SUMMARY OF FISHERIES INDICATORS OF SOUTHERN BLUEFIN TUNA STOCK IN 2012

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Abstract : Various fisheries indicators were carefully examined to overview the current status of southern bluefin tuna stock. The indicators suggested that the current stock levels for 4, 5, and 6&7 age groups were well above ones observed in the late 1980s and the mid 2000s, which were the historically lowest levels. When looking to recent years, The standardized Japanese longline CPUE indices for these age classes, especially age classes 5 and 6&7, showed marked recovery. The CPUE index for age 8-11 have declined slightly and gradually since 2008. Age class 12+ had fluctuated around the past 5-year average and the index value in 2011 was lower than the average. The current stock levels for these older age groups are still very low similar to ones observed in past. Many indices indicated low recruitments of 1999, 2000, 2001, and 2002 cohorts. This reflected the fact that the acoustic survey indices from Recruitment Monitoring Program suggested sequential low recruitments for four years (the 2000-2003 surveys corresponding to the 1999-2002 cohorts). Agreed with these results of the surveys, longline CPUE indicators suggested considerable decline of recruitments of 1999-2002 cohorts. On the other hand, some inconsistencies in recruitment level were observed in comparisons between some fishery-dependent indicators and the results of the 2005 and 2006 acoustic surveys (corresponding to the 2004 and 2005 cohorts). In addition, while low level of recruitment for cohorts of 1999, 2000, and 2001 was observed in the acoustic survey and the trolling survey, the trolling indices for the 2002, 2004 and 2005 cohorts showed higher level of recruitment than the acoustic survey indices. Corresponded to the 2004 and 2005 cohorts, 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, and age 6&7 in 2010 and 2011 showed increasing trends. Considering sequential detections of similar trends in these different age classes, these positive upturns may be indications of stock recovery. However, there is some concern about recent recruitments. Although the age of observed fish in the trolling survey differs from that in the aerial and SAPUE survey, the index values of the three surveys in 2012 dropped to the mid-2000s level.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, further careful monitoring and examining both fishery-dependent and fishery-independent indicators are continuous tasks with high priority.

要旨：ミナミマグロの資源状態を概観するために各種漁業指数を精査した。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十分上にあることを示していた。近年を詳しく見ると、これら年齢クラス、特に 5 歳及び 6&7 歳の日本はえ縄船における標準化 CPUE 指数は顕著な回復を見せていた。8-11 歳クラスの CPUE 指数は 2008 年以来、徐々に減少してきている。12+歳クラスは、過去 5 年平均の周りを変動し、2011 年の指数値はその平均よりも低かった。これらのより高齢のグループの現在の資源状態は依然として過去に見られたものと同じ極めて低いレベルにある。多くの指標は 1999、2000、2001、2002 年級の加入が低かったことを示していた。これは、加入量モニタリング調査による音響指数が 4 年間（1999-2002 年級に対応する 2000－2003 年の調査）続けて加入が低くかったことに対応していた。音響調査の結果と一致して、はえ縄の CPUE 指標も 1999-2002 年級の加入の大きな減少を示していた。一方、いくつかの漁業指標と 2005 年及び 2006 年の音響調査結果（2004 及び 2005 年級に対応する）との間には加入レベルについて矛盾がみとめられた。また、1999、2000、2001 年級の低い加入は音響調査及び曳き縄調査ともにみとめられたが、2002、2004 及び

2005 年級の曳き縄指数は音響調査のものより高い加入レベルを示した。2004 年級と 2005 年級に対応した、2007 年と 2008 年の 3 歳魚、2008 年と 2009 年の 4 歳魚、2009 年と 2010 年の 5 歳魚、2010 年と 2011 年の 6&7 歳魚のはえ縄 CPUE 指数は増加傾向を示していた。これら異なる年齢クラスにおいて似たような傾向が連続して検出されたことを考えると、これらの正の上昇は資源回復の兆候だろう。しかし、近年の加入に関しては懸念がある。曳縄調査で観測している魚の年齢と航空機目視及び SAPUE 調査のそれとは異なるものの、これら三調査の 2012 年の指数値は 2000 年代の中頃レベルまで落ち込んだ。インドネシアの漁獲に基づく親魚資源指標は解釈が難しく、特定の結論は導かなかった。精査した全ての指標に内在する不確実性を考慮すると、今後も漁業依存の指標と漁業とは独立の指標の両者をさらに慎重にモニター及び鋭意検討することが引き続き最優先の作業である。

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 Extended Scientific Committee (ESC) of CCSBT selected a set of fisheries indicators to overview the SBT stock status. These indicators have been revised and used in past Stock Assessment Group (SAG) and 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 considered. This document summarizes results of updated fishery-dependent indicators and our overall interpretations. Some fishery-independent indices based on research surveys were also presented. It should be noted that conclusions in the reports of 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. The ESC agreed to use the new growth curve proposed by Australia (Polacheck et al. 2002) from the 2011 Data Exchange. All CPUE indicators in this document based on catch at age data by the new growth curve.

1. Japanese longline CPUE[1]:

Nominal CPUE

Nominal CPUE data by age group of Japanese longline fishery include those of joint-venture with Australia and New Zealand (Fig. 1-1). Caution is necessary for interpretation of age 3 and 4 CPUE in 1995 and 1996 because of direct impacts of non-retention of smaller fish than 25kg occurred in these years. The most recent year's data exclusively rely on information collected by the Real Time Monitoring Program

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

(RTMP) which covers only SBT targeting vessels. When all the other non SBT-targeting vessels' data (based on logbooks) become available and are included in the existing dataset the following year, CPUE of the most recent year tends to drop slightly (Takahashi et al. 2001). So the most recent year's CPUE must be also looked at with caution. However, those differences have decreased gradually and almost no difference has been found in recent years because the RTMP covers more than 95% of efforts in SBT distribution. There was some drop observed for age 4, 5, and 6&7 classes in 2010 (Data were not shown).

CPUE in recent years must be further looked to carefully 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 (2012a).

When focusing on trends for the recent five or six years, nominal CPUE for age 3 fluctuated around the past 5-year mean (Fig. 1-1). The 2011 value for this age was higher than the mean. CPUE for age 4 largely increased between 2008 and 2009, and then decreased toward year 2011 of which CPUE was still above the past 5-year mean over 2006-10. Although age classes 5, 6&7, and 4+ had declined since the early 2000s hitting the bottom in 2006, recent CPUEs for these ages showed increasing trends. The 2011 values for these ages were also markedly higher than the past 5-year averages, except for age class 4+. Nominal CPUEs for age classes 8-11 and 12+ declined from 2008 to 2011 and the recent CPUE values were lower than the past 5-year averages.

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. CPUE for age 3, 4 and 5 fish generally showed consistent trends, suggesting that age 3 CPUE could be used as an indicator of relative cohort strength, although large variations in trends and inconsistency between ages have been observed in recent years (Fig. 1-2). Cause(s) of this inconsistency has been unknown (A partial cause might be release of small fish in recent years). A large decline of 1999 cohort (2000 acoustic survey in Fig. 3-1) was not be able to detected by age 3 CPUE.

Overall levels of CPUE across age 3 to 11 by cohort can be grouped as the periods of 1980-1986, 1987-1992, 1993-1999, and 2000s cohorts (Fig. 1-3). Within each period, variations of the CPUE levels were small and the decease rates were similar, except for the 2000s cohorts. Since 2000 cohort, the catch rates have varied considerably and have not shown simple decreasing trends. Whether these large variations in catch rate were due to change in catchability and/or population fluctuation is unrevealed. The 1987-1991 cohorts showed more drastic declines than other cohorts, which was probably due to targeting towards smaller fish in the early 1990s caused by depleted stock status of cohorts recruited in pre1987 years and less structured management schemes at that time. The cohorts recruited from 1992 to 1999 showed slower decline rates, suggesting a reduced level of exploitation rates for these cohorts. Fig. 1-3 also indicates acute decreases of CPUE level for age 3 fish of 2000-2002 cohorts to about the same or lower levels comparable to those experienced by the early 1980s cohorts, while showing that 2003-06 cohorts were similar to the late 1980s levels (see also Recruitments section below). Cause(s) of these weak cohorts is still unknown, whether it be a reflection of oceanographic and/or fish availability changes, or it be an indication of a consequence of fishing pressure. Although the CPUE levels for age 3 of 2005-2008 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 obtained from RTMP in 2012 were plotted in Fig. 1-4. Past years' data are shown for comparison. CPUEs for about age 4 to 7 fish of recent two or three years were higher than that of the previous years. This occurred in most Area/month strata. These fish corresponded to cohorts come after the weak recruitments of which the acoustic monitoring survey had detected drastic declines between 1999 and 2002 (Fig. 3-1). Corresponding to these weak cohorts, substantial CPUE reductions of age 4 to 11 fish were detected, especially in Area 4 and 7 (e.g., CPUEs for age 6 to 9 fish of 2008, CPUEs for age 7 to 10 of 2009 in Fig. 1-4).

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 2011 (the most recent year) were based not on logbooks but RTMP data only, and thus should be looked at with caution as described above (Takahashi et al. 2001). These estimates may be changed when logbook data become available the subsequent year. Further, as mentioned above, recent years' CPUE must be examined carefully because Japanese longline fishery has introduced IQ system since 2006 (Itoh 2012a).

Looking to trends of the recent five or six years, the w0.5 and w0.8 indices for age 3 showed increasing trends from 2006 to 2008, and then decreased for two years in a row (Fig.1-5a). Upturns for this age in 2007 and 2008 inconsistently corresponded to low recruitments of 2004 and 2005 cohorts observed respectively in the 2005 and 2006 acoustic survey of the Recruitment Monitoring Program (Fig. 3-1), but were more or less consistent to results from the trolling survey in 2005 and 2006 (Fig. 3-2). Decline for age 3 from 2008 to 2010 were not observed in the trend of the trolling survey between 2006 and 2008 (Fig. 3-2). The 2011 indices for age 3 increased but were lower than the past 5-year averages over 2006-10. The CPUE index for age 3 varies year to year and 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). Thus, the age 3 index should be looked at and interpreted with caution.

The indices for the age 4 continuously increased from 2007 to 2009, decreased and then upturned slightly in 2011 (Fig. 1-5b). The low index values for age 4 observed in 2006 corresponded to low recruitments (2002 cohorts) observed in the acoustic survey conducted in 2003, respectively (Fig. 3-1). The acoustic survey was not conducted in 2004 corresponding to the 2003 cohort (Fig. 3-1). However, the index values for age 3 in 2006 and for age 4 in 2007 suggested a possibility that, although its recruitment level was still low, 2003 cohort was not so 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 surveys conducted in 2005 and 2006 showed low indices (Fig. 3-1). A similar increasing trend was also observed in the trolling survey in 2005 and 2006 (Fig. 3-2). The 2011 indices for age 4 were higher than the past 5-year means over 2006-10.

The CPUE indices for 5 and 6&7 age groups have shown uninterrupted increasing trends since 2007, except for age 5 in 2011 (Figs. 1-5c and d). These increases may be corresponding to ones observed in the trolling survey between 2002 and 2006 (Fig. 3-2). The low index values for these ages observed in 2007 corresponded to the low recruitment in the 2001, 2002, and 2003 acoustic survey (2000, 2001, and 2002 cohorts) (Fig. 3-1). All the indices for age classes 5 and 6&7 in 2011 were much above the past 5-year means. The CPUE index values for age 8-11 have declined slightly and gradually since 2008 (Fig. 1-5e). This may correspond to low recruitments of 1999-2002 cohorts observed in the 2000-2003 acoustic surveys (Fig. 3-1). The 2011 indices for this age class were almost the same level as the past 5-year average for w0.8 and slightly lower than the average for w0.5. The CPUE indices for age 12+ had fluctuated around the past 5-year averages. The indices in 2011 for this age group were lower than the averages (Fig. 1-5f).

The CPUE indices for age 4+ group have continuously increased since 2007 when the historically lowest level of CPUE was observed (Fig. 1-5g). The indices in 2011 for age 4+ were much higher than the past 5-year averages over 2006-10.

Fig. 1-6 shows trends of the CPUE indices for age 4+ calculated using the Core Vessel data and the standardization models agreed in the CPUE modeling Group (CCSBT 2010, Itoh 2012b). The "Base" series is the one used for the operating model (OM) conditioning and management procedure (MP) inputs in the SC. Other two series, namely "Reduced Base" and "Base with SxS," 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 trends of "Base" indices had patterns similar to that of the CPUE series using the Nishida and Tsuji model and all vessel data presented above, except that the CPUE of "Base" in 2011 decreased (Figs. 1-5g and 1-6).

<u>Spatial-Temporal (ST) windows CPUE and Laslett Core Area CPUE for age 4+</u>

“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” represents 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. 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 gently increased since 2007. The index value in 2011 was slightly higher than the past 5-year average.

“Laslett Core Area” applies another concept, based upon different criteria from the ST windows, that is to define and extract spatiotemporal strata in which longline fishing has consistently been occurred, and CPUE data for these strata are used to derive abundance indices by utilizing smoothing splines (Laslett 2001). The trend of the Laslett Core Area CPUE showed almost the identical pattern to that of w0.5 and w0.8 indices for age 4+ (Fig. 1-8, compare with Figs. 1-5g and 1-6). Although the 2011 index dropped, the value was still higher than the past 5-year average.

Both ST windows and Laslett Core Area series have been used for robustness tests of MP development in the SC and would be used for monitoring purposes because the two series can be considered as an envelope for the "Base" series (see above), given they have formed the recent upper and lower bounds of other CPUE-based series (CCSBT 2010).

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. 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 may correspond to low recruitments that were observed in the acoustic survey index and Japanese longline CPUE (Figs. 1-1, 1-4, and 1-5 for the longline, and Fig.3-1 for the acoustic survey). There was a large upturn of the CPUE observed in 2009/10 season. Both CPUEs in 2010/11 season were almost same as the past 5-year means over 2006-10.

The proportions for age 2 fish between 2004 (03/04 season) and 2009 (08/09 seasons) were greater than any for previous years (Fig. 2-2). Contrary, proportions for age 3 and 4 decreased for the same years. In 2011, the age composition increased for age 2, and decreased for age 3. A small proportion for age 5 and 6 appeared in 2011. Other than that, no strong signal was observed in the age composition of the purse seine catches. 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 and commercial spotting (SAPUE) survey indices in the Great Australian Bight (GAB) are shown in Fig. 2-3 (Farley and Basson 2012, Eveson et al. 2012). These indices 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 showed the moderately declining trend from 1993 to the early 2000s. The index values were more or less stable in the rest of the 2000s. The index markedly increased in 2010 and 2011, two years in a row, and then dropped in 2012. The 2012 value was below the past 5-year average over 2007-11 and a similar level to the 2000s estimates. The overall trend of SAPUE appeared to be increasing during 2004-2011 period. The 2011 SAPUE also declined in 2012 and went to below the past 5-year average.

3. Recruitments:

<u>Acoustic survey</u>

Acoustic survey of the Recruitment Monitoring Program was aimed to monitor changes in relative abundances of age 1 fish moving through the survey area in the southwestern coast of Australia. This index represented the age 1 fish abundance within the survey area standardized with 15 days' survey period. The index showed a drastic decline in 2000 and stayed at very low levels which were non-estimable because of lack of records identified as SBT with a certain estimated biomass with sonar (Fig. 3-1). No field activities were conducted in 2003/2004 season, and the survey ended in the 2005/2006 season.

As explained above, cohorts showing the extreme low abundance levels in the 2000, 2001, 2002, 2003, 2005, and 2006 surveys have been available to Japanese longline fishery and mostly showed substantially low CPUEs (Figs. 1-1, 1-4 , and 1-5). It has been common understanding in the CCSBT SC that the recruitment trend detected by the acoustic surveys reflected the real situation, and we have seen at least four years' low longline CPUEs coming in sequence which were resulted from the low recruitments of 1999, 2000, 2001, and 2002 cohorts (corresponded to cohorts detected by the 2000-2003 surveys). This has caused devastative impacts on both SBT stock and longline fishery. Now these cohorts have entered to age classes 8-11 and 12+ and appeared in CPUE series between 2007 and 2011, showing somewhat gently declining trends (Figs. 1-5e and f).

However, there is some inconsistency observed for 2004 and 2005 cohorts. The CPUE indices for age 3 in 2007 and 2008, for age 4 in 2008 and 2009, for age 5 in 2009 and 2010, and for age 6&7 in 2010 and 2011 were apparently at the same levels of or higher than that of the late 1990s and the early 2000s (Figs. 1-5a, b, c, and d) whereas the 2005 and 2006 acoustic surveys indices indicated low recruitments (Fig. 3-1). Further, although we tend to assume that 2003 cohort (not acoustic-surveyed) was similarly weak because the acoustic survey indices of previous and following years' indicate low recruitments (Fig. 3-1), the corresponded CPUEs for age3 in 2006, for age 4 in 2007, for age 5 in 2008, and for 6&7 age class in 2009 and 2010 showed upturns (Figs. 1-5a, b, c and d), suggesting that the 2003 cohort may not be so weak as the previous ones. Thus, considering such uncertainty about influence of 1999-2005 cohorts observed as low levels in the 2000-2006 acoustic survey, we need to monitor other indicators synthetically and carefully along the acoustic survey index for next several years.

The Recruitment Monitoring acoustic survey ended in the 2005/2006 season due to budget matter and was replaced by much lower-cost trolling survey to monitor relative abundance of age 1 fish (see below).

Trolling survey

Since a vast amount of costs was necessary for conducting the Recruitment Monitoring acoustic surveys (above), a recruitment index of age 1 fish estimated from results of much lower-cost trolling surveys has been currently being developed. Details of the survey design, estimation method, results and its interpretation were documented in Itoh (2007) and Itoh et al (2012). Fig. 3-2 illustrates the trend of the trolling catch index. The median trend of the trolling index based on bootstrap sampling increased from 2005 to 2008, declined toward 2012, except for a large upturn in 2011, although bootstrapped 5% and 95% quantiles were quite wide (indicated by lower and upper lines, or vertical bars). It should be noted that the length frequency distribution observed in the 2012 survey was quite different from those in previous years (Itoh et al. 2012). Thus, it would not be appropriate to assess the recruitment level simply based on the index value in 2012.

Cohorts of 1999, 2000, and 2001 (2000, 2001, and 2002 surveys) showed considerably low levels of recruitment. These low recruitment levels were consistent with the ones observed in results of the acoustic surveys (Fig. 3-1). In contrast, the trolling indices for 2002, 2004, and 2005 cohorts (2003, 2005, and 2006 surveys) inconsistently showed higher levels of recruitment than the acoustic survey did. However, the increase levels of 2004 and 2005 cohorts were compatible with upturns observed in the longline CPUE indices for age 3 fish in 2007 and 2008, for age 4 in 2008 and 2009, for age 5 in 2009 and 2010, and for age 6&7 in 2010 and 2011 (Figs. 1-5a, b, c, and d). No survey was conducted in 2004, so any speculation on recruitment status of 2003 cohort could not be drawn from the trolling catch index.

For 2006 and 2007 cohorts (2007 and 2008 surveys), the trend of the trolling index was consistent with longline CPUE for age 4 in 2010-11 but inconsistent with that for age 3 in

2009-10 (Figs. 1-5a and b).

As compared above, the levels of trolling indices were compatible with that of other indices (e.g., acoustic indices, Japanese longline CPUE), of course there were some exceptions though. Thus, some usefulness of the indices to monitor age 1 recruitment was recognized. Reliability of the trolling indices is still being verified and it is necessary to compare these indices with CPUE for corresponded cohorts recruited into longline fishery for further verification. The trolling indices may not be used as rigorous quantitative indicators for recruitment. However, they can be used as indicators to detect some qualitative signals of the recruitment level, indicating “high”, “medium”, or “low.”

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 ones for 8-16 ages throughout the 1990s. In contrast, many of yearly catches for the 17+ group have been similar to or lower than ones for 8-16 ages since 2000/01 season. A marked increase of catch in 2001/02 season may have mainly been 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 or changes in fishing practices.

The catch trends of both in number and in weight for age 8-16 and 17+ combined appeared to gradually decline with fluctuations from 1997/98 season to the present.

The low levels of the older portion and the gradual declining trend of spawning stock throughout the 2000s give some concerns of potential low reproduction in recent years.

5. Overall Conclusion:

Fisheries indicators examined generally supported a view that the current stock levels for 4, 5, and 6&7 age groups were well above ones observed in the late 1980s and the mid 2000s, which were the historically lowest levels. The standardized Japanese longline CPUE indices for these age classes, especially age classes 5 and 6&7, showed marked recovery. The CPUE index for age 8-11 have declined slightly and gradually since 2008. Age class 12+ had fluctuated around the past 5-year average and the index value in 2011 was lower than the average. The current stock levels for these older age groups are still very low similar to ones observed in past. Many indicators suggested considerable low recruitments in past years but differ in indication of how low they were. The acoustic indices suggested continuous low recruitments for four years (the 2000-2003 acoustic surveys corresponding to the 1999-2002 cohorts). Agreed with the results of the surveys, the longline CPUE indicators suggested considerable decline of recruitments of 1999-2002 cohorts. However, there were some inconsistencies in recruitment level observed in comparisons between some indicators and the results of the 2005 and 2006 acoustic surveys (corresponding to the 2004 and 2005 cohorts). In addition, while the low levels of recruitment for cohorts of 1999, 2000, and 2001 were observed in the acoustic survey and the trolling survey, the trolling indices for the 2002, 2004 and 2005 cohorts showed higher levels of recruitment than the acoustic survey indices. Corresponded to the 2004 and 2005 cohorts, 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, and age 6&7 in 2010 and 2011 showed increasing trends. Considering sequential detections of similar trends in these different age classes, these positive upturns may be indications of stock recovery. However, there is some concern about recent recruitments. Although the age of observed fish in the trolling survey differs from that in the aerial and SAPUE survey, the index values of the three surveys in 2012 dropped to the mid-2000s level. The trends of the recruitment surveys and 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, further careful monitoring and examining both fishery-dependent and fishery-independent indicators are continuous tasks with high priority.

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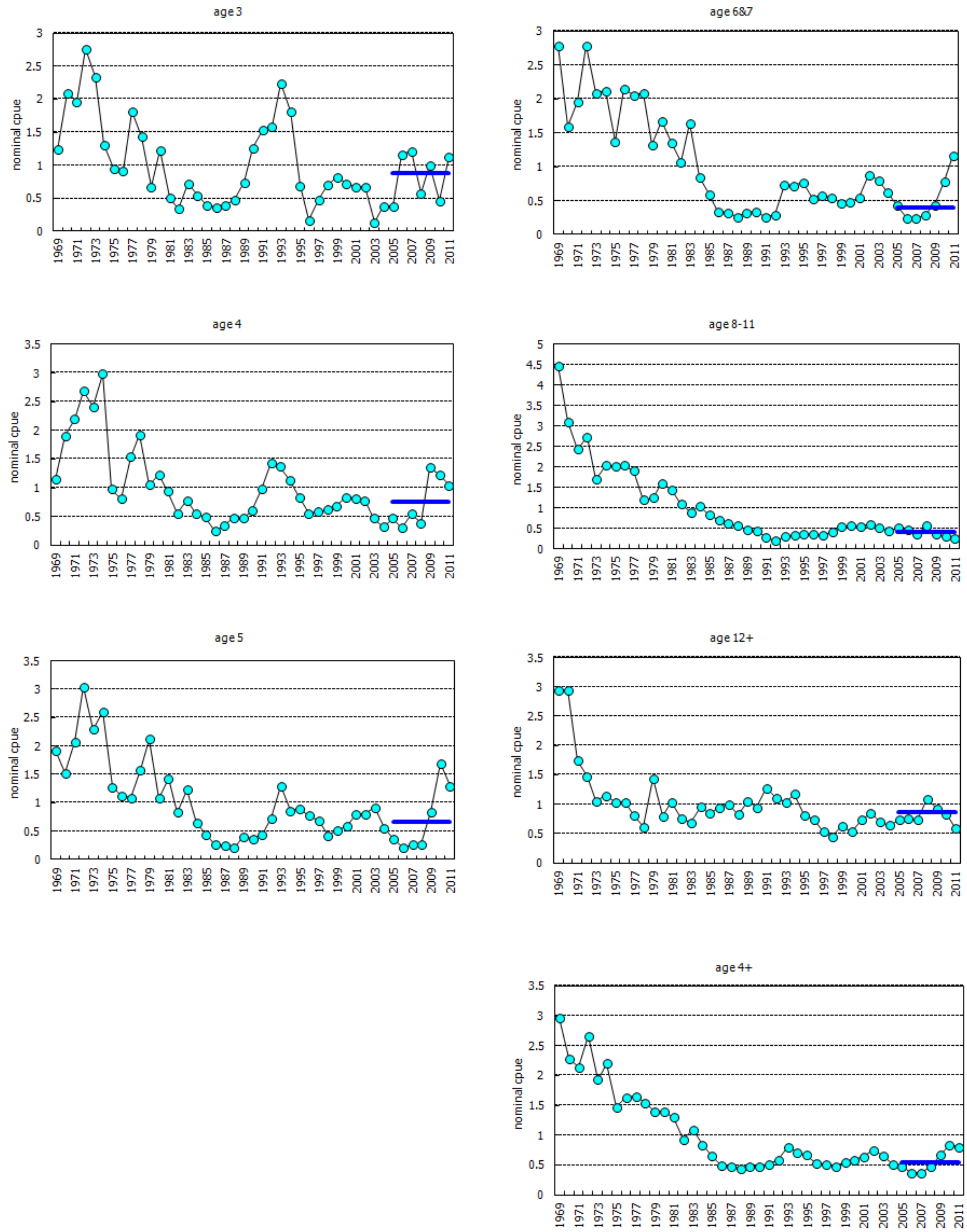


Fig. 1-1. Nominal CPUE of Japanese longline fishery by age groups. The horizontal lines indicate the past 5-year averages over 2006-10.

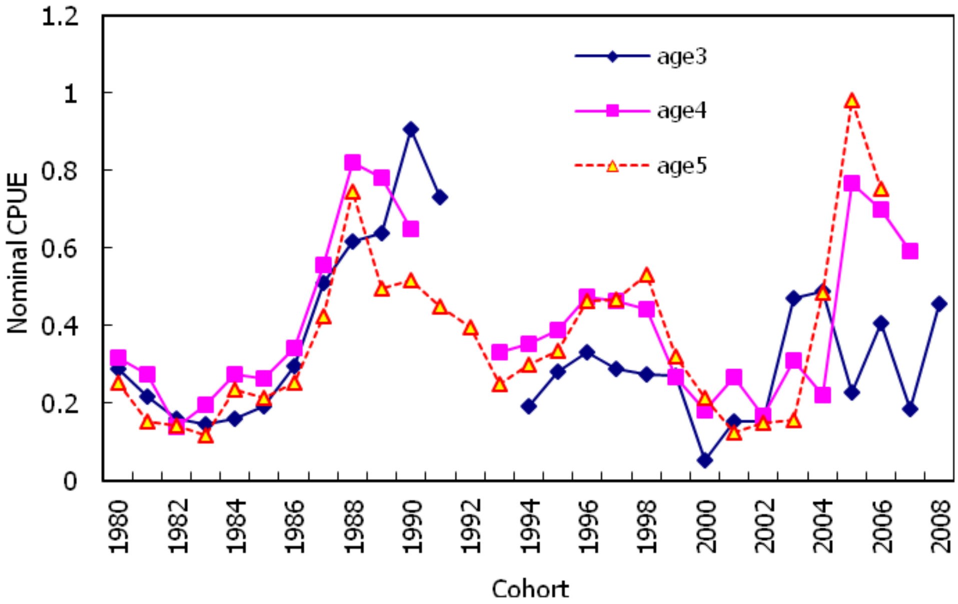


Fig. 1-2. Nominal CPUE of Japanese longline fishery by cohorts for age 3, 4, and 5.

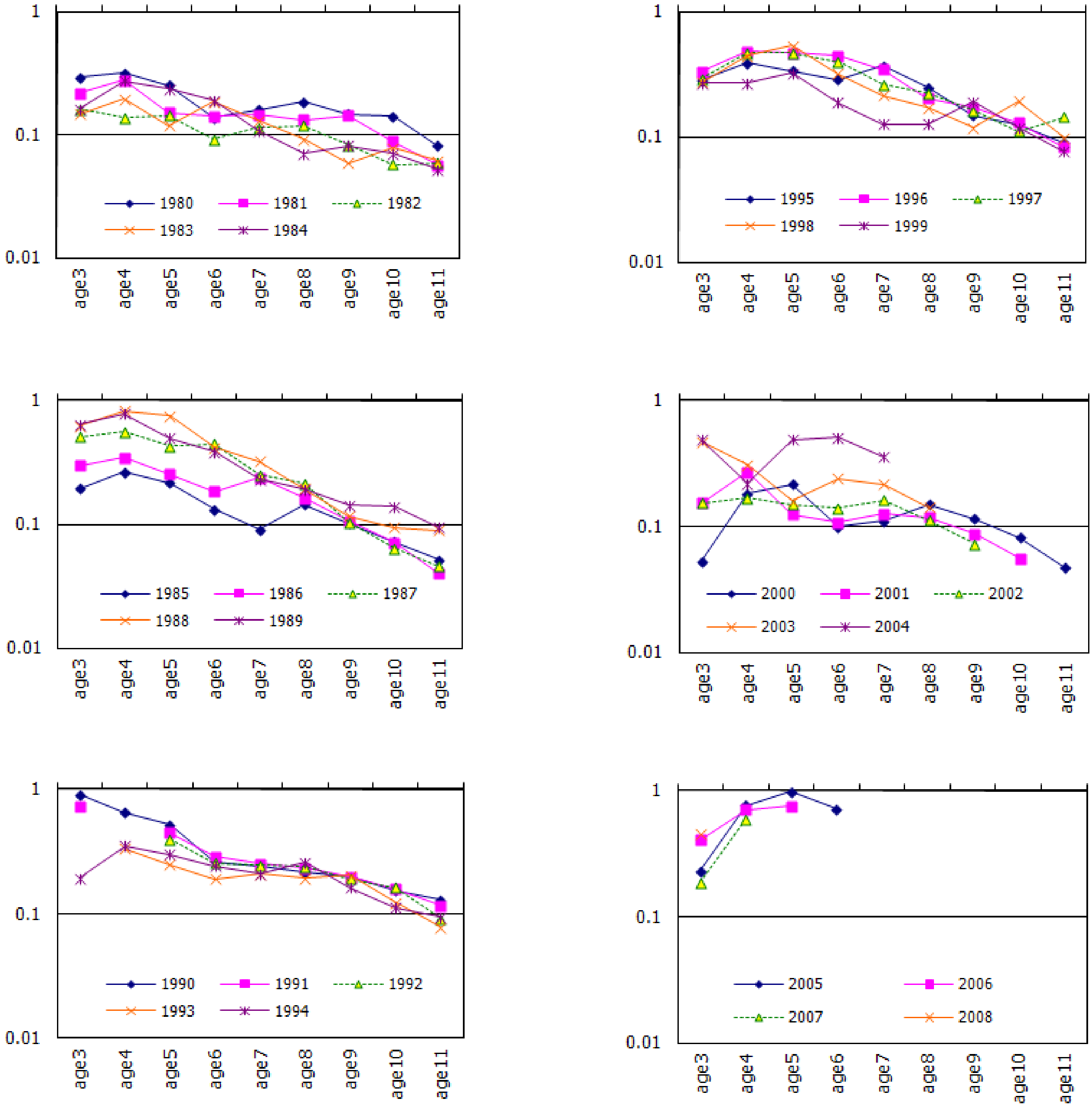


Fig. 1-3. Nominal CPUE of Japanese longline fishery by cohorts in log-scale.

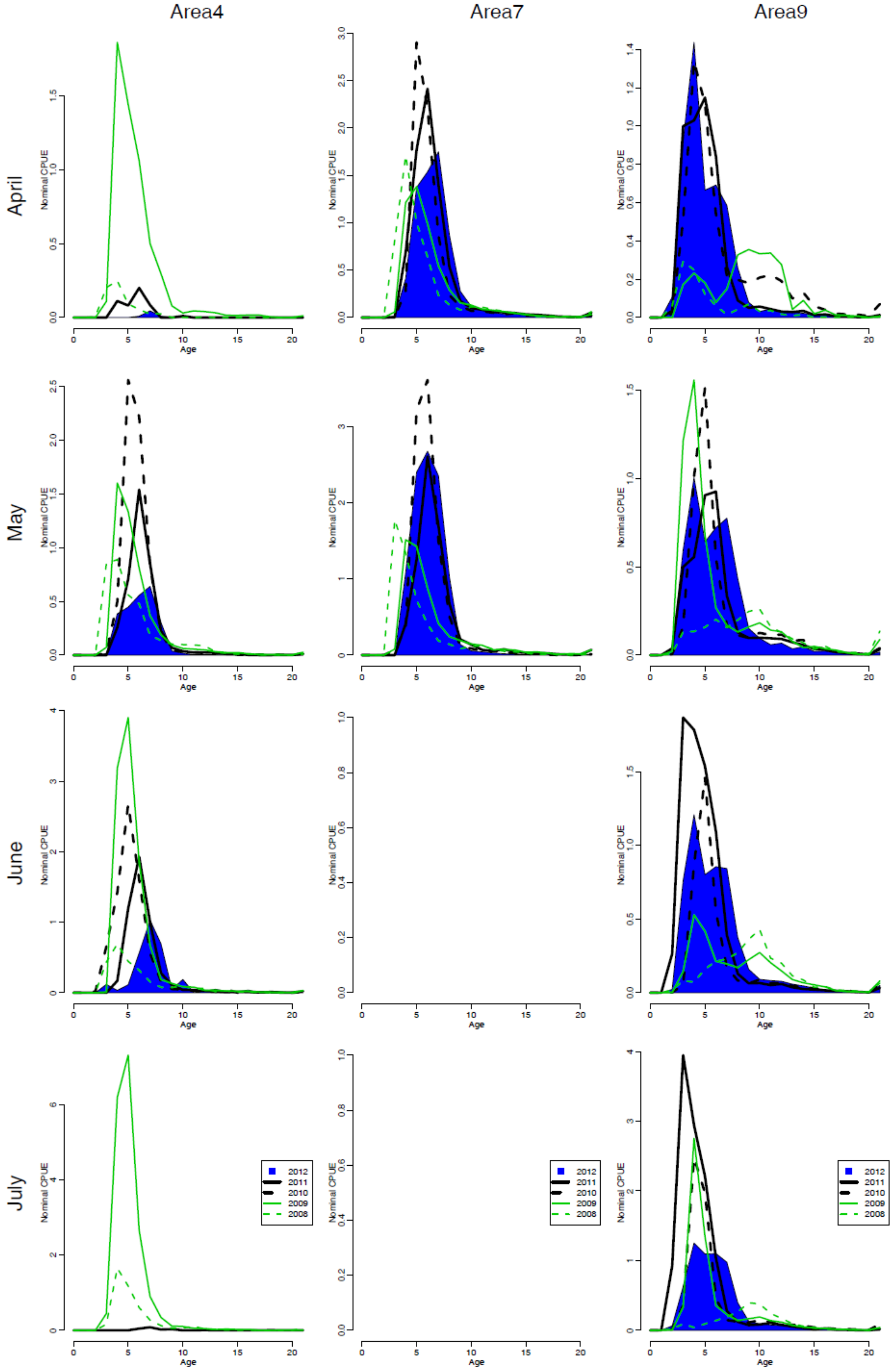


Fig. 1-4. Age composition of nominal CPUE of RTMP data for recent five years by month and areas.

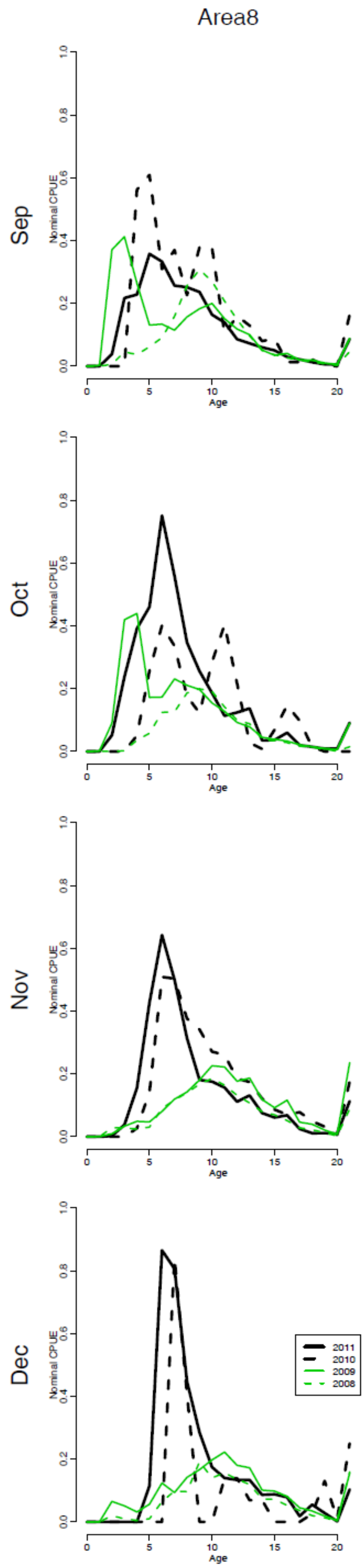
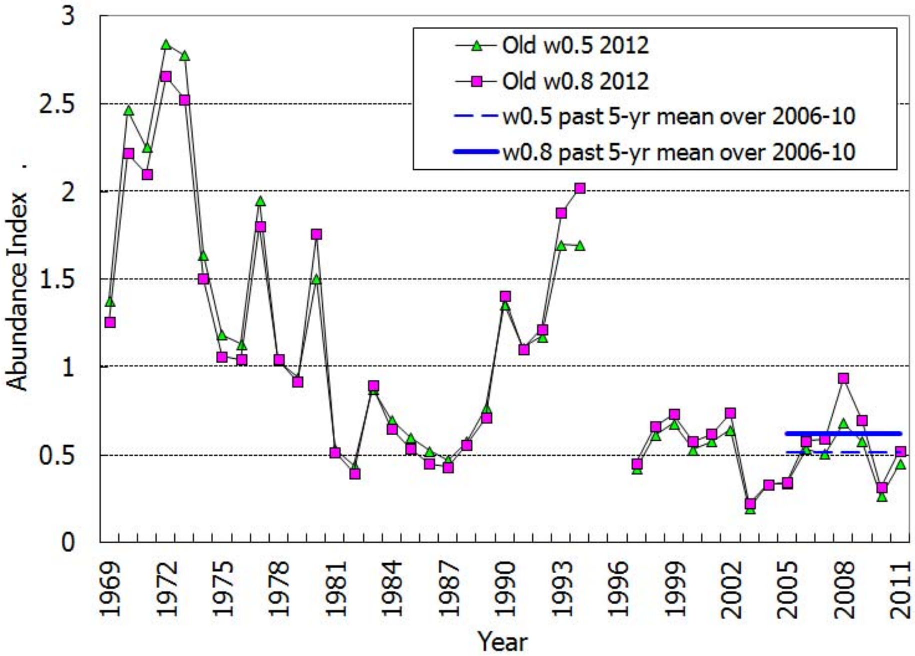


Fig. 1-4 (cont'd). Age composition of nominal CPUE of RTMP data for recent four years by month and areas.

(a) Age 3



(b) Age 4

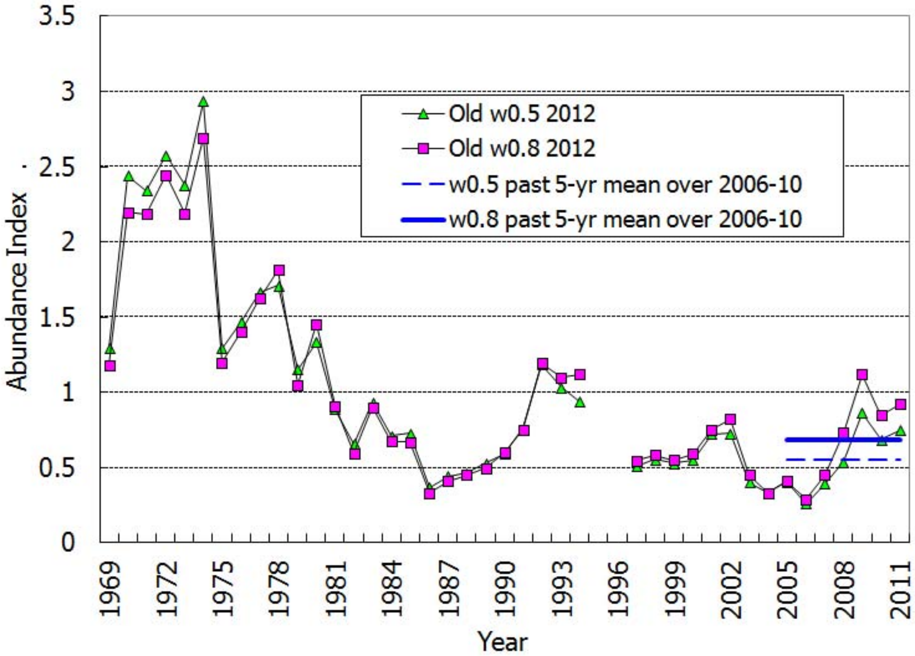
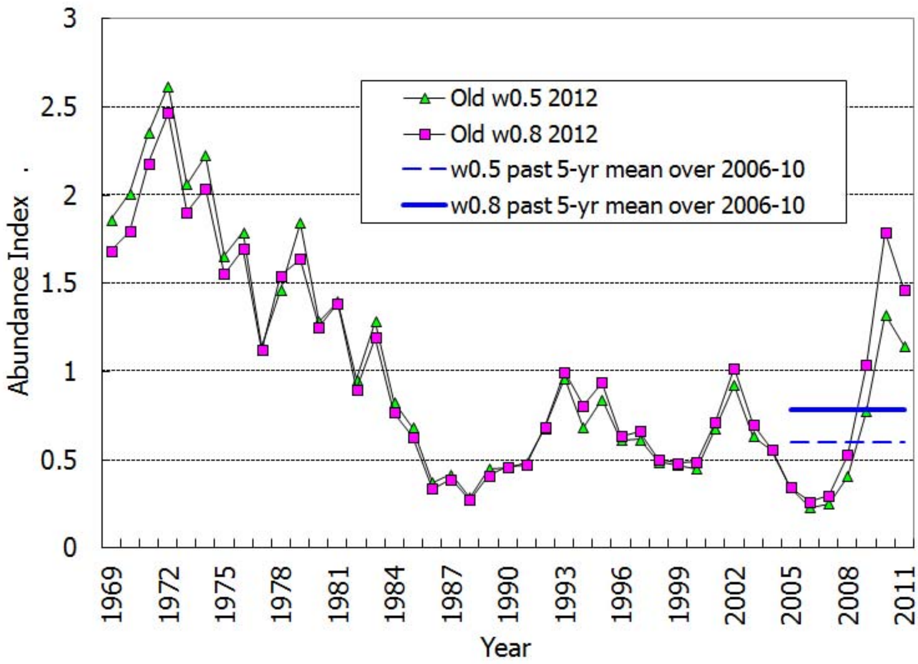


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998).

(c) Age 5



(d) Age 6&7

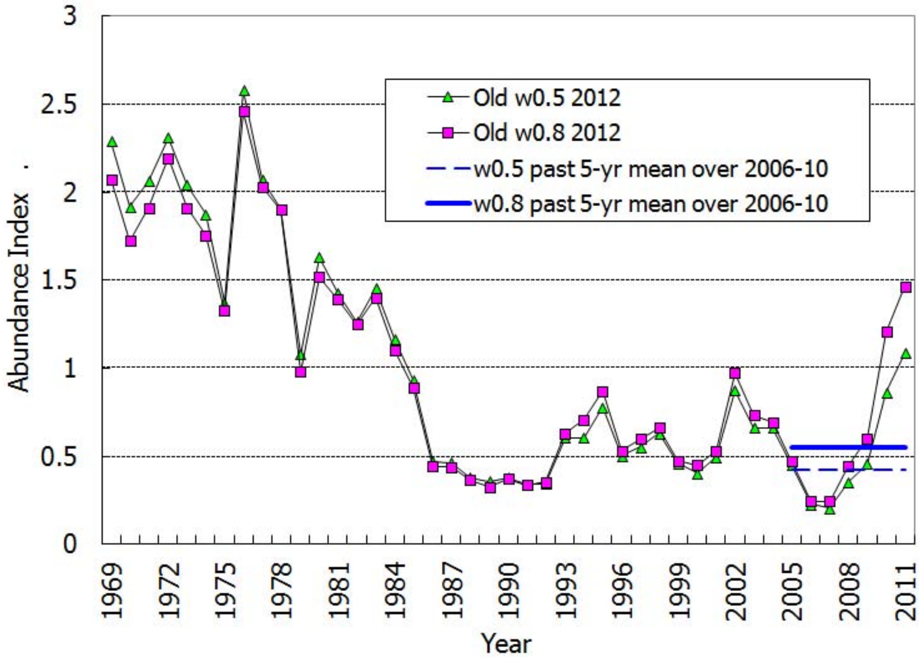
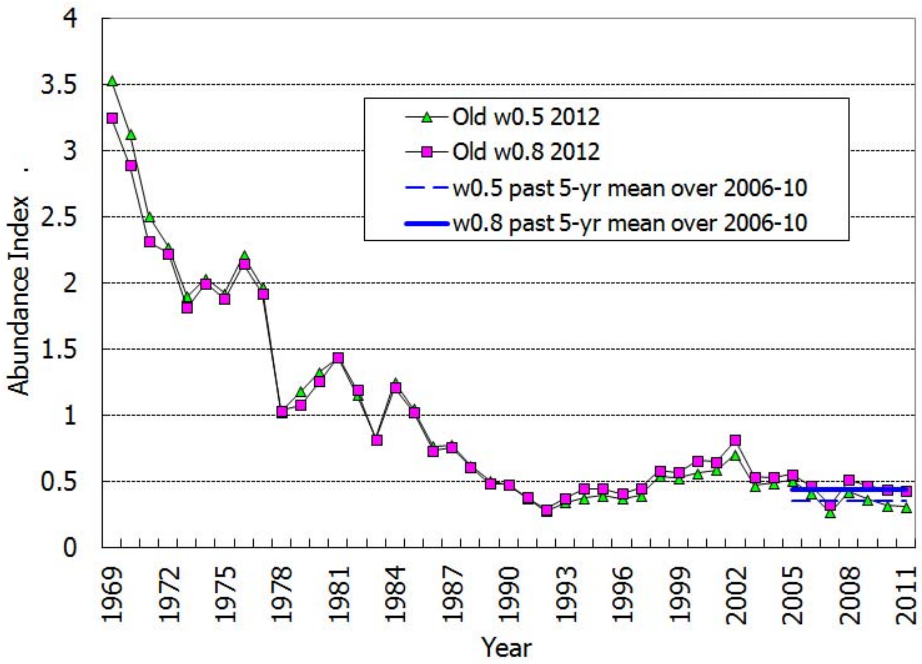


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998). (cont'd)

(e) Age 8-11



(f) Age 12+

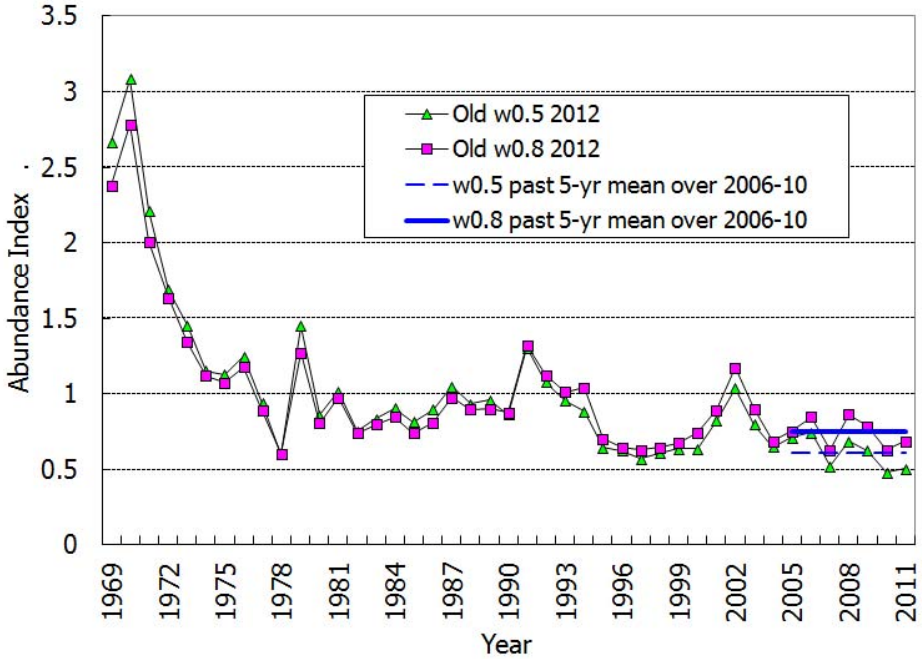


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998). (cont'd)

(g) Age 4+

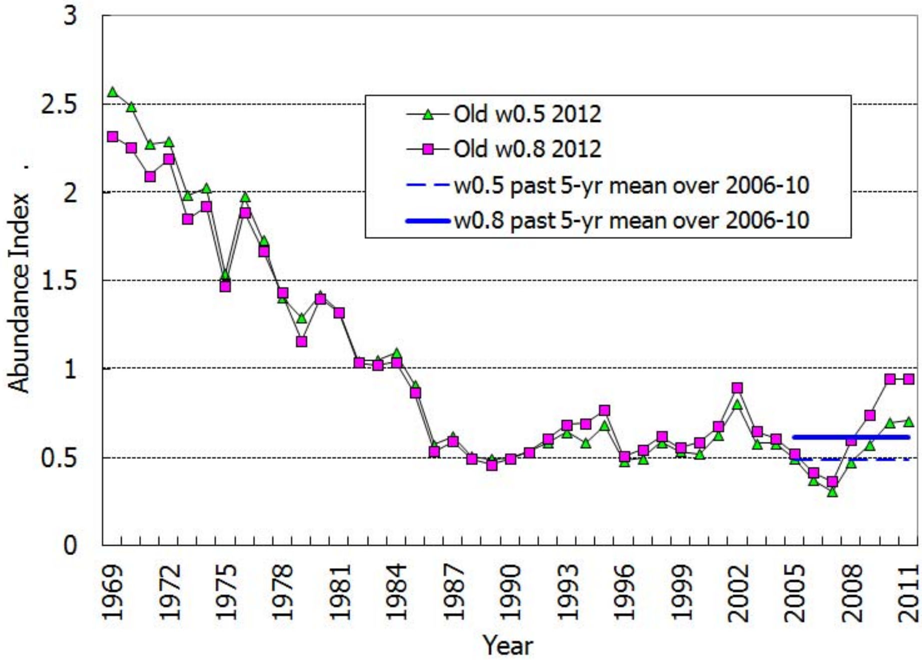
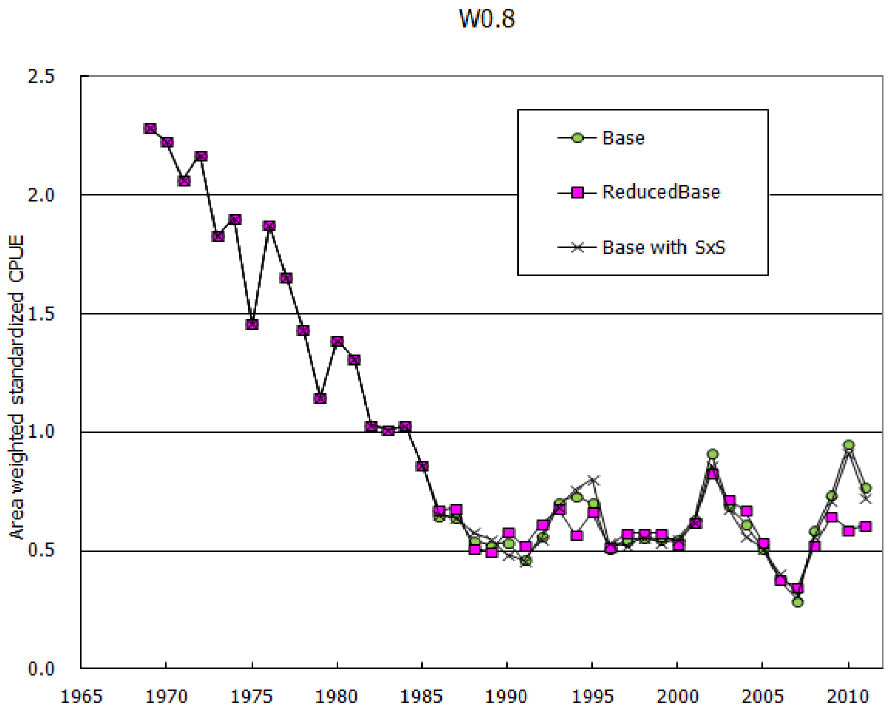


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998). (cont'd)



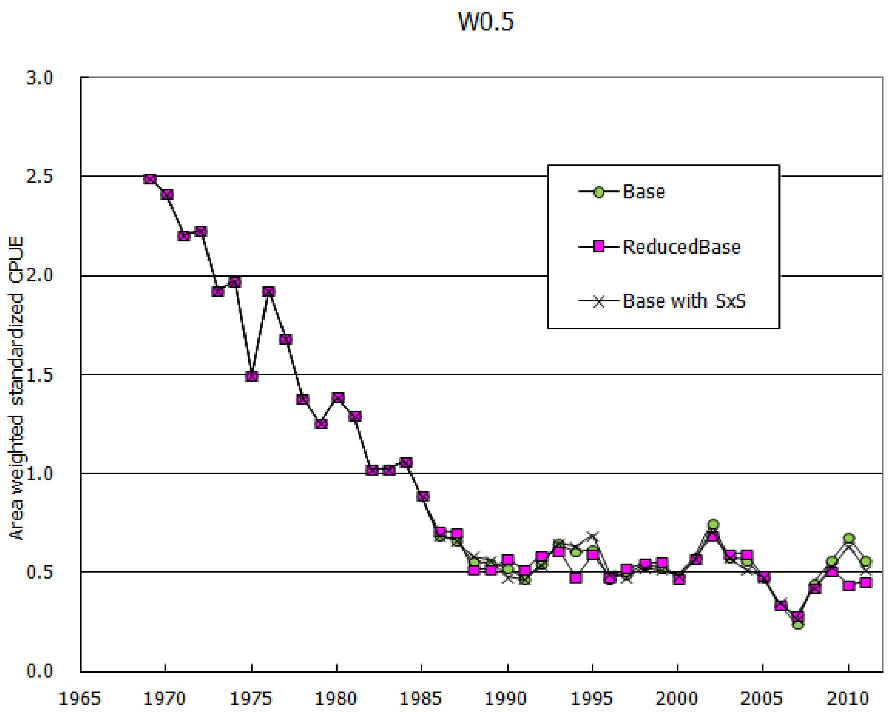


Fig. 1-6. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices using the Core Vessel data (from Itoh 2012b). The standardization models used were the ones agreed in the CPUE Modeling Group (CCSBT 2010).

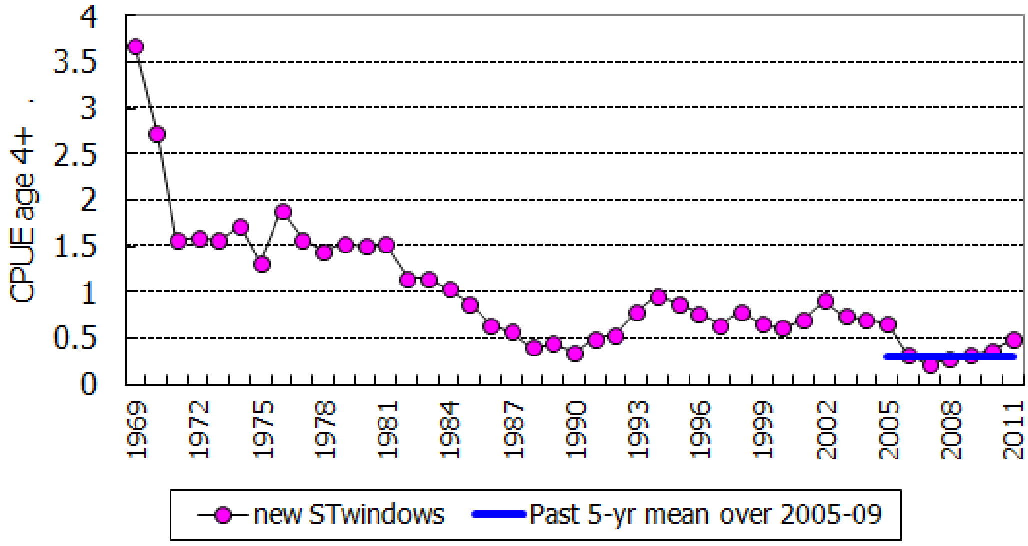


Fig. 1-7. Trend of normalized "ST Windows" index for age 4+ fish by the new calculation method.

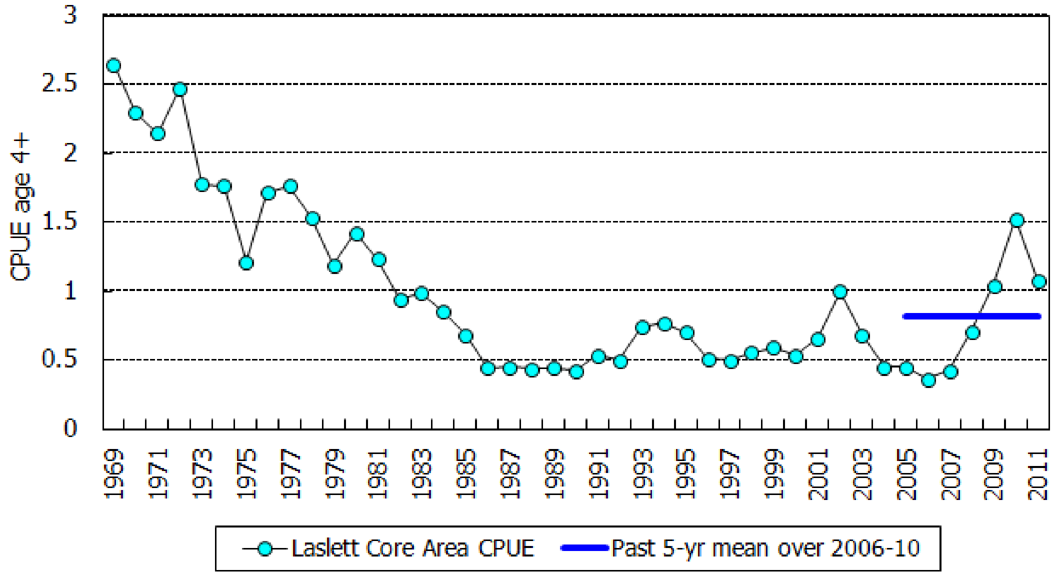


Fig. 1-8. Trend of normalized Laslett Core Area CPUE index for age 4+ fish.

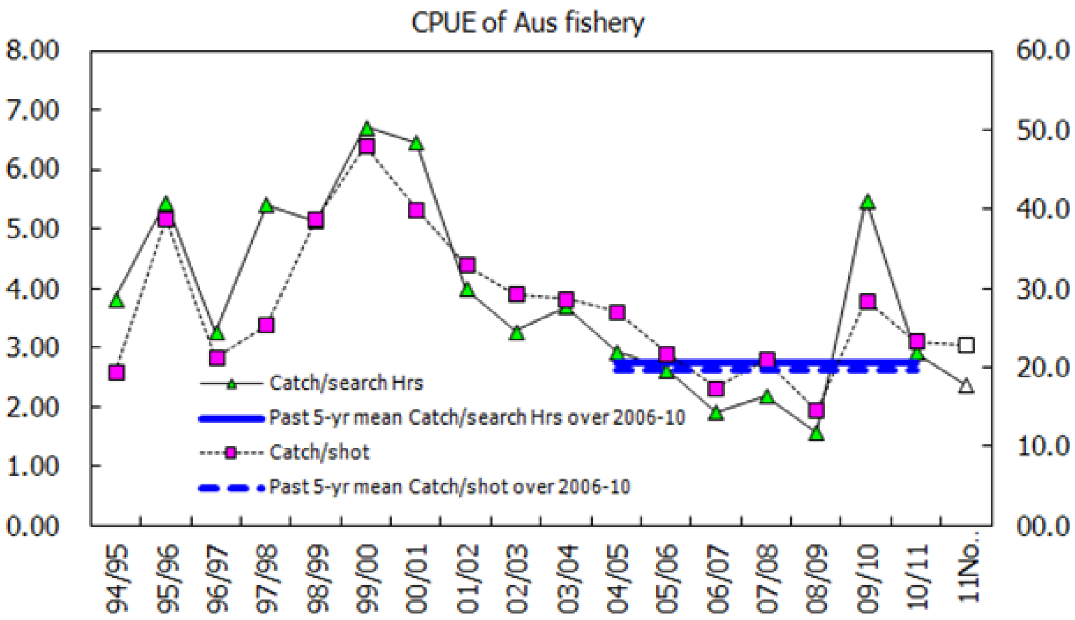


Fig. 2-1 Catch by efforts for Australia purse seine fishery.

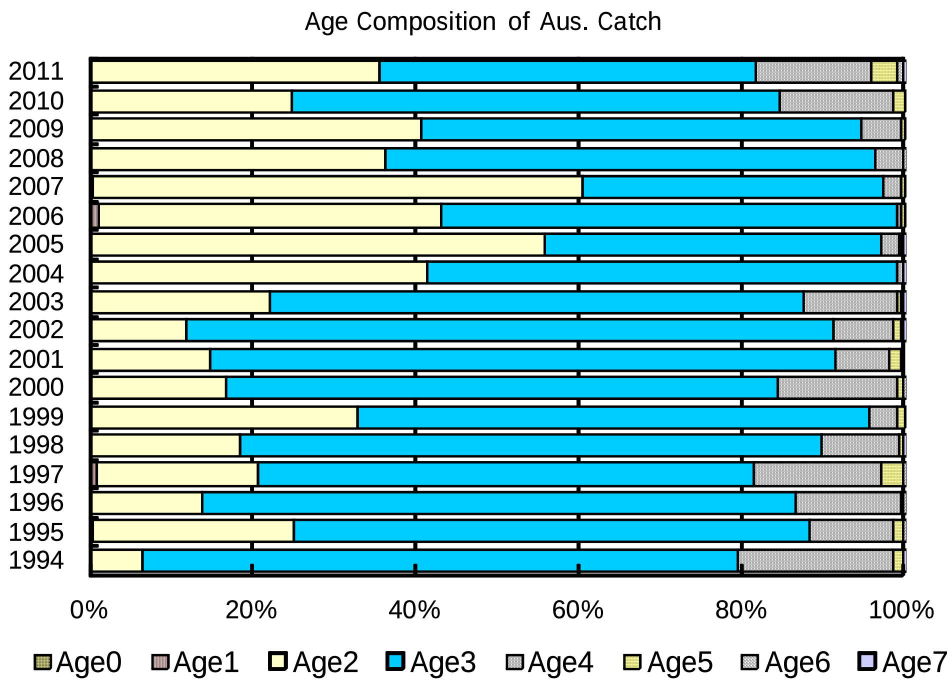


Fig. 2-2 Changes in age composition of Australia purse seine catches.

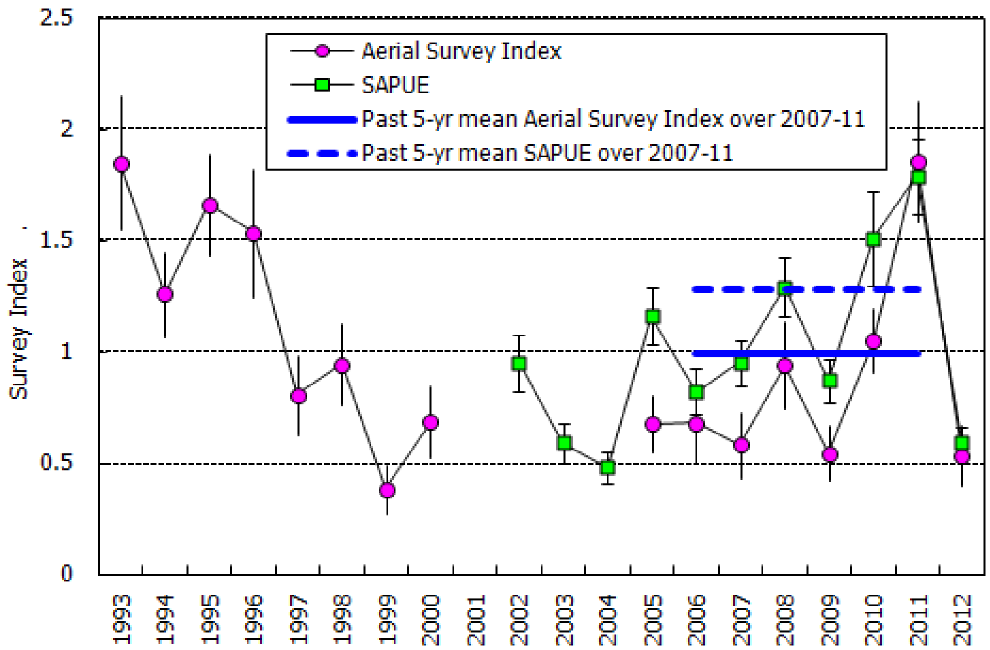


Fig. 2-3 Changes in aerial and commercial spotting (SAPUE) indices in the Great Australian Bight. Vertical bars indicate standard errors.

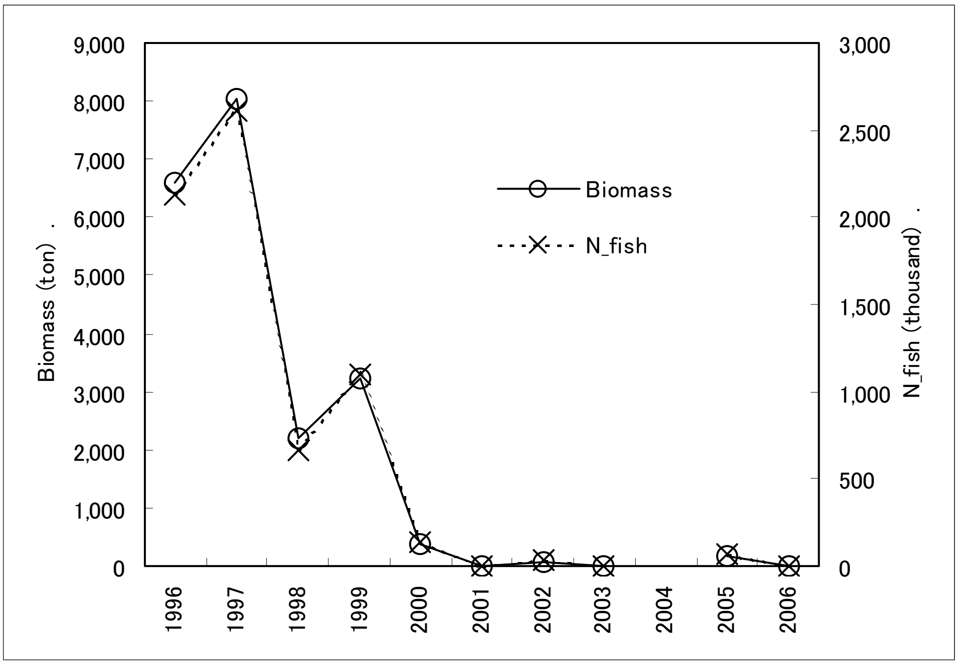


Fig. 3-1. Trends of acoustic index of age 1 SBT in the Western Australia. The acoustic survey ended in the 2005/2006 season (shown as “2006” in the figure).

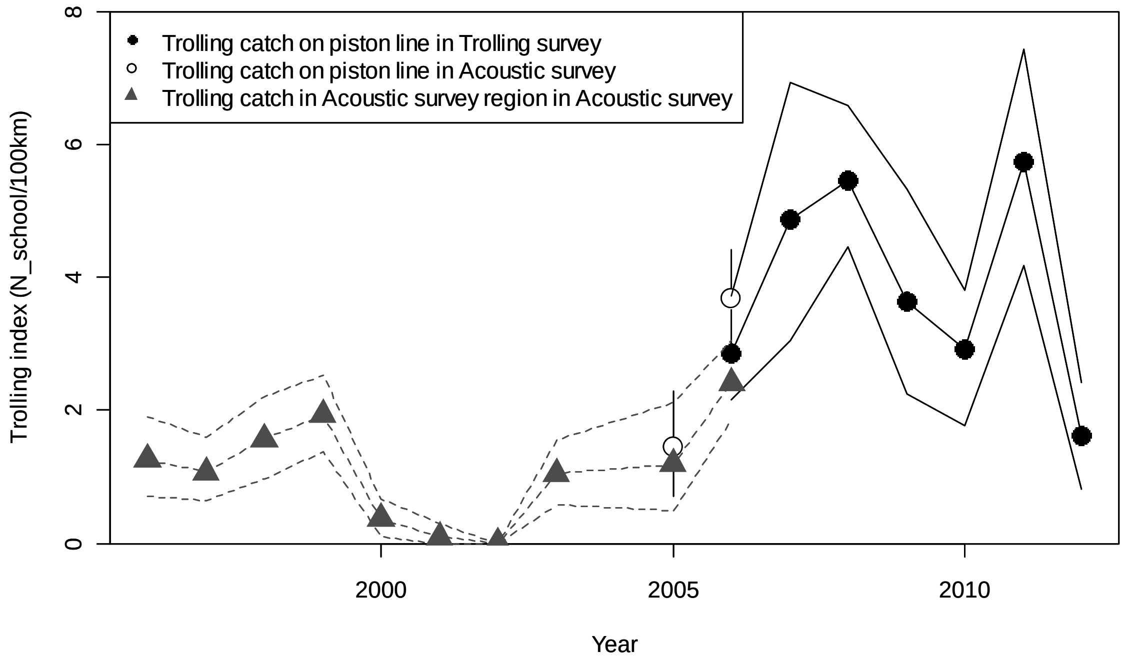


Fig. 3-2. Trends of trolling catch index of age 1 SBT in the Western Australia.

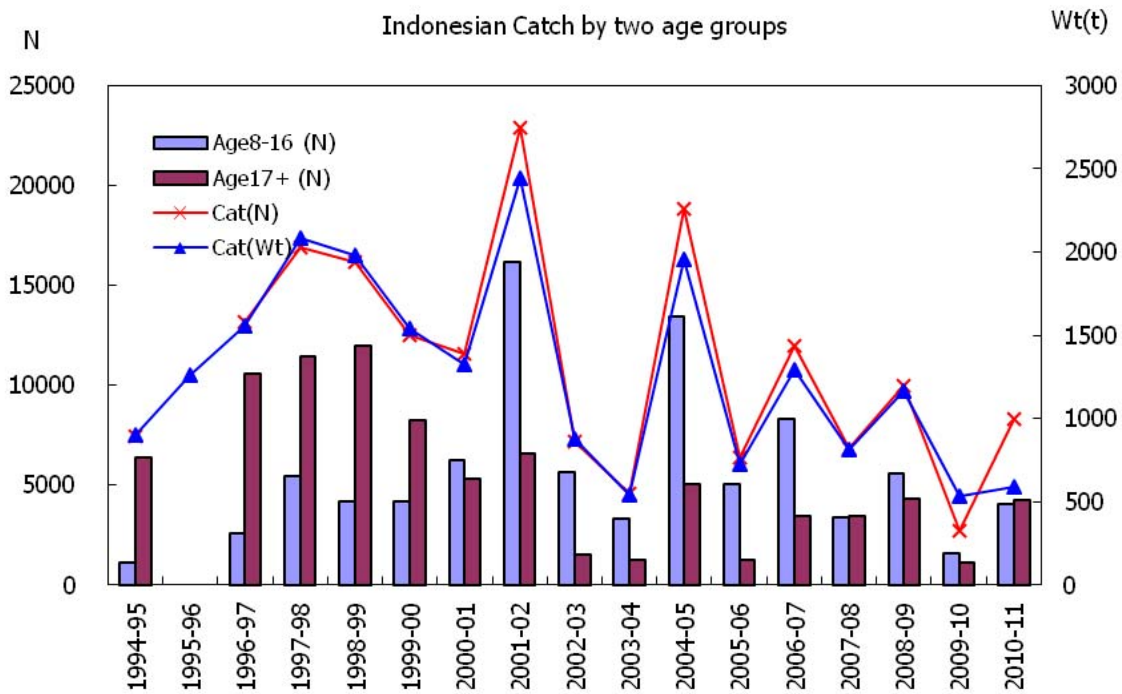


Fig. 4-1. Trends of Indonesian catches with proportion of two age groups occurrences.

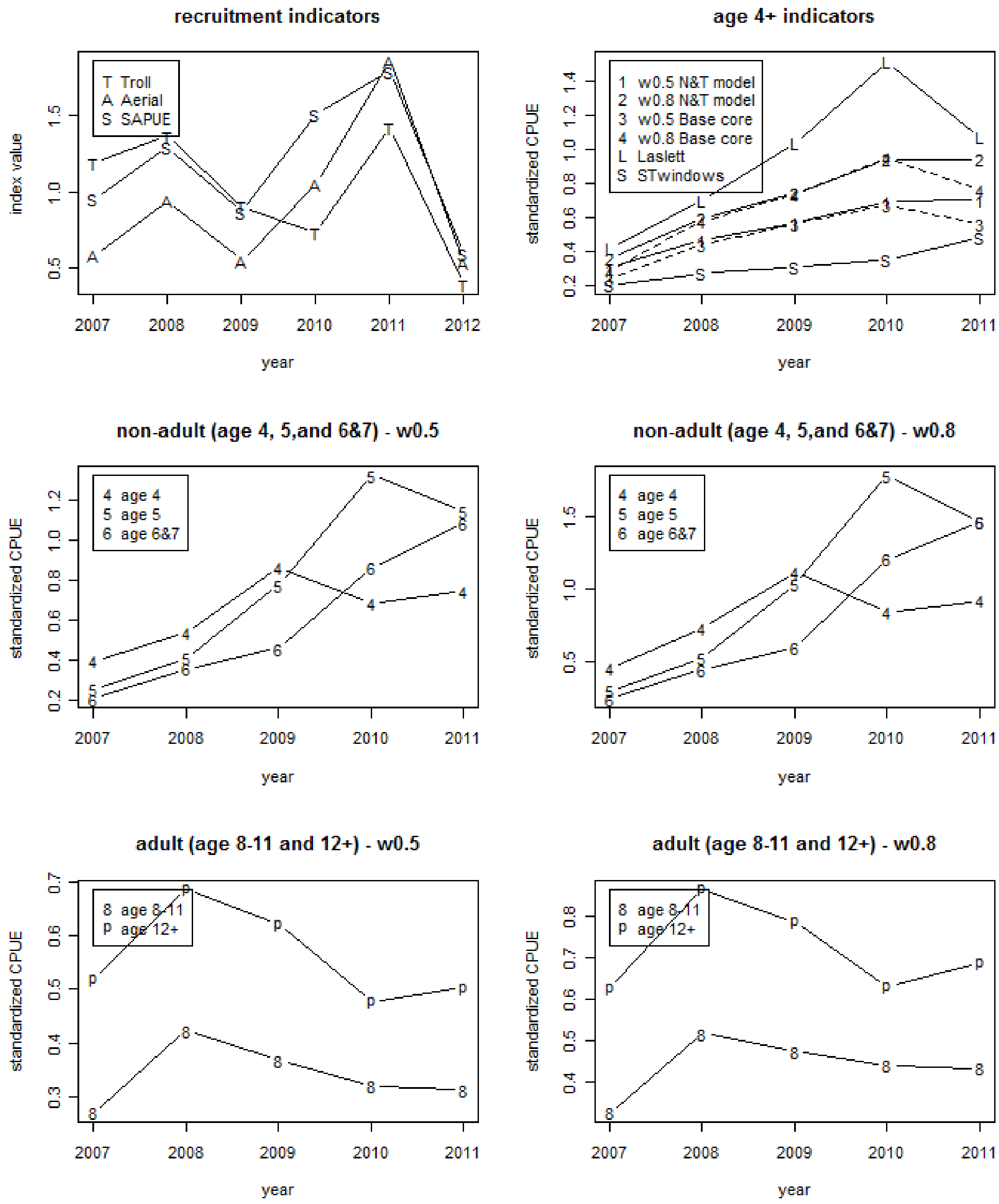


Fig. 5-1. Trends of recruitment surveys and CPUE-based indicators in recent 5 years.