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LENGTH BASED CATCH ANALYSIS FOR EAST ATLANTIC MEDITERRANEAN BLUEFIN TUNA

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SUMMARY

Although the bluefin assessment is based on catch-at-age data, ageing using hard parts is an expensive and difficult process. Therefore length data are converted into age for bluefin using a growth curve, i.e. age slicing. Where age is predicted from length using the inverse of the von Bertalanffy growth curve. Here we show how a simple method based on length data alone can be used to estimate population parameters such as total mortality (Z).

RÉSUMÉ

Même si l'évaluation du thon rouge est basée sur les données de prise par âge, la détermination de l'âge à l'aide des pièces dures est un processus onéreux et difficile. C'est pourquoi les données de taille du thon rouge sont converties en âge à l'aide d'une courbe de croissance, c.-à-d. découpage des âges. L'âge est ainsi prédit à partir de la taille en utilisant l'inverse de la courbe de croissance von Bertalanffy. Nous montrons ici comment une simple méthode basée seulement sur les données de taille peut être utilisée pour estimer les paramètres de la population, tels que la mortalité totale (Z).

RESUMEN

Aunque la evaluación de atún rojo se basa en los datos de captura por edad, la determinación de la edad mediante la utilización de partes duras es un proceso difícil y oneroso. Por tanto, para el atún rojo los datos de talla se convierten en edad utilizando una curva de crecimiento, a saber, procedimiento de corte de edad. En dicho procedimiento se predice la edad a partir de la talla utilizando el inverso de la curva de crecimiento de von Bertalanffy. En este documento se muestra cómo puede utilizarse un método simple basado sólo en datos de edad para estimar parámetros de población como, por ejemplo, la mortalidad total (Z).

KEYWORDS

Bluefin, catch curve analysis, growth, length, mortality

1. Introduction

An alternative to model based advice is to use indicators such as mean size e.g. Jennings (2005) and Blanchard et al. (2005). Such indicators could be used in an empirical harvest control rule (HCR) or as an index for use by a stock assessment method.

Indicators based on catch rates alone are potentially very misleading. In contrast, indicators based on the mean size of the catch perform better, because these quantities change in a more predictable manner with abundance Punt et al. (2001). However, translating mean size into the Kobe Advice framework, which is based on biomass and harvest rate is problematic. We therefore estimate total mortality (Z) from catch-at-size (CAS) using the Powell-Wetheral method.

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2.Materials and Methods

Beverton and Holt (1956) developed a method to estimate population parameters such as total mortality (Z) from length data e.g.,

$$Z = K\frac{L_\infty - \bar{L}}{\bar{L} - L^t} \qquad (1)$$

Where L∞ and K are parameters from the von Bertalanffy growth equation. Lt is a given size in a sample and L is the mean size of all individuals larger than Lt .So that L − Lt is the difference between a particular length and the mean of all greater lengths. _

This equation was extended to estimate growth and mortality parameters by Wetherall et al. (1987). Where it is assumed that the right hand tail of a length frequency distribution is determined by the asymptotic length L∞ and the ratio between Z and the growth rate K.

Rearranging equation 1 gives

$$\bar{L} - L^t = a + bL^t \qquad (2)$$

where Lt takes any value between the smallest and largest sizes and allows the parameters a and b to be estimated by linear regression, which can be used to estimate L∞ and K

$$L_\infty = -a/b \qquad (3)$$

$$\frac{Z}{K} = \frac{-1-b}{b} \qquad (4)$$

Other simple methods such as catch curve analysis based on age slicing require that K and L∞ are known. The Powell-Wetherall method only requires an estimate of K to estimate Z since L∞ is estimated by the method as well as Z/K. If K is unknown then relative Z can be calculated using equation 4 from different years

As well as assuming that growth follows the von Bertalanffy growth equation, it is also assumed that the population is in a steady state with constant exponential mortality, there are no changes in selection pattern of the fishery and recruitment is constant. These assumptions are violated for an analysis of catch-at-size data from a single year. Therefore Gedamke and Hoenig (2006) extended the Powell-Wetherall method for use in non-equilibrium situations. However, in this study we are simply evaluating whether catch-at-size data could potentially be of use and so are less concerned about the bias due to assuming equilibrium.

3. Results and Discussion

The length frequency data from 2000 to 2011 are plotted in **Figure 1** and the corresponding Powell-Wetherall plots in **Figure 2**.

The Powell-Wetherall plots for 2000 to 2006 all show an initial decline followed by an increase at a length of about 75cm. The curves then reach a peak at length of about 125cm followed by another decline. This could be caused by biomodal size distribution or selection pattern. In constrast from 2007 onwards the Powell-Wetherall plots appear to show a linear decline, which suggest that Z and the selection pattern is now even across lengths.

However, there appears to be problems with violations of the assumptions, particularly that of constant recruitment, and so the length frequency distribution is very variable within and between years.

If first size in the analysis corresponds to a larger size class (e.g., spawners) the effects of variable year-class strength are less apparent. Therefore we repeated the analysis for fish greater than 200cm. The length frequencies are shown in **Figure 3** and the corresponding Powell-Wetherall plots in **Figure 4**.

The length frequencies for fish greater than 200cm for 2008 to 2011 appear to show a rebuilding of the spawning stock. However, in 2009 (as in other years) a single size class obscures the pattern; this is probably due to a problem with the data or how samples were raised to the total catch.

The corresponding Powell-Wetherall plots are shown in **Figure 4**, a steeper slope of the regression corresponds to a lower Z. Comparison across rows suggests that Z has declined for larger fish between 2008 and 2011.

Although this is a relatively simple method (only requiring K to be known to estimate Z), the size distribution of larger fish does potentially appear to be a useful indicator. Such an indicator may also make biological and economic sense making it be easier to explain in discussions with stakeholders. However, like catch per unit effort and reported catch, it will be sensitive to a wide variety of biases. Therefore before it could be used within a management framework a Management Strategy Evaluation (MSE) should be conducted.

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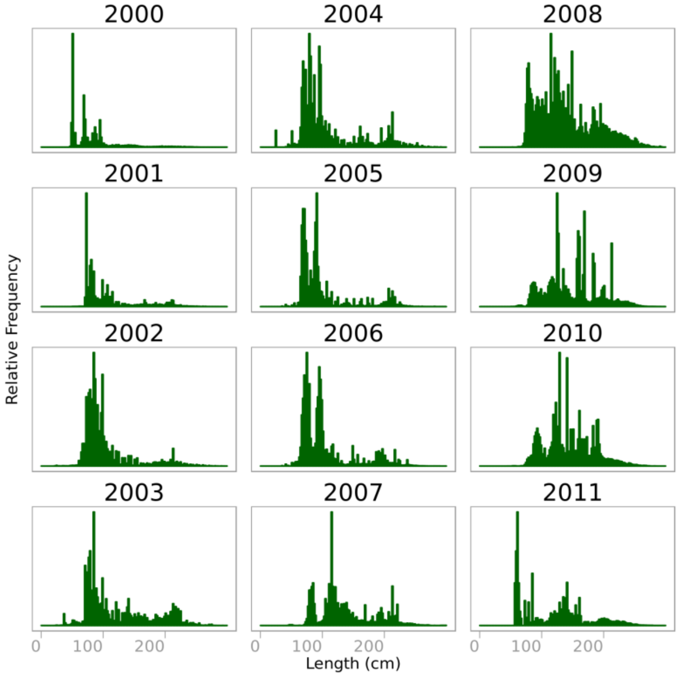

Figure 1. Length frequency distribution.

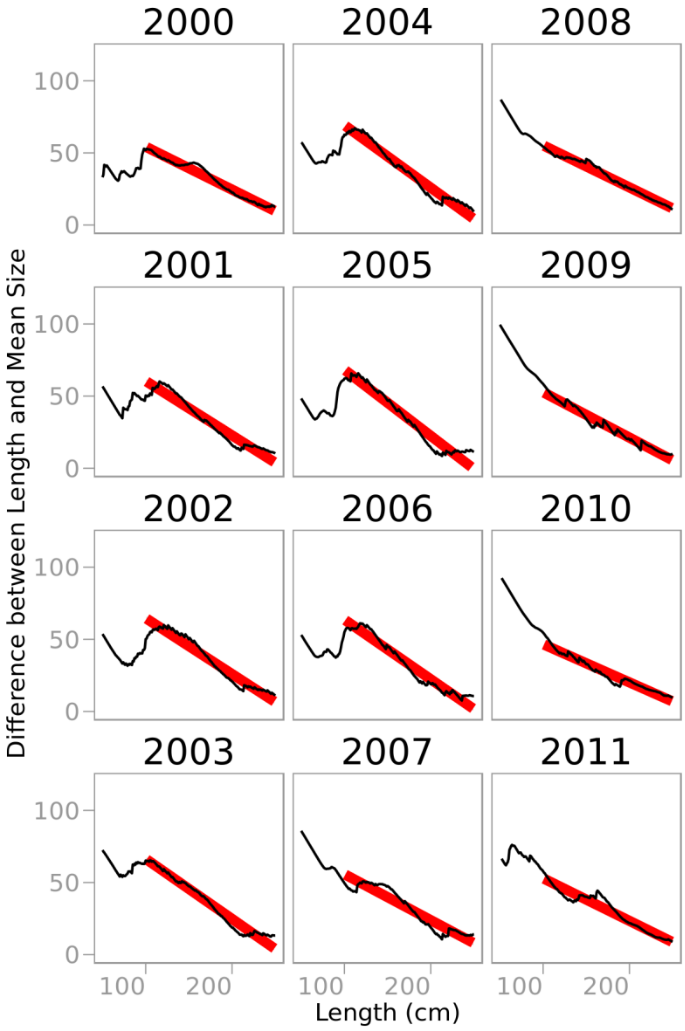

Figure 2. Powell-Wetherall plot of L−Lt against $\overline{L}t$, red line is a linear regression fitted to lengths greater than 100cm.

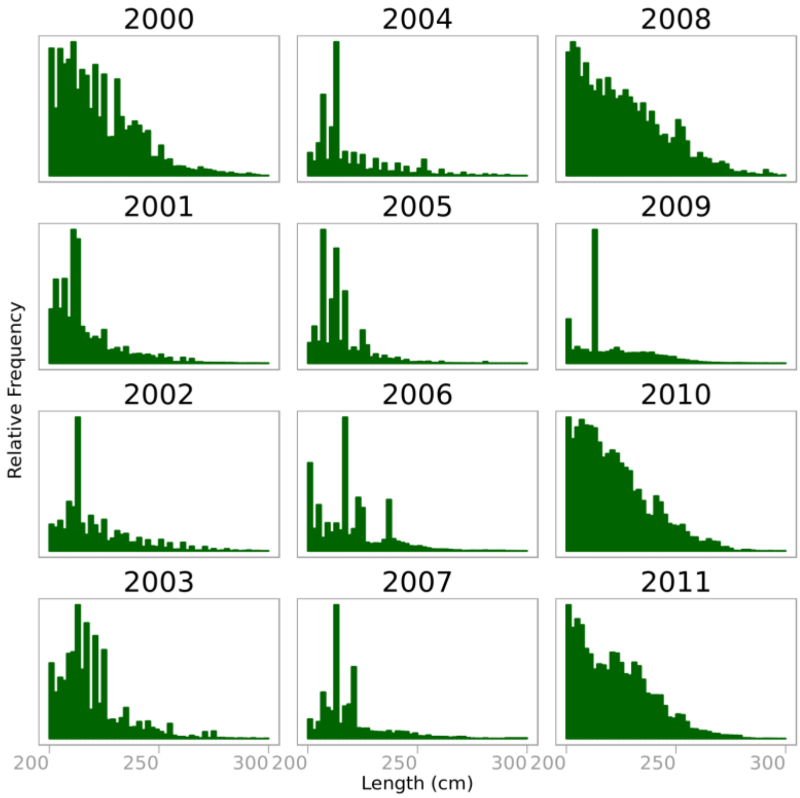

Figure 3. Length frequency distribution for fish greater than 200cm.

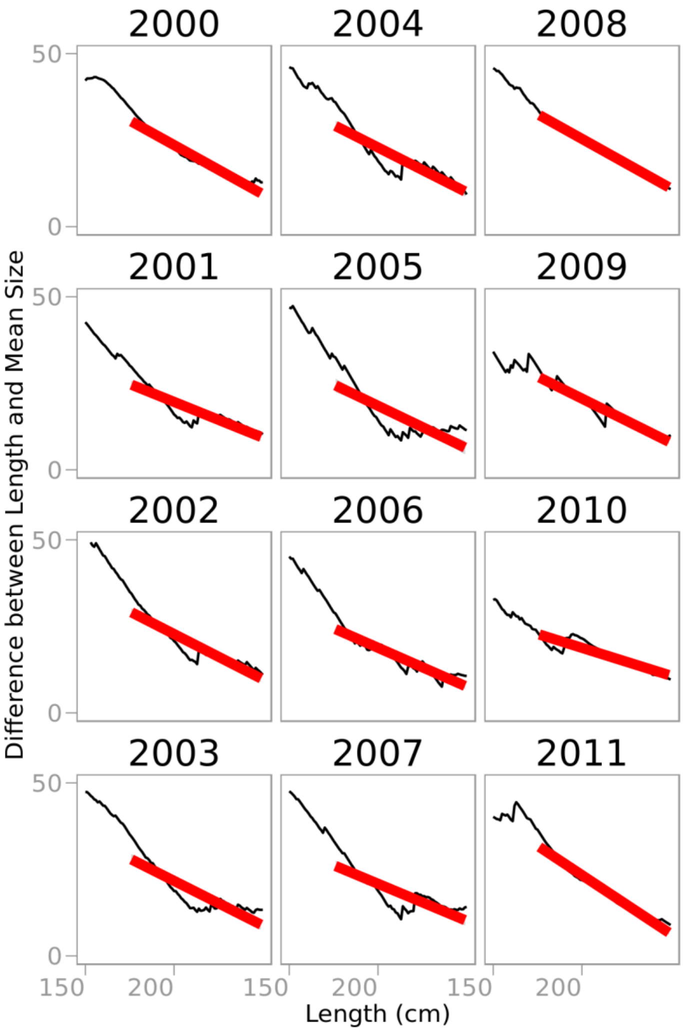

Figure 4. Powell-Wetherall plot of L−Lt against $\overline{Lt}$, red line is a linear regression fitted to lengths greater than 175cm.