BLUEFIN TUNA (*Thunnus thynnus*) BIOMASS ESTIMATION DURING TRANSFERS USING ACOUSTIC AND OPTIC TECHNIQUES

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Introduction

In modern tuna ranching, adult Atlantic Bluefin Tuna (ABT) are captured in breeding areas from May to July by purse-seining fleet, fattened for four to six months in farms and finally marketed. ABT populations were considered severely overfished and tuna ranching was criticized, arguing that it can produce pressure on the stock and increase their depletion rate. To reverse the trend and control catches for tuna ranching, International Commission for the Conservation of Atlantic Tunas (ICCAT) implemented a recovery plan to mainly enforce: fishing quotas, closed fishing season and minimum catching size of 30 kg (De la Gándara et al., 2016; Fromentin & Powers, 2005).

To control fishing quotas, authorities perform a biomass assessment during fish transfers: counting tuna (with an error lower than 10%) and sizing at least 20% of transferred tunas (ICCAT, 2014). The use of a stereoscopic system to estimate biomass during transfers is established by ICCAT in 2015. Human operators must manually mark fish snout and fork in both stereo images to estimate fish length. This process is slow and laborious, and introduces the variability of manual measuring in the biomass estimation. Stereo-vision is a very appropriate non-intrusive method but it has to overcome limited visibility caused by: water conditions, cameras field of view, crowded situation, etc.

This communication presents a new method to automatically estimate tuna biomass (counting and sizing tuna) during transfers using acoustic and optic systems. Also, a floating structure to place the sensors and meet ICCAT gate size recommendations is proposed.

Materials and Methods

Data set of transfers was acquired with synchronized stereo-video cameras and a side scan sonar working at 200 kHz. A new floating structure was designed and placed between transfer cages, with cameras and scan looking towards the surface to obtain a ventral silhouette of the fish (figure 1). Tuna swam from 6 to 16 meters to the recording equipment.

We use acoustic data to count transferred tunas, while the stereo-video is processed to produce tuna sizes. Echogram is analyzed with Matlab® software. First, using image processing techniques, regions representing tuna candidates are detected, characterized and filtered according to minimum region area and minimum energy criteria. Then, maximum energy values and region properties are analyzed to disambiguate cases when one fish or a group of fish have similar energy values. Finally, an acoustic energy threshold is applied. As a result of this process, the number of transferred tuna is obtained.

An image processing procedure is performed on each stereo-video frame to extract individual fish, followed by a fitting procedure to adjust the fish model to the extracted targets, adapting it to the bending movements of the fish. The proposed system is able to give accurate measurements of tuna Snout Fork Length (SFL) without manual intervention (Atienza-Vanacloig et al., 2016)

Results

Nine transfers (four two-way and one one-way transfers) were recorded in Grup Balfegó facilities (Tarragona NE, Spain) for this study. Figure 2 shows the automatic counting error achieved, being in all cases lower than 10 %. Structure design (T1 transfers), sea conditions (T2 transfers) and divers position (T3 transfers) during transfers affected measurements by decreasing the automation possibilities. These problems were solved for the last transfers (T4 and T5), obtaining the best results, as it can be seen in figure 2.

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Fig. 1. Design of floating structure, real structure (height 16m, width 12m, 8m in central part), structure between transfer cages and platform with scans and cameras.

Transfers	*Transferred tuna*	*Acoustic counting*	*Error (%)*
T1.1	608	574	5.6
T1.2	608	549	9.7
T2.1	577	551	4.5
T2.2	577	542	6.1
T3.1	577	554	4.0
T3.2	577	535	7.3
T4.1	577	575	1.0
T4.2	577	570	1.2
T5	503	493	2.0

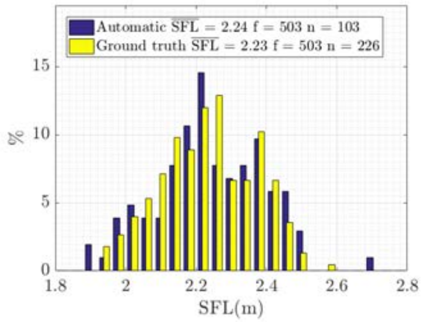

Fig. 2. Left: Table of acoustic counting results. Right: Normalized SFL frequency histogram. Ground truth in dark-blue and automatic measurements in light-yellow. $\overline{SFL}$, mean SFL; f, number of fish; n, number of samples.

About biomass estimation, fully automatic SFL measurements were obtained in T5 transfer processing the stereo-video, and compared with true data measurements from harvests (figure 2). Differences in mean and frequency distributions are analyzed with statistical tests, obtaining no significant difference between ground truth and automatic measurements.

Discussion and Conclusions

Our results show that the use of an acoustic transducer in transfers offers the possibility of performing an automatic counting with error below 10%, which is decreased to 1.2% after improving structure and algorithms. Moreover, the proposed procedure for automatic sizing using stereoscopic system achieved an accurate estimation of SFL distribution compared to true data from harvests, automatically measuring 20% of the fish.

References

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