through the collaborative work including seven CPUE web-meetings up to September 2008, the dataset for analysis including data from other LL1 components in Australia and NZ were prepared, and the base model for CPUE standardization was determined (CCSBT-ESC/0809/09). In ESC 13 held in September 2008, Japan submitted CCSBT-ESC/0809/38. It showed table of observer coverage by year, month and Area which was requested last ESC meeting and showed CPUE comparison between observers who were SBT longline fishermen in the past and other observers. There were no substantial differences evident in comparing CPUEs by observer type. In the interpretation of the results, it was pointed out there was a possibility that higher CPUE of observer was due to higher CPUE within EEZ where observer coverage was usually high. It was also pointed out the issue relating higher CPUE in 1995 and 1996 when small SBT were released by vessels without observers. SAG 9 endorsed the working plan made by CPUE Modeling Group including these issues (Attachment5 of SAG9 Report) and noted that "evaluate GLMs with data from observed and unobserved sets for SBT separately for SBT larger and smaller than 25kg" and that "include appropriate factors for sets within and outside national EEZ's".

Then, this working paper treats effect for CPUE comparison between with and without observers on (1) small fish release in 1995 and 1996, and (2) within or out side of EEZ.

[Method]

日本、NZ のジョイントベンチャー、豪州のジョイントベンチャーをあわせたデータを用いた。EFP については、商業漁業的な海域規制を設けなかった操業のみを含めた。データレコードにはオブザーバーの有無、EEZ 内外に区分するコードを付した。EEZ の判定は NZ、豪州研究者が作成し、わずかでも EEZ 内に入る 1 度区画は EEZ 内とした。

1995、1996 年に日本延縄船は 25kg 未満の小型魚を放流したが、オブザーバーが乗船した場合には小型魚の年齢組成を正確に求める目的から全ての魚を取り込んだ。しかし年齢別漁獲尾数はオブザーバー乗船操業の漁獲尾数に対して、その月・5x10 度の全船による体長組成･年齢組成を当てはめて推定したため、オブザーバー乗船操業における 4 歳以上の推定漁獲尾数は実際よりも過大に計算されている。すなわち、小型魚放流の CPUE への影響は、年齢別漁獲尾数を求める際の人工的な影響である。この影響を除くため、1995 年と 1996 年のオブザーバー乗船操業に限って、4 歳以上の CPUE はその操業における体長測定データから求めた。

また、体重 25kg は 4 歳以上、5 歳未満の魚の大きさに相当し、4 歳以上の CPUE でもオブザーバー乗船操業の CPUE が過大となる。そこで、体重 25kg に相当する体長 118cm（1995 年 RTMP のサイズ測定データより。製品重量 25kg の 3258 個体の平均体長が 117.95cm であったため）以上の魚の CPUE も求めた。

標準化用のデータを 4-9 月、4-9 海区のものに限定した。Base モデル（CCSBT-ESC/0809/09）にオブザーバーの有無、オブザーバー*年の交互作用、EEZ 内外の効果を含んだモデルとしたところ、LS-mean が推定されない年が多く生じた。そこで、EEZ 外のデータに限定し、Base モデルにオブザーバーの有無、オブザーバー*年の交互作用の効果を含んだモデルで標準化した。

使用した SAS コード例を示す。

```
proc glm data =   SSCTeez ;
class Year Month Area Lat5 observer;
model logCPUE25=Year Month Area Lat5 BETcpue YFTcpue Month*Area Year*Lat5 Year*Area
observer Year*observer/ss2 ss3 solution;
means Year Month Area Lat5 observer;
output out=residual student=stdresid ;
lsmeans Year*observer / stderr cl out=estimate ;
```

The dataset including longline of Japan, Australia and NZ were used. Data items of observer presence and in/out of EEZ were added. EEZ definition were made by NZs and Australian scientists for 1x1 degree cell. If a part of a 1x1 degree cell was within EEZ, the whole 1x1 cell was defined as in EEZ.

In 1995 and 1996, Japanese longline fleets released small fish less than 25 kg in body weight. If observers were on board, all the SBT caught were retained and measured to collect data of length frequency of whole size range. The catch-at-size data that has been used for the CPUE analyses, as well as submitted to CCSBT data exchange, were calculated based on size data of the month in the 5 degree latitude and 10 degree longitude from all vessels, even for longline operations with observer. This caused an artificial bias of higher CPUE of age 4+ fish for operations with observers because some part of catch with observer were less than age 4. Although proportion of number of operation with observers was small and would be little effect on usual analysis for all vessels, this issue become remarkable when data with observers were highlighted. In order to exclude this artificial bias, size data of each operation with observer were applied for data of the vessels with observers in 1995 and 1996.

CPUE were calculated for two types. One was CPUE of age 4+ as usual. The other was CPUE of more than 25 kg in body weight (processed weight). SBT in 25 kg corresponds between age 4 and age 5, which means CPUE age 4+ was also over-estimation on CPUE with observer. 118cmFL was used as 25 kg in body weight because average fork length of 25 kg was 117.95 cm in 1995 RTMP size data (N=3258).

Data for CPUE standardization were treated as usual; in Area 4-9, month 4-9 and Area 5 and Area 6 were combined. The base model （CCSBT-ESC/0809/09）adding observer presence, observer*year interaction and EEZ were used, but LS-mean were not estimated for many years. Therefore, a model adding observer presence and observer*year interaction were used for data outside of EEZ, then LS-means of observer*year interaction were extracted.

[Result]

データを EEZ 外に限定することでオブザーバー乗船有無による CPUE の差は大きく減少した（Fig.1、Fig.2）。オブザーバー乗船操業の CPUE の方が 1995-2000 年には高いが、2002、2003、2005 年にはむしろ低くなった。CPUE 差は、オブザーバー船の体長組成で体重 25kg 以上魚の尾数に補正した場合に 1995 年、1996 年の差がさらに減少した(Fig.3)。

Fig.1 shows results of an analysis on data including both within and outside of EEZ, and Fig.2 shows those on data including outside of EEZ only. The CPUE difference between with and without observers is smaller in Fig.2 than in Fig.1. In both Fig. 1 and Fig.2, CPUE with observers were higher than that without observers between 1995 and 2001, but rather lower in 2002, 2003 and 2005. The differences between CPUE with and without observers became smaller in 1995 and 1996 if CPUE 25 kg+ were used rather than age4+ were used (Fig. 3).

[References]

CCSBT-ESC/0609/39: (2006) CPUE comparison for Japanese longline vessels in the RTMP with and without observers. O. Sakai, H. Shono and T. Itoh

Report of SAG7 Report: (2006) Report of the Seventh Meeting of the Stock Assessment Group.

CCSBT-CPUW/0705/06: (2007) CPUE comparison of Japanese longline vessels between data reported by observers and those recorded in logbooks. O. Sakai, H. Shono and T. Itoh

2nd CPUEWG Report: (2007) Report of the Second CPUE Modelling Workshop.

CCSBT-ESC/0809/09: (2008) The development of new agreed CPUE series for use in future MP work.

CCSBT-ESC/0809/38: (2008) Comparison between observer data and data reported by fishermen. O. Sakai and T. Itoh

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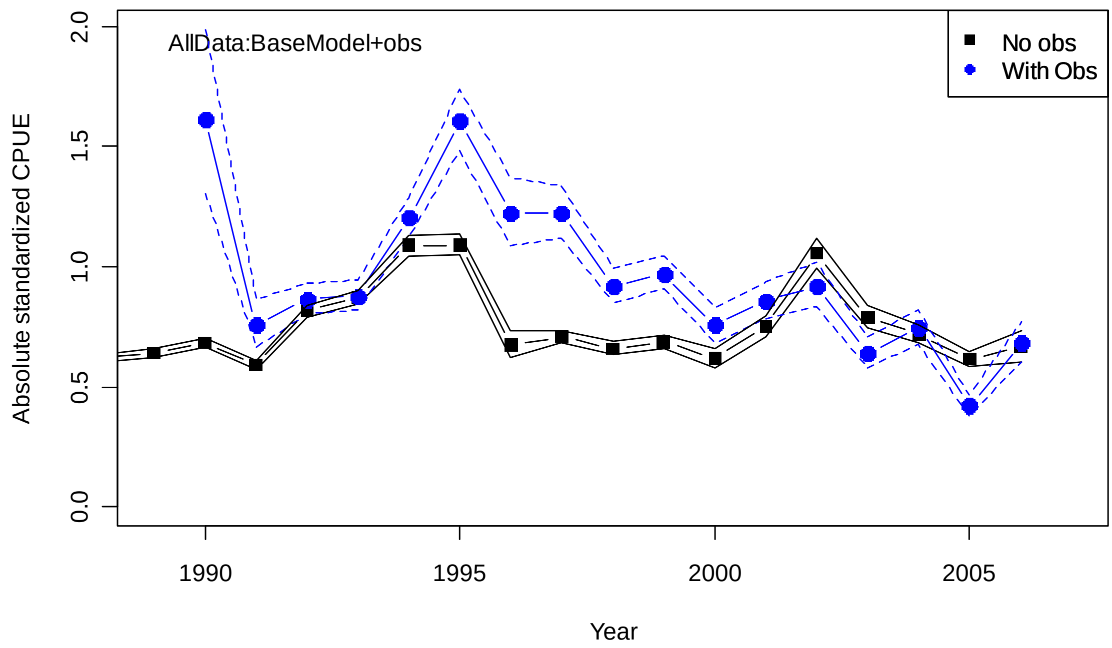

Fig.1 Standardized CPUE by observer presence. The range shows 95% confidence interval. Data are including both within and out of EEZ. Catch of SBT age 4+ in 1995 and 1996 were corrected by using the size data by the observed vessel.
オブザーバー乗船別の標準化した CPUE。範囲は 95%信頼区間。データは EEZ 内外の両方を含む。1995 年と 1996 年の 4 歳以上魚の尾数は、オブザーバー乗船操業のサイズデータで補正。

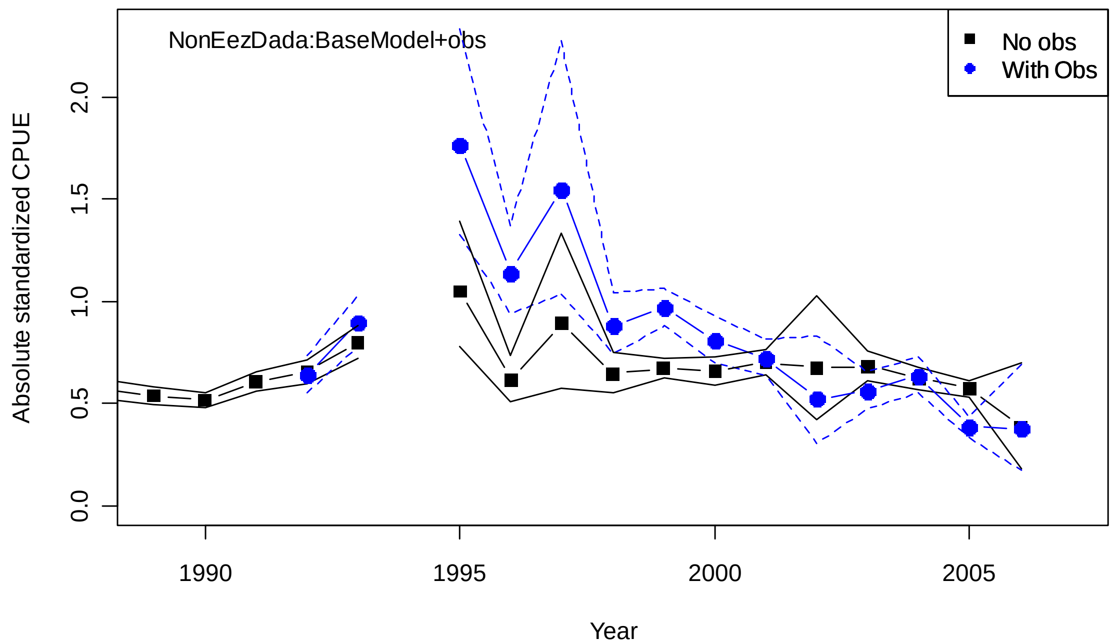

Fig.2 Standardized CPUE by observer presence. The range shows 95% confidence interval. Data are including out of EEZ only. Catch of SBT age 4+ in 1995 and 1996 were corrected by using the size data by the observed vessel.
オブザーバー乗船別の標準化した CPUE。範囲は 95%信頼区間。データは EEZ の外側のみ。1995 年と 1996 年の 4 歳以上魚の尾数は、オブザーバー乗船操業のサイズデータで補正。

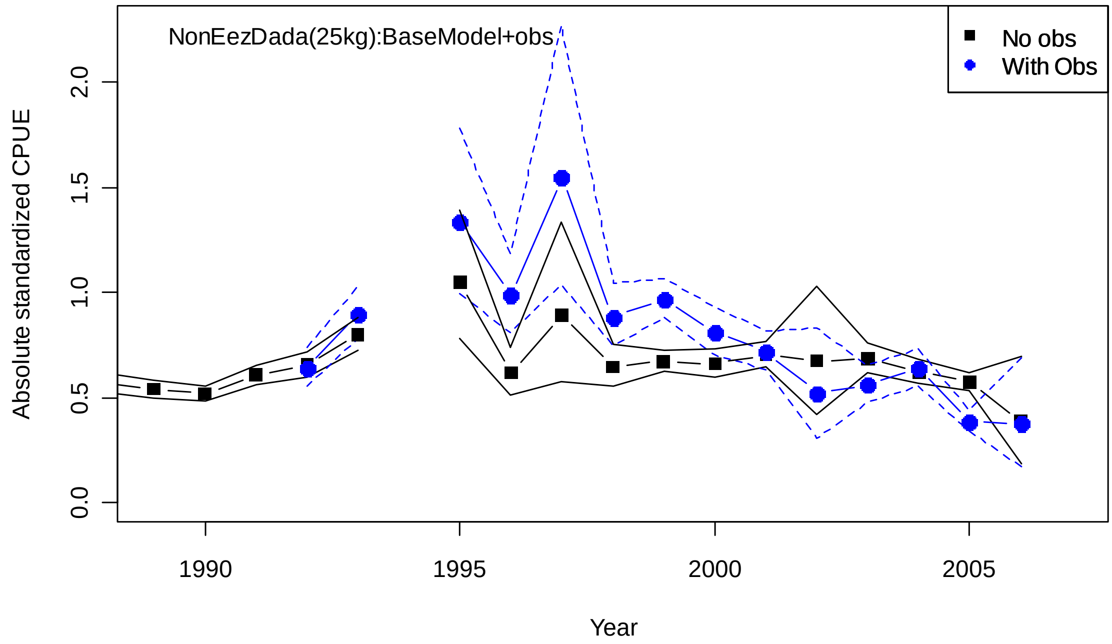

Fig.3 Standardized CPUE by observer presence. The range shows 95% confidence interval. Data are including out of EEZ only. Catch of SBT in 1995 and 1996 were corrected by using the size data > 25kg in body weight by the observed vessel.
オブザーバー乗船別の標準化した CPUE。範囲は 95%信頼区間。データは EEZ の外側のみ。1995 年と 1996 年の尾数は、オブザーバー乗船操業のサイズデータ（体重 25kg 以上）で補正。