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

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CCSBT-ESC/1309/12

Prepared for the CCSBT Extended Scientific Committee for the 18th Meeting of the Scientific Committee 2-7 September 2013, Canberra, Australia

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Citation

Farley, J., Nugraha, B. and Proctor, C. (2013). Update on the length and age distribution of SBT in the Indonesian longline catch. CCSBT-ESC/1309/12, 18th Meeting of the Scientific Committee, 2-7 September 2013, Canberra, Australia.

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Important disclaimer

Acknowledgments

The success of the SBT monitoring program was only possible due to the dedicated efforts of all in the scientist team at Research Institute for Tuna Fisheries (Benoa, Bali), and in particular that of Mr Kiroan Siregar and Mr Rusjas Mashar, the biological samplers and primary measurers of the SBT. We also thank Mr Enjah Rahmat (RIMF) for earlier years of data entry into the SBT biological database and to Mr Budi Iskandar Prisantoso (RCFMC) and Ms Retno Andamari (Gondol Mariculture Research Institute) in their former roles as database manager and monitoring program manager respectively. The cooperation of the longline tuna industry (coordinated through Asosiasi Tuna Longline Indonesia), and the individual processing companies in providing access and facilities to carry out the sampling is much appreciated. We also acknowledge the support of all other agencies within Ministry of Marine Affairs and Fisheries (Indonesia) for the research activities. This work was funded by Australia's Department of Agriculture, Fisheries and Forestry, and CSIRO's Wealth from Oceans Flagship.

Contents

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 20 spawning seasons (1993/94 to 2012/13) and age frequencies for 18 seasons (1993/94 to 2011/12, but excluding 1995/96). This year, ageing of 500 otoliths collected in the 2011/12 season was not undertaken and thus it was not possible to build a direct age-length-key (ALK) for the season. To estimate the age distribution of the catch, we developed an ALK using the direct age data for the two preceding spawning seasons (2009/10 and 2010/11) and applied it to the 2011/12 length frequency data.

As noted in previous reports to CCSBT-ESC, considerable change has occurred in the size and age distribution of SBT landed by the Indonesian longline fleet since monitoring began. In summary:

1) **Length distribution**: Between 1993/94 and 2002/03, the mean size of SBT landed declined from 188.1 to 166.8 cm fork length (FL), and it has fluctuated between 168.3 and 171.0 cm FL since that time. In the latest season, however, the mean length of SBT was only 162.1 cm FL. This is the lowest since monitoring began. Although a large proportion of fish ranged between 150 and 190 cm FL, 23.6% of fish were < 150 cm FL. In previous seasons, less than 2.6% of fish were < 150 cm FL. When the data were examined by month, 74.9% of the small (<150 cm) fish were landed in October and November 2012. The mean size of fish landed after November was only slightly below the mean size for the same time period in previous seasons. Investigations are in progress to determine whether the small SBT landed were caught on or south of the SBT spawning ground, and whether they can be considered part of the SBT spawning population.

2) **Age distribution**: Similarly, the mean age of SBT landed by Indonesia declined between the late 1990s and early 2000s from ~20 years to ~15 years old. In 2011/12 (the latest season we have data for), the mean age was 16.0 years. Although the mean age of SBT has been relatively stable since the 2001/02 season, there appears to be a decline in the average age of SBT ≥20 years. This may be driven by a general increase in the proportion of 20-30 year-olds in the catch, rather than a decline in very old age 30+ SBT (Fig. 6).

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. (2012) by including the most recent length and age data available for the Indonesian fishery. Length frequency data are presented up to the 2012/13 season and age frequency data up to the 2011/12 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 1373 SBT in the 2012/13 spawning season (Table 1).

Direct ageing of a subsample of 500 otoliths was not undertaken this year (due to funding restrictions) and thus it was not possible to build a direct age-length-key (ALK) for the season. However, to estimate the age distribution of the catch for 2011/12, we developed an ALK using the direct age data for the two preceding spawning seasons (2009/10 and 2010/11). The ALK 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 2011/12 length-frequency distribution. Using age-length data from two seasons, rather than one, reduced the issue of 'missing rows' where no ages were available for some length classes if only one season's data were used.

Previously, the iterative ALK method of Kimura and Chikuni (1987) was investigated (see Farley et al., 2011). That method accounts for situations where ALK's from one year are being applied to length frequency data collected in a different year. However, the age distribution obtained using that method for previous seasons (2007/08 and 2008/09) contained large 'spikes' for some ages, which were not consistent with previous seasons. This was primarily due to low sample sizes, or no samples, for some ages and the fact that age classes cannot be grouped together because of the catch-at-age data requirements of the operating model. Given this, the standard ALK method seemed more appropriate in the current circumstance.

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 those caught just south of the spawning ground (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 until 2012/13 (Table 1).

In 2012/13, the mean length of SBT caught was 162.2 cm FL, the lowest since monitoring began (Table 1; Fig. 3). The size frequency of SBT appears bimodal with peaks at ~146 cm and ~170 cm FL (Fig. 1). Although a large proportion of fish ranged between 150 and 190 cm FL, 23.6% of fish were < 150 cm FL (Fig. 1; Fig. 2). In previous seasons, less than 2.6% of fish were < 150 cm FL. When the data were examined by month, 74.9% of the small (<150 cm) fish were landed in October and November 2012. The mean size of fish landed after November (165.8 cm FL) was only slightly below the mean size for the same time period in previous seasons (Fig. 3). Investigations are in progress to determine whether the small SBT sampled were caught on

or south of the SBT spawning ground, and whether they can be considered part of the SBT spawning population.

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

SPAWNING SEASON	FORK LENGTH (CM)		OTOLITHS	AGE (YEARS)	
	N	MEAN	*N*	*N*[1]	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*	*16.0*
2012/13	1373	162.1	1373	*NA*	*NA*
Total	24790	172.3	19466	7823	

[1] A random sub-sample of 500 are selected for ageing, apart from the 2011/12 season where an ALK based on data from the previous two seasons was used.

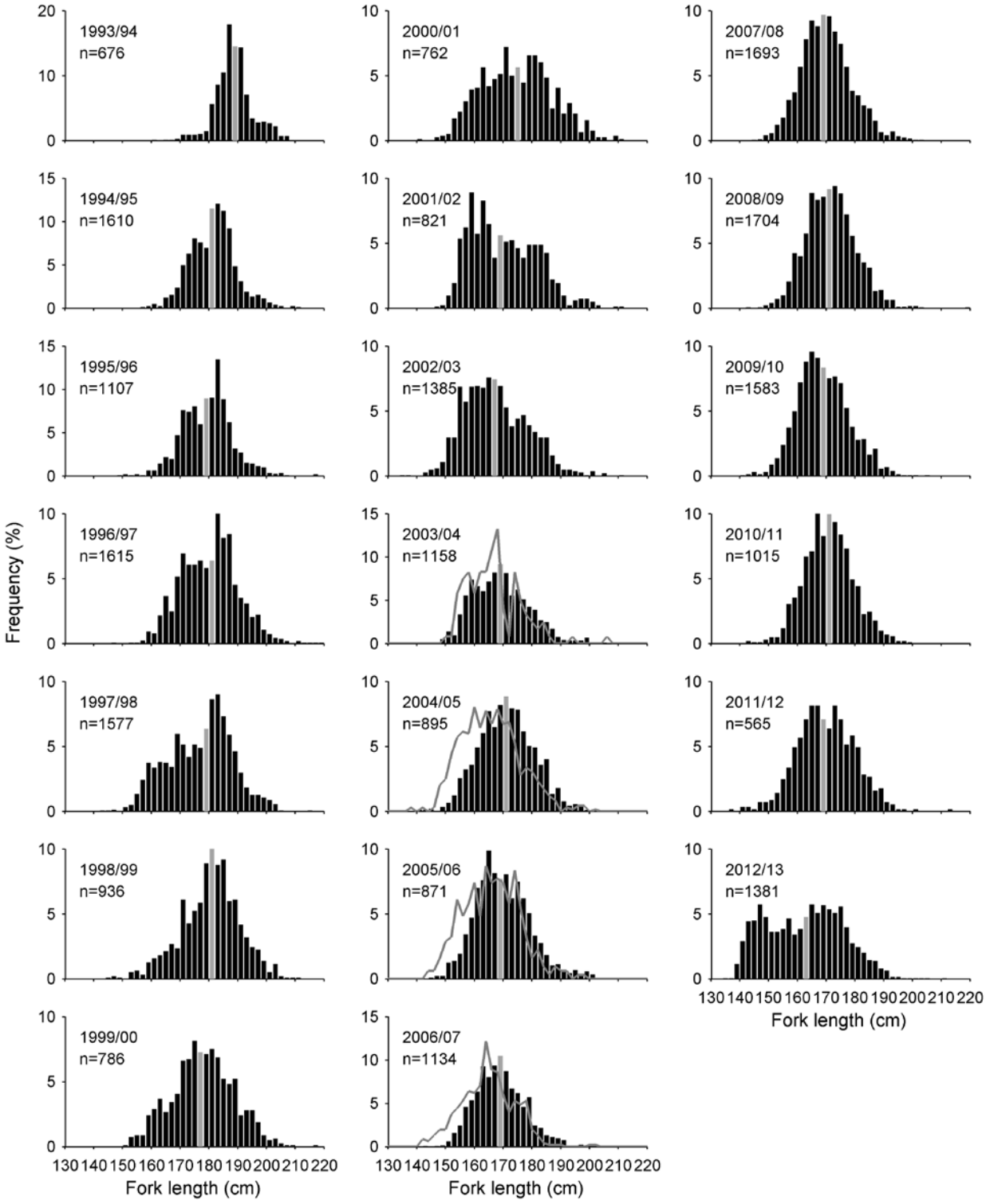

Figure 1. Length frequency (2 cm intervals) of SBT caught on the spawning ground (bars) by spawning season. The grey bar shows the median size class. For comparison, the length distribution of SBT thought to be caught south of the spawning ground (Processor A) is shown for the 2003/04 (n=121), 2004/05 (n=685), 2005/06 (n=311) and 2006/07 (n=452) seasons (grey line) (see Farley et al., 2007).

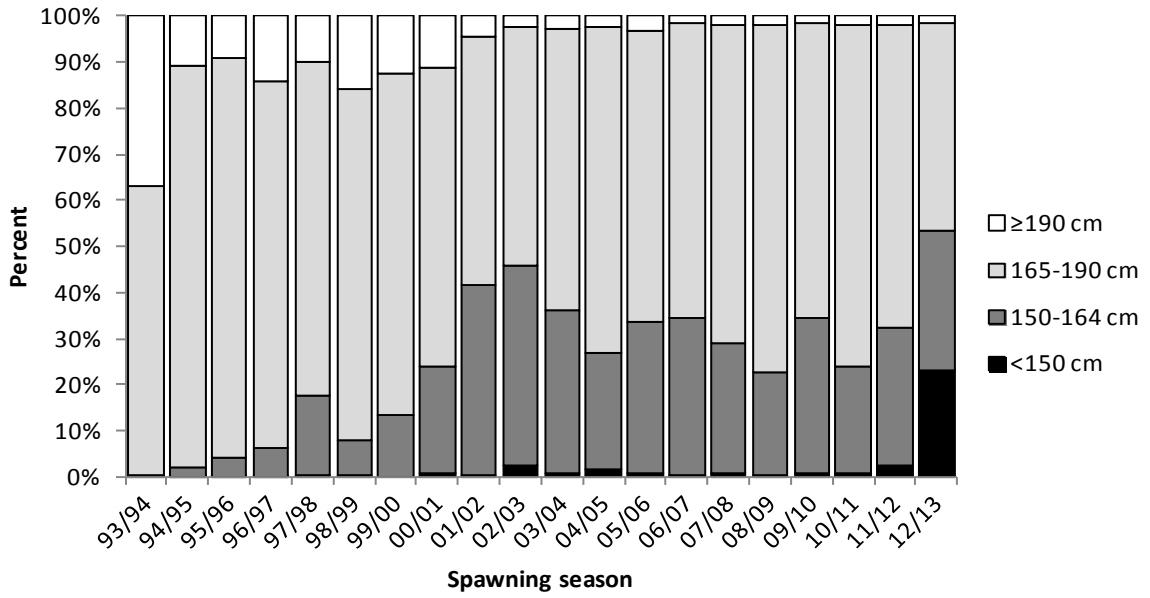

Figure 2. Proportion of SBT caught on the spawning ground by very small (<150 cm), small (150-165 cm), medium (165-190 cm) and large (≥190 cm) SBT by season. Data from Processor A are excluded.

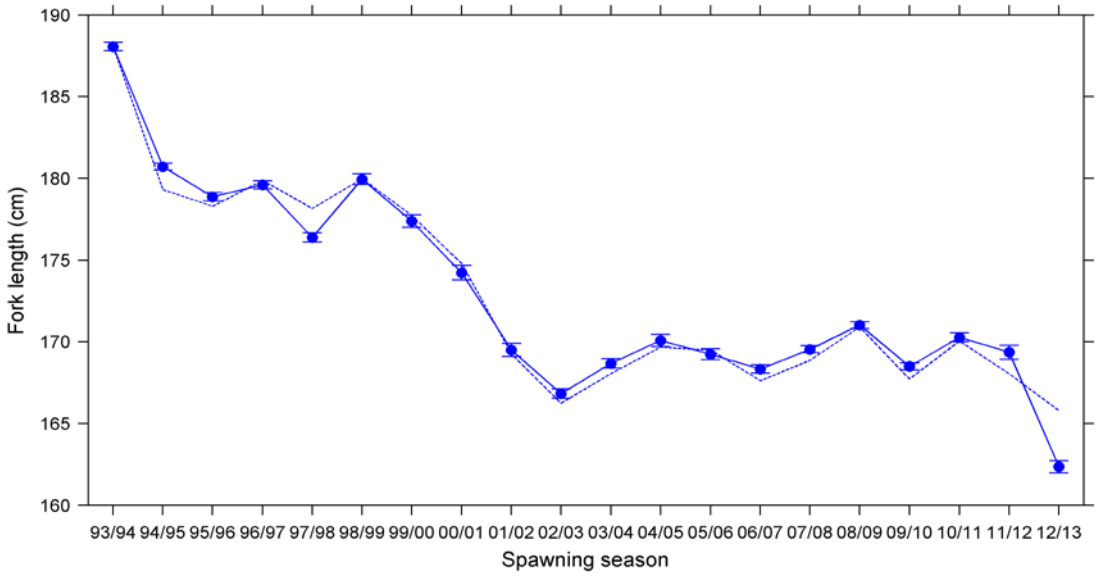

Figure 3. Mean length (+/- 95%CI) of SBT in the Indonesian catch on the spawning ground. Data from Processor A are excluded. Dashed line is the mean length of SBT caught in December to May only, to allow for direct comparison with the 1993/94 season when SBT were only sampled in those months. The horizontal line indicates the mean for the 2001/02 to 2011/12 seasons.

4.2 Direct age estimates and age distribution

Figure 4 shows the estimated age structure of the Indonesian catch by spawning season. As reported previously, the age composition of the catch has changed over time, 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). In 2011/12 (the latest season we have data for), the mean age was 16.0 years. Although the mean age of SBT appears to have been relatively stable since that time, there appears to be a decrease in the average age of SBT ≥20 years since the mid-2000s (Fig. 5) which is being driven by a general increase in the proportion of 20-30 year-olds in the catch, rather than a decline in very old age 30+ SBT (Fig. 6).

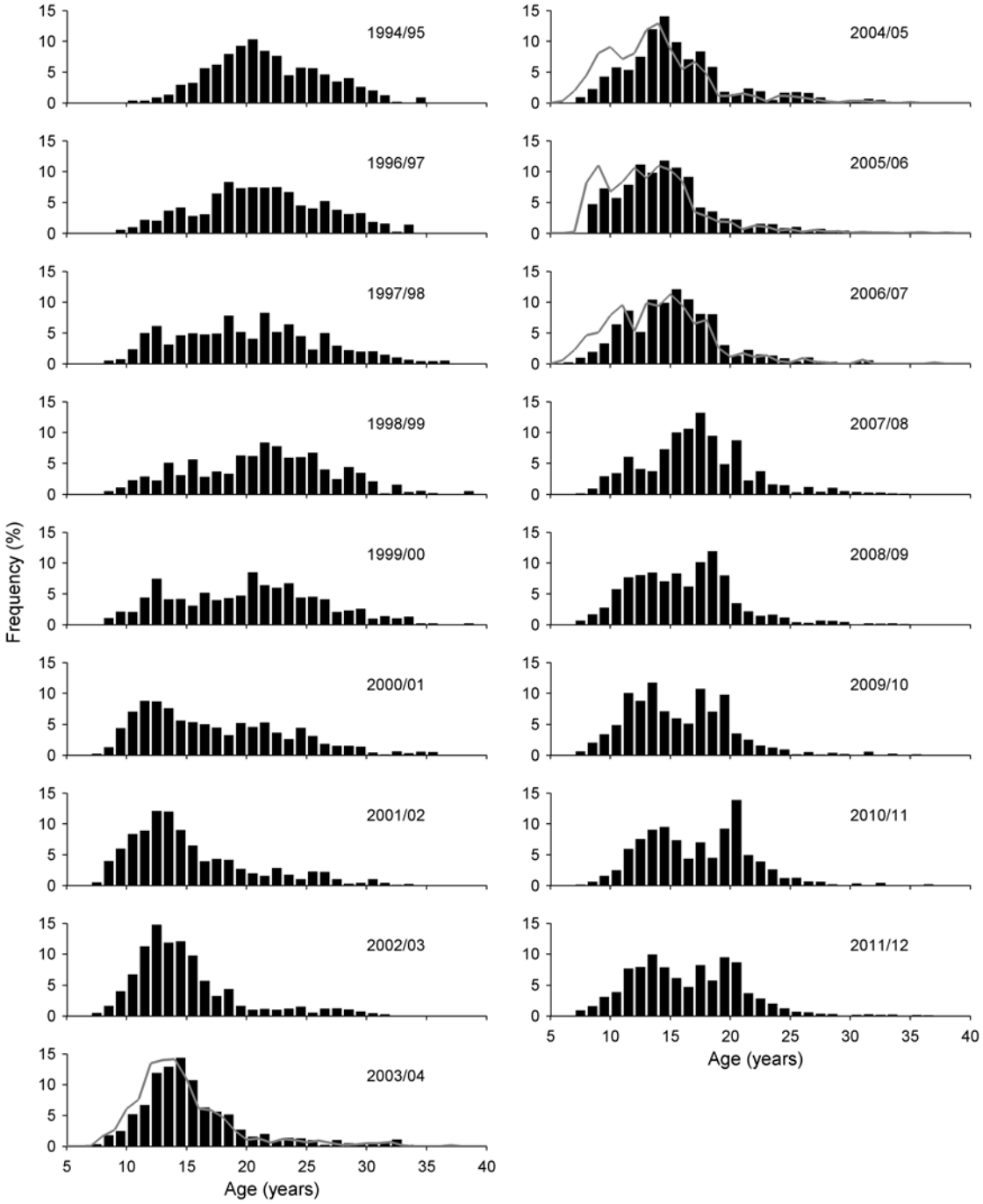

Figure 4. Age frequency distribution of SBT in the Indonesian catch on the spawning ground by spawning season estimated using age-length keys from our sub-samples of aged fish and length frequency data obtained through the Indonesian monitoring program. For comparison, the age distribution of SBT caught south of the spawning ground (Processor A) is shown for the 2004/05, 2005/06 and 2006/07 seasons (grey line).

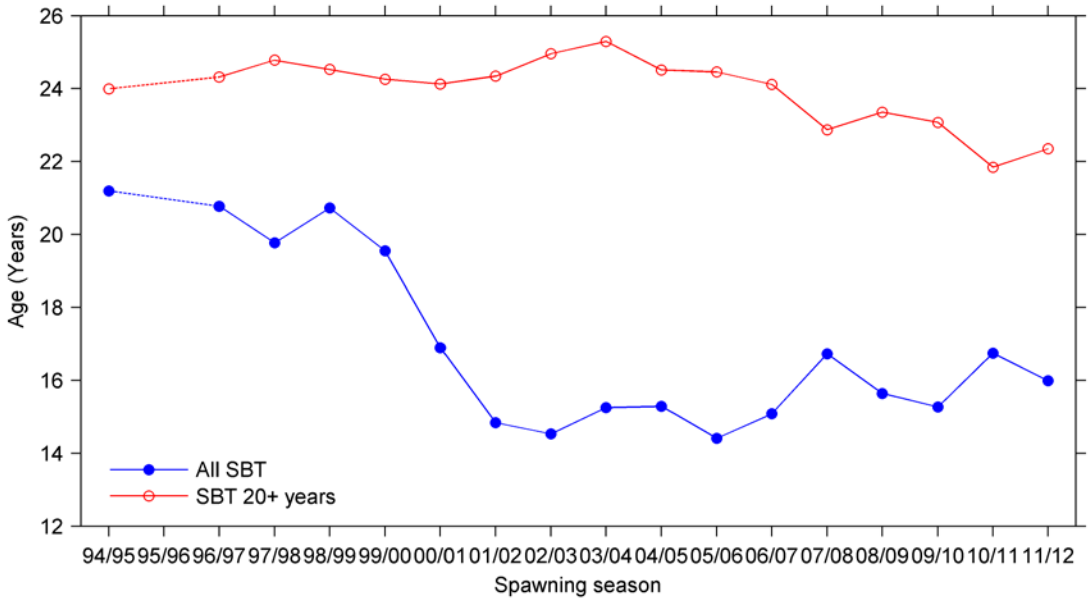

Figure 5. Estimated mean age of SBT in the Indonesian catch on the spawning ground. Data from Processor A are excluded. Note there are no age data for the 1995/96 season.

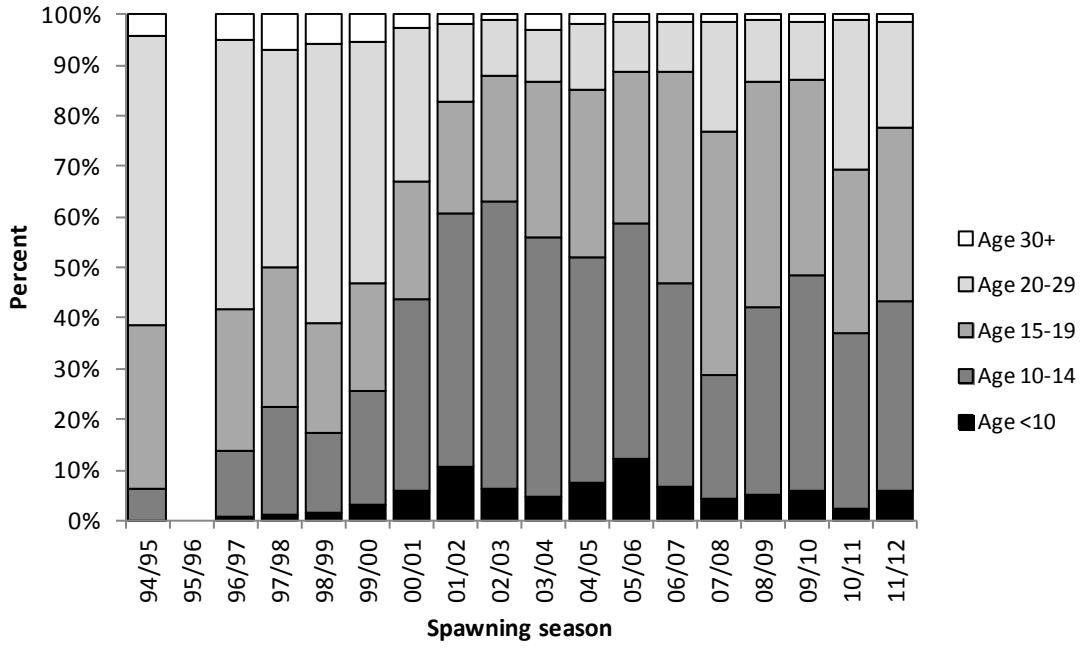

Figure 6. Estimated proportion of SBT by age class in the Indonesian catch on the spawning ground. Note there are no age data for the 1995/96 season. Age data are not available for the 2012/13 season.

5 Summary

We present the length and age distribution of the Indonesian longline catch from the mid-1990s through to the 2012/13 and 2011/12 spawning seasons respectively. In each season prior to 2011/12, 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. In 2011/12, however, no direct age estimates were available. Thus, an ALK was developed using direct age data for the two preceding spawning seasons and applied to the 2011/12 length frequency data. It is difficult to assess the variance and bias that this method may introduce to the age distribution for 2011/12 season, but the ALK is thought to be the best available at this stage.

The size and age distribution of the Indonesian SBT catch has remained relatively stable since the early-2000s until the 2011/12 season. In the 2012/13 season, a relatively large proportion (23.6%) of SBT landed fleet were <150 cm FL, compared to <2.2% for all previous seasons. The majority of these small SBT were landed in October and November 2012. Investigations are in progress to determine whether the small SBT landed were caught on or south of the SBT spawning ground, and whether they can be considered part of the SBT spawning population.

6 References

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