SCRS/2022/075 Collect. Vol. Sci. Pap. ICCAT, 79(3): 275-280 (2022)

DESCRIPTION OF THE ICCAT LENGTH AT AGE DATA BASE FOR BLUEFIN TUNA FROM THE EASTERN ATLANTIC, INCLUDING THE MEDITERRANEAN SEA

E. Rodriguez-Marin[1], P. Quelle[1] and D. Busawon[2]

SUMMARY

This study aims to describe the current length at age database available for Eastern Atlantic bluefin tuna management area. A total of 8 500 spines and 5 000 otoliths were read from specimens caught from 1984 to 2017 in both the Atlantic Ocean and Mediterranean Sea. Obtaining ALKs for this species is difficult, as it has a wide length range and spatial distribution, and sampling is costly. Unfortunately, there are practically no contributions to this database from the East Atlantic and Mediterranean Sea countries, and only thanks to the initiative of the GBYP has it been possible to increase the number of samples in the ICCAT database in the last 10 years. As a result, the current ICCAT length at age database has incomplete spatial, temporal and size range coverage. However, it may be suitable as conditional age-at-length data for the Stock Synthesis model.

RÉSUMÉ

Cette étude vise à décrire la base de données actuelle sur la taille par âge disponible pour la zone de gestion du thon rouge de l'Atlantique Est. Au total, 8.500 épines et 5.000 otolithes ont été lus sur des spécimens capturés de 1984 à 2017 dans l'océan Atlantique et la mer Méditerranée. Il est difficile d'obtenir des clefs longueur-âge (ALK) pour cette espèce, car elle a une large gamme de longueur et de distribution spatiale, et l'échantillonnage est coûteux. Malheureusement, les pays de l'Atlantique Est et de la Méditerranée n'ont pratiquement pas contribué à cette base de données, et ce n'est que grâce à l'initiative du GBYP qu'il a été possible d'augmenter le nombre d'échantillons dans la base de données de l'ICCAT au cours des 10 dernières années. Par conséquent, la base de données actuelle de l'ICCAT sur la taille par âge a une couverture spatiale, temporelle et une gamme de taille incomplètes. Cependant, elle peut être utile en tant que données conditionnelles de l'âge par taille pour le modèle Stock Synthesis.

RESUMEN

El objetivo de este estudio es describir la actual base de datos de talla por edad disponible para la zona de ordenación del atún rojo del Atlántico este. Se leyeron un total de 8.500 espinas y 5.000 otolitos de ejemplares capturados entre 1984 y 2017 tanto en el océano Atlántico como en el mar Mediterráneo. La obtención de las claves edad-talla (ALK) para esta especie es difícil, ya que tiene un amplio rango de talla y una distribución espacial, y el muestreo es costoso. Lamentablemente, prácticamente no hay contribuciones a esta base de datos por parte de los países del Atlántico este y del Mediterráneo, y solo gracias a la iniciativa del GBYP ha sido posible aumentar el número de muestras en la base de datos ICCAT en los últimos 10 años. En consecuencia, la base de datos actual de ICCAT de talla por edad tiene una cobertura incompleta espacial, temporal y de rango de talla. Sin embargo, podrían ser adecuados como datos de talla por edad condicionales para el modelo Stock Synthesis.

KEYWORDS

Direct ageing, age-length key, otolith, fin spine, Thunnus thynnus

[1] National Center Spanish Institute of Oceanography, CSIC. Santander OC (Spain). enrique.rmarin@ieo.es

[2] St. Andrews Biological Station, St. Andrews, DFO (Canada).

1. Introduction

Stocks assessments used to provide management advice for Atlantic bluefin tuna (*Thunnus thynnus*, ABFT) rely on age-structured population analysis. The method applied for transforming length structured data to age structured data is age slicing using a deterministic growth model (Anon. 2018). This method divides size distributions into age classes under the assumption that there are distinct lengths separating adjacent age classes. Given the variability in growth between individuals, which increases as fish grows, this technique can assign an incorrect age when one or more ages classes overlaps in length. Growth variability over time and strong cohorts signal can also be affected by this deterministic method (Kell and Ortiz, 2011).

For more than 10 years the bluefin tuna Species Group from the International Commission for the Conservation of Atlantic Tunas (ICCAT) has been attempting to use an alternative approach to estimate age composition using age-length keys (ALKs). To this end, several laboratories on both sides of the Atlantic and the Atlantic Bluefin Tuna Research Project (GBYP) are carrying out direct age readings using calcified structures. Despite delays in the use of calcified structures to obtain age-length keys, the whole process of preparation and readings has progressed in a joint and standardized way for all the laboratories involved. This has been possible thanks to the realization of international workshops for direct age reading, calibration exchanges and the use of standardized preparation and reading protocols (Luque *et al.*, 2014; Busawon *et al.*, 2015; Rodriguez-Marin *et al.*, 2020; 2021).

In this paper we will describe the current length at age database available for Eastern ABFT. We will also examine the spatial-temporal and length range coverage of this database.

2. Material and methods

Direct age readings were obtained by counting translucent or opaque bands found in two calcified structures: first dorsal fin radius (spines) and otoliths. The structures come from three sources: 1) CN Spanish Institute of Oceanography-CSIC (IEO, 60%); ICCAT-GBYP (GBYP, 38%) and St. Andrews Biological Station-DFO (SABS, 2%).

A total of 8 500 spines were read, including historical readings made with non-standard methodology. The historical spine readings include 4 168 records of tuna caught in the Bay of Biscay from 1984 to 1996. A total of 661 samples were selected from the previous historical samples in proportion to their abundance by size range to be re-read with the standardized reading methodology (Luque *et al.*, 2014). Diagnosis of paired age agreement was assessed, and these readings were accepted (Rodríguez-Marín *et al.*, 2018). The remaining spines from 1984 from other geographical areas and from 1997 to 2012 were prepared and read following the standardized methodology (Luque *et al.*, 2014). A comparison of age estimates from otoliths and spines from the same specimen, showed an agreement up to 14 years old, therefore spines aged older than 13 years were excluded (Rodriguez-Marin *et al.*, 2016). The Age adjustment criterion described in Luque *et al.*, (2014) was applied.

Direct age reading from otoliths amounted to about 5 000 samples and followed two standardized protocols: Busawon *et al.*, (2015) and Rodriguez-Marin *et al.*, (2020). Both band counts were age-adjusted following the protocol described in Rodriguez-Marin *et al.*, (2020) (OLD), and the more recently developed protocol using marginal increment and marginal edge type analysis to determine the timing of band deposition (Rodriguez-Marin *et al.*, 2022) (NEW). The new criterion uses 30 November as the end date for the formation of the opaque band, whereas the previous protocol set it at 1 July. A correction vector was applied to the band counts performed by the laboratory contracted to provide age estimates from 4000 otolith samples (Fish Ageing Services, FAS) with more than 10 annual bands, due to the bias found in calibration exercises (Rodriguez-Marin *et al.*, 2021). Included in this age-length data are otoliths collected in the management area west of 45 degrees W, but whose stock identification analysis showed an eastern signature.

The database is made up of the following fields described in the spreadsheet: Source, SampID, ICCATSamplingArea, Fishing_Gear, Country_Capture, YearCatch, MonthCatch, ReadingLabID, StructureAged, SFL (cm), SFLType, RWT (kg), RWT_Type, Band_counting, Band_counting corrected, BandTypeCount, Read_Criterion, Light type, Edge type, Edge Confidence, Sample Readability, ID reader, AgerExp, AgeAdjusted_OLD, AgeAdjusted_NEW, Probability (East).

3. Results and Discussion

Spines were obtained from specimens caught from 1984 to 2017. Samples prior to 2003 came almost entirely from Atlantic catches, as sampling in the Mediterranean did not start till 2003 (**Table 1**, **Figure 1**). In the years from 1984 to 2004, ages 0 to 5 years are well represented and from 2005 onwards there is a better coverage of the age range up to 12 years, but coverage is incomplete in most years (**Figure 2**). Regarding otoliths, the years sampled range from 2010 to 2018, with both Atlantic Ocean and Mediterranean Sea areas being well represented (**Table 1**, **Figure 1**). Size range coverage is uneven with a majority sampling from 5 to 13 years (**Figure 2**). The best represented fishing gears are baitboat, 55%; longline, 15%; purse seine, 15% and traps, 9%, with the remaining gears accounting for 6%. The change in the date of the otolith fitting criterion allows for a better outline of the strong 2003-year class (**Figure 3**).

Thanks to the coordinated work between laboratories and the use of standardized methodologies, all age-length databases on both sides of the Atlantic are compatible. However, obtaining ALKs for this species is difficult, as it has a wide length range and sampling is costly. In addition, contributions from different countries are needed to sample and read calcified structures from fisheries that catch a different fraction of the ABFT length range in various geographical areas. Unfortunately, there are practically no contributions to this database from the East Atlantic and Mediterranean Sea countries, and only thanks to the initiative of the GBYP has it been possible to increase the number of samples in the ICCAT database in the last 10 years. As a result, the current ICCAT length at age database has incomplete spatial, temporal and size range coverage.

This has meant that methodologies to cover incomplete data (i.e., not all ages or sizes covered in a single year) have had to be employed to obtain catch at age (CAA) for Virtual Population Analysis (VPA) such as the method of Hoenig *et al.*, (2002), a combination of forward and inverse ALKs (Anon. 2018). However, this method assumes that the sample is representative of the catch as a whole in that age/size range, which is not true for the present Eastern ABFT data base. If age-length data are not representative of the age-structure of the population, this could cause bias and imprecision (Lee *et al.,* 2019). It is therefore not possible to use the present database to replace the growth curve in the VPA. However, it may be suitable as conditional age-at-length (CAAL) data for the Stock Synthesis (SS) model. SS uses the growth curve and can takes into account additional information as CAAL. Introducing CAAL for the Western stock during the 2017 assessment, enabled the SS model to sharpen the estimate of the 2003 cohort rather than blurring it between 2002 and 2003 (Anon. 2018). Another possible option is to use the age error matrix derived from the current database in the SS model.

Acknowledgements

We would like to thank Lisa Ailloud for her comments and suggestions for the appropriate use of age-length data in the assessment models.

References

Anonymous 2018. Report of the 2017 ICCAT bluefin Stock Assessment Meeting. Collect. Vol. Sci. Pap. ICCAT, 74(6): 2372-2535

Busawon, D.S., Rodriguez-Marin, E., Luque, P.L., Allman, R., Gahagan, B., Golet, W., Koob, E., Siskey, M., Ruiz, M., Quelle, P., Neilson, J.D., Secor, D.H. 2015. Evaluation of an Atlantic bluefin tuna otolith reference collection. Collect. Vol. Sci. Pap. ICCAT 71, 960-982.

Hoenig, J.M., R.C. Hanumara and D.M. Heisey. 2002. Generalizing double and triple sampling for repeated surveys and partial verification. Biometrical Journal 44:603-618.

Kell, L. T. and Ortiz, M. 2011. A comparison of statistical age estimation and age slicing for Atlantic Bluefin tuna (*Thunnus thynnus*). Collective Volume of Scientific Papers. ICCAT, 66(2), 948-955.

Lee, H., Piner, K. R., Taylor, I. G., & Kitakado, T. 2019. On the use of conditional age at length data as a likelihood component in integrated population dynamics models. Fisheries Research, 216, 204-211.

Luque, P., Rodriguez-Marin, E., Landa, J., Ruiz, M., Quelle, P., Macias, D., Ortiz De Urbina, J. 2014. Direct ageing of *Thunnus thynnus* from the eastern Atlantic Ocean and western Mediterranean Sea using dorsal fin spines. J. Fish Biol. 84, 1876-1903.

Rodriguez-Marin, E., Busawon, D., Addis, P., Allman, R., Bellodi, A., Castillo, I., Garibaldi, F., Karakulak, S., Luque, P.L., Parejo, A., Quelle, P. 2021. Calibration of Atlantic bluefin tuna otolith reading conducted by an independent fish ageing laboratory contracted by the ICCAT Research Programme GBYP. Collect. Vol. Sci. Pap. ICCAT, 78(3): 938-952.

Rodriguez-Marin, E., Busawon, D., Luque, PL., Castillo, I., Stewart, N., Krusic-Golub, K., Parejo, A. and Hanke, A. 2022. Determination of annual periodicity in annuli formation in Atlantic bluefin tuna otoliths. SCRS/2022/103. *In press*

Rodríguez-Marín E, Quelle P, Addis P, Alemany F, Bellodi A, Busawon D, et al., 2020. Report of the ICCAT GBYP international workshop on Atlantic bluefin tuna growth. Collect Vol Sci Pap ICCAT. 76(2):616-49.

Rodriguez-Marin, E., Quelle, P, Ruiz, M., Busawon, D., Golet, W., Dalton, A., Hanke, A. 2016. Updated comparison of age estimates from paired calcified structures from Atlantic bluefin tuna. Collect Vol Sci Pap ICCAT. 73(6): 2037-2043.

Rodriguez-Marin E, Quelle P, Ruiz M, Ceballos E, Ailloud L. 2018. Direct ageing for constructing age-length keys and re-estimating the growth curve for east Atlantic and Mediterranean bluefin tuna. Collect Vol Sci Pap ICCAT. 74(6): 3281-3289.

Table 1. Atlantic bluefin tuna spine and otolith readings by ICCAT sampling area.

	Spines				Otoliths								
Year	BF54 (E-Atl)	BF58 (E-Atl)	BF59 (Med)	Total	BF50 (W-Atl)	BF51 (W-Atl)	BF52 (W-Atl)	BF53 (E-Atl)	BF54 (E-Atl)	BF58 (E-Atl)	BF59 (Med)	Central Atl	Total
1984	42	157		199									
1985	577			577									
1986	541		1	542									
1987	401			401									
1988	507			507									
1989	231			231									
1990	272	75		347									
1991	316			316									
1992	245		2	247									
1993	251			251									
1994	206			206									
1995	230		2	232									
1996	349			349									
1997	377			377									
1998	375			375									
1999	162			162									
2000	197			197									
2001	170			170									
2002	170			170									
2003	102		52	154									
2004	187		52	239									
2005	208	145	100	453									
2006	92			92					1				1
2007	96		83	179									
2008	97	29	260	386									
2009	122		81	203									
2010	122	44	96	262		3	1	1		36			41
2011	139	47	286	472	10	23	2		81	179	398		693
2012	90	24	82	196	12	12	3	7	45	175	362		616
2013			9	9	19	3	1	42	133	86	187	5	476
2014					39	22	8	54	150	36	86		395
2015					28	47		107	136	58	185	9	570
2016								7	85	71	937		1100
2017										69	870		939
2018										58	65		123
Total	6874	521	1106	8501	108	110	15	218	631	768	3090	14	4954

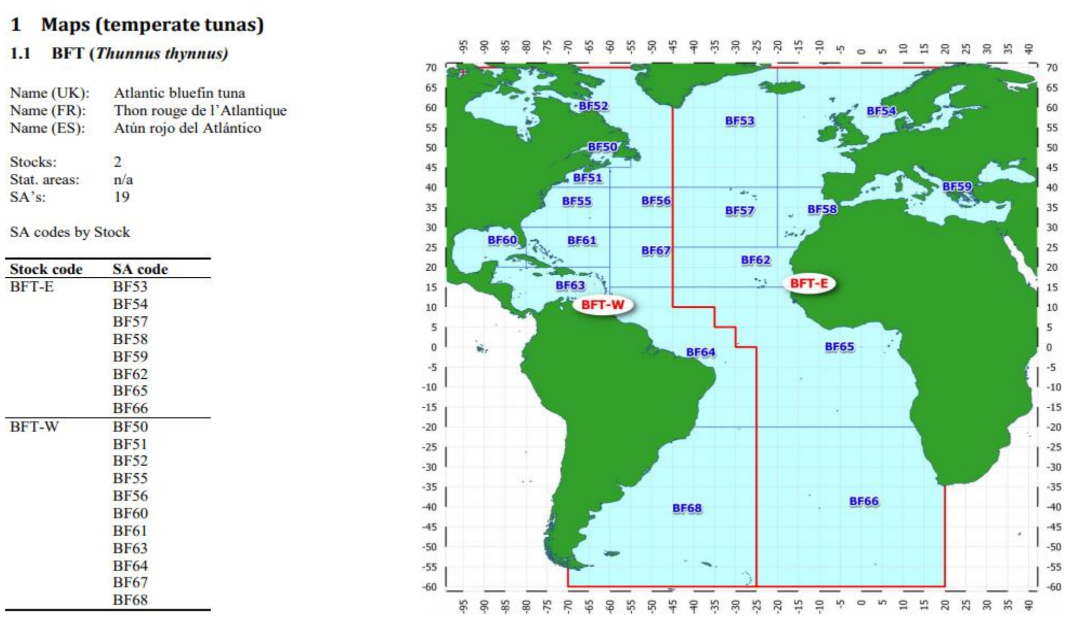

Figure 1. ICCAT sampling areas for Atlantic bluefin tuna.

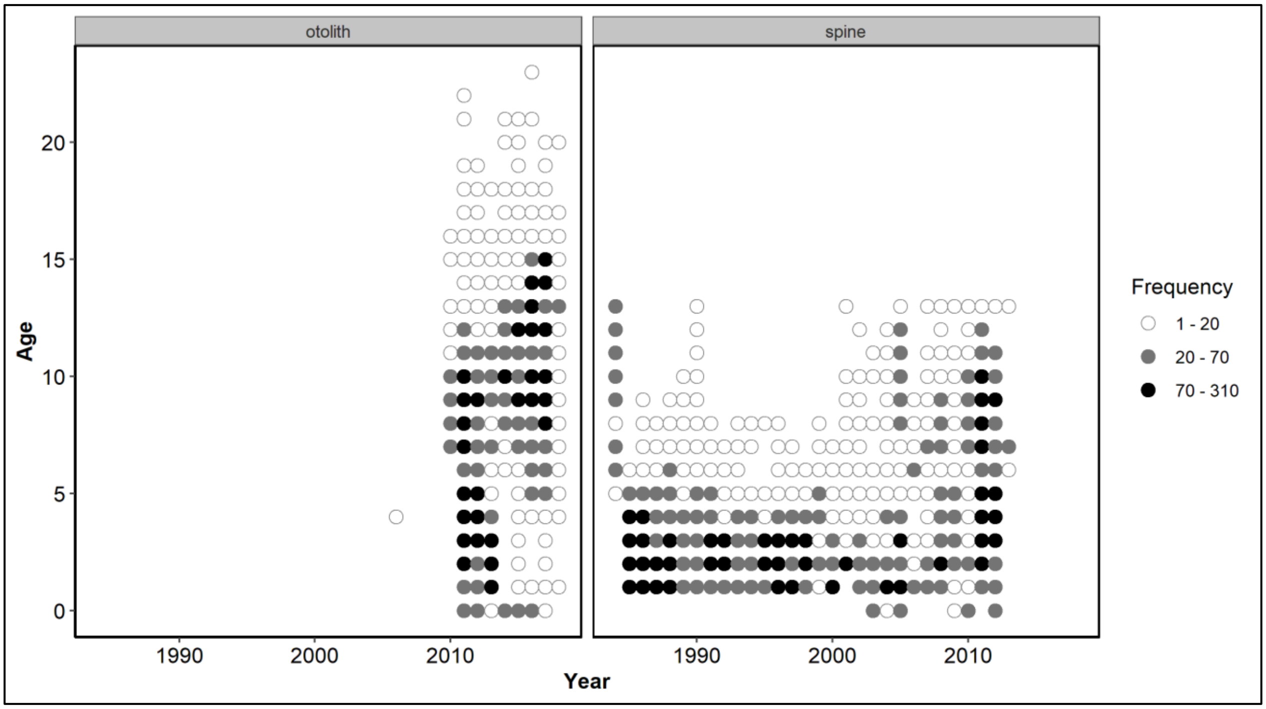

Figure 2. Sampling frequency by age range, calcified structure and year of Atlantic bluefin tuna.

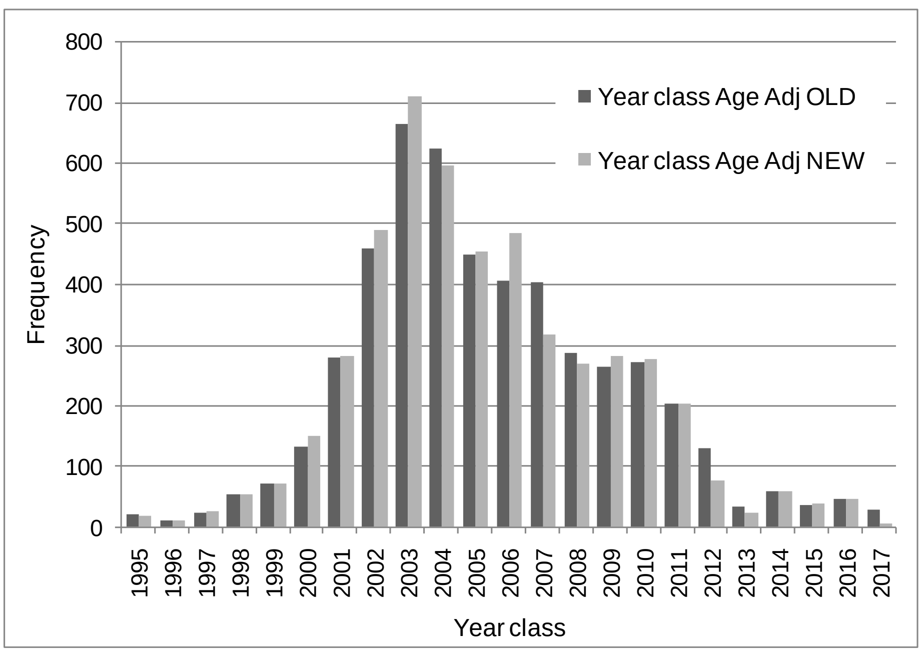

Figure 3. Number of Atlantic bluefin tuna by year class by applying the old and new age adjustment criteria to otolith band counts.