SHORT-TERM CONTRACT FOR THE PILOT PROJECT TO TEST THE USE OF STEREOSCOPIC CAMERAS DURING THE FIRST TRANSFER AND THE AUTOMATION OF VIDEO FOOTAGE ANALYSIS

Technical Report for Objective 2: test during first transfers of Bluefin Tuna the use of available software and artificial intelligence to automatically determine the number of individuals and their weight

P. Muñoz-Benavent, J. Martínez-Peiró, G. Andreu-García, S. Morell-Monzó, V. Puig-Pons, and V. Espinosa. Universitat Politècnica de València (UPV)

This study assessed the feasibility and accuracy of estimating the number and weight of bluefin tuna during first transfers, and the potential for automation through computer vision and artificial intelligence, across different fishing scenarios: purse seiners in the Mediterranean and Adriatic Seas, and trap fisheries. Fish were monitored using monocameras for counting and stereocameras for length estimation, consistent with ICCAT Recommendations 22-08 and 24-05. Manual snout–fork length measurements were used as a reference, and results were validated against harvesting data where available. Automatic fish counts ranged from 74% to 135% of manual counts, with lower performance in the Adriatic due to dense schooling. In contrast, automatic length estimation proved more robust, covering 59–87% of individuals in Mediterranean transfers and 48–68% in trap transfers. Length–frequency distributions derived from automatic measurements closely matched both manual and harvesting data. Across scenarios, analysis time was reduced by up to 90%. The results demonstrate that automatic estimation of bluefin tuna number and weight during first transfers is technically feasible in the Mediterranean and trap fisheries, while further testing and algorithm development are required for Adriatic conditions. Improvements to tracking and counting algorithms remain essential to ensure reliable sample sizes and consistent performance across fishing scenarios.

1. Description of the work carried out during the analysis of the footage

The pilot project has two independent objectives: a) to test the use of stereoscopic cameras during the first transfers from purse seine vessels or traps to towing cages in order to be able to estimate at this stage the weight of the captured bluefin tuna (BFT). b) to test the use of available software and artificial intelligence to automatically determine the number of individuals and their weight. This report focuses on the second objective.

The work included testing the system in at least three transfers in the following scenarios:

- First transfer from a purse seiner to a transport cage in the Mediterranean.
- First transfer from a trap to a transport cage.
- First transfer from a purse seiner to a transport cage in the Adriatic.

The first transfer from a purse seiner scenario, both in the Adriatic and Mediterranean, was addressed during the 2024 season, whereas the first transfer from a trap scenario was addressed in the 2025 season. The specific work carried out in each scenario is reported separately under Objective 1 of the Pilot Project. The available recordings include stereocamera and conventional camera recordings both in first transfers (from purse seine vessels to towing cages) and second transfers (from towing cages to fattening cages), and both in the Mediterranean and the Adriatic, and are summarized in Table 1 and Table 2.

The tasks performed with all available recordings are summarized as follows:

- Manual counting in videos from conventional cameras.
- Manual counting in stereoscopic video.
- Manual marking of snout and tail on stereoscopic video to obtain fish length.
- Automatic counting and length estimations with AI tools

Moreover, the following comparisons are presented:

- Automatic versus manual counting
- Automatic versus manual length estimation.
- Comparison with the results obtained by the control authorities through manual means.
- Comparison with the results obtained at harvesting.

First transfer ID	M1	M2	M3	M4	A
Date and time	20240604 17:23 – 18:34	20240605 10:46 – 11:52	20240611 10:07 – 10:57	20240613 07:05 – 08:16	20240713 08:59-9:30
Video duration (min)	71	66	50	71	31
Video duration transferring (min)	7	12	10	14	1
Number of cameras	2 lateral SC 1 ventral SC 1 MC	2 lateral SC 1 ventral SC 1 MC	2 lateral SC 1 MC	2 lateral SC 1 MC	2 lateral SC and 1 MC
Video links	Link	Link	Link	Link	Link

Second transfers ID	ESP010R (with another transfer)	ESP014R	ESP008R	EUHRV013 (with other 4 transfers)
Date and time	09/07/2024 10:22-11:34	23/07/2024 07:41-10:05	10/07/2024 12:30-14:32	17/07/2024 11:12-12:13
Video duration (min)	72	144	122	61
Video duration transferring (min)	24	32	12	36
Number of cameras	1 lateral SC 1 MC	1 lateral SC 1 MC	1 lateral SC 1 MC	1 lateral SC 1 MC
Video links	Link	Link	Link	Link

Table 1. First and second transfers in the Mediterranean and the Adriatic. SC: stereocamera; MC: monocamera.

First transfers ID	TR1	TR2	TR3
Date and time	20250707 08:55 – 09:12	20250708 09.55 – 10:20	20250710 07:59 – 8:15
Video duration (min)	17	25	16
Number of cameras	2 lateral SC and 1 MC		
Video links	Link		

Table 2. Transfers from trap to transport cages. SC: stereocamera; MC: monocamera.

2. Materials and methods

2.1. Stereocamera calibration

The principles of stereoscopic vision rely on projective geometry and matrix algebra. Calibration of stereoscopic cameras involves determining the intrinsic parameters (such as focal length, principal point, and lens distortion for each camera) and extrinsic parameters (the geometric relationship between the two cameras). This process is essential for correcting image distortions and establishing the correspondence between 2D image pixels and real-world 3D dimensions. Calibration typically entails capturing images of a checkerboard pattern from various angles, which are subsequently processed to estimate the parameters through mathematical optimisation. Accurate 3D measurements depend critically on precise camera calibration. Figure 1 shows a setup using the checkerboard method, which determines the rotation (R) and translation (T) between cameras, crucial for deriving length measurements from images.

In our projects, software such as MATLAB and the OpenCV library is used to perform the required geometric transformations and matrix computations. Figure 2 illustrates a part of the calibration process using MATLAB's Stereo Calibration Tool. This approach ensures compatibility across all stereocamera models and has been successfully demonstrated with the AM100 stereocamera from AQ1 Systems in our research articles.

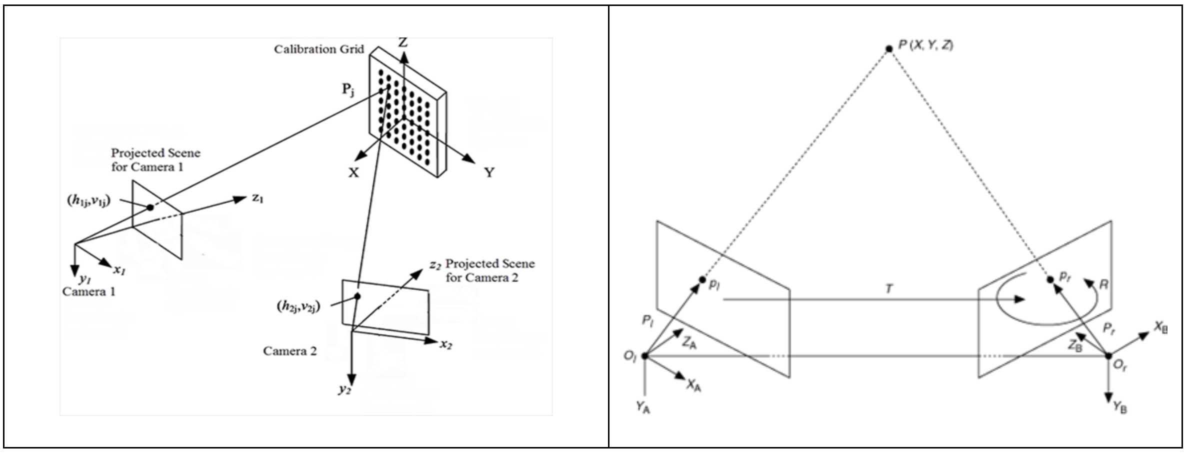

Figure 1. Description of a stereocamera calibration setup to find the rotation R and translation T between the two cameras.

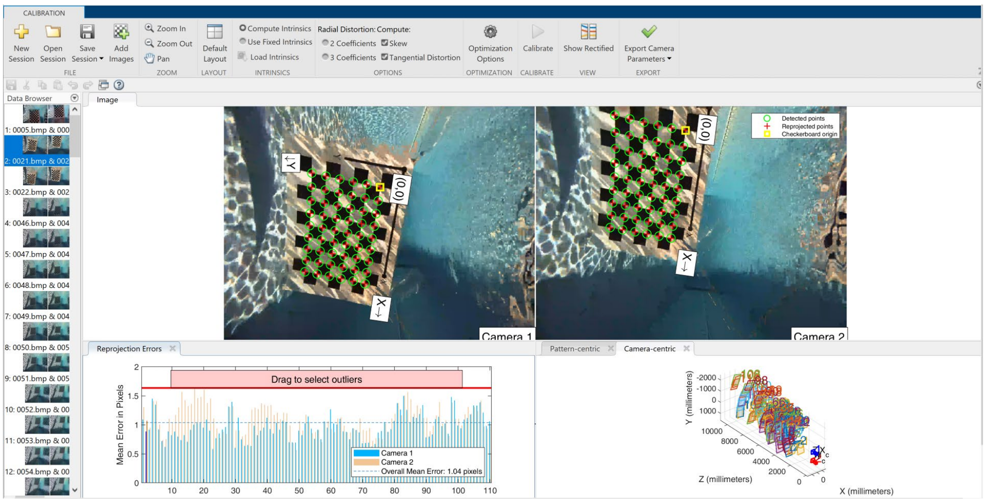

Figure 2. Snapshot of the stereocamera calibration conducted using MATLAB's Stereo Calibration Tool.

2.2. Fish sizing and counting software

Custom software was developed for manual sizing and counting of the fish, featuring a user-friendly interface. Users can navigate through video recordings, zoom in on specific regions, and mark the snout and fork tail points of selected fish in both the left and right video frames. This allows the extraction of Straight Fork Length (SFL), and the software can also infer fish weight based on established length-weight relationships. Figure 3 and Figure 4 showcase the software's interface and a length-frequency histogram from a first transfer in the Mediterranean. In addition to manual processing, the software is equipped for automatic processing of the recordings.

For automatic fish sizing, we use Deep Learning (DL) and Convolutional Neural Networks (CNN) to extract fish features from the video frames, ensuring robust detection despite variations in image attributes. DL techniques have revolutionized various fields, surpassing the state of the art in areas such as speech recognition, face recognition, character recognition, and particularly in image analysis. Nonetheless, the efficacy of such systems hinges on extensive datasets (images in our case) and prolonged neural network training periods to achieve optimal performance. Additionally, a tracking algorithm has been developed that uses temporal and spatial information to provide reliable and more accurate size measurements by repeating several measurements of the same fish. Since each fish is measured multiple times, the software computes the fish length as the median of all lengths. Our software has been retrained thanks to the recordings provided within the scope of this project by the fishing authorities from Malta and Croatia.

By using the median, the influence of extreme outliers is discarded, making it a useful measure for datasets with potential high-deviated measurements. The software is designed to be intuitive and requires no knowledge of the underlying algorithms. It has already been applied in situ on first transfers in multiple seasons by Balfegó Tuna and in Southern BFT transfers in Australia. The algorithm's details and performance are set to be published soon in a research article, while previous versions of these procedures have been documented in various of our studies (Muñoz-Benavent et al. 2018a, 2018b, 2024 and Puig-Pons et al., 2019).

To evaluate whether automatic fish-length estimates were statistically consistent with traditional manual measurements, a two-sample Kolmogorov–Smirnov (KS) test was performed. This non-parametric test compares the cumulative distribution functions of two independent continuous datasets without assuming a specific underlying distribution. The null hypothesis ($H0$) was that manual and automatic length measurements were drawn from the same distribution. The KS test computes the D-statistic, representing the maximum absolute difference between the two cumulative distributions. A statistically significant result ($p < 0.05$) leads to rejection of the null hypothesis, indicating that the two methods yield significantly different length distributions. All statistical analyses were conducted in Python using SciPy, with a significance level of $\alpha = 0.05$.

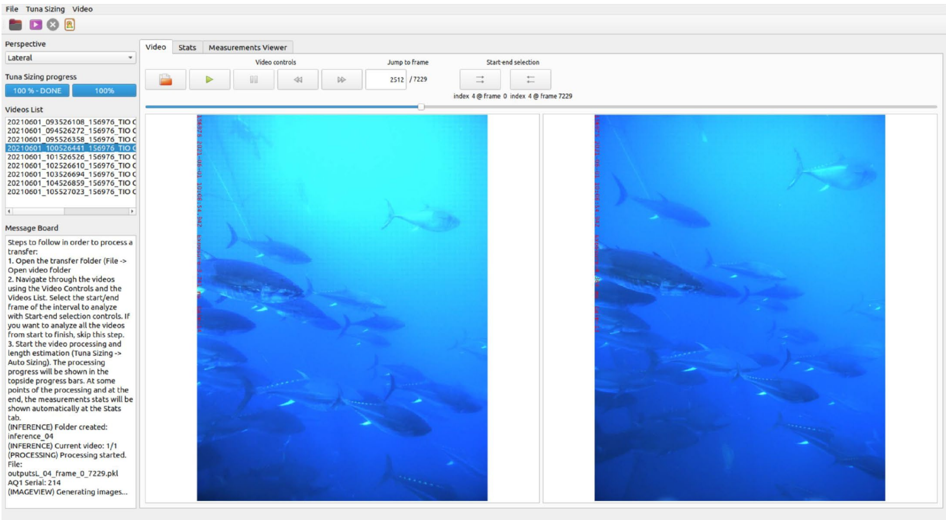

Figure 3. Snapshot of the software's user interface for fish sizing and counting from stereocamera recordings.

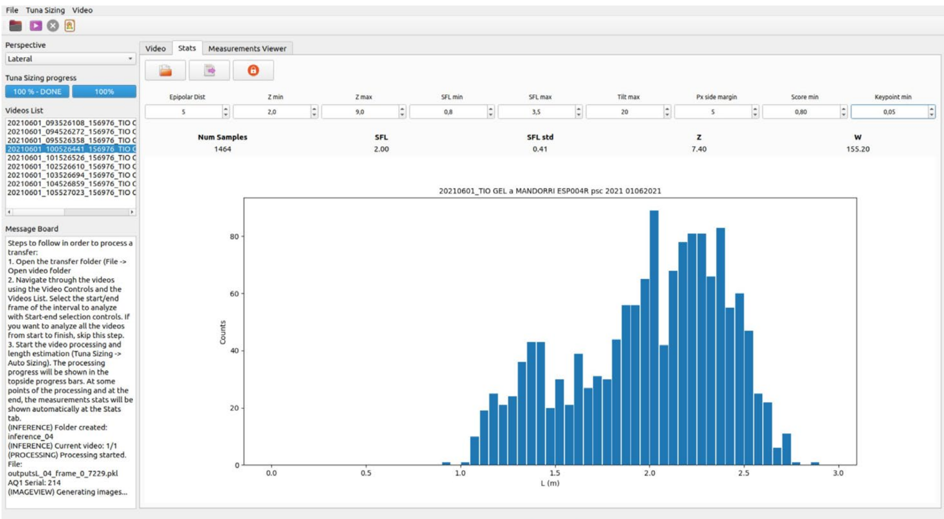

Figure 4. Snapshot of the length-frequency histogram resulting from fish sizing using UPV software.

3. Results

This section presents an analysis of the procedures for counting and sizing fish during both first and second transfers operations. Fish counting was performed manually by visual inspection of recordings from a monocamera and a stereocamera, as well as automatically using the software. For fish sizing, stereocamera recordings were processed by both manual and automatic methods to examine the average length, sample size, and time invested. Where available, results were compared with harvest data provided by the authorities.

3.1. Fish counting

Table 3 summarises manual and automatic fish counts obtained from monocamera and stereocamera recordings during first and second transfers in the Mediterranean and Adriatic; results for trap transfers are given in Table 4.

In the Mediterranean, automatic counting produced 54%, 94%, 83%, and 93% of the manual stereocamera counts for first transfers M1–M4, respectively, while reducing the time required from 10.5 hours to 26 minutes. The low result in M1 is attributed to the stereocamera being positioned too close to the fish. For monocamera recordings, automatic counting yielded 95%, 79% and 93% of manual monocamera counts for M2–M4; automatic counting was not feasible for M1 owing to poor visibility, which also produced a wide range of manual counts (308–430). For second transfers, counts were generally lower due to poorer visibility. Nevertheless, automatic counts corresponded to 72%, 93% and 48% of manual monocamera counts, and to 80%, 60% and 70% of manual stereocamera counts for ESP010R, ESP014R and ESP008R, respectively. In the Adriatic, dense schooling complicated individual detection, indicating that the counting algorithm requires further development and testing; nonetheless, the software achieved 61% of the stereocamera count in the single recorded transfer. For trap transfers, results of 120%, 135% and 74% indicate over- and under-counting in different cases and likewise call for algorithm refinement. In both Mediterranean and trap recordings, some fish could not be counted because the stereocamera's narrower field of view limited coverage, rendering the stereocamera unsuitable for counting in those situations.

First transfers ID		M1	M2	M3	M4	A
MC recordings	Manual counting	308/430	282	1379	688	290/300
	Automatic counting	Bad visibility	267 (95%)	1093 (79%)	638 (93%)	65 (22%)
SC recordings	Manual counting	313	272	1138	559	243/250
	Automatic counting	169 (54%)	257 (94%)	946 (83%)	521 (93%)	150 (61%)
Time (min)	Manual counting	120 (2h)	90 (1.5h)	240 (4h)	180 (3h)	60 (1h)
	Automatic counting	5	4	12	5	-

Second transfers ID		ESP010R (with another transfer)	ESP014R	ESP008R	EUHRV013 (4 transfers)
MC recordings	Manual counting	1207	1379	688	-
	Automatic counting	873 (72%)	1282 (93%)	333 (48%)	-
SC recordings	Manual counting	1140	1119	642	2668
	Automatic counting	910 (80%)	664 (60%)	451 (70%)	-

Table 3. Manual and automatic fish counting with the monocamera and stereocamera during first and second transfers in the Mediterranean and the Adriatic.

First transfers ID		TR1	TR2	TR3
MC recordings	Manual counting	129	368	91
	Automatic counting	155 (120%)	495 (135%)	67 (74%)
Time (min)	Manual counting	15	20	12
	Automatic counting	5	4	5

Table 4. Manual and automatic fish counting with the monocamera during first transfers from trap.

3.2. Fish length estimation

Table 5 summarises fish-length estimation results for the Mediterranean and Adriatic. In each transfer, fish were measured manually and automatically. obtained by marking snout and fork-tail points for at least 20% of transferred. For transfer M4, 73% of fish observed in the stereocamera recording were measured manually, the remainder being occluded. Note that sample percentages depend on whether counting is based on monocamera or stereocamera recordings.

In the Mediterranean, automatic sizing measured 73%, 90%, 75%, and 73% of the fish counted with the stereocamera in M1–M4 (equivalent to 63%, 87%, 62% and 59% of the monocamera counts). Average lengths from manual and automatic methods were very similar (differences of -1.7%, -2.0%, -2.0% and +1.5%, respectively) and processing time fell from 16 hours to 2 hours when summing time per transfer. Length-frequency histograms and Kernel Density Estimates (KDE) are shown in Figure 5; distribution shapes for manual and automatic measurements are similar, and KS p-values exceed 0.05 in three of the four transfers. KDEs reveal two modes (a minor peak near 130 cm and a major peak near 210 cm); such bimodality increases sensitivity to sampling and can cause apparent differences in mean length between samples.

For second transfers, automatic sizing obtained 71%, 36% and 49% of stereocamera counts for ESP010R, ESP014R and ESP008R (equivalent to 67%, 30% and 49% of monocamera counts). Sample sizes were generally smaller in second transfers owing to poorer visibility. Average lengths from manual and automatic methods were again similar (+1.2%, +5.1% and +0.8%, respectively). Figure 6 presents the corresponding histograms and KDEs; only one of the three transfers has a KS p-value > 0.05, likely reflecting differences in sample size because manual measurements adhered to the minimum required 20% sampling. Automatic length distributions and KDEs were broadly consistent with harvest data for the Mediterranean (Table 5 and Figure 7). Observed differences in average length (214.6–219.0 cm, 202.4–210.1 cm and 209.0–215.2 cm for ESP010R, ESP014R and ESP008R, respectively) and shifts in KDEs are attributable to growth during time in cages and harvest selectivity, which can alter sampled composition. The discrepancy between manual measurements and harvest data for ESP014R (192.6–210.1 cm), where 68% of the population was harvested, would imply an implausible mean growth of 17.5 cm in a few months and therefore suggests underestimation in the authorities' manual sample, probably due to the small sample fraction (24%).

In the Adriatic, manual measurements covered 65% of stereocamera counts (54% of monocamera counts); the remainder were occluded. Comparison between first- and second-transfer manual sizing was not possible because fish from four other first transfers had been placed in the transport cage. Initial automatic analysis of the Adriatic transfer sampled only 12% of stereocamera counts (10% of monocamera counts), a limitation attributed to dense schooling and insufficient prior training of the algorithm for these conditions. After retraining with local videos supplied by the authorities, automatic coverage rose to 45% of stereocamera counts (38% of monocamera counts). Average lengths from manual and automatic methods differed by −1.4%, and processing time fell from 3 hours to 3 minutes. Figure 8 shows that automatic and manual length distributions are closely matched; the distance-frequency histogram indicates measurements were made at similar ranges (4–9 m). The low KS p-value is likely driven by increased error when estimating small fish lengths (an average of 78.4 cm) at those distances. A setup that reduces measurement range to ~3–7 m (as in second transfers) should be considered. No harvest data are available for the Adriatic (harvest of cage HRV008004 is scheduled for the following year).

Table 6 summarises trap-transfer length estimates. Manual measurements covered 85%, 35% and 79% of monocamera counts for TR1–TR3, while automatic sizing covered 67%, 48% and 68%. Average lengths from manual and automatic methods were similar (differences of −2.8%, +0.4% and −3.9%), and total processing time fell from 4.5 hours to 1 hour across all trap transfers. Figure 9 shows the corresponding length-frequency histograms and KDEs; all three trap transfers have KS p-values > 0.05. Deviations in mean lengths are associated with the bimodal distribution and varying

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proportions of the two dominant modes in different samples. No harvest data were available for these transfers.

Spreadsheets containing detailed results for all transfers and the videos with automatic detections are available via the following link [1], demonstrating the software's outputs and ensuring transparency.

First transfers ID		M1	M2	M3	M4	A
Manual counting with monocamera		308/430	280/285	1379	687/689	290/300
Manual counting with stereocamera		313	272	1138	559	243/250
UPV Manual	Number of samples (%SC - %MC)	97 (31% - 23%)	56 (21% - 20%)	507 (45% - 37%)	406 (73% - 59%)	132 (53% - 45%)
	Average length (cm)	207.3	212.7	201.9	210.5	78.5
	Average distance (m)	5.6	5.6	5.8	5.4	6.4
	Time (min)	150 (2.5h)	80 (1.3h)	570 (9.5 h)	180 (3h)	180 (3h)
Auto	Number of samples (%SC - %MC)	230 (73% - 63%)	244 (90% - 87%)	859 (75% - 62%)	409 (73% - 59%)	110 (SC: 45% - MC: 38%)
	Average length (cm)	203.8 (-1.7%)	208.5 (-2.0%)	197.8 (-2.0%)	213.7 (+1.5%)	76.5 (-2.5%)
	Average distance (m)	6.3	6.0	6.0	5.5	6.4
	Time (min)	14	33	35	42	3

Second transfers ID		ESP010R (with another transfer)	ESP014R	ESP008R	EUHRV013 (with other 4 transfers)
Date		2024/07/09	2024/07/23	2024/07/10	-
Manual counting with monocamera		1207	1315	650	-
Manual counting with stereocamera		1140	1119	642	2668
Authorities Manual	Number of samples (%SC - %MC)	242 (21% - 20%)	270 (24% - 21%)	130 (20% - 20%)	917 (34%)
	Average length (cm)	212.0	192.6	207.4	79.1
	Average distance (m)	6.2	6.1	6.3	5.4
Auto	Number of samples (%SC - %MC)	807 (71%-67%)	400 (36%-30%)	316 (49%-49%)	cam257 no calib
	Average length (cm)	214.5 (+1.2%)	202.4 (+5.1%)	208.2 (+0.4%)	-
	Average distance (m)	6.1	5.5	6.6	-
Harvests	Number of samples	882 (73%)	892 (68%)	341 (52%)	0 (0%)
	Average length (cm)	218.5	210.1	215.2	-
	Dates	+ 5.5-6 months 2024/12/13 to 2025/01/08	+2-5 months 2024/09/26 to 2024/12/09	+3.5-4 months 2024/10/25 to 2024/11/04	-

Table 5. Fish length estimation with stereocamera during first and second transfers in the Mediterranean. (%SC - %MC): Percentage of samples with respect to manual counting with stereocamera and monocamera.

First transfers ID		TR1	TR2	TR3
Manual counting with monocamera		129	368	91
UPV Manual	Number of samples (%MC)	110 (85%)	130 (35%)	72 (79%)
	Average length (cm)	202.5	155.5	188.9
	Time (min)	90 (1.5h)	120 (2h)	60 (1 h)
Auto	Number of samples	86 (67%)	175 (48%)	62 (68%)
	Average length (cm)	197.1 (-2.7%)	156.1 (+0.4%)	181.6 (-3.9%)
	Time (min)	25	24	12.5

Table 6. Fish length estimation with stereocamera during first transfers from trap.

[1] https://upvedues-my.sharepoint.com/:f:/g/personal/pamuobe_upv_edu_es/EmBbujDyRMVAumwubK3X7KEB_zxNufx-wtOoqgMIeKA1bg?e=aIDPRG

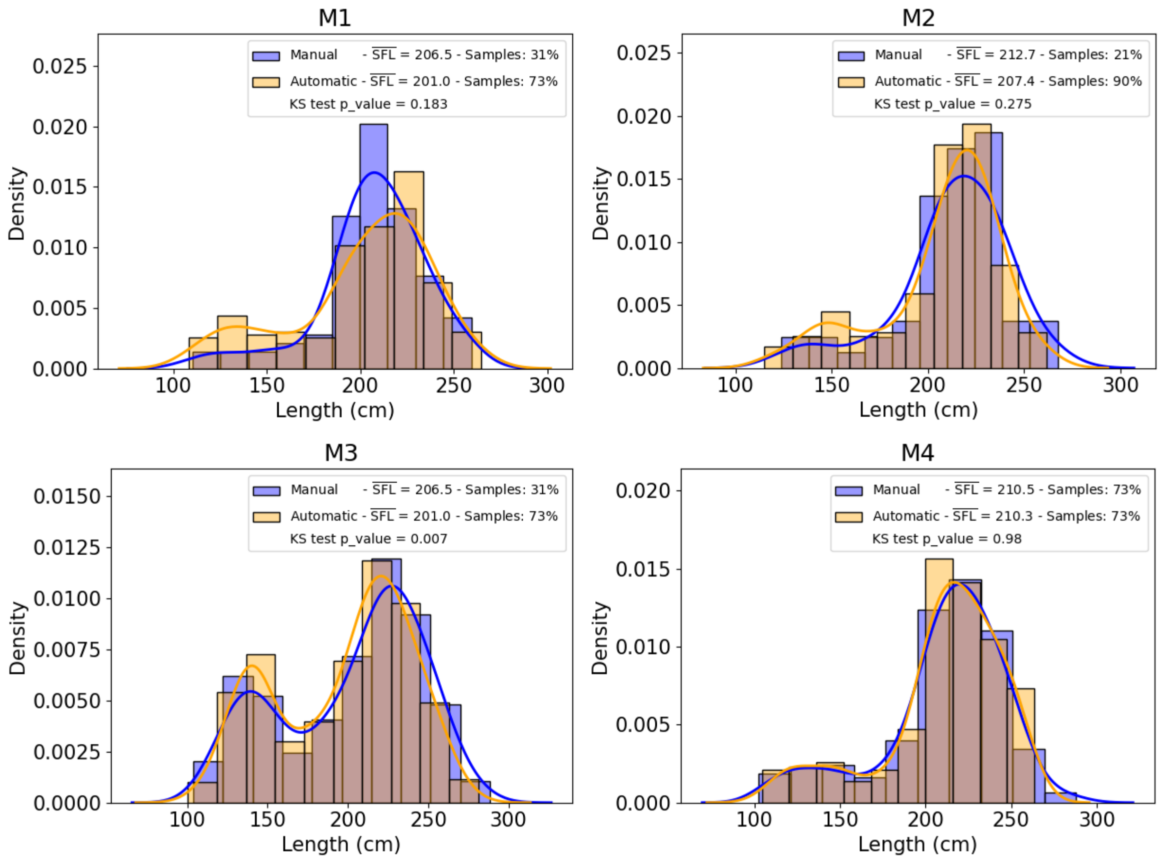

Figure 5. Length-frequency density histograms and Kernel Density Estimates (KDE) comparing manual and automatic measurements of the four first transfers in the Mediterranean.

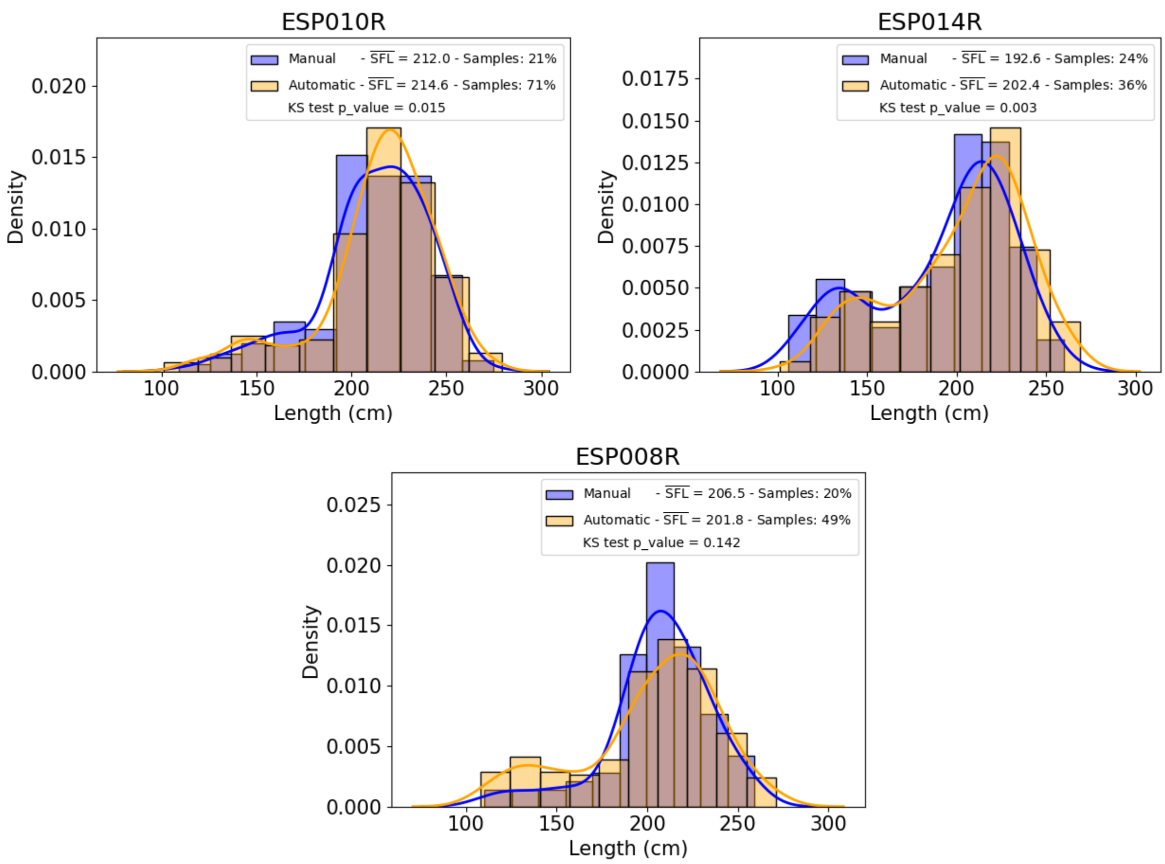

Figure 6. Length-frequency density histograms and Kernel Density Estimates (KDE) comparing manual and automatic measurements of the three second transfers in the Mediterranean.

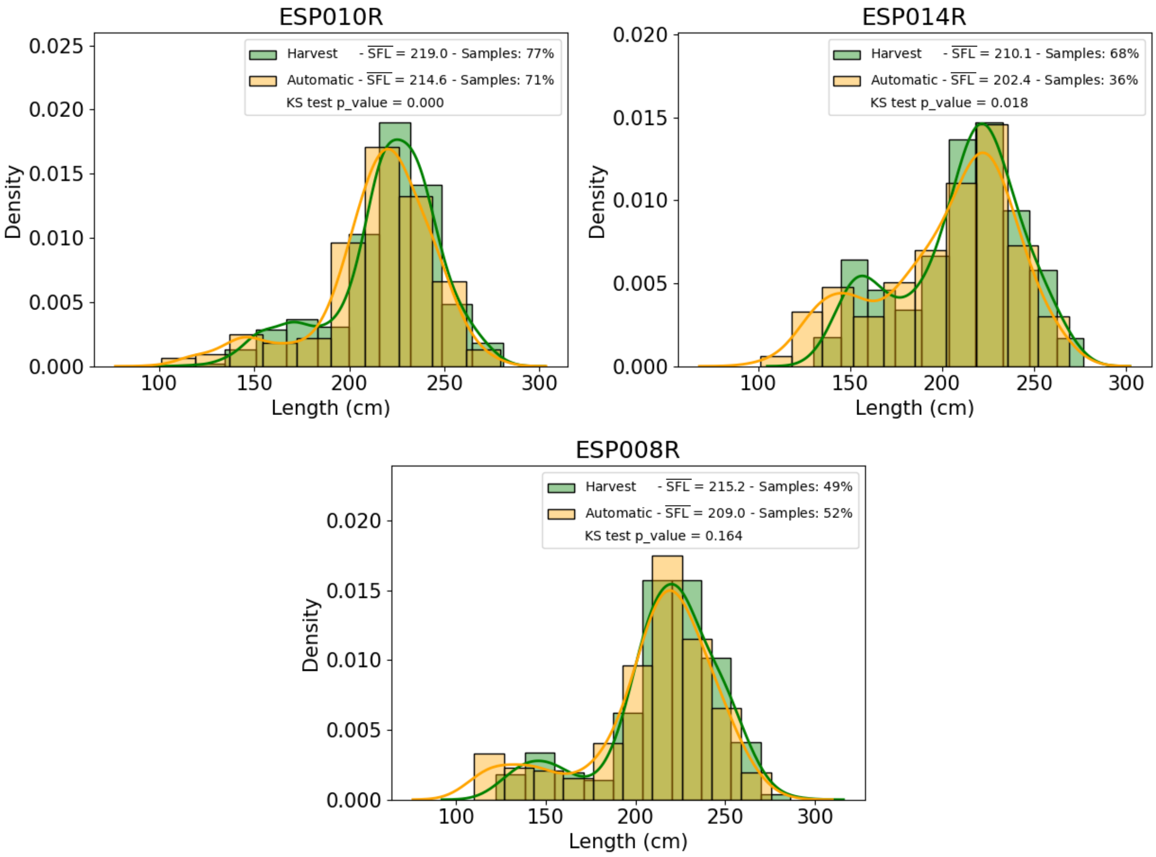

Figure 7. Length-frequency density histograms and Kernel Density Estimates (KDE) comparing automatic measurements with data from harvesting of the three second transfers in the Mediterranean.

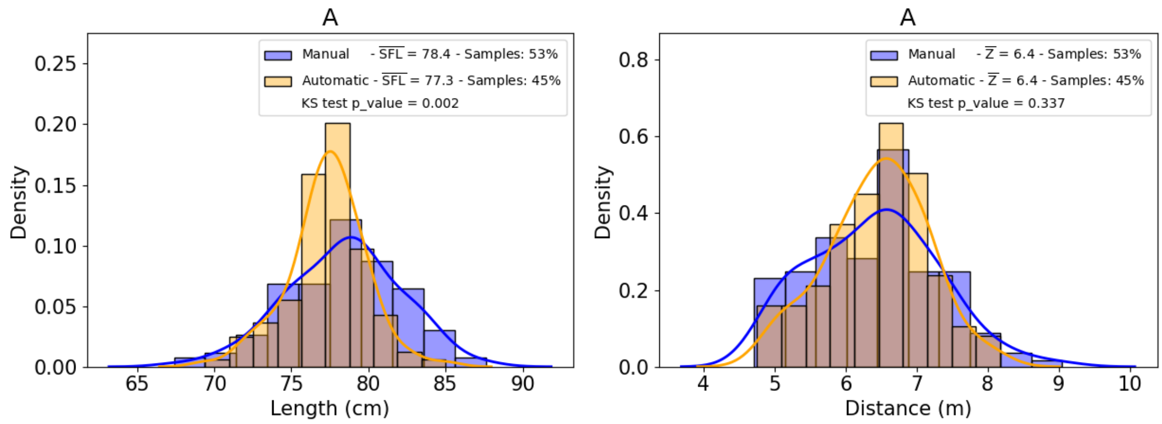

Figure 8. Length-frequency density histograms and Kernel Density Estimates (KDE) comparing manual and automatic measurements of one first transfer in the Adriatic.

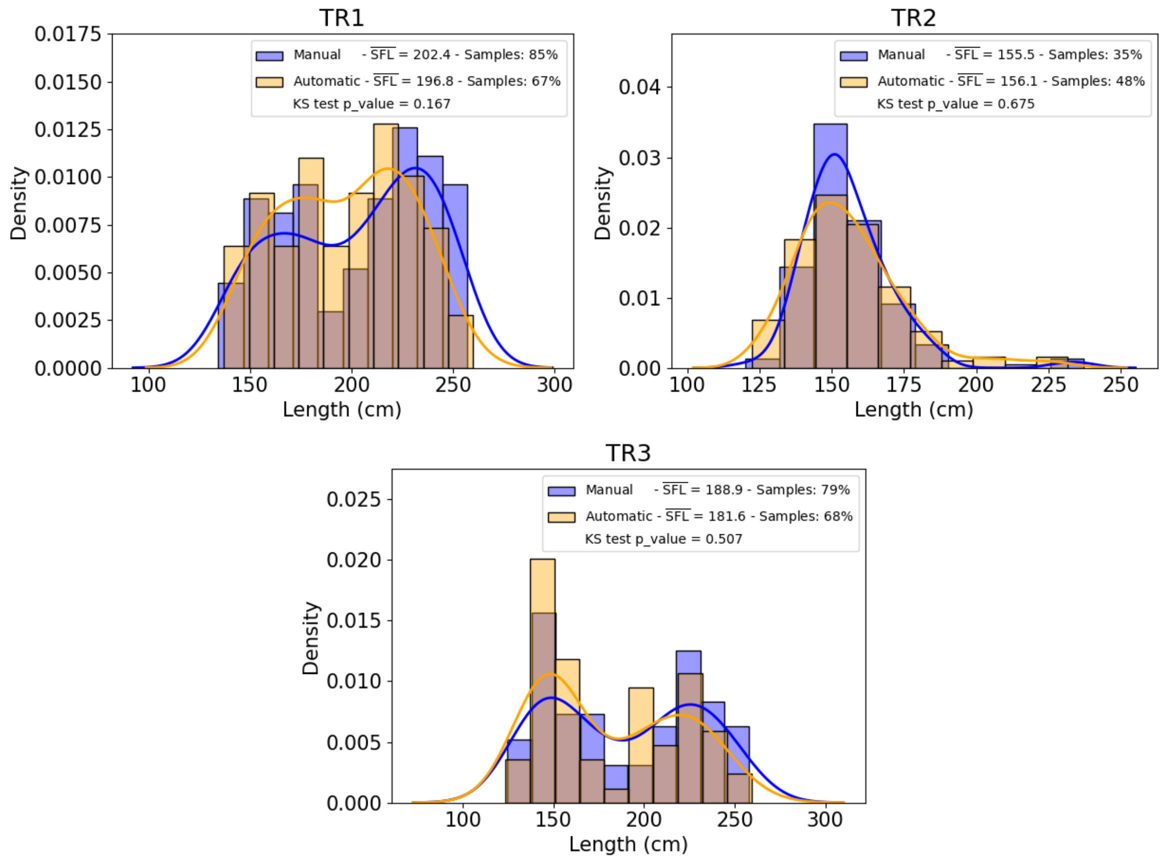

Figure 9. Length-frequency density histograms and Kernel Density Estimates (KDE) comparing manual and automatic measurements of three first transfers from trap.

3.3. Assessment of Measurement Reliability

In previous projects involving Southern Bluefin Tuna transfers, incorrect measurements were found to range from 1% to 4%. However, removing these errors resulted in a minimal impact, reducing the average length by less than 1 cm. A comparable analysis was performed here using two-minute clips from M3 and M4 (Mediterranean) and the full Adriatic transfer. Results in Table 7 indicate that incorrect measurements accounted for less than 1.5% of measurements. Most errors occurred when the snout point was placed on one fish and the fork point on a neighbouring fish (see Figure 10, Figure 11, Figure 12 and Figure 13 for representative examples of each type of incorrect measurement). Future algorithm training will include such cases to reduce these errors.

Note that the number of correct measurements refers to the total number of measurement events, not the number of unique individuals. The tracking algorithm measures each fish multiple times and the final length is the median of those measurements. This process increases measurement accuracy and helps filter out errors. On average, each fish was measured between 5.5 and 12.4 times in the Mediterranean (means of 5.5, 12.4, 9.1 and 7.4 for M1–M4, respectively) and 2.3 times in the Adriatic. These differences reflect school density and the time individual fish remain within the camera field of view, which in turn depends on distance from the camera. For an incorrect measurement to determine the final length, the snout and fork points must be misplaced in both images of the stereocamera pair and this incorrect measurement must recur in most measurement events for that fish.

Tracking failures are another source of inaccuracy: when tracking fails the same fish can be assigned multiple identities and measured repeatedly, inflating the percentage of fish measured relative to the true number of unique individuals. All incorrect tracking detections were reviewed and removed, so the samples reported in Section 3.2 represent unique individuals. Erroneous detections were quantified, yielding overestimations of 17%, 8%, 2%, 11% and 1% across the Mediterranean and Adriatic transfers (Table 8).

		M3	M4	A	Example image
Type of incorrect measurement	Keypoints in different near fish	13	1	1	Figure 10 and Figure 13
	Keypoints in different overlapped fish	14	2	-	Figure 11
	Keypoints in points different from snout and fork	3	-	-	Figure 12
Number of incorrect measurements		30 (0.9%)	3 (0.5%)	1 (1.5%)	
Number of correct measurements		3459	608	67	

Table 7. Quantification and classification of incorrect measurements identified in two-minutes video clips from transfers M3 and M4 in the Mediterranean and the entire transfer in the Adriatic.

First transfers ID		M1	M2	M3	M4	A
Manual counting with monocamera		308/430	280/285	1379	687/689	290/300
Auto fish sizing	Number of samples	230 (63%)	244 (87%)	859 62%)	409 (59%)	30 (10%)
	Number of unique samples	169 (46%)	222 (79%)	821 (60%)	331 (48%)	28 (9%)

Table 8. Comparison of total samples detected by the tracking algorithm and the number of unique samples obtained after removing erroneous detections.

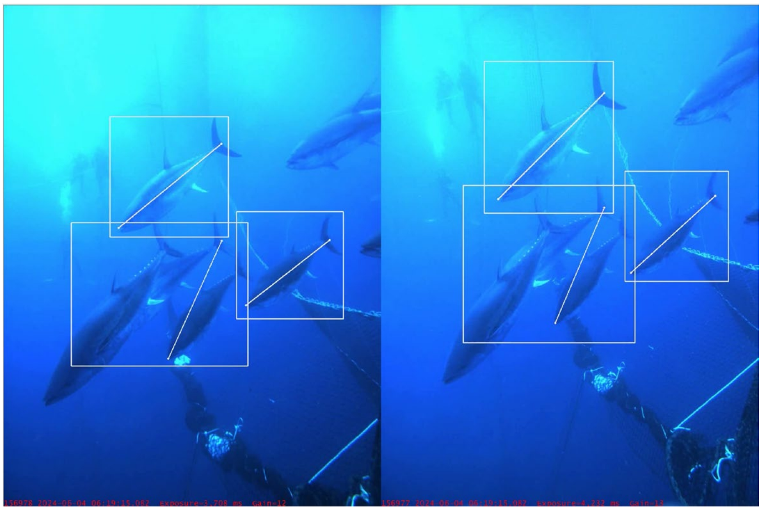

Figure 10. Example of incorrect measurement, where the snout point is placed on one fish and the fork point on a nearby fish.

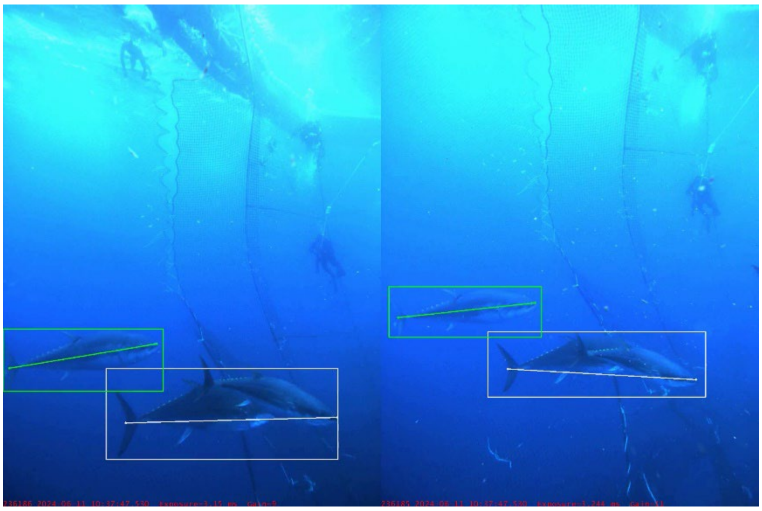

Figure 11. Example of incorrect measurement, where the snout point is placed on one fish and the fork point on a nearby fish due to overlap.

Figure 12. Example of incorrect measurement, where the fork point is placed on the dorsal fin instead of the tail fork.

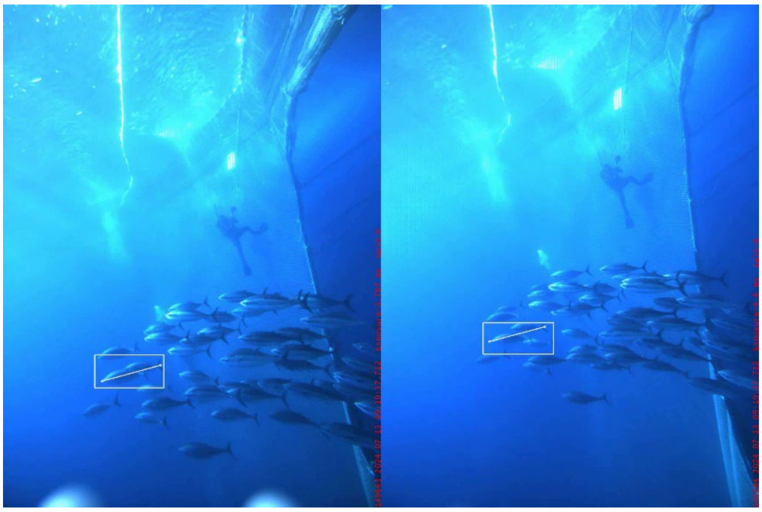

Figure 13. Example of incorrect measurement, where the snout point is placed on one fish and the fork point on a nearby fish.

Conclusions

The tests were conducted during the 2024 fishing seasons in the Mediterranean and Adriatic, and during the 2025 season in Portugal, with two main objectives: (i) to evaluate the accuracy of estimating the number and average size of bluefin tuna during first transfers, and (ii) to assess the potential of software and artificial intelligence to automatically determine fish number and weight. Trials were carried out in three scenarios: four first transfers from purse seiners to transport cages in the Mediterranean in collaboration with Balfegó Tuna; one first transfer in the Adriatic in collaboration with Jadran Tuna; and three first transfers from traps to fattening cages in collaboration with Tunipex. This report focused on the second objective.

For all transfers, fish were counted and measured both manually (marking snout and fork-tail points) and automatically (deep-learning software), allowing direct comparison. Additionally, in the Mediterranean a high percentage of the fish were later harvested, allowing for a comparison with harvesting results.

Automatic fish counting in the Mediterranean achieved 79–95% of manual counts under good visibility, while reducing analysis time from 10.5 hours to 26 minutes. In contrast, performance in the Adriatic was limited due to the difficulty of detecting fish within dense schools, compared with the more dispersed swimming observed in the Mediterranean. In trap transfers, automatic counting ranged from 74% to 135% of manual counts, indicating the need for further refinement of the algorithm.

For fish length estimation, the software successfully measured a large proportion of individuals: 63%, 87%, 62%, and 59% in the Mediterranean transfers, and 67%, 48%, and 68% in the trap transfers. Average lengths, length-frequency histograms and Kernel Density Estimates derived from automatic measurements closely matched manual measurements, with KS p-values greater than 0.05 in seven of the eight first transfers, and automatic measurements consistent with harvesting results when available. In the Adriatic, the software estimated lengths for 45% of fish in one transfer, with automatic average length similar to manual results. Overall, analysis time was significantly reduced: from 16 hours to 2 hours in the Mediterranean, from 4.5 hours to 1 hour in trap transfers, and from 3 hours to 3 minutes in the Adriatic.

These findings demonstrate that automatic estimation of fish weight during first transfers is technically feasible in the Mediterranean and in trap transfers, but further testing is required to confirm feasibility in the Adriatic. Finally, visual inspection revealed that tracking failures occasionally led to inflated percentages of fish measured, emphasizing the need for further development of the tracking algorithm to ensure reliable sample sizes, alongside continued improvements to the automatic counting system.

Acknowledgements

This work has been carried out within the scope of the project REM-BFT (project acronym) and co-funded by the European Union through the EU Grant Agreement No. 101103829, and a voluntary contribution by the United States.

The authors acknowledge the collaboration of Balfegó Tuna and the Spanish Navy patrol vessel *Alborán* (P-62) for providing vessels and divers during the transfers conducted in the Mediterranean. Appreciation is also extended to Jadran Tuna and the Croatian Ministry of Agriculture for their support in the Adriatic transfers, and to Tunipex for their assistance with the trap transfers.

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