SUMMARY OF FISHERIES INDICATORS IN 2009

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Abstract : Various fisheries indicators were examined to overview the current status of Southern Bluefin tuna stock. The indicators suggest that current stock levels for 4, 5, 6&7 age groups are the same as or lower than those observed in the late 1980s, which are the historically lowest levels. When looking to recent seven years, CPUE indices for these age classes show steadily declining trends, except for showing some upturns in last two years. Other age classes, 3, 8-11, and 12+ tend to increase or keep at the same level after 2003. Current stock levels for these age groups, however, are still at low levels similar to ones observed in past. Many indices indicate recent low recruitments of 1999, 2000, 2001, and 2002 cohorts. This reflects the fact that the acoustic survey indices from Recruitment Monitoring Program (RMP) suggest sequential low recruitments for four years (the 2000-2003 surveys corresponding to the 1999-2002 cohorts). On the other hand, some inconsistencies in recruitment level are observed in comparisons between some fishery-related indictors 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 is observed in the acoustic survey and the trolling survey, the trolling indices for the 2002, 2004 and 2005 cohorts show higher level of recruitment than the acoustic survey indices. The further careful monitoring of recruitments and serious consideration on impacts of potential low recruitments on stock management are continuous tasks with the highest priority. Indices on spawning stock are difficult to interpret and thus no specific conclusion was drawn.

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検討した。現時点での 4、5、6&7 年齢グループの資源状態は、1980 年代後半に見られた歴史的に最低レベルと同じかそれより低い状態にある。最近 7 年間を詳しく見ると、これら年齢クラスの CPUE 指数は、直近の過去 2 年の上昇傾向を除いて、着実な減少傾向を示している。その他の年齢クラスである、3、8-11、12+は、2003 年以降、増加あるいは同じレベルを保っている。しかし、現時点でのこれら年齢グループの資源状態は依然として過去に見られたものと同じ低いレベルにある。多くの指標は 1999、2000、2001、2002 年級の加入が悪いことを示している。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）続けて加入が低いことに対応している。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る。また、1999-2001 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るが、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。今後は、さらに慎重に加入動向をモニターすること、加入の悪化が資源管理にどのような影響を及ぼすかを鋭意検討することの 2 点が重要である。親魚資源指標は解釈が難しく、これといった判断は行わなかった。

The 2001 Scientific Committee 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) meetings to examine whether unexpected changes of stock status requiring 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-related indicators and our overall interpretations. 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 discussion on how information of catch anomalies is used to update CPUE data is still underway in the CCSBT Scientific Committee.

1. Japanese longline CPUE:

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 (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 looked at with caution. However, those differences have decreased gradually and almost no difference is found in recent years because the RTMP covers more than 95% of efforts in SBT distribution.

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 (2009) and Sakai et al. (2009).

When focusing on trends for the recent five or six years, nominal CPUE for age classes, 4, 5 and 6&7 decline to almost the same lowest levels observed in past (the late 1980s to the early 1990s). In last two years, the CPUE for these age classes slightly increase or stay at the same level as the previous year. CPUE for age 3 shows substantial decrease to the historically lowest level in 2003, and then continues to increase afterwards except for the most recent year. A drastic increase for this age is observed from 2005 to 2007. CPUE trends for age groups 8-11 and 12+ have been more or less stable at the low level since the late 1990s, except that there are some upturns observed in the most recent year.

Trends of nominal CPUE of Japanese longline by cohort were plotted in Fig. 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 show consistent trends, suggesting that age 3 CPUE could be used as an indicator of relative cohort strength, although a large decline of 1999 cohort (2000 acoustic survey in Fig. 3-1) was not be able to detected by age 3 CPUE (Fig. 1-2).

Overall levels of CPUE by cohort after 1990 are higher than that of cohorts recruited in pre1990 years, except for 1999, 2000, 2001, and 2002 cohorts (Fig. 1-3). The 1986-1991 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 pre1986 years and less structured management schemes at that time. The cohorts recruited from1992 to 1999 show slower decline rates, suggesting a reduced level of exploitation rates for these cohorts. Fig. 1-3 also indicates acute decline of age 3 fish in the recent years to about the same or lower levels comparable to those experienced by the early 1980s cohorts, except for 2003 and 2004 (see also Recruitments section below). Cause(s) for these weak cohorts is still unknown, whether it be a reflection of oceanographic/fish availability changes or it be an indication of a consequence of fishing pressure. However, a lack of small fish in the recent years may eventually lead to an increase of number of large fish caught under the same amount of quota allocation. This indicator should continue to be carefully monitored every year.

Age compositions of nominal CPUE obtained from RTMP were plotted in Fig. 1-4. Recent seven years (six years for Area 8) data are shown for comparison. Although there are some exceptions, substantial CPUE reductions of age 4 and younger fish are detected in 2003-2006, especially in Area 4 and 7, e.g. Australian coast. Declines of such small fish are much less distinct in Area 9 (off Cape area) for the same period. But, in contrast, disappearance of the small fish in Area 9 becomes somewhat apparent in 2008. These fish showing the considerable CPUE reduction in 2003-2006 correspond to the same cohort that the acoustic monitoring survey had detected drastic declines of recruitment level since 2000 (see Fig. 3-1). Reflecting such decreases of the small fish CPUE, reductions of corresponded CPUE for medium size fish (e.g., age 5-8) are detected in later years (2003-2007) in Area 4 and 7. Similar patterns of the CPUE declines are not observed in Area 8.

Increases of CPUE for around age 3 to 5 fish are observed in 2006-2008. These CPUE values are noticeably high relative to previous years in Area 4/May to July, Area 7/April to July, Area 9/April, May, and July, and Area 8/September. Whether these increases of CPUE for small fish reflect recovery of recruitment or influence of operation pattern by introduction of IQ system still remains unknown.

<u>Standardized CPUE</u>

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). Estimates of CPUE indices for 2008 (the most recent year) were based on RTMP data only not on logbook, 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 next year. Further, as mentioned above, recent years' CPUE must be examined carefully because Japanese longline fishery has introduced IQ system since 2006.

The w0.5 and w0.8 series calculated for the previous SAG meeting are also plotted in Fig. 1-5 for comparison. There were no apparent differences found between the two series of 2007 and 2008.

Looking to trends of the recent six or seven years, the w0.5 and w0.8 indices for age 3 largely decline to the historically lowest level in 2003 (Fig.1-5a). Then the two indices increase afterwards. These upturns for age 3 somewhat inconsistently correspond to low recruitments of 2004 and 2005 cohorts observed respectively in the 2005 and 2006 acoustic survey of the Recruitment Monitoring Program (RMP) (see Fig. 3-1). Trends for the age 4 indices keep more or less the same levels between 2003 and 2006 after a notably decrease to the 1986 low level in 2003 , and then increase afterwards (Fig. 1-5b). The historical lowest indices are the ones seen in 2006. Low index values for age 4 observed in 2003-2006 correspond to extreme low recruitment (1999, 2000, 2001, and 2002 cohorts) observed in the acoustic survey of the Recruitment Monitoring Program (RMP) conducted in 2000-2003, respectively (see Fig. 3-1). The acoustic survey was not conducted in 2004 corresponding to the 2003 cohort (Fig. 3-1). However, index values for age 3 in 2006 and for age 4 in 2007 suggests a possibility that, although its recruitment level is still low, 2003 cohort is not so weak as that of 1999-2002, showing some upturns (Fig. 1-5a and b). Furthermore, the similar increase patterns are observed for age 4 in 2008 and for age 3 in 2007 and 2008 corresponding to the 2004 and 2005 cohort (Fig. 1-5a and b) while the acoustic surveys conducted in 2005 and 2006 show extremely low indices (Fig. 3-1). The indices for age 3 in 2002 were not be able to detect a low recruitment (1999 cohort) observed in the 2000 acoustic survey whereas this low recruitment was detected by a substantial drop of age 4 indices in 2003 (Fig.1-5a and b). The CPUE indices for 5 and 6&7 age groups steadily decline from 2002 to 2006, and then stay more or less at the same low level in 2007, which the same as or lower than the historical low levels observed in the late 1980s (Fig. 1-5c and d). Some upturns of these indices are observed in 2008. The low recruitments observed in the 2000, 2001, 2002, and 2003 acoustic survey (1999, 2000, 2001, and 2002 cohorts) correspond to these low index values in 2004-2008 (see Fig. 3-1). Trends of CPUE for age 8-11 keep at the same level for last several years except for 2007 (Fig. 1-5e). The CPUE indices for age 12+ gradually increased during 2004-2006 after declining to the historical low levels from 2002 to 2004 as same as ones in the late 1990s (Fig. 1-5f). In 2007, again, the indices decrease back to low levels, and then increase in 2008.

The CPUE indices for age 4+ group continuously decrease from 2002 to 2007 toward the lower level than the historical low levels observed in the late 1980s (Fig. 1-5g). Some drastic upturn is observed in 2008.

In summary, only the w0.5 and w0.8 CPUE series for age groups 3 show increase trends in recent years. Other age groups' indices are decreasing to or staying at the historically lowest levels. These tendencies are also observed in both nominal CPUE and ST windows (for age 4+, explained below).

Spatial-Temporal (ST) windows CPUE and Laslett Core Area 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" 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. A trend of the "ST windows" is shown in Fig. 1-6. The updated index more or less keeps the same level ranging between 0.5-1.0 index values from 1992 to 2005. For the last three years, the index stays at lower level than the historical low levels as in the late 1980s.

"Laslett Core Area" is another concept, based upon different criteria from ST windows, 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 applying smoothing splines (Laslett 2001). Trend of the Laslett Core Area CPUE shows almost the identical pattern to that of w0.5 and w0.8 indices for age 4+ (Fig. 1-5g and Fig. 1-7).

2. Australia surface fishery:

Changes of catch per efforts and age composition of Australia surface fishery catches are plotted in Fig. 2-1 and 2-2. Although interpretation of catch per efforts of the surface 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 appear to be gradually declining from 1999/00 to 2007/08 seasons (Fig. 2-1). This decline of juvenile probably corresponds to recent low recruitments that were observed in the acoustic survey index and Japanese longline CPUE (see Fig. 1-1, 1-4, and 1-5 for the longline, and Fig.3-1 for the acoustic survey).

Proportions for age 1 and 2 fish aggregated for the recent four years (2005-2008) are greater than any for previous years (Fig. 2-2). Contrary, proportions for age 3 decrease for the same years except for 2008. A small proportion for age 1 appears in 2005-2008 while there was no age 1 fish appeared during 2002-2004. In 2004-2008, proportions of age 4 are low relative to past years. Other than that, no strong signal was observed in age composition of surface catches.

Trends of both the aerial and commercial spotting (SAPUE) survey indices in the Great

Australian Bight (GAB) are shown in Fig. 2-3 (Basson and Farley 2009, Eveson et al. 2009). 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 (RMP) since 1993. Estimates of the aerial survey index for previous years are different than those provided last year probably because the analysis methods have changed (Eveson et al. 2009). 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 shows moderately declining trend throughout the survey period. The index values are more or less stable in recent years. An overall trend of SAPUE appears to be increasing slightly during 2002-2008 period.

Indicators obtained from Australian surface fishery suggest moderate decline of juvenile abundance in the GAB. However no considerable sign was observed to indicate drastic decrease of juvenile abundance such as that observed longline-related indicators and acoustic survey index.

3. Recruitments:

Acoustic survey

Acoustic survey of the Recruitment Monitoring Program (RMP) is aimed to monitor changes in relative abundances of age 1 fish moving through the survey area in the southwestern coast of Australia. This index represents 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 level in 2002 with a very slight upturn from 2001 level, then became non-estimative level 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 extreme low abundance levels in the 2000, 2001, 2002, 2003, 2005, and 2006 surveys are now available to Japanese longline fishery and mostly showing substantially low CPUE (see Fig. 1-1, 1-4 , and 1-5). If the recruitment trend detected by the acoustic survey reflects the real situation, we expect possibly six years' low recruitments to come in sequence. This must cause devastative impacts on both SBT stock and longline fishery. However, there is some inconsistency observed for 2004 and 2005 cohorts. CPUE indices for age 3 in 2007 and for age 4 in 2008 are apparently at the same levels of that of the late 1990's and the early 2000's (Fig. 1-5a and b) whereas the 2005 acoustic survey index indicates low recruitment (Fig. 3-1). The similar pattern was observed in a comparison between CPUE indices for age 3 in 2008 and the 2006 acoustic index (Fig. 1-5a and 3-1). Further, although we tend to assume that 2003 cohort (not acoustic-surveyed) is similarly weak because the acoustic survey indices of previous and following years' indicate low recruitments (Fig. 3-1), corresponding CPUE for age3 in 2006 and for age 4 in 2007 show upturns (Fig. 1-5a and b), suggesting that the 2003 cohort may not be so weak as the others. Thus, considering such uncertainty about recruitment we need to monitor these indicators synthetically and carefully for next several years.

The RMP acoustic survey ended in the 2005/2006 season due to budget matter and is 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 RMP acoustic survey, a recruitment index of age 1 fish estimated from results of much lower-cost trolling surveys has been currently being developed. Details of survey design, estimation method, results and its interpretation are documented in Itoh (2007) and Itoh and Sakai (2009). Fig. 3-2 illustrates trends of the trolling catch indices. Cohorts of 1999, 2000, and 2001 (2000, 2001, and 2002 surveys) show considerably low levels of recruitment. These low recruitment levels are consistent with the ones observed in results of the acoustic surveys (see Fig. 3-1). In contrast, the trolling indices for 2002, 2004, and 2005 cohorts (2003, 2005, and 2006 surveys) inconsistently show higher levels of recruitment than the acoustic survey does. However, increased levels of the 2004 and 2005 cohorts are compatible with upturns observed in longline-related indices for age 3 fish in 2007 and 2008 and for age 4 in 2008 (see Fig. 1-5a and b). Trends of the trolling catch indices are increasing from 2005 to 2008. No survey was conducted in 2004, so any speculation on recruitment status of 2003 cohort cannot be drawn from the trolling catch index.

Levels of trolling indices are consistent with that of other indices (e.g., acoustic indices, Japanese longline CPUE) for some years. Thus, some usefulness of the indices to monitor age 1 recruitment is 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 one such as "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, changes between years (Fig. 4-1).

A marked increase of catch in 2001/02 season may mainly be due to large increase of younger age classes. Then, catches drastically decline in 2002/03 and 2003/04 seasons without change in the age composition pattern for 2001/02. No information available to conclude whether this decline reflected changes in fish abundance or changes in fishing practices. In 2004/05 season, another large increase of catch occurred, similar to that observed in 2001/02. Again catch dropped in 2005/06 and increased to some extent in 2006/07. Low levels of the older portion of spawning stock in recent years and potentially low reproduction give some concerns.

5. Overall Conclusion:

Fisheries indicators examined generally support a view that current stock levels for 4, 5, 6&7 age groups are the same as or lower than that observed in the late 1980s, which are the historically lowest levels. Looking at recent seven years, CPUE indices for these age classes show steadily declining trends, except for showing some upturns in last two years. Other age classes, 3, 8-11, and 12+ tend to increase or keep at the same level after 2003. Current stock levels for these age groups, however, are still low similar to ones observed in past. Many indicators suggest recent low recruitments but differ in indication of how low they would be. The acoustic indices suggest continuous low recruitments for four years (the 2000-2003 acoustic surveys corresponding to the 1999-2002 cohorts). Agreed with these results of the surveys, longline fishery-related indicators suggest considerable decline of recruitments of 1999, 2000, 2001, and 2002 cohorts. However, there are 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). Thus, further careful monitoring of recruitments and serious consideration on impacts of the potential low recruitments on stock management are continuous tasks with the highest priority.

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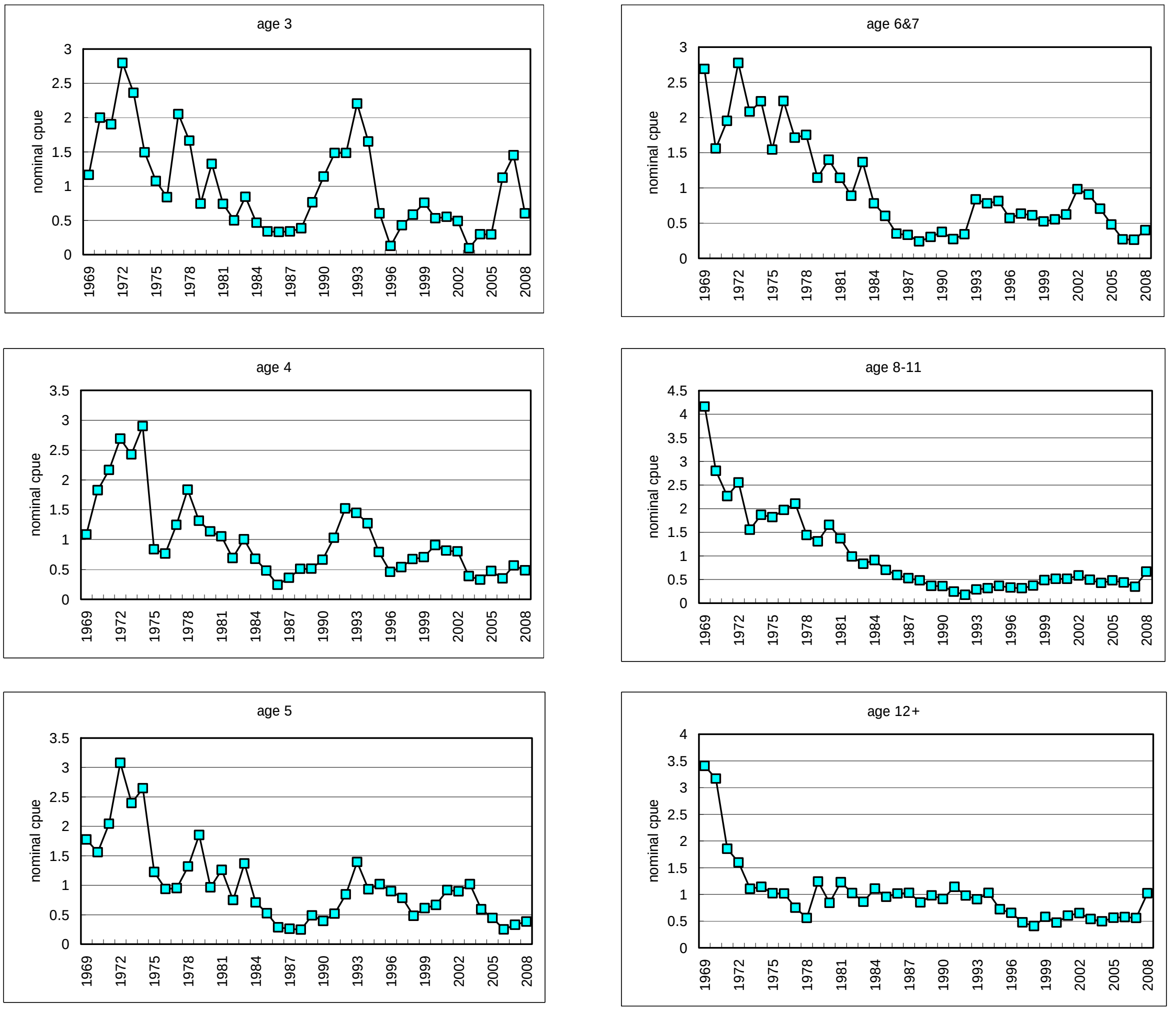


Fig. 1-1. Nominal CPUE of Japanese longline fishery by age groups.

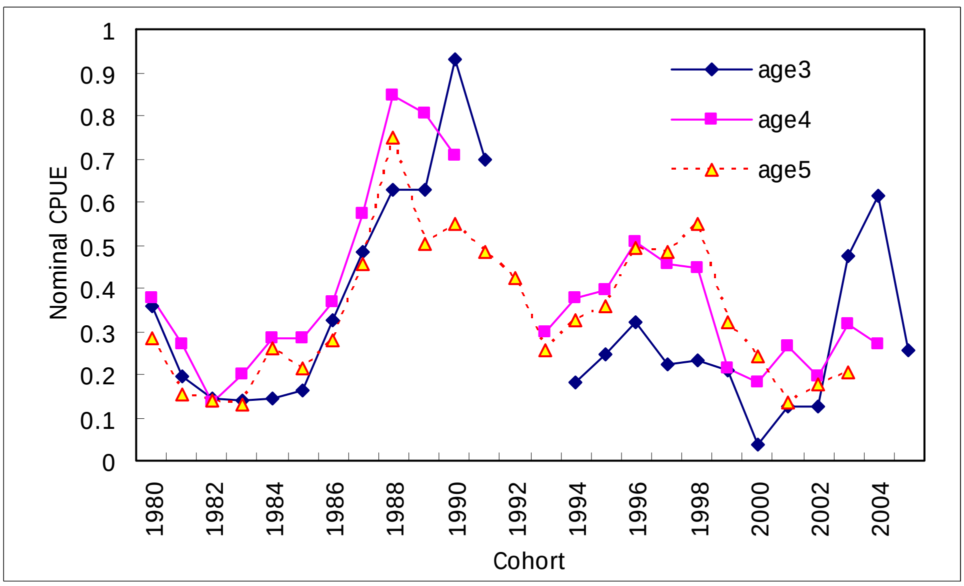


Fig. 1-2. Nominal CPUE of Japanese longline fishery by cohorts for age 3, 4, and 5.

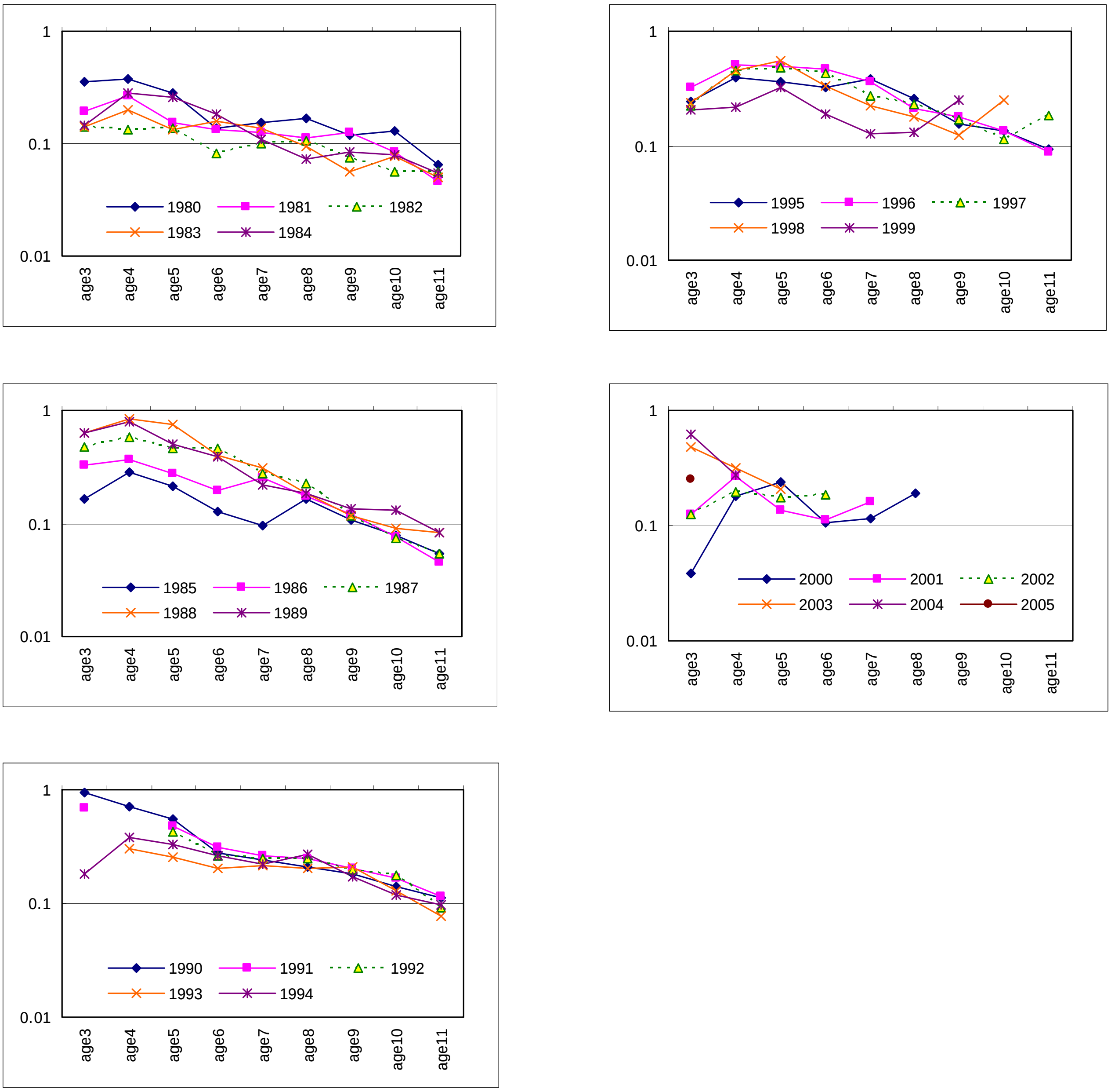


Fig. 1-3. Nominal CPUE of Japanese longline fishery by cohorts in log-scale.

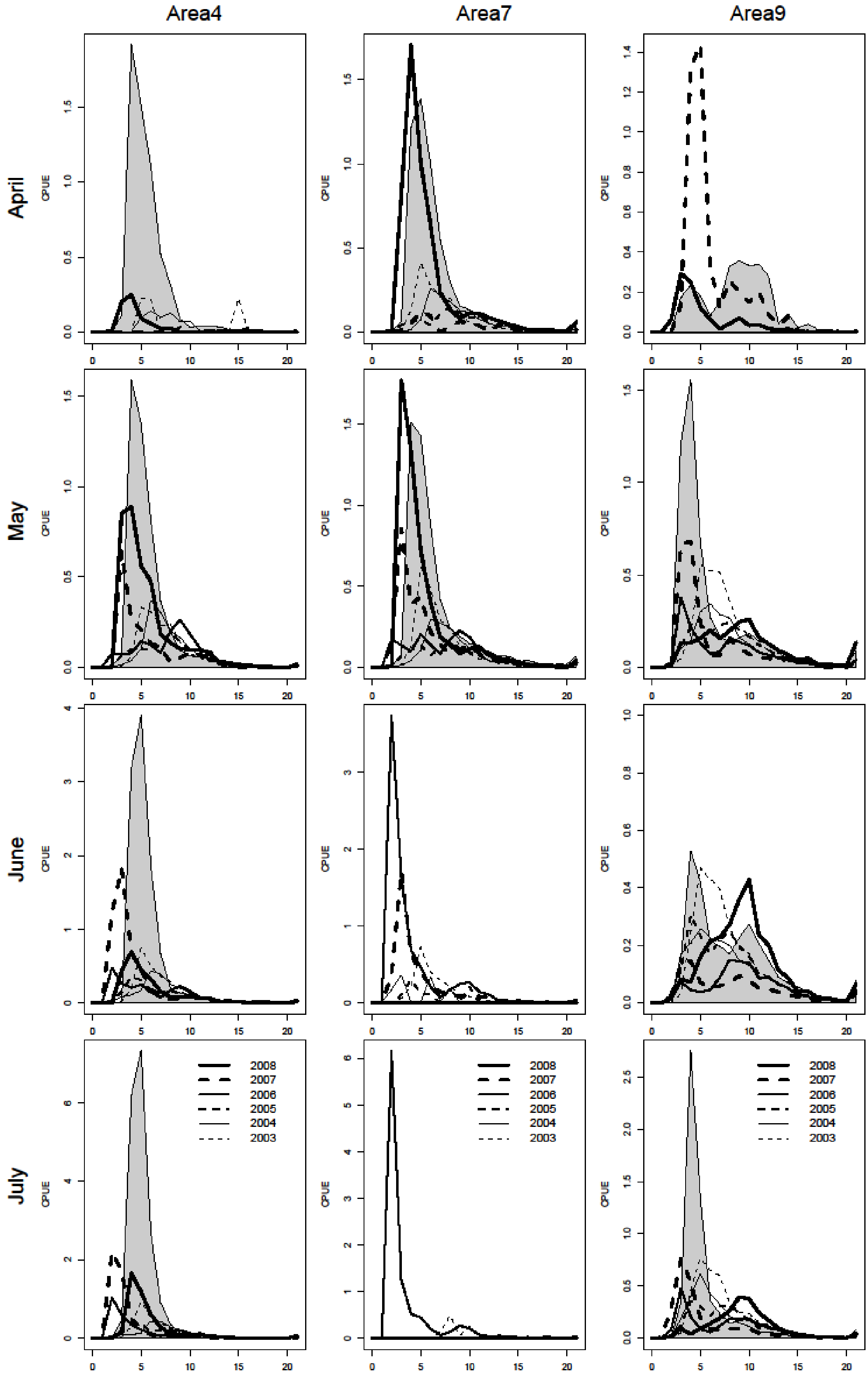


Fig. 1-4. Age composition of nominal CPUE of RTMP data for recent seven years by month and areas. Note that x-axes are age and shaded portions represent the year 2009.

Area 8

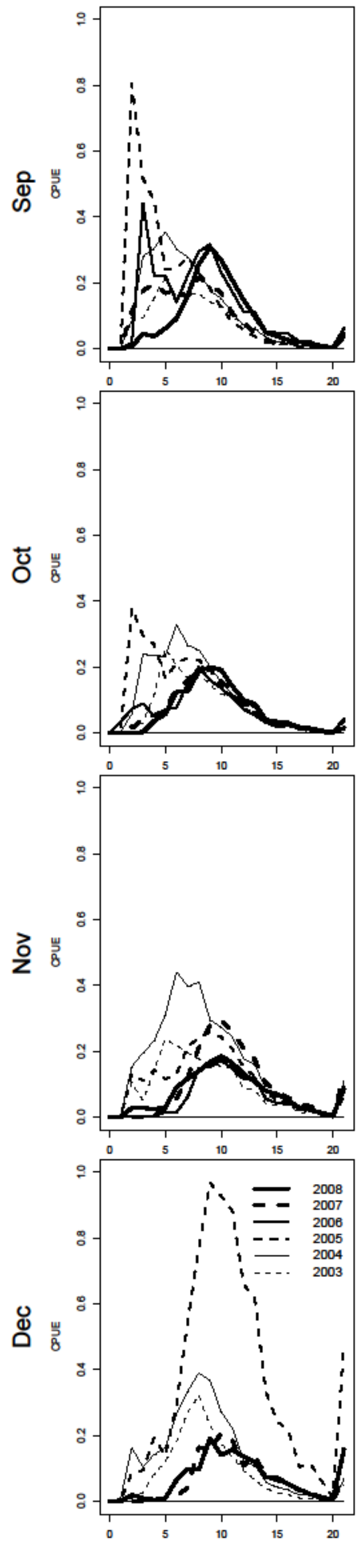
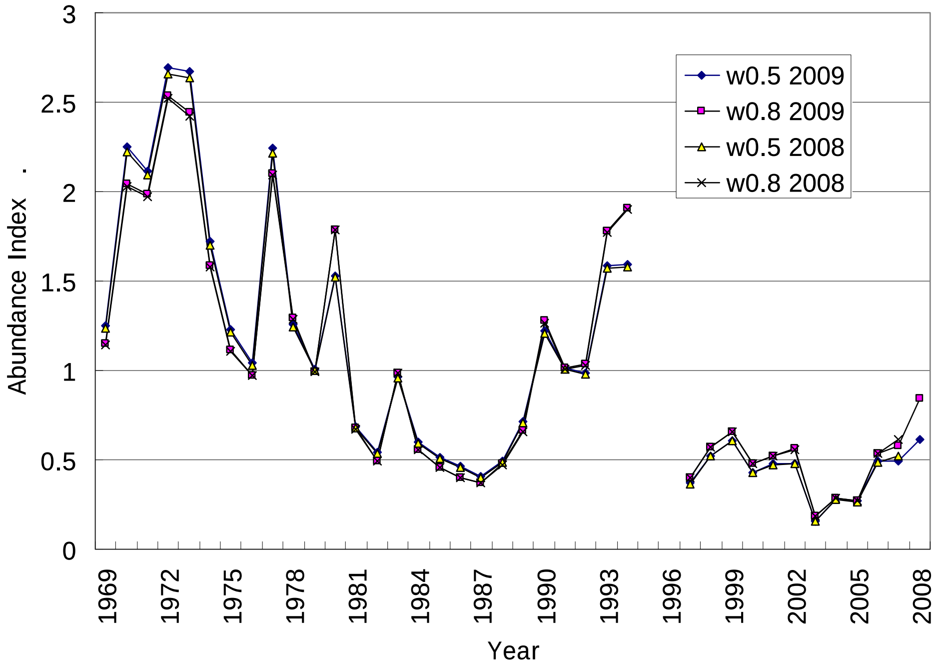


Fig. 1-4 (cont'd). Age composition of nominal CPUE of RTMP data for recent six years by month and areas. Note that x-axes are age.

(a) Age 3



(b) Age 4

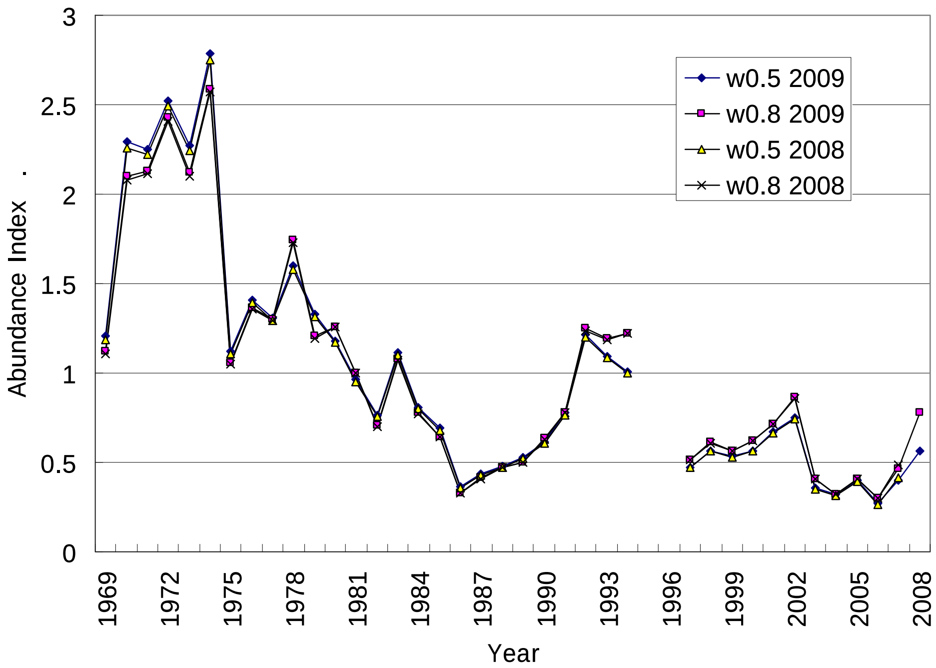
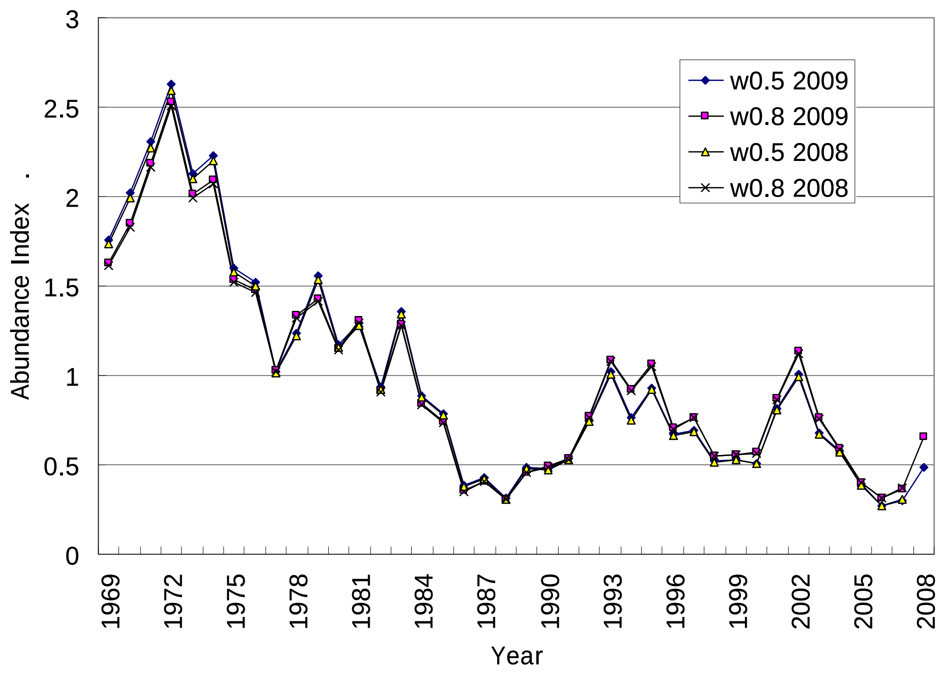


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices, estimated from 2008 and 2009 data.

(c) Age 5



(d) Age 6&7

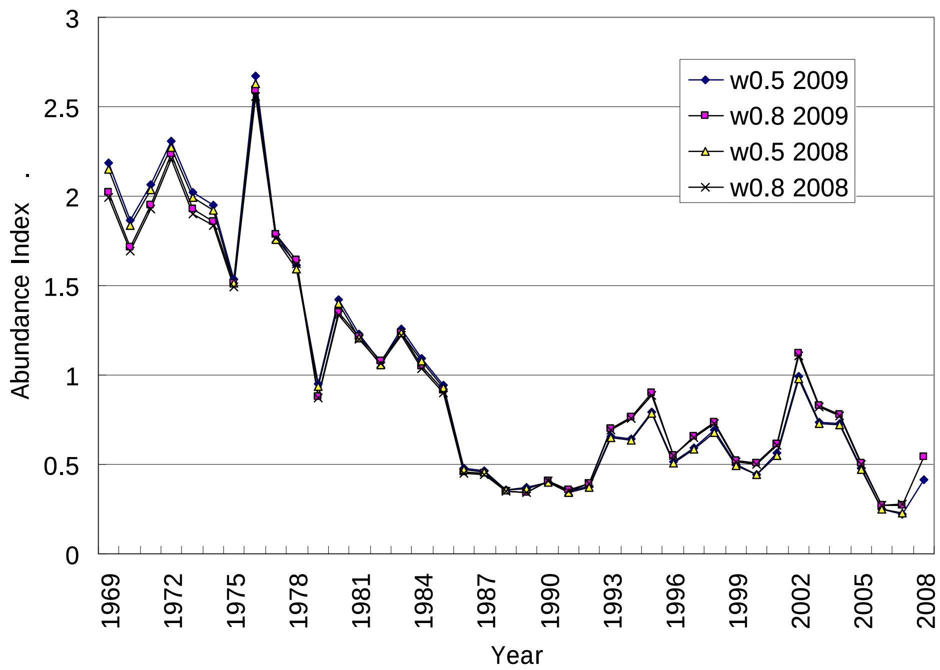
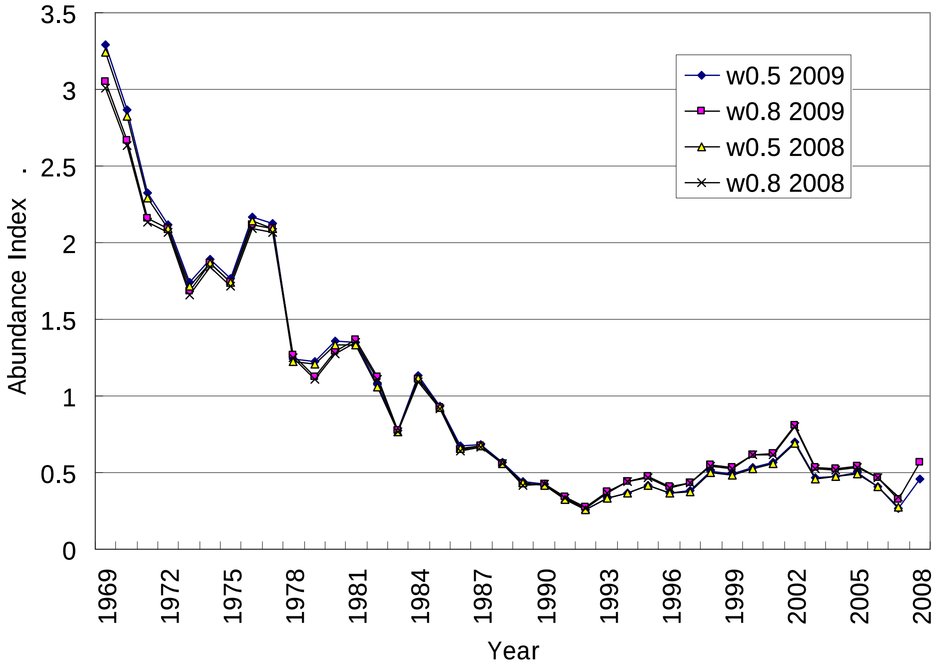


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices, estimated from 2008 and 2009 data. (cont'd)

(e) Age 8-11



(f) Age 12+

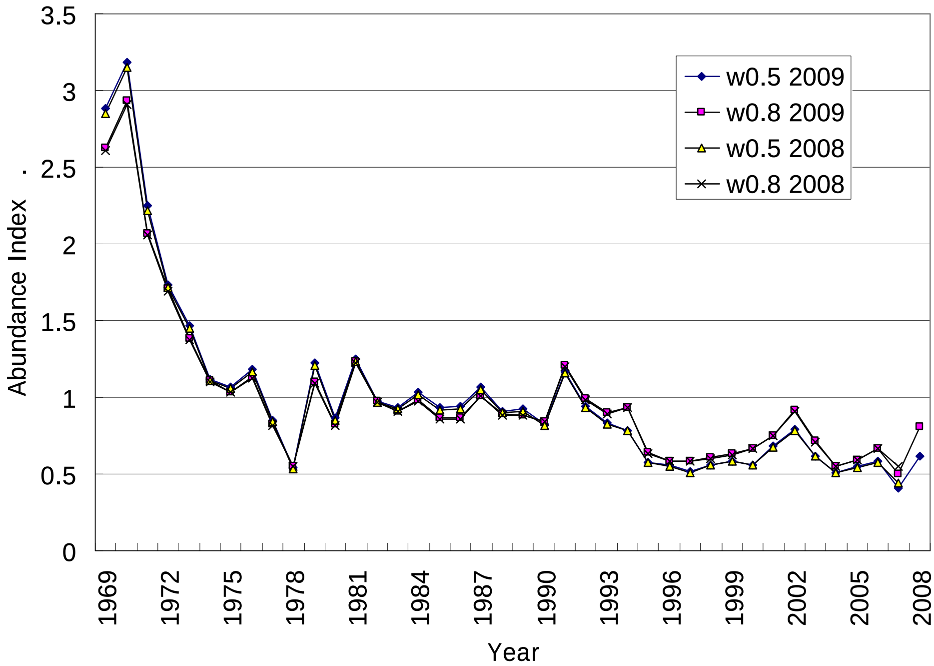


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices, estimated from 2008 and 2009 data. (cont'd)

(g) Age 4+

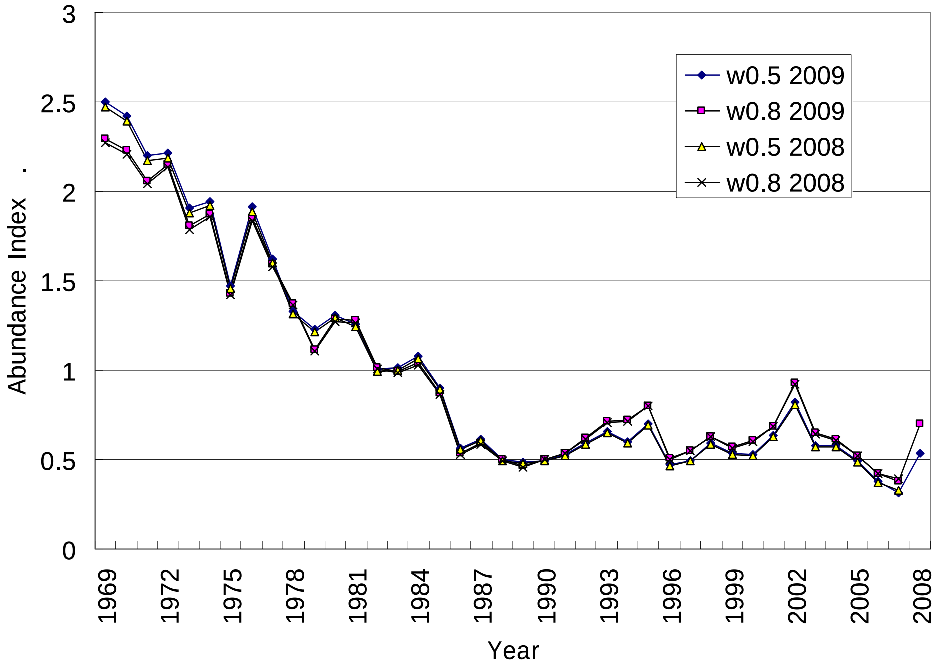


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices, estimated from 2008 and 2009 data. (cont'd)

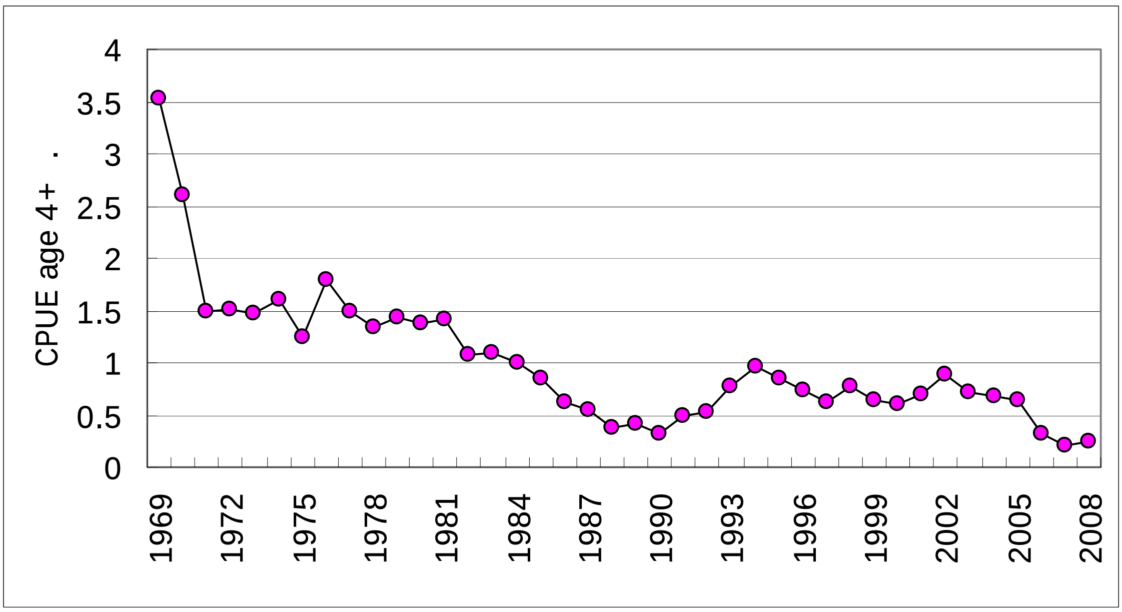


Fig. 1-6. Trend of normalized "ST Windows" index for age 4+ fish by the new calculation method.

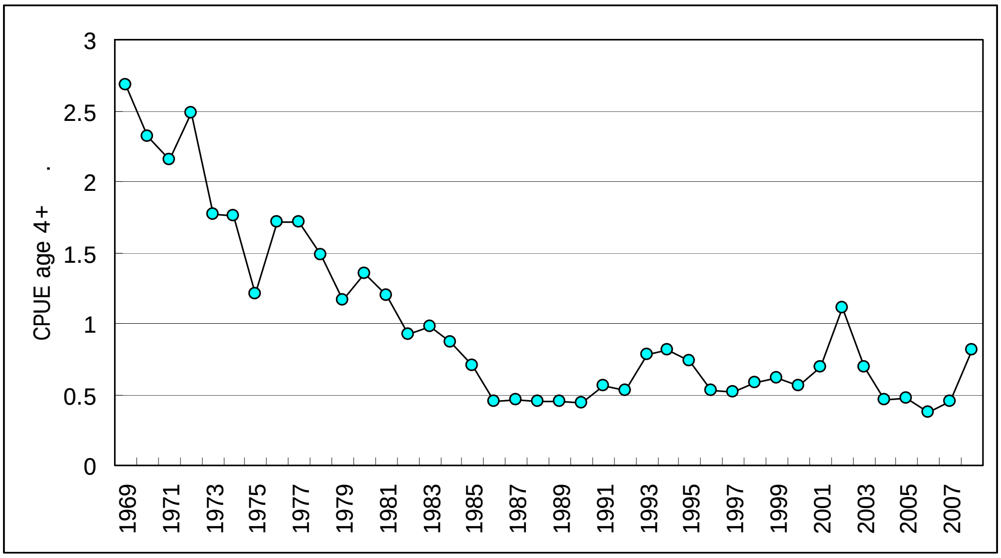


Fig. 1-7. Trend of normalized Laslett Core Area CPUE index for age 4+ fish.

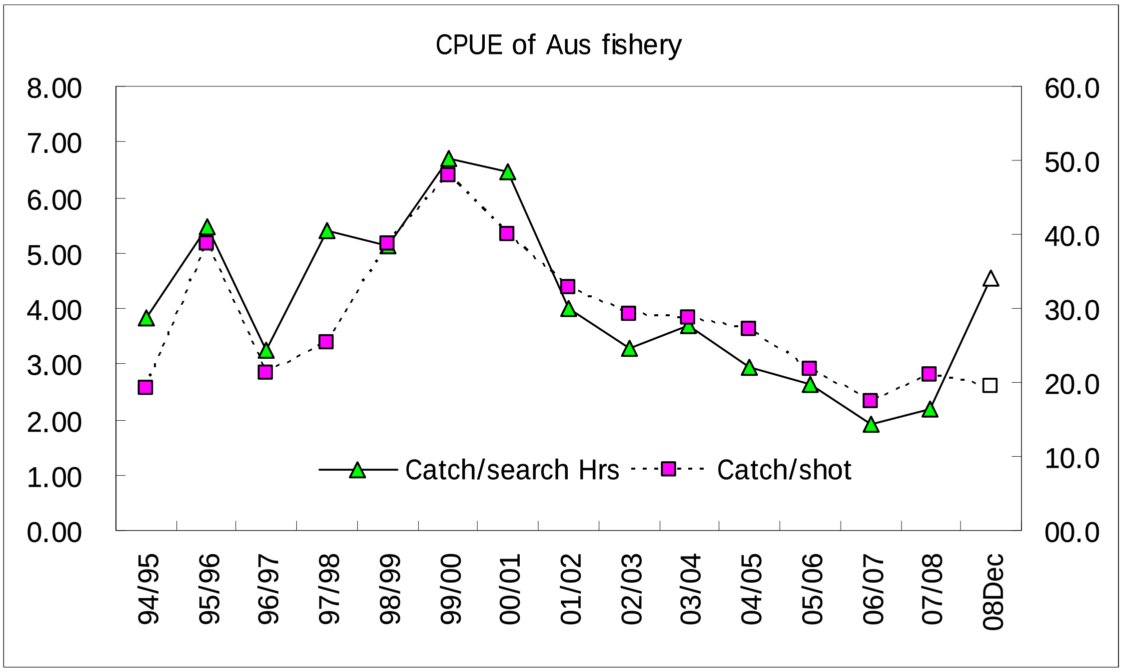


Fig. 2-1 Catch by efforts for Australia surface fishery.

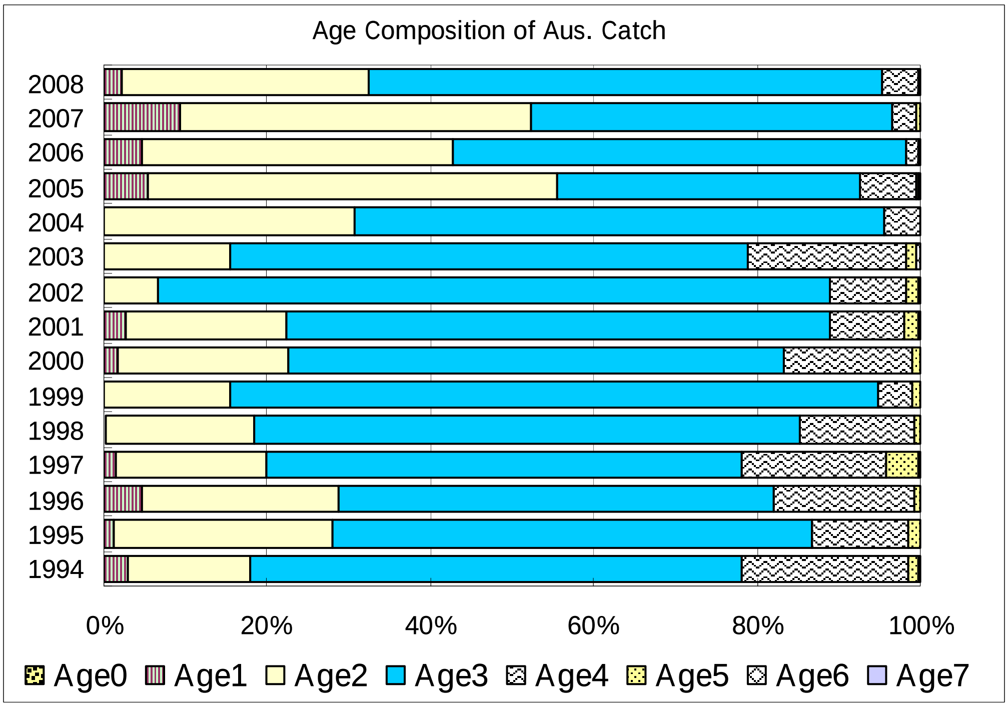


Fig. 2-2 Changes in age composition of Australia surface catches.

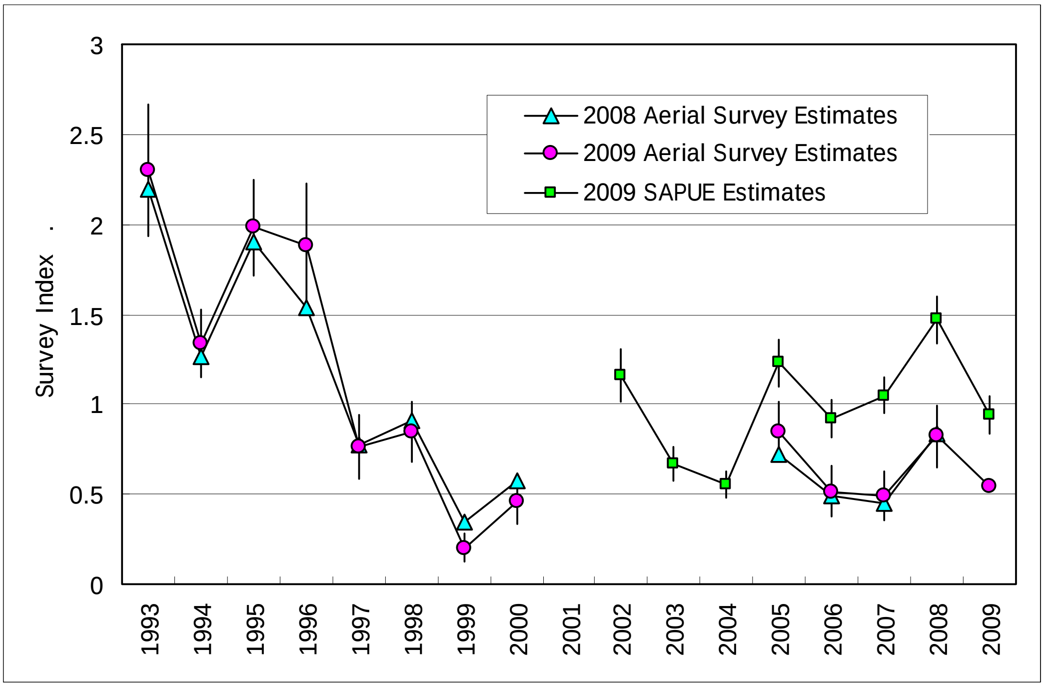


Fig. 2-3 Changes in aerial and commercial spotting (SAPUE) indices in the Great Australian Bight. Vertical bars indicate standard errors.

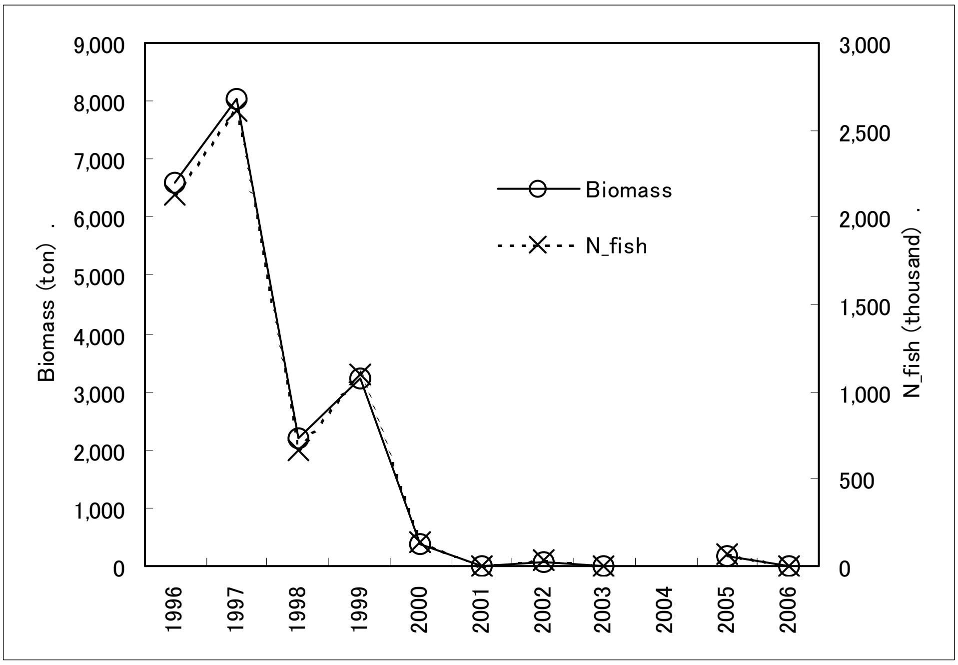


Fig. 3-1. Trends of acoustic index of age 1 SBT in the Western Australia. The acoustic survey ended in the 2005/2006 season (shown as “2006” in the figure).

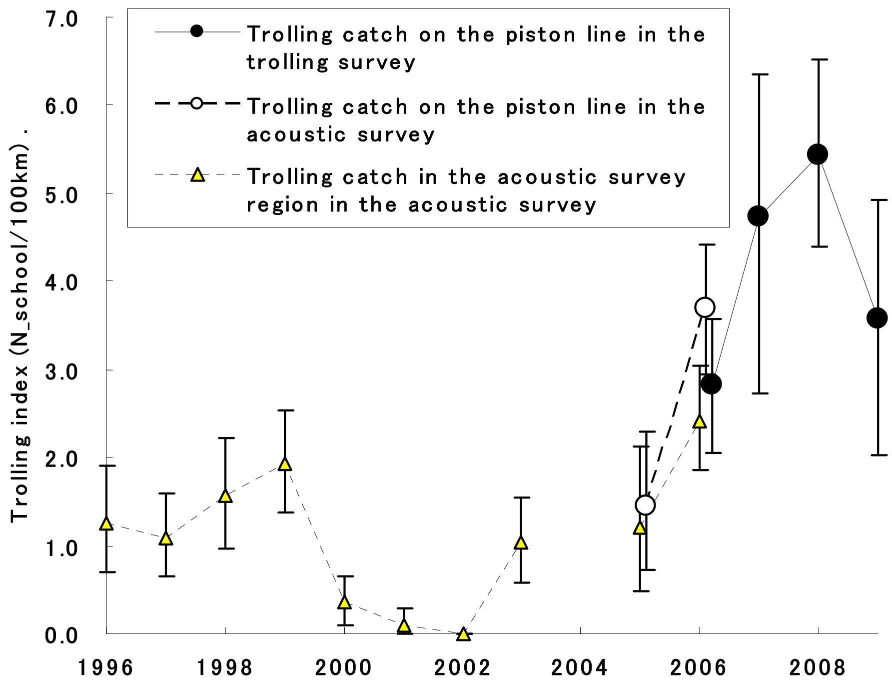


Fig. 3-2. Trends of trolling catch index of age 1 SBT in the Western Australia.

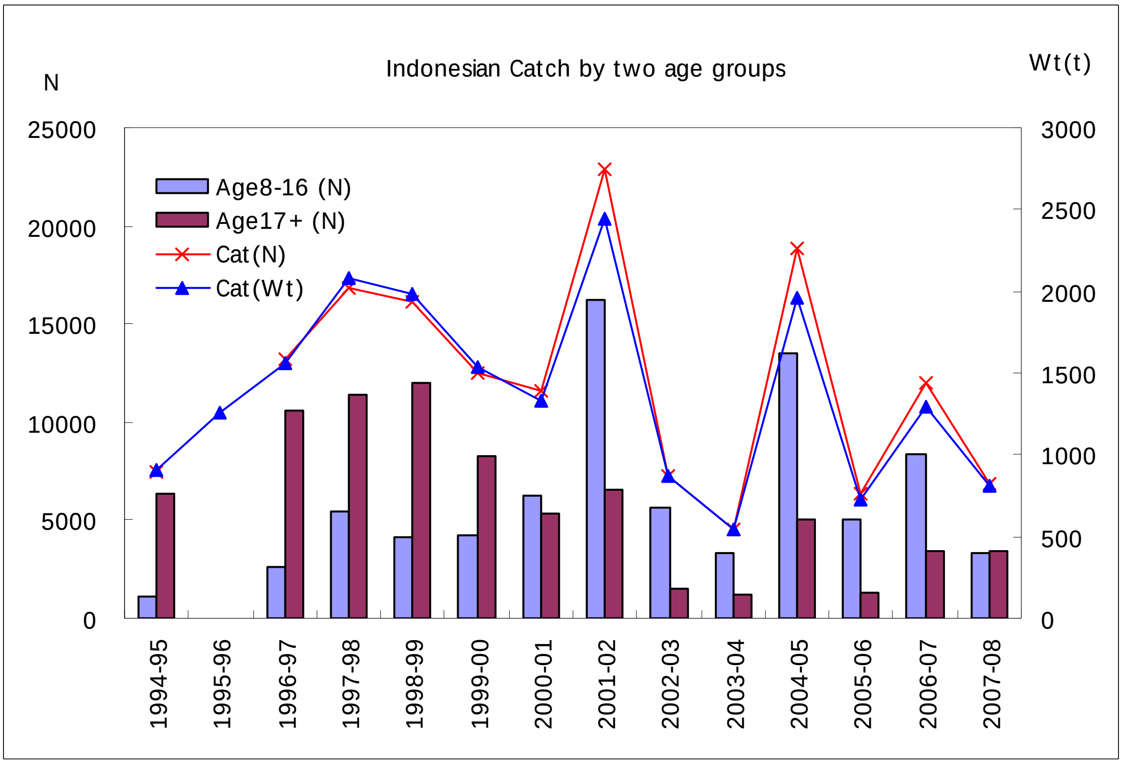


Fig. 4-1. Trends of Indonesian catches with proportion of two age groups occurrences.