

CATCH RATES AND CATCH SIZE STRUCTURE OF THE BALFEGÓ PURSE SEINE FLEET IN BALEARIC WATERS FROM 2000 TO 2014; TWO YEARS OF SIZE FREQUENCY DISTRIBUTION BASED ON VIDEO TECHNIQUES

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SUMMARY

This study updates the catch-rate time series of Balfegó purseiners, 15 years of unbroken abundance indices of spawners in Balearic waters. In addition, approximations of the annual length frequency and age structure were estimated from the visual estimations reported by the skippers on each haul: size and individual weight. Although this data cannot provide a reliable estimation of the length frequency of the Balfegó joint fleet catch, it is less distorted than the extrapolation used by ICCAT in the last few years, estimated with the same procedure but from a subsample of the French purse seine fleet. A more reliable length frequency of the Balfegó joint fleet was estimated for 2013 and 2014 based on video techniques implemented by Spanish inspectors during the catch transfers to Balfegó fattening facilities. The results showed that the CPUE in 2014 consolidates the ascending trend observed in previous years: a CPUE six times higher than that observed in 2013. In 2013 and 2014 the age structure estimated from the inspectors' measurements showed that modal age groups are 11 and 12 (2002 and 2003 year class), ages that may be considered fully recruited to the Balearic spawning grounds by the end of May. But as the period and length of the fishing season alters the length frequency distribution of the catch, the interannual differences in the age structure should not be considered as interannual differences in the structure of the spawning stock.

RÉSUMÉ

La présente étude met à jour la série temporelle du taux de capture des senneurs de Balfegó, une série ininterrompue longue de 15 ans d'indices d'abondance de reproducteurs des eaux des Baléares. En outre, des approximations de la fréquence annuelle des tailles et de la structure par âge ont été estimées à partir des estimations visuelles déclarées par les capitaines lors de chaque prise : taille et poids de chaque spécimen. Même si ces données ne permettent pas de fournir d'estimation fiable de la fréquence de tailles de la capture réalisée par la flottille conjointe de Balfegó, elles sont moins faussées que l'extrapolation utilisée par l'ICCAT ces dernières années, estimées selon la même procédure, mais avec un sous-échantillon de la flottille de senneurs battant le pavillon de l'UE-France. Une fréquence de tailles plus fiable de la flottille conjointe de Balfegó a été estimée au titre de 2013 et 2014 sur la base de techniques vidéo mises en œuvre par des inspecteurs espagnols pendant les transferts des prises vers les établissements d'élevage de Balfegó. Les résultats indiquaient que la CPUE de 2014 consolide la tendance à la hausse observée ces dernières années, la CPUE étant six fois plus élevée que celle observée en 2013. En 2013 et 2014, la structure des âges estimée à partir des mesures des inspecteurs indiquait que les groupes d'âges modaux s'élevaient à 11 et 12 (classe d'âge de 2002 et 2003), des âges pouvant être considérés comme pleinement recrutés dans les zones de frai des Baléares à la fin du mois de mai. Ceci dit, étant donné que la période et la durée de la saison de pêche altèrent la distribution de la fréquence de tailles de la prise, les différences interannuelles de la structure des âges ne devraient pas être considérées comme des différences interannuelles de la structure du stock reproducteur.

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RESUMEN

Este estudio actualiza la serie temporal de tasas de captura de los cerqueros de Balfegó, 15 años de índices de abundancia continuos de reproductores en aguas baleares. Además, se estimaron aproximaciones de la frecuencia de tallas anual y la estructura por edad a partir de las estimaciones visuales comunicadas por los patrones en cada lance: talla y peso individual. Aunque estos datos no pueden proporcionar una estimación fiable de la frecuencia de tallas de la captura de la flota conjunta de Balfegó, es menos distorsionada que la extrapolación usada por ICCAT en los últimos años, estimada con el mismo procedimiento pero a partir de una submuestra de la flota de cerco francesa. Se estimó para 2013 y 2014 una frecuencias de tallas más fiable de la flota conjunta de Balfegó basada en técnicas de vídeo implementadas por inspectores españoles durante las transferencias de la captura a las instalaciones de engorde de Balfegó. Los resultados demostraron que la CPUE en 2014 consolida la tendencia ascendente observada en años anteriores: una CPUE seis veces más elevada que la observada en 2013. En 2013 y 2014, la estructura por edad estimada a partir de las mediciones de los inspectores demostró que los grupos de edad modal eran 11 y 12 (clase anual de 2002 y 2003), edades que podrían considerarse totalmente reclutadas en las zonas de desove baleares al final de mayo. Pero dado que el periodo y la longitud de la temporada de pesca altera la distribución de frecuencia de tallas de la captura, las diferencias interanuales en la estructura por edad no deberían considerarse diferencias interanuales en la estructura del stock reproductor.

KEYWORDS

Bluefin tuna, Catch rates, Purse seiners, Size distribution, Tuna farming

Introduction

The assessment of East Atlantic bluefin tuna will be improved by incorporating better-quality data. To minimize the uncertainty due to the poor quality or lack of data, it is necessary to update and improve the historical time series and enlarge it with data of more recent fisheries. The addition of new fishing indices is becoming essential, as some of the historical time series are losing spatial representativeness and continuity. Among the recent fishing modalities, very notable is the purse seine fishery of capture-based aquaculture, which may provide valuable information on ABFT spawners' trends in the most recent years. This was confirmed by the significant correlation found between the catch rates of the Balfegó fleet in the Balearic spawning ground and Spanish traps (Gordoa 2013), indicating the suitability of the Balfegó catch rates as an additional index of abundance of the East Atlantic Bluefin tuna spawners. On the other hand, it should be mentioned that the Balfegó CPUE did not show any significant correlation with the Morocco trap index, which may be indicative of a temporal mismatch between the Morocco and Spanish traps indices. The Balfegó CPUE has been presented in previous years (Gordoa 2010; Gordoa 2011; Gordoa 2013; Gordoa 2014) and in this study it is updated with the 2014 catch rates. In addition, the structure of the annual catch, based on visual haul estimations, is also updated, with the purpose of providing an approximation of the annual size frequency distribution. The method applied for this estimation is the same as that used by ICCAT for a subsample of French purse seiners haul descriptors, which have been extrapolated for the all the purse seine fleets. This generalization implies that the length frequency of the catch does not change between countries, fishing grounds or fishing periods. Although the estimation method is a rough approximation, if applied to the observed hauls of each fleet the results will be less distorted. The technological development implemented by the Spanish Directorate-General for Fisheries and carried out during the control protocol provides individual measurements of the tuna transferred to the Spanish fattening facilities. In this study we estimated the length frequency of catches by the Balfegó joint-fishing fleet in 2013 and 2014 and their respective age structure, which are compared with the rough estimations estimated previously from visual haul observations.

Material and Methods

The Balfegó purseiners' report on catch and fishing days has increased in detail from 2006 onwards. The information received from 2000 to 2005 was for the whole spawning season and from 2006 onwards it has been reported on a daily basis, haul by haul. Since 2006 the fishing period has changed, adjusting to the modifications implemented in the fishing season (**Table 1**).

In order to compare and minimize the annual variability in catch efficiency due to changes in the fishing period, an additional catch rate is being estimated for the period prior to the 8th of June. This temporal window was not subject to fishing before 2006, partially covered by the fleet from 2006 to 2009 and covering the whole fishing season from 2010 onwards. Annual catch rates were estimated by dividing the total catch (kg) of the Balfegó vessels by the total number of days in the fishing ground. The catch structure has been roughly estimated for those years when 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 fishing power or catching efficiency between vessels. Information on the catch of each haul is available for the years 2006, 2007 and 2009-2014. The information per haul collects the following descriptors: date, hour, position and visual estimation of catch in weight and number. A total of 196 hauls were analyzed.

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 ($W=0.000196*L^{3.009}$). Length frequency distributions were calculated by intervals of 10 cm.

The average age for each haul was estimated by 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). In addition, the annual average haul size was estimated in weight and number as a proxy of spawners' school size.

The length frequency distribution of the 2013 and 2014 catches was directly estimated and based on the individual length estimated by video techniques and presented with its resultant age structure using the same equation previously specified. The measurements, a new tool implemented in the control protocol, were made by Spanish fisheries inspectors at the time of transferring tuna from the transport vessels to the fattening facilities. The measured subsample represented 17.9 % of the tuna transferred in 2013 and 20% in 2014. The information has been provided by the Spanish Directorate-General for Fisheries.

Results

Annual Catch Rates (CPUE)

The annual CPUEs from 2006 onwards, represented by a solid line (**Figure 1**), are more consistent, as they were estimated over the same temporal window and may be indicative of the annual variation in the abundance of spawners in Balearic waters. The minimum levels of abundance were observed in 2006 and 2007, an average daily catch of around 10 t, and an increase was observed in 2008, reaching catch rates around 10.25 t. The catch rate level reached in 2008 remained steady until 2011 with slight annual fluctuations. A highly relevant increase in CPUE took place in 2012, three times higher than in 2011, where the average daily catch was around 35 t. In 2013 the positive trend continued, with an increase of 23% over the previous year. In 2014 the CPUE has increased intensely (6 times the 2013 CPUE), supporting the upward trend beyond all expectations.

From 2000 to 2006, vessels operated freely during the spawning season, targeting the period of highest density of spawners, so 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, the total catch rates up to 2009, represented by broken lines in **Figure 1**, are overestimated compared to the CPUE time series calculated from fishing carried out at the beginning of the spawning period (solid line).

Annual average haul size

The annual average haul size was calculated in weight (**Figure 2**) and number (**Figure 3**). The average weight of hauls did not show any significant differences between years until 2013. In the last two fishing seasons the haul size, indicative of the spawners' shoal size, has increased significantly, at least doubling the haul size of the previous spawning season.

Length Frequency Distribution

The length frequency distribution based on visual estimations of the catch of purse-seine sets showed high inter-annual differences (**Figure 4-5**). To some extent these differences may result from annual differences in the dates of the fishing season and in its extension. The wider the temporal window of the fishing season, the closer the catch will represent the length frequency of the spawners during the whole spawning season. The fishing season has gradually shifted to the beginning of the spawning period and, parallel to it, the number of fishing days at sea has been gradually reduced (around 30 days in 2006 to 1 day in 2014). As the arrival at the spawning ground is staggered and considered size-driven, only an extensive fishing season would ensure a size structure close to that of the spawners during the spawning season.

The apparently identical length frequencies from the visual observation of catch hauls (LFH) in 2013 and 2014 are clearly differentiated from those estimated from video technique measurements (LFS) (**Figure 6**). The LFH in 2013 and 2014 did not show any dispersion, the single interval length around 90 cm in both fishing seasons being lower than the modal length interval of LFS.

Age Structure

The representativeness of the age structure from purse seine catches suffered from the same flaw explained for size frequency distributions. The gradual losses of age classes in the purse seine annual catches cannot be interpreted as failures of year classes, although the outstanding age classes may provide information on relevant annual cohorts. But as these age classes are estimated from length frequencies estimated visually, which seem to underestimate those estimated directly from visual techniques, the corresponding ages should be similarly underestimated.

Age classes 4, 5 and 7 can be distinguished in the catch rates of 2006, 2007 and 2009 (**Figure 7**). Accordingly, these age classes would correspond to fish born in 2002 – but after 2010, when the quota was filled earlier, the 2002 year class goes off track. In 2010 and 2011 the maximum catch corresponds to the 2004 year class. In 2012 and 2013, the catch was dominated by the recognized 2003 year class previously observed in other fisheries (Kimoto *et al.*, 2013; Hanke *et al.*, 2013). In the 2014 catch, the 2005 year class stands out.

But these results are, without a doubt, very uncertain, as is shown by those obtained from video techniques (**Figure 8**). Results from video techniques are more precise but they only represent the age structure of spawners at the beginning of the fishing season, and the relatively low abundance of individuals younger than 9 years old cannot be extrapolated to the whole fishing season. The shorter the fishing season and the lesser number of hauls, the narrower the age interval. Assuming the absence of bias in the video measurements, the ascending catch trend with age up to the inflection point may result from an age differential pattern recruited to this particular spawning region and timing; the peak at 11-12 years may point to the ages fully recruited to the region by the end of May. The 2002 year class has been fully recruited in the 2014 fishing season and it has represented the modal age class in 2013 and 2014. The 2003 year class contributes significantly to the purse seiners' catch in 2013 and 2014 but is exceeded by the catch of the 2002 year class. However, there is a possibility that the identified cohorts, 2002 and 2004, in the previous years do, fully or partially, belong to the 2003 cohort.

The minimum weight established in 2007 has reduced juvenile catches and consequently the induced fishing mortality. The impact of this measure fully affects those tuna born after 2006 (younger than 7 years) but their arrival at the spawning ground may be later and their real abundance may be underestimated by the current fishing period.

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Table 1. Fishing periods and minimum size 2000-2014.

<i>Year</i>	<i>Start of closure period</i>	<i>Aerial survey</i>	<i>Minimum size (kg.)</i>	<i>Quota filled</i>
2000	16 July	Forbidden in June	6.4	
2001	16 July	Forbidden in June	6.4	
2002	16 July	Forbidden in June	6.4	
2003	16 July	Forbidden in June	6.4	
2004	16 July	Forbidden in June	6.4	
2005	16 July	Forbidden in June	10	
2006	16 July	Forbidden in June	10	11 July
2007	1 July	Forbidden in June	10	30 June
2008	1 July (closed by 23 June)	Forbidden	30	21 June
2009	15 June (+5)	Forbidden	30	13 June
2010	15 June (closed by 8 June)	Forbidden	30	8 June
2011	15 June	Forbidden	30	9 June
2012	15 June	Forbidden	30	26 May
2013	25 June	Forbidden	30	2 June
2014	25 June	Forbidden	30	27 May

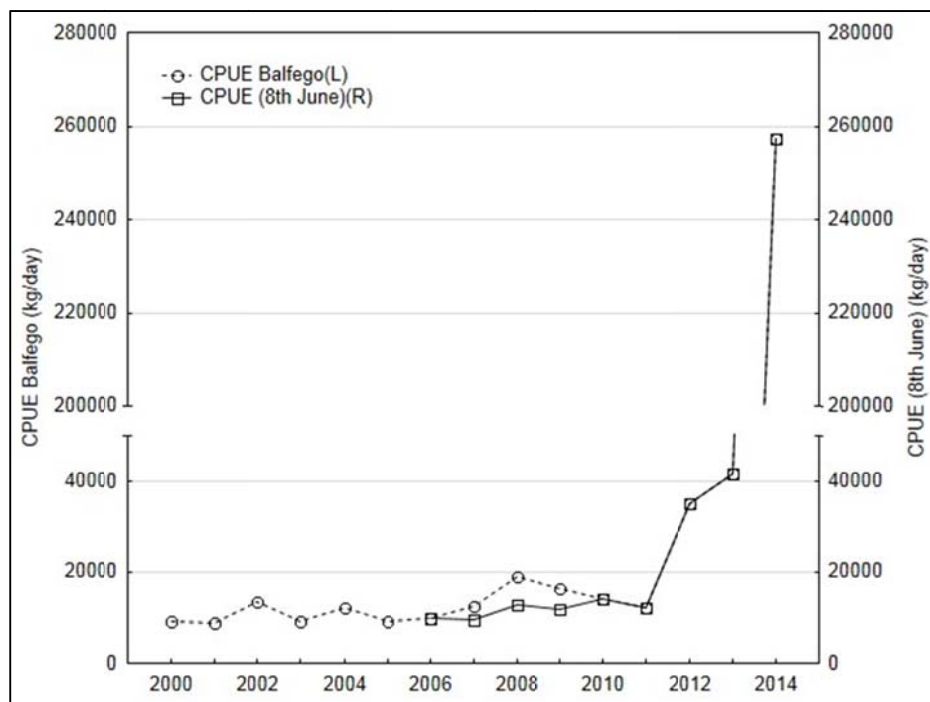


Figure 1. Balfegó CPUE (Kg/day) in Balearic spawning grounds; calculated from the whole spawning fishing season (broken line) and from catches before the 9th of June (solid line)

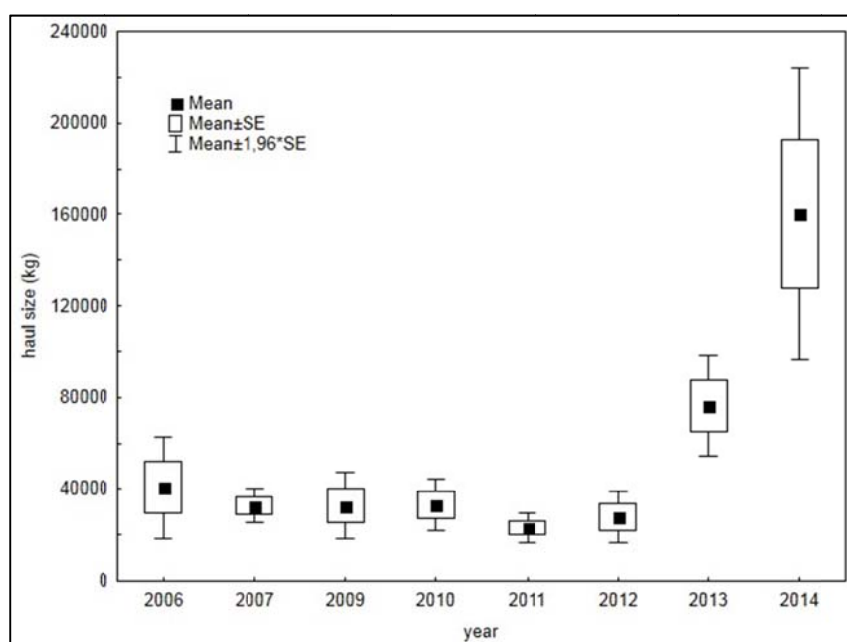


Figure 2. Annual average haul size in weight (kg) calculated from the Balfegó joint fishing fleet.

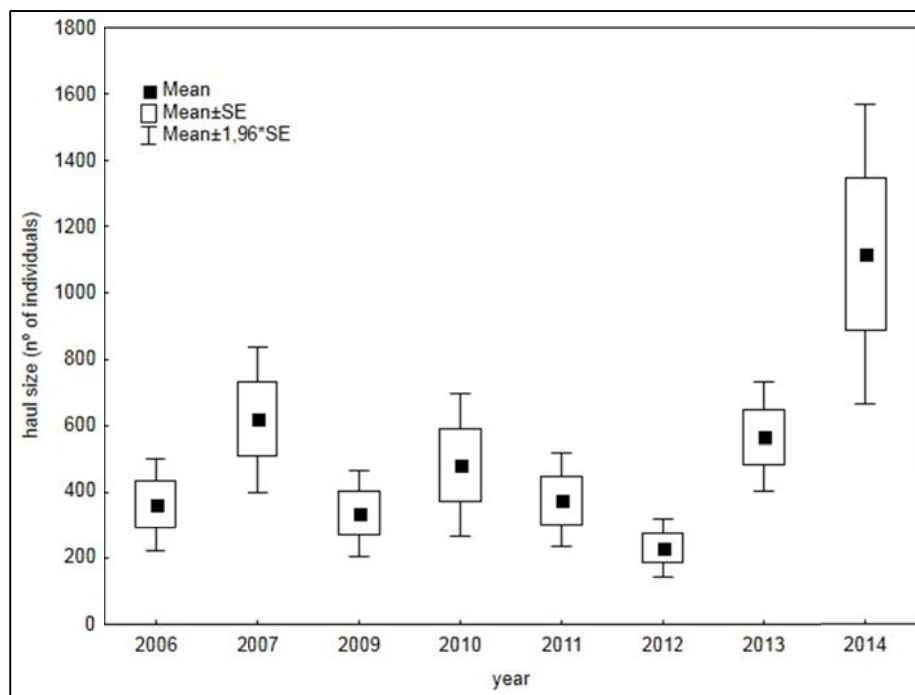


Figure 3. Annual average haul size in number of individuals calculated from the Balfegó joint fishing fleet.

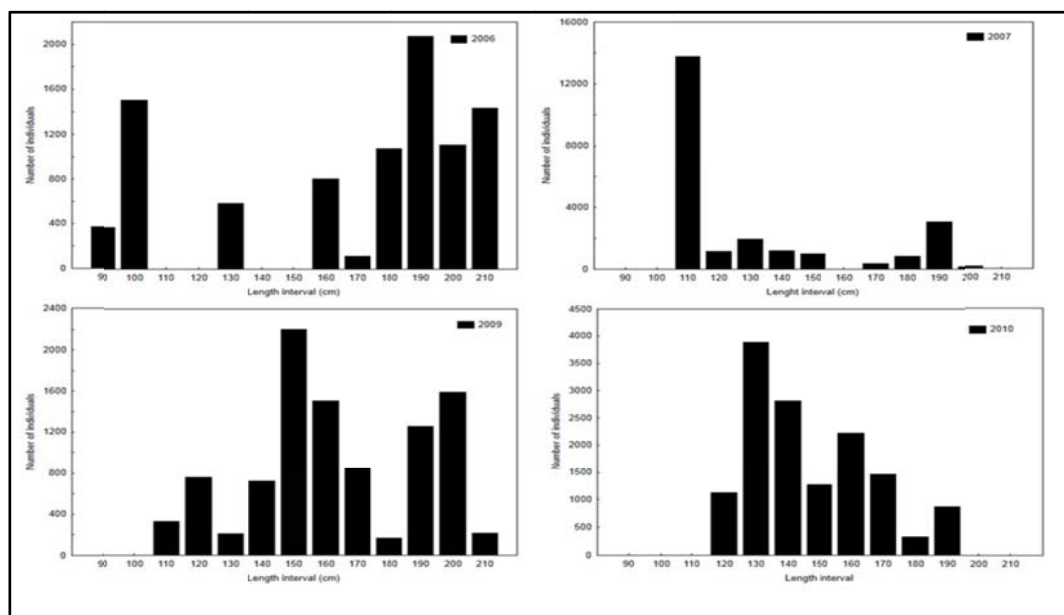


Figure 4. Length frequency distribution of the Balfegó joint fishing fleet from 2006-2010.

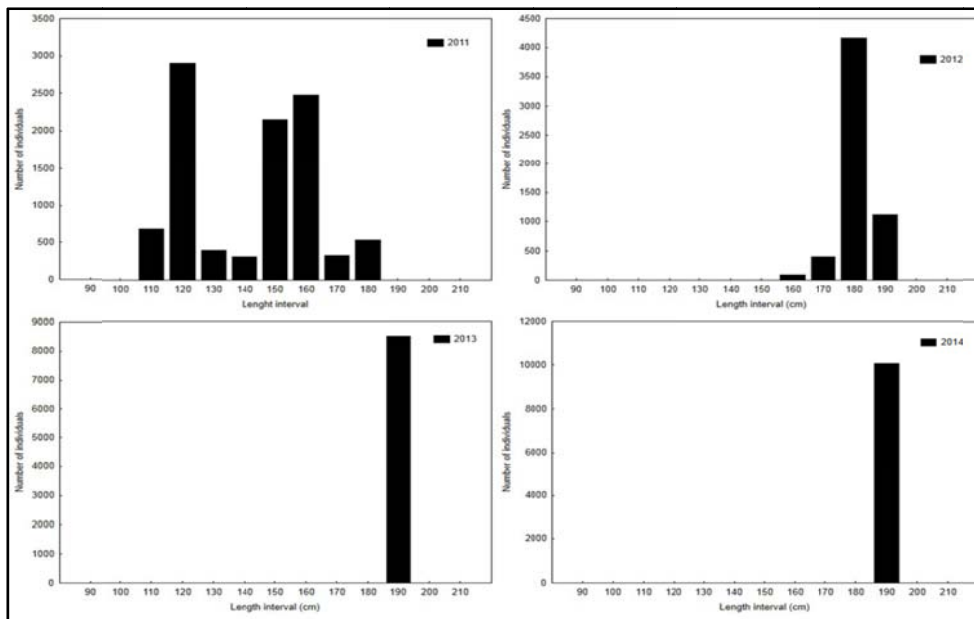


Figure 5. Length frequency distribution of the Balfegó joint fishing fleet from 2011-2014.

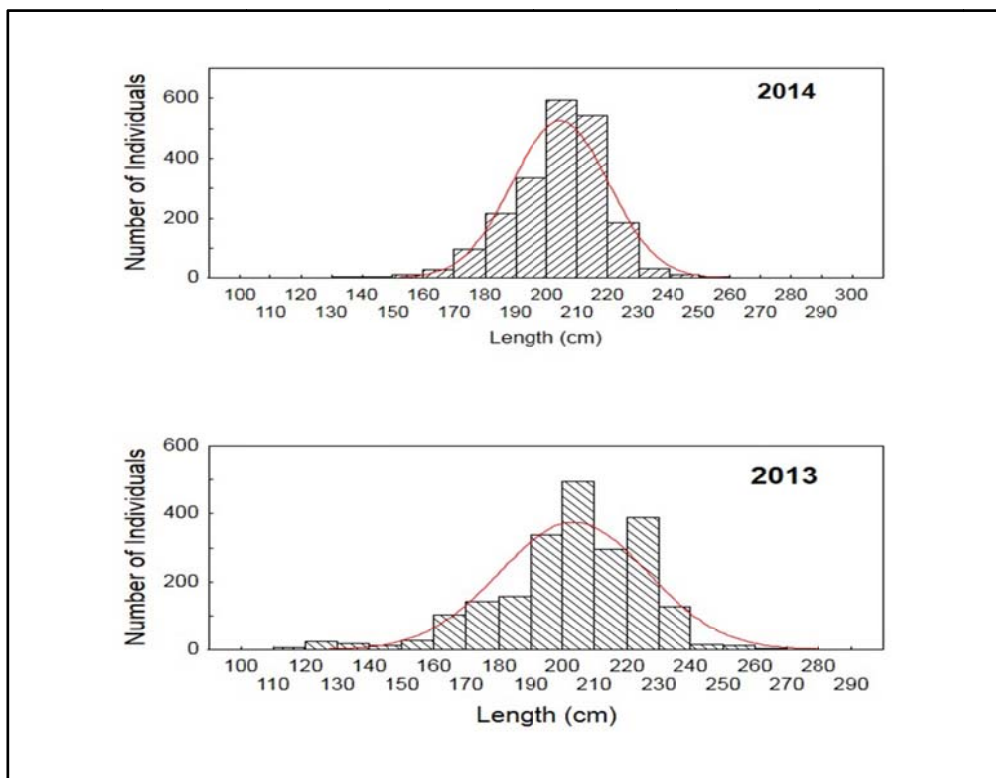


Figure 6. Size frequency distribution of the Balfegó purseiners fleet, based on video measurements.

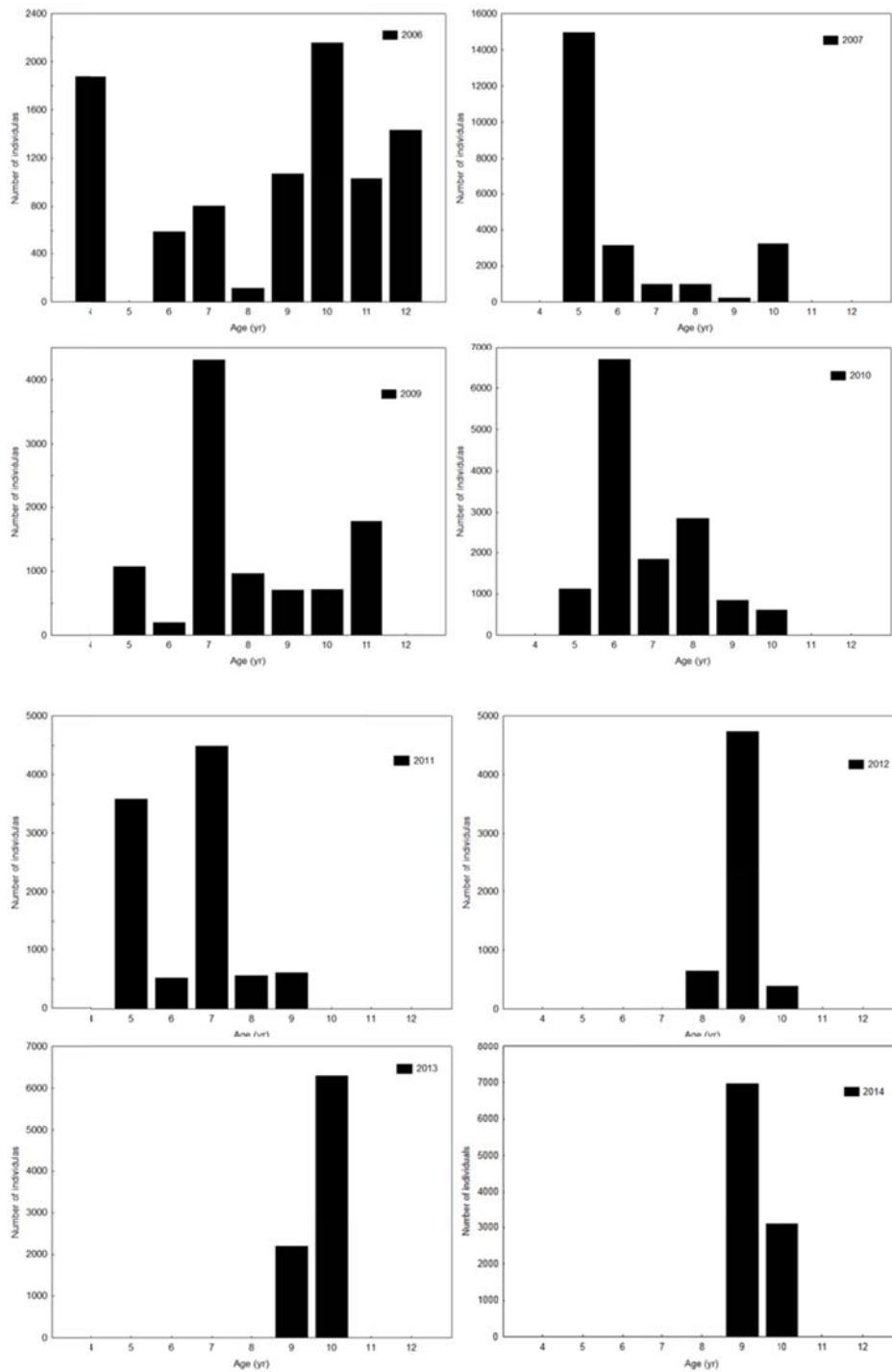


Figure 7. Atlantic Bluefin tuna catch age structure of the Balfegó joint fishing fleet from 2006-2014 estimated from visual haul approximation.

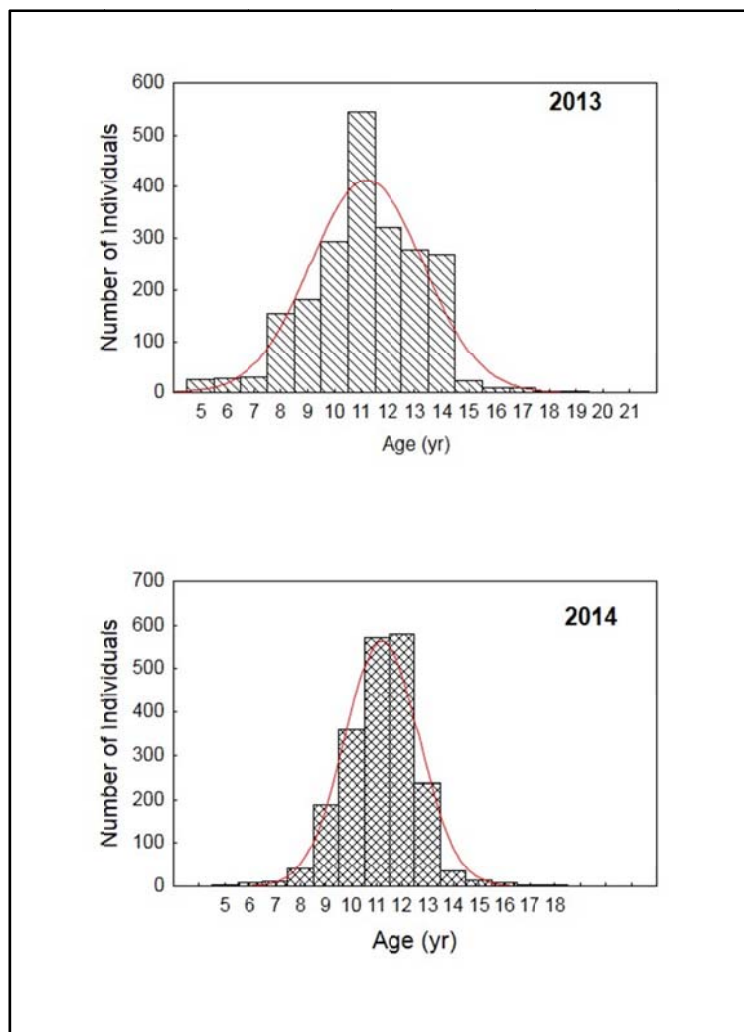


Figure 8. Catch age structure of the Balfegó purseiners fleet, derived from video measurements.