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ANALYSES OF CONNECTIONS BETWEEN ATLANTIC BLUEFIN TUNA FISHERIES AT BOTH SITES OF THE ATLANTIC COMPRISING BALFEGÓ CATCH RATES IN BALEARIC SPAWNING GROUND

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SUMMARY

This study analyzes connections among Atlantic bluefin tuna fisheries at both sites of the Atlantic. Catch rates of nine fisheries including Balfegó CPUE are analyzed in this study. In 2012 Balfegó CPUE near triplicates 2011 rates and showed the strength of 2003 cohort. The correlation analysis showed positive [1]correlations between The Gulf of St. Lawrence fishery, Japanese LL in area 2, Spanish traps and Balfegó purse seiners, indicators of the eastern Atlantic bluefin tuna breeders. The U.S. northeast Atlantic fishery correlates negatively with Gulf of St Lawrence, south of Nova Scotia and Japanese LL in region 17&18 but positively with eastern juveniles of Spanish baitboat indices of ages 1, 2, and 3. Japanese longliners indices of western and eastern correlate positively; no correlation was found within each group. Japanese longliners Area 3 correlates positively with Spanish baitboat age 1, age 2 with areas 5&med and 17&18. The south Nova Scotia fishery correlates negative with ages 3 and 4. Morocco traps, the only fishery that did not correlate with any other. This study showed valuable information and reveals the need to revise the current western and eastern fisheries categorization criteria and provides additional tool to investigate the Atlantic bluefin tuna distribution.

RÉSUMÉ

La présente étude analyse les connexions entre les pêcheries de thon rouge de l'Atlantique des deux côtés de l'Atlantique. Les taux de capture de neuf pêcheries, y compris la CPUE de Balfegó, sont analysés dans la présente étude. En 2012, la CPUE de Balfegó a presque triplé les taux de 2011 et a montré la force de la cohorte de 2003. L'analyse de corrélation a montré des corrélations positives entre la pêcherie du golfe du Saint-Laurent, la pêcherie palangrière japonaise dans la zone 2, les madragues espagnoles et les senneurs de Balfegó, indicateurs des thons rouges reproducteurs de l'Atlantique Est. La pêcherie de l'Atlantique Nord-Est des États-Unis a une corrélation négative avec le golfe du Saint-Laurent, le Sud de la Nouvelle-Écosse et la pêcherie palangrière japonaise dans les régions 17 et 18, mais elle a une corrélation positive avec les juvéniles orientaux des indices des canneurs espagnols d'âges 1, 2 et 3. Les indices palangriers japonais de l'Ouest et de l'Est ont une corrélation positive ; aucune corrélation n'a été trouvée au sein de chaque groupe. Les palangriers japonais de la zone 3 ont une corrélation positive avec les canneurs espagnols d'âges 1 et 2 dans les zones 5 & Méd. et 17 et 18. La pêcherie de la Nouvelle-Écosse a une corrélation négative avec les âges 3 et 4. Les madragues marocaines sont la seule pêcherie qui n'avait aucune corrélation avec les autres. La présente étude a fourni des informations importantes et révèle la nécessité de réviser les critères actuels de catégorisation des pêcheries de l'Ouest et de l'Est et fournit un outil supplémentaire pour examiner la distribution du thon rouge de l'Atlantique.

RESUMEN

Este estudio analiza las conexiones entre las pesquerías de atún rojo del Atlántico en ambos lados del mismo. En este estudio se analizan las tasas de captura de nueve pesquerías, lo que incluye la CPUE de Balfegó. En 2012, la CPUE de Balfegó casi triplicó las tasas de 2011 y demostró la fuerza de la cohorte de 2003. El análisis de correlación mostraba correlaciones positivas entre la pesquería del golfo de San Lorenzo, el palangre japonés en el área 2, las almadrabas españolas y los cerqueros de Balfegó, indicadores de los reproductores de atún rojo del Atlántico oriental. La pesquería estadounidense del Atlántico nororiental se correlaciona negativamente con el golfo de San Lorenzo, el sur de Nueva Escocia y el palangre japonés en la región 17 y 18, pero positivamente con los juveniles orientales de los índices de

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cebo vivo español de edades 1, 2 y 3. Los índices de los palangreros japoneses orientales y occidentales se correlacionan positivamente y no se halló correlación dentro de cada grupo. Los palangreros japoneses del área 3 se correlacionan positivamente con el cebo vivo español de edad 1 y 2 en las áreas 5 y med y 17 y 18. La pesquería del sur de Nueva Escocia se correlaciona de forma negativa con las edades 3 y 4. Las almadrabas de Marruecos son la única pesquería que no se correlacionaba con ninguna otra. Este estudio muestra información valiosa y revela la necesidad de revisar los actuales criterios de categorización de las pesquerías occidentales y orientales facilitando una herramienta adicional para investigar la distribución del atún rojo del Atlántico.

KEY WORDS

Bluefin tuna, Thunnus thynnus, geographical distribution, tuna fisheries, fishery management.

1. Introduction

The last assessment of East Atlantic bluefin tuna was associated with a high degree of uncertainty. The uncertainty due to the poor quality of data is a major persistent concern of the SCRS but the reliability of particular assumptions of the biological reference points had been also thrown into question (Suzuki, 2010). Moreover results from electronic tagging revealed high connectivity between individuals from eastern and western origin (e.g. Stokesbury *et al*., 2004; Block *et al*., 2005; Walli *et al*., 2009; Wilson *et al*., 2011) so the lack of data on population structure and movements may prevent the success of rebuilding plans (Rooker *et al*., 2008). There is a high diversity of fisheries harvesting on the ABFT populations with a wide spatial distribution which add a degree of difficulty but this complexity is also a valuable source of spatial information that may provide clues to deepen in the stocks distribution and linkages.

Different fisheries from both sides of the Atlantic showed an upper trend in their catch rates at the end of the last decade. The ascending trend, remarkable in 2009, was observed in: the Japanese longline fishery in the Northeast Atlantic (Kimoto *et al*., 2011), the southern Gulf of St. Lawrence (Paul *et al*., 2011), tuna traps of Portugal, Spain and Sardinia (dos Santos and Coelho, 2011; Ortiz de Urbina *et al*., 2011; Addis *et al*., 2012), Spanish bait boat fishery in the Bay of Biscay (Rodriguez-Marin *et al*., 2011) and Balfegó Purseiner fleet in the Balearic spawning ground (Gordoa, 2011). Some of this fisheries target exclusively without question on the Eastern stock where common trends should be expected. However the same trend in the Gulf of St. Lawrence, not observed in its closer fishing grounds (southwest Nova Scotia and U.S.A fishery) raised the question if the ascending trend in this region is due to environmental influences as pointed by Vanderlaan *et al*., (2011) or is influenced by the fluctuations of the Eastern stock. It is also remarkable that Morocco trap CPUE index did not show the ascending trend observed in the CPUE of Portugal, Spanish or Sardinian traps.

The aim of this study is to analyze potential connections among fisheries at both sites of the Atlantic to contribute to the understanding of the effect of the spatial connectivity between the stocks on different fleets and to deepen in the adequacy of the indices currently used for each stock. In addition the catch rates of Balfego purse seiners in the Balearic spawning ground are updated (2000-2012) as additional information of the temporal trend of the spawners in the Balearic spawning ground. The Balfegó CPUE time series has been presented in previous years (*Gordoa 2009; Gordoa* 2010) and here it is contrasted with other fisheries indicators to assess its reliability as an additional indicator.

2. Material and Methods

Balfegó purse seiners provided their catch and fishing days since 2000 and from 2006 catch was reported on daily basis haul by haul.

The total Catch per unit effort during the spawning season is sensitive to the fishing period as the density of spawners increase gradually from the first arrivals to the peak of spawning which in this region takes place around the third week of June (Gordoa 2010) so since the fishing season was advanced to the 15^{th} of June the annual catchability of purse seiners decreased. To remove from the CPUE the annual variability due to changes in the fishing period an additional catch rates have been estimated for the period earlier to the 8th of June, a temporal window partially covered by the fleet since 2006.

The age catch structure has been roughly estimated for those years that the catch has been reported haul by haul. In this analysis the hauls from the whole Balfego 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 and 2012. A total of 172 hauls were analyzed. The provided information per haul gathered the following descriptors: date, hour, position, estimated catch in weight and number.

For each haul the individual weight was estimated by dividing the estimated catch in weight by the estimated catch in number. Once estimated the weight, the length per haul was estimated applying the growth length weight relationship adopted by ICCAT (2010) for the East Atlantic and Mediterranean stock for individuals bigger than 100 cm ($W = 1.96*10^{-5} * FL^{3.009}$). Next, 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 and Mediterranean stock ($K= 0.093$; $L_\infty=319$; $t_0=-0.093$) and adopted by ICCAT (2010).

The set of fisheries indicators considered in this study were:

1. Moroccan Atlantic traps CPUE scaled index (Abid and Idrissi, 2010), analyzed period: 1986-2009. Labeled in this study as: MT
2. Spanish traps Standardized relative abundance indices by age (Ortiz de Urbina *et al*., 2011), analyzed period: 1984-2009. Labeled in this study as: A5, A6, A7, A8, A9, A10+.
3. Balfego purse seiners CPUE (estimated in this study), analyzed period: 2000-2012. Labeled as: Bp.
4. Line/rod and reel fishery in the Gulf of St. Lawrence standardized CPUE (Paul *et al*., 2011). Analyzed period: 1984-2009. Labeled as: GstL.
5. Rod and reel/ tended line/harpoon in the Southwest Nova Scotia standardized CPUE (Paul *et al*., 2011). Analyzed period: 1984-2009. Labeled as: SNS.
6. Rod and reel/handline fishery off Northeast United states standardized CPUE by size (Brown, 2011). Analyzed period: 1993-2009. Labeled as: US.NE66-114, US.NE115-144, US.NE>177.
7. Japenese Longline Western indices; Area2 (analyzed period: 1984-2009), Area 3 (analyzed period: 1990-2009), Area17+18 (analyzed period 1984-2009).
   (Source: BFTCPUEsWest20100619.xls). Labeled as: JPLLWa2, JPLLWa3, JPLLWa17&18.
8. Japenese Longline Eastern indices: Area 5 and Med (analyzed period: 1984-2009); Central (Area3) + Northeast (Area4 + Area5 (north of 40N)) (analyzed period:1990-2009).
   (Source: BFTCPUEsEast20100619.xls). Labeled as: JPLLEa5&med, JPLLEa345.
9. Spanish bait boat fishery scaled CPUE by age (BFTCPUEsEast20100619.xls). Analyzed period 1984-2009. Labeled as: BB1, BB2, BB3, BB4, BB5+.

To identify potential links between fisheries Pearson correlation analyses were estimated between series by casewise deletion of missing data. Autocorrelation analyses were run for each series in order to identify cycling patterns with the exception due to the length limitations of USA.NE and Balfegó series.

3. Results and Discussion

The two Balfegó CPUE time series showed differences in the annual trends with the exception of the last three years where the fishing temporal window was the same for both time series (**Figure 1**). Unfortunately catch rates before the 8th of June could not be estimated for the first five years as purseiners fishing activity on the spawning ground was carried out later in the fishing season. In those early years the purseiners deployed their activity during the period of higher fishing efficiency.

The CPUE (8th June) showed a clear positive trend from 2007 to 2008. The 2008 catch rate exihibit little changes from 2009 to 2011 fluctuating around 12,6 tons per day. The catch rate in 2012 revealed an strong increase , close to triplicate 2011 CPUE. Consequently, 2012 quota was filled fast, in six fishing days and fishing activity finished by the end of May.

The results of catch structure by age should be pondered with caution as they derived from a rough estimation of catch in weight and number per haul. In adition the fishing period changed from year to year, from a wide temporal window in 2006 (June-July) to the narrowest in 2012 (May). The wider the temporal window the wider size range of spawner should be expected as this species undertakes a hierarchical migration according to the size of fish, arrival is gradual and considered chronological segragated by spawners size, the larger spawners enter first into the Mediterranean (Idrisi and Abid, 2011; Abid *et al*., 2012). The average length per month and year of Balfegó purseiners also corroborate previous observations (**Figure 2**). Consequently the annual catch by age also showed high variability between years (**Figure 3**). Nevertheless some strong cohorts could be identify. The high cacth of individuals of age 4 in 2007 pointed the strength of the 2003 cohort but not noticeable in the following years until 2012 with the remarkable catch of 9 yrs old individuals. The strength of 2003 cohort was also observed in the Spanish bait boat fishery (Rodriguez-Marin *et al*, 2011). The age class 4 was absent in the fishery after 2007, this could be result of the advance in the closure of the fishing season. The catch of age 5 in 2010 and 2011 was also noticeable, presumibly corresponding to 2005 and 2006 cohorts respectively, but were undetectable in the following years unless a missestimaton in ageing occurred. The missestimation was likely to happen due to the rough age aproximation done in this study. The increase in catch of age 5 in two consecutive years could be partially due to the conservation measure implemented by ICCAT in the minimum size limit.

The results of Balfegó CPUE trend showed similarities with other fishing indicators reported in previous studies presented in ICCAT 2010 WG. At the time of writing this document the updated time series are unknown and updated comparisons with other fisheries can not yet be extended to 2012.

The results of correlations between different fisheries showed certain links between eastern and western fisheries and no realtionships among closer fisheries at each side of the Atlantic (**Table 1**). This is the case of the Spanish and Morocco traps fisheries which did not show any significant correlation between them. The Spanish trap catch rates form age 5 to age 9 correlates significantly between them. Catch rates of ages 8 and 9 correlated significantly with Balfegó catch rates as well as with the western fishery in the Gulf of St. Lawrence. In addition catch rates of Japanese longline fleet in area 2, used as index for the western stock, also showed significant correlation with Spanish traps, age 8 and 9, and with Gulf of St Lawrence fishery and close to be significant with Balfegó purse seiners catch rates (no significant probably due to the short length of Balfegó time series). On the contrary the Japanese indices used for the eastern stock did not correlate with Spanish traps.

The Japanese longline indices showed an unexpected relationship between them. It should be highlighted the high correlation (r=0.99) between Japanese west index of area 17&18 and the one considered east, area5&med. Also a strong relationship (r=0.99) was observed between the eastern indices of area 345 and the area 3 for the western, here most of the fluctuations should be caused by area 3. From the spatial overlap of western and eastern breeders shown by Block *et al*., (2005) the region corresponding to area 3 is characterized by high overlapping, the overlap decrease significantly towards eastern regions, areas 4 and 5. Thus, based on this results it will be convenient to work the three areas separately, area 3 are influence by both stock while in area 4 and 5 the influence of the western stock could be irrelevant.

The U.S. northeast Atlantic fishery catch rates of the smaller group (66-144) correlates negative with other western fisheries: the Nova Scotia fishery and Japanese longline index of 17&18. A further investigation should be developed to discern if the observed negative correlation is indicative that the smaller tuna alternates its distribution between both feeding grounds, fluctuating from northward (South Nova Scotia) to southward distribution (USA NE) in addition to the seasonal migratory pattern revealed in previous studies (Stokesbury *et al*., 2004; Block *et al*., 2005; Walli *et al*., 2009). The same group (US.NE66-144) correlates negatively with Area5 & Med where apparently fluctuations are dominated by area 5. This should be tested using only area5 index with NE 66-144 index. The only positive correlation of this size class was with the CPUE of age 1 of Spanish bait boat fishery. The catch rates of the intermediate size class (115-144) correlates also positive with the catch rates of age 2 of Spanish bait boat fishery. The catch rates of the bigger group (US.NE>177) correlates negative with the Gulf of St. Lawrence but when correlations are done over the last decade period (r=-0.22) it lose significance while increase the Gulf of St. Lawrence with the Spanish traps (StA5, r=0.77; StA6, r=0.64, StA8, r=0.72 and StA9, r=0.84)). This is indicative that the breeders in the Gulf of St Lawrence belong to both stocks with high contribution of the eastern and the contribution of eastern fraction could be increase during last decade. This contrast with the high percentage of giant Bluefin tuna of western origin reported in the Gulf of St. Lawrence by Rooker *et al*., (2008).

To understand the results of the relationship of Spanish bait boat CPUE series by age with other fisheries is necessary to remark that the correlation within these series is only significant between age 3 and 4. CPUE of age 1 only showed positive correlation with western indices: JPLLW3, JPLLW345, and USANE66-115 fisheries.

Age 2 correlates positively with Japanese longline eastern index of Area5&Med, likely due to area 5 fishery and not related with the Mediterranean catch rates as they are still immature individuals. Age 2 also correlates positive with western indices: 17&18 and USANE115-144. Age 3 had a negative correlation with South Nova Scotia index and positive with the CPUE of the small fishes (66-144) of USA NE fishery, these western fisheries also showed a negative correlation between them. Does it mean that these age groups when they feed predominantly off NE USA waters rather than south of Nova Scotia feeding grounds then the transatlantic migration mostly ends or begins in the gulf of Biscay? This is no more than hypothesis that needs further analysis. Anyhow there is no doubt that the bait boat CPUE time series for ages 1 to 3 correlate positively with USA NE fishery and age 1 with area 3, age 2 with area 5 and 17&18. But age 4 only correlates negatively and it did with: South Nova Scotia index and Japanese Longline in area 17&18 and Area5&Med and the western index of areas 17&18. In other words when CPUE of age 4 goes up in the Gulf of Biscay it goes down in South of Nova Scotia, area 17/18 and Area 5. It should be highlighted that age 2 and age 4 showed opposite correlations with Area 5 and areas 17&18 and age 4 does not correlate positively with any other fishery. Age 5+ of Spanish bait boat only correlates with the oldest age group of Spanish traps (10+).

Autocorrelations analyses were applied for each time series with the purpose of identifying cyclic fluctuations. Some fisheries showed significant autocorrelation; Spanish traps significant but negative every 4 years for ages 5, 6, and 8. Also negative and every 8 years for Morocco trap and age 4 in Spanish Bait boat fisheries. Positive autocorrelation was observed every 8 years for catch rate of age 1 of Spanish Bait boat fisheries. Japanese longline fishery in Area2 correlates positively every 2 years. Further investigation should be done to analyze if these apparently cycling patterns in some fisheries influenced or hide linkages between fisheries and to what extent they are driven by oceanographic patterns.

4. Summary

Morocco traps were the only fishery that did not correlate positive or negative with any of the fisheries analyzed in this study.

The Gulf of St. Lawrence fishery, Spanish traps, Japanese LL in Area2 and Balfegó purse seiners showed significant positive correlations. This is indicative that these fisheries are linked by the same stock and can be consider as indicators of the fluctuations of the Eastern Atlantic Bluefin tuna spawners. The Japanese longline indices showed an unexpected relationship between them. Japanese longline fishery of Area·3&4&5 represents mostly the fishery in Area 3 (r=1). The indices of Area 17&18 strongly correlate with Area 5&Med (r=1). Thus western and eastern Japanese indicators correlates positively while no correlation have been found within each group. It should be consider separately indices by each area: 3, 4, 5 and Mediterranean.

The USA northeast Atlantic fishery did not show any positive correlations with western or North or central Atlantic fisheries but significantly negative. The catch rates of the smaller group (66-144 cm) correlate negative with: the fishery in South of Nova Scotia, Japanese longline in area17&18 and Area5&Med. While the bigger group (> 177 cm) correlates negative with the Gulf of St. Lawrence fishery. The positive correlations were found with the Spanish bait boat indices of ages: 1, 2, 3.

The CPUE by age group of the Spanish bait boat fishery helps to understand the spatial dynamic of younger tuna. Catch rates of 1 year old tuna also correlates positively with Japanese longline in Area 3. Catch rates of Age 2 also correlates positively with Japanese fishery in area 17&18 and area 5&Med. The previous relationship found between area17&18 and area5&med could be due to this age group. Age 3 which also correlate positively with USA.NE fishery showed a negative correlation with South Nova Scotia fishery. Also should be investigated in future studies if the negative relationship found between these neighbor fisheries could then be mostly due to tuna around Age 3 of eastern origin. The distribution of this age group in the western Atlantic may shift from USA NE feeding grounds to Nova Scotia. Catch rate of Age 4, contrary to the younger groups, correlates negatively with USA.NE fishery and also with Nova Scotia, Area5&Med, and Area 17&18. Does it mean that when age 4 visited the Gulf of Biscay does not have any transatlantic migration? But as there is no evidence that age 4 is present all year around in the Gulf of Biscay then the doubt is to where this age class moves afterwards. The bait boat catch rate of the older group (5+) only correlates with the older group of Spanish traps.

The results presented here showed that North American fisheries appear to be supported to a large degree by the Mediterranean juvenile (< 4 years) population. Juvenile could exhibit preferential and distinctive areas in the Atlantic, age 1 in Area 3, Age 2 in Area 5 (<2 years). The negative correlation of bait boat Age 3 and Age 4 with south Nova Scotia fishery area is also indicative that these groups visited that region. Where age 4 moves towards after visiting the Gulf of Biscay should be investigated but the lack of positive correlation with the western fishery could be indicative that at this phase most of them does not move to western feeding grounds and a more detail information of catch rates in European waters could enable to clarify it.

The analyses between different fisheries showed linkages between them that help to understand the Atlantic Bluefin tuna distribution and should be considered a valuable tool to understand the type of information fisheries indices are providing. In this study the approach have been done to understand the linkage of eastern fluctuations with the western and it should be completed with a more detail spatial information and also completed with a western population approach by including in the analysis indices from the Gulf of Mexico.

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Table 1. Pearson´s correlation coefficient between 9 different fisheries. **GstL**: Gulf of St. Lawrence; **SNS**: South Nova Scotia; **StA5-AsTA10+:**Spanish traps for ages 5 to 10+; **Mt**: Morocco trap; **US.NE66-114**: USA North East Atlatic group size 66-114; **US.NE 115-144**: USA North East Atlatic group size 115-144; **US.NE>177**: North East Atlatic group size >177 cm; **Bp**: Balfegó pusein fleet; **JPLLEa5&med**: Japanese long line fleet area 5 and Mediterranean; **JPLLEa345:** Japanese long line fleet area 3-5; **JPLLWa2:** Japanese long line fleet area; **JPLLWa3:** Japanese long line fleet area 3; **JPLLWa17&18**: Japanese long line fleet area 17 and 18; **SPBB1-SPBB5+:** Spanish bait boat fishery from age class 1 to 5+. * significant coefficients ($p<0.05$)

	GstL	*SNS*	*StA5*	*StA6*	*StA7*	*StA8*	*StA9*	*StA10+*	*Mt*	*US.NE 66-114*	*US.NE 115-144*	*US.NE >177*	*Bp*
GstL	1.00												
SNS	-0.04	1.00											
StA5	0.18	0.06	1.00										
StA6	0.06	0.24	**0.89***	1.00									
StA7	0.27	0.26	**0.79***	**0.92***	1.00								
StA8	**0.55***	0.12	**0.68***	**0.74***	**0.91***	1.00							
StA9	**0.61***	0.04	**0.59***	**0.62***	**0.77***	**0.93***	1.00						
StA10+	0.09	-0.05	0.17	0.25	0.19	0.27	0.49	1.00					
Mt	-0.01	-0.04	-0.10	-0.07	-0.07	0.01	0.05	0.15	1.00				
US.NE 66-114	-0.36	**-0.71***	0.39	0.27	-0.05	-0.26	-0.27	0.21	- 0.22	1.00			
US.NE 115-144	-0.14	-0.39	-0.35	-0.22	-0.06	-0.04	-0.01	0.06	0.47	-0.19	1.00		
US.NE >177	**-0.59***	-0.46	-0.03	0.07	-0.07	-0.26	-0.31	0.19	0.14	0.31	**0.77***	1.00	
Bp	**0.61**	0.26	0.43	0.49	0.51	**0.65***	**0.70***	0.51	- 0.33	-0.37	-0.18	-0.15	1.00

Table 1. cont.

	JPLLEa5&med	JPLLEa345	JPLLWa2	JPLLWa3	JPLLWa17&18
GstL	-0.1	0.11	**0.81***	0.11	-0.1
SNS	0.33	-0.41	-0.08	-0.41	0.33
StA5	-0.29	0.06	0.27	0.06	-0.29
StA6	-0.23	-0.14	0.1	-0.15	-0.23
StA7	-0.11	-0.15	0.21	-0.15	-0.11
StA8	-0.03	-0.07	**0.42***	-0.08	-0.03
StA9	-0.04	-0.11	**0.52***	-0.12	-0.04
StA10+	-0.05	0.03	0.09	0.03	-0.05
Mt	0.09	-0.02	-0.12	-0.02	0.09
US.NE 66-114	**-0.52***	0.16	-0.21	-0.16	**-0.52***
US.NE 115-144	0.24	-0.23	-0.18	-0.22	0.24
US.NE >177	-0.12	0.45	-0.38	0.46	-0.11
Bp	0.4	0.29	0.49	0.29	0.04
JPLLEa345	-0.35	1			
JPLLWa2	-0.21	0.37	1		
JPLLWa3	-0.35	**1.00***	0.37	1	
JPLLWa17&18	**1.00***	-0.34	-0.2	-0.35	-0.35

Table 1. cont.

	SPBB1	SPBB2	SPBB3	SPBB4	SPBB5+
GstL	-0.14	-0.15	-0.14	-0.06	0.11
SNS	0.30	0.21	**-0.51***	**-0.47***	-0.11
StA5	0.18	-0.22	0.22	0.08	0.10
StA6	0.12	-0.20	0.02	0.09	0.22
StA7	-0.02	-0.13	0.01	0.00	0.17
StA8	-0.18	-0.14	0.09	0.10	0.18
StA9	-0.20	-0.16	0.13	0.08	0.25
StA10+	0.06	0.08	0.24	0.26	**0.46***
Mt	0.21	-0.02	-0.12	-0.14	-0.01
US.NE 66-114	**0.64***	-0.01	**0.52***	0.31	0.03
US.NE 115-144	-0.42	**0.58***	0.25	0.18	0.01
US.NE >177	0.38	0.38	0.44	0.36	0.13
Bp	-0.16	0.17	***0.46***	0.00	-0.18
JPLLEa5&med	-0.32	**0.43***	-0.09	**-0.51***	-0.38
JPLLEa345	**0.65***	0.05	0.35	0.35	0.10
JPLLWa2	0.35	-0.23	0.13	0.26	-0.02
JPLLWa3	**0.65***	0.06	0.35	0.35	0.1
JPLLWa17&18	-0.32	**0.43***	-0.09	**-0.51***	0.38

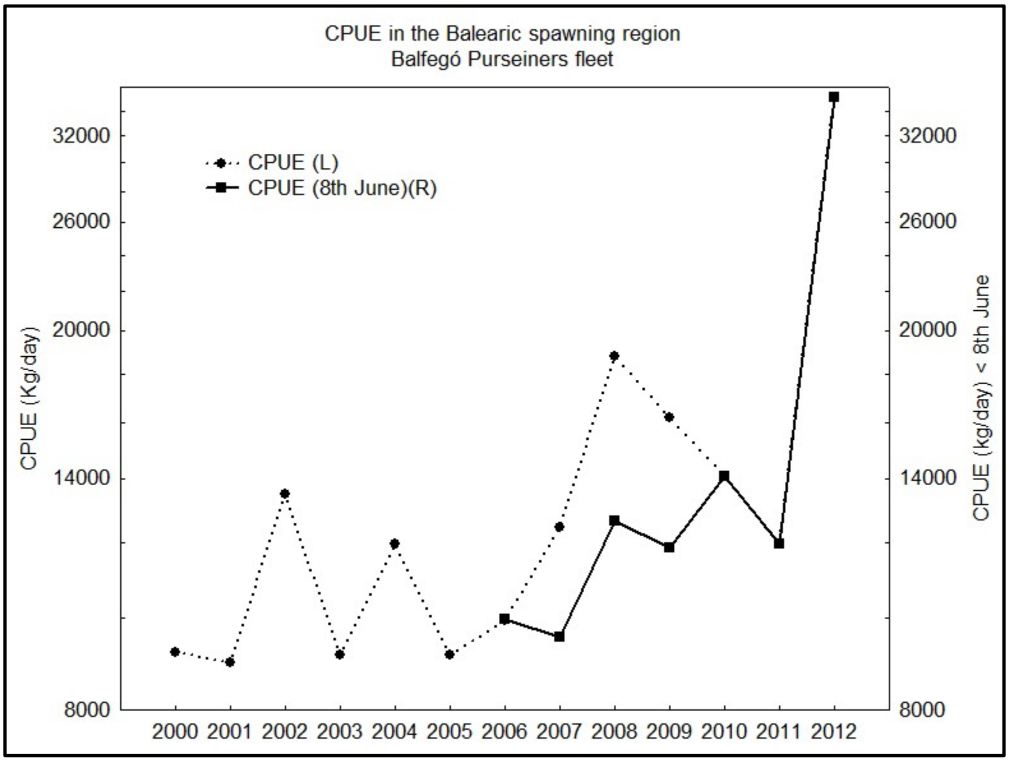

Figure 1. Daily catch rate (kg/day) of Balfego purseiners in the Balearic spawning ground. Broken line: cacth rate estimated over the whole fishing season, Solid line: catch rate estimated over the period earlier to the 9th of June.

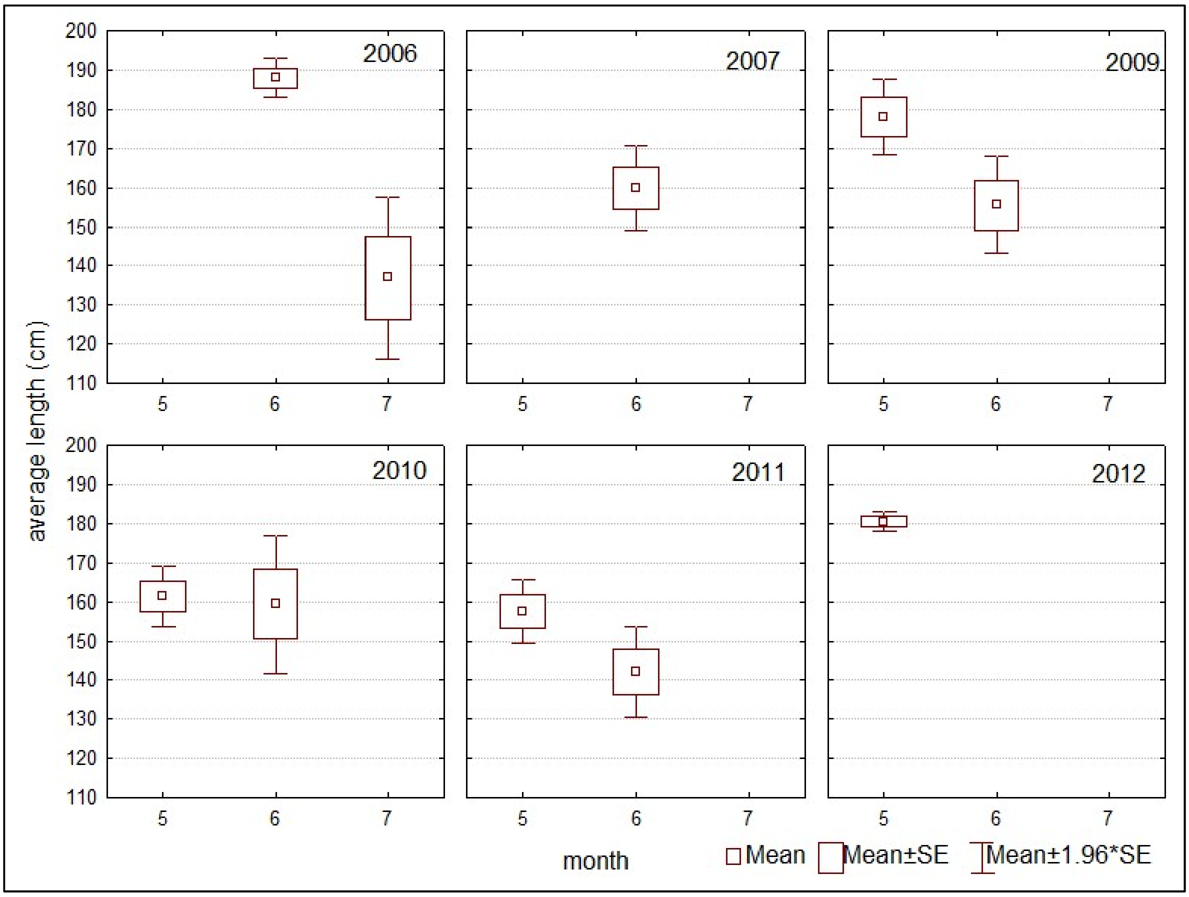

Figure 2. Average length (cm) per month and year caught by Balfegó joint fishing fleet.

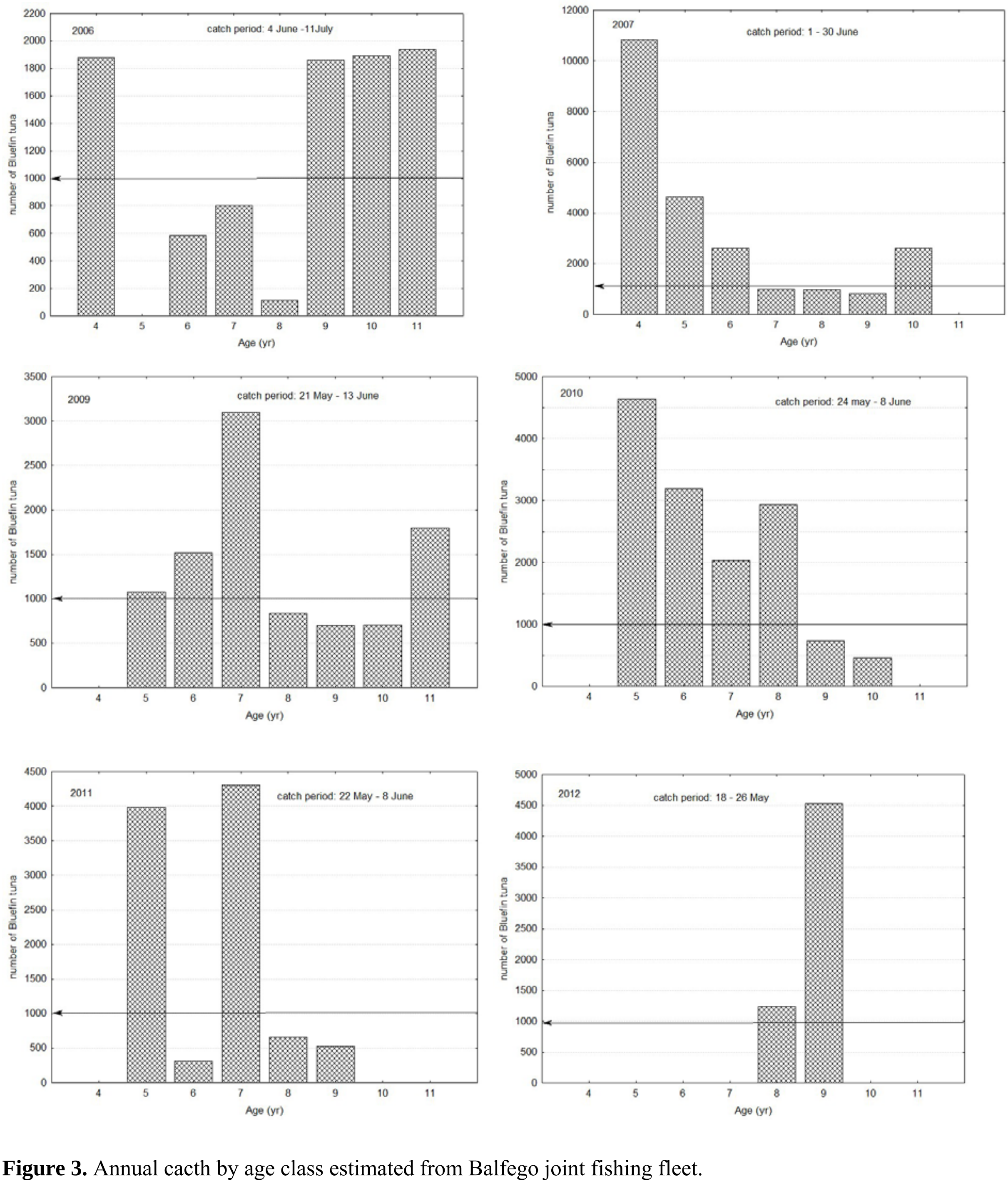

Figure 3. Annual cacth by age class estimated from Balfego joint fishing fleet.