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

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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 for 2010/11 and age-frequency data for 2009/10 spawning seasons are presented for the fishery. This year, ageing of 500 otoliths collected in the 2009/10 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 (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.

2) Age distribution: the mean of the age distribution declined from 19-21 years in the mid- and late-1990s to 14-16 years since 2001/02. 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. The most obvious change is a decline in the relative abundance of 10-14 year olds and an increase in relative abundance of 15-19 year olds.

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[3] (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

[3] Formerly "Research Centre for Capture Fisheries", now "Research Centre for Fisheries Management and Conservation (RCFMC)".

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. (2010) by including the most recent length and age data available for the Indonesian fishery. Length frequency data are presented up to the 2010/11 season and age frequency data up to the 2009/10 season. The data provided to the CCSBT in the April 2010 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.

Methods

As in previous years, targeted sampling of SBT occurred at the Port of Benoa. Length measurements were obtained for 1538 SBT in the 2009/10 spawning season (Table 1) and these data were provided for data exchange with CCSBT in April 2010. Length data for the 2010/11 spawning season were not available at the time of the data exchange but have since been received for fish with otoliths sampled (n=1015).

This year, direct ageing of a subsample of 500 otoliths was not undertaken (as there was no Australian funding provided) and thus it was not possible to build a direct age-length-key for the season. However, to estimate the age distribution of the catch for 2009/10, we developed an ALK using the direct age data for the two preceding spawning seasons (2007/08 and 2008/09). 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 2009/10 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.

The iterative ALK method of Kimura and Chikuni (1987) was also investigated. This 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 this method 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 circumstances.

Results and Discussion

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 as 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 (e.g. CCSBT-ESC/1009/17) 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 (Figure 3). In 2010/11, the mean length of SBT caught was 170.4 cm. 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	Length data	Otolith/age data	
	Measured	Otoliths collected	Age estimated[1]
1993/94	676	0	0
1994/95	1610	549	486
1995/96	1107	225	0
1996/97	1615	602	475
1997/98	1577	519	485
1998/99	936	660	474
1999/00	786	533	498
2000/01	762	720	481
2001/02	821	715	489
2002/03	1385	1502	488
2003/04	1279	1283	494
2004/05	1580	1523	493
2005/06	1182	1180	486
2006/07	1586	1586	491
2007/08	1693	1709	485
2008/09	1704	1697	479
2009/10	1538	1538	*0*
2010/11	1015	*Na*	*0*
Total	22852	16541	6804

[1] A random sub-sample of 500 are selected for ageing

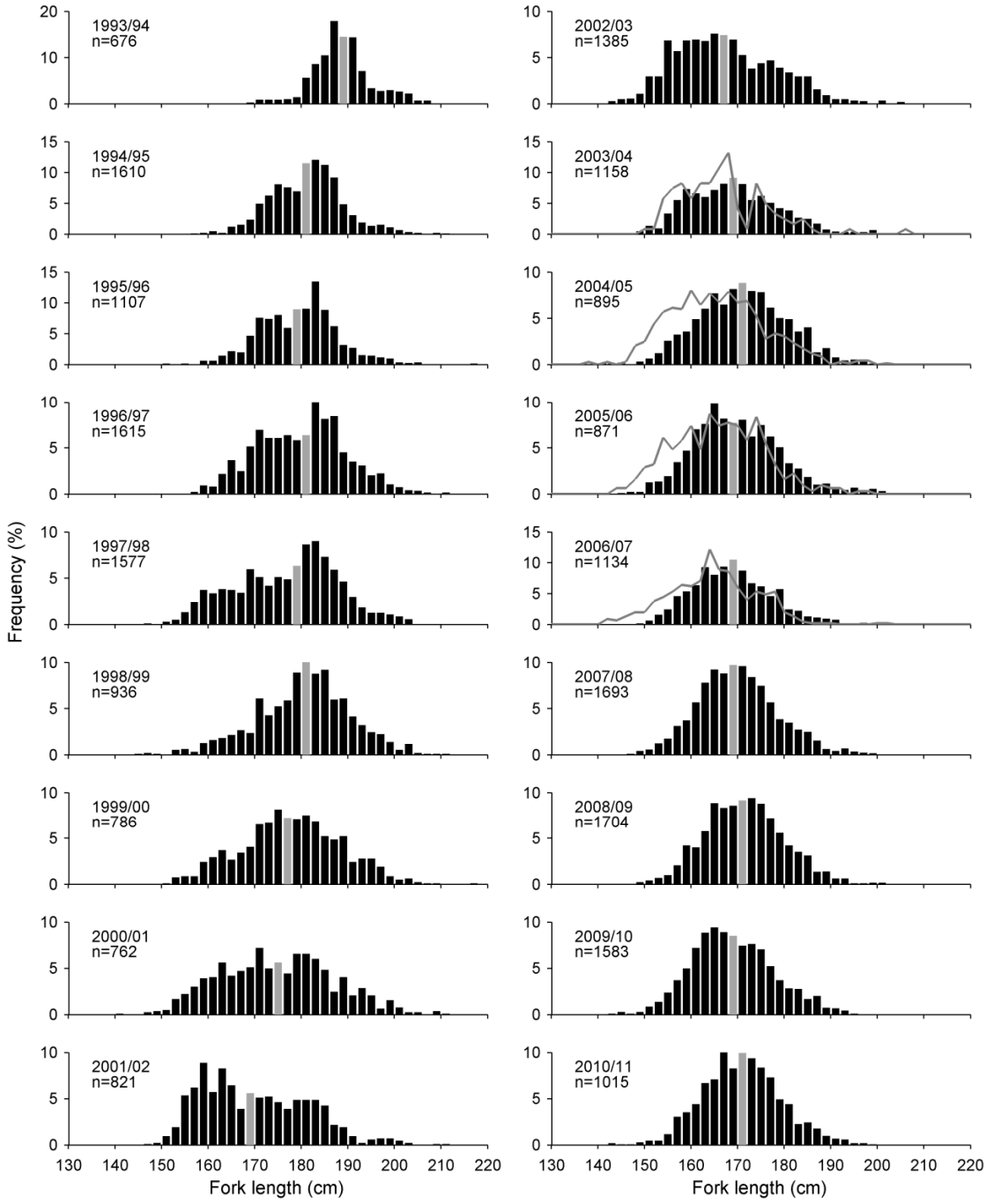

Figure 1. Length frequency (2 cm intervals) of SBT caught on the spawning ground (bars) by spawning season. The grey bar shows the median size class. For comparison, the length distribution of SBT thought to be caught south of the spawning ground (Processor A) is shown for the 2003/04 (n=121), 2004/05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

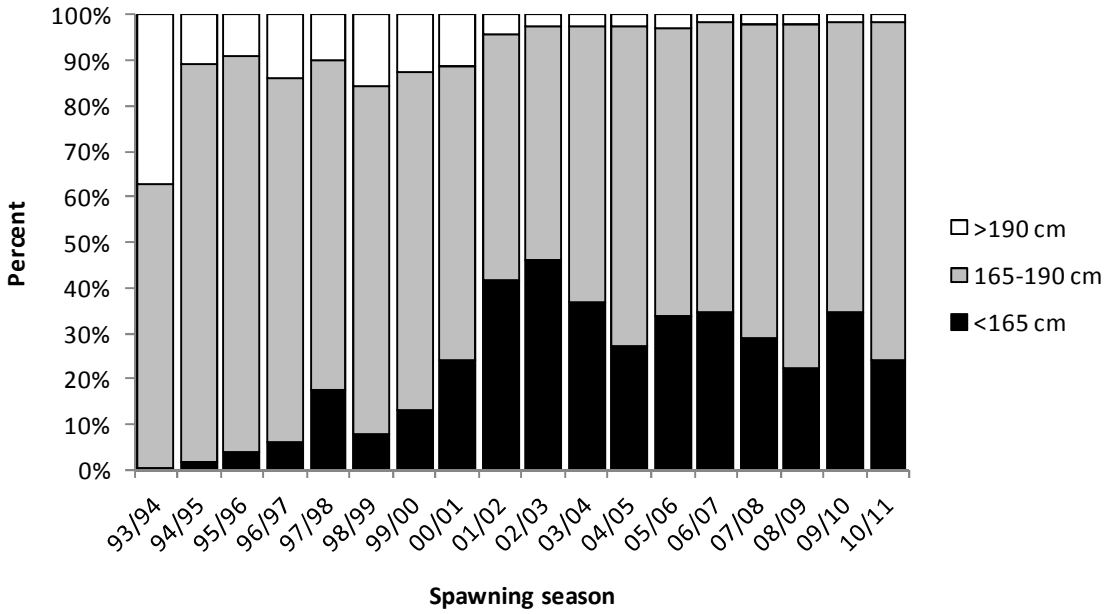

Figure 2. Proportion of SBT caught on the spawning ground by small (<165 cm), medium (165-190 cm) and large (>190 cm) SBT by season. Data from Processor A are excluded.

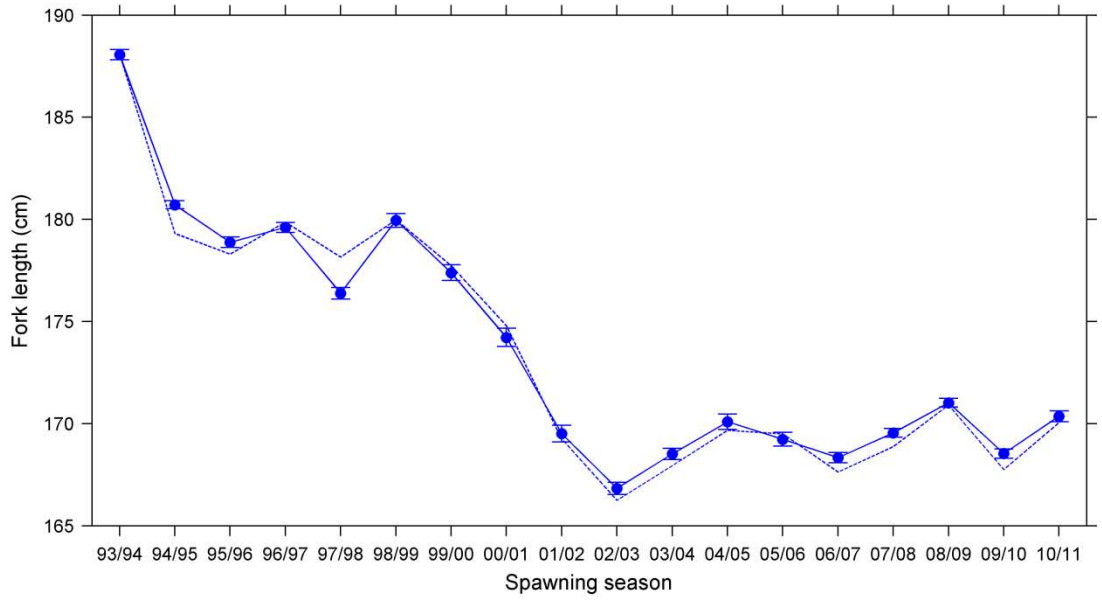

Figure 3. Mean length (+/- 95%CI) of SBT in the Indonesian catch on the spawning ground. Data from Processor A are excluded. Dashed line is the mean length of SBT caught in December to May only.

Age composition of the catch

Figure 4 shows the estimated age structure of the Indonesian catch by spawning season based on ALKs developed using our aged fish. As reported in previous reports to CCSBT, the age

composition of the catch has changed dramatically since monitoring began with an increase in the relative abundance of younger fish in the catch since being caught since the 2000/01 season. The mean of the age distribution declined from 19-21 years in the mid- and late-1990s to 14-16 years since 2001/02 (Figure 5). 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. The most obvious change is a decline in the relative abundance of 10-14 year olds and an increase in relative abundance of 15-19 year olds (Figure 6). The other age classes appeared to have remained relatively stable over the past 9 years.

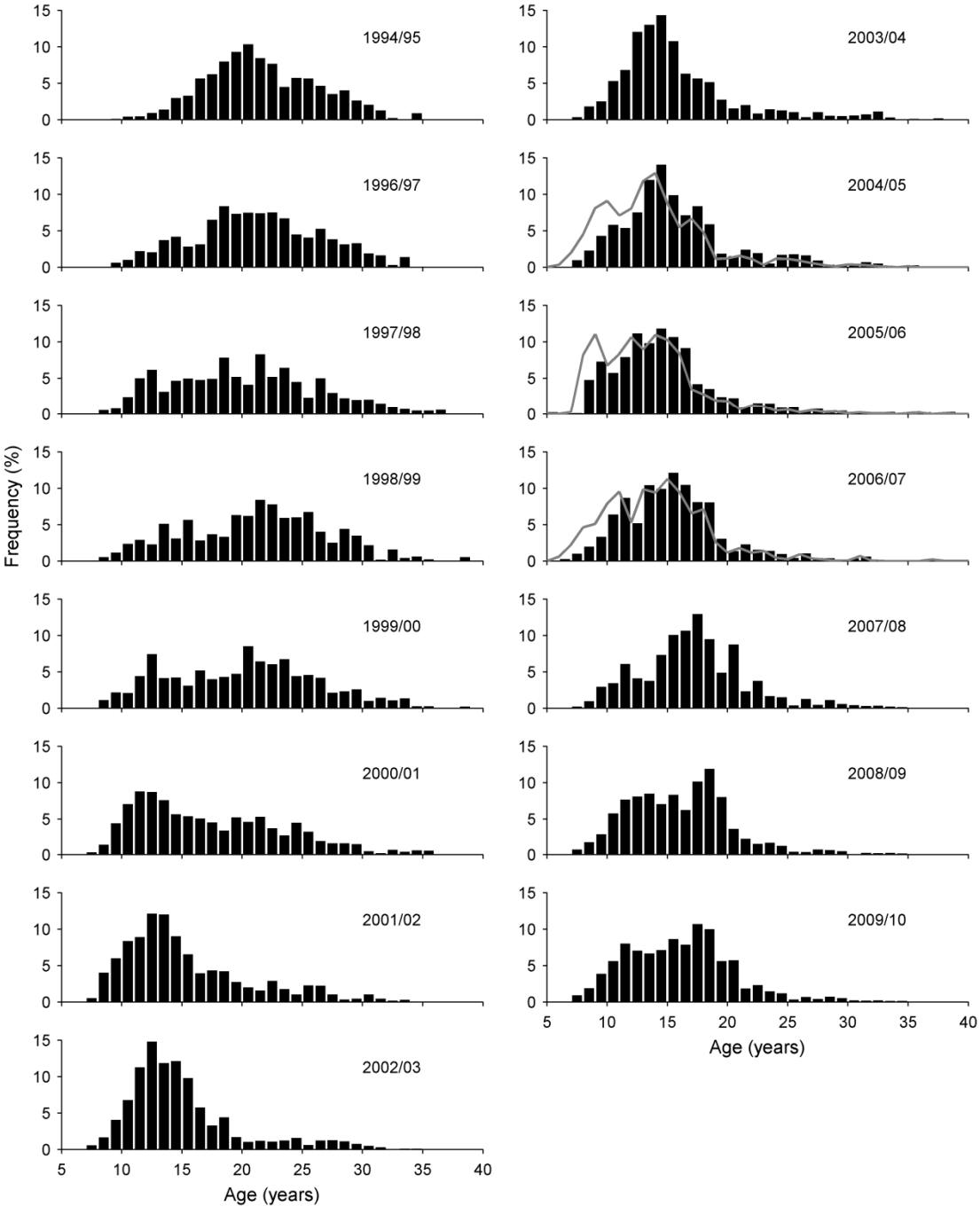

Figure 4. Age frequency distribution of SBT in the Indonesian catch on the spawning ground by spawning season estimated using age-length keys from our sub-samples of aged fish and length frequency data obtained through the Indonesian monitoring program. For comparison, the age distribution of SBT caught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

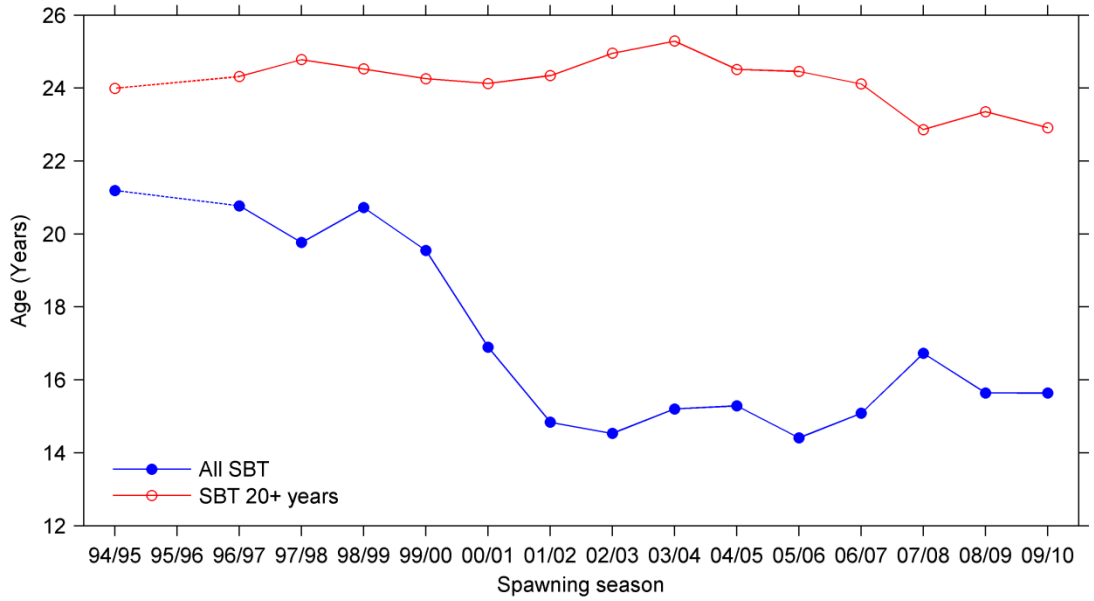

Figure 5. Estimated mean age of SBT in the Indonesian catch on the spawning ground. Note there are no age data for the 1995/96 season.

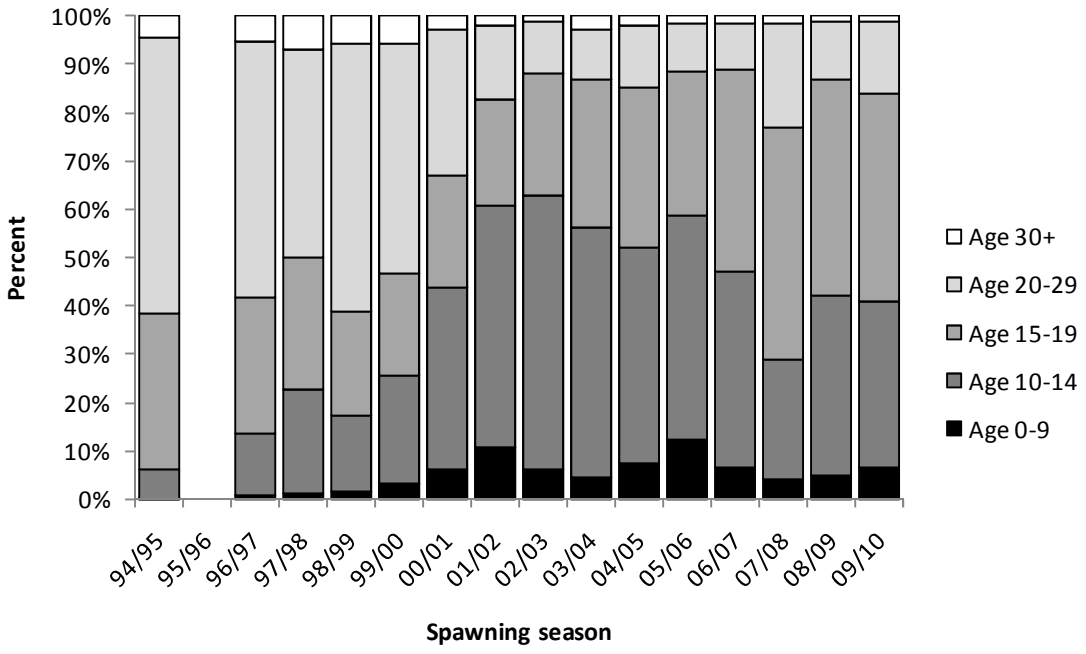

Figure 6. Estimated proportion of SBT by age class in the Indonesian catch on the spawning ground. Note there are no age data for the 1995/96 season.

Summary

We present the length and age distribution of the Indonesian longline catch from the mid-1990 through to the 2009/10 spawning season. In each season prior to 2009/10, 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 2009/10, however, no direct age estimates were available. Thus, an ALK was developed using direct age data for the two preceding spawning seasons (2007/08 and 2008/09) and applied to the 2009/10 length frequency data. It is difficult to assess the variance and bias that this method may introduce to the age distribution for the2009/10 season, but the ALK is thought to be the best available at this stage.

Acknowledgements

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.

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