Summary of Fisheries Indicators of Southern Bluefin Tuna Stock in 2014

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Abstract : Various fisheries indicators along with fishery-independent indices were carefully examined to overview the current status of southern bluefin tuna stock. The longline CPUE indicators suggest that the current stock levels for 4, 5, and 6&7 age groups are above the historically lowest levels of the late 1980s and the mid-2000s. However, the indices for these age classes, especially age 5, show decreasing trends in recent years. The CPUE indices for age 8-11 group declined slightly and gradually from 2008 to 2011, upturned in 2012 and remain at the same level as 2012 in 2013. CPUEs for age class 12+ also decreased from 2008 to 2010 and have fluctuated around a low level afterward. The current stock levels for these older age groups are still very low. Many indices indicate low recruitments of 1999 to 2002 cohorts. However, there are some inconsistencies in recruitment level observed in comparisons between some indicators (Japanese longline CPUE indices and the grid-type trolling index, GTI) and the 2005 and 2006 acoustic sonar index (corresponding to the 2004 and 2005 cohorts), suggesting that the 2004 and 2005 recruitments were higher than those the acoustic sonar index indicated. Both recruitment and longline CPUE indices indicate that the recruitment levels for the 2006 to 2010 cohorts were also higher than those for the 1999 to 2002 cohorts. These indicators also suggest that possibly the levels of recruitment have gradually decreased from 2006 to 2010 cohorts although there have been some variations in the trends.

要旨：ミナミマグロの資源状態を概観するため、漁業に依存しない指数とともに各種漁業指数を精査した。はえ縄 CPUE 指標は、現在の 4、5、及び 6&7 年齢グループの資源水準が 1980 年代後半と 2000 年代中頃に見られた歴史的最低レベルより上にあることを示している。しかし、近年、これら年齢クラス、特に 5 歳に対する指数は減少傾向を見せている。8-11 歳クラスの CPUE 指数は 2008 年から 2011 年にかけて徐々に減少したが、2012 年に上昇し、2013 年は 2012 年と同様の水準にある。12+歳クラスの CPUE もまた、2008 年から 2010 年まで減少し、その後は低水準で変動している。これらのより高齢グループの現在の資源状態は依然として極めて低い水準にある。多くの指標は 1999 年級から 2002 年級までの加入が低かったことを示している。しかし、いくつかの指数（日本はえ縄 CPUE 指数及びグリッドタイプ曳縄指数、GTI）と 2005 年及び 2006 年の音響ソナー指数（2004 及び 2005 年級に対応）との間には加入水準について矛盾がみとめられており、2004 年と 2005 年の加入量が、音響ソナー指数が示す加入量よりも高いことを示唆している。加入指数及びはえ縄 CPUE 指数はともに、2006 年級から 2010 年級の加入水準も 1999 年級から 2002 年級の加入水準よりも高いことを示している。また、これらの指数は、トレンドに変動はあるものの、加入水準が 2006 年級から 2010 年級にかけて徐々に減少してきている可能性も示唆している。

Southern bluefin tuna (SBT, *Thunnus maccoyii*) stock is one of valuable fisheries resources distributed throughout the southern hemisphere. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is responsible for the management of the SBT stock throughout its distribution. The CCSBT's objective is to ensure, through appropriate management, the conservation and optimum utilization of the stock.

The 2001 Scientific Committee (SC) of CCSBT selected a set of fisheries indicators to overview the SBT stock status (CCSBT 2001). These indicators have been revised and used in past Stock Assessment Group (SAG), SC and Extended Scientific Committee (ESC) meetings to examine whether unexpected changes of stock status requiring urgent full stock assessment occurred. Also, the 3rd Meeting of Management Procedure Workshop in 2004 agreed to review fisheries indicators every year to monitor whether the SBT stock status stays within an expected range of uncertainty which the operating model (OM) considered (CCSBT 2004). This document summarizes examinations of updated fishery-dependent indicators and our overall interpretations. Some fishery-independent indices based on research surveys were also reviewed along with the fisheries-dependent indicators.

It should be noted that conclusions on catch anomalies of longline and purse seine fisheries in the reports by the Japanese Market and Australian Farming Investigation Panels are not taken into account of in this summary because how to incorporate information of catch anomalies into past CPUE data is difficult.

1. Japanese longline CPUE[1]:

Nominal CPUE

Nominal CPUE indicators by age group were plotted in Fig. 1-1. These indicators base on Japanese longline fishery data, including those of joint-venture with Australia and New Zealand. Caution is necessary for interpretation of age 3 and 4 CPUE in 1995 and 1996 because fish smaller than 25 kg were released in these two years. Data in the most recent year exclusively rely on information collected by the Real Time Monitoring Program (RTMP) which covers only SBT targeting vessels. When all data from the other non SBT-targeting vessels (based on logbooks) become available and are included in the existing dataset the following year, CPUE of the most recent year tends to decrease slightly (Takahashi et al. 2001). So CPUE in the most recent year must be also looked at with caution. However, those differences have disappeared gradually and almost no difference has been found in recent years because the RTMP covers more than 95% of efforts in SBT distribution.

CPUE indicators must be further looked to carefully from year 2006 onward because Japanese longline fishery has introduced Individual Quota (IQ) system since 2006. Changes in the number of catch and the distribution pattern of effort before and after 2006 were examined and discussed in detail in Itoh (2014a). Additionally, in concurrence with the implementation of the IQ system, releases and discards of small SBT from Japanese longline fishery began to occur (Itoh et al 2014). This is probably due to fishermen’s motives to desire to use their limited IQ by releasing and discarding small fish which have low commercial values.

When focusing on trends for the recent years, nominal CPUE for age 3 fluctuates around the past 5-year mean (Fig. 1-1). The 2013 value for this age was lower than the mean. The points of the recent 3 years show a decreasing trend. CPUE for age 4 largely increased between 2008 and 2009, and then consecutively decreased toward 2013 of which CPUE is lower than the past 5-year mean over 2008-12. CPUEs for age classes 5, 6&7, and 4+ increased around 2010. However, CPUEs for 5 and 6&7 age groups declined after 2010 and 2012, respectively. The 2013 values for these ages were similar to or higher than the past 5-year averages. Nominal CPUEs for age classes 8-11 and 12+ declined from 2008 to 2011 and show some increases afterward. The recent CPUE value for 12+ was almost similar to

[1] Catch per Unit Effort. In southern bluefin tuna case, CPUE is the number of catch per 1000 hooks.

the past 5-year average while the CPUE for 8-11 was higher the 5-year average.

Trends of nominal CPUE of Japanese longline by cohort were plotted in Figs. 1-2 and 1-3. Fig. 1-2 is a comparison of nominal CPUE of juveniles among different cohorts and Fig. 1-3 compares decrease rate by cohort in the logarithmic scale. CPUEs for age 3, 4 and 5 fish show consistent trends between 1980 and 2004 cohorts. However, some variations in trend and divergence from trends of CPUEs for age 4 and 5 have been observed for age 3 after 2004 cohort (Fig. 1-2) which suggest that age 3 CPUE cannot be used as an indicator of relative cohort strength for recent years. Cause(s) of this variation and divergence have been unknown (A partial cause might be release of small fish in recent years).

Overall levels of CPUE across age 3 to 11 by cohort can be grouped as the periods of 1980-1986, 1987-1992, 1993-1998, 1999-2003 and 2004-2010 cohorts (Fig. 1-3). Within each period, variations of the CPUE levels were small (except for age 3 CPUEs in 1999-2003 and 2004-2010 cohorts) and the decease rates were similar. For 1999-2003 and 2004-2010 cohorts, the catch rates of age 3 varied considerably. These large variations in catch rate would be due to change in catchability and/or population fluctuation. The 1987-1992 cohorts show more drastic declines than other cohorts, which is probably due to targeting towards smaller fish in the early 1990s caused by depleted stock status of cohorts recruited in pre-1987 years and less structured management schemes at that time. The cohorts recruited from 1993 to 1998 show slower decline rates, suggesting a reduced level of exploitation rates for these cohorts. Fig. 1-3 also indicates acute decreases of overall CPUE level of 1999-2003 cohorts to about the same or lower levels comparable to those experienced by the early 1980s cohorts, while showing that 2004-2010 cohorts were similar to the late 1980s levels (see also Recruitments section below). Cause(s) of these weak 1999-2003 cohorts has been unknown, whether it would be a reflection of change in oceanographic and/or fish availability, or it be an indication of a consequence of excessive fishing pressure. Although the CPUE levels for age 3 of 2004-2010 cohorts varied depending on cohorts, the CPUE levels for age 4-6 were similar to or higher than ones of any cohorts in past.

Age compositions of nominal CPUE for 2013 (Area 8) and 2014 (Areas 4, 7 and 9) obtained from RTMP were plotted in Fig. 1-4. Data for past years are also shown for comparison. In Area 7/April and May, CPUEs for age 6 and 7 in 2013 and 2014 were lower than those in previous years. In contrast, CPUEs for the same age classes in Area 9/April to July of 2013, and in Area 8/September to November of 2012 and 2013 were higher than those in previous years. CPUEs for ages younger than 4 in Area 9/June and July of 2013 and 2014, and in Area 8/September and October of 2012 and 2013 decreased from those in previous years. These decreases of the younger fish are partly caused by recent release of small fish from Japanese longline vessels.

Substantial CPUE reductions for ages 9 to 12 in some Area/month strata, especially for the 2010 to 2013 periods (Fig. 1-4), corresponded to weak recruitments of which the grid-type trolling index (GTI, see below) had detected drastic declines between 2000 and 2003 (Fig. 3-1, corresponding to 1999 to 2002 cohorts). In some other Area/month strata, CPUE values for ages 7 and 8 from 2012 and 2014 were higher than those in previous years, corresponding to cohorts that came after the weak recruitments between 1999 and 2002.

Standardized CPUE

Two GLM standardized CPUE indices of w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) were updated (Fig. 1-5) using the same method as described in Takahashi et al. (2001; see also Takahashi 2008 for correction of editorial errors in the formulae for calculating the indices). The standardization model used was the same as that of Nishida and Tsuji (1998). Estimates of the CPUE indices for 2013 (the most recent year) were based not on logbooks but RTMP data only, and thus should be looked at with caution as described in the Nominal CPUE section above (Takahashi et al. 2001). These estimates may be changed when logbook data become available the subsequent year. Further, as mentioned above, CPUE in recent years must be examined carefully because Japanese longline fishery has introduced the IQ system since 2006 (Itoh 2014a).

Looking to trends of the recent years, the w0.5 and w0.8 indices for age 3 alternatively repeat increase and decrease by 2 or 3 years cycle (Fig.1-5a). Upturns for this age in 2007 and 2008 inconsistently correspond to low recruitments of 2004 and 2005 cohorts observed respectively in the 2005 and 2006 acoustic sonar index (Fig. 3-2), but are more or less consistent to the grid-type trolling index (GTI) in 2005 and 2006 (Fig. 3-1). Decline for age 3 from 2008 to 2010 were not observed in the trend of the GTI between 2006 and 2008 (Fig. 3-1). The 2013 indices for age 3 decreased to values lower than the past 5-year averages over 2008-12. The CPUE index for age 3 varies year to year, especially in recent years (see Fig. 1-2), and thus its trend is not necessarily consistent with ones for age 4 and 5 by various reasons (e.g., incomplete recruitment of age 3 fish into Japanese longline fishery, small fish release in recent years). Therefore, as a signal of recruitment fluctuation, the age 3 indices should be looked at and interpreted with caution.

The indices for the age 4 continuously increased from 2007 to 2009 and have tended to decrease gradually since 2009 although there was slight increase from 2010 to 2012 (Fig. 1-5b). The low index values for age 4 observed in 2006 correspond to relatively low recruitments (2002 cohorts) observed in the GTI in 2003 (Fig. 3-1). The GTI is not available for 2004 corresponding to the 2003 cohort. However, the index values for age 3 in 2006 and for age 4 in 2007 suggest a possibility that, although its recruitment level is still low, 2003 cohort is not much weak as that of 1999-2002, showing some upturns (Figs. 1-5a and b). Furthermore, similar upturn patterns were observed for age 4 in 2008 and 2009 corresponding to the 2004 and 2005 cohort (Fig. 1-5b) while the acoustic sonar index in 2005 and 2006 showed low values (Fig. 3-2). A similar increasing trend was also observed in the GTI in 2005 and 2006 (Fig. 3-1). The 2013 indices for age 4 were lower than the past 5-year means over 2008-12.

The CPUE indices for age 5 showed continuous increasing trends from 2007 to 2010 and have declined afterward (Figs. 1-5c). This increase between 2007 and 2010 may be corresponding to ones observed in the GTI between 2003 and 2006 (Fig. 3-1). The low index values for this age observed in 2007 correspond to relatively low recruitment of the GTI value in 2003 (2002 cohorts) (Fig. 3-1). The indices for age 5 in 2013 were much lower than the past 5-year means.

As same as age 5, the CPUE indices for age group 6&7 increased steadily from 2007 to 2012 and then decreased in 2013 (Figs. 1-5d). The increasing trend observed between 2007 and 2012 may relate to ones observed in the GTI between 2001 and 2007 (Fig. 3-1). The low index values for this age group observed in 2007 correspond to the low recruitment of the 2001 and 2002 GTI values (2000 and 2001 cohorts) (Fig. 3-1). The indices for this age class in 2013 were lower than the past 5-year averages.

The CPUE index values for age 8-11 decreased slightly and gradually from 2008 to 2011 and have increased afterward (Fig. 1-5e). The declining trend between 2008 and 2011 may correspond to low recruitments of 1999-2002 cohorts observed in the 2000-2003 GTI (Fig. 3-1). Upturns of the indices in 2012 and 2013 might indicate that 2003 to 2005 cohorts which came after the weak recruitments between 1999 and 2002 have started entering into the 8-11 age group. The 2013 indices for this age class were increased to levels higher than the past 5-year average.

The CPUE indices for age 12+ showed a decline from 2008 to 2010 and have fluctuated around a considerably low level afterward (Fig. 1-5f). This decline and staying at the low level of the indices may relate to weak cohorts of 1999 to 2001 observed in the 2000-2002 GTI (Fig. 3-1). The indices in 2013 for this age group were slightly lower than the 5-year averages.

Fig. 1-6 compares trends of various CPUE indices for age 4+. These indices are: “Base” series which used 5x5-degree aggregated Core Vessel data and the standardization model agreed in the CPUE modeling Group (CCSBT 2010, Itoh and Takahashi 2014); “Base with SxS” series which used the same data and model as the Base except that data resolution was by shot-by-shot basis; “Base 40&45 combined” series which is same as the Base except for combining data of 40S and 45S latitudes (CCSBT 2014); “Reduce Base” series which used the same data and model as the Base except for excluding by-catch and year interaction terms from the model (Itoh and Takahashi 2014); “GAM” series which was standardized by a general additive model using 5x5-degree aggregated all vessel data (Chambers 2014); “N&T model” series which used Nishida and Tsuji (1998) model and 5x5-degree aggregated all vessel data.

The Base series is the one used for the operating model (OM) conditioning and management procedure (MP) inputs in the ESC. Other series are used for monitoring to check if there is any unexpected thing happened to both SBT and the fishery along with the Base series. The N&T model series had been used in the stock assessment by the OM until the Base series was developed.

All trends of these indices for age 4+ show similar patterns except that the trends of Reduced Base series in recent years are different from those of other indices (Fig. 1-6). These differences is to continue to be monitored and examined in the CPUE Working Group. All the indices had increased from 2007 to 2010 and then appear leveled off afterward.

Spatial-Temporal (ST) windows CPUE for age 4+

“Spatial-temporal (ST) windows” CPUE index for age 4+ (Takahashi et al. 2002) was also updated using the new method as described in Takahashi (2006). “ST windows” represent Area 9/May and June, and Area 8/September and October. By inspecting historical Japanese longline catch/effort data, these spatiotemporal strata were so defined as to persistently observe substantial effort of the longline fishery. Recently, however, it was noted that the assumption on such persistency in the ST windows concept was no longer valid due to changes in operation pattern of Japanese longliners (Takahashi and Itoh 2012). Given this, the ESC agreed that while the ST windows series had been a useful “extreme” series for contrast with the Base series, there was a need to replace the ST Windows series (CCSBT 2012) and therefore the series is no longer submitted to the CCSBT Secretariat in data exchange. Yet we consider that it may be useful to continue monitoring the ST windows series because the series would still be able to capture some aspect of stock trend, and thus we decided to include this series in this document.

The trend of the ST windows is shown in Fig. 1-7. The updated index more or less has kept the same level ranging between 0.5-1.0 values for the past 20 years. For the last five years, although the index still stays at levels lower than or same as the historical low levels observed in the late 1980s, the index has gradually increased since 2007. It would be worthwhile to mention here that the trend of the ST windows looks similar to those of CPUE indices for 8-11 or 12+ age groups (Fig. 1-1 and Fig. 1-5e and 1-5f), suggesting that the series could capture some signal of spawning stock dynamics. The index value in 2013 was in the similar level to the past 5-year average.

2. Australia purse seine fishery:

Changes of catch per efforts and age composition of Australia purse seine fishery catches were plotted in Figs. 2-1 and 2-2. Although interpretation of the CPUE of this fishery is contentious, monitoring changes of the CPUE merits having some insight into status of juvenile fish along with the aerial survey index and SAPUE (below).

Both catch per shot and catch per searching hours appeared to be gradually declining from 1999/00 to 2008/09 seasons (Fig. 2-1). In part, this decline of juvenile fish probably corresponds to very low recruitments that were observed in the GTI and Japanese longline CPUE (Figs. 1-1, 1-4, and 1-5 for the longline, and Fig. 3-1 for the GTI). There was a large upturn of the CPUE observed in 2009/10 season, and then the CPUE decreased in 2010/11 and has kept more or less the same level as the previous points afterward. Both CPUEs in 2012/13 season were the similar level to the past 5-year means over 2008-12.

Generally the proportions for age 2 fish in purse seine catch between 2004 (03/04 season) and 2012 (11/12 season) were greater than any of previous years (Fig. 2-2). Contrary, proportions for age 3 and 4 decreased for the same years except for age 4 in 2010 and 2011. In 2012, the age composition largely increased for age 2, and decreased for age 3. If the trend of the age composition (or frequency) for age 2 is compared with the trends of aerial survey index and SAPUE (Fig. 2-3, see below), all the trends show similar increasing tendencies between 2003 and 2013 although there are some differences in fluctuation patterns. This possibly suggests that aerial survey index and SAPUE could detect signals more for age 2 than those for ages 3 or 4, or 2-4 combined.

It should be noted that applying cut points of the new growth curve (as from the 2010 SC) made almost all age 1 fish proportions disappear from the age composition chart. This is because fish being classified as age 1 by the previous growth curve are now categorized as age 2 by the new growth curve.

The trends of both aerial (Eveson et al. 2014) and commercial spotting (SAPUE; Farley et al. 2014a) survey indices in the Great Australian Bight (GAB) are shown in Fig. 2-3. These indices are considered to monitor surface abundance of age 2-4 fish combined distributed in the GAB region. The aerial surveys have been conducted by Australia under the Recruitment Monitoring Program since 1993. Full scale line transect aerial surveys were suspended between 2001 and 2004. Although a limited number of lines was continued to be surveyed during this period, it was concluded that the indices of limited scale survey were not able to provide information comparable to the full scale aerial survey. Overall the aerial survey index (AI) showed a moderate decline from 1993 to the early 2000s. The AI values were more or less stable in the rest of the 2000s. The AI markedly increased in 2010 and 2011, two years in a row, then largely dropped in 2012 and then drastically upturned toward 2014. The 2014 value of the AI was much higher than the past 5-year average over 2009-13 and this is the highest level throughout the entire survey period. The overall trend of SAPUE appeared to be increasing during 2004-2011 period. The 2011 SAPUE also declined in 2012 and then increased in 2013 and 2014. The 2014 value of SAPUE was above the past 5-year average, but did not drastically increase such like the AI.

3. Recruitments:

Trolling survey index

Since a vast amount of costs was necessary for conducting the Recruitment Monitoring acoustic surveys using a sonar unit (below), a recruitment index of age 1 fish estimated from results of much lower-cost trolling surveys has been currently being developed. Details of the trolling survey design, estimation method, results and its interpretation were documented in Itoh (2007), and Itoh and Tokuda (2014). Besides the first attempt to standardize the trolling survey index (called "grid-type trolling index (GTI)") was described in Itoh (2014b). The GTI was standardized by using all data which included those of trolling catch collected in past acoustic sonar surveys and those of trolling catch in past and current trolling surveys over the whole survey area containing survey-piston lines. Therefore, the GTI provides a single consistent indicator for age 1 SBT from 1996 to 2014.

Fig. 3-2 compares trends between of the previously reported trolling indices and of the GTI. For the previous trolling indices, only the bootstrap estimates of median were plotted. The median trends of both previous index and GTI appear fairly similar although there are some differences in trend due to standardization for the GTI. All these indices increased from 2005 to 2008 and have gradually declined while fluctuating since then.

Cohorts of 1999, 2000, and 2001 (corresponding to the 2000, 2001, and 2002 trolling surveys) show considerably low levels of recruitment. These low recruitment levels are consistent with the ones observed in results of the past acoustic sonar surveys (Figs. 3-1 and 3-2). Now these cohorts have entered to age classes 8-11 and 12+ and appeared in CPUE series between 2007 and 2013, showing somewhat slight and gradual declining trends (Figs. 1-5e and 1-5f).

In contrast, the trolling indices for 2002, 2004, and 2005 cohorts (2003, 2005, and 2006 trolling surveys) inconsistently show higher levels of recruitment than the acoustic sonar index. The increase levels of 2004 and 2005 cohorts are compatible with upturns observed in the longline CPUE indices for age 3 in 2007 and 2008, for age 4 in 2008 and 2009, for age 5 in 2009 and 2010, for age 6&7 in 2010 to 2012, and for age 8-11 in 2012 and 2013 (Figs. 1-5a, 1-5b, 1-5c, 1-5d, and 1-5e).

As compared above, the levels of trolling indices are compatible with that of other indicators (e.g., acoustic indices, Japanese longline CPUE), of course there are some exceptions though. Therefore, usefulness of the trolling indices to monitor age 1 SBT is apparent. Reliability of the trolling indices is still being verified and it is necessary to compare these indices with CPUE indicators for corresponded cohorts recruited into longline fishery for further verification (some comparisons are done in Itoh (2014b) and in this document). The trolling indices, especially the GTI, could be used as quantitative indicators for recruitment.

Acoustic sonar index

Acoustic sonar survey of the Recruitment Monitoring Program had been conducted from 1995/96 to 2005/06 seasons (except 2003/04) aiming to monitor abundance of age 1 fish moving through the southwestern coast of Australia. The survey ended in the 2005/06 season due to budget matter and was replaced by a much lower-cost trolling survey (above). Acoustic sonar index by this survey was the first indicator that had detected a drastic decline of age 1 SBT in 2000 and subsequent low recruitments afterward (Fig. 3-2). Thus, it would be worthwhile to briefly mention here the relationship between the sonar index and other indicators.

Low longline CPUE indices of four-year sequence observed in past years agree with the low recruitments from 1999 to 2002 cohorts (corresponding to cohorts detected by the 2000-2003 sonar surveys) (Figs. 1-1, 1-2, 1-3, 1-4 , and 1-5). However, there is some inconsistency between trends observed for 2004 and 2005 cohorts (corresponding to the 2005 and 2006 sonar surveys) and those of longline CPUE indicators. The CPUE indices for age 3 in 2007 and 2008, for age 4 in 2008 and 2009, for age 5 in 2009 and 2010, for age 6&7 in 2010 to 2012, and for age 8-11 in 2012 and 2013 are apparently at the same levels of or higher than that of the late 1990s and the early 2000s (Figs. 1-5a, 1-5b, 1-5c, 1-5d, and 1-5e) whereas the 2005 and 2006 sonar indices indicate low recruitments (Fig. 3-2).

4. Indonesian Catch (Spawning ground fishery) :

Indonesian SBT catch both in number and weight as well as catches by two age groups, age 8-16 and age 17 and older, changed between years (Fig. 4-1).

Catches for age class 17+ were higher than those for 8-16 ages throughout the 1990s. In contrast, many of yearly catches for the 17+ group have been similar to or much lower than those for 8-16 ages since 2000/01 season. Spiky increases of catch in 2001/02, 2004/05, 2006/07, 2008/09, and 2012/13 seasons may be mainly due to large increase of younger age classes. No information has been available to conclude whether this replacement in the age composition reflected changes in fish abundance and/or distribution, or changes in fishing ground (Farley et al. 2014b).

The catch trends of both in number and in weight for age 8-16 and 17+ combined appear to gradually decline with fluctuations from 1997/98 season to 2009/10 season. The catch trends have increased since 2009/10 season.

The low levels of the older portion of Indonesian catch since 2001/02 season raise some concerns of potential low reproduction in recent years.

5. Overall Conclusion:

Fisheries indicators examined generally support a view that the current SBT stock levels for 4, 5, and 6&7 age groups are above the ones observed in the late 1980s and the mid-2000s which were the historically lowest stock levels. However, the CPUE indices for these age classes, especially age 5, show decreasing trends in recent years. The CPUE indices for age 8-11 group declined slightly and gradually from 2008 to 2011, upturned in 2012 and remain at the same level as 2012 in 2013. CPUEs for age class 12+ also decreased from 2008 to 2010 and have fluctuated around a low level afterward. The current stock levels for these older age groups are still very low similar to ones observed in past.

Many indicators suggest considerable low recruitments in past years but differ in indication of how low they were. Both grid-type trolling index (GTI) and acoustic sonar index suggest continuous low recruitments for four years (the 2000-2003 trolling surveys and acoustic sonar surveys corresponding to the 1999-2002 cohorts). Agreed with these indices, the longline CPUE indicators suggest considerable declines of recruitments of 1999-2002 cohorts. However, there are some inconsistencies in recruitment level observed in comparisons between some indicators (Japanese longline CPUE index and the GTI) and the 2005 and 2006 acoustic sonar index (corresponding to the 2004 and 2005 cohorts), suggesting that the 2004 and 2005 recruitments were higher than those the acoustic sonar index indicated.

Both recruitment indices and longline CPUEs indicate that the recruitment levels for the 2006 to 2010 cohorts were also higher than those for the 1999 to 2002 cohorts. These indicators also suggest that possibly the levels of recruitment gradually decreased from 2006 to 2010 cohorts although there have been some variations in the trends.

The trends of the recruitment indices and the CPUE-based indicators in recent 5 years were summarized in Fig. 5-1. The indices of spawning stock based on Indonesian catch were difficult to interpret and thus no specific conclusion was drawn. Considering uncertainty inherent in all the indicators inspected, both fishery-dependent and fishery-independent indicators should continue to be further monitored and carefully examined in a synthetic way.

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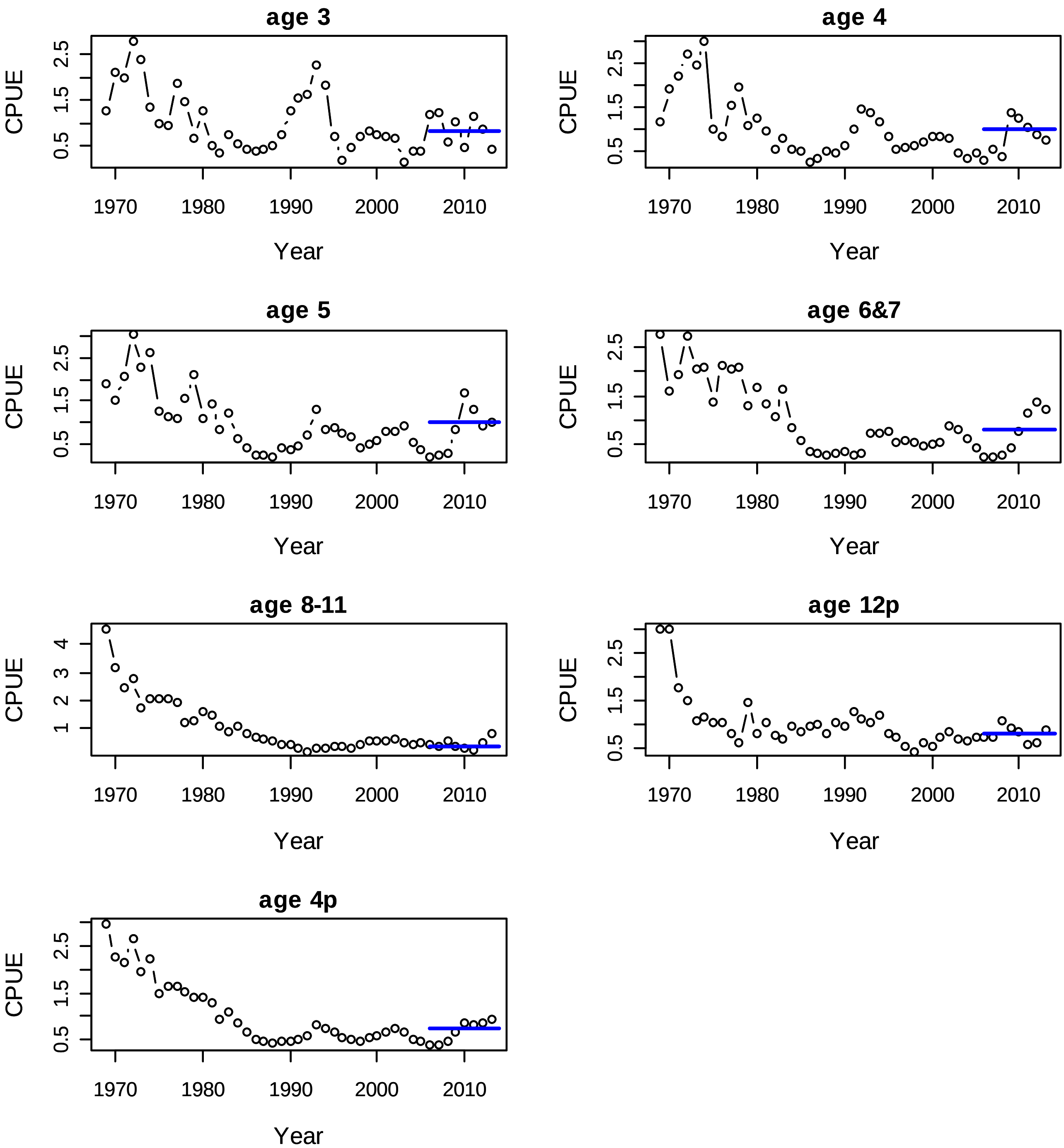


Fig. 1-1. Nominal CPUE of Japanese longline fishery by age groups. The horizontal lines indicate the past 5-year averages over 2008-12.

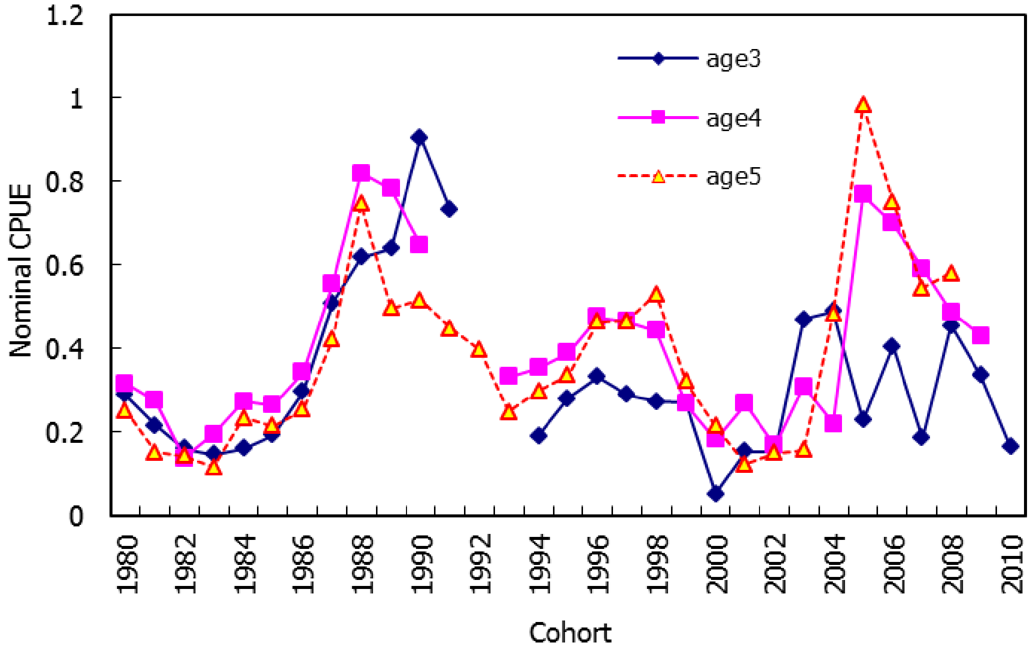


Fig. 1-2. Nominal CPUE of Japanese longline fishery by cohorts for age 3, 4, and 5.

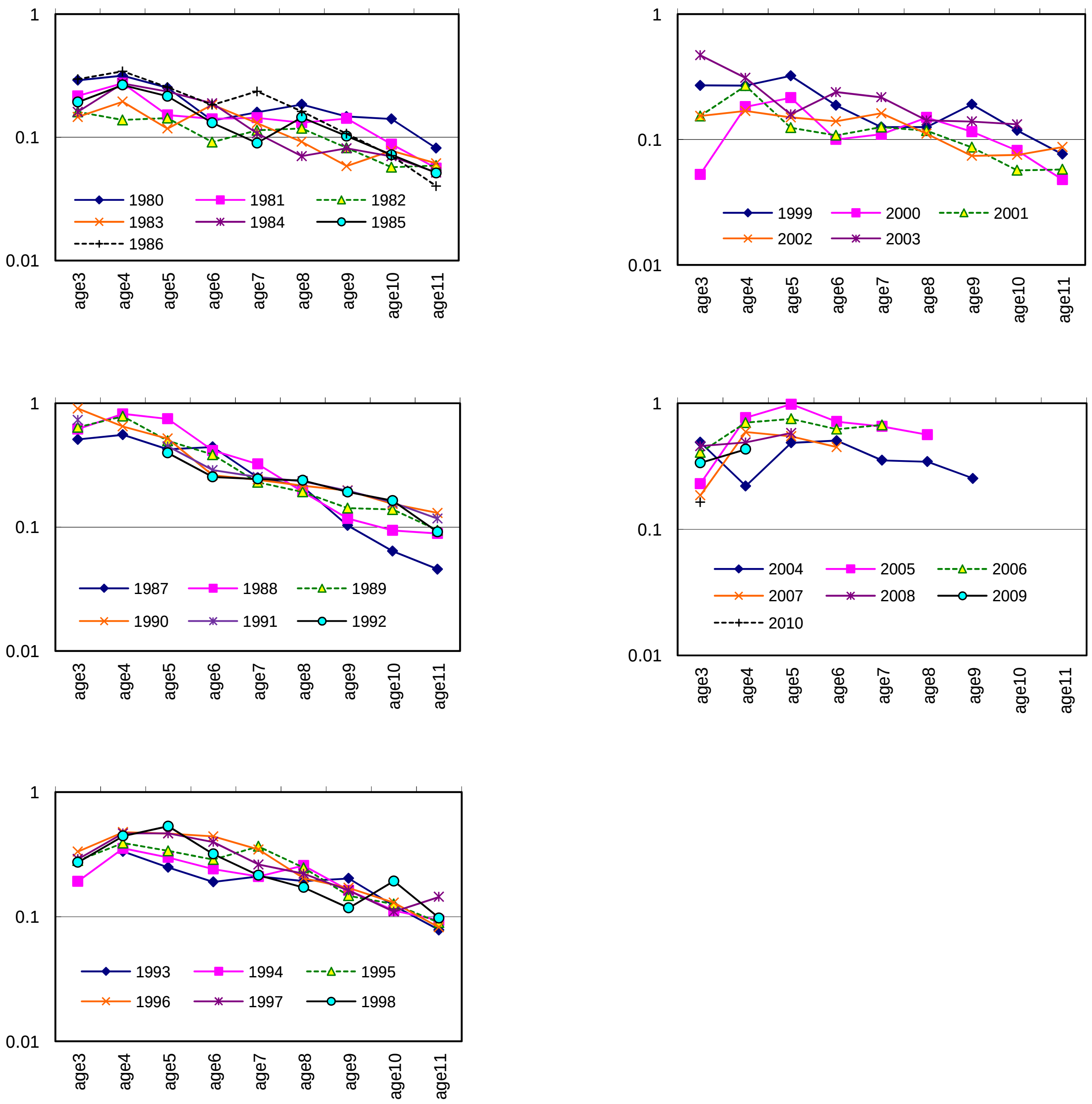


Fig. 1-3. Nominal CPUE of Japanese longline fishery by cohorts in log-scale.

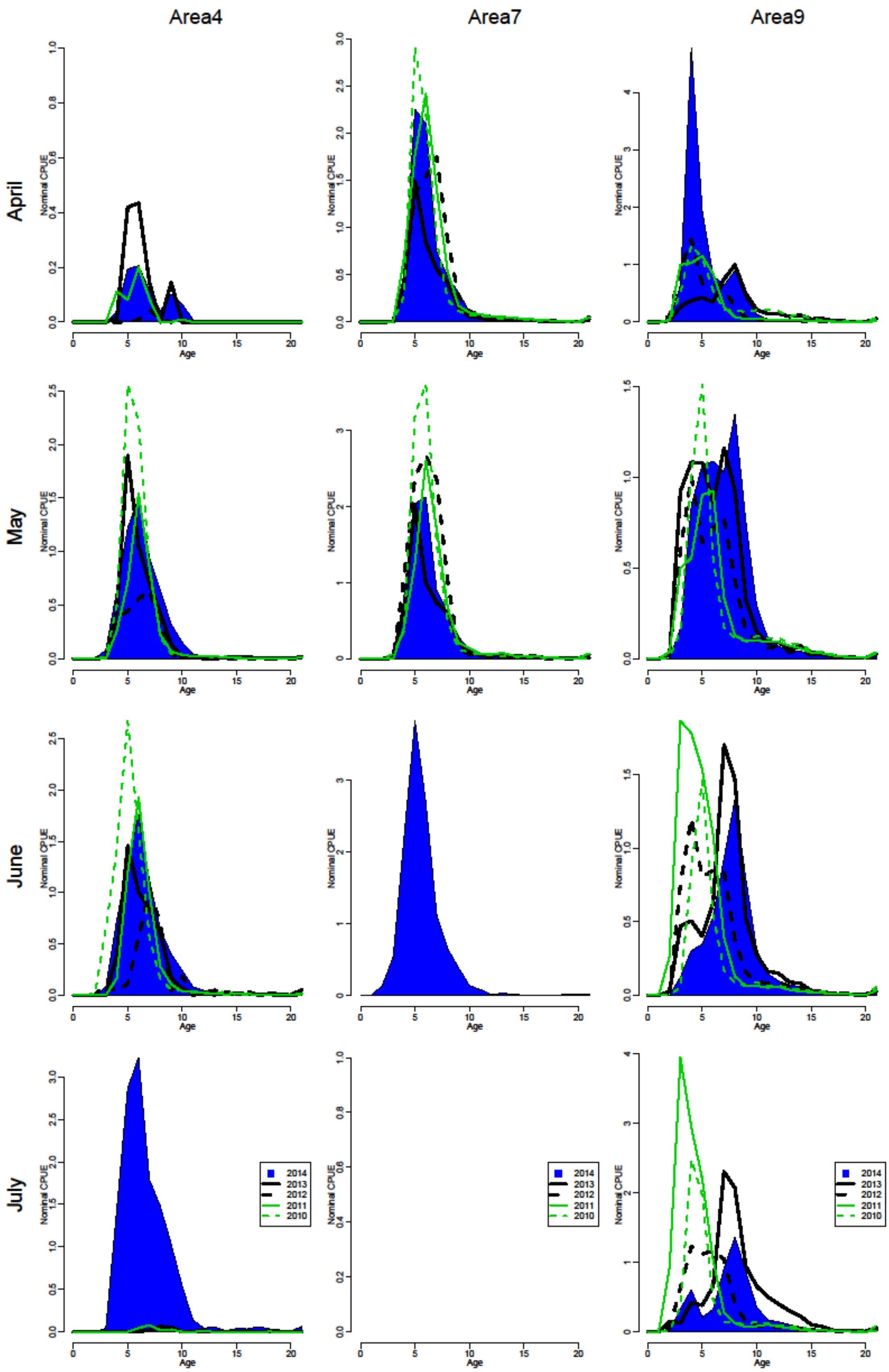


Fig. 1-4. Age composition of nominal CPUE of RTMP data for recent five years by month and areas.

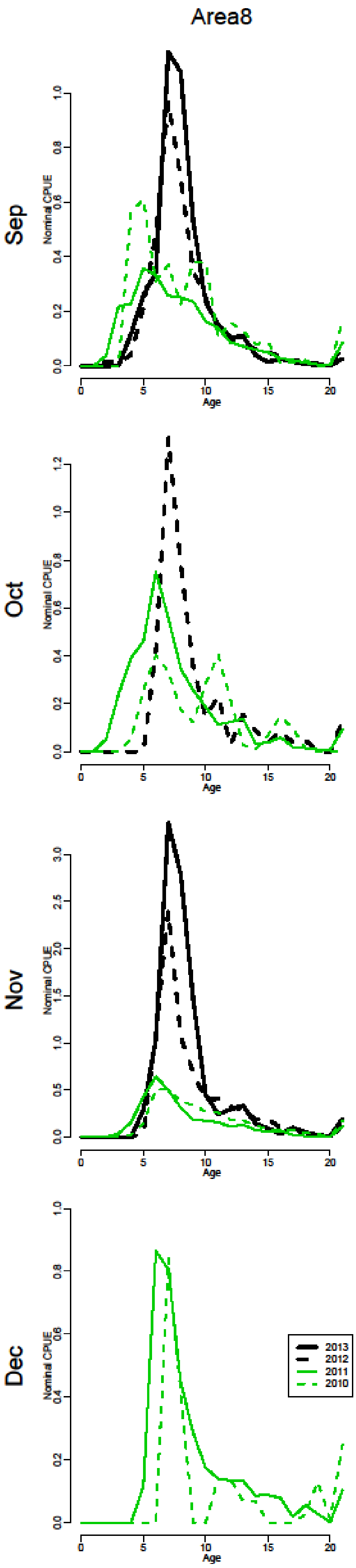
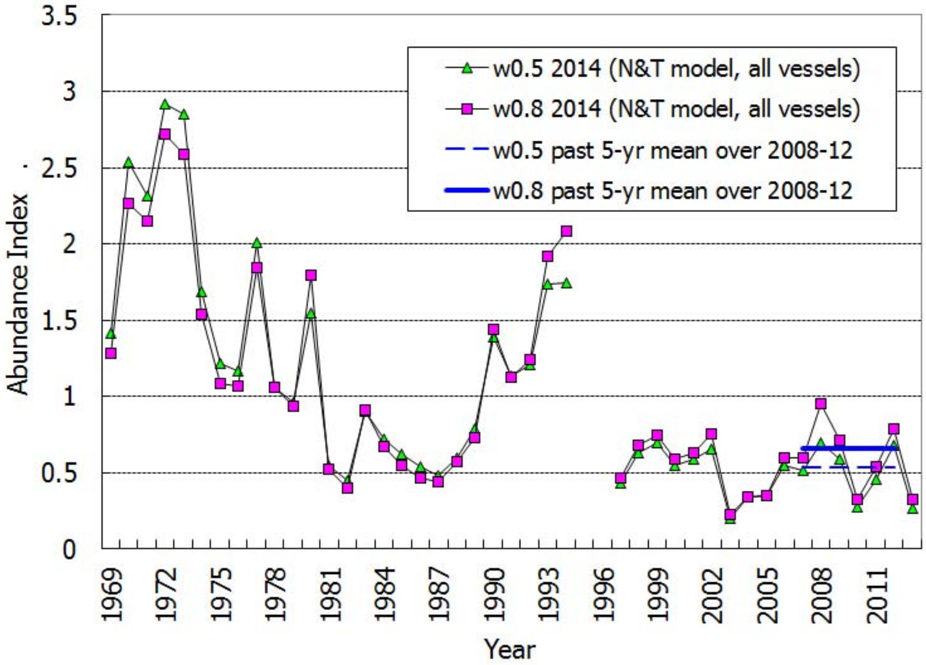


Fig. 1-4 (cont'd). Age composition of nominal CPUE of RTMP data for recent four years by month and areas.

(a) Age 3



(b) Age 4

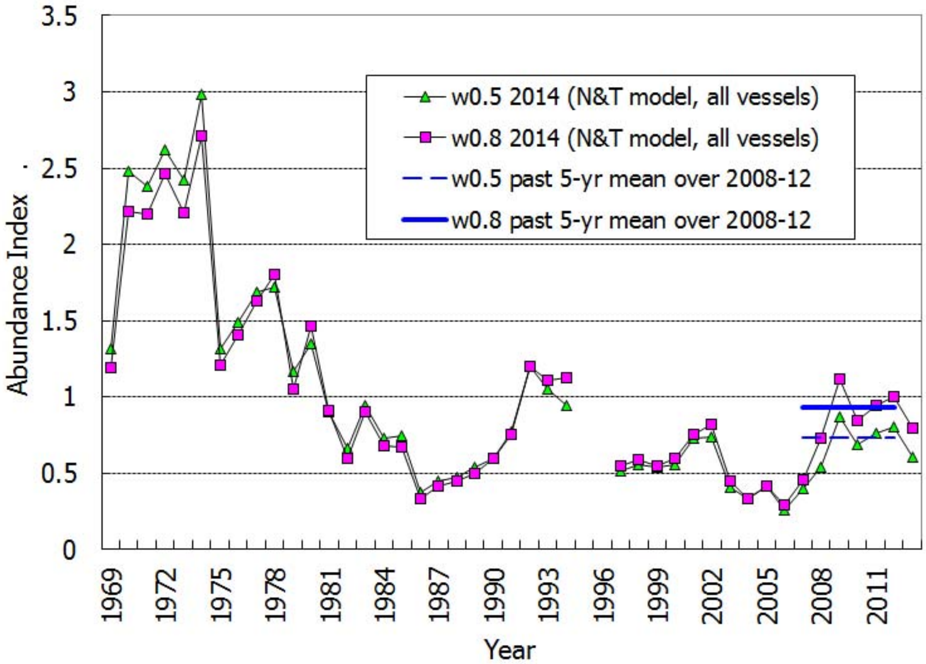
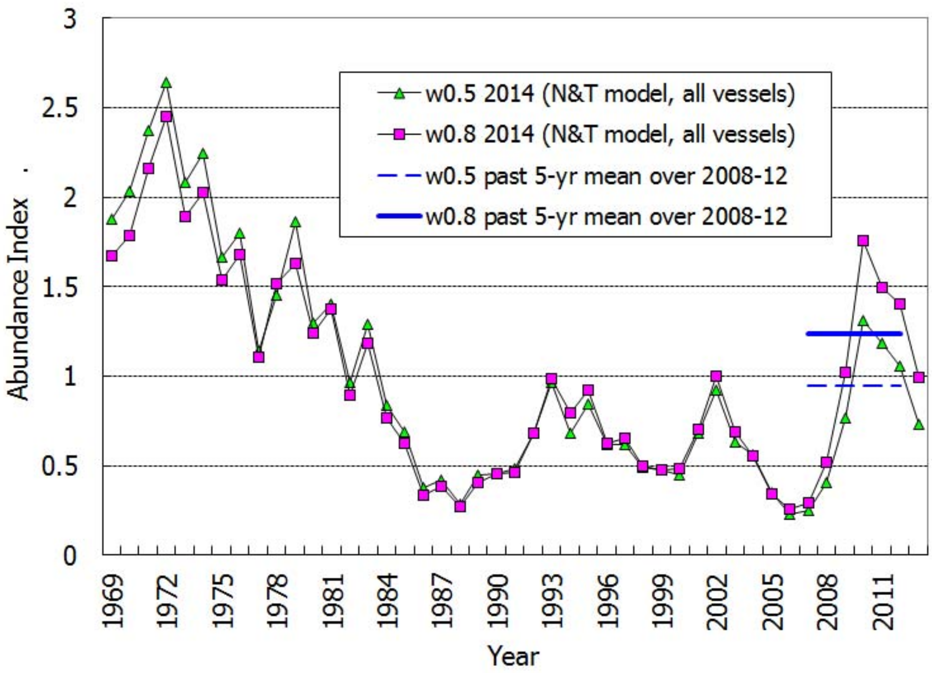


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998).

(c) Age 5



(d) Age 6&7

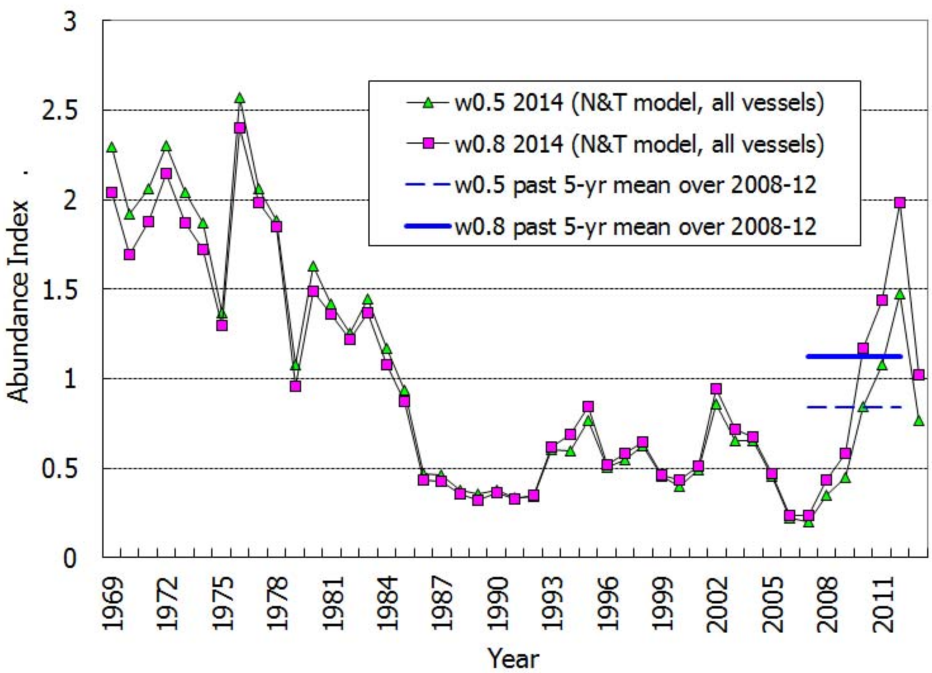
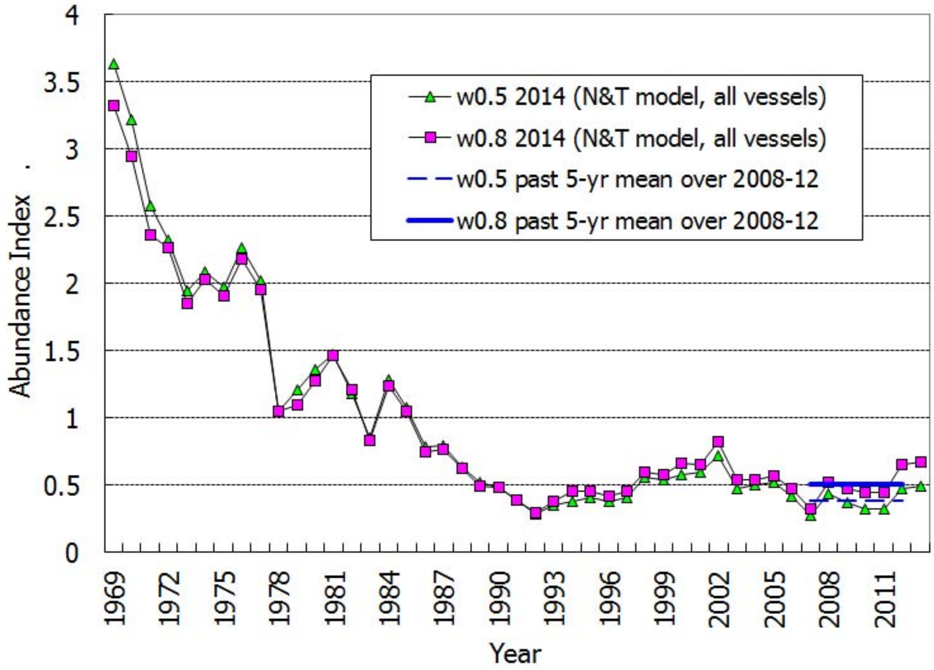


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998). (cont'd)

(e) Age 8-11



(f) Age 12+

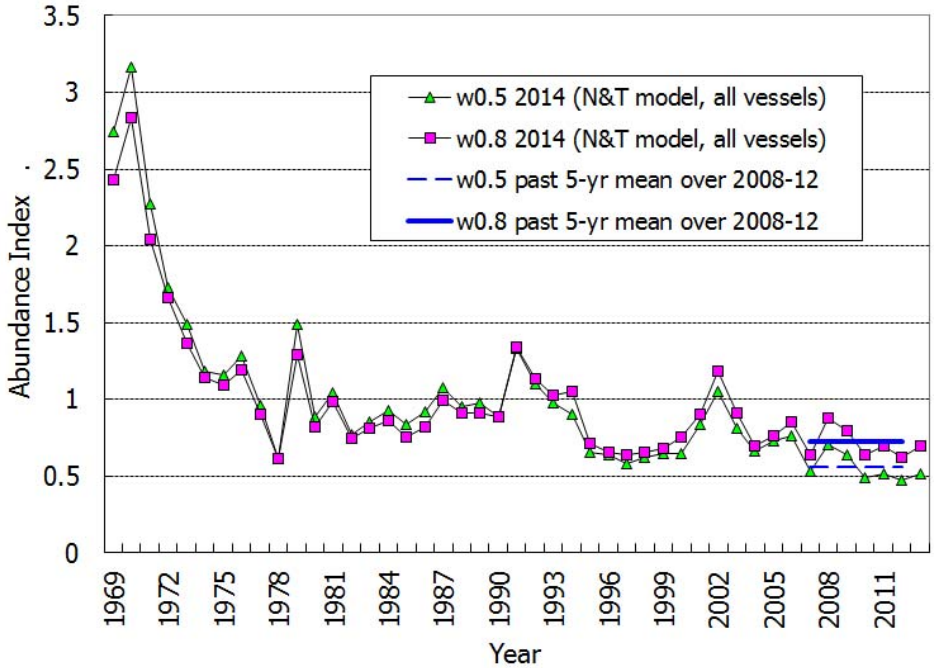
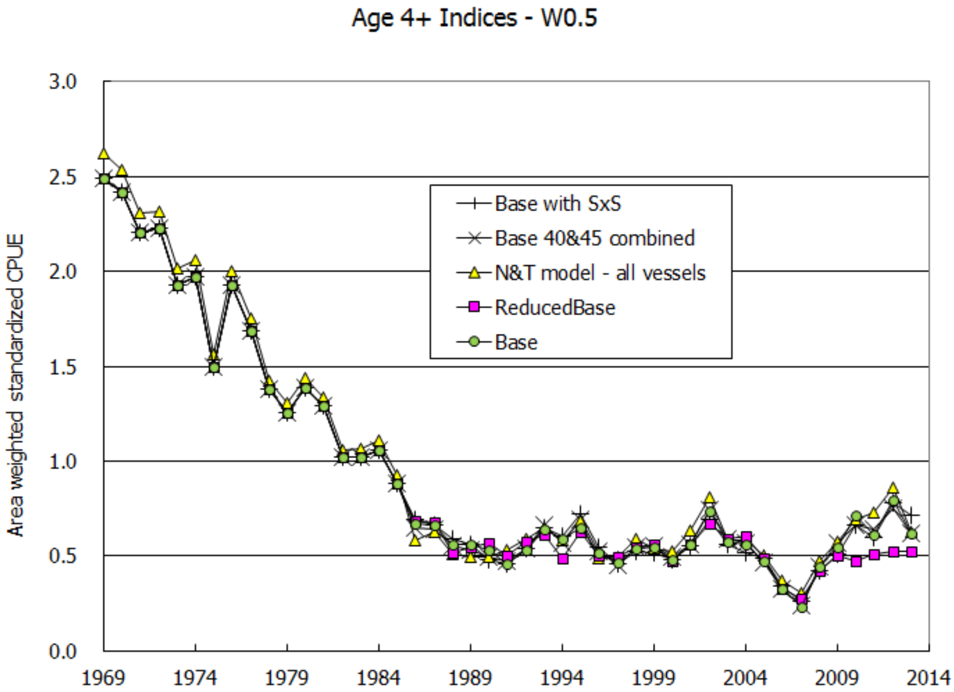


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998). (cont'd)



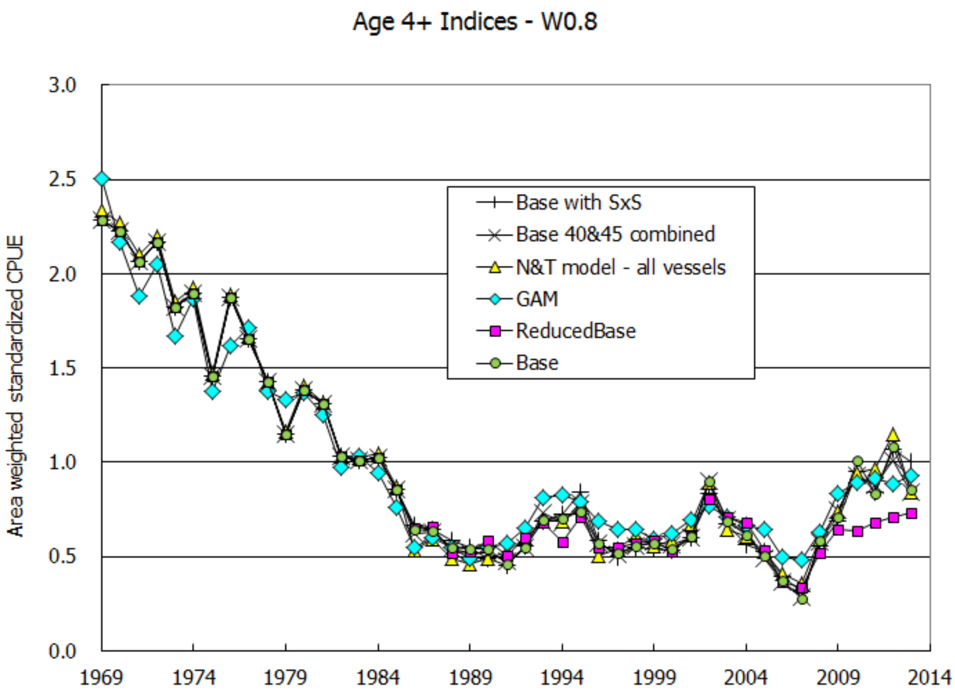


Fig. 1-6. Trends of various abundance indices for age 4+: Base model (Base) with core vessel data (Core); Reduced Base model with Core; Base with shot-by-shot Core; Base with Core, 40S and 45S latitude data combined; Nishida & Tsuji model with all vessel data; GAM with all vessel data. GAM series was plotted together with w0.8 series as overall levels of these indices are similar.

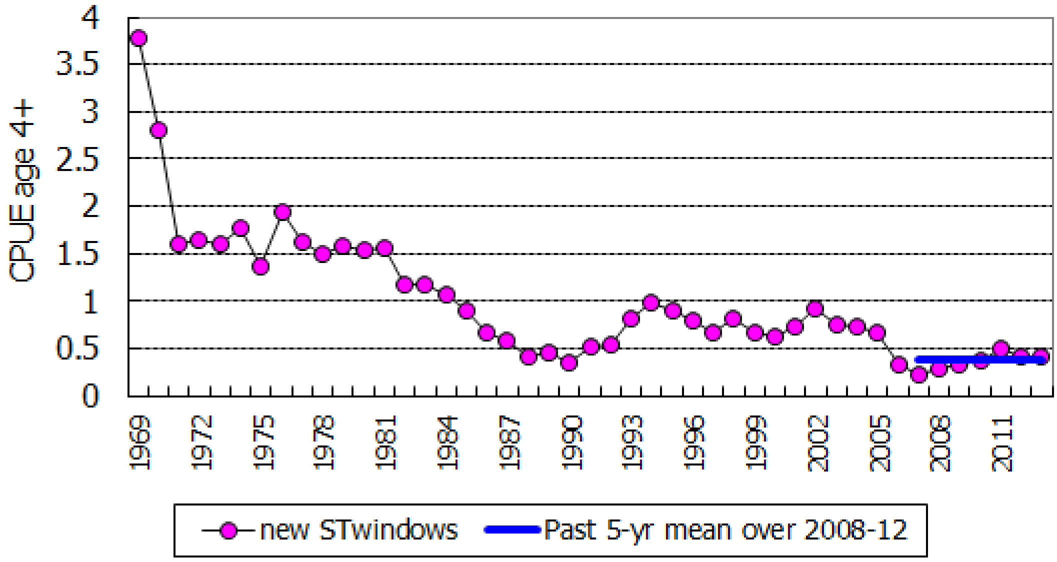


Fig. 1-7. Trend of normalized “ST Windows” index for age 4+ fish by the new calculation method.

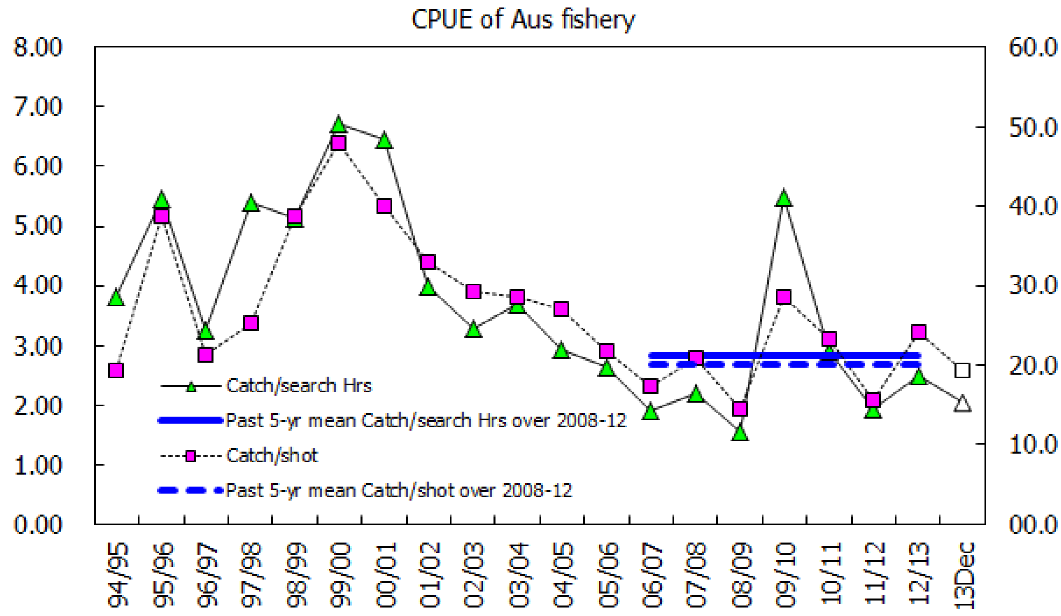


Fig. 2-1 Catch by efforts for Australia purse seine fishery.

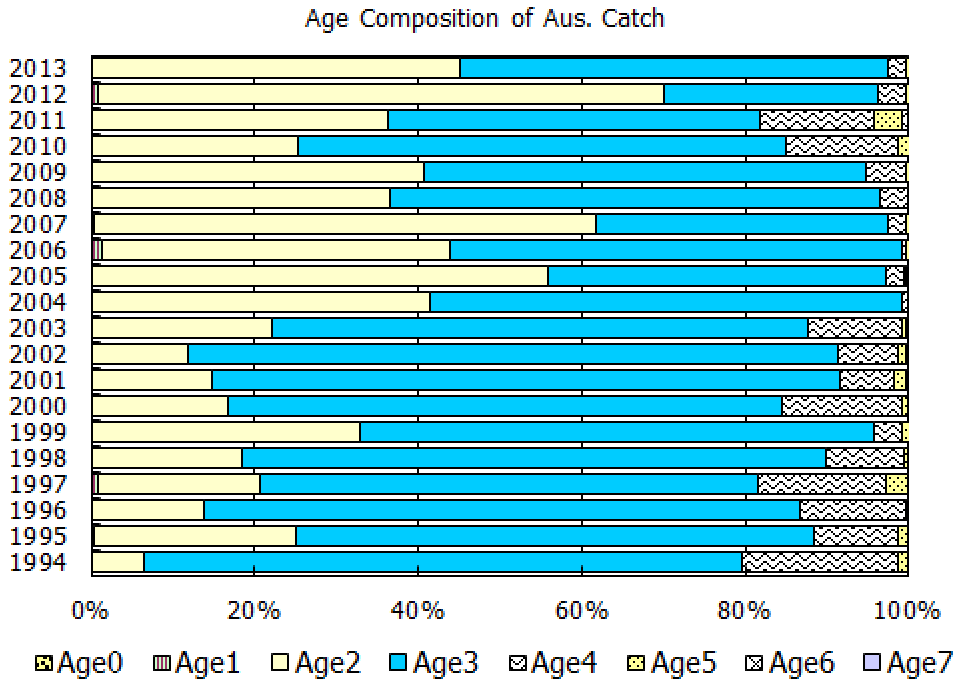


Fig. 2-2 Changes in age composition of Australia purse seine catches.

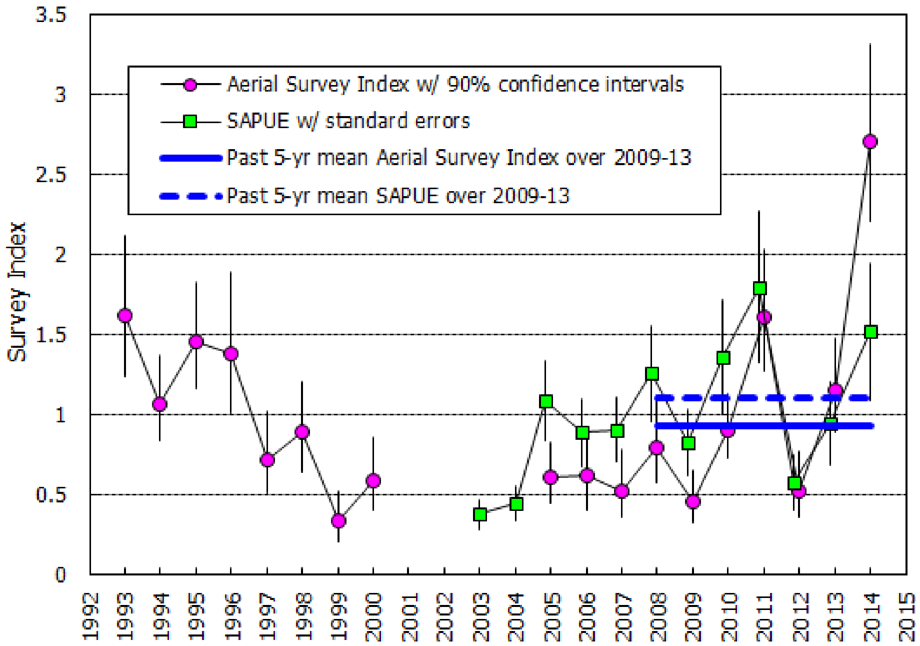


Fig. 2-3 Changes in aerial and commercial spotting (SAPUE) indices in the Great Australian Bight. Vertical bars indicate standard errors.

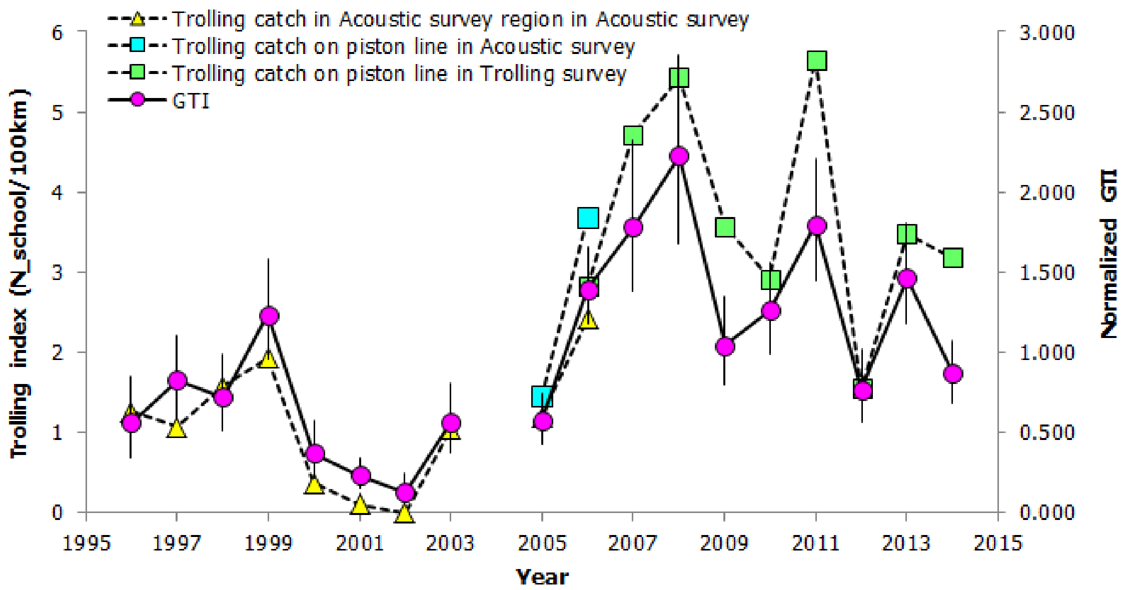


Fig. 3-1. Trends of various trolling catch index for age 1 SBT in the Western Australia. The previously reported trolling indices were indicated by dotted lines with symbols (Only the bootstrap estimates of median were plotted). “GTI” represents the standardized grid-type trolling index and vertical lines of each point indicate the bootstrap estimates of 90% confidence interval.

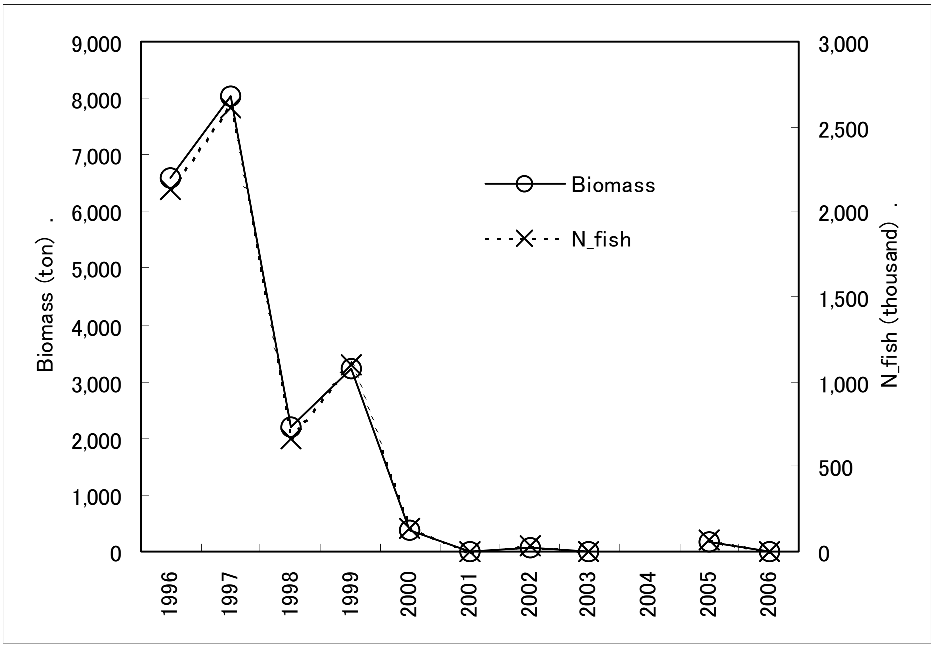


Fig. 3-2. Trends of acoustic sonar index of age 1 SBT in the Western Australia. The acoustic sonar survey ended in the 2005/06 season (shown as "2006" in the figure).

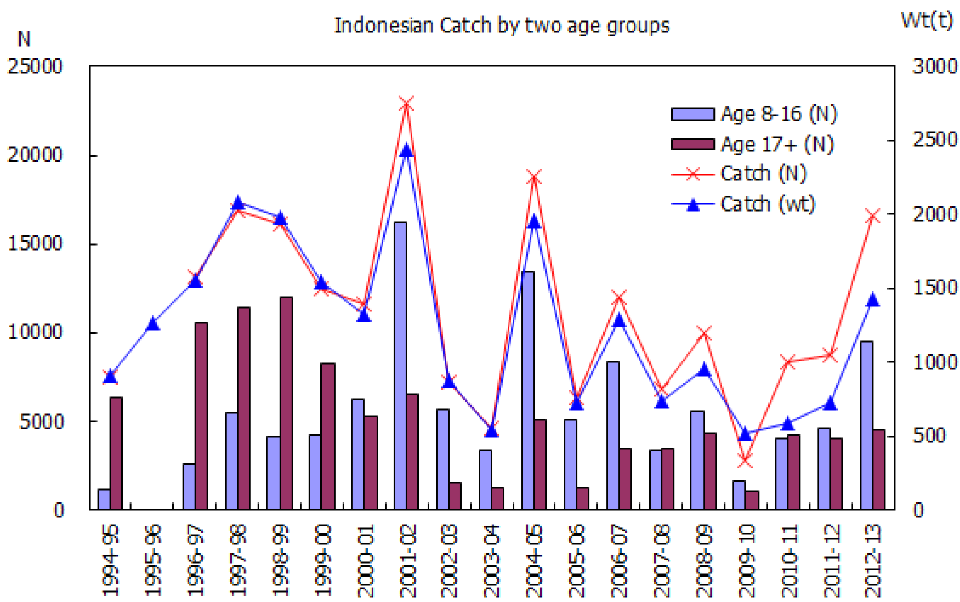


Fig. 4-1. Trends of Indonesian catches with proportion of two age groups occurrences.

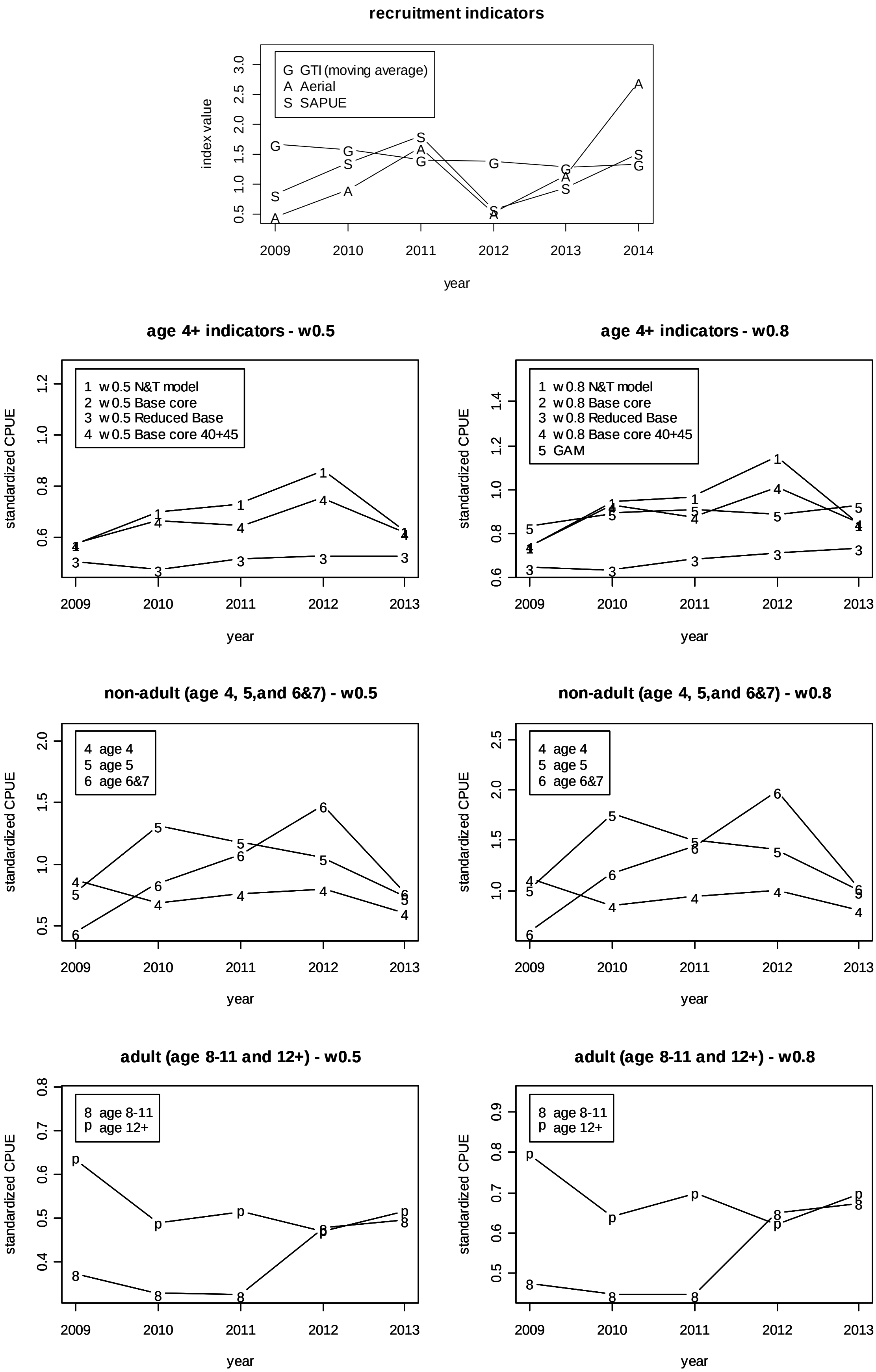


Fig. 5-1. Trends of recruitment surveys and CPUE-based indicators in recent 5 years.