UPDATE REVIEW OF BLUEFIN TUNA (*THUNNUS THYNNUS*) SIZE AND WEIGTH MEASURES TAKEN WITH STEREO VIDEO CAMERAS AT CAGING OPERATIONS IN THE MEDITERRANEAN SEA 2014

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SUMMARY

Size frequency data of bluefin tuna from stereo-video camera systems at caging transfer operations was compiled, updated and preliminary analysis done to estimate size at catch of farmed fish. Preliminary results indicated a multimodal size distribution for bluefin destined to farming in 2014; with a large mode of small fish of about 75 FL cm, and two modes for medium 120 FL cm and large 210 FL cm. Comparisons with alternative catch at size estimates from prior years (2010-2013) indicate significant differences of density and cumulative size frequency distributions by flag. At present, however it is not possible to conclude if these differences are due to changes in the catch of 2014 compare to prior years or to the methodology for estimating catch at size from the size at harvest reports. Weight estimates from the stereo video systems need to be revised, including standardizing the size-weight relationship used in the video algorithms.

RÉSUMÉ

Les données de fréquences de tailles du thon rouge obtenues au moyen des systèmes de caméras stéréoscopiques au moment des opérations de transfert dans les cages ont été rassemblées, mises à jour et analysées de manière préliminaire afin d'estimer la taille au moment de la capture des poissons élevés. Les résultats préliminaires indiquaient une distribution de taille multimodale du thon rouge destiné à l'élevage en 2014, avec un mode important de petits poissons d'environ 75 cm FL et deux modes de poissons de taille moyenne (120 cm FL) et de grande taille (210 cm FL). Des comparaisons avec d'autres estimations de la prise par taille d'années antérieures (2010-2013) montrent des différences significatives de densité et de distributions cumulatives de la fréquence des tailles par pavillon. À l'heure actuelle, il n'est toutefois pas possible de conclure si ces différences se doivent aux changements de la capture de 2014 par rapport aux années antérieures ou à la méthodologie employée pour estimer la prise par taille à partir des rapports de la taille au moment de la mise à mort. Les estimations de poids obtenues à partir de systèmes de caméras stéréoscopiques doivent être révisées et il convient de standardiser la relation taille-poids utilisée dans les algorithmes de la vidéo.

RESUMEN

Se compilaron y actualizaron los datos de frecuencias de tallas de atún rojo obtenidos mediante sistemas de cámaras estereoscópicas en las operaciones de transferencia a las jaulas y se realizó un análisis preliminar para estimar la talla de captura de los peces de las granjas. Los resultados preliminares indicaban una distribución de tallas multimodal para el atún rojo destinado a granjas en 2014, con una gran moda de peces pequeños de aproximadamente 75 cm FL y dos modas para ejemplares medianos 120 cm FL y grandes 210 cm FL. Las comparaciones con estimaciones alternativas de captura por talla de años anteriores (2010-2013) mostraron importantes diferencias de densidad y distribuciones de frecuencias de tallas acumulativas por pabellón. Sin embargo, en la actualidad, no es posible concluir si estas diferencias se deben a cambios en la captura de 2014 en comparación con años anteriores o a la metodología utilizada para estimar la captura por talla a partir de los informes de talla en el momento del sacrificio. Se tienen que revisar las estimaciones de peso obtenidas a partir de sistemas de vídeo estereoscópicos se tiene que revisar, lo que incluye su estandarización, la relación talla-peso utilizada en los algoritmos de vídeo.

KEYWORDS

Bluefin, Farm bluefin tuna, Size frequency

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1. Introduction

Farming operations has become one of the major destinations of most of eastern bluefin tuna catches in the latest decade. Based on the catches by purse-seine fleets, about 60% of the annual catch is destined to farms in the Mediterranean Sea. Because of the logistics of the fishing operation and transfers of live fish into the cages at farms, there has been limited information on the size and age distribution of caught wild bluefin recently. This has substantially increased the uncertainty in recent stock status evaluations (Anon. 2013). The SCRS had recommended exploring and implementing alternative methods for sizing the catches of bluefin tuna destined to farming operations. After several trials, research between scientist, government authorities and bluefin tuna farms have reached a point for implementing protocols with Stereo-video cameras at transfers between holding pens and farm cages for recording passing bluefin fish (http://www.aq1systems.com/farming/13510002). With the assistance of specialized software, the video recordings allow to count and measure fish and using conversion factors, estimate the weight of individual fish.

In 2014 several CPCs began submitting data collected from the Stereo Video camera systems to the Secretariat, this document is a preliminary analysis of size and weight measures collected and submitted as of February 2015 for the 2014 calendar year. The primary objective of this analysis is to consolidate, review and standardized the available information into a single database. Afterwards, and following recommendations from the SCRS, analyses were conducted to estimate size frequency at catch and compare these results with alternative estimates.

2. Data

The Secretariat received size and weight estimates at caging of bluefin tuna from stereo video camera systems from four CPCs: EU_Malta, EU_Spain, EU_Croatia and Turkey (**Table 1**). The data has been submitted in different formats; usually including a general report with date of recording, species, site (farm ID), vessel associated and files names. Some reports also include names of calibration files, and model formula to estimate weight. Summary statistics include average size (m) and weight (kg), minimum and maximum value, standard deviation, coefficient of variance and sample size. Individual fish measures include the size, estimated weight, error percent of FL, caudal fork, and nose measures, frame and video file name. However, not all CPCs provided complete detailed information. In some instances, the individual reports include only size and weight. Information on the calibration procedures, estimation of the error measure or any other diagnostic of measurements by the system have not been yet provided to the Secretariat.

In total 17,162 observations were available with sizes (FL m) and weights (RW kg). These represent at least 52 different caging operations realized between 29 April and 21 October 2014. The data correspond to at least 10 different farms (not all records provide farm site) **(Figure 1**). Overall bluefin tuna size ranges from 73 to 303 cm FL, size distribution of all data shows a multimodal distribution, with peaks at 75, 120, and 210 cm FL (**Figure 2**).

As indicated before, weights were estimated by the software program using a conversion factor provided by the user. In most cases the current size weight relationship adopted by the SCRS were applied, but not in all cases (**Figure 3**). In fact, some CPCs used a different size-weight relationship among their farms. Few outlier size-weight observations were also identified (**Figure 3**). At least 10 different tuna farms were identified. By CPC, EU_Croatia reported from 2 farms, EU_Malta 4 farms, EU_Spain from 3 farms, and Turkey at least 2 farms; although farm ID was missing from several observations from Turkey.

3. Methods

Preliminary analysis were done with the size data by CPC level and then estimating size frequency distributions to compare with previous estimates of size at catch distribution of purse-seine operations for the same CPCs, that were estimated from the size distributions at the harvest operations (Ortiz et al. 2015).

Figure 4 shows the size distribution (FL) and histograms by Flag of the stereo camera caging operations. Clearly, small bluefin were reported by caging operations from EU_Croatia, with fish ranging from 73 cm to 150 cm, but strong left-skew towards small fish with a high peak around 75 FL cm. By comparison EU_Malta and Turkey show a size catch of larger fish, with a bimodal distribution shape and peaks at 110 cm and 210 cm FL. Instead EU_Spain show a unimodal size distribution with peak at 210 cm FL and catches of mostly large fish ranging from 109 to 277 cm FL. Density and cumulative density plots show also the different size at catch distributions by Flag (**Figure 4**). There were also noticed differences in the size distribution of the catch by month (**Figure 5**).

4. Results and discussion

The Stereo Video size data represent only a subset of the whole caging operations in 2014. It reported 17,162 fish from 49 different caging operations and at least 10 farms, with sampling size within operation varying from 40 up to 1330 fish measured with a median of 297 fish sized per operation. For comparison and based on the e-BCD database (as of August 2014), it is estimated that at least 48,800 fish have been caught by purse seine operations from these CPCs in 99 fishing operations.

From the summary reports submitted with the stereo video data, it is concluded that the measured fish are a subset of the total count fish in each video of the caging operation. When the number of fish counted was provided, the percent of measured fish is about 20% of the total fish in the video file recorded. Communications from the operators of the video recording indicated that every other 5th fish that shows in the screen is measured, assuring a randomly selected sample that should represents the size frequency of the whole catch.

Comparison of the size frequency distributions from Stereo video systems were done against the estimated size frequency distribution at catch from the Farms Harvest reports previously presented (Ortiz et al. 2015). The ideal comparison would be same year catch and same farm/Flag, however from the Harvest reports the latest catches are from 2013, while the Stereo video measures are all from 2014. Density and cumulative density size frequencies were then compared by Flag using an average of the 2010-2013 data from the Harvest reports versus the 2014 Stereo video measures (**Figure 6**). There are differences in the density and cumulative density plots by Flag. For EU_Croatia the 2014 size distribution of catch is for smaller fish than the average of 2010-2013 years. Similarly for EU_Spain the 2014 size distribution is unimodal of large size fish, while the 2010-2013 average shows a bimodal distribution, with catches of smaller bluefin (110- 150 cm). In the case of EU_Malta, both distributions show the bimodal type distribution, but 2014 catches show a lower size for the larger fish peak and much lower proportions of fish over 250 FL cm compare to the averages of 2010-2013. In the case of Turkey, there also differences in the size frequency distributions showing overall smaller fish being caught in 2014 compared to the 2010-2013 averages. In a single case, with the EU_Spain data, comparison of the catch at size estimated from the Harvest of 2013 against the 2014 stereo video camera catch at size showed more similar trends (**Figure 7**).

The results indicate substantial differences in the size distributions of bluefin catch by Flag. These differences can be due to; a) the size frequency estimates are different for the two methods, the Stereo video system and the back-estimation from the Farm Harvesting reports, or b) actual catch at size differences between 2014 and prior years. However it can be also possible a combination of both factors. Unfortunately same year data is not yet available from both methods, if farms Harvest reports continue, likely in a near future it will be possible to repeat the comparison with same year catch. Overall size frequency estimates from the Stereo video system are shift to the left compare to Harvest report estimates, (e.g. smaller sizes) but with the exception for the EU_Spain data. The margin of error reported from the Stereo video system is relative small, less or equal to 5%, however no details were provided on how this error was estimated, and or calibration procedures from the Stereo camera system. No comparisons were done with weight estimates, as they are directly from a size dependent formula defined by the user in the stereo video system. Nevertheless it is important to standardize what formulations should be used, including the recently update size-weight relationships for bluefin tuna by month for higher precision in the estimates. In some of the stereo video reports it was indicated significant differences (above 10%) between the total weight estimated from the Stereo video recording and the values reported in the e-BCD, in all cases indicating greater total catch in weight to the values reported in the eBCDs.

Literature Cited

Anon., 2013. SCRS/2012/015. Report of the 2012 Bluefin tuna stock assessment session. Madrid, Spain September 4 to 11, 2012. Collect. Vol. Sci. Pap. ICCAT 69(1): 199-203.

Ortiz M., Justel-Rubio A. and Gallego J.L., 2015. SCRS/2014/040. Review and analysis of farm harvested size frequency samples of eastern bluefin tuna (*Thunnus thynnus*). Collect. Vol. Sci. Pap. ICCAT 71(2): 1018:1035.

Table 1. Summary of bluefin tuna measures (size and weight) from stereo video camera systems submitted in 2014 by flag, farm ID and month.

CPC	Farm ID	Apr	May	Jun	Jul	Aug	Oct
EU_Croatia	ATEU0HRV00003			2233			
	ATEU0HRV00006			1745			
EU_Malta	ATEU1MLT00001			1071	943		
	ATEU1MLT00003			795	624		232
	ATEU1MLT00004			804	210		
	ATEU1MLT00008				198	1342	
EU_Spain	ATEU1ESP00001			1388			
	ATEU1ESP00004	75	573				
	ATEU1ESP00005			2062			
Turkey					1857	200	
	AT001TUR00011				810		
Total		**75**	**573**	**10098**	**4642**	**1542**	**232**

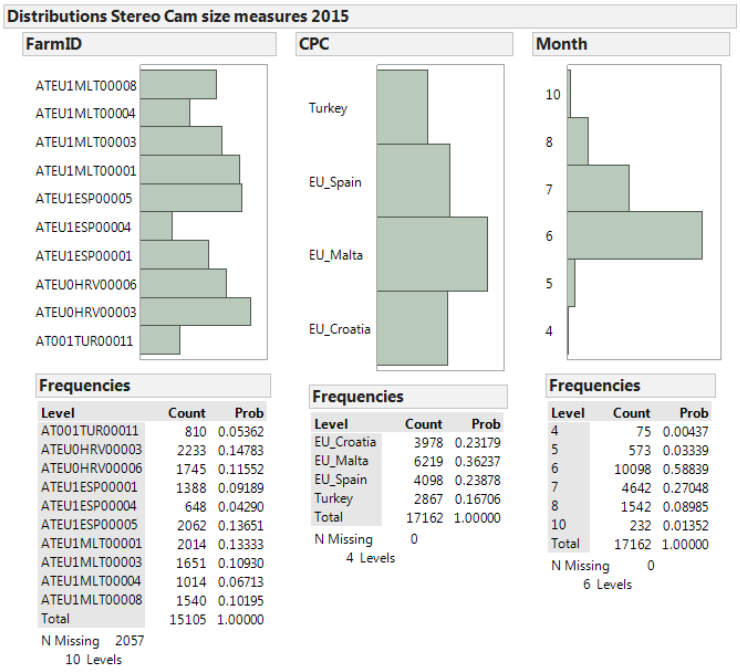

Figure 1. Distribution of size measures from stereo video systems by Flag, Farm ID and month.

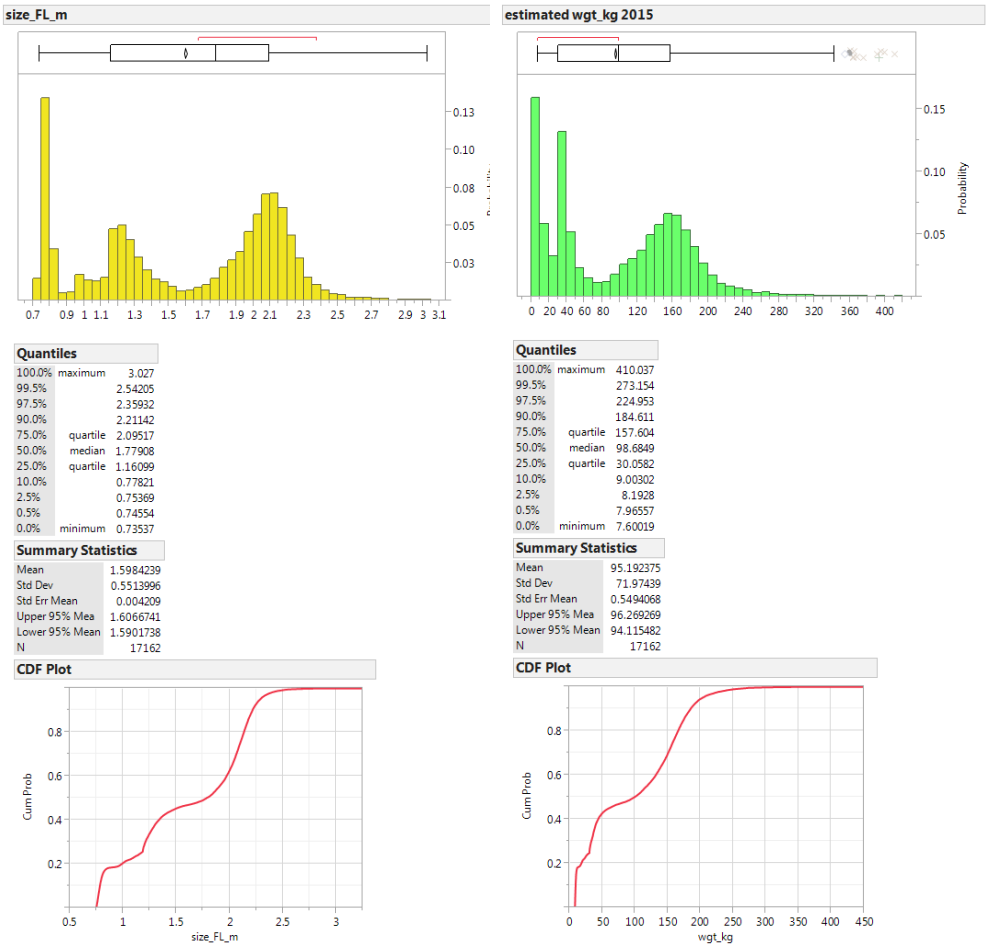

Figure 2. Overall size (left) and weight (right) distribution from stereo video data 2014.

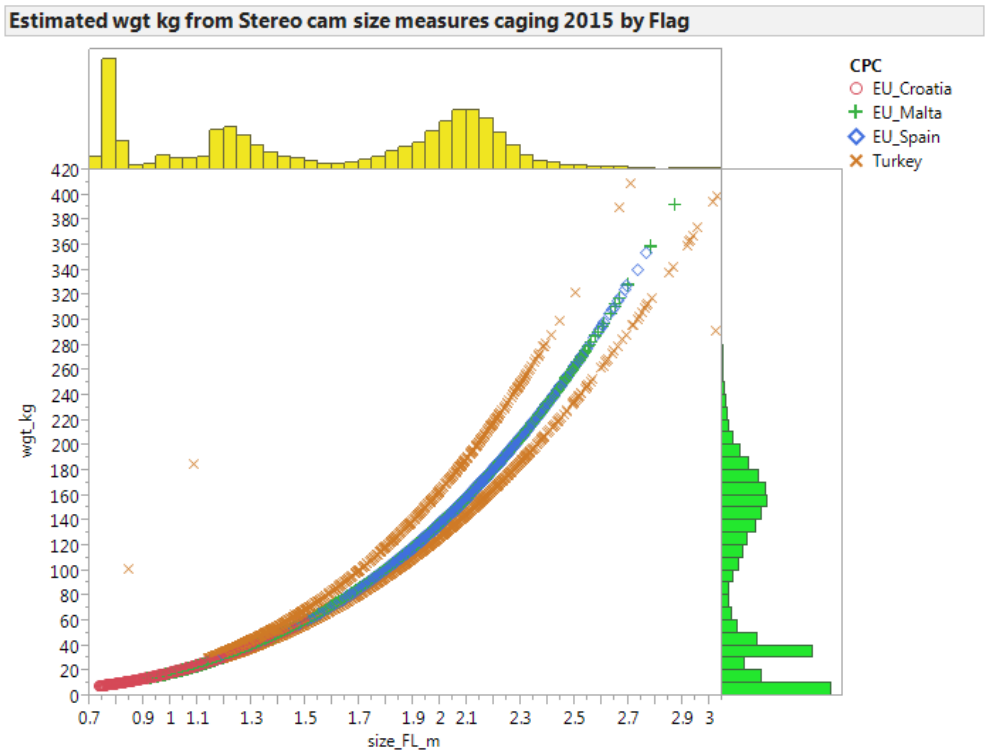

Figure 3. Scatter plot of weight at size from the stereo video data by flag for 2014.

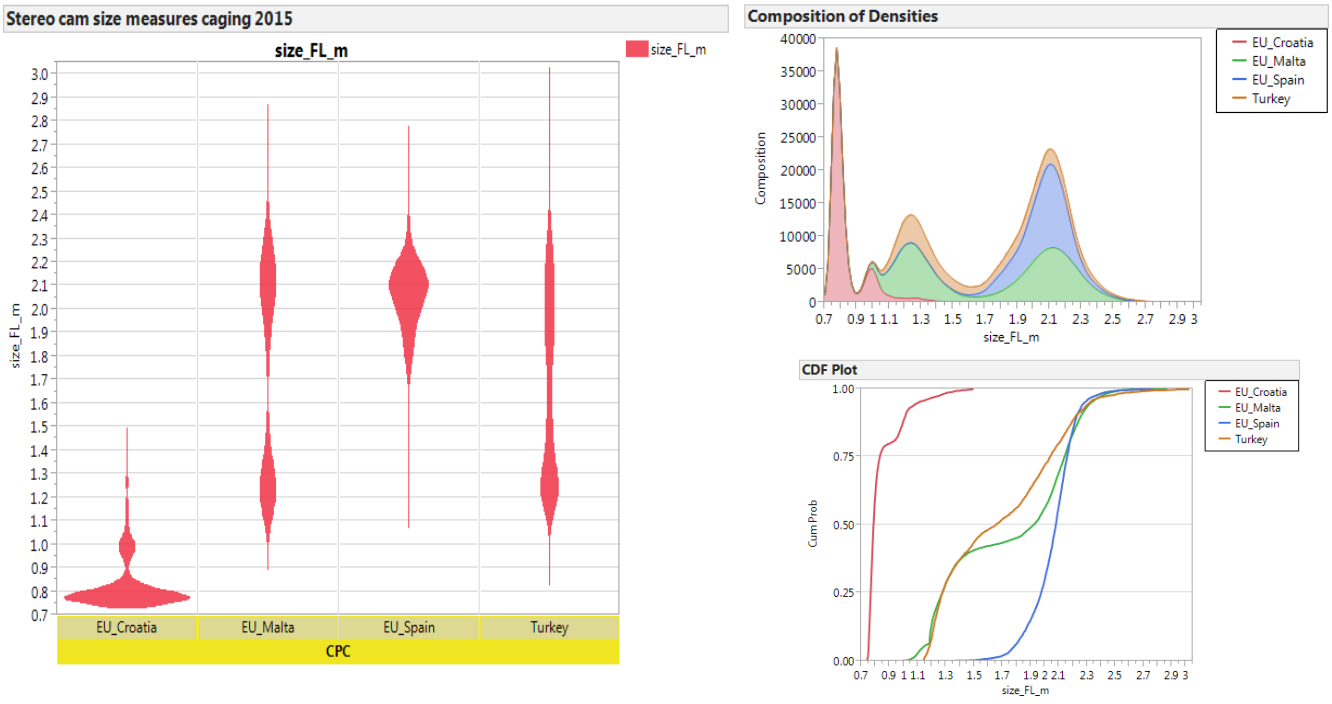

Figure 4. Cumulative and density size distributions of catch at size from the stereo video for bluefin tuna by flag 2014.

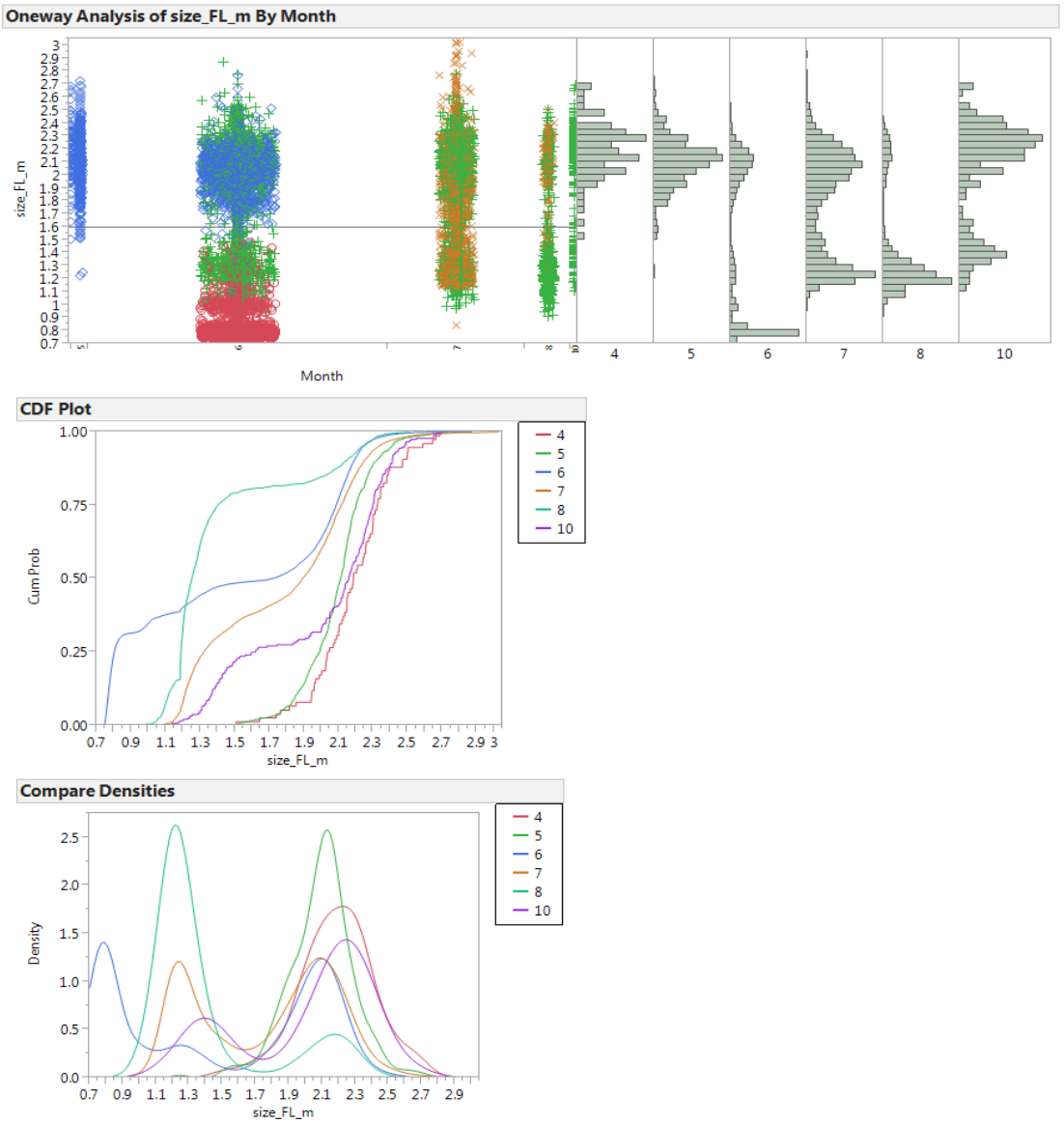

Figure 5. Cumulative and density size distributions of catch at size from the stereo video for bluefin tuna by month in 2014.

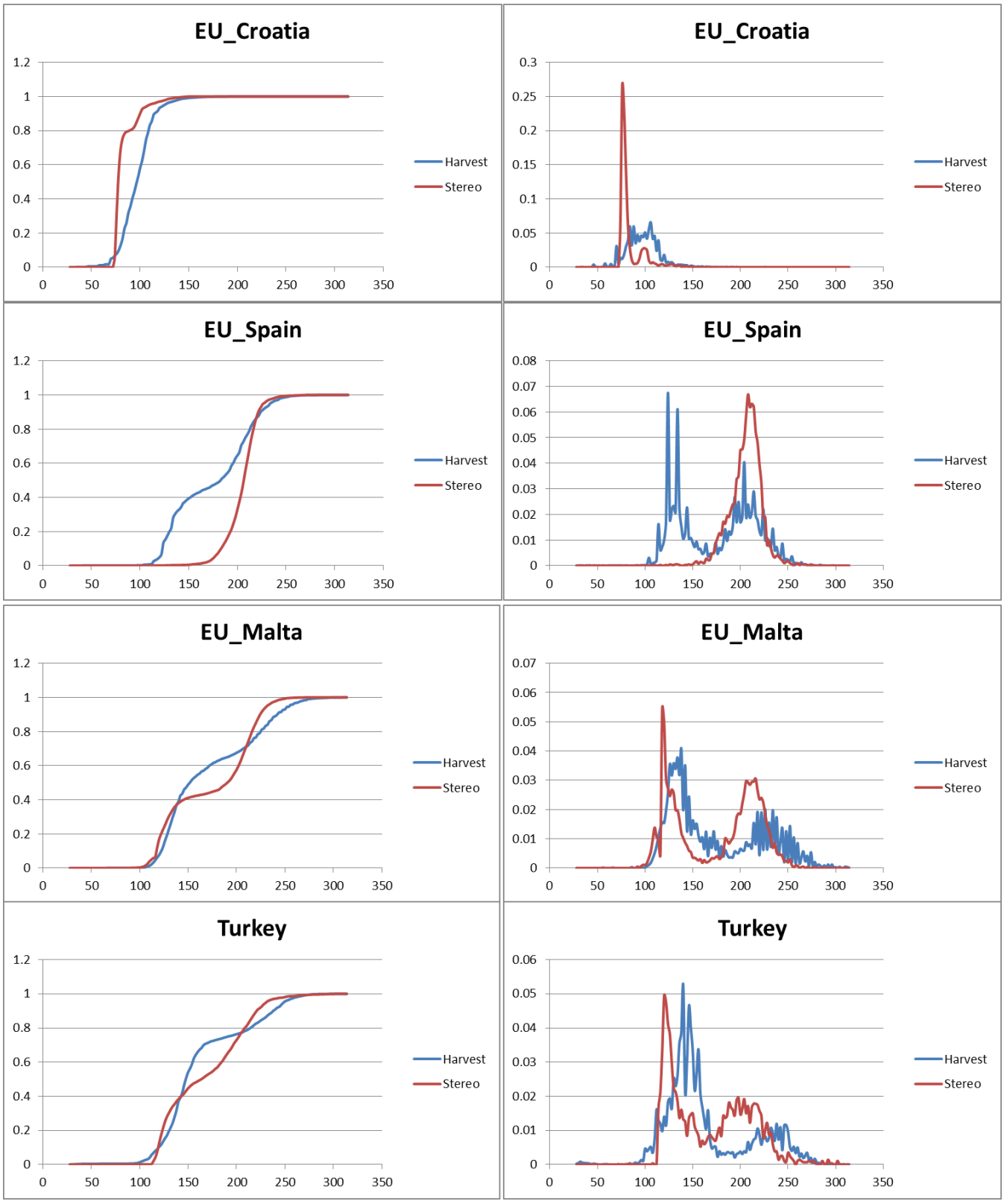

Figure 6. Comparison of cumulative (left) and density (left) size frequency distribution of catch at size for eastern bluefin tuna destined to farming operations by flag. The Harvest line represent estimated size at catch from the size at harvest reports (2010-2013 average) while the Stereo line correspond to size data from the stereo video camera systems and size data from 2014 caging operations.

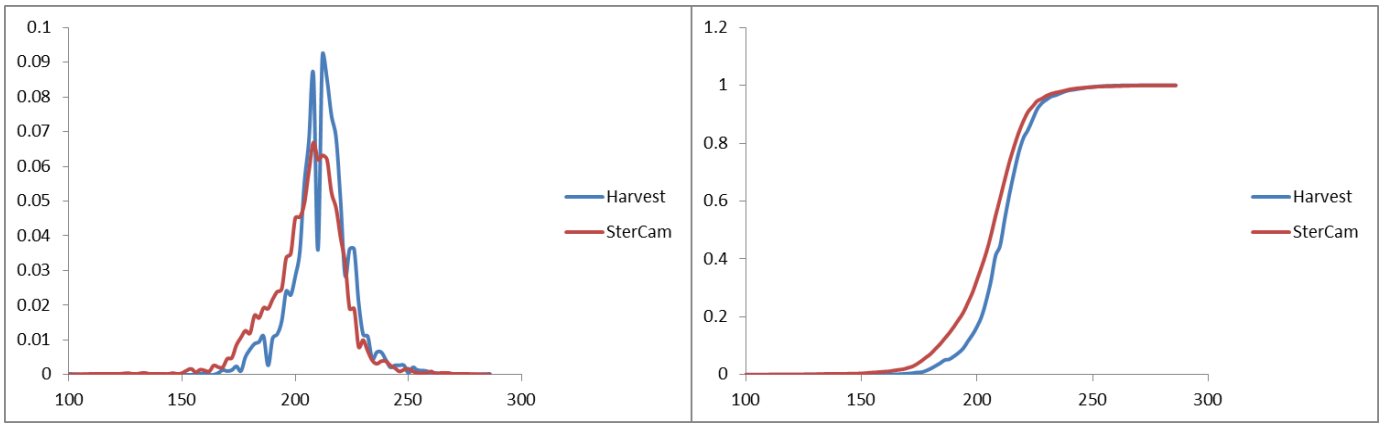

Figure 7. Comparison of catch at size distribution (density and cumulative) for bluefin tuna destined to farming operations from EU-Spain. Harvest line represents the catch at size estimated from harvest reports of 2013, while the SterCam line corresponds to the stereo video systems data from 2014.