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Potential inclusion of direct ageing data in the SBT operating model

Ann Preece, Paige Eveson, Jessica Farley, Rich Hillary, Marinelle Basson and Campbell Davies

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Contents

1 Abstract

The 2012 ESC workplan (Anon, 2011) includes consideration of use of direct ageing data in the operating models (OM). This paper provides background information on the available direct ageing data and issues related to inclusion of those data in place of cohort-sliced catch at age (CAA) and catch at length data used in the OM, for consideration by the ESC.

2 Introduction

The 2012 ESC workplan (Anon, 2011) includes consideration of the use of direct ageing data in the OM. Direct ageing data are used in the current OM to derive the CAA for the Indonesian fishery only. For the Australian surface fishery, CAA data from cohort-slicing are used in the OM; for the longline fisheries defined in the OM, data on proportion of catch at length are used.

3 Background

Inclusion of direct ageing data has been discussed in past SC/ESC meetings. In 2002, an agreed otolith sampling scheme was adopted by CCSBT members, to expand and extend the otolith collection activities that some members had already commenced. Direct ageing of otoliths was discussed and a standardised approach developed at the 2002 CCSBT direct ageing workshop (Anon, 2002).

In 2003, Morton and Bravington (2003, CCSBT-ESC/0309/32), provided information on otolith sample sizes that should be collected. The 2003 ESC agreed on targets for otolith sampling to be collected by members. It was agreed that 100-200 otoliths would need to be aged from the Australian surface fishery, 200-500 from the Japanese fishery and 500 from the Indonesian fishery. It was noted at the time that the sample size estimates may require further refinement based on information on the need for spatial or fleet stratification, and that the precision and accuracy requirements of the direct ageing data and their actual use in stock assessment or operating models had yet to be defined, and could affect the sampling requirements.

In 2004, the SC noted that there appeared to be no need to further divide the Japanese fishery otolith collection over finer strata. The 2004 SC agreed that the Taiwanese fishery needed to be maintained as a separate strata for otolith collection purposes to provide CAA information for that fishery. In 2005, the difficulties in ageing otoliths collected in the New Zealand (NZ) fishery because of laying down of bands during winter was discussed, and further intersessional work on the topic recommended.

In 2005, Basson et al. (2005) implemented several methods for calculating the age-frequency of the catch and the associated variance for the Australian surface fishery catches. Basson et al. (2005) discuss use of the data in stock assessments/OMs and distinguish between calculation of catch age frequency or population age frequency, and how this difference in use of the data needs to be taken into account in calculations and implementation in OMs. Methods implemented for the surface fishery included the standard age-length key (ALK) and the Morton and Bravington (2003) method with and without known growth. In 2005, Shono and Itoh (2005), provided a paper on hybrid methods and discuss the theoretical calculation of age frequencies, suggesting that these could also be included in an evaluation of a variety of methods in the future.

Between 2006 and late 2011, the work required to include direct ageing data in the OMs has been on hold due to the MP development workload. However, otolith collection, archiving, direct ageing and calculation of age frequency of the catches for some fisheries have continued.

4 What data are available?

Several members are providing direct ageing data, sampled from their collection of otoliths. Sample sizes vary. The numbers of otoliths collected is documented in country reports. The otolith collection data was last collated in a table in attachment 12 of the 2005 SC report (Anon, 2005), and could perhaps be updated to record the numbers of otoliths collected in each year and the numbers of those collected which have been read, for an improved understanding of otolith collection activities.

The direct age data provided to the CCSBT includes: year, month, area, lat. and lon. in some cases, age, length, and sex in some cases. In addition there are occasional comments that give information on the confidence in, or difficulties with, the age estimate.

Table 1. Summary of the number of direct ageing estimates by year and country (CCSBT data as at Jun 2012).

YEAR	AU	ID	JP	NZ	TW
1994		194	4		
1995		292	14		
1996		368			
1997		422	56		
1998		333	249		
1999		733	587		
2000		343	281		
2001	17	463	354	198	
2002	114	542	254	197	
2003	175	384	478	197	102
2004	161	638	347	196	294
2005	131	570	413	252	77
2006	91	259	107	249	56
2007	78	514	290	254	
2008	100	524	232		
2009	100	225	152	268	81
2010	98			256	70
2011	92				

Source: CCSBT DataCD_InterimUpdate_2012 (20/7/2012)

5 What ageing procedures need to be used?

To create an age frequency from the direct ageing data and length data, Basson et al. (2005) note that the appropriate procedure is dependent on how the data are to be used in the OM. Two alternatives for use of the data are distinguished and discussed (Basson et al. 2005). The current use of the age-frequency for the Australian surface fishery and proportions at length for the longline fisheries are as catch age/length frequencies, not population age/length frequencies, and therefore the rest of this discussion will assume that the use of direct ageing data will be to replace these existing datasets for that same purpose.

In addition to how the data will be used, the appropriate method is also dependent on the age ranges captured by a particular fishery. There are several possible methods available for converting the length frequency of the catch to an age frequency using the direct ageing data. For the Australian surface fishery which catches juveniles, Morton and Bravington's methods use additional length data for a parametric estimation of the age frequency, since the length data are informative for these younger age classes. For the Indonesian fishery the common ALK conversion is currently being used since the length data for these older fish are less informative.

The Taiwanese fishery is generally a juvenile fishery and therefore one of the Morton and Bravington methods may be appropriate, and for the Japanese fishery, the age range of the catch is broader, and a variety of methods could be considered including the Shono and Itoh (2005) hybrid models. As in Basson et al. (2005) and Farley et al. (2012 and preceding CCSBT papers), a possible way to proceed is to calculate age-frequencies for these fisheries using each of the alternative methods and then compare.

The alternative methods have been examined in detail for the Australian surface fishery in Farley et al. (2012 and preceding papers; Basson et al. 2005). Their results indicate that the appropriate method for the Australian surface fishery is the Morton and Bravington (M&B) method using unknown growth. However, a mismatch in 2010/11 in the length- frequency of the catch and the lengths of fish that were directly aged has led to higher CVs for the estimates for ages 2 and 3 in this season, and highlights additional difficulties in the sampling system within the constraints of the farming/aquaculture fishery (see Farley et al. 2012 for further discussion).

6 Implementation in the OM

The implementation in the OM is fairly straight forward for the Australian surface fishery component, because the data used by the OM are proportions of catch by age so the structure of the data will be largely unchanged. The cohort-sliced proportions of catch by age would stop at year 2001 and, from that year on, the age would be determined using direct ageing data and the Morton and Bravington method with unknown growth.

For the longline fisheries (excluding the Indonesian fishery which is already using direct ageing data), the data currently used by the OM are proportions of catch by length. If a direct age component can be developed, the structure would then change to proportions of catch by age. This will have a few programming implications in the OM, with the combination of historical proportions of catch by length and more recent proportions of catch by age for the same fishery to work around.

In addition to proportions of catch by age, the OM also requires a value for the effective sample size in each year for each fishery. For the Australian surface fishery, estimates for effective sample size are provided below; for the longline fisheries, this issue would still need to be resolved.

7 Australian surface fishery catch at age and effective sample size

Farley et al. (2012) have calculated the proportion of catch by age for the Australian surface fishery using the direct ageing data (Table 2). These data would replace the data in the SBTdata.dat file for seasons 2002-2011, ages 1-7.

Table 2. The Australian surface fishery proportions of catch at age for each fishing season (from Farley et al. (2012) estimated using the M&B method with unknown mean and variance in length at age.

SEASON	1	2	3	4	5	6	7	8
2001-2002	NA	0.0803	0.7093	0.1780	0.0279	0.0040	0.0006	NA
2002-2003	0.0008	0.1478	0.6195	0.2059	0.0256	0.0002	0.0001	0.0000
2003-2004	0.0003	0.3813	0.5646	0.0536	0.0002	0.0000	0.0000	NA
2004-2005	0.0000	0.5023	0.4527	0.0393	0.0053	0.0003	0.0000	0.0000
2005-2006	0.0000	0.3735	0.6251	0.0010	0.0002	0.0001	NA	NA
2006-2007	0.0000	0.3156	0.6348	0.0490	0.0005	0.0001	0.0000	NA
2007-2008	0.0000	0.2268	0.7259	0.0428	0.0041	0.0005	NA	NA
2008-2009	NA	0.2868	0.6213	0.0882	0.0036	0.0000	NA	NA
2009-2010	NA	0.2238	0.5759	0.1805	0.0179	0.0018	NA	NA
2010-2011	NA	0.5184	0.4028	0.0642	0.0113	0.0033	0.0000	NA

Source: Farley et al. (2012) Table 4, page 10.

The effective sample sizes for these seasons are calculated as part of the M&B method (M&B ESSy) (Table 3). The effective sample sizes need to be in the same scale as the sample sizes for all age and length composition data. The sample size value used in the OM for the Australian surface fishery cohort-sliced data is 86.6 for 1965 onwards (from sqrt.dat data file). In 2004 the panel proposed (Anon, 2004, CCSBT-ESC/0409/42**)** the use of reduced samples sizes for all age and length compositions by taking sqrt of *n* times 5, where *n* is the sample size (these values are in sqrt.dat, the original values for *n* are in orig.dat, we haven't found the documentation for these original sample size estimates). The reduced sample size ($\sqrt{ESSy}$ *5) has been calculated for these seasons (Table 3), but we note that these values are a lot larger than those used for the cohort sliced data. This would down weight the earlier years, relative to the latter. The appropriate values to use will need to be discussed by the SC.

The effective sample size in 2010-11 and 2009-10 are lower than previous seasons because fewer cages were sampled (23 cages in 09/10 and 10/11 compared with 31-40 cages in previous seasons).

Table 3. Effective sample sizes for the Australian surface fishery for seasons 2002-2011 if direct ageing data are used (M&B ESSy), and the reduced sample sizes ($\sqrt{ESSy}$ *5).

SEASON	M&B ESSY	$\sqrt{ESSy}$ *5
2001-2002	1489.1	192.9
2002-2003	1383.6	186.0
2003-2004	1389.0	186.3
2004-2005	1386.6	186.24
2005-2006	1366.1	184.8
2006-2007	1259.4	177.4
2007-2008	1060.3	162.8
2008-2009	1086.5	164.8
2009-2010	718.8	134.1
2010-2011	729.7	135.1

8 Considerations for use of direct ageing data for the longline fisheries

The LL1 fishery definition includes: Japanese longline catches except from Areas 1 and 2, Taiwan targeted SBT longline catches, Australia domestic longline catches, Australian joint venture longline catches, New Zealand charter catches, New Zealand domestic catches, all other nations longline catches not included in fisheries LL2, 3 and 4 (estimated from Japanese import statistics).

Direct ageing data are available for some components of the LL1 fishery, but not all, and as with the Australian surface fishery, only for a subset of the time series. The available data would need to be examined in detail to ascertain whether the age frequency from direct ageing could be applied to the catches from fleets in this fishery where direct ageing data does not exist. Several methods for calculating the age frequency from direct age and length data could be compared to enable choice of the most appropriate method. Effective sample sizes would need to be estimated (e.g. see Trenkel et al., in press).

For the other (non-Indonesian) longline fisheries defined in the OM, some direct ageing data are available but sample sizes might be small (e.g. see Itoh et al. 2011).

The key questions for further work and discussion are: 1) Which methods to use for creating an age frequency from the direct ageing data? 2) Are sample sizes sufficient? 3) Are there data from all the fleet components that make up the fishery definitions used in the OM? 4) What would be the effective sample sizes each year for use in the OM?

9 Cross validation of otolith ageing

It has been 10 years since the last CCSBT workshop on ageing in 2002. Creating an opportunity (e.g. a inter-laboratory comparison workshop) to do some cross validation work, refresh skills, discuss issues, and capacity building in some cases, may be useful with the potential inclusion of these data in the OM. At the 2002 direct ageing workshop a reference set of otoliths was created with the intention that this would assist with maintaining reading standards into the future. However, there is no documentation on the use of these reference otoliths that we are aware of. For the direct ageing of the Australian and Indonesian otoliths, a protocol for at least 10% cross–reading of otoliths has been established where the otoliths are first aged at 'Fish Ageing Services Pty Ltd' and then a subset are read by CSIRO. The New Zealand otoliths are also aged at Fish Ageing Services. The same otolith readers have undertaken this work since 2002. Other members also use multiple readers for their otoliths. At the 2008 SC it was suggested that regular cross-lab comparisons for quality control be considered to avoid "drift in age-estimations occurring over a long period".

10 Summary

Direct ageing data are available for the Australian surface fishery, and inclusion into the OM should be fairly straightforward because the catch at age data derived from the direct ageing data would simply replace the existing cohort-sliced data. Effective sample sizes for the Australian surface fishery for the seasons using direct ageing data have been calculated; however, these need to be on the same relative scale as the historical cohort-sliced data. The things to consider for use of the direct ageing data in the OM for the longline fisheries are slightly more complicated. The key questions for further work and discussion are: 1) Which methods to use for creating an age frequency from the direct ageing data? 2) Are sample size sufficient? 3) Is there data from all the fleet components that make up the fishery definitions used in the OM? 4) What would be the effective sample sizes each year for use in the OM?

Since it has been 10 years since the last direct ageing workshop, the ESC might consider further cross-validation work through an inter-laboratory direct ageing comparison workshop.

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CONTACT US

t 1300 363 400
+61 3 9545 2176
e enquiries@csiro.au
w www.csiro.au

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FOR FURTHER INFORMATION

CSIRO Marine and Atmospheric Research/
Wealth from Oceans
Ann Preece
t +61 3 6232 5336
e ann.preece@csiro.au
w www.csiro.au/wfo