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# Fishery indicators for the southern bluefin tuna stock 2012–13

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# Summary

Fishery indicators have played an important role in the provision of advice to the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) on the status of the southern bluefin tuna (SBT) stock by the CCSBT Extended Scientific Committee (ESC) and its trilateral predecessor.

In 2011, at the eighteenth meeting of the CCSBT, the Commission agreed on the Management Procedure (MP) that would be used to guide the setting of the SBT global total allowable catch (TAC) to ensure that the SBT spawning stock biomass achieves the interim rebuilding target of 20 per cent of the original spawning stock biomass. The CCSBT will set the TAC based on the outcome of the MP unless the CCSBT decides otherwise based on information that is not otherwise incorporated into the MP. In 2001, it was agreed to monitor and review fishery indicators on an annual basis and fishery indicators are included in the development of the Scientific Committee's advice on status of the stock. Fishery indicators are particularly important in years where the stock assessment has not been updated.

The 2012–13 update of fishery indicators for the SBT stock summarises indicators in two groups: (1) indicators unaffected by the unreported catch identified by the 2006 Japanese Market Review and Australian Farm Review; and (2) indicators that may be affected by the unreported catch. Data collected in the longline fisheries after 2006 are unlikely to be affected by unreported catches because of the catch documentation activities that have been undertaken by CCSBT members, and therefore only the historical data for some indicators are possibly affected.

In this paper, interpretation of indicators is limited to subset 1, and recent trends in some indices from subset 2. The three indicators of juvenile (age 1–4) SBT abundance in the Great Australian Bight exhibited increases over the past 12 months (scientific aerial survey index, surface abundance per unit effort (SAPUE) / commercial spotting index and trolling index). Indicators of age 4+ SBT exhibited some upward trends with the catch per unit effort (CPUE) from the New Zealand domestic and charter fisheries increasing in 2012. However, the Japanese longline nominal CPUE for ages 4+ decreased slightly. Indonesian otoliths were not aged for 2011–12 season. However, the median length class of SBT on the spawning grounds decreased slightly in 2011–12, but has fluctuated around the same values since 2001–02.

# 1 Background

Fishery indicators have played an important role in the provision of advice to the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) on the status of the southern bluefin tuna (SBT) stock by the CCSBT Extended Scientific Committee (ESC). In 2001 it was agreed to monitor and review fishery indicators on an annual basis (CCSBT-SC 2001). Indicators can provide a broad perspective on recent changes in the status of the SBT stock and include some information that is not otherwise incorporated into model-based assessments. In particular, some indicators reflect the status of the juvenile portion of the stock and represent some of the only fisheries-independent data available to the ESC.

Some fisheries-dependent indicators could have been affected by unreported catches and potential biases identified by the 2006 Japanese Market Review (Lou et al. 2006) and Australian Farm Review (Fushimi et al. 2006). Data collected in the longline fisheries after 2006 are unlikely to be affected by unreported catches because of the catch characterisation and documentation activities that have been undertaken by the CCSBT members. The 2012–13 update of fishery indicators for the SBT stock summarises indicators in the same groups presented in previous updates in 2007 to 2012 (Hartog et al. 2007, Hartog & Preece 2008, Phillips 2009, Patterson et al. 2010, Patterson et al. 2011, Patterson et al. 2012):

1) **Indicators unaffected by the unreported catch:**

- Aerial spotting data in the Great Australian Bight (scientific aerial survey; surface abundance per unit effort [SAPUE] / commercial spotting index)
- Trolling index
- New Zealand catch per unit effort (CPUE; charter and domestic)
- New Zealand longline fishery size composition
- Indonesian longline fishery size/age composition.

2) **Indicators that may be affected by the unreported catch**

- Reported global catch and retrospective estimates of unreported catch
- Japanese, Korean and Taiwanese CPUE
- Size/age composition in the Japanese, Korean and Taiwanese longline fisheries
- Age composition in the Australian surface fishery.

In this paper, interpretation of indicators is restricted to the subset (1) considered to be unaffected by the unreported catch, and recent trends in some indicators from subset 2. This paper updates the information provided by Patterson et al. (2012) with the most recent data available through the CCSBT data exchange in July 2013.

# 2 Indicators unaffected by the unreported catch

## Scientific aerial survey

The scientific aerial survey index has been updated from data provided by Australia through the CCSBT data exchange (AU_AerialSurvey_93_13).

A line-transect aerial survey conducted in the Great Australian Bight between January and March provides a fisheries-independent estimate of the relative abundance of aggregated 2–4 year old SBT (Eveson et al. 2013). The survey was suspended in 2001 because of logistical problems, but re-established in 2005 after analyses demonstrated that the survey provides a suitable indicator of relative juvenile abundance (Eveson et al. 2013).

The index of relative juvenile abundance in 2013 (the 2012–13 fishing season) is substantially higher than the 2012 estimate (2011–12 fishing season). Indeed, the 2013 index is the second highest index obtained for the scientific aerial survey over the past 9 years.

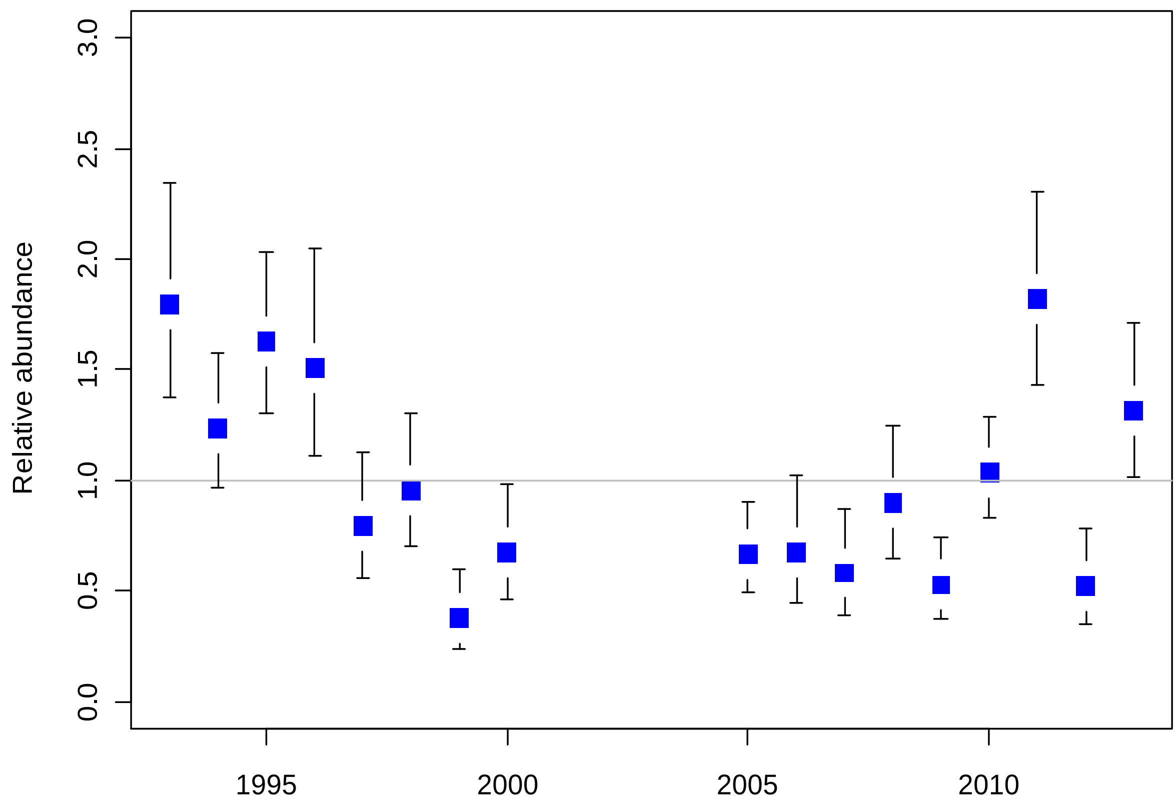


**Fig. 1. Scientific aerial survey index of relative abundance of juvenile SBT in the Great Australian Bight, January–March (hence the 2013 value represents the 2012–13 fishing season etc) from Eveson et al. (2013). Vertical lines are 90% confidence intervals. The horizontal line represents a relative abundance of 1.0.**

# Surface abundance per unit effort (SAPUE) / commercial spotting index

The commercial spotting (SAPUE) index has been updated from data provided by Australia through the CCSBT data exchange (AU_CommercialSpotting_2003_13).

Data on sightings of SBT schools in the Great Australian Bight were collected by experienced tuna spotters as part of commercial spotting operations over eleven fishing seasons, 2001–02 to 2012–13. The data were used to produce standardised fishery-dependent indices of juvenile SBT relative abundance (surface abundance per unit effort; SAPUE). The SAPUE index reflects the aggregated abundance of age 2–4 year old SBT. The lowest values in the series (2002–03 and 2003–04) therefore represent, as age 2–4 year olds, the low year classes observed in 1999–2001 and 2000–02 in other data sets (Farley & Basson 2013). Farley & Basson (2013) urge caution when directly comparing the last nine years of the SAPUE with the overlapping period of the scientific aerial survey index (2004–05 to 2012–13) as the data were collected using different methods and commercial flights cover a much smaller area than the scientific line transect aerial survey. Note that the SAPUE is now from 2003 onwards, rather than 2002. This is due to a change in the model that includes variables that were not collected in 2002.

Median estimates have varied over the series, however an increasing trend is discernable up to 2011 (Fig. 2). The 2012–13 value was substantially higher than the value in 2011–12 (Fig. 2).

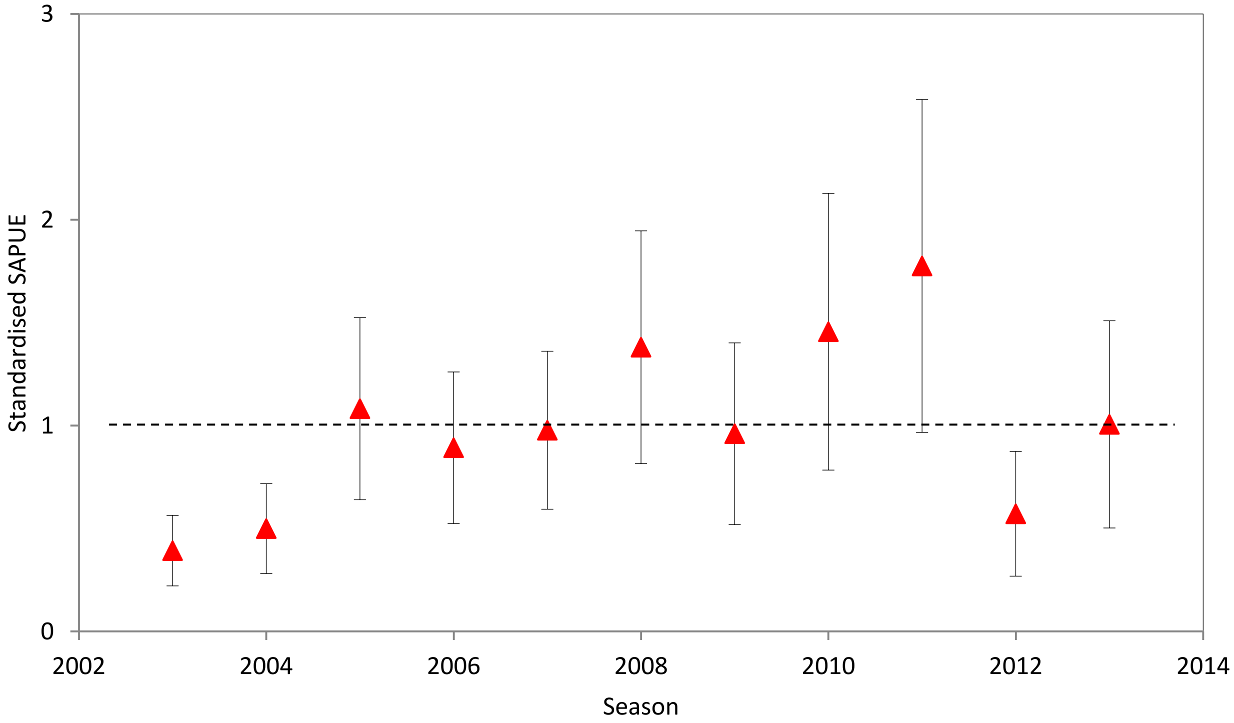


**Fig. 2. SAPUE index of relative surface abundance of juvenile SBT in the Great Australian Bight, December–March (Farley & Basson 2013). Estimates are median ± 2 standard errors. The dashed horizontal line indicates the mean. 'Season' represents the second year in a split-year fishing season, i.e. '2013' is the 2012–13 fishing season.**

# Trolling index

The trolling survey index has been updated from data provided by Japan through the CCSBT data exchange (JP_Trollindex2013).

The trolling survey is conducted by the Japanese National Research Institute of Far Seas Fisheries and is designed to provide a qualitative index of relative recruitment strength of age 1 SBT off the Western Australian coast (CCSBT-ESC13 2008, para 115). The ability of the index to measure abundance of age 1 SBT is still unknown (Itoh 2007). The trolling index is comprised of: (1) a piston-line trolling survey, 2006–13; (2) trolling catch data from the acoustic survey 'on' the piston line, 2005–06; and (3) trolling catch data from the acoustic survey off the piston line, 1996–2003 and 2005–06 (Itoh & Sakai 2009). Methods used to obtain comparable data from these three sources are documented by Itoh (2007) and Japan has noted that all the indices reflect the number of SBT schools per 100 km, but have not been merged or converted to be quantitatively the same (CCSBT-SC 2010, para 81). The ESC has noted that data from the new piston line trolling survey (from 2006 onwards) gives high estimates with larger variances compared with the acoustic survey data from earlier years and suggested changes to the experimental design that may assist in addressing this issue (CCSBT-SC13 2008, para 114).

In 2012, the index steeply declined to the lowest level recorded for the piston-line survey and well below the average median value (red line, Fig 3). However, in 2013 the index increased to just below the average median value.

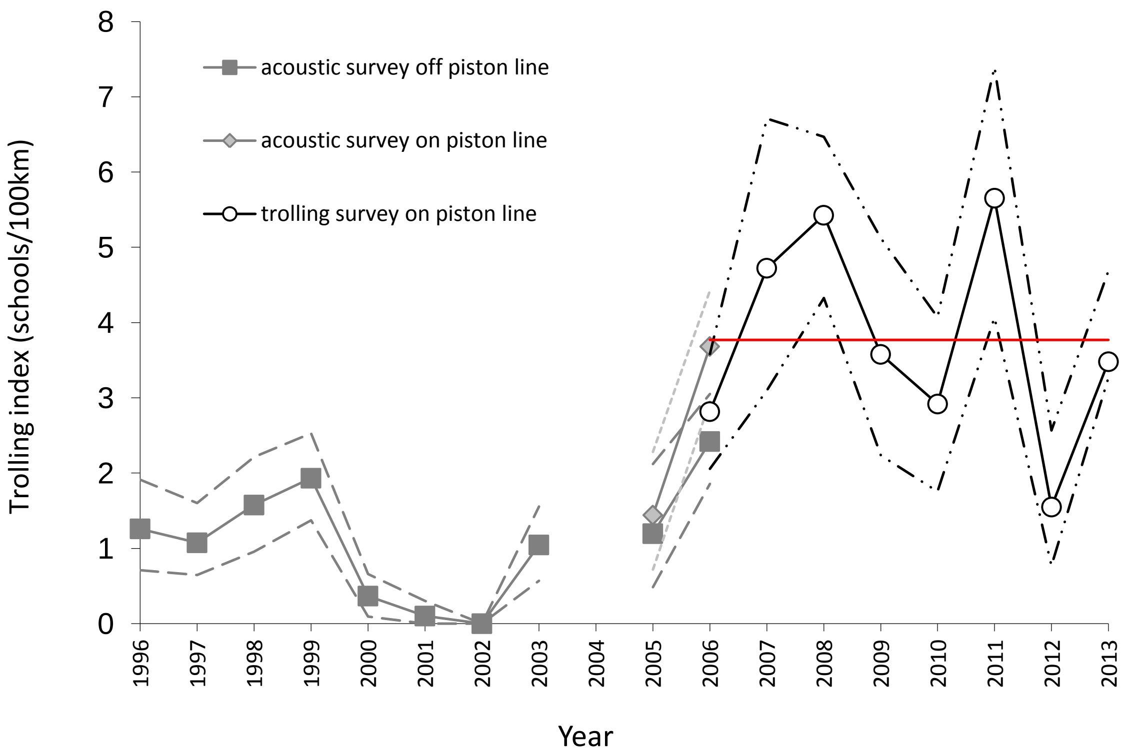


**Fig. 3. Trolling index, showing number of schools per 100 km off the Western Australian coast in January. Dashed lines are 90% confidence intervals. The red line shows the average median value of the piston line survey from 2006–13.**

# Catch per unit effort

## New Zealand joint venture (charter) longline CPUE

New Zealand (NZ) joint venture (charter) longline CPUE for statistical areas 5 and 6 (aggregated for all age classes) was updated from CPUE input data provided in the 2013 interim update of the CCSBT database.

The NZ charter fishery had close to 100 per cent observer coverage until 2007, and these data are assumed to be unaffected by the unreported catches identified in the Japanese Market Review (Lou et al. 2006). Observer coverage is still high (100% vessels covered, >80 per cent catch observed and measured). The NZ fleets fish a small portion of the SBT stock, and interpretation of CPUE might be particularly sensitive to inter-annual variability in the spatial distribution of the stock (Hartog & Preece 2008). The CPUE in the southern fishery (CCSBT statistical area 6) increased in 2012 and remains well above the ten-year mean level. Effort and catch in statistical area 5 remains more variable.

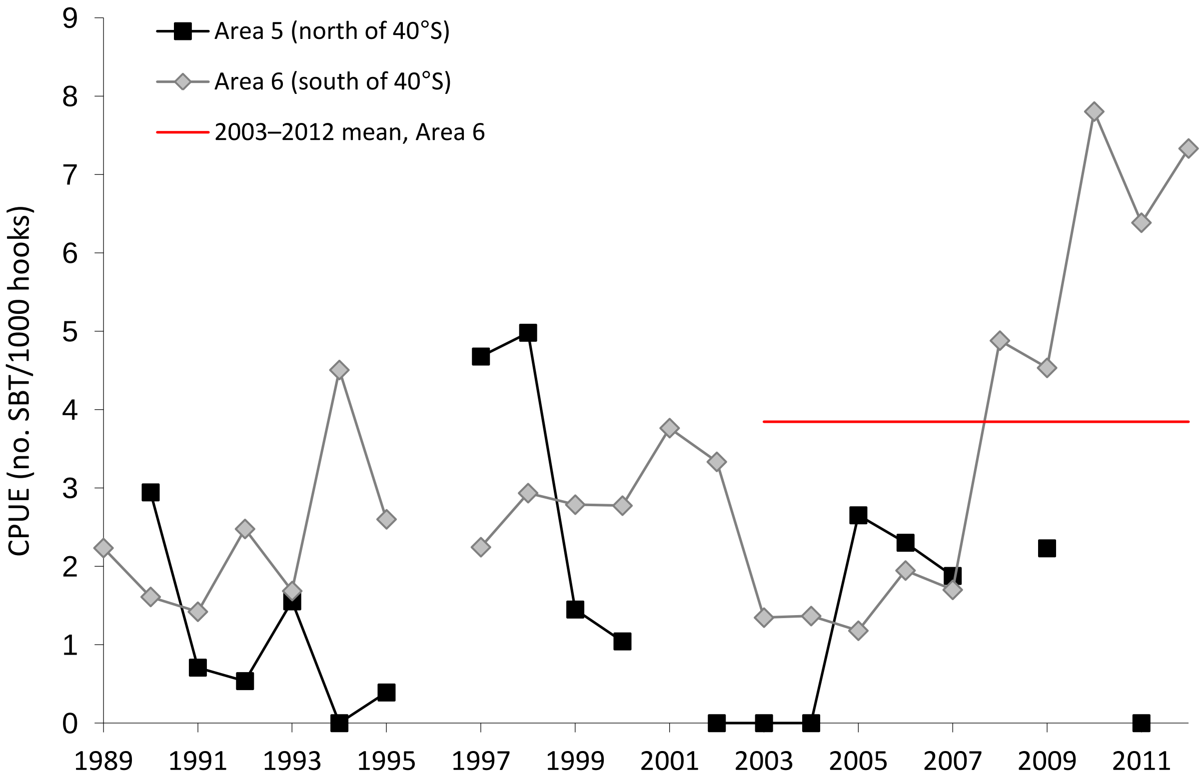


**Fig. 4. Nominal CPUE (number per 1000 hooks) for the NZ charter fishery. The red, horizontal line indicates the ten-year mean (2003–12) in Area 6.**

## New Zealand domestic longline CPUE

The NZ domestic nominal CPUE was updated from aggregated catch and effort data provided in the 2013 interim update of the CCSBT database. The CPUE series has been compiled for longline vessels only; the handline/troll fishery virtually disappearing in the 1990s. The NZ domestic nominal CPUE is aggregated across all age classes. Historically there have been lower levels of observer coverage in the NZ domestic fishery than in the NZ joint venture fishery (Anon 2008a). However, NZ domestic catches are landed fresh and exported as fresh product to Japan, and are thus assumed to be unaffected by results of the Japanese Market Review (which examined frozen product, see Lou et al. 2006).

Overall, catch rates in the NZ domestic fishery have increased over the last decade, increasing substantially in 2012.

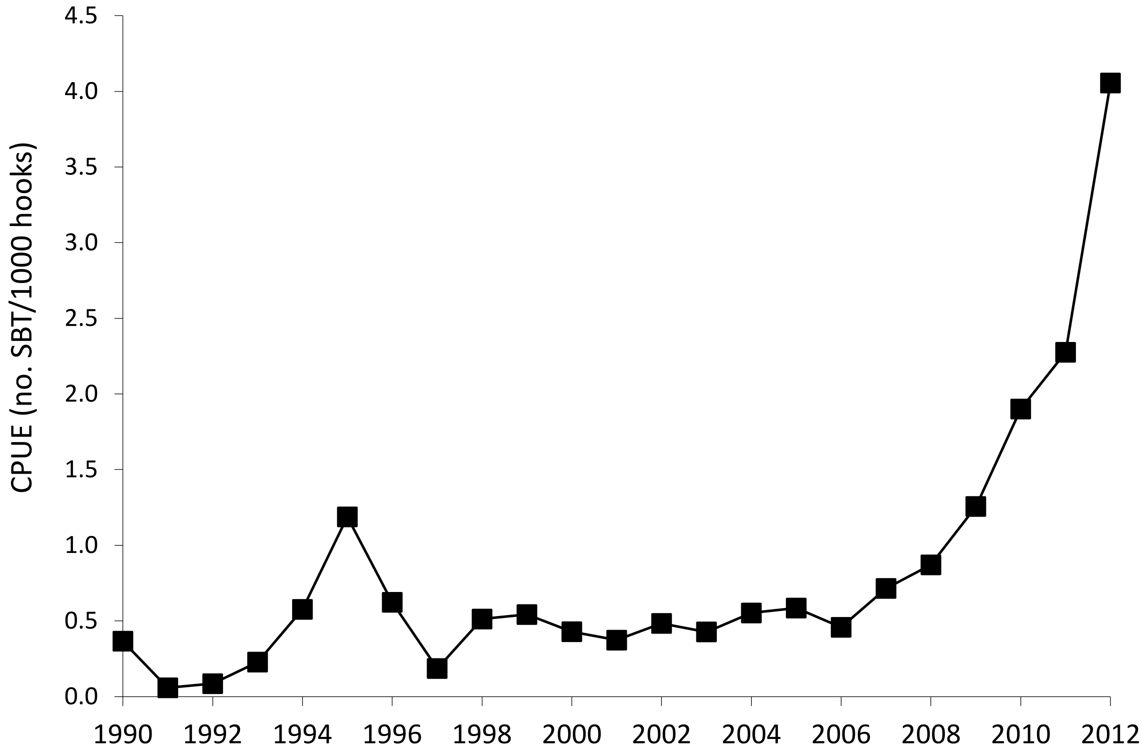


**Fig. 5. Nominal CPUE (number per 1000 hooks) for the NZ domestic longline fishery.**

# Catch size/age composition

## New Zealand longline fishery size composition

Size composition data for SBT caught by the NZ joint venture and domestic fisheries were extracted from the 2013 interim update of the CCSBT database and were examined for trends in juvenile fish less than 6 years of age. Fish in these size classes (i.e. <130 cm) have comprised ~19 per cent of the New Zealand joint venture catch on average since 2000 and in 2011 comprised ~14 per cent (Anon 2012). This is a decline from 2010 where they accounted for ~36 per cent. The proportions fluctuation on 2–3 years cycles, consistent with periods of above and below average recruitment (Anon 2012).

In the NZ domestic fishery, juvenile fish aged less than 6 years have comprised on average 18 per cent of the catch, although size composition is not as well estimated for this fleet as for the charter fleet. All size composition data for the charter fishery are derived from longline vessels. The data for the early years of the domestic fishery are dominated by handline and troll caught fish and in more recent years by longline vessels. As such, caution should be used in interpreting the full time series because of this discontinuity (Hartog & Preece 2008).

It has been assumed that the following size categories represented ages 0–2, 3, 4 and 5:

- ≤86 cm: age 0–2
- >86 to ≤102 cm: age 3
- >102 to ≤114 cm: age 4
- >114 to ≤126 cm: age 5

Age 4 and age 5 SBT all but disappeared from the NZ joint venture fishery in 2003 and 2004, respectively (Fig. 6). Both age classes began to show some signs of re-emergence in 2006, and this continued until 2008 and 2009 for age 4 and age 5, respectively. In 2012, however, both age classes increased. The NZ joint venture fishery catches virtually no age 0–2 SBT, and continued to catch small amounts of age 3 SBT in 2012, with no clear trends in the abundance of this size/age class apparent over the past decade (Fig. 6). Given the general 100 per cent observer coverage in the NZ joint venture fishery up to 2007, and continued high coverage since, it is assumed that the proportions of juveniles in the catch for these years would not be affected by discarding.

In the size/age categories examined, the NZ domestic fishery has historically landed age 4 and 5 SBT, with some small, recent spikes in the abundance of age 3 SBT (2006 and 2010) (Fig. 7). The abundance of the juvenile age classes declined in 2004 (similar to the trend observed in the NZ joint venture fishery). Age 5 SBT increased in 2012, with small increases in the 3 and 4 age classes (Fig. 7). There is a lower level of observer coverage in the NZ domestic fishery, and some discarding of juveniles may occur.

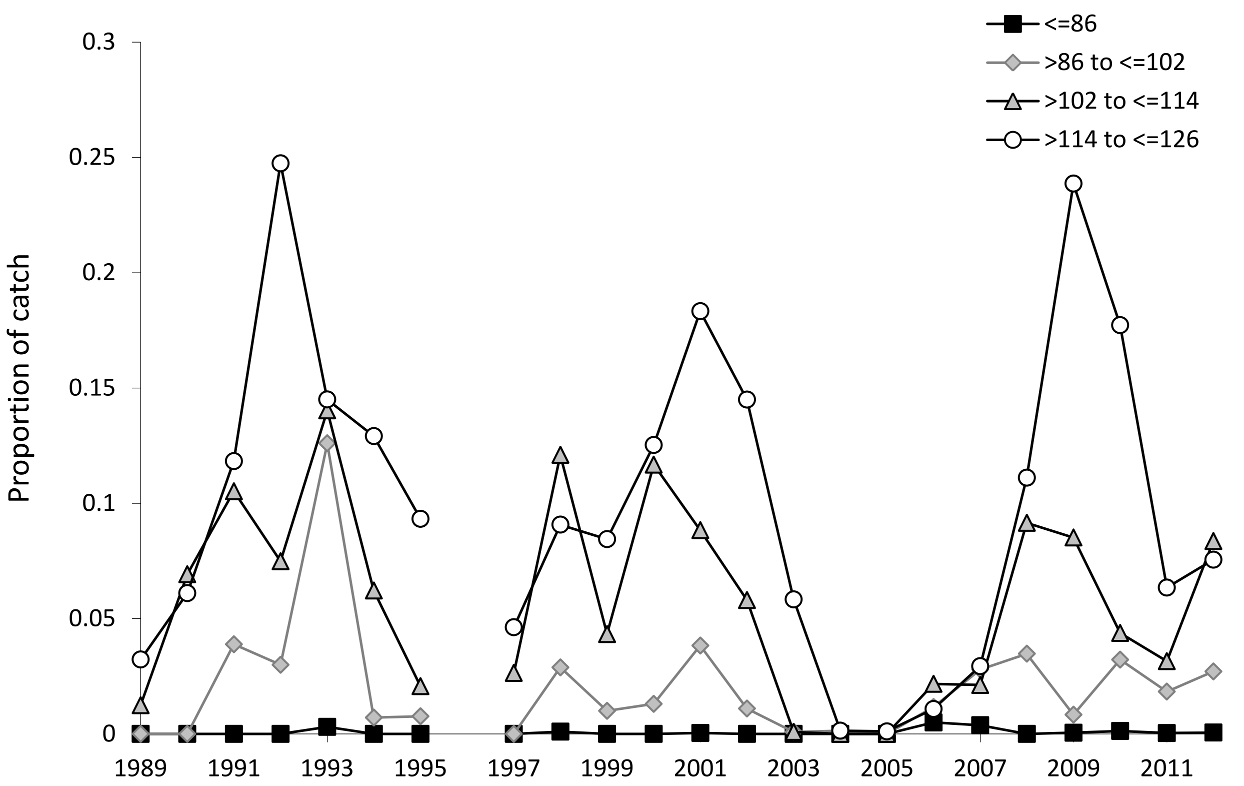


**Fig. 6. Size composition for the NZ joint venture longline fishery, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.**

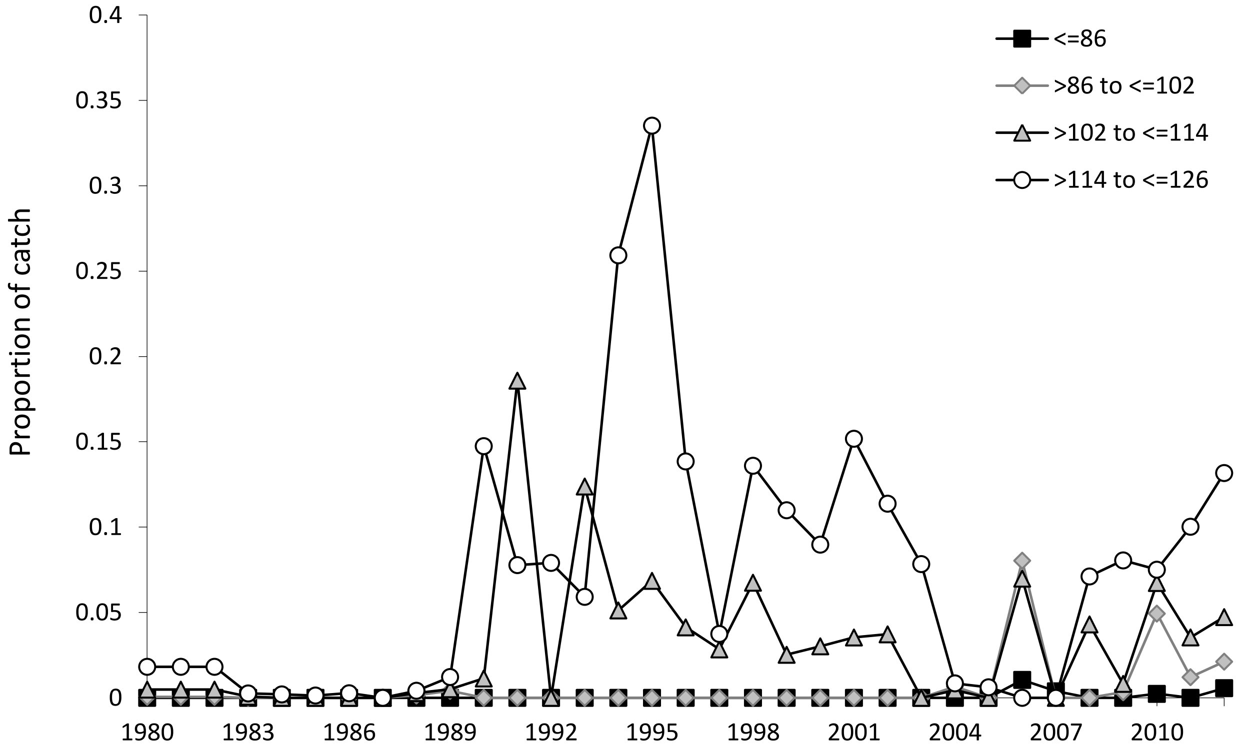


**Fig. 7. Size composition for the NZ domestic fishery, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.**

## Indonesian spawning ground size/age composition

The Indonesian catch data provides an important source of information about the spawning population if we assume that the selectivity of this fishery has been constant over time (Farley et al. 2012). The Indonesian size data for the 2011–12 season were provided in 2012 (Farley et al. 2012).

The median size class (2 cm size classes) decreased slightly in 2011–12 from 170 cm to 168 cm (mean size 170 cm to 169 cm) (Fig. 8). The mean size of SBT declined from 1993–94, when sampling commenced, to the early 2000s. Since the 2001–02 season the median size class has remained relatively stable. Four of the graphs also show the median size of SBT taken south of the spawning ground by Processor A. These data have been excluded from the spawning ground size and age analyses (Farley et al. 2007).The proportional size composition on the spawning ground from the 1993–94 to 2011–12 spawning seasons has been reproduced from Farley et al. (2012) (Fig. 9).

There has been no direct ageing of the 2011–12 otoliths collected in the Indonesian fishery, and therefore the age-frequency for the 2011–12 season is based on the 2011–12 length frequency data and the age-length-key (ALK) from direct ageing in the previous two seasons. The 2009–10 and 2010–11 proportions of SBT aged greater than 20 years declined again in 2010–11, while the mean age of all SBT on the spawning ground increased in 2010–11 (Fig. 10 and 11).

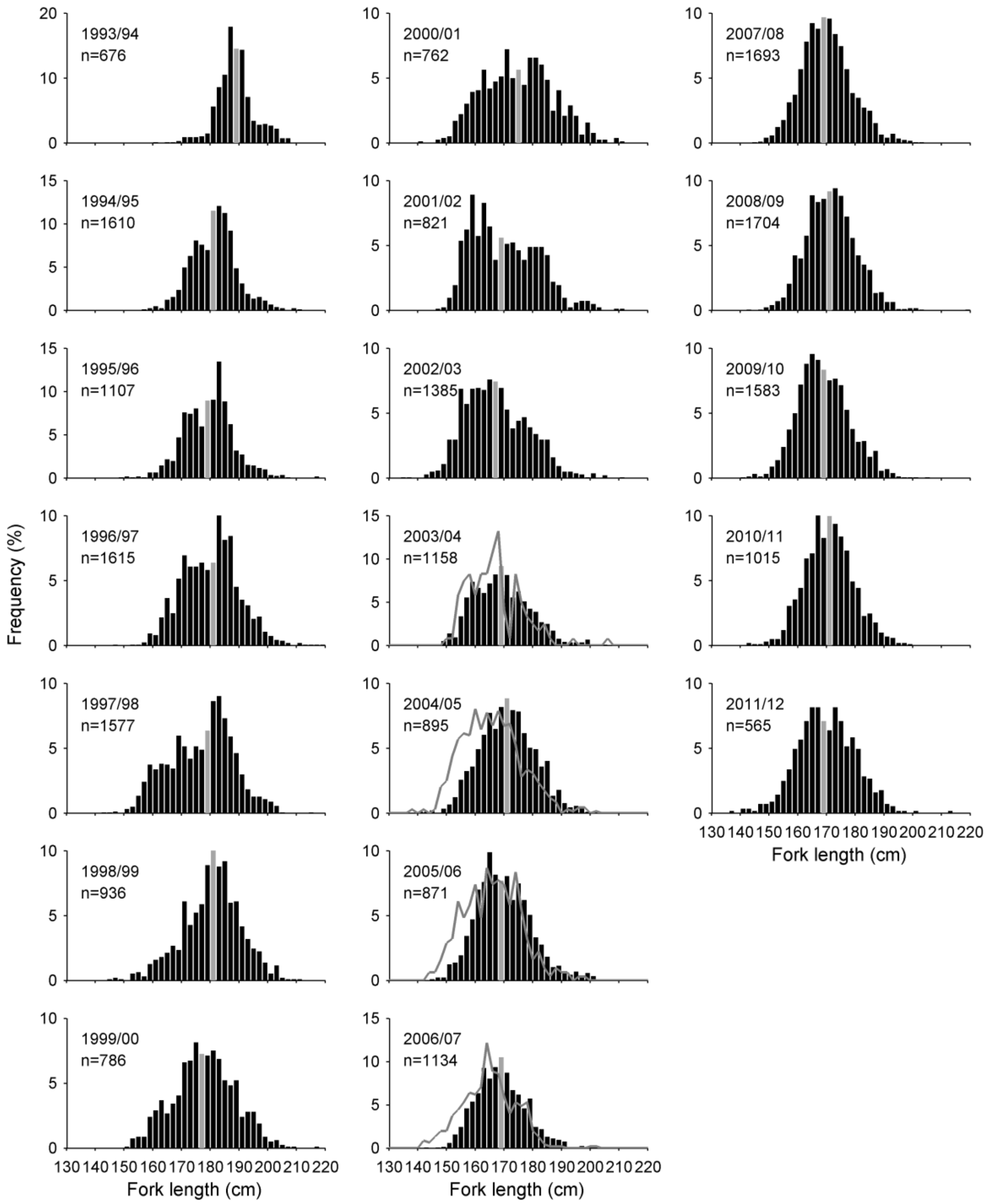


**Fig. 8. Length frequency (2 cm intervals) of SBT caught on the spawning ground (bars) by spawning season (Farley et al. 2012). The grey bar shows the median size class. For comparison, the length distribution of SBT thought to be caught south of the spawning ground (Processor A) is shown for the 2003/04 (n=121), 2004/05 (n=685), 2005/06 (n=311) and 2006/07 (n=452) seasons (grey line) (see Farley et al. 2007).**

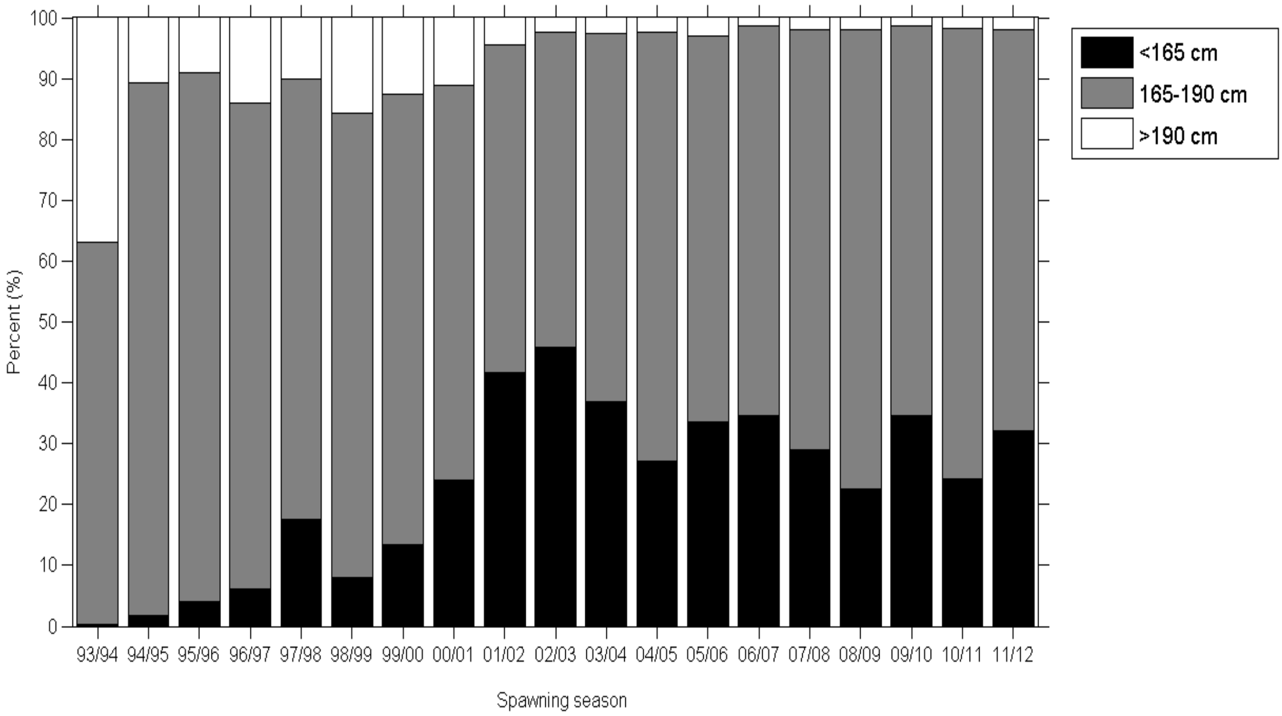


**Fig. 9. Size composition of SBT caught on the spawning grounds by the Indonesian longline fishery by spawning season (from Farley et al. 2012). Data from Processor A are excluded.**

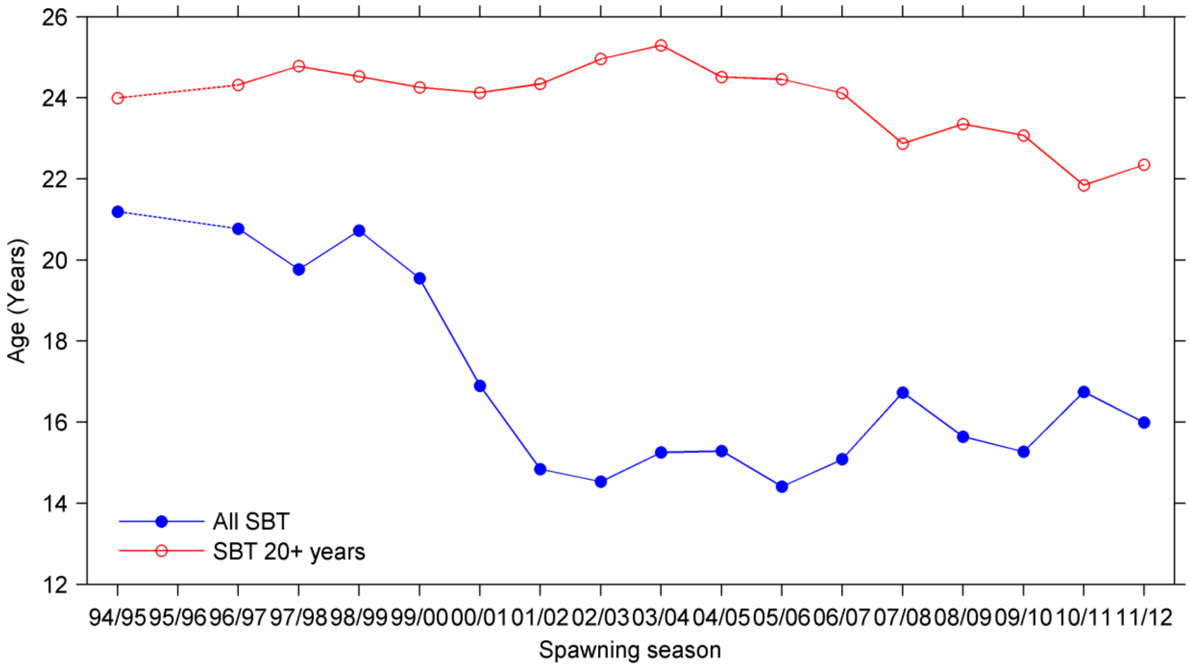


**Fig. 10. Mean estimated age (years) of SBT caught on the spawning grounds by Indonesian longliners. Age estimates for 2011/12 are based on the age-length key from the previous two seasons and 2011/12 length frequency data. Data from Processor A are excluded.**

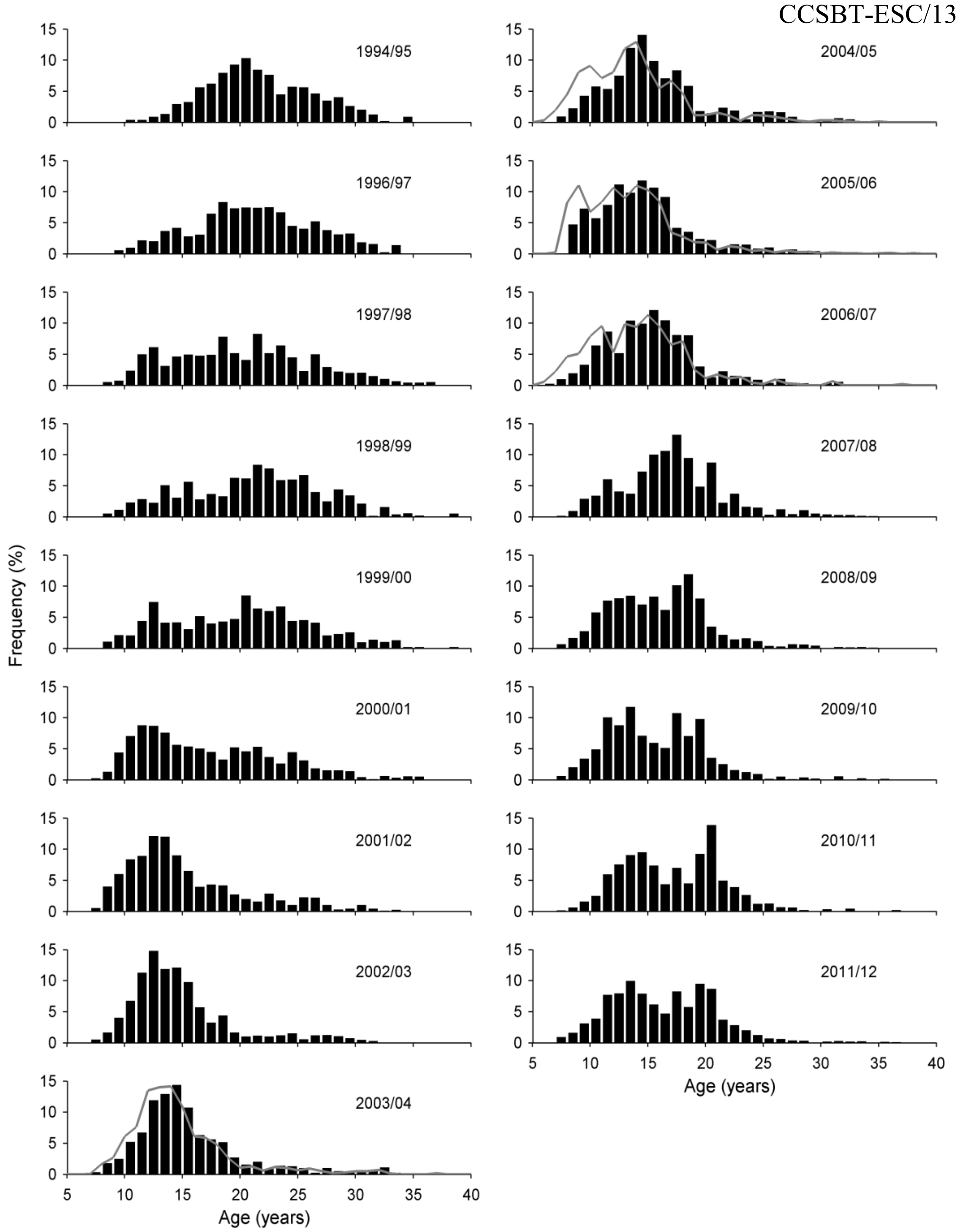


**Fig. 11. Age frequency distribution of SBT in the Indonesian catch on the spawning ground by spawning season estimated using age-length keys from our sub-samples of direct aged fish and length frequency data obtained through the Indonesian monitoring program. There has been no direct ageing of the 2011–12 otoliths and therefore the 2011–12 age frequency is based on the age-length key from the previous two seasons and 2011–12 length frequency data. For comparison, the age frequency of SBT thought to be caught south of the spawning ground (Processor A) is shown for the 2004–05 to 2006–07 seasons (grey line) (see Farley et al. 2007).**

# 3 Indicators that may be affected by the unreported catch

The indicators included in this section may or may not be affected by unreported catches identified in the Japanese Market Review (Lou et al. 2006) or the Australian Farm Review (Fushimi et al. 2006). These indicators have been updated with information provided through the CCSBT data exchange in 2013, but it is recommended that their interpretation be treated with caution. Recent trends in some of these indicators are unlikely to be affected by unreported catches because of the improvements in catch documentation that have been implemented since 2006.

## Global catch

Reported catch updates per country and retrospective estimates of unreported catches were obtained from official catch data provided through the May 2013 CCSBT data exchange.

Reported catches have declined by over a third since 2005 (from ~16 000 t to below 10 000 t in 2011) (Fig. 12), largely due to a reduction in Japan's national allocation from 6065 t to 3000 t in 2006, the introduction of an interim catch allocation of 750 t to Indonesia's SBT fishery in 2007, and the global quota reduction in 2010. However, with the implementation of the management procedure in 2011, the global quota was increased in 2012.

Australia's reported catches in 2008–12 (by calendar year) were 5033 t, 5108 t, 4200 t, 4200 t and 4503 t, respectively. Japan's reported catches over the same period were 2952 t, 2659 t, 2223 t, 2518 t and 2528 t. The Taiwanese catch has remained relatively stable in recent years, but increased by ~300 t from previous years to 1208 t in 2010, with only 533 t and 497 t reported in 2011 and 2012, respectively. Korean catches have been more variable since its accession as a full member to CCSBT in 2001, although catches have been relatively stable over the past three years. The effect of retrospective unreported catches on the interpretation of other indicators in this section is unknown.

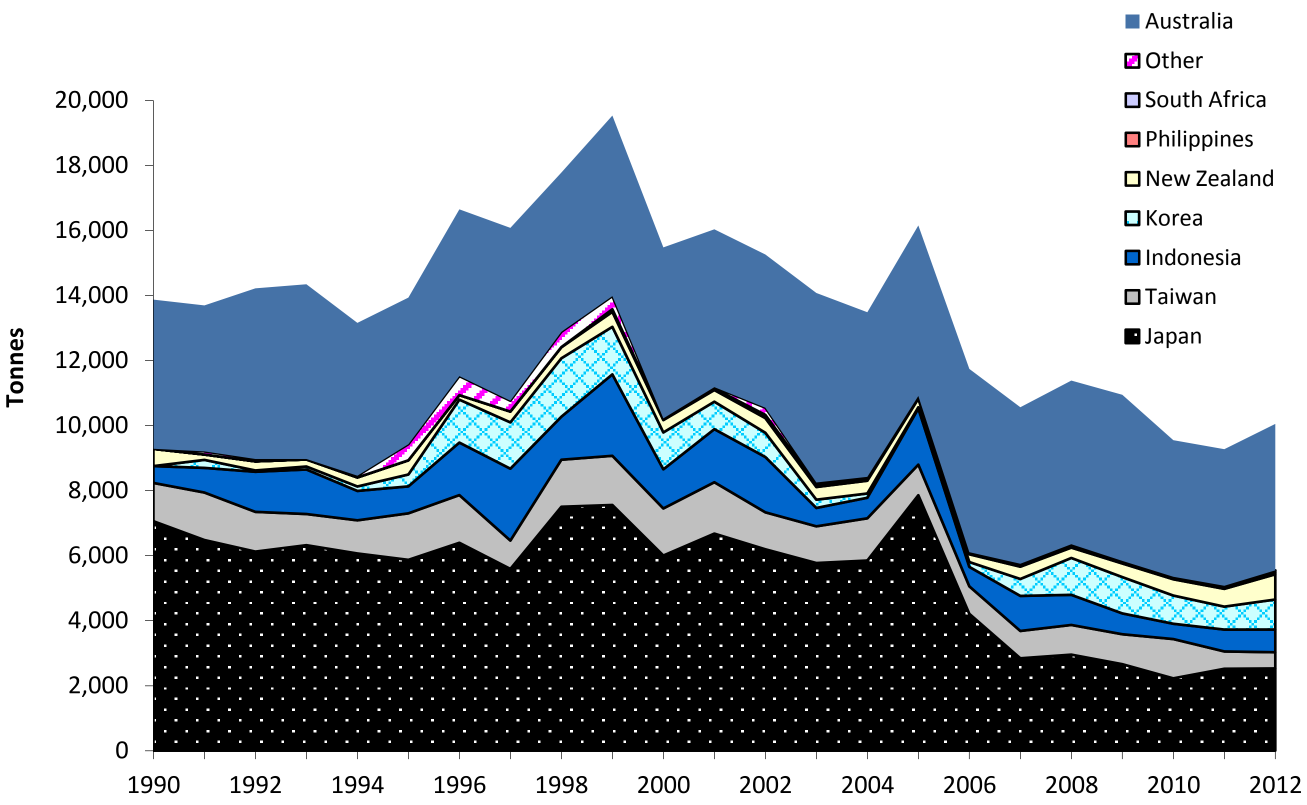


**Fig. 12. Reported catches (tonnes) by country since 1990. Shaded areas are stacked so that y-axis values represent total catch reported by all Members in a calendar year.**

# Catch per unit effort (CPUE)

## Japanese longline CPUE

Nominal CPUE series for Japanese longliners was extracted from the CPUE input data provided in the CCSBT data exchange (SEC_CPUEInputs_65_12 updated 2nd Aug 2013). Other effort series (e.g. number of squares fished) were derived from the same data. Standardised CPUE series were obtained from updates provided by Japan (CPUE_series _STwin/w05_08 revised August 2013 and CorevesselCPUE_6912) through the CCSBT data exchange. Note the base w0.5 and w0.8 series shown here are from core vessels.

In recent years there have been several perturbations significantly affecting the continuity of the Japanese longline CPUE series. In 2005 Japan recorded an over quota catch of 1748 t and a subsequent reduction in allowed catch in 2006. Further, major changes were made to the management of the Japanese longline fleet in April 2006 (introduction of individual quota and removal of restrictions on fishing area and season) (Itoh 2006). Additional reductions in the Japanese total allowable catch (TAC) have been in place since 2006. It is not known to what extent the Japanese longline CPUE series would be affected by the unreported catches identified in 2006 (Polacheck et al. 2006). The nominal CPUE in the most recent years (since 2006) is not likely to be affected by unreported catches because of new catch documentation methods. The standardised CPUE series are still potentially affected, and should be interpreted with caution.

The following updates for 2012 have been compiled:

- Nominal aggregate CPUE for age 4+ SBT in areas 4–9 in months 4–9. The series showed an overall decline from 2002 until 2007, increased in 2010 and declined slightly in 2011. The series increased in 2012 and is above the 2002–12 mean (Fig. 13, horizontal line).

- Nominal CPUE for age 4–7, 8–11 and 12+ SBT. The nominal CPUE series in 2012 of the age 4–7 CPUE has remain relatively stable since 2009. A slight increase can be observed for age 8–11 SBT in 2012, although overall the trend is stable. The CPUE of age 12+ SBT has remained low with little variability since the early 1970s (Fig. 14).

- Nominal CPUE for age 0–2, 3, 4 and 5 SBT. In 2006 and 2007, the age composition of juvenile SBT became dominated by age 3 SBT, with an increase of a similar scale apparent in age 0–2. However, relative proportions of both age 0–2 and 3 dropped markedly in 2008. Age 4 and 5 SBT are the dominant year classes in 2012, despite declines in the proportion of all age classes depicted (Fig. 15).

- Age-specific nominal CPUE for SBT of ages 4, 5, 6, 7, 8 and 9 in different statistical areas. CPUE for ages 4 and 5 declined in all areas in 2012. CPUE for age 6 and 7 SBT increased in all areas except age 6 which declined in areas 4–7. CPUE for ages 8 and 9 increased in all areas, particularly age 8 (Fig. 16).

- Total number of 5×5° grid squares with Japanese longline fishing effort in months 4–9 for statistical areas 4–9, 4–7, 8 and 9. The number of grid squares fished per month has shown a strong downward trend over time in all statistical areas considered, potentially leading to over-optimism in the aggregate catch rates through a spatial hyperstability effect on the relationship between abundance and CPUE (Hartog & Preece 2008). The number of grid squares fished in 2012 was mixed in all areas, with both increases and decreases depending on the month (Fig. 17).

- Standardised CPUE. The standardised and normalised monitoring CPUE series from all vessels (W.0.5, W0.8) exhibited an overall increasing trend from 2007, while the normalised series from the core vessels (Base W0.5 and Base W0.8) increased from 2007, decreased in 2011, and increased in 2012. STwindows has followed a similar increasing trend since 2007, but declined in 2012 (Fig. 18).

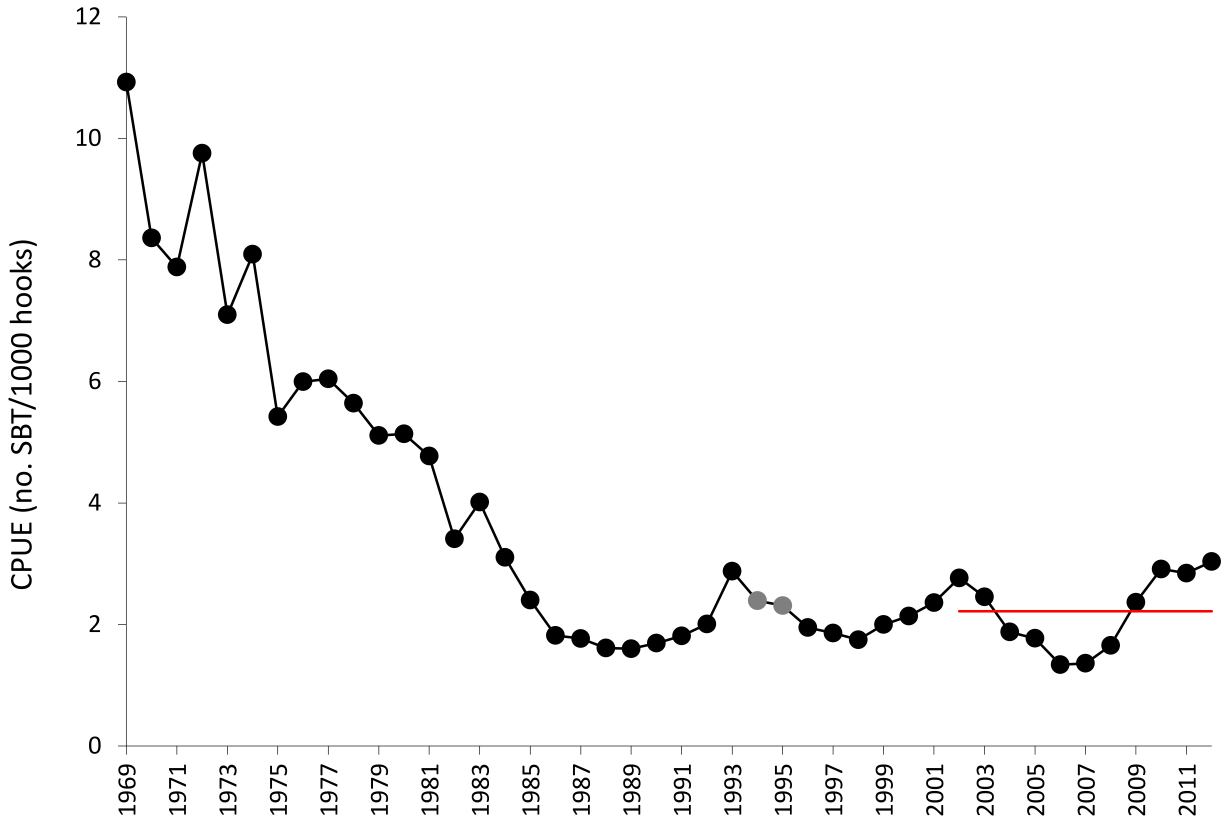


**Fig. 13. Nominal CPUE of age 4+ SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9. The 1995 and 1996 values are plotted as grey circles to indicate increased uncertainty about these points due to changes in retention policies for small fish in these two years, when a policy of releasing small fish applied. The horizontal line is the 2002–12 mean.**

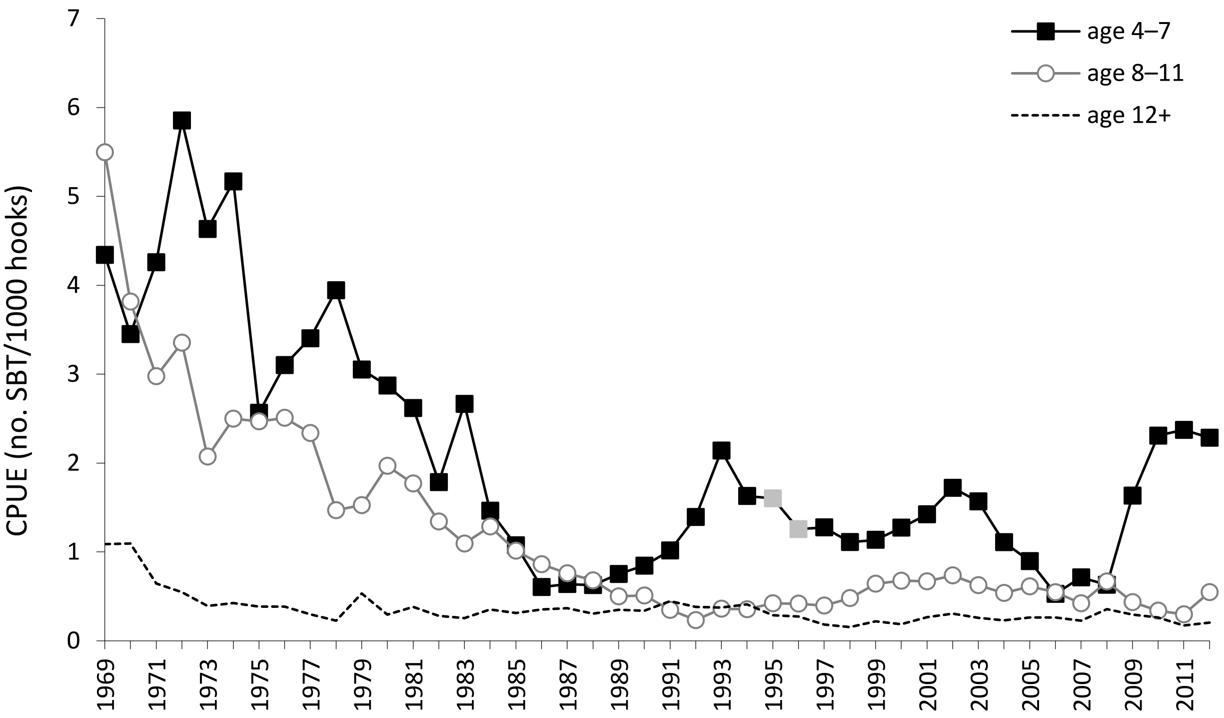


**Fig. 14. Nominal CPUE of ages 4–7, 8–11 and 12+ SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9. The 1995 and 1996 values for ages 4–7 are plotted as grey squares to indicate increased uncertainty about these points due to changes in retention policies for small fish in these two years.**

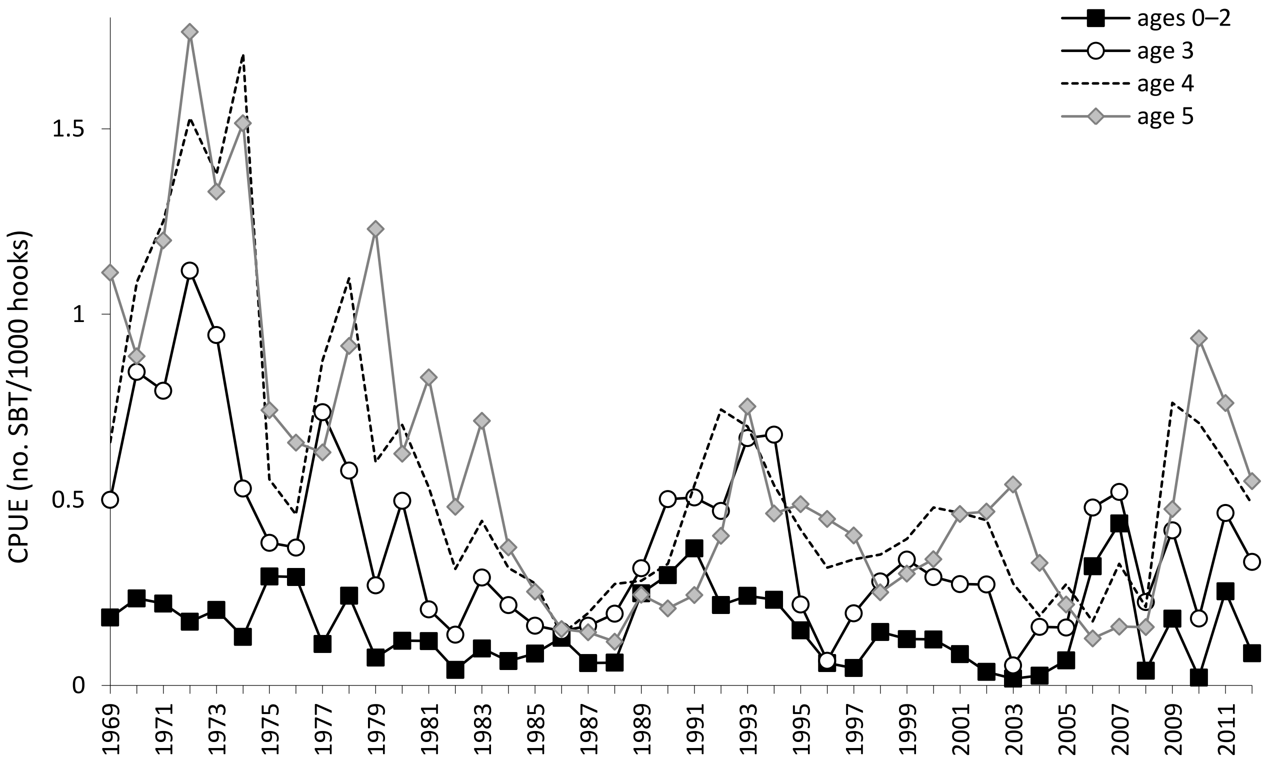


**Fig. 15. Nominal CPUE of ages 0–2, 3, 4 and 5 SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9.**

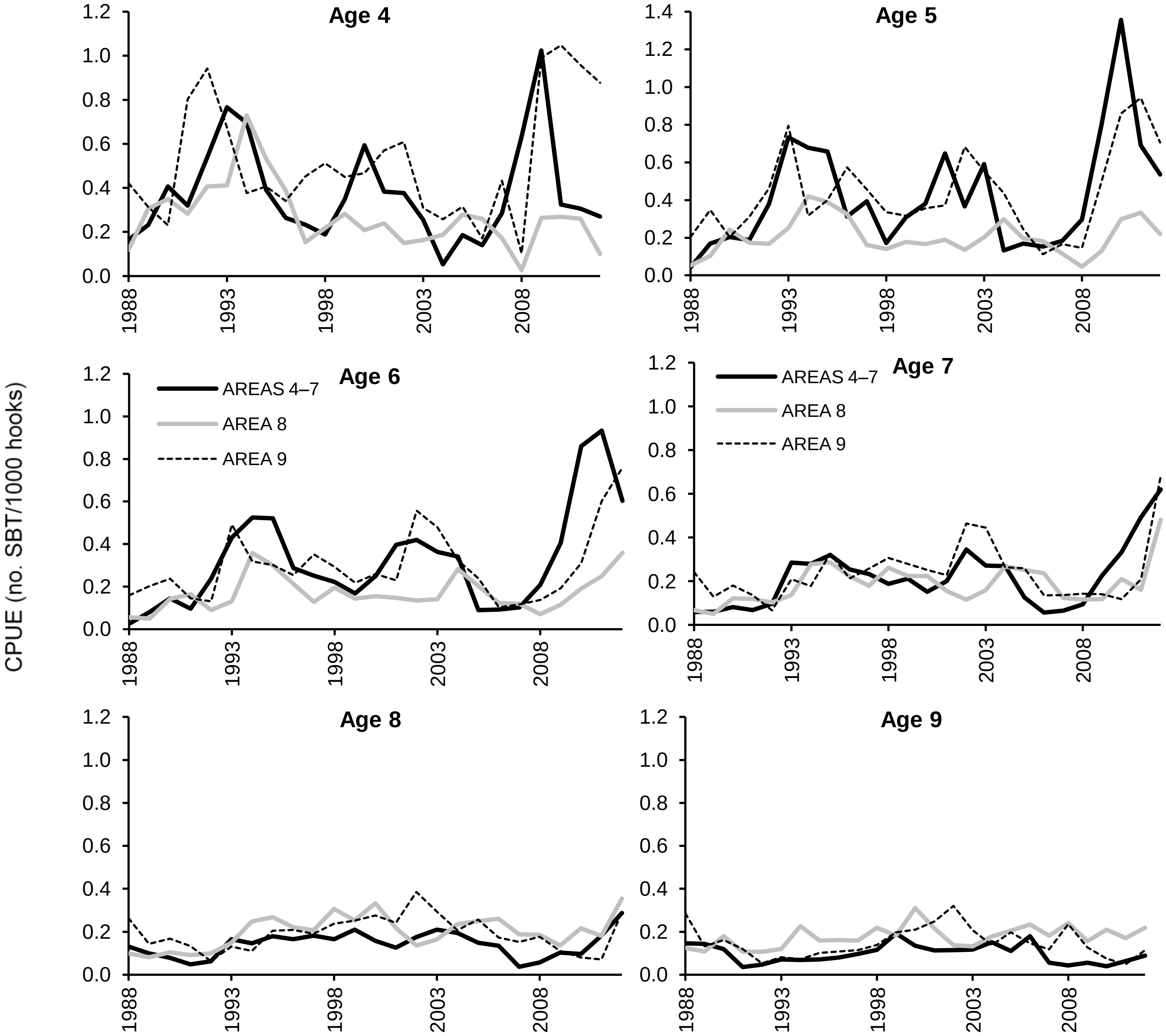


**Fig. 16. Comparison of age-specific nominal CPUE for Japanese longliners in different statistical areas in months 4–9.**

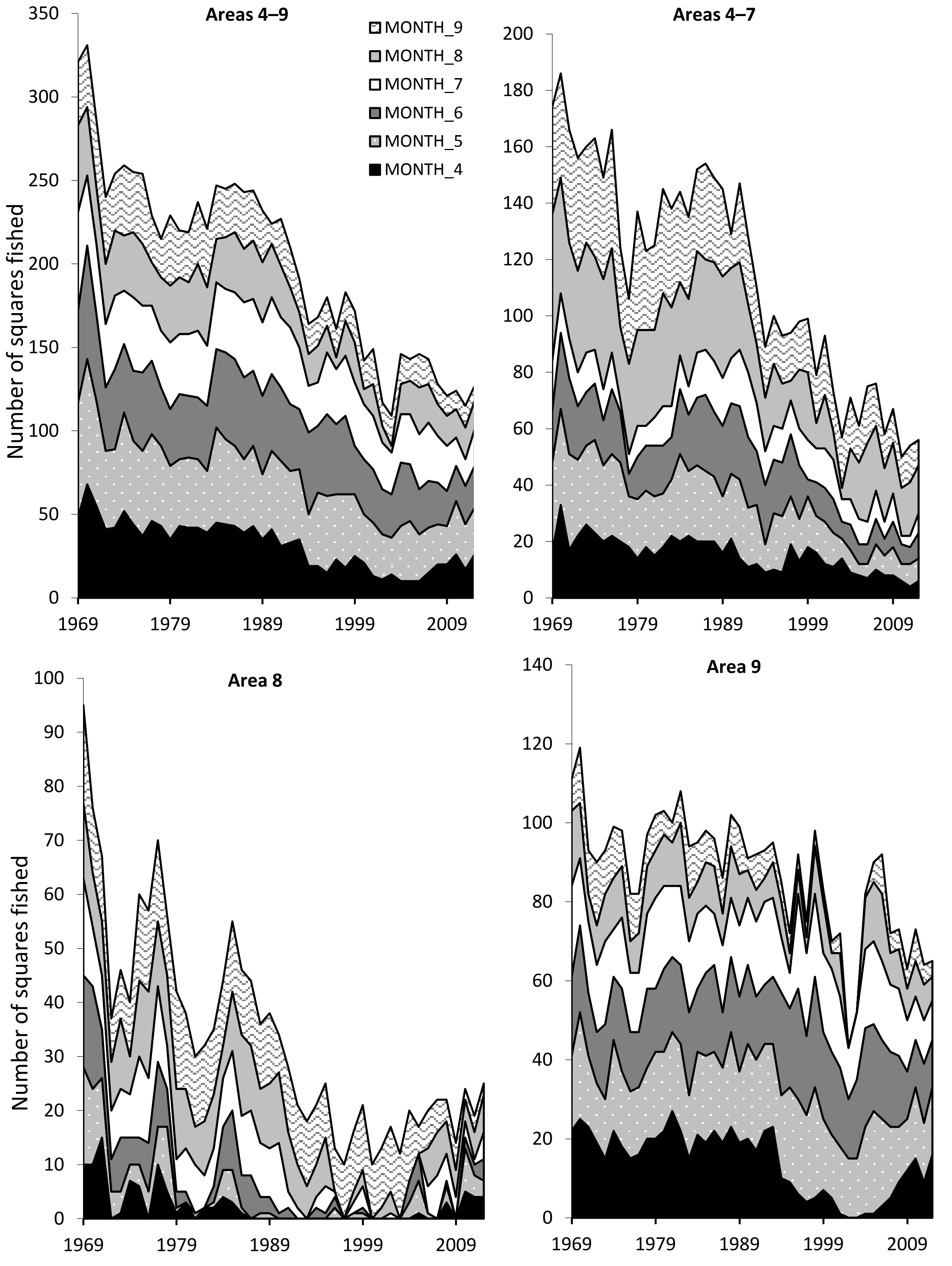


**Fig. 17. Total number of 5×5° grid squares with Japanese longline fishing effort in months 4–9 for different statistical areas. Shaded series in each plot are stacked (i.e. y-axis values are cumulative), with the legend and shaded series being stacked in the same order.**

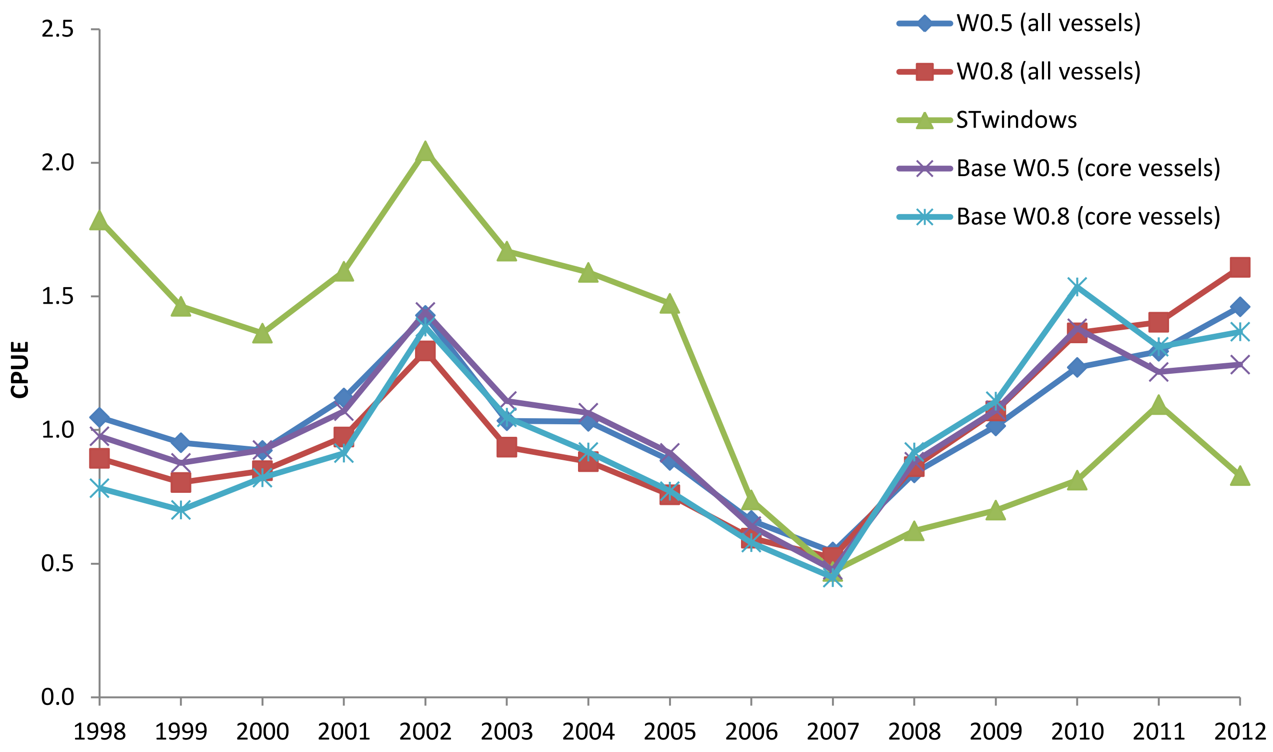


**Fig. 18. Comparison of subsets of the standardised CPUE series. Each subset has been normalised by dividing by the mean.**

## Korean longline CPUE

Nominal CPUE series for Korean longliners were obtained from aggregated catch and effort data provided in the 2013 interim update of the CCSBT database.

Korean CPUE has been reasonably stable since 1995, apart from very low catch rates in 2004 and 2005. Both nominal and average CPUE increased slightly in 2012 (Fig. 19). In 2007 and 2008, the spatial distribution of the fleet shifted from its normal pattern to take catches from western and central fishing grounds in the Indian Ocean (An et al. 2008).

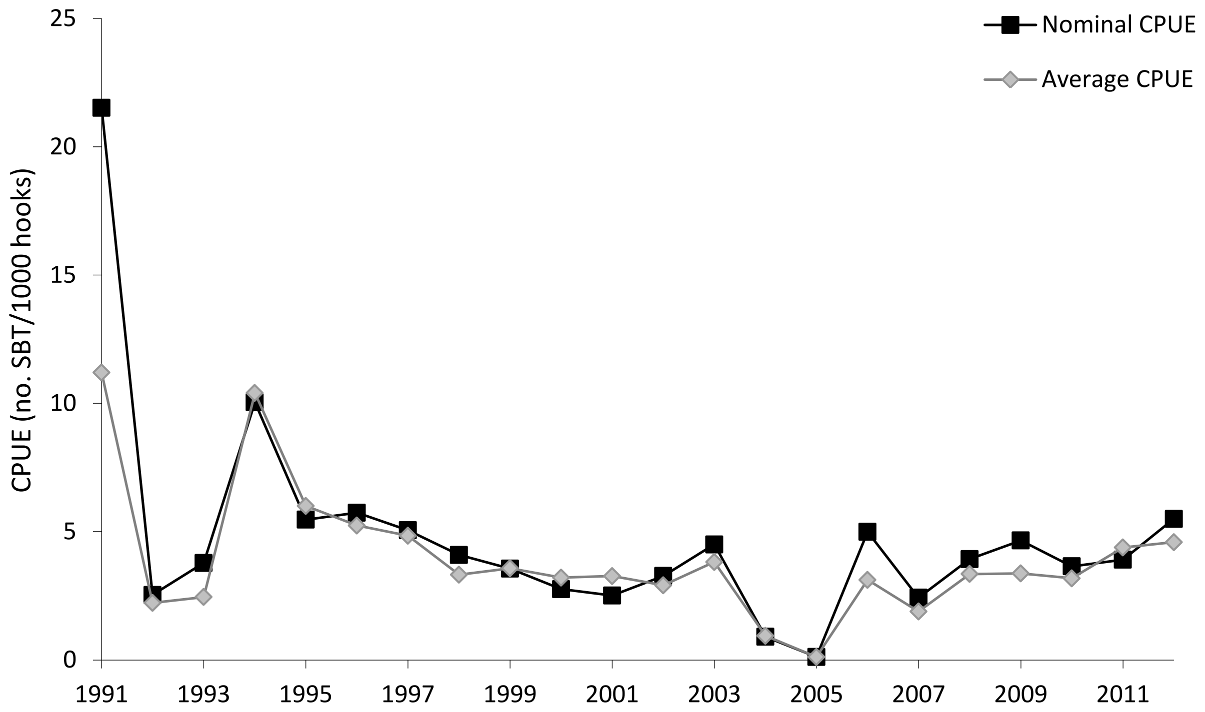


**Fig. 19. Nominal and average CPUE of SBT for Korean longliners operating in statistical areas 4–9 in months 4–9. Nominal CPUE is the total number of SBT over total effort (1000 hooks), while average CPUE is the mean of the nominal rate in each 5×5° grid square per month.**

## Taiwanese longline CPUE

Nominal CPUE series of Taiwanese longliners were obtained from aggregated catch and effort data provided in the 2013 interim update of the CCSBT database.

Fishing effort (vessel numbers) and spatial area fished by Taiwanese longliners began to increase in the 1980s (Fig. 20). While SBT has previously been caught as bycatch of other Taiwanese tuna fisheries, in recent years vessels have begun to target SBT on a seasonal basis (Anon 2008b). The Taiwanese fishery operates in both the northern fishery (areas 2, 14, 15), and the southern fishery (areas 8, 9) (Fig. 21). The main area of effort is the southern 5 degrees of latitude in statistical areas 2, 14 and 15, where vessels have historically targeted albacore (Fig. 22).

Catch rates have fluctuated over time, with a substantial increase in areas 2, 14 and 15 in 2012 and a slight decrease in areas 8 and 9 (Fig. 20). Catch rates in 2012 were highest in the southern 10 degrees of areas 2, 14 and 15 (Fig. 21). Taiwan informed the 2009 ESC that changes in collection of fishery statistics was largely responsible for the increase seen in nominal catch rates in area 2, 14 and 15 since 2000 (Fig. 20, 21) (Anon 2009). Effort in areas 8 and 9 declined in 2012 (Fig 22).

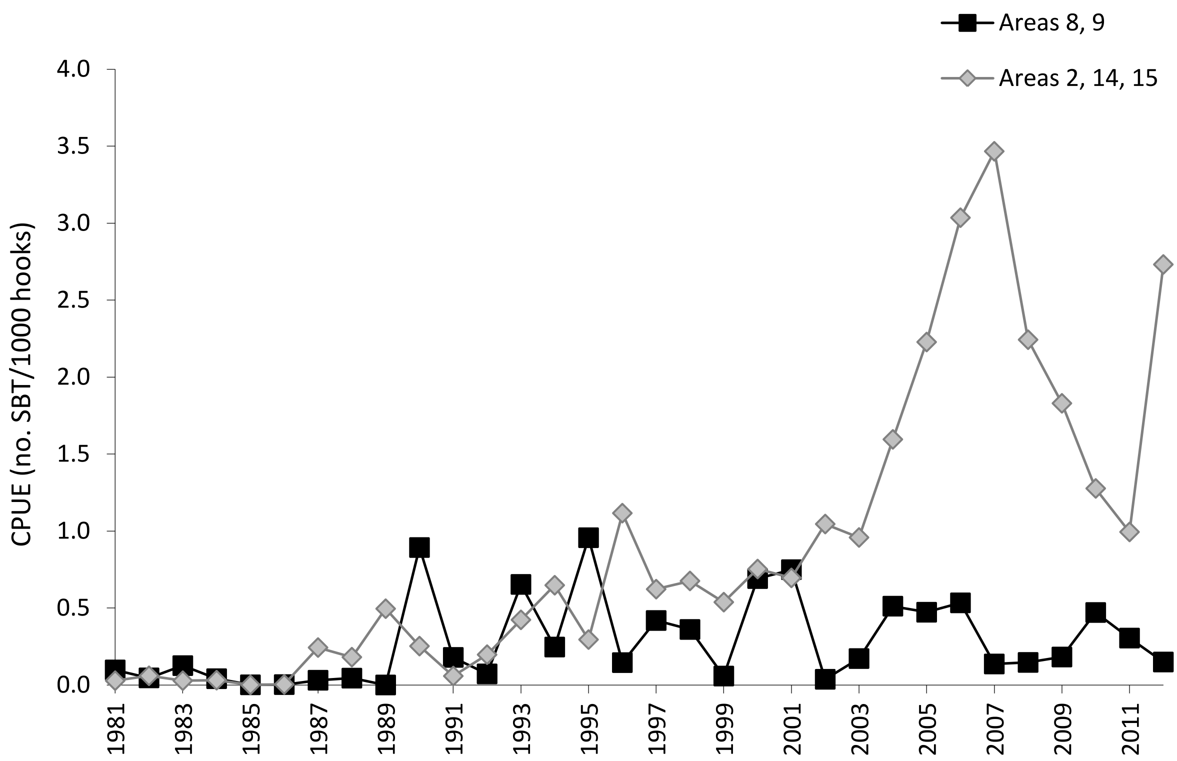


**Fig. 20. Nominal CPUE of SBT for Taiwanese longliners operating in statistical areas 8 and 9 (pooled) and 2, 14 and 15 (pooled) in months 4–9.**

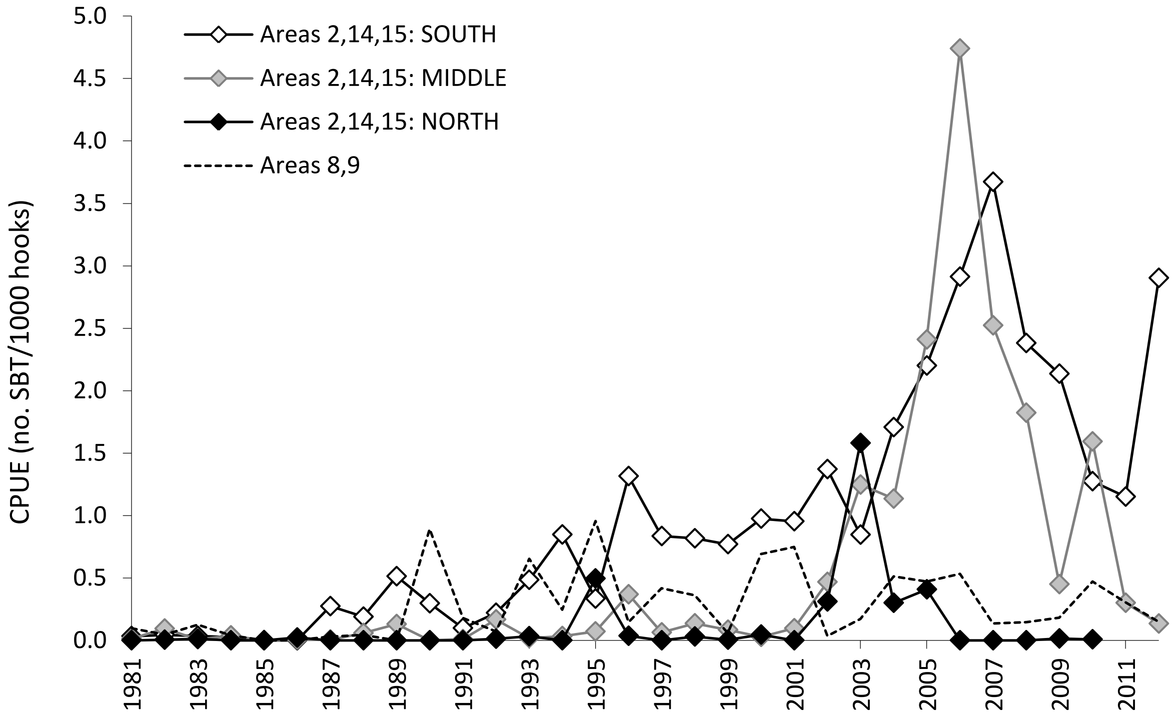


**Fig. 21. Nominal CPUE of SBT for Taiwanese longliners operating in statistical areas 2, 14 and 15 (pooled) by 5° latitudinal strips: South = 30–35°S; Middle = 25–30°S; North = 20–25°S. Nominal CPUE in areas 8 and 9 (pooled) shown for comparison. Data are from months 4–9 only.**

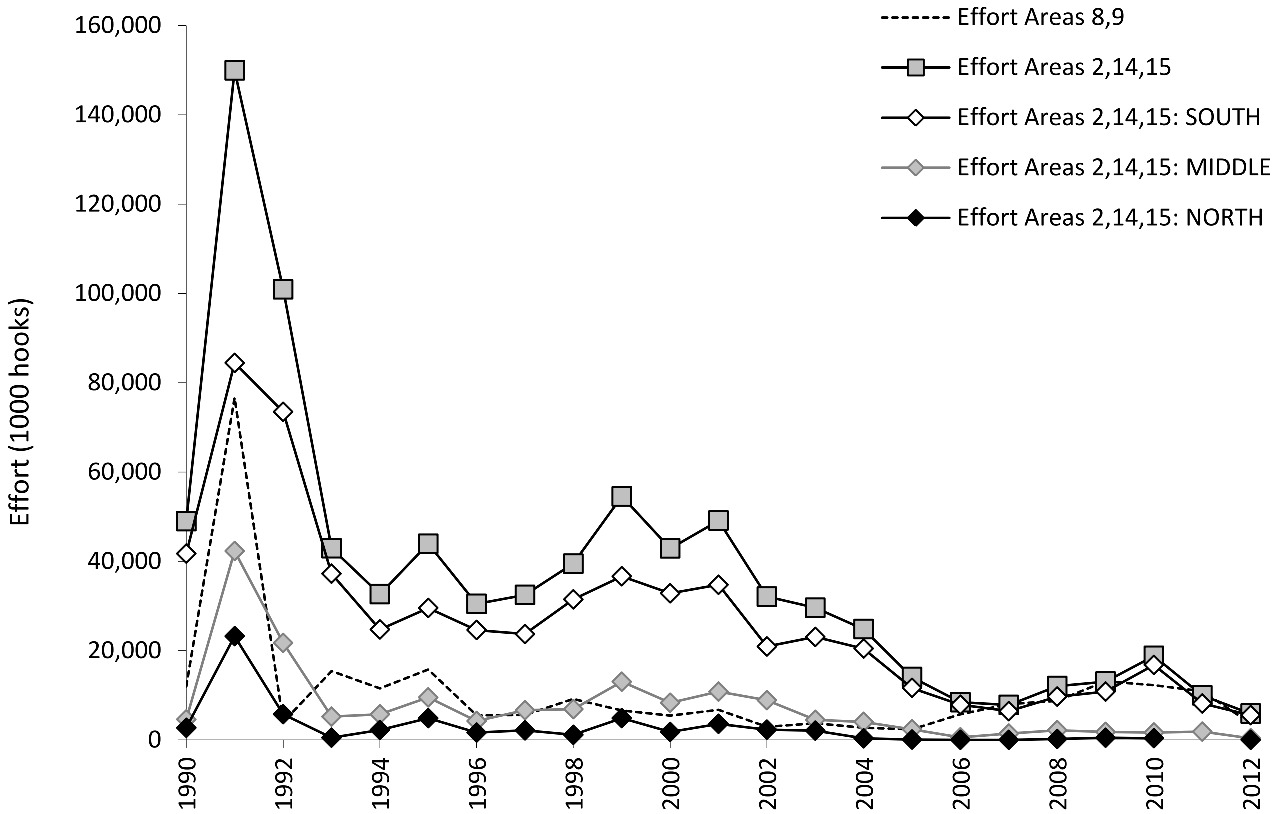


**Fig. 22. Effort (1000 hooks) from Taiwanese longliners in statistical areas 8 & 9 (pooled) and 2, 14 and 15 (pooled). Areas 2, 14 and 15 are also separated into 5° latitudinal strips: South = 30–35°S; Middle = 25–30°S; North = 20–25°S. Data are from months 4–9 only.**

# Catch size/age composition

Size and age composition of the unreported catch identified by the 2006 Japanese Market Review is unknown and the effect on age/size data from the bias identified in the Australian Farm Review has not been resolved. Therefore, the long-term trends in these data should be interpreted with caution. Data collected since 2006 for the longline fisheries are unlikely to be affected by unreported catches.

## Japanese longline fishery size/age composition

Size composition data for SBT caught by Japanese longliners were obtained from the 2013 CCSBT data exchange (revised interim data report, August 2013). These data are examined in detail below for trends for juvenile fish aged less than 6 years.

The age composition of SBT caught by the Japanese longline fishery has been highly variable over time. The relative proportion of all age classes examined here declined in 2012 (Fig. 23). Observer coverage on vessels has been less than or around 10 per cent since 2003, and discarding of juveniles cannot be discounted.

For comparison with size/age composition in the NZ, Korean and Taiwanese longline fisheries, Japanese length data have also been compiled assuming that the following size categories represented ages 0–2, 3, 4 and 5:

- ≤86 cm: age 0–2
- >86 to ≤102 cm: age 3
- >102 to ≤114 cm: age 4
- >114 to ≤126 cm: age 5

The age calculations take into account the time through the year at which the fish was caught, and adjusts the upper and lower cut-points to account for growth through the year, whereas the size data are simply aggregated for the entire year.

Trends in size composition indicate a decrease in the proportion of all the size classes in 2012, although the smallest size class has been relatively stable at very low levels since 2008 (Fig. 24).

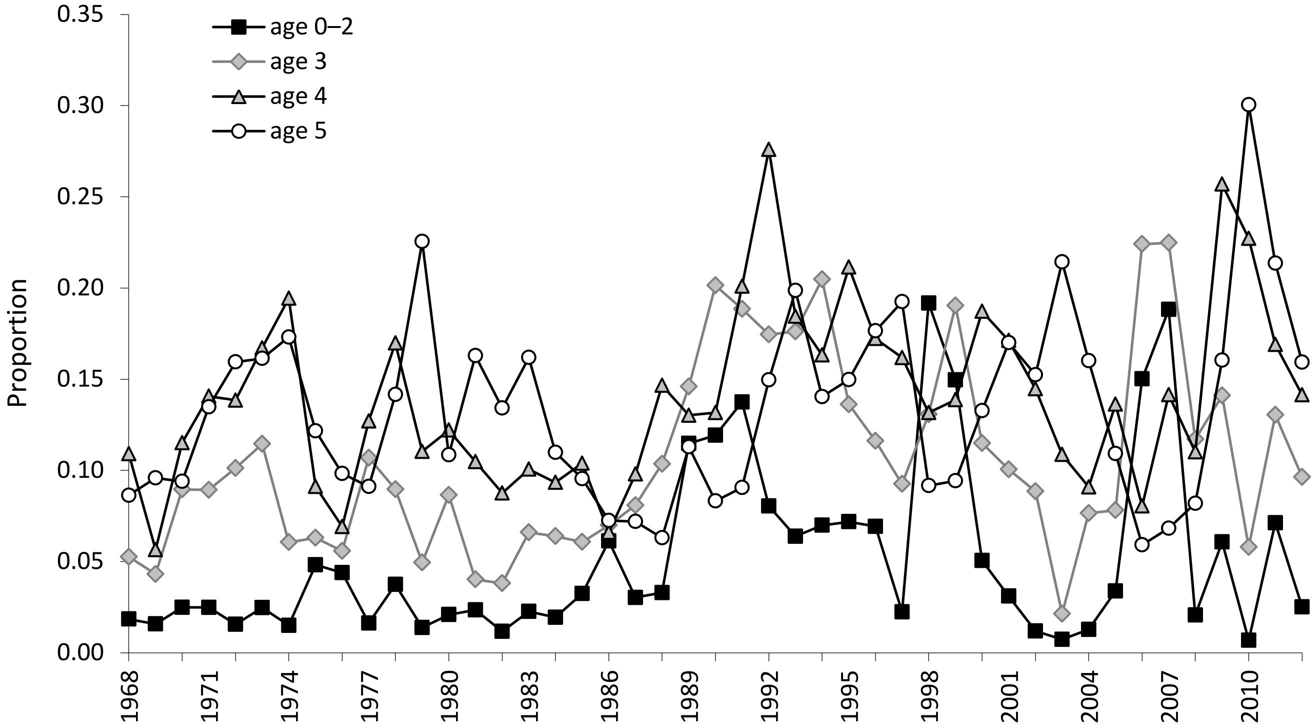


**Fig. 23. Age composition (proportion of total catch) of ages 0–2, 3, 4 and 5 in the Japanese longline fishery in statistical areas 4–9, months 4–9.**

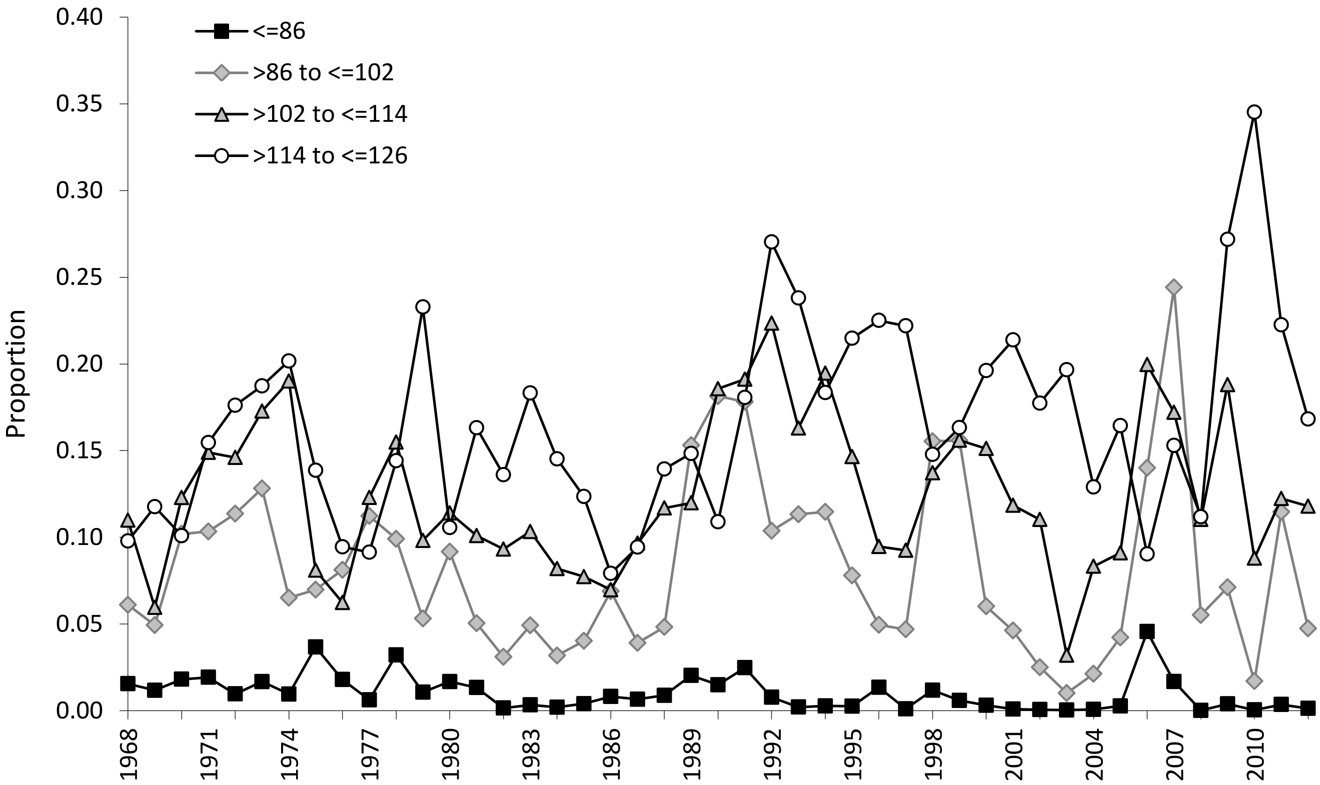


**Fig. 24. Size composition (proportion of total catch) of juvenile SBT caught by Japanese longliners in statistical areas 4–9, months 4–9, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.**

## Korean longline fishery size/age composition

Size composition data from logbooks for SBT caught by Korean longliners were obtained from the 2013 interim update of the CCSBT database. Due to the small sample sizes in some years, only raw frequencies were available and a final index for inclusion in the summary of indicators (Table 1) was therefore not calculated. This indicator should therefore be interpreted with caution.

It has been assumed that the following size categories represented ages 0–2, 3, 4 and 5:

- ≤86 cm: age 0–2
- >86 to ≤102 cm: age 3
- >102 to ≤114 cm: age 4
- >114 to ≤126 cm: age 5

No data were available for the Korean size classes in 2005 and 2008. Data from 2011 was also excluded as it was taken from the CDS catch tagging information rather than logbooks. While data was provided for 2012, it was limited (Fig. 25). Coverage on vessels has been less than 10 per cent in some past years, and discarding of juveniles cannot be discounted.

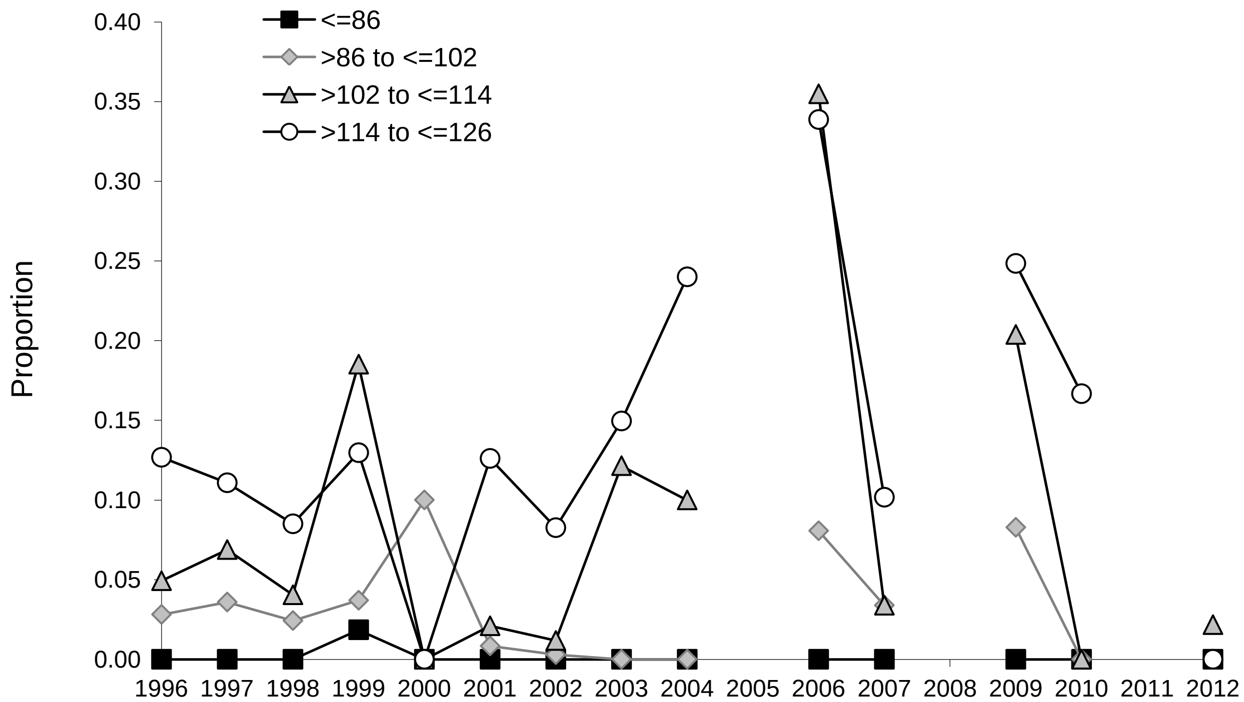


**Fig. 25. Size composition (proportion of total catch) of juvenile SBT caught by Korean longliners in statistical areas 4–9, months 4–9, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.**

## Taiwanese longline fishery size/age composition

Size composition data for SBT caught by Taiwanese longliners were obtained from the 2013 interim update of the CCSBT database (table MP_OM_CALCULATED_CATCH_AT_LENGTH). Data in this table are not linked to statistical area or month of capture. Therefore, all available size data in this table have been aggregated.

It has been assumed that the following size categories represented ages 0–2, 3, 4 and 5:

- ≤86 cm: age 0–2
- >86 to ≤102 cm: age 3
- >102 to ≤114 cm: age 4
- >114 to ≤126 cm: age 5

Taiwanese longliners have historically targeted albacore tuna in the southern sections of statistical areas 2, 14 and 15 (i.e. between 25–35°S, see 'Taiwanese longline CPUE'), and generally catch higher proportions of juvenile SBT (Hartog & Preece 2008). In 2012, proportions of age 5 decreased from 2011, and increased for all other ages (Fig. 26). Observer coverage on vessels has been less than 10 per cent in some past years, and discarding of juveniles cannot be discounted.

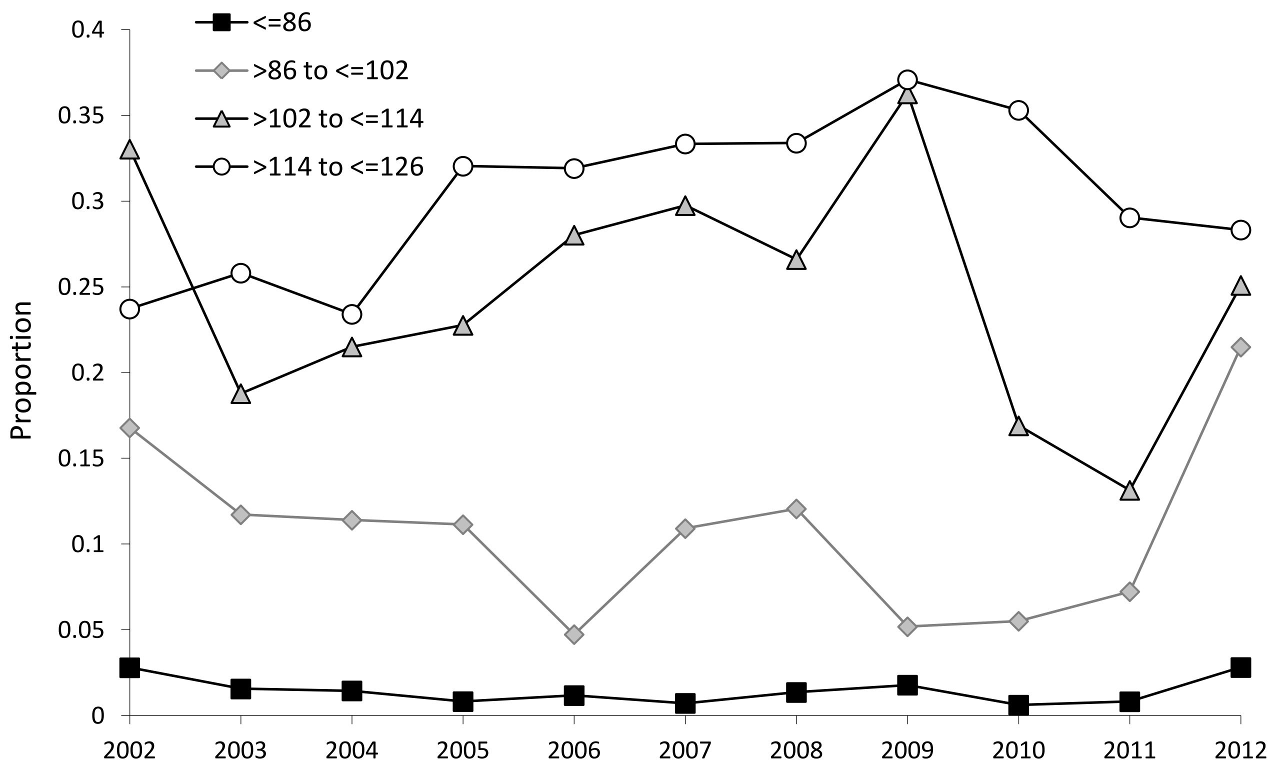


**Fig. 26. Size composition (proportion of total catch) of juvenile SBT caught by Taiwanese longliners, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.**

## Australian surface fishery age composition

The age composition of SBT caught by the Australian surface fishery was updated from data prepared by the Secretariat for the Management Procedure and provided through the CCSBT data exchange (SEC_ManagementProcedureData_52_12). The catch at age is calculated from length frequency data (Preece et al, 2004).

The 2006 Australian Farm Review was unable to resolve whether there were biases in the 40-fish sampling program that would affect the size/age composition of the reported catch (Fushimi et al. 2006). Age composition in the Australian surface fishery has not changed markedly and continues to be dominated by age 2 and age 3 SBT (Fig. 27). These two age classes have historically comprised around 90 per cent of the catch. In 2010 and 2011 these age classes comprised 85 and 82 per cent of the surface catch, respectively, with older age classes (4–6) comprising 15 and 18 per cent of the catch, respectively. However, in 2012 the age 2 and 3 age classes accounted for 95 per cent of the catch.

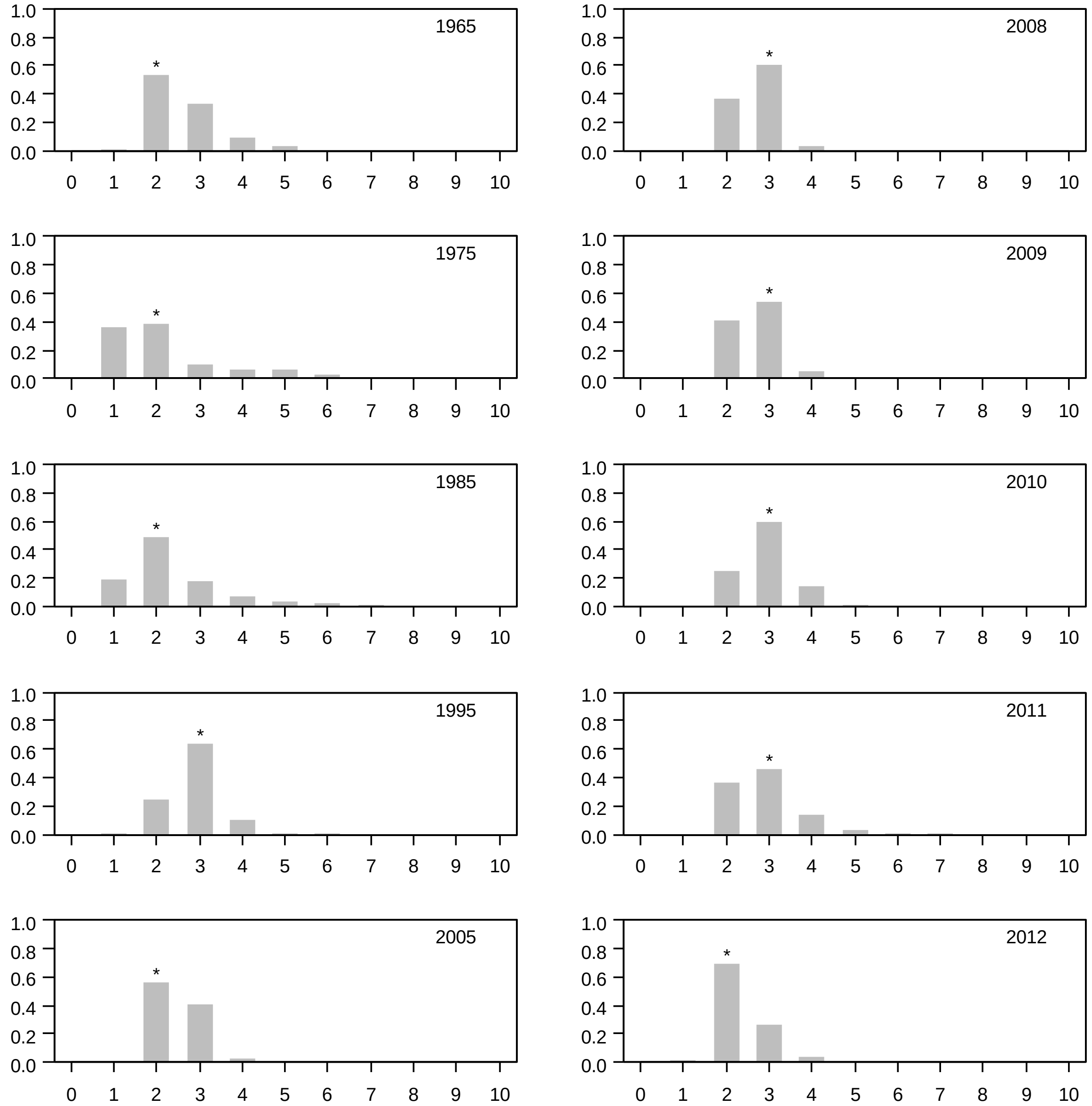


**Fig. 27. Age composition in the Australian surface fishery. Median age classes are indicated with asterisks.**

# 4 Summary

Recent trends in all indicators are summarised in Appendix 1 (with the exception of the Korean size composition which had small sample sizes in some years). Overall, there were mixed results in the indicators, with some increasing while others declined. For example, the proportion of age classes examined here all declined in the Japanese catch in 2012, but generally increased in the Taiwanese catch. In addition, CPUE increased in most of the Japanese standardised series (Base W0.5, Base W0.8, W0.5, W0.8) and in some of the nominal series for Japan and Taiwan, while decreasing in others (e.g. STwindows, Taiwanese nominal CPUE, areas 8 and 9).

Potential causes for these declines are discussed elsewhere, and therefore the indicators presented here should be interpreted with caution. In addition, some of the indicators may have been affected in the past by unreported catch, and historical trends must continue to be interpreted with caution. The recent trends in for some of these indicators are unlikely to be affected by unreported catches. In this paper, interpretation of indicators is restricted to the subset considered to be unaffected by the unreported catch.

## Trends in juvenile abundance

The three indices of juvenile (age 1 to 4) abundance—the scientific aerial survey index, SAPUE index and trolling index—exhibited increases over the past 12 months from values observed in the 2011–12 fishing season (austral summer). The scientific aerial survey in particular exhibited a substantial increase and is at its second highest level since the survey resumed in 2005. The SAPUE and trolling survey indices were close to or on the mean or median values, respectively.

## Trends in age 4+ SBT

Similar to the overall trends observed in age 1–4 SBT, indicators of age 4+ SBT were generally positive. The CPUE in both the NZ domestic and charter fisheries increased in 2012 compared with 2011. The catch rate in the NZ charter fishery for statistical area 6 increased slightly in 2012, and remains well above the 10 year mean. There was no fishing in area 5 in 2012. Juvenile fish also comprised a slightly larger portion of the NZ charter catch in 2012. Indonesian otoliths were not aged for 2012–13. However, the median length class of SBT on the spawning grounds decreased slightly in 2011–12, but has fluctuated around the same values since 2001–02. In addition, although potentially affected by the overcatch, the nominal CPUE for the Japanese longline fishery for 4+ SBT increased in 2012 and remains above the 10 year mean.

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# Appendix 1. Recent trends in all indicators of the SBT stock

**Table 1. Recent trends in all indicators of the SBT stock. Minimum and maximum values in the time series are also shown.**

| Indicator | Period | Min. | Max. | 2009 | 2010 | 2011 | 2012 | 2013 | 12 month trend |
|---|---|---|---|---|---|---|---|---|---|
| Scientific aerial survey | 1993–2000<br>2005–13 | 0.38 (1999) | 1.82 (2011) | 0.53 | 1.03 | 1.82 | 0.52 | 1.32 | ↑ |
| SAPUE index | 2003–13 | 0.39 (2003) | 1.70 (2011) | 0.96 | 1.46 | 1.78 | 0.57 | 1.01 | ↑ |
| Trolling index | 1996–2003<br>2005–06<br>2006–13 | 2.817 (2006) | 5.65 (2011) | 3.58 | 2.92 | 5.65 | 1.55 | 3.48 | ↑ |
| NZ charter nominal CPUE (Areas 5+6) | 1989–2012 | 1.339 (1991) | 7.83 (2010) | 4.33 | 7.81 | 6.30 | 7.33 | | ↑ |
| NZ domestic nominal CPUE | 1989–2012 | 0.000 (1989) | 4.06 (2012) | 1.26 | 1.90 | 2.28 | 4.06 | | ↑ |
| NZ charter age/size composition (proportion age 0–5 SBT)* | 1989–2012 | 0.001 (2005) | 0.414 (1993) | 0.33 | 0.25 | 0.11 | 0.19 | | ↑ |
| NZ domestic age/size composition (proportion age 0–5 SBT)* | 1980–2012 | 0.001 (1985) | 0.404 (1995) | 0.09 | 0.19 | 0.15 | 0.21 | | ↑ |
| Indonesian median size class | 1993–94 to 2011–12 | 166 (2002–03) | 188 (1993–94) | 170 | 168 | 170 | 168 | | ↓ |
| Indonesian age composition: mean age on spawning ground, all SBT | 1994–95 to 2010–11 | 14 (2005–06) | 21 (1994–95) | 15.6 | 15.3 | 16.8 | --- | | - |
| Indonesian age composition: mean age on spawning ground 20+ | 1994–95 to 2010–11 | 21.8 (2010–11) | 25.3 (2003–0496) | 23.4 | 23.1 | 23.8 | --- | | - |
| Indonesian age composition: median age on spawning ground | 1994–95 to 2010–11 | 13 (2001–03) | 21 (1994–97, 1998–99) | 15 | 15 | 17 | --- | | - |

*derived from size data

**Table 1. (cont'd). Recent trends in all indicators of the SBT stock. Minimum and maximum values in the time series are also shown. Japanese age composition refers to ages in statistical areas 4–9 for months 4–9 only.**

| Indicator | Period | Min. | Max. | 2009 | 2010 | 2011 | 2012 | 12 month trend |
|---|---|---|---|---|---|---|---|---|
| Reported global catch | 1952–2012 | 829 t (1952) | 81 750 t (1961) | 10 946 t | 9558 t | 9281 t | 10 059 | ↑ |
| Japanese nominal CPUE, age 4+ | 1969–2012 | 1.390 (2006) | 22.143 (1965) | 2.364 | 2.911 | 2.844 | 3.036 | ↑ |
| Japanese standardised CPUE (W0.5, W0.8, Base w0.5, Base w0.8, STwindows) | 1969–2012 | 2007 (0.212–0.306) | 1969 (2.284–3.734) | 0.315-0.739 | 0.365–1.00 | 0.492–0.969 | 0.643–1.111 | ↑ |
| Korean nominal CPUE | 1991–2012 | 0.118 (2005) | 21.523 (1991) | 4.659 | 3.651 | 3.909 | 5.499 | ↑ |
| Taiwanese nominal CPUE, Areas 8+9 | 1981–2012 | <0.001 (1985) | 0.956 (1995) | 0.182 | 0.471 | 0.305 | 0.149 | ↓ |
| Taiwanese nominal CPUE, Areas 2+14+15 | 1981–2012 | <0.001 (1985) | 3.466 (2007) | 1.829 | 1.277 | 0.994 | 2.731 | ↑ |
| Japanese age comp, age 0–2* | 1969–2012 | 0.004 (1966) | 0.191 (1998) | 0.061 | 0.007 | 0.071 | 0.025 | ↓ |
| Japanese age comp, age 3* | 1969–2012 | 0.015 (2003) | 0.284 (2007) | 0.141 | 0.058 | 0.130 | 0.096 | ↓ |
| Japanese age comp, age 4* | 1969–2012 | 0.052 (1969) | 0.286 (1992) | 0.257 | 0.227 | 0.169 | 0.141 | ↓ |
| Japanese age comp, age 5* | 1969–2012 | 0.079 (1986) | 0.345 (2010) | 0.272 | 0.345 | 0.213 | 0.159 | ↓ |
| Taiwanese age/size comp, age 0–2* | 1981–2012 | <0.001 (1982) | 0.251 (2001) | 0.018 | 0.006 | 0.008 | 0.028 | ↑ |
| Taiwanese age/size comp, age 3* | 1981–2012 | 0.024 (1996) | 0.349 (2001) | 0.052 | 0.055 | 0.072 | 0.215 | ↑ |
| Taiwanese age/size comp, age 4* | 1981–2012 | 0.027 (1996) | 0.502 (1999) | 0.363 | 0.169 | 0.131 | 0.251 | ↑ |
| Taiwanese age/size comp, age 5* | 1981–2012 | 0.075 (1997) | 0.371 (2009) | 0.371 | 0.353 | 0.290 | 0.283 | ↓ |
| Australia surface fishery median age composition | 1964–2012 | age 1 (1979–80) | age 3 (multiple years) | age 3 | age 3 | age 3 | age 2 | ↓ |

*derived from size data

# Appendix 2. Map of CCSBT statistical areas