THE BFT FARM GROWTH SUB-GROUP STATUS OF ACTIVITIES

Anon

SUMMARY

The Commission has requested the SCRS to update the farmed Atlantic bluefin tuna growth table published in 2009. In this request, the use of individual fish to determine growth was emphasized as well as the consideration of differences between geographical areas. As a consequence of this request, the GBYP launched a series of studies in 2019, which will continue during 2020 and 2021, and a sub-group on growth of BFT in farms was established in 2020 within the BFT Species Group. This sub-group was created to ensure the best scientific data would be provided to the Commission. The sub-group held several online meetings to discuss how to carry out this request using different approaches and assessing their limitations, so that a scientifically sound updated growth table or tables could be provided. To facilitate this process, the analyses required were split into a number of study areas; the action plans of these study areas were presented to the sub-group during the last online meeting (17 July 2020).

RÉSUMÉ

La Commission a demandé au SCRS de mettre à jour le tableau de croissance du thon rouge de l'Atlantique d'élevage publié en 2009. Dans cette demande, l'utilisation de poissons individuels pour déterminer la croissance a été soulignée, ainsi que la prise en compte des différences entre les zones géographiques. A la suite de cette demande, le GBYP a lancé une série d'études en 2019, qui se poursuivront en 2020 et 2021, et a créé en 2020 un sous-groupe sur la croissance du thon rouge dans les fermes au sein du Groupe d'espèces sur le thon rouge. Ce sous-groupe a été créé pour garantir que les meilleures données scientifiques soient fournies à la Commission. Le sous-groupe a tenu plusieurs réunions en ligne pour discuter de la façon de donner suite à cette demande en utilisant différentes approches et en évaluant leurs limites, afin de pouvoir fournir un ou plusieurs tableaux de croissance actualisés et scientifiquement fondés. Pour faciliter ce processus, les analyses requises ont été divisées en plusieurs domaines d'étude ; les plans d'action de ces domaines d'étude ont été présentés au sous-groupe lors de la dernière réunion en ligne (17 juillet 2020).

RESUMEN

La Comisión ha solicitado al SCRS que actualice la tabla de crecimiento del atún rojo del Atlántico de granjas publicada en 2009. En esta solicitud se hizo hincapié en la utilización de peces individuales para determinar el crecimiento, así como en la consideración de las diferencias entre las zonas geográficas. Como consecuencia de esta solicitud de, el GBYP puso en marcha una serie de estudios en 2019, que continuarán durante 2020 y 2021, y un subgrupo sobre crecimiento del atún rojo en las granjas se estableció en 2020 dentro del Grupo de especies de atún rojo. Este subgrupo se creó para garantizar que se proporcionen los mejores datos científicos a la Comisión. El subgrupo ha celebrado varias reuniones en línea para examinar cómo llevar a cabo esta solicitud utilizando diferentes enfoques y evaluando sus limitaciones, de manera que se pueda proporcionar una o varias tablas de crecimiento actualizadas y científicamente sólidas. Para facilitar este proceso, los análisis necesarios se separaron en diversas áreas de estudio, los planes de acción de estas áreas de estudio se presentaron al subgrupo durante la última reunión en línea (17 de julio de 2020).

KEYWORDS

Atlantic bluefin tuna, farming, growth, L-W relationships, tagging

1. Introduction

In Recommendations 18-02 and 19-04, the Commission requested that an update of the growth table used for farmed Atlantic bluefin tuna be provided:

> *The SCRS, on the basis of a standardized protocol to be established by the SCRS for the monitoring of recognizable individual fish, shall undertake trials to identify growth rates including in weight and size gains during the fattening period. Based on the result of the trials and other scientific information available, the SCRS shall review and update the growth table published in 2009, and the growth rates utilized for farming the fish referred to under paragraph 35 c, and present those results to the 2020 Annual meeting of the Commission. In updating the growth table, the SCRS should invite independent scientists who have appropriate expertise to review the analysis. The SCRS shall also consider the difference among geographic areas (including Atlantic and Mediterranean) in updating the table. Farm CPCs shall ensure that the scientists tasked by the SCRS for the trials can have access to and, as required by the protocol, assistance to carry out the trials. Farm CPCs shall endeavor to ensure that the growth rates derived from the eBCDs are coherent with the growth rates published by the SCRS. If significant discrepancies are found between the SCRS tables and growth rates observed, that information should be sent to the SCRS for analysis.*

Following this request, the GBYP initiated a number of studies in 2019 which will continue into 2020 and 2021. Final reports of the first Phases of these studies are available at https://www.iccat.int/GBYP/en/biostu.asp (Phase 9 folder). Additionally, the BFT Species Group set up a sub-group to tackle this request.

Numerous online meetings were held involving many participants. The various discussions identified numerous issues which would impact on the updating of the growth table. These were split into five Study Areas, each with a Team Leader, so that they could be tackled in more detail by participants forming part of each the Study Area teams. Each of the Study Area leaders prepared a plan of action to be followed within their respective Study Areas. These were presented at an online meeting held on the 17th of July 2020 and are presented below.

2. Plans for each of the Study Areas

2.1 Study Area i) Analysis of the SC/Harvest data held by the Secretariat & other available datasets

Study Area leader: Mauricio Ortiz (ICCAT Secretariat, Spain)

The Group has reviewed all the available information and ongoing projects regarding growth rates of East bluefin tuna during farming operations. Following the recommendations from the Commission, individual growth rates are being evaluated main using individual tagging research projects.

However, due to the complexity and length of research, results are expected to be available later in 2021. In the meanwhile, a review of alternative methodologies to estimate growth rates are being pursue with data from the stereo-camera and harvest reports. The Group in coordination with the Secretariat is compiling the required data, and starting the analyses considering regional and temporal potential differences associated with the farming operations. It is expected that the Group can review these analyses soon and compared it with the results from the individual growth studies during 2021.

2.2 Study Area ii) determining growth of individual fish/tagging

Study Area leader: Chris Bridges (TUNATECH/HHU, Germany)

Final Report 2020 Summary for Portugal

Pedro G. Lino, Rubén Muñoz-Lechuga, Maria Nunes, Alfredo Poço, Inga Barata, Morikawa Hirofumi & Rui Coelho: TUNIPEX

In summary: 89 fish captured between 27 June and 21 August were taken out of the water weight, and length measured and double tagged and then replaced in the water. The survival rate was relatively low as shown in **Table 1**.

Afterwards the SC was used to determine their weight (shown below) and there was good agreement between the two methods (**Figure 1**). The tagged fished were then transferred to the growing out cage with other fish and after harvesting or death of the fish due to natural causes the weight increases were determined (**Figure 2**). This indicated an initial weight decrease probably due to non-feeding through disturbance of being out of water which then followed a period of growth as indicated by the 20% increase after 37 days.

When tagged fish and non-tagged fish were compared the L/W relationship was the same (**Figure 3**).

Final Report 2020 Summary for Croatia

Leon Grubišić, Ivan Katavić, Tanja Bubić Šegvić PELAGOS NET FARM d.o.o. (PNF)

Briefly two different tagging methods were used one using external tags and fin clipping the other insertion of a PIT tag in the head of the fish. In the first attempt, 12 tuna juveniles were externally tagged where high mortality of 40% was recorded. The PIT tag was more successful. GBYP supported and provided equipment for applying and reading PIT tags. During five days 26th to the 31st of July: 206 bluefin tuna juveniles between 7.5 and 10 kg were PIT tagged into the head muscle, weight and length measured. To prevent infection, puncture site was protected with iodine based antiseptic-geramycin cream. Initial mortality was less than 1%. An initial stereo camera size distribution was made of the holding cage before tagging. The tagged fish were equally distributed into two experimental cages (Cage #1 and Cage 5). The following stereo camera observations were then made: 28,08.2019 and 08.12.2019 (**Figure 4**).

As can be seen from the frequency distribution figures for Cage #1 and Cage#2 for the 28.8,2019 and the 8.12.2019, growth rates could be estimated at three monthly intervals and work is ongoing using Modal progression analysis by the other study area sub-group. Further data analysis is now required. In May 2020, 20 fish from each cage (#1,#5) were sampled to look at separate trial involving fish length and weight to check in the condition of the fish after the winter growth period. It is not clear if any tagged fished were amongst this sample. This harvest and sampling is planned for January/February 2021 depending upon market demands of the farm. It is assumed that further stereo camera measurements will be made over a three-month period.

SUMMARY AND FUTURE PLANS; **Study area II: Determining growth of individual fish/tagging**

1. To date in two different areas Portugal and Croatia attempts have been made to weigh individual fish. There has been no attempt as far as we know to do the same thing for the Mediterranean.

2. It is clear from the detailed report from Portugal that high mortality rates are to be expected if a fish of over 50 kg is to be removed from the water and then replaced. This is especially critical when the condition factor of the fish is relatively poor. Tag loss has also played a part in low return rates and precautions are envisaged for future work. The first pilot study in Portugal indicated that tagged and untagged fish have similar growth rates according to their length weight relationships and that the stereo camera data gave similar data to the actual weight measurements. It was however noted that after removal from the water and return weight gain could be negative. The mean increase in weight was around 27% (range 0% - 54%).

3. In the preliminary work from Croatia working with much smaller fish approximately 10 kg external tagging led to higher mortality rates whereas the use of a head PIT tag is much more successful. The PIT tags being removed at slaughtering. With 206 successfully implanted fish distributed between two cages monitoring with stereo, has continued every three months.

4. At the moment it is planned that further sampling should be carried out in Portugal from fish caught in the traps leaving the Mediterranean and that in Croatia stereo camera should be carried out at 3 monthly intervals with final sampling of absolute weight in early 2021.

It is clear that the remit to determine individual growth rates via the tagging and weighing fish out of the water has a much higher success rate in smaller individuals of around 10 kg. With larger fish this can only be accomplished at high mortality rates especially considering the numbers of individuals required for statistical analysis.

Suggested Recommendations

1. Continuation of the pilot study in Portugal with modifications of the tag to prevent loss and expected lower mortality rates.

2. Further analysis of the data obtained from the stereo cameras in Croatia for growth rates and final sampling in 2021.

3. Investigate the setting up of a pilot study for the Mediterranean with the tagging and transfer of approximately 100 fish using visually coded tags and PIT tags which can be recovered at slaughtering.

2.3 Study Area iii) Regional L-W equations

Study Area leader: Rafik Zarrad (INSTM, Tunisia)

The conclusion is:

- The tasks are to build a data base for length weight relation for wild fish available from CPCs (stored in the Secretariat) and from GBYP.
- The looking of a separate relation by region should be tested statistically.
- We should look in the LW relation effect by starvation time (between catch and cage transfer).

Work plan

- Summarize the situation on LW data available
- Build the data base
- Data analysis and estimation of LW relationships
- Statistical test of LWRs between regions

2.4 Study Area iv) New methods of determining growth (acoustic/image analysis; AI)

Study Area leader: Víctor Espinosa (UPV, Spain)

In this area it was planned to apply the methodology described in (Muñoz-Benavent, 2018) in different pilot studies across the Mediterranean farming areas, starting in May 2020 at Larache (Morocco). Unfortunately and due to the constricted COVID scenario the pilot studies have been reduced to an only experience in the Balfego's facilities in L'Ametlla de Mar (Spain).

Pilot study at Balfego's farm

Duration: end of July- end of Novembre 2020

Work plan

An autonomous system composed by an upwards-looking stereoscopic video camera and echosounder will be moored in the bottom of a fattening cage with communications and power supply units fixed to the cage upper rings. The system will record every day during 3 hours, and the recordings will be analysed automatically by a AI-based software on a daily basis providing fork length distributions as well as the width of tuna measured at 5 control points along its silhouette (Muñoz-Benavent, 2018).

During this study it is intentded to validate also the acoustical monitoring of tuna growth through the measurement of maximum acoustical target strength of fish from ventral perspective (V. Puig 2017) and the measurement of acoustical height following (Soliveres *et al.* 2017).

It has been programmed that the experimental cage (Cage number 2 of the facilities) will contain a population with the highest dispersion in size that it could be possible to obtain. The same cage will be monitored once a month to obtain length and maximum height distributions with standard stereoscopic-camera measurements performed by Balfegó & Balfegó.

All tuna will be measured at harvesting to obtain weight, fork length, maximum width and maximum height.

Expected outputs:

- Growth curves during the monitored period for different size groups.
- Comparison outputs from Study area «Modal analysis for the determination of growth and possible correlations with environmental factors and food supply».
- Validation of new acoustical techniques.
- Statystical study on the robustness of distributions as a function of number of measurements and spatial distribution of tuna in the cage water column.

The growth results should be considered as preliminar, and it is programmed to repeat this experience in Morocco and otther places during the 2021 campaign.

2.5 Study Area v) Modal analysis for the determination of growth and possible correlations with environmental factors and food supply.

Study area leader: Francisco Alemany (GBYP, ICCAT, Spain)

1) Compilation, standardization and formatting, to fit with the FISAT II software requirements, of length data files from the stereo-camera measurements and from measurements at harvesting carried out within the framework of Phase 9 GBYP studies. *Responsible:* Alfonso Pagá, with the help of data provides if necessary. *Timeframe:* June/mid July 2020. Expected output: ungrouped length frequencies FISATII files.
2) Preliminary work on rough length data files to generate length distributions suitable for Modal Progression Analyses (selection of optimal bins and smoothing of raw data). *Responsible:* Francisco Alemany, with the help of any SG member if offered. *Timeframe:* 15-30 July 2020. Expected output: grouped length frequencies FISAT II files (.lfq).
3) Identification of modal groups in each available LF from Phase 9 studies and modal progression analyses to determine growth rates, including elaboration of a draft report. *Responsible:* Francisco Alemany, with the help of any SG member if offered. *Timeframe:* August 2020. Expected output: seasonal growth rates by modal groups in all the GBYP phase 9 study areas.
4) Elaboration of a definitive preliminary report on seasonal growth rates from MPA analyses. *Responsible:* whole SG. *Timeframe:* September 2020. Expected output: Preliminary report.
5) Compilation and standardization of environmental factors data (food supply/physical variables) for the Phase 9 studies. *Responsible:* Alfonso Pagá, with the help of rest of GBYP coordination team and data providers if necessary. *Timeframe:* September 2020. Expected output: environmental factors data files at adequate temporal scales (matching with LF data).
6) Compilation, standardization and formatting, to fit with the FISAT II software requirements, of length data files from the stereo-camera measurements and from measurements at harvesting carried out within the framework of Phase 10 GBYP studies. *Responsible:* Alfonso Pagá, with the help of data provides if necessary. *Timeframe:* from September 2020 to around April 2021, of till the end of field studies-. Expected output: ungrouped length frequencies FISATII files.
7) Preliminary work on rough length data files to generate length distributions suitable for Modal Progression Analyses (selection of optimal bins and smoothing of raw data). *Responsible:* Francisco Alemany, with the help of any SG member if offered. *Timeframe:* Around April 2021 Expected output: grouped length frequencies FISAT II files (.lfq).
8) Identification of modal groups in each available LF analyses from Phase 10 studies and modal progression to determine growth rates. *Responsible:* Francisco Alemany, with the help of any SG member if offered. *Timeframe:* around May 2020. Expected output: seasonal growth rates by modal groups in all the GBYP phase 10 study areas.
9) Compilation and standardization of environmental factors data (food supply/physical variables) for the Phase 10 studies. *Responsible:* Alfonso Pagá, with the help of rest of GBYP coordination team and data providers if necessary. *Timeframe:* December 2020 - around April 2021. Expected output: environmental factors data files at adequate temporal scales (matching with LF data).
10) Modelling the relationships between growth rates and environmental factors, considering phase 9 and phase 10 data (Methodological approach to be discussed and agreed within the SG. *Responsible:* To be determined, volunteers required. *Timeframe:* June/July 2021. Expected output: determination of functional relationships between seasonal growth rates and environmental factors.

11) Elaboration of a final report on this line of activity. *Responsible:* To be determined, volunteers required. *Timeframe: August 2021.* Expected output: Final report on this line of research.

2.6 Summary of the 17th of July 2020 discussions on the Study Areas

The following section summarises points made during the discussion following the presentation of each of the Study Areas by the Study Area Leader.

2.6.1 Study Area i)

Secretariat has database available. Under current circumstances, issue of available time needed to carry out the analysis.

2.6.2 Study Area ii)

Problem with retention of tags in Portugal, now solved. Other options are available. Need to expand tagging experiments in Med with bigger sized fish. Discussion about mortalities due to handling and mechanisms for compensating the farms for loss of fish. It would not look good to be killing lots of fish. How many fish are actually needed? It would be possible to tag fish underwater (very little mortalities have been experienced) and use the SC to determine SFL, but that still doesn't provide the RWT which is the expected starting point of the determination of the growth determination (unless a fully calibrated LW relationship is available).

Using SC has certain limitations in situations of high-water turbidity (e.g. Malta vs Portugal). Numerous papers have shown that the SC readings can accurately provide determinations of SFL. Studies involving image analysis may be able to provide an accurate determination of RWT. It was suggested that a method of validation of the LW equation could be by using fish which are not caged. It was pointed out that the GBYP had requested information about the mortalities occurring during the catch and transfer processes, but such data was not officially available and more cooperation on this is needed. Some information is available from the mortalities which occurred in the Portuguese traps.

Tagging data in Portugal indicates that there is a short period (after tagging) where the fish actually lose weight, but weight increase resumes after this initial period. It is possible that fish are also still spawning within this initial period.

2.6.3 Study Area iii)

This is a very important topic. There appears to be no significant differences between yearly LW equations. Morocco is carrying out a sampling programme of wild BFT caught in the Atlantic to look at the LW equation which can have a significant impact on the potential growth in farms. This data will be available for this Study Area and although not finalised, preliminary analysis suggest that the average RWT of fish sampled in May could be slightly higher than that predicted by the currently used (Med) LW equation.

2.6.4 Study Area iv)

The possibility of using acoustic tags to follow individual fish growth was discussed. Although technically difficult, this approach when combined with the acoustic method of determining RWT could address the issues of handling of BFT to determine RWT at caging whilst providing the requested individual fish growth information. A study using this approach could be taken up by the GBYP.

2.6.5 Study Area v)

It was confirmed that the farms in which the GBYP growth studies are being carried out would keep the fish for as long as possible, although in some cases, a majority of the fish were harvested. During these harvests, all fish were individually weighed and measured (SFL).

The GBYP is compiling the table with trial work carried out/ongoing and all participants were reminded to send such trial details to the GBYP team to put into the table.

References:

Pau Muñoz-Benavent, Gabriela Andreu-García, José M Valiente-González, Vicente Atienza-Vanacloig, Vicente Puig-Pons, Víctor Espinosa, Automatic Bluefin Tuna sizing using a stereoscopic vision system, ICES Journal of Marine Science, Volume 75, Issue 1, January/February 2018, Pages 390–401, https://doi.org/10.1093/icesjms/fsx151

Vicent Puig Control y caracterización del Atún Rojo en jaulas marinas. PhD Thesis, Universitat Politècnica de València, 2017 http://www.revistaaquatic.com/ojs/index.php/aquatic/article/download/380/329

E.Soliveres et al. Monitoring fish weight using pulse-echo waveform metrics,Aquacultural Engineering Volume 77, May 2017, Pages 125-131, https://doi.org/10.1016/j.aquaeng.2017.04.002

Table 1. Number of fish harvested, dead and unrecovered per tagging date.

Tagging date	Harvested	Dead	Unrecovered
27-06-2019	3	3	14
02-07-2019	8	4	2
09-07-2019	7	10	0
10-07-2019	2	3	1
26-07-2019	6	13	1
21-08-2019	8	4	0
Total Result	**34**	**37**	**18**

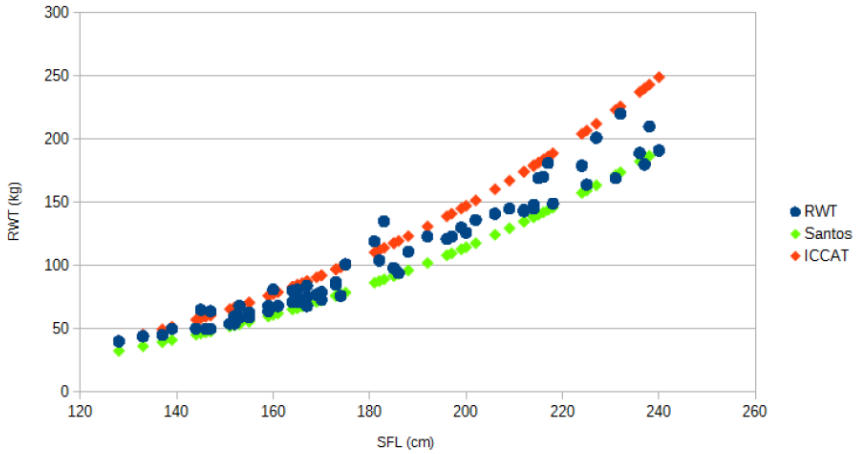


Figure 1. Relation between round weight (RWT) and straight fork length (SFL) at tagging compared to estimated weight at the same length using the ICCAT L-W equation (red dots) and the Santos *et al.* (2003) (green dots).

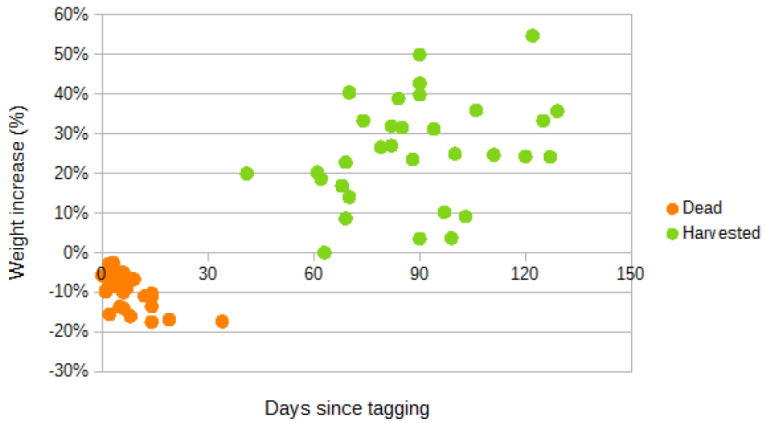


Figure 2. Weight increase as a proportion of initial weight with time after tagging.

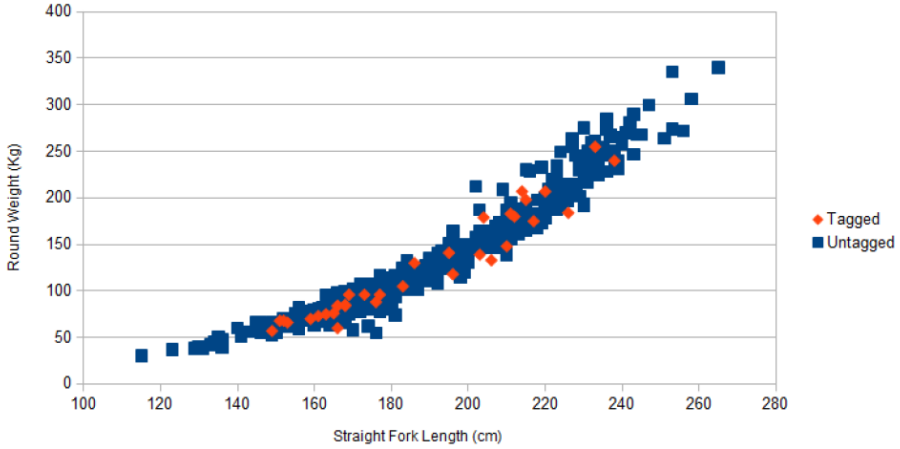
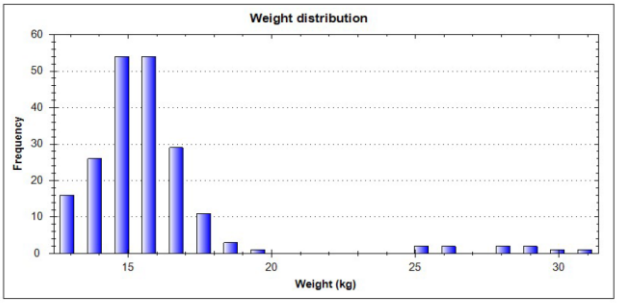
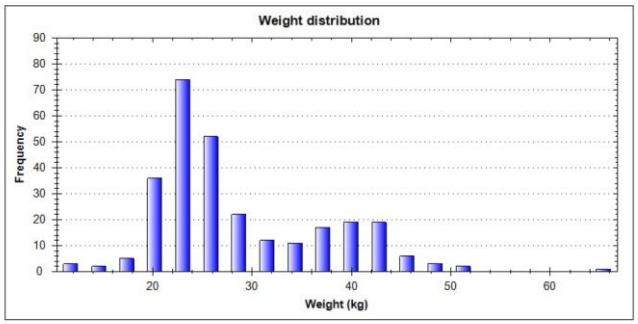


Figure 3. Straight Fork Length vs Round Weight of all fish in the monitored cage harvested after 5 September (date the first tagged fish was harvested).

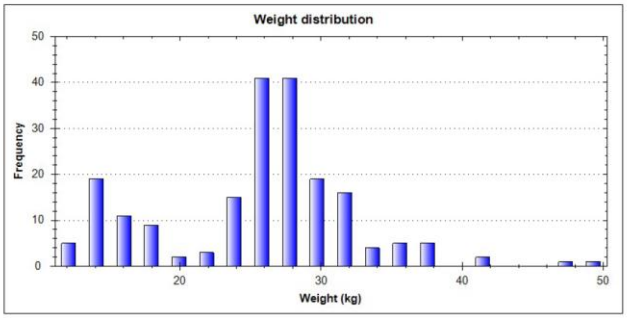
Cage: #1
Date: 28.08.2019.
First footage



WEIGHT DISTRIBUTION
Cage: #1
Date: 08.12.2019.
First footage



WEIGHT DISTRIBUTION
Cage: #5
Date: 28.08.2019.
First footage



WEIGHT DISTRIBUTION
Cage: #5
Date: 08.12.2019.
Frist footage

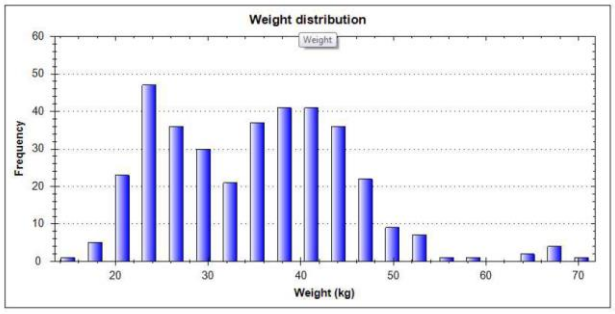


Figure 4. Stereocamera observations made from the two experimental cages on 28.08.19 and 08.12.19.