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Fishery indicators for the southern bluefin tuna stock 2011–12

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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 2001, it was agreed to monitor and review fishery indicators on an annual basis. At the ninth meeting of the Stock Assessment Group in 2008, it was agreed that the basis for management advice to the Commission in 2009 and beyond would be a reconditioned operating model in conjunction with an evaluation of current stock status and recent recruitment based on indicators; that conditioning of the operating model would be broadened to include some of the available indicators (notably the scientific aerial survey); and that a management procedure adopted by the Commission should incorporate indicators such as the scientific aerial survey.

The 2010–11 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 declines 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 fishery increasing in 2011 and the Japanese longline nominal CPUE for ages 4-7 increasing in 2011; the CPUE for the New Zealand charter fishery declined in 2011 but remains relatively high, and the Japanese longline nominal CPUE for ages 4+ also decreased slightly in 2011. The mean age of 20+ fish on the Indonesian spawning grounds decreased again in 2010–11; however, the mean age of all SBT on the spawning grounds increased in 2010–11.

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) (Hartog & Preece 2008). 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.

At the ninth meeting of the Stock Assessment Group in 2008, it was agreed that the basis for management advice to the Commission in 2009 would be a reconditioned operating model in conjunction with an evaluation of current stock status and recent recruitment based on indicators (CCSBT-ESC13 2008).

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 2011–12 update of fishery indicators for the SBT stock summarises indicators in the same groups presented in previous updates in 2007 to 2011 (Hartog et al. 2007, Hartog & Preece 2008, Phillips 2009, Patterson et al. 2010, Patterson et al. 2011):

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. (2011) with the most recent data available through the CCSBT data exchange in June 2011.

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_12).

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. 2012). 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. 2012).

The index of relative juvenile abundance in 2012 (the 2011–12 fishing season) is substantially lower than the 2011 estimate (2010–11 fishing season), indeed, the 2012 index is the second lowest index obtained for the scientific aerial survey since the survey began in 1993. Taking confidence bounds into account, however, 2012 is similar to estimates obtained in 1999 and several years during the period 2005–09. All of the confidence intervals are slightly underestimated because they do not account for uncertainty in the observer effect estimates (Eveson et al. 2012).

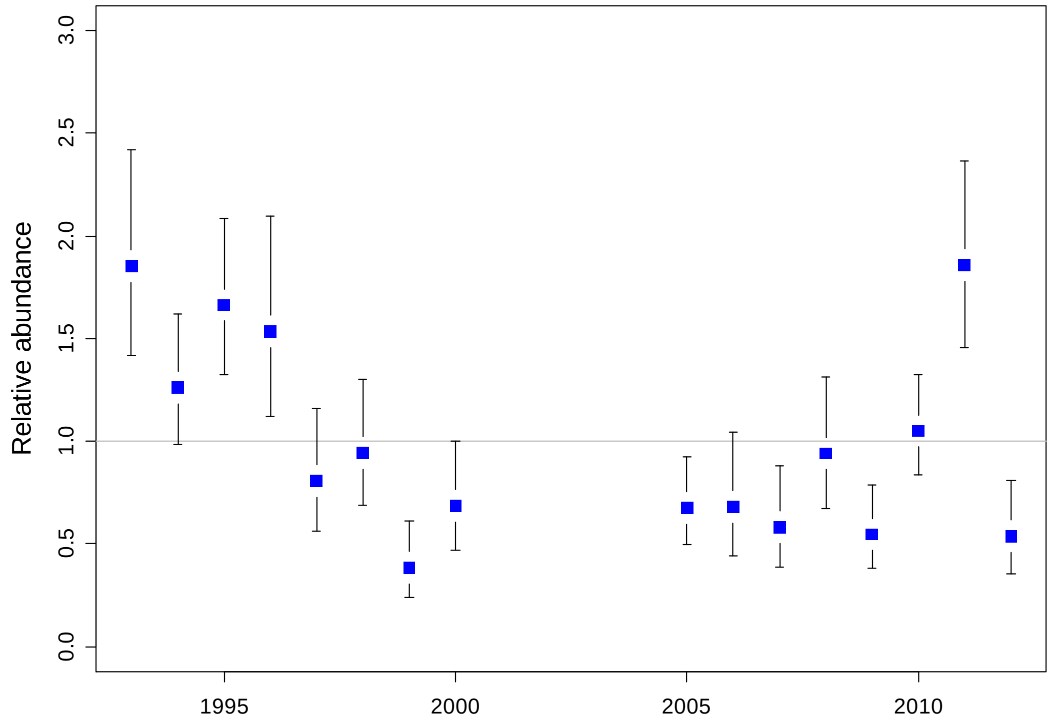

Fig. 1. Scientific aerial survey index of relative abundance of juvenile SBT in the Great Australian Bight, January–March (hence the 2012 value represents the 2011–12 fishing season etc) from Eveson et al. (2012). Vertical lines are 90% confidence intervals. The horizontal line represents a relative 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_02_12).

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 2011–12. 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 2012). Farley & Basson (2012) urge caution when directly comparing the last eight years of the SAPUE with the overlapping period of the scientific aerial survey index (2004–05 to 2010–12) as the data were collected using different methods and commercial flights cover a much smaller area than the scientific line transect aerial survey.

Median estimates have varied over the past eight years, however an increasing trend is discernable up to 2011 (Fig. 2). Although not dissimilar to some previous years, the value in 2011–12 was significantly lower than the 2010–11 estimate (Fig. 2). The potential causes of this decline are discussed in Farley and Basson (2012), which notes that particular caution should be applied when interpreting the 2012 SAPUE index.

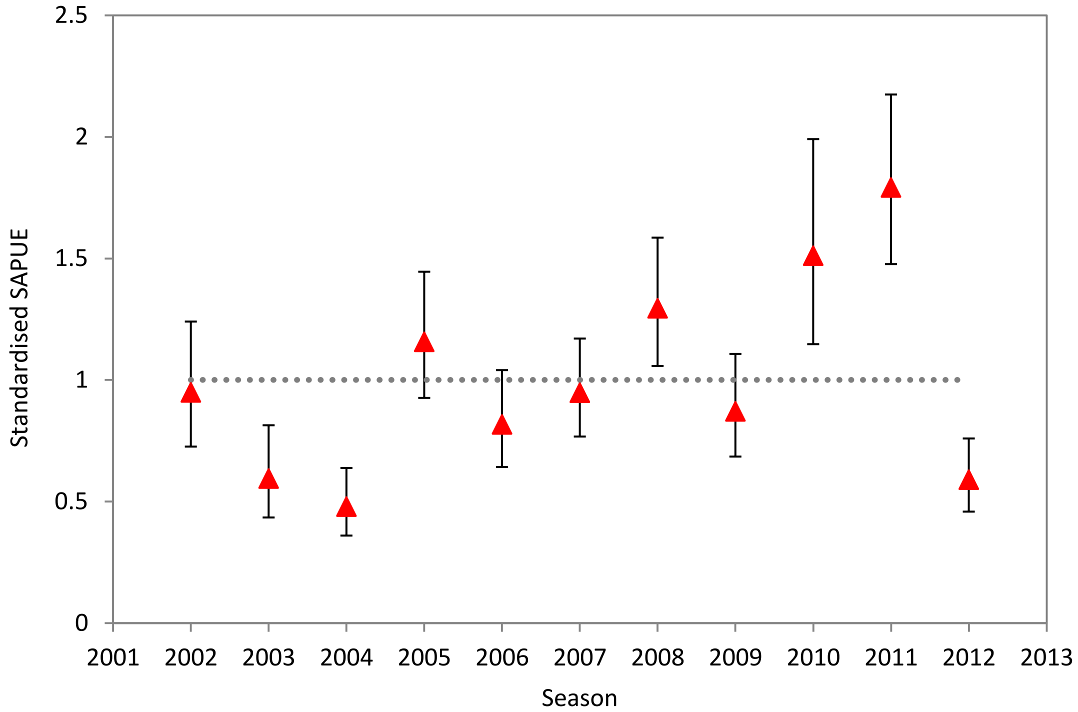

Fig. 2. SAPUE index of relative surface abundance of juvenile SBT in the Great Australian Bight, December–March (Farley & Basson 2012). Estimates are median ± 2 standard errors. 'Season' represents the second year in a split-year fishing season, i.e. '2012' is the 2011–12 fishing season.

Trolling index

The trolling survey index has been updated from data provided by Japan through the CCSBT data exchange (JP_Trollingindex96_12).

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, 2006–12; (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 (CCSBT-SC13 2008, para 114). Other issues, such as limited temporal/spatial coverage of the survey, and analysis to address potential auto-correlation from multiple encounters of individual schools, were recommended to be addressed in refinements to the survey design (CCSBT-SC 2008).

The index increased from 2005 to 2008, but declined in 2009 and 2010 before increasing in 2011 to well above the average median value of the piston line survey (Fig. 3, horizontal line). In 2012, the index steeply declined to the lowest level recorded for the piston-line survey.

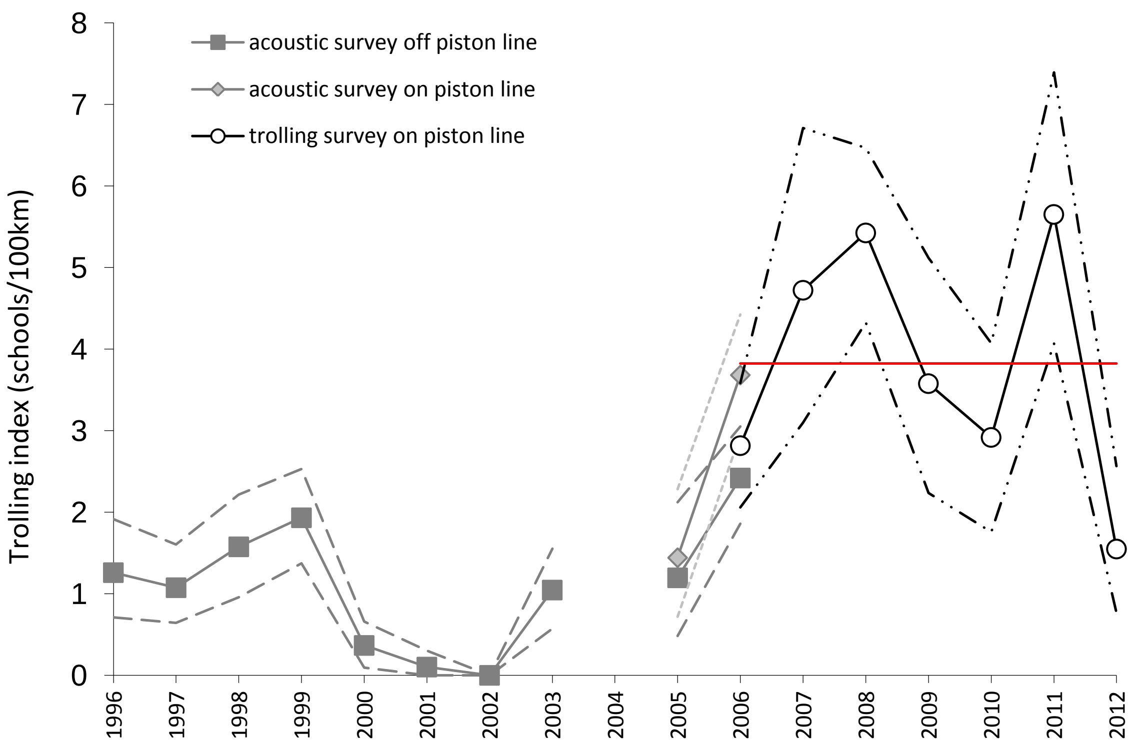

Fig. 3. Trolling index, showing number of schools per 100 km off the Western Australian coast in January. Dashed lines are 90% confidence intervals. The red line shows the average median value of the piston line survey from 2006–12.

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 2012 interim update of the CCSBT database.

The NZ charter fishery had close to 100% 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 relatively high. 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 (statistical area 6) decreased slightly in 2011, but remains well above the ten-year mean level. There was no effort in the northern fishery (statistical area 5) in 2011.

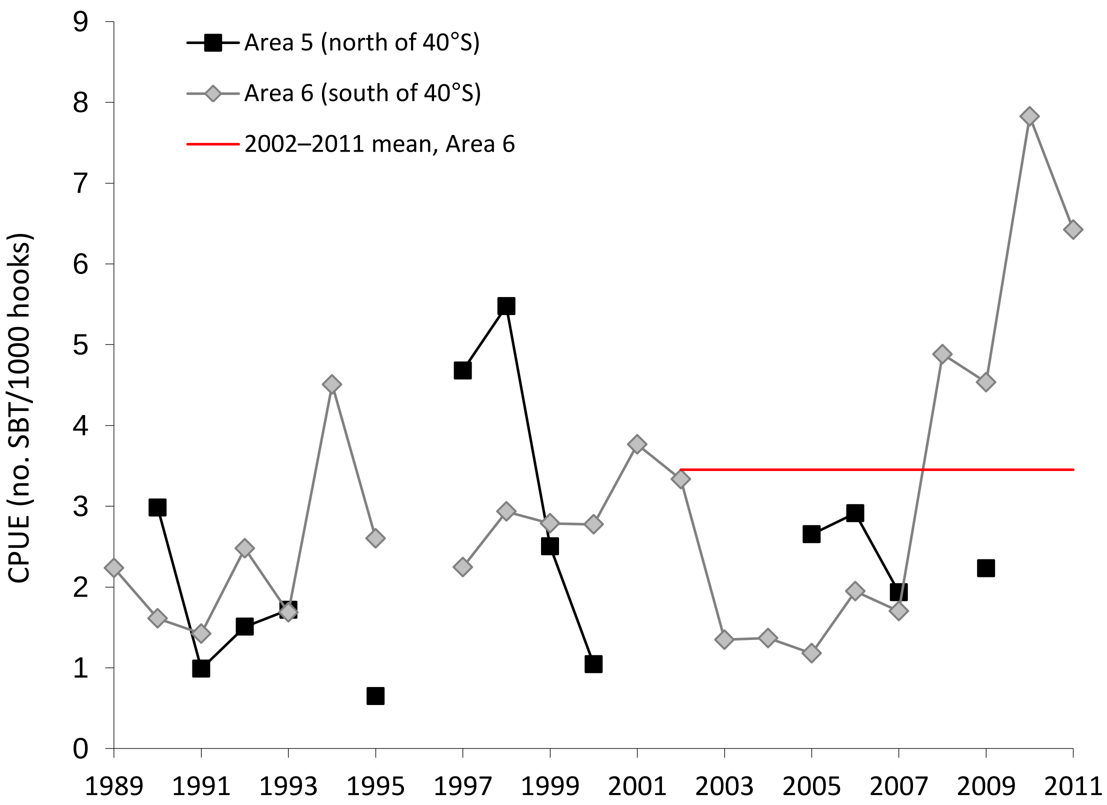

Fig. 4. Nominal CPUE (number per 1000 hooks) for the NZ charter fishery. The red, horizontal line indicates the ten-year mean (2002–11).

New Zealand domestic longline CPUE

The NZ domestic nominal CPUE was updated from aggregated catch and effort data provided in the 2012 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 again in 2011.

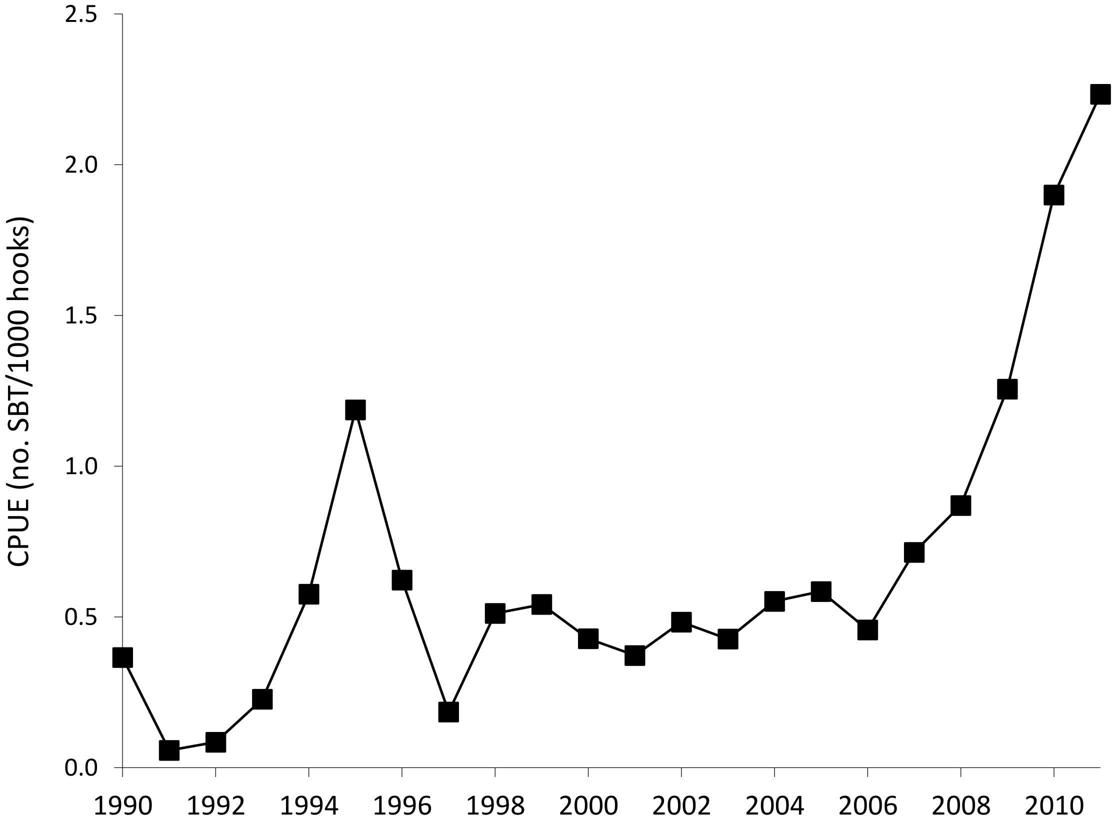

Fig. 5. Nominal CPUE (number per 1000 hooks) for the NZ domestic longline fishery.

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 2012 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 have comprised ~25% of the New Zealand joint venture catch on average and in 2010 comprised ~50% (Anon 2011). In the NZ domestic fishery, juvenile fish aged less than 6 years have comprised on average 18% 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 (from Hartog & Preece 2008) 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 2011, however, age 5 SBT declined to levels similar to 2003 and age 4 SBT also declined. The NZ joint venture fishery catches virtually no age 0–2 SBT, and continued to catch small amounts of age 3 SBT in 2011, with no clear trends in the abundance of this size/age class apparent over the past decade (Fig. 6). Given the general 100% observer coverage in the NZ joint venture fishery up to 2007, 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 slightly in 2011. Overall, the 0-4 age classes, which have only comprised a very small proportion of the NZ domestic catch since the late 1990s, declined in 2011(Fig. 7). There is a lower level of observer coverage in the NZ domestic fishery, and some discarding of juveniles may occur.

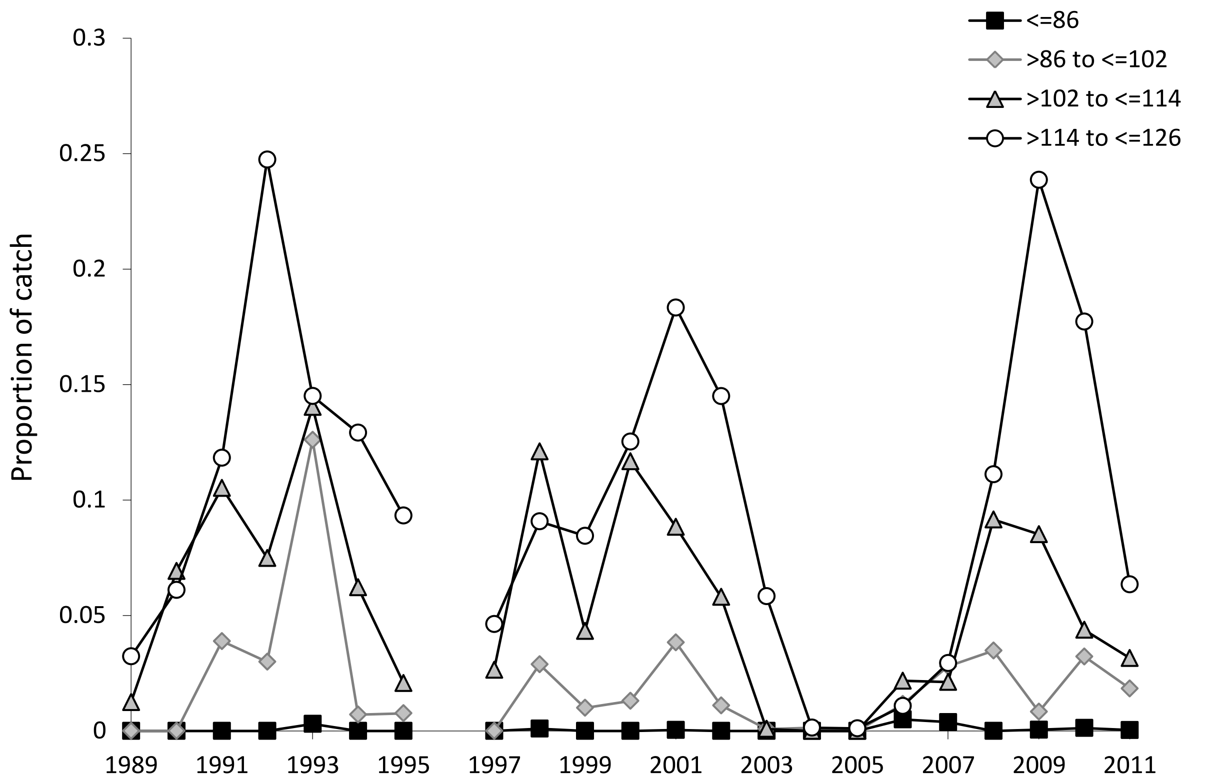

Fig. 6. Size composition for the NZ joint venture longline fishery, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

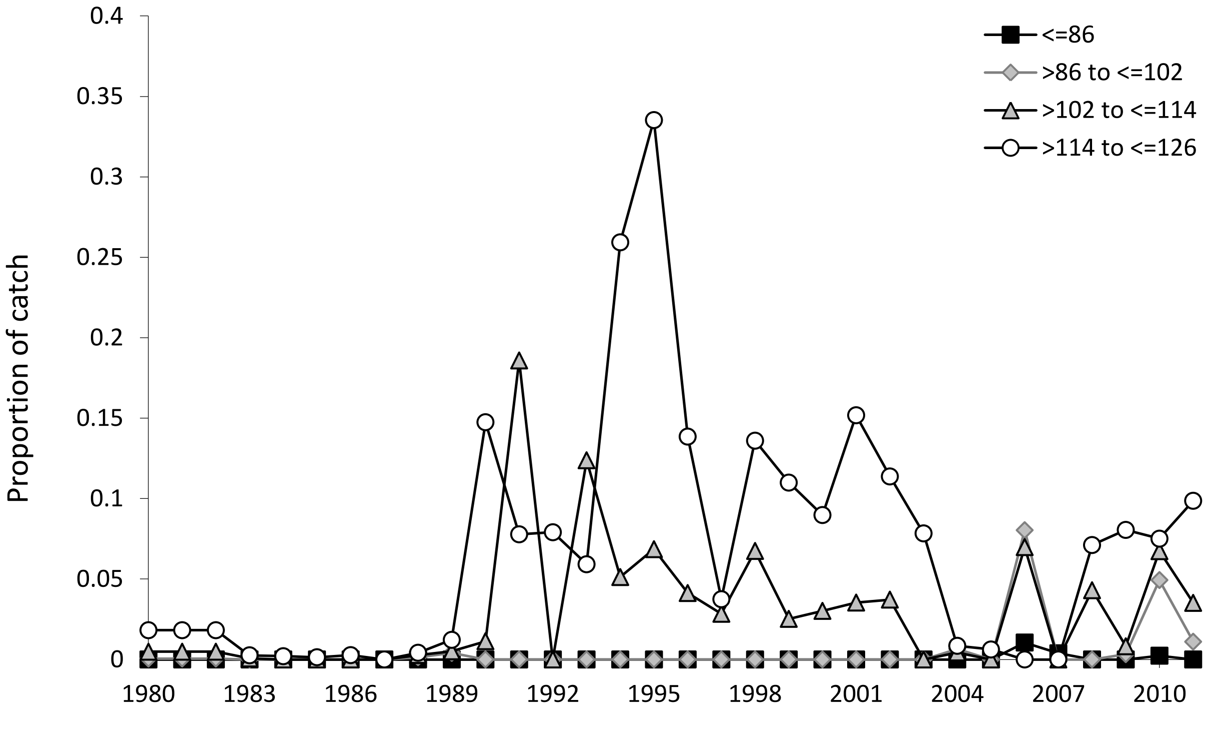

Fig. 7. Size composition for the NZ domestic fishery, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

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). Updates on mean age of SBT caught by Indonesian longliners on the spawning ground and age frequency data were obtained from 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 2009–10 spawning seasons has been reproduced from Farley et al (2012) (Fig. 9).

Direct age data have been used to update the age frequency for the 2009–10 and 2010–11 seasons (see Farley et al. 2012). 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).

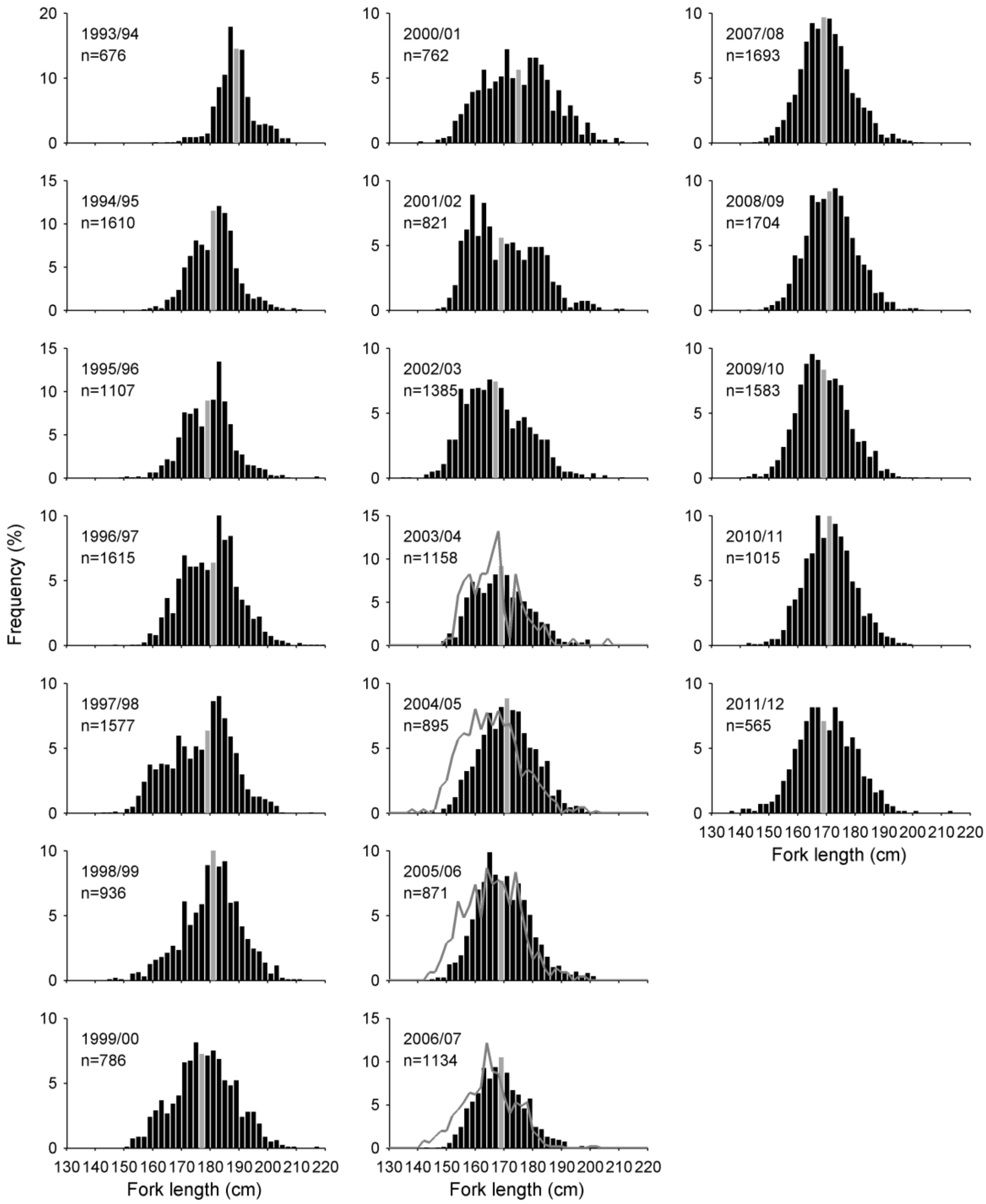

Fig. 8. Length frequency (2 cm intervals) of SBT caught on the spawning ground (bars) by spawning season (Farley et al. 2012). The grey bar shows the median size class. For comparison, the length distribution of SBT thought to be caught south of the spawning ground (Processor A) is shown for the 2003/04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

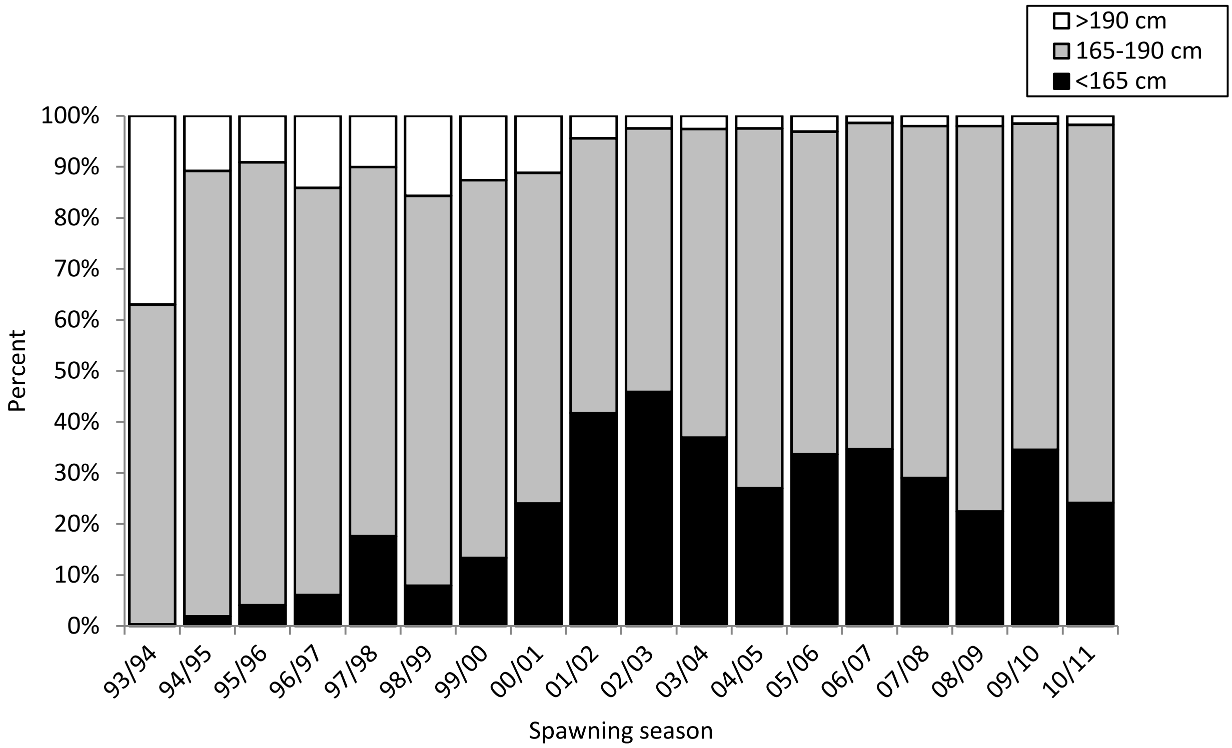

Fig. 9. Size composition of SBT caught on the spawning grounds by the Indonesian longline fishery by spawning season (from Farley et al. 2012). Data from Processor A are excluded.

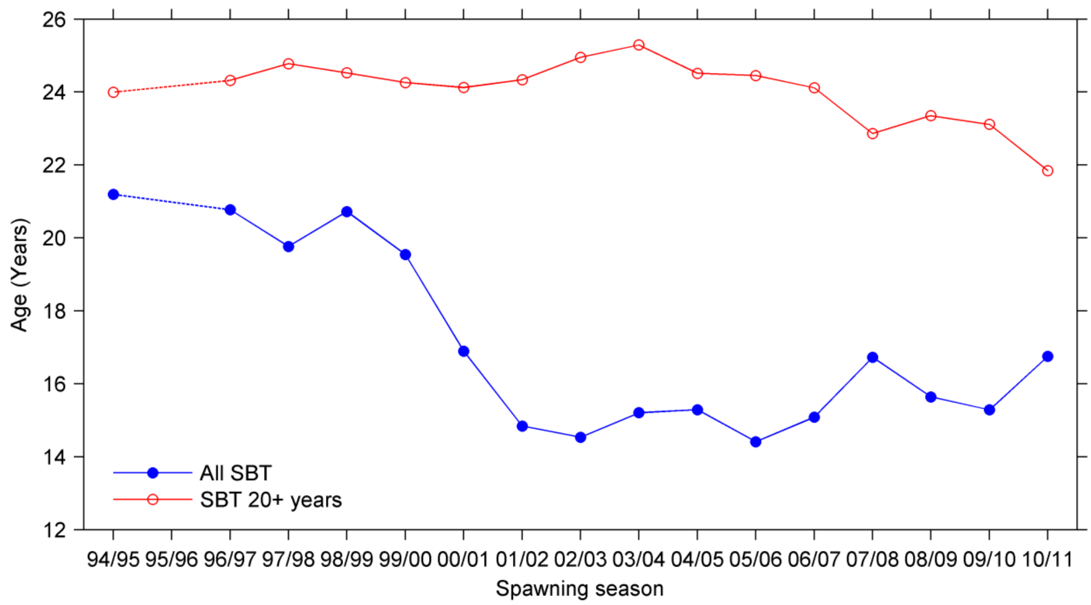

Fig. 10. Mean estimated age (years) of SBT caught on the spawning grounds by Indonesian longliners. Data from Processor A are excluded.

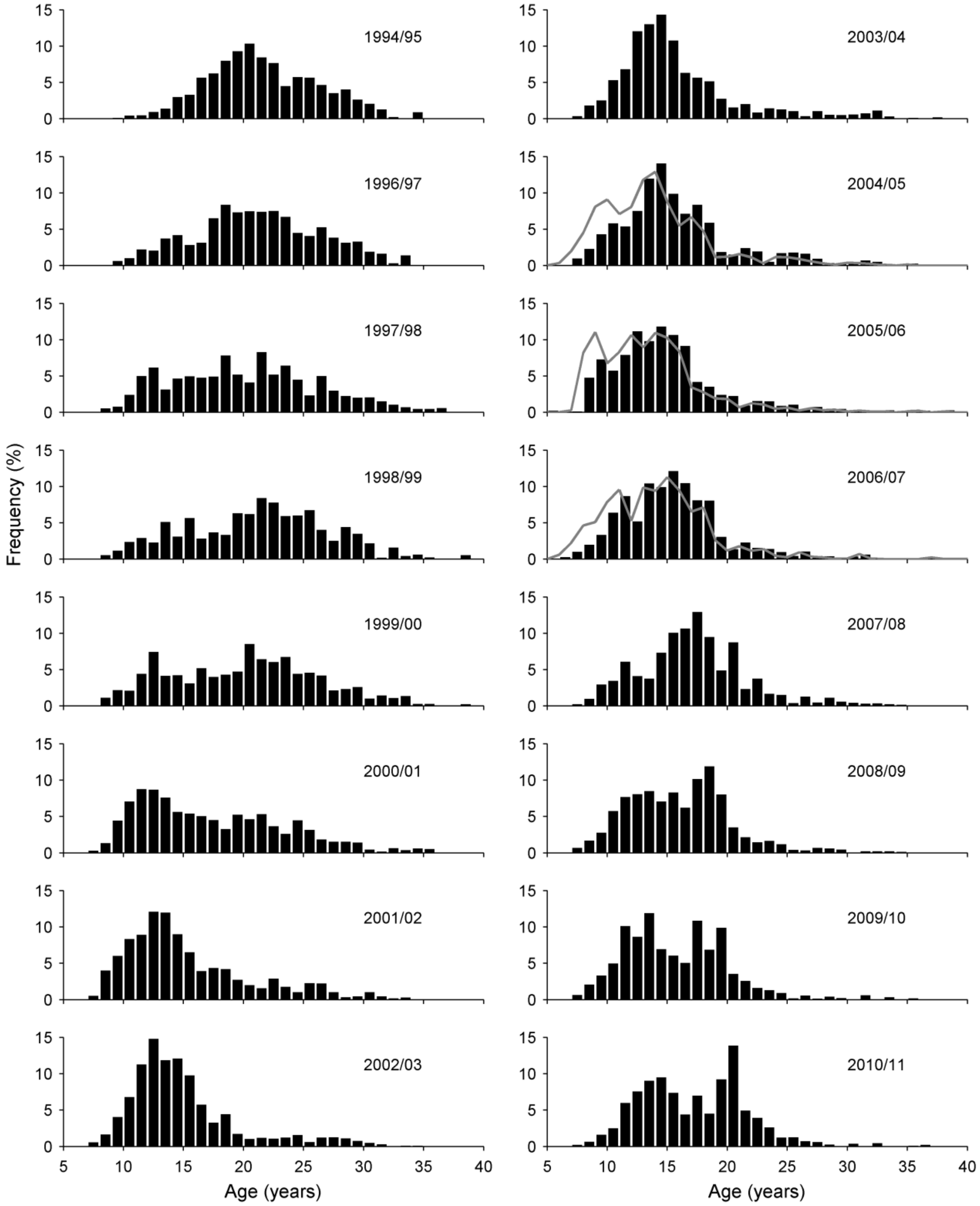

Fig. 11. Age frequency distribution of SBT in the Indonesian catch on the spawning ground by spawning season estimated using age-length keys from our sub-samples of direct aged fish and length frequency data obtained through the Indonesian monitoring program. The 2009–10 and 2010–11 seasons have been updated to use direct age data (Farley et al. 2012). 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 2012, 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 2012 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. Australia's reported catches in 2007–11 (by calendar year) were 4813 t, 5033 t, 5108 t, 4199 t and 4206, respectively, while Japan's reported catches over the same period were 2840 t, 2952 t, 2659 t, 2223 t and 2519 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 556 t reported in 2011. Korean catches have been more variable since its accession as a full member to CCSBT in 2001. The effect of retrospective unreported catches on the interpretation of other indicators in this section is unknown.

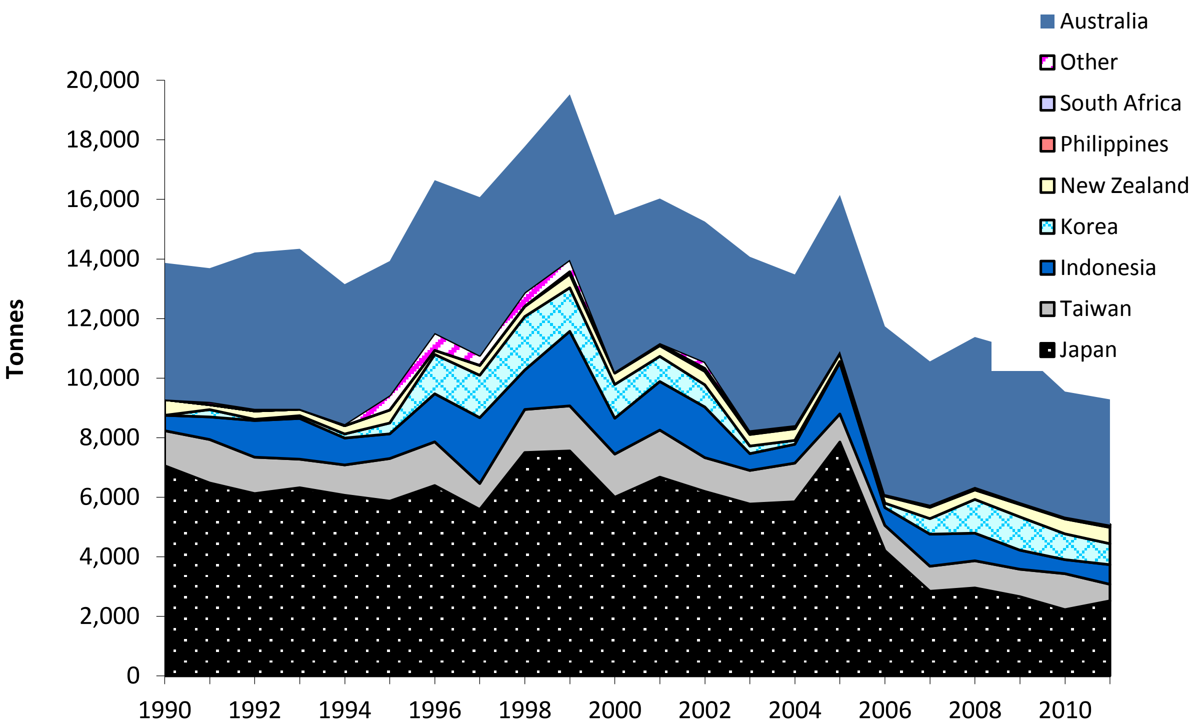

Fig. 12. Reported catches (tonnes) by country since 1990. Shaded areas are stacked so that y-axis values represent total catch reported by all Members in a calendar year.

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_11). 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 (newST Windows_2011SC and w05w08_for_monitoring_2011SC) and Australia (Laslett Core Area) through the CCSBT data exchange (AU_CPUE_Nominal_Laslett).

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 2011 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, but increased to 2010. While there was a slight decline in 2011, it is above the 2002–11 mean (Fig. 13, horizontal line).

- Nominal CPUE for age 4–7, 8–11 and 12+ SBT. The recent upward trend in aggregate 4+ CPUE (Fig. 14) is likely related to a similar recent increase in the CPUE of age 4–7 SBT (Fig. 14). A slight decline can also be observed for age 8–11 SBT since 2008, 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, although they have increased in 2011. Age 5 SBT are the dominant year class in 2011, despite a decline, followed by age 4 SBT, which also declined in 2011 (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 areas 4-7 in 2011, but increased in area 9. CPUE for all areas increased for age 6. CPUE for age 7 SBT increased for areas 4-7. CPUE of ages 8 and 9 were generally stable in all areas (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 2011 increased slightly in 2011 for areas 4-7, but declined in other areas (Fig. 17).

- Standardised CPUE. The standardised and normalised CPUE series exhibited an overall declining trend from 2002 to 2007, but have increased since then. In 2011, ST Windows increased substantially, while W0.5 increased slightly and W0.8 decreased slightly from 2010 levels. The Laslett Core series declined to a level similar to 2009 (Fig. 18).

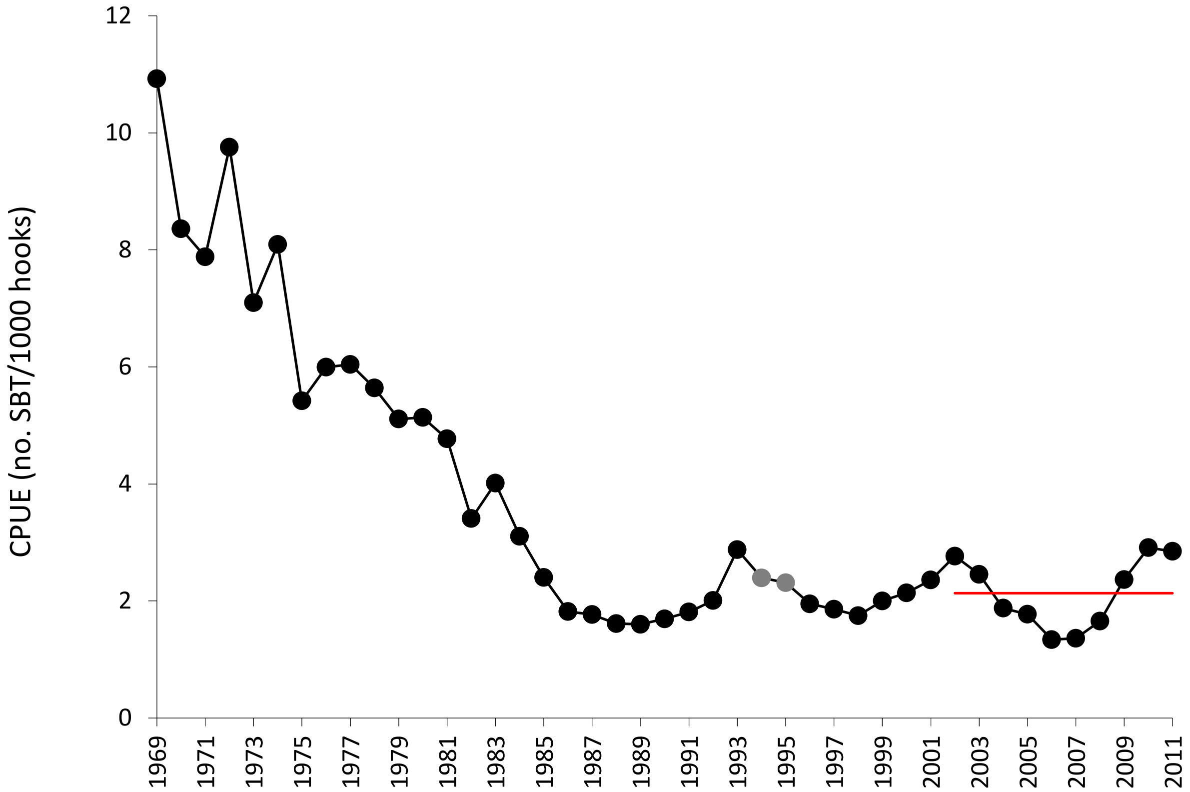

Fig. 13. Nominal CPUE of age 4+ SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9. The 1995 and 1996 values are plotted as grey circles to indicate increased uncertainty about these points due to changes in retention policies for small fish in these two years, when a policy of releasing small fish applied. The horizontal line is the 2002–11 mean.

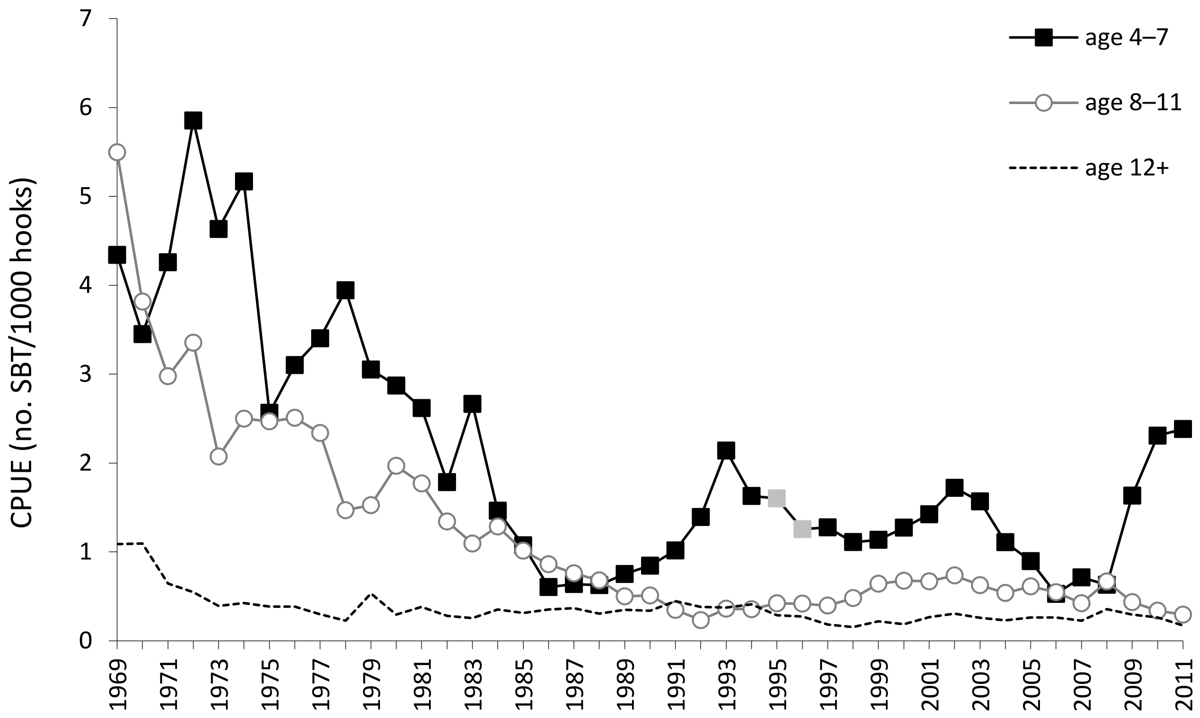

Fig. 14. Nominal CPUE of ages 4–7, 8–11 and 12+ SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9. The 1995 and 1996 values for ages 4–7 are plotted as grey squares to indicate increased uncertainty about these points due to changes in retention policies for small fish in these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

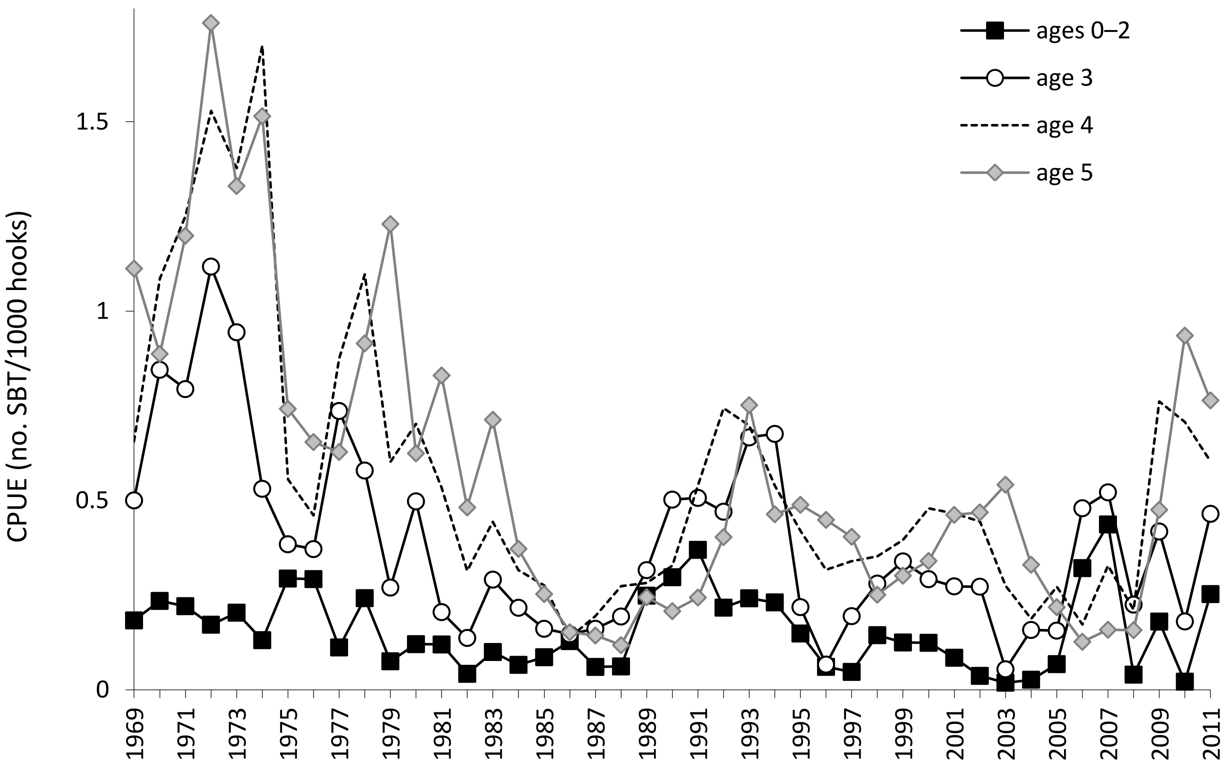

Fig. 15. Nominal CPUE of ages 0–2, 3, 4 and 5 SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9.

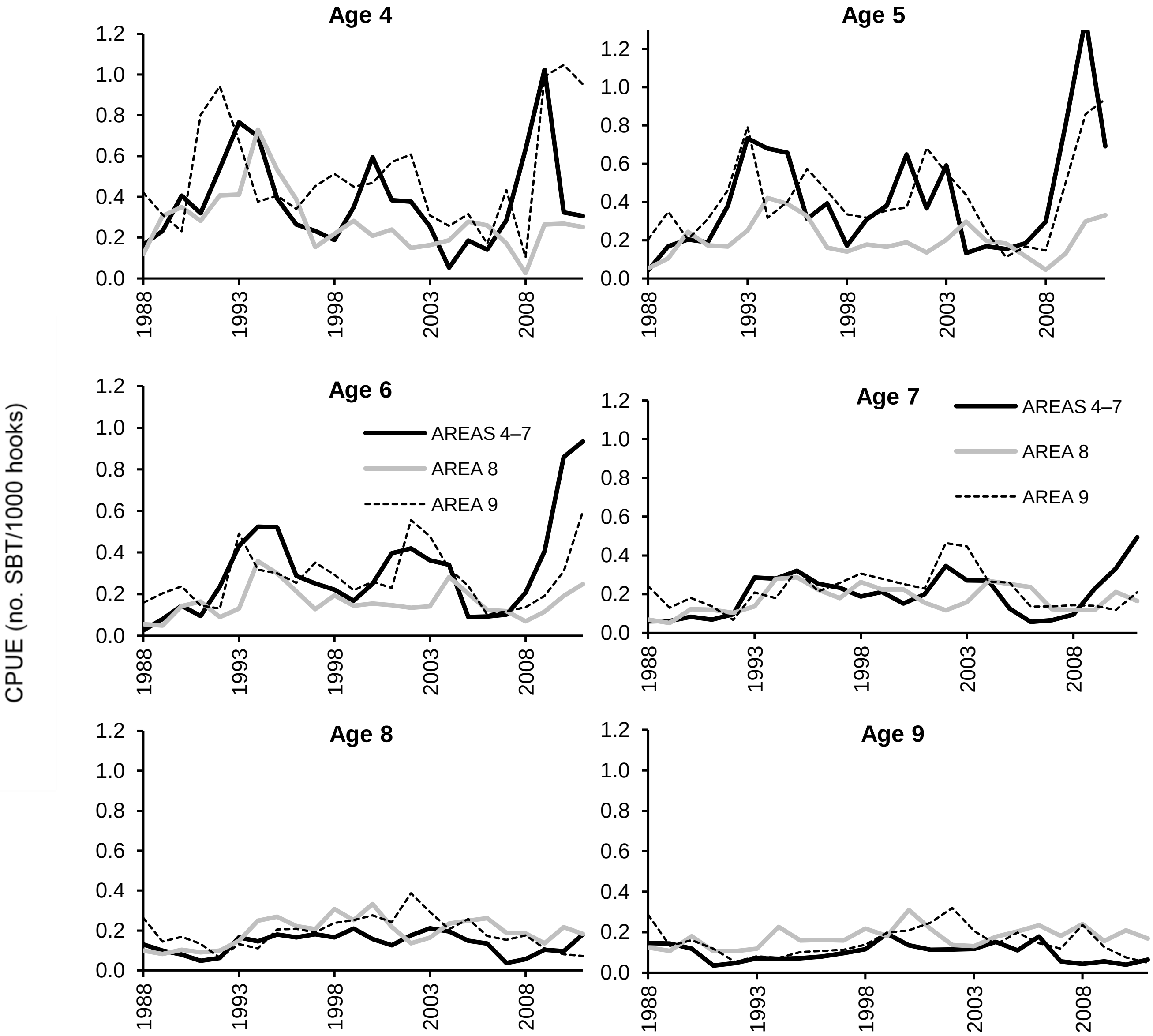

Fig. 16. Comparison of age-specific nominal CPUE for Japanese longliners in different statistical areas in months 4–9.

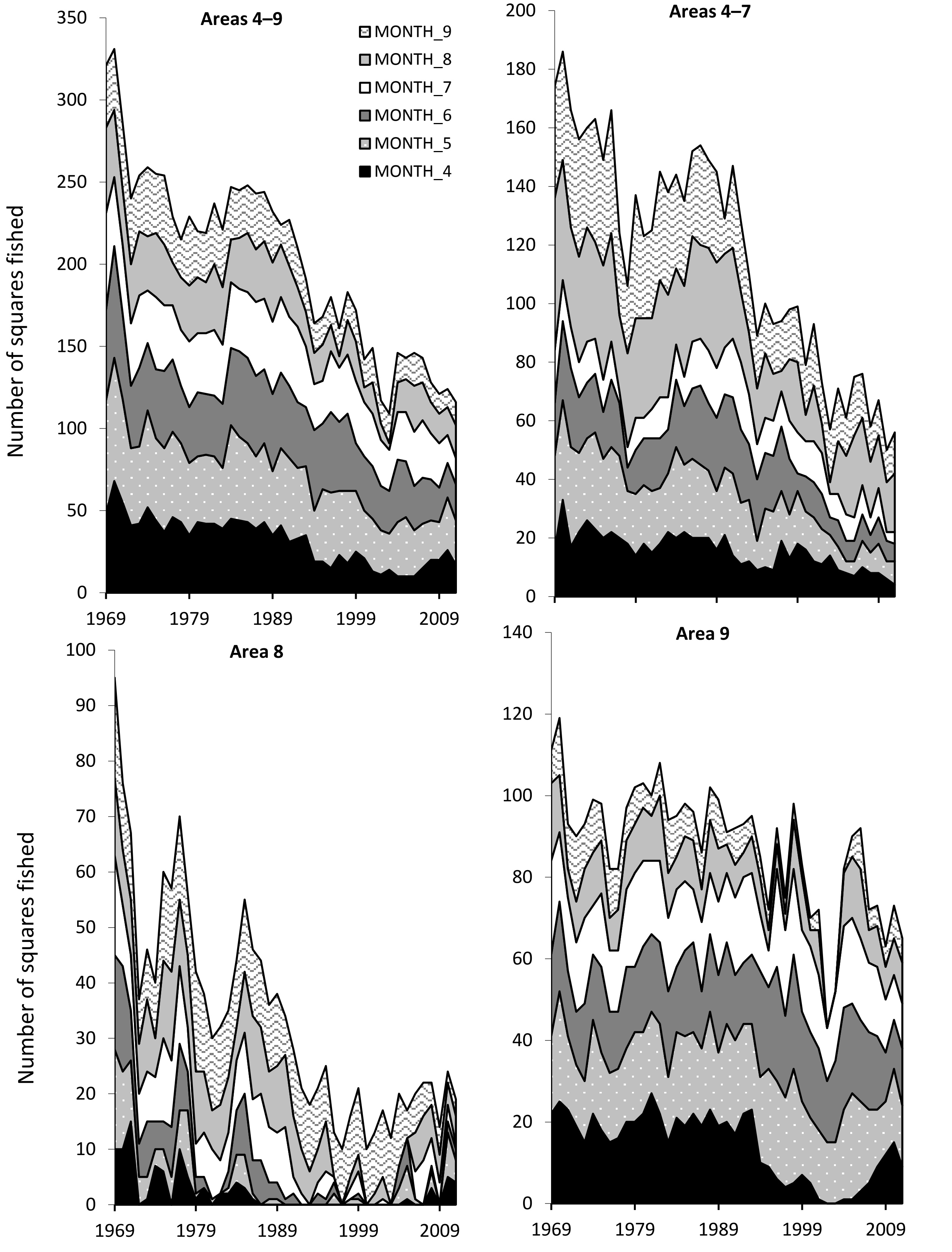

Fig. 17. Total number of 5×5° grid squares with Japanese longline fishing effort in months 4–9 for different statistical areas. Shaded series in each plot are stacked (i.e. y-axis values are cumulative), with the legend and shaded series being stacked in the same order.

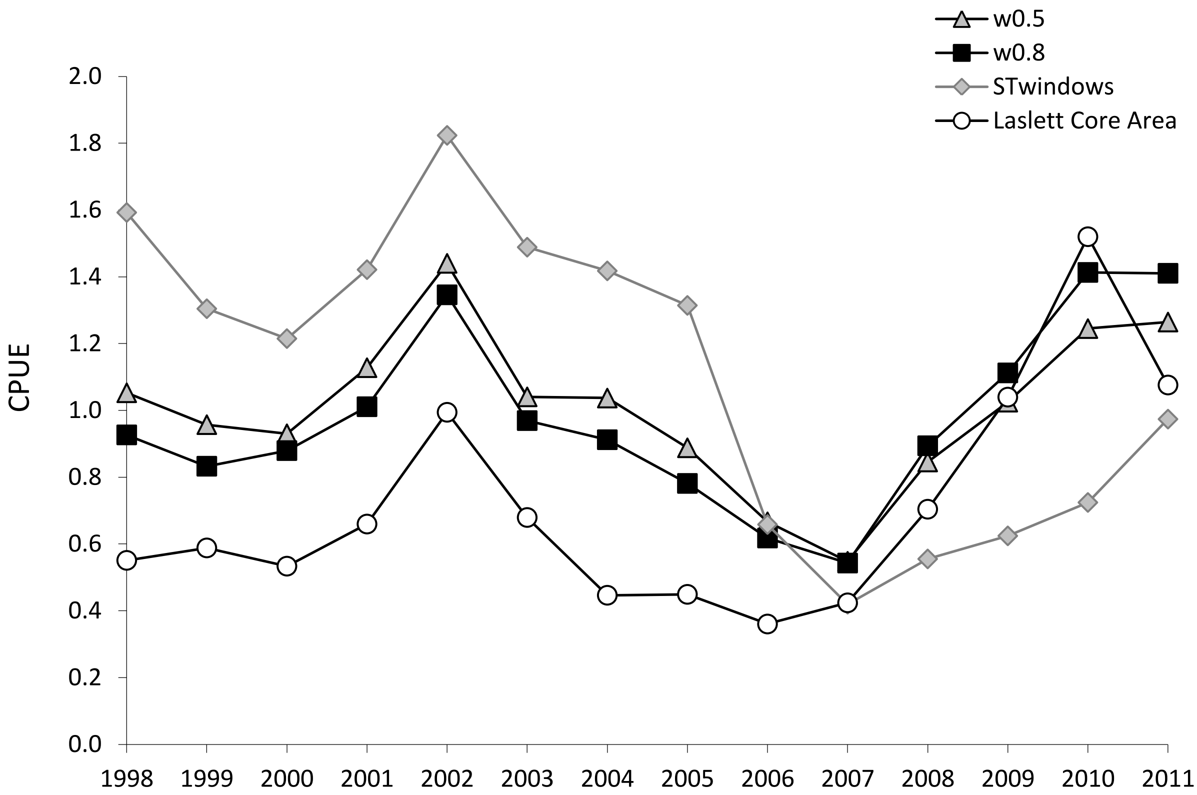

Fig. 18. Comparison of subsets of the standardised CPUE series. Each subset has been normalised by dividing by the mean.

Korean longline CPUE

Nominal CPUE series for Korean longliners were obtained from aggregated catch and effort data provided in the 2012 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 2011 (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).

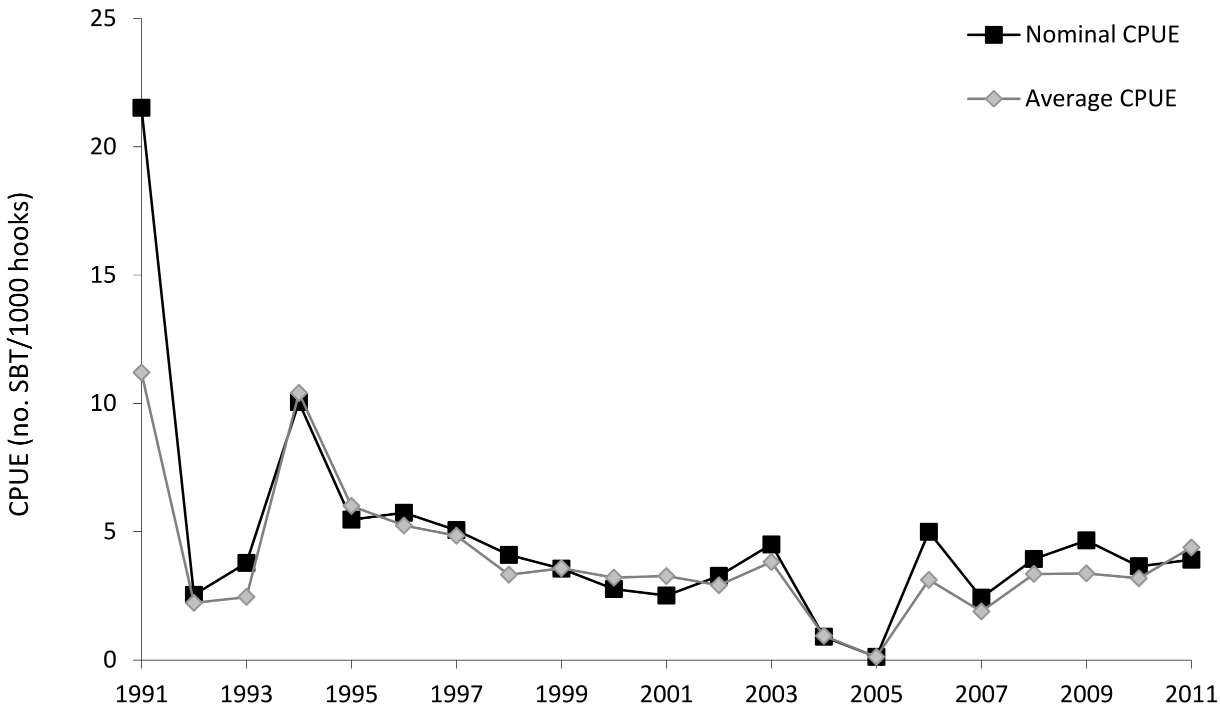

Fig. 19. Nominal and average CPUE of SBT for Korean longliners operating in statistical areas 4–9 in months 4–9. Nominal CPUE is the total number of SBT over total effort (1000 hooks), while average CPUE is the mean of the nominal rate in each 5×5° grid square per month.

Taiwanese longline CPUE

Nominal CPUE series of Taiwanese longliners were obtained from aggregated catch and effort data provided in the 2011 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 decrease in areas 2, 14 and 15 in 2011 and a slight decrease in areas 8 and 9 (Fig. 20). Catch rates in 2011 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 2011 and is similar to that in areas 2, 14 and 15, which also declined in 2011(Fig 22).

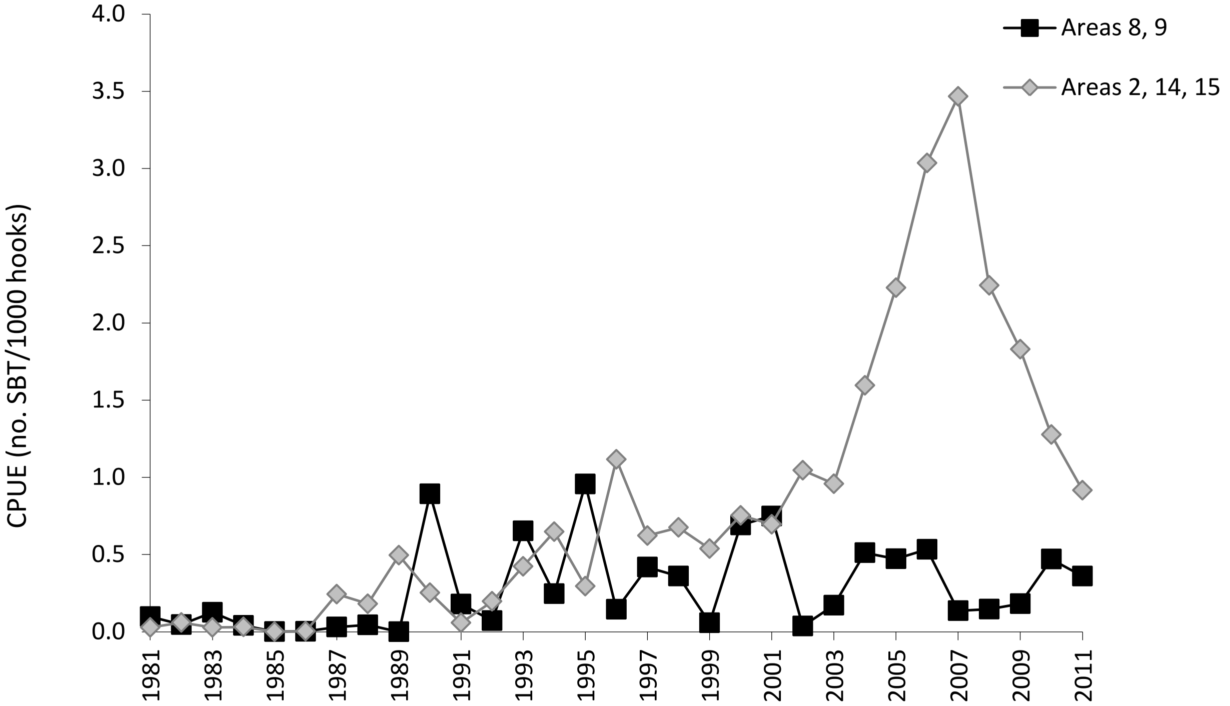

Fig. 20. Nominal CPUE of SBT for Taiwanese longliners operating in statistical areas 8 and 9 (pooled) and 2, 14 and 15 (pooled) in months 4–9.

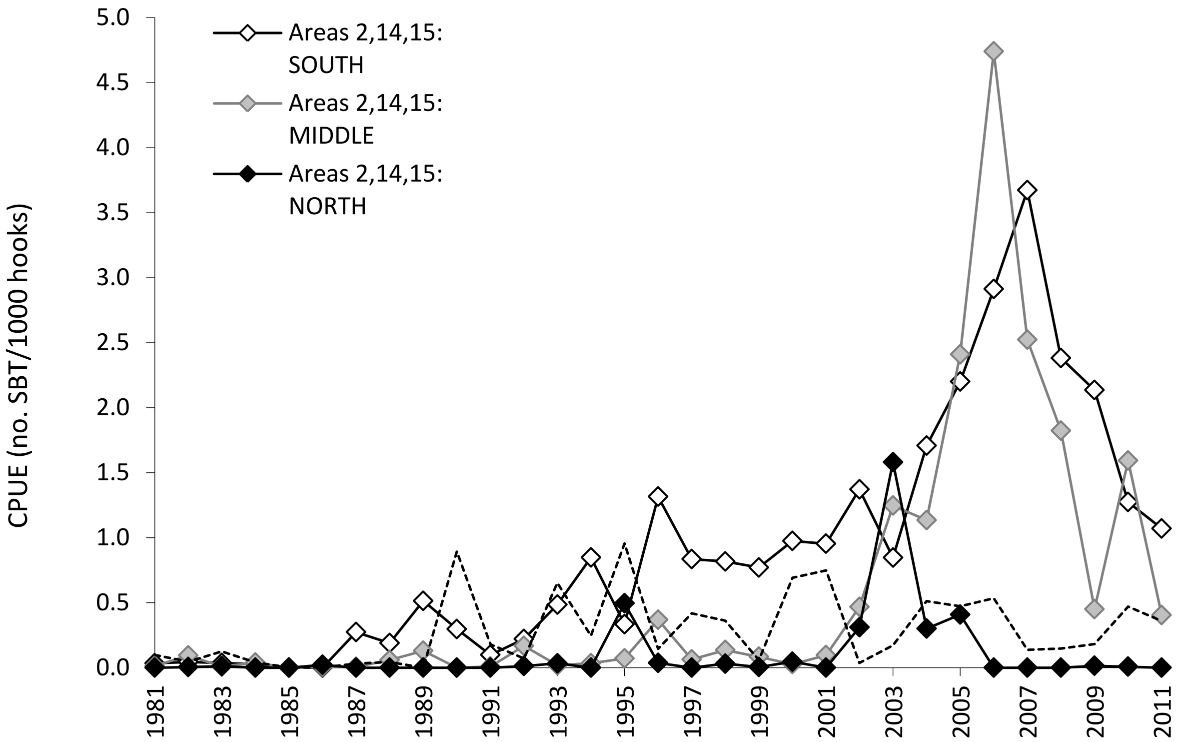

Fig. 21. Nominal CPUE of SBT for Taiwanese longliners operating in statistical areas 2, 14 and 15 (pooled) by 5° latitudinal strips: South = 30–35°S; Middle = 25–30°S; North = 20–25°S. Nominal CPUE in areas 8 and 9 (pooled) shown for comparison. Data are from months 4–9 only.

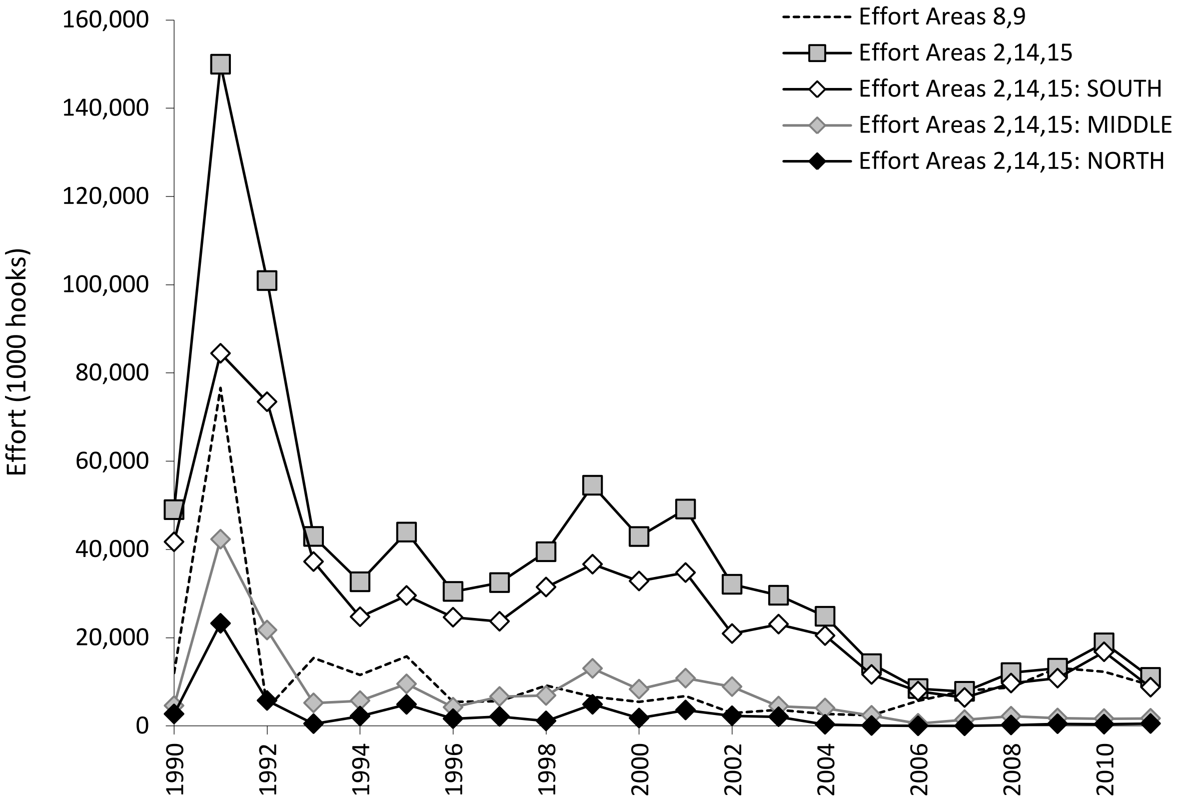

Fig. 22. Effort (1000 hooks) from Taiwanese longliners in statistical areas 8 & 9 (pooled) and 2, 14 and 15 (pooled). Areas 2, 14 and 15 are also separated into 5° latitudinal strips: South = 30–35°S; Middle = 25–30°S; North = 20–25°S. Data are from months 4–9 only.

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 and age composition data for SBT caught by Japanese longliners were obtained from the 2012 interim update of the CCSBT database. 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 age 5 and age 4 SBT declined in 2011, while the proportion of the other juvenile age groups increased. However, the proportion of age 5 SBT remains at its highest level since the late 1970s (Fig. 24). Observer coverage on vessels has been less than or around 10% 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 the largest size class (Fig. 25), with the two middle size classes increasing and, in the case of the smallest size class, remaining virtually unseen in the fishery.

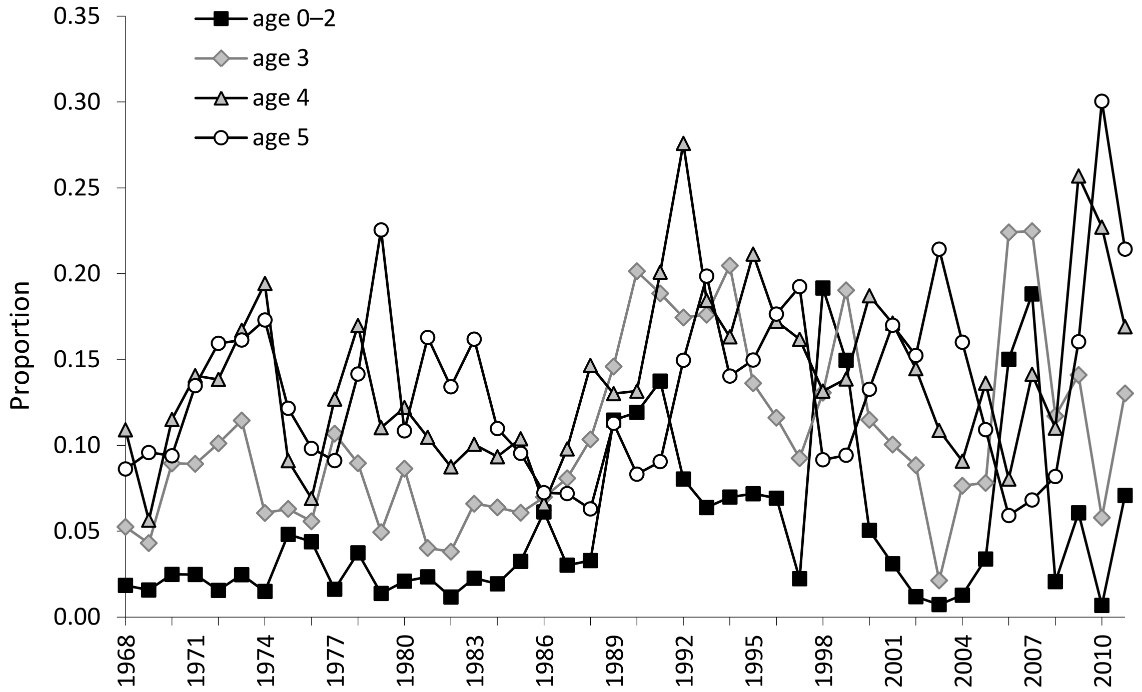

Fig. 23. Age composition (proportion of total catch) of ages 0–2, 3, 4 and 5 in the Japanese longline fishery in statistical areas 4–9, months 4–9.

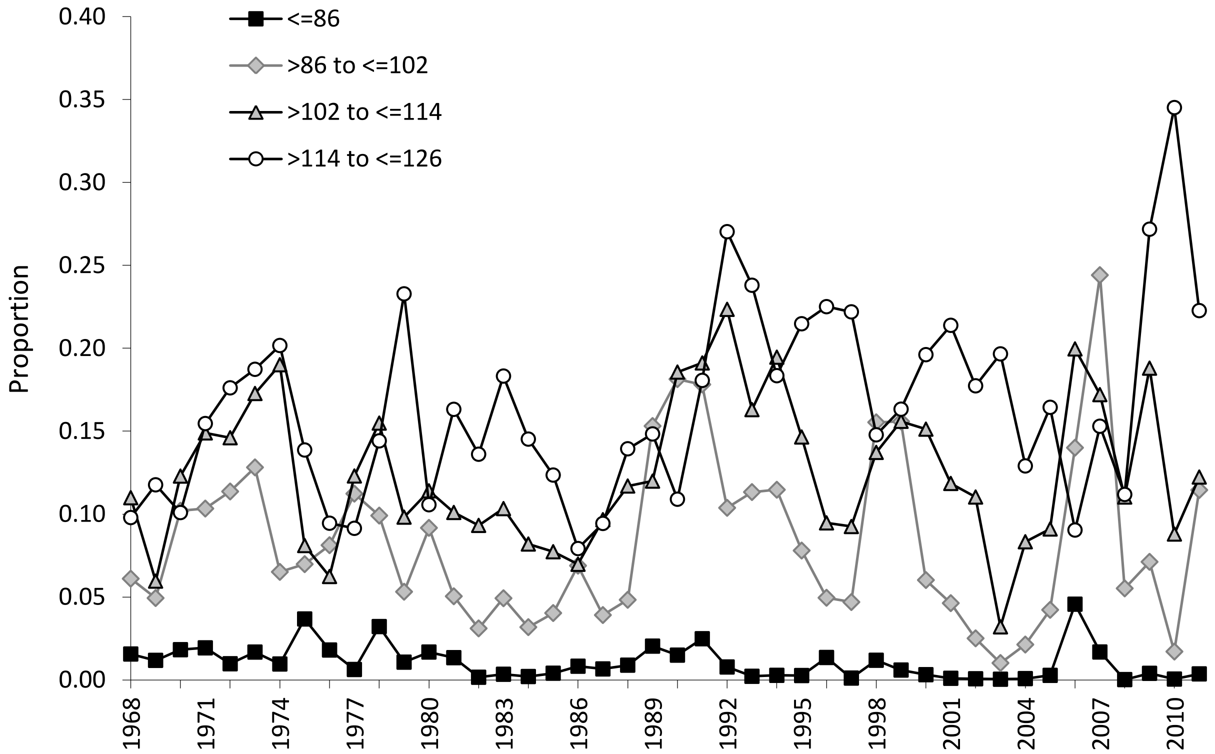

Fig. 24. Size composition (proportion of total catch) of juvenile SBT caught by Japanese longliners in statistical areas 4–9, months 4–9, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

Korean longline fishery size/age composition

Size composition data for SBT caught by Korean longliners were obtained from the 2012 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. The proportions of all juvenile size classes increased in 2011 (Fig. 25), including the smallest size class, which has been unseen in the fishery in the past. Observer coverage on vessels has been less than 10% in some past years, and discarding of juveniles cannot be discounted.

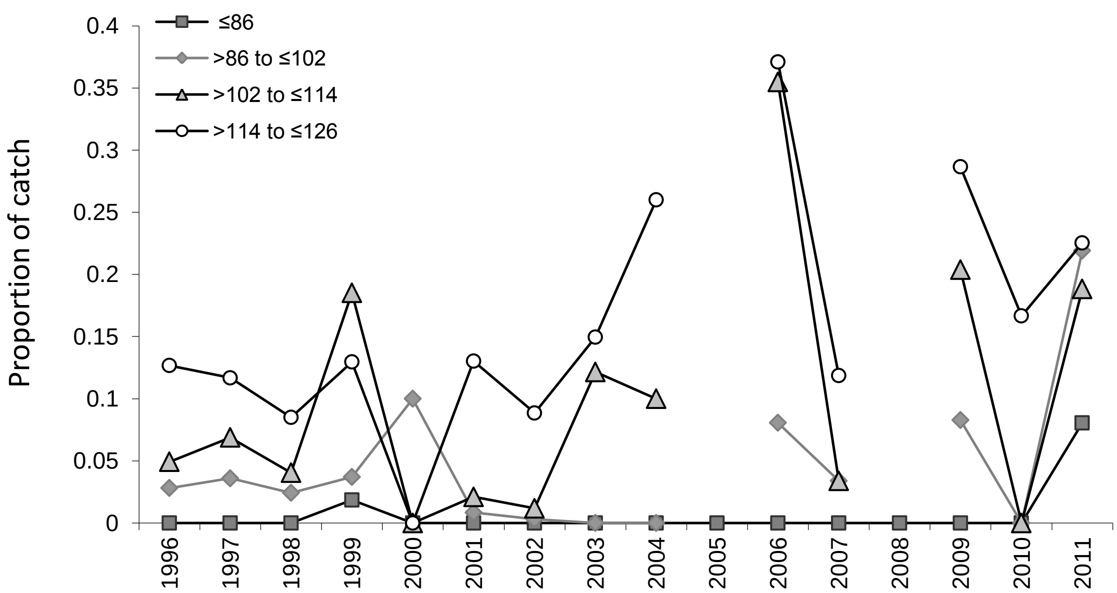

Fig. 25. Size composition (proportion of total catch) of juvenile SBT caught by Korean longliners in statistical areas 4–9, months 4–9, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

Taiwanese longline fishery size/age composition

Size composition data for SBT caught by Taiwanese longliners were acquired from the June 2011 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 2011, proportions of age 4 and age 5 decreased from 2010, with ages 0–2 and age 3 SBT remaining fairly stable (Fig. 26). Observer coverage on vessels has been less than 10% in some past years, and discarding of juveniles cannot be discounted.

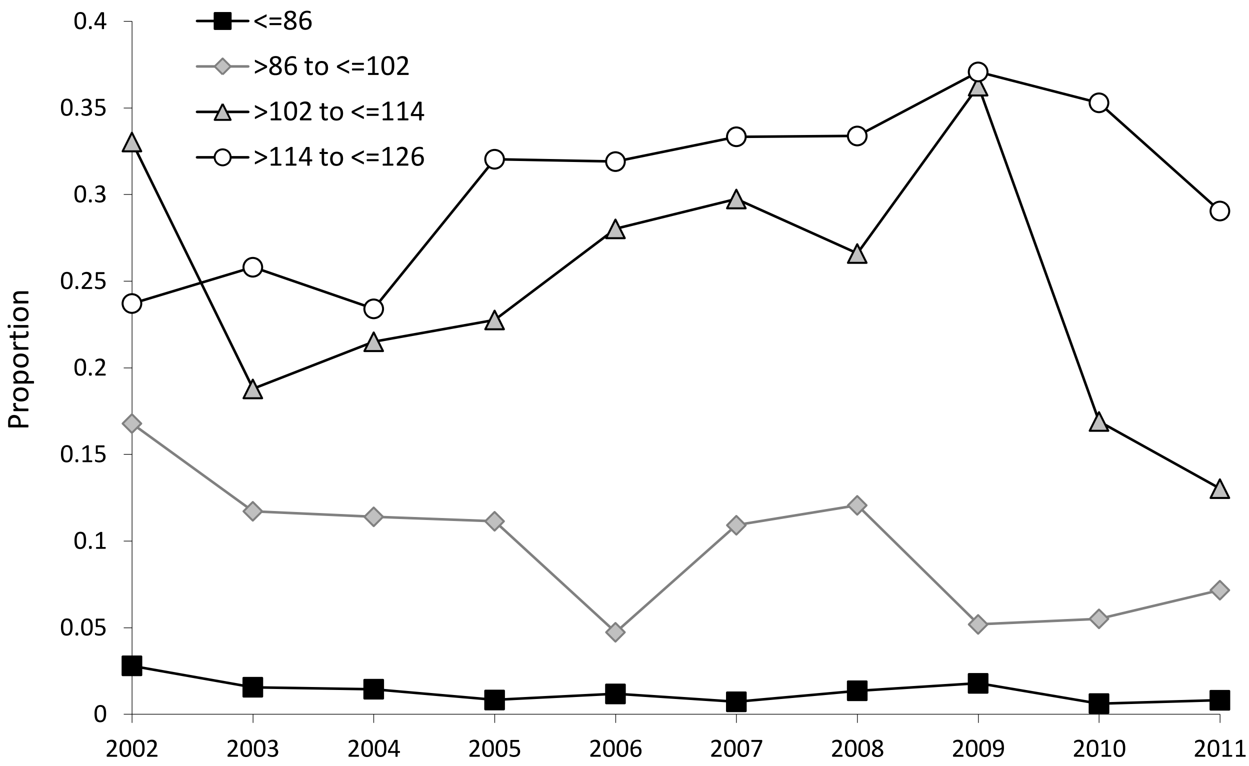

Fig. 26. Size composition (proportion of total catch) of juvenile SBT caught by Taiwanese longliners, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

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_11).

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% of the catch. However, in 2010 and 2011 these age classes comprised 85% and 82% of the surface catch, respectively, with older age classes (4–6) comprising 15% and 18% of the catch, respectively.

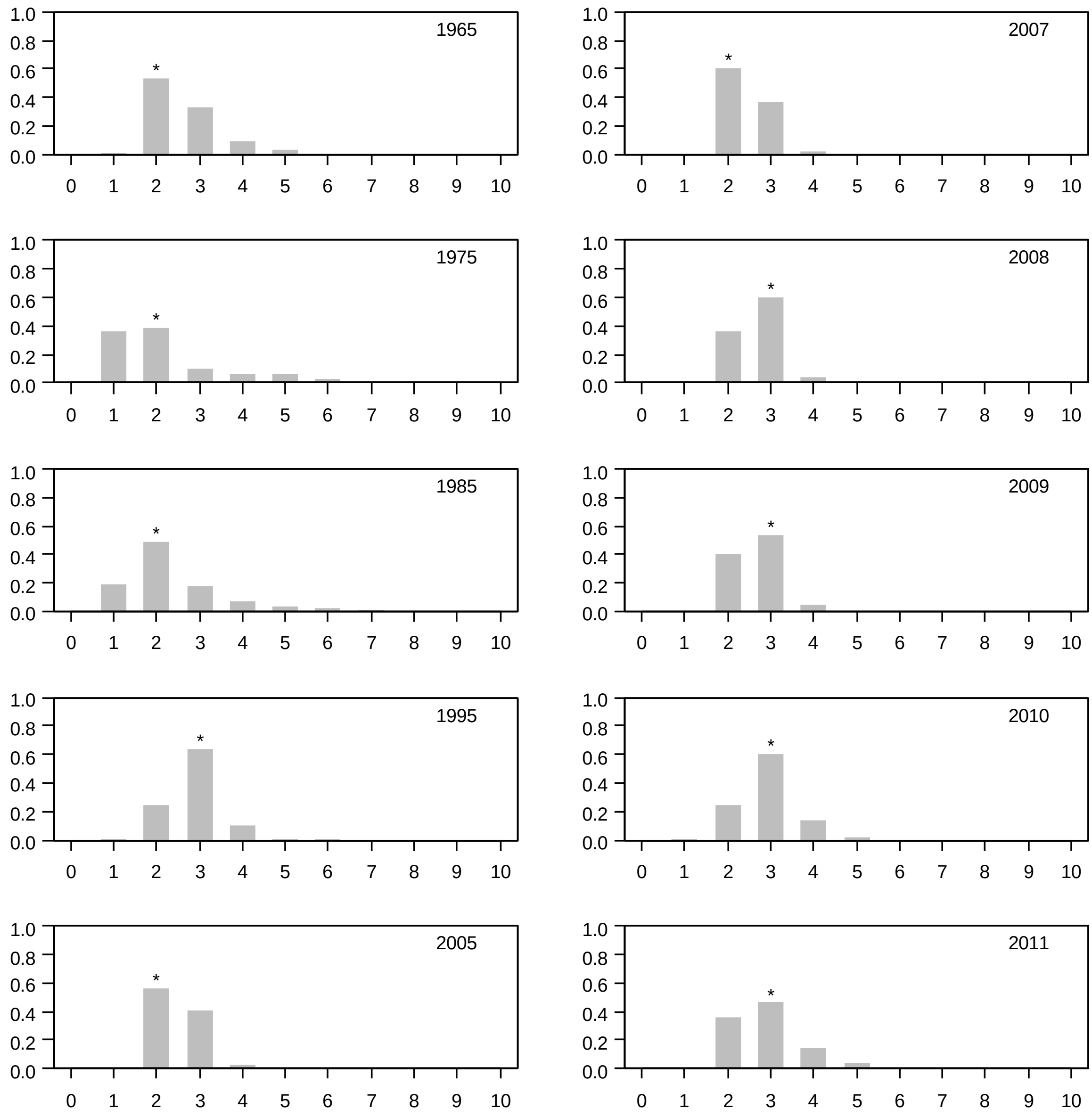

Fig. 27. Age composition in the Australian surface fishery. Median age classes are indicated with asterisks.

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 notably declined. 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.

Trends in juvenile abundance

The three indices of juvenile (age 1 to 4) abundance in the Great Australian Bight—the scientific aerial survey index, SAPUE index and trolling index—exhibited decreases over the past 12 months from values observed in the 2010–11 fishing season (austral summer). The scientific aerial survey in particular exhibited a substantial decrease and is at its second lowest level since the survey began in 1993. However, 2012 is similar to estimates obtained in 1999 and several years during the period 2005–09.

Trends in age 4+ SBT

In contrast to the overall trends observed in age 1–4 SBT, indicators of age 4+ SBT exhibited some upward trends. CPUE in the NZ domestic fishery increased in 2011 compared with 2010, and the Japanese longline nominal CPUE for ages 4-7 increased. The catch rate in the NZ charter fishery for statistical area 6 decreased slightly in 2011, but was well above the 10 year mean. There was no fishing in area 5 in 2011. Juvenile fish also comprised a smaller portion of the NZ charter catch in 2011. The Japanese longline nominal CPUE for ages 4+ also decreased slightly in 2011. The mean age of all SBT caught on the Indonesian spawning grounds increased in 2010–11, while the mean for 20+ year old fish decreased again in 2010–11.

References

An D, Hwang S, Moon D, Kim S, Seok K (2008) Review of Korean SBT fishery of 2006–07. CCSBT-ESC/0809/SBT Fisheries—Korea, CCSBT, Rotorua

Anon (2008a) Annual review of national SBT fisheries for the Scientific Committee: New Zealand. CCSBT-ESC/0809/SBT Fisheries—New Zealand, CCSBT, Rotorua

Anon (2008b) Review of Taiwanese SBT fishery of 2006–07. CCSBT-ESC/0809/SBT Fisheries—Taiwan, Rotorua

Anon (2011) Annual review of national SBT fisheries for the Scientific Committee: New Zealand. CCSBT-ESC/1107/SBT Fisheries—New Zealand, CCSBT, Bali

CCSBT-SC (2001) Report of the Sixth Meeting of the Scientific Committee. CCSBT, Tokyo

CCSBT-SC (2008) Report of the Thirteenth Meeting of the Scientific Committee. CCSBT, Rotorua

CCSBT-SC (2010) report of the Fifteenth Meeting of the Scientific Committee. CCSBT, Taipei

Eveson P, Farley J, Bravington J (2012) The aerial survey index of abundance: updated analysis methods and results for 2011/12 fishing season. CCSBT-ESC/1208/16, CCSBT, Tokyo

Farley J, Basson M (2012) Commercial spotting in the Australian surface fishery, updated to include the 2011/12 fishing season. CCSBT-ESC/1208/15, CCSBT, Tokyo

Farley J, Andamari R, Proctor C (2007) Update on the length and age distribution of SBT in the Indonesian longline catch. CCSBT-ESC/0709/10, CCSBT, Hobart

Farley,J, Nugraha B, Proctor, C (2012) Update on the length and age distribution of SBT in the Indonesian longline catch. CCSBT-ESC/1208/25, CCSBT, Tokyo

Fushimi H, Yamakawa T, O'Neil T, Battaglene S (2006) Independent review of Australian SBT farming operations anomalies. Report for the Commission for the Conservation of Southern Bluefin Tuna

Hartog J, Preece A, Basson M, Kolody D (2007) Fishery indicators for the SBT stock 2006–07. CCSBT-ESC/0709/14, CCSBT, Hobart

Hartog J, Preece A (2008) Fishery indicators for the SBT stock 2007–08. CCSBT-ESC/0809/16, CCSBT, Rotorua

Itoh T (2006) Possible effect on longline operation resulted from the 2006 changes in Japanese SBT fishery regulation. CCSBT-ESC/0609/44, CCSBT, Tokyo

Itoh T, Sakai O (2009) Report of the piston-line trolling survey in 2007/2008. CCSBT-ESC/0909/32, CCSBT, Busan

Lou X, Hidaka T, Bergin A, Kageyama T (2006) Independent review of Japanese southern bluefin tuna market data anomalies. Report for the Commission for the Conservation of Southern Bluefin Tuna

Patterson H, Preece A, Hartog J (2010) Fishery indicators for the SBT stock 2009–10, CCSBT-ESC/1009/09, CCSBT, Taipei

Patterson H, Preece A, Hartog J (2011) Fishery indicators for the SBT stock 2010–11, CCSBT-ESC/1107/08, CCSBT, Bali

Phillips K (2009) Fishery indicators for the SBT stock 2008–09. CCSBT-ESC/0909/08, CCSBT, Busan

Polacheck T, Preece A, Hartog J, Basson M (2006) Information and issue relevant to the plausibility of alternative CPUE time series for southern bluefin tuna stock assessments. CCSBT-ESC/0609/24, CCSBT, Tokyo

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.	2008	2009	2010	2011	2012	12 month trend
Scientific aerial survey	1993–2000 2005–12	0.38 (1999)	1.86 (2011)	0.94	0.55	1.05	1.86	0.54	↓
SAPUE index	2002–12	0.55 (2004)	1.70 (2011)	1.29	0.87	1.51	1.79	0.59	↓
Trolling index	1996–2003 2005–06 2006–12	2.817 (2006)	5.653 (2011)	5.43	3.58	2.92	5.65	1.55	↓
NZ charter nominal CPUE (Areas 5+6)	1989–2011	1.339 (1991)	7.825 (2010)	4.88	4.53	7.83	6.42		↓
NZ domestic nominal CPUE	1989–2011	0.000 (1989)	1.904 (2010)	0.87	1.26	1.90	2.23		↑
NZ charter age/size composition (proportion age 0–5 SBT)*	1989–2011	0.001 (2005)	0.414 (1993)	0.24	0.33	0.25	0.11		↓
NZ domestic age/size composition (proportion age 0–5 SBT)*	1980–2011	0.001 (1985)	0.404 (1995)	0.11	0.09	0.19	0.15		↓
Indonesian median size class	1993–94 to 2011–12	166 (2002–03)	188 (1993–94)	168	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)	16.7	15.6	15.3	16.8		↑
Indonesian age composition: mean age on spawning ground, 20+	1994–95 to 20108–11	21.8 (2010–11)	25.3 (2003–0496)	22.9	23.4	23.1	21.8		↓
Indonesian age composition: median age on spawning ground	1994–95 to 2010–11	13 (2001–03)	21 (1994–97, 1998–99)	17	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.	2008	2009	2010	2011	12 month trend
Reported global catch	1952–2011	829 t (1952)	81 750 t (1961)	11 396 t	10 946 t	9558 t	9296	↓
Japanese nominal CPUE, age 4+	1969–2011	1.390 (2006)	22.143 (1965)	1.655	2.364	2.911	2.848	↓
Japanese standardised CPUE (w0.5, w0.8, STwindows, Laslett)	1998–2011	observed 2006–07	observed 1969	0.276-0.704	0.310–1.039	0.360–1.520	0.484–1.076	↓
Korean nominal CPUE	1991–2011	0.118 (2005)	21.523 (1991)	3.931	4.659	3.651	3.909	↑
Taiwanese nominal CPUE, Areas 8+9	1981–2011	<0.001 (1985)	0.956 (1995)	0.146	0.182	0.471	0.360	↓
Taiwanese nominal CPUE, Areas 2+14+15	1981–2011	<0.001 (1985)	3.466 (2007)	2.243	1.829	1.277	0.916	↓
Japanese age composition, age 0–2	1969–2011	0.004 (1966)	0.191 (1998)	0.021	0.061	0.007	0.071	↑
Japanese age composition, age 3	1969–2011	0.015 (2003)	0.284 (2007)	0.117	0.141	0.058	0.130	↑
Japanese age composition, age 4	1969–2011	0.052 (1969)	0.286 (1992)	0.110	0.257	0.227	0.169	↓
Japanese age composition, age 5	1969–2011	0.065 (2006)	0.234 (1965)	0.082	0.160	0.300	0.214	↓
Taiwanese age/size comp, age 0–2*	1981–2011	<0.001 (1982)	0.251 (2001)	0.014	0.018	0.006	0.008	↑
Taiwanese age/size comp, age 3*	1981–2011	0.024 (1996)	0.349 (2001)	0.121	0.052	0.055	0.072	↑
Taiwanese age/size comp, age 4*	1981–2011	0.027 (1996)	0.502 (1999)	0.266	0.363	0.169	0.130	↓
Taiwanese age/size comp, age 5*	1981–2011	0.075 (1997)	0.371 (2009)	0.334	0.371	0.353	0.291	↓
Australia surface fishery median age composition	1964–2011	age 1 (1979–80)	age 3 (multiple years)	age 3	age 3	age 3	age 3	–

*derived from size data

Appendix 2. Map of CCSBT statistical areas

Map of CCSBT Statistical Areas