

**CATCH RATES AND CATCH STRUCTURE OF THE BALFEGÓ PURSE
SEINE FLEET IN BALEARIC WATERS FROM 2000 TO 2013.
FIRST ESTIMATION OF SIZE FREQUENCY DISTRIBUTION
BASED ON VIDEO TECHNIQUES**

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SUMMARY

This study analyzed catches rates of Balfegó purse seiners from 2000 to 2013. In addition, an approximation of catch structure was estimated from the data reported by the skippers since 2006 and a rough approximation of hauls size and tuna individual weight. In 2013 the individual length estimated by Spanish inspectors with video technique provides the fork length of 17% of the catch transferred to Balfegó fattening facilities. The results showed that the 2013 catch rate in Balearic waters continued the ascending trend observed in previous years. The proxy estimation of age structure in 2013 indicates that the catch was comprised of bluefin tuna of 9 and 10 years, clearly dominated by age 10, which represent those tuna born in 2003. The age structure estimated from inspectors' measurements showed a bell shape distribution with all parameters of central tendency at age 11 (2002 year class). This might be indicative of an age differential recruitment to this particular spawning region and variable within each spawning season.

RÉSUMÉ

La présente étude a analysé les taux de capture des senneurs de Balfegó de 2000 à 2013. En outre, une approximation de la structure des captures a été estimée à partir des données déclarées par les capitaines depuis 2006, ainsi qu'une vague approximation de la taille des halages et du poids individuel des thons. En 2013, la longueur individuelle estimée par les inspecteurs espagnols au moyen de techniques vidéo a fourni la longueur à la fourche de 17% de la prise transférée dans les installations d'engraissement de Balfegó. Les résultats ont montré que le taux de capture de 2013 dans les eaux des Baléares a poursuivi sa tendance ascendante qui avait été observée au cours d'années antérieures. En 2013, l'estimation approximative de la structure démographique indique que la capture était composée de thons rouges de 9 et 10 ans, clairement dominée par l'âge 10, qui représente les thons nés en 2003. La structure démographique estimée par les mesures des inspecteurs a fait apparaître une distribution en forme de cloche avec tous les paramètres de tendance centrale à l'âge 11 (classe annuelle de 2002). Ceci pourrait indiquer un recrutement différentiel entre les âges dans cette zone de frai particulière, qui est variable en fonction de chaque saison de frai.

RESUMEN

Este estudio analiza las tasas de captura de los cerqueros de Balfegó desde 2000 a 2013. Además, se estimó una aproximación de la estructura de captura a partir de los datos comunicados por los patrones desde 2006 y se hizo una aproximación a grandes rasgos del tamaño de los lances y del peso individual de los atunes. En 2013, la longitud individual estimada por los inspectores españoles con técnicas de vídeo proporciona la longitud a la horquilla del 17% de la captura transferida a las instalaciones de engorde de Balfegó. Los resultados demostraron que la tasa de captura de 2013 en aguas baleares continuaba la tendencia ascendente observada en años anteriores. La estimación de la aproximación de la estructura por edad en 2013 indica que la captura estaba compuesta por atunes rojos de 9 y 10 años, dominando claramente la edad 10, lo que quiere decir que estos atunes nacieron en 2003. La estructura por edad estimada a partir de las mediciones de los inspectores mostraba una distribución en forma de campana, con todos los parámetros de la tendencia central en la edad 11 (clase anual de 2002). Esto podría ser indicativo de un reclutamiento diferenciado por edad en esta región de desove en particular y variable en cada temporada de desove.

KEYWORDS

Fishery statistics, Fishery indicators, Experimental programmes, Farming, Bluefin

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1. Introduction

The assessment of East Atlantic bluefin tuna is associated with a high degree of uncertainty as was revealed by the results of the last ICCAT reports. To minimize the uncertainty due to the poor quality of data is necessary to update and improve the historical time series and enlarging it with data of more recent fisheries. Among the recent fishing modalities stands out the purse seine fishery of capture-based aquaculture. In spite of its relative short life this fishery might provide valuable information on ABFT spawners trends in the most recent years. This was confirmed by significant correlation found between the catch rates of Balfegó fleet in the Balearic spawning ground and Spanish traps (Gordoa 2012) indicating the suitability of Balfegó catch rates as an additional index of abundance of the East Atlantic Bluefin tuna spawners. The Balfegó CPUE has been presented in previous years (Gordoa 2010; Gordoa 2011; Gordoa 2012) and in this study is updated with 2013 catch rates. In addition the structure of the annual catch is analyzed with the purpose to provide an approximation of the annual size frequency distribution and other characteristics that might provide information of the state of the resource and the fishery. Furthermore, this is the first time that the observed size frequency distribution from purseiners is provided. The technological development permitted individual measurements of tuna caught in 2013 by Balfegó joint-fishing fleet, a new tool implemented in the control protocol by the Spanish Directorate-General for Fisheries.

2. Material and method

Balfegó purseiners provide their catch and fishing days since 2000 and from 2006 onwards it is reported on daily basis, haul by haul. The information per haul collects the following descriptors: date, hour, position and the estimated catch in weight and number.

Since 2006 the fishing period has changed adjusting to the modifications implemented in the fishing season. To get a more reliable CPUE time series where the annual variability due to the fishing period can be depicted, an additional catch rates is being estimated for the period earlier to the 8th of June. This temporal window was not subject to fishing before 2006, partially covered by the fleet since 2006 and covering the whole fishing season from 2010 onwards. Annual catch rates were estimated by dividing the total catch (Kg) of Balfegó vessels by the total number of fishing days.

A catch structure analysis has been roughly estimated for those years that the catch has been reported per haul. In this analysis the hauls from the whole Balfegó joint fishing fleet were considered as this information is not biased by differences in the fishing power or catching efficiency between vessels. Information of catch by haul is available for years: 2006, 2007, 2009, 2010, 2011, 2012 and 2013. A total of 187 hauls were analyzed. In addition the annual average of hauls size was estimated in weight and number as a proxy of ABFT school size. For each haul the average individual weight was estimated by dividing the estimated catch in weight by the estimated catch in number. Once the weight was estimated, the length per haul was calculated applying the growth length weight relationship adopted by ICCAT (2010) for the East Atlantic-Mediterranean stock and for individuals bigger than 100 cm ($W=0.0000196*L^{3.009}$). Length frequency distributions were calculated by interval of 10 cm.

The age for each haul was estimated applying the inverse of the von Bertalanffy growth length at age equation estimated by Cort (1991) for the East Atlantic - Mediterranean stock and adopted by ICCAT (2010). The size frequency distribution in 2013 based on the individual length estimated by video technique is also calculated and presented with its resultant age structure. The measurements, a new tool implemented in the control protocol, were done by Spanish fisheries inspector at the time of transferring tuna from the transport vessels to the fattening facilities as. The measured subsample represented 17.9 % of the tuna transferred. The information has been provided by the Spanish Directorate-General for Fisheries.

3. Results

Annual catch rates (CPUE)

The annual catch rates of purse-seine fleet in Balearic spawning grounds are sensitive to changes in the fishing period and this issue is necessary to comprehend for the correct interpretation of CPUE time series (**Figure 1**). From 2000 to 2006 vessels operated freely during the spawning season targeting on the period of higher density of spawners and fishing before the 8th of June was absent while from 2006 to 2009 some fishing activity was observed at the beginning of June and since 2010 all the fishing activity had to be concentrated at the beginning of the spawning season. Thus, total catch rates up to 2009 represented by broken lines in **Figure 1** are over estimated compare to the CPUE time series calculated from fishing carried out at the beginning of the spawning period (solid line).

The annual CPUE from 2006 onwards represented by solid line (**Figure 1**) are more consistent as they were estimated over the same temporal window and might be indicative of the annual variation in the abundance of spawners in Balearic waters. The minimum levels of abundance were observe in 2006 and 2007, average daily catch around 10 t, an increase was observed in 2008 reaching catch rates around 10,25 t. The catch rate level reached in 2008 remained until 2011 with slight annual fluctuations. A highly relevant increase in CPUE took place in 2012, three times higher than in 2011, where average daily catch was around 35 t. In 2013 the positive trend continued and CPUE reached values closed to 43 t.

Annual average haul size

The annual average size of hauls was calculated in weight (**Figure 2**) and number (**Figure 3**). The average weight of hauls did not show significant differences between years until 2013 a year that stands out due to its significant increase in weight.

On the contrary, the average size in number exhibit high inter-annual variability with no relevant trend or outstanding year. The differences between the annual variability in average weight and average size are indicative of high annual differences in the individual size of the spawners.

Length frequency distribution

The length frequency distribution might represent the size frequency of spawners during the fishing season but the inter-annual differences are of such magnitude that is implausible to represent the length frequency of spawners during the spawning season. The wider the temporal window of the fishing season the closer the catch will represent the length frequency of the spawners during the spawning season. The fishing season has been gradually shifted to the beginning of the spawning season and the number of fishing days at sea has been gradually reduced, from around 30 days in 2006 to 5 days in 2013. As the arrival to the spawning ground is staggered and considered size driven only a wide fishing season would be ensure a size structure close to that of the spawners in the system.

The homogeneity of sizes increased gradually and the annual reduction of smaller sizes in the catch is an artifact produced by the changes in the fishing season as has been explained above.

In the last three years the fishing period was similar but the temporal window has been reduced from 14 days in 2011 to 6 and 5 days in 2012 and 2013 respectively. The homogeneity in the size of spawners caught in 2013 is exceptional; the rough visual estimation indicates that the whole catch was formed by spawners around 190 cm.

Age structure

The representativeness of age structure from purse seine catches suffered the same flaw explained for size frequency distributions. Although the gradual loses of age classes in the purse seine annual catches cannot be interpreted as fails in the spawning population the outstanding age classes in the catch might provide information of relevant annual cohorts.

Age classes 4, 5, 7 and 8 can be distinguished in the catch rates of 2006, 2007, 2009 and 2010 respectively (**Figure 6**). Accordingly these age classes would correspond to fish born in 2002 but after 2010 it goes off track. In 2010 and 2011 outstands ages 6 and 7 corresponding to those tuna born in 2004 but once again it cannot be track in the last two years. It is also remarkable age class 5 in 2011 catches. In 2012 and 2013 catch was almost fully formed by ages 9 and 10 respectively (**Figure 7**). These ages correspond to individuals born in 2003, the strength of this year class has been previously observed in other fisheries (Kimoto *et al.*, 2012; Hanke *et al.*, 2012).

The strength of 2003 cohort in the Balearic grounds in the last two fishing seasons is out of question. Why it was not depicted earlier? But, it would be reckless to reject the possibility that the identified cohorts, 2002 and 2004, in the previous years do, fully or partially, belong to 2003 cohort.

The age structure calculated in this study is based on a rough approximation of the size frequency distribution of purse seine catch. Nevertheless, this proxy provides an insight of the spawners catch structure and it merits to be improved in the near future.

Catch structure from video measurements

Size frequency distribution

The forkal length of 2164 tunas shows a size frequency distribution different from the approximation derived from the visual categorization of purseiners hauls. The mean (206 cm) and mode (227 cm) were higher than those obtained from the rough estimation (mean= 187 cm; mode=189 cm). The major difference lies in the shape of distributions, video measurements provide a wider and a more representative distribution (**Figure 7**).

Age structure

The age range of tuna spawners caught by Balfegó purseiners was wide; from 5 to 21 years. The parameters of central tendency (mean, mode and median) give the same result: 11 yrs. It is out of question that the age distribution estimated previously from rough visual guesstimate was unreliable, showing one single year class (10 yrs). Although, it might be expected that the distribution based on direct measurements would be around the same year class. The single year class showed by the rough estimation corresponds to those born in 2003, a year class which its strength has been observed in other fisheries. The question is why the most reliable age distribution shows clearly that age 11 outstands in the tuna caught by purseiners in Balearic spawning ground.

The minimum weight established in 2007 has reduced juvenile catches and consequently the induced fishing mortality. The impact of this measure only affects to those tuna born after 2006 (youngsters than 7 years), so the catch structure of tuna older than 7 years result from equivalent fishing pressure and their relative contribution to the total catch result from differences in the year class strength, mortality and the fraction of presence of each age group. Assuming the absence of a positive bias in the video-measurements (over estimation of length and derived age) the ascending trend of catch with age up to the inflection point might result of an age differential recruitment to this particular spawning region and timing; the peak at 11 yrs might points the age fully recruited to the region by the end of May.

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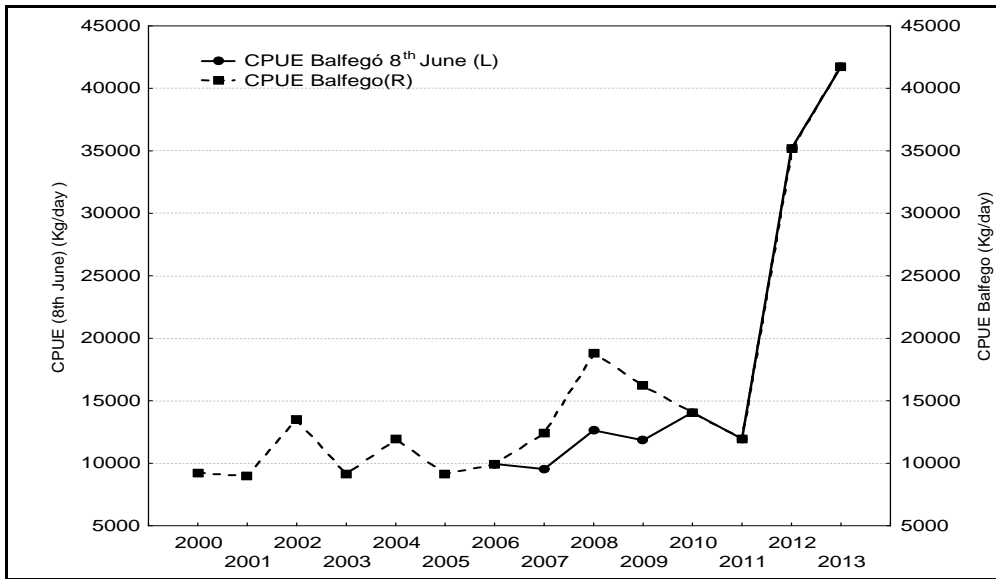


Figure 1. Balfegó CPUE (Kg/day) in Balearic spawning grounds; calculated from the whole spawning fishing season (broken line) and from catches before the 9th of June (solid line).

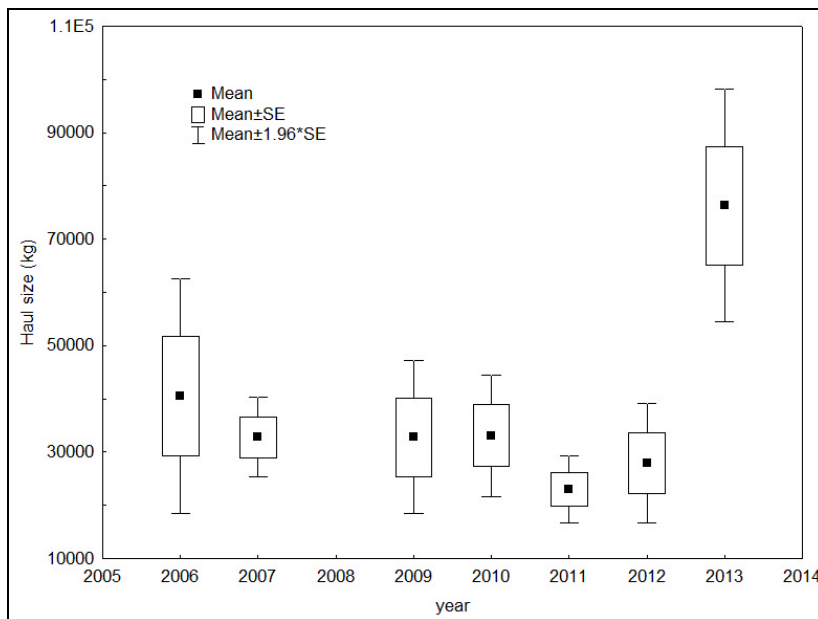


Figure 2. Annual average haul size in weight (kg) calculated from Balfegó joint fishing fleet.

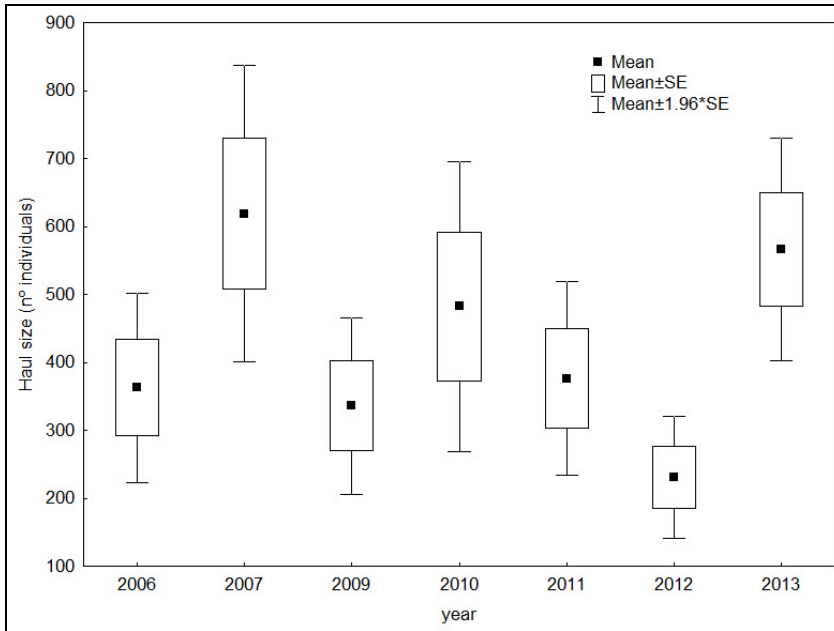


Figure 3. Annual average haul size in number of individuals calculated from Balfegó joint fishing fleet.

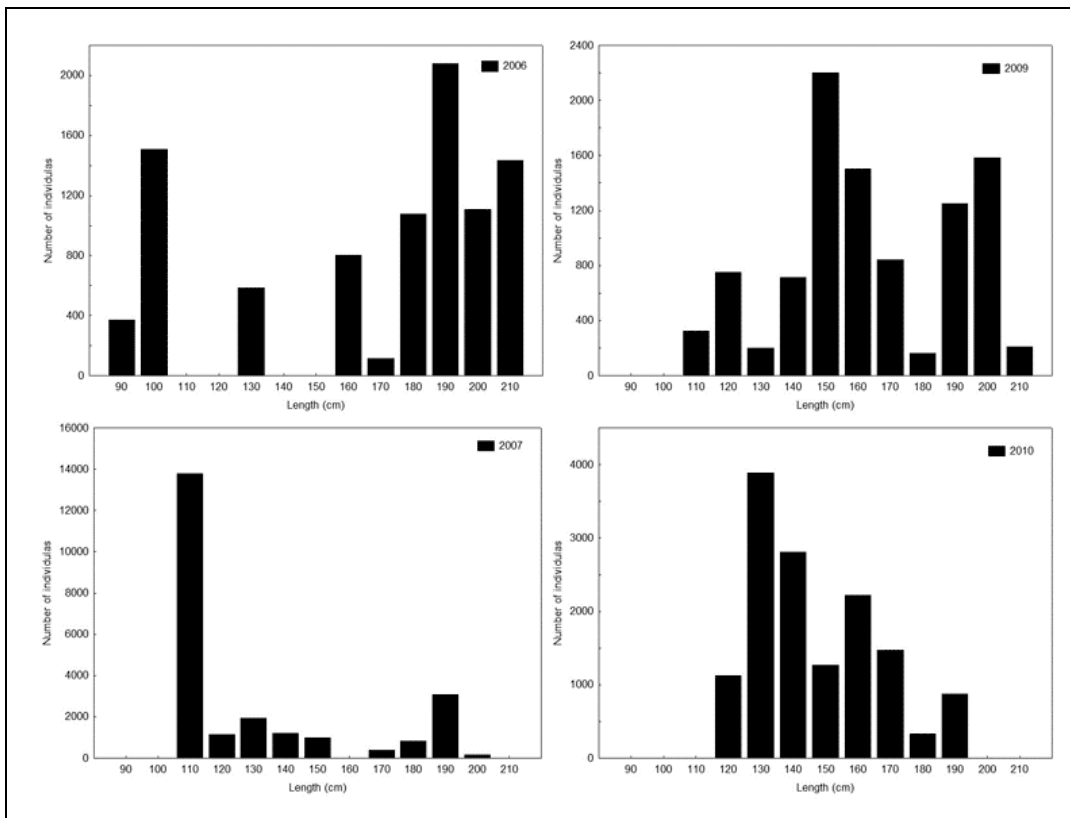


Figure 4. Length Frequency distribution of Balfegó joint fishing fleet from 2006-2010.

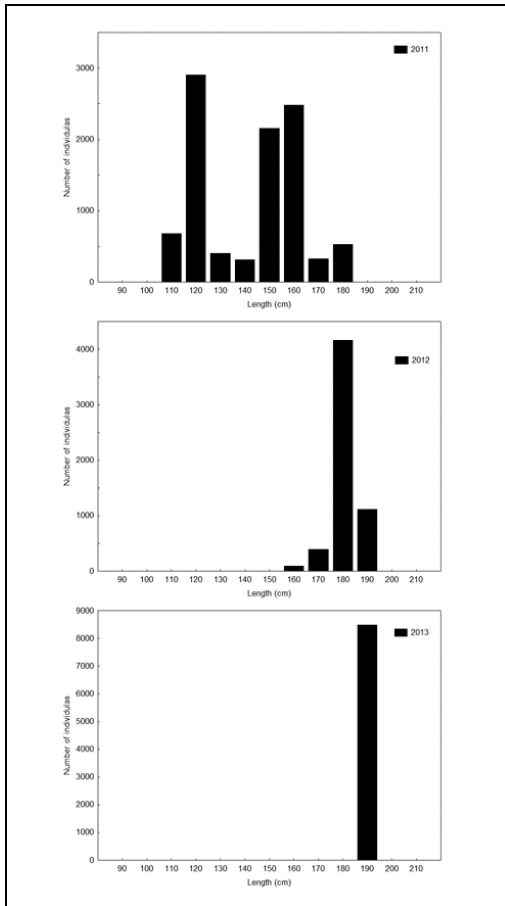


Figure 5. Length Frequency distribution of Balfegó joint fishing fleet from 2011-2012.

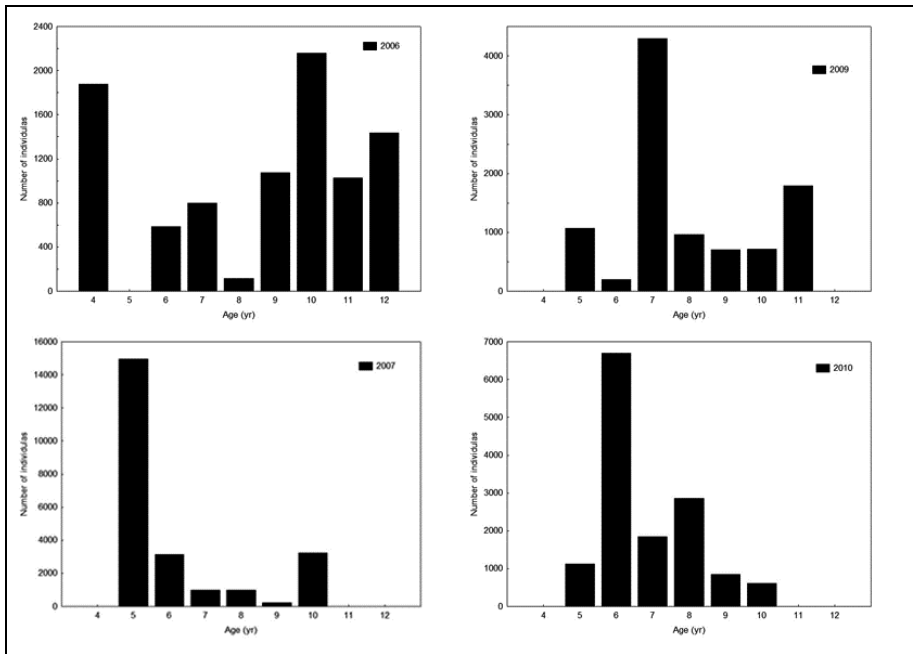


Figure 6. Atlantic Bluefin tuna catch age structure of Balfegó joint fishing fleet from 2006-2010.

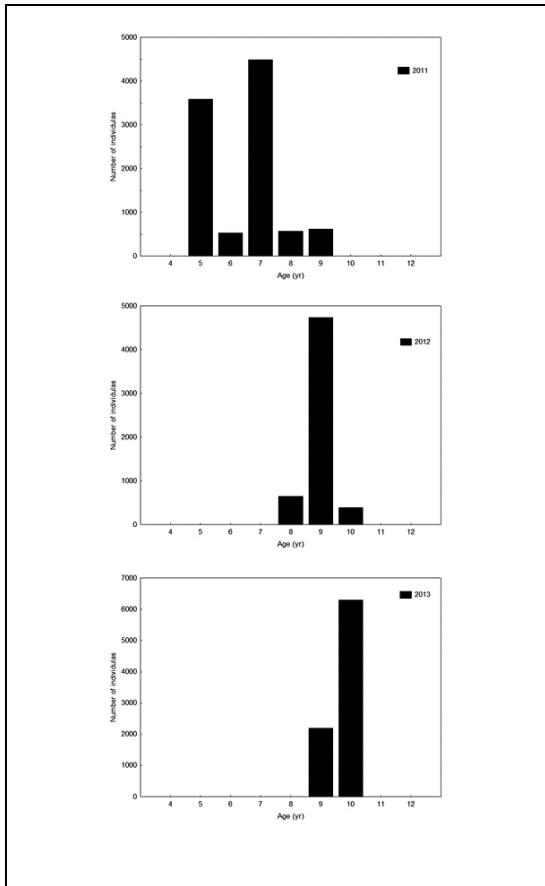


Figure 6. Continued. Atlantic Bluefin tuna catch age structure of Balfegó joint fishing fleet from 2011-2013.

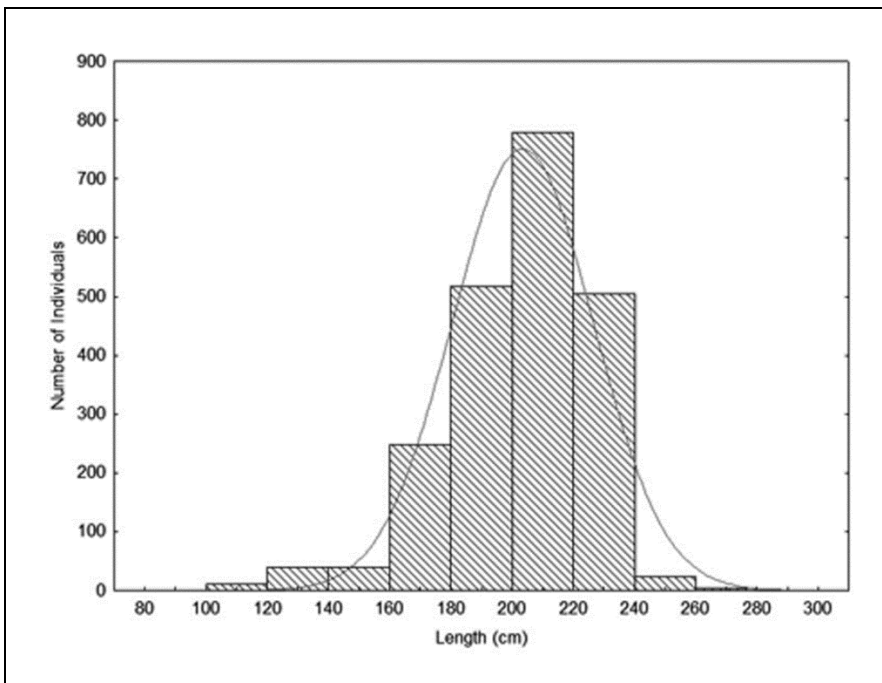


Figure 7. Size frequency distribution of Balfegó purse seiners fleet, based on video measurements over 17% of the 2013 quota transferred to the fattening facilities.

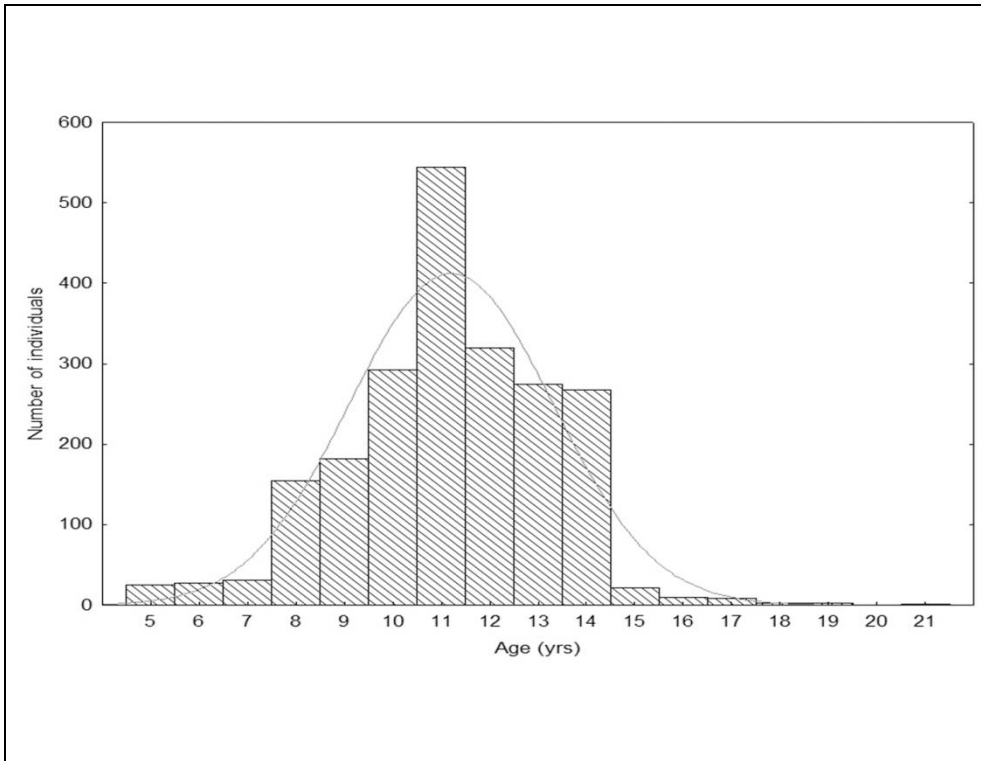


Figure 8. Catch age structure of Balfegó purse seiners fleet, derived from video measurements over 17% of the 2013 quota transferred to the fattening facilities.