REVIEW OF THE ICCAT-GBYP TAGGING ACTIVITIES 2010-2014

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SUMMARY

The ICCAT GBYP tagging activities were launched in Phase 1, by adopting a tagging design and manual, and then carried out in all the following Phases. The tagging activity in 2014 was minimal, due to budget constraints. A total of 24,236 tags have been implanted so far, including several electronic tags, with 7,807 double tagging. Tag awareness and recovery activities were launched in Phase 2 and being pursued during all Phases, including Phase 4. A field tag awareness programme was implemented in 2014 in several countries. Up to date, a total of 216 tags have been reported and recovered, but it is still hard, in several cases, getting together both tag release and tag recovery data, because not all releases are reported to ICCAT. The tag recovery is clearly improving in the last two years, as a result of the GBYP activities, marking a difference between the period previous to GBYP and the current one.

RÉSUMÉ

Les activités de marquage du GBYP/ICCAT ont été lancées dans la Phase 1 en adoptant un schéma et manuel de marquage et ont ensuite été réalisées dans toutes les phases suivantes. En 2014, les activités de marquage ont été au point mort en raison de contraintes budgétaires. Jusqu'à présent, 24.236 marques ont été implantées, dont plusieurs marques électroniques et le double marquage de 7.807 spécimens. Les activités de sensibilisation et de récupération des marques ont été lancées dans la phase 2 et se sont poursuivies pendant toutes les phases, y compris la phase 4. En 2014, un programme de sensibilisation aux marques sur le terrain a été mis en œuvre dans plusieurs pays. Jusqu à ce jour, 216 marques ont été signalées et récupérées, mais il est encore difficile, dans plusieurs cas, de rassembler les données de remise à l'eau et de récupération des marques, car les remises à l'eau de marques ne sont pas toutes déclarées à l'ICCAT. La récupération des marques s'est de toute évidence améliorée au cours de ces deux dernières années, comme suite aux activités du GBYP, ce qui marque une différence entre la période antérieure au GBYP et la période actuelle.

RESUMEN

Las actividades de marcado del GBYP ICCAT se iniciaron en la Fase 1, adoptando un manual y un diseño de marcado que posteriormente se llevaron a cabo en las siguientes fases. Las actividades de marcado fueron mínimas en 2014 debido a limitaciones presupuestarias. Se han implantado hasta ahora 24.236 marcas, incluidas varias marcas electrónicas, con 7.807 dobles marcas. Las actividades de concienciación y recuperación de marcas se iniciaron en la Fase 2 y se han continuado durante las demás fases, incluida la Fase 4. En 2014 se implementó en varios países un programa de campo de concienciación sobre marcado. Hasta la fecha, se han comunicado y recuperado en total 216 marcas, pero sigue siendo difícil, en algunos casos, obtener los datos tanto de colocación como de recuperación de las marcas, porque no todas las marcas colocadas se comunican a ICCAT. La recuperación de marcas ha mejorado claramente en los dos últimos años, como resultado de las actividades del GBYP, marcando una diferencia entre el periodo anterior al GBYP y el actual.

KEYWORDS

Tagging, Bluefin tuna, Distribution range, Tag recovery, Awareness

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1. Introduction

The main objectives of the ICCAT Atlantic-Wide Research Program on Bluefin Tuna (GBYP) are to improve: (a) the understanding of key biological and ecological processes, (b) current assessment methodology, (c) management procedures, and (d) advice.

Key tasks are to reduce uncertainty in stock assessment and to provide robust management advice. This requires improved knowledge of key biological processes and parameters. However, currently almost all the data used in stock assessments are obtained from the fisheries-dependent sources. After the adoption of a bluefin tuna quota, the data (which were already defined as "unreliable" by the SCRS, became almost useless for any assessment purpose. It is, therefore, important to obtain data from alternative fishery-independent sources, such as tagging studies, in order to verify the assumptions made when conducting the assessments. A well-designed tagging programme, being developed over several years and with a progressive methodological approach, will therefore be important to improve our understanding of bluefin tuna ecology and ethology and for developing more accurate stock assessment methods.

An ICCAT GBYP Tagging Design and an ICCAT GBYP Tagging Manual, written by IEO, were approved and officially adopted after the presentation to the SCRS at the beginning of GBYP Phase 2 (http://www.iccat.int/GBYP/Documents/TAGGING/PHASE%201/Annex%201.%20Tag%20design%20report_fin_rev.pdf and http://www.iccat.int/GBYP/Documents/TAGGING/PHASE%201/ICCAT%20GBYP%20TAGGING%20MANUAL_fin_rev.pdf).

The adoption by the ICCAT Commission of the Rec. 11-06, which allows GBYP to use up to 20 tons per year of bluefin tuna for research purposes, permitting also derogation from the minimum size and allowing for the use of all fishing gears at any time of the year for biological sampling and tagging, was an essential step forward for carrying on the tagging programme (see Di Natale 2015).

Over the last decades, the tag recovery and the tag reporting rates for bluefin tuna in the eastern Atlantic and the Mediterranean Sea have been extremely low; these rates have been roughly estimated in past years to be less than 5% in the eastern Atlantic (almost exclusively Bay of Biscay) and less than 0.5% in the Mediterranean Sea, including also specific non-ICCAT activities (STECF, 2008). This situation is possibly due to many factors, among which the lack of both awareness and an adequate communication, together with the unfortunate attitude of several fishermen and fisheries not to report the tags eventually found, undermining all efforts.

One of the tasks assigned to ICCAT GBYP is to improve this situation, also taking into account the larger number of networks and stakeholders concerned as compared to some years ago and the increasing number of communication possibilities existing now. One tool is the policy of improving "a reward per tag", which could be the way to thank the fishers and/or the stakeholders for their collaboration. At the same time, some "high rewards" were established (i.e., for the recovery of electronic tags, a GBYP annual lottery, etc.).

Another tool is the awareness and communication campaign, which is particularly difficult because of such a huge ICCAT Convention area which includes many countries, with a variety of peoples, languages, cultures and educational levels, as well as an extensive variety of fisheries and fishers (industrial, artisanal and recreational). Tag awareness posters and stickers, printed in 12 languages, have been disseminated by ICCAT-GBYP in all countries and in many fisheries (see: http://www.iccat.int/GBYP/images/mapamunditicks.jpg).

2. Objectives

The essential elements of the on-going ICCAT-GBYP tagging activity are:

- Carry out a challenging tagging scientific programme with the objective of improving the general and scientific knowledge of the bluefin tuna, which is essential to properly manage this important fish resource in a sustainable way. The specific objectives of the tagging design in relation to conventional tagging are:
    1. Validation of the current stock status definitions for populations of bluefin tuna in the Atlantic and Mediterranean Sea. It is particularly important to consider possible sub-stock units and their mixing or population biomass exchange in the Mediterranean Sea.

2. Estimate the natural (M) and or total mortality (Z) rates of bluefin tuna populations by age or age-groups.
3. Estimate natural growth rates (possible both in length and weight).
4. Estimate tagging reporting rates for conventional tags, by major fishery and area, using the observer programs currently deployed in the Mediterranean fisheries.

While in relation to the potential use of electronic tags the objectives are

5. Evaluate habitat utilization and movement patterns (spatio-temporal) of the spawning population with emphasis on: (I) vertical and horizontal distribution patterns of the spawning stock, to help calibrate the aerial surveys and estimate sighting probabilities; (II) investigating how mature specimens use the spawning grounds (e.g., do bluefin tuna visit the same spawning grounds every year to the exclusion of all others, or do they visit several spawning sites and, if so, over what periods). Additional objectives are related to a general improvement of bluefin tuna distribution (both juveniles and adults) patterns in the ICCAT convention area.

- Define the most appropriate tagging techniques and approaches, by testing the tagging possibilities with various gears, in different areas and for different fish size.
- Test various types of conventional tags with the purpose of defining the most resistant and appropriate.
- Try to provide detailed results by using various types of electronic tags.
- Improve the tag reporting quality of the data.

The specific objectives of the GBYP awareness campaign for the bluefin tuna tagging programme were set as:

- Improve the general knowledge about the ICCAT GBYP tagging programme.
- Increase the awareness of all the bluefin tuna stakeholders about the GBYP Tagging Programme and tag recovery and reporting activities.
- Provide rewards and dedicated feedbacks for all tags reported.
- Improve tag recovery and reporting rates.

3. Methods

At first, ICCAT GBYP acquired a considerable amount of tags during these first Phases of the programme, allowing both the tag delivery to all stakeholders who have a bluefin tagging activity (either opportunistic or institutional) and to the GBYP contractors. In detail, ICCAT-GBYP acquired the followings:

- No. 30000 single barb conventional spaghetti tags
- No. 18000 double-barb small billfish conventional spaghetti tag
- No. 12000 double-barb large billfish conventional spaghetti tag
- No. 2400 applicators for single barb tags
- No. 5273 applicators for double-barb small billfish tag
- No. 5072 applicators for double-barb large billfish tag
- No. 85 mini-PATs pop-up electronic tags
- No. 10 applicators for mini-PATs
- No. 50 internal archival tags

Furthermore, additional tags were made available by other institutions:

a) 35 mini-PATs by WWF-MedPO (implanted in Morocco and in the Mediterranean Sea)
b) 8 mini-PATs by the Stanford University (USA) (implanted in Morocco)
c) 8 acoustic tags provided by Stanford University (USA) (implanted in Morocco)
d) 5 mini-PATs by the St. Andrews Biological Station (CAN) (implanted in Canada)
d) 1 mini-PAT by Aquastudio Research Institute (EC-ITA).

Furthermore, GBYP acquired a total of 40 PIT readers, but then PIT tags, which have been planned in Phase 2, were not used because of some legal problems raised by an ICCAT CPC.

Many posters were used for the tag awareness campaign, along with a similar number of stickers, in 12 languages. Tag awareness posters were partly revised and reprinted in 2014. A dedicated budget item was set for tag rewarding and the annual ICCAT GBYP tag lottery.

4. Tag awareness campaign and tag rewarding policy

The tag awareness activity is considered essential for improving the very low tag reporting rate existing so far in the Eastern Atlantic and the Mediterranean Sea. The tag awareness material was produced in 12 languages, considering the major languages in the ICCAT convention area and those of the most important fleets fishing in the area: Arabic, Croatian, English, French, Greek, Italian, Japanese, Mandarin, Portuguese, Russian, Spanish and Turkish. In total, more than 15,750 posters of various sizes (A1, A3 and A4) and more than 18,000 stickers were produced so far; two posters and all stickers were revised in 2014. All posters are also available on the ICCAT-GBYP web page http://www.iccat.int/GBYP/en/AwCamp.asp . The SCRS and the ICCAT Commission were both informed about the campaign. A capillary distribution of the tag awareness material was carried out directly by GBYP, sending copies to all stakeholders such as: Government Agencies, scientific institutions, tuna scientists, tuna industries, fishers, sport fishery federations and associations, the RFMOs and RACs concerned; the coverage was complete in the ICCAT Convention area, including also non-ICCAT countries and entities fishing in the area. The map clearly shows the distribution effort (**Figure 1**). The ICCAT-GBYP web page has the full list of contacts http://www.iccat.int/GBYP/images/mapamunditicks.jpg.

The GBYP staff actively participated every year to the formation of ICCAT ROPs, with a specific focus on tag awareness and tag recovery, but also for having reports of any natural tag in bluefin tuna harvested in farms.

Following the Steering Committee recommendation, a Call for tenders was launched and awarded in 2014. The Consortium in charge has the objective to further promote the tag awareness to all stakeholders in the main fishing areas in the eastern Atlantic and the Mediterranean, with a major attention to farms and traps, through direct contacts, promoting also the dissemination of press releases and videos. The basic material was provided to the contractor by GBYP. The draft final report was provided to ICCAT GBYP on September 12 and it is currently under revision.

Posters are now present in most of the ports where bluefin tuna are usually or potentially landed, in tuna farms, tuna traps, industries, sport fishers clubs, fishers associations, bars where fishers are usually going, local port authorities and on many fishing vessels. Some articles were also promoted and they have been published on newspapers and magazines. According to the first data, this activity is a starting to provide better tag reporting results.

Following the recommendations made by SCRS and the GBYP Steering Committee, the ICCAT-GBYP tag reward policy was considerably improved since the beginning, with the purpose of increasing the tag recovery rate which was extremely and unacceptably low. The new strategy includes the following rewards: spaghetti tag 50€/ or a T-shirt; electronic tag 1000 €; annual ICCAT-GBYP lottery (September): 1000 € for the first tag drawn and 500 € each for the 2nd and 3rd tag drawn. According to the first data, this policy (along with the strong tag awareness activity) was very useful for considerably improving the tag reporting.

5. Tagging activities

Since the beginning of GBYP, it was established to implant double conventional tags on a target of 40% of tagged tunas. One of the tags shall be a single-barb and the second a double-barb of one of the two types (billfish or large billfish), depending on the size of each fish. This method should allow evaluating the more resistant type of tags to be used in future trials.

The ICCAT-GBYP tagging activity was based on the recommendations provided by the GBYP Steering Committee and on annual contracts, released after public Calls for tenders.

In Phase 2 the conventional tagging activity was carried out by a Spanish Consortium, headed by IEO, which used baitboats in the Bay of Biscay and in the Strait of Gibraltar and purse-seiners in the Mediterranean, targeting mostly juvenile bluefin tunas. An experimental electronic tagging activity on adult bluefin tunas was organised in a Moroccan trap, under a cooperative agreement among the INRH, the Moroccan Tuna Trap industry, the Fuentes Group and WWF-MedPO, with the support of the Moroccan Fishery Authorities and ICCAT-GBYP. All activities are summarised on **Table 1**.

In Phase 3 the conventional tagging and electronic tagging activities were carried out by another Spanish Consortium, headed by AZTI, which used baitboats in the Bay of Biscay, in the Strait of Gibraltar and in the Mediterranean, targeting juvenile bluefin tunas. The electronic tagging in the Moroccan traps was also conducted by the same cooperative team which was active in Phase 2. All activities are summarised on **Table 2**.

The Steering Committee, in December 2012, adopted a different tagging strategy for Phase 4 which included some pilot tagging activities. As a matter of fact, the activities in Phase 4 were much more complex, trying to improve the tagging possibilities. In Phase 4 (2013) the conventional tagging and electronic tagging activities were carried out by a Spanish Consortium, headed by AZTI, which used baitboats in the Bay of Biscay and in the Strait of Gibraltar. The work in the Moroccan tuna traps was carried out by an international Consortium headed by INRH, who carried out both electronic and conventional tagging on adult bluefin. Adult bluefin tunas have been also experimentally conventionally tagged underwater in Sardinian traps by an Italian Consortium headed by COMBIOMA, and using purse-seiners in the Tyrrhenian Sea by another Italian Consortium headed by UNIMAR. Juvenile bluefin tunas were conventionally and electronic tagged using purse-seiners and cages in the Adriatic Sea by a Croatian Company, Kali Tuna; an experimental complimentary tagging activity on adult bluefin tunas released from cages in Malta was carried out by Oceanis srl. A complimentary electronic tagging on giant tunas was carried out in Canada by the St. Andrews Biological Station.

No institutional GBYP tagging was possible in 2014, due to serious budget constraints. Still in Phase 4 but in 2014, several complimentary activities have been agreed between GBYP and various institutions: an electronic tagging on pre-spawners was carried out in Moroccan traps, with a cooperative work which included the Moroccan Trap Association, the INRH and the Stanford University; other complimentary conventional tagging activities on pre-spawners were carried out in the Sardinian tuna traps by COMBIOMA and by Oceanis srl. All activities are summarised on **Table 3**.

Complimentary tagging is carried out by various entities, including sport fishermen, in several areas but mostly in the Mediterranean Sea.

Up to 15 September 2014[3], ICCAT-GBYP tagged 16,631 bluefin tuna through Phases 2, 3, and 4 (without counting those implanted this last phase in Strait of Gibraltar), implanting a total of 24,237 tags of various types. Among these, 6,364 bluefin tunas were double tagged, reaching 46.9% of the fish, a percentage which is well over the target. Electronic tags (both pop-up and archival) have been regularly implanted during these first Phases. All tagging activities are summarised on **Table 4**.

The progression of tagging activities during these four Phases of ICCAT GBYP was impressive and it is better visible on **Figure 2**. The distribution of tags in the various areas (**Figure 3**) appears unbalanced compared to the distribution of bluefin tuna catches, but it is according to the strategies decided by the Steering Committee and the SCRS and the practical opportunities for carrying out the tagging.

6. Tag recovery data processing and analysis

All entities contracted for tagging purposes since the first year of the ICCAT GBYP tagging programme (Phases 2, 3 and 4) are requested to provide the tag release data in the specific ICCAT data base form developed by the Secretariat. These data go through a quality control process set by GBYP before incorporating them in the ICCAT tagging data base. This is a process routinely developed along with the validation of all the reports (deliverables) provided by the ICCAT-GBYP contractors.

The necessary follow-up is the tag recovery. ICCAT-GBYP is currently in charge of taking care of all data recovered from bluefin tunas, independently from the entity which tagged the fish or the type of tag. Every time a tag is reported to ICCAT-GBYP, it activates a process in order to get all the necessary data. These recovery data are quality verified together with the tag release data and cross-checked. This quality process is extremely important and sometimes takes months to be finalized if not all data are available or if a tag was implanted by an entity which never reported to ICCAT the tag release data. If a recovered tag was implanted by an entity which is not an ICCAT-GBYP contractor, then the recovery data are transmitted to this entity as soon as all necessary data have been quality checked by ICCAT-GBYP. A tag reward can be released only when all necessary recovery data are properly reported to GBYP, including all details about the person or entity reporting the tag and this last part of data acquisition sometimes takes many weeks. The information about the tag release data is usually provided to the person who provided the recovery to ICCAT GBYP.

[3] The data are referred to tag deployment activities reported to ICCAT GBYP and incorporated in the ICCAT data base; some complimentary tagging activities are still to be incorporated, because data arrived too late or in inappropriate formats.

A separate GBYP specific data base "Tag Release/Tag Recapture" was created in order to handle this information without jeopardizing the ICCAT Data base. Each year, at the beginning of September, GBYP transmit all tag release and tag recovery data which have been fully quality-checked to the ICCAT tag data base, for officially incorporating them in the system. At the same time, the tag recovery data will be used for the annual ICCAT GBYP lottery; all bluefin tuna tags reported after the 5th of September will go to the next year ICCAT GBYP lottery.

For the preliminary analysis of the tag recovered and reported to GBYP, a focus was made on:

- The summary number of each type of implanted tags.
- Their distribution among the different areas (fishing grounds).
- The tag recovery/reporting by the different fishing gears (fisheries).
- The annual trend of the tags recoveries, starting from 2006, the first year available in the data set, up to September 2014 (ongoing phase 4 of ICCAT GBYP).
- The recoveries by calendar seasons (1st, 2nd, 3rd and 4th quarters).

7. Results

While considering the results of the ICCAT-GBYP tag recovery/reporting activities, it is very important to consider that about 90% of the conventionally tagged fish in Phases 2, 3 and 4 were juveniles (age 0-3) (see data up to 2013 in Di Natale *et al*., 2014b); about 70% were surely immature fish (age 0-2) and then it is difficult for these fish to be caught by most of the fisheries, particularly taking into account the ICCAT minimum size regulation.

Up to the 15th of September 2014, there have been 209 tags recovered, over the 216 included in the tables, because the last 7 tags recovered by ICCAT in 2002-2009 were also included. The GBYP recoveries are summarized as follow:

- 133 Conventional "Spaghetti" tags (63.6% of the total)
- 50 Conventional "Double/Single barb" tags from double tagged fish (23.9% of the total)
- 17 External Electronic "mini-PATs" tags (8.1% of the total)
- 5 Internal Electronic "Archivals" tags (2.4% of the total)
- 3 Commercial "Trade" bluefin tuna tag (1.4% of the total)

In terms of fishing grounds (areas) where these 217 tags have been recovered (**Table 5**), these are the details:

1. West Atlantic: 4 tags (1.8%): 2 spaghetti, 1 internal archival and 1 trade tag;
2. North Atlantic: 4 tags (1.8%): 1 spaghetti, 1 Archival and 2 trade tags;
3. East Atlantic: 88 tags (40.7%): 76 spaghetti, 9 miniPATs, 2 internal archival and 1 trade tag;
4. Mediterranean Sea: 116 tags (53.7%): 109 spaghetti, 4 miniPATs and 3 internal archival tags;
5. Unknown area: 4 tags (1.8%), all miniPATs[4]

Concerning the fishing gears (fisheries) used to catch the bluefin tuna individuals carrying these tags at the moment of their capture, they are as follow (**Table 6**):

1. Bait boat: 63 tags (42.5%): all spaghetti tags;
2. Long line fisheries: 24 tags (11.1%): 22 spaghetti & 2 internal archival tags;
3. Farms: 22 tags (10.2%): 21 spaghetti, & internal archival tag;
4. Unclassified gears: 21 tags (9.7%): 17 spaghetti and 4 miniPATs;
5. Non-fishermen[5]: 17 tags (13.8%): 12 miniPATs, 1 internal archival and 4 trade tags;
6. Trolling: 9 tags (4.2%): all spaghetti tags;
7. Purse seine: 6 tags (2.8%): 5 spaghetti and 1 miniPAT;
8. Hand line: 6 tags (2.8%): all spaghetti tags;
9. Sport & Recreational: 5 tags (2.3%): all spaghetti tags;
10. Traps: 5 tags (2.3%): 3 spaghetti and 2 internal archival tags;
11. Rod & Reel: 4 tags (1.8%): all spaghetti tags;

Minor recaptures were obtained by other gears.

[4] These are tags reported by vessels, after a long fishing campaign, and the recovery location was not available. The location will be defined later, when the manufacturer will be able to recover the data stored inside the tags, if still possible.
[5] Non-fishermen are persons who found tags in open sea or washed ashore.

Table 7 shows that 90.28% of the recoveries have occurred during the last three years (2012-2014) over the period 2002-2013. The year 2012 (Phases 2-3 of GBYP), with 23.61% of these recoveries, is the first one after the beginning of the tag awareness activities enforced by GBYP. The recoveries in 2013 (43.98% of the total) were the higher so far, while the recoveries in 2014 (22.69%) are still partial.

The 3rd trimester (July – September) is the season during which most of the tag recoveries have occurred so far (103 tags, representing 47.7% of the total), followed by the 4th trimester (61 tags, representing 28.4% of the total) (**Table 8**). These data leave good chances for further improving when all 2014 recoveries will be included.

Double tagging was tentatively initiated in 2011, with the purpose to evaluate the best type of tags (single barbs, double barbs small or double barbs large) to be used, because all available previous studies were providing contrasting and non-definitive results. As reported above, a target of 40% double tagging was set by the Steering Committee but this target was overtake, tagging 46.9% of the fish (7,807 fish double tagged so far). Up to 15 September 2014, tags were recovered from 52 double tagged fish and both tags have been recovered from 44 fish (84.6% of the double tagged fish recoveries). 5 fish had only the billfish (double-barb) tag on, while 3 fish had only the single barb spaghetti on. According to these first data, it seems that both types of tags are quite resistant, with a slight prevalence (96.9%) of the double barb against the single barb ones (94.8%). **Table 9** details the double tagged recoveries, including also the year of deployment and the year of recapture.

It is extremely difficult and almost impossible at the moment to define a recovery rate for GBYP conventional tagging activities, taking into account that most of the conventionally tagged tunas were juveniles and they will be possibly available in most of the fisheries within the ICCAT Convention area only in future years. Whenever we consider, as a preliminary exercise, the number of tags recovered so far in comparison with the number of GBYP tags deployed, the provisional recovery rate is only 0.89%, but this rate is clearly negatively biased by the juvenile ages of more than 92.4% of the tagged fish, and positively biased by the presence of non-GBYP implanted tags. At the same time, it is impossible assessing the recovery rate of tags which were not deployed by ICCAT-GBYP, because ICCAT does not have the complete number of implanted tags by each tagging entity.

As concerns the results of the electronic tagging with miniPATs, most of them for Phases 2, 3 and for the initial part of Phase 4 have been already provided to SCRS and the Commission in 2012 and 2013 (Quílez-Badia *et al*., 2013a, 2013b; Abid *et al*., 2014; Di Natale *et al*., 2014a, 2014c). Further results were provided to the Tenerife SCRS Meeting in May 2013 and at the SCRS Bluefin Tuna Data Preparatory Meeting in May 2014.

It is important to note that several premature detachments[6] were noticed for mini-PATs since the beginning; this problem was discussed with various specialists and with the manufacturer Company. Different anchors were supplied by Wildlife Computers in Phase 4 and used by GBYP contractors and the situation is improving. The full analyses of the detachments will be possibly provided at the end of Phase 4.

The preliminary maps of the mini-PATs deployed by GBYP in the various areas and popped-off in the first part of Phase 4 are on **Figures 4** to **7**. The data from tags which transmitted corrupted data or those staying for less than 10 days at sea are not included in those figures. The most recent data concerning tag pop-off in Phase 4 which have been not processed up to May 2014 will be included in the final report of Phase 4. A very last-minute information, obtained from Ph.D. Barbara Block, informs about one of the tag implanted in Larache in May 2014, which popped-off in the south-eastern waters of Greenland in the first part of September 2014.

Some of the juvenile tunas electronically tagged in the Bay of Biscay are confirming that their movements in the short period are usually much extended, while one specimen showed extensive movements over a longer period of time; other remained in the same area. The juveniles electronically tagged in the Gulf of Lion shows a permanence in the Western Mediterranean Sea; only one specimen moved towards the Southern Mediterranean area, possibly for its first spawning. Those juveniles and young bluefin tuna electronically tagged in the Strait of Gibraltar had many varieties of movements: some of them remained closer to the Strait of Gibraltar, while others had more extensive movements and some of these latter reached well-known spawning areas.

[6] The full analyses will be carried out in next months, because in some cases it is not clear if the premature detachment was a real one or a catch.

The adult pre-spawners which were tagged in the Moroccan traps showed a general behaviour very similar to the one noticed in Phase 2 and Phase 3: a considerable percentage of individuals did not entered into the Mediterranean Sea for spawning during the spawning season and remained in Atlantic areas, independently from the tagging technique; this confirms the high interest of getting more data from this area. The preliminary data analyses of some selected tags presented during the Tenerife meeting showed the relevance of this tagging activity either for confirming spawning behaviour evidences or for calculating the time at the surface. This last point is very useful for better calibrating the aerial survey data in future analyses, as it was originally planned.

In 2013, for the first time within the GBYP activities, a first tentative trial of implanting pop-up tags in juveniles in the Adriatic Sea was enforced and the results shows that almost all fish remained in the Adriatic Sea, while one went SE of Malta in January 2014 (**Figures 8, 9 and 10**).

It will be particularly important to investigate the behaviour and the origin of the fish going to Moroccan traps before getting there and particularly in the last part of winter and the first part of spring. Anecdotic information collected by GBYP confirms that bluefin tuna is distributed in several parts of the southern Atlantic Ocean, but scientific data are missing for various reasons. The analyses of all mini-PATs released up to the date will be available at the end of Phase 4.

No bluefin tuna, tagged with electronic tags, went to the eastern Mediterranean and this fact, which possibly supports the evidence of a separate subpopulation, needs to be further investigated, possibly carrying out an electronic tagging activity in Turkey or in other eastern Mediterranean areas in next GBYP Phases.

8. Discussion

As reported above, the important tag reporting improvement registered after the beginning of the tagging and tag awareness activities by ICCAT-GBYP is impressive: the average recovery for the period 2002-2009 was only 0.77 tags per year, while the average of the GBYP recovery activities from 2010 to 2014 was 41.8 tags per year, with 5,429% increase. If we consider only the years after the beginning of the ICCAT GBYP tag awareness campaign and the enforcement of the new tag rewarding policy, then the average for the period 2002-2011 reach 1.9 tags by year, while the average for the period 2012-2014 (the last year being still partial) reach 65.7, with an increase in reporting of 3,457%.

The year 2013, when tagging activities were carried out in many areas and tag awareness activities were already settled, GBYP recovered a total of 95 tags, about 45.5% of the total over the whole period. It is possible that 2014 recoveries will be at a similar level at the end of the year. We have to note that, for the first time in ICCAT bluefin tuna tagging activities, the number of tags recovered and reported from the Mediterranean Sea is higher than any other area. This is the clear evidence that GBYP tag awareness campaign is producing positive effects.
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As concerns the tag reporting by area, the fact that most of the tags were recovered in the Eastern Atlantic and the Mediterranean is logical when considering the quota available for this stock, compared to the quota of the Western Atlantic stock. In any case, the tag reporting rate from the Western Atlantic is too low, certainly lower than expected and it is suspected that several tags were reported to various entities in the West and were not reported to ICCAT so far.

It is quite a positive result that in 44 cases it was possible to recover both tags implanted by GBYP on bluefin tunas and that several tags remained implanted on the fish for more than one year and up to 4 years so far: these first recoveries provide the hope of having useful results for defining the best type of dart to be used in next years of tagging activities.

The high number of tags reported by the baitboat fishery in the Bay of Biscay is mirroring several peculiar facts: a) this fishery is used to work with various scientists since many years and is well aware of the tagging activities; b) this fishery is traditionally targeting juvenile bluefin tunas and this is one of the few fisheries having a derogation from the minimum size regulation; c) several tagging activities were carried out so far in the Bay of Biscay, allowing for recaptures in the same area.

The number of tags reported by two important activities in the Eastern Atlantic and in the Mediterranean Sea (purse-seiners/cages and tuna traps) are surprisingly very low. The purse-seine fishery is historically the most productive in the last decades, reaching over 70% of the total catch in some years; since 1999, almost all catches are moved to cages and then to fattening farms and these activities are strictly monitored by ICCAT observers (ROPs). Consequently, the GBYP was supposed to have a high tag recovery and reporting rate from purse-seiners and farms, but the data are showing a different reality: so far, only two Spanish farms (Balfegó and Fuentes), two Maltese farms (ADJ Tuna Ltd and Fish & Fish Ltd) and one Greek farm (Bluefin Tuna Hellas SA) had recovered 22 tags, of various types (18 spaghetti, 3 billfish, 1 archival). Even considering that most of the recent tagging activities were targeting juveniles, the recovery and reporting rate from farms is unrealistically too low (10.4% of the total recoveries), while even the cumulative rate PS+farms (13%) is very far from the percentage of catches usually obtained by these activities.

The same considerations can be done for the traps, because only one Spanish tuna trap (Tarifa) and 1 Italian trap (Carloforte) had reported 5 tags to ICCAT within the period taken into account (2 spaghetti, 1 billfish, 2 internal archival). Even in this case, the recovery and reporting rate (2.4% of the total) is unrealistically too low.

A similar consideration is applicable even to the long-line fishery; including both the bluefin tuna targeted fishery and the many long-liners targeting other pelagic species having the bluefin tuna as a by-catch (25 tags in total, 14 spaghetti, 9 billfish and 2 archival, equal to 11.6% of the total). The possible reasons for the low report rates from these fisheries are detailed in Di Natale *et al* (2014b).

The relative high number of mini-PATs recovered and reported to ICCAT in these last years is indicative of both the curiosity induced by these tags (which are sometimes found stranded on the beach by tourists) and the effect of the high reward policy adopted by ICCAT-GBYP. Even in this case, a better communication using all media will certainly increase the reporting rate.

Unfortunately, we are aware that many tags of various types, including the precious internal archival ones (which are able to store up to 9 years of detailed data), have been recovered so far by several fishermen and fisheries and never reported to ICCAT for various reasons:

a) Orders by some traders, owners or captains, for providing them the tags, then avoiding or seriously delaying the report to ICCAT.

b) Recovery of bluefin tuna tags during IUU fishing operations, including those targeting juveniles, or fishing outside the quota, or as not allowed by-catch or fisheries conducted in months or areas when the bluefin tuna fishery is not permitted (this is also the case of some miniPATs, which were taken during fishing operations and later discarded at sea).

c) The well-known historical attitude of several fishermen to never inform anybody about any detail of their fishing activity, linked to ancestral fears.

d) The lack of information or ignorance about the scientific relevance of reporting a tag.

e) The insufficient knowledge about the ICCAT GBYP tag awareness and rewarding campaign.

During the first part of the ICCAT-GBYP it was also noticed the extreme importance of having all tag release data related to all tagging activities carried out on bluefin tuna (but also on all other species under the management of ICCAT) concentrated in the ICCAT tag data base. This is essential because recoveries can be logically reported to ICCAT at any time and it is not always easy, due to time/effort consuming activities in finding the entity which implanted the tags if data are not properly stored. At the moment this tag release communication is not mandatory, but it should be, because it has a general interest, including for the various entities and institutions carrying out this activity.

However, without the conscientious collaboration of the various stakeholders, fishermen, traders, scientists, ICCAT-ROPs and any other people in direct contact with bluefin tuna individuals at the moment of their capture, the tremendous effort being deployed by ICCAT would not be rewarding. In this, it is to be mentioned the important cooperation, also in terms of awareness, of all GBYP Contractors, the scientists concerned and the ROPs.

In terms of awareness, besides all the material spread out over all the world and particularly in the ICCAT Convention area, there are still large spaces for improvements: further direct field contacts with all stakeholders, more articles on the press, use of all communication media, use of education/awareness tools for pupils and students in coastal areas, etc. The scientific relevance of a successful tagging programme is high and invaluable, even for adopting proper management measures.

9. Acknowledgments

A particular note of thanks is due to all the conscientious persons who have contributed to this ambitious under-construction work, including professional and sport fishermen, traders, tuna farmers, and individuals.

A special acknowledgement is given to the professional field job accomplished or being undertaken by all teams engaged in ICCAT-GBYP activities, contracted in these first phases of the programme, and particularly those engaged for the tag release activities, the awareness campaign and the tag recovery assistance.

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Table 1. Details of tags implanted by ICCAT GBYP in Phase 2.

Phase 2

	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED						
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+ Acoustic+ Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.
Bay of Biscay	1279	783	1	0	0	0	495	0	0	0	0		0
Morocco	10	0	0	5	0	0	0	5	0	0	0		0
Strait of Gibraltar	1391	759	28	0	0	0	604	0	0	0	0		0
West Med.	913	651	4	0	0	0	258	0	0	0	0		0
Central Med.	0	0	0	0	0	0	0	0	0	0	0		0
		2193	**33**	**5**	**0**	**0**	**1357**	**5**	**0**	**0**	**0**		**0**
GRAND TOTAL	**3593**	**SUBTOTAL = 2231**					**SUBTOTAL = 1362**						

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Bay of Biscay	1774	1278	496	0	0	0
Morocco	15	0	5	10	0	0
Strait of Gibraltar	1781	1363	418	0	0	0
West Med.	1170	909	261	0	0	0
Central Med.	0	0	0	0	0	0
	4740	**3550**	**1180**	**10**	**0**	**0**

Table 2. Details of tags implanted by ICCAT GBYP in Phase 3.

Phase 3

	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED						
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+ Acoustic+ Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.
Bay of Biscay	3413	1987	0	3	0	0	1399	11	0	0	13	0	0
Morocco	0	0	0	0	0	0	0	0	0	0	0	0	0
Strait of Gibraltar	1489	244	9	0	0	0	1190	16	5	0	23	2	0
West Med.	313	210	11	0	0	0	87	5	0	0	0	0	0
Central Med.	97	97	0	0	0	0	0	0	0	0	0	0	0
		2538	**20**	**3**	**0**	**0**	**2676**	**32**	**5**	**0**	**36**	**2**	**0**
GRAND TOTAL	**5312**	**SUBTOTAL = 2561**					**SUBTOTAL = 2751**						

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Bay of Biscay	4836	3410	1399	14	13	0
Morocco	0	0	0	0	0	0
Strait of Gibraltar	2732	1459	1227	21	25	0
West Med.	405	298	102	5	0	0
Central Med.	97	97	0	0	0	0
	8070	**5264**	**2728**	**40**	**38**	**0**

Table 3. Details of tags implanted by ICCAT GBYP in Phase 4.

Phase 4 - Up to 15/09/2014

	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED						
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+ Acoustic+ Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.
Canada	6	0	1	0	0	0	0	5	0	0	0	0	0
Bay of Biscay	3009	1403	0	0	0	0	1599	7	0	0	0	0	0
Morocco*	273	129	0	7	0	0	121	8	0	7	0	0	1
Portugal	29	6	6	0	0	0	17	0	0	0	0	0	0
Strait of Gibraltar***	2681	1251	6	0	0	0	1418	6	0	0	0	0	0
West Med. **	420	70	343	0	0	0	7	0	0	0	0	0	0
Central Med. ****	1308	675	135	0	0	0	479	7	0	0	12	0	0
		3534	**491**	**7**	**0**	**0**	**3641**	**33**	**0**	**7**	**12**	**0**	**1**
GRAND TOTAL	**7726**	**SUBTOTAL = 4019**					**SUBTOTAL = 3694**						

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Canada	11	0	6	5	0	0
Bay of Biscay	4615	3009	1599	7	0	0
Morocco*	417	258	129	22	0	8
Portugal	46	23	23	0	0	0
Strait of Gibraltar	4105	2669	1430	6	0	0
West Med. **	427	77	350	0	0	0
Central Med.	1806	1154	633	7	12	0
	11427	**7190**	**4170**	**47**	**12**	**8**

Table 4. Details of all tags implanted by ICCAT GBYP in Phase 2 to Phase 4.

All GBYP Phases (2, 3 & 4) - Up to 15/09/2014

	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED							
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+ Acoustic+ Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.	% by area
Canada	6	0	1	0	0	0	0	5	0	0	0	0	0	**0,0%**
Bay of Biscay	7701	4173	1	3	0	0	3493	18	0	0	13	0	0	**46,3%**
Morocco*	283	129	0	12	0	0	121	13	0	7	0	0	1	**1,7%**
Portugal	29	6	6	0	0	0	17	0	0	0	0	0	0	**0,2%**
Strait of Gibraltar***	5561	2254	43	0	0	0	3212	22	5	0	23	2	0	**33,4%**
West Med. **	1646	931	358	0	0	0	352	5	0	0	0	0	0	**9,9%**
Central Med.	1405	772	135	0	0	0	479	7	0	0	12	0	0	**8,4%**
		8265	**544**	**15**	**0**	**0**	**7674**	**70**	**5**	**7**	**48**	**2**	**1**	
GRAND TOTAL	**16631**	**SUBTOTAL = 8811**					**SUBTOTAL = 7807**							**100,0%**

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED					
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	% by area
Canada	11	0	6	5	0	0	**0,0%**
Bay of Biscay	11225	7697	3494	21	13	0	**46,3%**
Morocco*	432	258	134	32	0	8	**1,8%**
Portugal	46	23	23	0	0	0	**0,2%**
Strait of Gibraltar***	8618	5491	3075	27	25	0	**35,6%**
West Med. **	2002	1284	713	5	0	0	**8,3%**
Central Med.	1903	1251	633	7	12	0	**7,9%**
TOTAL	**24237**	**16004**	**8078**	**97**	**50**	**8**	**100,0%**
%	**100%**	**66,0%**	**33,3%**	**0,4%**	**0,2%**	**0,0%**	

no tagging in Eastern Mediterranean!

(*)7 miniPATs (GBYP) + 7 miniPATs (WWF) + 8 Acoustic (SU)
(**) 11 fish were tagged in the Balearic Sea; all tags were single barb (FT-1-94)
(***) 10 fish had a second tagging and release, 1 with double tagging - not included in the table
West Med = Gulf of Lions, Balearic Sea, Ligurian Sea and Sardinia.
Central Med = Tyrrhenian Sea, Adriatic Sea, Malta.

Table 5. Geographical distribution of the areas where the tag recoveries occurred, in numbers and percent, by type of tag.

Fishing Area / Tags	Spaghetti Tags	Single/Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
East Atl	49	27	9	2	1	88	40,74
Med	85	24	4	3		116	53,70
North Atl	1			1	2	4	1,85
West Atl	2			1	1	4	1,85
Unknown			4			4	1,85
Grand Total	137	51	17	7	4	216	100
%ge	63,4%	23,6%	7,9%	3,2%	1,9%	100,0%	

Table 6. Details of tag recovery by fishery, in numbers and percent.

Fishery -Gear / Tags	Spaghetti Tags	Single/Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
BB	63	29				92	42,59
FARM	18	3		1		22	10,19
HAND	3	3				6	2,78
LL	14	8		2		24	11,11
LLHB		1				1	0,46
NF			12	1	4	17	7,87
PS	3	2	1			6	2,78
RR	3	1				4	1,85
SPOR	5					5	2,31
TN	1	1				2	0,93
TP	1			1		2	0,93
TRAP	2	1		2		5	2,31
TROL	7	2				9	4,17
UNCL	17		4			21	9,72
Grand Total	137	51	17	7	4	216	100

Table 7. Annual trend of the bluefin tuna tags recovered under GBYP, in numbers and percent, by type (yellow shading put into evidence tags recovered by ICCAT previously to GBYP).

Recovery Year / Tags	Spaghetti Tags	Single/Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
2002	1	1		1		3	1,39
2006	1			1		2	0,93
2008	1					1	0,46
2009	1					1	0,46
2010	3					3	1,39
2011	8		1			9	4,17
2012	36	7	6	1	1	51	23,61
2013	56	28	8	2	1	95	43,98
2014	30	15		2	2	49	22,69
Undefined (2012 or 2013)			2			2	0,93
Grand Total	137	51	17	7	4	216	100

Table 8. Bluefin tuna tag recoveries by season, in numbers and percent, by type.

Recovery Season / Tags	Spaghetti Tags	Single/Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
1	6	3	2	1	1	13	6,02
2	24	5	3	4	1	37	17,13
3	73	27	1	1	1	103	47,69
4	34	16	9	1	1	61	28,24
(blank)			2			2	0,93
Grand Total	137	51	17	7	4	216	100

Table 9. Bluefin tuna tag recoveries from double tagged fish by type.

Release	Spaghetti tag only	Single/Double Barb Tag only	Both	TOTAL
2011	0	2	5	7
2012	2	2	27	31
2013	1	1	12	14
Total	3	5	44	52
%	5,77	9,62	84,62	100

RcCode: 2conv	both recovered			
	Year of Recovery			
Year of Release	2012	2013	2014	Grand Total
2011	1	3	2	6
2012	5	15	6	26
2013		6	6	12
Grand Total	6	24	14	44

Figure 1. Overview of the localities where the ICCAT GBYP tag awareness material was distributed so far.

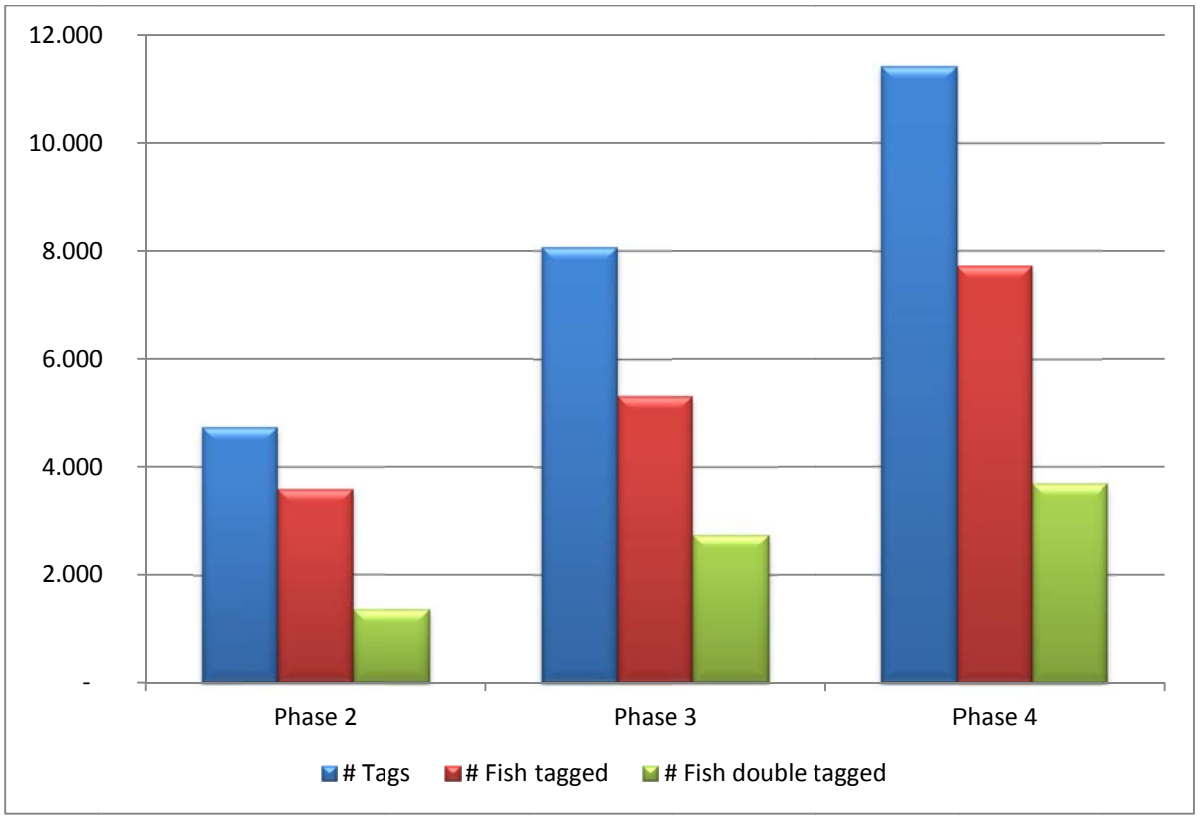

Figure 2. Progression of ICCAT GBYP tagging activities in the first Phases.

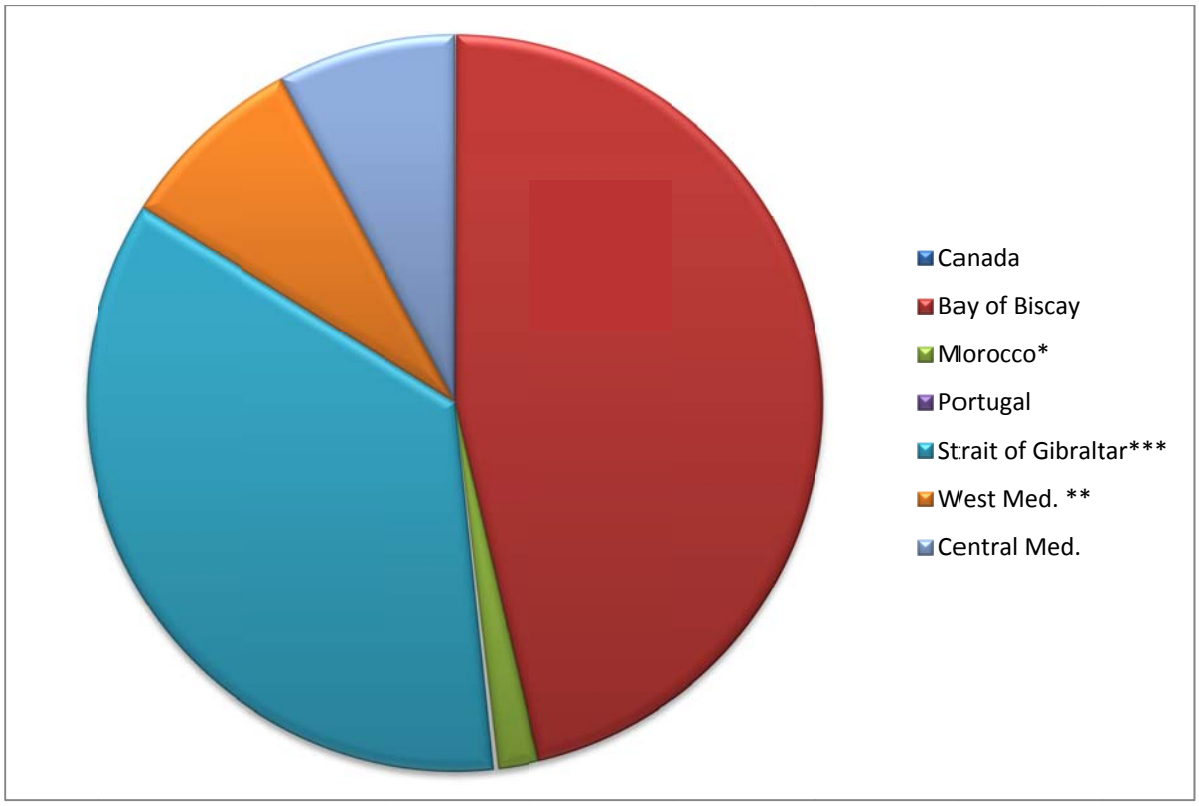

Figure 3. Distribution of implanted tags by areas in the first Phases of ICCAT GBYP.

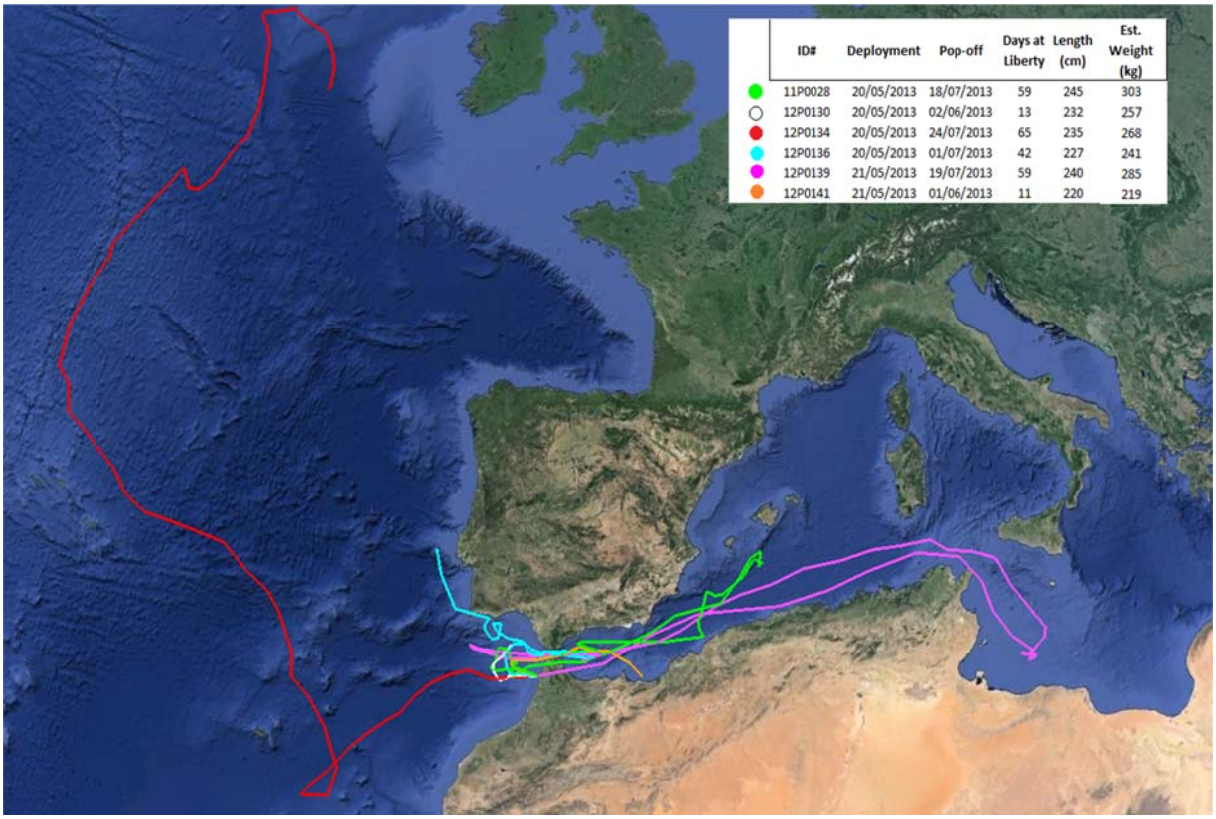

Figure 4. Tracks of adult bluefin tunas tagged with mini-PATs in the Moroccan traps in GBYP Phase 4 (2013).

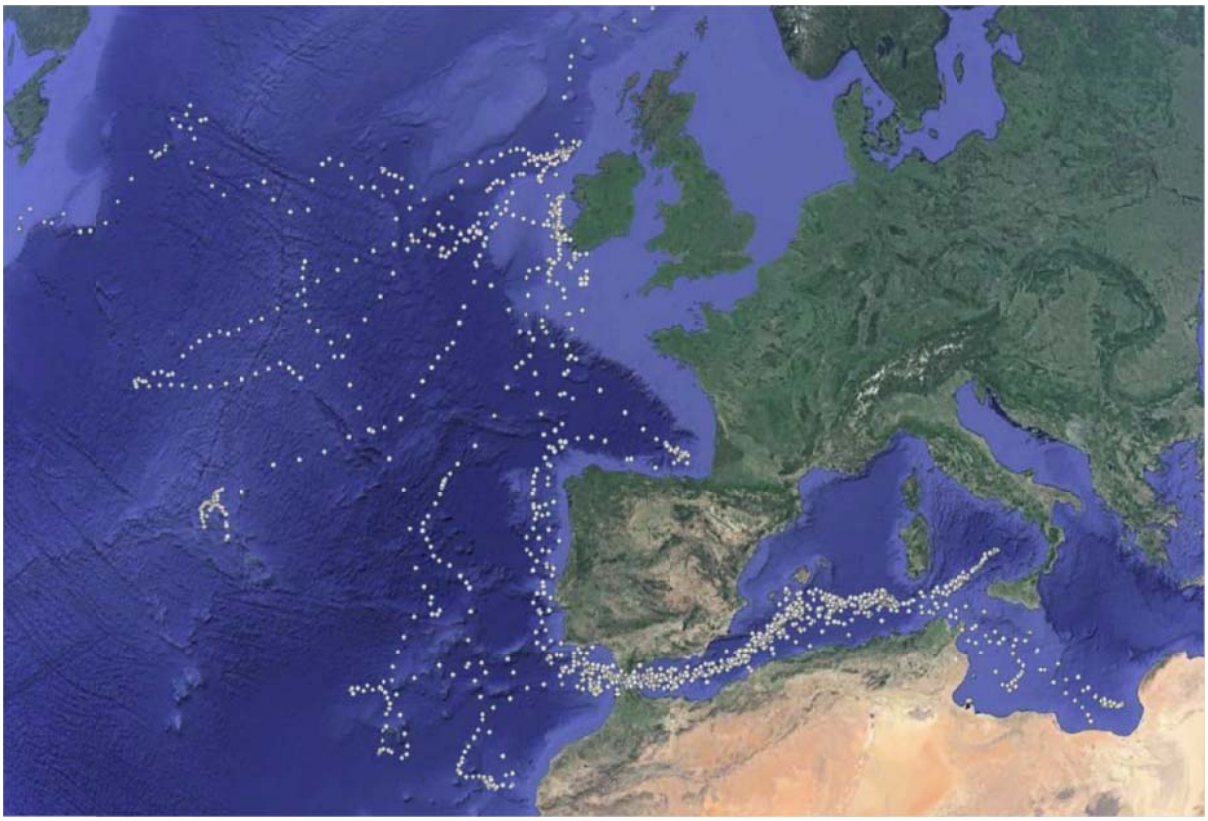

Figure 5. Tracks of 13 mini-PATs deployed by GBYP and WWF.

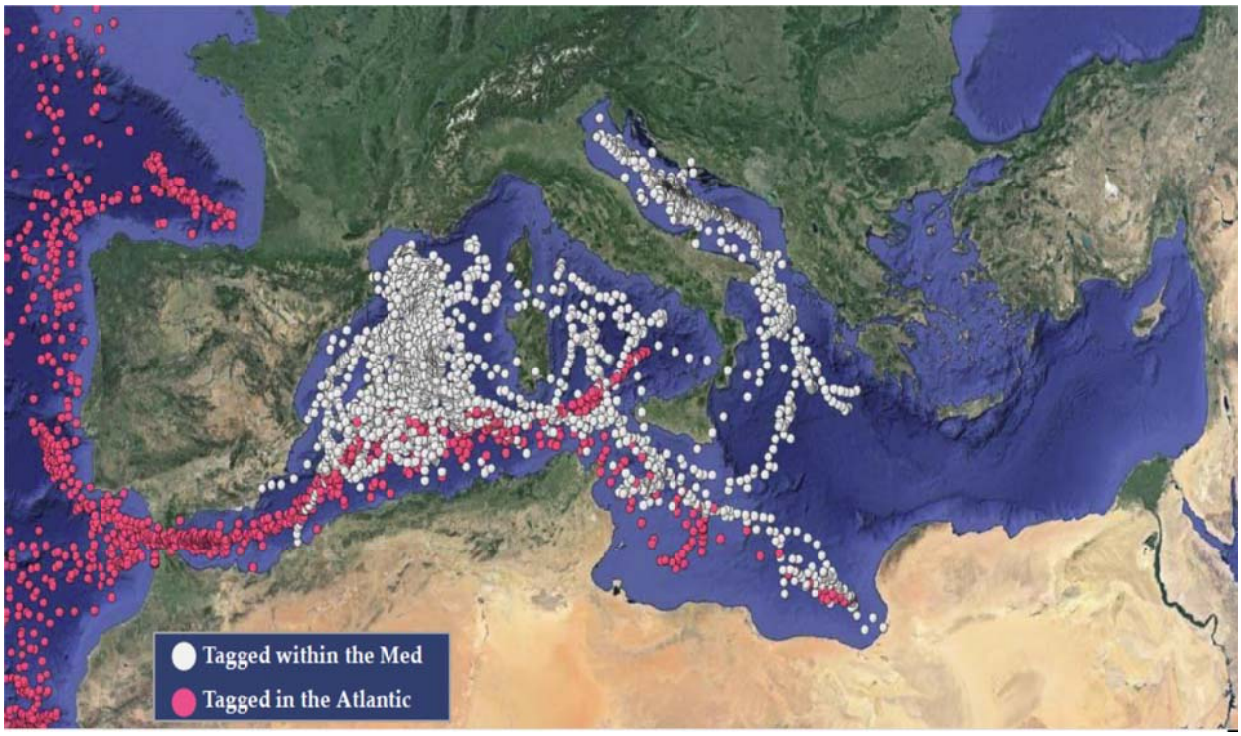

Figure 6. Accumulate tracks of mini-PATs deployed by both GBYP and WWF in various years. It is evident that no bluefin tuna never went to the eastern Mediterranean Sea.

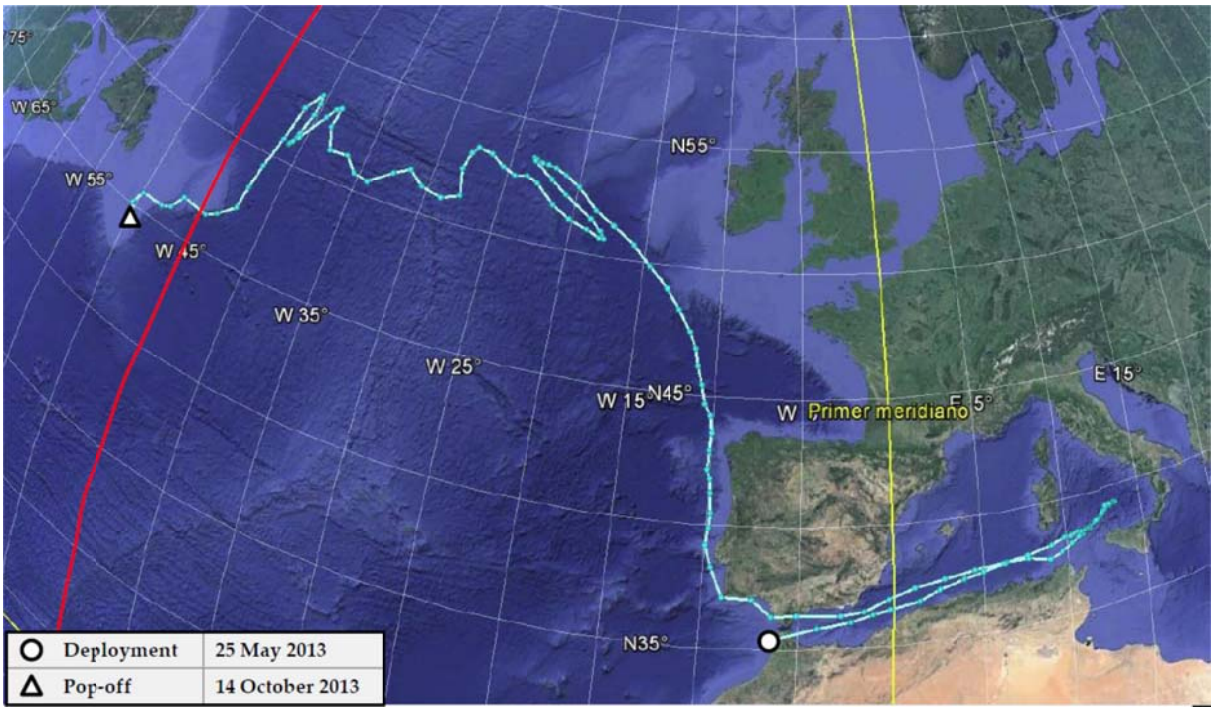

Figure 7. Track of one mini-PAT deployed by GBYP and WWF in the Moroccan trap of Larache in 2013. This fish spawned in the Tyrrhenian Sea and then travelled up to Newfoundland.

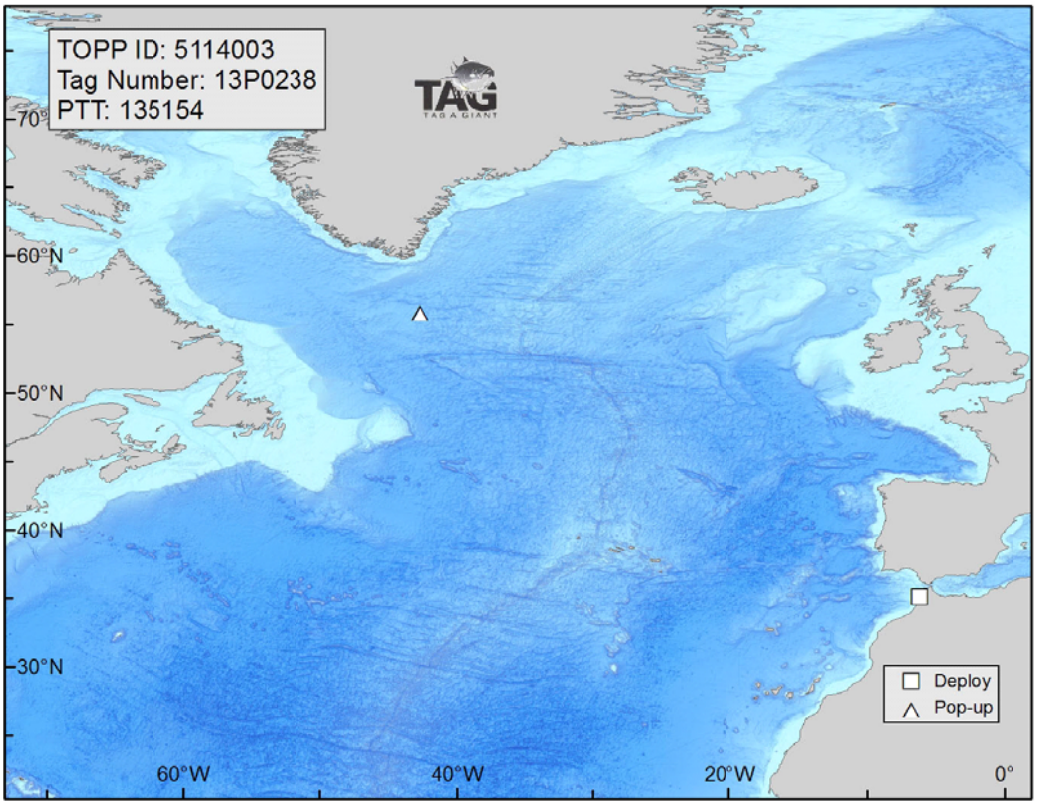

Figure 8. Preliminary data of one mini-PAT deployed by the teams of Stanford University and the INRH in the Moroccan trap of Larache in May 2014, during a complimentary activity in cooperation with ICCAT GBYP. This fish travelled up to southeastern Greenland waters between May and September 2014, but full track is still not available at the moment (courtesy of Ph.D. Barbara Block).

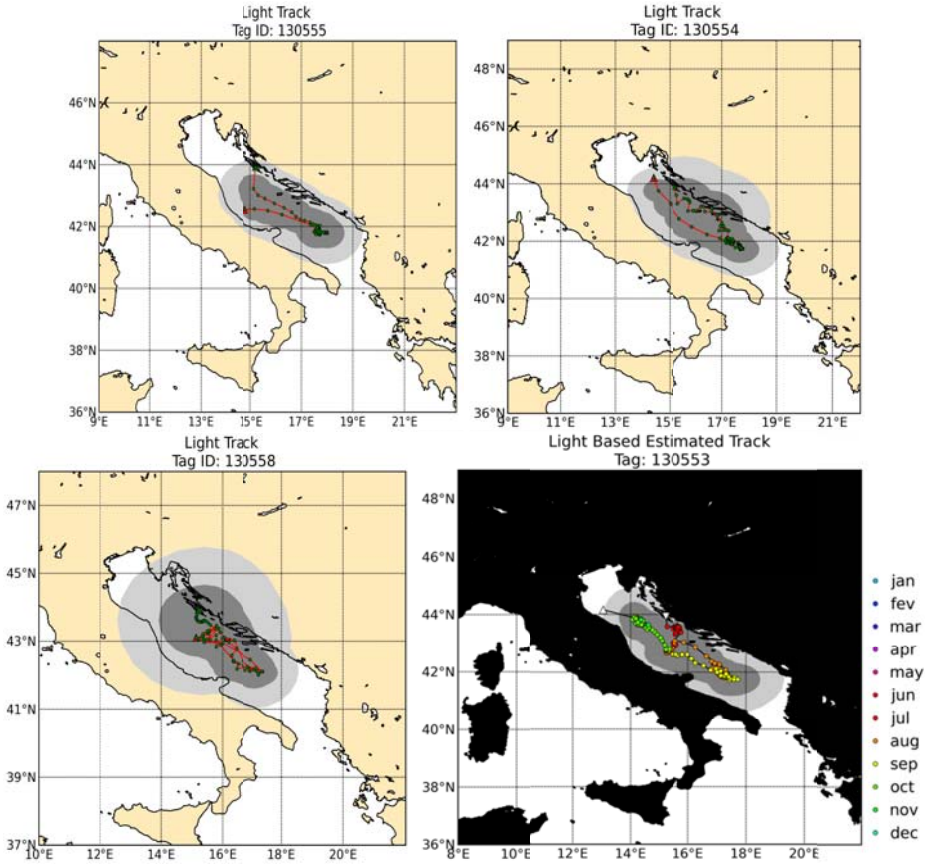

Figure 9. Tracks of four mini-PAT deployed in the Croatian waters in 2013. These young fish remained in the Adriatic after tagging.

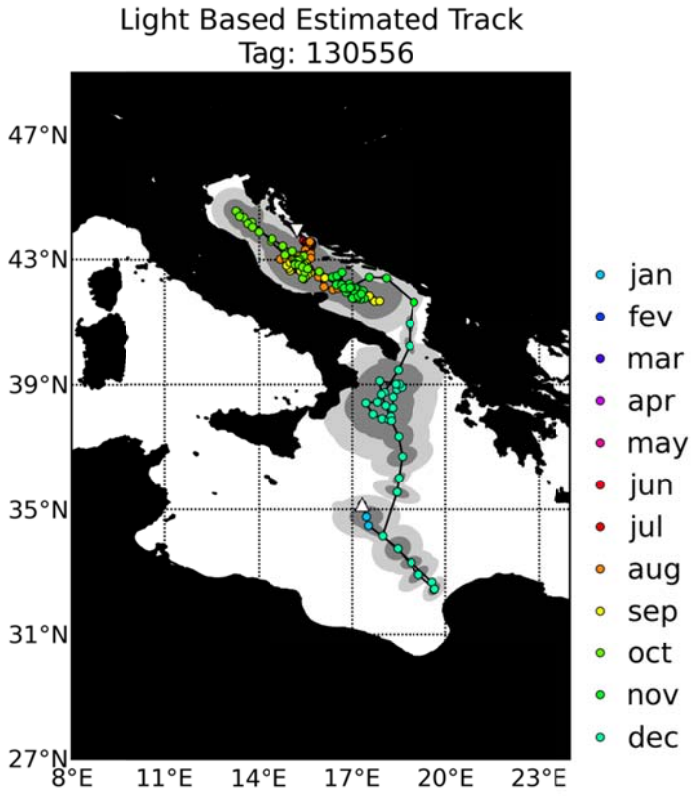

Figure 10. Track of one mini-PAT deployed by GBYP in the Adriatic Sea in 2013. This fish was the only one going to the eastern Libyan waters.