

BRIEFING ON THE PROGRESS OF THE RESEARCH ACTIVITIES CONCERNING THE GROWTH IN FARMS OF BLUEFIN TUNA

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SUMMARY

This briefing provides a summary of two informal meetings held to coordinate the communication of the activities carried out by the BFT Growth in Farms Sub-group to the Panel 2 of the ICCAT Commission, and to analyze the implications of the Panel 2 answer to SCRS about how the initial weights of caged specimens should be estimated. A summary of the main lines of research of the Sub-group is also presented.

RÉSUMÉ

Le présent briefing fournit un résumé de deux réunions informelles qui se sont tenues afin de coordonner la communication des activités menées par le sous-groupe sur la croissance du thon rouge dans les fermes à la Sous-commission 2 de la Commission de l'ICCAT, et d'analyser les implications de la réponse de la Sous-commission 2 au SCRS sur la manière dont les poids initiaux des spécimens mis en cage devraient être estimés. Un résumé des principaux axes de recherche du sous-groupe est également présenté.

RESUMEN

Este informe proporciona un resumen de dos reuniones informales celebradas para coordinar la comunicación de las actividades llevadas a cabo por el Subgrupo de crecimiento de atún rojo en granjas a la Subcomisión 2 de la Comisión de ICCAT, y para analizar las implicaciones de la respuesta de la Subcomisión 2 al SCRS sobre cómo deben estimarse los pesos iniciales de los ejemplares introducidos en jaulas. También se presenta un resumen de las principales líneas de investigación del subgrupo.

KEYWORDS

Bluefin tuna, Thunnus thynnus, farm, growth, length-weight relationships

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1. Introduction

This brief report provides a summary of two informal meetings held to coordinate the communication of the research activities carried out by the BFT Growth in Farms Sub-group to Panel 2 of the ICCAT Commission and discuss the potential implications on the ongoing SCRS works of the answer provided by Panel 2 to the request of clarification about how the initial weight of caged bluefin tuna should be calculated within the framework of the updating of the farm growth rates posed by the SCRS. The informal meetings were attended by the Sub-Group Coordinator, SCRS Chair and vice-Chair, BFT Chairs, GBYP Coordinator, and ICCAT Secretariat.

During the Intersessional meeting of Panel 2 (online, 2-5 March 2021) a presentation of the SCRS progress in studies on the review of bluefin tuna (BFT) growth in farms was made by the Coordinator of the GBYP. Regarding the answer from Panel 2 to SCRS question, after the various interventions of the contracting parties, the summary of the requirements of Panel 2 was as follows:

"The Chair of Panel 2 confirmed that weight at capture, which would be estimated based on the length at caging, and the length-weight relationship for wild fish was to be used for the growth rate estimation". "Request to update the growth rates, taking into account the difference between the weight at caging, derived from the length at first measurement given by stereo cameras, and the weight at harvest time" (Anon., 2021).

Considering this answer, the aforementioned members of the Growth in farms Subgroup met to discuss the potential problems derived from the existence of different official Length-Weight (L-W) relationships and to make a preliminary analysis of their adequacy to be used within the framework of the ongoing growth in farms studies to answer the Commission's request on the updating of the reference tables on growth rates in farms.

The most important conclusions from these informal meetings are the following:

- The estimation of farm growth rates is a matter of compliance for the Commission, since some unusually high reported growth rates could not be explained considering current reference tables. Moreover, the fattening capacity is important for the farm sector and it is also useful to know how much it differs in relation to the potential increase in condition factor compared with wild fish. In addition, an accurate estimation of the biomass of BFT that is caught by the purse seine fleet and destined to farms is essential for the stock assessment, since it represents more than 60% of the catch in the East Atlantic and the Mediterranean Sea stock.
- Catch estimation is currently done from stereoscopic cameras at the time of caging (it is rarely possible to use them at the time of the first transfer, just after capture, due to oceanographic conditions). Stereo camera systems measure lengths and convert these lengths into weight using specific L-W functions. Several equations have been used. Since 2017 stereo-camera systems have used the Deguara et al. (2017) function (SCRS clarification by the Commission regarding the use of algorithms for the purpose of bluefin tuna caging operations in Mediterranean Sea during May-June period. *In: Anon., 2016*), with the exception of the Adriatic catches that use a different function for juvenile fish (Katavic et al., 2018) (Conversion algorithm for the caging operations. Rec. [14-04] Annex 9, item iii *In: Anon., 2017*).
- The L-W equation from Deguara et al. (2017), estimating the L-W relationship for wild BFT caught in the Mediterranean during the months of May and June, obtains weights per length lower (5% in average) than those obtained by the Rodriguez-Marin et al. (2015) annual L-W relationship for BFT and even lower weights per length than the monthly L-W relationships of May (10%) and June (8%) of the aforementioned Rodriguez-Marin et al. (2015) equation. These differences in weight are for the size range 70 - 320 cm SFL, which is currently the size range for BFT destined to farm operations excluding Croatia (Adriatic juvenile catches).
- It was noted that at present there is an inconsistency between the L-W relationship used by the SCRS to provide the assessment advice and the L-W relationship used to monitor the catches of the farmed bluefin tuna. The potential effects of this inconsistency should be evaluated by the BFT Species Group.

There were also raised some concerns about the fact that the current L-W relationships used to convert stereo-camera length measurements to RWT does not provide accurate estimations of weights in certain geographical areas and/or certain size classes. No differences have been found from the Moroccan trap data and for bluefin tuna juveniles caught during purse seine fishing season in the Adriatic (Katavic et al., 2018) with the Rodriguez-

Marin et al. (2015) functions. On the other hand, differences were seen with the function of Deguara et al. (2017) for both data sources and this is the reason for the exclusion of the use of the latter equation for the estimation of the BFT weight from Croatian farms. The only exception is the Portuguese reverse traps (BFT leaving the Mediterranean Sea after spawning), where differences with both Rodriguez-Marin et al. (2015) and Deguara et al. (2017) L-W functions occur, probably due to the very low BFT condition factor of these fish.

Finally, it was proposed to estimate the maximum growth in farms as an expected percent increase in weight of farmed BFT as a function of the size at caging and the length of time in the farms (**Figure 1**, see below 4th line of research).

2. Description of current lines of research related to growth rates in farms:

In 2019, after verifying the logistical and budgetary impossibility of developing new reference growth in farms reference tables taking into account possible geographical differences based exclusively on individual growth trajectories, GBYP launched several complementary lines of research to determining growth rates in farms. In 2020, in order to integrate the results from all these research lines in a single and coherent answer to the Commission request 18-02, paragraph 28 (amended by Rec. 19-04), it was constituted the SCRS BFT Subgroup on growth in farms, which was structured in several lines of research. Each of the four research lines providing growth rates estimations are briefly described below:

2.1 Determination of individual growth trajectories using tagging techniques.

This type of study has been performed in the two areas where farm owners accepted to carry out tagging operations in their caged fish, it is in the Adriatic sea (Pelagos farm) and Southern Portugal (Tunipex farm). The study in the Adriatic hastargeted 2-3 years old fish at capture, which have been maintained under usual farming conditions along more than one year and a half. A total of 206 fish distributed in two cages were tagged with pit tags, most of which have been successfully detected at harvesting, which has allowed to get 157 individual growth rates, with a mean increase in length around 60% and gain in weight around 455% in 19 months (mean increase of 51 cm in length and mean weight gain of 46.5 kg in fish measuring 85 cm and weighing around 10 Kg at caging).

In Portugal tagging trials have been carried out for two consecutive years, involving adult fish captured in traps when leaving the Mediterranean after spawning, tagging 89 and 107 fish respectively. The premature mortality of tagged fish has been high, around 38% and almost 13% of fish lost the external tags before harvesting. So, 95 individual growth rates have been obtained, showing a high variability after four/four and a half months of fattening, between 10 and almost 80% of weight gain, with a mean around 40%.

These individual growth trajectories will allow us to get a precise idea about the potential variability in growth rates and validate the results obtained from the rest of studies.

2.2 Studies focused on the analysis of seasonal growth of modal groups, based on sequential (bimonthly) stereo camera measurements along with farming period and length and weight data at harvesting.

These studies have been carried out in Malta, Turkey, Croatia and Spain, covering the whole usual length range of fish farmed in each of these areas. The duration of the studies have been variable, from around 6 to 16 months in adult fish and 19 in juveniles. They will allow to estimate seasonal growth rates in length and the total weight gain along the whole fattening period of each of the modal groups (annual cohorts) present in the cages in most of the areas where BFT is farmed, and relate these growth rates with environmental parameters and food supply. If possible, similar studies will be performed in Morocco shortly.

2.3 Studies based on the continuous monitoring of growth in length and weight of modal groups using a combination of acoustic and image analysis systems.

A pilot study was started in July 2020 in the western Mediterranean (Balfegó farm), which is planned to finish in July 2021. A second study in Morocco was planned but was canceled due to the Covid pandemic.

The acoustic and image analysis system allows collecting a large amount of data by day on length, width, and height of all fish in the monitored cages, allowing the identification and characterization of all modal size groups present in the cage. Given that besides length, also width, and height data are recorded with the stereoscopic

cameras and the sonar placed in the bottom of the cage, it is possible to estimate, through adhoc morphometric models, the increase in the weight of the caged population with less than 2% error. It is expected that this system will allow getting precise estimations of growth in length and weight of each size modal group at any selected time scale, even daily or weekly if required, along all the farming period. In addition, if the fish would be tagged with acoustic tags and a series of hydrophones placed in the monitored cage, the system could provide estimates of growth rates for each tagged fish. At present, the outputs from the first pilot study will be useful to get information about seasonal growth in weight and evaluate the accuracy of the studies described in item 2.

2.4 Determination of growth rates by farm based on the comparison between estimated weights at caging from official stereo camera measurements and weights at harvesting.

This approach takes advantage of the broad data set available on the length distributions at caging from the official stereo camera measurements submitted to ICCAT Secretariat since 2014, covering in theory 100% of caging operations, and the bluefin tuna harvesting database that also covers all harvesting operations in farms. Initial weight will be estimated from the size measurements of stereo-camera data by farm/caging operation, while size and weight at harvest are collected from harvesting data reports submitted by the farms (Ortiz et al., 2014). The analysis will evaluate the variability of weight at size and the potential variations in fish condition at caging as a function of geographical and temporal factors. Non-linear quantile regression will be used to allow deviations from the assumption of normal distribution of weight at size (Ortiz, 2018). This approach will allow estimating the mean total gain in weight along the farming period as a function of time and size of the caged fish by the required geographical scale (by farm, by area...) (**Figure 1**).

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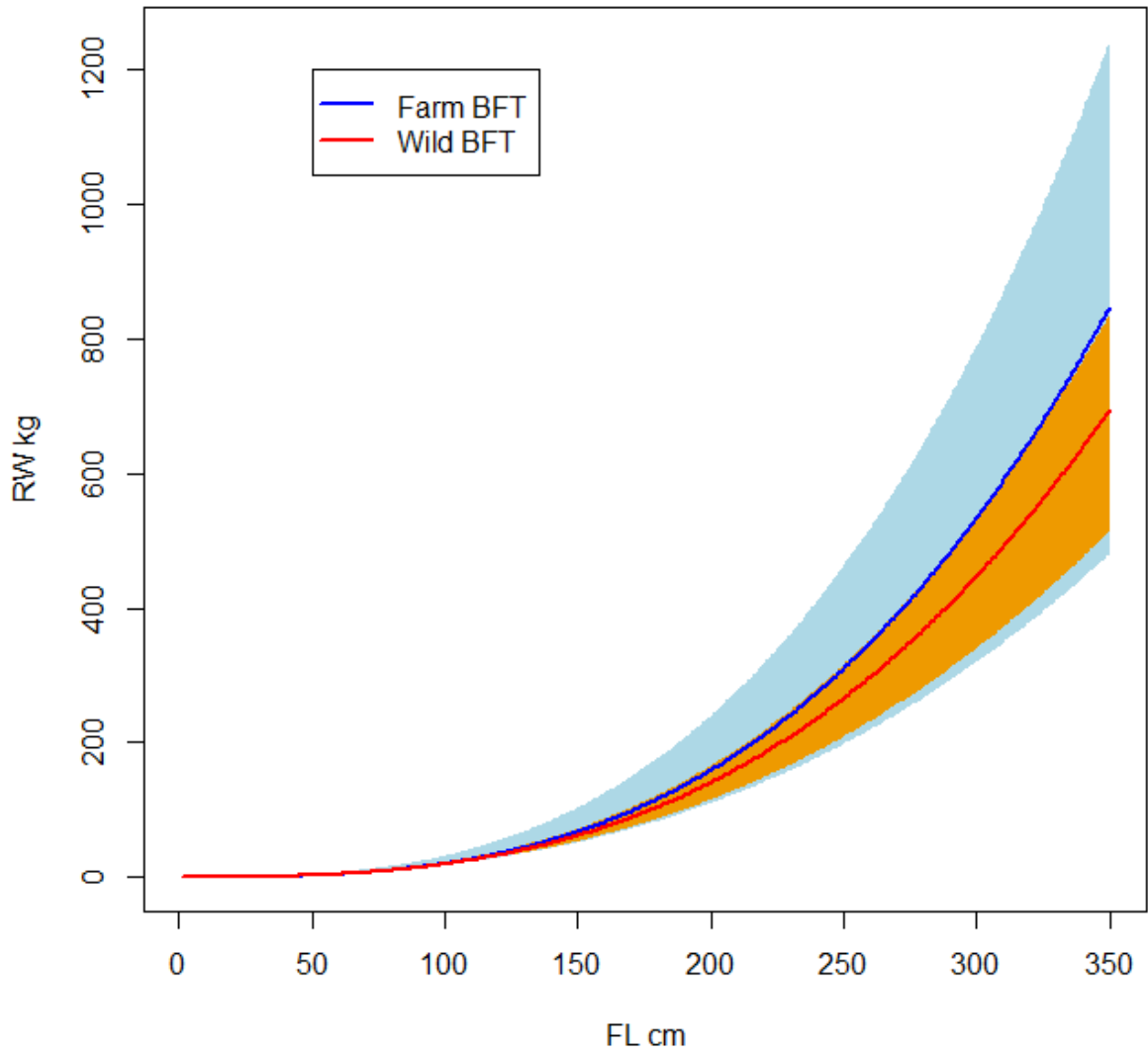


Figure 1. Comparison of the 95% quantile regression estimates for bluefin tuna weight at size from farm harvest fish (blue shade, and solid blue line) and wild fish (orange shade and red line). Figure from Ortiz et al. (2014).