

UPDATE REVIEW OF BLUEFIN TUNA (*THUNNUS THYNNUS*) SIZE AND WEIGHT MEASURES TAKEN WITH STEREO VIDEO CAMERAS AT CAGING OPERATIONS IN THE MEDITERRANEAN SEA - 2015

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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. Data indicate a multimodal size distribution for bluefin destined to farming in 2014 and 2015; with a large mode of small fish of about 75 SFL cm, and two modes for medium 120 SFL cm and large 210 FL cm. Caged bluefin show similar size distributions for 2014 and 2015. Weights are estimated by the stereo camera software with a user input of the size-weight relationship, however there is not consistency in the relationship between CPCs, it is recommended that the current East BFT monthly wgt-size relationship are used as they reflect changes in the fish condition associated with spawning, migration and feeding conditions.

RÉSUMÉ

Les données de fréquence des tailles du thon rouge obtenues au moyen de 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 données indiquent une distribution de taille multimodale du thon rouge destiné à l'élevage en 2014 et 2015, avec un mode important de petits poissons d'environ 75 cm SFL et deux modes de poissons de taille moyenne (120 cm SFL) et de grande taille (210 cm FL). Le thon rouge élevé en cage fait apparaître des distributions de tailles similaires pour 2014 et 2015. Les poids sont estimés par les caméras stéréoscopiques où l'utilisateur a saisi la relation taille-poids ; néanmoins, la relation n'est pas cohérente entre les CPC et il est recommandé que la relation poids-taille mensuelle actuelle du thon rouge de l'Est soit utilisée sachant qu'elle reflète les changements de l'état du poisson associés aux conditions de reproduction, migration et trophiques.

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 datos indican una distribución de tallas multimodal para el atún rojo destinado a la cría en 2014 y 2015, con una gran moda de peces pequeños de aproximadamente 75 cm SFL, y dos modas para los medianos de 120 cm SFL y grandes en 210 cm FL. El atún rojo enjaulado presenta distribuciones por tallas similares para 2014 y 2015. Los pesos se estimaron mediante el programa informático de las cámaras estereoscópicas con introducción del usuario de la relación talla-peso, sin embargo, no hay coherencia en las relaciones entre las CPC, y se recomienda utilizar la actual relación talla-peso mensual del atún rojo del este ya que refleja los cambios en la condición de los peces asociados a las condiciones de desove, migración y alimentación.

KEYWORDS

Bluefin, farm bluefin tuna, size frequency, stereo video

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Introduction

Farming operations is one of the major destinations of most of eastern bluefin tuna catches in recent years. 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, the SCRS had recommended stereo-video protocols for sizing the catches of bluefin tuna destined to farming operations. Starting in 2014, the Commission entailed video recording of all fish transfers to cages between holding pens and farm cages, requesting also a minimum random size measuring of 20% of the fish transferred. Logistic details and technical software descriptions of the recordings can be found at <http://www.aqlsystems.com/farming/13510002>. The video recording software provides direct count of all fish transferred and size measures of individual fish (20% of the total count or 200 fish), and using conversion factors estimate the weight of individual fish. Then with the total number of fish times the average weight of the fish measured, it is estimated the total biomass of bluefin tuna transferred.

In 2014 several CPCs began submitting data collected from the stereo-video camera systems to the Secretariat, this document updates and summarizes size and weight measures collected and submitted for the 2014 and 2015 fishing calendar year (Ortiz 2016). An objective of this analysis is to consolidate, review and standardized the available information into a single database.

1. Data

The Secretariat has received size and weight reports of caging bluefin tuna from stereo video camera systems from six CPCs: EU_Malta, EU_Spain, EU_Croatia, Morocco, Tunisia and Turkey (**Table 1, Figure 1**). Some CPCs involve in the catch of BFT have also send stereo video data reports (EU_Italy, Egypt, EU_France and Tunisia), but these reports are also send by the CPC farm flags and they are duplicated data. To avoid duplications, only data from the farm CPCs has been used and integrated into a database once confirmed that the data is submitted by the corresponding farm CPC flag. 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 (SFL m) and weight (RW kg), minimum and maximum value, standard deviation, coefficient of variance and sample size. Individual fish measures include the size, estimated weight, error percent of SFL, 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. In 2015 the Secretariat provided a modified version of the ST06-SZFM electronic form to submit video size and weight reports by CPS, however at present not all CPCs have adopted this e-form for submission of data.

In total 51,119 observations were available with sizes (SFL m) and weights (RW kg), representing at least 141 different caging operations (52 in 2014, 89 in 2015). The data indicated caging operations into at least 23 different tuna farms (**Table 2, Figure 1**). Overall bluefin tuna size ranges from 53 to 316 cm SFL, size distribution of all data shows a multimodal distribution, with peaks at 75, 120, and 210 cm SFL (**Figure 2**).

As indicated before, weights are estimated by the software program using conversion factor(s) inputted by the user. In some cases the current size weight relationship adopted by the SCRS were applied, but not in all cases (**Fig 3**). In fact, some CPCs used a different size-weight relationship among their farms. Some outlier size-weight observations were identified in particular from a Tunisia farm transfer in 2015 (**Figure 3**). In total twenty three tuna farms have reported caging operations, by CPC these are; EU_Croatia reports from 4 farms, EU_Malta 4 farms, EU_Spain 5 farms, Turkey from 6 farms, Morocco 1 farm (2014) and Tunisia 3 farms (2015) (**Table 2**).

2. Methods and Results

Analyses were done with the size data by different levels of aggregation and by estimating size frequency distributions. **Figure 4** shows the size density distribution (SFL) by Flag and year of the stereo camera caging operations. In general, the size distributions of caged bluefin tuna were similar between 2014 and 2015. Small bluefin were mainly caged by EU_Croatia farms, with fish ranging from 73 cm to 150 cm, but with a strong left-skew distribution towards small fish with a high peak around 75-80 SFL cm. By comparison EU_Malta and Turkey farms show a size distribution of medium and larger fish caged, with a bimodal distribution shape and peaks at 110 cm and 210 cm SFL, respectively. On the other hand, EU_Spain farms caged mainly larger fish, showing a unimodal size distribution with peak at 210 cm SFL ranging from 109 to 277 cm SFL. From

Morocco caging data is only available from 2014, showing on average the largest caged size bluefin with a peak at 230 cm SFL, while from Tunisia 2015 caging show a unimodal size distribution of medium-large fish with a peak of 160 cm SFL, and range from 110 to 220 cm SFL (**Figure 4**). About 53% of the caging operations took place during June, followed by July (33%) but caging of bluefin extend from April (2015) to October (2014) albeit in much lower proportions (**Figure 5**). When reviewed the size distribution of cage bluefin by farm, interestingly most of the farms show similar size distribution of caged fish between 2014 and 2015 (**Figure 6**), in particular the EU_Spain, EU_Malta and EU_Croatia farms. Instead the Turkey farms show more differences in the size distributions of their caged fish between 2014 and 2015.

As the catch and caging dates are known, the difference represents the tow time of the fish between the catch location and the destined farm. **Figure 7** shows the distribution of estimated tow-days, by farm flag. Towing can extend from 1 up to 31 days, with an average of 13 days, however there is substantial variance between farms/flags; Morocco shows the shortest towing time overall with a mean of 1.5 day, followed by EU_Croatia with a median of 9 towing days, Turkey and Tunisia also show a median of 8 and 10 towing days, respectively but with a wider range, with some fishing operations extending up to 31 days, although 75% of the towing/transfer operations are less than 24 days. EU_Spain farms expend on average 13 days between catching and caging bluefin tuna, while EU_Malta overall shows the largest time on towing fish at sea, with an average of 17 days and 50% quantile between 9 and 24 days. These variations of tow time could have strong impact in the weight/condition of the fish between the time of capture and the caging operation, maxima if the fish is not feeding and or stressed by the operations.

As indicated before, user inputted the weight-size relationship in the video software to estimate the weight of measured fish, and then the average weight of the sampled fish is multiply by the count of fish to obtain the biomass of the transferred fish. In 2015 the SCRS adopted weight-size relationship for E-BFT with monthly coefficients that reflect the changes in fish condition of bluefin likely associated with spawning and migration patterns. The weight of each fish was calculated using these conversion factors at the time of the catch and compared with the weights reported by the farms. **Figure 8** shows a ratio of the total sum of weight by year and farm, in general the farms reported lower weights of caged fish particularly in 2014, while in 2015 this varied between farms. Differences are about 10% on average, albeit in some instances can be larger up to 30%.

3. Discussion and Recommendations.

At least for 2014, the stereo video size data represents a subset of the whole caging operations, the increase in number of farm reports and number of fish measured in 2015 (about twice the number of 2014) likely is due to the full implementation of video recording requirements by CPCs in 2015. However, the size distribution of the bluefin caged in both years is very similar overall and by CPCs, even within most of the farms they tend to caged similar size fish. This likely represents specialized husbandry and logistic conditions of a particular farm.

There is still a need for standardizing the stereo video data submission by CPCs, it is strongly recommended that CPCs use the ST06-T2FM and complete all the information required for each caging transfer. It is also recommended that CPCs used the SCRS current eastern bluefin tuna monthly conversion factors (http://www.iccat.int/Documents/SCRS/Manual/Appendices/Appendix_4_III_BFT_ENG.pdf) to estimate the biomass of the caged fish. To note, however that the tow time between actual catch and the caging of the fish is about 2 weeks but variable, and can extend up to 31 days, thus it is expected that the weight and fish condition of the fish at caging is diminished compare to the actual catching date, due to stress and/or non-feeding during towing.

References

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- Ortiz, M. 2016. Update review of bluefin tuna (*Thunnus thynnus*) size and weight measures taken with stereo video cameras at caging operations in the Mediterranean Sea 2014. Collect. Vol. Sci. Pap. ICCAT, 72(6):1440-1448 (2016).

Table 1. Summary of bluefin tuna measures (size and weight) from stereo video camera systems submitted in 2014 and 2015 by flag and month.

Number BFT size measured with Stereo cameras at caging

CPC	YearCaged												All	
	2014					2015								
	Month caging					Month caging								
	May	Jun	Jul	Aug	Oct	All	Apr	May	Jun	Jul	Aug	Sep	All	
EU_Croatia	0	3978	0	0	0	3978	0	0	9085	0	0	0	9085	13063
EU_Malta	0	2670	2448	1342	231	6691	0	0	2985	4499	1364	798	9646	16337
EU_Spain	649	2062	1388	0	0	4099	90	1030	4077	0	0	0	5197	9296
Maroc	247	0	0	0	0	247	0	0	0	0	0	0	0	247
Tunisia	0	0	0	0	0	0	0	0	140	1572	0	0	1712	1712
Turkey	0	0	3217	0	0	3217	0	0	2400	3916	1011	0	7327	10544
All	896	8710	7053	1342	231	18232	90	1030	18687	9987	2375	798	32967	51199

Table 2. Number of bluefin tuna size measures from stereo video camera systems by farm CPC and Farm ID for 2014 and 2015.

CPC	Farm ICCAT No	2014	2015
EU_Croatia	ATEU1HRV00003	2233	2426
	ATEU1HRV00006	1745	3013
	ATEU1HRV00008		2057
	ATEU1HRV00011		1589
EU_Malta	ATEU1MLT00001	2014	3200
	ATEU1MLT00003	1650	1688
	ATEU1MLT00004	1014	1148
	ATEU1MLT00008	2013	3610
EU_Spain	ATEU1ESP00001	1388	
	ATEU1ESP00004		
	ATEU1ESP00005	2062	
	ATEU1ESP00010		
	ATEU2ESP00002	649	
Maroc	AT001MAR00002	247	
Tunisia	AT001TUN00001		686
	AT001TUN00004		439
	AT001TUN00006		587
Turkey	AT001TUR00001		290
	AT001TUR00005	600	1522
	AT001TUR00010	488	1985
	AT001TUR00011	1200	1565
	AT001TUR00013	464	1204
	AT001TUR00014	465	761

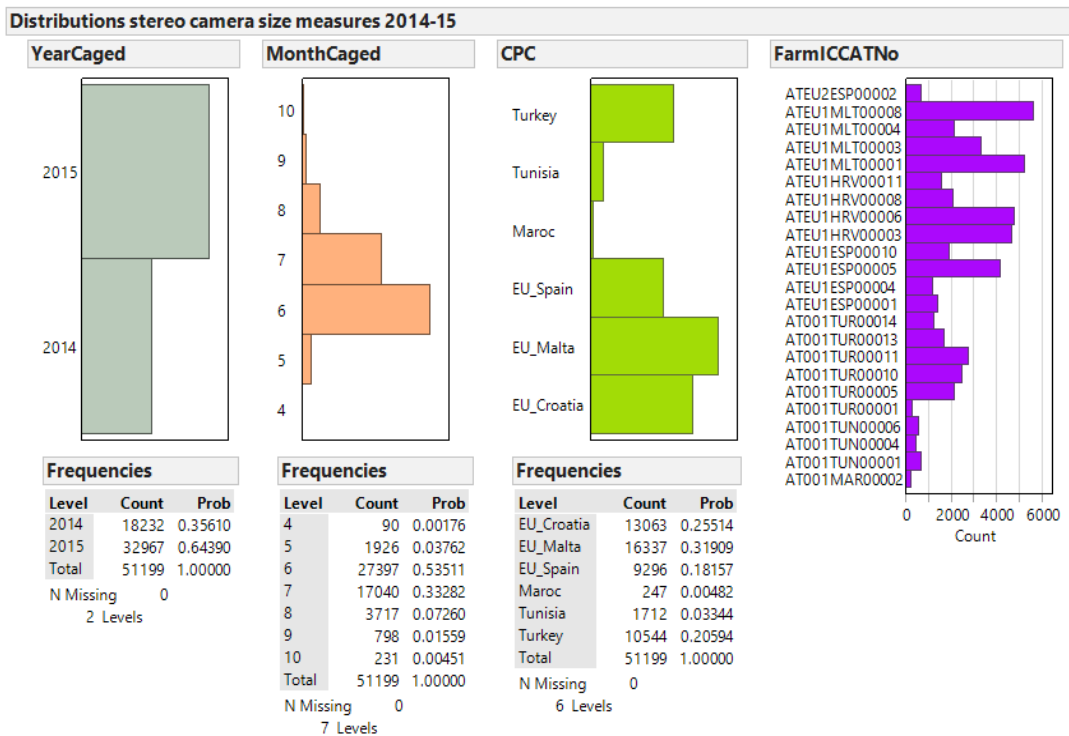


Figure 1. Distribution of size measures from stereo video systems by year of caging, month, flag and farm ID.

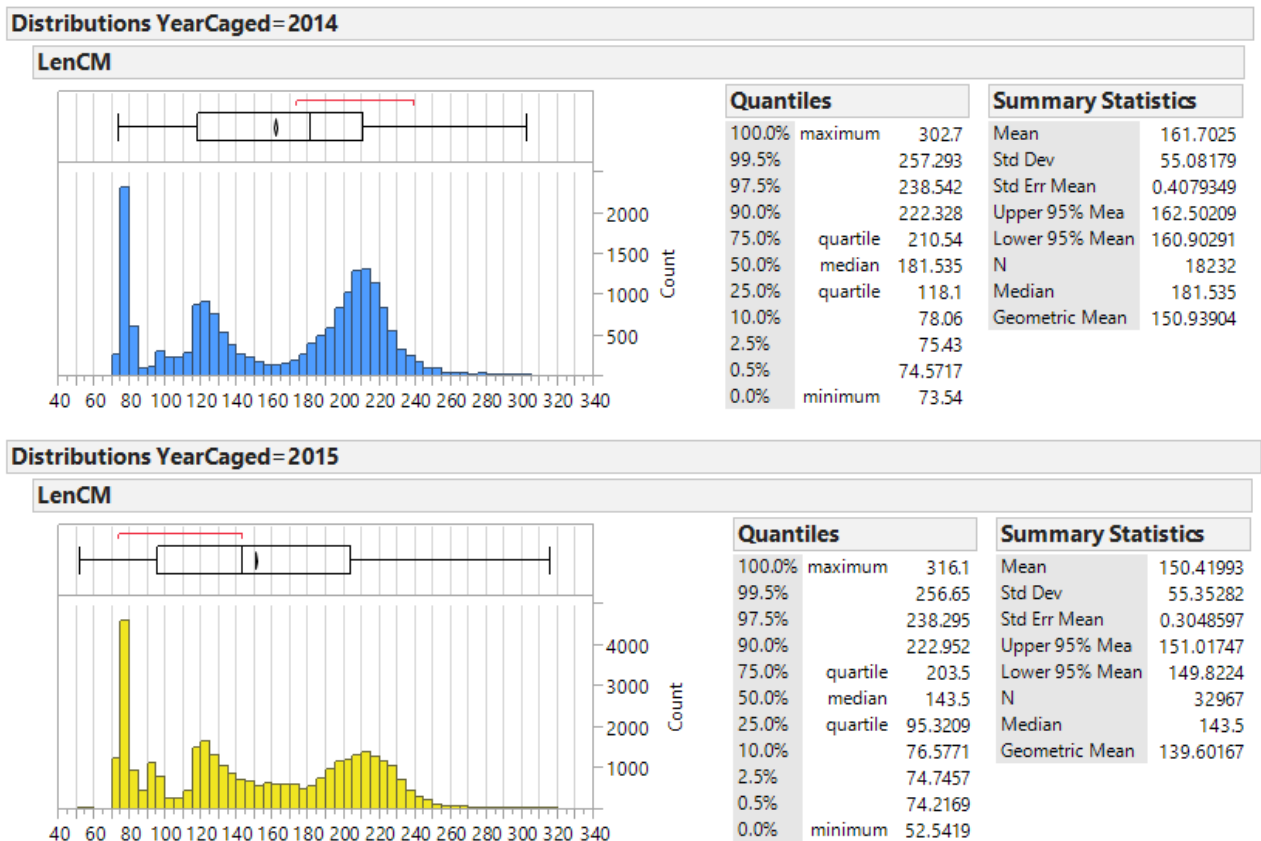


Figure 2. Overall caged BFT size distribution from stereo video data 2014 and 2015.

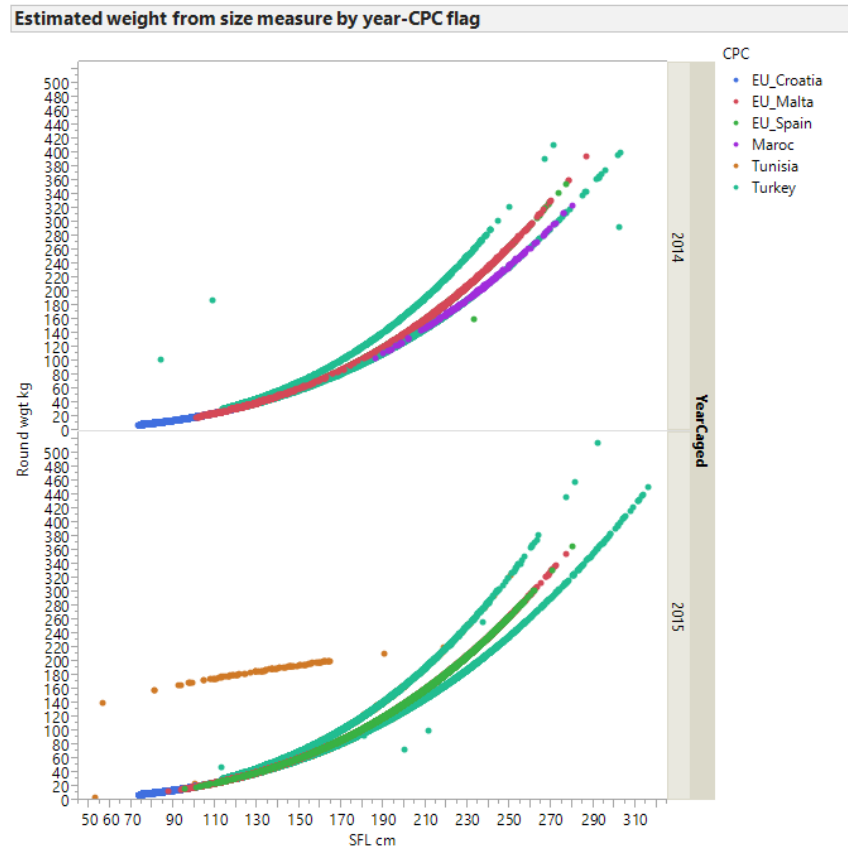


Figure 3. Scatter plot of caged BFT estimated weight (RW kg) at size (SFL cm) from the stereo video data by year.

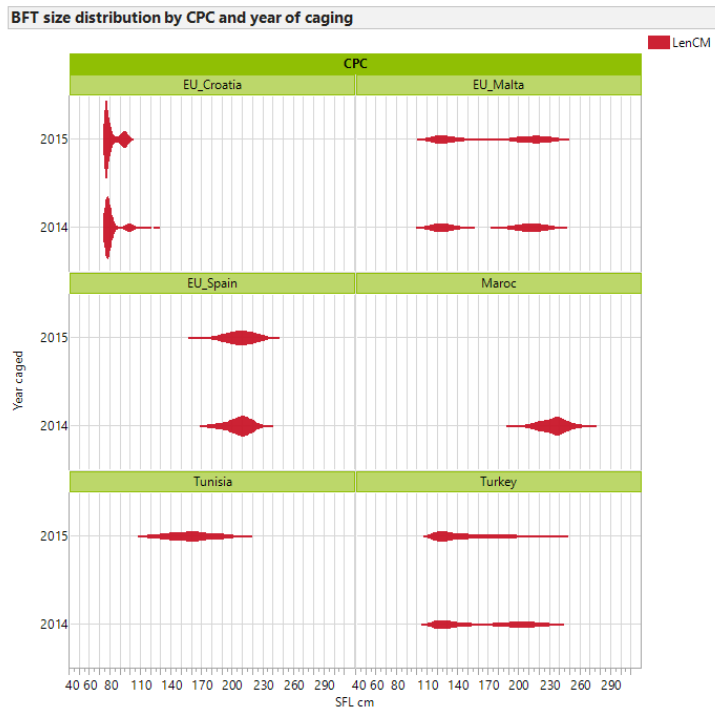


Figure 4. Density size distributions of caged bluefin tuna by flag and year of caging.

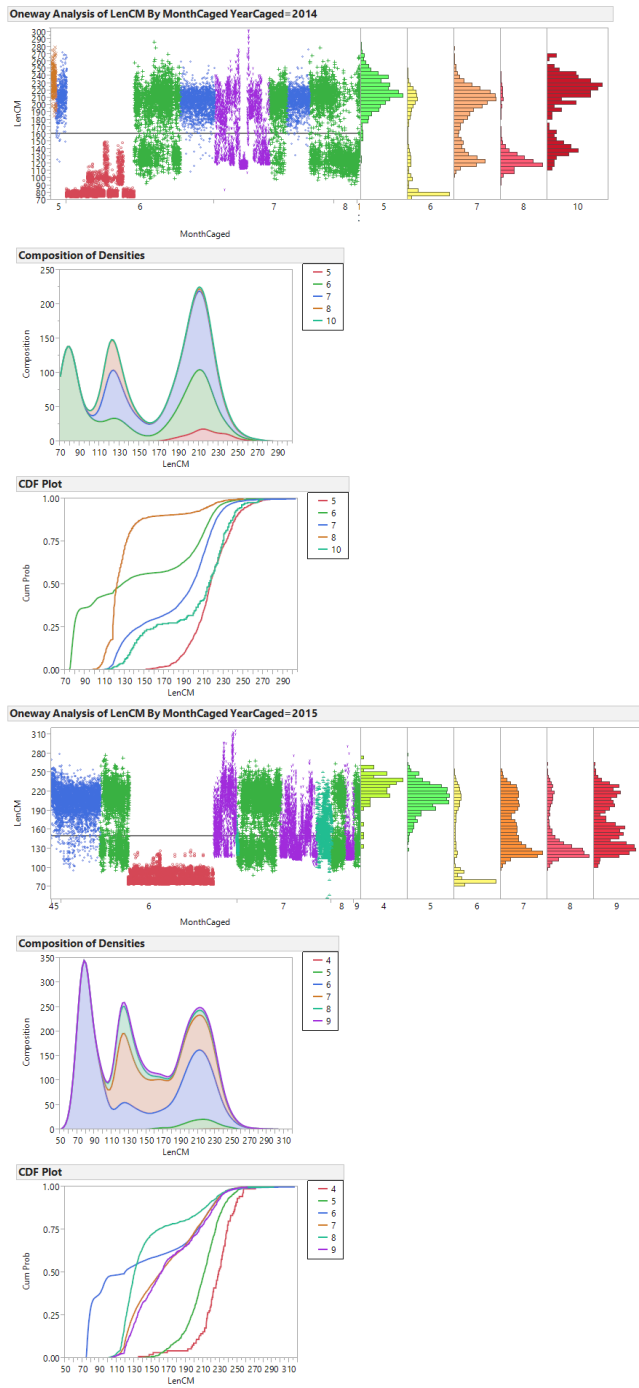


Figure 5. Cumulative and density size distributions of caged bluefin from the stereo video by month and year.

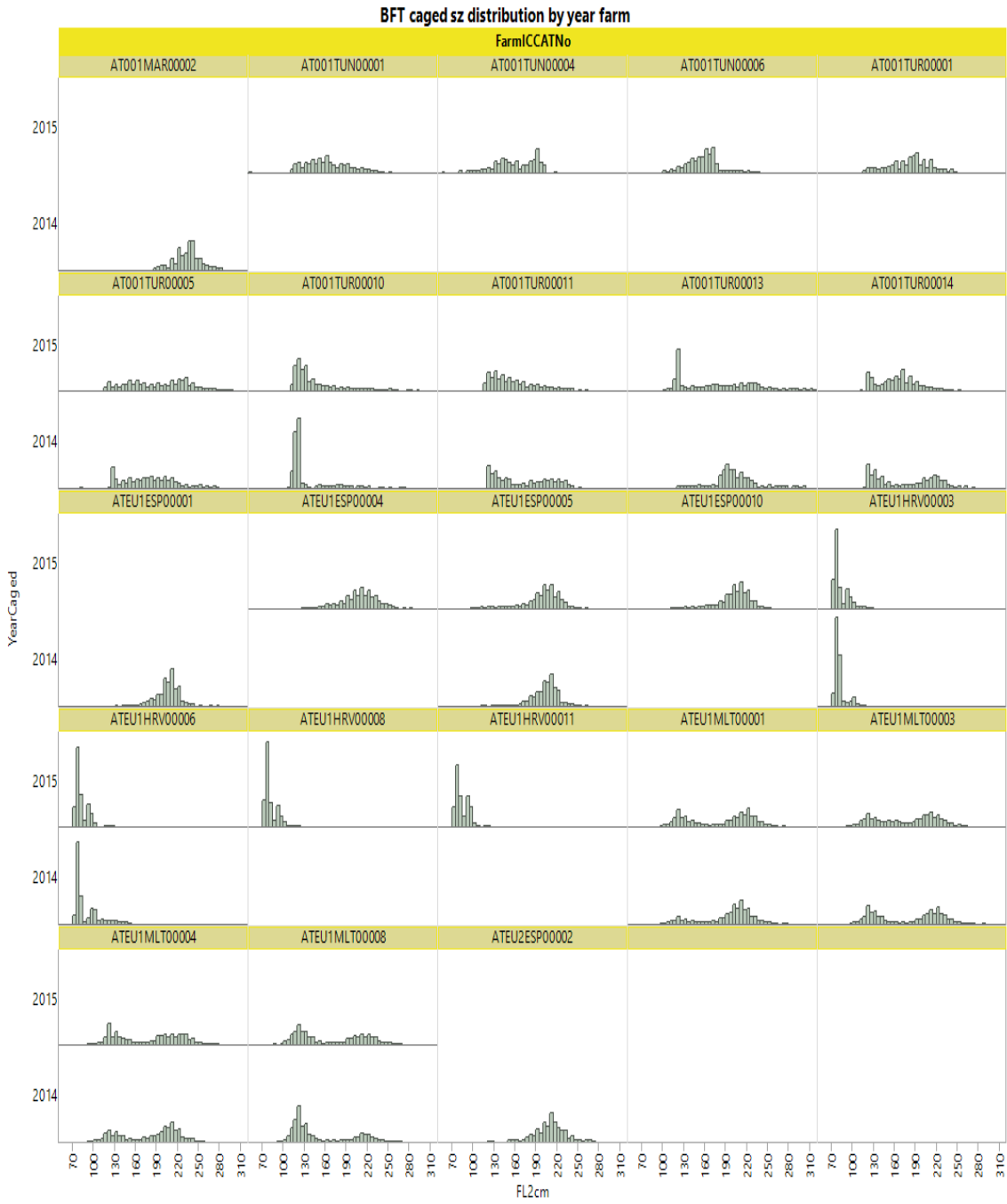
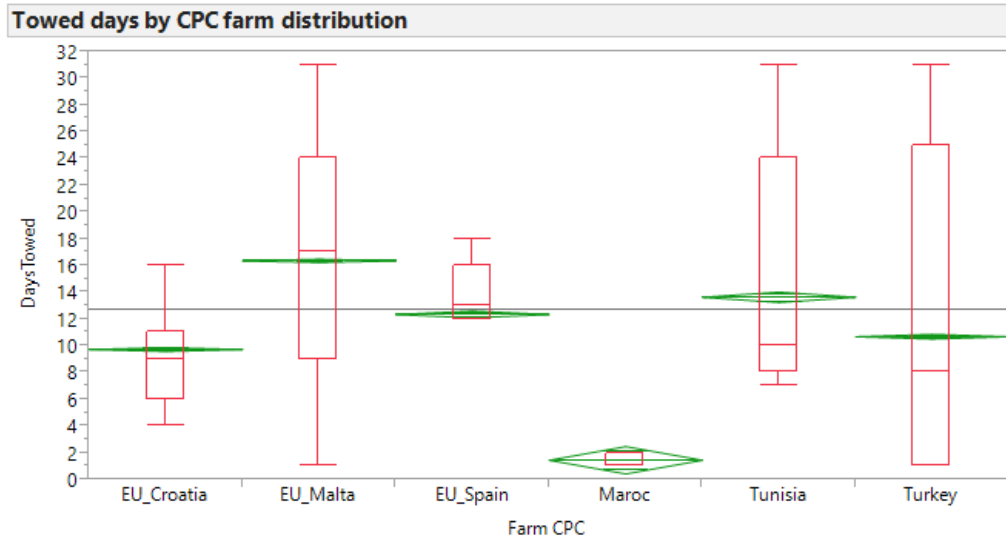


Figure 6. Size frequency distribution of caged bluefin tuna by farm ID and year of caging.



Missing Rows 7990

Quantiles							
Level	Minimum	10%	25%	Median	75%	90%	Maximum
EU_Croatia	4	5	6	9	11	13	25
EU_Malta	1	3	9	17	24	30	31
EU_Spain	1	2	12	13	16	17	18
Maroc	1	1	1	1	2	2	2
Tunisia	7	7	8	10	24	25	31
Turkey	1	1	1	8	25	27	31

Figure 7. Distribution and quantiles summary of days towing (date of caging – date of catch) by CPC for the 2014 and 2015 caging operations.

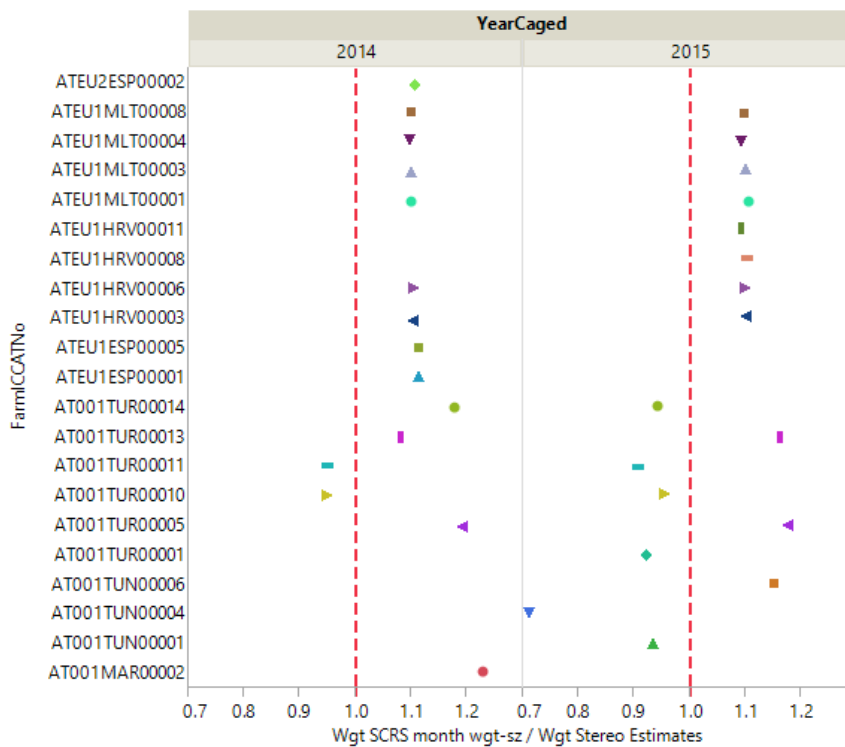


Figure 8. Ratio comparison between the estimated weight of caged fish by farm using the SCRS current monthly conversion wgt-sz factors for eastern bluefin tuna and the weight reported by CPCs.