

## NOTES ON THE DESIGN AND IMPLEMENTATION BY GBYP OF THE BROAD STUDY ON BFT GROWTH IN FARMS REQUESTED BY THE ICCAT COMMISSION (PARAGRAPH 28 REC. 18-02)

F. Alemany, M. Ortiz, C. Palma, S. Tensek, A. Pagá García, M. Neves dos Santos

### SUMMARY

*During the Commission 21<sup>st</sup> Special meeting, GBYP programme was committed to carry out a broad study on BFT growth in farms in order to update the table of maximum expected growth in weight for farmed Bluefin tuna as function of size/age at caging and number of months in farm provided by the SCRS in 2009. Firstly, in order to put in context such a study this paper presents an in-depth review of previous Commission recommendations on this issue, as well of the answers from the SCRS to each one of these recommendations. Following, the successive steps taken by GBYP Coordination, GBYP Steering Committee and ICCAT Secretariat to design and start to implement the requested study, including: compilation, review and analysis of relevant scientific literature; study approach and initial work-plan; scoping study; design of definitive work-plan; implementation of field and desk work for base data generation and, finally, data analysis and reporting, the last two still ongoing, are described.*

### RÉSUMÉ

*Lors de la 21<sup>e</sup> réunion extraordinaire de la Commission, le programme GBYP s'est engagé à réaliser une vaste étude sur la croissance du thon rouge dans les fermes afin de mettre à jour le tableau de la croissance maximale escomptée du poids du thon rouge d'élevage en fonction de la taille/âge à la mise en cage et du nombre de mois passé dans la ferme fourni par le SCRS en 2009. Tout d'abord, afin de mettre en contexte une telle étude, ce document présente un examen approfondi des recommandations précédentes de la Commission sur cette question, ainsi que des réponses du SCRS à chacune de ces recommandations. Ensuite, sont décrites les mesures successives prises par la coordination du GBYP, le comité directeur du GBYP et le secrétariat de l'ICCAT pour concevoir et commencer à mettre en œuvre l'étude demandée, notamment : la compilation, l'examen et l'analyse de la littérature scientifique pertinente ; l'approche de l'étude et le plan de travail initial ; l'étude de viabilité ; la conception du plan de travail définitif ; la mise en œuvre du travail de terrain et du travail documentaire pour la génération des données de base et, enfin, l'analyse et la déclaration des données, les deux dernières étant encore en cours.*

### RESUMEN

*Durante la 21<sup>a</sup> reunión extraordinaria de la Comisión, el programa GBYP se comprometió a realizar un amplio estudio sobre el crecimiento del atún rojo en las granjas con el fin de actualizar el crecimiento máximo previsto en peso del atún rojo en las granjas, como una función de la talla/edad en el momento de introducción en jaulas y el número de meses pasados en la granja facilitada por el SCRS en 2009. En primer lugar, con el fin de poner en contexto dicho estudio, este documento presenta una revisión en profundidad de previas recomendaciones de la Comisión sobre este tema, así como las respuestas del SCRS a cada una de dichas recomendaciones. A continuación, se describen los pasos sucesivos dados por la coordinación del GBYP, el Comité directivo del GBYP y la Secretaría de ICCAT para diseñar y empezar a implementar el estudio solicitado, lo que incluye: compilación, revisión y análisis de la bibliografía científica pertinente, enfoque del estudio y plan de trabajo inicial, establecer el ámbito del estudio, diseño del plan de trabajo definitivo, implementación del trabajo de campo y de oficina para la generación de los datos de base y, por último, análisis de los datos y comunicación, estos dos últimos en curso.*

### KEYWORDS

*Atlantic Bluefin tuna, BFT farming, growth rates*

## 1. Background

Following the recommendation 18-02, Paragraph 28, adopted by the Commission during the 21<sup>st</sup> Special meeting, the GBYP was committed to undertake scientific studies based on the monitoring of recognizable individual fish to identify growth rates, including in weight and size gains during the fattening period and considering the difference among geographic areas (including Atlantic and Mediterranean).

In order to put this research in context relevant official documents on this topic, regarding both ICCAT Commission recommendations and SCRS reports, have been reviewed. An extract of the texts from these documents directly related to the study of the growth of caged fishes are provided in **Annex 1** (Commission recommendations) and **Annex 2** (SCRS reports), respectively.

### 1.1 Revision of relevant Commission Recommendations

- Regarding ICCAT Commission Recommendations, the first one dealing with this topic was the Rec. 02-10 on Bluefin tuna farming, which in its points 2b and 2c stated, respectively, that the CPCs, Cooperating non-Contracting Parties, Entities or Fishing Entities should adopt the necessary measures to recommend the tuna farms and the scientific institutes to *obtain data on the size of the fish caught and estimates of the growth while in captivity*.
- Next year the Rec. 03-09, addressed only to CPCs, included also these points and added a new one (2e), it is that a *sampling program should be established for the estimation of the numbers-at-size of the bluefin tuna caught*.
- In 2004, the Rec. 04-06, merged in one single point (2b) the previous paragraphs on obtaining data on size composition of the catch and the sampling program to this end, establishing a minimum sampling size (100 individuals by 100 tons), specifying that the sampling should be carried out during harvesting. The recommendation about estimates of the growth while in captivity was maintained (2c) and, for the first time, the SCRS was directly committed to *undertake trials to identify growth rates including weight gains* during the fattening or penning period (10).
- In the next two years, the Recs. 05-04 and 06-07 repeated exactly the same recommendations (in paragraphs 2b, 2c and 12, and 2c, 2d and 12, respectively).

From 2008 to 2017 all these recommendations related to the growth of caged fishes were included in the successive amendments of the multiannual recovery plan for bluefin tuna in the eastern Atlantic and Mediterranean. In general, such recommendations were centered on the same objective than the previous one, to determine the growth rates of caged fishes after getting the basic data to do it. Thus, along this period the Commission asked first the CPCs to define the growth factors to be applied to bluefin tuna farmed in their cages and to carry out pilot studies to better estimate both the number and weight of bluefin tuna at the point of capture and caging, including through the use of stereoscopic camera systems, and then, from 2014, finally implementing such system following standardized protocols. In parallel, the SCRS was committed first to further study the growth factors defined by CPC to provide advice to the Commission for its annual meeting in 2010 and after that to review information from BCDs and other submitted data and further study growth rates so as to provide advice to the Commission. More specifically:

- The Rec. 08-05, in its point number 96, requested CPCs to define growth factors to be applied to bluefin tuna farmed in its cages and notify to ICCAT Secretariat and to the SCRS the factors and methodology used, which should be reviewed by the SCRS at its annual meetings in 2009 and 2010, further studying the estimated growth factors to provide advice to the Commission for its annual meeting in 2010.
- The Rec. 10-04 reiterated these requests (point 98) and, in addition, asked CPCs initiate pilot studies (paragraph 87) on how to better estimate both the number and weight of bluefin tuna at the point of capture and caging, including through the use of stereoscopic camera systems, establishing sampling programmes and/or an alternative programmes at the time of caging to this end. SCRS should explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging.
- On 2012, the Rec. 12-03 repeated the requests to CPCs (paragraph 88), imposing that a programme using stereoscopic cameras systems or alternative techniques that provide the equivalent precision should cover 100% of all cagings in order to refine the number and weight of the fish in each caging operation, submitting the results to SCRS, which should evaluate such procedures and results and, in addition, review information from BCDs and other submitted data and further study growth rates so as to elaborate updated growth tables (paragraph 98) and report to the Commission by the 2013 Annual meeting.

- Two years later the Rec. 14-04 reiterated these requests, asking CPCs to take the necessary measures and actions to better estimate both the number and weight of bluefin tuna at the point of capture and caging and report the results to the SCRS, whereas SCRS should continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and (paragraph 82) and review information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission by the 2016 Annual meeting (paragraph 96), but gave one step further regarding the use of stereoscopic cameras, adopting the protocols described in the Annex 9 of such Recommendation (paragraph 83).
- The Rec. 17-07 included in the last amendment of the BFT recovery plan is, regarding the paragraphs 82, 83 and 96, a mere copy-paste of Rec. 14-04, including the obligation of reporting to the Commission 2016 annual meeting.

Finally, the current Recommendation 18-02 included in the new multi-annual management plan for BFT in the Eastern Atlantic and Mediterranean Sea, in spite it maintains the previous recommendation regarding the use of the stereoscopic camera systems to estimate the number and weight of fishes at caging (paragraph 99), changes totally the scope in relation to the determination of growth rates of caged fishes. This new approach is detailed in paragraph 28, in which the SCRS is committed specifically to undertake trials to identify growth rates, including in weight and size gains, during the fattening period based on the monitoring of recognizable individual fish.

Based on the result of the trials and other scientific information available, 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. Paragraph 28 also states that in updating the growth table, the SCRS should also consider the difference among geographic area (including Atlantic and Mediterranean) and invite independent scientists who have appropriate expertise to review the analysis. Farm CPCs are requested to 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 SCRS for analysis.

### ***1.2 Description of actions carried out by CPCs and SCRS in relation to the above described relevant recommendations and its results***

In spite that the first Commission Recommendation on this issue (Rec. 02-10) dates back from 2002, the first mention to this issue in SCRS reports was the point “*16.3 Consideration of sampling programs for farmed Bluefin*” included in the SCRS report of the biennial period 2004-05 part I volume 2, which simply stated that no new information had been submitted to SCRS in previous year.

In the report of the biennial period 2006-07 part I volume 2 this question was tackled again, specifically in the point *15.5 Review of information on farmed bluefin tuna growth rates*, addressing the Rec. 05-04, stating that since the implementation of this recommendation did not enter into force until June 2006, no new studies had been initiated at this time. However, some relevant works on tuna farming issues were listed, including a paper by Ticina *et al.* (2006) based on tagging experiments, which reported growth rates of small bluefin tuna in the cages significantly higher than those figures of 25% of gain in weight and the factor of 0.8 applied to fattening practice of large bluefin tuna confirmed within the 6th GFCM-ICCAT Meeting on Stocks of Large Pelagic Fishes in the Mediterranean (Anon., 2003). It was pointed out also that the lack of accurate estimations of initial size of individual fish that enter in the cages prevents to obtain accurate estimation of weight gain during the rearing period. However, a weight gain of 25% due to the fattening was assumed for BFT stock assessment.

In the following year, in the SCRS report of the biennial period 2006-07 part II volume 2, in the point *15.5 Review of information on farmed bluefin tuna growth rates*, addressing Rec. 06-07, the Committee reviewed the limited new scientific information available, specifically two works from Ticina *et al.* (2006 and 2007) on juvenile bluefin fishes caged in the Adriatic, which showed weight gains of 340% in 511 days, which represent a weight gain that doubles that in the wild. However, considering that the weight gain can be highly variable depending on various factors, the Committee solicited proposals to collect needed scientific information to complete the advice to the Commission.

In 2008 the report of the biennial period 2008-09 part I volume 2, the Rec. 06-07 was addressed again, in the point *15.4 Review of information on farmed bluefin tuna growth rates*. This time the Committee stressed once more the importance of not having information on the weight of the fishes at the moment of caging, since the estimated weights back calculated from the data at harvesting applying the ICCAT length-weight relationship for eastern

bluefin showed some estimates which appeared to be biased, and even negative growth. Consequently, the Committee requests that CPCs involved in farming or fattening operations find the means to best obtain these growth rates by providing best estimates of the weight of fish at time of capture.

In the following year, in the report of the biennial period 2008-09 part II volume 2, the Rec. 06-07 was considered once, in the point *16.6 Review of information on farmed bluefin tuna growth rates*. The Committee pointed out that by the time of the 2009 SCRS meeting, Contracting Parties had not notified the ICCAT Secretariat or the SCRS the growth factors or methodology used for tuna kept in their farms, as requested in the paragraph 96 of the Rec. 08-05. Nevertheless, the Committee reviewed several industry-sponsored studies (see Anon. 2010) and references therein) and concluded that the gain in weight of bluefin tuna in farms can be significantly higher than the value which had been used to-date. As a result, the Committee reviewed and provided a table of maximum expected growth in weight for farmed Bluefin tuna as function of size/age at caging and number of months in farm (Table 16.6). This table was based on five different growth studies done by national scientist in Spanish, Maltese, and Croatian BFT farms between 2006 and 2009, each study focusing in different size/age group and time of caging. Base on this information, the SCRS estimated an overall expected maximum increase per size/age as function of caging time), but recognizing that the high variability associated with diverse factors and indicating that the maximum growth was expected only for “optimal” conditions of farming operations. The Committee recommended that Contracting Parties tentatively adopt growth factors that are consistent with those in Table 16.6. It was highlighted also that it is critical to obtain measurements of fish sizes as they enter cages, since the use of length frequencies from the farmed fish at the time of harvest would introduce a significant bias in stock assessments. Consequently, the Committee also recommended that Contracting Parties continue to conduct studies that can lead to a better quantification of the inputs into cages, developing methods to measure the size of the fish entering the cages, as stereoscopic video cameras, which in those days were under development and should be tested and pursued for operational applications.

In 2010, in the report of the biennial period 2010-11 part I volume 2, the Rec. 06-07 and 08 were addressed in the point *16.4 Review of information on farmed bluefin tuna growth rates*. The Committee noticed that the application of growth rates in table 16.6 to back calculate sizes and weight at capture resulted in unrealistic size distribution, since these rates are only maximum growth rates and when applied underestimate the real sizes at capture, pointing out also that to generate the table 16.6 rates losses due to mortality or escapement during caging were not taken into account. Consequently, the Committee recommended Contracting Parties continue to conduct studies that can lead to a better quantification of the inputs into cages, taking into account losses and to develop methods to measure the size of the fish entering the cages, as stereo-cameras, encouraging the farms to test these systems.

Next year, in the report of the biennial period 2010-11 part II volume 2, the Rec. 10-04 was addressed in the point *18.3 Exploration of operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging*, which deals with the revision of four papers about the use of stereo-cameras presented in 2010. The Committee concluded that in spite few technical issues remain to be solved results were promising, and hence encouraged CPCs to complete these studies by 2012 in order to implement a system based on stereo-cameras as soon as possible.

In the report of the biennial period 2012-13 part I volume 2, the Rec. 10-04 was addressed again, in the point *18.10 Explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging*, focusing on the revision of three new papers on the use of stereo-cameras presented in 2012. The SCRS was encouraged by the progress made, but noted that a number of factors may affect the accuracy of the stereoscopic camera measurements, and also that fish may also suffer a drop in condition from the time of capture to the actual caging. The Committee recommended moving beyond the pilot study phase and setting up a technical working group to establish procedures for implementing stereoscopic camera systems by 2013.

In 2013, in the report of the biennial period 2012-13 part II volume 2, the Committee addressed the Rec. 12-03 in the point *16.2 Evaluate the BFT pilot studies to estimate both the number and weight of bluefin tuna at the point of capture and caging using stereoscopic system, Rec. [12-03], paragraph 88*. Two new papers on the use of stereo-cameras were reviewed and discussed. As a result, the SCRS concluded that more work was needed for establishing standard procedures and stated that an in-depth analysis of all the studies should be done to compare methods, but without clarifying who should do this exercise, and recommended setting up a standardized protocol for the implementation and use of stereoscopic camera systems by 2014. The Rec. 12-03 was also addressed in the point *16.4 Provide updated tables of BFT growth rate in weight based on the information from BCDs and other submitted data, Rec. [12-03], paragraph. 98*, confirming its commitment to continue the work of the Trade Group, initiated in 2012, to establish procedures based on BCDs and other available information to confirm the catch numbers of fish and weights declared on BCDs, aiming at ensuring that no underreporting or misreporting can occur.

The report of the biennial period 2014-15 part I volume 2 addressed the Rec. 13-08 in the point *18.2 Review the technical specifications of the use of stereoscopic cameras systems*, stating that since the CPCs had provided data from stereoscopic cameras but not the technical specifications followed to generate the data it had been not possible to perform any review or comparative study. Consequently, the Committee recommended CPCs to provide such technical specifications. The Rec. 13-07 was also addressed, in the point *18.3 Continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and evaluate the BFT pilot studies to estimate both the number and weight of bluefin tuna at the point of capture and caging using stereoscopic systems*. The Committee noted that because the aforementioned lack of information about technical specifications it was not possible to know if observed differences between the data from different flags reflected real differences in catches or were the result of differences in the methodologies used. Consequently, the SCRS recommended that procedures for the use of the stereo camera be standardised and made available to the SCRS, requesting that the Secretariat provide to the CPCs. a standard electronic format for data submission. The Group also recommended reviewing and providing appropriate conversion factors to estimate weight based on the size measures, as well the use of the stereo camera measurements to validate estimations of size frequency at catch from harvest data. This Rec. 13-07 was addressed also in the point *18.5 Provide updated BFT growth rates tables based on the information from BCDs and other submitted data*, in which the results from a new study based in harvest data from 130000 individuals, providing new proxies of maximum growth rates based on the probability distribution of variance of weight at size, from three alternative statistical models were summarized. However, it was concluded that the differences between these new growth proxies and the growth rates in table 16.6 should be further reviewed before an updated growth table can be provided.

In 2015, in the report of the biennial period 2014-15 part II volume 2, the Rec. 14-04 paragraph 82 was addressed in the point *19.4 Continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission*, in which the Committee noted that finally the CPCs had started to submit reports of technical details of the stereo-camera systems besides the size and weight measures. The results from three new studies on the use of stereo-cameras were reviewed, which allowed the Group to conclude that stereoscopic cameras have been demonstrated as viable technologies. The paragraph 83 of the Rec. 14-04 was addressed in the point *19.5 Evaluate the results of the 100% coverage programme using stereoscopic cameras systems or alternative techniques that provide the equivalent precision to refine the number and weight of the fish during all caging operations*. The Committee, considering the results presented in the aforementioned papers, confirmed that the growth can be significant during farming period, but that significant differences can be found depending on various factors. It also noted that CPCs were still using different methodologies and hence remembered that a standardized universal protocol should be determined.

In the report of the biennial period 2016-17 part I volume 2, the Rec. 14-04 paragraph 82 was addressed again, specifically in the point *18.6 Continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission*, in which two new studies dealing with stereo-cameras measurements were discussed, pointing out the high variability in the time from capture to caging, which result in important difference in the condition of the caged fishes. The paragraph 84 of Rec. 14-04 was addressed in the point *18.7 Evaluate the results of the 100% coverage programme using stereoscopic cameras systems or alternative techniques that provide the equivalent precision to refine the number and weight of the fish during all caging operations*, in which the Committee noted that recognized that the reporting of stereo-camera data had increased substantially thanks to the fully compliance of Rec. 14-04, but that problems in reporting systems, as submission of duplicated information and the use of non-standard forms, had occurred. Consequently, SCRS recommended that the Secretariat, in collaboration with the Sub-committee of Statistics, make clear guidelines and forms for streamlining the stereo-cameras data submission. As regards the paragraph 96 of Rec. 14-04, addressed through the point *18.9 Review the information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission*, it was only stated that due to time and data limitations it had not been possible to revise and update estimates of potential growth rates.

Finally, in the report of the biennial period 2016-17 part II volume 2, the Rec. 14-04 was only addressed in one point, referred to the Annex 9, item iii of such Rec., dealing with conversion algorithms. Thus, in the point *20.22 Conversion algorithm for the caging operations* the Committee noted that the algorithm proposed by SCRS was not adequate for Adriatic and proposed an alternative equation based on the results of the study presented by Katavic *et al.* in 2017.

## **2. Planning and implementation of the GBYP study on BFT growth in farms**

### ***2.1 Phase 1: Compilation, review and analysis of relevant scientific literature***

As a first step to set the basis for the planning of future GBYP activities on this issue, scientific contributions directly related with the growth rates of caged BFT, including all the references mentioned in SCRS reports, were compiled and analyzed (See attached bibliography).

The analysis of these scientific papers showed that two main approaches have been applied up to now to determine the growth of BFT in farms. The first, involving direct length and weight measurements of farmed specimens at different moments (Katavic *et al.*, 2002; Ticina *et al.*, 2006; Gimenez-Casalduero and Sanchez, 2006; Ticina *et al.* 2007; Deguara *et al.*, 2010) and the second, an indirect method based on the comparison between the weight and length data measured during harvesting operations and estimates of the weight and length at capture or caging obtained from theoretical growth functions and length-weight relationships (Tzoumas *et al.* 2010; Gordo 2010; Deguara *et al.*, 2010; Ortiz *et al.*, 2015; Ortiz, 2017).

It is worth pointing out that only three of these papers, those by Katavic *et al.* (2002), Ticina *et al.* (2006 and 2007), all of them carried out on juvenile fishes in the Adriatic, included tagging of fishes allowing to determine individual growth trajectories, as requested in paragraph 28 of Rec. 18-02.

### ***2.2 Phase 2: Study approach and initial work-plan***

Once covered this preliminary phase of bibliographic revision, in order to start the design and implementation of the GBYP study on BFT growth rates in farms, the GBYP Steering Committee (SC) tackled this question during its meeting held in Madrid on December 2018. The GBYP SC considered firstly that since the Rec. 18-02 ask for data on recognizable growth trajectories of individual fish the study should be mainly based on fishes that had to be tagged before fattening takes place, which should be regularly monitored for weight/size gain until harvesting. Furthermore, it was discussed the timing of the study, concluding that the final version of the requested growth rate table could not be totally finished by 2020, as requested. This is because not all the fish batches tagged during the 2019 caging season, would be harvested in 2020 and in due time for the necessary analysis of the collected data. Moreover, it was noted that some facilities that operate with smaller sized specimens currently hold the fish for even longer periods, as is the case of some Croatian farms where harvesting takes place almost 3 years after the fish catch, and therefore would be not available before the 2021 harvesting season. Thus, although some results could be made available by 2020 as requested by the Commission, the updated table growth rate table can only be made available by 2021, though it's final version, including results on juvenile fishes growth in Croatian farms for more than two years, would only be provided in 2022.

Taking into account the recommendation from the Commission that differences among geographic areas (including Atlantic and Mediterranean) should be considered in updating the growth table, as well the logistic and budgetary constraints, it was decided to explore the possibility of carrying out trials in five different areas, as follows: Gulf of Cadiz in the Atlantic, and Balearic Sea, Central Mediterranean, Adriatic Sea and Levantine sea in the Mediterranean Sea.

In order to speed up the whole process and make the best use of available resources (it must be pointed out that no additional funds were provided to GBYP to carry out this broad study), the GBYP SC (which includes SCRS Chairman, W-BFT rapporteur and E-BFT rapporteur, a well as an external expert and the ICCAT Executive Secretary) decided that the scoping study aiming at gathering information to elaborate the definitive work-plan would be done under GBYP Phase 8 budget. To this end a proposal for the amendment of the Grant signed with the EU for developing such GBYP Phase 8 was elaborated and presented to the EU on January 2019. The first field studies would be then developed under the GBYP Phase 9, using fish caught during the 2019 fishing season. Thus, a specific budget for that was included in the Phase 9 GBYP proposal.

It was also decided that the scoping study would consist in a questionnaire on tuna farming strategies that should be distributed to all the operative tuna farms, and a series of visits to tuna farms in the 5 selected areas, aiming at getting first-hand information regarding operational capacities, farming practices and associate them to the logistics requirements of the planned study. The meetings with the farm owners would be used also to explore the willingness of specific farms to get involved directly in such study, as currently there is no mandatory obligation for the operators to be engaged in such studies, nor has GBYP the financial means to rent caging facilities without the cooperation of the operators. The information gathered from the questionnaire, which will be compiled in a database, would be used to interpret properly the results in the different areas and to evaluate the representativeness of the selected farms on current fattening practices and conditions. Furthermore, the information gathered during the visits to the different farms would also be used for elaborating the final work-plan.

### **2.3 Phase 3: Scoping study: visit to farms, general questionnaire on current BFT farming strategies and methodologies and preliminary analysis of the information available in ICCAT Secretariat**

#### **2.3.1 Visits to the farms**

As decided within the December 2018 GBYP SC meeting, ICCAT Secretariat representatives including the ICCAT Executive Secretary (or ICCAT Assistant Executive Secretary) and the GBYP Coordinator, accompanied in some cases by a member of the SC, held meetings with BFT farms responsible. Local scientist and/or national authorities also attended these meetings in all the five areas selected *a priori* by the GBYP SC.

The specific purposes of these visits were:

- to explore the willingness of farm owners to collaborate in the proposed study;
- to get first-hand information about the logistic capabilities of the farms to carry out the envisaged activities, specially tagging and stereo-cameras image recording;
- to present the questionnaire elaborated by GBYP to get detailed information about farming procedures, to clarify any doubt and ask for feedback to improve it;
- to inform about the context, objectives and general methodological approach of the proposed study;
- to ask for rough cost per unit estimations by type of activity.

The location, date and participants in these meetings are summarized below:

- Portuguese farm, TUNIPEX facilities (South Portugal). Dates and attendants: 8-10 January 2001. GBYP Coordinator and ICCAT Assistant Executive Secretary / Tunipex representatives / IPMA scientists.
- Spanish farms, BALFEGÓ facilities (Catalonian coasts, NW Mediterranean). Dates and attendants: 22-23 January 2019. GBYP Coordinator, ICCAT Assistant Executive Secretary and BFT SCRS Species Group Co-chairman/ Balfegó representatives.
- Maltese farms (Central Mediterranean). Dates and attendants: 21 January-2 February 2019. GBYP Coordinator, ICCAT Executive Secretary/AquaBiotech representatives/ Federation of Maltese Aquaculture Producers (FMAP) representatives/ Maltese farming companies' representatives/owners belonging to the FMAP.
- Croatian farms (Adriatic Sea). Dates and attendants: 18-20 February 2019. GBYP Coordinator, ICCAT Assistant Executive Secretary/ IZOR scientist/ GBYP external expert/ Most of Croatian farming companies' representatives/owners.
- Turkish farms (Levantine Sea). Dates and attendants: 19-22 March 2019. GBYP Coordinator, ICCAT Assistant Executive Secretary/Turkish authorities/ Most of Turkish farming companies' representatives/owners

All these visits were successful, since not only all the aforementioned objectives were accomplished, but all the contacted stakeholders gave a very positive response. In addition, during all these meetings it was possible to visit the farming facilities in the field and, in the case of Turkish and Croatian farms, it was possible also to observe harvesting operations, which was very useful to get a precise knowledge about the difficulties for carrying out a complete biological sampling at that moment. These visits allowed also to note that, in spite the BFT farms do not show striking differences in rearing procedures, each of them present special characteristics, referring both to logistic capabilities and to the initial size range of the reared fishes, which condition the harvesting strategies to a great extent. This results in a variety of scenarios, and such heterogeneity make difficult to apply a single and common methodological approach.

The most relevant issues regarding each one of the visited areas, from the point of view of the study general design, are summarized in **Annex 3**.

#### **2.3.2 General questionnaire on BFT farming procedures**

A first draft of the questionnaire was elaborated within the December 2018 GBYP SC meeting. It was later completed and refined taking into account the feedback from the tuna farmers provided during the visits to the different countries. A definitive version of the questionnaire (**Annex 4**) was elaborated in March 2019 and submitted to the ICCAT delegates of all the CPCs in which BFT farming takes place, accompanied by a letter from ICCAT Executive Secretary asking them to distribute the letter among the stakeholders, requesting to submit the answers to ICCAT GBYP before 1<sup>st</sup> May 2019. Due to some communication issues, some questionnaires have been delivered later than envisaged, in July-August 2019. As of today all the operative BFT farms have provided the filled questionnaires to GBYP. These are being compiled and a summary of current *status quo* will be made available to the SCRS as soon as possible.

### *2.3.3 Preliminary analysis of the information available in ICCAT Secretariat*

Firstly, to help in the planning of tagging operations, in such a way that they be carried out ensuring that tagged specimens be representative of the whole caged populations, but keeping the costs to the lowest possible level, some length distributions obtained from stereo-cameras measurements carried out in the selected areas in previous years and available at ICCAT Secretariat, were reviewed. In addition, to explore the potential use of the datasets from stereo-cameras and harvesting operations measurements, which should allow to take one more step in the use of approach followed in 2009 to generate the maximum growth rates included in the table that must be updated, by providing direct estimations of length distributions at caging and hence preventing the need of back-calculating them from length distributions at harvesting (Ortiz, 2017), the GBYP coordinator asked the ICCAT Department of Research and Statistics responsible about the availability of such information.

Consequently, GBYP Coordinator was informed that ICCAT has inventoried (raw files) individual size measurements of alive bluefin tuna (BFT) caught by purse seiners in the Mediterranean Sea, obtained from two main sources:

- a) Size data harvested on farms (direct measurements): obtained while harvesting BFT at the farming facilities (raw data available since 2003).
- b) Size data from stereoscopic cameras (indirect estimations): obtained at the time of transfer to the cages for the farming facilities (raw data available since 2014)

The first dataset does not reflect the size/weight of the wild BFT, but instead the size/weight of the fattened fish. To obtain wild equivalent BFT size estimations, the relative growth of the fattened fish is therefore discounted using back-calculation techniques (see Ortiz (2015)). Overall, this is the best source of BFT size data associated with the purse seine (PS) fishing activity, before the full implementation of the stereoscopic cameras size sampling at caging. Lately, BFT size composition of PS catches is estimated from the stereo camera sampling records obtained during caging operations, being a crucial source of PS size information for stock assessments and other biological studies. The majority of the BFT Task II size frequencies (T2SZ) related to PS activity is now collected with this system.

In spite that part of the available information (up to 2016) have been revised and used for analysis, currently ICCAT Secretariat does not have a complete and systematic way of handling (validate, integrate, store) these two sources of BFT size samples. The current practice is to inventory the raw data of all the PS BFT size samples, and only prepare this important size data set for the BFT stock assessments. Only then, the information is ready and available to the SCRS and the Commission. This poses several problems of data availability in the intermediate periods, i.e., between stock assessments and the Secretariat cannot provide complete T2SZ datasets to the ICCAT community on a yearly basis. Furthermore, it must be pointed out that neither the data sets from stereo-cameras submitted by the CPCs are complete and are always submitted using the standard forms, nor the videos of caging operations submitted to fulfill compliance requirements are always the stereoscopic camera videos used to count and estimate the size distribution of the caged bluefin tuna.

### ***2.4 Phase 4: Design of definitive work-plan***

Given that, according to the request stated in the Rec.18-02, the study should be based on recognizable growth trajectories of individual fish, which implies the use of tagging techniques, the scoping study described above was focused on exploring the logistic possibilities of carrying out such type of experiments in all the selected areas, taking into account the limited funds available and the farmers availability to cooperate. However, the feedback received from the contacted stakeholders showed that only in two facilities such tagging experiments could be carried out at an affordable cost: in the Adriatic tuna farms (Croatia) and in the TUNIPEX facilities off the southern coast of Portugal.

In the first case it was because the caged fishes are mostly juveniles, which can be handled more easily than adults for tagging, without causing excessive stress to the rest of fishes in the cage and, in case of incidental deaths, they can be compensated at a relatively low cost. As regards TUNIPEX, the adult fishes to be tagged can be also separated from the rest of the caged fishes in a relatively easy way, taking advantage of the trap structures associated to the farm, where the fish are captured before being transferred to the rearing cages, as demonstrated by previous tagging experiences.



Contrastingly, the rest of tuna farms refused to carry out large scale tagging activities since, as demonstrated by previous trials, it can result not only in massive mortalities of tagged fishes but also induce unacceptable stress to all the fishes in the monitored cage that significantly affect the farms activities. Thus, due to the potentially very high short-term mortality, which would impede to get relevant information and imply a very high cost per unit of adult BFT that GBYP would need to compensate the farmers for the economic losses induced by the tagging operations, and on the other hand considering the available budget, it was decided to modify the initially planned work-plan, exploring complementary methods to provide precise data on size and weight gains during farming period, other than tagging of farmed fish.

Thus, the definitive work-plan was agreed in close coordination among the GBYP Steering Committee (which, as mentioned above, includes as external expert one of the pioneer and most recognized researchers in the field of tuna farming, Dr. Ivan Katavic), the GBYP Coordination team and the ICCAT Secretariat Department of Research and Statistics, considering the new information gathered from the meetings with different stakeholders and available resources.

Summing up, it was first decided to maintain growth studies focused on the analysis of individual growth trajectories of tagged specimens in Adriatic Sea and in southern Portugal. It must be pointed out that this shall allow to get detailed data on growth rates of a wide range of age and size of farmed BFT specimens: in the Adriatic the caged fishes are mostly 2-3 years old individuals, but also a small percentage of 4 and even 5 years old specimens are farmed; whereas, in the Portuguese traps most farmed specimens correspond to adults leaving the Mediterranean after spawning.

In addition, in order to apply a common and standardized methodology in all the considered study areas, which could provide also precise information on growth rates of caged BFT of different sizes and maintained during different time periods under farming conditions, it was agreed to monitor intensively one or two selected cages in each one of the farms. Such monitoring should include the measurement of the size distribution of caged populations by means of stereoscopic camera system, not only at the moment of caging, but also seasonally (every 2-3 months), until all the fishes in the cage be harvested. In addition, also parameters potentially affecting growth rates should be routinely recorded, such as environmental variables (e.g. temperature, salinity and dissolved oxygen) and type and amount of food provided along the whole farming period. The size distribution of the monitored cages should be representative of that of the whole population caged in the different farms, including both large individuals that are harvested less than one year after caging and smaller specimens that are usually maintained in the farms for longer periods (i.e. between one and a half to two years).

A complementary study should be carried out in the Western Mediterranean area, in the Balfegó farm, taking advantage of the immediate availability of detailed data of fish size and weight at harvesting and their size distribution at caging. An additional advantage is that in these farmed fishes are harvested sequentially along the whole year, which allow to follow the seasonal evolution of growth.

#### *2.4.1 Development of a database for stereoscopic size records*

Finally, in order to allow to perform similar studies in the rest of farms in a near future, a work-plan to complete and standardize the data sets available at ICCAT Secretariat on BFT measurements from harvesting and from stereo-cameras measurements at caging, and to integrate all this information in an operative relational database, has been also agreed in close coordination between GBYP and ICCAT Research and Statistics department with the support and agreement of GBYP SC, which is currently being implemented by GBYP and ICCAT Secretariat staff. This will allow in future to update and improve the reference tables on potential growth rates in all the considered areas whenever required, including information from caged fishes in all the farms operating in the Mediterranean and the Atlantic. The methodology will be similar to that used for generating the reference table on potential growth rates by size group in 2009, but the results will be much more consistent and reliable, since the data sets will be more complete and the data on sizes at caging will come from direct measurements and not from back-calculations based L/W relationships.

#### **2.5 Phase 5: Implementation of field and desk work for base data generation**

Once decided the work plan, all the visited farms which had expressed their willingness of getting directly involved in the study were invited to present detailed budgets to carry out the agreed actions. When final agreements were reached, *ad hoc* contracts with each one of the farms, or in the case of Malta a private research company which will subcontract a Maltese farm, were prepared and signed in May 2019. Specifically, the contractors are: TUNIPEX S.A. in southern EU-Portugal; Balfegó&Balfegó S.L. in EU-Spain, Western Mediterranean;

Aquabiotech Ltd. in EU-Malta, Central Mediterranean; Pelagos Net Farma D.O.O. in EU-Croatia, Adriatic Sea and Akua-group su urunleri A.S. in Turkey, Eastern Mediterranean. This first set of contracts will cover the activities to be carried out within GBYP Phase 9, but the total budgets and terms of reference to complete the studies have been already agreed. Thus, pending on the funding made available through GBYP Phase 1, it is envisaged to sign new ad hoc contracts to continue the monitoring and data analysis in 2020.

It must be pointed out that in all cases the monitoring activities will be carried out or closely supervised by local experienced scientific teams, both belonging to the contractor staff (Balfegó&Balfegó and Aqua-biotech group) or to research institutions (IPMA in Portugal, IZOR in Croatia and Ege University in Turkey). The terms of reference of each contract are included in **Annex 5**. The field works have been initiated in all the areas, and the first deliverables, describing in detail these first activities, have been already sent to GBYP.

### ***2.6 Phase 6: Data analysis and reporting***

This phase has been just initiated, since only few preliminary data sets are available, and up to now the tasks in relation to data analysis have been limited to the gathering, review and compilation in standard formats of that information available from stereo-cameras and harvesting operations available at ICCAT Secretariat, and the storage and inventory of the first data files submitted by contractors.

The whole work plan and all the activities carried out up to now in relation to this study will be firstly reported to SCRS through this paper and the GBYP annual activity report presented to the BFT Species Group, and later through the GBYP Phase 8 final report. Partial results, based on the fish that will be harvested in 2020 season, will be reported within 2020 relevant SCRS meetings, and the definitive results are expected to be presented at the 2021 SCRS meetings.

Preliminary data processing will be carried out by the local scientific teams, under the supervision of GBYP and the Secretariat staff involved. Such groups will be also invited to participate in the global data analysis, which will be carried out jointly by GBYP Coordination and ICCAT Secretariat teams, under the supervision of GBYP Steering Committee. If considered necessary, external data analysis specialists will be contracted to contribute to such data analysis. In any case, such data analysis process will be presented and discussed within relevant SCRS meetings prior to the presentation of final results and conclusion to the Commission.

## References

- Anonymous 2003. Report of the Sixth GFCM-ICCAT Meeting on Stocks of Large Pelagic Fishes in the Mediterranean (Sliema, Malta, 15-19 April 2002). Col. Vol. Sci. Pap. ICCAT, 55(1): 1-84.
- Anonymous 2010. Record of the 2009 Species Group discussions on Atlantic bluefin tuna. Col. Vol. Sci. Pap. ICCAT, 65(3): 1044-1051.
- Deguara S., Caruana S., Agius C. 2010. Results of the first growth trial carried out in Malta with 60 kg farmed Atlantic bluefin tuna (*Thunnus thynnus* L.). Col. Vol. Sci. Pap. ICCAT, 65(3): 782-786.
- Gimenez-Casalduero F. and Sánchez-Jerez P. 2006. Fattening rate of bluefin tuna *Thunnus thynnus* in two Mediterranean fish farms. *Cybium* 30(1): 51-56
- Gordoa, A. 2010. Estimating the fattening factor of Atlantic bluefin tuna (*Thunnus thynnus*) on tuna farms: Ametlla de Mar facility as a case study. Col. Vol. Sci. Pap. ICCAT, 65(3): 848-857.
- Katavic I., Ticina V., Fanicevic V. 2002. A preliminary study of the growth rate of bluefin tuna from Adriatic when reared in the floating cages. Col. Vol. Sci. Pap. ICCAT, 54(2): 472-476.
- Ortiz, M. 2015. Preliminary evaluations of potential growth of fattened/farmed eastern bluefin tuna (*Thunnus thynnus*) from ICCAT farm size database. Col. Vol. Sci. Pap. ICCAT, 71(3): 1505-1525.
- Ortiz, M. 2017. Update review of bluefin tuna (*Thunnus thynnus*) size and weight measures taken with stereo video cameras at caging operations in the Mediterranean Sea – 2015. Col. Vol. Sci. Pap. ICCAT, 73(7): 2289-2298.
- Ortiz, M, Justel-Rubio A, Gallego J.L. 2015. Review and analysis of farm harvested size frequency samples of Eastern bluefin tuna (*Thunnus thynnus*). Col. Vol. Sci. Pap. ICCAT, 71(2): 1018-1035.
- Ticina V. 2007. Tagging of the northern bluefin tuna (*Thunnus thynnus*) in the east Atlantic and Mediterranean Sea in 2005. Col. Vol. Sci. Pap. ICCAT, 60(4): 1416-1420.
- Ticina, V., Grubisic L., Katavic I., Franicevic V. and Ticina V.E. 2006. Report on research activities on bluefin tuna tagging within growth-out farming cages. Col. Vol. Sci. Pap. ICCAT, 59(3): 877-881.
- Ticina, V., Katavic, I., Grubisic, L. 2007. Growth indices of small northern bluefin tuna (*Thunnus thynnus*, L.) in growth-out rearing cages. *Aquaculture* 269 (1-4): 538-543.
- Tzoumas A., Ramfos A, De Metrio G., Corriero A., Spinos E., Vavassis C., Katselis, G. 2010. Weight growth of Atlantic bluefin tuna (*Thunnus thynnus*, L. 1758) as a result of a 6-7 months fattening process in the central Mediterranean. Col. Vol. Sci. Pap. ICCAT, 65(3): 787-800.

**Relevant Recommendations from ICCAT Commission****2002/02-10 RECOMMENDATION BY ICCAT ON BLUEFIN TUNA FARMING**

2. Contracting Parties, Cooperating non-Contracting Parties, Entities or Fishing Entities under whose jurisdiction are located the farms for bluefin tuna in the Convention area shall adopt the necessary measures to:

b) recommend that the tuna farms and the scientific institutes obtain data on the size of the fish caught as well as the date, time and area of harvest and the fishing method used, in order to improve statistics for stock assessment purposes.

c) ensure the reporting of the quantities of bluefin tuna placed in cages and estimates of the growth and mortality while in captivity and the amounts sold.

**2003/03-09 RECOMMENDATION BY ICCAT ON BLUEFIN TUNA FARMING**

2. The CPCs under whose jurisdiction are located the farms for bluefin tuna in the Convention area shall adopt the necessary measures to:

b) recommend that the tuna farms and the scientific institutes obtain data on the size of the fish caught as well as the date, time and area of harvest and the fishing method used, in order to improve statistics for stock assessment purposes,

c) ensure the reporting of the quantities of bluefin tuna placed in cages and of estimates of the growth and mortality while in captivity and of the amounts sold (in t),

d) establish a sampling program for the estimation of the numbers-at-size of the bluefin tuna caught, e.g., through scientific observers on-board the vessels or at the farming sites. Such programs shall be transmitted to and validated by the SCRS.

**2004/04-06 BFT RECOMMENDATION BY ICCAT ON BLUEFIN TUNA FARMING**

2. The CPCs under whose jurisdiction the farms for bluefin tuna are located in the Convention area shall adopt the necessary measures to:

b) ensure that the tuna farms and the national scientific institutes obtain data as specified in the following paragraph on the size composition of the fish caught as well as the date, time and area of catch and the fishing method used, in order to improve statistics for stock assessment purposes; To this end, establish a sampling program for the estimation of the numbers-at-size of the bluefin tuna caught which requires notably that size sampling at cages must be done on one sample (= 100 specimens) for every 100 t. of live fish. Size sample will be collected during harvesting at the farm following the ICCAT methodology for reporting Task II. The sampling should be conducted during any harvesting, covering all cages. Data must be transmitted to ICCAT, by 31 July for the sampling conducted the previous year

c) ensure the reporting of the quantities of bluefin tuna placed in cages and of estimates of the growth and mortality while in captivity and of the amounts sold (in t);

10. The SCRS shall undertake trials to identify growth rates including weight gains during the fattening or penning period.

**2005/05-04 BFT RECOMMENDATION BY ICCAT TO AMEND THE RECOMMENDATION ON BLUEFIN TUNA FARMING [REC. 04-06]**

2. The CPCs under whose jurisdiction the farms for bluefin tuna are located in the Convention area shall adopt the necessary measures to:

b) ensure that the tuna farms and the national scientific institutes obtain data as specified in the following paragraph on the size composition of the fish caught as well as the date, time and area of catch and the fishing method used, in order to improve statistics for stock assessment purposes. To this end, establish a sampling program for the estimation of the numbers-at-size of the bluefin tuna caught which requires notably that size sampling at cages must be done on one sample (= 100 specimens) for every 100 t of live fish, or on a 10% sample of the total number of the caged fish. Size samples will be collected during harvesting at the farm, following the ICCAT methodology for reporting Task II. The sampling should be conducted during any harvesting, covering all cages. Data must be transmitted to ICCAT, by 31 July for the sampling conducted the previous year.

c) ensure the reporting of the quantities of bluefin tuna placed in cages and of estimates of the growth and mortality while in captivity and of the amounts sold (in t);

12. The SCRS shall undertake trials to identify growth rates including weight gains during the fattening or caging period.

**2006/06-07 BFT RECOMMENDATION BY ICCAT ON BLUEFIN TUNA FARMING**

2. The CPCs under whose jurisdiction the farms for bluefin tuna are located in the Convention area shall adopt the necessary measures to:

c) ensure that the tuna farms and the national scientific institutes obtain data as specified in the following paragraph on the size composition of the fish caught as well as the date, time and area of catch and the fishing method used, in order to improve statistics for stock assessment purposes; To this end, establish a sampling program for the estimation of the numbers-at-size of the bluefin tuna caught which requires notably that size sampling (length or weight) at cages must be done on one sample (=100 specimens) for every 100 t of live fish, or on a 10% sample of the total number of the caged fish. Size samples will be collected during harvesting<sup>1</sup> at the farm and on the dead fish during transport, following the ICCAT methodology for reporting Task II. The sampling should be conducted during any harvesting, covering all cages. Data must be transmitted to ICCAT, by 31 July for the sampling conducted the previous year.

d) ensure the reporting of the quantities of bluefin tuna placed in cages and of estimates of the growth and mortality while in captivity and of the amounts sold (in t);

12. The SCRS shall undertake trials to identify growth rates including weight gains during the fattening or caging period.

**2008/08-05 BFT RECOMMENDATION AMENDING THE RECOMMENDATION BY ICCAT TO ESTABLISH A MULTI-ANNUAL RECOVERY PLAN FOR BLUEFIN TUNA IN THE EASTERN ATLANTIC AND MEDITERRANEAN**

*Growth factors* 96. Each CPC shall define growth factors to be applied to bluefin tuna farmed in its cages. It shall notify to ICCAT Secretariat and to the SCRS the factors and methodology used. The SCRS shall review this information at its annual meetings in 2009 and 2010 and shall report to the Commission. The SCRS shall further study the estimated growth factors and provide advice to the Commission for its annual meeting in 2010.

**2010/10-04 BFT RECOMMENDATION BY ICCAT AMENDING THE RECOMMENDATION BY ICCAT TO ESTABLISH A MULTI-ANNUAL RECOVERY PLAN FOR BLUEFIN TUNA IN THE EASTERN ATLANTIC AND MEDITERRANEAN**

87. CPCs shall initiate pilot studies on how to better estimate both the number and weight of bluefin tuna at the point of capture and caging including through the use of stereoscopic systems and report the results to the SCRS. SCRS shall explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging. A sampling programme and/or an alternative programme shall be established at the time of caging in order to improve the counting and the weight estimations of the caged fish.

*Growth factors* 98. Each CPC shall define growth factors to be applied to bluefin tuna farmed in its cages. It shall notify to ICCAT Secretariat and to the SCRS the factors and methodology used. The SCRS shall review this information at its annual meetings in 2009 and 2010 and shall report to the Commission. The SCRS shall further study the estimated growth factors and provide advice to the Commission for its annual meeting in 2010.

**2012/12-03 BFT RECOMMENDATION BY ICCAT AMENDING THE RECOMMENDATION BY ICCAT TO ESTABLISH A MULTI-ANNUAL RECOVERY PLAN FOR BLUEFIN TUNA IN THE EASTERN ATLANTIC AND MEDITERRANEAN**

88. CPCs shall implement pilot studies on how to better estimate both the number and weight of bluefin tuna at the point of capture and caging including through the use of stereoscopic systems and report the results to the SCRS. SCRS shall continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission at the 2013 Annual meeting. A programme using stereoscopic cameras systems or alternative techniques that provide the equivalent precision shall cover 100% of all cagings in order to refine the number and weight of the fish in each caging operation. The quantities derived in the programme shall be used to complete the caging declarations and relevant sections of the BCD.

The results of this programme shall be submitted annually to SCRS by all farming CPCs. The SCRS should evaluate such procedures and results and report to the Commission by the 2013 Annual meeting.

*Growth factors* 98. The SCRS shall review information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission by the 2013 Annual meeting.

**2014/14-04 BFT RECOMMENDATION BY ICCAT AMENDING THE RECOMMENDATION 13-07 BY ICCAT TO ESTABLISH A MULTI-ANNUAL RECOVERY PLAN FOR BLUEFIN TUNA IN THE EASTERN ATLANTIC AND MEDITERRANEAN**

82. CPCs shall take the necessary measures and actions to better estimate both the number and weight of bluefin tuna at the point of capture and caging and report the results to the SCRS. SCRS shall continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission at the Annual meetings.

83. A programme using stereoscopic cameras systems or alternative techniques that provide the equivalent precision shall cover 100% of all caging operations, in order to refine the number and weight of the fish. This program shall be conducted in accordance with the procedures set out in Annex 9.

The results of this programme shall be submitted by 15 September annually to SCRS by all farming CPCs. The SCRS should evaluate such procedures and results and report to the Commission by the Annual meeting in accordance with Annex 9.

*Annex 9 Standards and procedures for stereoscopic cameras systems in the context of caging operations Use of stereoscopic cameras systems The use of stereoscopic cameras systems in the context of caging operations, as required by article 83 of this Recommendation, shall be conducted in accordance with the following:*

- i. The sampling intensity of live fish shall not be below 20% of the amount of fish being caged. When technically possible, the sampling of live fish shall be sequential, by measuring one in every five specimens. Such a sample shall be made up of fish measured at a distance between 2 and 8 meters from the camera.*
- ii. The dimensions of the transfer gate connecting the donor cage and the receiving cage shall be set at maximum width of 10 meters and maximum height of 10 meters.*
- iii. When the length measurements of the fish present a multi-modal distribution (two or more cohorts of distinct sizes), it shall be possible to use more than one conversion algorithm for the same caging operation. The most up to date algorithm(s) established by SCRS shall be used to convert fork lengths into total weights, according to the size category of the fish measured during the caging operation.*
- iv. Validation of the stereoscopic length measurements shall be undertaken prior to each caging operation using a scale bar at a distance of 2 and 8 m.*
- v. When the results of the stereoscopic program are communicated, the information shall indicate the margin of error inherent to the technical specifications of the stereoscopic camera system, which shall not exceed a range of +/- 5 percent.*

- vi. *The report on the results of the stereoscopic program should include details on all the technical specifications above, including the sampling intensity, the way of sampling methodology, the distance from the camera, the dimensions of the transfer gate, and the algorithms (length-weight relationship). SCRS shall review these specifications, and if necessary provide recommendations to modify them.*
- vii. *In cases where the stereoscopic camera footage is of insufficient quality to estimate the weight of bluefin tuna being caged, a new caging operation shall be ordered by the flag CPC authorities of the catching vessel/trap, or the flag CPC authorities of the farm.*

*Growth factors* 96. The SCRS shall review information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission by the 2016 Annual meeting.

**2017/17-07 BFT RECOMMENDATION BY ICCAT AMENDING THE RECOMMENDATION 14-04 ON BLUEFIN TUNA IN THE EASTERN ATLANTIC AND MEDITERRANEAN**

82. CPCs shall take the necessary measures and actions to better estimate both the number and weight of bluefin tuna at the point of capture and caging and report the results to the SCRS. SCRS shall continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission at the Annual meetings.

83. A programme using stereoscopic cameras systems or alternative techniques that provide the equivalent precision shall cover 100% of all caging operations, in order to refine the number and weight of the fish. This program shall be conducted in accordance with the procedures set out in Annex 9 (it is the same Annex 9 than in Rec.14-04).

The results of this programme shall be submitted by 15 September annually to SCRS by all farming CPCs. The SCRS should evaluate such procedures and results and report to the Commission by the Annual meeting in accordance with Annex 9.

*Growth factors* 96. The SCRS shall review information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission by the 2016 Annual meeting.

**18-02 BFT RECOMMENDATION BY ICCAT ESTABLISHING A MULTI-ANNUAL MANAGEMENT PLAN FOR BLUEFIN TUNA IN THE EASTERN ATLANTIC AND THE MEDITERRANEAN SEA**

*Growth rates* 28. 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, 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 area (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 SCRS for analysis.

*Measures and programmes to estimate the number and weight of bluefin tuna to be caged* 99. A programme using stereoscopic cameras systems or alternative methods that guarantee the same level of precision and accuracy shall cover 100% of all caging operations, in order to refine the number and weight of the fish. This programme using stereoscopic cameras shall be conducted in accordance with the procedures set out in Annex 9 (it is the same Annex 9 than in Rec.14-04). In case of the use of alternative methods, those methods should be duly analysed by the SCRS, who should present its conclusions regarding their precision and accuracy for endorsement by the Commission during the Annual meeting before an alternative methodology could be considered as valid for the purpose of monitoring the caging operations. The farm CPC shall communicate the results of this programme to the catching CPC, and, to the Regional Observer. When these results indicate that the quantities of bluefin tuna being caged differ from the quantities reported caught and/or transferred, an investigation shall be launched.

The results of this programme shall be submitted by 15 September annually to SCRS by all farm CPCs. The SCRS should evaluate such procedures and results and report to the Commission by the Annual meeting in accordance with Annex 9.



**Relevant paragraphs from SCRS biennial reports****REPORT BIENNIAL PERIOD 2004-05 PART 1 VOL 2 SCRS (Report of the SCRS Madrid, Spain - October 4 to 8, 2004, pp 169)***16.3 Consideration of sampling programs for farmed bluefin*

No new information was submitted to the SCRS on this subject. The Committee suggests that the terms “farming” and “fattening” be interpreted interchangeably in future considerations related to Recommendation [Rec. 03-09].

**REPORT BIENNIAL PERIOD 2006-07 PART 1 VOL 2 SCRS (Report of the SCRS Madrid, Spain - October 2 to 6, 2006, pp 173)***15.5 Review of information on farmed bluefin tuna growth rates [Rec. 05-04]*

The Recommendation by ICCAT to amend the recommendation by ICCAT on bluefin tuna farming [Rec. 05-04] requires the SCRS to undertake trials to identify growth rates including weight gains during the fattening or caging period. Since the implementation of this recommendation did not enter into force until June 2006, no new studies have been initiated at this time.

However, bluefin tuna farming issues in the Mediterranean Sea have been discussed and reported in number of SCRS papers in the past (Fromentin, 2003), (Miyake et al, 2003) and SCRS/2002/037, unpublished) and also in the Reports of the GFCM/ICCAT Working Group on Sustainable Tuna Farming/Fattening Practices in the Mediterranean (Anon. 2004b). In addition, (Ticina et al, 2005) provided information on the factors for conversion of farmed bluefin tuna gilled and gutted product weight to round weight.

Bluefin tuna farming issues were discussed during the 6th GFCM-ICCAT Meeting on Stocks of Large Pelagic Fishes in the Mediterranean held in Sliema, Malta, April 15-19, 2002 (Anon. 2003). At that time, it was confirmed that the factor of 0.8, which is currently applied to fattening practice of large bluefin tuna (i.e., assuming 25% gain in weight due to fattening), should be maintained. However, in the paper SCRS/2005/114, which reports research activities on bluefin tuna tagging activities within grow-out farming cages, significantly higher growth rates of small bluefin tuna in the cages are given. Currently, in most of the bluefin tuna farms there are difficulties related to accurate estimation of initial size of individual fish that enter in the cages. Consequently, even if sizes of these fish at harvesting are accurately measured, no accurate estimation of weight gain during the rearing period can be obtained.

It is possible that growth rates could be significantly different from farm to farm and even from year to year (due to differences in feeding practices, feed compositions, environmental conditions, duration of caging, etc.). Therefore, no one general estimate should be made that will cover all situations for back-calculating of the initial quantity of captured tunas that were put in the farming cages.

For the most recent bluefin tuna stock assessment purpose, a weight gain of 25% due to the fattening was assumed.

**REPORT BIENNIAL PERIOD 2006-07 PART 2 VOL 2 SCRS (Report of the SCRS Madrid, Spain – October 1 to 5, 2007, pp 192)***15.5 Review of information on farmed bluefin tuna growth rates [Rec. 06-07]*

Following the Recommendation by ICCAT on Bluefin Tuna Farming [Rec. 06-07], the Committee reviewed available scientific information for identification of growth rates of caged bluefin tuna. This information is rather limited at present. Based on available information for the SCRS, the Committee assumed that large fish held for several months for fattening gain on average weight 25% of their capture weight (i.e. a conversion factor of 0.8). Ticina *et al.* (2006) reported significantly higher growth rates for small (juvenile) bluefin tuna in the cages. A more detailed study presented by Tičina (2007) indicated that small bluefin tuna are able to increase their initial biomass by more than 340% within 511 days. In other words, juvenile bluefin would gain weight twice as fast in cages as compared to the wild.

The Committee expects that weight gain is highly variable depending on various factors, such as season, year, duration of caging, initial size of the fish, feeding, location, environmental conditions, etc. Therefore, the Committee is soliciting proposals to collect needed scientific information to complete our advice to the Commission.

**REPORT BIENNIAL PERIOD 2008-2009 PART 1 VOL 2 SCRS (Report of the SCRS Madrid, Spain - September 29 to October 3, 2008, pp 193)**

*15.4 Review of information on farmed bluefin tuna growth rates [Rec. 06-07]*

Following the Recommendation by ICCAT on Bluefin Tuna Farming [Rec. 06-07], the Committee reviewed in 2007 available scientific information for identification of growth rates of caged bluefin tuna. This information was rather limited at that moment. Based on available information for the SCRS, the Committee assumed that large fish held for several months for fattening gain on average weight 25% of their capture weight (i.e. a conversion factor of 0.8). Ticina *et al.* (2006) reported significantly higher growth rates for small (juvenile) bluefin tuna in the cages. A more detailed study presented by Tičina (2007) indicated that small bluefin tuna are able to increase their initial biomass by more than 340% within 511 days. In other words, juvenile bluefin would gain weight twice as fast in cages as compared to the wild.

The Committee expected that weight gain was highly variable depending on various factors, such as season, year, duration of caging, initial size of the fish, feeding, location, environmental conditions, etc.

This year the Committee updated the review with new information. The Committee used the available data to attempt to calculate the increase in weight of bluefin during their fattening in pens (Section 15.4). These are bluefin that are kept in pens for relatively short period of times (usually 2-6 months) with the goal of increasing the body fat content. This operation is different from the farming operation that keeps bluefin tuna for longer periods (usually more than one year) to increase the biomass.

Not all of the available datasets had an essential piece of information: the weight of fish at the time they were placed in the pens. Results based on the provided length at harvest and the ICCAT length-weight relationship for eastern bluefin showed some estimates which appeared to be biased and some showed negative growth. Excluding negative growth estimates, the estimated average growth was 14.5% which was lower than the previously assumed estimate of 25%.

It is of benefit to all parties that improved estimates of growth during all caging operations (defined as both farming and fattening, [Rec. 06-05]) be obtained so that total removals can be accurately Estimated. The Committee recognizes the difficulty of obtaining weights of live fish at the time of initial capture.

However, given that the absence of this information can lead to anomalous or biased estimates of growth, the Committee requests that CPCs involved in farming or fattening operations find the means to best obtain these growth rates.

This could be achieved either by providing best estimates of the weight of fish at time of capture or by providing another suitable proxy for this information based upon their expert knowledge of the caging processes.

**REPORT BIENNIAL 2008-09 PART 2 VOL 2. SCRS (Report of the SCRS Madrid, Spain - October 5 to 9, 2009, pp 225-226)**

*16.6 Review of information on farmed bluefin tuna growth rates [Rec. 06-07]*

The 2008 Recommendation by ICCAT Amending the Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean [Rec. 08-05] states:

96. "Each CPC shall define growth factors to be applied to bluefin tuna farmed in its cages. It shall notify to ICCAT Secretariat and to the SCRS the factors and methodology used. The SCRS shall review this ICCAT REPORT 2008-2009 (II) information at its annual meetings in 2009 and 2010 and shall report to the Commission. The SCRS shall further study the estimated growth factors and provide advice to the Commission for its annual meeting in 2010."

By the time of the 2009 SCRS meeting, Contracting Parties had not notified the ICCAT Secretariat or the SCRS the growth factors or methodology used for tuna kept in their farms. Nevertheless, the Committee reviewed several industry-sponsored studies conducted in Croatia, Greece, Malta and Spain, and concluded that the gain in weight of bluefin tuna in farms can be significantly higher than the value which has been used to-date (see SCRS/2009/192).

The weight gain obtained during fattening/farming is a combined effect of (a) an increase in the condition of the fish, and (b) structural somatic growth. An improvement in the fish condition can result in a weight gain from 5% to 38% for fish between 100 cm and 300 cm FL within the first six months of farming. Together with structural somatic growth, a total gain in weight of between 140% (for 30 kg bluefin) and 41% (for large bluefin) per year can be achieved. For smaller fish, weight gains can be much larger. Table 16.6 provides gain estimates (as percentages) based on studies presented to the Committee, for fish starting at 30 kg and kept for up to one year. These growth factors can be used to estimate the maximum gain in weight for bluefin of a given size at caging, depending on the duration of the caging operation. It is important to note that these growth factors do not take into account any of the losses that are known to occur (e.g., due to mortality, escapees and other sources of loss). Therefore, applying these factors to an amount of harvested bluefin in order to estimate the initial caged amount will likely result of an underestimate of the input to the cages.

The Committee noted, however, that the apparent gain in both length and weight of individual fish held in farms is much higher than observed for wild fish over a wide range of sizes. It is critical to obtain measurements of fish sizes as they enter cages, rather than after the fact, since use of length frequencies from the farmed fish at the time of harvest would introduce a significant bias in stock assessments.

The Committee recommends that Contracting Parties tentatively adopt growth factors that are consistent with those in Table 16.6.

The Committee also recommends that Contracting Parties continue to conduct studies that can lead to a better quantification of the inputs into cages. This includes average growth factors that take losses into account. However, more importantly, it is necessary to develop methods to measure the size of the fish entering the cages. Technological applications such as stereoscopic video cameras are under development and should be tested and pursued for operational applications.

**REPORT BIENNIAL PERIOD 2010-2011 PART 1 VOL 2 SCRS (Report of the SCRS, Madrid, Spain - October 4 to 8, 2010, pp 192)**

*16.4 Review of information on farmed bluefin tuna growth rates [Rec. 06-07; 08-05]*

The 2008 Recommendation by ICCAT Amending the Recommendation by ICCAT to Establish a Multi-Annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean [Rec. 08-05] states:

96. "Each CPC shall define growth factors to be applied to bluefin tuna farmed in its cages. It shall notify to ICCAT Secretariat and to the SCRS the factors and methodology used. The SCRS shall review this information at its annual meetings in 2009 and 2010 and shall report to the Commission. The SCRS shall further study the estimated growth factors and provide advice to the Commission for its annual meeting in 2010."

At the 2009 SCRS meeting, the Committee reviewed several industry-sponsored studies and concluded that the gain in weight of bluefin tuna in farms can be significantly higher than the value which has been used to-date (see Anon. 2010i). The Committee recommended that Contracting Parties tentatively adopt growth factors that are consistent with those in Table 16.6 of the 2009 SCRS Report, although the Committee advised it is important to note that these growth factors do not take into account any of the losses that are known to occur (e.g., due to mortality, escapees and other sources of loss). The Committee advised that applying these factors to an amount of harvested bluefin in order to estimate the initial caged amount will likely result of an underestimate of the input to the cages.

In 2010, the Committee examined the implications of these growth factors by their application to observations from the Japanese fresh auction market weight distributions and found application of the weight gain rates from Table 16.6 (2009 SCRS Report), resulted in back-calculate fish weights at initial capture which seemed to show unrealistic size distributions, in that more fish below the 30 kg minimum are calculated as having been caught than would be expected given existing controls. The Committee reemphasized concern about using the available farmed bluefin tuna growth rates (Anon. 2010i; 2009 SCRS Annual Report) to back-calculate individual fish weight, since those rates seem to represent a maximum weight gain that might be obtained only under the best of conditions; the

consequence of the overestimation of growth rates would be an underestimate of sizes at original capture, such as appears to be occurring in application of these rates to recent observations.

The Committee also recommends that Contracting Parties continue to conduct studies that can lead to a better quantification of the inputs into cages. This includes average growth factors that take losses into account. However, more importantly, it is necessary to develop methods to measure the size of the fish entering the cages.

As real size samples at time of the catch are needed to significantly decrease uncertainties in future stock assessment, it is necessary to routinely use a system (dual camera system or any other operational technology) that will provide sizes of fish entering into cages. Therefore, the SCRS strongly encourages the farms to test these systems that have been recently developed as soon as possible.

**REPORT BIENNIAL PERIOD 2010-2011 PART 2 VOL 2 SCRS (Report of the SCRS, Madrid, Spain - October 3 to 7, 2011, pp 194)**

*18.3 Exploration of operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging [Rec. 10-04]*

The 2010 Recommendation amending previous Recommendations by ICCAT to Establish a Multi-annual Recovery Plan for Bluefin Tuna in the eastern Atlantic and Mediterranean [Rec. 10-04] requests the CPCs to initiate pilot studies on how to better estimate both the number and weight of bluefin tuna at the point of capture and caging including through the use of stereoscopic systems and report the results to the SCRS.

During the BFT Species Group held in September 2010, four SCRS documents regarding the use of stereoscopic camera systems were presented to the SCRS (SCRS/2011/173, SCRS/2011/189, SCRS/2011/190 and SCRS/2011/191). These documents describe some work in progress on board of Mediterranean cages in 2011. The estimates of fork length remain incomplete because of a few technical issues that remain to be solved. However, the first results are encouraging and confirm the potential of stereoscopic camera to recover the length composition of the fish that are transferred alive into cages. The SCRS strongly encourages the CPCs to carry on and complete these studies in 2012, so that stereoscopic camera systems become operational as soon as possible.

While the cages do not correspond to the exact points of captures, the information from cages may be, however, adequate to reconstruct the size composition of the catch if the measurements are performed at the arrival of the towing vessel. Trials with stereoscopic camera on board of fishing vessel have been also investigated in 2011, but the results of these operations were not provided to the SCRS.

**REPORT BIENNIAL PERIOD 2012-2013 PART 1 VOL 2 SCRS (Report of the SCRS, Madrid, Spain - October 1 to 5, 2012, pp 220-221)**

*18.10 Explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging [Rec. 10-04]*

The 2010 Recommendation Amending Previous Recommendations by ICCAT to Establish a Multi-annual Recovery Plan for Bluefin Tuna in the Eastern Atlantic and Mediterranean [Rec. 10-04] requests the CPCs to initiate pilot studies on how to better estimate both the number and weight of bluefin tuna at the point of capture and caging including through the use of stereoscopic systems and report the results to the SCRS.

During the Bluefin Tuna Species Group held in September 2011, four SCRS documents were presented on use of stereoscopic camera systems on board of Mediterranean cages (Ramfos et al 2012; SCRS/2011/189, Puig et al 2012; and Anon. 2012d). While a few technical difficulties still needed to be overcome, these studies confirmed the potential of stereoscopic cameras to recover the length composition of the fish that are transferred alive into cages. In 2011, the SCRS strongly encouraged the CPCs to carry on and complete these studies in 2012, so that stereoscopic camera systems could become operational as soon as possible.

Three additional SCRS documents were presented during the bluefin tuna stock assessment held in September 2012. Document SCRS/2012/052 used a stereoscopic camera to measure the length of fish in the cage and during the transfer to another cage through a gate. These observations compared favorably with subsequent measurements taken after the caged population was harvested. The authors affirmed the validity of utilization of the stereoscopic camera for counting and measuring bluefin tuna and made several suggestions for improving the procedure and equipment. Similar work was described in document SCRS/2012/136, where the stereoscopic camera was applied

at the point of first transfer into the farm cage. A comparison of the measurements made by the camera with direct measurements of a subsample of the fish in the cage suggested that further work is required to further improve the accuracy of measurement with the stereoscopic camera and better define the mathematical models used to convert measured length to weight. Finally, SCRS/2012/133 presented an alternative approach where a video-camera and acoustical system were used in tandem during the transfer of bluefin tuna from one cage to another. The authors described the various different equipment options available for the application of this technique and practical considerations for improving the accuracy of the system.

The SCRS was encouraged by the progress made in the practical application of alternative techniques, in particular that of the stereoscopic camera, to the counting and measurement of fork length of caged bluefin tuna. It noted that a number of factors may affect the accuracy of the stereoscopic camera measurements, including lighting conditions, general weather conditions, distance from fish being measured and the angle of measurement in relation to the swimming of the fish. Fish may also suffer a drop in condition from the time of capture to the actual caging and additional field work will be needed to establish appropriate L-W relationships to convert the fork length determined by the stereoscopic camera to weight. Nevertheless, the Committee stressed that measurements made by stereoscopic cameras are possibly more precise than the current catch at size reported for the purse seine fleet. The Committee recommends moving beyond the pilot study phase and setting up a technical working group to establish procedures for implementing stereoscopic camera systems by 2013.

**REPORT BIENNIAL PERIOD 2012-2013 PART 2 VOL 2 SCRS (Report of the SCRS, Madrid, Spain - September 30 to October 4, 2013, pp 241-242)**

*16.2 Evaluate the BFT pilot studies to estimate both the number and weight of bluefin tuna at the point of capture and caging using stereoscopic system, Rec. [12-03], paragraph 88*

The 2012 Recommendation amending previous Recommendations by ICCAT to Establish a Multi-annual Recovery Plan for Bluefin Tuna in the eastern Atlantic and Mediterranean [Rec. 12-03] requests the CPCs to implement pilot studies on how to better estimate both the number and weight of bluefin tuna at the point of capture and caging including through the use of stereoscopic systems and report the results to the SCRS.

During the Bluefin Tuna Species Group held in September 2013, two papers presented the results of pilot studies involving the use of the stereoscopic camera.

In document SCRS/2013/182, the results of a pilot study involving a comparison of stereoscopic camera fork length estimates of individual fish and the same fish measured with calipers after harvesting were presented. A detailed procedure was established which, if followed correctly, would give a good level of precision and accuracy. However, the effects of deviations from the steps in the procedure on the percentage error in fork length estimation were not quantified but could well be significant. The procedure presented only concerned the measurement of fork length using the stereoscopic camera software and did not attempt to establish a methodology for obtaining footage of fish in a net or cage for the purpose of counting fish or fork length determination.

Document SCRS/2013/202 describes a pilot study carried out by Libya and Korea with a stereoscopic camera on the high seas before, during and after transfer at sea and after a release event. In this study, results of fork length determination were reported. Fork length measurements of the same population of fish in the fishing net and after transfer (in the towing cage) gave significantly different average weights. The document also discussed the various practical difficulties arising during the actual deployment of the stereoscopic camera at sea and numerous factors affecting the precision and accuracy of fish counting and fork length measurement during the subsequent analysis.

The group discussed the fork length measurement procedure proposed and considered it important to establish the magnitude of the errors inherent in the various steps of the procedure as well as the errors resulting as a consequence of the deployment methodology during the collection of the footage to be used in fork length determination. At the same time, it has to be kept in mind that the procedure presented only applies to the stereoscopic camera system used in this particular study, but similar procedures (and the corresponding errors) would need to be established for other technologies and footage collection methodologies. The results of fork length estimation of the Libyan/Korean pilot study were not considered very promising and, considering the practical difficulties encountered, it is very clear that much more work would be needed to establish standardized procedures for all aspects of the stereocamera (or alternative technology) deployment in such circumstances.

The SCRS reaffirmed the importance of the fork length data coming from the stereoscopic camera for the purpose of having catch at size data for the Mediterranean purse seine fleet for use in stock assessments. 100% of Mediterranean cages had stereoscopic camera in 2013. The group also felt that an analysis of any available stereoscopic camera footage and results from CPCs should be made available to compare methodologies, results and errors in fork length measurement, whilst comparing to the procedure presented during the meeting, although it was not clear who would do this exercise.

The Committee recommends setting up a standardized protocol to set up a common procedure for the implementation and use of stereoscopic camera systems in all the Mediterranean and East Atlantic by 2014.

*16.4 Provide updated tables of BFT growth rate in weight based on the information from BCDs and other submitted data, Rec. [12-03], paragraph. 98*

The SCRS analyzed the information available for bluefin tuna growth rate in weight, and confirmed its commitment to continue the work of the Trade Group, initiated in 2012 (referring to the discussions and conclusions of the Trade Group reported in the Report of the 2012 Atlantic Bluefin Tuna Stock Assessment Session (Anon. 2013d), to establish procedures based on BCDs and other available information (stereoscopic cameras/alternative technology to accurately quantify the transferred fish, observer reports, scientific sampling, trade statistics, etc.) to confirm the catch numbers of fish and weights declared on BCDs (Task I data). This analysis should be done keeping in mind the complexity of the whole process, from the point of capture to final trade, as recorded in the BCDs and other sources of information. The ultimate objective of these procedures is to ensure that no underreporting or misreporting of catches can occur.

The framework for the analysis of market/auction data recovered by GBYP, which was discussed by SCRS during the bluefin tuna assessment in 2012 and by the GBYP Steering Committee in December 2012 (see corresponding reports), was defined by the GBYP Steering Committee.

**REPORT BIENNIAL PERIOD 2014-2015 PART 1 VOL 2 SCRS (Report of the SCRS, Madrid, Spain - September 29 to October 3, 2014, pp 228-229)**

*18.2 Review the technical specifications of the use of stereoscopic cameras systems as defined in Rec. [13-08]*

Background: [Rec. 13-08] paragraph 6 requests the SCRS to review the technical specifications of the use of stereoscopic cameras systems as defined in paragraphs 1 to 5 of this recommendation. The SCRS shall also provide any recommendations to improve the system.

Six CPCs submitted in 2014 size and weight data from measures at caging operations using stereoscopic cameras systems. However, information on the specific details of the technical specifications of the stereoscopic cameras systems used was not provided. Therefore, the Committee was not able to review or compare the specification provided in Rec. [13-08]. The Committee recommends that CPCs using stereoscopic cameras systems do provide to the Secretariat the specification of their applications including:

- Logistic settings of the cameras between the holding cage and transferring nets.
- Specifics of the cameras, distance, video recording specification, count and size determinations specifics.
- Software and settings for converting digital images and measures to actual size equivalent measure, as well as conversion factors for weight.

These specifications should be provided in conjunction with the size and weight data submitted. A preliminary review of the stereoscopic camera data collected and submitted is provided in SCRS/2014/141.

*18.3 Continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and evaluate the BFT pilot studies to estimate both the number and weight of bluefin tuna at the point of capture and caging using stereoscopic systems, Rec. [13-07] paragraph 88*

Background: [Rec. 13-07] paragraph 88 requests CPCs to provide to the SCRS data and information collected under pilot studies implemented to better estimate both the number and weight of bluefin tuna at the point of capture and caging including through the use of stereoscopic cameras systems or alternative techniques that provide the equivalent precision and shall cover 100% of all cagings in order to refine the number and weight of the fish in each caging operation. The SCRS shall continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission at the 2014 annual meeting.

In 2014 six flags started submitting size and weight measures of bluefin tuna at caging operation using stereo camera video systems. However, the data submitted did not include technical specifications on the operation and software used. Document SCRS/2014/141 summarized size distribution of the data provided and compared the modal distributions to back-calculated harvest size data from previous years (2010-2013). Differences were found between the density and size frequency distributions by flag and it was not possible to determine if these differences reflect differences in the catches of different years or in the methodologies related to back-calculating catch at size from harvest data.

The Group recommended that procedures for the use of the stereo camera, calibration and estimation of size from video recording be standardised and made available to the SCRS. It was also requested that the Secretariat provide a standard electronic format for data submission to the CPCs.

The Group also recommends reviewing and providing appropriate conversion factors to estimate weight based on the size measures. Finally, the Group recommend use of the stereo camera measurements to validate methods that use size and weight at harvest data for estimation of size frequency of bluefin catch destined to farms. New results including area/time specific relationships will be presented during the next data preparatory group.

*18.5 Provide updated BFT growth rates tables based on the information from BCDs and other submitted data, Rec. [13-07], paragraph 98*

Background: [Rec. 13-07] paragraph 98 requests the SCRS to review information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission by the 2014 Annual meeting.

Harvest data from over 130,000 caged bluefin were analysed in document SCRS/2014/162 to estimate maximum potential growth factors in farms (not any specific farm). The document presents possible proxies of “maximum” growth, based on the probability distribution of variance of weight at size, from three alternative statistical models, using the 75% percentile of the cumulative density functions. These estimated proxies were compared to the current maximum growth table adopted by the SCRS in 2010. Two of the estimated proxies were found to be lower. This analysis confirmed that farming increases the weight compared to similar sized wild fish and indicated that there were seasonal effects on growth. However, it was concluded that the differences between the growth proxies and the current growth table should be further reviewed and evaluated before an updated growth table can be submitted to the Commission.

**REPORT BIENNIAL PERIOD 2014-2015 PART 2 VOL 2 SCRS (Report of the SCRS, Madrid, Spain - September 28 to October 2, 2015, pp 249-250)**

*19.4 Continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission, Rec. 14-04 paragraph 82*

Background: Rec. 14-04 paragraph 82 requests CPCs to take the necessary measures and actions to better estimate both the number and weight of bluefin tuna at the point of capture and caging and report the results to the SCRS. The Commission requests the SCRS to continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission at the annual meetings.

Since 2014, CPCs with bluefin tuna farms have been submitting size and weight measures of bluefin tuna at caging operation using stereo camera video systems. In 2015, as of 15 September, 78 caging reports were received, from 10 farms and 6 CPC flags, with over 21,000 thousand size/weight measurements provided. In addition, all involved CPCs provided reports of technical details of the camera systems used in the farms.

A number of studies related to the use of the stereoscopic camera were presented. Document SCRS/2015/166 provides a detailed account of the procedures applied in Malta for the deployment of the stereoscopic camera systems during caging operations. This document gave a detailed description of the steps taken during and after the footage is taken and the methodology applied to count the number of fish caged. The paper also described the procedure for the random selection of the 20% sample of fish to be measured in order to determine size distribution and the total biomass of fish caged, in line with ICCAT Recommendation 14-04. Document SCRS/2015/195 reported on growth of bluefin tuna in size at farms by measuring changes in straight fork length of fish caged for 4 to 5 months. A stereo camera system was deployed in 3 cages just before harvesting was started and the footage was used to measure the straight fork lengths of fish from the two size groups of fish normally found in cages in

Malta. The overall increase in straight fork length in the period from caging to preharvest in small fish was found to be 19.6% on average and that of bigger fish was found to be 6.7% on average. This represents an average RWT increase of 85.5% and 36.4% for the small and big fish respectively over the 4 to 5 month farming period.

Paper SCRS/2015/200 reported on research carried out in eight cages of four Croatian farms studying the reliability of the stereoscopic camera measurements obtained from footage of bluefin tuna just prior to harvesting of fish caged between 18 and 32 months before. Comparing stereoscopic camera straight fork length measurements with actual caliper measurements made during the harvest of the fish showed that the average difference between measurements was less than 1%. When converted to RWT, the difference between stereoscopic camera predicted RWT and actual harvest RWT was also small, less than 4%.

In summary, stereoscopic cameras have been demonstrated as viable technologies. As stated in Rec. 14-04, CPCs should use the same L/W relationship to convert size estimates into weights, i.e. the adopted SCRS relationships (on the ICCAT website).

*19.5 Evaluate the results of the 100% coverage programme using stereoscopic cameras systems or alternative techniques that provide the equivalent precision to refine the number and weight of the fish during all caging operations. Rec. 14-04 paragraph 83*

Background: Rec. 14-04 paragraph 83 requests all farming CPCs to submit annually to the SCRS, by 15 September, the results of this programme which uses stereoscopic cameras systems or alternative techniques. The SCRS should evaluate such procedures and results and report to the Commission by the annual meeting in accordance with Annex 9 of the Rec. 14-04.

Two documents were presented to the SCRS demonstrating the reliability and accuracy of the stereoscopic camera systems to determine the size (straight fork length SFL) of bluefin tuna at caging and prior to harvest in farms. The results indicated accuracy on size measures close to 99% when compared to actual fish measurements. The estimates of weight were close to 96% compared with actual weights. In 2014 and 2015, over 38,000 stereoscopic camera size (FL) measurements were provided from caging operations providing new size frequency data for use in stock assessments.

The SCRS continues to analyse the SFL data from stereoscopic camera footage obtained during caging operations and the SFL and RWT data coming from harvesting operations in order to study the average growth by size category of the fish during the farming period. Information from two documents presented to the SCRS confirm that growth can be significant during the farming period but showed that there are significant differences in growth rates between and within farms likely depending on various factors, including environmental factors (such as temperature), farm management and company strategy.

The Committee continues to see considerable value in the use of stereocamera technology to estimate fish size. It was noted that CPCs are using different methodologies and a standardized universal protocol remains to be determined.

**REPORT BIENNIAL PERIOD 2016-2017 PART 1 VOL 2 SCRS (Report of the SCRS, Madrid, Spain, 3-7 October 2016, pp 277-278)**

*18.6 Continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission, Rec. 14-04, paragraph 82*

Background: Rec. 14-04 paragraph 82 requests CPCs to take the necessary measures and actions to better estimate both the number and weight of bluefin tuna at the point of capture and caging and report the results to the SCRS. The Commission requests the SCRS to continue to explore operationally viable technologies and methodologies for determining the size and biomass at the points of capture and caging and report to the Commission at the annual meetings.

Since 2014, CPCs with bluefin tuna farms have been submitting size and weight measures of bluefin tuna at caging operation using stereo camera video systems. In 2015/2016, caging reports were received, from 23 farms and six CPC farm-flags, with over 51,000 thousand size/weight measurements provided. Some of the CPCs involved in the catch operations of fish destined to farming had also submitted stereo camera video reports; although they do not themselves have bluefin tuna farms.



In 2015 three studies related to the use of the stereoscopic camera were presented confirming and demonstrating the reliability and usefulness of video recordings for counting and sizing the bluefin transferred to farms. In 2016 two documents related to stereoscopic camera systems were presented. Document SCRS/2016/201 compared age size distribution of the catch of juvenile bluefin in the Adriatic Sea from purse seine operations using age-length keys or the cohort slicing method. The sizing of the catch was obtained with the stereoscopic video cameras. Document SCRS/2016/187 summarizes the size distribution of the caged bluefin for the 2014 and 2015 years submitted by farm-CPCs, overall the size distribution is very similar in the two years, with a tri-modal distribution of small fish (75 SFL cm), medium size fish (120 SFL cm) and large size fish (210 SFL cm). Interestingly, size distributions are very similar for most farms in both years. The analyses indicated also that the average time between catch and caging (two days), when the stereo camera video is recorded is about 13 days ranging from 1 to 31 days in some instances. It was noted that during this time the fish is not feeding, plus the stress of the operation would likely reduce the fish condition, reducing the actual biomass of the caged fish compared to the biomass at catch.

*18.7 Evaluate the results of the 100% coverage programme using stereoscopical cameras systems or alternative techniques that provide the equivalent precision to refine the number and weight of the fish during all caging operations, Rec. 14-04, paragraph 83*

Background: Rec. 14-04 paragraph 83 requests all farming CPCs to submit annually to the SCRS, by 15 September, the results of this programme which uses stereoscopical cameras systems or alternative techniques. The SCRS should evaluate such procedures and results and report to the Commission by the annual meeting in accordance with Annex 9 of the Rec. 14-04.

In 2015 documents were presented to the SCRS demonstrating the reliability and accuracy of the stereoscopic camera systems to determine the size (straight fork length SFL) of bluefin tuna at caging and prior to harvest in farms. The results indicated accuracy on size measures close to 99% when compared to actual fish measurements. In 2014 and 2015, over 51,000 stereoscopic camera size (FL) measurements were collected from caging operations providing new size frequency data for use in stock assessments.

In 2015, the number of stereoscopy camera video reports increased substantially as the full compliance of Rec. 14-04 is in place. There is however some potential for duplicate data submissions; for example, as CPCs are required to report caging operations within a week of the transfer most farms submitted transfer reports in non-standard formats. Also farm-CPCs submit an Annual Report of all transfer operations following Rec. 14-04 [83]. As complete information [e.g. date of catch, date of actual transfer, e-BCD associated] is not provided in both reports there is difficulty in identifying what data are being duplicated in some reports. In other instances, some of the CPCs involved in the catching operation(s) are submitting stereoscopy camera video reports, although the fish is caged in another farm-CPC flag. The SCRS is recommending that the Secretariat in collaboration with the Subcommittee of Statistics review the data reporting requirement and make clear guidelines and forms for streamline the data submission of the stereoscopy camera caging operations reports.

*18.9 Review the information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission, [Rec. 14-04] paragraph 96*

Background: Rec. 14-04 paragraph 96 requests the SCRS to review information from BCDs and other submitted data and further study growth rates so as to provide updated growth tables to the Commission.

Due to time and data limitations it was not possible to revise and update estimates of potential growth rates of bluefin tuna within farms. It is recommended that CPCs continue submitting detailed information of their harvest operations and carry size and weight measure sampling to have appropriated conversion factors for farmed fish and make this available for the SCRS.

**REPORT BIENNIAL PERIOD 2016-2017 PART 2 VOL 2 SCRS (Report of the SCRS, Madrid, Spain, 2-6 October 2017, pp 289)**

*20.22 Conversion algorithm for the caging operations. Rec. [14-04] Annex 9, item iii*

Background: In 2016 the SCRS provided to the Commission a response to their request regarding algorithms for the purposes of bluefin tuna caging operations (Response to the Commission 18.13 of the SCRS 2016 Report).

During the discussions of this response that took place during the 2016 Commission meeting, it was noted that the algorithm proposed by the SCRS,  $RWT = 2.8684 \text{ E-5} * SFL ^ 2.9076$  (1) may not be appropriate for caging operations in the Adriatic. The Commission agreed to use the alternative algorithm for the Adriatic until additional guidance on a more appropriate algorithm was provided by the SCRS,  $RWT = 3.508 \text{ E-5} * SFL ^ 2.883091788$  (2) where, RWT is the specimen round weight (in kg) and SFL is the specimen straight fork length (in cm). During 2017 Croatian scientists collected additional information on lengths and weights of fish caged in the Adriatic Sea and presented to the SCRS a document (Katavić *et al.*, 2017) confirming that equation (2) is more appropriate for the Adriatic than equation (1). Therefore, the Committee recommends equation (2) to be used to convert SFL in to RWT during caging operations in the Adriatic Sea.

### Summary visits to tuna farms

As decided within the December 2018 GBYP SC meeting, ICCAT Secretariat representatives (ICCAT Executive Secretary or ICCAT Assistant Executive Secretary) and GBYP Coordinator, accompanied in some cases by SC members (Ana Gordo and Ivan Katavic) have held meetings with BFT farms responsible, in some cases involving local scientist or national authorities, in all the five areas selected by the GBYP SC (Portugal, Spain, Malta, Croatia and Turkey).

The purposes of these visits were:

- to explore the willingness of farm owners to collaborate in the proposed study
- to get first-hand information about the logistic capabilities of the farms to carry out the envisaged activities, specially tagging and stereo-cameras image recording
- to present the questionnaire elaborated by GBYP to get detailed information about farming procedures, to clarify any doubt and ask for feedback to improve it
- to inform about the context, objectives and general methodological approach of the proposed study
- to ask for rough cost per unit estimations by type of activity

In addition, some of these visits have been used to achieve additional objectives related to other GBYP activities, as negotiate questions about aerial surveys in Balfegó, start talking about the organization of a workshop on tagging methodologies in Olhao, taking advantage of TUNIPEX facilities or exploring the possibility of carrying out a massive biological sampling of adults in Turkish farms.

In general, it can be said that all these visits were successful, since not only all the aforementioned objectives were accomplished, but all the contacted stakeholders gave a very positive response.

These visits allowed also to note that, in spite the BFT farms do not show striking differences in rearing procedures, each of them present special characteristics, referring both to logistic capabilities and to the initial length distributions of the reared fishes, which condition the harvesting strategies to a great extent. This results in a variety of scenarios, and such heterogeneity make difficult to apply a single and common methodological approach.

Following, the most relevant issues regarding each one of the visited areas, from the point of view of the study general design, are summarized below.

#### **TUNIPEX (South Portugal)**

##### **Dates and attendants: 8-10 January 201. GBYP Coordinator and ICCAT Assistant Executive Secretary / Tunipex representatives / IPMA scientist**

- Most of captured fishes are large ones, over 2 meters. In some years there is a secondary mode between 150 and 200 cm
- The harvesting starts two months after capture, and it is carried out through massive sacrifices in the following months, ending around mid-November. There is not carry over of fishes to the next season.
- The farm and cages structure allow to separate and tag selected individuals without stressing the whole cage. Tagging is feasible.
- All the fishes maintained in the cages have been directly captured in June/July, when they are leaving the Med after spawning, in the trap located besides the farming/fattening facilities.
- IPMA researchers (Pedro Lino, Rui Coelho), who have been working with TUNIPEX for long time, would take care of the scientific supervision and preliminary data processing

#### **BALFEGÓ (Catalonian coasts, NW Mediterranean)**

##### **Dates and attendants: 22-23 January 2019. GBYP Coordinator, ICCAT Assistant Executive Secretary and BFT SCRS Species Group Co-chairman/ Balfego representatives**

- Most of captured fishes are large ones, over 2 meters, but smaller individuals can be also present
- The harvesting is carried out on a regular basis and all year round, taking around 150 individuals by week. Smaller fishes can be maintained in the cages more than one year, up to around 15 months.
- The farm and cages structure do not allow to separate and tag selected individuals without stressing the whole cage. Tagging is not feasible.
- The farm takes, by means of its own stereo-cameras, the length distribution at the transfer to the transporting cages

- All the fishes in this farm come from Balearic sea, and have been captured during a short period, even few days, having experienced similar conditions during the transport to the farm, which takes around a couple of weeks

#### **MALTESE FARMS (Central Mediterranean)**

**Dates and attendants: 21 January-2 February 2019. GBYP Coordinator, ICCAT Executive Secretary/AquaBiotech representatives/ Federation of Maltese Aquaculture Producers (FMAP) representatives/ Maltese farming companies representatives-owners belonging to the FMAP**

- The length distribution of captured fishes is wide, mixing small and large individuals
- The caged fishes come from different areas, from western, eastern and central Mediterranean, having experienced different transporting periods
- The harvesting is carried out through massive sacrifices, from September to January/February.
- Small fishes are carried over till the next harvesting season
- The farm and cages structure do not allow to separate and tag selected individuals without stressing the whole cage. Tagging is not feasible.
- AquaBiotech researchers (Dr. Simeon Deguara), who have been working with Maltese farmer association for long time, would take care of the scientific supervision and preliminary data processing

#### **CROATIAN FARMS (Adriatic Sea)**

**Dates and attendants: 18-20 February 2019. GBYP Coordinator, ICCAT Assistant Executive Secretary/ IZOR scientist/ Most of Croatian farming companies' representatives/owners**

- The length distribution of captured fishes includes mostly very small individuals, with a clear mode around 75cm, with a secondary minor peak around one meter and occasionally larger individuals, up to 150cm
- The caged fishes come from nearby areas in the Adriatic, having experienced short transporting periods
- The harvesting is carried out through massive sacrifices, in January/February, one year and a half after capture, as a minimum
- Young fishes can be easily captured with hooks for tagging. Tagging is feasible.
- Experienced Croatian researchers (Dr. Ivan Katavic and Leon Grubisic), who have been working on this topic from long time, would take care of the scientific supervision and preliminary data processing

#### **Turkish FARMS (Levantine Sea)**

**Dates and attendants: 19-22 March 2019. GBYP Coordinator, ICCAT Assistant Executive Secretary/Turkish authorities/ Most of Turkish farming companies representatives/owners**

- The length distribution of captured fishes is wide, including small and large individuals.
- The caged fishes come from the Cyprus spawning area
- The harvesting is carried out through massive sacrifices, in autumn/winter.
- Smaller fishes are carried over the next harvesting season.
- Fishes cannot be tagged without causing excessive stress. Tagging is not feasible.
- All the planning activities have been organized by national fishing authorities (contact person Burcu Bilgin).
- Local scientists, proposed by the Ministry, would take care of the study.

## General Questionnaire on BFT farms characteristics and strategies

### Objective

To determine specific farm features and procedures for bluefin tuna farming/fattening so as to gain insight on weight and size growth of caged wild bluefin as a function of size and time at farm.

### Introduction

Earlier studies have shown that bluefin tuna kept in farms can attain weight and size growth rates comparable or greater than those of wild fish as a result of husbandry conditions. The increase in weight/size that can be attained at farms appears to be highly variable and related to several factors, including: size of the caged fish, fish condition at capture, duration of fattening/farming, husbandry practices, weather and environmental conditions, etc. However, there is evidently a biological maximum limitation of somatic growth for bluefin tuna. It is likely that the weight gains during BFT farming operations are also the result of economic balance between cost and benefits, as well as market conditions, which ultimately determine optimal farming operations for wild fish. The main objective of this questionnaire is to determine the characteristics of each farm, from farming operations and harvesting strategies to farming facilities and equipment, in order to identify potential factors within each farm that can affect the growth of caged wild bluefin tuna to be considered when defining expected “maximum growth rates” as a function of size at caging and time in the farming facility.

### General farm characteristics

- Name of the farm:
- ICCAT registration number:
- Location: Latitude Longitude
- Average bottom depth (m):
- Distance from coast/island/port (km):
- Number of BFT cages:
- Cages dimensions (diameter (m) and depth (m)):
- Biomass capacity per cage (maximum theoretical capacity under acceptable rearing conditions) (kg):
- Total BFT capacity of farm (kg or number of a given mean size):

### Local environmental conditions in cage(s)

*Please let us know if further detailed data can be provided in electronic format (Excel).*

- Average surface temperature in cages by month:
- Average surface min temperature in cages by month:
- Average surface max temperature in cages by month:
- Average surface DO<sub>2</sub> (dissolved oxygen) in cages by month:
- Average surface salinity in cages by month (ppm):

### Normal husbandry conditions

- Please describe the normal feeding strategy:

*If the farm has different feeding strategies for different cages,*

- How many?:
- Description of each strategy:

*Details on type and amount of food and feeding timings (if several strategies, please answer the following questions for each one).*

- Fish species used for food:
- Condition of the food (live fish, fresh fish, frozen fish, fishmeal or pellets...):
- Number of feeds per day:

- Feeding time/times (hours) during the day:
- Daily percent of food per bluefin biomass in cage:
- If any supplemental feeding (e.g. vitamins, antibiotics, others) is used normally, please describe:
- Describe temporal variation of feeding and reasons, for example if the feeding changes in winter, summer, or prior to harvesting, immediately after caging, etc.:

#### **Bluefin status monitoring conditions**

- A brief description of how the condition of caged bluefin tuna is usually monitored:

*If the following apply, please complete.*

- Divers in the cage, frequency and time of dives:
- Video-camera monitoring and frequency:
- Sampling of fish in cages (frequency, reasons, procedure):
- Average mortality per month per cage:

#### **Caging and processing of BFT in farm**

- A brief description of the procedures for caging and harvesting of bluefin tuna in the farm:

##### ***Caging procedure***

- Average density of fish per cage: units (e.g. number fish of a given mean size per cage or kg fish per cage).
- Cage transfers and movement of cages within the farm:

##### ***Harvesting procedure***

- Harvesting periodicity (e.g. every week):
- Procedure for selection of fish for harvest:
- Selection criteria (e.g. size, demand from customers):
- General process for killing and conservation of harvested fish:
- Average gain in weight per fish-size category per month/semester (kg):

#### **Length and weight distributions:**

- Length and weight distributions of harvested fish in the last three years:
- If available, length distributions of captured fish at the moment of transfer to cages:

*Please provide any other information that you consider is important in determining the maximum growth of BFT in farms.*

- Comments:

Thank you in advance for your collaboration.

### Technical specifications of the first contracts for the “Growth in Farms” study

#### ➤ **BALFEGÓ & BALFEGÓ S.L.**

The activities related to the determination of BFT growth in farms shall be carried out in accordance with the specifications detailed below:

1. Whenever possible, BFT that have died incidentally during transportation from fishing grounds or at the time of first caging in a farm, shall be weighed and measured following the Biological sampling protocols ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)), so that these data may be used to evaluate the accuracy of available length/weight relationships.
2. On transferring the fishes captured in the wild to the farm at least one cage containing the widest length range of individuals from the current fishing season, including both larger specimens that will be harvested in a few months and smaller ones that will be presumably carried over and harvested more than one year after capture, shall be selected as the monitoring cage.
3. The length distribution of the fishes in the monitored cage shall be estimated at caging by means of a stereoscopic-camera system, following the standard procedures derived from ICCAT obligations when applicable (Taking into account that there will be no door, no transfer to different cage, and no interest for the algorithm - weight), Subsequently, such length distribution shall be estimated by the Contractor every two months making use of the same stereoscopic-camera system, measuring at least 20% of caged fishes, following recommendations detailed in Annex 9 of the ICCAT Rec (when applicable). 17-07 (<https://www.iccat.int/Documents/Recs/compendiopdf-e/2017-07-e.pdf>).
4. The amount and type of food provided to the fishes in the monitoring cage shall be recorded on a daily basis.
5. The most relevant environmental parameters in the monitored cage (i.e. temperature, salinity and dissolved oxygen) shall be recorded at least on a weekly basis (preferably on a daily basis) with calibrated scientific equipment and stored in an Excel file.
6. At harvesting, all the fishes from the monitored cage shall be weighed and measured following the procedures described in Biological sampling protocols ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)).

As regards the reporting of all the activities carried out under this contract, the following deliverables will be submitted before the dates stated below:

1. A short report on any preliminary preparation work or any initial sampling activity, including the description of the work carried out up to that date (**Deliverable #1**), shall be submitted before the end of July
2. An update of said initial report on the sampling activities (**Deliverable #2**) shall be submitted at the latest by **20 September 2019**, including the description of the work carried out up to that date .
3. Another short report updating the previous reports, with information on the sampling activities carried out until late October 2018 (**Deliverable #3**), to be used to inform the ICCAT Commission, shall be provided by **10 November 2019**.
4. A draft final report (**Deliverable #4**) shall be submitted at the latest by **10 December 2019**, consisting in a scientific report describing in detail the work carried out and the obtained results, including:
  - a) a full description of the initial conditions of the monitored cages (origin of the caged fishes -date and area of capture-, characteristics of the monitored cage, initial number and biomass of caged fishes);
  - b) a detailed description of all the methodologies and protocols, applied for the monitoring of environmental variables, biological sampling of dead fishes and measurements of live fishes -both direct or through stereoscopic-cameras - (how protocols have been applied, any departure from the protocol, difficulties encountered, etc.);
  - c) files containing videos and raw data from stereo-camera measurements carried out after the first official stereo-camera measurements at caging;
  - d) detailed tables including:

- length and weight of any fish that have died in the monitored cages for causes other than harvesting operations, as well as relevant data on biological samples from these fishes, if any,
  - weekly records of environmental parameters (T, S, DO2) in the monitored cages,
  - daily quantities and types of feed given to the trial cage/s,
  - length distributions of the fishes in the monitored cages estimated from the successive measurements with the stereoscopic-camera system,
  - length and weight of each fish harvested from the monitored cages (specifying date of harvesting),
  - the length distributions estimated from stereo-camera system measurements at the moment of transfer from fishing nets to transporting cages of all the fishes captured in the 2016 and 2017 fishing seasons, as well the length and weight of all these fishes at harvesting
- e) An Executive Summary of the final report.
5. A final report, including the definitive version of the scientific report detailed in the previous point prepared taking into account any comment provided by ICCAT (**Deliverable #5**) and the full administrative report including copies of all the administrative documents, shall be submitted by **18 December 2019**.

➤ **PELAGOS NET FARMA D.O.O.**

The activities related to the determination of BFT growth in farms shall be carried out in accordance with the specifications detailed below:

1. Whenever possible, BFT to be stocked in the experimental cages if died incidentally during transportation from fishing grounds or at the time of first caging in a farm, shall be weighed and measured following the Biological sampling protocols ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)), so that these data may be used to evaluate the accuracy of available length/weight relationships.
2. On transferring the fishes captured in the wild to the farm at two cages containing the widest length range of individuals from the current fishing season, shall be selected as the monitoring cages.
3. The length distribution of the fishes in the monitored cage shall be estimated at caging by means of a stereoscopic-camera system, following the standard procedures derived from ICCAT obligations. Subsequently, such length distribution shall be estimated by the Contractor every three months making use of the same stereoscopic-camera system, measuring at least 20% of caged fishes, following recommendations detailed in Annex 8 and Annex 9 of the ICCAT Rec. 17-07 (<https://www.iccat.int/Documents/Recs/compendiopdf-e/2017-07-e.pdf>).
4. After caging, before starting the feeding operations, a sub group of 100 fishes from each monitoring cage, covering the whole length range of the caged population, shall be tagged using pit tags provided by ICCAT, following standard procedures and recommendations stated in Tagging manual ([https://www.iccat.int/GBYP/Docs/Tagging\\_Manual.pdf](https://www.iccat.int/GBYP/Docs/Tagging_Manual.pdf)). In addition, each fish will be injected with a minimum dose of oxytetracyclin of 40mg per kilogram of fish by means of an injection gun. These tagged fishes will be not used in any case for human or animal consumption within min 40 days after being injected
5. The amount and type of food provided to the fishes in the monitoring cage shall be recorded on a daily basis.
6. The most relevant environmental parameters in the monitored cage (i.e. temperature, salinity and dissolved oxygen) shall be recorded with calibrated scientific equipment at least on a weekly basis (preferably on a daily basis) and stored in an Excel file.

As regards the reporting of all the activities carried out under this contract, the following deliverables will be submitted before the dates stated below:

1. A short report on any preliminary preparation work or any initial sampling activity, including the description of the work carried out up to that date (**Deliverable #1**), shall be submitted **at the latest 30 days after the signature of the Contract**.
2. An update of said initial report on the sampling activities (**Deliverable #2**) shall be submitted at the latest by **20 September 2019**, including the description of the work carried out up to that date and a short PowerPoint presentation, to be used also to inform the SCRS.



3. Another short report updating the previous reports, with information on the sampling activities carried out until late October 2019 (**Deliverable #3**), to be used to inform the ICCAT Commission, shall be provided by **10 November 2019**.
4. A draft final report (**Deliverable #4**) shall be submitted at the latest by **10 December 2019**, consisting in a scientific report describing in detail the work carried out and the obtained results, including:
  - a) a full description of the initial conditions of the monitored cages (origin of the caged fishes -date and area of capture-, characteristics of the monitored cage, initial number and biomass of caged fishes);
  - b) a detailed description of all the methodologies and protocols, applied for the monitoring of environmental variables, biological sampling of dead fishes and measurements of live fishes -both direct or through stereoscopic-cameras -, and tagging operations (how protocols have been applied, any departure from the protocol, difficulties encountered, etc.);
  - c) files containing videos and raw data from stereo-camera measurements carried out after the first official stereo-camera measurements at caging;
  - d) detailed tables and graphs including:
    - length and weight of any fish that have died in the monitored cages for causes other than harvesting operations, as well as relevant data on biological samples from these fishes, if any,
    - weekly records of environmental parameters (T, S, DO2) in the monitored cages,
    - daily quantities and types of feed given to the trial cage/s,
    - length distributions of the fishes in the monitored cages estimated from the successive measurements with the stereoscopic-camera system,
  - e) An Executive Summary of the final report.
5. A final report, including the definitive version of the scientific report detailed in the previous point prepared taking into account any comment provided by ICCAT (**Deliverable #5**), a document demonstrating that all samples have been duly sent to the entity indicated by ICCAT GBYP, and the full administrative report including copies of all the administrative documents, shall be submitted by **18 December 2019**.

➤ **TUNIPEX, S.A. EMPRESA DE PESCA DE TUNÍDEOS**

The activities related to the determination of BFT growth in farms shall be carried out in accordance with the specifications detailed below:

1. Whenever possible, BFT that have died incidentally in the trap shall be weighed and measured following the Biological sampling protocols ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)), so that these data may be used to evaluate the accuracy of available length/weight relationships.
2. On transferring the fishes captured in the trap to the farming cages one cage containing the widest length range of individuals shall be selected as the monitoring cage.
3. The length distribution of the fishes in the monitored cage shall be estimated at caging by means of a stereoscopic-camera system, following the standard procedures derived from ICCAT obligations.
4. After caging, before starting the feeding operations, a sub group of 80 fishes from the monitoring cage, covering the whole length range of the caged population, shall be temporary transferred to a special trap section to be hauled, weighed, measured and double tagged with numbered conventional tags provided by ICCAT, following standard procedures and recommendations stated in Tagging manual ([https://www.iccat.int/GBYP/Docs/Tagging\\_Manual.pdf](https://www.iccat.int/GBYP/Docs/Tagging_Manual.pdf)). Following, after confirming that the tagging operations have not affected negatively the fishes, they will be transferred again to the monitoring cage.
5. Such fishes will be measured during the transfer to the special section from which they will be hauled for tagging by means of a stereoscopic camera system, following recommendations detailed in Annex 8 and Annex 9 of the ICCAT Rec. 17-07 (<https://www.iccat.int/Documents/Recs/compendiopdf-e/2017-07-e.pdf>).
6. The amount and type of food provided to the fishes in the monitoring cage shall be recorded on a daily basis.
7. The most relevant environmental parameters in the monitored cage (i.e. temperature, salinity and dissolved oxygen) shall be recorded with calibrated scientific equipment at least on a weekly basis (preferably on a daily basis) and stored in an Excel file.

8. At harvesting, all the fishes from the monitored cage, including the tagged fishes, shall be weighed and measured following the procedures described in Biological sampling protocol ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)).

As regards the reporting of all the activities carried out under this contract, the following deliverables will be submitted before the dates stated below:

1. A short report on any preliminary preparation work or any initial sampling activity, including the description of the work carried out up to that date (**Deliverable #1**), shall be submitted **at the latest 30 days after the signature of the Contract**.
2. An update of said initial report on the sampling activities (**Deliverable #2**) shall be submitted at the latest by **20 September 2019**, including the description of the work carried out up to that date and a short PowerPoint presentation, to be used also to inform the SCRS.
3. Another short report updating the previous reports, with information on the sampling activities carried out until late October 2018 (**Deliverable #3**), to be used to inform the ICCAT Commission, shall be provided by **10 November 2019**.
4. A draft final report (**Deliverable #4**) shall be submitted at the latest by **10 December 2019**, consisting in a scientific report describing in detail the work carried out and the obtained results, including:
  - a) a full description of the initial conditions of the monitored cages (origin of the caged fishes -date and area of capture-, characteristics of the monitored cage, initial number and biomass of caged fishes);
  - b) a detailed description of all the methodologies and protocols, applied for the monitoring of environmental variables, biological sampling of dead fishes and measurements of live fishes -both direct or through stereoscopic-cameras -, and tagging operations (how protocols have been applied, any departure from the protocol, difficulties encountered, etc.);
  - c) files containing videos and raw data from stereo-camera measurements carried out after the first official stereo-camera measurements at caging for measuring tagged fishes;
  - d) detailed tables and graphs including:
    - length and weight of any fish that have died in the monitored cages for causes other than harvesting operations, as well as relevant data on biological samples from these fishes, if any,
    - weekly records of environmental parameters (T, S, DO2) in the monitored cages,
    - daily quantities and types of feed given to the trial cage/s,
    - length and weight of each fish harvested from the monitored cages (specifying date of harvesting),
    - length and weight of all the tagged fishes at tagging and at harvesting, as well as data on biological samples from tagged fishes,
  - e) An Executive Summary of the final report.
5. A final report, including the definitive version of the scientific report detailed in the previous point prepared taking into account any comment provided by ICCAT (**Deliverable #5**), a document demonstrating that all samples have been duly sent to the entity indicated by ICCAT GBYP, and the full administrative report including copies of all the administrative documents, shall be submitted by **18 December 2019**.

#### ➤ **AQUABIOTECH LTD**

The activities related to the determination of BFT growth in farms shall be carried out in accordance with the specifications detailed below:

1. Whenever possible, BFT that have died incidentally during transportation from fishing grounds or at the time of first caging in a farm, shall be weighed and measured following the Biological sampling protocols ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)), so that these data may be used to evaluate the accuracy of available length/weight relationships.

2. On transferring the fishes captured in the wild to the farm at least one cage containing the widest length range of individuals from the current fishing season, including both larger specimens that will be harvested in a few months and smaller ones that will be presumably carried over and harvested more than one year after capture, shall be selected as the monitoring cage.
3. The length distribution of the fishes in the monitored cage shall be estimated at caging by means of a stereoscopic-camera system, following the standard procedures derived from ICCAT obligations. Subsequently, such length distribution shall be estimated by the Contractor every two months making use of the same stereoscopic-camera system, measuring at least 20% of caged fishes, following recommendations detailed in detailed in Annex 8 and Annex 9 of the ICCAT Rec. 17-07 (<https://www.iccat.int/Documents/Recs/compendiopdf-e/2017-07-e.pdf>).
4. The amount and type of food provided to the fishes in the monitoring cage shall be recorded on a daily basis.
5. The most relevant environmental parameters in the monitored cage (i.e. temperature, salinity and dissolved oxygen) shall be recorded with calibrated scientific equipment at least on a weekly basis (preferably on a daily basis) and stored in an Excel file.
6. At harvesting, all the fishes from the monitored cage shall be weighed and measured following the procedures described in Biological sampling protocol (<https://www.iccat.int/GBYP/Docs/Biological Studies Phase 8 Sampling Protocol.pdf>).

As regards the reporting of all the activities carried out under this contract, the following deliverables will be submitted before the dates stated below:

1. A short report on any preliminary preparation work or any initial sampling activity, including the description of the work carried out up to that date (**Deliverable #1**), shall be submitted **at the latest 30 days after the signature of the Contract**.
2. An update of said initial report on the sampling activities (**Deliverable #2**) shall be submitted at the latest by **20 September 2019**, including the description of the work carried out up to that date and a short PowerPoint presentation, to be used also to inform the SCRS.
3. Another short report updating the previous reports, with information on the sampling activities carried out until late October 2018 (**Deliverable #3**), to be used to inform the ICCAT Commission, shall be provided by **10 November 2019**.
4. A draft final report (**Deliverable #4**) shall be submitted at the latest by **10 December 2019**, consisting in a scientific report describing in detail the work carried out and the obtained results, including:
  - a) a full description of the initial conditions of the monitored cages (origin of the caged fishes -date and area of capture-, characteristics of the monitored cage, initial number and biomass of caged fishes);
  - b) a detailed description of all the methodologies and protocols, applied for the monitoring of environmental variables, biological sampling of dead fishes and measurements of live fishes -both direct or through stereoscopic-cameras - (how protocols have been applied, any departure from the protocol, difficulties encountered, etc.);
  - c) files containing videos and raw data from stereo-camera measurements carried out after the first official stereo-camera measurements at caging;
  - d) detailed tables and graphs including:
    - length and weight of any fish that have died in the monitored cages for causes other than harvesting operations, as well as relevant data on biological samples from these fishes, if any,
    - weekly records of environmental parameters (T, S, DO2) in the monitored cages,
    - daily quantities and types of feed given to the trial cage/s,
    - length distributions of the fishes in the monitored cages estimated from the successive measurements with the stereoscopic-camera system,
    - length and weight of each fish harvested from the monitored cages (specifying date of harvesting),
  - e) An Executive Summary of the final report.

5. A final report, including the definitive version of the scientific report detailed in the previous point prepared taking into account any comment provided by ICCAT (**Deliverable #5**) and the full administrative report including copies of all the administrative documents, shall be submitted by **18 December 2019**.

➤ **AKUA-GROUP SU URUNLERI A.S.**

The activities related to the determination of BFT growth in farms shall be carried out in accordance with the specifications detailed below:

1. Whenever possible, BFT that have died incidentally during transportation from fishing grounds or at the time of first caging in a farm, shall be weighed and measured following the Biological sampling protocols ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)), so that these data may be used to evaluate the accuracy of available length/weight relationships.
2. On transferring the fishes captured in the wild to the farm at least one cage containing the widest length range of individuals-as possible- from the current fishing season, including both larger specimens that will be harvested in a few months and smaller ones that will be presumably carried over and harvested more than one year after capture, shall be selected as the monitoring cage.
3. The length distribution of the fishes in the monitored cage shall be estimated at caging by means of a stereoscopic-camera system, following the standard procedures derived from ICCAT obligations. Subsequently, such length distribution shall be estimated by the Contractor every two months making use of the same stereoscopic-camera system, measuring at least 20% of caged fishes, following recommendations detailed in Annex 8 and Annex 9 of the ICCAT Rec. 17-07 (<https://www.iccat.int/Documents/Recs/compendiopdf-e/2017-07-e.pdf>).
4. The amount and type of food provided to the fishes in the monitoring cage shall be recorded on a daily basis.
5. The most relevant environmental parameters in the monitored cage (i.e. temperature, salinity and dissolved oxygen) shall be recorded at least on a weekly basis (preferably on a daily basis) with calibrated scientific equipment and stored in an Excel file.
6. At harvesting, all the fishes from the monitored cage shall be weighed and measured following the procedures described in Biological sampling protocol ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)).

The activities related to the complete biological sampling of 300 adult bluefin tuna-if possible- from the 2019 fishing season, which can be carried out preferably but not necessarily on specimens from the same cages monitored within the framework of the study of BFT growth in farms, shall be conducted following the technical requirements and the Biological sampling protocol ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)).

1. For each bluefin tuna specimen, the Contractor shall collect all the following data and samples:
  - a) Straight fork length (SFL) in cm
  - b) Length to the first dorsal (LD1) in cm
  - c) Total weight in kg
  - d) Sex identification
  - e) Sagitta otoliths, whenever possible
  - f) Tissue sampling for genetic studies
2. The Contractor shall provide complete sets of the data and samples listed in the previous point from 300 specimens- from the Levantine Sea. In the case of sagitta otoliths sampling, given that the killing method used during harvesting can potentially destroy or make unavailable one or both otoliths, the contractor is only committed to try to recover as much otoliths as possible
3. The Contractor shall conduct the sampling and samples labelling according to the Biological sampling protocol ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)).
4. The Contractor shall record the data for each sample in the sampling table and duly codify them according to the Biological sampling protocol ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)).
5. The Contractor shall provide the appropriate storage for all collected samples.

6. The Contractor shall ship the samples to the laboratory in charge of storing them for ICCAT GBYP, full address of which is detailed in the Biological sampling protocol ([https://www.iccat.int/GBYP/Docs/Biological\\_Studies\\_Phase\\_8\\_Sampling\\_Protocol.pdf](https://www.iccat.int/GBYP/Docs/Biological_Studies_Phase_8_Sampling_Protocol.pdf)). The shipping costs will be borne by ICCAT GBYP.
7. Photos and videos of the field activities are welcome. These materials will be stored by GBYP and eventually used for project dissemination activities. The author of each photo or video shall be recorded for the credits.

As regards the reporting of all the activities carried out under this contract, the following deliverables will be submitted before the dates stated below:

1. A short report on any preliminary preparation work or any initial sampling activity, including the description of the work carried out up to that date (**Deliverable #1**), shall be submitted **at the latest 30 days after the 2019 catch campaign**, which shall be ended on 30 May 2019.
2. An update of said initial report on the sampling activities (**Deliverable #2**) shall be submitted at the latest by **20 September 2019**, including the description of the work carried out up to that date and a short PowerPoint presentation, to be used also to inform the SCRS.
3. Another short report updating the previous reports, with information on the sampling activities carried out until late October 2018 (**Deliverable #3**), to be used to inform the ICCAT Commission, shall be provided by **10 November 2019**.
4. A draft final report (**Deliverable #4**) shall be submitted at the latest by **10 December 2019**, consisting in a scientific report describing in detail the work carried out and the obtained results, including:
  - a) a full description of the initial conditions of the monitored cages (origin of the caged fishes -date and area of capture-, characteristics of the monitored cage, initial number and biomass of caged fishes);
  - b) a detailed description of all the methodologies and protocols, applied for the monitoring of environmental variables, biological sampling of dead fishes and measurements of live fishes -both direct or through stereoscopic-cameras -, and tagging operations (how protocols have been applied, any departure from the protocol, difficulties encountered, etc.);
  - c) files containing videos and raw data from stereo-camera measurements carried out after the first official stereo-camera measurements at caging;
  - d) detailed tables and graphs including:
    - length and weight of any fish that have died in the monitored cages for causes other than harvesting operations, as well as relevant data on biological samples from these fishes, if any,
    - weekly records of environmental parameters (T, S, DO2) in the monitored cages,
    - daily quantities and types of feed given to the trial cage/s,
    - length distributions of the fishes in the monitored cages estimated from the successive measurements with the stereoscopic-camera system,
    - length and weight of each fish harvested from the monitored cages (specifying date of harvesting),
    - length and weight of all the tagged fishes at tagging and at harvesting, as well as data on biological samples from tagged fishes,
    - length and weight of all the fishes sampled within the framework of the biological sampling of BFT adults in farms activity, as well as data on biological samples from these fishes.
  - e) An Executive Summary of the final report.
5. A final report, including the definitive version of the scientific report detailed in the previous point prepared taking into account any comment provided by ICCAT (**Deliverable #5**), a document demonstrating that all samples have been duly sent to the entity indicated by ICCAT GBYP, and the full administrative report including copies of all the administrative documents, shall be submitted by **18 December 2019**.