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ILLUSTRATION OF A SUGGESTED SIMPLE APPROACH FOR RECOMMENDING ATLANTIC BLUEFIN TACs FOR THE 2021 SEASON

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SUMMARY

A simple approach for recommending the Atlantic bluefin TACs for the 2021 season is put forward. It is based on the concept of maintaining the current fishing mortality in each of the West and East areas by adjusting immediately preceding TACs in proportion to an inverse-variance-weighted average of recent trends for the various abundance indices. An example is used to illustrate the approach.

RÉSUMÉ

Une approche simple servant à recommander les TAC de thon rouge de l'Atlantique pour la saison 2021 est proposée. Celle-ci repose sur le concept de maintien de la mortalité par pêche actuelle dans chacune des zones Ouest et Est en ajustant les TAC les plus récents de manière proportionnelle à une moyenne pondérée par l'inverse de la variance des tendances récentes pour les différents indices d'abondance. Un exemple illustre cette approche.

RESUMEN

Se presenta un enfoque simple para recomendar los TAC para el atún rojo del Atlántico para la temporada de 2021. Se basa en el concepto de mantener la mortalidad por pesca actual en las zonas oriental y occidental ajustando los TAC inmediatamente precedentes en proporción a una media ponderada por varianza inversa de las recientes tendencias para los diversos índices de abundancia. Se utiliza un ejemplo para ilustrar el enfoque.

KEYWORDS

TAC, Atlantic bluefin tuna, simple approach, undercatch

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Introduction

Given the likely postponement of completion of a Management Procedure for North Atlantic bluefin tuna until after the 2020 ICCAT Commission meeting, an approach will be needed for the 2020 SCRS meeting to serve as a basis to develop scientific recommendations for the 2021 TACs for the West and the East areas.

Since use of previous assessment approaches will likely prove problematic for reasons of, *inter alia*, shortage of time, other simpler approaches which could readily be implemented within the deadline that will apply, need to be considered.

This document puts forward one such simple approach, with an accompanying illustration.

Method

The underlying basis for the proposal is to provide TAC recommendations for 2021 which will correspond to unchanged fishing mortalities from those applied in 2020 (which themselves are intended to be close to $F_{0.1}$). Since (to a good approximation) this is achieved by changing TACs proportionally to abundances, it follows that:

$$TAC^{W/E}(2021) = TAC^{W/E}(2020)\,[\,1 + \mu^{W/E}] \qquad (1)$$

where $\mu^{W/E}$ is the estimated annual proportional rate of change in the (exploitable) component of the resource biomass in the West/East area.

To obtain values for $\mu^{W/E}$, the assumption is made that log-linear regression slopes over recent periods for the series available for each index of abundance provide reasonable estimates of this proportional rate of change (this is essentially the "slope" method used for empirical management procedures based on indices of abundance, which generally exhibit reasonably robust performance). For a minimum variance outcome, the slope estimates available for an area are averaged over the indices available using inverse variance weighting.

An illustration

To illustrate the approach, an example is developed using the data for abundance indices being considered in the current MSE conditioning process, and kindly provided to the authors by Tom Carruthers. The logarithms of these annual values (where available) are shown in **Table 1** for the period 2010-2016.

Table 1 also provides estimates of the slopes of (effectively log-linear) regressions (these slopes are, approximately, average annual proportional changes) over the last seven (2010-2016) and last five (2012-2016) years, together with their standard errors. These slopes are then averaged over the indices available for each area using inverse-variance-weighting. The averages are shown for fishery-independent and fishery-dependent indices separately, and then for all indices combined.

These slope results are plotted in **Figure 1** for each index separately, and then combined as above. Note that although some of these slopes have high and differing values, there is perhaps only one instance of a statistically significant difference (thus pointing to the importance of averaging over the different indices using an appropriate weighting procedure, to get a result as that is as precise as possible). Although **Table 1** shows results for equal- as well as inverse-variance-weighting options for averaging, the latter is clearly preferable as indicated by (for example) its resultant smaller standard errors compared to equal weighting.

As regards the period considered for a regression of recent abundance indices, while there is little to choose between the 5- and 7-year options for the West area, for the East the latter is clearly preferable in terms of precision, given fewer series and missing values.

Hence in this example the estimates of μ which would be suggested for use would be $\mu^{W} = -0.037$ (se: 0.088) and $\mu^{E} = 0.025$ (se: 0.112). If equation (1) were to be implemented to recommend TACs for 2017, based on the catches[2] for 2016, the results would be:

[2] Catches are used here only because the values thereof were immediately available; on implementation, the intent is that the method would use TACs.

$TAC^W(2017) = 1.901 [1 – 0.037] =$ 1.831 thousand mt - a drop of 70 mt

$TAC^E(2017) = 19.130 [1 + 0.025] =$ 19.608 thousand mt - an increase of 478 mt

Should this approach come to be applied to make recommendations for 2021, applications of equation (1) would use the final TACs set by the Commission to apply for 2020. At the time the recommendations would need to be made, the values of most of the abundance indices for 2020 would not then yet be available. Assuming, based on the above, that index slopes would be estimated for a seven-year period, that period would then need to be 2013-2019.

An Annex discusses the implications of undercatches of TACs for this approach.

Acknowledgements

We thank Tom Carruthers for providing the data used for the example, and Ai Kimoto who prepared these data for him.

Annex

On the Impact of Undercatch on TAC Recommendations

The main text suggests equation (1):

$$TAC^{W/E}(2021) = TAC^{W/E}(2020)\ [\ 1 + \mu^{W/E}]$$

as a basis for recommending the TACs for 2021 for bluefin in the west (W) and east (E) areas, based on the value of $\mu_{W/E}$, which is the current proportional change in abundance per annum in the area concerned. This, in turn, is suggested to be based on recent trends in abundance indices.

A point raised in discussion of the main text was that an undercatch of a TAC would lead to a greater increase in abundance indices than estimated under the assumption that the TAC would be taken. An indication of the size of such an effect is provided by inspection of the projections for SSB[3] under different future TACs reported in the 2017 SCRS report. Estimating roughly from these plots, the impact on the proportional annual change in abundance μ of an undercatch of 1 000 mt of the TAC in each of the west and the east areas would be 2.5% and 1% respectively.

The TACs set at present for 2020 are 2 350 mt for the west, and 36 000 mt for the east area. Say each was undercaught by 10%. The effect on indices, and hence on μ, would then be to increase this by about 0.006 (0.6%) for the west for an undercatch of 235 mt, and by about 0.036 (3.6%) for the east for an undercatch of 3 600 mt. Say, for example, that the intent of the recommendation for 2021 is to maintain the same fishing mortality in 2021 as intended for 2020, and that the estimates from indices for μ^W is 0.03, and for μ^E is 0.02. Applying equation (1) would yield 2021 TACs of:

$TAC^W(2021) = 2\,350\ [\ 1 + 0.03] = 2\,421$ i.e. an increase of 71 mt

$TAC^E(2021) = 36\,000\ [\ 1 + 0.02] = 36\,720$ i.e. an increase of 720 mt

The impact of a 2020 undercatch on these results can be argued in various ways:

- First note that the undercatch in 2020 would not impact the indices used to estimate μ, as those indices would be available only to 2018 at the time the recommendation needed to be made; hence the results above would not be affected.

- It could be argued that undercatches in 2019 and anticipated for 2020 should be added to the values calculated above, as that would then result (if the TACs for 2021 are fully taken) in a net effect on the resources by the end of 2021 being as would have resulted from consistent application of the Commission's intended fishing mortality over the whole 2019-2021 period.

It should be noted that the issues that arise from possible undercatches of the TACs for 2019 and 2020 on TAC advice for 2021 are not unique to the TAC recommendation method suggested in the main text. These issues need to be considered, and could play out differently, for any method considered to provide TAC recommendations for 2021.

[3] For other components of the biomass, in **relative** terms the magnitude of this differential effect will be very similar.

Table 1: 2010-2016 annual catches (in '000 mt) and log-abundance indices for the East and West areas.

	Annual catches		Fishery Independent Indices					Fishery dependent (CPUE) indices											
	East	West	East			West		East			West								
Year	East Catch	West Catch	FR_AER_SUV2	MED_LAR_SUV	GBYP_AER_SUV_BAR	CAN_ACO_SUV	GOM_LAR_SUV	SPN_FR_BB	MOR_POR_TRAP	JPN_LL_NEAtl2	US_RR_66_114	US_RR_115_144	US_RR_177	US_GOM_PLL2	JPN_LL_West2	CAN GSL	CAN SWNS		
2010	11.338	1.857	-1.371		-0.122	0.265	-0.743	0.142		-0.983	-0.673	0.015	0.255	0.197	-1.247	1.450	0.508		
2011	9.774	2.007	-0.509		0.076	0.003	0.354	0.412		-0.288	-0.546	-0.509	-0.135	0.086	-0.024	0.917	0.389		
2012	10.934	1.754	-1.110	0.557		0.706	-0.944	0.224	-0.408	0.260	-0.774	-0.577	-0.235	1.222	0.196	1.135	0.401		
2013	13.244	1.481		0.492	-0.135	0.116	0.305	-0.162	0.359	0.028	-0.529	0.217	-0.804	0.204	-0.087	1.028	0.023		
2014	13.260	1.626	0.233	0.015		0.421	-1.017	-1.000	-0.242	0.490	-0.774	-0.748	-0.505	-0.041	0.134	0.932	0.088		
2015	16.200	1.842	-0.315	0.816	0.151	0.381	-0.616		0.080	-0.005	-1.158	-1.529	-0.055	0.016	-0.358	0.707	0.285		
2016	19.130	1.901	1.215	0.485		0.568	1.220		0.035	-0.082	-1.068	-0.343	0.098	0.094	0.566	1.055	0.349		
	7 years	slope	0.339	0.018	0.033	0.049	0.138	-0.286	0.060	0.125	-0.086	-0.117	-0.021	-0.061	0.168	-0.065	-0.036		
		s.e.	0.550	0.333	0.150	0.243	0.864	0.374	0.326	0.419	0.171	0.556	0.392	0.455	0.486	0.199	0.173		
	5 years	slope	0.495	0.018	0.143	-0.001	0.341	-0.612	0.060	-0.072	-0.122	-0.128	0.142	-0.244	0.047	-0.048	0.016		
		s.e.	0.600	0.333	-	0.255	0.914	0.185	0.326	0.237	0.190	0.696	0.326	0.409	0.387	0.168	0.189	**Overall average**	
Average - equal weighting																		East	West
	7 years	slope	0.130			0.094		-0.033			-0.031							0.048	-0.003
		(s.e.)	(0.220)			(0.449)		(0.217)			(0.143)							(0.154)	(0.149)
	5 years	slope	0.256	(GBYP not incl.)		0.170		-0.208			-0.048							-0.022	0.000
		(s.e.)	(0.343)			(0.474)		(0.148)			(0.143)							(0.163)	(0.153)
Average - inverse-variance weighting																		East	West
	7 years	slope	0.049			0.056		-0.034			-0.052							0.025	-0.037
		(s.e.)	(0.119)			(0.263)		(0.146)			(0.209)							(0.112)	(0.088)
	5 years	slope	0.130	(GBYP not incl.)		0.024		-0.329			-0.041							-0.250	-0.033
		(s.e.)	(0.187)			(0.240)		(0.142)			(0.225)							(0.121)	(0.087)

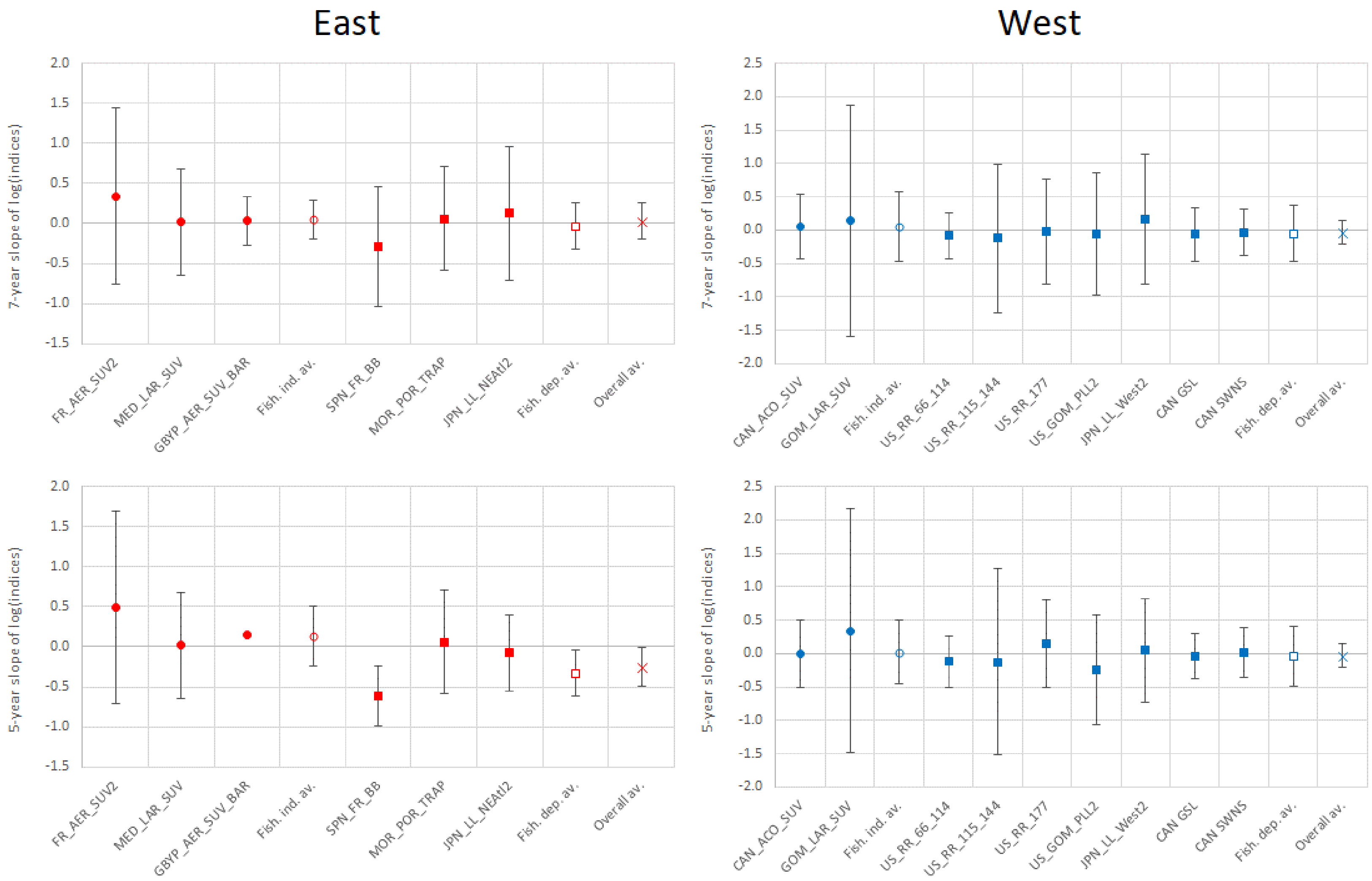

Figure 1. 7-year (top row) and 5-year (bottom row) slopes (essentially proportional annual increase rates) of log-abundance indices for the East and West areas. Medians are shown together with error bars corresponding to +- 2 standard errors. Inverse variance weighted averages are shown for the fishery independent and fishery dependent indices, first separately and then for all indices together for each area.