

## PRELIMINARY INFORMATION ABOUT THE ICCAT GBYP TAGGING ACTIVITIES IN PHASE 5

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### SUMMARY

*The ICCAT GBYP tagging activities were launched in Phase 1, by adopting a tagging design and manual, and then were carried out in all the following Phases. The tagging activity in Phase 5 was limited to mini-PATs. Tagging was carried out in four locations, Moroccan and Sardinian traps, Turkish purse seiners and a complimentary tagging in a cage in the southern Tyrrhenian Sea. Some tags provided very useful results even in the short time, because they were able to show that previous hypotheses about the lack of interchanges between the central and eastern Mediterranean were not consistent, while at the same time they confirmed the genetic analyses showing a general mixing among areas. This paper also provides a first discussion about a possible explanation for the different behaviours showed by the tuna tagged in Morocco, which could be linked to the different natal origin of these fish. A limited number of tags are still at sea and data will be available later. A general overview of all ICCAT GBYP tagging activities and tag recovery activities is also provided, updating the previous available reports.*

### RÉSUMÉ

*Les activités de marquage de l'ICCAT-GBYP 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. L'activité de marquage dans la phase 5 s'est limitée aux mini-PAT. Le marquage a eu lieu à quatre endroits, dans les madragues marocaines et de Sardaigne, par les senneurs turcs et une activité de marquage complémentaire dans une cage dans le sud de la mer Tyrrhénienne. Certaines marques ont fourni des résultats très utiles même dans le court terme, parce qu'elles ont permis de démontrer que les hypothèses précédentes concernant l'absence d'échanges entre la Méditerranée centrale et orientale n'étaient pas cohérentes, alors que dans le même temps, elles ont confirmé les analyses génétiques qui montraient un mélange général entre les zones. Ce document fournit également une première discussion sur une possible explication des différents comportements qu'ont les thons marqués au Maroc, qui pourraient être liés à l'origine natale différente de ces poissons. Un nombre limité de marques est encore en mer et les données seront disponibles ultérieurement. Un aperçu général de toutes les activités de marquage de l'ICCAT GBYP et activités de récupération des marques est également fourni, actualisant les précédents rapports disponibles.*

### 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. La actividad de marcado de la Fase 5 se limitó a miniPAT. El marcado se realizó en cuatro sitios, almadras marroquíes y de Cerdeña, cerqueros turcos y uno complementario en una jaula del mar Tirreno meridional. Algunas marcas proporcionaron resultados muy útiles a corto plazo, porque pudieron demostrar que las hipótesis previas acerca de la falta de intercambios entre el Mediterráneo oriental y central no eran coherentes y, al mismo tiempo, confirmaron los análisis genéticos demostrando una mezcla general entre las zonas. Este documento proporciona también una primera discusión acerca de una posible explicación para los diferentes comportamientos que presentan los túnidos marcados en Marruecos, que podrían estar vinculados con los diferentes orígenes natales de estos peces. Un número limitado de marcas continúa en el mar por lo que los datos estarán disponibles más adelante. Se proporciona también una visión general de todas las actividades de marcado y de recuperación de marcas del ICCAT GBYP, actualizando los informes previamente disponibles.*

### KEYWORDS

*Tagging, Bluefin tuna, Distribution range, Electronic tags, 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 fishery-dependent 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 of for uses in MSE approaches.

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](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](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: SCRS/2015/145).

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); Fromentin (2010) reports a nil recovery rate for the conventional tagging carried out by IFREMER in the Mediterranean Sea. 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 any effort.

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, an ICCAT GBYP annual lottery, etc.).

Another tool is the awareness and communication campaign, which is particularly difficult because of the extent of the 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.

The initial, short-term GBYP objective was to implant 30,000 conventional tags and 300 electronic tags in three years in the eastern Atlantic and Mediterranean, with a total budget of €9,765,000; the mandatory tag awareness and rewarding campaigns, as well as the tagging design study and protocol, were not included. So far, with only 37.65% of the funds (a total of €3,767,593, including the budget amount set for Phase 5, equal to €431,758), GBYP deployed 81.05% of the conventional tags (24,314) and 79.33% of the electronic tags (238; 180 mini PATs, 50 internal archival tags and 8 acoustic tags); furthermore, the tagging design and protocols, the awareness and rewarding campaigns were included in the activities carried out so far. It is very clear that the general objectives sets for the tagging activities in these first Phases were largely accomplished so far, taking into account the proportion of the available budget.

### 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. 132 mini-PATs pop-up electronic tags
- No. 13 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).

In addition to this tagging material, 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 one of the ICCAT CPCs.

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 freely available on the ICCAT GBYP web page <http://www.iccat.int/GBYP/en/AwCamp.asp>. The SCRS and the ICCAT Commission were kept updated 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, regional organisations, and the RFMOs 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>.

A field tag awareness activity was carried out on contract in Phase 4. The report is available on [http://www.iccat.int/GBYP/Documents/TAGGING/PHASE%204/ Tag\\_Awareness\\_Report\\_2014.pdf](http://www.iccat.int/GBYP/Documents/TAGGING/PHASE%204/ Tag_Awareness_Report_2014.pdf)

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.

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.

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 €1,000; annual ICCAT GBYP lottery (September): €1,000 for the first tag drawn and €500 each for the 2<sup>nd</sup> and 3<sup>rd</sup> 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.

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.

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. Another Italian Consortium headed by UNIMAR carried out an experimental underwater tagging activity in a purse-seine. 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. Adult bluefin tunas were complimentary tagged in Portuguese traps by IPMA. All activities up to September 2014 are reported by Di Natale and Idrissi (2015), while the complete list of tagging activities in Phase 4 are on **Table 1**.

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

The Steering Committee, in September 2014, adopted a different tagging strategy for Phase 5, keeping the conventional baitboat tagging only in the Bay of Biscay and in the Strait of Gibraltar, while electronic tagging activities were planned in traps for tagging adults (both in Morocco and Sardinia); an experimental tagging with miniPATs was planned in the eastern Mediterranean by purse seine for adults in the Turkish area. The draft call for tenders was ready at the beginning of Phase 2 (February 2015).

In February 2015, the Steering Committee considered that the tag reporting rate for conventional tag was too low and recommended revising the plan for Phase 5, cancelling the conventional tagging, and addressing all activities only to the electronic tagging by miniPATs in the three areas previously identified, increasing the number of tags as much as possible, according to the availability of tags by Wildlife Computers and the budget possibilities.

After several discussions, a revised Call for tender was agreed by the Steering Committee and it was issued on 22 April 2015. The contracts were provided to an international consortium headed by INRH with the participation of WWF MedPO for the Moroccan traps, to an Italian consortium headed by COMBIOMA for the Sardinian traps, and to a joint team made by the University of Istanbul and UNIMAR for tagging in the eastern Mediterranean. Further tagging activities were carried out in Phase 5 on a complimentary base by INRH (conventional tagging in Moroccan tuna traps), by an Italian team headed by Federcoopesca (electronic and conventional tags in southern Tyrrhenian Sea) and by Alleanza Pescatori Ricreativi (occasional conventional tagging by sport fishermen). For this last activity, the use of 5 miniPATs provided by ICCAT GBYP was specifically agreed by the GBYP Steering Committee. The ICCAT GBYP electronic tagging with mini-PATs in Phase 5 were carried out on adult fish in all areas. Other complimentary conventional tagging activities will be carried out later in the season in Portuguese traps by IPMA.

The updated situation of the tagging activities in Phase 5 is showed on **Table 2**. In total, up to September 1, 2015, the total number of bluefin tunas tagged so far in all Phases of GBYP are 16883, and a total of 24,560 tags of various types have been implanted. Among these, 7,878 bluefin tunas were double tagged, reaching 46.6% of the fish, a percentage which is well over the target (**Table 3**).

**Figure 2** shows the progression of the ICCAT GBYP tagging activities in the various years, clearly showing the yearly improvements up to 2014 and the remarkable reduction in Phase 5, due to the cancellation of the conventional tagging. 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, taking into account also 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, 4 and 5) have been 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 and sometimes it requires an important amount of time and work before having all necessary data according to the right format.

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. During these years, unfortunately some tag release data were not possible to obtain, while some recovered tags, sent to ICCAT in an anonymous format (therefore making impossible any further contact for requesting details), were not able to provide all necessary tag recovery data.

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 transmits 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 5<sup>th</sup> 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 2015 (ongoing phase 5 of ICCAT GBYP).
- The recoveries by calendar seasons (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> quarters).

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, 4 and 5 were juveniles (age 0-3) (see also data up to 2013 in Di Natale *et al.*, 2014b, Di Natale and Idrissi, 2015) and therefore 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 September 4, 2015, there have been 341 tags recovered by GBYP. The GBYP recoveries are summarized as follow:

- 217 Conventional “Spaghetti” tags (63.6% of the total)
- 94 Conventional “Double-barb” (two types) tags (27.6% of the total)

- 19 External Electronic “mini-PATs” tags (5.6% of the total)
- 7 Internal Electronic “Archivals” tags (2.1% of the total)
- 4 Commercial “Trade” bluefin tuna tag (1.2% of the total)

In terms of fishing grounds (areas) where these 340 tags have been recovered (**Table 4**), these are the details:

1. West Atlantic: 5 tags (1.5%): 3 spaghetti, 1 internal archival and 1 trade tag;
2. North Atlantic: 6 tags (1.8%): 4 spaghetti and 2 trade tags;
3. East Atlantic: 91 tags (26.7%): 80 spaghetti, 9 miniPATs, 1 internal archival and 1 trade tag;
4. Mediterranean Sea: 235 tags (68.9%): 223 spaghetti, 6 miniPATs and 5 internal archival tags;
5. Unknown area: 4 tags (1.2%), all miniPATs<sup>2</sup>

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 5**):

1. Bait boat: 170 tags (49.9%): all spaghetti tags;
2. Farms: 36 tags (10.6%): 34 spaghetti & 2 internal archival tags;
3. Long line fisheries: 32 tags (9.4%): 30 spaghetti & 2 internal archival tags;
4. Purse seine: 20 tags (5.9 %): 18 spaghetti, 1 miniPAT & 1 internal archival tag;
5. Unclassified gears: 17 tags (5%): 13 spaghetti and 4 miniPATs;
6. Non-fishermen<sup>3</sup>: 17 tags (5%): 12 miniPATs, 1 internal archival and 4 trade tags;
7. Hand line: 15 tags (4.4%): 14 spaghetti & 1 miniPAT;
8. Sport & Recreational: 12 tags (3.5%): all spaghetti tags;
9. Trolling: 9 tags (2.6%): all spaghetti tags;
10. Traps: 6 tags (1.8%): 4 spaghetti and 2 internal archival tags;
11. Rod & Reel: 5 tags (1.5%): all spaghetti tags;

Minor recaptures were obtained by other gears.

**Table 6** shows that 96.5% of the recoveries have occurred during the last three and a half years (2012-1 September 2015). The year 2012 (Phases 2-3 of GBYP), with 15% of these recoveries, is the first one after the beginning of the tag awareness activities enforced by GBYP in 2011. The recoveries in 2013 represent the 29.037% of the total in this period, the recoveries in 2014 (31.67%) were the highest so far, while the recoveries in 2015 (20.23%) are still partial and related to the period January to 4 September.

The 3<sup>rd</sup> trimester (July – September) is in average the season during which most of the tag recoveries have occurred so far (133 tags, representing 39% of the total), followed by the 4<sup>th</sup> trimester (100 tags, representing 29.337% of the total) (**Table 7**).

Double tagging was tentatively initiated in 2011, with the purpose to evaluate the best type of tags (single-barb, double-barbs small or double-barbs large) to be used, because all studies carried out so far on this matter 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 46.6% of the fish (7,878 fish double tagged so far). Up to September 3, 2015, tags were recovered from 90 double tagged fish and both tags have been recovered from 74 fish (82.2% of the double tagged fish recoveries). 9 fish had only the billfish (double-barb) tag on, while 7 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 (92.2%) of the double barb against the single barb ones (90%). The tag recovery rate for all double tagged fish by GBYP is currently 1.14%. **Table 8** details the double tagged recoveries, including also the year of deployment and the year of recapture.

It is extremely difficult at the moment defining 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 GBYP tags recovered so far in comparison with the number of GBYP tags deployed, the provisional recovery rate is only about 0.95%, but this rate is clearly negatively biased by the juvenile ages for about 89% of the tagged fish. 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.

<sup>2</sup> 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.

<sup>3</sup> Non-fishermen are persons who found tags in open sea or washed ashore.

## 7. Results

### 7.1 Electronic tagging

As concerns the results of the electronic tagging with miniPATs, most of them for Phases 2, 3 and 4 have been already provided to SCRS and the Commission in 2012, 2013 and 2014 (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 and in February 2015.

The full analyses of the detachments will be possibly provided at the end of Phase 5.

The ICCAT GBYP Steering Committee decided to improve the electronic tagging activities in Phase 5 and therefore a total of 83 tags were implanted in various areas.

A summary overview map of the trajectories of the tags implanted in the various areas and popped-off before 16 September 2015, is provided in **Figure 4**. About 50% of the tags were set for popping-up after 196 days, while the others were set at 1 year, but most of the tags popped-off at a premature date. At the moment it is very difficult to better define the reasons for these premature detachments, but most of the tags popped-off in areas where many fishing vessels were actively fishing, not necessarily for bluefin tuna. We examined in great detail all vertical profiles of the tags which provided data so far and, excluding the tags that were clearly taken on board of vessels or even were moved inland, it is very difficult to understand if the pop-off was caused just by a premature detachment for physical or technical reasons or if the fish was fished and suddenly discarded at sea. As a matter of fact, we are aware that several tunas, taken as by-catch particularly in longliners targeting swordfish in the last three years and particularly in 2015, were immediately discarded at sea for avoiding any compliance problem. This attitude could explain that some tags popped-off just after reaching the maximum depth for the tag or when the fish was at the usual depth for the hooks of a pelagic longliner, immediately after a normal fish behaviour in previous days.

Up to 14 September 2015, data from 74 miniPATs were received, with an average of about 22 days of recording (min 4 days, max 82 days).

The first tagging activity was carried out in a Moroccan Atlantic trap, in Larache, where this activity was carried out since the beginning of GBYP. The Consortium in charge was headed by the INRH and worked together with Maromadra SA and WWF-MedPO. A total of 20 miniPATs were deployed there at the end of May and 18 popped-off before 1 September 2015. The tags which transmitted so far (18) worked for a total number of days ranging from 5 to 50 days, with an average of 26.6 days. Even in this case, most of the tags popped-off in areas where fishing vessels were active. One fish electronically tagged in Larache (tag 150398) went to the eastern Mediterranean, reaching the southern part of Crete and then coming back to the Ionian Sea, where it was apparently fished and immediately discarded dead at sea. Only one of the bluefin tuna tagged in Morocco (tag 150403) and popped-off so far did not entered into the Mediterranean after tagging; this represents a percentage of 5.6%. **Figure 5** shows the variety of movements among 10 selected tracks.

The second activity was carried out in Turkey, in the Gulf of Antalya, by a team composed by the University of Istanbul and Unimar, with Akua Group as subcontractor. A total of 40 miniPATs were provided to the team, along with conventional tags. The plan set by the GBYP coordination was to tag the fish fished by a purse seiner and kept in a floating cage, at the end of the local fishing season. Due to several logistic and economic constraints, the local team decided to carry out the tagging during the fishing season. This change of strategy had effects on the final results. As a matter of fact, only about 40 tunas were kept in a cage and the tagging operations were very difficult due to the nervous and extremely reactive behaviour of the fish. Finally, it was possible to deploy 30 tags on 31 May 2015, and all fish were released into the wild.

13 of these tags popped-off in 2-week time, all in the Turkish area or the Levantine Sea; apparently, these fish were fished and some tags were moved inland but, besides the many efforts, no tags were recovered. Two of these tags moved eastward and one reached the area between Turkey and Syria. All other tags remained at sea for more time, but all tags popped-off prematurely, possibly due to fishery in most of the cases. **Figure 6** shows the variety of movements among 8 selected tracks.

The most interesting results from the tagging activities in Turkey came from one tag (145466) which travelled with the fish for 82 days and popped-off in the NE Atlantic, off the Faroes Islands, and from another tag (145461) which popped-off after 53 days well off the NW Galician coast. Furthermore, another tag (145440) popped-off in



the Libyan waters after 19 days and 2 tags (145452 and 145460) popped-off in the Ionian Sea, respectively after 19 and 27 days. In addition to these electronic tags, this year, for the first time, it was possible to recover some conventional tags in Turkey and all were implanted in other areas. Specifically one tag (CR011647), which was implanted along the SE Spanish Mediterranean coast on 16 June 2011, was recovered at the harvesting in a Turkish cage on 24 January 2015, while a double-tagged tuna (GBYP059266 and GBYP022716) which was tagged in Croatia on 12 July 2013, was fished in Turkey on 14 June 2015. These tags clearly shows that bluefin tuna in the eastern Mediterranean moves everywhere. **Figure 7** shows the estimated tracks of the electronically tagged fish and the trajectories of the conventional tags.

The third activity was carried out in a Sardinian tuna trap by a small Consortium headed by COMBIOMA, which worked with Carloforte Tonnare PIAM. A total of 20 miniPATs were initially provided to the team, along with conventional tags. After the tagging activity in Turkey, 10 more miniPATs were available and, after consultation with the Steering Committee, it was decided to move these tags to Sardinia, along with a limited support tagging team from UNIMAR. The tagging activities were carried out on 1 July 2015, at the end of the fishing season, deploying 28 tags. Even in this case, 10 tags popped-off within 2-week time and again fishing activities seem the motivation. A total of 20 tags popped-off up to 4 September 2015. Most of them went west of Sardinia. Two (150404 and 150416) moved to the large area between Sardinia, North Algeria and Balearic Islands with slightly different courses; one (150421) moved in the area between Sardinia and NE Algeria, where possibly spawned, then went NE before being possibly fished; one (150406) moved irregularly towards Menorca; another one (150407) moved directly to SE, passing the Strait of Sicily and then it was fished between the island of Pantelleria and Malta. One (150412) made an interesting course, moving west of Sardinia, for apparently spawning, for then moving northwards and crossing the Strait between Sardinia and Corsica to the Tyrrhenian Sea, then moving towards the Ligurian Sea, where the fish was fished close to the northern part of Corsica. Two others (150409 and 150419) remained for some weeks west of Sardinia and then went to the northern part, close to the isle of L'Asinara, where they both popped-off. Another tagged fish (150405) went to the central Tyrrhenian Sea, where it possibly spawned, then moved northwards where the tag popped-off. **Figure 8** shows the variety of movements among 8 selected tracks.

A fourth activity was decided taking an opportunity we had, thanks to the availability of several tunas kept in a cage in the southern Tyrrhenian Sea and that were released. A complimentary proposal was received from a team headed by Federcoopescas, having the scientific assistance of Prof. Corrado Piccinetti and the tagging assistance of UNIMAR, under the control of the Italian Directorate for Marine Fisheries and Aquaculture and the Fishery Department of Regione Campania. After the agreement of the Steering Committee, it was decided to provide 5 miniPATs and several conventional tags to this team. The 5 electronic tags were deployed on 23 July 2015. All tags popped-off so far. 2 tagged fish remained almost in the same area, but one had enough time for reaching the area north of the isle of Stromboli (150401) and then go back to the tagging site, one went westwards to Sardinia, another one (150418) moved to the Aeolian islands, then crossed the Strait of Messina, went to the Ionian Sea off Siracusa and finally went back to the tagging site; another (150400) one went to Libya, off Cirenaica, but the track is still not available. **Figure 9** shows two of the tracks.

Up to 16 September 2015, some data are still to be received from Argos and 8 tags are still at sea.

## 8. Discussion

### 8.1 Discussion about the eastern Mediterranean bluefin tuna

For several years there was the suspect that the bluefin tuna in the eastern Mediterranean Sea might belong to a possible sub-population, particularly taking into account the ancient existence of bluefin tuna in the whole Black Sea area and in the Marmara Sea (Di Natale, 2015b) and the fact that no one single tag (electronic or conventional) was demonstrating any mixing between the bluefin tuna in the eastern Mediterranean Sea and the other parts of the Mediterranean or the opposite (Quilez-Badía *et al.*, 2013a, 2013b; Di Natale, 2015b). On the opposite, the ICCAT GBYP genetic analyses obtained from many samples (**Figure 10**) were showing very few differences among the Mediterranean areas and therefore a mixing. This was mostly the reason that the tagging strategy in 2015 included the eastern Mediterranean as a first target.

In 2015 the tag recovery data reported above in subchapter 7.1 finally confirmed that genetic data were showing a possible reality and that previous tagging data were somewhere possibly affected by various factors, mainly still to be understood. As a matter of fact, in 2015 the electronic tags showed movements from Turkey to other parts of the central Mediterranean and also to the NE Atlantic, while the recovery of two fish (one was double tagged) showed opposite movements, as well as for a bluefin tuna tagged in a Moroccan trap which travelled to the eastern Mediterranean, going back to the Atlantic Ocean before the pop-off of the tag.

These tags reveal a situation which is fully different from the hypotheses considered prior to 2015, but at the same time pose some questions concerning the many previous electronic tags implanted in the other parts of the ICCAT area, which never went to the eastern Mediterranean. Was this caused by simple casualty or was this showing possible yearly changes in the behaviour? According to the genetic evidence, the first option seems the best.

### ***8.2 Discussion about a possible motivation for the different behaviour of bluefin tuna tagged in Moroccan traps***

The different behaviour showed by the bluefin tunas tagged in Morocco in the past years raised many discussions, because some of these tunas, which were adult spawners, do not enter into the Mediterranean Sea for spawning in the same year of the tagging. The percentage of these tunas which remained in the Atlantic Ocean at least for the following months was 66.67% in 2011, 42.86% in 2012 and 20% in 2013, but these data concern only the analysis of the tags which remained attached to the fish for more than 19 days and for which all satellite data were available. This year (with data up to 14 September 2015), the percentage was only 5.6%.

One of the main sponsored opinions, discussed at the SCRS Species Group in the last years, was that the behaviour was affected by the different methodology for tagging, because some of the fish were tagged on board and some underwater. The rationale was that tagging bluefin tunas on board implies a stress for the fish and this is able to induce a modification of the behaviour in the following weeks. As a matter of fact, 56.3% of the tunas tagged on board in the period 2011-2013 in the Atlantic Moroccan traps did not enter into the Mediterranean Sea, while the percentage decreased to 9.1% (period 2012-2013) for those tagged underwater. This year all fish were tagged underwater and the percentage of those which did not enter into the Mediterranean Sea for spawning is 5.6%. Apparently, the correlation exists.

At the same time, at the end of Phase 4, it was possible to have a first overview of the micro-chemistry analyses carried out in many parts of the ICCAT area during the last GBYP Phases, for detecting the natal origin of the fish. The results of the cumulative analyses by area are shown on Figure 11 and they show some surprising data.

As it was reported in 2014 to the SCRS (Di Natale, 2015b), the micro-chemistry analyses, conducted by a team of specialists which operated within the Consortium headed by AZTI within the GBYP framework, showed in some years an important presence of western origin bluefin tuna in the Ibero-Moroccan area. The percentage of western Atlantic bluefin tuna ranged from about 73% in 2011 to 0 in 2012, which increased again to about 21% in the Canary area in 2013, showing a remarkable inter-annual variability. After the very first analyses in 2012, the idea was that the results were partly biased by the total number of samples, but the analyses in the following years confirmed the validity of the first data.

Of course, according to the current available knowledge about the spawning behaviour of the two bluefin tuna stocks, it is very unlikely that a bluefin tuna born in the Gulf of Mexico would like to spawn in the Mediterranean Sea and the opposite. If this fact is true, therefore it is possible that the different behaviour of the tunas tagged in Moroccan traps might be related to the different natal origin of these fish and the different percentage of tunas not entering into the Mediterranean Sea in the same year of the tagging might vary according to the different proportion of these western fish, always taking into account the relatively low numbers in both tagged fish and sampled fish.

This peculiarity shall be better examined in future studies, even if it is currently impossible to have the natal origin information for all tagged tunas, if those tunas are not recovered and duly sampled after the tag pop-off, a system that is far from any reality.

A particular behaviour was noticed about a bluefin tuna complimentary tagged in a Moroccan trap on 13 May 2014 by the team of the Stanford University (headed by Prof. Barbara Block) and the INRH, within the ICCAT GBYP framework. This miniPAT (tag 135154) was initially and preliminarily reported in the GBYP report (Di Natale, 2015a, 2015b), because it popped-off SE of Greenland on 12 September 2014 and this course was considered extremely interesting. This year we recovered even the spaghetti tag (AY02802), because this tuna was finally fished on 26 June 2015 in the Strait of Gibraltar, between Tarifa and Tanger (**Figure 12**). This fish was a male, with 230 cm FL and 158 kg at the recapture. It did not enter into the Mediterranean for spawning in the same year of its tagging, but it was moving into the Mediterranean Sea the year after, even if late in the spawning season. As a matter of fact, this behaviour poses additional questions and deserves further investigations.

### **8.3 General discussion about the GBYP tagging activities and updated results**

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 ICCAT recovery for the period 2002-2009 was only 0.77 tags per year, while during GBYP tag recovery activities the average was 60.14 tags per year<sup>4</sup>, with 7810% increase. The year 2014, after that tagging activities were carried out in many areas and the tag awareness activities were already settled, GBYP recovered a total of 108 tags, about 31.8% of the total over the whole period. Even considering that large-scale conventional tagging was suspended in 2015 and only very poorly done in 2014 (due to the lack of budget)<sup>5</sup>, it is possible that 2015 final recoveries will be close to a similar level at the end of the year. It should be noted that, for the first time in ICCAT bluefin tuna tagging activities, the number of tags recovered and reported from the Mediterranean Sea is much higher than any other area. Considering that reported tags from the Mediterranean were almost nil before the GBYP activities, this is the clear evidence that GBYP tag awareness campaign is producing positive effects.

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 GBYP tags recovered so far in comparison with the number of GBYP tags deployed, the provisional recovery rate is only about 0.9%, but this rate is clearly negatively biased by the large number of juveniles tagged so far, which cannot be fished due to size limits. 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 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 73 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, even if the available data are showing that the different shedding rate between single-barb and double-barb darts seems minimal.

The high number of tags reported in previous years 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. Now the tag reporting activity of the baitboats operating in the Strait of Gibraltar is clearly growing, due to the awareness activities carried out by the IEO colleagues working within the GBYP framework.

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), one Greek farm (Bluefin Tuna Hellas SA) and one Turkish farm had recovered 36 tags, of various types (28 single-barb spaghetti, 6 double-barb spaghetti, 2 archival). Even considering that most of the recent tagging activities were targeting juveniles, the recovery and reporting rate from farms is unrealistically too low (10.6% of the total recoveries), while even the cumulative rate PS+farms (16.43%) is very far from the percentage of catches usually obtained by these activities. Anyway, the situation is slowly improving, even if it is still far from a proportional one.

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<sup>4</sup> Without considering that GBYP initiated its activities in March 2010 and the tag recovery considers only tags reported before 1 September 2015. The first year was considered as full year.

<sup>5</sup> During 2014 and 2015, conventional tagging was limited to complimentary activities only.

The same considerations can be done for the traps, because only one Spanish tuna trap (Tarifa) and 1 Italian trap (Carloforte) had reported 6 tags to ICCAT within the period taken into account (3 single-barb spaghetti, 1 double-barb spaghetti, 2 internal archival). Even in this case, the recovery and reporting rate (1.76% of the total) is unrealistically too low, even taking into account that many catches are moved to farms in recent years.

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 (32 tags in total, 19 single-barb spaghetti, 11 double-barb spaghetti and 2 archival, equal to 9.38% of the total). The possible reasons for the low reporting rates from these fisheries are detailed on the document SCRS/2013/177.

In 2015 it was possible to recover also two conventional tags in Canadian fisheries, which were deployed in a Portuguese tram in the previous year. It is to be noticed that Canadian recoveries are provided in real time to ICCAT GBYP, thanks to the strong cooperation of the Canadian colleagues.

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 or local inhabitants) and the effect of the high reward policy adopted by ICCAT GBYP. We remark the low reporting rate in 2015 besides the considerable increasing of mini-PATs implanted and released in this last year and the improvements concerning the provision of real-time information to the colleagues working in the various areas. 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 clearly 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.

In 2015 all electronic tagging was done directly underwater. The techniques were slightly different from one place to the other, but well-trained divers were used in all tagging sites. In most of the cases, the tags were implanted in the right part of the body, just below the dorsal fin, but the nervous behaviour of the fish in most of the cases caused problems for the divers and real difficulties for implanting all tags, particularly in Turkey. In this case, further problems were caused by the activity of many tuna fishing vessels in the area, which possibly fished most of the tagged fish within a couple of weeks.

It is important to note that several premature detachments<sup>6</sup> 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. In Phase 5 it was decided to use the type of anchor which was unanimously considered the best by the most experienced colleagues, the “Domeier large” type. One of the experts hired by ICCAT GBYP carried out some tests, trying to detach the dart from a dead bluefin tuna that was used for this purpose. The trial revealed that the dart was holding very well and it was impossible extracting it by strongly polling. This test confirms the reliability of the choice made with this type of dart. At the same time, the wound made by the dart is not minimal and, even using the best disinfectants and local antibiotics as set by the protocol, we cannot exclude that the friction made by the wire could create later infection in the wound, which might result in weakening the skin itself around the wound in few weeks. It is to be noted that most of the “premature detachments” happened in areas and times where several fishing vessels were operating and this is particularly true for the tags in 2015.

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<sup>6</sup> 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 the result of a fishing activity, as it seems in most of the cases.

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, to find the tag release data as needed. 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. An ICCAT Recommendation on this mandatory tag release reporting will certainly improve the situation.

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 (possibly producing short advertising and attractive videos), 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.

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**Table 1.** Details of tags implanted by ICCAT GBYP in Phase 4.

Phase 4														
	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	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	116	17	11	0	0	0	88	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	
		3545	496	7	0	0	3712	33	0	7	12	0	1	
<b>GRAND TOTAL</b>	<b>7813</b>	<b>SUBTOTAL = 4048</b>					<b>SUBTOTAL = 3765</b>							
	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	204	139	65	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								
	11585	7306	4212	47	12	8								

**Table 2.** Details of tags implanted by ICCAT GBYP in Phase 5, up to 1 September 2015.

Phase 5 (up to 1 September 2015)													
	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	0												
Bay of Biscay	0												
Morocco*	44		24	20									
Portugal	0												
Strait of Gibraltar***	0												
West Med. **	29	1		28									
Central Med. ****	62	1	56	5									
East Med.	30			30									
		2	80	83	0	0	0	0	0	0	0	0	0
<b>GRAND TOTAL</b>	<b>165</b>	<b>SUBTOTAL = 165</b>					<b>SUBTOTAL = 0</b>						
	TOTAL NUMBER OF TAGS	TAGS IMPLANTED											
		FT-1-94	FIM-96 or BFIM-96	Mini-PATS	Archivals	Acoustic							
Canada	0												
Bay of Biscay	0												
Morocco*	44		24	20									
Portugal	0												
Strait of Gibraltar	0												
West Med. **	29	1		28									
Central Med.	62	1	56	5									
East Med.	30			30									
	165	2	80	83	0	0							

**Table 3.** Details of all tags implanted by ICCAT GBYP from Phase 2 to Phase 5 (up to 15 September 2015).

All GBYP Phases (2, 3, 4 & 5) (up to 1 September 2015)															
	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED						% by area		
		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	0	0,0%
Bay of Biscay	7701	4173	1	3	0	0	3493	18	0	0	13	0	0	0	45,6%
Morocco*	327	129	24	32	0	0	121	13	0	7	0	0	1	1,9%	
Portugal	116	17	11	0	0	0	88	0	0	0	0	0	0	0,7%	
Straits of Gibraltar***	5561	2254	43	0	0	0	3212	22	5	0	23	2	0	32,9%	
West Med. **	1675	932	358	28	0	0	352	5	0	0	0	0	0	9,9%	
Central Med.	1467	773	191	5	0	0	479	7	0	0	12	0	0	8,7%	
East Med.	30	0	0	30	0	0	0	0	0	0	0	0	0	0,2%	
<b>GRAND TOTAL</b>	<b>16883</b>		<b>629</b>	<b>98</b>	<b>0</b>	<b>0</b>	<b>7745</b>	<b>70</b>	<b>5</b>	<b>7</b>	<b>48</b>	<b>2</b>	<b>1</b>	<b>100,0%</b>	
			SUBTOTAL = 9005				SUBTOTAL = 7878								
	TOTAL NUMBER OF TAGS	TAGS IMPLANTED					% by area								
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic									
Canada	11	0	6	5	0	0	0,0%								
Bay of Biscay	11225	7697	3494	21	13	0	45,7%								
Morocco*	476	258	158	52	0	8	1,9%								
Portugal	204	139	65	0	0	0	0,8%								
Straits of Gibraltar***	8618	5491	3075	27	25	0	35,1%								
West Med. **	2031	1285	713	33	0	0	8,3%								
Central Med.	1965	1252	689	12	12	0	8,0%								
East Med.	30	0	0	30	0	0	0,1%								
<b>TOTAL</b>	<b>24560</b>	<b>16122</b>	<b>8200</b>	<b>180</b>	<b>50</b>	<b>8</b>	<b>100,0%</b>								
%	100%	65,6%	33,4%	0,7%	0,2%	0,0%									

(\*)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 4.** Geographical distribution of the areas where the tag recoveries occurred, in numbers and percent, by type of tag (up to 4 September 2015).

Fishing Area / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
East Atl	53	27	9	1	1	91	26,69
Med	159	65	6	5		235	68,91
North Atl	3	1			2	6	1,76
West Atl	2	1		1	1	5	1,47
Unknown			4			4	1,17
<b>Grand Total</b>	<b>217</b>	<b>94</b>	<b>19</b>	<b>7</b>	<b>4</b>	<b>341</b>	<b>100</b>
%ge	63,6%	27,6%	5,6%	2,1%	1,2%	100,0%	

**Table 5.** Details of tag recovery by fishery, in numbers and percent.

Fishery -Gear / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
BB	112	58				170	49,85
FARM	28	6		2		36	10,56
HAND	7	7	1			15	4,40
LL	17	9		2		28	8,21
LLHB	2	2				4	1,17
NF			13		4	17	4,99
PS	13	5	1	1		20	5,87
RR	3	2				5	1,47
SPOR	11	1				12	3,52
TN	1	1				2	0,59
TRAP	3	1		2		6	1,76
TROL	7	2				9	2,64
UNCL	13		4			17	4,99
<b>Grand Total</b>	<b>217</b>	<b>94</b>	<b>19</b>	<b>7</b>	<b>4</b>	<b>341</b>	<b>100</b>



**Table 6.** Annual trend of the BFT tags recovered under GBYP, in numbers and percent, by type (yellow shading put into evidence tags recovered by ICCAT prior to GBYP).

Recovery Year / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
2002	1	1		1		3	
2006	1			1		2	
2008	1					1	
2009	1					1	
TOT 2002-2009	4	1	0	2	0	7	
2010	3					3	0,88
2011	8		1			9	2,64
2012	36	7	6	1	1	51	14,96
2013	60	28	8	2	1	99	29,03
2014	72	30	1	3	2	108	31,67
2015	38	29	1	1		69	20,23
Undefined (2012 or 2013)			2			2	0,59
Grand Total	217	94	19	7	4	341	100

**Table 7.** BFT tag recoveries by season, in numbers and percent, by type.

Recovery Season / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
1	17	11	2	1	1	32	9,38
2	46	21	3	3	1	74	21,70
3	91	38	2	1	1	133	39,00
4	63	24	10	2	1	100	29,33
(blank)			2			2	0,59
Grand Total	217	94	19	7	4	341	100

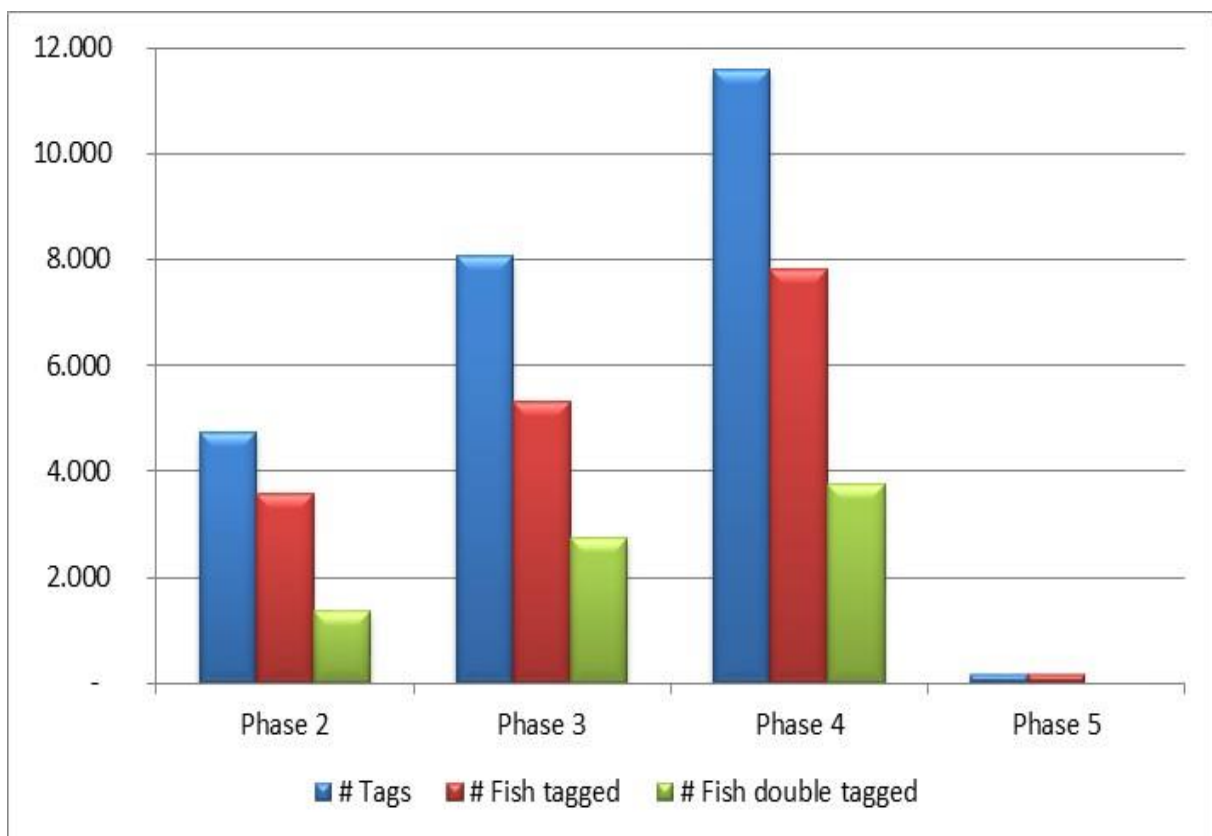
**Table 8.** BFT tag recoveries from double tagged fish by type (up to 4 September 2015).

Release	Spaghetti tag only	Double Barb Tag only	Both	TOTAL FISH	TOTAL TAGS
2011	0	2	5	7	12
2012	3	4	34	41	75
2013	4	3	35	42	77
Total	7	9	74	90	173
%	7,78	10,00	82,22	100	
RcCode: 2conv	both recovered				
	Year of Recovery				
Year of Release	2012	2013	2014	2015	TOTAL FISH D/T
2011	1	3	2	0	6
2012	5	15	10	3	33
2013		6	15	14	35
TOTAL	6	24	27	17	74
%	8,11	32,43	36,49	22,97	100

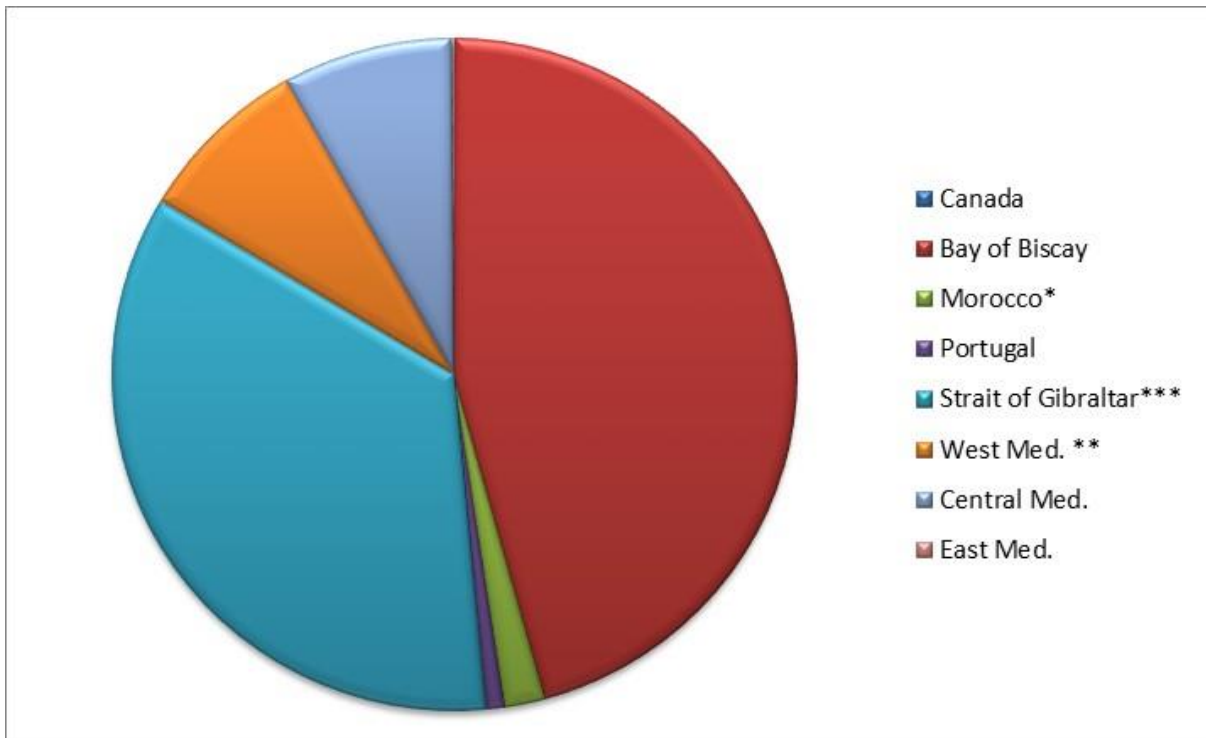
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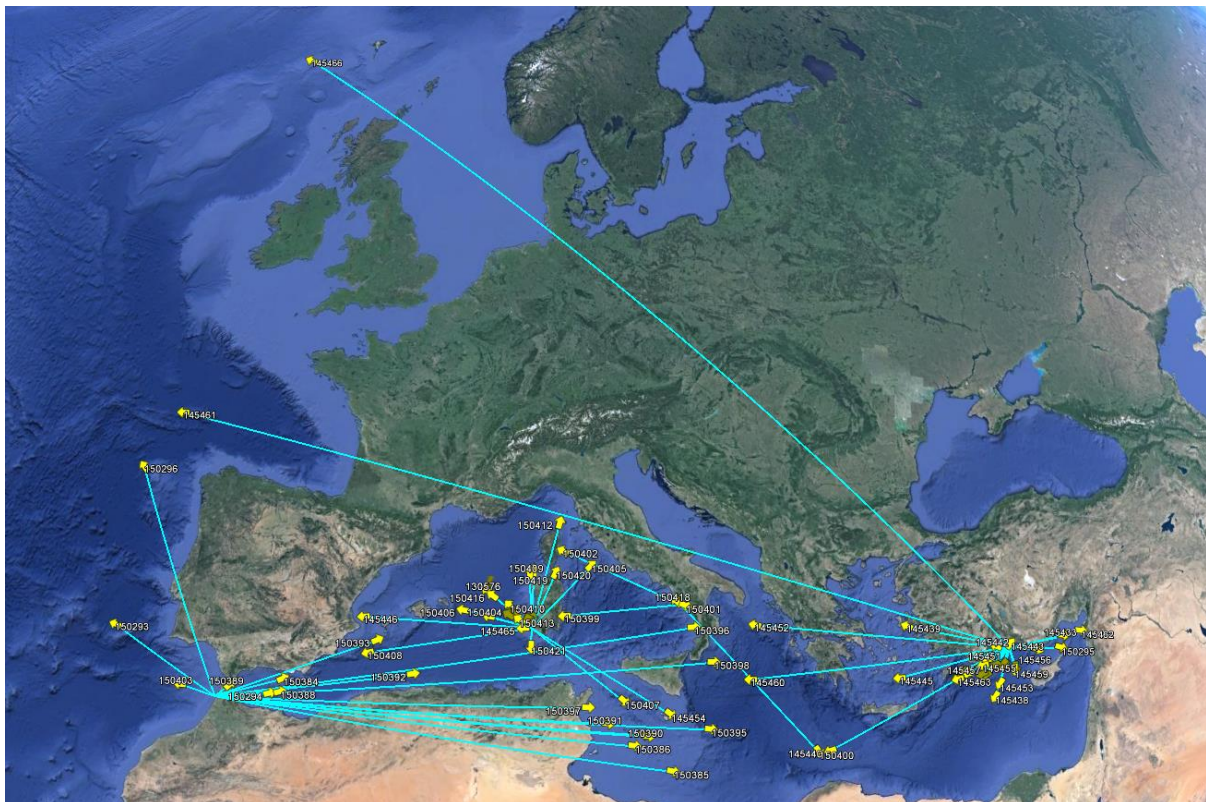
**Figure 1.** Overview of the localities where the ICCAT GBYP tag awareness material was distributed so far.



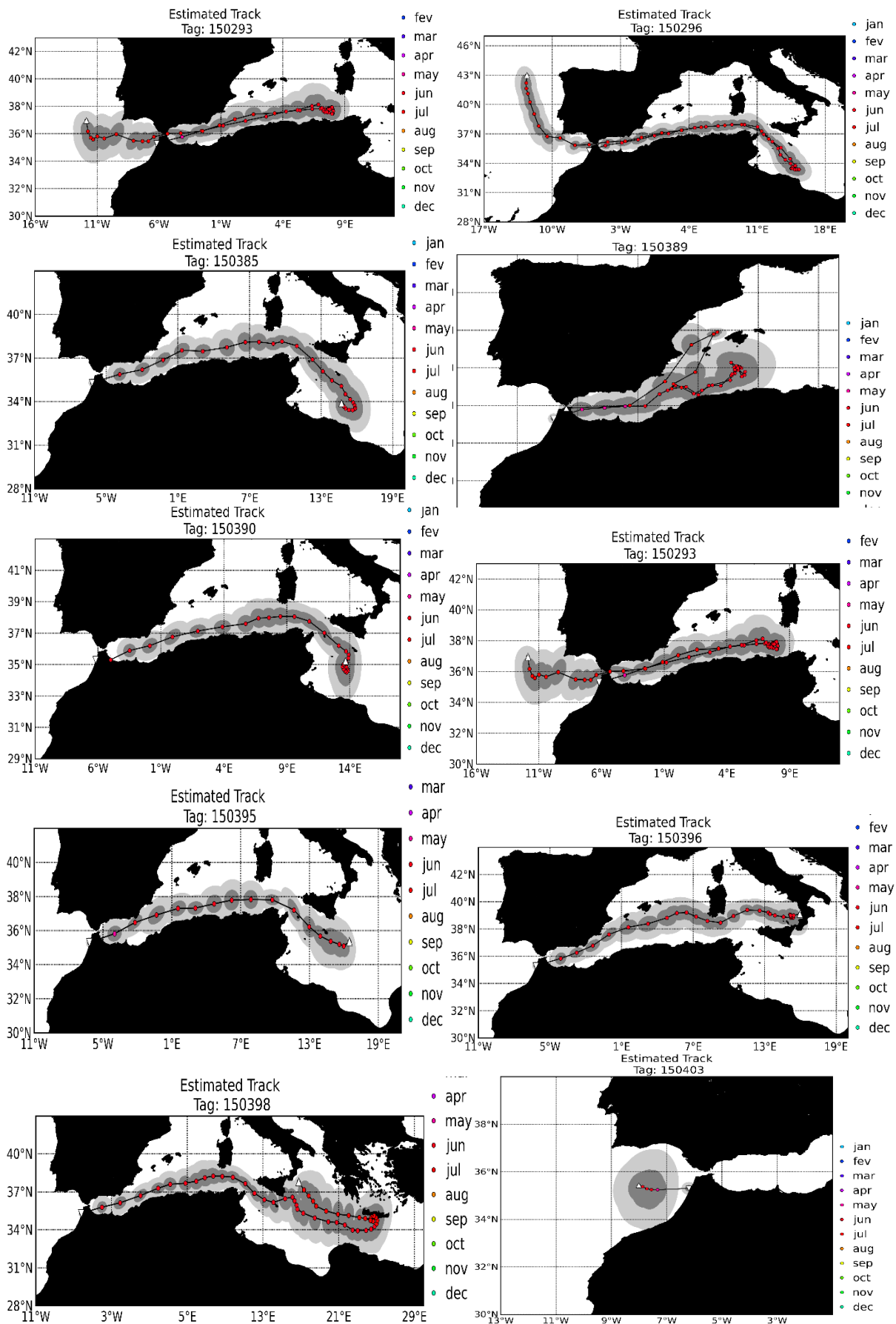
**Figure 2.** Progression of ICCAT GBYP tagging activities in the first Phases (up to 1 September 2015).



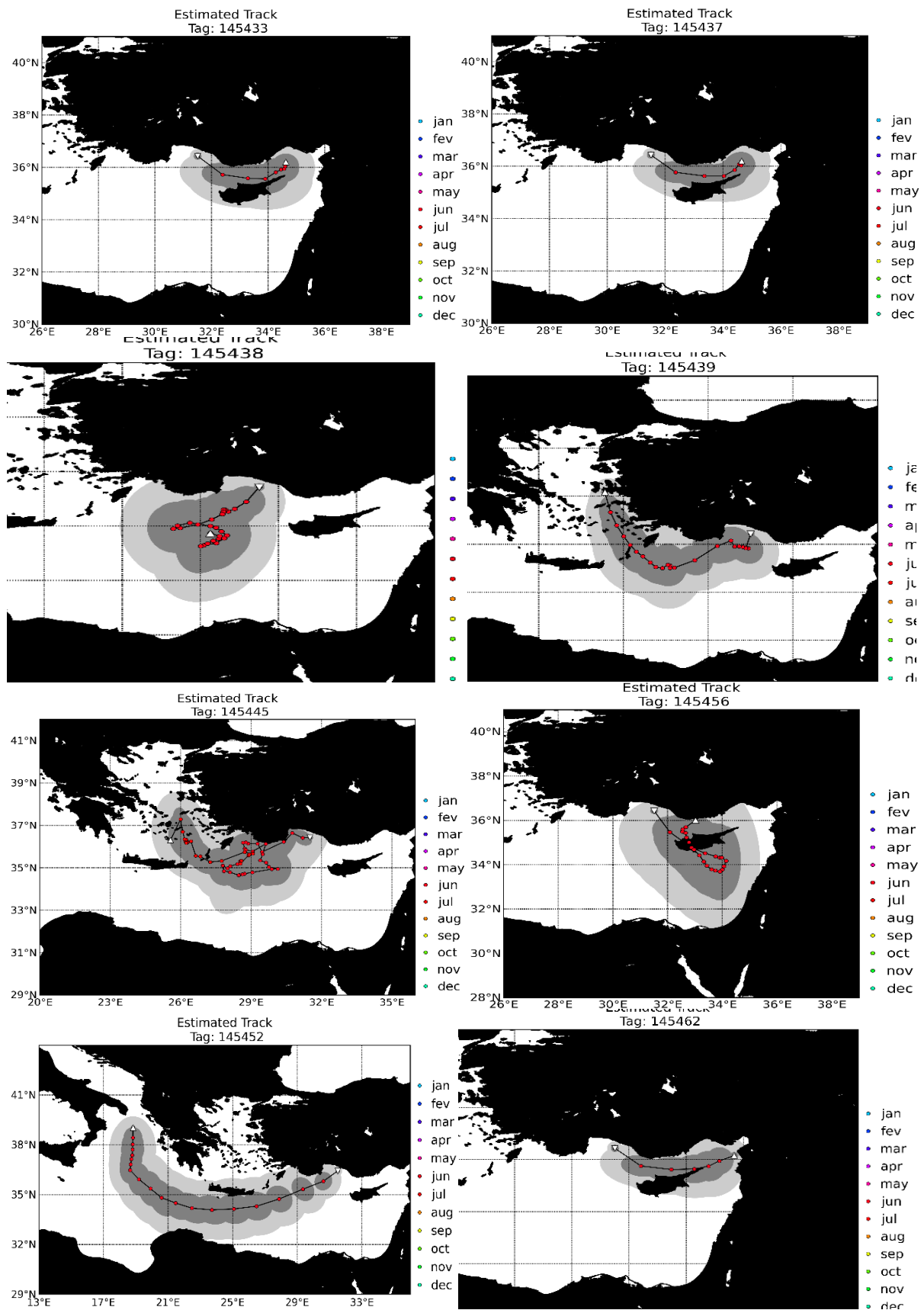
**Figure 3.** Distribution of tags implanted by area in the first 5 Phases of ICCAT GBYP (up to 1 September 2015).



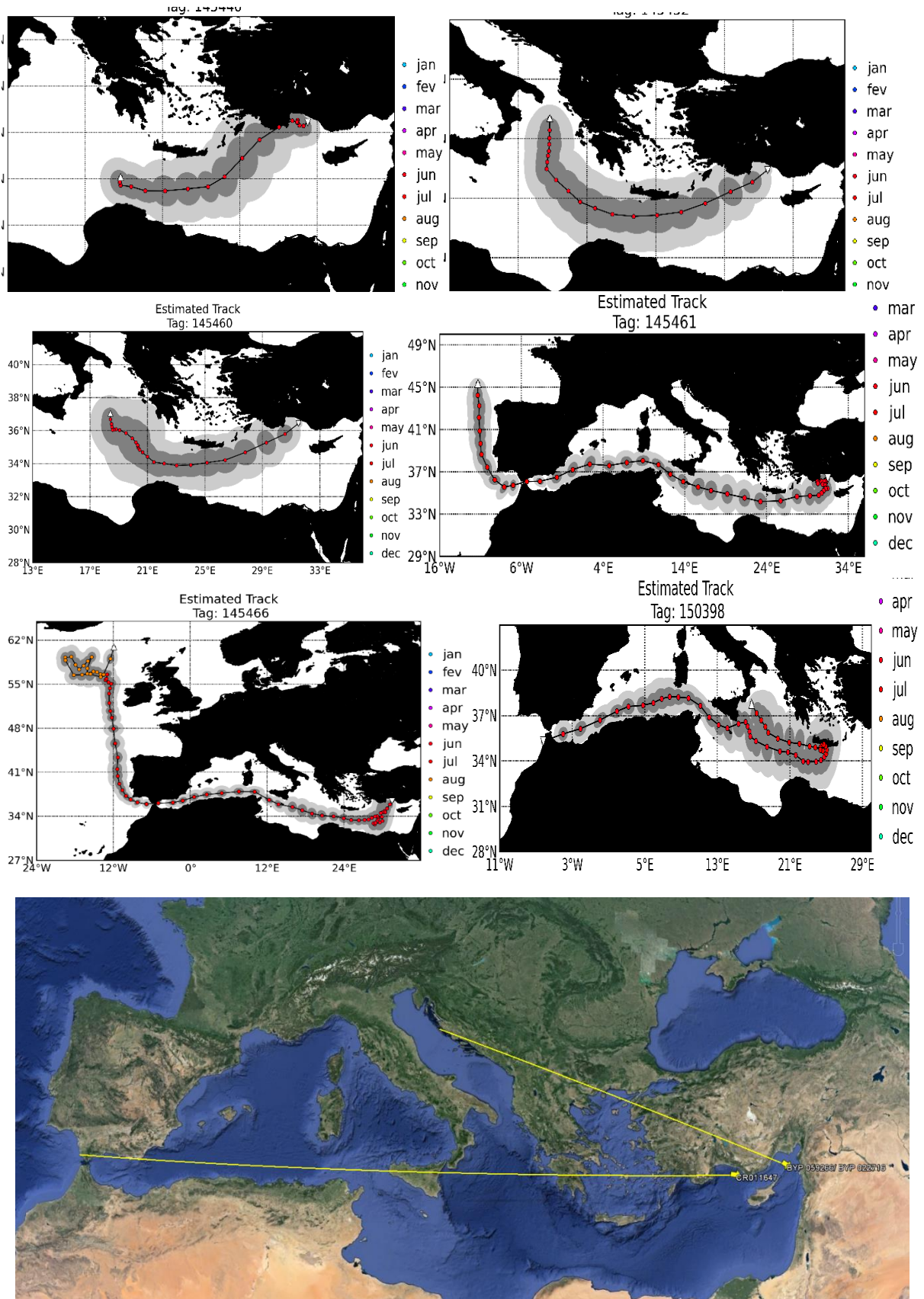
**Figure 4.** Tag release-tag pop-up vectors of adult bluefin tunas tagged with miniPATs in the Moroccan and Sardinian traps, in Turkish purse-seine and in an Italian cage in GBYP Phase 5 (2015) (updated on 16 September 2015).



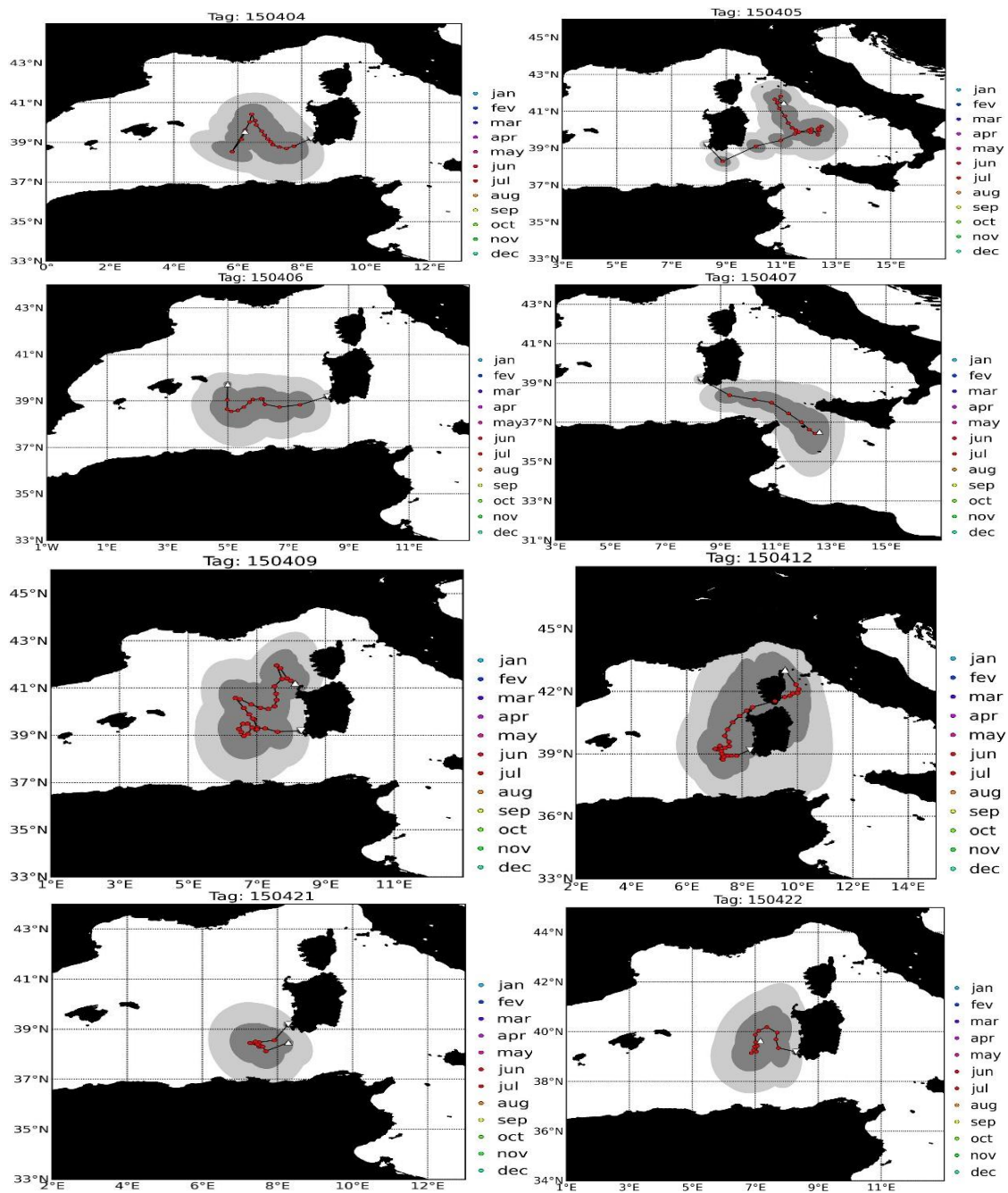
**Figure 5.** Selected tracks of 10 miniPATs deployed in Morocco in 2015, showing different behaviours.



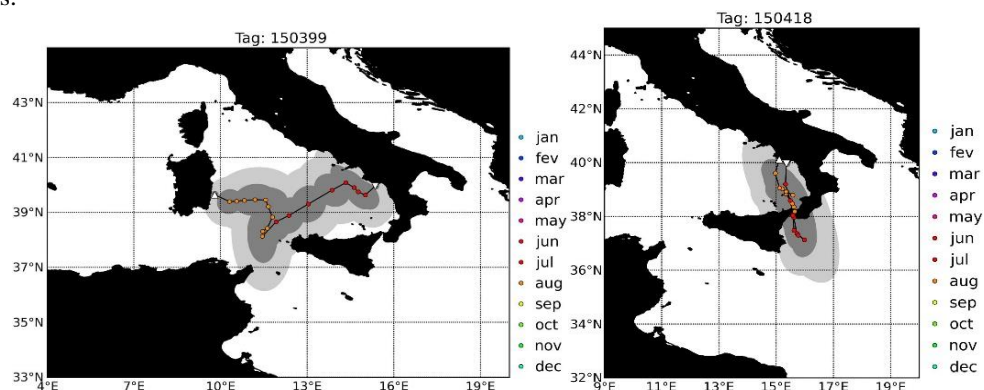
**Figure 6.** Selected tracks of 8 miniPATs deployed in Turkey in 2015, showing different behaviours.



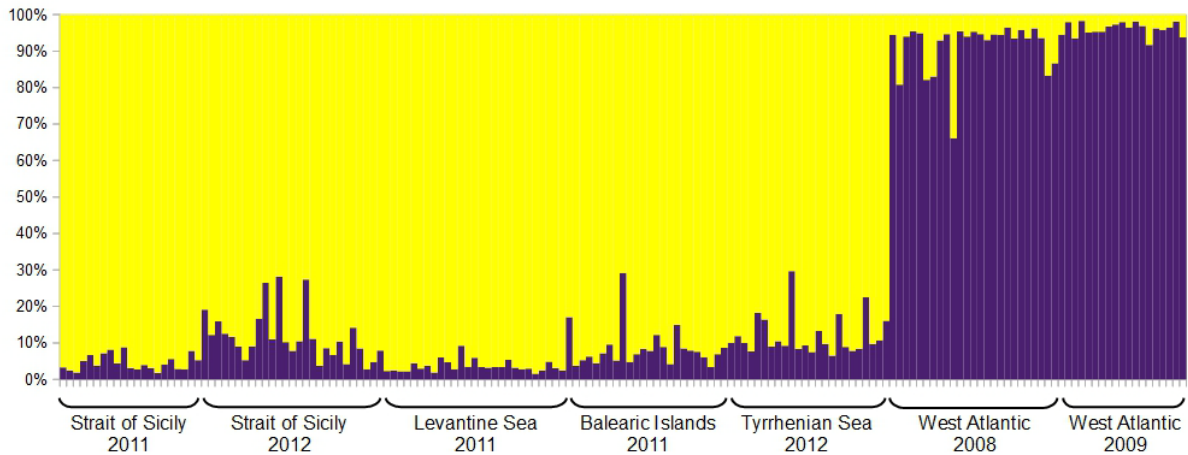
**Figure 7.** Tracks of 5 miniPATs deployed in Turkey in 2015, moving westwards from the eastern Mediterranean, of one tag deployed in a Moroccan trap in 2015 which reached the eastern Mediterranean, and trajectories of two bluefin tunas conventionally tagged in 2011 and 2013, moving into the eastern Mediterranean Sea.



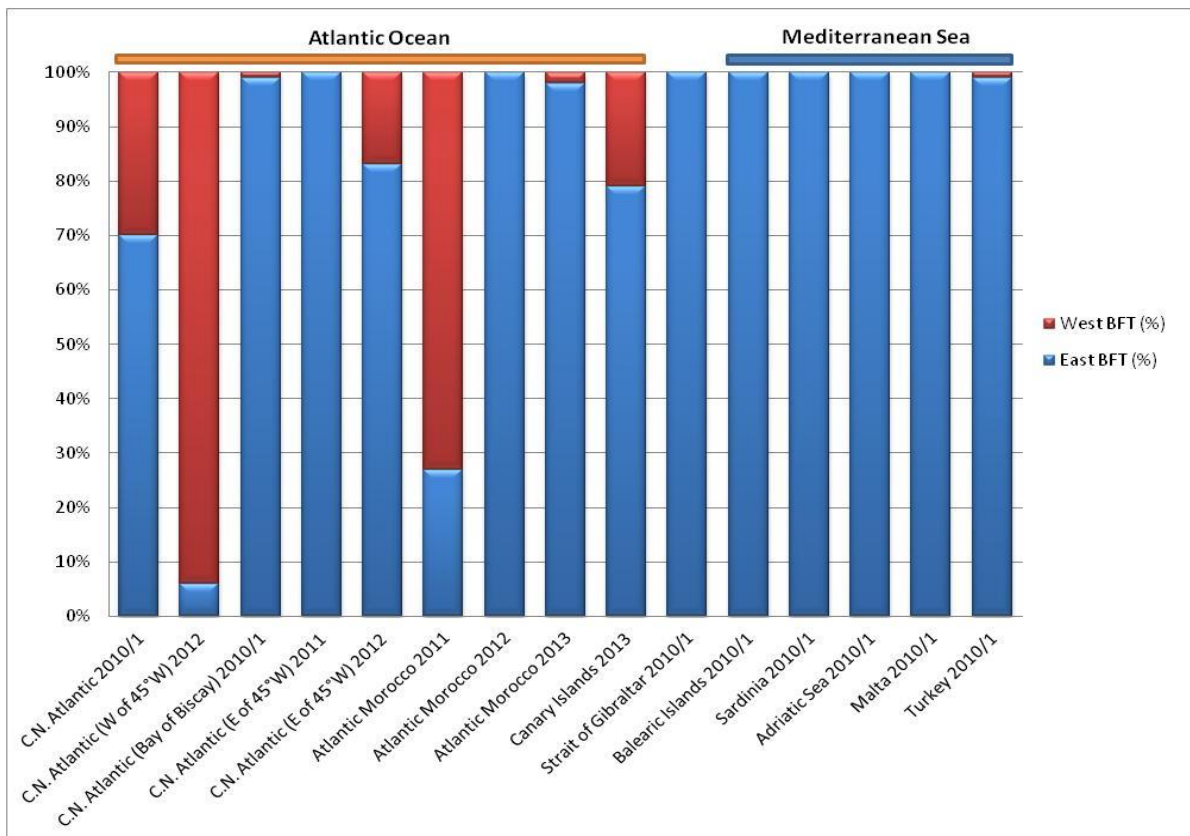
**Figure 8.** Selected tracks of 6 bluefin tunas tagged with miniPatS in Sardinia in 2015, showing different behaviours.



**Figure 9.** Selected tracks of 2 bluefin tunas tagged with miniPatS in Tyrrhenian Sea in 2015, showing different behaviours.

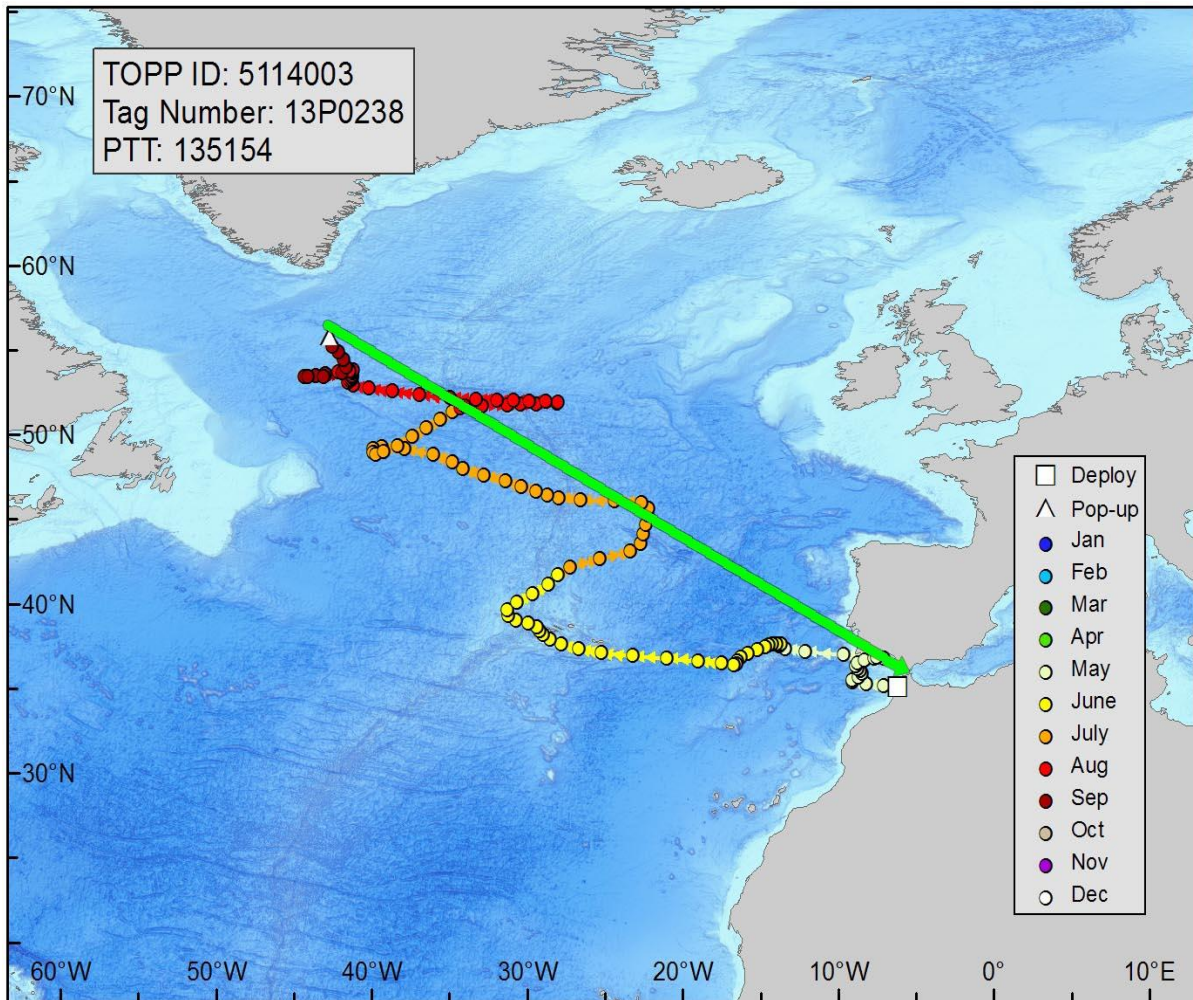


**Figure 10.** STRUCTURE analysis of 167 BFT from the Mediterranean and Western Atlantic using a subset of 59 SNPs from the 96 SNP panel developed by the BGSA Genetics Consortium. The model used assumes 2 ancestral populations. An example from the final reports of Phase 4 provided by the Consortium headed by AZTI to GBYP.



**Figure 11.** Graphic presentation of maximum likelihood prediction of the origin of bluefin tuna collected from various areas and analysed in Phase 3 and Phase 4. Estimates are given by percentages and mixed-stock analyses (HISEA program) was run under bootstrap mode with 1000 runs to obtain standard deviations (~error) around estimated percentages (re-elaborated from the final reports of Phase 3 and 4 provided by the Consortium headed by AZTI to GBYP).





**Figure 12.** Graphic presentation of estimated track of a male bluefin tuna tagged in Larache (Morocco) on 13 May 2014 (bullets in color), which went to Greenland on the same year (pop-off on 12 September 2014) without entering into the Mediterranean Sea during the spawning season and therefore moved somewhere in the Atlantic Ocean. Finally, this tuna was fished in the Strait of Gibraltar on 25 June 2015 (straight line) and the tag was reported to ICCAT GBYP (data and image courtesy of Prof. Barbara Block, University of Stanford, USA).