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A COMPARATIVE ANALYSIS OF INDIAN AND ATLANTIC YELLOWFIN AND BIGEYE TUNA SIZE DATA

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SUMMARY

Length-based methods can either be complex integrated stock assessment methods or simple methods with few assumptions. Simple methods are valuable due to their visual appeal, simple statistical basis, minimal assumptions and the ease with which estimates can be derived from different data sets. In this paper we analyse length frequency data from yellowfin and bigeye from the Atlantic and Indian Oceans to compare differences in growth, selectivity and mortality.

RESUME

Les méthodes fondées sur la taille peuvent être des méthodes d'évaluation des stocks intégrées et complexes ou de simples méthodes dotées de peu de postulats. L'avantage des méthodes simples réside dans leur attrait visuel, leur base statistique simple, les postulats minimaux et la facilité avec laquelle les estimations peuvent être obtenues des différents jeux de données. Dans ce document, nous analysons les données de fréquence des tailles de l'albacore et du thon obèse provenant des océans Atlantique et Indien afin de comparer les différences de croissance, sélectivité et mortalité.

RESUMEN

Los métodos basados en la talla pueden ser métodos de evaluación de stock complejos integrados o métodos simples con pocos supuestos. Los métodos simples son valiosos debido a su atractivo visual, su base estadística sencilla, sus supuestos mínimos y la facilidad con la cual pueden obtenerse estimaciones a partir de diferentes conjuntos de datos. En este documento se analizan los datos de frecuencias de tallas del patudo y rabil en los océanos Atlántico e Índico con el fin de comparar las diferencias en el crecimiento, la selectividad y la mortalidad.

KEYWORDS

Yellowfin, bigeye, catch-at-size, length frequency

1. Introduction

Length-based methods can either be complex integrated stock assessment methods like Multifan-CL Fournier et al. (1998) or simple methods with few assumptions. Cotter et al. [2004] in a review of stock assessment methods recommended the use of simple methods due to their visual appeal, simple statistical basis, minimal assumptions and the ease with which estimates can be derived from different data sets. A criticism of simple methods is that they do not estimate absolute stock numbers or fishing mortality but neither do other methods unless M is accurately known, which is seldom true.

In this paper we analyze length frequency data from yellowfin and bigeye from the Atlantic and Indian Oceans. We do this to compare growth, selectivity and mortality.

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2. Materials and Methods

2.1 Data

Data used are catch-at-size raised to the total catch from the ICCAT and IOTC databases for bigeye and yellowfin.

2.2 Methods

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

$$Z = K\frac{L_\infty - \bar{L}}{\bar{L} - L^t}$$

Based on this equation Powell [1979] developed a method, extended by Wetherall et al. [1987], to estimate growth and mortality parameters. This assumes 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. The Beverton and Holt method assumes good estimates for K and L_∞, while the Powell-Wetherall method only requires an estimate of K, since both L_∞ and *Z/K* are estimated. These methods therefore provide estimates from each length distribution of *Z/K* and Z if K is known. As well as assuming that growth follows the von Bertalanffy growth function, it is also assumed that the population is in a steady state with constant exponential mortality, no changes in selection pattern of the fishery and constant recruitment.

In the Powell-Wetherall method L^t can take any value between the smallest and largest sizes. Equation 1 then provides a series of estimates of Z since

$$\bar{L} - L^t = a + bL^t$$

a and b can be estimated by a regression analysis where

$$b = \frac{-K}{Z + K}$$

$$a = -bL_\infty$$

Therefore plotting $\bar{L} - L^t$ against L^t therefore provides an estimate of L_∞ and Z/K

$$L_\infty = -a/b$$

$$\frac{Z}{K} = \frac{-1 - b}{b}$$

3. Results

Plotting these values i.e. each estimate.

Figure 1 shows the length frequency data from the Atlantic and Indian Oceans for yellowfin and bigeye. For yellowfin there two modes are apparent. This is due to the juveniles exhibiting schooling behaviour and attraction to floating objects; they then disperse before being caught as adults.

Figures 2 and **3** show the Powell-Wetherall plots by Ocean and decade for the two species. **Figure 3** for bigeye is relatively easy to interpret since there was only one mode; **Figure 2** for yellowfin has two modes and so is harder to interpret.

The estimates of L_∞ are 187 cm and 190 cm in 1990 and 2000 respectively in the Atlantic, and 184 cm and 192 cm in 1990 and 2000, respectively, in the Indian Ocean.

If K is assumed to be 0.2 then the estimates of *Z* are 0.63 and 0.52 in 1990 and 2000 respectively in the Atlantic, and 0.94 and 0.99 in 1990 and 2000 respectively in the Indian Ocean. The plot suggests that bigeye tuna are fully selected at about 75cm.

For yellowfin the analysis was restricted to fish of length greater than 100 cm, L_∞ was very similar for all decades and Oceans.

4. Discussion

Although the Powell-Wetherall method is very simple with few assumptions, it was able to answer some important questions, i.e. to provide estimates and compare L_∞ , Z and length at full selectivity for bigeye. All of which are important parameters for stock assessment. The analysis for yellowfin is more complicated since two modes are seen in the data. However, the Powell-Wetherall method could be fitted to the two modes separately, allowing estimates of selectivity and Z by the juvenile and adult fisheries to be derived. A problem however is that yellowfin growth is assumed to be a two stanza growth model (Gascuel) therefore not parameters were derived for yellowfin.

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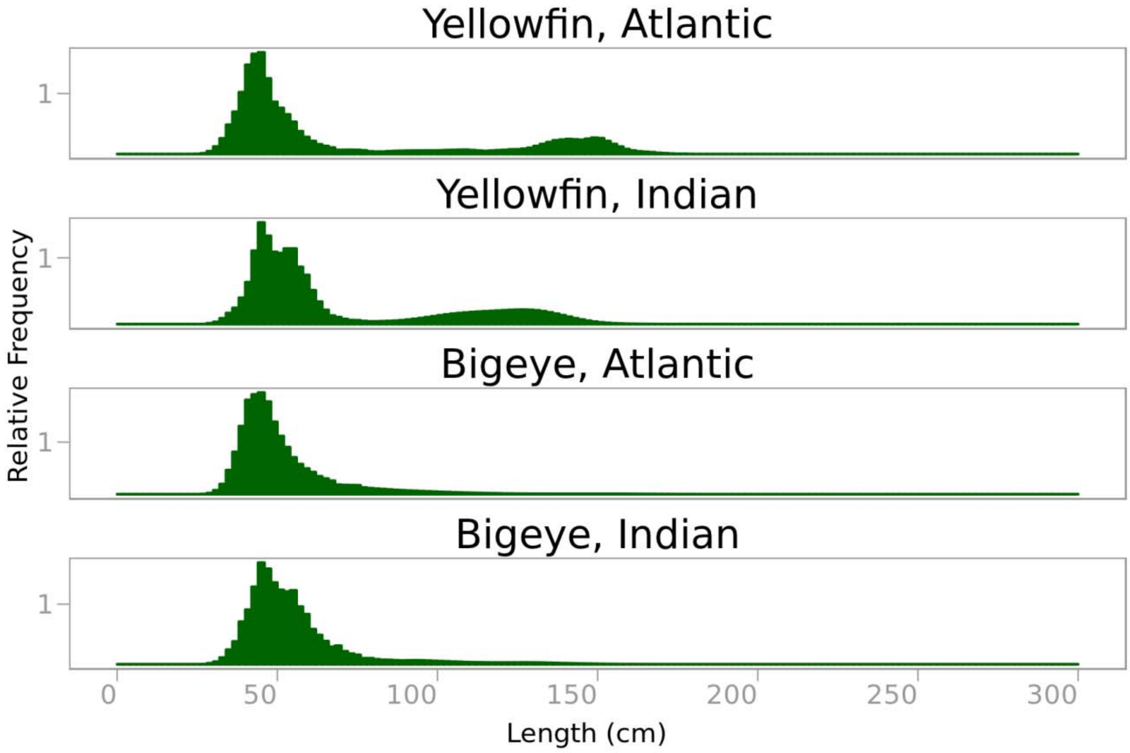

Figure 1. Length frequency distribution by ocean and species.

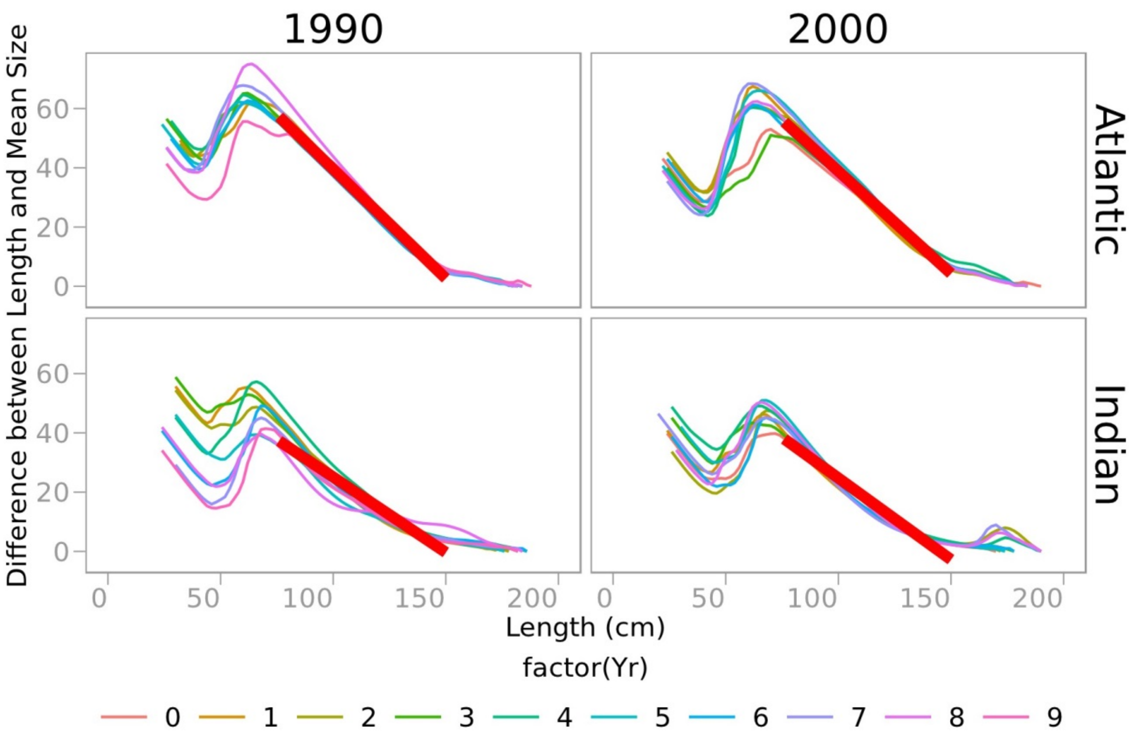

Figure 2. Powell-Wetherall plot for yellowfin, showing of the difference between a size class and the mean size of fish greater than that size class.

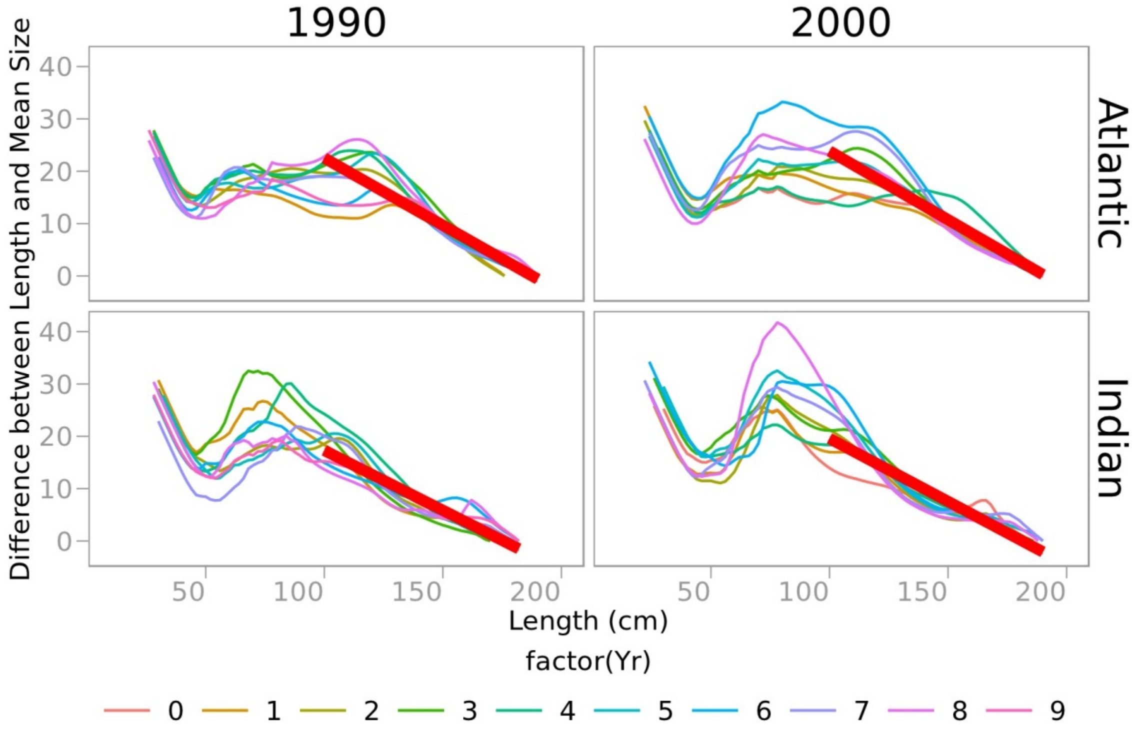

Figure 3. Powell-Wetherall plot for bigeye, showing of the difference between a size class and the mean size of fish greater than that size class.