GROWTH RATE OBSERVED IN BLUEFIN TUNA FARMED IN EASTERN ATLANTIC AND THE MEDITERRANEAN

Submitted by Japan

1. Background

Rec. 18-02 and its predecessors mandate the use of stereoscopic cameras to estimate weight of bluefin tuna caught and caged for farming purposes. The estimated weight is counted against national quota and the TAC. Although the introduction of stereoscopic camera is a significant development from previous measures which used conventional camera, the estimate still involves uncertainties compared to direct measurement of fish, due to technical constraints.

Rec. 18-02 requires that stereoscopic cameras shall cover 100 % of caging operation and be used in accordance with the standardized protocol. However, it is not mandatory to involve government authorities in the analysis of the video footage, and a regional observer is not tasked to monitor, validate or verify the analysis. This could be another source of uncertainties.

In contrast to weight at caging, weight at harvesting can be directly measured after killing fish. Therefore, monitoring of growth rates during farming operation and its comparison with known maximum growth rates is informative for the management authority in considering accuracy of the initial weight estimates by stereoscopic cameras. It is worth noting that Rec. 18-02 says "*Farm CPCs shall endeavor to ensure that the growth rates derived from the eBCDs are coherent with the growth rates published by the SCRS*".

2. SCRS Growth table established in 2009

In 2009, the SCRS established a table ("SCRS growth table", hereinafter) which offers expected maximum weight gain over a period of a year for farmed bluefin tuna. In reporting the SCRS growth table to the Commission, the SCRS noted that:

> *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 (SCRS Report for biennial period, 2008-09 PART II (2009) - Vol. 2)*

In other words, the SCRS made it clear that the maximum gain provided by the SCRS growth table was an overestimate.

ICCAT Rec. 18-02 requested the SCRS to update the growth table, based on the result of trials to be implemented based on a standardized protocol for the monitoring of recognizable individual fish. Japan appreciates ongoing efforts by the SCRS and relevant farming CPCs, but the result of studies will become available after 2021 through 2023 at earliest. This means that the 2009 table is the only and best available information on the maximum weight gain of Atlantic bluefin tuna up to date. Although some farming CPCs emphasized an improvement of growth techniques since 2009, Japan has not received any objective evidence justifying significant improvement of growth compared to the "overestimated" "maximum weight gain" published by the 2009 growth table.

3. Japan's effort on growth rate

(1) Dialogue with farm CPCs started in 2018

In 2018, illegal harvest and trade of Atlantic bluefin tuna was reported in European farming states. As a responsible market state, Japan initiated a dialogue with relevant states to ensure that such illegal fish would not be imported to Japan.

In addition, also in 2018, Japan strengthened its examination of imported Atlantic bluefin by analyzing growth rates observed during the farming period, based on the information from eBCDs that Japan received. The growth rates on a farm by farm basis showed that several farms demonstrated high growth rates in excess of the SCRS growth table, sometimes much higher figures, even taking into account possible improvement of growth. Accordingly, Japan initiated dialogues with farm CPCs and requested for additional explanation justifying the high growth rates observed, before authorizing the import of some consignment of farmed Atlantic bluefin. Japan sincerely appreciates those farm CPCs which engaged in this dialogue productively.

The explanation provided by farm CPCs included the following:

- Japan has no access to eBCDs of fish destined for non-Japanese markets, so is not able to evaluate the whole picture of the growth
- Larger fish were selected for the Japanese market, while smaller fish went to non-Japanese markets
- The farm used special feed with high fat contents
- The growth should start from the time of catch, not the time of caging, because farmed fish shows compensatory growth (gaining weight after caging which compensates for lost growth during the towing and standby period)
- The farm CPC has its own calculation methods and control measures on the growth rates, which are different from Japan's one
- The SCRS growth table is outdated and needs to be updated
- The farm CPC fully implements ICCAT Recommendation, so there is no need to pay attention to growth rates

(2) Additional effort made in 2019

In order to overcome constraints Japan faced in 2018 (lack of timely access to comprehensive data etc.), in June 2019, Japan developed an excel spreadsheet named "Growth Calculation Sheet" ("GCS", hereinafter) (**Appendix**) and requested farm CPCs to provide GCS with all the caging and harvesting data on a cage by cage basis, regardless of destination of fish, from the 2019 caging season. When an user puts information on caging (caging date, no. of fish, weight of fish) and on harvesting (harvesting date, no. of fish, weight of fish) into GCS, it automatically calculates the average growth rate and compares it with the expected average growth based on the SCRS growth table (with 10% and 20% margin on the output). The data provision using this sheet allows Japan to analyze growth rates with a whole picture data. Also, it would help farm CPC and business operators to know how Japan evaluates the growth rates in full transparency.

Many of farm CPCs have kindly provided farming data using GCS as well as its updates. Japan is examining growth rates of Atlantic bluefin imported to Japan based on eBCDs it receives, as well as comprehensive data in GCS provided by farm CPCs.

(3) Constraint of Japan's effort as a single market state

However, what Japan can do on the growth rate is still limited, because Japan (and its importers) have no control on farming operation at farming sites. Further efforts taking advantage of growth rates by farm CPCs and at an ICCAT level is essential to rectify the current situation.

One of farm CPCs kindly offered scientific cooperation with Japan, including invitation of Japanese scientists to caging and harvesting operations, which was helpful for Japan to learn enhanced scientific efforts of the CPC. At the request of Japan, the farm CPC provided stereoscopic video footages in the 2019 caging season. Japan worked hard with Japanese importer and established harvest limitation in a private business agreement based on the SCRS table (with 10% margin on the output); however, at the last minute of harvesting, the CPC's authority did not allow implementation of the harvest limitation and encouraged the farmer to sell the fish harvested beyond such limitation to non-Japanese markets. This regrettable example demonstrates that Japan's unilateral effort has limited effects without coordinated efforts of other market states and/or at an ICCAT level.

More recently, Japan received a BFTRC re-exported from a third market country, one of whose accompanying eBCD attached thereto indicated that, in 2018, 1741 bluefin tuna were caged at the average size of 64 kg and harvested at the average size of 320 kg, in 4 months period. There is a rumor that eBCDs with high growth rates went to the third market country, to avoid the growth rate monitoring by Japan.

(4) Length-weight relationship used in stereoscopic camera analysis

ICCAT Rec. 18-02 requires that "The most up to date algorithm(s) established by the SCRS shall be used to convert fork lengths into total weights, according to the size category of the fish measured during the caging operation." (Annex 9, para iii).

In 2016, SCRS recommended the following formula (except for Adriatic Sea):

RWT = 2.8684x10^-5* SFL ^ 2.9076 ("Formula A") (SCRS Report for biennial period, 2016-17 PART I (2016) - Vol. 2) which was based on the samples caught in the Mediterranean (no samples from Atlantic) in May and June, among those collected in the study by Rodriguez-Martin et al., 2015. This formula has been widely used in many CPCs to convert length measured by stereoscopic cameras into estimated weight.

Rodriguez-Marín *et al.* (2015) also reported other formulas, based on the samples taken in wide range of eastern/western Atlantic and the Mediterranean. SCRS scientists usually use these formulas for their scientific work.
RWT = 3.50801x10^-5* SFL ^ 2.878451 (whole year)
RWT = 3.50801x10^-5* SFL ^ 2.88691388 (fish caught in May) ("Formula B")

Japan compared these formulas with length-weight relationship reported by one of coastal CPCs calculated based on the samples taken in coastal Atlantic in May (n=175):
RWT = exp (-9.072)* SFL ^ 2.680 ("Formula C") (SCRS/2014/041)

The result of the comparison between Formula A, B, and C is presented in **Figure 1**. It illustrates a possibility that many of the fish caught and caged in the coastal Atlantic could be underestimated by Formula A in the order of 20, 30, or higher kilograms.

(5) High growth rates observed in 2018 harvest season

The growth rates observed in farmed Atlantic bluefin caged in 2018 and harvested in 2018 through early 2019 are summarized in **Table 1**. Please note that the data source is only eBCDs that Japan received and is not comprehensive. The growth was calculated using GCS. The observed growths were significantly higher than expected by the "overestimated" "maximum growth rate" provided by the SCRS growth table.

(6) Ongoing effort by SCRS in trials to update SCRS growth table

The SCRS reported that, in implemented trials for the update of the growth table in accordance with paragraph 28 of Rec. 18-02, it identified logistical and methodological issues due to the mortality generated and the uncertainty related to different behavior of tagged fish. It suggests that trials may require other methods such as the use of stereoscopic-cameras for collection of data at caging without individual fish identification. However, it should be recalled that the Commission requested the SCRS to update the SCRS growth table because the growth rates derived from stereoscopic cameras were different from the SCRS growth table. The use of stereoscopic camera to update the growth rates is simply going to endorse the current practice which involves uncertainties.

4. Japan's concern

Based on these observations, Japan has a strong concern that the current methodology using stereoscopic cameras is seriously underestimating the weight of fish caught and caged for farming purposes. To be specific, Japan is concerned that:

a) The analysis by stereoscopic cameras is biased. There is a possibility that technicians intentionally or unintentionally select smaller fish in the footage. And the analysis is not currently verified by a third party such as regional observers. Also, there is a possibility that the calibration of stereoscopic camera is not properly implemented.
b) The length-weight relationship currently recommended by the SCRS (SCRS 2016) does not fit (underestimate the weight of) fish caught in some areas including the coastal Atlantic.

5. Japan's proposal to the ICCAT annual meeting in 2019

(1) Proposal 1:

Japan proposes that the SCRS growth table should be updated based on data from trials with individual fish identification by tagging. Japan hopes that such tagging trials will be conducted at as many farms in various locations as possible. At the time of caging, the length and weight of the fish should be directly measured, and an identification tag should be attached. At the time of harvest, the same fish should be directly measured as usual. The caged fish should be measured by stereoscopic cameras as well, and its results should be compared with the direct measurement. It should also be confirmed that "Validation of stereoscopical length measurement" (as required by Rec. 18-02) is properly conducted.

Although mortality by tagging is inevitable to some extent, we should note that these trials are temporary efforts targeting a limited number of fish. Above all, such trials with monitoring of recognizable individual fish is essential for the update of the SCRS growth table with a high confidence. The mortality (and different behavior of fish) is expected to decrease as the technician get used to tagging operation. Tagging fish is a widely used methodology in scientific studies of tuna species in learning its behavior, and technical advice from tagging experts should be able to contribute to this project. However, if all the Panel 2 members believe that such a mortality should be compensated for outside their national quotas, one of possible ways forward is to use the unallocated reserve of 115 t to accommodate such a mortality.

(2) Proposal 2:

Japan proposes that the Commission request the SCRS to establish a length-weight conversion formula specialized for the fish caught and caged in the coast of Atlantic (in May). If the SCRS finds that the currently available data is insufficient to complete this task, it should request additional data from relevant CPCs including those obtained from the trials proposed above.

(3) Proposal 3:

Japan would like to encourage other market states to monitor the growth rates observed in farmed bluefin they import. When high growth rates are observed, the market state should be encouraged to contact the farming/exporting CPCs to share its observation and request an additional explanation.

At the same time, Japan notes that monitoring of growth rates by each CPC is time-consuming and gives a partial picture. In the case of Japan, the staff of the Fisheries Agency are picking up caging and harvesting information from each eBCD and put them into excel files for the analysis of growth, which is very time-consuming. Also, no CPC has access to eBCDs accompanying bluefin tuna destined for other markets than its own.

To overcome these difficulties, Japan would like to propose that the Secretariat analyze the growth rates observed in farmed bluefin tuna, on a farm by farm basis, using the GCS Japan has developed, and report the result of analysis to the SCRS and the Commission. The current eBCD system has a function to download caging/harvesting data in combination, and the Secretariat should have access to raw data which are useful to assess the growth comprehensively. If necessary, Japan is willing to give a technical assistance to the Secretariat in using the GCS. Also if necessary, ICCAT should consider to employ a consultant to work on the analysis and the report.

(4) Proposal 4:

A Japanese company has developed an AI system to analyze stereoscopic camera footage. This AI system can estimate the straight fork length of all the fish suitable for analysis with a high precision and accuracy. Japan would like to propose that the AI system should be used in the trials to compare the result with direct measurement and human's analysis of footage. The company is selling its own stereoscopic camera kit which is useable with the AI system, but video footage from AQ-1 system is also analyzable by the AI system as far as the stereoscopic camera is sent to the Japanese company for calibration.

Figure 1. Comparison between different length-weight relationship

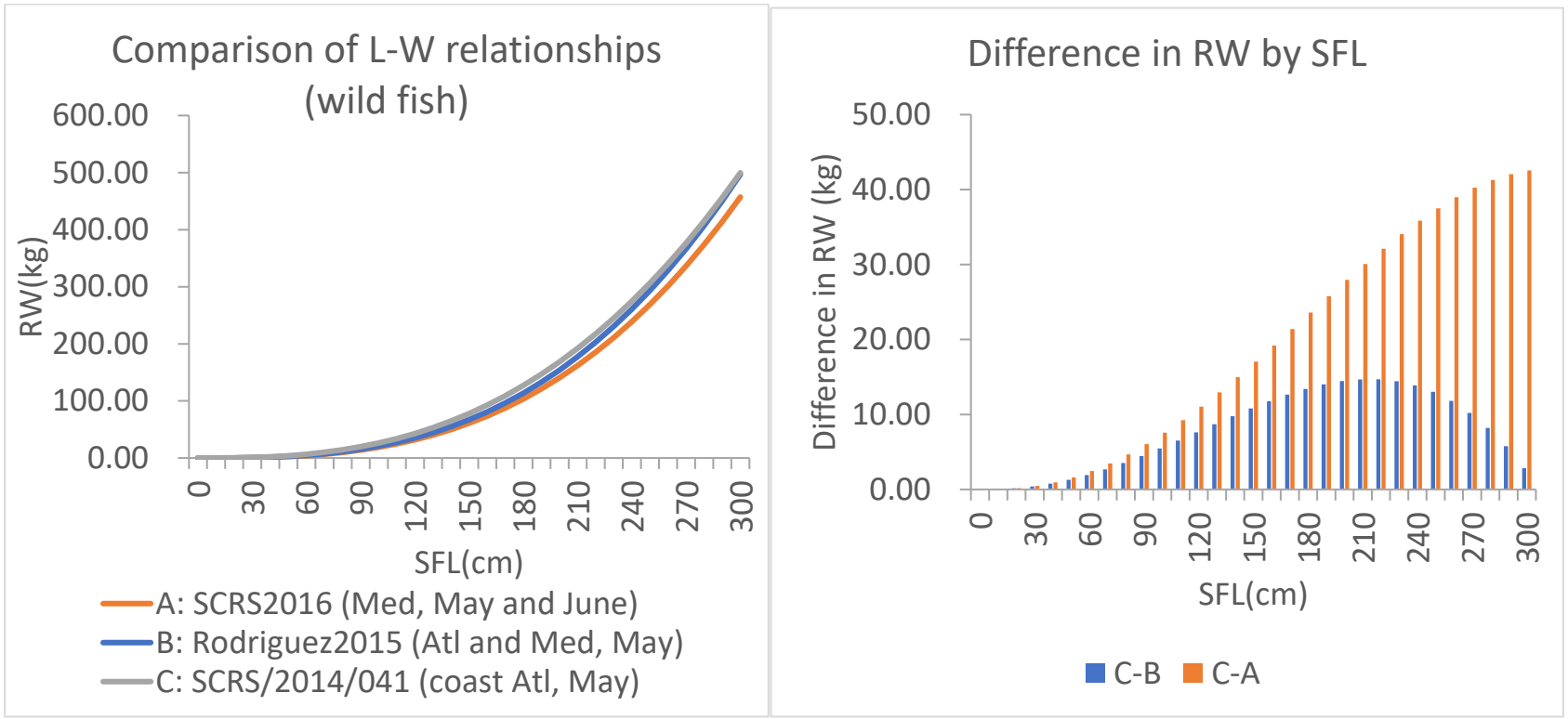

Table 1. Growth rate observed in farmed fish caged in 2018 and harvested in 2018 through early 2019

Name of the Farm	average weight at caging (kg)	average weight at harvest (kg)	% Harvested	average farming duration (day)	Growth								
					Expected average weight after **SCRS growth *1.0**	Excess kg	Excess %	**SCRS growth *1.1**	Excess kg	Excess %	**SCRS growth *1.2**	Excess kg	Excess %
Farm A	113	192	79.2%	109	154.59	37.42	24.2%	170.05	21.96	12.9%	185.51	**6.501**	**3.5%**
Farm B	70	163	65.1%	128	104.28	58.65	56.2%	114.71	48.22	42.0%	125.14	**37.79**	**30.2%**
Farm C	116	224	68.9%	108	157.95	65.81	41.7%	173.75	50.01	28.8%	189.54	**34.22**	**18.1%**
Farm D	135	231	88.4%	136	194.05	36.97	19.1%	213.46	17.56	8.2%	232.86	OK	OK
Farm E	114	208	82.0%	126	162.89	45.42	27.9%	179.18	29.13	16.3%	195.47	**12.84**	**6.6%**
Farm F	137	334	41.0%	177	208.39	125.8	60.3%	229.23	104.9	45.8%	250.07	**84.07**	**33.6%**
Farm G	140	255	67.3%	147	204.83	50.26	24.5%	225.31	29.78	13.2%	245.80	**9.292**	**3.8%**
Farm H	141	245	96.7%	118	194.89	50.35	25.8%	214.38	30.86	14.4%	233.87	**11.37**	**4.9%**
Farm I	51	88	72.5%	191	86.72	1.77	2.0%	95.39	OK	OK	104.06	OK	OK
Farm J	45	83	67.5%	191	77.71	5.693	7.3%	85.48	Ok	OK	93.25	OK	OK
Farm K	38	63	80.6%	161	63.93	OK	OK	70.32	OK	OK	76.72	OK	OK
Farm L	33	58	57.8%	208	60.61	OK	OK	66.67	OK	OK	72.73	OK	OK
Farm M	178	313	89.7%	111	238.61	74.78	31.3%	262.47	50.92	19.4%	286.33	**27.06**	**9.4%**
Farm N	136	187	50.3%	90	174.53	12.1	6.9%	191.98	OK	OK	209.44	OK	OK
Farm O	119	156	99.4%	120	167.11	OK	OK	183.82	OK	OK	200.53	OK	OK
Farm P	153	235	99.6%	117	210.09	25.4	12.1%	231.10	4.391	1.9%	252.11	OK	OK