

Summary of Fisheries Indicators in 2008

Norio TAKAHASHI and Tomoyuki ITOH

National Research Institutes of Far Seas Fisheries
Fisheries Research Agency

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 that observed in the late 1980s, which are the historically lowest levels. When looking to recent six years, CPUE indices for these age classes show steadily declining trends. 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 six years (1999-2002 cohorts, 2004 and 2005 cohorts). 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6年間を詳しく見ると、これら年齢クラス別のCPUE指数は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6年間（1999-2002年級、2004および2005年級）続けて加入が低いことに対応している。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.

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 2007, 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. A drastic increase for this age is observed in the last two years. CPUE trends for age groups 8-11 and 12+ have been more or less stable at the low level since the late 1990s.

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 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. Those cohorts recruited in 1992 and after 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 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 be carefully monitored for the next several years.

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. Comparison with observer data proved high reliability of size (i.e., age) information obtained from RTMP (Itoh and Miyauchi 2005). 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, 7, and 9. 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.

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 agreed 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 2007 (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 2006 and 2007.

Looking to trends of the recent five or six 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 cohorts observed in the 2005 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 2007 after a notably decrease to the 1986 low level in 2003 (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 (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). 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 (Fig. 1-5c and d). The most recent index levels for these age classes are the same as or lower than the historical low levels observed in the late 1980s. 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 recent years (see Fig. 3-1). Trends of CPUE for age 8-11 keep at the same level for last several years (Fig. 1-5e). From 2006 to 2007, however, the CPUE values decrease probably because the impact of the low recruitment of 1999 cohort on age 8 fish became apparent in 2007. 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.

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 toward 2007. These tendencies are also observed in both nominal CPUE and ST windows (for age 4+, explained below).

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” 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. In 2006 the index decreases to the same historical low levels as in the late 1980s.

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 it 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 2006/07 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 2 fish for recent three years (2005-2007) are greater than any for previous years (Fig. 2-2). Contrary, proportions for age 3 decrease for the same years. A small proportion for age 1 appears in 2005-2007 while there was no age 1 fish appeared during 2002-2004. In 2004-2007, 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 (Eveson et al. 2008, Farley and Basson 2008). 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. 2008). 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 upturn from 2007 to 2008. An overall trend of SAPUE appears to be increasing during 2002-2008 period.

Fig. 2-4 shows yearly trends of tentative estimates of F-value for Australian surface fishery based on the simple method described in Takahashi et al. (2004) with updated conventional tag recaptures. Except for 2002 with relatively a small number of releases in 2001 and extremely low recovery in 2002, F trends show roughly consistent decreasing patterns of catch per effort of the surface fishery observed in Fig. 2-1.

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.

As explained above, cohorts showing extreme low abundance levels in the 2000, 2001, 2002, 2003, and 2005 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 devastating impacts on both SBT stock and longline fishery. However, there is some inconsistency observed for 2004 cohort. CPUE indices for age 3 in 2007 are apparently at the same levels of that of the late 1990's and the early 2000's (Fig. 1-5a) whereas the 2005 acoustic survey index indicates low recruitment (Fig. 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 (2008). 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, an increased level of the 2004 cohort is compatible with an upturn observed in a longline-related index for age 3 fish in 2007 (see Fig. 1-5a). Trends of the trolling catch indices are increasing in recent four years.

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 six years, CPUE indices for these age classes show steadily declining trends. 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 six years (1999-2002 cohorts, 2004 and 2005 cohorts). Agreed with these results of the acoustic survey, longline fishery-related indicators suggest considerable decline of recruitments of 1999, 2000, 2001, and 2002 cohorts. 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.

References

- Eveson, P., Bravington, M., and Farley, J. 2008. The aerial survey index of abundance: updated analysis methods and results. CCSBT-ESC/0809/24. 24 pp.
- Farley, J., and Basson, M. 2008. Commercial spotting in the Australian surface fishery, updated to include the 2007/8 fishing season. CCSBT-ESC/0809/25. 18 pp.
- Itoh, T. 2007. Some examination on the recruitment index of age 1 southern bluefin tuna derived from the trolling survey. CCSBT-ESC/0709/39.
- Itoh, T. and O. Sakai. 2008. Report on the piston-line trolling survey in 2007/2008. CCSBT-ESC/0809/41.
- Itoh, T. and K. Miyauchi. 2005. Report of Japanese scientific observer activities for southern bluefin tuna fishery in 2004. CCSBT-ESC/0509/37.
- Takahashi, N. 2006. Future use of "ST windows" index calculated by a new method: A proposal. CCSBT-ESC/0609/47. 3 pp.
- Takahashi, N. 2008. Data and method used to calculate B-ratio Proxy (w0.5) and Geostat Proxy (w0.8) CPUE Series. A methodology document submitted to the CCSBT Secretariat on 27 June, 2008. 3 pp.
- Takahashi, N., H. Shono, and S. Tsuji. 2002. Some consideration on Japanese longline CPUE as a potential input to management procedures. CCSBT-CPUE/0203/09. 11 pp.
- Takahashi, N., S. Tsuji, and H. Kurota. 2004. Review of the current CCSBT Tagging Program and potential improvements. CCSBT-ESC/0409/36. 18 pp.
- Takahashi, N., S. Tsuji, T. Itoh, and H. Shono. 2001. Abundance indices of southern bluefin tuna based on the Japanese longline fisheries data, 1969-2000, along the interim approach agreed for the 2001 assessment. CCSBT-SC/0108/28. 39 pp.

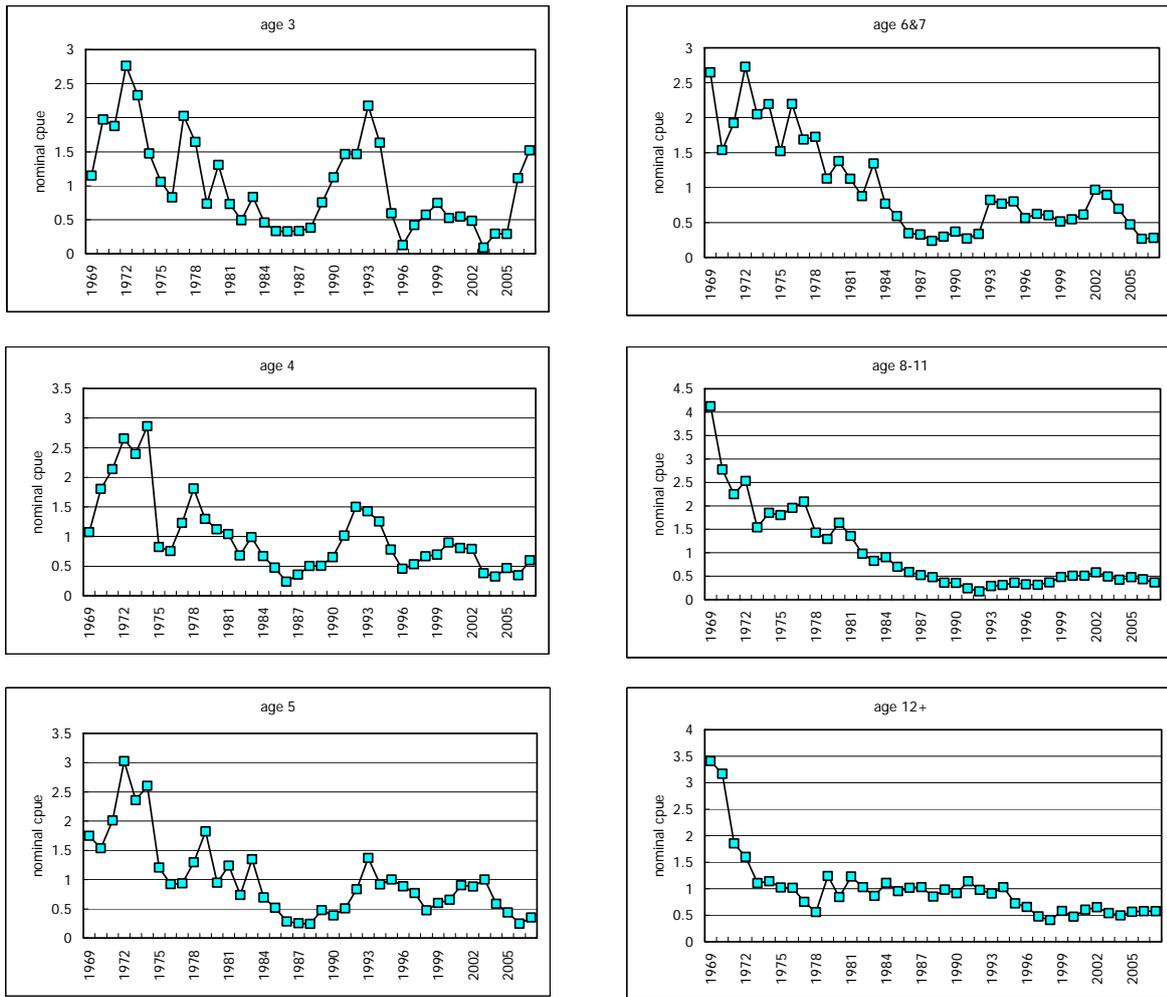


Fig. 1-1. Nominal CPUE of Japanese longline fishery by age groups.

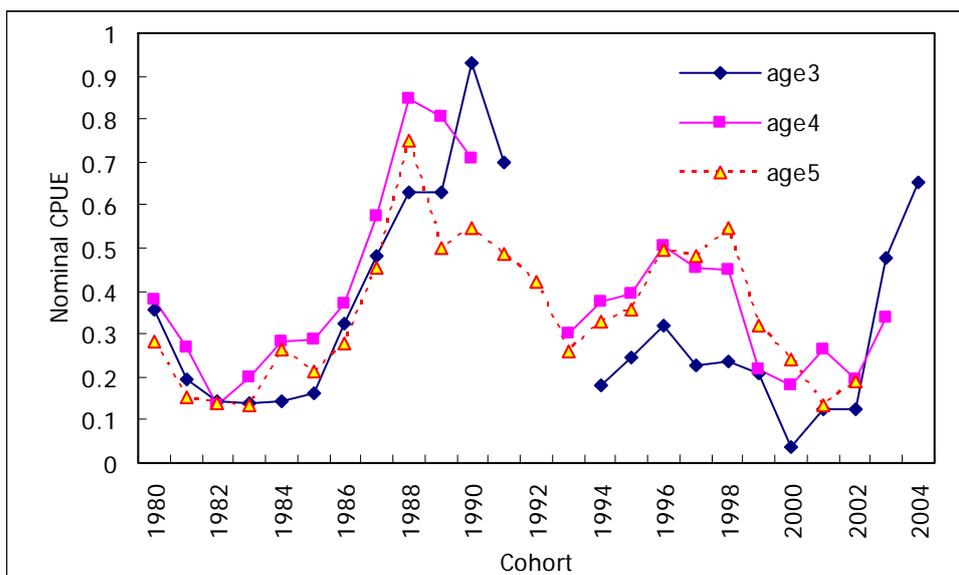


Fig. 1-2. Nominal CPUE of Japanese longline fishery by cohorts for age 3, 4, and 5.

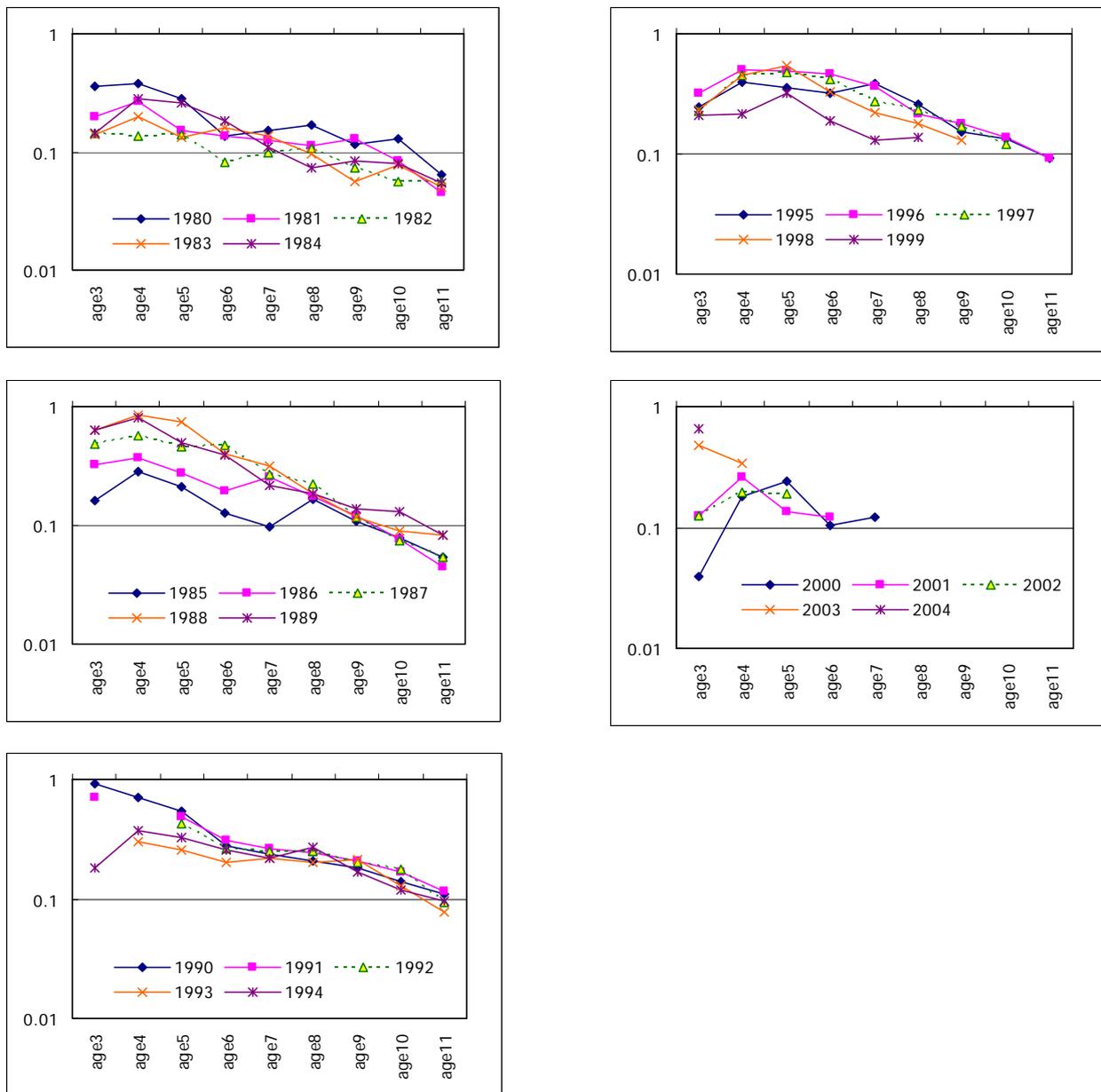


Fig. 1-3. Nominal CPUE of Japanese longline fishery by cohorts in log-scale.

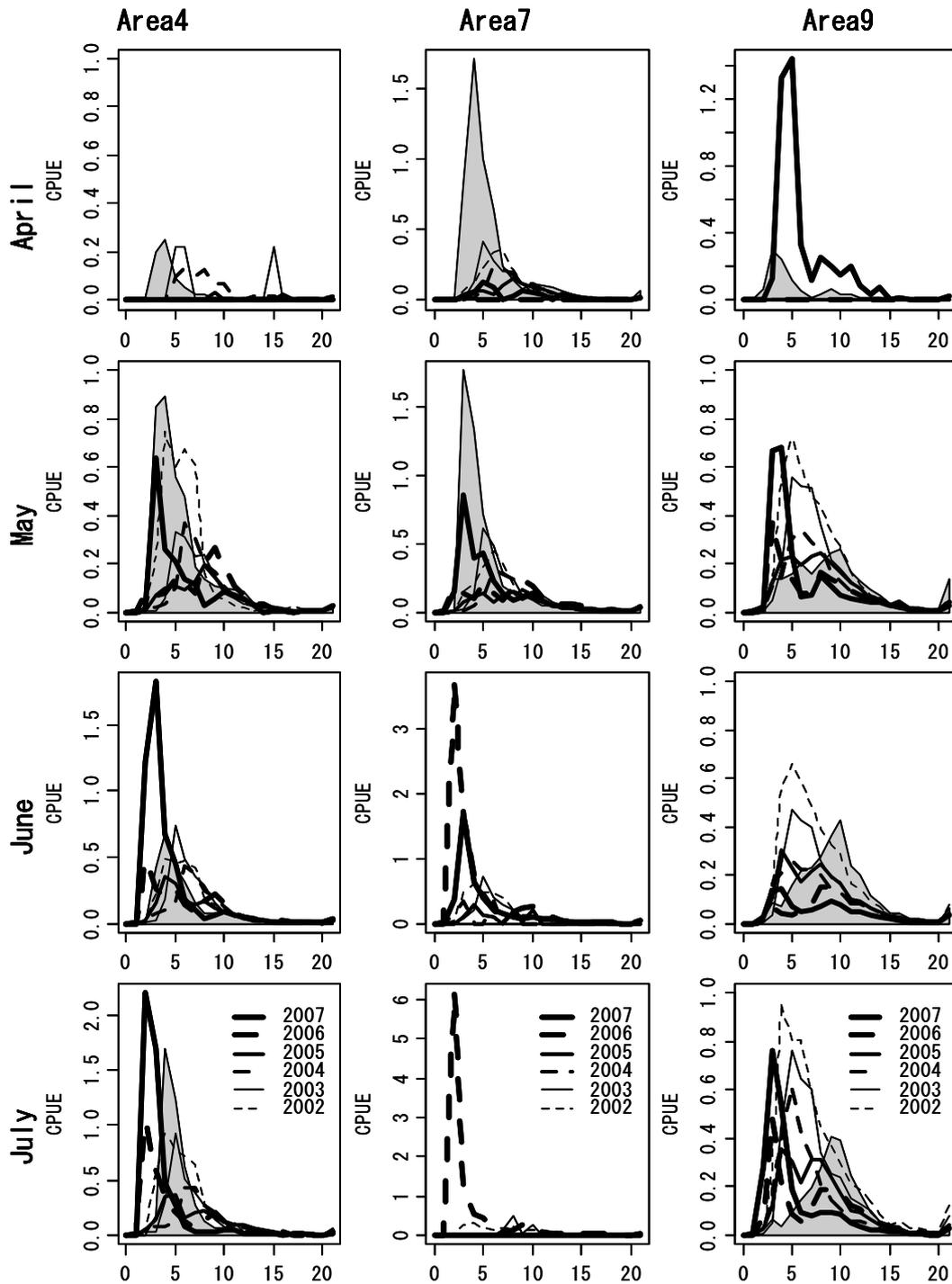


Fig. 1-4. Age composition of nominal CPUE of RTMP data for recent seven years by month and areas. Note that x-axes are age and shaded portions represent the year 2008.

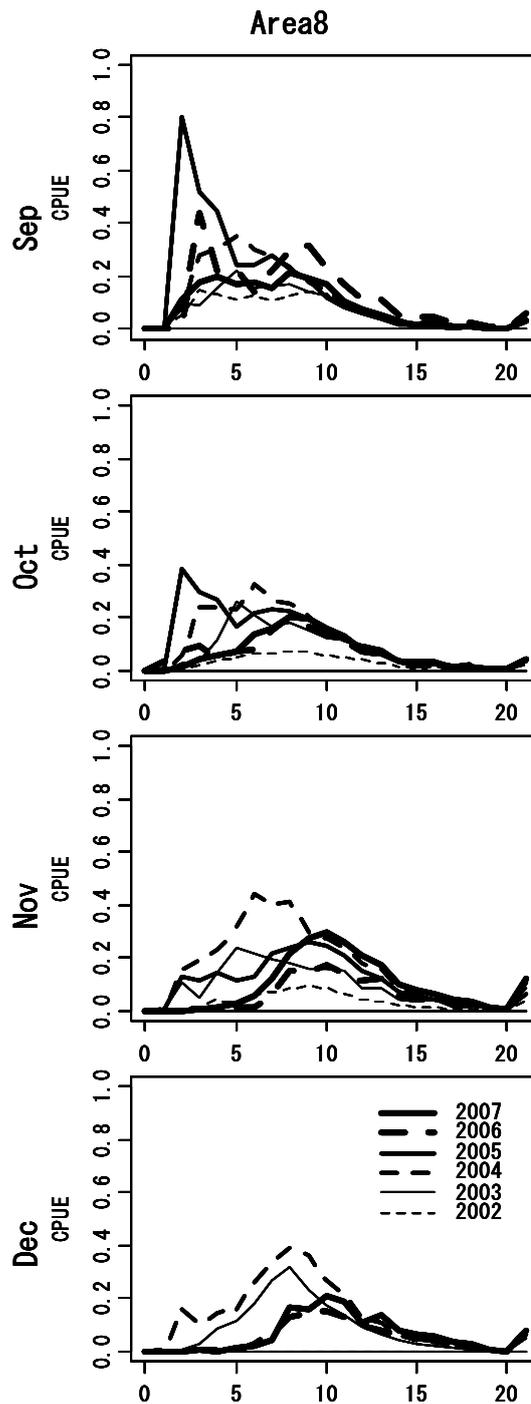
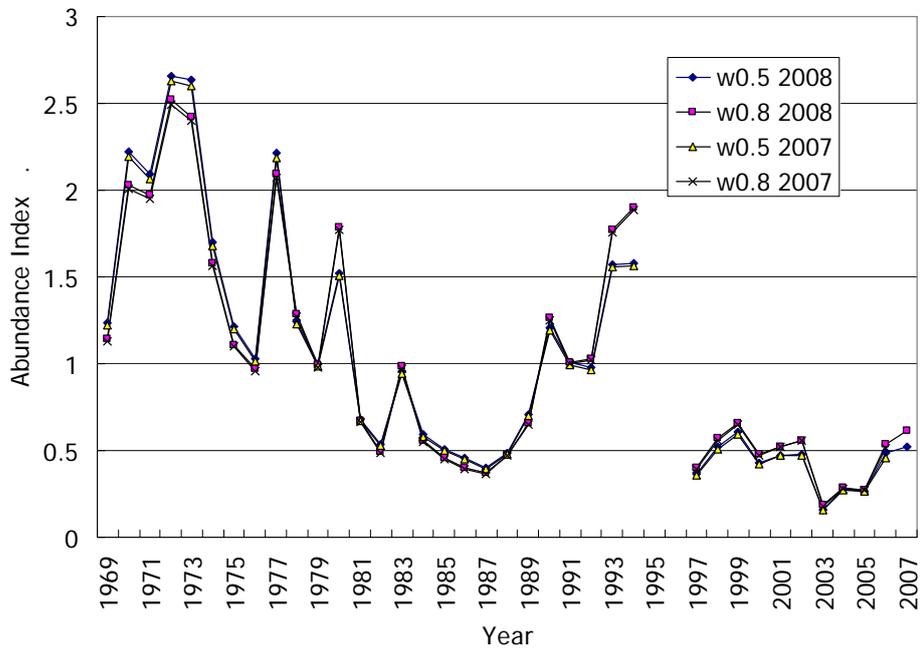


Fig. 1-4 (cont'd). Age composition of nominal CPUE of RTMP data for recent six years by month and areas. Note that x-axes are age. Also note that CPUE for large fish in December 2005 was extremely higher than that in past years and thus this data was not shown in the figure regarding inappropriate for comparison purpose.

(a) Age 3



(b) Age 4

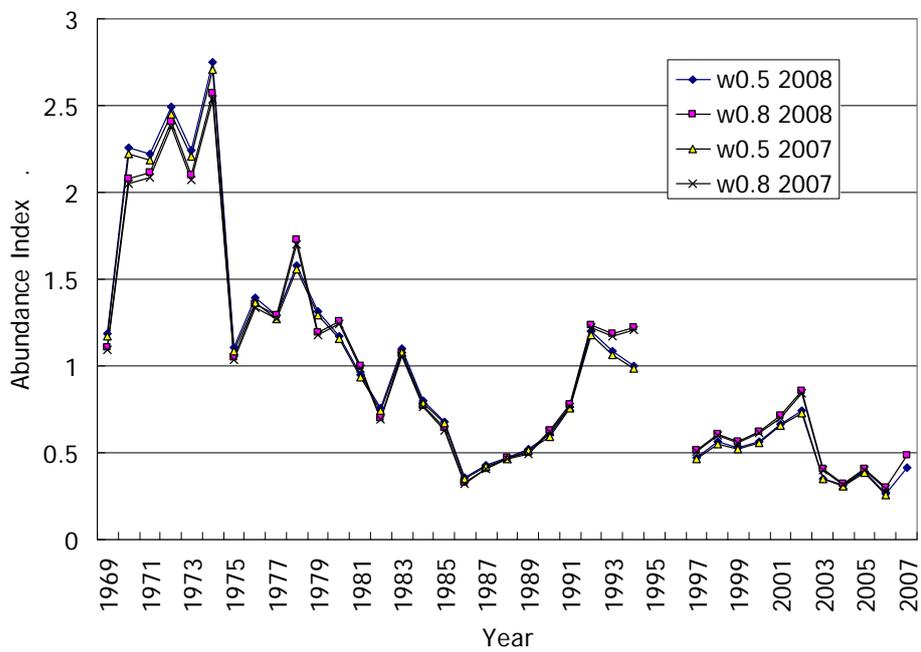
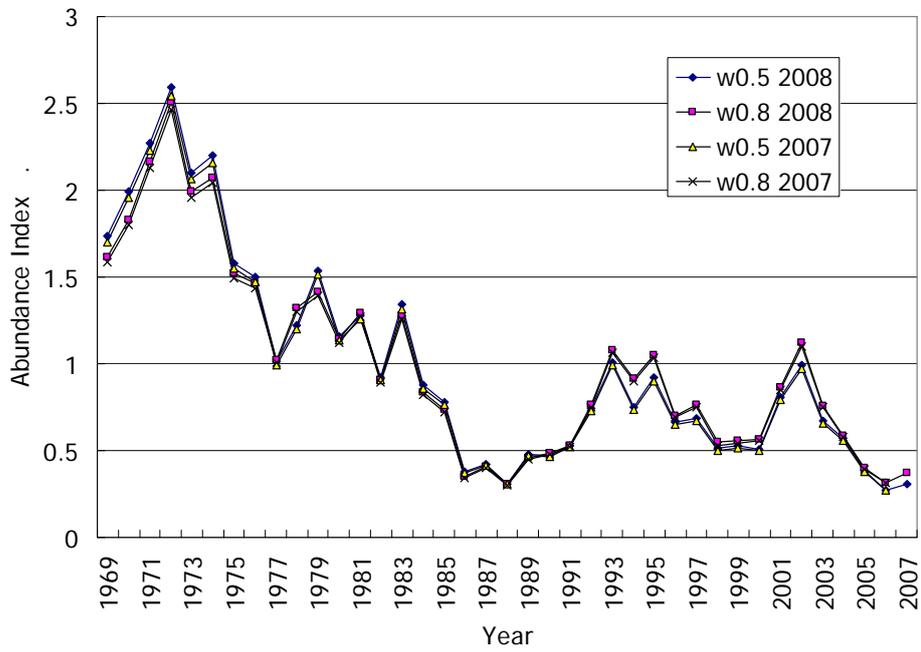


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices, estimated from 2007 and 2008 data.

(c) Age 5



(d) Age 6&7

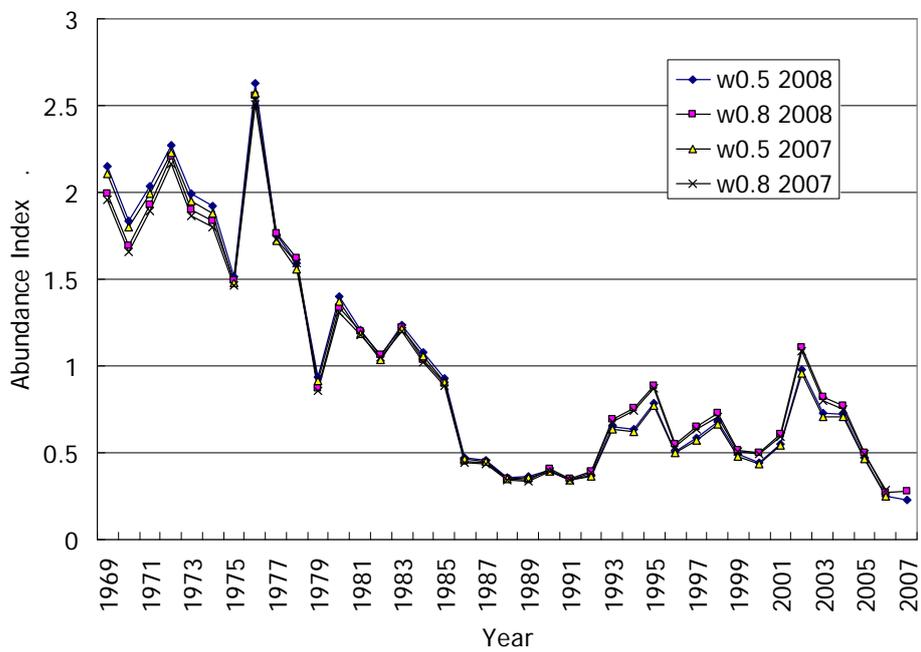
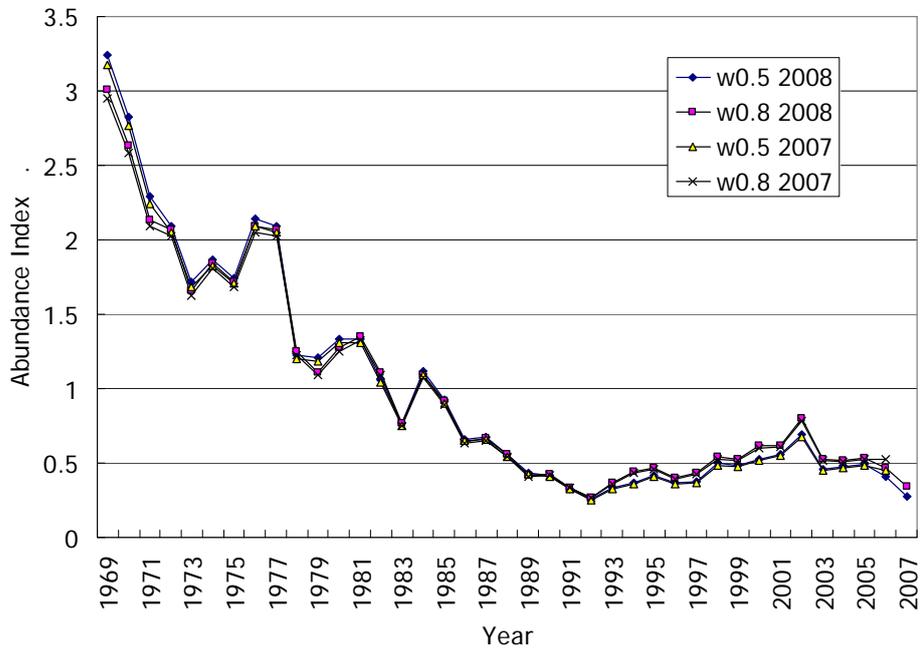


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices, estimated from 2007 and 2008 data. (cont'd)

(e) Age 8-11



(f) Age 12+

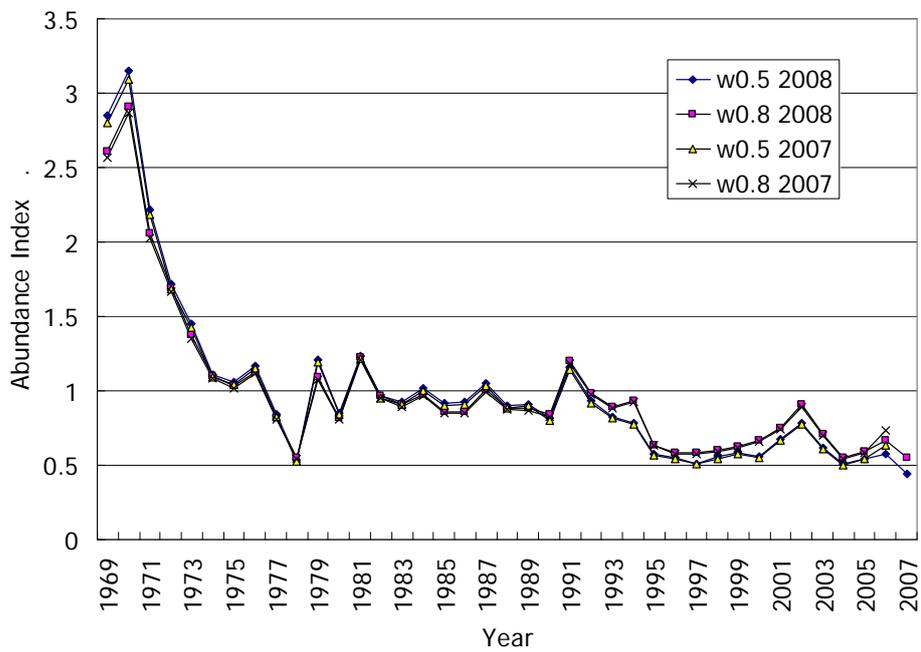


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices, estimated from 2007 and 2008 data. (cont'd)

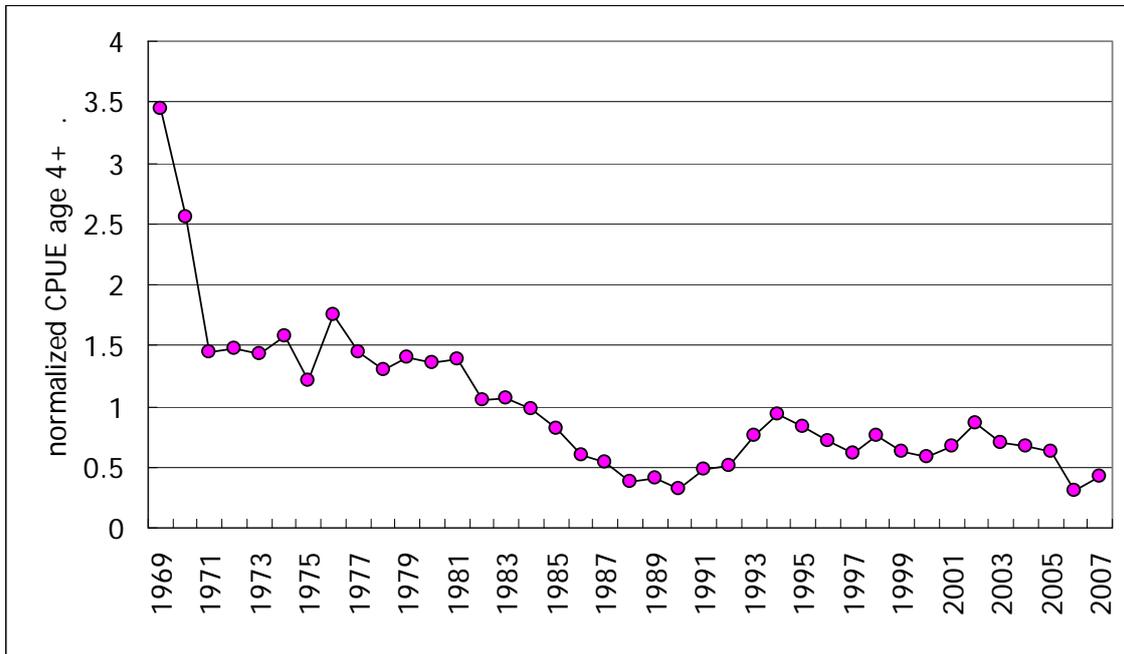


Fig. 1-6. Trends of normalized "ST Windows" indices for age 4+ fish by the new calculation method.

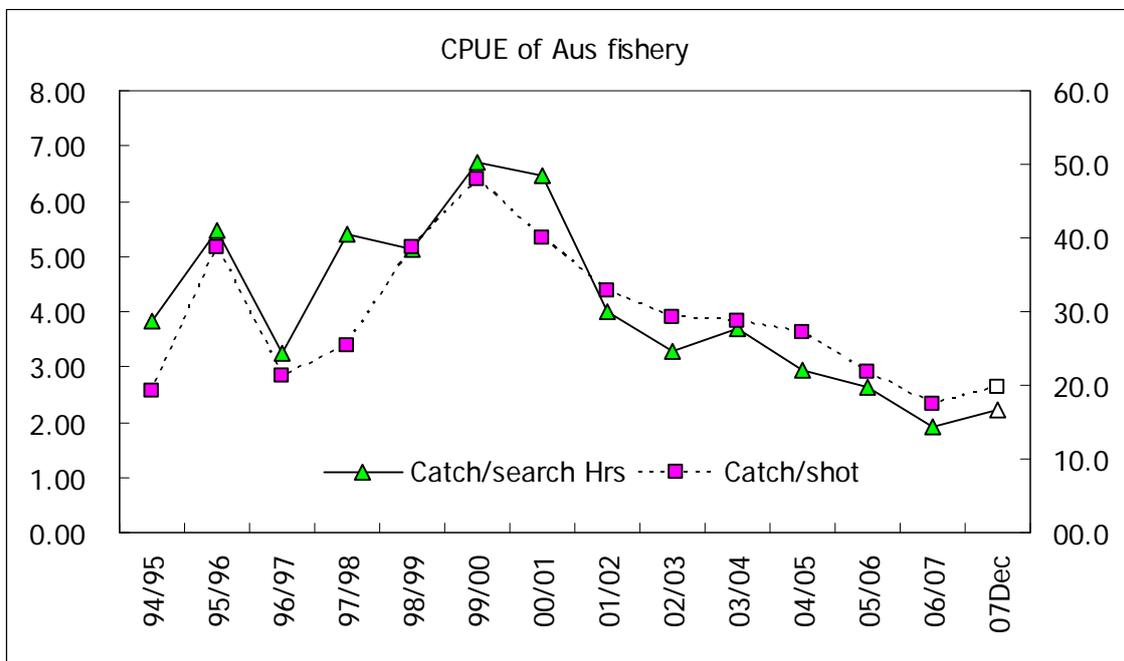


Fig. 2-1 Catch by efforts for Australia surface fishery.

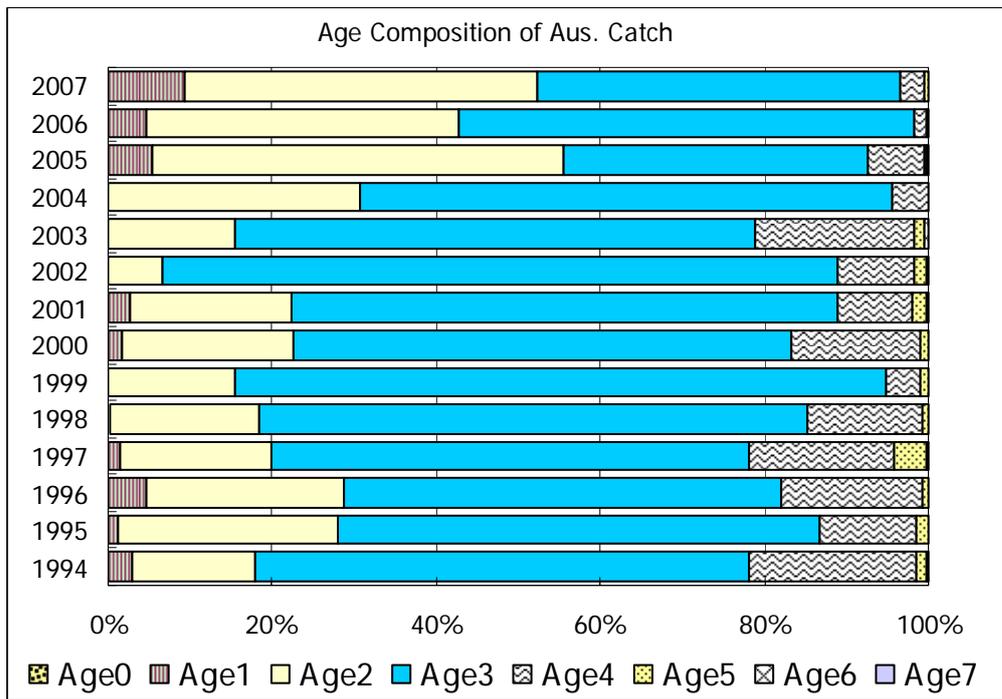


Fig. 2-2 Changes in age composition of Australia surface catches.

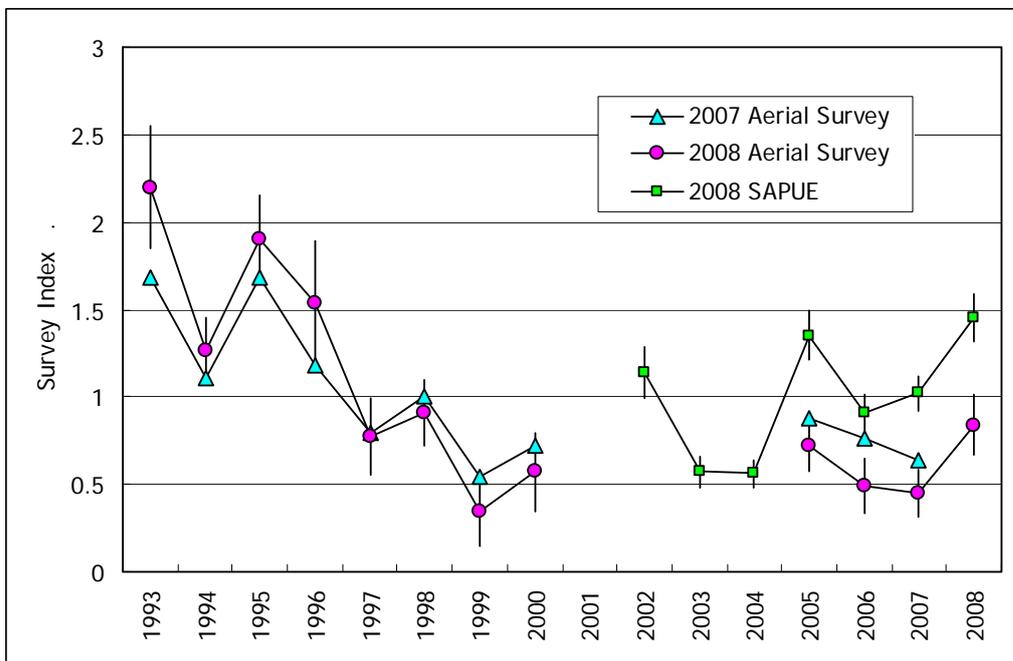


Fig. 2-3 Changes in aerial and commercial spotting (SAPUE) indices in the Great Australian Bight. Vertical bars indicate standard errors.

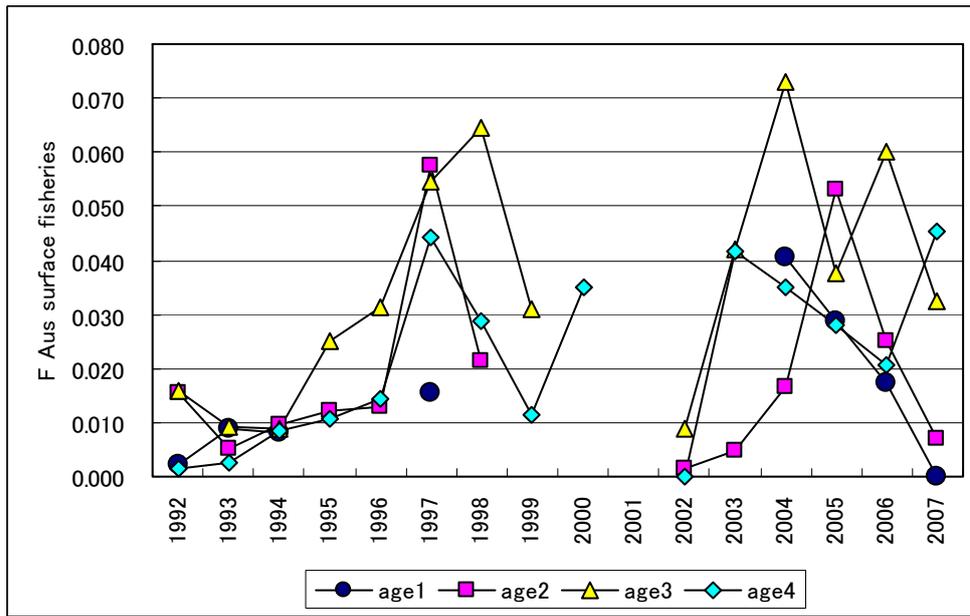


Fig. 2-4 Tentative F-estimates of Australian surface fishery based on conventional tag-recapture.

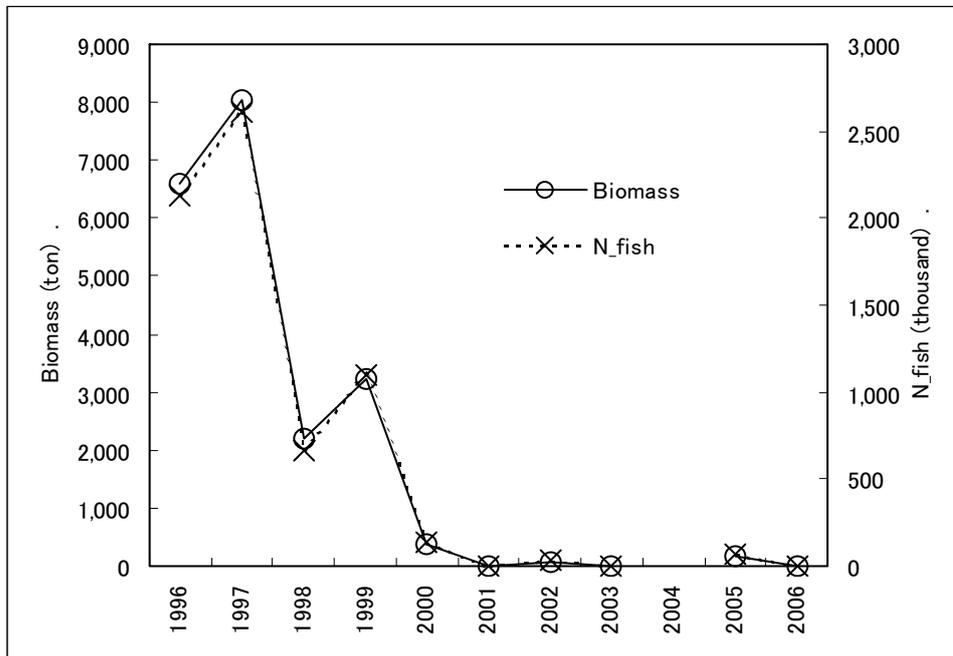


Fig. 3-1. Trends of acoustic index of age 1 SBT in the Western Australia. The acoustic survey ended in the 2005/2006 season (shown as “2006” in the figure).

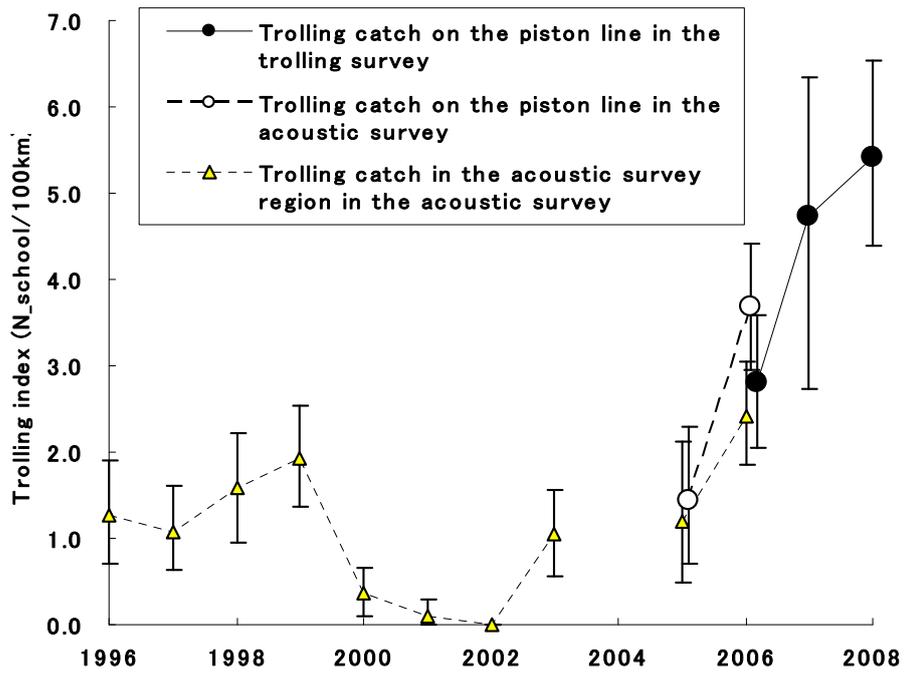


Fig. 3-2. Trends of trolling catch index of age 1 SBT in the Western Australia.

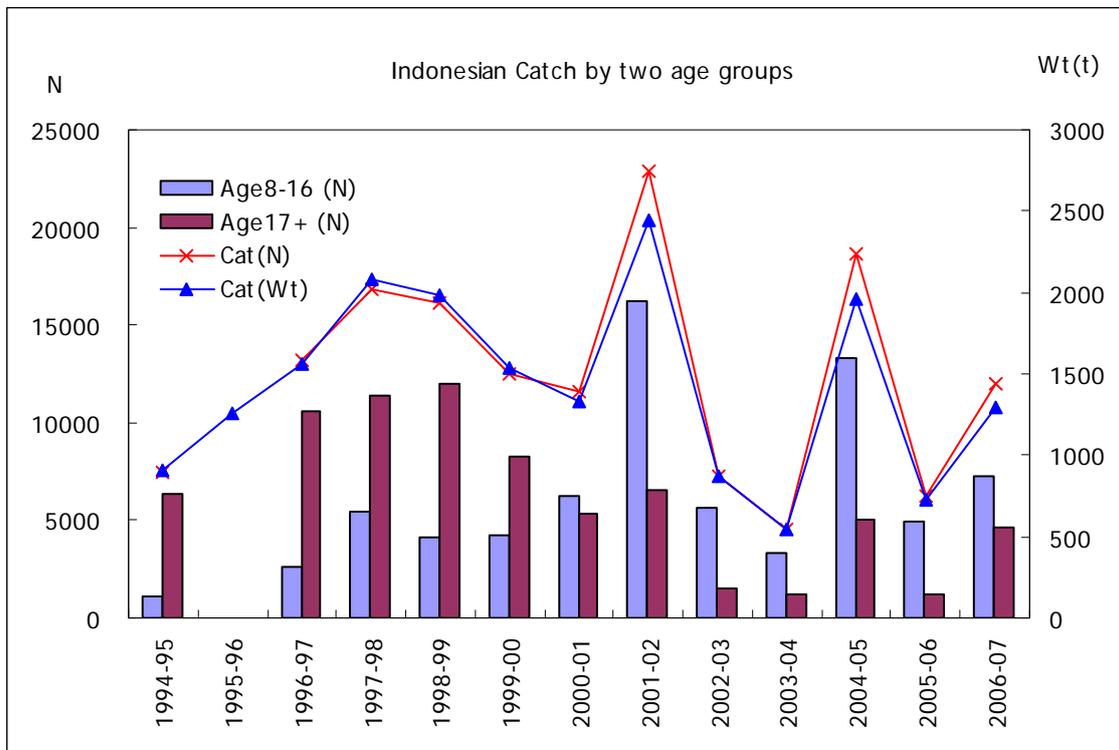


Fig. 4-1. Trends of Indonesian catches with proportion of two age groups occurrences.