Summary of Fisheries and Scientific Survey Indicators of Southern Bluefin Tuna Stock in 2025

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Abstract: Fisheries and scientific survey indicators were examined to provide information for overviewing the current stock status of southern bluefin tuna. The Japanese longline CPUE indicators for 4, 5, 6&7, 8-11, and 12+ age groups are well above the historically lowest levels observed in the late 1980s or the mid-2000s. CPUE indices for these age groups have fluctuated in an aperiodic way and/or showed increasing trend over the past 8 years. Especially, CPUE indices for age 4 and 5 showed drastic increases in recent years while other CPUEs for other age groups did not show such changes. Age-aggregated (age 4+ group) CPUE indices that include the one used in the operating model and management procedure show increasing trends over the past 10 years. The current levels of these indices are well above the historically lowest observed in the mid-2000s. Various recruitment indicators inspected suggest that recruitment levels in recent years have been similar to or higher than those observed in the 1990s (before markedly low recruitments of 1999 to 2002 cohorts occurred) but the levels of recruitment have varied from year to year. It should be noted that among the two indices derived from the trolling survey for age-1 fish, the TRG recruitment index shows a low level from the 2016 to 2024 cohort, as well as the TRP recruitment index recorded zero values in 2018 and 2019, suggesting some concern of potential low recruitment in recent years.

要旨：ミナミマグロの資源状態を概観するための情報を提供することを目的に，漁業ならびに科学調査指数を精査した．4，5，6&7，8-11，および 12＋年齢グループの日本はえ縄 CPUE 指数は，1980 年代後半あるいは 2000 年代中頃に見られた歴史的最低水準より十分上にある．過去 8 年間，これらの年齢グループの指数は非周期的に変動している，かつ/あるいは，増加傾向を示している．特に，4 および 5 歳の CPUE 指数は 2021 年から 2022 年に顕著な増加を見せている．一方，他の年齢グループの CPUE はそのような変化を見せていない．オペレーティングモデルや管理方式に使用されているものを含む年齢をまとめた CPUE 指数（4+歳グループ）は，過去 10 年間，増加傾向を示している．それら指数の現在の水準は，2000 年代中頃に見られた歴史的最低値より十分上にある．精査した様々な加入指標は，近年の加入水準は年によって変動するものの，1990 年代に見られた水準（1999 年級から 2002 年級の顕著に低い加入が起こる以前）と近いか，あるいはより高いことを示唆している． 1 歳魚を対象にした曳縄調査から得られた 2 つの加入指標において，グリッドタイプ曳縄加入量指数（TRG）が 2016 年級から 2024 年級まで低い値であること，また，ピストンライン曳縄加入量指数（TRP）が 2018 年および 2019 年にゼロ値を記録していることは，近年の潜在的な低加入の懸念を幾分示しており，留意しておくべきである．

Introduction

Southern bluefin tuna (SBT, *Thunnus maccoyii*) stock is one of the 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. CCSBT's objective is to ensure, through appropriate management, the conservation and optimum utilization of stock.

The 2001 Scientific Committee (SC) of CCSBT selected a set of fisheries indicators to overview the SBT stock status (CCSBT 2001). These indicators have been revised and used in past Stock Assessment Group (SAG), SC and Extended Scientific Committee (ESC) meetings to examine whether unexpected changes of stock status that require urgent full stock assessment occur. After adopting a management procedure (MP) in 2011 to guide the setting of the global total allowable catch (TAC) for SBT, as a part of the "metarule" process for the MP, the ESC annually reviews fisheries and scientific survey indicators to monitor the SBT stock and fisheries with respect to assumptions/predictions made in the operating model (OM) (CCSBT 2012). This document summarizes examinations and our overall interpretations of updated fisheries and scientific survey indicators.

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

1. Japanese longline CPUE [1]:

<u>Nominal CPUE</u>

Nominal CPUE indicators by age group were plotted in Fig. 1-1. Age was estimated from fork length based on the growth curve used in the CCSBT. These indicators based on Japanese longline fishery data, including those of joint-venture with Australia and New Zealand occurred in past. Data in the most recent year exclusively rely on information collected by the Real Time Monitoring Program (RTMP) which covers all SBT targeting vessels. When all data from the other non SBT-targeting vessels (based on logbooks) become available and are included in the existing dataset the following year, CPUE of the most recent year tends to decrease slightly (Takahashi et al. 2001). However, almost no difference of CPUE based on the RTMP and logbook data has been found in recent years.

CPUE indicators must be looked to carefully from year 2006 onward because Japanese longline fishery has introduced Individual Quota (IQ) system since 2006 (Itoh 2012). Changes in the number of catch and the distribution pattern of effort before and after 2006 were examined and discussed in detail in Itoh (2025a). Additionally, in concurrence with the implementation of the IQ system, releases and discards of small SBT from Japanese longline fishery began to occur (Itoh et al. 2014). These releases and discards are probably due to fishermen's motives to desire to use their limited IQ because of the low commercial value for small fish. Although these release and discards have been reported through the RTMP and documented in the national report of Japanese SBT fisheries every year (Itoh et al. 2025), both nominal CPUE and standardized CPUE (below) were calculated without including the releases/discards.

[1] <u>C</u>atch <u>p</u>er <u>U</u>nit <u>E</u>ffort. In southern bluefin tuna case, CPUE is the number of catch per 1000 hooks.

When focusing on the trends for the recent past, nominal CPUE for age 3[2] showed an increasing trend from 2019 to 2024 overall (Fig. 1-1). The 2024 value for this age was substantially higher than the past 5-year mean over 2019-23. CPUE for age 4 fluctuated by a large amount between 2019 to 2024. CPUE for age 4 in 2024 was greatly higher than the past 5-year mean. CPUE for age 5 from 2019 to 2024 fluctuated around the past 5-year mean. The most recent CPUE for age 5 was below the past 5-year mean. CPUE for age class 6&7 increased from 2021. The value of 2024 was higher than the past 5-year average. Recent nominal CPUE for 8-11 age group has kept constant in the last five years. The CPUE value in 2024 was at the same level as the 5-year mean. The CPUE values for 12+ age group showed consistently increasing trends in recent years, and CPUE in 2024 were substantially higher than the 5-year mean. CPUE for 4+ age class has increased in recent years and the value of 2024 was above the 5-year mean.

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 juvenile SBT among different cohorts and Fig. 1-3 compares decrease rates by cohort in the logarithmic scale. CPUEs for age 3, 4 and 5 fish show consistent trends between 1980 and 2004 cohorts. Some variations in trend and divergence from trends of CPUEs for age 4 and 5 have been observed for age 3 after 2004 cohort (Fig. 1-2) which may suggest that age 3 CPUE cannot be used as an indicator of relative cohort strength for recent years. Cause(s) of this variation and divergence might be a change in catchability, population fluctuation, and/or releases/discards of small fish in recent years. Since 2012, however, the relative trends of nominal CPUE for age 3, 4, and 5 all show increasing patterns while the CPUE trends for age 4 and 5 have been fluctuating.

Overall levels of CPUE across age 3 to 11 by cohort can be grouped as the periods of 1980-1986, 1987-1992, 1993-1998, 1999-2003, 2004-2009, 2010-2015, and 2016-2021 cohorts (Fig. 1-3). Within each period, variations of the CPUE levels were relatively small (except age 3 CPUEs in the 1999-2003 cohort group) and deceasing rates were similar. The 1987-1992 cohorts showed more drastic declines than other cohorts, which was probably due to targeting smaller fish in the early 1990s caused by stock depletion of the cohorts recruited in pre-1987 years and less structured management schemes at that time. Then, the cohorts recruited from 1993 to 1998 showed slower decline rates, suggesting a reduced level of exploitation rates for these cohorts. Fig. 1-3 also indicates decreases of overall CPUE level of 1999-2003, while showing that 2004-2009 cohorts were higher overall CPUE levels. Cause(s) of these weak 1999-2003 cohorts has been unknown, whether it would reflect change in oceanographic and/or fish availability, or it be an indication of a consequence of excessive fishing pressure. Although the CPUE levels for age 3 of 2004-2009, 2010-2015, and 2016-2021 cohorts varied depending on cohorts, most of the CPUE levels for age 4 to 10 were similar to or higher than ones of any cohorts in the past.

Age composition of nominal CPUE for 2024 (Areas 4, 7, 8, and 9) and 2025 (Areas 4, 7 and 9) obtained from the RTMP were plotted in Fig. 1-4. Data for past years are also shown for comparison. A large portion of catches occurred approximately between ages 3 to 10 for Areas 4, 7, and 9, and between ages 5 to 15 for Area 8. Most small fish (5 years old and younger) were caught in Areas 4, 7, and 9 only, whereas catches of large fish (over 10 years old) were observed in all Areas depending upon month. For Areas 4, 7 and 9, the age composition of CPUE tended to be skewed toward younger ages (< age 5) after 2022. No marked increase of CPUE was observed in 2021, 2022, 2023, 2024, and 2025 as corresponding to the highest value in 2016 observed in the scientific aerial survey index (if assumed that the aerial survey index primarily represents age 3 SBT abundance, see Fig.

[2] Caution is necessary for interpretation of age 3 and 4 CPUE in 1995 and 1996 because fish smaller than 25 kg were released in these two years.

2-3). For example, if the recruitment level were markedly high as shown by the scientific aerial survey index in 2016 for age 3 SBT, CPUE would also be substantially high in age 9 in 2022 and age 10 in 2023 compared to other years, but this has not occurred clearly.

In Area 4/May 2025, and in Area 9/May and June 2025, higher CPUE values were observed compared to those in past years.

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) except some modification described below. The standardization model used was the same as that of Nishida and Tsuji (1998). The terms "w0.5" and "w0.8" represent weightings between Variable Square (VS) and Constant Square (CS) hypotheses (Takahashi et al. 2001). For instance, w0.8 weighs 0.8 of CS.

At the ESC for the SC21 in 2016, New Zealand (NZ) and Japan advised that no Japanese-flagged foreign charter vessels in the NZ SBT fishery (NZ joint-venture) operated in 2016 due to amendment of the NZ domestic law for vessels operating within the NZ exclusive economic zone, and therefore there would be no observations from the charter vessels for Areas 5 and 6 in the CPUE dataset from 2016 onward (CCSBT 2016). To minimize the impact of the loss of these data on the CPUE series, an approach that the statistical areas in which the charter fishery operated historically with those immediately adjacent were combined (Area 5 into 4 and Area 6 into 7) was proposed (Takahashi 2017) and agreed to be used for future analysis (CCSBT 2017). This approach retained historical data in the standardization and did not have an appreciable impact on the indices, although there were some divergence/differences in trends between CPUE indices by this and previous approaches, especially for age groups 5, 8-11, and age 12+ (see Appendix Fig. A-1 in Takahashi and Itoh 2017).

As mentioned in the nominal CPUE section above, estimates of the CPUE indices for 2024 (the most recent year when catch and effort data are available) were based not on logbooks but RTMP data only as described in the Nominal CPUE section above. Although these estimates may be changed slightly when logbook data become available the subsequent year (Takahashi et al. 2001), almost no change has been found between the RTMP and logbook in recent years.

As also mentioned above, CPUE in 2006 and subsequent years must be examined carefully because Japanese longline fishery has introduced the IQ system since 2006 (Itoh 2012).

Looking to trends in about past 5 years, the w0.5 and w0.8 indices for age 3[3] have increased consistently (Fig.1-5a). The 2024 indices for this age were considerably above the past 5-year averages over 2019-23. As in the case of nominal CPUE (Fig. 1-2), the trend of CPUE index for age 3 has diverged from ones for age 4 and 5 by various reasons (e.g., incomplete recruitment of age 3 fish into Japanese longline fishery, small fish releases/discards in recent years). Therefore, as a signal of recruitment fluctuation, the age 3 indices should be looked at and interpreted with caution.

The indices for age 4 fluctuated from 2019 to 2024 and substantially increased in 2022 then

[3] Caution is necessary for interpretation of age 3 and 4 CPUE in 1995 and 1996 because fish smaller than 25 kg were released in these two years.

dropped in 2023 (Fig. 1-5b). The age 4 indices may also be influenced by small fish releases/discards in recent years. The 2024 indices for age 4 were above the past 5-year averages.

The CPUE indices for age 5 increased substantially in 2022 and 2023, then dropped in 2024 (Figs. 1-5c). The indices for age 5 in 2024 were lower than the past 5-year means.

The CPUE indices for age group 6&7 increased from 2021 (Figs. 1-5d). The indices for this age class in 2024 were considerably higher than the past 5-year averages.

The CPUE indices for age group 8-11 fluctuated around the same level from 2020 to 2024 (Fig. 1-5e). The 2024 indices for this age class were slightly higher than the past 5-year averages.

The CPUE indices for age 12+ show increasing trends from 2020 overall (Fig. 1-5f). The indices in 2024 for this age group were higher than the past 5-year means.

Fig. 1-6 compares trends of various CPUE indices for age 4+. These indices are: "N&T model" series which used Nishida and Tsuji (1998) model and 5x5-degree aggregated all vessel data; "GAM22" series which was agreed in 2022 as the CPUE index used for the operating model (OM) conditioning and management procedure (MP) inputs and future stock assessment (CCSBT 2022, Hoyle 2022, Itoh and Takahashi 2025). The terms "w0.5" and "w0.8" represent weightings between VS and CS (see above).

All trends of these indices for age 4+ showed similar patterns up to about 2007, but divergences have occurred since then (Fig. 1-6). Overall, the indices for age 4+ show increasing trends from 2007. The occurrence of the divergences coincides with the implementation of the IQ system into the Japanese longline fishery.

<u>Spatial-Temporal (ST) windows 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" represent Area 9/May and June, and Area 8/September and October. By inspecting historical Japanese longline catch/effort data, these spatiotemporal strata were so defined as to persistently observe substantial effort of the longline fishery. However, it was noted that the assumption on such persistency in the ST windows concept was no longer valid due to changes in operation pattern of Japanese longliners (Takahashi and Itoh 2012). Given this, the ESC agreed that while the ST windows series had been a useful "extreme" series for contrast with other series, there was a need to replace the ST Windows series (CCSBT 2012) and therefore the series is no longer submitted to the CCSBT Secretariat as a data exchange requirement. Yet we consider that it may be useful to continue monitoring the ST windows series because the series would still be able to capture some aspect of stock trend, and thus we include this series in this document.

The trend of the ST windows is shown in Fig. 1-7. Overall, the index has increased gradually since 2007, when the historically lowest level was observed, to 2020. The index showed a slightly decreasing trend in recent past years. The 2024 point was just below the past 5-year average.

2. Recruitment indices:

Australia purse seine fishery

Changes of catch (in weight, ton) per effort and age composition of Australia purse seine fishery catches were plotted in Figs. 2-1 and 2-2, respectively. Although interpretation of the CPUE of this fishery is contentious, monitoring changes of the CPUE merits having some insight into status of juvenile fish along with other recruitment indices.

There were no marked changes observed in both catch per shot and catch per search hour in recent years (Fig. 2-1). Both catch/shot and catch/search hour in 2024 (2023/24 season) were below the past 5-year mean over 2019-23.

Generally, the proportions for age 2 fish in purse seine catch between 2004 (03/04 season) and 2024 (23/24 season) were greater than any of other years except for 2010, 2014, and 2017 (Fig. 2-2). Since 2020, the age 2 fish have dominated the catch (about 80% or over of total catch), and its proportion (ca. 98%) was the highest among past years in 2023. Contrary, proportions for age 3 and 4 have decreased considerably since 2022.

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 previous 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.

Scientific aerial survey (AS) index

Trend of aerial survey (AS) index (Eveson and Farley 2017) in the Great Australian Bight (GAB) are shown in Fig. 2-3. This index is considered to monitor surface abundance of ages 2-4 fish combined distributed in the GAB region. The AS had been conducted by Australia since 1993. Full scale line transect AS was suspended between 2001 and 2004. The AS had been financially assisted by other CCSBT members through the Secretariat since 2013. The AS was not conducted in 2015 for budgetary reasons and resumed in 2016. The AS has not been conducted since 2018 for both budgetary and logistic reasons. The AS index was replaced with an index for age 2 fish abundance obtained from the gene-tagging (GT) project (CCSBT 2015a, Preece et al. 2015).

Although the AS index has not been available since 2018, the figure for the AS index is presented to compare with other indicators.

Overall, the AS index showed a moderate decline from 1993 to the early 2000s. The AS index values were at a similar level in the rest of the 2000s. The AS index increased in 2010 and 2011, largely dropped in 2012, and then drastically upturned in 2014 and 2016. The 2017 value of the AS index decreased to the similar level of the 2014 AS index and was near the past 5-year average over 2011-16. However, the 2017 estimate was significantly above the long-term average (Eveson and Farley 2017).

Age 2 SBT abundance from the gene-tagging (GT) project

The GT project for SBT (Preece et al. 2015) has been conducted under the CCSBT Scientific Research Program (SRP) since 2016 (CCSBT 2015b) to obtain an estimate of absolute abundance of age 2 SBT as a fisheries-independent indicator for recruitment in place of the AS index.

For estimation of age 2 abundance in 2023, in total, 2,759 fish were tagged in 2023, 13,297 fish were included in the harvest sample set of 2024, and 14 matches were detected (Preece et al. 2025, Table 1). The abundance estimate is 2.62 million with a CV of the estimate of 0.267. Although the age 2 abundance estimates increased from 2019 to 2021 with respect to point estimates, this increasing trend is unclear given the CVs.

There is not an estimate of age 2 abundance in 2020, because the 2020 tagging field work was cancelled due to COVID-19 restrictions, poor weather conditions and difficulty finding fish (Preece and Bradford 2023).

Table 1. The results of the gene-tagging programs 2016-2023.

Year	N releases	N harvests	N matches	Abundance estimate (millions)	CV
2016	2952	15389	20	2.27	0.224
2017	6480	11932	67	1.15	0.122
2018	6295	11980	66	1.14	0.123
2019	4242	11109	31	1.52	0.180
2020	Interrupted by Covid-19 and others			NA	NA
2021	6401	10742	41	1.68	0.156
2022	5084	14714	38	1.97	0.162
2023	2759	13297	14	2.62	0.267

<u>Trolling survey index</u>

Because a vast amount of costs was necessary for conducting the Recruitment Monitoring acoustic surveys using a sonar unit in the past (1996-2006), a recruitment index of age 1 fish estimated from results of much lower-cost trolling surveys was developed in 2006. Details of the trolling survey design, estimation method, results and its interpretation were documented in Itoh (2007), and Itoh (2025b). In addition, standardization of the trolling survey index (called "grid-type trolling index (TRG)") was described in Itoh (2025c). The TRG was standardized by using all data which included those of trolling catch collected in past acoustic sonar surveys and those of trolling catch in past and current trolling surveys over the whole survey area containing survey-piston lines. Therefore, the TRG provides a single consistent indicator for age 1 SBT from 1996 to 2025. The trolling survey was not conducted in 2015 to use time for doing in-depth analyses of the data.

Fig. 3-1 compares trends between the trolling indices and the TRG. For the trolling indices, only the bootstrap estimates of median were plotted. The trolling index on piston line (TRP) for 2021 could not be estimated because the survey design for 2021 had to be modified (no piston line was surveyed) due to the COVID-19 situation.

The median relative trends of trolling index and TRG appear similar although there are some differences in trend due to standardization for the TRG. Both TRG and TRP indices increased from 2005 to 2008 and fluctuated afterward showing somewhat decreasing trends. It should be noted that levels of TRG in recent years are near 2003 and 2005 levels, and TRP values in 2018 and 2019 are zero, suggesting potentially low recruitment.

Fig. 3-2 compares relative historical trends between the TRG and other recruitment indicators including recruitment estimates from the OM (Hillary et al. 2023). The trend of TRG was similar to those of OM estimates and standardized CPUEs for age 4 and 5 up to the 2015 cohort. Those trends appear to consist of the medium level of the mid-1990s year classes, the low level of the 2000 to 2002 cohorts, and the high level of the 2005 to 2014 cohorts. The trends have diverged after the 2016-year class. TRG has been at a low level since the 2015 cohort. Compared to this, recruitment indicators based on Japanese longline CPUE for ages 4 and 5 in the 2018- and 2017-year classes are considerably high. Estimates from gene-tagging suggest that the 2019 and later year classes are higher than the 2015- to 2017-year classes. Of the recruitment estimates from the OM, the 2018-year class is significantly higher than previous cohorts. It should be noted that the OM recruitment estimation includes data of Japanese longline CPUE (new GAM CPUE series, although different from the CPUE series for ages 4 and 5 used here) and data from gene-tagging, which means that the OM recruitment estimates are not independent from CPUE and gene-tagging. Contrary, TRG is not used for the recruitment estimation by the OM and thus can be considered as an independent index. Cause(s) of inconsistency among indices is not clear. One possibility is that the distribution and migration of age-1 SBT may have differed from those of other years. If this is true, it may have affected the age composition in the Great Australian Bight (Fig. 2-2) as well as the distribution and migration of age-2 fish and would affect estimates of gene-tagging. The status of other year classes beyond the 2021-year class are totally unknown except for TRG. It is necessary to continue to carefully monitor the status of recruitment in recent years by making full use of various information from scientific research as well as from fisheries.

3. Indonesian Catch (Spawning ground fishery):

Indonesian SBT catch both in number and weight as well as catches by two age groups, 8-16 and 17 and older, have varied from year to year (Fig. 4-1).

Catches for age class 17+ were higher than those for 8-16 ages throughout the 1990s. In contrast, many of yearly catches for the 17+ group have been similar to or lower than those for 8-16 ages since 2000/01 season. Spiky increases of catch in 2001/02, 2004/05, 2006/07, 2012/13, 2013/14, 2017/18 and 2019/20 seasons may be mainly due to large increase of younger age classes under 17 (also see Farley et al. 2021). Some earlier investigations suggested that the catch of small/young SBT was likely to have come from catches made in the south of the spawning ground (Farley et al. 2017). However, data which only included SBT catches by vessels predominantly operating in Area 1 (spawning ground) indicate that catches of small/young SBT came from the spawning ground (Farley et al. 2021).

Catch trends of both in number and in weight for age 8-16 and 17+ combined appear to gradually decline with fluctuations from 2001/02 season to 2009/10 season. The trends increased from 2009/10 to 2012/13 and then continued to decrease until 2016/17. The catches in number and weight have fluctuated afterward.

Smaller proportions of the older ages of Indonesian catch since 2001/02 season raise some concern of potentially low reproduction in spawning ground.

4. Overall Conclusion:

Fisheries indicators examined generally support the view that the current SBT stock levels for 4, 5, 6&7, 8-11, and 12+ age groups are well above the historically lowest levels observed in the late 1980s or the mid-2000s. CPUE indices for these age groups have fluctuated in an aperiodic way and/or showed increasing trends over the past 8 years. Especially, CPUE indices for age 4 and 5 showed drastic increases in recent years while other CPUEs for other age groups did not show such changes. Age-aggregated (age 4+ group) CPUE indices that include the one used in the operating model and management procedure show increasing trends over the past 10 years. The current levels of these indices are well above the historically lowest observed in the mid-2000s.

Various recruitment indicators inspected suggest that recruitment levels in recent years have been similar to or higher than those observed in the 1990s (before markedly low recruitments of 1999 to 2002 cohorts occurred) but the levels of recruitment have varied from year to year. It should be noted that the TRG recruitment index shows somewhat a low level from 2017 to 2025 (2016 to 2024 cohorts), and the TRP recruitment index recorded zero values in 2018 and 2019, suggesting some concern of potential low recruitment in recent years. High recruitment levels of the 2013 and 2014 cohorts estimated from the OM in the 2023 stock assessment (Hillary et al. 2023) (directly pertained to the highest value of the 2016 AS index) are not supported by longline CPUE indices by age (from 4 to 8 years old) from 2017 to 2021 and not supported by the TRG value in 2014. Further, the high recruitment level of the 2018 cohort estimated in the 2023 assessment (directly pertaining to the highest value of the 2022 GAM longline CPUE index) is not consistent with the 2019 TRG value.

Fishery indicators for spawning stock based on Indonesian catch were difficult to interpret and thus no specific conclusion was drawn.

The trends of the recruitment indices and the CPUE-based indicators in recent years were summarized in Fig. 5-1 and Fig. 5-2, respectively.

Considering uncertainty inherent in all the indicators examined, both fishery-dependent and fishery-independent indicators should continue to be further monitored and carefully examined in a synthetic way.

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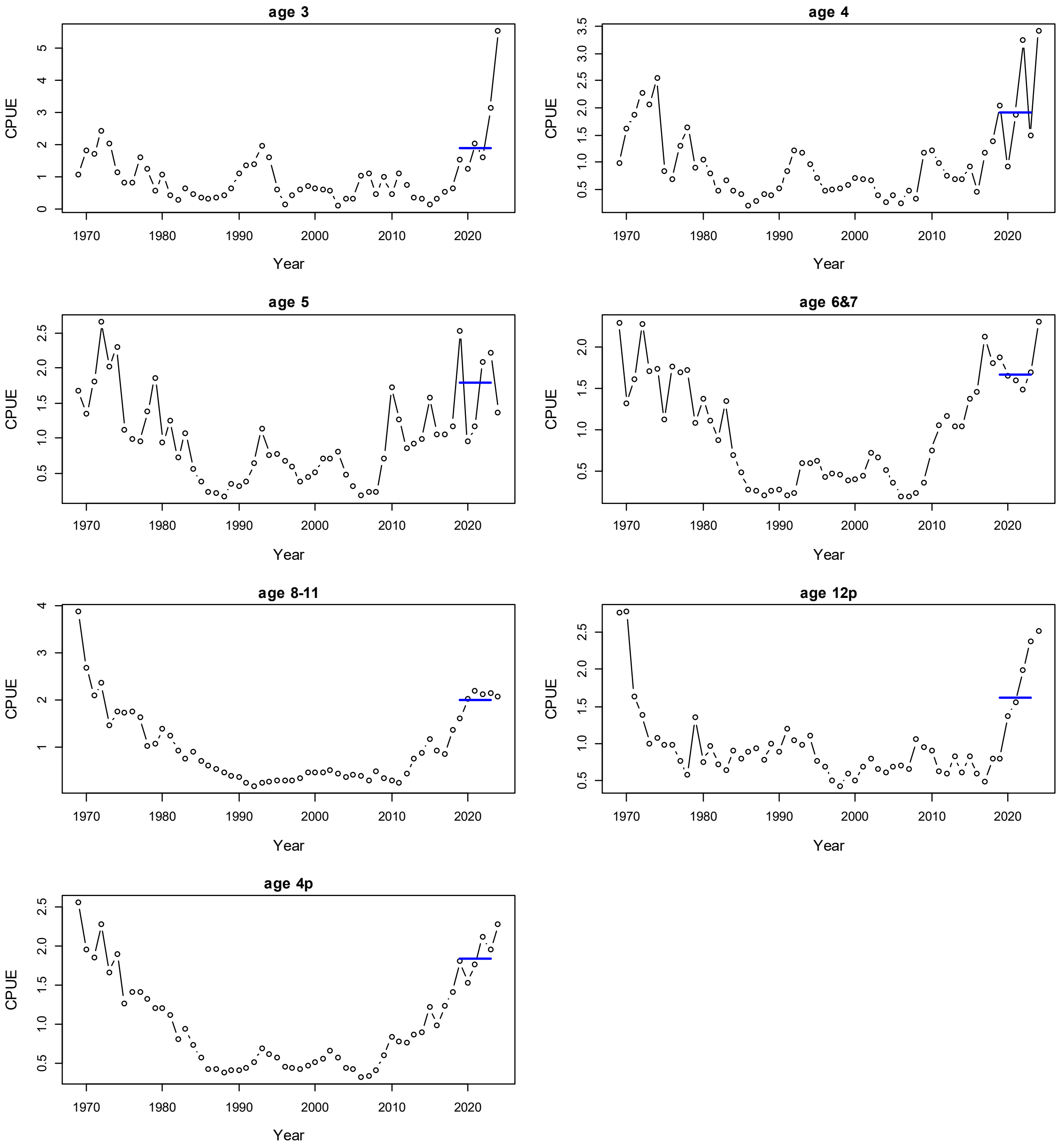


Fig. 1-1. Nominal CPUE of Japanese longline fishery by age groups. The horizontal lines indicate the recent past 5-year averages over 2019-23.

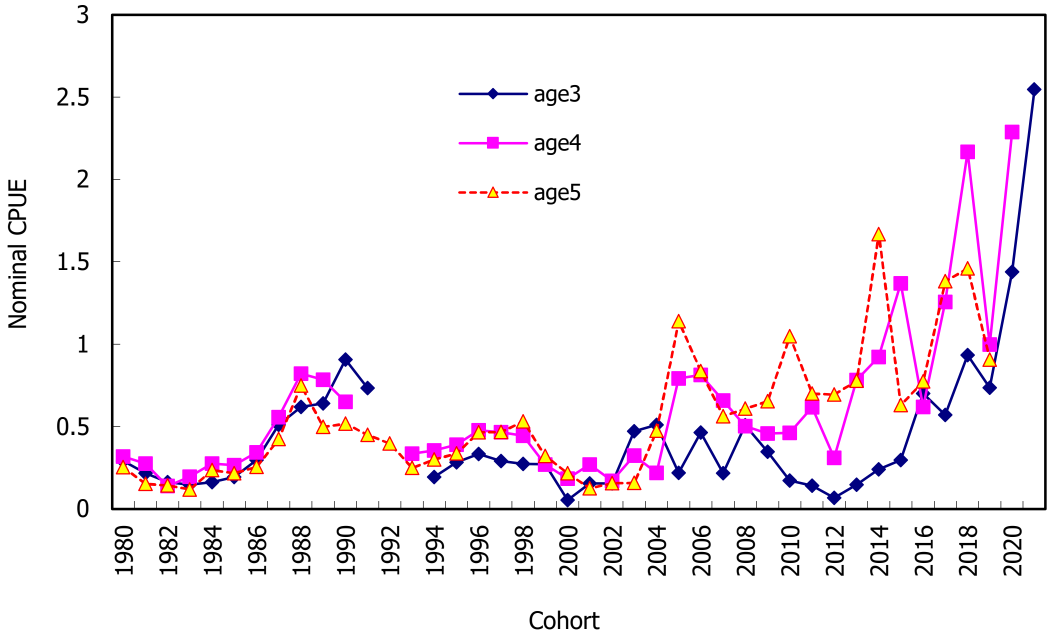


Fig. 1-2. Nominal CPUE of Japanese longline fishery by cohorts for age 3, 4, and 5.

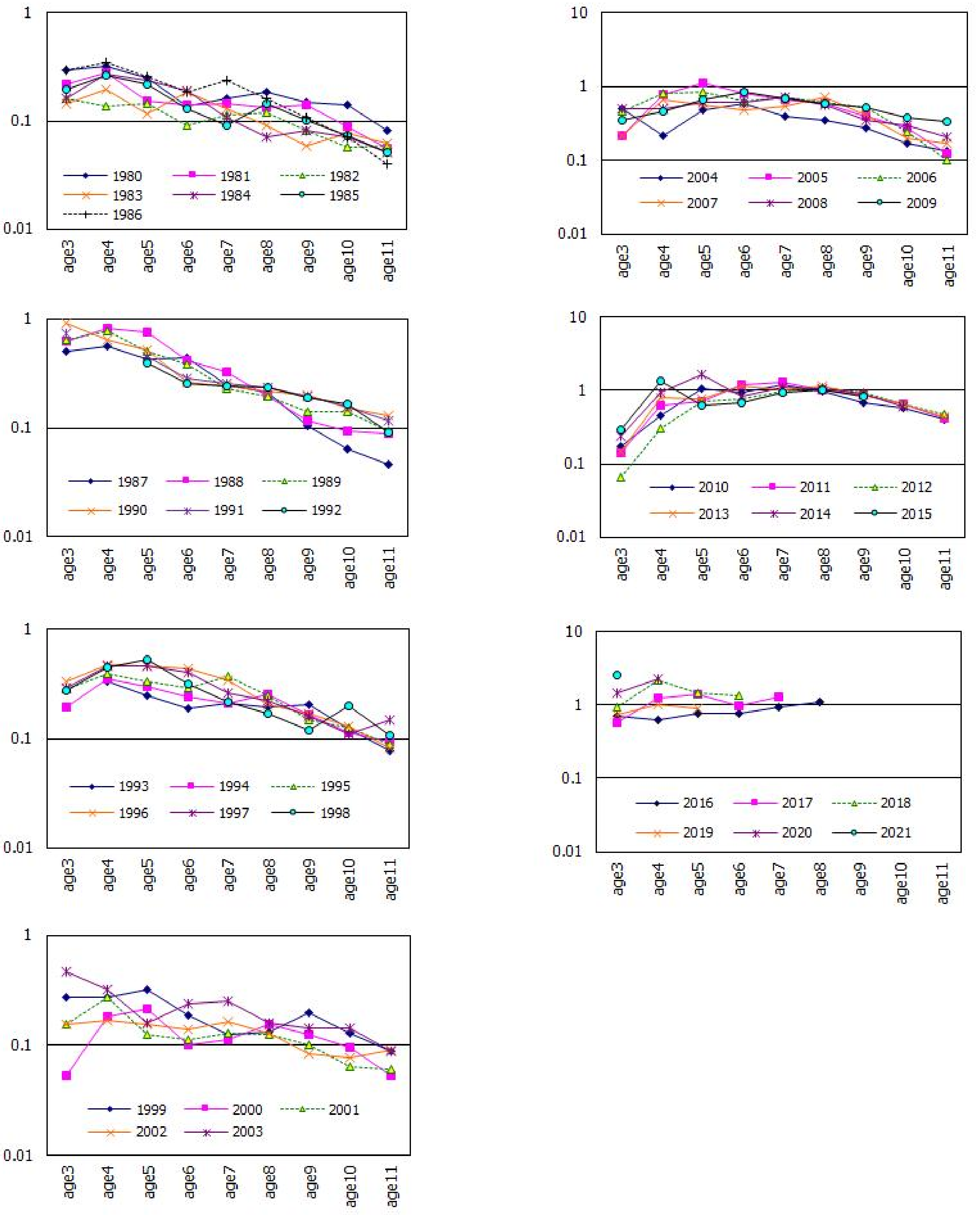


Fig. 1-3. Nominal CPUE of Japanese longline fishery by cohorts in log-scale.

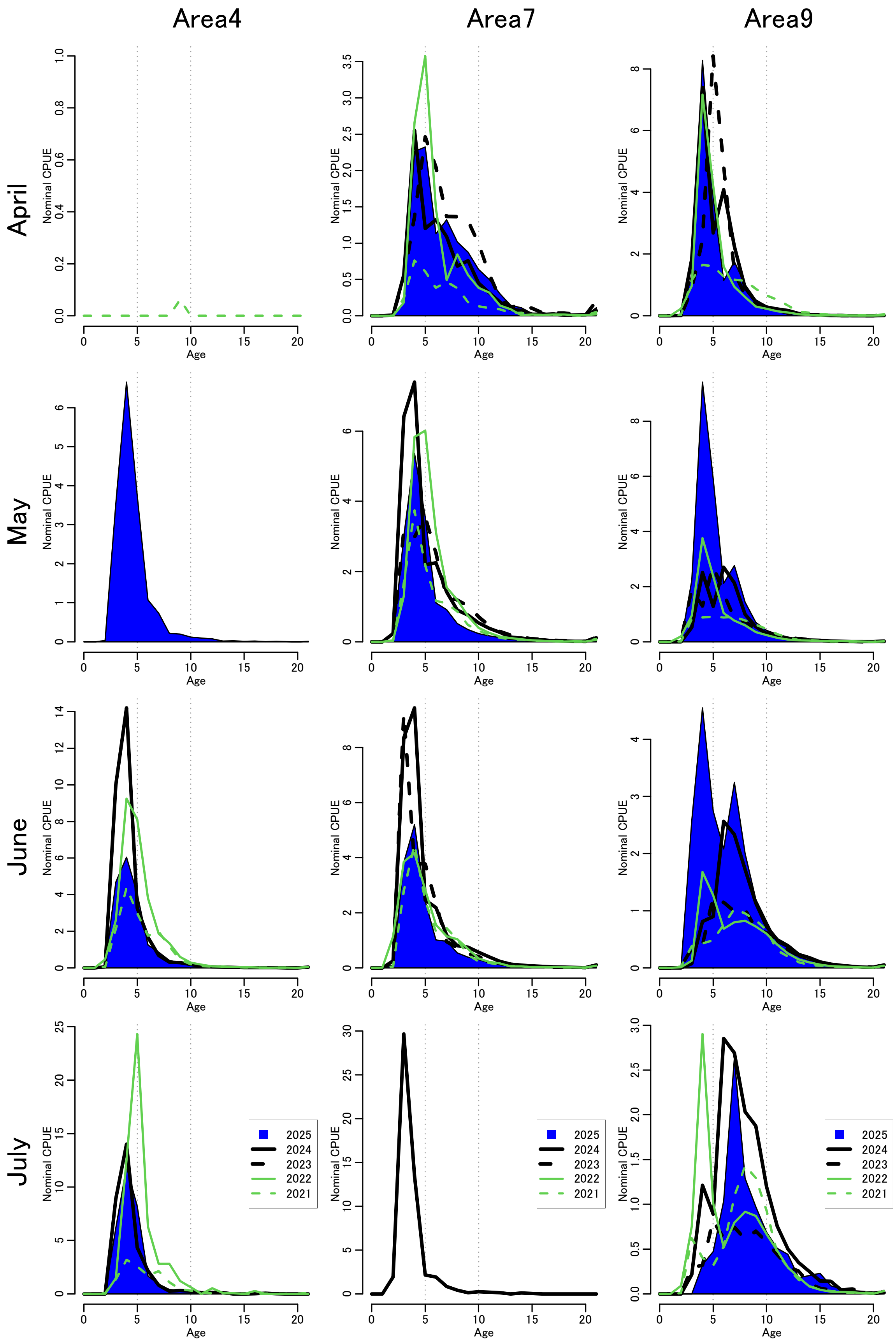


Fig. 1-4. Age composition of nominal CPUE of RTMP data for the recent five years by month and areas.

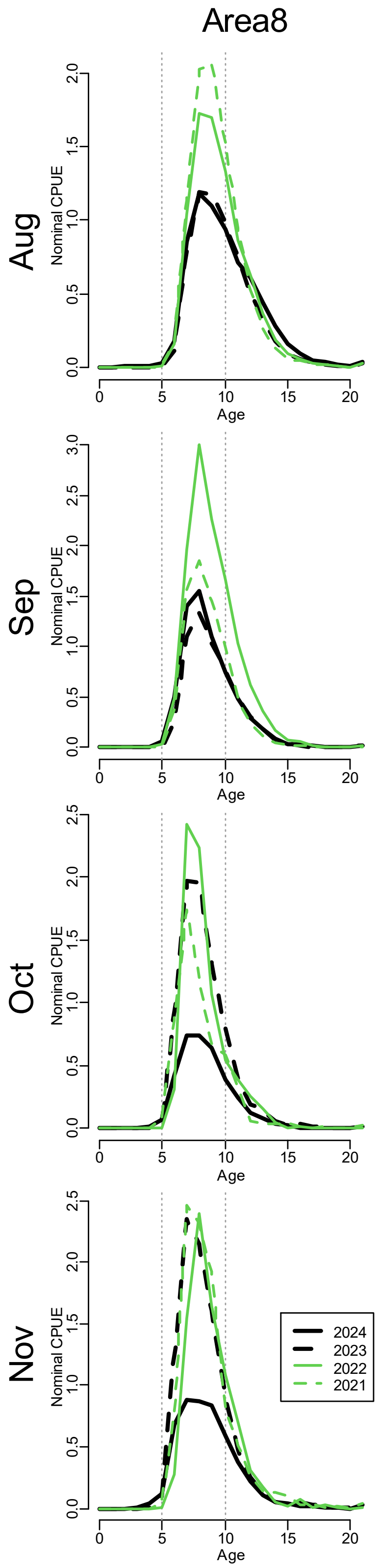
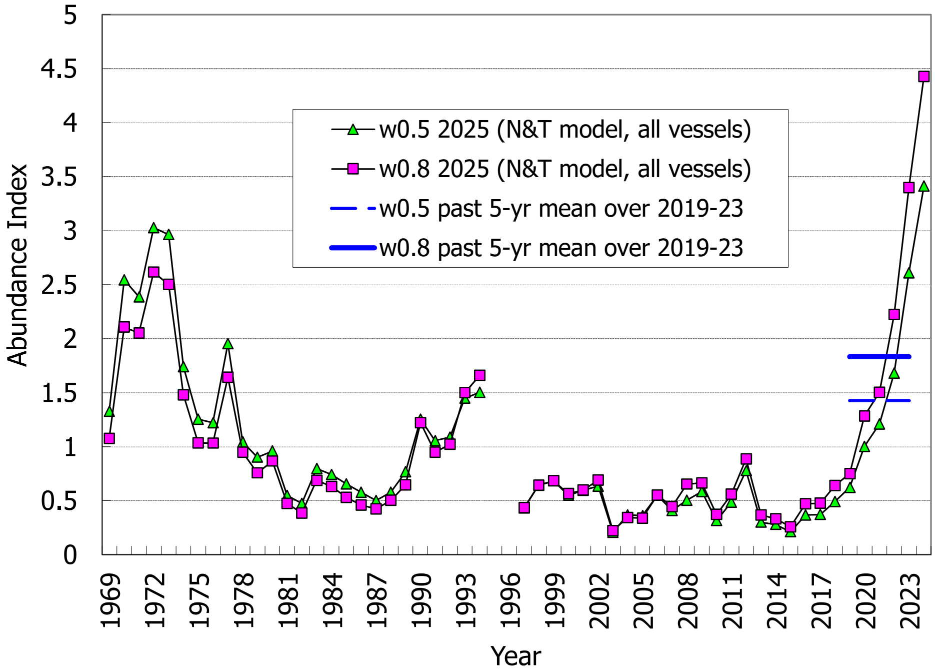


Fig. 1-4 (cont'd). Age composition of nominal CPUE of RTMP data for the past four years by month and areas.

(a) Age 3



(b) Age 4

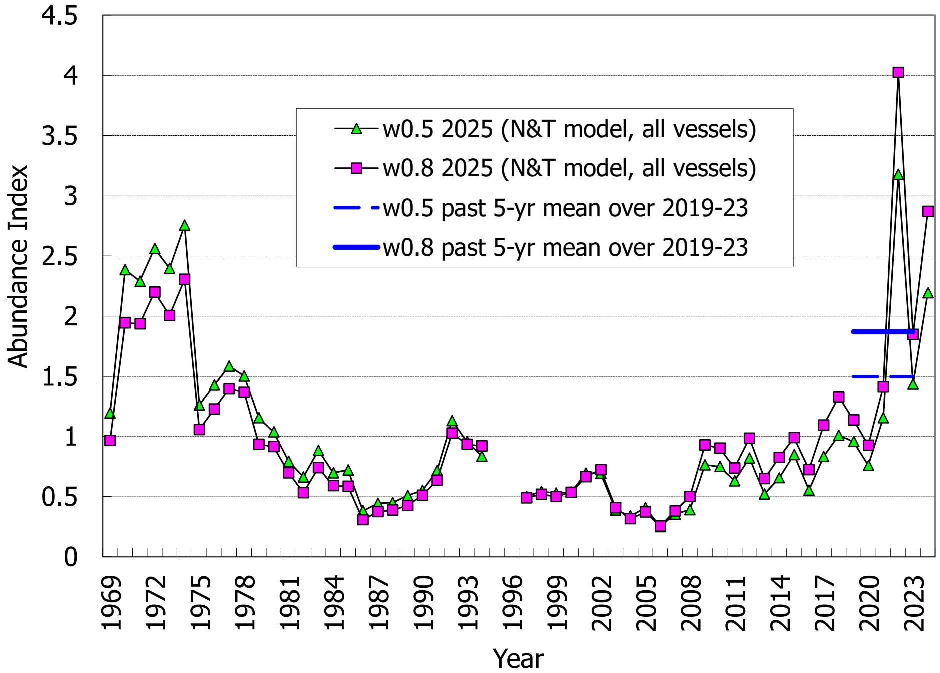
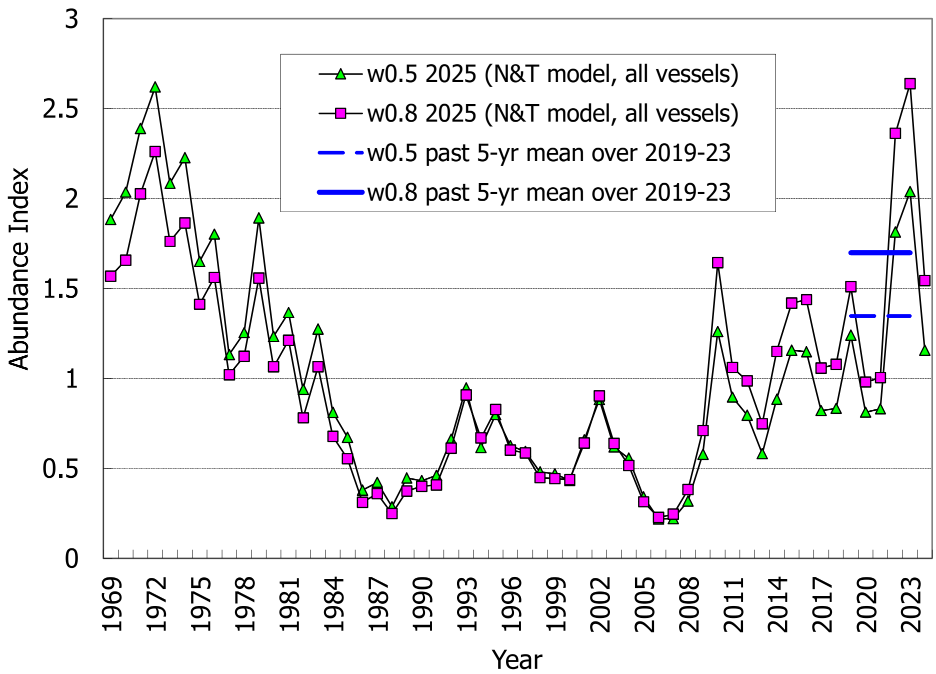


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998).

(c) Age 5



(d) Age 6&7

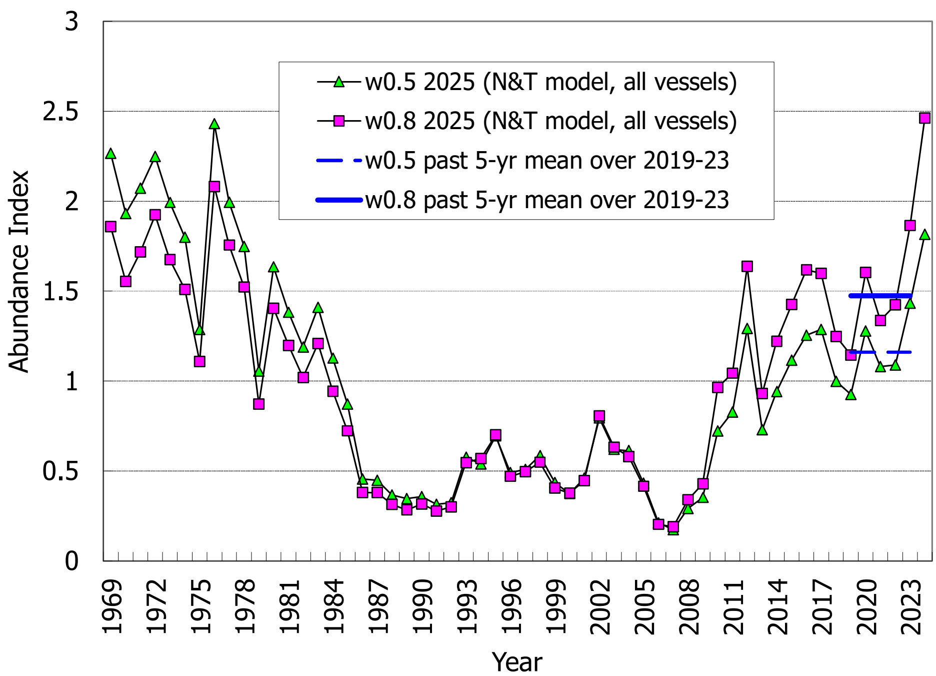
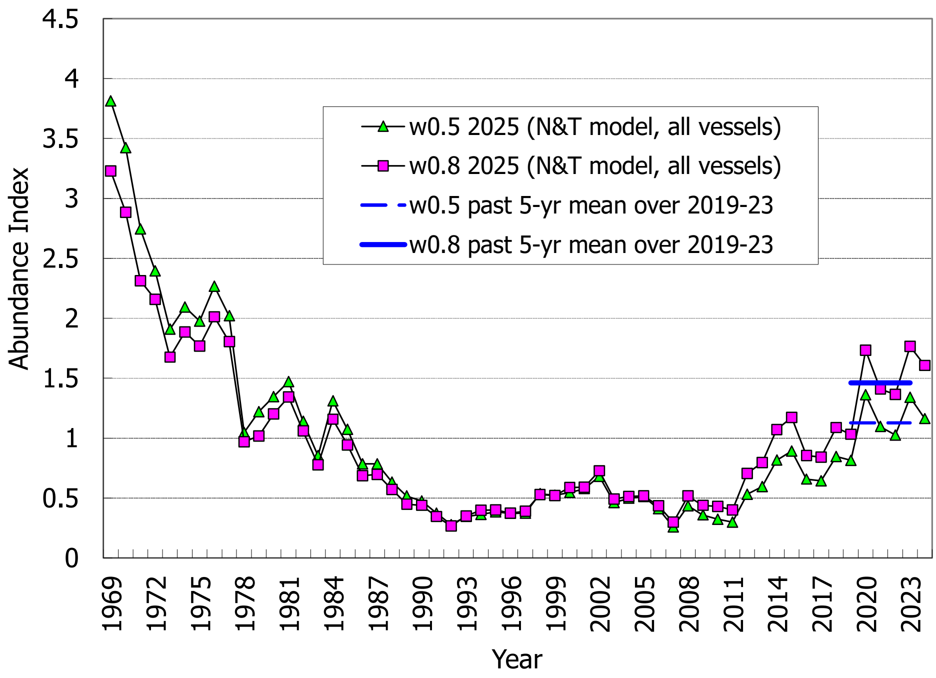


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998). (cont'd)

(e) Age 8-11



(f) Age 12+

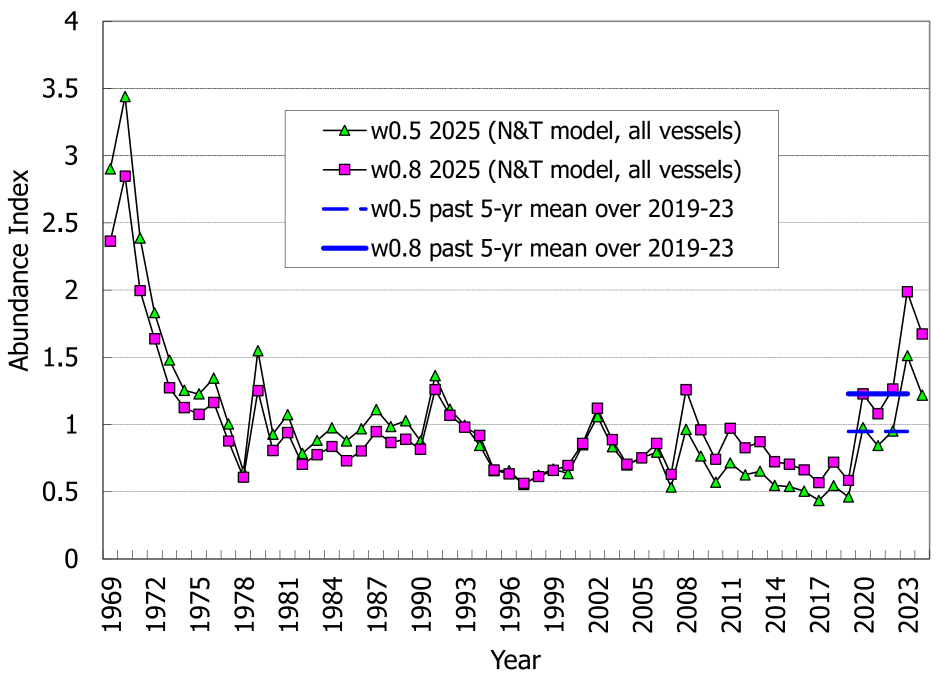


Fig. 1-5. Trends of normalized w0.5 (B-ratio proxy) and w0.8 (Geostat proxy) abundance indices. The standardization model used was the same as that of Nishida and Tsuji (1998). (cont'd)

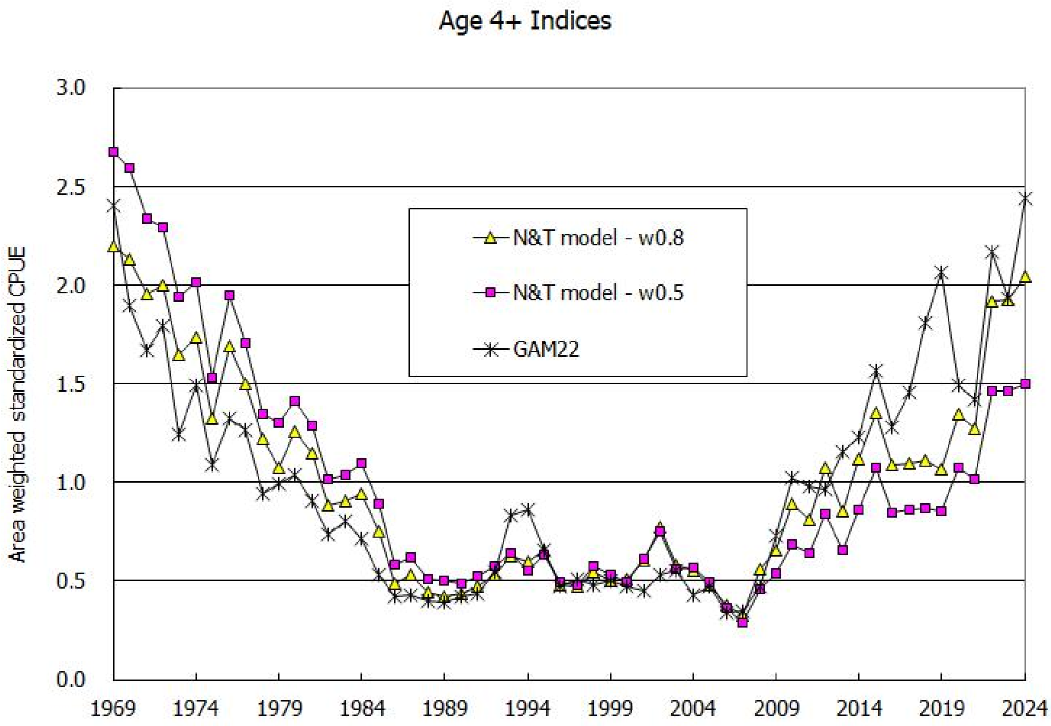


Fig. 1-6. Trends of various abundance indices for age 4+: Nishida & Tsuji model with all vessels data; GAM22 series with all vessels data.

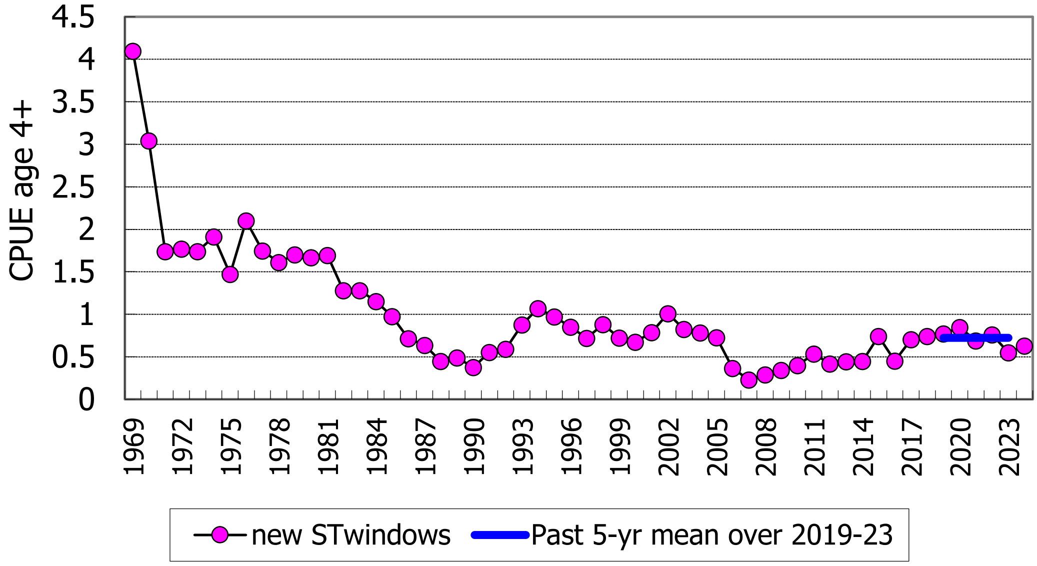


Fig. 1-7. Trend of normalized “ST Windows” index for age 4+ fish by the new calculation method.

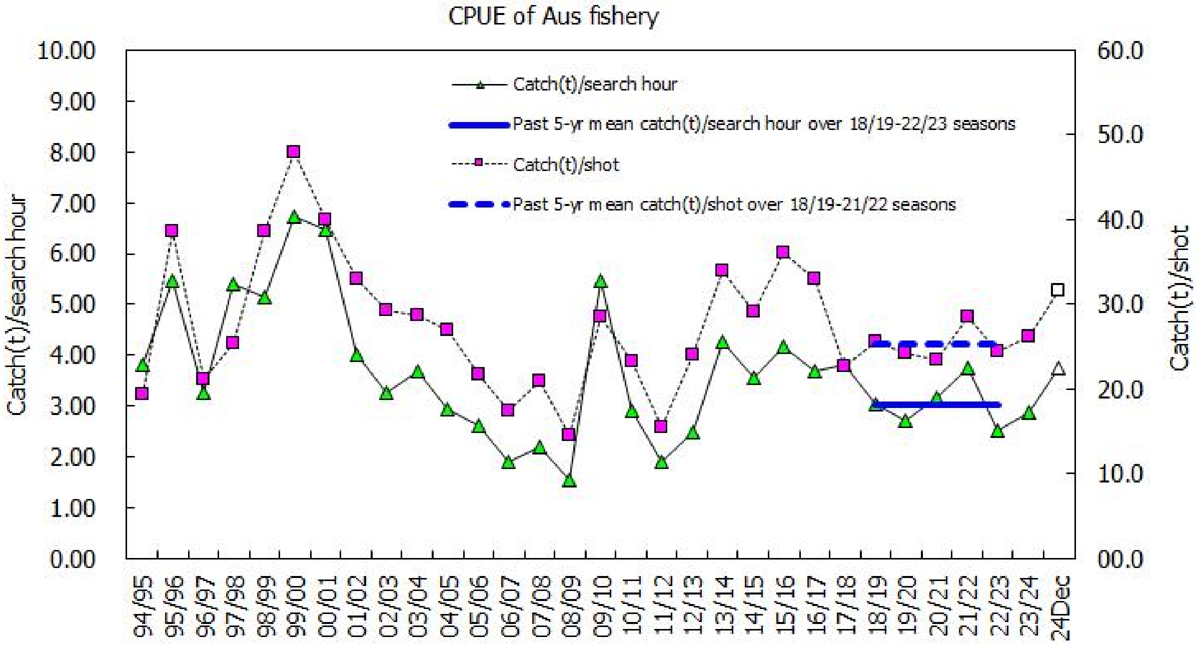


Fig. 2-1 Catch (in weight) per effort for Australia purse seine fishery.

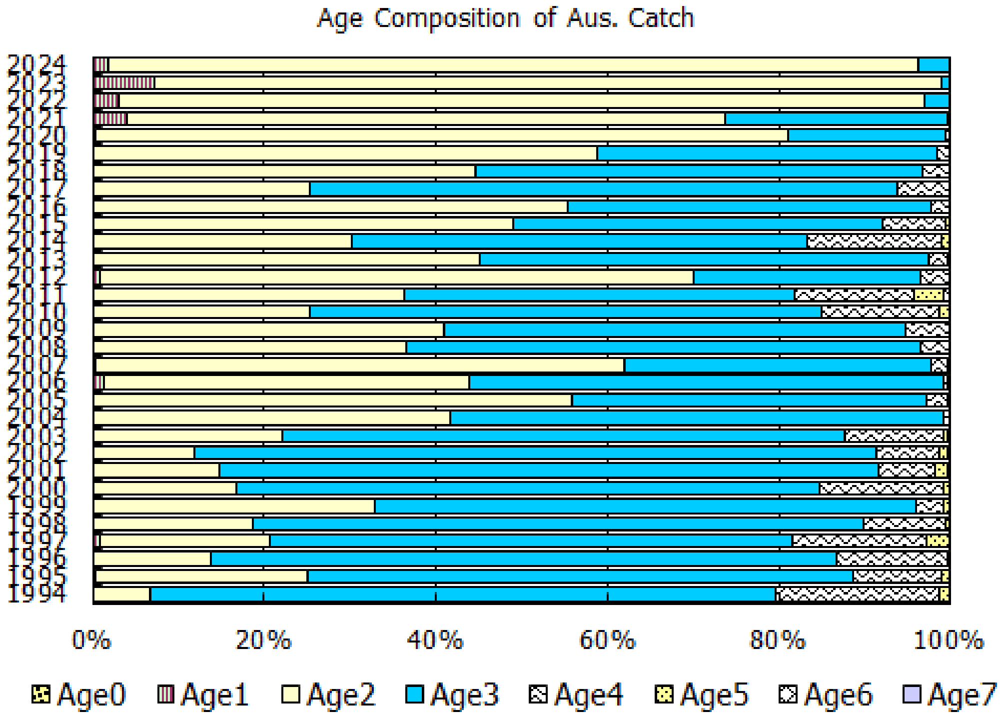


Fig. 2-2 Changes in the age composition of Australia purse seine catches.

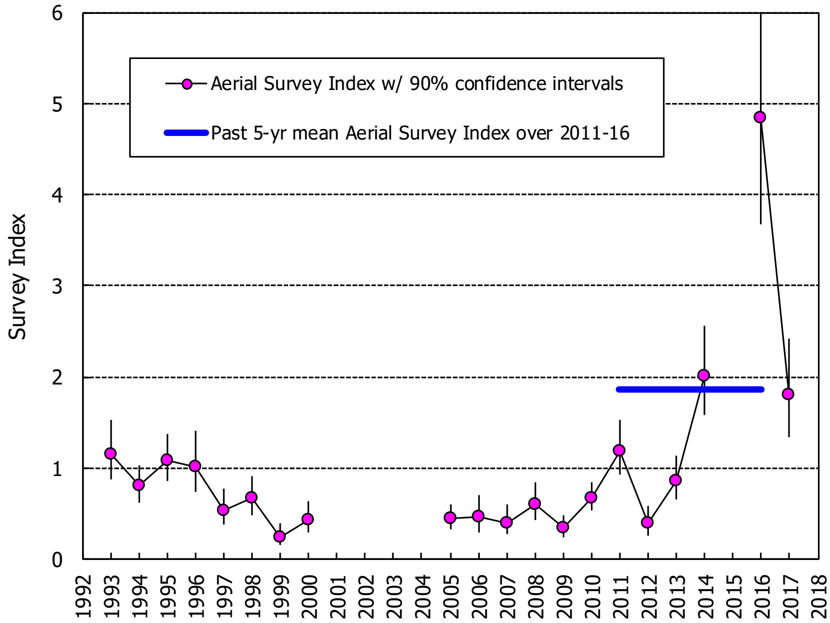


Fig. 2-3 Change in aerial survey index in the Great Australian Bight. Vertical bars indicate 90% confidence intervals.

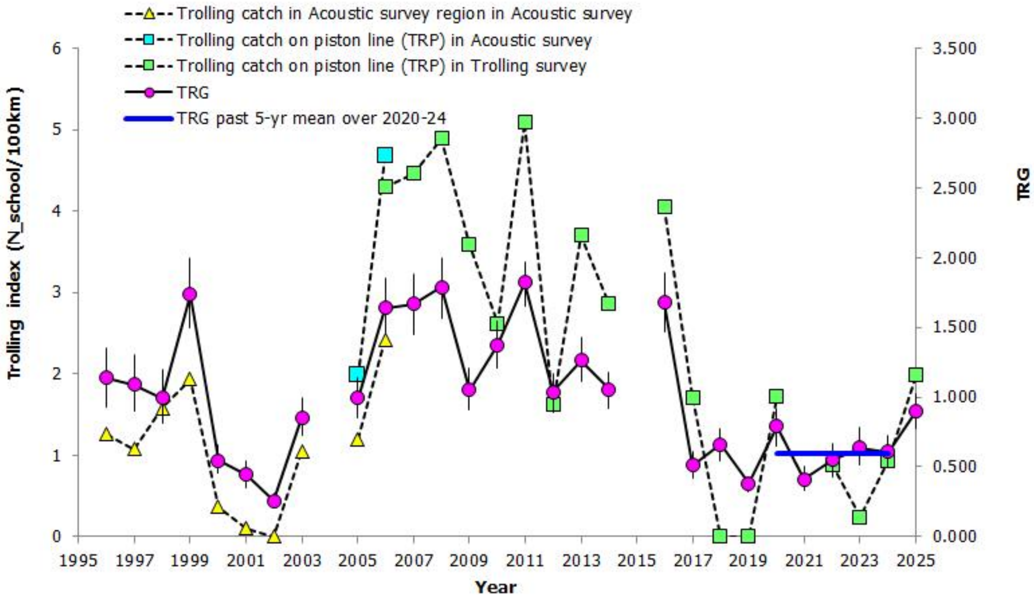


Fig. 3-1. Trends of various trolling catch index for age 1 SBT in the Western Australia. The previously reported trolling indices were indicated by dotted lines with symbols (Only the bootstrap estimates of median were plotted). "TRG" represents the standardized grid-type trolling index and vertical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

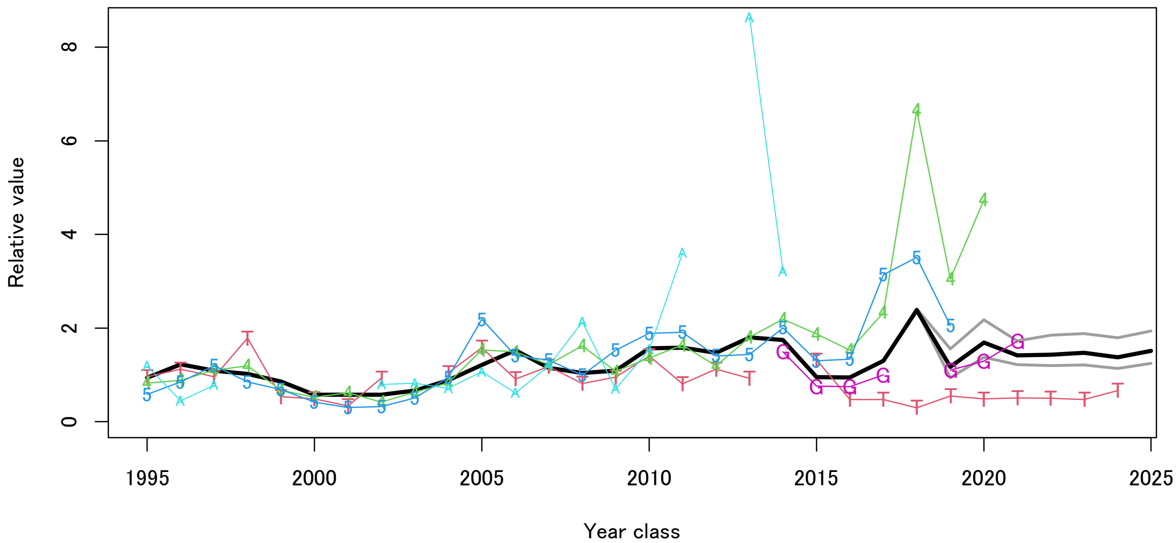


Fig. 3-2. Comparison of relative historical trends of various SBT recruitment indicators including recruitment estimates from the OM. A: aerial survey index, G: age 2 SBT abundance estimated from gene-tagging, T: grid-type trolling index, 4 and 5: standardized Japanese longline CPUE index for age 4 and 5 SBT, black and grey solid lines: median recruitment (with an 80% probability envelope) estimated from stock assessment using the OM. The G estimates were plotted as relative values to the average from 2014- to 2017-year classes, and other indices and estimates were relative to the average from 1995- to 2010-year classes.

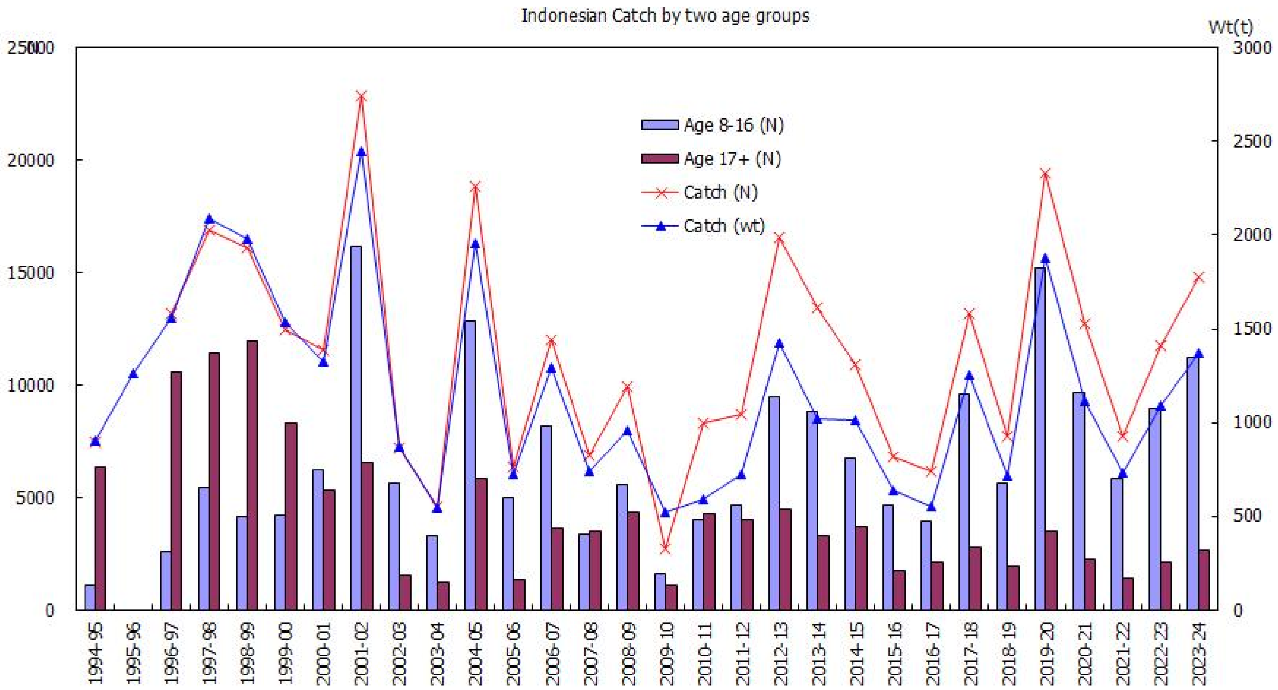


Fig. 4-1. Trends of Indonesian catches with proportion of two age groups occurrences.

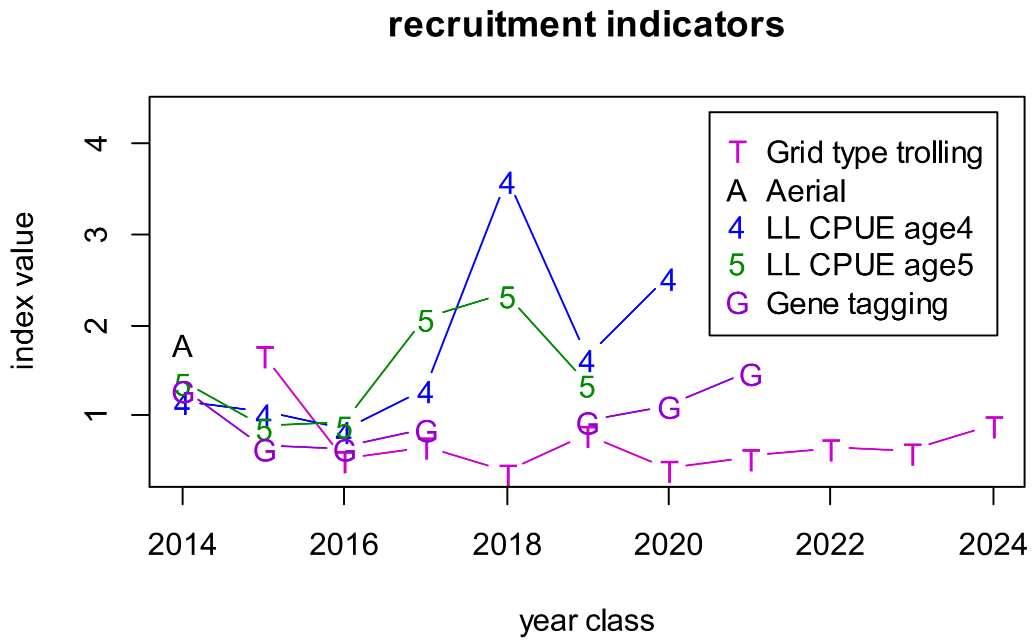


Fig. 5-1. Trends of recruitment in recent years. Note that the x-axis is year class, and the aerial survey (AS) index was plotted assuming that the AS index primarily represented the trend of age 3 SBT.

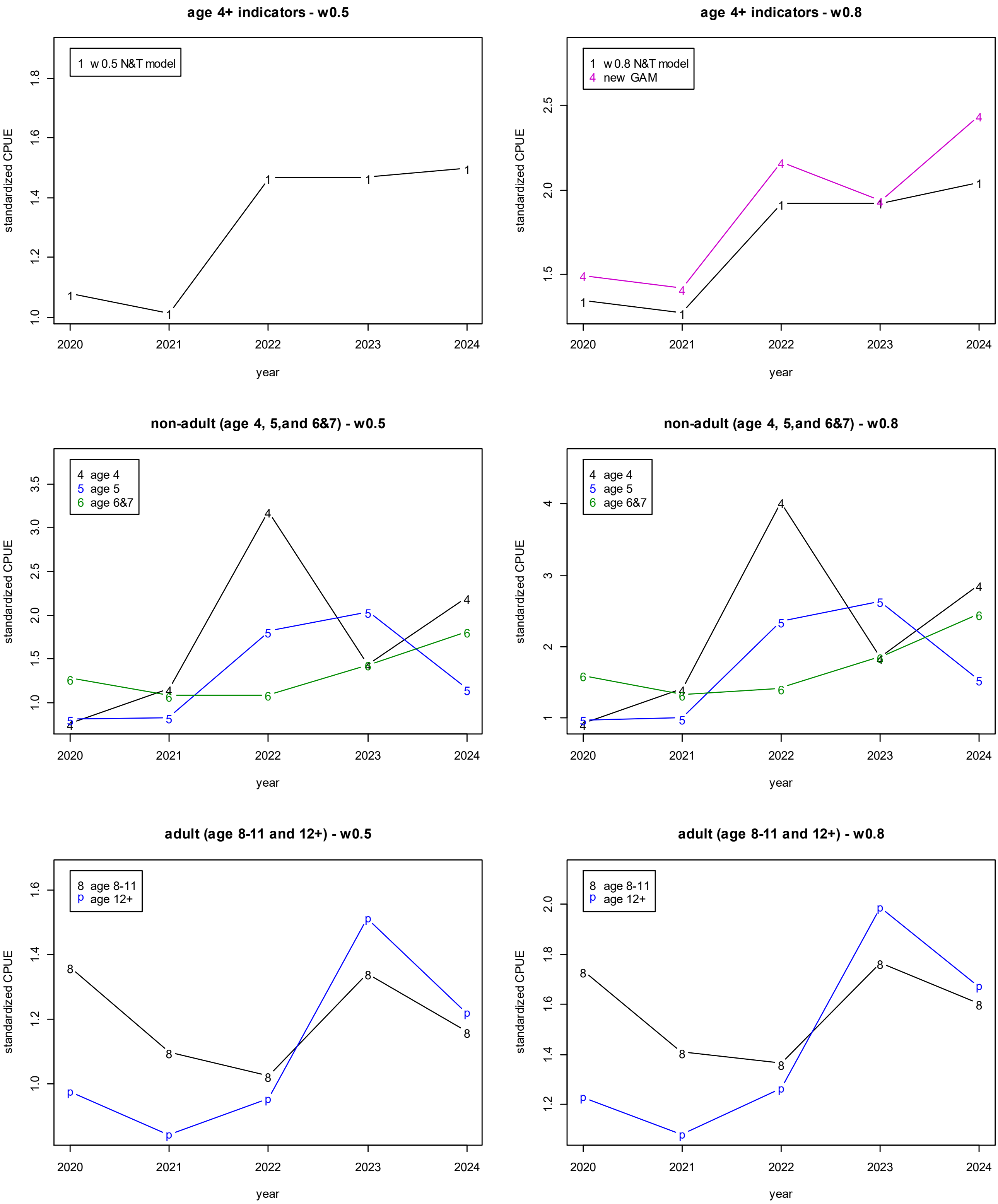


Fig. 5-2. Trends of CPUE-based indicators in recent years.