

ELECTRONIC TAGGING OF BLUEFIN TUNA IN THE TRAP FISHERY OF SARDINIA (W-MEDITERRANEAN)

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SUMMARY

The Sardinian trap fishery has been considered for electronic tagging under the research tasks of the ICCAT-GBYP tagging programme 2015. On 1 July, the electronic tagging (miniPATs) of 28 Atlantic bluefin tuna (average fork length 132 ± 24 cm) was conducted in the trap fishery of Isola Piana (south-western Sardinia - western Mediterranean). The fishing gear and the equipment for tagging were adapted to accomplish the proposed tagging design. Changes regarded the use of speargun, underwater action cameras, and green laser pointers useful for size estimation of tunas. Preliminary results of tags popping-off showed that bluefin tuna tagged in Sardinia are spread from the Balearic Sea to the Strait of Sicily, including the Ligurian Sea.

RÉSUMÉ

La pêche de madragues de Sardaigne a été envisagée pour le marquage électronique dans le cadre des activités de recherche menées dans le programme de marquage de l'ICCAT-GBYP en 2015. Le 1er juillet, le marquage électronique (miniPAT) de 28 thons rouges de l'Atlantique (longueur à la fourche moyenne 132 ± 24 cm) a été effectué dans la pêche de madragues de Isola Piana (Sud-Ouest de la Sardaigne - Méditerranée occidentale). L'engin de pêche et l'équipement de marquage ont été adaptés pour accomplir la conception de marquage proposée. Les changements ont concerné l'emploi de fusils sous-marins, de caméras sous-marines ainsi que de pointeurs laser vert utiles pour estimer la taille des thonidés. Les résultats préliminaires des marques qui se sont détachées ont montré que le thon rouge marqué en Sardaigne s'étend depuis la mer des Baléares jusqu'au détroit de Sicile, y compris la mer Ligurie.

RESUMEN

Se ha considerado la pesquería de almadrabas de Cerdeña para realizar marcado electrónico en el marco de las tareas de investigación del programa de marcado del ICCAT GBYP de 2015. El 1 de julio se llevó a cabo el marcado electrónico (miniPAT) de 28 atunes rojos del Atlántico (longitud a la horquilla media 132 ± 24 cm) en la pesquería de almadrabas de isla Piana (Cerdeña sudoccidental - Mediterráneo occidental). El arte pesquero y el equipamiento para el marcado se adaptaron para lograr el diseño de marcado propuesto. Los cambios estaban relacionados con la utilización de arpones, cámaras subacuáticas y la utilización de punteros láser verdes útiles para la estimación de tallas de los túnidos. Los resultados preliminares de las marcas que emergieron demuestran que el atún rojo marcado en Cerdeña se extiende desde el mar Balear hasta el estrecho de Sicilia, incluido el mar de Liguria.

KEYWORDS

Bluefin tuna, Trap fishing, Electronic tagging, Sardinia, Western Mediterranean

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1. Introduction

The Sardinian trap fishery for the first time has been considered for electronic tagging under the research tasks of the ICCAT-GBYP tagging programme 2015.

Considering previous experience, the trap represents a favorable system for tagging large numbers of bluefin tuna by conventional tags (Abid *et al.* 2014; Addis *et al.* 2014), but can also be useful for implanting electronic tags (De Metrio *et al.* 2003; Abid *et al.* 2014; Quílez-Badia *et al.* 2013).

The tagging campaign was planned in May-July 2015. Ad-hoc consortium composed by the Centro di Competenza sulla Biodiversità Marina (Com.Bio.Ma.), representing the leading scientific entity and the Carloforte Tonnare PIAM (Isola Piana trap), was established to accomplish the goals of the project. This paper reports preliminary data on surfaced tags and activities conducted in the traditional trap of Isola Piana.

2. Material and methods

2.1 Geographic area and trap description

Tagging activities were conducted at the Isola Piana trap (**Figure 1**) deployed in south-western Sardinia in the island of San Pietro (39°11'N; 08°18'E - ICCAT number: ATEU2ITA00003).

The trap array consists of nylon nets arranged in five chambers: the “Grande” (120 m x 45 m), the “Bordonaro” (50 m x 45 m), the “Bastardo” (45 m x 40 m), the “Camera di ponente” (45 m x 40 m) and the “Camera della morte” (the “death chamber”) (45 m x 30 m). Only the death chamber has a vertical moving net ‘floor’ (corpus) used to pull up bluefin tuna during the “mattanza”. The death chamber has been properly used for conventional tagging in the past (Addis *et al.* 2014) and the same technical arrangements were used for electronic tagging.

2.2 Fishing season 2015

In 2015 the quota assigned to the trap fishery by the Italian Ministry for Agriculture Policy and Forestry was 194.06 t (distributed by three traps). In late April 2015 the trap of Isola Piana was fully operative and the first observation of entrapped bluefin tuna occurred in the end of April. Mostly bluefin tuna entrapped are transferred in transporting cages and then moved to Malta in a tuna farming. Only a small amount of bluefin tuna are captured by “mattanza” on site. In the current fishing season transfer operations were concluded on June 26, and from this date onwards extra-quota tunas were available for electronic tagging.

2.3 Tagging protocol

Thirty MiniPATs (Wildlife Computers™) were provided by ICCAT to be implanted by the team of Com.Bio.Ma. (20 tags) and Consorzio Unimar (10 tags). MiniPATs template was provided by ICCAT considering previous trials carried out in Morocco traps (Quílez-Badia *per. com.*), with expected time of release of 250 and 365 days (for details see **Table 1**).

Tagging protocol refers to SCRS/2014/189 (Mariani *et al.* 2014) with some changes adopted for the implantation of 20 tags. Differences regards: a) the use of pneumatic spearguns (**Figure 2**) instead of Arbalete and b) size estimates by laser instead of the methodology proposed by Mariani *et al.* (2014).

In details, the preference for pneumatic spearguns was strictly necessary to assemble laser pointers on the gun barrel (unworkable on the Arbalet barrel due to rubbers); size estimate was accomplished by testing coupled laser pointers (green laser; wavelength 532 nm; inter-distance of laser beams = 17.8 cm) and GoPro cameras fastened on the speargun.

2.4 Length estimation by laser

Fork length was estimated by image analysis using frames which were captured during each tagging action (software TpsDig2.14; Rohlf, 2009). The laser beams' inter-distance (**Figure 3**) was the scale reference on the tuna body. The assumption for an accurate size estimate by image analysis is that the body of the tuna and the trajectories of the lasers must be orthogonal (90°). Nevertheless, this assumption is far from the control of the diver during shooting, because tunas swim speedily with unexpected changes of trajectory. Thus, the exact angle

between the tuna and the laser cannot be detected by the frame analyses “a posteriori”. In order to ameliorate size estimates by lasers, we carried out a trial using a dead tuna with a known fork length (FL=113 cm) on which we carried out measurements considering five angles of shots (30-45-60-80 and 90°).

3. Results

A total of 28 bluefin tuna were tagged and released in one operational days. Underwater visual observation conducted afterwards tagging operations inside the death chamber, revealed no mortality for tagged and untagged fish. Moreover, we didn't observe any behavioural change due to the implantation of MiniPATs by spearguns thus excluding stress for the fish.

According to most recent queries to CLS-Argos data base, 21 tags surfaced (Di Natale et al. SCRS/205/149). In western Mediterranean some tags surfaced close to the original tagging location and off the western Sardinia coast (between Sardinia and Balearic). One tag surfaced in the southwest of the Balearic; three in the Strait of Bonifacio and two in the north part of Tyrrhenian Sea. Finally, two tags surfaced in the central Mediterranean close the area of Malta (**Table 1**).

In **Table 1** and **Figure 1**, are also reported three findings of conventional tag implanted in 2013 and 2014 in the same trap fishery and recovered in south France (fishing zone of Sete).

Results of the trial for size estimates indicate that as the shot angle decreases (from 90° to 30°), the laser inter-distance increase. Therefore estimated fork length by image analysis resulted always underestimated (**Figure 4**, **Table 2**). The calculated error, ranged from 1.5% to 44.9% for shot angles 90° and 30°, respectively. Fork lengths of tagged bluefin tunas were therefore calculated with an average error of 25%.

4. Conclusion

The use of traditional traps in Sardinia has been demonstrated suitable both for conventional tagging and for electronic tagging of bluefin tuna.

Preliminary data from surfaced tags show that bluefin tuna after the crossing point of south-western Sardinia spread in a wide geographical area, even reaching distant locations in a short time (Malta area). The popping-off of 21 tags before the planned date of release could be ascribed either to the low retention of the tags in the tuna's body or to the capture of tagged specimens. Interestingly, data from conventional tagging has shown that there is evidence of a spatial relationships between the area of tagging and the area of recapture (south France), at least for medium size bluefin tunas.

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Table 1. Summary information on the deployments of electronic and spaghetti tags implanted in the Sardinia trap fishery.

<i>ID</i>	<i>ID tag</i>	<i>Days release</i>	<i>Deployment date</i>	<i>Pop-off/ Capture date</i>	<i>Days at liberty</i>	<i>Pop-off/ Capture Area</i>	<i>FL (cm)</i>	<i>W (kg)</i>
1	130573	250	01/07/2015	15/09/2015	76	Balearic Sea	134.5*	43.3
2	130574	250	01/07/2015	No	-	-	130.1*	39.2
3	130575	250	01/07/2015	No	-	-	121.7*	32.1
4	130576	250	01/07/2015	No	-	-	118.9*	29.9
5	130577	250	01/07/2015	No	-	-	141.2*	50.2
6	145448	250	01/07/2015	27/07/2015	26	Balearic Sea	147.5*	57.2
7	145454	250	01/07/2015	06/09/2015	67	Strait of Sicily	119.8*	30.6
8	145465	250	01/07/2015	29/07/2015	28	Balearic Sea	115.5*	27.4
9	146446	250	01/07/2015	No	-	-	117.8*	29.1
10	150404	250	01/07/2015	17/07/2015	16	Balearic Sea	103.8	21.3
11	150405	250	01/07/2015	17/08/2015	47	Tyrrhenian Sea	110	25
12	150406	365	01/07/2015	14/07/2015	13	Balearic Sea	138.6	47.8
13	150407	365	01/07/2015	09/07/2015	8	Strait of Sicily	191.9	118.9
14	150408	365	01/07/2015	01/09/2015	62	Balearic Sea	119.8	31.8
15	150409	250	01/07/2015	20/08/2015	50	Strait of Bonifacio	93.3	15.8
16	150410	250	01/07/2015	20/08/2015	50	Balearic Sea	111.3	25.9
17	150411	250	01/07/2015	08/07/2015	7	Balearic Sea	163.2	75.6
18	150412	250	01/07/2015	20/08/2015	50	Ligurian Sea	130	40
19	150413	250	01/07/2015	09/07/2015	8	Balearic Sea	123	34.2
20	150414	365	01/07/2015	07/07/2015	6	Balearic Sea	120	32
21	150415	365	01/07/2015	02/08/2015	32	Balearic Sea	127.2	37.6
22	150416	250	01/07/2015	11/08/2015	41	Balearic Sea	164.3	77
23	150417	365	01/07/2015	No	-	-	135.7	45.1
24	150419	365	01/07/2015	20/08/2015	50	Strait of Bonifacio	103.9	21.3
25	150420	250	01/07/2015	05/09/2015	66	Strait of Bonifacio	130	40
26	150421	365	01/07/2015	13/07/2015	12	Sardinia Channel	133.6	43.2
27	150422	250	01/07/2015	07/08/2015	37	Balearic Sea	155.8	66.4
28	150423	365	01/07/2015	No	-	-	146.3	55.6
29	BYP071749	**	20/06/2013	18/05/2015	697	Gulf of Lion	148	58
30	BYP071824	**	02/07/2013	18/09/2013	78	Gulf of Lion	151	60
31	BYP072413	**	22/06/2014	27/08/2015	431	Gulf of Lion	140.3	49.62

* Size estimates according to SCRS/2014/189

** Conventional tags (spaghetti tag)

Table 2. Summary of the trial for size estimates considering one specimen (FL=113) and five shot angles.

<i>Shot angle °</i>	<i>Real FL (cm)</i>	<i>Speargun Distance (m)</i>	<i>Calculated laser point distance (cm)</i>	<i>Estimated FL (cm)</i>	<i>Error %</i>
90°	113	1	17.8	111.3	1.5
80°	113	1	18.1	107.9	4.5
60°	113	1	20.6	97.2	14.0
45°	113	1	25.2	84.5	25.2
*30°	113	1	35.6	62.3	44.9

*Unlikely angle shot

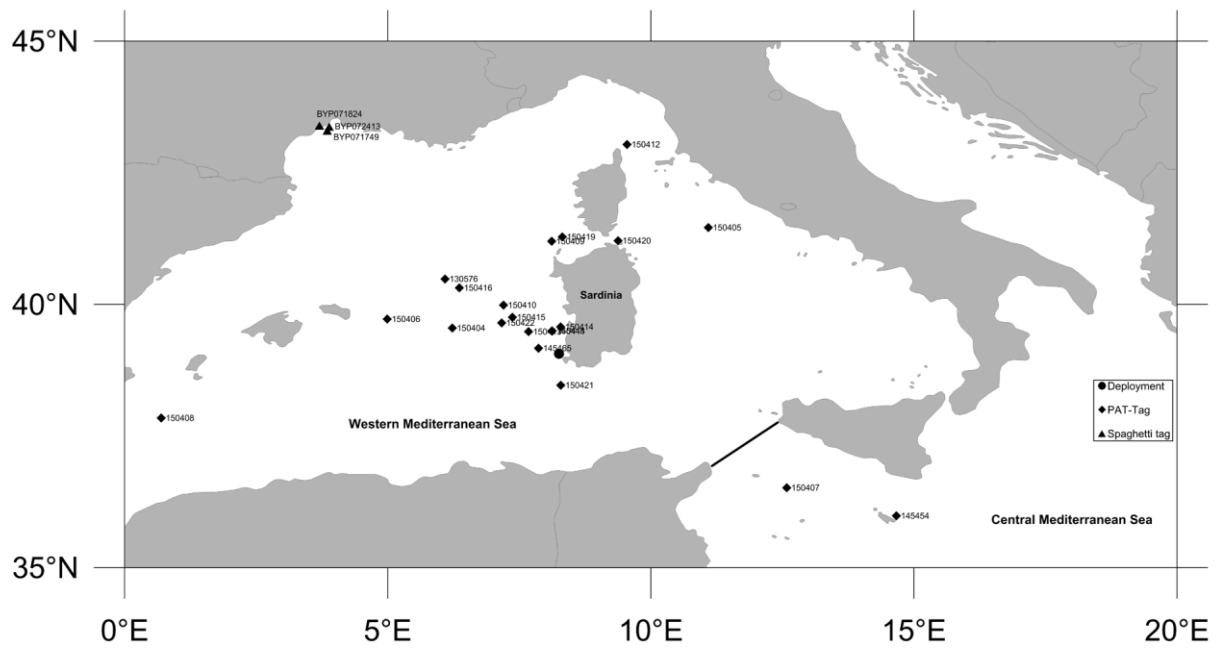


Figure 1. Localization of the tagging location (●), Pop-off positions (◆) of MiniPATs implanted to bluefin tuna in the trap fishery of Sardinia in 2015 and recovery of conventional spaghetti tags (▲) implanted in the trap in 2013 and 2014.



Figure 2. Laser system adopted for size estimate.



Figure 3. Frame showing the tagging action with laser landmarks visible on the bluefin tuna.

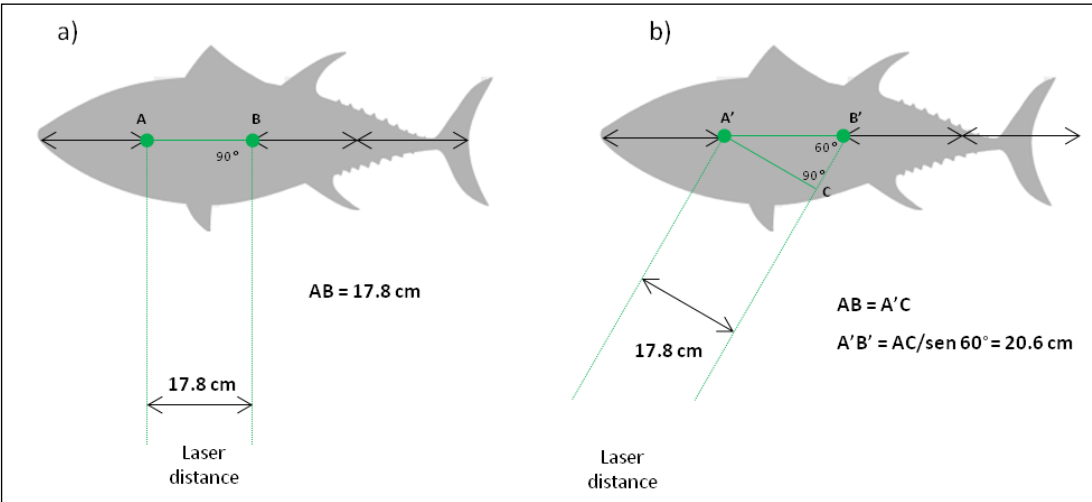


Figure 4. Scheme of the trial for size estimates a) Laser inter-distance with an angle of 90° ; b) Laser inter-distance with a shot angle of 60° (20.6 cm).