

QUANTIFYING THE IMPACT ON ESTIMATES OF RECRUITMENT TRENDS OF PREVIOUSLY UNREPORTED CATCHES OF AGE-0 BLUEFIN TUNA IN THE MEDITERRANEAN

Tom Carruthers¹ and Doug Butterworth²

SUMMARY

We update the 2017 SCRS-agreed VPA assessment for the Eastern Atlantic bluefin tuna to include previously unreported catches of age-0 tuna in the Mediterranean. Except for three years in the 1980s, the change in estimates of annual recruitment are negligible. The pattern that indicates a regime shift in the 1980s remains. We consequently propose no related change in the current specifications for the Reference Set of Operating Models for the Atlantic bluefin MSE.

RÉSUMÉ

Le présent document met à jour l'évaluation de la VPA de 2017 approuvée par le SCRS pour le thon rouge de l'Atlantique Est, afin d'inclure les captures de thon d'âge 0 qui n'avaient pas été déclarées en Méditerranée. À l'exception de trois années dans les années 1980, les changements dans les estimations du recrutement annuel sont négligeables. La tendance qui indique un changement de régime dans les années 1980 existe toujours. En conséquence, nous ne proposons aucune modification connexe des spécifications actuelles pour l'ensemble de modèles opérationnels de référence pour la MSE du thon rouge de l'Atlantique.

RESUMEN

Se actualiza la evaluación VPA acordada por el SCRS en 2017 para el atún rojo del Atlántico este con el fin de incluir capturas no comunicadas anteriormente de atunes de edad 0 en el Mediterráneo. Excepto para tres años en los 80, el cambio en las estimaciones del reclutamiento anual es insignificante. Continúa existiendo el patrón que indica un cambio de régimen en los 80. Por consiguiente, proponemos que no se hagan cambios en las actuales especificaciones para el conjunto de modelos operativos de referencia para la MSE del atún rojo del Atlántico.

KEYWORDS

Stock assessment, VPA, unreported catches, stock-recruitment, bluefin tuna

¹ IOF, 2202 Main Mall, University of British Columbia, Vancouver, B.C., Canada, V6T 1Z4. E-mail: t.carruthers@oceans.ubc.ca

² Dept Maths and Applied Maths, University of Cape Town, Rondebosch 7701, South Africa. E-mail: doug.butterworth@uct.ac.za

1. Introduction

Current stock assessments for Eastern Atlantic bluefin tuna (Anon. 2017) suggest that there may have been a shift in productivity in the 1980s from generally low recruitment before 1980 to high recruitment after 1990 (**Figure 1**). However, according to ICCAT documents (e.g. SCRS/1986/050), the catches of age-0 Mediterranean fish may be underreported in the current ICCAT dataset for the years 1972-1976, 1981-1985 and 1992. In this paper we evaluate whether these missing catches (whose determination was kindly co-ordinated by Dr Kimoto, who provided the results to us) substantially alter the basis to infer a regime-shift in the 1980s for the Eastern stock by adding these catches to the numbers at age estimated by the most recent VPA stock assessment agreed by the ICCAT SCRS (Anon 2017).

2. Methods

Management advice for the East is currently provided by a VPA assessment that estimates stock numbers by adding observed catches at age for younger fish, back in time, along the cohort. In this assessment framework it is relatively simple to evaluate the potential range of impact of the missing age-0 catches, since they are the last catches to be added to each cohort. The current assessments report recruitment to the fishery in age-1 N_1 . It follows that for a year y , age-0 catches $C_{0,y-1}$ can be added to model predictions of age-1 numbers $N_{1,y}$ to provide a revised estimate of age 1 numbers $\hat{N}_{1,y}$, by assuming a rate of natural mortality M_0 that would have occurred in the year before these fish reached age-1:

$$\hat{N}_{1,y} = N_{1,y} + C_{0,y-1}e^{-M_0} \quad (1)$$

Note that this process does not impact the objective function minimised in fitting the VPA, as that depends only on numbers-at-age at higher ages, and these remain unchanged in this process.

Here we consider three scenarios. The first is illustrative only, and assumes that all of the age-0 catches survived and can be added directly to the VPA estimated numbers at age 1 ($M_0 = 0$). The second scenario assumes that the age-0 catches were subject to the age 1 mortality rate (of the VPA assessment, Anon. 2017) before adding these to VPA predicted numbers at age 1 ($M_0 = M_1 = 0.41$). As in many fish species bluefin are assumed to exhibit greater natural mortality at smaller sizes. Age-0 mortality rate can be extremely high. We hence also consider a further natural mortality rate scenario that is double age-1 mortality rate to provide a credible lower bound for the impact of age-0 catches on assessment predictions of recruitment to age-1 ($M_0 = 2M_1 = 0.82$).

3. Results

The addition of the age-0 catches made a qualitative difference to only three years 1983, 1984 and 1986 (**Table 2, Figure 1**). The absolute maximum impact these could have assuming no mortality is a 40%, 37% and 29% increase in recruitment in these years (**Table 2**). A more likely magnitude of increase for these years is that between scenarios 2 and 3, which are approximately half these magnitudes at around 20%, 20% and 15% increases respectively (**Table 2**).

4. Discussion

The increases in age-1 recruitment estimated by the VPA assessment do not qualitatively change the pattern of low recruitment prior to 1980 and high recruitment after 1990, even under the maximum impact- no mortality rate scenario. If anything, the missing catches serve to somewhat smooth the transition from the low to high recruitment regime (**Figure 1**).

In the context of Operating Models for the purposes of MSE, the new recruitment estimates do not lessen the need to consider this shift in the typical magnitude of recruitment. The updates are quantitatively minor and do not affect the mean recruitment prior to 1980 or after 1990.

We therefore propose that, in this respect, earlier decision about conditioning and alternative recruitment scenarios remain unchanged. In principle, these additional age zero catches could be included when conditioning the Operating Models (OMs). However for technical reasons that would not be a straightforward exercise, and would make very little difference to results; given the amount of time this would require in what is an already time-challenged schedule, we advocate not to attempt this for the Reference Set OMs.

5. Acknowledgements

We thank Ai Kimoto for co-ordinating the investigation of the literature for information on these previously unreported catches, and providing her results to us. This work was carried out under the provision of the ICCAT Atlantic Wide Research Programme for Bluefin Tuna (GBYP), funded by the European Union, several ICCAT CPCs, the ICCAT Secretariat and by other entities (see: <http://www.iccat.int/GBYP/en/Budget.htm>). The contents of this paper do not necessarily reflect the viewpoints of ICCAT or other funders and in no ways anticipate ICCAT future policy in this area.

References

Anon. 2017. Report of the 2017 ICCAT bluefin stock assessment meeting. International Commission for the Conservation of Atlantic Tunas. Available online at: https://www.iccat.int/Documents/SCRS/DetRep/BFT_ASS_ENG.pdf [accessed October 2018]

Table 1. The assumed age-specific natural mortality rate M for each age class, as assumed for the SCRS-agreed 2017 VPA assessment of Eastern Atlantic bluefin tuna.

Age	1	2	3	4	5	6	7	8	9	10
M (y^{-1})	0.41	0.32	0.26	0.22	0.19	0.17	0.15	0.14	0.13	0.12

Table 2. The percentage increase in numbers of age-1 recruits by year for each natural mortality rate scenario.

Year	1: max impact	2: high impact	3: low impact	
1973		0	0	0
1974		3	2	1
1975		2	1	1
1976		1	1	0
1977		8	5	3
1978		0	0	0
1979		7	5	3
1980		1	1	1
1981		3	2	1
1982		1	1	0
1983		40	26	17
1984		37	24	16
1986		29	19	13
1993		1	0	0

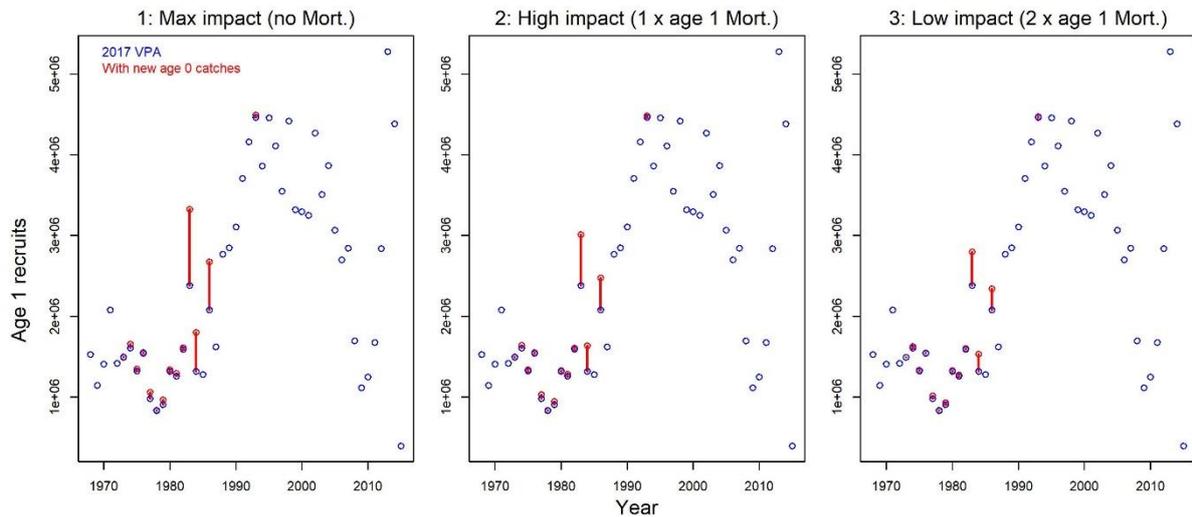


Figure 1. The impact of missing age-0 catches on estimates of age-1 recruitment for Eastern Atlantic bluefin tuna. Three scenarios are presented that (1) assume that all age-0 fish that were caught would have survived to age 1, (2) age-0 fish would have been subject to age-1 natural mortality rate and (3) age-0 fish would have been subject to twice age-1 natural mortality rate. Note that the most plausible real scenario is probably between scenarios 2 and 3.