ICCAT/GBYP 08/2016

TAGGING PROGRAMME 2016

ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA (ICCAT GBYP – PHASE 6)

Electronic tagging of adult bluefin tunas in Portuguese traps in the eastern Atlantic Ocean

DELIVERABE 4:

Final Report

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CONTENTS

1. EXECUTIVE SUMMARY

One of the major research tasks of the ICCAT Atlantic wide Research Programme on Bluefin Tuna (GBYP) is to carry out a large, wide and intensive scientific tagging programme. In 2016, ICCAT/GBYP made a particular call for carrying out field tagging activities in the Portuguese tuna traps, where bluefin tuna moving into the Atlantic after spawning can be tagged. After this call, a proposal was made by Tunipex (contractor) and IPMA (scientific sub-contractor), which was accepted by ICCAT to fulfill the required work.

The Tunipex tuna trap, where the tagging operations took place, is located about two and a half nautical miles from the coast of the Algarve, between about 20-60m depth. The central location of the trap is at: Lat=37.0194 (North); Long= -7.7056 (West). The tags used were Wildlife Computers miniPATs with an intra-muscular tag applicator, and were programmed according to the tagging programming currently used by ICCAT/GBYP. The bluefin tunas were tagged by experienced divers directly underwater using a long pole. An underwater stereoscopic camera was used during the tagging operations, and each tagging pole also had a fixed underwater GoPro camera. Opportunistic conventional tagging (double tagging with one single barb and one double barb) and biological sampling was carried out on other bluefin tuna from the same school.

The tagging took place on the 22 July 2016, and it was possible to successfully deploy 24 miniPAT tags. All tagged bluefin tuna were adults, with estimated round weights (RWT) between 120 kg and 250 kg (average = 173.3kg, SD = 28.5). After conversion, the estimated stretched fork length (SFL) ranged between 189 and 244 cm (average = 213.7 cm, SD = 12.1). Additionally, a total of 146 conventional tags were deployed on other 79 bluefin tuna (most double tagged) from the same school. The estimated RWT of the conventionally tagged specimens ranged between 100 kg and 280 kg (average = 163.7kg, SD = 34.3). After conversion, the estimated SFL of the conventionally tagged specimens ranged between 177 and 253 cm (average = 208.6 cm, SD = 15.4). All tagging data were recorded and transmitted to ICCAT in the appropriate ICCAT tagging forms. Tissue samples (muscle) for genetic analysis were collected from 16 additional specimens and will be sent to the GBYP biological sampling coordinator.

In conclusion, the tag deployment process was carried out successfully according to the ICCAT call and the contractor proposal. After the tagging was completed, we also provide some additional recommendations, specifically in terms of underwater tagging operations, individual specimen weight estimations, and conventional tags used, that may be considered for adjusting the tagging strategy on future phases of the ICCAT/GBYP tagging project.

2. BACKGROUND

One of the major research tasks under the ICCAT Atlantic wide Research Programme on Bluefin Tuna (GBYP) is to carry out a large, wide and intensive scientific tagging programme to address several important biological and ecological topics regarding Atlantic bluefin tuna as well as to possibly provide independent estimates of abundance and/or fishing mortality rates. In 2016, ICCAT/GBYP made a particular call for carrying out the second part of the field tagging activities in 2016. Following the recommendation by the GBYP Steering Committee, the call was limited to electronic tagging focusing the attention on particular areas. One of the priority areas requested was the Portuguese traps, where bluefin tuna moving into the Atlantic after spawning can be tagged (Part B of the planned tagging activities).

Given the importance of the bluefin tuna as a marine resource (Fromentin & Powers, 2005) and captures in the Algarve tuna traps, particularly in the Tunipex tuna trap, catches and biological data have been recorded since 1998 in a strait collaboration between IPMA and Tunipex. Between 2010 and 2016, five papers were presented to the ICCAT SCRS describing the bluefin catches on this trap in terms of number, weight and size frequency distribution (Lino et al., 2016; Santos & Coelho, 2011; Santos et al., 2011, 2014, 2015).

Following the call made in GBYP - Phase 6 - Tagging Programme 2016, a proposal was presented and accepted by Tunipex (contractor) and IPMA (scientific sub-contractor) to fulfill the required work tagging adult bluefin tunas in Portuguese traps in the eastern Atlantic Ocean.

3. OBJECTIVES

The objective of this document is to provide **Deliverables 2 and 3** (Update of Work and Draft Final Report) of the Project ICCAT/GBYP - Phase 6 - Tagging Programme 2016 for Item b) Electronic tagging of adult bluefin tunas in Portuguese traps in the eastern Atlantic Ocean. The details included in this Report, as requested in the call for tender and in the detailed proposal submitted, include the following:

I. Scientific report (this report) containing:

a) Full description of the work carried out for the tagging activities in the various areas, with the total number of tagged tunas and specification of any double tagged tuna;

b) Detailed description of the methodology and protocols;

c) Maps of the areas in which the tagging was carried out;

d) Detailed tables with the definitive number of tagged specimens by area, size composition and type of tag (miniPATs or miniPATs + conventional spaghetti tag);

e) Copy of the data input worksheets from the ICCAT tagging database;

f) Possible recommendations for adjusting the tagging strategy for conventional tagging in future Phases of ICCAT GBYP;

g) Executive Summary.

II. A PowerPoint presentation of the main results.

III: Copy of the databases in the ICCAT format, specifically:

a) TG01-CnvEleTSurv: Summary of tagging activities (campaigns & others) [Form-A]; contained in file: "TG01-CnvEleTSurv_PRT_GBYP6_FINAL.XLSX".

b) TG02-CnvTReRc: Conventional Tag release-recovery data (Version: v11). Contained in file: "TG02-CnvTReRc_PRT_GBYP6_FINAL.XLSX".

c) TG03-EleTReRc: Electronic Tagging Release - Recovery Information (Version: v11). Contained in file: "TG03-EleTReRc_PRT_GBYP6_FINAL.XLSX".

4. DETAILED DESCRIPTION OF THE METHODOLOGY

4.1. Description, mapping and scheme of the tuna trap for the tagging operations

Traditional tuna traps are composed by a complex net system that leads the individuals through a maze so they may be trapped and captured (Costa 2000; Leite et al., 1986). Those nets are a fixed and passive fishing gear that stays at sea during a certain period of the year, during the migratory route of the bluefin tunas.

The bluefin tuna were tagged in a Portuguese trap in the eastern Atlantic Ocean, specifically in the Tunipex tuna trap operating in the Algarve region, Southern Portugal (**Fig. 1**). The tuna trap is located about two and a half nautical miles away from the coast line of the Algarve, and between about 20-60m depth. The central location of the trap is at: Lat=37.0194 (North); Long= -7.7056 (West).

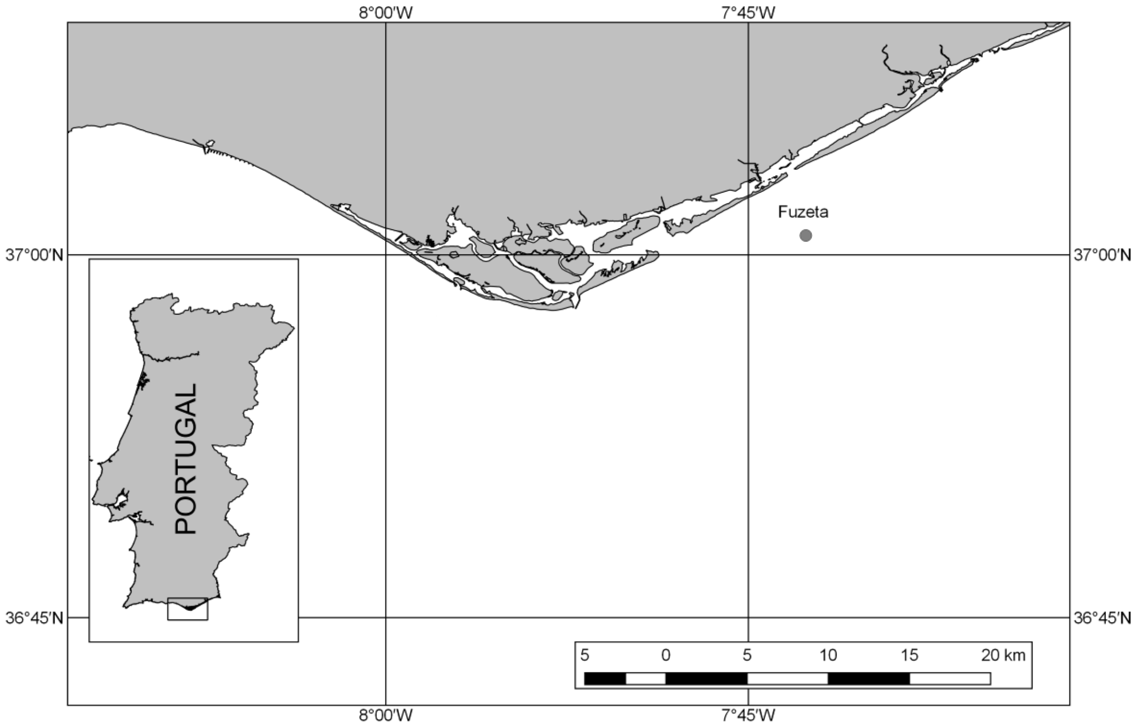

Fig. 1. Location of the Tunipex tuna trap in the Algarve, Southern Portugal (NE Atlantic).

In terms of operational scheme, the Tunipex set net consists of 2 leading nets, a playground net, an ascending slope net, a box net and two crawl nets (**Fig. 2**). When the tunas encounter the leading nets they move along those nets and end up entering the set net. The area where the tuna first enter the set net is called the playground net, which is a large space surrounded by nets. This is a large space that allows the fish to swim in a calmer and less stressful manner for some time. On the opposite side of the playground area there is a device called the ascending slope net which has the role of preventing the fish from escaping the set net. This is an open channel, that is not completely closed and allows the fish to swim freely between the playground area, but without exiting the set net. The next and final stage is to move the fish into the box net, where the tunas are captured. To catch the fish in the box net, the fishermen hoist the box net up. If necessary, some fish are moved to the crawl nets temporally, due to operational adjustments (**Fig. 2**).

The contractor, Tunipex, was available to perform all tagging operations as described above. The time frame for the activities was set up to a maximum of 2 weeks immediately after the quota closure of the tuna trap fisheries in Portugal. After the quota was reached, the tuna trap remained operational for the extra time until a bluefin tuna school of sufficient size entered the trap. This allowed for the tagging of bluefin tunas that spent relatively little time (few days) in the trap.

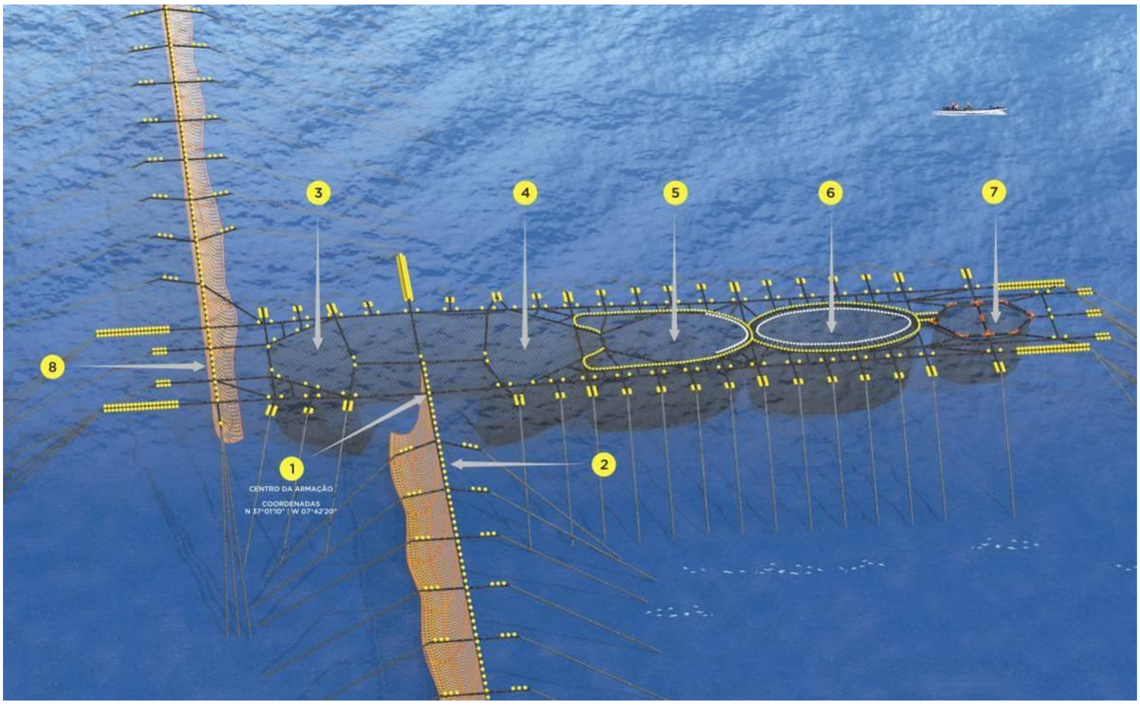

Fig. 2. Scheme of the Tunipex tuna trap in the Algarve, Southern Portugal (NE Atlantic), with details of the entrance and center of the trap (1), leading nets (2 and 8), playground net (3), ascending slope net (4), box net (5) and crawls (6 and 7).

4.2. Satellite tagging operations and logistics

As specified in the detailed proposal that was submitted and detailed in Deliverable 1, the tagging coordinator for the project was Mr. Alfredo Poço (Tunipex). Mr. Alfredo Poço has more than 20 years experience on the daily handling operations of tuna traps and performing regular dives in the traps, and has also considerable experience tagging bluefin tuna, as well as other species like sharks, in the tuna traps.

The tagging protocol adopted for deploying the satellite tags was the preferred option as specified in the call for tenders and in the detailed proposal. In general, the methodology for tagging followed Mariani et al (2015) with the improvements reported in SCRS/2015/181.

The tags were Wildlife Computers miniPATs with an intra-muscular tag applicator that were provided already rigged by ICCAT/GBYP. The detailed instructions on the program to be used in the tags (deployment duration, data types to be collected and transmitted, periodicity of data collection and transmission, as well as all other tag programming specifications), were also provided by ICCAT/GBYP. **Annex I** shows an example of a tagging template used in the satellite tags. The sub-contractor (IPMA) received the tags from ICCAT, and programmed the tags locally using this programming template through the Wildlife Computers online Tag Portal.

For the tagging logistics and operations, the contractor Tunipex used its 2 main boats (length 22m, 800hp) and the 2 smaller boats (length 7m, 160hp). Those are the boats used in the regular tuna trap operations, and were used to provide assistance during the tagging operations to the trap operators, divers, the underwater stereoscopic camera operators and the IPMA (sub-contractor) personnel that were present.

With the tagging option adopted, the tunas were tagged by divers directly underwater using a long pole. All divers were hired personnel by the tuna trap that have substantial work experience in the regular work (including underwater) of the tuna trap operations. Several additional divers were underwater at all times to record images and perform assistance during the operations (**Fig. 3**). An underwater stereoscopic camera was used, that was operated by one scuba diver and had one permanent onboard operator (**Figs 4 and 5**). Additionally, for collecting additional imaging during the tagging operations, both tagging poles used (two) were equipped with fixed underwater GoPro cameras (**Fig. 6**).

Fig. 3. Divers (taggers, assistants and video operators) preparing for the underwater tagging operations. This operation was taking place in the box net, where around 40 tunas were isolated from the rest of the school during tagging.

Fig. 4. Underwater stereoscopic camera used during the tagging operations.

Fig. 5. Recording video from the underwater stereoscopic camera during the tagging operations.

Fig. 6. The tagging coordinator, Mr. Alfredo Poço, preparing a satellite tag in one of the underwater tagging poles. A 2nd pole is visible with a fixed GoPro camera.

4.3. Conventional tagging

Opportunistic tagging was carried out on other fish from the same school as the satellite tagged fish, but not on the same fish in order to avoid additional stress on the satellite tagged tuna. Double tagging was planned and carried out, with the use of 1 single barb tag and 1 large double barb tag on each tagged specimen. All tags and applicators were provided by ICCAT/GBYP.

Tagging for conventional tags used the same protocol as the satellite tagging, with the double tags rigged at the extreme of long tagging poles and the tagging taking place underwater by experienced divers.

4.4. Biological sampling

Biological sampling was carried out during the tagging activities, in fish from the same school but not on the same fish in order to avoid additional stress in the satellite tagged fish.

The samples collected were muscle for genetic analysis. The biological sampling was conducted according to the protocols adopted by the contractor in charge of the biological and genetic sampling and analyses. Specifically, a piece of muscle tissue was collected and stored in non-denatured Ethanol 96%, in 5ml tubes, that were labeled according to the labeling codes used in GBYP. The samples are currently stored in cold at IPMA and will be shipped later to the laboratory in charge, or possibly hand delivered to researchers from that Institute.

4.5. Data recording and reporting

While tagging, the divers estimated the specimen weights that were properly recorded. As mentioned before, the divers are extremely experienced personnel that have substantial work experience in the regular trap operation work, and are used to underwater estimate weights of the fish in the tuna traps with very good accuracy. Additionally, the images from each of the GoPro cameras rigged in each of the tagging poles and from the underwater stereoscopic camera and then analyzed to further revise the estimated specimen weights (RDW - round weight) of the tagged bluefin tuna. The specimen sizes (SFL - strait fork length) were then converted from RDW using the Rodriguez-Marin (2015) equations, in this case specifically for eastern bluefin tuna for the month of July, that are included in the ICCAT manual Appendix 4-III (ICCAT, 2006-2016).

All data, including the serial and PTT numbers of each tag, the size/weight estimate of each specimen, the condition/injuries of the specimens, and other notes (e.g., sea surface temperature, cloud coverage, wind speed, etc) were properly recorded. All data were recorded in the appropriate ICCAT tagging forms. Specifically, the survey summary data were reported in file template "TG01-CnvEleTSurv.xlsx", the electronic/satellite tagging were reported using file template "TG03-EleTReRc.xlsx" and the additional conventional tags deployed were reported using file template "TG02-CnvTReRc.xlsx".

5. FULL DESCRIPTION OF THE WORK CARRIED OUT

5.1. Satellite tagging

A total of 25 satellite pop-up tags (miniPATS from Wildlife Computers) were sent by ICCAT to the sub-contractor (IPMA) for deployment in adult bluefin tuna (> 30 kg). As referred in the tagging protocol, IPMA programmed the tags before deployment using the tagging template prepared by ICCAT/BGYP that is available from the Wildlife Computers online Tag Portal (**Annex I**).

The bluefin tuna traps quota in Portugal closed in mid-July, and after that period the Tunipex prepared the tuna trap for the tagging operations, which took several days while in stand-by for the tagging activities.

A large school with an estimated size of 550 specimens entered the trap over the weekend of 16-17 July, remaining in the playground net area. The following days were devoted by Tunipex for the preparation of the tagging activities, that would take place in the box net. Specifically, the box net was divided into two separated areas, in order to have the satellite tagged tuna in a separate and quiet environment, therefore avoiding any additional stress and possible mortality events. The tagging operation took place on the 22 July, when approximately 40 randomly selected specimens were separated from the main school and lead into the subdivision area of the box net, for the satellite tagging operations. This allowed for a very quiet and non-stressful environmental for the tunas that were therefore swimming in a much slower manner and easier to tag successfully (**Fig 7**). After tagging, the satellite tagged tunas were placed with the remaining school in the main area of the box net, and released together with the entire school.

Of the 25 miniPATS prepared, 24 were successfully deployed in bluefin tuna (**Figs 8, 9, 10 and 11**). In one specific case the attachment section of the tag broke by the RD1800 release device during the tagging process. That tag was recovered, put back in stand-by mode as it had activated during the tagging attempt, and transported back to the ICCAT Secretariat.

All tagged bluefin tuna were adults, with estimated round weights ranging between 120 kg and 250 kg (average RDW = 173.3kg, SD = 28.5). After conversion the individual weights to sizes (RDW-SFL) with the Rodriguez-Marin (2015) equation (eastern bluefin tuna for July), the estimated SFL ranged between 189 and 244 cm (average SFL = 213.7 cm, SD = 12.1). The summarized information on the tagged specimens is presented in **Table 1** (section 5.6) of this report. The detailed information is provided in the ICCAT electronic tagging reporting forms.

Fig. 7. The tagging coordinator, Mr. Alfredo Poço, supervising the tagging operations, and preparing a tagging pole with a fixed GoPro camera for satellite tag deployments.

Fig. 8. Tagging a bluefin tuna. It is possible to see the diver preparing for deployment of the satellite tag using the long pole with the rigged satellite tag at the end, and a GoPro camera fixed in the tagging pole. This image is captured from another GoPro camera operated by another diver.

Fig. 9. Tagging a bluefin tuna. It is possible to see the diver preparing for deploying the satellite tag, using the long pole with the rigged satellite tag at the end and a GoPro camera fixed in the tagging pole. It is also possible to see the operator of the stereoscopic camera in the background and the umbilical cord of the camera (yellow cable). This image is captured from another GoPro camera operated by another diver.

Fig. 10. Tagging a bluefin tuna. Image captured from one of the GoPro cameras rigged in each of the tagging poles.

Fig. 11. Tagging a bluefin tuna. Images (left and right) captured from the stereoscopic underwater camera.

5.2. Conventional tagging

A total of 144 conventional tags (double tagging) we deployed on 79 bluefin tuna specimens (**Fig. 12**). As explained previously, those specimens tagged with conventional tags were specimens from the same school as the satellite tagged fish, but not the same fish in order to avoid additional stress on the satellite tagged tuna.

There was an attempt to double tag all the conventionally tagged specimens, specifically with 1 single barb tag and 1 large double barb tag (provided by ICCAT/GBYP). The double tagging with both tag types was successful in 66 specimens. For 12 of the remaining specimens only the large double barb tags were successfully deployed, as the single barb broke while tagging. On one case, only the single barb was successful and the double barb tag failed. Specimen sizes were estimated underwater by the divers and are reported in detail in the respective ICCAT conventional tag reporting forms. In summary, the estimated total weight (RWT) of the specimens tagged with conventional tags ranged between 100 kg and 280 kg (average RWT = 163.7kg, SD = 34.3). After conversion of the individual weights to sizes (RDW-SFL) with the Rodriguez-Marin (2015) equation (eastern bluefin tuna for July), the estimated SFL of the conventional tagged specimens ranged between 177 and 253 cm (average SFL = 208.6 cm, SD = 15.4). The summarized information on the tagged specimens is presented in **Table 1** (section 5.6) of this report. The detailed information is provided in the ICCAT conventional tagging reporting forms.

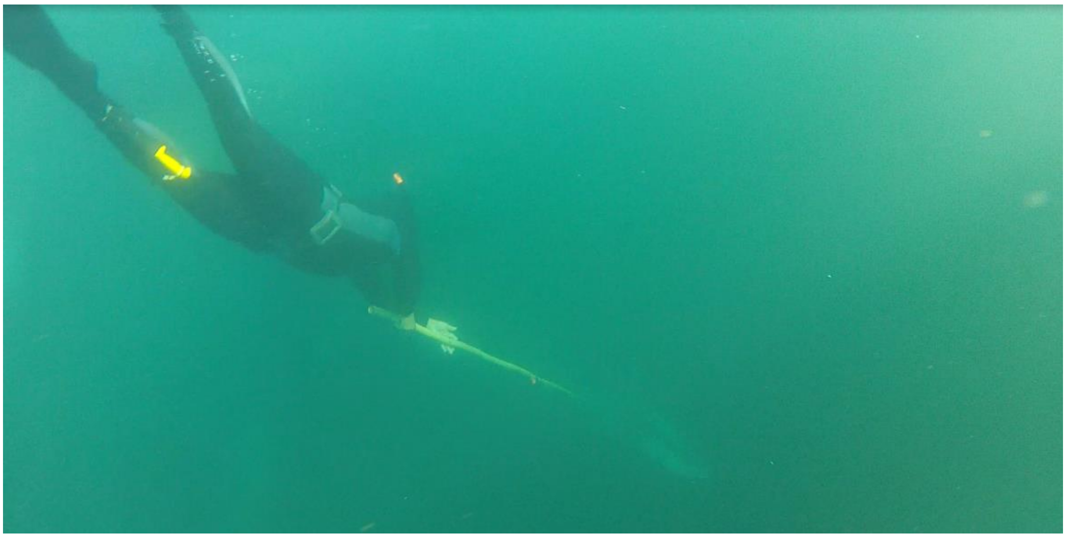

Fig. 12. Tagging additional bluefin tuna with conventional tags (double tagging with 1 single barb tag and 1 large double barb tag).

5.3. Biological sampling

Tissue samples (muscle) for genetic analysis were collected from 16 additional specimens (**Fig 13**). All data were recorded and will be sent to the GBYP biological sampling contractor. The samples are currently stored in cold at IPMA in non-denatured Ethanol 96%, and will be shipped or hand delivered to the Institute in charge of the GBYP biological sampling.

Fig. 13. Collecting biological tissue samples.

5.4. Detailed tables with the definitive number of tagged specimens by area, size composition and type of tag

The summarized information of the definitive numbers of tagged specimens by tag type and size class is shown bellow in **Table 1** and **Fig 14**.

Table 1: Detailed table with the definitive number of tagged specimens by size composition (10 cm SFL size classes) and type of tag. All specimens were tagged in the Tunipex tuna trap in Southern Portugal, NE Atlantic (Lat: 37.0194 North, Long: 7.7056 West).

Size class (10 cm FL)	Satellite (miniPAT)	Conventional - double tagging (Dart 1)	(Dart 2)	Total
170		4	5	9
180	1	9	9	19
190	3	9	12	24
200	5	11	13	29
210	9	19	23	51
220	4	10	11	25
230	1	3	4	8
240	1			1
250		1	1	2
Total	**24**	**66**	**78**	**168**

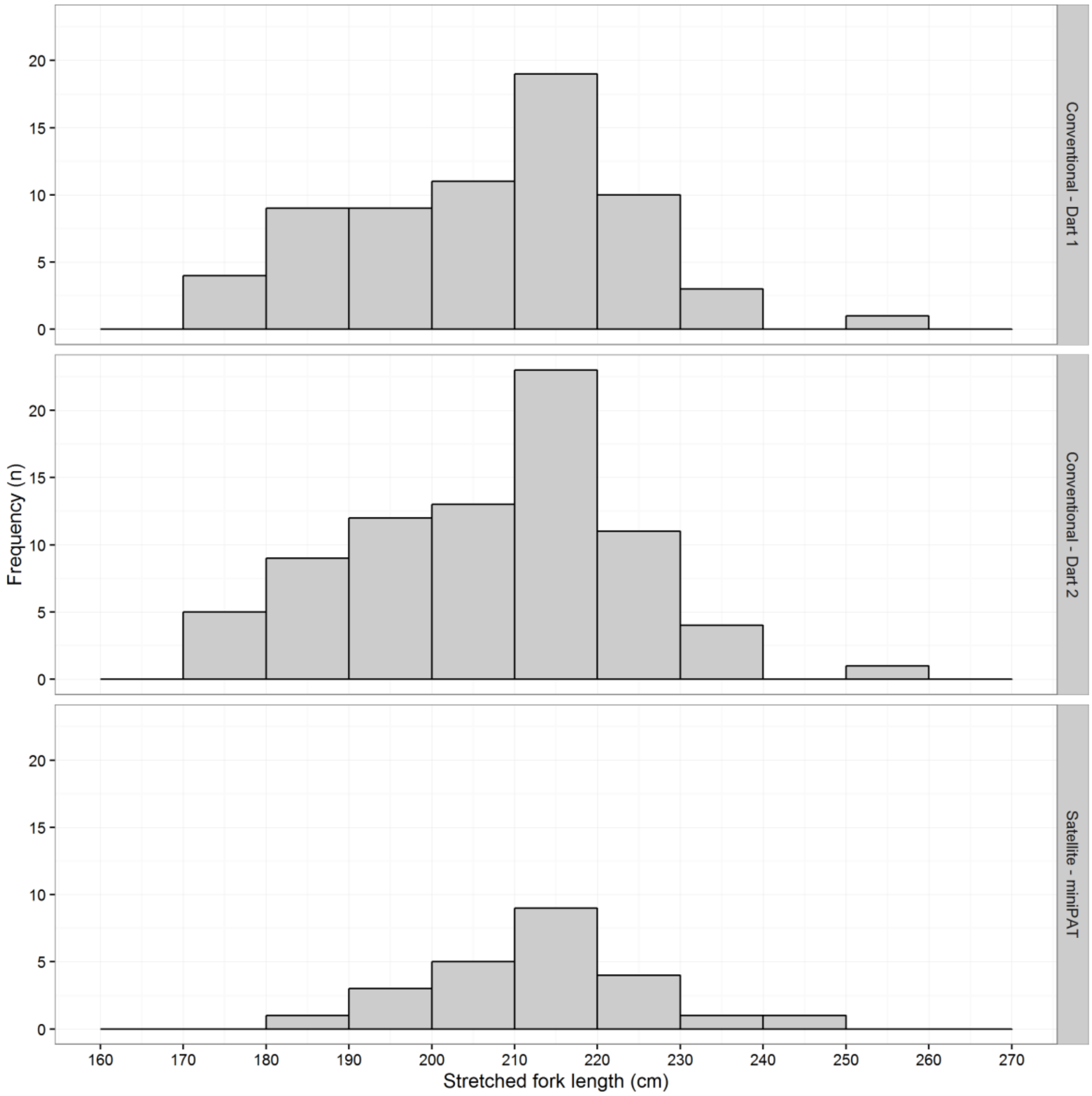

Fig. 14: Size distribution of the definitive number of BFT specimens tagged, by size composition (10 cm SFL size classes) and type of tag. All specimens were tagged in the Tunipex tuna trap in Southern Portugal, NE Atlantic (Lat: 37.0194 North, Long: 7.7056 West). Note that most specimens tagged with conventional tags were doubled tagged with one single and one double barb tags.

6. DATA INPUT WORKSHEETS FROM THE ICCAT TAGGING DATABASE

As specified in the detailed description of the methods, all data was recorded during the field mission and is reported to ICCAT in the appropriate ICCAT tagging forms. Specifically, the followign files were provided to the ICCAT Secretary:

- TG01-CnvEleTSurv_PRT_GBYP6_FINAL.xlsx: Summary of tagging activities (campaigns & others) [Form-A].

- TG02-CnvTReRc_PRT_GBYP6_FINAL.xlsx: Conventional Tag release-recovery data (Version: v11).
- TG03-EleTReRc_PRT_GBYP6_FINAL.xlsx: Electronic Tagging Release - Recovery Information (Version: v11).

7. RECOMMENDATIONS FOR ADJUSTING THE TAGGING STRATEGY FOR FUTURE PHASES OF ICCAT GBYP

7.1. Satellite tagging

- Underwater *vs* onboard tagging: All BFT were tagged underwater during this project. In the project proposal, there was also the option of tagging onboard, as an alternative method. We believe that the method used (underwater tagging) is appropriate, as it allows for an efficient and fast tagging process, with low stress for the tagged specimens and in this case producing no mortality events. Therefore, in the future we **recommend** keep using this technique of underwater specimen tagging. Alternative methods as onboard tagging may still be considered, but the underwater tagging technique should be maintained as the main tagging option.
- Specimen weight estimations: The individual specimen weights were estimated with a combination of underwater visual estimations from the divers while tagging and a posterior verification with the video recordings, both from the GoPro cameras rigged in the tagging poles and from the underwater stereoscopic camera. We **recommend** to keep this combination of various weight estimation methods during the tagging process, as it provides additional information for verification of the estimated individual specimen weights.

7.2. Conventional tagging

- Efficiency of double tagging: As in previous years, the Tunipex tuna trap and IPMA scientists tried to double tag BFT specimens with conventional tags. In this specific year the main difference was that the conventionally tagged specimens were from the same school as the satellite tagged specimens. As in previous years, it was noted again that the single barb tags tend to fail more than the double barb tags during the deployment process. As such, if at some point in the future there is the need to select only one type of conventional tag type for BFT, we **recommend** using the double barb tags.

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ANNEX 1

Example of the tagging template used in the ICCAT/GBYP Phase 6 satellite miniPAT tags. This template was created by ICCAT and the sub-contractor (IPMA) used it to program the tags before deployment.

```
Serial Number: 16P0352
Report date: 07-Jul-2016 10:53:32 UTC
  General
    Tag Identification
      Serial Number  16P0352
      Tagware Version  2.4n
    Argos PTT
      PTT Uplink ID  15830:19
      PTT ID Dec  162961
      PTT ID Hex  F75A213
      Repetition Interval  60 seconds
  Data To Transmit
    Daily Messages
      Light Level Geolocation Messages  Always Transmit
      Daily Data Messages  Never Transmit
    Time-Series
      Depth Messages  Always Transmit
      Temperature Messages  Always Transmit
      Sampling Interval  600 Seconds
    Summary Messages
      Transmit MLT Messages  Always Transmit
      Transmit Histogram Messages  Always Transmit
      PDT Messages  Always Transmit
        PDT Resolution  low
      Summary Period  24 Hours
      Histograms
        Time-at-Temperature (C)
          Number of TAT Bins  12
          TAT Limits  3;6;9;12;15;18;21;24;27;30;33;>33
        Time-at-Depth (m)
          Number of TAD Bins  12
          TAD Limits  0;2;10;20;50;100;150;200;300;400;500;>500
  When To Release
    External Release Device False
    Planned:
      Date or Days after deployment:   365 days
    Exceptions:
      Immediately Release if depth exceeds 1700m:  False
      The Following events will trigger a Release if depth exceeds:  10 meters
      And the event lasts longer than:  3 days
        Floats at surface  False
        Stays Deeper than:  Disabled
        Constant Depth Range  (+/- 2.5m)
    Flash size (MB)  64
    Archive Storage Capacity (KB)  65377
    All Sensors Sampled at a Rate of  3 Seconds
    Homing Pinger Setup
      Enable Homing Pinger  False
      Ping Interval  1 seconds
```