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 2009/10 and age-frequency data for 2008/09 spawning seasons are now available for the fishery. 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 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 fluctuated between 168.3 and 171.0 cm for the following six seasons. In 2009/10, the mean length of SBT caught was 168.5 cm.
2) Age distribution: the mean of the age distribution declined from 19-21 years in the mid- and late-1990s to 14-15 years since 2001/02. In the 2007/08 season, the mean age of SBT caught was 16.7 years and this declined slightly in 2008/09 to 15.6 years.

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 Fisheries 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. (2009) by including the most recent length and age frequency data for the Indonesian fishery. Length frequency data includes the 2009/10 spawning season, while age frequency data are presented up to the 2008/09 season. The data provided to the CCSBT in the April 2009 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

Length measurement

As in previous years, targeted sampling of SBT occurred at the Port of Benoa. Length measurements were obtained for 1704 SBT in the 2008/09 spawning season (Table 1) and these data were provided for data exchange with CCSBT in April 2010. Length data for the 2009/10 spawning season were not available at the time of the data exchange but have since been received for all fish with otoliths sampled (n=1583).

Otolith sampling and direct age estimates

Otoliths were sampled from SBT caught by the Indonesian fishery in the 2008/09 (n=1697) and 2009/10 (n=1583) spawning seasons (Table 1). Of the otoliths sampled in 2008/09, 500 were selected for age estimation. A fixed number of otoliths were chosen from each 5 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 by Clear et al. (2000). FAS is a fee-for-service ageing laboratory established in early 2009. The SBT otolith reader at the FAS is the same reader associated with the 'Central Ageing Facility' and has read the Indonesian SBT otoliths for the past prior to 10 years.

Each otolith was read twice by the primary otolith reader (FAS) and then given a final age estimate. A sub-sample of 50 otoliths were read twice by a secondary otolith reader (CSIRO) and a final age was estimated for 47. 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.

To determine the age structure of the Indonesian catch of SBT in 2008/09, an age-length key was developed using our sample 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. Age distributions were estimated for the spawning population on the spawning ground, and for SBT caught south of the ground. The age distributions obtained were compared to the estimated age distributions for previous seasons.

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	1583	na
Total	20299	16586	6804

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

Results and Discussion

Length distribution

Length measurements for SBT with otoliths sampled are available up to February 2010, which covers the majority of the 2009/10 spawning season (Aug 2009 - Apr 2010). Figure 1 shows the length frequency of SBT caught by spawning season separated into those caught on and 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 noted in Farley et al. (2009), 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 for the next 6 seasons (Figure 3). In 2009/10, the mean length of SBT caught was 168.5 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).

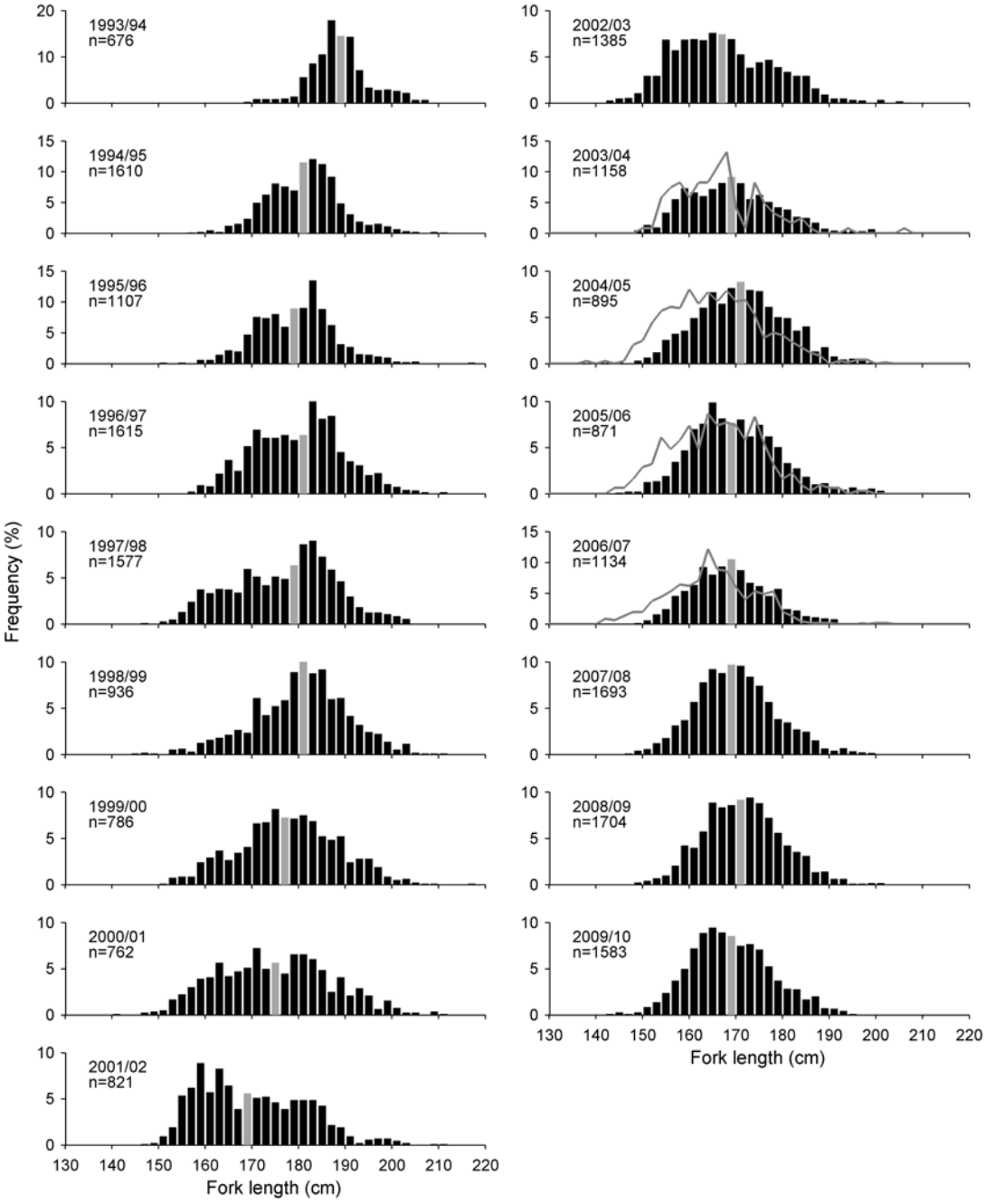

Figure 1. Length frequency (2 cm intervals) of SBT caught on the spawning ground (bars) by spawning season. The grey bar shows the median size class. For comparison, the length distribution of SBT thought to be caught south of the spawning ground (Processor A) is shown for the 2003/04 (n=121), 2004/05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

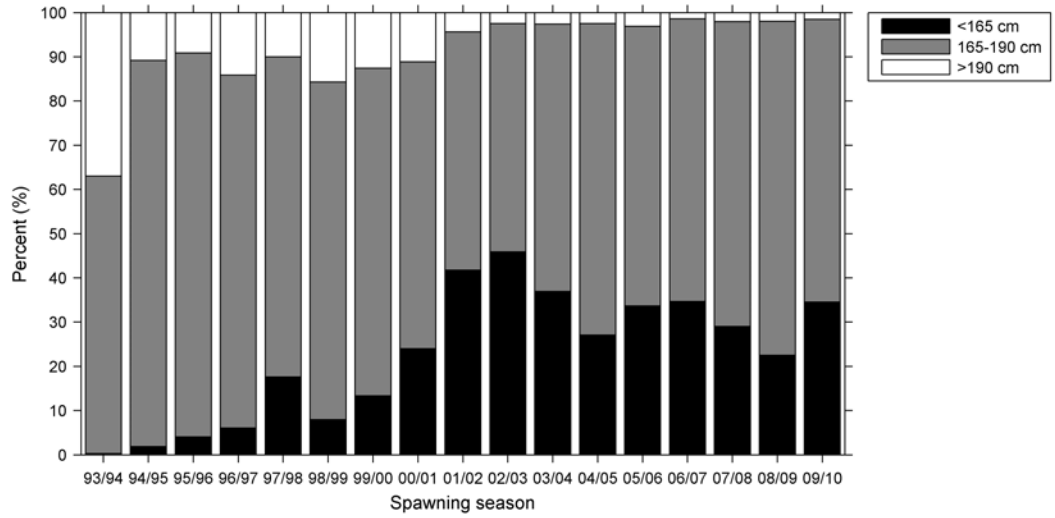

Figure 2. Proportion of SBT caught on the spawning ground by small (<165 cm), medium (165-190 cm) and large (>190 cm) SBT by season. Data from Processor A are excluded.

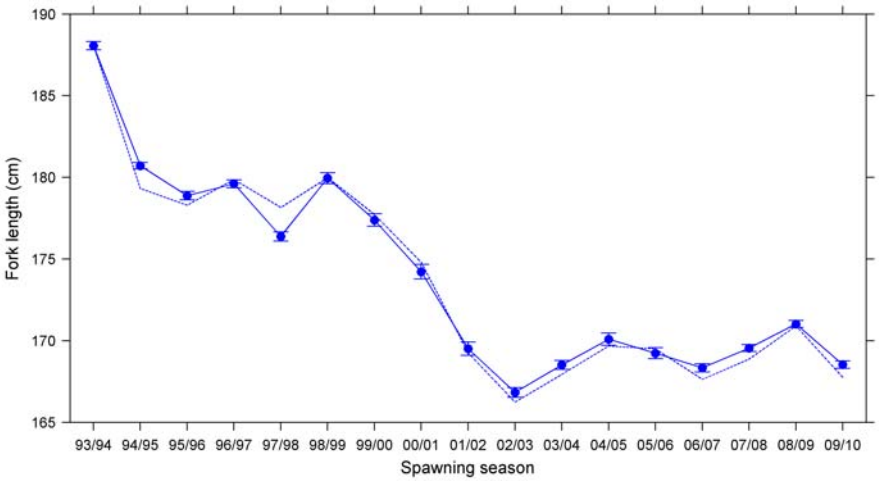

Figure 3. Mean length (+/- 95%CI) of SBT in the Indonesian catch on the spawning ground. Data from Processor A are excluded. Dashed line is the mean length of SBT caught in December to May only.

Direct age estimates

A final age was estimated for 479 SBT in the 2008/09 spawning season from fish ranging in size from 143-219 cm LCF. Age estimates ranged from 7 to 39 years. The precision of readings by the primary reader (intra-reader consistency) was considered good; the CV between readings was 4.59. The second age estimate agreed with the original estimate in 43.4% of cases, and 84.6% were within one years of the original. The CV between the primary and secondary readers was 5.14. An age bias plot (Campana et al., 1995) showed no bias in the age estimates between readers.

Age composition of the catch

Age has been estimated over 6,800 SBT caught in the longline fishery over 14 spawning seasons (Table 1). 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. The mean of the age distribution declined from 19-21 years in the mid- and late-1990s to 14-15 years since 2001/02. In the 2007/08, the mean age of SBT caught was 16.7 years and this declined slightly in 2008/09 to 15.6 years, while the mean age of 20+ fish shows a slight decline over the past 5 years (Figure 5). Although the mean age of SBT in the catch declined in 2008/09, the proportion of young SBT (≤ 10 years) in the catch increased slightly compared to the previous season but is showing a relatively flat trend over the 2000s (Figure 6).

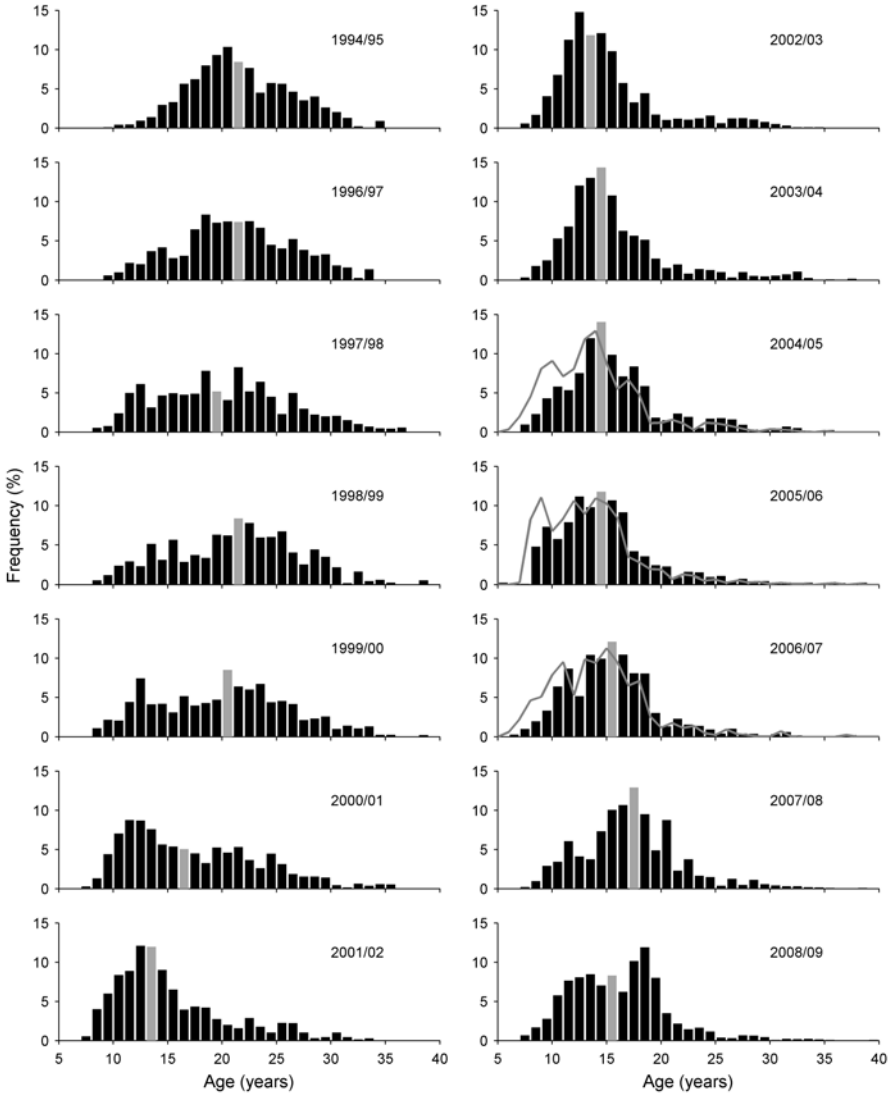

Figure 4. Age frequency distribution of SBT in the Indonesian catch on the spawning ground by spawning season estimated using age-length keys from our sub-samples of aged fish and length frequency data obtained through the Indonesian monitoring program. The grey bar shows the median age class. For comparison, the age distribution of SBT caught south of the spawning ground (Processor A) is shown for the latter three seasons (grey line).

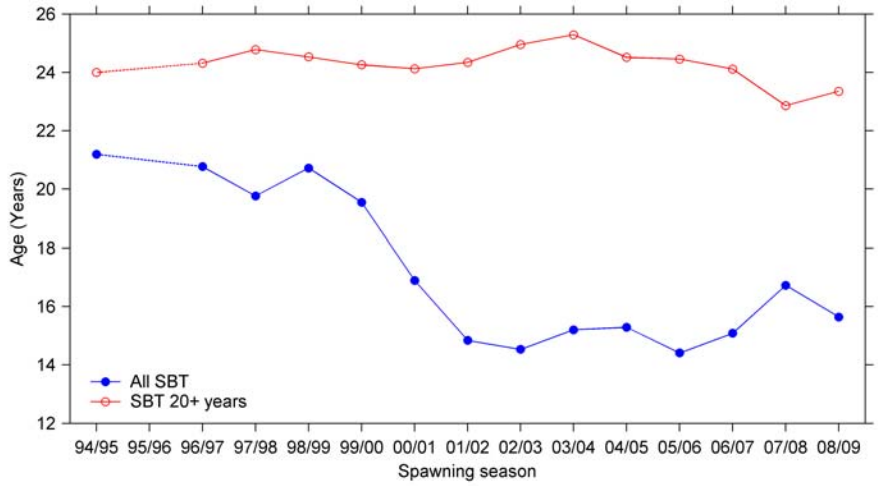

Figure 5. Estimated mean age of SBT in the Indonesian catch on the spawning ground. Note there are no age data for the 1995/96 season.

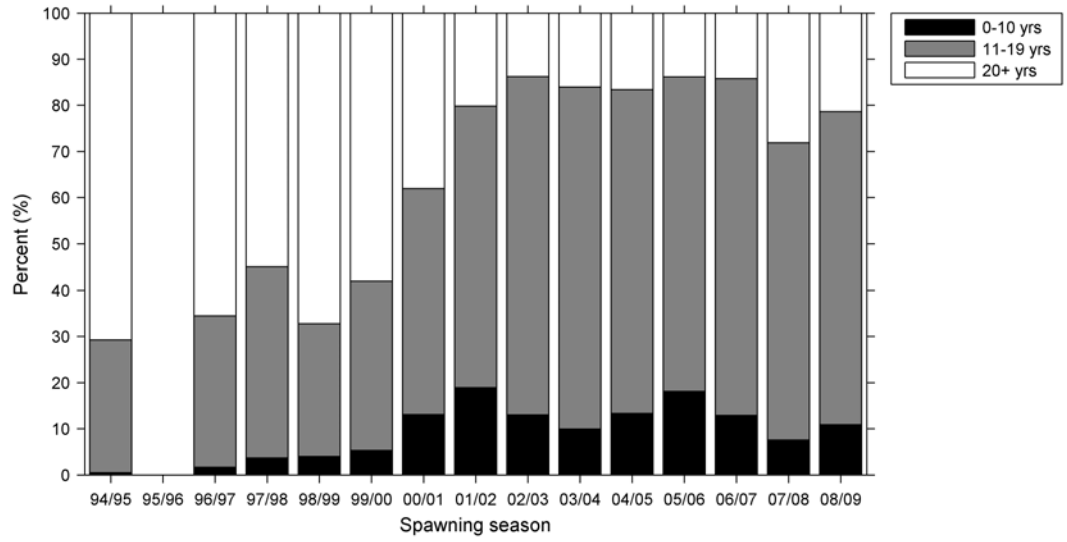

Figure 6. Estimated proportion of SBT by age class in the Indonesian catch on the spawning ground. Note there are no age data for the 1995/96 season.

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