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Fisheries indicators for the southern bluefin tuna stock 2019–20

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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 and fishery indicators are included in the development of the Extended Scientific Committee's advice on status of the stock. Fishery indicators are particularly important in years where the stock assessment has not been updated.

In 2011, 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% of the original spawning stock biomass. A new MP was adopted in 2019 and will be used to set the global TAC from 2021 onwards. The review of fishery indicators forms part of the MP's metarule process to determine whether exceptional circumstances exist.

The 2019–20 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 and some standardised indicators are possibly affected.

In this paper, interpretation of indicators is limited to subset 1, and recent trends in some indices from subset 2. Two indicators of juvenile (age 1–4) SBT abundance were provided in 2020; the trolling index increased from 2019 while the gene-tagging abundance estimate decreased very slightly. Indicators of age 4+ SBT exhibited mixed trends. The newly developed close-kin mark recapture index of abundance decreased for the latest year it was calculated (2015). The standardised catch per unit effort (CPUE) from the New Zealand domestic longline fishery decreased while the Japanese longline nominal CPUE increased in 2019. In contrast, the Japanese standardised, normalised CPUE series for core vessels decreased substantially, but this decrease was not seen for the CPUE for all vessels, which remained stable. The mean length of SBT caught by Indonesia has generally decreased since 2011 and decreased slightly in 2019. The mean age of SBT decreased slightly in 2019.

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). The review of fishery indicators forms part of the management procedure's metarule process, undertaken by the ESC, to determine whether exceptional circumstances exist (Attachment 10, ESC18). Indicators can provide a broad perspective on recent changes in the status of the SBT stock and include some information that may not otherwise be incorporated into model-based assessments.

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 2019–20 update of fishery indicators for the SBT stock summarises indicators in the same groups presented in previous updates in 2007 to 2019, including the new gene tagging and close-kin mark recapture indices added in 2019 (Hartog et al. 2007; Hartog & Preece 2008; Phillips 2009; Patterson et al. 2010, 2011, 2012, 2013, 2016, 2017, 2018; Patterson & Hennecke 2019; Patterson & Stobutzki 2014, 2015). The scientific aerial survey data have been retained for information, although the survey was not updated in 2020. The list of indicators explored here includes:

(1) Indicators unaffected by the unreported catch:

- Scientific aerial survey in the Great Australian Bight (for reference only)
- Trolling index
- Gene tagging
- Close-kin mark recapture
- New Zealand catch per unit effort (CPUE domestic fleets)
- New Zealand longline fishery size composition (domestic fleets)
- Indonesian longline fishery size/age composition.

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

- Japanese, Korean and Taiwanese CPUE
- Size/age composition in the Japanese and Taiwanese longline fisheries
- Age composition in the Australian surface fishery.

2 Indicators unaffected by unreported catch

2.1 Scientific aerial survey

The final scientific aerial survey index was updated in 2017 through the CCSBT data exchange (Sec-AerialSurvey (1993_2017)).

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 and Farley 2016). 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. The survey was not conducted in 2015 and was discontinued after 2017.

The historic trend in the scientific aerial survey index and the spatial distribution of sightings is discussed fully in Eveson and Farley (2017). This index of relative juvenile abundance in 2016 (the 2015–16 fishing season) was substantially higher than the 2014 estimate (2013–14 fishing season); the 2016 index was the highest index obtained for the scientific aerial survey over the past 10 years. The 2017 index declined and was on par with the 2014 index, although it remained above the mean for the series.

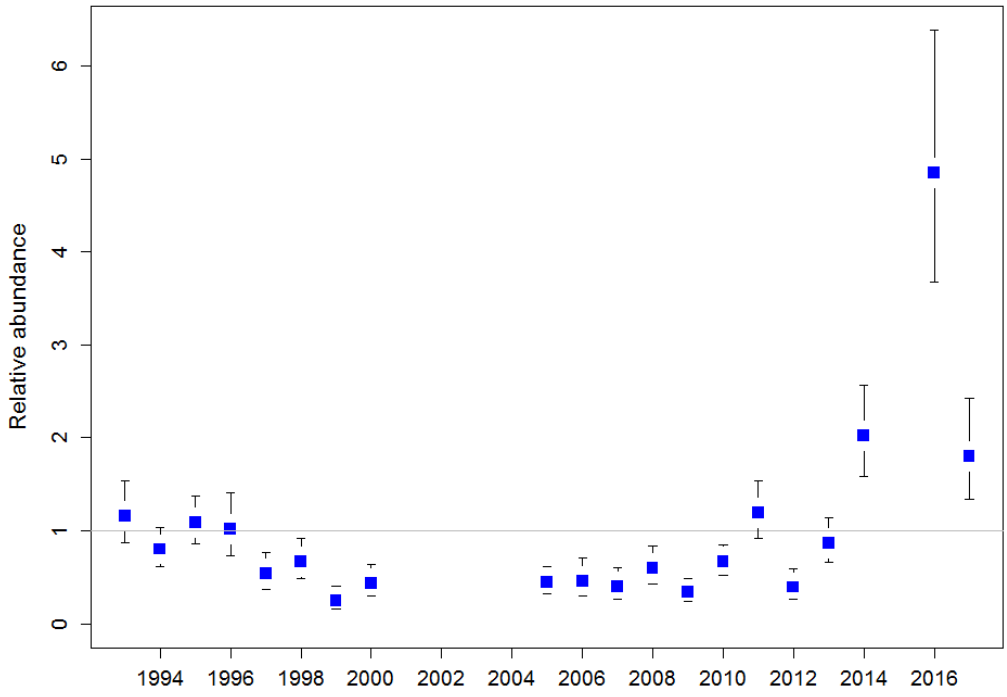

Figure 1. Scientific aerial survey of relative abundance for juvenile SBT in the Great Australian Bight, January–March (hence the 2014 value represents the 2013–14 fishing season etc) from Eveson and Farley (2017). Vertical lines are 90% confidence intervals. The horizontal line represents relative abundance of 1.0.

2.2 Trolling index

The trolling survey index was updated in 2020 from data provided by Japan through the CCSBT data exchange (JP_Trollindex_2020). No trolling survey was conducted in 2015.

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 objective of the recent piston-line trolling survey has been to provide a recruitment index at low cost (Itoh et al. 2013). The ESC 2015 identified research needed if the index was to be considered for use in a candidate MP in future (CCSBT-SC 2015). The trolling index is comprised of: (1) a piston-line trolling survey, 2006–14; (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).

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 2). In 2016, the index was above the average median value, but declined in 2017 and declined again in 2018 to zero. It remained at zero in 2019 before increasing in 2020.

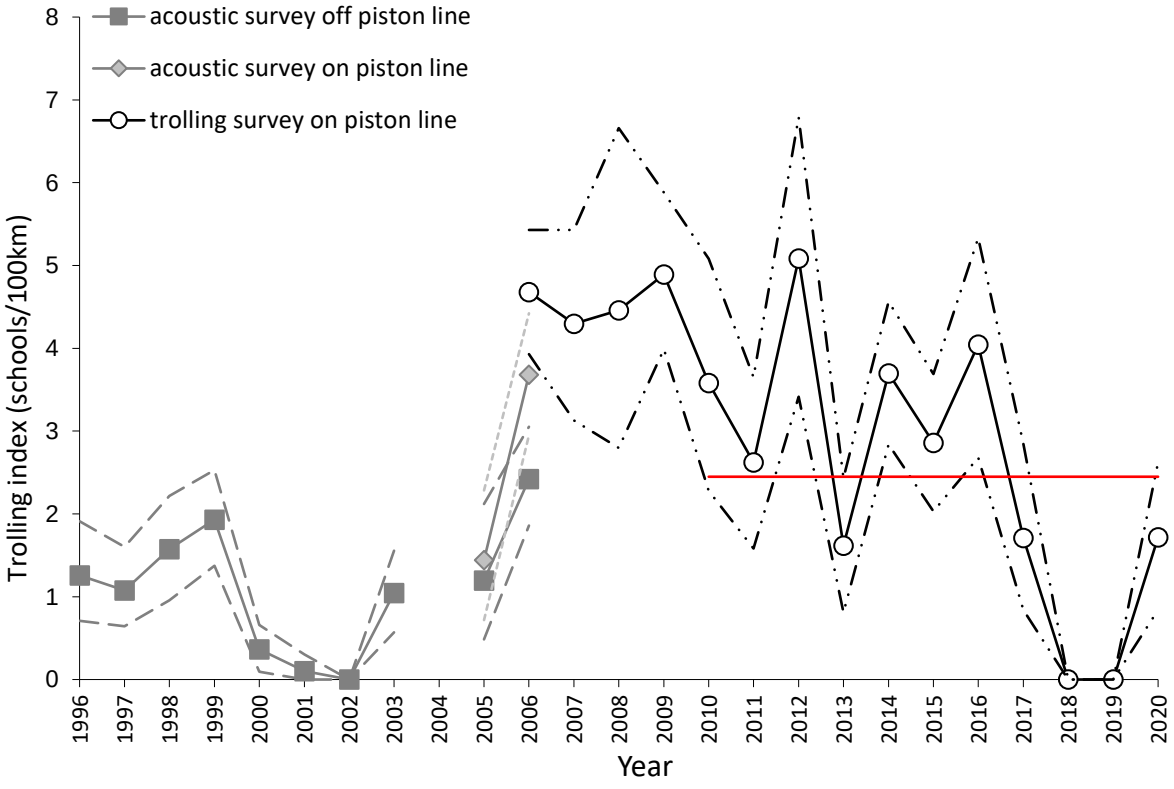

Figure 2. Trolling index, showing number of schools per 100 km off the Western Australian coast in January. Dashed lines are 90% confidence intervals. The red line shows the average median value of the piston line survey from 2010–20.

2.3 Gene tagging

A pilot study examining the feasibility of conducting a large-scale SBT gene-tagging program was undertaken in 2016 to determine if this method could be used to provide a fisheries-independent estimate of the absolute abundance of juveniles; this would replace the scientific aerial survey which was discontinued in 2017 (Preece et al. 2018). The pilot project successfully demonstrated the technical feasibility of using this technique to provide abundance estimates for monitoring and management. It was therefore recommended that this program continue, the estimates from which will be used in the testing of the candidate management procedures and stock assessments.

New data (2018) from the ongoing program were provided to the CCSBT data exchange (GeneTagging_Data_GT2018_for2020dataexchange). Four years of tagging have now been completed (2016–19), with the next abundance estimate (2-year old abundance in 2018) now available for the 2020 stock assessment and new management procedure implementation (Preece et al. 2020). The estimate of absolute abundance of 2-year olds decreased slightly in 2018.

Table 1. Gene-tagging estimates for 2016, 2017 and 2018 (adapted from Preece et al. 2020)

	N release	N harvest	N Matches	Abundance estimate (millions)	CV
2016	2952	15390	20	2.27	0.224
2017	6480	11932	67	1.15	0.122
2018	6295	11980	66	1.14	0.123

2.4 Close-kin mark recapture

Close-kin mark recapture (CKMR), which began tissue collection in 2014–15, is a high priority for CCSBT as it provides an estimate of abundance and is included in the Operating Model. Information on this index and update is provided in Hillary et al. (2016) and Hillary et al. (2020), repectively. An empirical index of spawning stock abundance has been developed for inclusion in this paper and for use in the review of fisheries indicators by the ESC. The index is not included in Appendix 1.

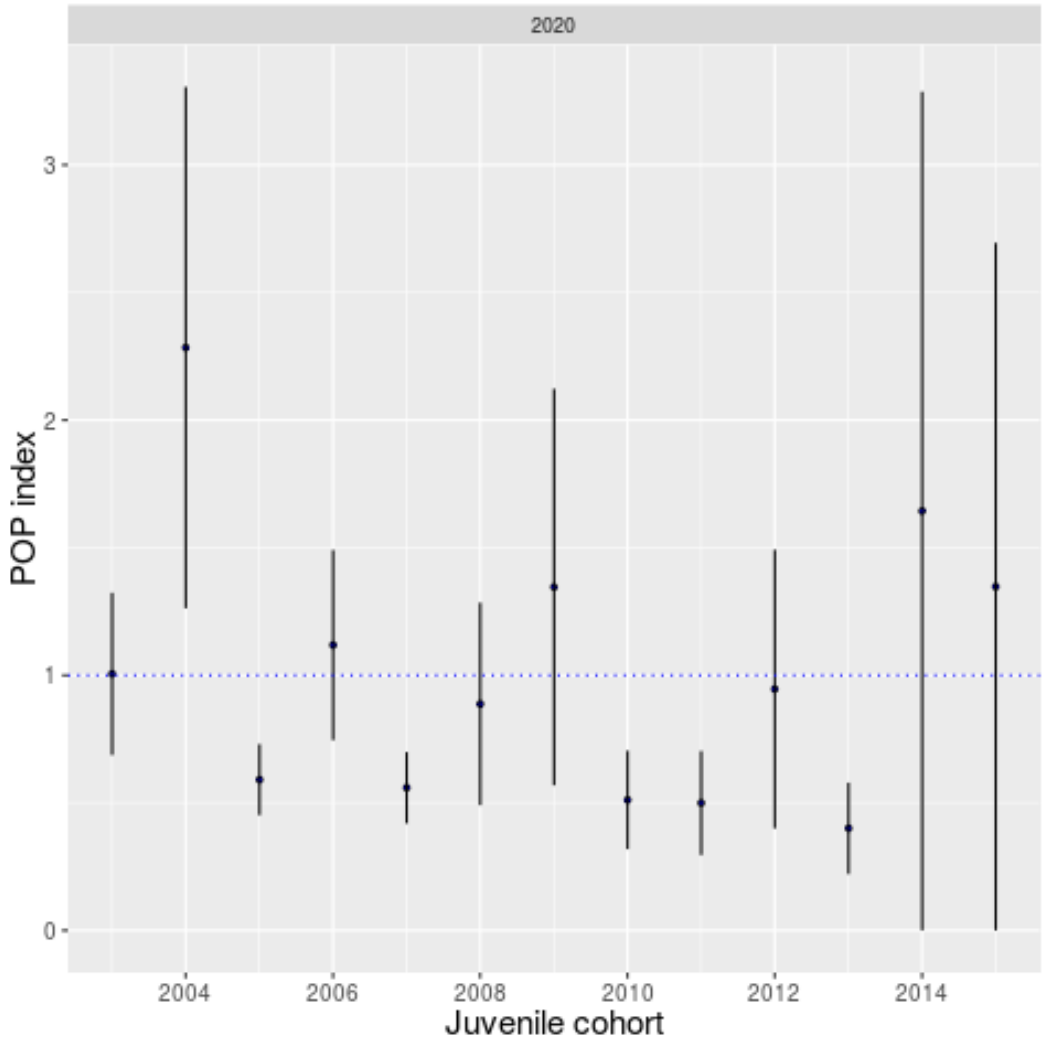

Figure 3. Empirical index of spawning stock abundance from CKMR Parent-Offspring Pairs (POPs) for use in CCSBT ESC review of fisheries indicators. The raw index, for a given juvenile birth year (Juvenile cohort), is calculated as the number of comparisons (across all adult capture ages and years) divided by the number of identified POPs (across all adult capture ages and years) in the time-series. The CV on the index is 1/square-root (number of POPs). The index plotted in the figure above has been standardised to the mean of the series. The error bars are +/- one standard error.

2.5 Catch per unit effort

2.5.1 New Zealand domestic longline CPUE

In previous years the nominal CPUE for the NZ domestic fishery has been provided, based on aggregated catch and effort data provided in the interim update of the CCSBT database. New Zealand has now updated their national report to include a standardised CPUE. For consistency, Fig 4 uses the values provided by New Zealand. The methodology used in generating these data is provided in CCSBT-ESC/2008/SBT Fisheries - New Zealand.

Overall, catch rates in the NZ domestic fishery increased from 2007, with a sharp increase seen in 2016 (Fig 4). However, CPUE has decreased since 2016, with a steep decline in 2019.

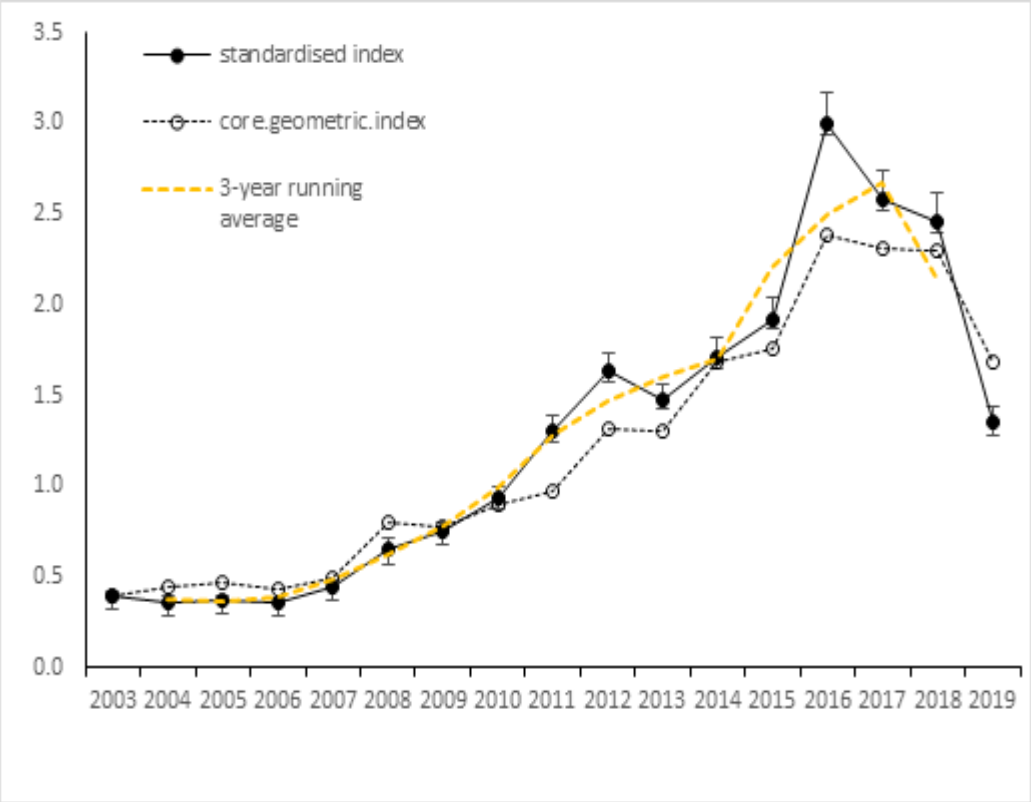

Figure 4. Standardised CPUE for the NZ domestic longline fishery, core geometric index and 3-year running average. Figure provided by New Zealand.

2.6 Catch size/age composition

2.6.1 New Zealand domestic longline fishery size composition (< 6 years)

Size composition data for SBT caught by the NZ domestic fisheries were extracted from the interim update of the CCSBT database and were examined for trends in juvenile fish less than 6 years of age. In the NZ domestic fishery, juvenile fish aged less than 6 years have comprised on average 22% of the catch over the past ten years, although size composition is not as well estimated for this fleet as for the charter fleet. 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

In the size/age categories examined, the NZ domestic fishery has historically landed age 4 and 5 SBT, with some small spikes in the landing of age 3 SBT in 2006 and 2010 (Fig. 5). The relative abundance of the juvenile age classes declined in 2003 and 2004 and has been variable since that time. The oldest age class decreased in 2019, while the second oldest declined slightly (Fig. 5). The age 3 class increased slightly, but remained low. The 0–2 age class, which has been virtually zero throughout the time series, remained near zero.

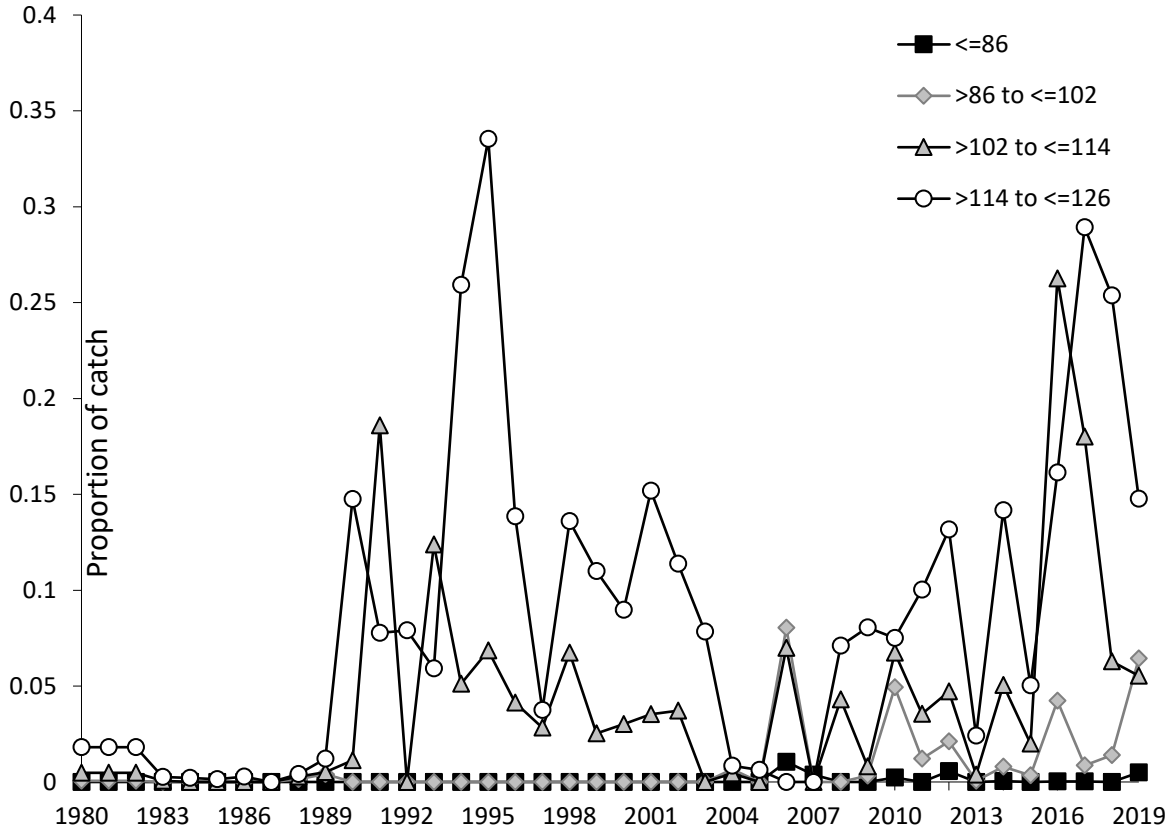

Figure 5. Size composition of juvenile fish (< 6 years) for the NZ domestic longline fishery, where age 0–2<86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

2.6.2 Indonesian spawning ground size/age composition

The Indonesian catch data provide an important source of information about the spawning population if we assume that the selectivity of this fishery has been constant over time. The Indonesian size and age data for the 2018–19 season were provided in the 2019 and 2020 data exchanges, respectively[1] (Sulistyaningsih et al. 2020).

Since the mid- to late-1990s the size of SBT landed in this fishery has declined. As reported previously, since 2012–13 the length data indicate a new mode of relatively small fish in the catch that have progressed through the fishery, although this mode seems to be disappearing (Fig. 6, Fig. 7; Sulistyaningsih et al. 2020). The mean size class decreased from 170.4 cm in 2011–12 to 161.1 cm in 2018–19.

There was also an increase in the catch of young SBT (7–10 years) in 2012–13 (Sulistyaningsih et al. 2020). The mean age of SBT on the spawning ground decreased substantially from 16.8 years in 2011 to 13.2 years in 2019. The median age remained at 12.5 in 2019 (Fig. 8, Fig. 9).

It has been determined that SBT caught by Indonesia are taken in CCSBT statistical areas 1, 2 and 8. It is therefore possible that the small fish noted in the data are not being collected on the spawning grounds, but rather are being caught south of the spawning grounds (Farley et al. 2017). Resolving the location of this catch is important for interpreting the indicators, as well as the use of these data in the operating model. A preliminary investigation was undertaken in 2019 (Fahmi et al. 2019).

[1] Note that the analysis of the Indonesian data was updated after the April data exchange and the result can be seen in Appendix A of the Sulistyaningsih et al. (2020).

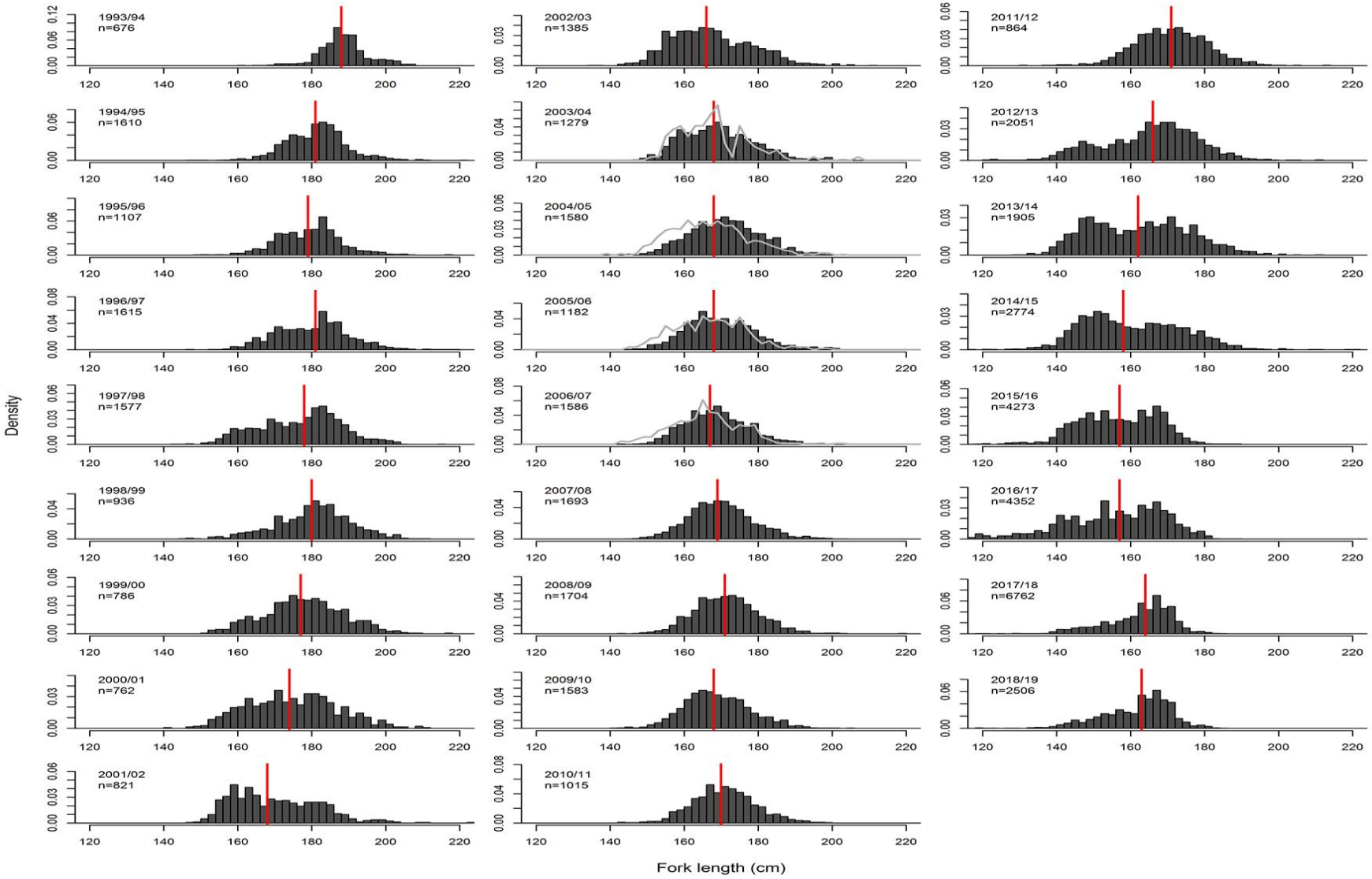

Figure 6. Length frequency (2 cm intervals) of SBT caught on the spawning ground (bars) by spawning season (Sulistyaningsih et al. 2020). The grey bar shows the median size class. For comparison, the length distribution of SBT thought to be caught south of the spawning ground (Processor A) is shown for 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). Note that 36 fish <120cm are not shown and the data for 2017/18 are preliminary.

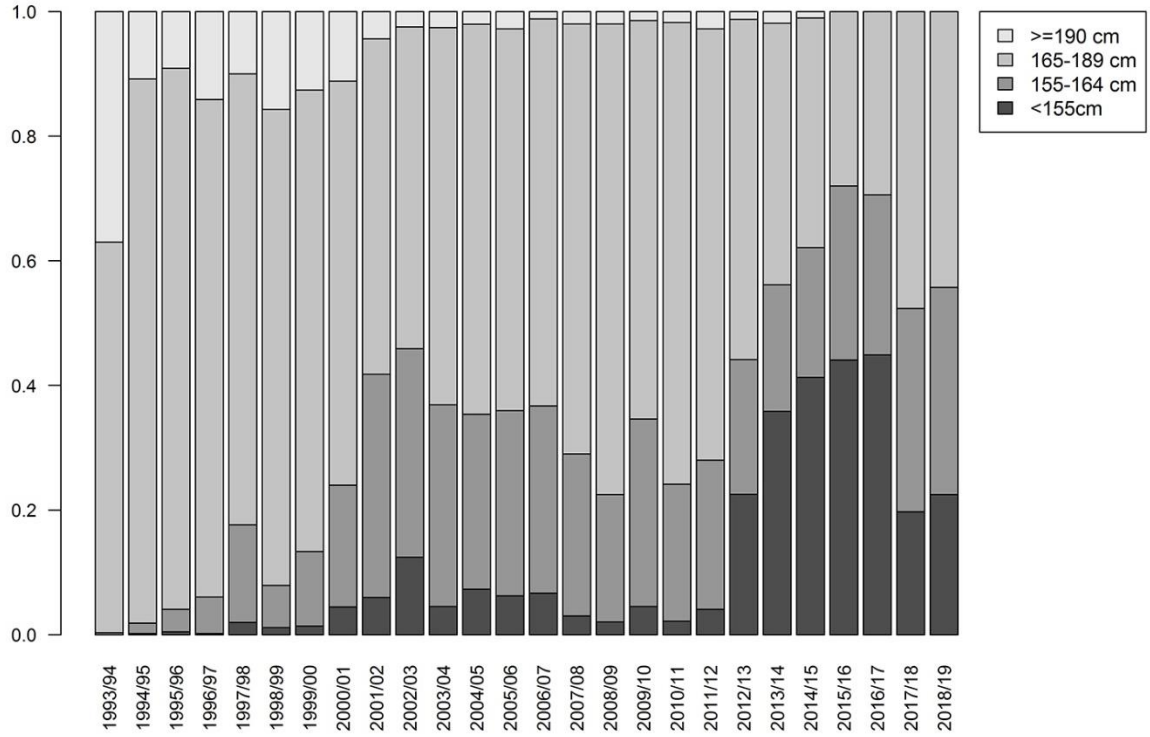

Figure 7. Size composition of SBT caught on the spawning grounds by the Indonesian longline fishery by spawning season (from Sulistyaningsih et al. 2020). Data from Processor A are excluded.

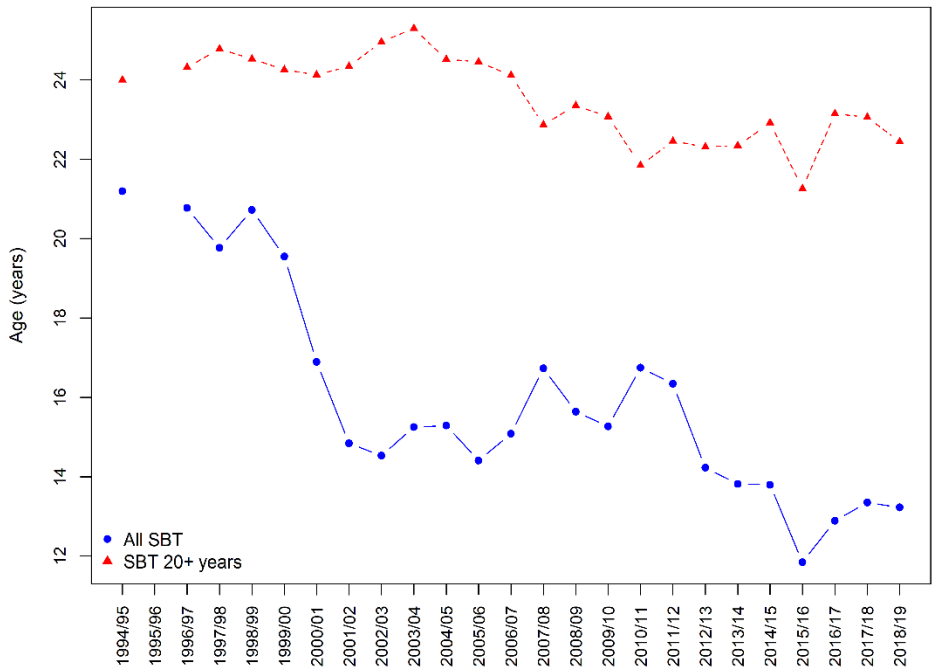

Figure 8. Mean estimated age (years) of SBT caught on the spawning grounds by Indonesian longliners (from Sulistyaningsih et al. 2020). Data from Processor A are excluded. Note that there are no age data for the 1995–96 season.

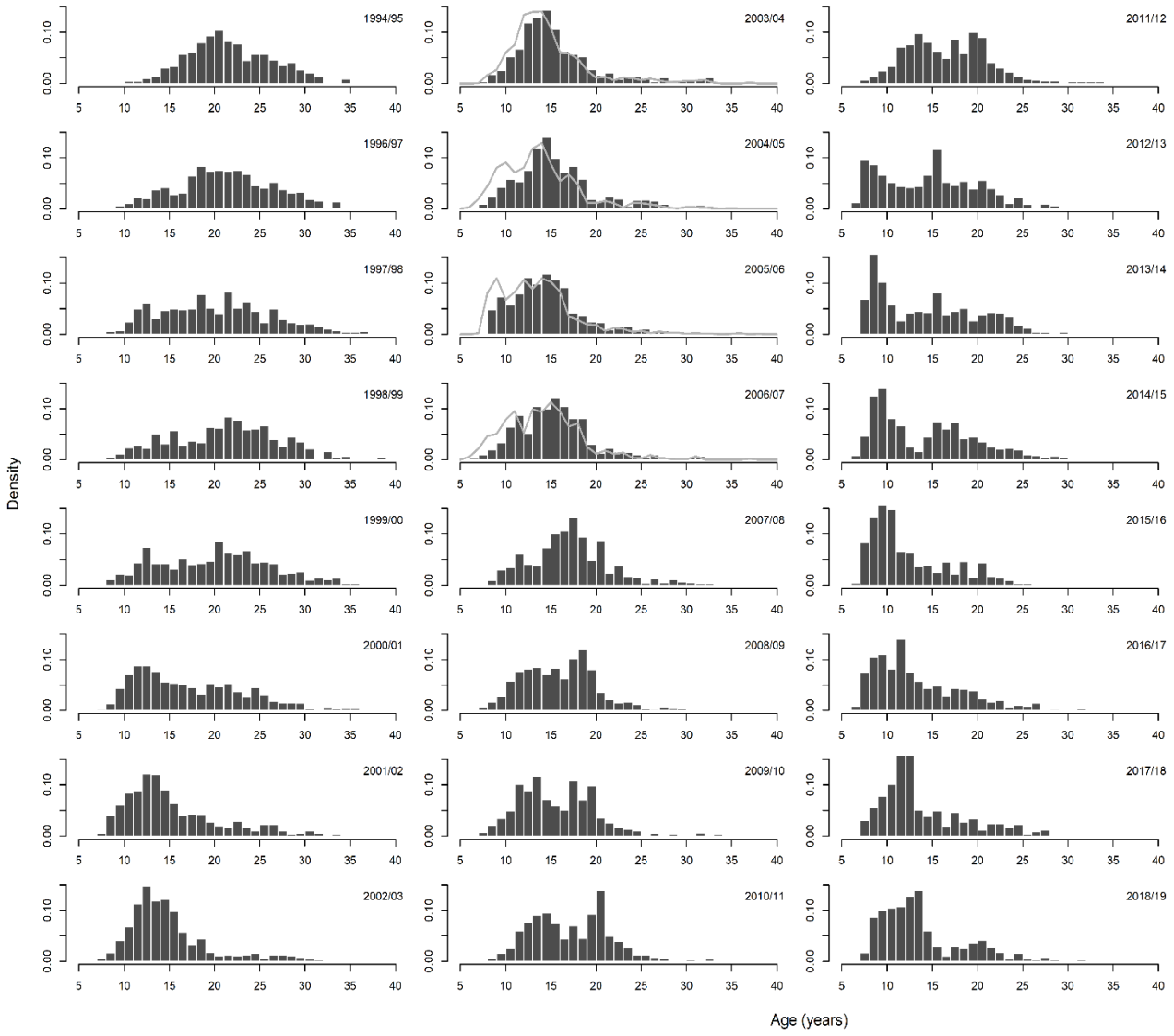

Figure 9. Age frequency distribution of SBT in the Indonesian catch on the spawning ground by spawning season estimated using age-length keys from our sub-samples of direct aged fish and length frequency data obtained through the Indonesian monitoring program (Sulistyaningsih et al. 2020). There was no direct ageing of the 2012–13 otoliths; age frequency is based on the age-length key from the previous two seasons and 2012–13 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 potentially affected by unreported catch

The indicators included in this section are based on fishery-dependent data and may or may not have been 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 2019, 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.

3.1 Catch per unit effort (CPUE)

3.1.1 Japanese longline CPUE

Nominal CPUE series for Japanese longliners was extracted from the CPUE input data provided in the CCSBT data exchange (CPUEInputs_6519). Standardised CPUE series were obtained from updates provided by Japan (JP_CPUE_w05_08_for_monitoring_2020ESC and JP_CorevesselCPUE_1969_2019) through the CCSBT data exchange.

There have been several perturbations significantly affecting the continuity of the Japanese longline CPUE series. 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). 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). In addition, the Japanese TAC has increased, as has the global TAC, with the adoption of the management procedure in 2011. The standardised CPUE series are still potentially affected, and should be interpreted with caution.

The following updates for 2020 have been compiled (note that age data are cohort slices from length composition):

- Nominal aggregate CPUE for age 4+ SBT in areas 4–9 in months 4–9. The series showed an overall decline until 2006–07, followed by an increase to 2015. The data point for 2019 increased and is above the mean of the most recent 10 years (Fig. 10, horizontal line).
- Nominal CPUE for age 4–7, 8–11 and 12+ SBT. The nominal CPUE series for ages 4–7 increased in 2019, as did the CPUE for ages 8–11. The CPUE of age 12+ SBT has remained low with little variability since the early 1970s (Fig. 11).
- 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 remain the dominant year classes in the juveniles, with a substantial increase of ages 3, 4 and 5 in 2019 (Fig. 12).

- Standardised CPUE. The standardised and normalised monitoring CPUE series from all vessels (W0.5, W0.8) remained stable in 2019, while the normalised series from the core vessels (Base W0.5 and Base W0.8) decreased substantially (Fig. 13).

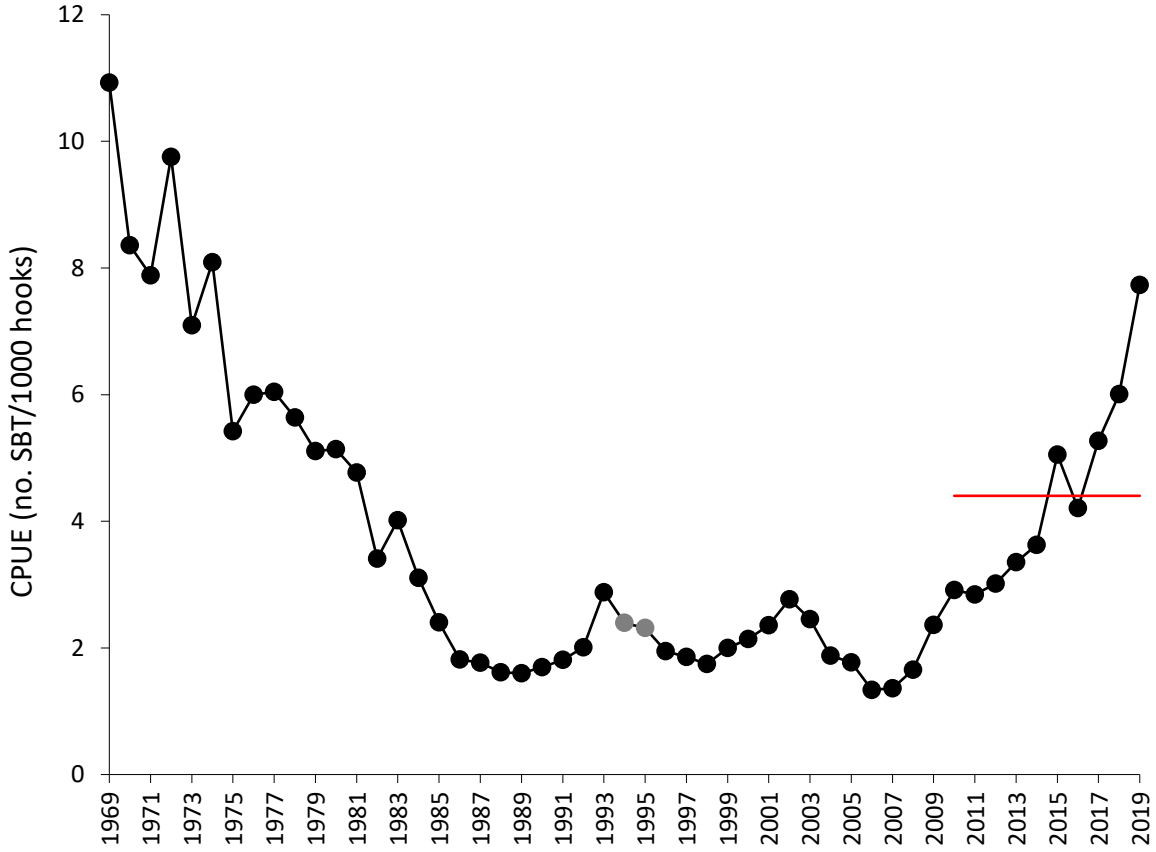

Figure 10. Nominal CPUE of age 4+ SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9. The 1995 and 1996 values are plotted as grey circles to indicate increased uncertainty about these points due to changes in retention policies for small fish in these two years, when a policy of releasing small fish applied. The horizontal line is the 2010-19 mean.

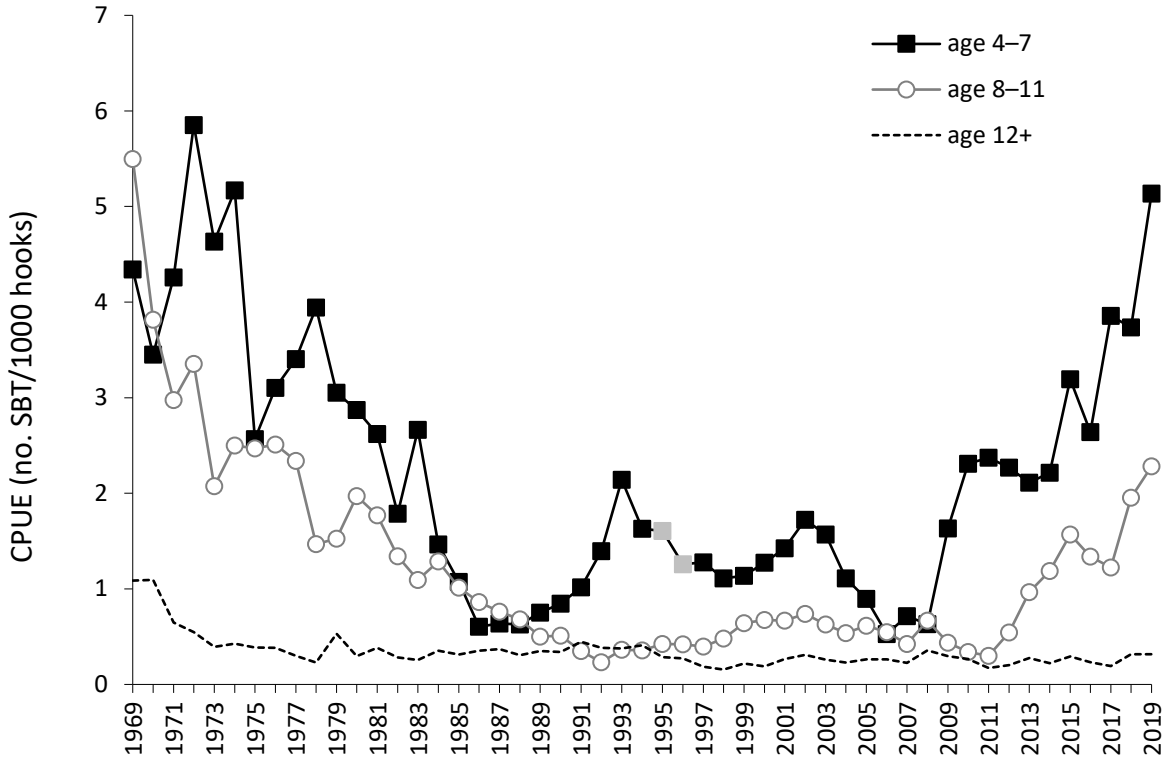

Figure 11. Nominal CPUE of ages 4–7, 8–11 and 12+ SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9. The 1995 and 1996 values for ages 4–7 are plotted as grey squares to indicate increased uncertainty about these points due to changes in retention policies for small fish in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

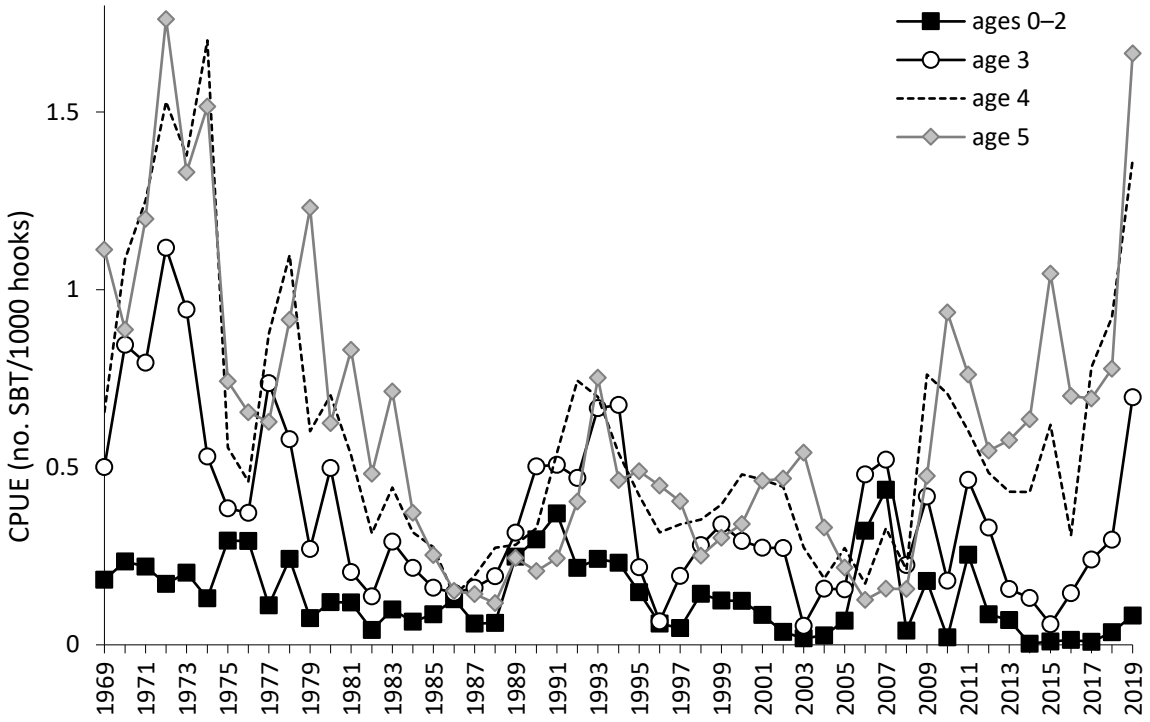

Figure 12. Nominal CPUE of ages 0–2, 3, 4 and 5 SBT for Japanese longliners operating in statistical areas 4–9 in months 4–9.

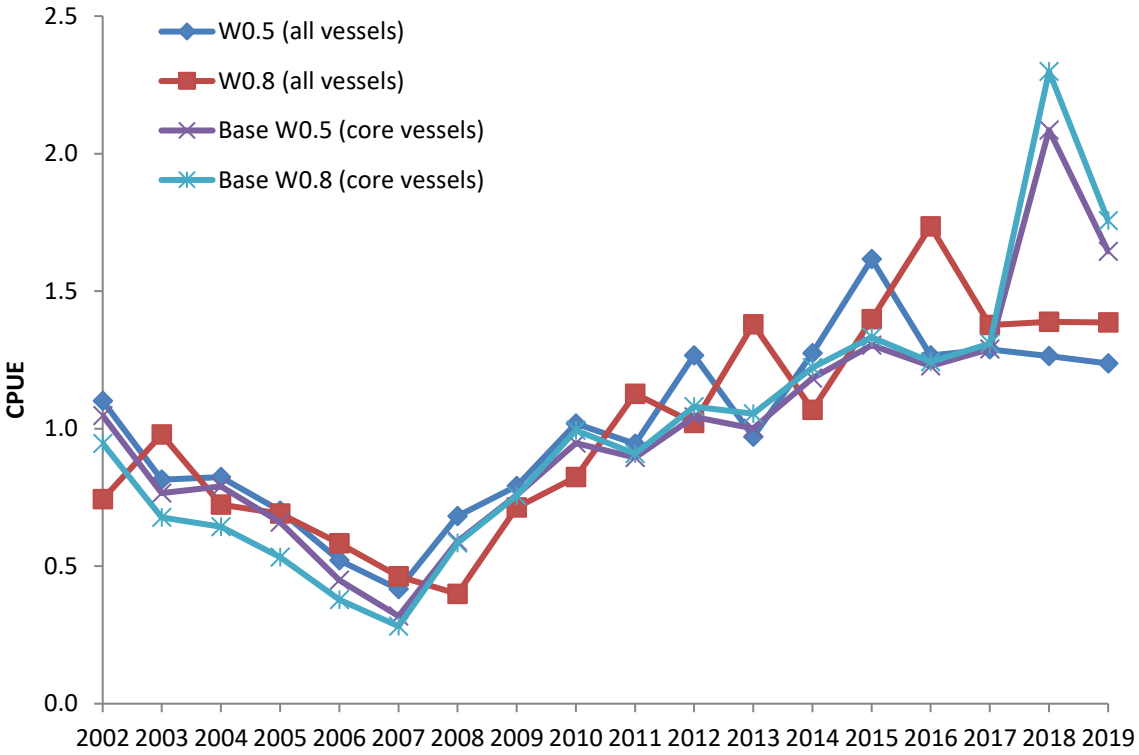

Figure 13. Comparison of subsets of the standardised CPUE series. Each subset has been normalised by dividing by the mean.

3.1.2 Korean longline CPUE

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

The Korean nominal CPUE has been reasonably stable since 1995, apart from very low catch rates in 2004 and 2005. Both the nominal and average CPUEs increased slightly in 2019, so that the two points overlap (Fig. 14). 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).

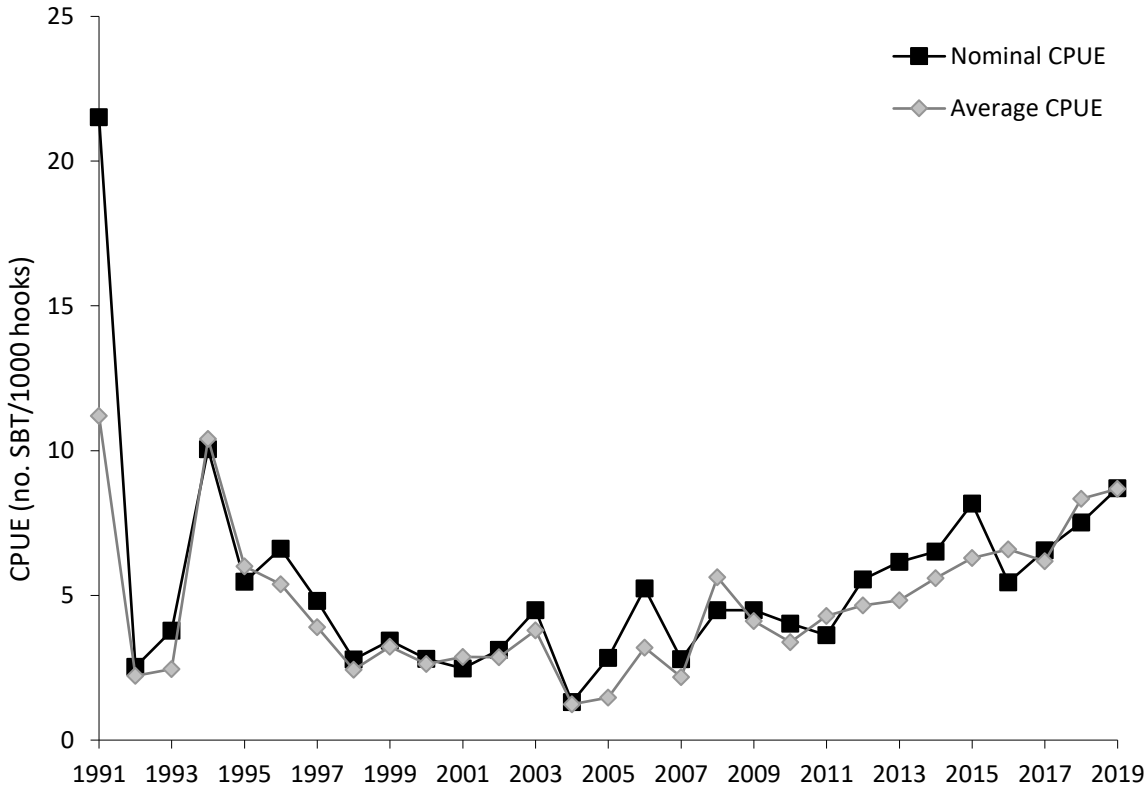

Figure 14. Nominal and average CPUE of total SBT for Korean longliners operating in statistical areas 4–9 in months 4–9. Nominal CPUE is the total number of SBT over total effort (1000 hooks), while average CPUE is the mean of the nominal rate in each 5×5° grid square per month.

3.1.3 Taiwanese longline CPUE

Nominal CPUE series of Taiwanese longliners were obtained from aggregated catch and effort data provided in the 2020 interim update of the CCSBT database.

The number of vessels in the Taiwanese fishery targeting SBT and catching SBT as bycatch has fluctuated since 2002 when records became more accurate (CCSBT-ESC/1309/SBT Fisheries-Taiwan). Catches began to increase in the 1980s, then stabilised from the late 1980s, but have reduced in recent years. The Taiwanese fishery operates in both the northern fishery (areas 2,

14, 15), and the southern fishery (areas 8, 9)(Fig. 15, 16). 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. 17).

Catch rates have fluctuated over time, with almost no change in both areas in 2019 (Fig. 15). Catch rates in 2019 were highest in areas 2, 14 and 15 south, with the catch rates in 2, 14 and 15 north and middle, and 8 and 9, very similar (Fig. 16). Taiwan informed the 2009 ESC that changes in collection of fishery statistics was largely responsible for the increase seen in nominal catch rates in areas 2, 14 and 15 since 2000 (Fig. 15, 16; Anon 2009). Effort in all areas remained largely stable in 2019 (Fig 17).

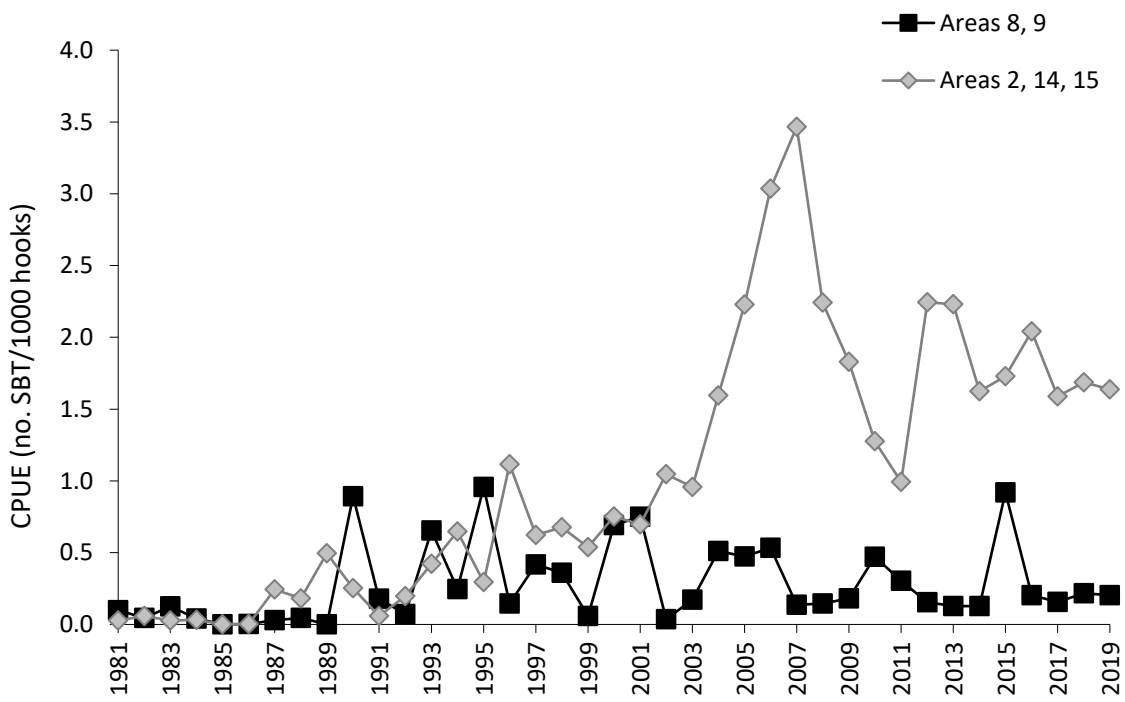

Figure 15. Nominal CPUE of SBT for Taiwanese longliners operating in statistical areas 8 and 9 (pooled) and 2, 14 and 15 (pooled) in months 4–9.

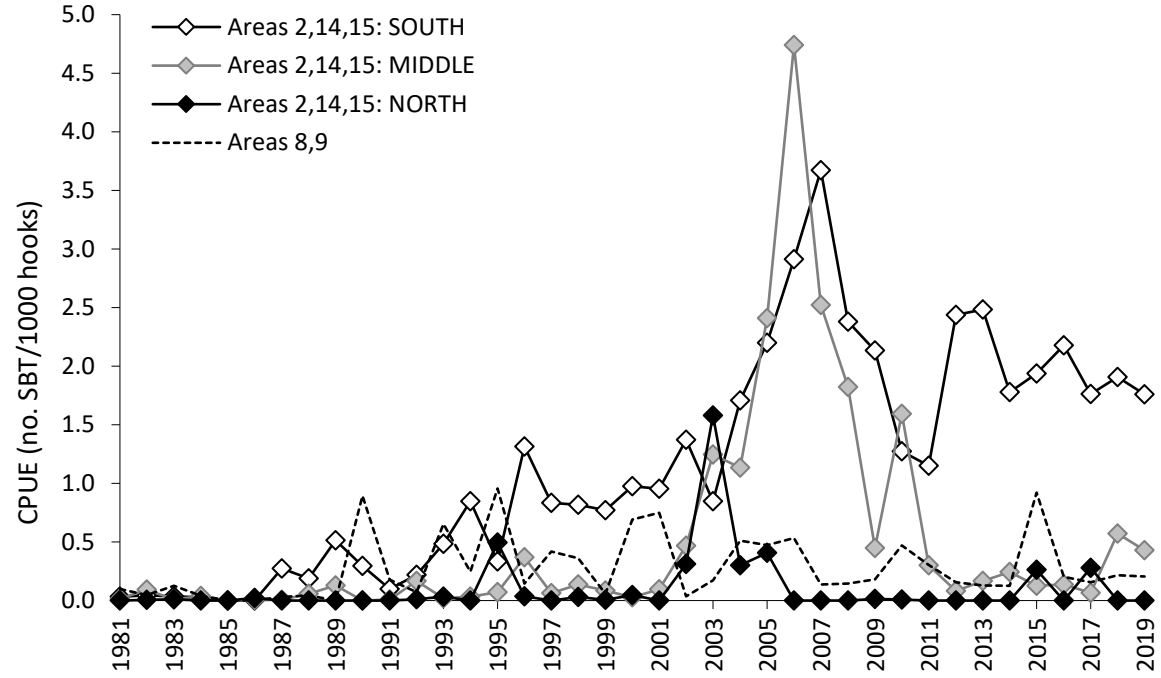

Figure 16. Nominal CPUE of SBT for Taiwanese longliners operating in statistical areas 2, 14 and 15 (pooled) by 5° latitudinal strips: South = 30–35°S; Middle = 25–30°S; North = 20–25°S. Nominal CPUE in areas 8 and 9 (pooled) shown for comparison. Data are from months 4-9 only.

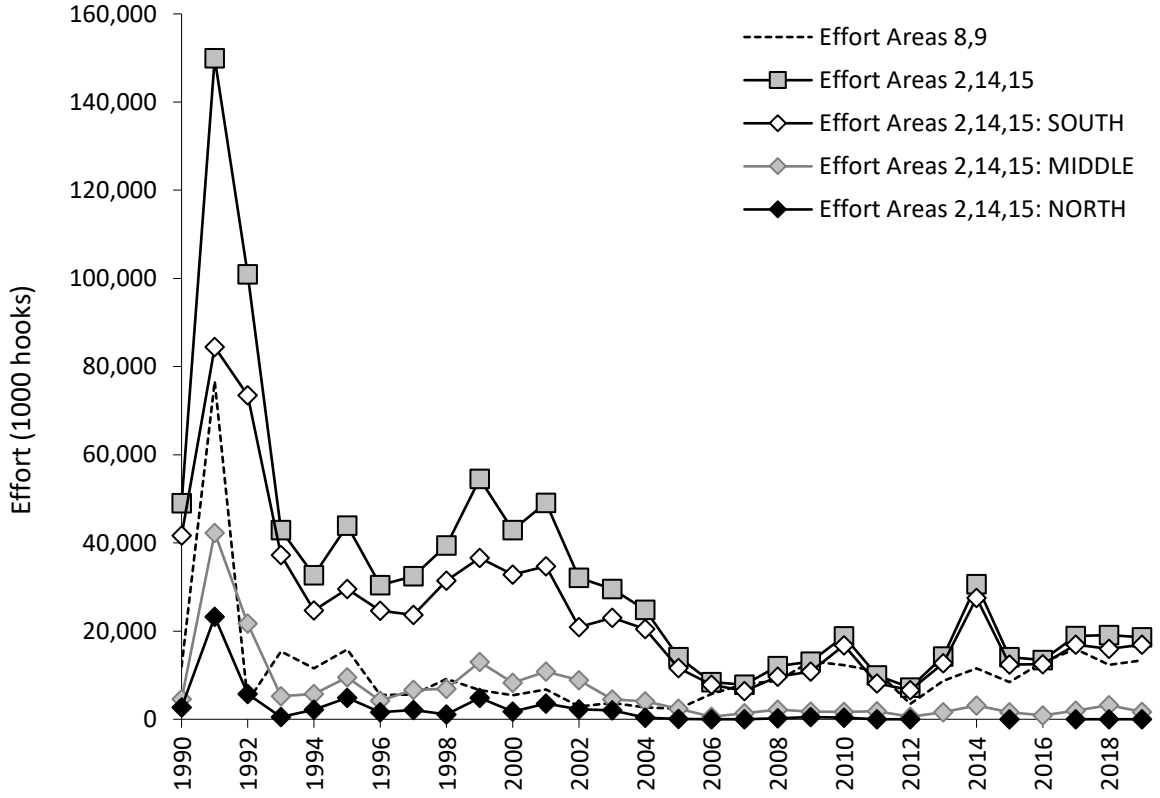

Figure 17. Effort (1000 hooks) from Taiwanese longliners in statistical areas 8 & 9 (pooled) and 2, 14 and 15 (pooled). Areas 2, 14 and 15 are also separated into 5° latitudinal strips: South = 30–35°S; Middle = 25–30°S; North = 20–25°S. Data are from months 4–9 only.

3.2 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.

3.2.1 Japanese longline fishery size/age composition

Size composition data for SBT caught by Japanese longliners were obtained from the CCSBT data exchange in June 2020. These data are examined in detail below for trends for juvenile fish aged less than 6 years.

The age composition of SBT (derived from cohort slicing) caught by the Japanese longline fishery has been highly variable over time. The relative proportion of the oldest age class examined here increased in 2019, as did the two younger age classes; the youngest age class remained near zero (Fig. 18). Observer coverage on vessels has been less than or around 10% since 2003. Discarding of juveniles has been reported since 2009 but may have commenced earlier and would impact the size/age composition (Sakai & Itoh 2013).

For comparison with size/age composition in the NZ and Taiwanese longline fisheries, Japanese length data have also been compiled for < 6 year-olds, 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 of < 126 cm indicate the proportion of the largest size class remained stable in 2019; the second and third largest size classes increased (Fig. 19), while the smallest size class remained near zero (Fig. 19).

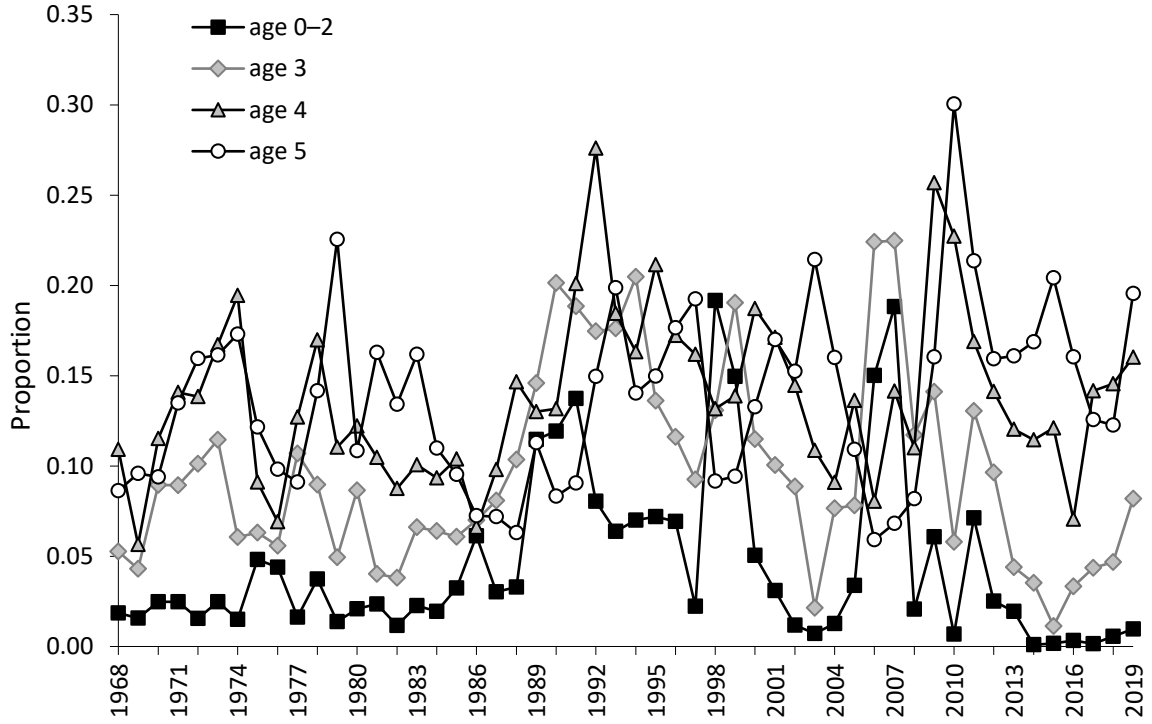

Figure 18. Age composition (proportion of total catch) of ages 0–2, 3, 4 and 5 in the Japanese longline fishery in statistical areas 4–9, months 4–9.

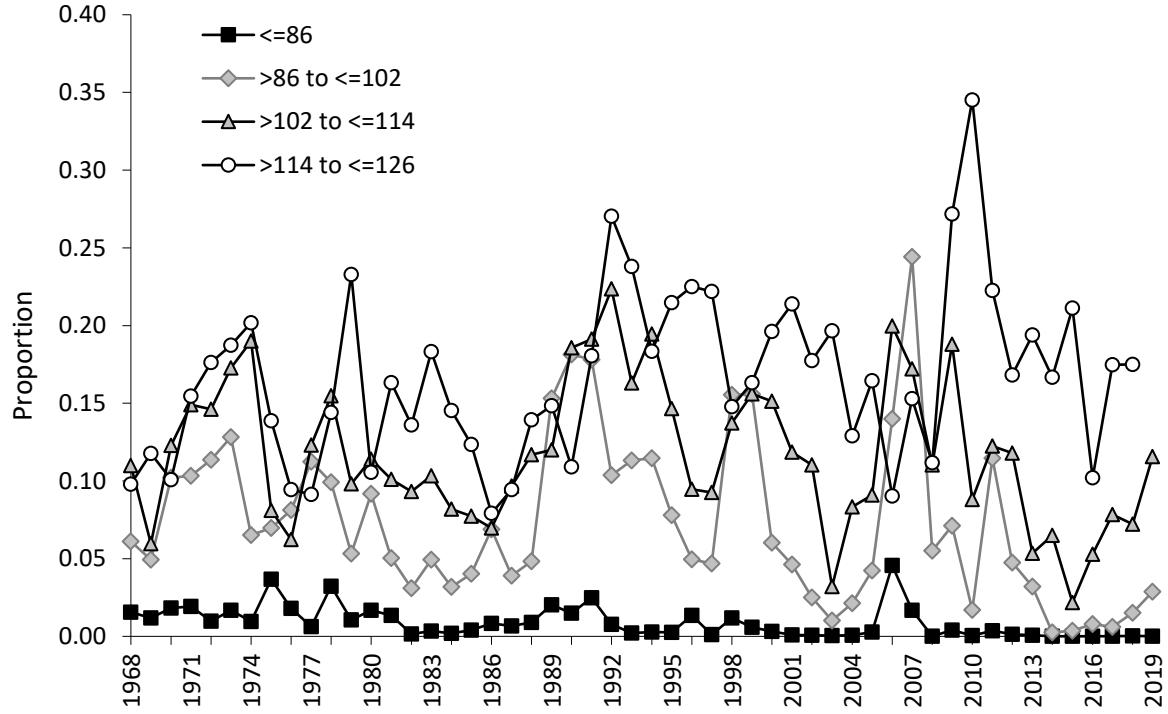

Figure 19. Size composition (proportion of total catch) of juvenile SBT caught by Japanese longliners in statistical areas 4–9, months 4–9, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

3.2.2 Taiwanese longline fishery size/age composition

Size composition data for SBT caught by Taiwanese longliners were obtained from the 2020 interim update of the CCSBT database. 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 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 2019, proportions of all size classes remained relatively stable, with very slight increases (Fig. 20). Observer coverage on vessels has been less than 10% in some past years, and discarding of juveniles cannot be discounted.

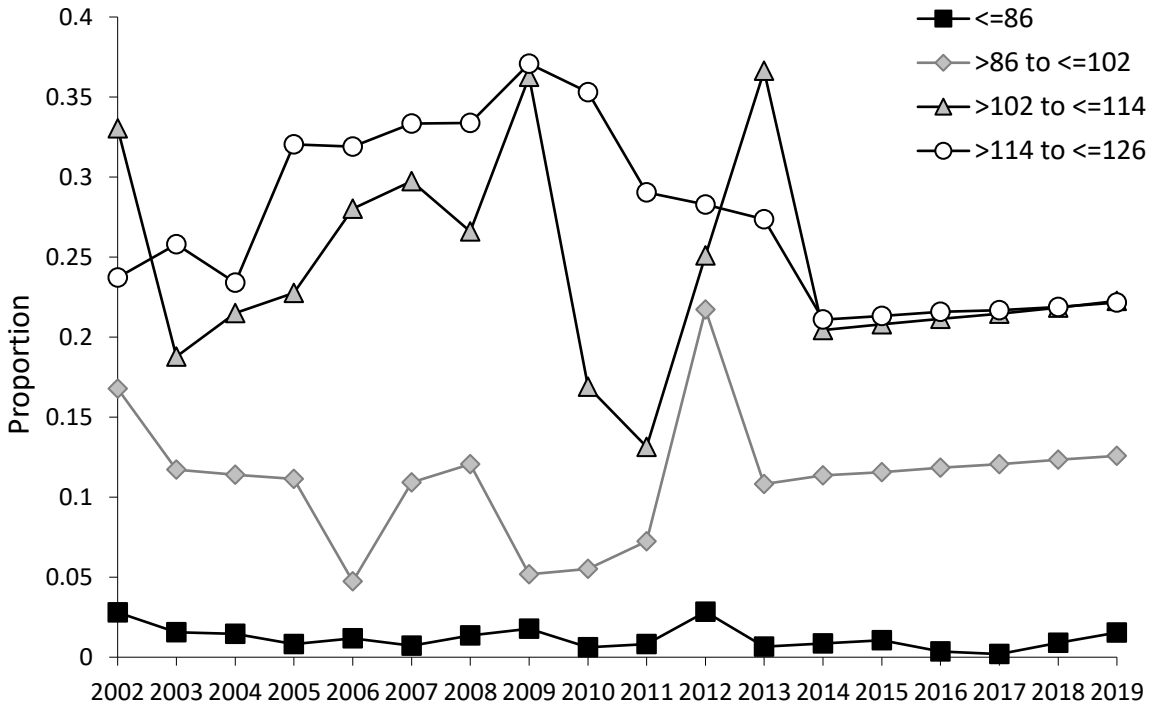

Figure 20. Size composition (proportion of total catch) of juvenile SBT caught by Taiwanese longliners, where age 0–2≤86 cm, 86<age 3≤102 cm, 102<age 4≤114 cm, 114<age 5≤126 cm.

3.2.3 Australian surface fishery age composition

The age composition of SBT caught by the Australian surface fishery was updated directly from the proportional catch-at-age data prepared by the Secretariat and provided through the CCSBT data exchange (SEC_ManagementProcedureData_52_19). 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. 21). These two age classes have historically comprised around 90% of the catch. In 2019, the 2 and 3-year old age classes accounted for about 98% of the catch.

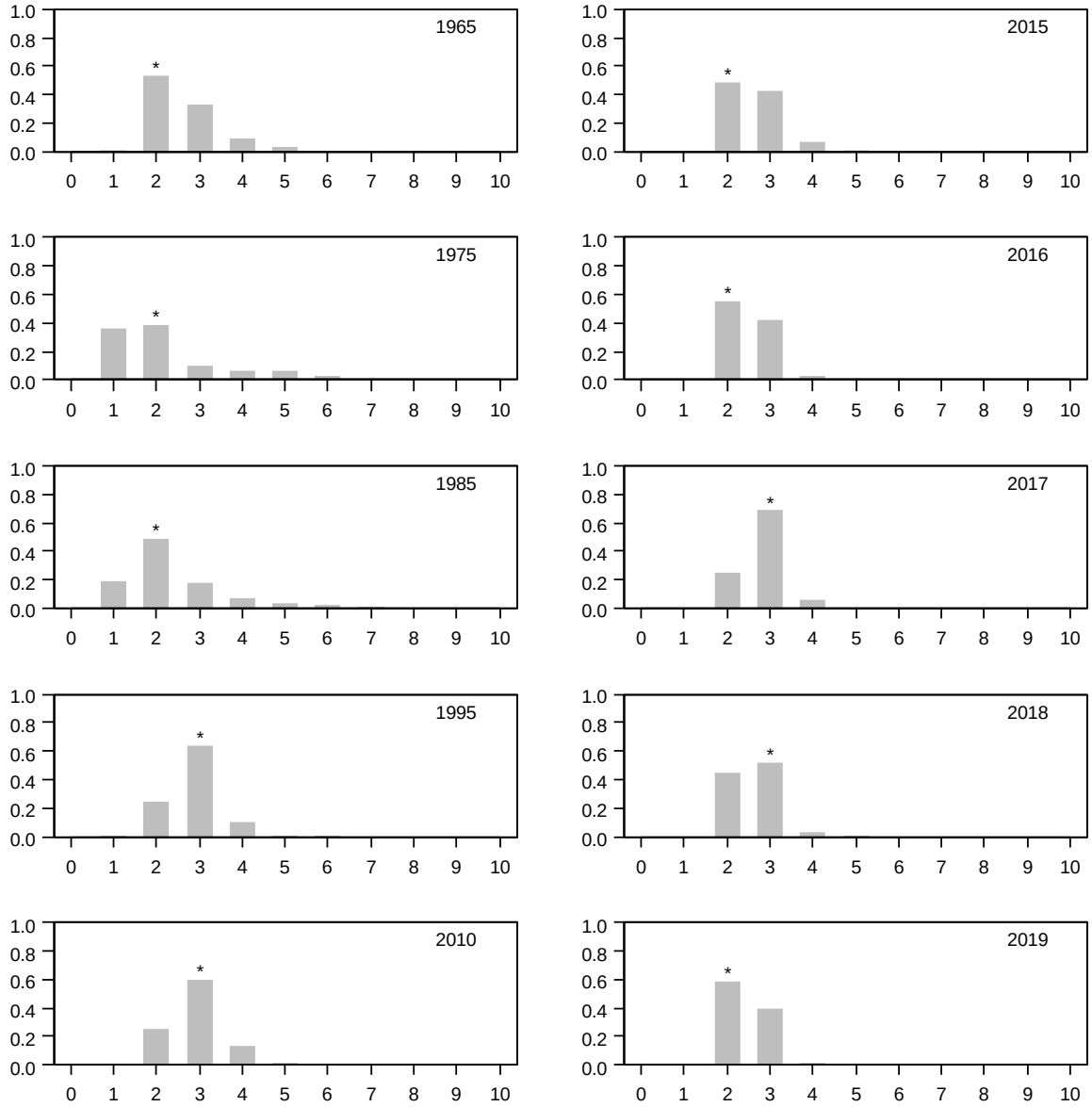

Figure 21. Age composition in the Australian surface fishery. Median age classes are indicated with asterisks.

4 Summary

Recent trends in all indicators are summarised in Appendix 1. Overall, there were mixed results in the indicators.

Potential causes for the changes 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 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.

4.1 Trends in juvenile abundance

The updated indices of juvenile (age 1 to 4) abundance were mixed, with the trolling index increasing, while the gene-tagging estimate decreased slightly.

4.2 Trends in age 4+ SBT

Similar to previous years, the 2019 indicators of age 4+ SBT were mixed. The CKMR index proposed for use when considering fishery indicators decreased slightly in the latest year for which it was calculated (2015). The standardised CPUE in the NZ domestic fishery decreased in 2019, as did the proportion of the two largest age classes in the NZ domestic fishery. While the mean age of SBT on the spawning ground has decreased substantially from 16.8 years in 2011, it decreased only slightly in 2019 to 13.2 from 13.4 in 2018. However, as discussed previously, determining the location where the smaller/younger fish have been caught is a priority for understanding these changes. In addition, although potentially affected by the overcatch, the nominal CPUE for the Japanese longline fishery for 4+ SBT increased in 2019, and remains above the 10 year mean. The standardised, normalised Japanese CPUE series for core vessels decreased substantially in 2019, while the CPUE for all vessels remained stable.

Appendix A: Recent trends in all indicators of the SBT stock

Table 2. Recent trends in all indicators of the SBT stock. Minimum and maximum values in the time series are also shown.

Indicator	Period	Min.	Max.	2016	2017	2018	2019	2020	12 month trend
Scientific aerial survey	1993–2000 2005–17	0.25 (1999)	4.85 (2016)	4.85	1.80	–	–	–	–
Trolling index	1996–2003 2005–06 2006–20	0.00 (2018, 2019)	5.09 (2011)	3.94	1.71	0.00	0.00	1.72	↑
Gene tagging	2016–18	1.15 (2017)	2.27 (2016)	2.27	1.15	1.14	-	-	↓
NZ domestic standardised CPUE	2003–2019	0.355 (2006)	2.99 (2016)	2.99	2.58	2.46	1.35		↓
NZ domestic age/size composition (proportion age 0–5 SBT)*	1980–2019	0.001 (1985)	0.48 (2017)	0.47	0.48	0.33	0.27		↓
Indonesian mean size class**	1993–2019	156 (2016)	188 (1994)	156	155	162	161		↓
Indonesian age composition:** mean age on spawning ground, all SBT	1994–2019	11.8 (2016)	21.2 (1995)	11.5	12.9	13.4	13.2		↓
Indonesian age composition:** mean age on spawning ground 20+	1994–2019	21.3 (2016)	25.3 (2004)	21.3	23.1	23.1	22.4		↓
Indonesian age composition:** median age on spawning ground	1994–2019	13 (2017)	21 (1994–95; 1996–97; 1998–99)	11.5	11.5	12.5	12.5		--

Table 2. (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.	2016	2017	2018	2019	12 month trend
Japanese nominal CPUE, age 4+	1969–2019	1.338 (2006)	22.123 (1965)	4.210	5.271	6.012	7.733	↑
Japanese standardised CPUE (W0.5, W0.8, Base w0.5, Base w0.8)	1969–2019	2007 (0.269–0.347)	1969 (2.284– 2.706)	0.909–1.292	0.926–1.307	0.925–2.269	0.888-1.756	↓
Korean nominal CPUE	1991–2019	1.312 (2004)	21.523 (1991)	5.451	6.552	7.518	8.702	↑
Taiwanese nominal CPUE, Areas 8+9	1981–2019	<0.001 (1985)	0.956 (1995)	0.203	0.156	0.217	0.204	↓
Taiwanese nominal CPUE, Areas 2+14+15	1981–2019	<0.001 (1985)	3.672 (2007)	2.042	1.588	1.686	1.638	↓
Japanese age comp, age 0–2*	1969–2019	0.004 (1966)	0.192 (1998)	0.003	0.002	0.006	0.009	↑
Japanese age comp, age 3*	1969–2019	0.011 (2015)	0.228 (2007)	0.033	0.044	0.047	0.082	↑
Japanese age comp, age 4*	1969–2019	0.091 (1967)	0.300 (2010)	0.071	0.142	0.145	0.160	↑
Japanese age comp, age 5*	1969–2019	0.072 (1986)	0.300 (2010)	0.160	0.126	0.123	0.196	↑
Taiwanese age/size comp, age 0–2*	1981–2019	<0.001 (1982)	0.251 (2001)	0.004	0.002	0.009	0.015	↑
Taiwanese age/size comp, age 3*	1981–2019	0.024 (1996)	0.349 (2001)	0.118	0.121	0.123	0.126	↑
Taiwanese age/size comp, age 4*	1981–2019	0.027 (1996)	0.502 (1999)	0.211	0.215	0.218	0.223	↑
Taiwanese age/size comp, age 5*	1981–2019	0.075 (1997)	0.371 (2009)	0.216	0.217	0.219	0.222	↑
Australia surface fishery median age composition	1964–2019	age 1 (1979–80)	age 3 (multiple years)	age 2	age 3	age 3	age 2	↓

*derived from size data; ** Indonesian catch not restricted to just the spawning grounds since 2012–13; na = not available

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