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ESTIMATION OF CAPTURE-AT-SIZE DATA OF LIVE BLUEFIN TUNA USING UNDERWATER STEREOSCOPIC CAMERA SYSTEM

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SUMMARY

Bluefin tuna farming, as a capture-based aquaculture activity, where fish captured mainly by purse seines are transferred into rearing cages for growing purposes, created a problem in collection of accurate catch-at-size data, having negative effect on quality of ICCAT Task 2 statistics. Use of stereoscopic camera system has been proposed as a possible solution to overcome this problem (ICCAT Rec. 12-03), as a tool that can improve quality and accuracy of Task 1 catch data and Task 2 size data, and therefore contribute to collection of catch-at-size data needed for bluefin tuna stock assessment. Some of first experiences of using stereoscopic camera system at Croatian bluefin tuna farms are described in this paper.

RÉSUMÉ

L'élevage du thon rouge, en tant qu'activité d'aquaculture fondée sur les captures, dans le cadre duquel les poissons capturés principalement à la senne sont transférés dans des cages à des fins d'engraissement, pose problème dans la collecte de données précises de la prise par taille, ce qui a un effet négatif sur la qualité des statistiques de tâche II de l'ICCAT. On a proposé d'utiliser le système de caméra stéréoscopique afin de surmonter ce problème (Rec. 12-03). Ce système servirait d'outil permettant d'améliorer la qualité et la précision des données de capture de la tâche I et des données de taille de la tâche II , et de contribuer ainsi à la collecte de données de prise par taille nécessaires pour l'évaluation du stock de thon rouge. Quelques-unes des premières expériences de l'utilisation du système de caméra stéréoscopique dans des fermes croates de thon rouge sont décrites dans le présent document.

RESUMEN

La cría de atún rojo, como actividad de acuicultura basada en la captura, donde peces capturados sobre todo por buques cerqueros se transfieren a jaulas con fines de cría, planteó un problema en cuanto a la recopilación de datos precisos de captura por talla, teniendo efecto negativo en la calidad de las estadísticas de la Tarea II de ICCAT. Se ha propuesto la utilización de sistemas de cámaras estereoscópicas como una posible solución para superar este problema (Rec. 12-03), ya que constituiría una herramienta que puede mejorar la calidad y precisión de los datos de captura de Tarea I y de los datos de talla de Tarea II y, por tanto, contribuiría a la recopilación de datos de captura por talla requeridos para la evaluación de stock de atún rojo. En este documento se describen algunas de las primeras experiencias del uso del sistema de cámaras estereoscópicas en las granjas de atún rojo croatas.

KEYWORDS

Tuna fisheries, Aquaculture systems, Imaging techniques, Size composition, Catch statistics, Accuracy

1. Introduction

Nowadays, tuna farming is important capture-based activity in aquaculture. It currently involves the capture of wild fish by purse seine, ranging from small to very big specimens, and their rearing in growth-out floating cages for periods spanning from a few months up to a few years. Therefore, this aquaculture activity interacts directly with bluefin tuna (BFT) fishery (Katavić and Tičina 2005), and relaying on sustainability of exploitation of wild BFT stocks. Fishing gears used for the purpose of supplying live BFT for stocking into growth-out floating cage anchored at BFT farms, are mostly purse seines (Miyake *et al*., 2003).

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After being caught by purse seine in the off shore waters, tunas are transferred into a floating towing cage. The purpose of towing cage is to collect live BFT from the purse-seine catches, and to transport live fish to the rearing cages anchored at BFT farms for stocking purpose. Given the fact that BFT caught by purse seines remains live and fish are not landed, the problem of collection of accurate catch-at-size data arise (Task 2).

Having live BFT captured in the net, many doubts are still present (i.e. How many tunas are there? What is the fish size? How many small or big fish has been taken from the wild population?) Only data we have at time of capture are rough estimate of fish numbers and size made by fishing vessels captains, divers and regional observer, as reported in Bluefin Catch Documents (BCD) and/or by measuring some morts.

So, the principal problem is how to obtain accurate catch-at-size data of live, not landed fish? Use of stereoscopic camera, as foreseen in ICCAT Rec 12-03, is likely to help us to resolve this problem, reduce uncertainties related to catch-at-size information, and eventually improve accuracy of data in BCD.

2. Methods

After being filled up with captured BFT at fishing area, towing cage transports fish to the farming site. Towing cage is attached to stationary cage, and divers join two cages by opening underwater “net-doors” and thus creating unobstructed passage to enable fish to swim from transport cage into rearing cage. Making fish records by stereoscopic camera (**Figure 1**) in that occasion, while swimming from one cage into another, enable eventual replay and analyses of the video record.

By analyzing video record (frame by frame) operator can count individual specimens on the screen, and estimate total number of fish captured in previous purse-seine fishing operations. In addition, stereoscopic camera software (AQ1) enable to measure in length a number of BFT individuals on the record. Measuring a determined portion of randomly selected fish caught (i.e. 20%), in the moment of their passage/swimming through net opening from the towing cage into stationary rearing cage, initial capture-at-size information are obtained (Task 2 data). However, before length measurements are made, accuracy of stereoscopic camera system need to be checked against an object of known length. Entering parameters of appropriate length-weight relationship, individual weights of fish measured are automatically calculated.

3. Results and discussion

It should be stressed that it is very important to obtain good quality video images. Important factors that needs to be taken into account are good lightening conditions, appropriate distance from camera to the fish (3-5 m), lateral orientation of the fish body and fish slow swimming (without panic and/or schooling). In addition, use of net opening limited by rigid frame (i.e. 4x4.5 m) with white panel in background for better contrast, may improve quality and accuracy of estimates made by stereoscopic camera. Examples of low quality image and good quality image made by stereoscopic camera are shown in **Figures 2** and **3**.

Output report from stereoscopic camera system (Technical stereoscopic camera report) contains information about species recorded, recording date and time, site, L-W relationship used, record filename and recording folder, as well as some comments. Statistical size information are reported also, in terms of mean size, minimum and maximum size, standard deviation and coefficient of variation. Frequency size distributions and weight distributions are included in output report as bar graphs.

In addition to this information, caging report is generated for each stocking event, with aim to ensure traceability of fish origin. Data on number of caging operation, name of the farm, numbers of related BCD and transshipment declaration, name and flag of the catching vessel, name and the flag of the towing vessel, date of stereoscopic camera operation and footage file name are reported in this document. Statistical size information (i.e. mean weight) from the Technical report, together with fish count estimates, are eventually used to assess total weight of BFT captured and to refine/update BCDs (Task 1 data).

Furthermore, raw output data files (.csv) are available also, and can be used as a source of Task 2 size information, since they contain direct video measurements of individual fish. In addition, based on fish length measurements and selected length-weight relationship, stereoscopic camera system calculates individual fish weight estimates (**Table 1**).

According to first experimental results (Grubišić *et al*., 2013), it seems that accuracy of length measurements made on BFT by stereoscopic camera is quite good. Comparison between estimates of direct FL measurement on dead fish vs. underwater measurements made by stereoscopic camera on a group of small BFT captured for farming purposes is shown in **Figure 4**.

Using individual fish size information from stereoscopic camera as input data, and appropriate age-length key, lengths are converted in corresponding BFT age groups. Also, if back-calculations are performed, these data are very useful for validation and/or improvement of existent Task 2 size statistics (Ortiz, 2015 (*in press*) contributing in overall catch-at-age (CAA) data matrix used for BFT stock assessment purposes.

Stereoscopic camera system is unlikely to be capable of counting and measuring length of all fish captured, but only a part of them. Also, it is possible that technical difficulties occur during cage stocking operation (i.e. camera freezing) and therefore interrupt data collection process.

4. Conclusions

It seems that stereoscopic camera system, if used by the skilled operator and under the appropriate working conditions, can be considered as a useful tool to collect accurate length measurements of live tunas captured for farming purposes, aiming to collect Task 2 size data needed for stock assessment purpose.

Based on fish length measurements and selected algorithm based on length-weight relationship, stereoscopic camera system calculate individual fish weight estimates. These estimates of catch size composition are of greater accuracy than rough estimations made on fishing vessel by regional observers and divers (1st estimates in BCD), and could be used also to refine/update data in BCDs and eventually improve accuracy of Task 1 statistics also. It should be highlighted that stereoscopic camera system is not designed to count fish automatically. Fish counting can be done „manually", on the screen (frame by frame) only, and good quality images are of utmost importance for obtaining accurate estimate of total fish number.

It should be taken into consideration that this system of data collection by stereoscopic camera it is still not absolutely certain, since technical difficulties sometimes may occur (camera freezing).

References

Grubišić, L., Katavić I., Šegvić-Bubić T., Mišlov K. and Tičina V. 2013. Preliminary experiences in applying the stereoscopic system in bluefin tuna size estimates. Col. Vol. Sci. Pap. ICCAT, 69(2): 704-709.

Katavić, I. and Tičina, V. 2005. Fishing and farming of the northern bluefin tuna (*Thunnus thynnus* L.) in the Adriatic Sea. *In* Cataudella, S., Massa, F. and Crosetti, D. (Eds.) Interactions between aquaculture and capture fisheries: A methodological perspective. GFCM, Studies and Reviews No.78, FAO, Rome: 181-188.

Miyake, P.M., De la Serna, J.M., Di Natale, A., Farrugia, A., Katavić, I., Miyabe N. and Tičina V. 2003. General review of bluefin tuna farming in the Mediterranean Area. Col. Vol. Sci. Pap. ICCAT, 55(1): 114-124.

Ortiz, M. *In press*. SCRS/2015/050. Update review of bluefin tuna (*Thunnus thynnus*) size and weight measures taken with stereo video cameras at caging operations in the Mediterranean sea 2014: 10 p.

Table 1. Example of data structure of detailed output results from stereoscopic camera (column with measured Task 2 size data is indicated in the bold).

Sizing Measurements									
ID	Label	Weight (kg)	**FL (m)**	FL error (%)	Nose error (mm)	Caudal fork error (mm)	Range (m)	Frame	Filename
1		8,380	**0,761**	1,420	4,678	0,632	3,629	64017	20140617.avi
2		8,915	**0,777**	0,920	0,385	0,969	4,018	63792	20140617.avi
3		14,966	**0,929**	0,668	2,411	0,866	3,730	63792	20140617.avi
4		8,395	**0,761**	0,742	1,693	1,639	3,104	63797	20140617.avi
5		9,023	**0,780**	0,615	4,217	1,205	2,708	63801	20140617.avi
6		17,619	**0,983**	0,565	1,553	4,366	2,886	63804	20140617.avi
7		8,761	**0,772**	0,585	0,020	1,917	2,949	15995	20140617.avi
8		17,243	**0,976**	1,128	4,745	4,887	3,178	22906	20140617.avi
9		8,903	**0,777**	0,570	1,611	3,592	2,816	22910	20140617.avi
10		10,186	**0,814**	1,383	0,487	1,009	3,669	22922	20140617.avi
11		8,109	**0,752**	1,465	4,411	2,127	4,072	22979	20140617.avi
12		8,033	**0,750**	0,945	0,698	2,056	3,153	22985	20140617.avi
…		…	…	…	…	…	…	…	…

Figure 1. Stereoscopic camera system, AQ 100.

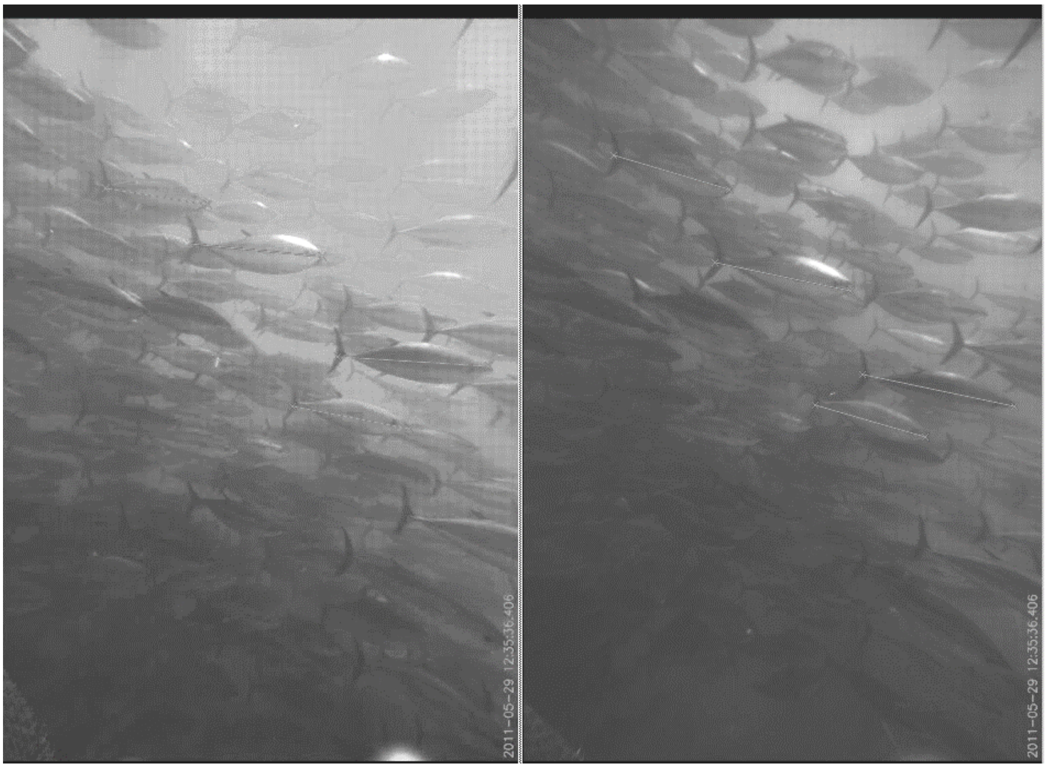

Figure 2. Example of low quality image: Aggregated small fish, passing through large net opening, many of them at inappropriate distance or body orientation; few fish only can be measured; inaccurate estimation of number of fish counted.

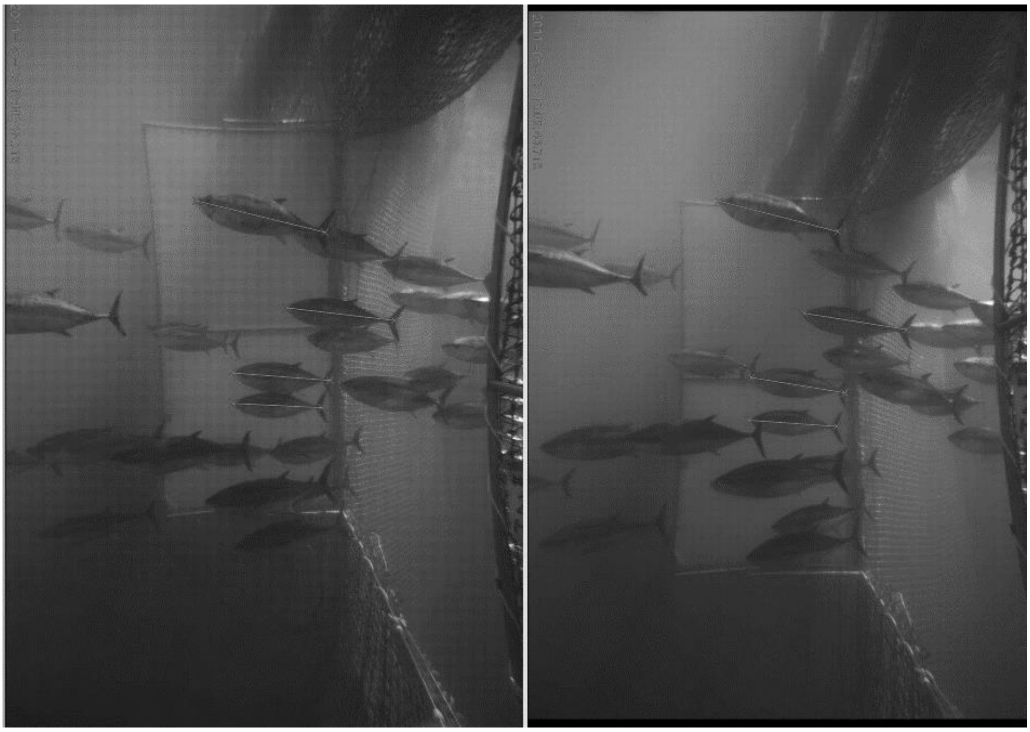

Figure 3. Example of good quality image: Disaggregated fish passing slowly at appropriate distance through net opening limited by rigid frame (4x4.5 m) with white panel in background for better contrast; many fish can be measured; accurate estimation of number of fish counted.

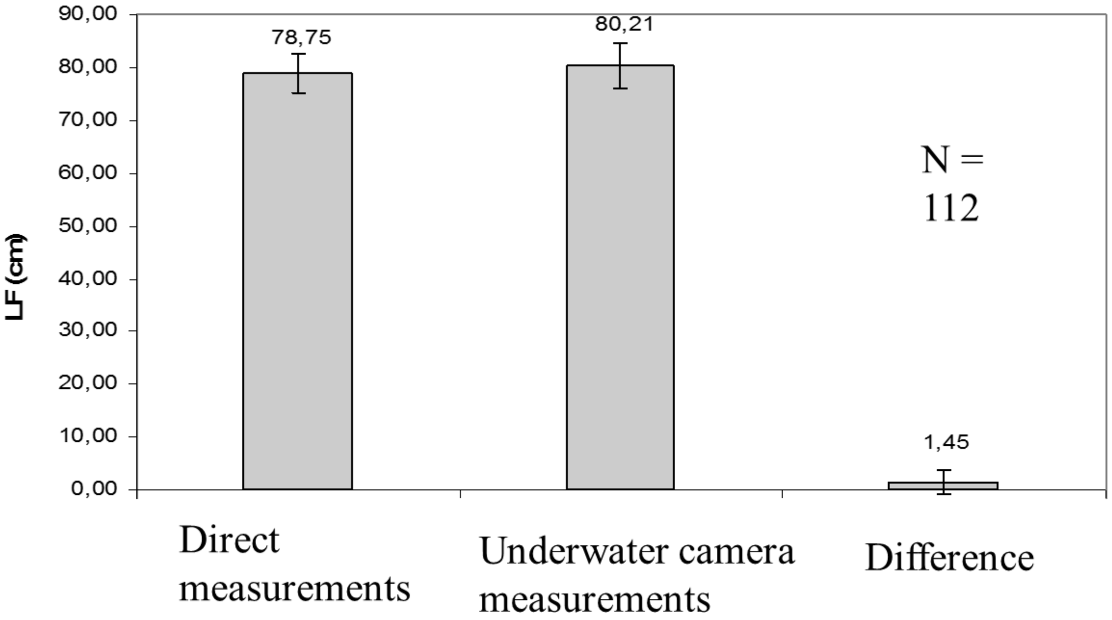

Figure 4. Comparison between estimates of average lengths (± SD) of direct measurement on dead fish vs. random underwater measurements by stereoscopic camera made on a group of small BFT captured for farming purposes (according to: Grubišić *et al*., 2013).