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Archival Hard Parts. A basis for routine ageing of tuna and billfish.

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Archival hard parts

A basis for routine ageing of tuna and billfish

Naomi Clear and Clive Stanley
CSIRO Marine and Atmospheric Research
GPO Box 1538, Hobart, Tasmania 7000
03 6232 5222

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Non-technical summary

The CSIRO hard parts archives comprise collections of otoliths, vertebrae, scales and fin spines from tuna and billfish species, and a supporting database. The archives are a resource for research on age and growth, migration, stock structure and physiology.

During 2006/07 samples collected from southern bluefin tuna, albacore tuna and broadbill swordfish were added to the hard parts archives. Specifically 2,032 SBT otoliths were added to the archives, the collection sources being:

1. the Indonesian domestic fishery that takes mature adult fish as a bycatch
2. the Australian domestic fishery off South Australia that catches 2-5 year old juvenile fish
3. tagging operations in which 1-5 year old fish are caught in South Australian and 1 and 2 year old fish are caught in Western Australia

This is the final year that the archiving will be funded as a stand-alone project. Since the late 1990s archiving in the CSIRO hard parts archives has been supported by 1-year AFMA-funded grants but from 2007/08 funding has been granted for a 3-year project that combines two annual AFMA-funded projects: archiving of hard parts and developing age-length keys based on direct age estimations using otoliths.

Background and Need

In the 1980s and 1990s, hardparts (eg otoliths, vertebrae and scales) were sampled from southern bluefin tuna (SBT) caught on Australian and Japanese fishing grounds in the southern oceans. By 1993, otoliths were also being sampled from SBT caught by Indonesian longline vessels on the spawning ground in the north-east Indian Ocean. These otoliths were catalogued and stored in the CSIRO hard parts archive, in preparation for future analysis. In the mid-1990s, CSIRO developed techniques to accurately estimate the age of SBT using the archived otoliths (Gunn et al., in press) and from this, and subsequent work, it was found that SBT is a relatively long-lived and late maturing species, and that the age composition of SBT varies considerably by geographic region.

By the late 1990s, it was recognised that a separate grant application for an appropriate cataloguing and archiving system (separate from field collection activities) was necessary for the continued storage of the large amounts of hard parts collected before any research work could commence. This cataloguing and storage has been carried out through a series of annual AFMA-funded grants and hard parts from several tuna and billfish species (SBT, bigeye, yellowfin, swordfish and albacore) are now included in the hard parts archives. There are over 25,000 SBT otoliths in the collection alone.

In 2003, CCSBT agreed that all SBT fisheries should collect and analyse hard parts (otoliths) to characterise the age distribution of their catch and consequently, part Australia's responsibility to CCSBT is to sample otoliths from the Australian fisheries (and Indonesian

fisheries through other projects) and archive them. This resulted in SBTMAC assigning a high research priority to such a system and this project addresses SBTMAC's research priority #1 — “develop and maintain systems for sampling of otoliths and routine ageing of all components of the commercial catch”.

Objectives

1. To continue the collection, preparation and archiving of tuna hard parts into an already established archive. In particular:
2. archive about 1000 sets of SBT otoliths from the Indonesian spawning grounds
3. archive 300-600 sets of SBT otoliths from the South Australian farm fishery of Australian juvenile stock
4. if CCSBT tagging operations in WA and SA are continued, archive about 100 sets of SBT otoliths per state
5. archive any otoliths collected from recaptures of strontium chloride-injected tagged fish
6. in collaboration with the CSIRO database manager continue to expand the capabilities of the database systems used

Methods

CSIRO, in collaboration with Indonesia, has continued to collect and archive otoliths from SBT caught in Indonesia's longline fishery annually. Otoliths from the Australian surface fishery were collected under AFMA supervision from the South Australian tuna farms (mortalities) in Port Lincoln by "Protec Marine Pty Ltd" and sent to CSIRO for archiving. SBT otoliths are also collected by CSIRO from incidental mortalities during CCSBT tagging operations in Western Australia and South Australia, and opportunistically by CSIRO off the east coast of NSW. These otoliths are routinely archived onto the hard parts collection.

Results/Discussion

A total of 2,032 sets of SBT otoliths were archived during 2006/2007 bringing the number of SBT otoliths in the collection to 25,281. The otoliths were collected from three sources: 1,597 sets from the Indonesian domestic fishery, 335 sets from the Australian domestic fishery in SA and 100 sets from tagging operations in South Australia and Western Australia (Table 1). The fish from which the otolith samples were taken were between 44 and 202 cm LCF with ranges between 44 and 91 cm for troll-caught fish in WA, 63-93 cm for troll-caught fish in SA, 55-142 for purse-seined fish in SA and 134-202 cm from the Indonesian longline fishery. Peaks in the length-frequency distribution (Fig 1) reflect these different areas and the first three peaks, which lie below 105 cm, indicate the age classes 1-3 years.

The objective to collect 1,000 otoliths from the Indonesian fishery this year was achieved. A total of 1,597 sets of otoliths were collected, well over the 1,000 sets aimed for. The collection system is functioning well and the contractor continues to be highly successful in drilling otoliths with minimal damage, resulting in two complete otoliths from each fish. The Indonesian material is aged each year and the results reported to CCSBT. The latest report by Farley et al. (2006) includes data relating to the annual age structure of the stock from 1995 to 2005 (Fig 2).

The objective to archive 300-600 sets of SBT otoliths from the South Australian farm fishery has also been achieved. Following the preparation of a manual for age determination (Anon., 2002), the ageing of the accumulated South Australian material has continued this year and was reported to CCSBT (Eveson et al., 2006, Farley, 2006). The collection of these otoliths by the contactors, Protec Marine, is still working well with the target of 10 samples per tow cage being met for all tow cages. As has occurred for the last few years the otoliths have been obtained from post tow mortalities, up to 2 to 3 weeks after the fish have been transferred to stationary cages. The system originally planned was to obtain samples from mortalities during the tow in phase but this never worked satisfactorily, mainly due to the lack of freezer storage on the tow vessels.

The total number of otoliths collected from troll caught fish obtained during tagging operations was 100, below the number set in the project objectives. Fifty one samples were collected from Western Australia, providing coverage of the 1+ and 2+ fish that occur in the area, and 49 samples were collected in South Australia. The main reason for the lower numbers was that there were fewer charter days available for the tagging program in the 2006/2007 season than in previous years. The trolling method is used during tagging operations only to determine if there are any fish near the surface so it is difficult to predict how many SBT will be caught using this method. Fish caught on troll lines are generally not suitable for tagging so any fish caught this way are sampled, not only for otoliths, but for other samples including muscle, liver, stomach, gonads, scales and blood.

No otoliths from strontium chloride-injected SBT this year were archived this year. These fish were released in the early 1990s and very few are now recaptured. They were released with an orange tag to indicate they had been injected with a salt that marked their otoliths, which was used to validate age estimates. The validation was carried out successfully for the first 6 age classes after a number of returns that came in during the first years after the releases. Fish at liberty would now be up to 15 years old and a return of the otoliths from even one or two of these fish would be valuable as a validation for age estimates in older fish.

Protec Marine has agreed to collect otoliths from these orange-tagged fish and also from fish released with archival tags, which could potentially provide information about SBT physiology and the migration and the behaviour of young SBT, in the period before they are large enough to be tagged.

As well as increasing the otolith collection in the hard parts archives this year the capabilities of the associated database has been developed further, fulfilling the last objective of the project. This has included establishing links between data held in both the hard parts and tag databases and improving the error-checking facility.

Benefits/Management outcomes

The results of this project were presented as a working paper at the CCSBT SAG/SC meeting in September 2007 (Stanley et al., 2007) as part of Australia's contribution to CCSBT requirements.

The collection and archiving of tuna hard parts has, and will continue to, underpin a number of research projects relating to the ageing of SBT and other tuna and billfish species. This is the final year that the hard parts archiving will be funded as a stand-alone project; in July 2007 a 3-year project commenced that combined two annual AFMA-funded projects called "Archiving of hard parts for routine ageing and developing age-length keys for the Australian SBT surface fishery 2007/8 - 2009/10". The goal of the project is to continue to archive SBT otoliths collected from the Australian and Indonesian fisheries, and to determine age-length keys for the Australian surface fishery. The combining of the two, directly related projects will be an efficient use of staff and resources and the extension to a three-year period is likely to provide real benefits to stock assessments and management procedure work by producing a time series of age data rather than a single year's worth.

Conclusion

The objectives of this project aimed to increase and improve the hard parts archives and its associated database capabilities. These outcomes have been achieved and the hard parts archives continue to be a valuable resource for research on tuna and billfish age and growth, migration, stock structure and physiology.

References

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Tables and Figures

Table 1. Collection sources for SBT otolith samples added to the archives June 2006-July 2007.

Collection Area	Source of samples	LCF (cm)	Number of samples
Indonesia	Longline fishery	134-202	1 597
South Australia	Farm mortalities	55-142	335
	Tagging	63-93	41
Western Australia	Tagging	44-91	59
Total		44-202	2 032

Table 2. Age length key for the 2001-02 to 2004-05 fishing seasons for the GAB surface fishery. The upper length of each 5cm length bin is given in the first column, and age estimates are shown across the top.

2001-02	1	2	3	4	5	6	7	8	9	10	Total
70		1									1
75		2	1								3
80		1	1								2
85		1									1
90			3								3
95		2	11	5							18
100			11	7	1						19
105			9	11							20
110			3	18							21
115			3	10	5						18
120				2	3	2					7
125					3						3
130					3	1					4
135					1						1
140						1	2				3
Total		7	42	53	16	4	2				124

2002-03	1	2	3	4	5	6	7	8	9	10	Total
65	1										1
70	1										1
75		2									2
80			1								1
85		4	4								8
90		4	7								11
95			3	3							6
100			7	3							10
105			6	3	1						10
110			3	6	1						10
115			2	7	1						10
120				8	2						10
125			1	3	6						10
130					11	1					12
135					1	3	2				6
140				1	1	3	1	2			8
145					1	1		1			3
150						2		1			3
Total	2	10	34	34	25	10	3	4			122

2003-04	1	2	3	4	5	6	7	8	9	10	Total
50	1										1
55	9										9
60	9										9
65	8	1									9
70	1	2									3
75		8									8
80		9									9
85		5	1								6
90		5	4	1							10
95		3	7								10
100		2	8								10
105			7	3							10
110			5	5							10
115			2	6	2						10
120				8	2						10
125			1	5	4						10
130				7	4						11
135				1	7	6					14
140					3						3
145						6	1				7
150						1					1
155											0
160											0
165							1				1
Total	28	35	35	36	22	13	2				171

2004-05	1	2	3	4	5	6	7	8	9	10	Total
50	4										4
55	5										5
60	6	2									8
65	3	5									8
70											0
75		7									7
80		6	1								7
85		5	2								7
90			6								6
95		2	6								8
100			5	1							6
105			3	2	1						6
110			3	4							7
115				4	2						6
120				6	1						7
125			1	1	3	1					6
130					5	2					7
135					4	1	1				6
140				1	1	2	3	1	1		9
145						2	4	4			10
150							9	2			11
155						1	2	3			6
160							1	2			3
165										1	1
170									1		1
Total	18	27	27	19	17	9	20	12	2	1	152

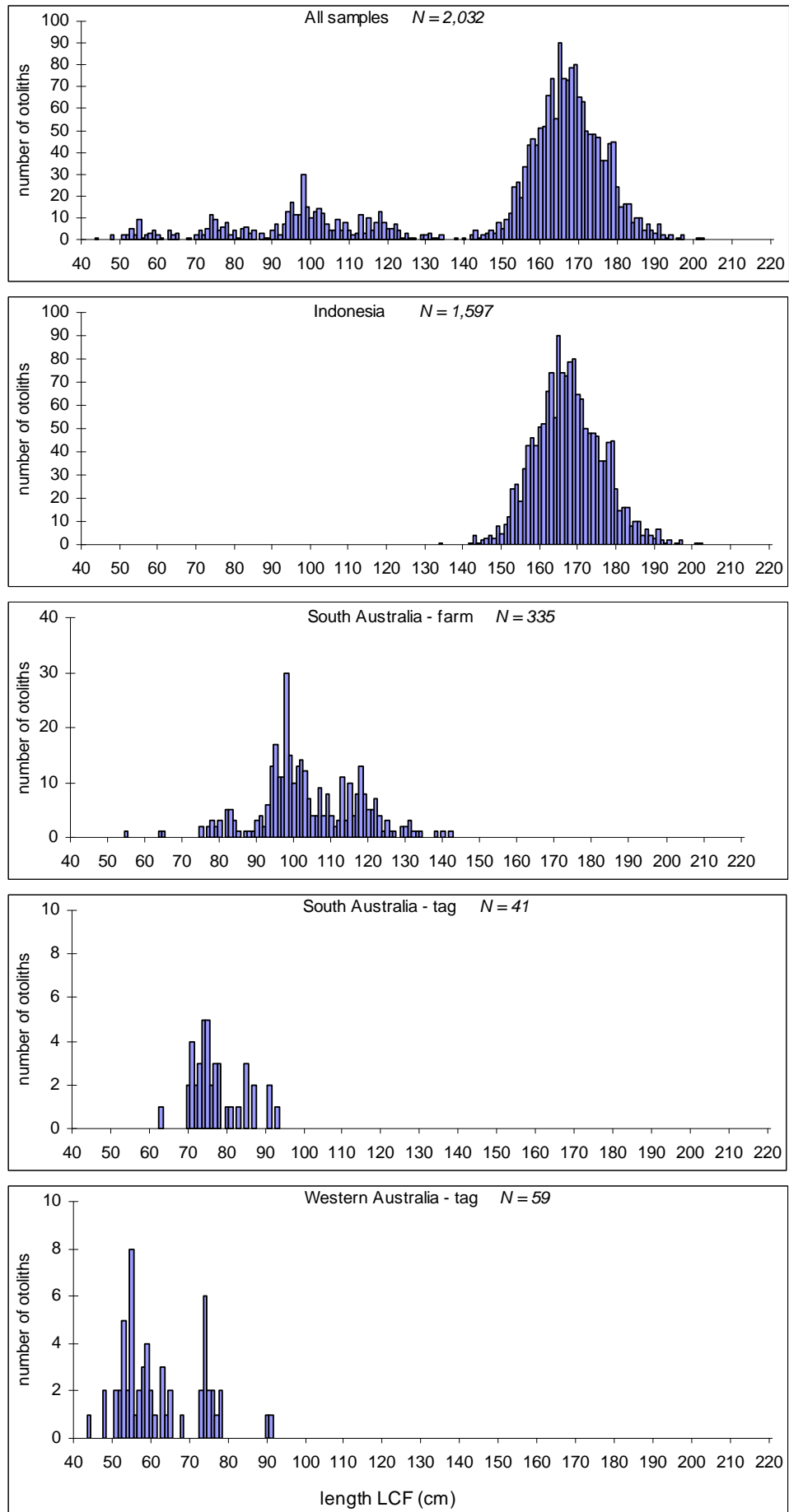


Figure 1. Length frequency distribution (LCF) of SBT otoliths archived in 2006-2007.

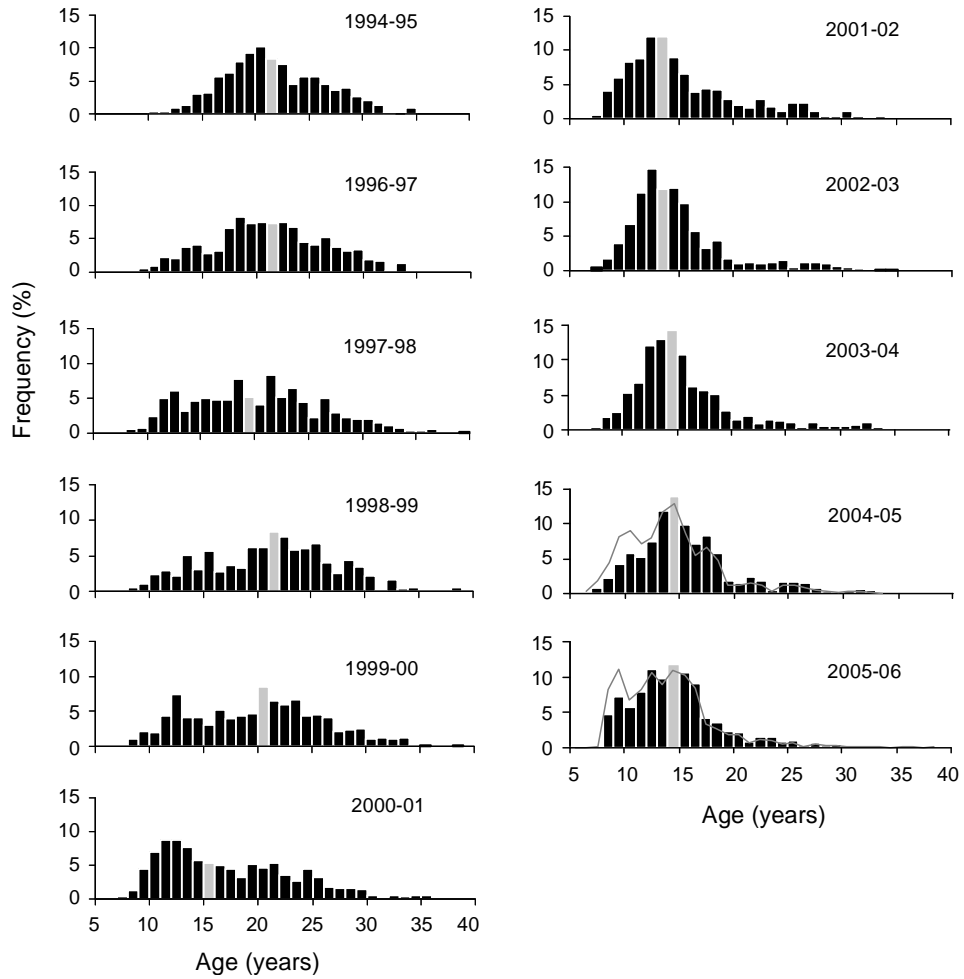


Figure 2. Age frequency distribution of SBT in the Indonesian catch on the spawning ground by spawning season. The grey bar shows the median age class. For comparison, the age distribution of SBT caught south of the spawning ground is shown for the latter two seasons (grey line).