A PILOT STUDY TO BETTER ESTIMATE NUMBER AND WEIGHT OF CAGED E-BFT BY STEREOSCOPIC UNDERWATER CAMERA SYSTEM

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SUMMARY

Over the past decade, farming and/or fattening of bluefin tuna (BFT) has played an increasingly important role in aquaculture among Mediterranean countries, including Turkey. In this study, length-weight relationship and size composition of 144 bluefin tuna were identified by stereoscopic camera system. Additionally, other length-weight measurements of 85 bluefin tuna were conducted by image analysis during the same day. In order to in-cage measure meristic characters of a total of 229 bluefin tuna, specific software called AM100 Tuna Sizing and Counting System was used. First, in the sea cage, AM100 recorded a movie for 5 minutes, and 144 bluefin tuna (15%) of the 932 bluefin tuna harvested were measured successfully by this software. Then, an empty identical cage was located and inserted to the bluefin tuna cage by the 8x16 m door. During the transfer, images of the bluefin tuna passing through the door were recorded by the AM100 device used by divers. Afterwards, these images were examined and also 85 bluefin tuna (9%) of the 932 bluefin tuna were measured successfully by this software. Consequently, data obtained by AM100 were similar in a 99% ratio for the same 39 length group.

RÉSUMÉ

Au cours de la dernière décennie, l'élevage et/ou l'engraissement du thon rouge joue un rôle de plus en plus important dans l'aquaculture des pays méditerranéens, notamment de la Turquie. Dans cette étude, la relation longueur-poids et la composition par tailles de 144 thons rouges ont été identifiées par un système stéréoscopique. En outre, pendant la même journée, 85 thons rouges ont été mesurés et pesés au moyen d'une analyse graphique. Afin de mesurer les caractéristiques méristiques d'un total de 229 thons rouges à l'intérieur des cages, le logiciel «Système de comptabilisation et de détermination de la taille des thons AM100» a été utilisé. D'abord, le système AM100 a réalisé un film de cinq minutes à l'intérieur de la cage placée en mer et sur les 932 thons rouges capturés, 144 d'entre eux (15%) ont été mesurés avec succès par ce logiciel. Ensuite, une cage vide identique a été placée en face de la cage des thons rouges séparée par une porte de 8 m x 16 m. Pendant le transfert, des plongeurs ont filmé avec le logiciel AM100 les thons rouges qui passaient par la porte. Ensuite, ces images ont été examinées et sur les 932 thons rouges, 85 d'entre eux (9%) ont été mesurés avec succès par ce logiciel. Par conséquent, les données obtenues par le logiciel AM100 étaient similaires à 99% à celles mesurées pour les mêmes 39 groupes de tailles.

RESUMEN

Durante la última década, el engorde y/o cría de atún rojo (BFT) ha desempeñado un papel cada vez más importante en la acuicultura en los países mediterráneos, entre ellos Turquía. En este estudio se identificaron las relaciones talla-peso y la composición por tallas de 144 atunes rojos mediante un sistema de cámara estereoscópica. Además, se realizaron otras mediciones talla/peso de 85 atunes rojos mediante análisis de imagen durante el mismo día. Con el fin de medir en las jaulas los caracteres merísticos de un total de 229 atunes rojos, se utilizó un programa informático específico denominado sistema de contabilización y determinación de la talla AM100. En primer lugar, en la jaula en el mar, AM100 realizó una grabación de cinco minutos y con este programa se midieron con éxito 144 atunes rojos (15%) de los 938 capturados. Posteriormente, una jaula idéntica vacía se colocó frente a la jaula de atún rojo separada por una puerta de 8 x 16 m. Durante la transferencia, las imágenes de los atunes

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rojos que pasaban por la puerta fueron grabadas con el dispositivo AM100 utilizado por varios buzos. Posteriormente se examinaron dichas imágenes y también se midieron con éxito con este programa 85 atunes rojos (9%) de los 932. Por consiguiente, los datos obtenidos mediante el AM100 fueron similares en un 99% a los datos de las mediciones para los 39 grupos de tallas.

KEYWORDS

Bluefin tuna, stereoscopic camera system, software, measurement

1. Introduction

Upon instruction of the General Directorate of Fisheries of the Ministry of Food, Agriculture and Livestock; Akua Kocaman Su Ürünleri Üretim ve Pazarlama Ltd. Şti. have requested the participation of a scientist in order to conduct and observe the study to be exercised on 09/01/2012 in one the BFT (Bluefin Tuna) farm, located in Izmir province, Karaburun district, Gerence region pursuant to Article 87 of Rec. 10-04 (the member countries have to contribute to the pilot studies) of the International Commission for the Conservation of Atlantic Tunas (ICCAT) by a written appeal to Ege University, Faculty of Fisheries on 02.01.2012.

This report was prepared by Ege University, Faculty of Fisheries in line with the application and the study concerned.

2. The Study

In this study, weight-length relationship (144 fish) and size composition of the BFT in Cage No: TUN-01-AKF5 of Akua Kocaman Company in Karaburun/Gerence region were identified through stereoscopic (dual) underwater camera on 9 January 2012. In the same day, length-weight relationships of the BFT in the same cage were identified through their images recorded during their transfer to a different cage (85 fish). The BFT in the Cage No: TUN-01-AKF5 were harvested later and the harvest dates, weight and length of mentioned 932 fish are listed in **Chart 1**.

BCD No	*Harvest Date*	*Quantity*	*Kg*
TN-11-740010-1-1	29.01.2012	66	5.549,00
TN-11-740010-1-2	30.01.2012	251	31.158,00
TN-11-740010-2-1	31.01.2012	362	32.409,00
TN-11-740010-1-3	05.02.2012	149	26.153
TN-11-740010-2-2	07.02.2012	104	30.516
TOTAL		**932**	**125.785,00**

Chart 1. Harvest Dates, Number and Weight of the BFT in Cage No: TUN-01-AKF5.

Mediterranean has a total surface area of 2.500.000 km^2 and an average depth of 1400 km. One of the tuna species available in this sea is bluefin tuna (*Thunnus thynnus*). Farming and/or fattening is started in 1990s. Today; Spain, Italy, Malta, Croatia, Turkey, Tunisia and Greece are the countries which exercises BFT farming and/or fattening activities in Mediterranean Sea. In Turkey, BFT Farming activities were started in 2002. Prior to this date; BFT production in Turkish fisheries was exercised through catches at sea only.

The aim of the International Commission for the Conservation of Atlantic Tunas-ICCAT, which was established in 1966, is to take necessary measures in order to control the harvests of the Tuna and Tuna like species at sustainable levels in management area. According to the current management plan, adopted in 2006 and developed consecutive years; a catch and recording system has been developed which covers the entire chain of BFT fisheries from catch, to market including catches, transfers, farming/fattening facilities, processing vessels and marketing. One of the rules contained in this system is article 87 of Rec. 10-04 which dictates the usage of stereoscopic (dual) underwater camera system so as to estimate the fish bio-mass accurately. In this way, developing measurement and counting without causing harm to the fish will be encouraged. In this method,

viewing BFT in the cages and/or during their transfer to cages is benefited from. Weights and lengths of the fish are identified through the images obtained. These identifications are expected to become more reliable over the time through advancing video camera technology.

In this study, images of the BFT in net cages which have diameters of 50 m. were recorded by using stereoscopic (dual) underwater camera system on 09/01/2012 and images of fish were also recorded during their transfer from the same cage to another cage again with a diameter of 50 m. by passing through the 8x16m gate. Lengths and weights of a total of 144 + 85 BFT were estimated through these images by using the special software AM100 Tuna Sizing and Counting System. The degree to which the stereoscopic (dual) camera system and special computer program (software) used are successful in sampling was tried to be understood through comparison of lengths and weights of dead BFT following the harvest of the same cage in which sampling was carried out. Fork length measurement of BFT is seen in **Figure 1**.

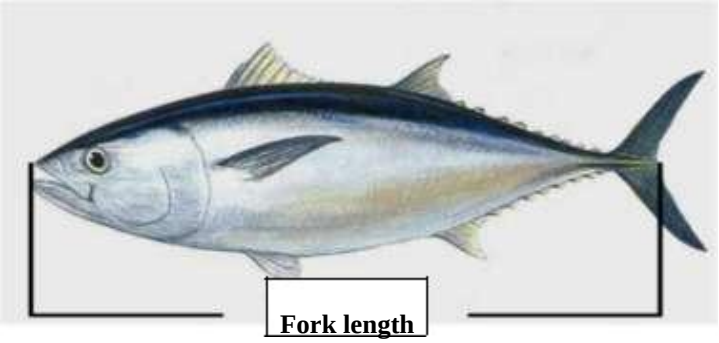

Figure 1. BFT Fork Length.

a) **Testing the device within the cage:** Cage No: TUN-01-AKF5 used for the study in the BFT farm has a diameter of 50 m. Side depth (edge) of the net of this cage is 13 m. while the half mesh is 70 mm. The depth of the bottom side of the cage net is approximately 23 m. together with its pot. Lengths of 144 BFT were measured by using AM100 Tuna Sizing and Counting System computer program from the Cage No: TUN-01-AKF5 from which 932 pcs. BFT was harvested after AM100 Tuna Sizing and Counting System made recording for five minutes in the cage.

b) **Testing the device during fish transfer:** An empty identical cage with a diameter of 50 m. was brought next to the Cage No: TUN-01-AKF5. The nets of the two cages were basted together in such a way that there will be a gate of 8 m. of height and 16 m of width in between. Then the volume of the net of the Cage No: TUN-01-AKF5 was reduced and the fish were enabled to pass through the existing gate to the other cage. In the meantime, the images of BFT passing through the door were recorded as AM100 device was used by divers. Afterwards these underwater images were examined and lengths of only a total of 85 tuna fish were identified among all the passing fish (932 fish) by using AM100 Tuna Sizing and Counting System computer program. **Figure 2** demonstrates the transfer of BFT from the Cage No: TUN-01-AKF5 to an empty identical cage.

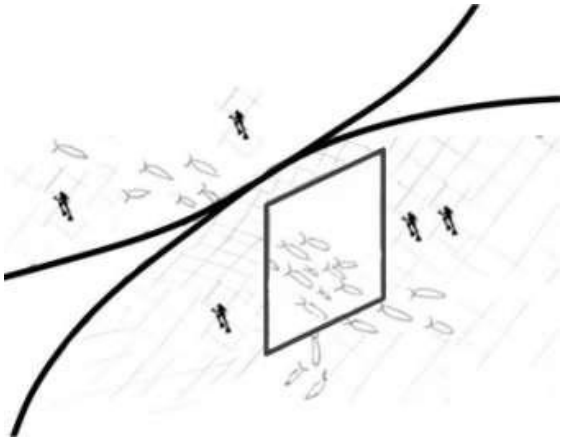

Figure 2. Transfer of BFT from cage to cage.

c) **Measuring length and weight of BFT in cage no TUN-01-AKF5 following their harvest:** The BFT in Cage No: TUN-01-AKF5 where stereoscopic dual underwater camera was tested, were harvested on 09.01.2012 and lengths and weights of a total of dead 932 BFT were measured. Information on lengths and weights of BFT harvested and measured by the camera is seen in **Chart 2**.

		Min-Max	*Ave ±S.E.*
Harvest (n=932)	Weight (Kg)	55 - 496	134,68 ± 3,43
	Length (cm)	131 - 298	183,44 ± 1,33
Camera (Intracage, n=932)	Weight (Kg)	46 - 323	184,13 ± 7,39
	Length (cm)	128 - 251	200,10 ± 3,18
Camera Transfer (n=932)	Weight (Kg)	44 - 515	205,58 ± 12,39
	Weight (Kg)	129 - 292	206,45 ± 4,85

Chart 2. Measurement of lengths and weights of BFT harvested and measured by camera.

If we look at the data obtained from the harvest of a total of 932 BFT, it can be seen that that the minimum weight is 55 kg, maximum weight is 496 kg. and that the BFT had an average weight of 134 ±3,42 kg. Also, it was found out from the length measurement during harvest that; the length of BFT was between 131 and 298 cm. and their average length was 183,43±1,33 cm. 144 fish measurements were made via the camera inside the cage and it was seen that their minimum weight was 43 kg, their maximum weight was 323 kg. and their average weight was 184,2±7,39 kg. It was also seen in cage measurement that the length of fish differed between 128 cm and 251 cm. and their average was 200,88±3,18 cm. In the measurements that were made during the transfer from one cage to another, it was seen that the fish had a minimum weight of 44 kg, maximum weight of 515 kg and their average weight was 205,58±12,39 kg. When we review the length measurements from the camera during the transfer, it was revealed that the fish was between 128 cm. and 292 cm. and the average length measurement was 206,45±4,85 cm. All data can be seen in the table below.

Consequently, by employing the AM100 device In the Cage Number TUN-01-AKF5 for 5 minutes, 144 fish out of total 932 (15%) were able to be measured. During the transfer of fish from the same cage to another, 85 BFT were measured (9%). The length–weight distribution of the BFT in the cage (**Annex 1)**, the length–weight distribution of fish measured by AM100 device in the cage (**Annex 2)**, length–weight distribution of fish measured by AM100 device during transfer (**Annex 3)** are provided with graphics. It is seen that 39 length groups are the same when the fish which are measured in cage, during fish transfer and harvest are separated into length groups. There are fishes in these length groups whose numbers differ between 1 and 27. For fishes that are greater than 1, weight averages are calculated. The separate weight sums of the fishes in total of 39 length group (measured in cage, during transfer and harvest) only differed 1% from each other. In other words, the weight determined by the AM100 device according to length measurement was 99% similar to the total weight values of the same 39 length group. Therefore, we can clearly and safely say that; the calibration of stereoscopic (dual) underwater camera system is well and the measurements are reliable. But the real problem with this device is that; it can only measure a small amount of fish. This device will operate more efficiently when the turbidity in the fish farm is at minimum or when it is operated while the caught fish are passing through the least amount of turbidity on their way to the cages at the BFT farm. Also, the gate dimensions recommended by the technical staff of the manufacturing company are 4x8 meters while the door used in the study on 09.01.2012 was 8x16 meters. The reason for that is the possibility of the number of the BFT damaged becomes higher if the gate is smaller. During the study which was conducted on 09.01.2012, AM100 device was only able to record 9% of the BFT that passed through the 8x16 meters door at a quality that allows measurement. Therefore, we can recommend that the above-mentioned camera be modified and equipped with technical specifications that allow efficient measurement in doors whose sizes are stated above. Also, since the stereoscopic camera requires electrical energy from outside in order to operate, it can be seen that the divers who are recording are in danger. Due to this characteristic of the device, it will be inconvenient to use it in high seas. According to the information we have received from the divers who used the device on 09.01.2012. Reportedly, they hardly could carry the cameras inside the water and have problems of keeping it stable due to the fact that metal part at which the camera is connected is very heavy. Finally, we can recommend mounting a small screen on the device in order for divers to see what is being recorded in real-time.

In conclusion, Assistant Professor Dr. Şükrü YILDIRIM from Ege University, Faculty of Fisheries participated in the study which was made with stereoscopic (dual) underwater camera on 09.01.2012. Also, veterinary surgeon Deniz KULAÇ from İzmir Provincial Directorate of Food, Agriculture and Livestock, Office of Animal Health, Aquaculture and Fisheries participated as national observer. While AM 100 underwater camera could only measure 85 out of 932 tuna fish during the transfer from one cage to another, 144 fish were measured during in-cage measurements. When the length measurements (which were recorded during two separate recordings) were compared with the values obtained after the fish were harvested; it can be seen that a total of 39 fish were in the same length. The difference between the weight sum of 39 fish in relation to their lengths and the weight sum of the same length of fishes after harvest is only 1%. In this case, we can safely say that; this device can be easily used in order to carry out sampling in BFT cages. And in the event that the technical specifications of the device are improved for BFT, it will be possible to measure a higher amount of fish.

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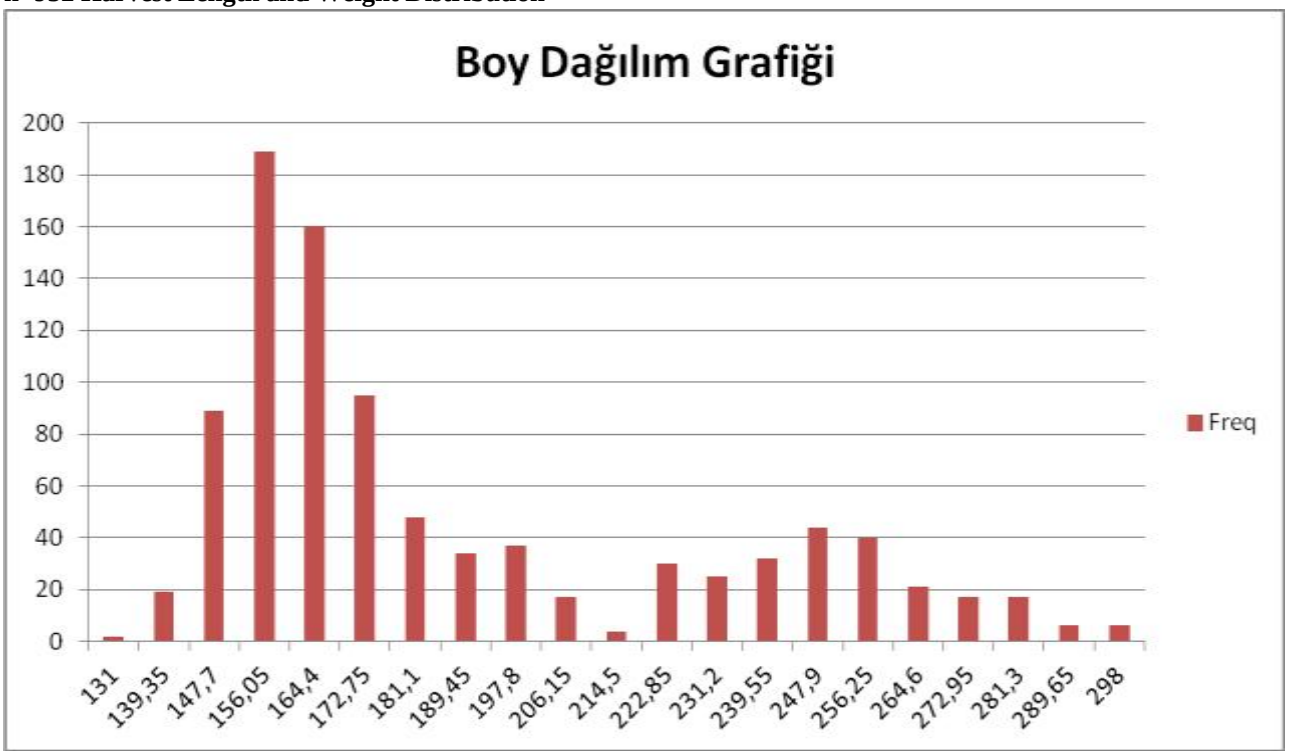
Annex 1

n=932 Harvest Length and Weight Distribution

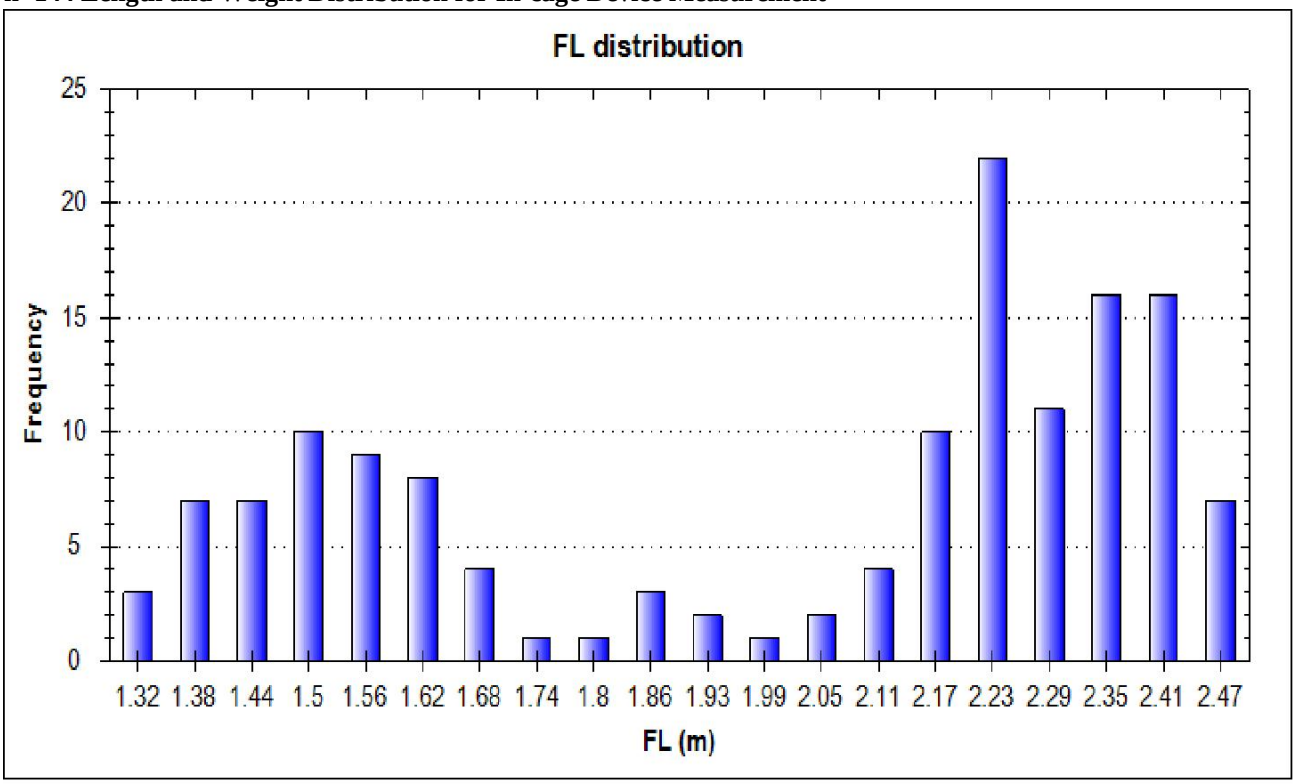


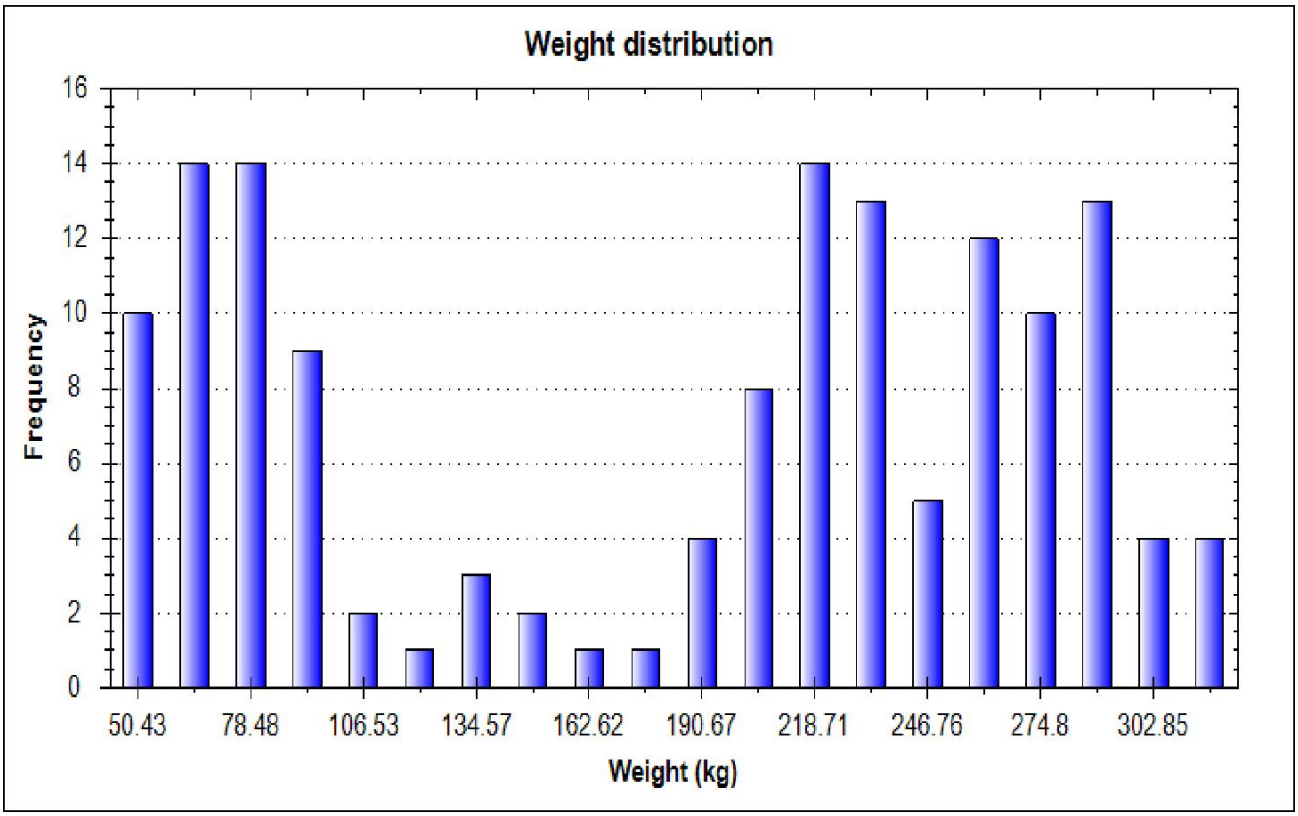
Length Distribution

Weight Distribution

Annex 2

n=144 Length and Weight Distribution for In-cage Device Measurement





Annex 3

n= 85 Length and Weight Distribution for Transfer Device Measurement