



# Update on the length and age distribution of SBT in the Indonesian longline catch

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Wealth from Oceans Flagship

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# 1 Abstract

This paper updates previous analyses of SBT length and age data from the Indonesian longline fishery operating out of the port of Benoa, Bali. Length-frequency data are presented for 19 spawning seasons (1993/94 to 2011/12) and age frequencies for 17 seasons (1993/94 to 2010/11, but excluding 1995/96). This year, ageing of 500 otoliths collected in both the 2009/10 and 2010/11 seasons allowed for the building of direct age-length-keys (ALK) for each season. The data presented for the 2009/10 season supersedes that presented by Farley et al. (2011) which was based on an ALK built using the direct age data for the two preceding spawning seasons (2007/08 and 2008/09) and applied it to the 2009/10 length frequency data.

As noted in previous reports to CCSBT-ESC, considerable change has occurred in the size and age distribution of SBT caught on the spawning ground since monitoring began. In summary:

- 1) Length distribution: the mean of the size distribution declined from 188.1 to 166.8 cm between 1993/94 and 2002/03, and has fluctuated between 168.3 and 171.0 cm since that time. In the latest season, the mean length was 169.4 cm.
- 2) Age distribution: the mean of the age distribution declined from 19-21 years in the mid- and late-1990s to 14-17 years since 2001/02. In the latest season, the mean age was 16.8 years. Although the mean age of SBT appears to have been relatively stable since 2001/02, changes have occurred in the relative abundance of some age classes over that time. There has been a general increase in the relative abundance of fish aged  $\geq 15$  years compared to younger fish since 2001/02.

# 2 Introduction

Southern bluefin tuna spawn from September to April in an area between Indonesia and the northwest coast of Australia (Farley and Davis, 1998). An Indonesian-based longline fishery operates on this spawning ground year-round targeting yellowfin and bigeye tuna, with a bycatch of SBT. Obtaining an accurate estimate of the size and age composition of SBT landed by the Indonesian longline fishery is vital for population modeling and stock assessments, and to monitor changes in the spawning population over time.

Since the early 1990s, the size and age structure of the SBT spawning population has been monitored through a series of collaborative research programs between CSIRO, Indonesia's Research Centre for Capture Fisheries (RCCF) and Research Institute for Marine Fisheries (RIMF), the Indian Ocean Tuna Commission (IOTC), and Japan's Overseas Fishery Cooperation Foundation (OFCF). The program monitors the catch of SBT by Indonesia's longline fleet operating on the SBT spawning ground in the north-east Indian Ocean. Initially, the program collected data on SBT landed at the port of Benoa in Bali, but in 2002 this expanded to include the ports of Muara Baru (Jakarta) and Cilacap (south coast Central Java), and to comply with IOTC protocols. The majority of targeted SBT sampling, however, still occurs at Benoa, as this is the port where the bulk of SBT are landed.

The collection of such large quantities of length frequency data, and the development of validated methods to directly age SBT using the otoliths sampled, have allowed us to accurately estimate the age composition of the Indonesian catch. These data have shown that the parental stock of SBT has undergone substantial changes since monitoring began; the greatest change being a shift in the mode of SBT caught from 18-22 years in the mid-1990s to 12-15 years in the early-2000s.

In this paper we update the information given in Farley et al. (2011) by including the most recent length and age data available for the Indonesian fishery. Length frequency data are presented up to the 2011/12 season and age frequency data up to the 2010/11 season. The data provided to the CCSBT in the data exchange process included the estimated size and age distribution of the whole Indonesian SBT catch, and were not divided into those caught on or south of the spawning ground.

## 3 Methods

As in previous years, targeted sampling of SBT occurred at the Port of Benoa. Length measurements were obtained for only 565 SBT in the 2011/12 spawning season (Table 1). This is in contrast to sampling of earlier spawning seasons where, in general, the sampling of a minimum of 1000 to 1500 SBT was achieved. At time of writing, investigations are in progress to determine the underlying reasons behind the much lower numbers of SBT landed during this last season. It is not yet clear whether it is the result of significant less fishing effort in the areas where SBT have been traditionally caught or whether the level of effort was not significantly lower but that catch rates were, for reason(s) yet to be determined. The length data were provided for data exchange with CCSBT.

This year, direct ageing of a subsample of 500 otoliths was undertaken for fish sampled in the 2009/10 and 2010/11 spawning seasons (Table 1). A fixed number of otoliths were chosen from each 1-cm length class to obtain as many age estimates from length classes where sample sizes were small. Otoliths were prepared, sectioned and read (age of fish estimated) at Fish Ageing Services Pty Ltd (FAS) in Victoria, using the techniques described in Anon. (2002). The otolith reader has at least 10 years experience reading SBT otoliths.

Each otolith was read twice by the primary otolith reader (FAS) and then given a final age estimate was given to 969 fish. The coefficient of variation (CV; Chang, 1982) between readings was used to measure consistency. All readings were conducted without reference to the size of the fish, date of capture, or to previous readings. A sub-sample of 10% of otoliths was not read by a secondary reader due to the late decision to proceed with otolith reading this year.

To determine the age structure of the Indonesian catch of SBT in 2009/10 and 2010/11 seasons, separate age-length keys were developed using the samples of aged fish. The age-length-key gives the proportion of fish at age in each 5-cm length class, which enabled us to infer the age-frequency distribution of the catch from the length-frequency distribution obtained through the monitoring. The age distributions obtained were compared to the estimated age distributions for previous seasons.

## 4 Results and Discussion

### 4.1 Length distribution

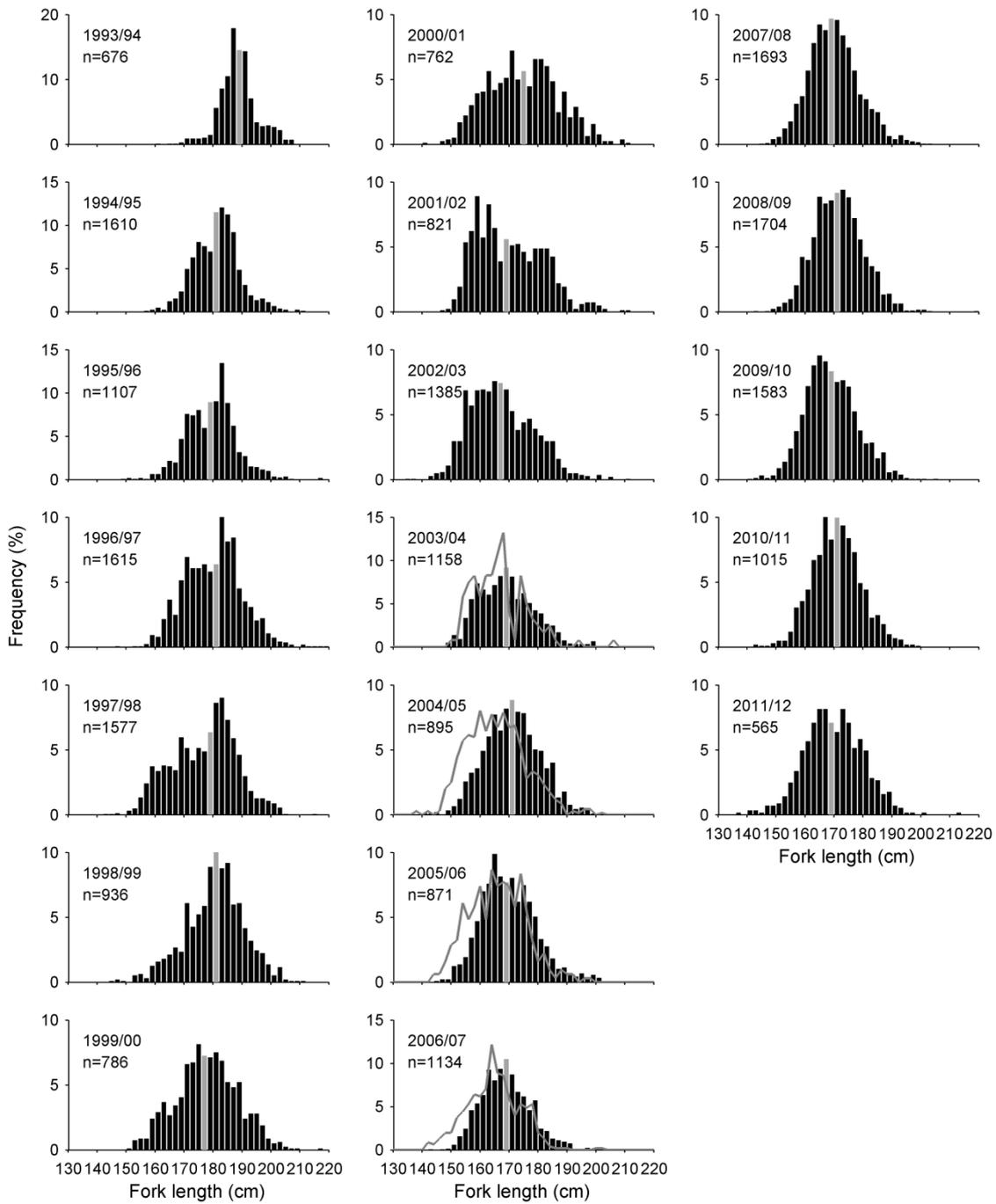
Figure 1 shows the length frequency distributions for SBT caught by the Indonesian longline fishery by season. The data are separated into those caught on and just south of the spawning ground where needed (see Farley et al., 2007). SBT caught south of the spawning ground are not included in our examination of the size/age distribution of the spawning population as it is unknown if these 'southern' fish were capable of spawning.

As noted in previous reports to CCSBT-ESC, considerable change has occurred in the size distribution of SBT caught on the spawning ground since monitoring began. In the mid- and late-1990s, the majority of SBT caught were between 165 and 190 cm FL with a median length of ~180 cm (Figure 1). In the early-2000s, the relative proportion of small SBT (<165 cm) in the catch increased (Figure 2). The mean size of SBT caught declined from 188.1 to 166.8 cm between 1993/94 and 2002/03, and remained between 168.3 and 171.0 cm since that time including the most recent season (Table 1). In 2010/11, the mean length of SBT caught was 169.4 cm, which is average for the past 10 years (Figure 3). Note that SBT from the first season studied (1993/94) may not be representative of the catch as SBT were all caught in the latter part of the season (December to May). However, if only data for December to May were selected for all seasons, a similar decline in the mean length by season is clear (Figure 3).

Table 1. Number of length measurements and age estimates for SBT by spawning season.

SPAWNING SEASON	FORK LENGTH (CM)		OTOLITHS <i>N</i>	AGE (YEARS)	
	<i>N</i>	MEAN		<i>N</i> <sup>1</sup>	MEAN
1993/94	676	188.1	0	0	NA
1994/95	1610	180.7	549	486	21.2
1995/96	1107	178.9	225	50	NA
1996/97	1615	179.6	602	475	20.8
1997/98	1577	176.4	519	485	19.8
1998/99	936	179.9	660	474	20.7
1999/00	786	177.4	533	498	19.5
2000/01	762	174.2	720	481	16.9
2001/02	821	169.5	715	489	14.8
2002/03	1385	166.8	1502	488	14.5
2003/04	1279	168.5	1283	494	15.2
2004/05	1580	170.1	1523	493	15.3
2005/06	1182	169.2	1180	486	14.4
2006/07	1586	168.3	1586	491	15.1
2007/08	1693	169.5	1709	485	16.7
2008/09	1704	171.0	1697	479	15.6
2009/10	1538	168.5	1538	488	15.3
2010/11	1015	170.4	1009	481	16.8
2011/12	565	169.4	543	NA	NA
<i>Total</i>	23417	172.9	18093	7337	

<sup>1</sup> A random sub-sample of 500 are selected for ageing



**Figure 1. Length frequency (2 cm intervals) of SBT caught on the spawning ground (bars) by spawning season. 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).**

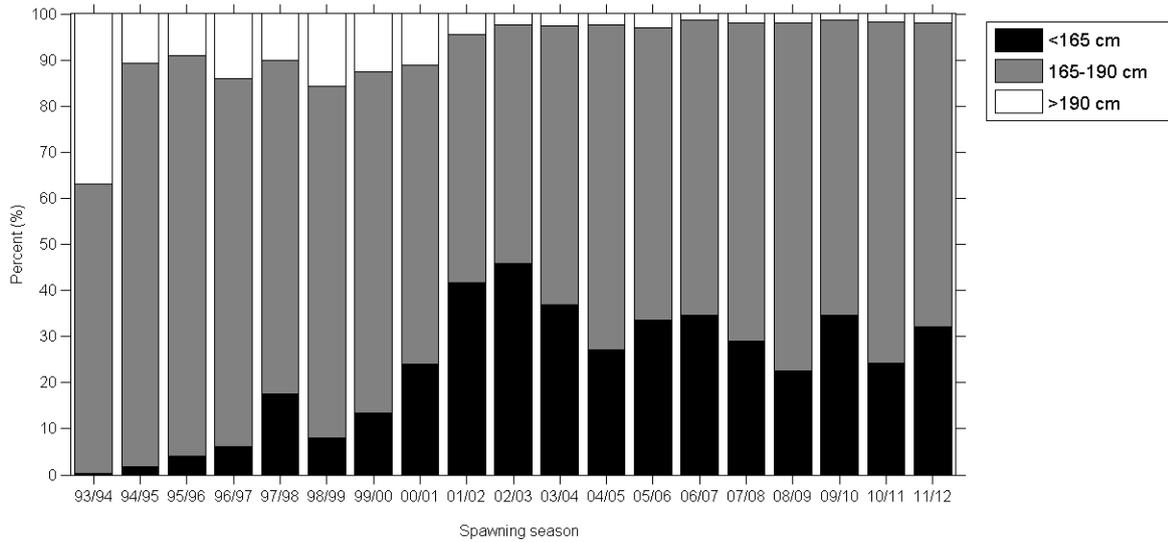


Figure 2. Proportion of SBT caught on the spawning ground by small (<165 cm), medium (165-190 cm) and large (>190 cm) SBT by season. Data from Processor A are excluded.

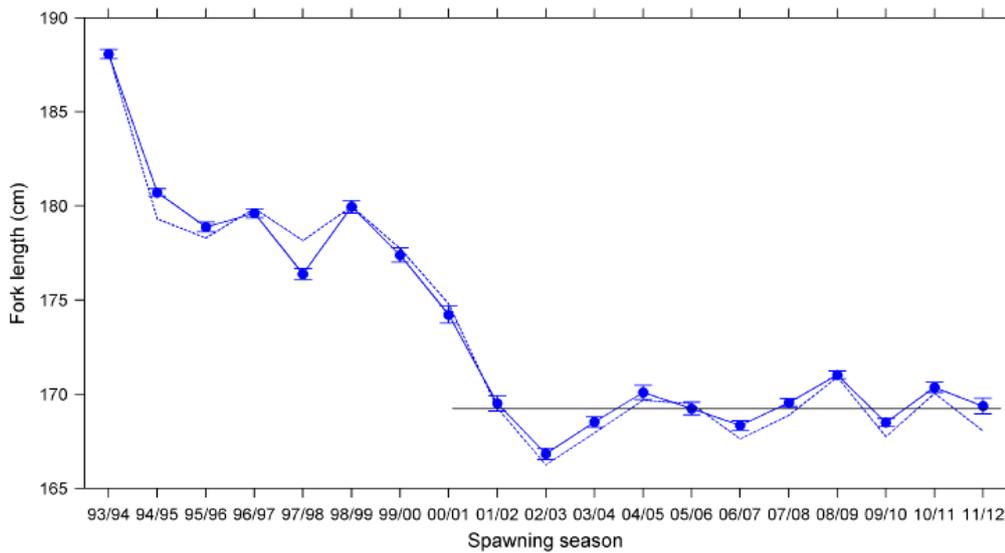
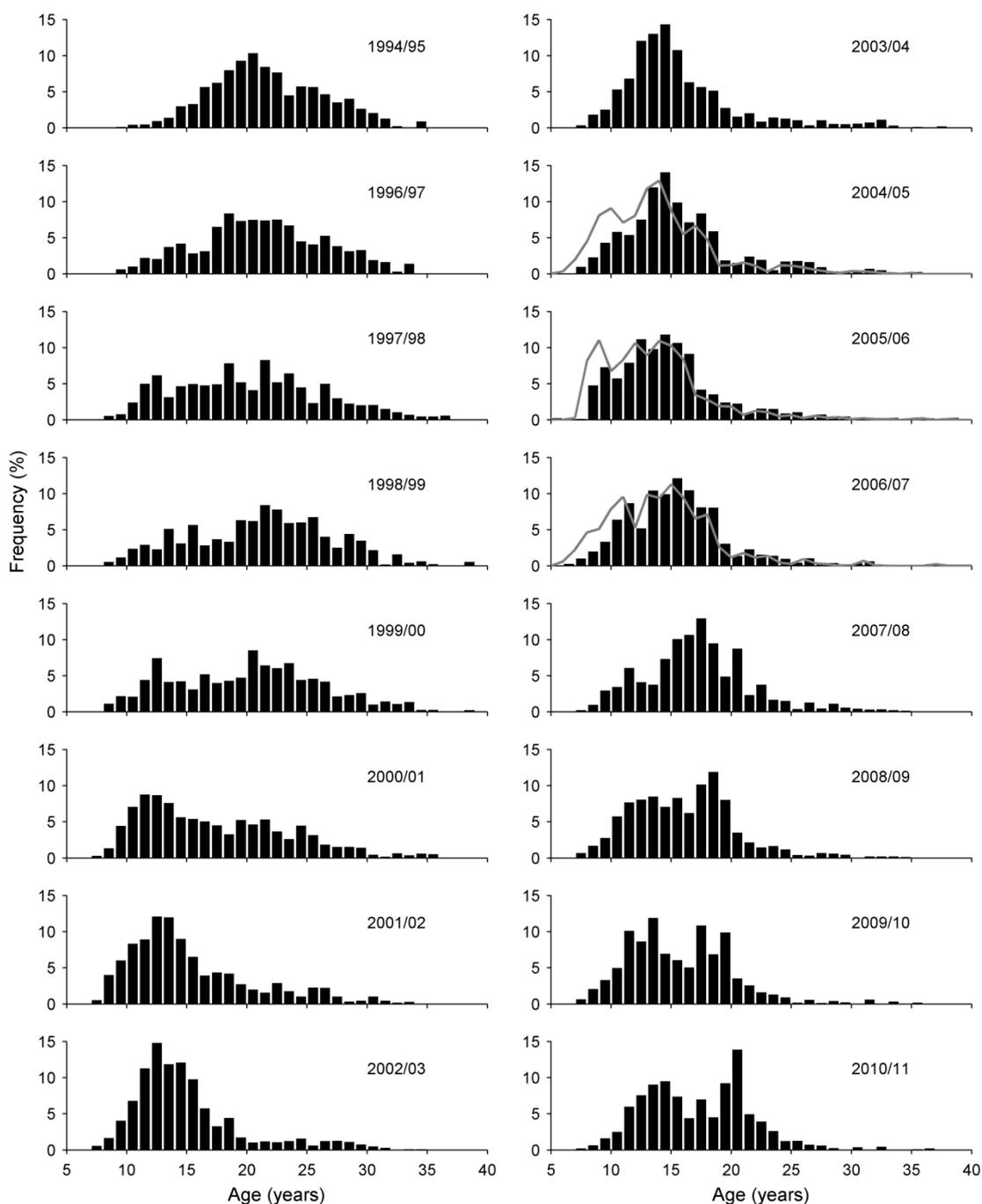


Figure 3. Mean length (+/- 95%CI) of SBT in the Indonesian catch on the spawning ground. Data from Processor A are excluded. Dashed line is the mean length of SBT caught in December to May only. The horizontal line indicates the mean for the 2001/02 to 2011/12 seasons.

## 4.2 Direct age estimates and age distribution

As already noted, a final age was estimated for 969 of the 1,000 otoliths read from the 2009/10 and 2010/11 spawning season. Fish ranged in size from 141-205 cm LCF and age estimates ranged from 6 to 36 years. The precision of readings by the primary reader (intra-reader consistency) was considered good; the CV between readings was 2.93 in 2009/10 and 4.68 in 2010/11. The second age estimate agreed with the original estimate in 46.3% of cases, and 91.0% were within one year of the original.

Figure 4 shows the estimated age structure of the Indonesian catch by spawning season based on ALKs developed using our aged fish. As reported previously, the age composition of the catch has changed since monitoring began with an increase in the relative abundance of younger fish since the 2000/01 season. The mean of the age distribution declined from 19-21 years in the mid- and late-1990s to 14-17 years since 2001/02 (Table 1; Figure 5). Although the mean age of SBT appears to have been relatively stable since that time, there appears to be a slight increasing trend in recent years. The mean age of SBT was 16.8 in 2010/11 compared to 15.3 in 2009/10. There has been a general increase in the relative abundance of fish aged  $\geq 15$  years compared to younger fish since 2001/02 (Figure 6).



**Figure 4. 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 aged fish and length frequency data obtained through the**

Indonesian monitoring program. For comparison, the age distribution of SBT caught south of the spawning ground (Processor A) is shown for the 2004/05, 2005/06 and 2006/07 seasons (grey line).

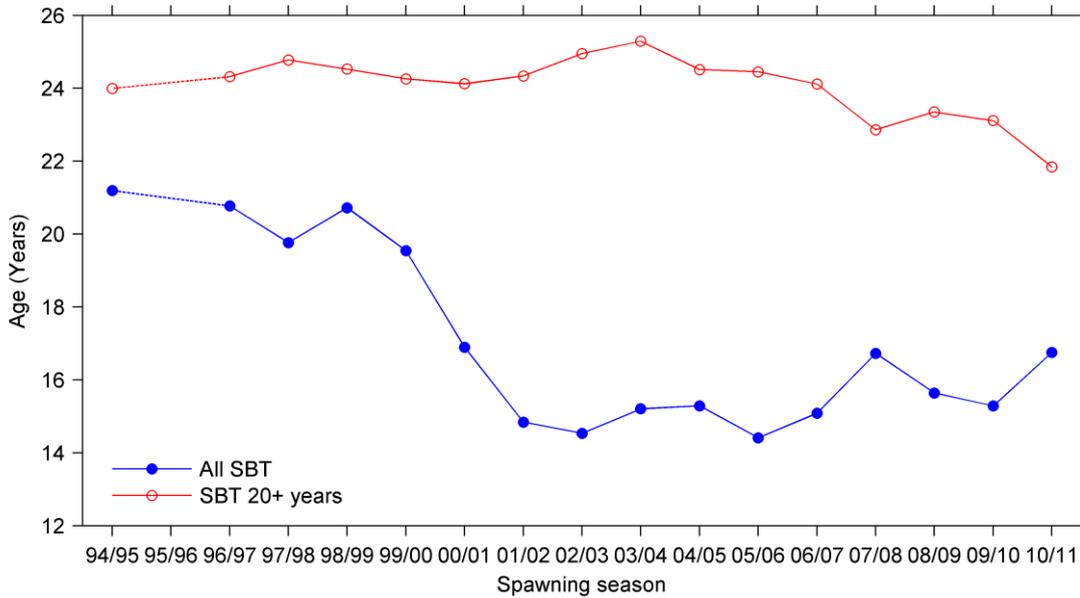


Figure 5. Estimated mean age of SBT in the Indonesian catch on the spawning ground. Data from Processor A are excluded. Note there are no age data for the 1995/96 season.

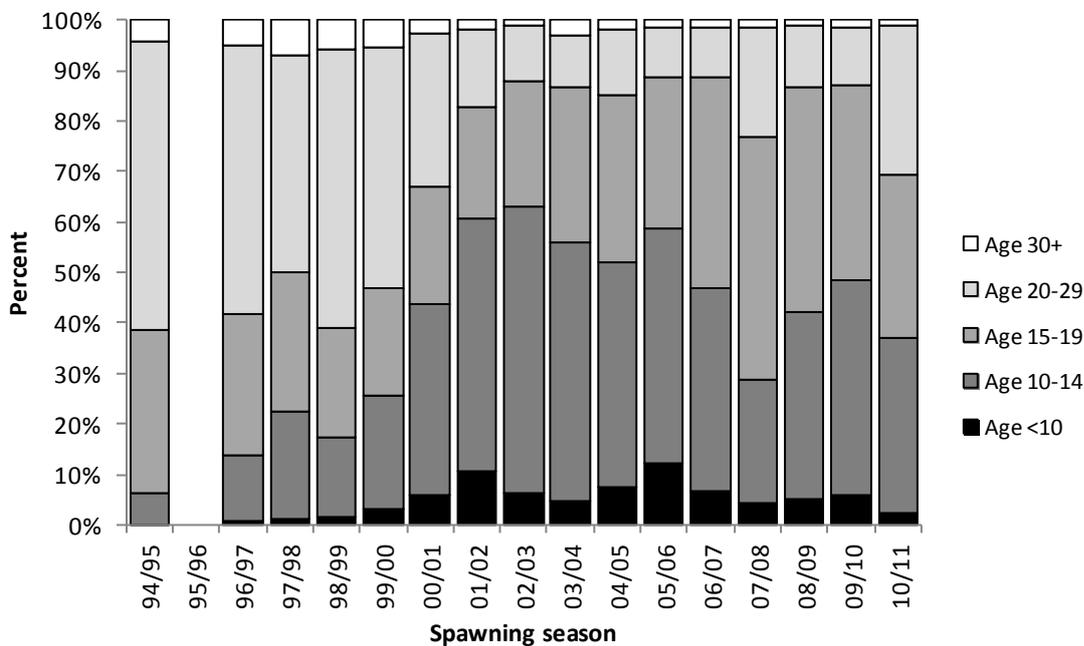


Figure 6. Estimated proportion of SBT by age class in the Indonesian catch on the spawning ground. Note there are no age data for the 1995/96 season.

## 5 Summary

We present the length and age distribution of the Indonesian longline catch from the mid-1990s through to the 2011/12 and 2010/11 spawning seasons respectively. In each season, an age-length-key (ALK) was developed using age estimates obtained from that season. Length frequency data was then applied to the ALK to estimate the age distribution of the catch. The size and age distribution of the Indonesian catch has remained relatively stable since the early-2000s, with the mean length and age fluctuating between 168 and 171 cm FL and 14 and 17 years respectively.

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