

**ICCAT ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA
(GBYP) ACTIVITY REPORT FOR 2013
(EXTENSION OF PHASE 3 AND FIRST PART OF PHASE 4)**

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SUMMARY

The Atlantic-wide research programme on bluefin tuna (GBYP) officially begun on October 2009. The third phase of GBYP activities began in May 2012 and was extended up to May 2013, including (a) continuation of data mining / recovery and elaboration, (b) biological and genetic sampling and analyses, (c) conventional tagging, including awareness and rewarding campaign, and (d) further steps of the modeling approaches. The extension period was used for improving several activities and particularly the data elaboration. Phase 4 was initiated in May 2013, including: (a) limited continuation of data mining / recovery and elaboration, (c) continuation of biological and genetic sampling and analyses, (d) continuation of conventional tagging and electronic tagging, including awareness and rewarding campaign, and (e) further steps of the modeling approaches. A very impressive amount of data was recovered in the first three phases, covering a period from 1509 to 2009, all available for the normal ICCAT procedure and officially presented to the ICCAT meeting on bluefin tuna data (May 2013). The conventional tag seeding in its first and second trials was close to the target while the third trial, engagement more consortia, is underway. The miniPATs implanted since 2011 provided very interesting results. The large participations of scientific institutions to the biological and genetic studies are also providing some interesting preliminary results, but more effort is needed for having all the analyses pursued. In terms of modelling, the GBYP initially focused on risk analysis to identify the main perceived sources of uncertainty related to assessment and advice, extending the task to the fourth phase, and on the development of new tools for a better use of the various data sets collected so far, for improving the knowledge of the species and for a more focused management.

RÉSUMÉ

Le Programme de recherche de l'ICCAT sur le thon rouge englobant tout l'Atlantique (GBYP) a commencé officiellement ses activités en octobre 2009. Au mois de mai 2012, la troisième phase des activités du GBYP a démarré et a été prolongée jusqu'à mai 2013, comprenant (a) la poursuite de l'exploration / récupération et élaboration des données ; (b) l'échantillonnage biologique et génétique et les analyses ; (c) le marquage conventionnel, y compris les campagnes de sensibilisation et de récompense et (d) les étapes ultérieures des approches de modélisation. La période d'extension a servi à améliorer plusieurs activités et notamment l'élaboration des données. La phase 4 a été lancée au mois de mai 2013 et incluait : (a) la poursuite limitée de l'exploration /récupération et élaboration des données ; (b) la poursuite de l'échantillonnage biologique et génétique et des analyses ; (c) la poursuite du marquage conventionnel et électronique, y compris les campagnes de sensibilisation et de récompense ; et (d) les étapes ultérieures des approches de modélisation. Un volume très impressionnant de données a été récupéré dans les trois premières phases, couvrant une période s'étirant de 1509 à 2009 et ces données sont désormais disponibles pour la procédure normale de l'ICCAT et ont été officiellement présentées à la réunion de l'ICCAT sur les données relatives au thon rouge (mai 2013). L'implantation des marques conventionnelles au cours des premier et deuxième essais s'est rapprochée de l'objectif et le troisième essai est en bonne voie. Les mini PAT, implantées depuis 2011, ont fourni des résultats très intéressants. La forte participation des institutions scientifiques aux études biologiques et génétiques fournit également des résultats préliminaires intéressants, mais des efforts restent à faire pour que toutes les analyses soient réalisées. En ce qui concerne la modélisation, le GBYP s'est concentré dans un premier temps sur l'analyse des risques visant à identifier les principales sources d'incertitude perçues se rapportant à l'évaluation et à l'avis, élargissant la tâche à la quatrième phase, ainsi que sur l'élaboration de nouveaux outils visant à une meilleure utilisation des divers jeux de données recueillis jusqu'à présent, afin d'améliorer les connaissances sur les espèces et d'obtenir une gestion plus ciblée.

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RESUMEN

El Programa de investigación sobre atún rojo para todo el Atlántico (GBYP) comenzó oficialmente en octubre de 2009. La tercera fase de las actividades del GBYP comenzó en mayo de 2012 y fue hasta mayo de 2013. Esta fase incluyó a) una continuación de la minería/recuperación y elaboración de datos; b) el muestreo biológico y genético y análisis; c) la continuación del mercado convencional lo que incluye una campaña de concienciación y recompensas y d) más pasos en los enfoques de modelación. El periodo de ampliación se utilizó para mejorar varias actividades y, en particular, la elaboración de datos. La Fase 4 se inició en mayo de 2013 e incluía: a) continuación limitada de la recuperación/minería de datos y elaboración de dichos datos; b) continuación del muestreo biológico y genético y análisis; c) continuación del mercado convencional y mercado electrónico, lo que incluye una campaña de concienciación y recompensas y d) más pasos en los enfoques de modelación. En las tres primeras fases se recuperó una cantidad impresionante de datos, que cubrían un periodo desde 1509 hasta 2009, y estos datos están ahora disponibles para el procedimiento normal de ICCAT y se presentaron oficialmente a la reunión de ICCAT sobre datos de atún rojo (mayo de 2013). La detección de marcas convencionales en el primer ensayo y segundo ensayo se acercó al objetivo, mientras que el tercer ensayo está en marcha. Las miniPAT colocadas desde 2011 produjeron resultados muy interesantes. La amplia participación de instituciones científicas en los estudios genéticos y biológicos está produciendo también algunos resultados preliminares interesantes, pero son necesarios más esfuerzos para finalizar todos los análisis. En términos de modelación, el GBYP se centró inicialmente en análisis de riesgo para identificar las principales fuentes percibidas de incertidumbre relacionadas con la evaluación y el asesoramiento, ampliando la tarea hasta la cuarta fase, y en el desarrollo de nuevas herramientas para utilizar mejor los conjuntos de datos recopilados hasta la fecha, con el fin de mejorar los conocimientos sobre las especies y lograr una ordenación más centrada.

KEYWORDS

Bluefin tuna, ICCAT, Biological analyses, Tagging, Genetics, Maturity, Microchemistry, Aerial survey, Mediterranean Sea, Atlantic Ocean

1. Introduction

The Atlantic-wide Research Programme for Bluefin Tuna was officially adopted by SCRS and the ICCAT Commission in 2008, and it started officially at the end of 2009, with the objective to:

- a) Improve basic data collection, including fishery independent data;
- b) Improve understanding of key biological and ecological processes;
- c) Improve assessment models and provision of scientific advice on stock status.

The total budget of the programme was estimated at about 19 million Euros in six years, with the engagement of the European Community and some other Contracting Parties to contribute to this programme in 2009 and in the following years. The initial year had a budget of 750,000 Euros, the second phase had a total budget of 2,502,000 Euros (against the original figure of 5,845,000 Euros and a revised figure of 3,476,075 Euros), while the third phase had a budget of 1,925,000 Euros (against the original figure of 5,845,000 Euros and a revised figure of 4,417,980 Euros), The fourth phase has a budget of 2,500,000 Euros (against the original figure of 5,195,000 Euros and a revised figure of 3,792,000 Euros). The overall GBYP operating budget for the first four phases (a total of 7,677,000 Euros) is about 43.5% of what was supposed to be (17,635,000 Euros). The annual budgets are on <http://www.iccat.int/GBYP/en/Budget.htm>.

Phase 1 and Phase 2 activities were jointly committed by the European Community (80%), Canada, Croatia, Japan, Libya, Morocco, Norway, Turkey, United States of America, Chinese Taipei and the ICCAT Secretariat, which have been joined for Phase 3 by Algeria, China, Korea and Tunisia. The latter two CPCs along with Libya have not paid yet their contributions for Phase 3 and on. For Phase 4, the contribution to the GBYP budget has been extended to other CPCs involved in BFT fishing, namely Egypt, Albania, Syria and Iceland, but none of them had paid so far, along with Libya, Algeria, China, Korea and Tunisia. Several private or public entities² provided funds or in kind support.

² Additional financial contributions to GBYP were provided by Asociación de Pesca, Comercio y Consumo Responsable de Atún Rojo (SP) and by Grupo Ricardo Fuentes e Hijos s.a. (SP) and, in kind, by Balfegó Grup (SP), IEO-Fuengirola (SP); INRH -Tangier (MO),

The third phase (7 months) officially initiated on June 20, 2012, after the signature of the Grant Agreement for co-financing the GBYP Phase 3 (SI2.625691) by the European Commission. Phase 3 officially expired on January 19, 2013, but closing the administrative issues took more time than scheduled, due to a delay of one contractor in providing the necessary documents. The GBYP activities up to the first part of Phase 3 were presented to the SCRS and the ICCAT Commission in 2012 and they have been approved.

The fourth phase (12 months) of GBYP officially initiated on January 21, 2013, after the signature of the Grant agreement for co-financing the GBYP Phase 4 (SI2.643831) by the European Commission and Phase 4 will be completed by 20 January 2014.

The GBYP activity is being supported by a twin programme carried out by NOAA-NMFS, which will focus its research activities on the western Atlantic Ocean.

2. Coordination activities

The GBYP Coordination Staff did not change during the last two phases: the Coordinator, Dr. Antonio Di Natale who started on March 2010, the Coordinator Assistant, Dr. M'Hamed Idrissi who started his duties on March 1, 2011, and Dr. Ana Justel-Rubio who started her activity on October 25, 2011, with a temporary contract, for the technical support of managing and organising the many data sets obtained by GBYP. The ICCAT Secretariat nominated Dr. Laurence Kell as internal focal point for the GBYP activities.

A total of 14 deliverables (periodic reports) were produced in the framework of the EC Grant Agreement. Several additional documents and reports have been also provided by GBYP for the needs of the Steering Committee for its meetings. A total of 13 scientific papers have been produced in Phase 3 (Annex I). Six Calls for Tenders were issued in Phase 3, signing a total of 8 contracts (Annex II).

A total of 6 Calls for Tenders were issued in the first part of Phase 4, providing 16 contracts up to 15 September 2013 (**Annex II**). In the last part of Phase 3 and in the first part of Phase 4 of GBYP, the coordination staff participated officially in 14 meetings in various countries (**Annex III**).

The administrative and desk work behind these duties was quite important and heavy and it was carried out in continuous and constructive contact with the ICCAT Secretariat and the Administrative Department, which had to face an important additional workload caused by GBYP activities.

A particular coordination effort was necessary for assisting the contractors engaged in the aerial survey activities and for assisting them for the many permits required, getting directly in touch with the relevant Authorities of the CPC concerned. A continuous assistance, 7/7 days 24/24h, was necessary for solving various problems, emergencies and operational difficulties for the aerial survey. Additional coordination efforts were required by the various contractors engaged in the field tagging activities, assisting them for many needs and problems. The GBYP assisted the ICCAT Secretariat and the SCRS in organising three meetings: two in Tenerife (SP) in May and one in Gloucester (US) in July. All these efforts and the heavy workload behind have been compensated by the results of the various activities.

In Phase 4, the GBYP Coordination was also in charge of assisting the scientists carrying out the mid-term review of the ICCAT-GBYP, providing all necessary support and all documents.

Furthermore, the GBYP coordination is providing scientific support to all the national initiatives which are potentially able to increase the effectiveness of the GBYP and its objectives. For this reason, since 2010 the Coordinator joined the Steering Committee for the bluefin tuna programmes of the NOAA, together with some members of the GBYP Steering Committee; in this function he participated to the evaluation session of the US domestic research programmes for bluefin tuna also in 2013.

In conformity with the Atlantic-Wide Bluefin Research Programme (GBYP) adopted by the SCRS and the Commission for Phase 3, the following research initiatives have been conducted or initiated (see also Annex II).

Maromadraba SARL and Es Sahel (Fuentes Group)(MO), Roberto Mielgo Bregazzi (SP), WWF Mediterranean Programme and the GBYP Coordinator.

3. Data mining and data recovery (Phases 3 & 4)

3.1 Objectives of the data recovery and data mining

The objective of data recovery and data mining activities is to fill the many gaps existing in several data series currently present in the ICCAT data base, concerning both recent and historical data, which causes a large amount of substitutions in the assessment process, increasing uncertainties. At the same time, data mining activities should provide reliable data series, longer than those currently available, recovering data from many sources, including archives having difficulties for the access. This activity will allow for a better understanding of the long-time catch series by gear, improving the data available for the assessment and possibly for replacing substitutions used for data gaps.

3.2 Data recovered in last part of Phase 3

The objective sets for data recovery and data mining in Phase 3 has been accomplished. After a second Call for tenders, it was possible to have a high-level team of Turkish scientists who explored the most important local archives, with the purpose of checking any data record of bluefin tuna catches or landings between the last part of the XIX century and the first part of the XX century. The team, which included Dr. Ali Fuat Örenc, Dr. Metin Ünver and Dr. Levent Düzcü, deeply explored and mined the Ottoman Archives, the Maritime Museum Archives and the Archives of the Istanbul Municipality. Many interesting and inedited details about the tuna trade in the Ottoman Empire were found (see: <http://www.iccat.int/GBYP/en/Drecovery.htm>). From this difficult exploration, which concerned an incredible amount of documents written in Ottoman, only very few data have been recovered, concerning the period 1915-1923 and those data were incorporated in the GBYP data base. Additional data have been provided by the Coordinator, using some rare literature sources, and also these additional data are now included in the GBYP data base.

3.3 Data recovery in Phase 4

Following the recommendations of the Steering Committee, made in December 2012 and before getting the report of Phase 3 data recovery activities, the objective for Phase 4 was set again focused on the Ottoman data, because additional data from the Eastern Mediterranean Sea, the Marmara Sea and the Black Sea are considered of basic importance for understanding the evolution of both the bluefin tuna population and fisheries. Due to the very peculiar difficulties included in this data mining activity, it was decided to have a meeting with the team of scientists who conducted the first part of the exploratory work in Phase 3 before issuing a Call for Tenders.

The meeting took place in Istanbul in April 2013, also attended by Dr. Saadet Karakulak, and all problems and possibilities were deeply analysed. As a result of this important operational meeting, it was decided to suspend the data mining activities in Turkey, until real possibilities of finding historical data will be detected. The frank and very professional cooperation of the Turkish team was very useful for taking the right decision.

Then, after taking into account the initial data mining and data recovery objectives set by the Commission when the GBYP was established and the information provided to GBYP by some scientists, concerning the opportunities for recovering or mining various data sets, it was issued the ICCAT-GBYP Call for Tenders 06/2013, targeting detailed fishery and size frequency data from NW Atlantic and historical genetic data from the Eastern Mediterranean. Two bids were received and the following activities will take place in the last part of Phase 4.

Furthermore, following the recommendation of the GBYP Steering Committee and the SCRS BFT Species Group, GBYP is working for setting a team able to analyse the many trade and auctions data provided as a gift in kind to GBYP. The objective of this work, to be done in the last part of Phase 4, will be defining and identifying all reliable data and make them available for SCRS uses. These data are potentially able to considerably improve our knowledge of bluefin tuna catches in the last decade.

3.4 Bluefin tuna fishery data analyses

All fishery and size data recovered by ICCAT-GBYP in the first Phases have been deeply quality checked, cross-controlled against the ICCAT BFT data base and analysed, as requested by the GBYP Steering Committee. The result of this intense and complex work were provided to the ICCAT Bluefin tuna Meeting on Biological Parameters Review (Tenerife, May 2013), specifically charged by SCRS to provide recommendations for the use

of data recovered by GBYP. The analyses and the overview of the data have been included in the document SCRS/2013/073. The summary results showing the total number of data recovered are on **Tables 1 and 2**.

Many GBYP data sets were directly used by the various small WG established during this Meeting. The final recommendations by the Tenerife Meeting (see the final Report on http://www.iccat.int/Documents/Meetings/Docs/2013-BFT_BIO_ENG.pdf) are the followings:

- a) For the Task II size data the Group considered that the methods used to validate those data have been appropriate and agreed to incorporate these data to the ICCAT data bases.
- b) As regards Task II catch and effort series that fill gaps in ICCAT current data base, once the quality checking is passed, be incorporated in the ICCAT data base.
- c) Regarding Task II catch and effort series recovered under the GBYP that overlap (see **Table 5**), scientists from the involved CPCs will work in collaboration with the Secretariat in order to solve the problem. Those corrections will be submitted to the next BFT Species Group for approval by the SCRS.
- d) Regarding Task II catch and effort series that overlap with those already in ICCAT database, scientists from the involved CPCs will work in collaboration with the Secretariat in order to solve the problem. Those corrections will be submitted to the next BFT Species Group for approval by the SCRS.

The action recommended in point a) has been already successfully completed and then the data will be finally officially incorporated in the ICCAT BFT Data Base. For action recommended in point b), once overlapping and conflicts will be fully identified, all other catch and effort data will be directly incorporated in the ICCAT BFT Data Base. For the actions recommended in points c) and d), the GBYP and the Secretariat will work with the Statistical Correspondents and the national scientists of each CPC concerned in order to possibly solve any data overlapping (partial or full) or conflict. Catch/effort data for the period prior to 1950 will be added to the ICCAT BFT data base.

The analysis work carried out by GBYP concerned also Task I data recovered by the Programme. These data were cross-checked against the data already existing in the ICCAT Task I BFT data base and the results are in Document SCRS/2013/177. A few conflicts were noticed and these should be further discussed according to the procedures in place. All other GBYP catch data having no conflicts or those for the period prior to 1950 will be added to the ICCAT BFT Task I data base.

4. Aerial Survey on Bluefin Tuna Spawning Aggregations

4.1 Objectives of the Aerial Survey for bluefin tuna spawning aggregations

ICCAT-GBYP Aerial Survey on bluefin spawning aggregations was initially identified by the Commission as one of the three main research objectives of the ICCAT-GBYP, in order to provide fishery-independent trends on the minimum SSB. Two surveys on selected areas have been carried out in GBYP Phase 1 and Phase 2. The aerial survey activity was suspended in Phase 3, following the recommendation by the GBYP Steering Committee, because it was requested an extended survey all over the potential Mediterranean spawning areas, which are on about 90% of the Mediterranean Sea surface, and because sufficient funds were not made available.

The document SCRS/2012/149, among other biological contents concerning bluefin tuna, presented a summary of the available scientific knowledge also on the spawning areas in the Mediterranean Sea, including a map, which was used by GBYP. At the end of Phase 3, under the GBYP Modelling item, it was possible to have a study for assessing the feasibility of a large-scale aerial survey on bluefin tuna spawning aggregations in the Mediterranean Sea for obtaining useful data for operating model purposes (see: http://www.iccat.int/GBYP/Documents/MODELLING/PHASE%203/Aerial_Survey_Feasibility_Study_Phase3.pdf) and this document was used as the base for developing a new aerial survey in Phase 4.

The GBYP Steering Committee, following the request by various CPCs during the 2013 Commission Meeting, included the extended aerial survey in the recommended research plans of Phase 4, under the condition to have the necessary permits by the various CPCs concerned for operating in their air spaces (FIR) (**Figure 1**). A budget was made available for conducting this survey.

4.2 The ICCAT-GBYP Revision of the Aerial Survey Design for Phase 4

Following the recommendation of the GBYP Steering Committee and taking into account the results of the preliminary survey carried out by the ICCAT Executive Secretary for exploring the opportunities of getting the aerial survey permits by the various CPCs and coastal States concerned, it was possible to have the map of the areas on which the 2013 aerial survey should be planned.

This map included only the areas for which ICCAT had received a preliminary declaration of cooperation by the CPC or coastal State concerned. Of course, areas where problems of various types were existing in spring 2013 were not included in the survey for security reasons.

ICCAT-GBYP released a contract to the same team which made the aerial survey designs in Phase 1 and 2, in order to follow a similar methodology, but according to the approach which was recommended by the Steering Committee, trying to balance the limited budget with the research needs of an extended survey. The study provided a design for the areas already surveyed in previous years, having a more dense number of transects, and for the areas never surveyed in previous years, having a less dense number of transects (see: <http://www.iccat.int/GBYP/en/asurvey.htm>).

The design was made with additional tracks, in order to provide opportunities when necessary. At the same time, the team in charge of the design was ready to provide modified tracks in case of any problem or need. The GBYP Aerial Survey Design was used for launching the Call for Tenders GBYP 03/2013 on 19 April 2013.

4.3 The ICCAT-GBYP Aerial Survey for Bluefin Tuna Spawning Aggregations in Phase 4

The ICCAT-GBYP Call for Tenders received several bids, most of them providing offers for the same areas and the selection procedure was quite complex and it was necessary to negotiate with all Companies in order to keep the budget within acceptable limits. At the end, four contracts have been awarded to Grup AirMed (Spain) (Area A), Air Périgord/Action Communication (France) (Area B), Périgord Travail Aérien (France) (Areas E and G) and UNIMAR (Italy) (Areas C, D and F). A training course for pilots, professional spotters and scientific observers was organised at the ICCAT Secretariat in Madrid, attended by 24 fellows, trained by two external experts (Dr. A. Cañadas and Dr. J.A. Vasquez) and by the GBYP Coordinator.

Once awarded the contracts, the ICCAT Secretariat immediately informed all concerned CPCs and assisted all contractors in all procedures for getting the necessary permits. This work needed a continuous assistance by the GBYP Coordination, because of the many delicate aspects concerned. The permits were not easy to get in many areas, besides of the good will expressed in advance by the CPCs concerned. Libya provided a letter of availability which arrived too late and well after awarding the contracts.

The major difficulties have been the permits for documenting the sightings with photos, because these permits are under the control of various different authorities. These permits, in some cases, caused a delayed beginning of the survey activities in some areas. It was necessary to partly readapt the survey design of areas F and G, in order to bring all transects concerning the Turkish FIR to a single Company, for allowing the Turkish national observer to carry out his duties; it was also necessary to partly modify some transects in area D, for avoiding some permit problems. Another problem was noticed in area E, due to the impossibility of releasing a flight permit by the Italian authorities to an aircraft registered in US; thanks to the good will and the availability of two Companies, the Italian FIR was then covered by an aircraft belonging to a different Company, for which a sub-contract was specifically authorised by ICCAT-GBYP. The survey was carried out using 7 aircrafts.

Furthermore, the flight permit was never provided by the Algerian authorities, besides of the many interventions of the ICCAT Executive Secretary, the GBYP staff and the efforts made by the Companies. As a consequence, the transects in areas A and B were reduced, and it was possible improving the number of surveys in the remaining part of these areas, thanks to additional tracks provided in real time. The final survey area is showed on **Figure 3**.

Strong winds, scarce visibility and military activities have been operative problems that caused the delay for completing the survey within the schedule in some areas.

It is important to note that this extended survey, never tried by any entity in the Mediterranean Sea, even considering the various limitations and problems, was possible only thanks to the remarkable help of various national officers in the many CPCs concerned and the extreme good-will and availability of all the four Companies contracted by ICCAT-GBYP and the team in charge of the survey design.

4.4 Elaboration of Aerial Survey Data

At the end of the survey, each Company provided a report for each area, including the excel forms with the detailed data. A contract for elaborating the 2013 aerial survey data was provided to the same institution which carried out the same analysis in previous years. The GBYP staff carried out a quality revision of each report, while the detailed data were checked directly by the external experts, cross-validating them with a continuous direct contact with the observers, whenever this was necessary. The results of this study are now available on <http://www.iccat.int/GBYP/en/asurvey.htm>.

The survey revealed that most of the sightings were concentrated very close to the areas selected by GBYP for conducting the surveys in 2010 and 2011 (**Figure 4**), confirming the initial choice based on scientific knowledge and recent fishery data obtained by a VMS analyses of the purse-seiners activities. Only very few sighting were made in other areas, where spawners usually travel not close to the surface. The delayed time schedule had effects in some areas, because the spawning aggregations were found already split in smaller schools.

The logistic of such an extended survey was really complex and the long transfers had a very serious impact on the effective available effort on transects. As a matter of fact, the total number of flight hours was about 415 h, which implied a total length of about 69928 km, but only 28947 km were on transects, Anyway, the survey allowed for the exploring a total surface of 1,558,224 km².

The main results for the areas surveyed in 2010, 2011 and 2013, with comparative data, are shown on **Table 3**. It is quite evident that the problems for conducting the survey in areas E and G, related to meteorological, permits and logistical problems strongly and negatively affected the results, because spawners had major concentration at the beginning of the season, while the survey was conducted later in the season. The highest increase in presence was in area C (Tyrrhenian Sea) and fishery anecdotal information is confirming this situation. The presence of some very large schools was noticed both in the Balearic Sea and in the Tyrrhenian Sea.

Additional quantities of bluefin tuna were detected in the areas where the extended survey was carried out in 2013 (called “outside” areas) and these are shown on **Table 4**, along with the quantities reported for the “inside” areas. It is very clear that the increase in number of detected schools noticed in 2013 is not corresponding to an increase in quantities (both tons and animals): this is the clear effect of the late survey in some areas, where large schools of spawners disaggregated in smaller schools, somebody leaving the upper strata of the sea for starting their post-spawning movements and migrations. It is extremely important to bear in mind these facts, caused by various logistic constraints, for better understanding the results of the 2013 aerial survey. Clearly, these are the “normal” risks when carrying out an extended survey with limited resources and with a short preliminary advice.

The main recommendations related to the aerial survey are the followings:

- a) The methodology for the survey design applied in 2010, 2011 and 2013 (i.e. equally spaced parallel lines) has proven to be feasible and successful and it is recommended to design future surveys in the same way.
- b) Concentrate the survey effort to only the known spawning areas (‘inside’ sub-areas) as the effort outside only serves to spread out effort and resources over areas with basically very small or no density of spawning bluefin tuna. The 2013 survey has been useful to prove that the previously surveyed spawning areas remain the important areas to be surveyed in the future.
- c) It would be interesting, though, to repeat a whole basin wide survey from time to time (i.e.: every decade) to assess possible variability over the time; if surveys are going to be done annually or bi-annually, the recommendation is to concentrate all efforts on the known and previously surveyed spawning areas.
- d) Concentrate the survey effort in a defined time period (i.e.: only June), the same all years, to allow a more realistic comparison of the results and avoid a potential temporal (seasonal) variability.
- e) Extend the G-inside sub-area slightly to the west on the north of Cyprus to cover the small area detected with high concentration of bluefin tuna for future surveys; extend the northern border of the C-inside subarea slightly as there was a concentration of off-effort sightings right outside the sub-area; possibly slightly extend the E-inside east boundary (see **Figure 8**).

- f) Allocate more effort to future surveys, to allow the reduction of the CVs.
- g) Possibly carry out the annual surveys continuously, in order to improve the technical capacity of the crews and take advantage of the problems rising each year for finding solutions. This approach will allow for an increasing quality of the results and for getting best trends.

5. Tagging activity

According to the general programme, after the adoption of the ICCAT-GBYP Tagging Design and GBYP Tagging Manual in Phase 1, it was planned to begin the tagging activity in GBYP Phase 2 and continue it in the following Phases. The tag awareness and recovery programme was also launched in Phase 2 and continued in the following Phases, including a new tag rewarding policy.

5.1 Objectives

The specific objectives of the GBYP tagging activity on the medium term are:

- a) Validation of the current stock status definitions for populations of bluefin tuna in the Atlantic and Mediterranean Sea. If the hypothesis of two stock units (eastern and western stocks) holds, the tags should provide estimates of mixing rates between stock units by area and time strata (ICCAT main area definitions and quarter at least). It is also important to consider possible sub-stock units and their mixing or population biomass exchange, particularly in the Mediterranean Sea³.
- b) Estimate the natural mortality rates (M) of bluefin tuna populations by age or age-groups and/or total mortality (Z).
- c) Estimate tagging reporting rates for conventional tags, by major fishery and area, also using the observer programs currently deployed in the Mediterranean fisheries (ICCAT ROP-BFT).
- d) Evaluate habitat utilization and large-scale movement patterns (spatio-temporal) of both the juveniles and the spawners.
- e) Estimate the retention rate of various tag types, due to contrasting experiences in various oceans.

Electronic Pop-up tags should provide data over a short time frame, while conventional tags, internal archival tags and PIT tags should provide data over a longer period of time, always depending on the reporting rate.

The objectives set for Phases 3 have been mostly accomplished, taking into account all the various changes and constraints the GBYP had to face, in particular the scarce or nil availability of some age classes in some areas at a certain time of the year and some “force majeure” operational problems in some areas.

The tagging activities in both Phases 3 and 4 started on schedule.

All details about the tagging activities carried out under the GBYP contract in Phase 3 are available on http://www.iccat.int/GBYP/Documents/TAGGING/PHASE%203/GBYP_TAGGING_FINAL_REPORT_PHASE_3.pdf. are included in Deliverables D1.1 (issued on March 21, 2011), “All Tasks.1” (issued on July 31, 2011), D1.2 (issued on July 31, 2011), D2.1 (issued on October 11, 2011) and D2.2 (issued on June 22, 2012).

For Phase 4, the GBYP Steering Committee recommended to extend conventional tagging to BFT adults in some areas, particularly in north-west African coast (Moroccan traps), in west Mediterranean (Italian traps, Sardinia) and in the Tyrrhenian Sea (Italian Purse seiner), while tagging for BFT juveniles be limited to Bay of Biscay and Strait of Gibraltar (Spanish baitboats). The first set of reports concerning the tagging activities in Phase 4 (up to 15 September 2013) is available in the Phase 4 folder on <http://www.iccat.int/GBYP/en/tagging.htm>.

³ Additional elements will be provided by the GBYP biological and genetic sampling and analyses.

5.2 Tags and correlate equipment

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
- b) 8 acoustic tags provided by Stanford University.

5.3 Tagging activities

The tagging activity in Phase 3 was defined by the Steering Committee on 7-8 February 2012 and then refined on 20-21 March 2012, adopting the strategy to use exclusively baitboat vessels and to have a tagging coordinator for following the field activities in real time and maintaining a continuous contact with the GBYP coordination. The Call for tenders was issued on March 26, 2012, anticipating the official beginning of Phase 3 for allowing the field activities to start on time. The contract was awarded on June 21, 2012, to a Spanish Consortium of nine partners (Spain) and 5 sub-contractors, headed by AZTI.

The Consortium encountered several problems for tagging, particularly in the western and central Mediterranean Sea, mostly due to causes of “*force majeure*” (bad weather conditions, accidents and absence of juvenile tunas at the surface when the vessels where on site), but also partly due to some mistakes in the strategy adopted by the taggers. In Phase 3 the tagging results obtained by the Consortium were as follows:

- 5264 spaghetti tags, from the objective of 11750 tags (44.8% of the target)
- 2751 double tagged fish, from the objective of 4700 tags equal to 40% double-tagging (58.5% of the target in number, but with a total of 51.8% double tagging)
- 40 mini-PATs, all implanted (21 in Strait of Gibraltar, 14 in Bay of Biscay and 5 in Gulf of Lion) (100% of the target)
- 38 Electronic internal tags (25 in Strait of Gibraltar and 13 in Bay of Biscay) (76% of the target)

In terms of the Phase 3 tagging objectives by area, the Consortium successfully reached 102 % in Bay of Biscay, while it failed in both Central Mediterranean and Gulf of Lions with 5% and 9%, respectively. In the Strait of Gibraltar it reached barely 46% of the objective.

The ICCAT-GBYP tagging activities in Phase 3 are summarized on **Table 5**.

The Steering Committee, in December 2012, adopted a different tagging strategy for Phase 4, keeping the baitboat tagging only in the Bay of Biscay and in the Strait of Gibraltar, while pilot activities were planned in traps for tagging adults (both in Morocco and Sardinia), with purse seine for adults in the Tyrrhenian Sea and with purse-seine and cages in the Adriatic Sea. The contracts were provided to a Spanish Consortium headed by AZTI for the baitboat-based tagging, 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, to an Italian consortium headed by UNIMAR for the purse-seine based tagging in the Tyrrhenian Sea and to a Croatian Company, Kali Tuna, for the purse-seine based tagging in the Adriatic Sea. At the moment of this report several activities are still going on and the most updated date are showed on **Table 6**.

In total, at the moment, the total number of bluefin tunas tagged so far in all Phases of GBYP are 14890, and a total of 21996 tags have been implanted (**Table 7**).

Figure 5a shows the progression of the ICCAT GBYP tagging activities in the various years, clearly showing the yearly improvements. **Figure 5b** shows the percentage distribution of tags implanted in the various geographical areas, up to September 2013.

The ICCAT-GBYP electronic tagging with mini-PATs was carried out on juveniles in the Bay of Biscay and in the Strait of Gibraltar in Phases 3 and 4, on juveniles in the Adriatic Sea in Phase 4 only and on adults in the Moroccan Atlantic in Phases 2, 3 and 4. GBYP internal archival tags have been implanted so far in the Bay of Biscay, in the Strait of Gibraltar and in the Adriatic Sea. Most of the results for Phases 2 and 3 have been already provided to SCRS and the Commission in 2012. Further results were provided to the Tenerife Meeting in May 2013, while the most updated ones are included in the present report.

It is important to note that several premature detachments⁴ 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. The full analyses of these premature 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 last part of Phase 3 and in the first part of Phase 4 are on **Figures 6 to 11**. 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 15 September 2013 are showed on **Figure 12**.

The juvenile tunas electronically tagged in the Bay of Biscay are confirming that their movements in the short period are usually extended, while one specimen showed extensive movements over a longer period of time. 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 and for this reason it was decided to present two different figures, one for those staying closer to the Strait of Gibraltar (**Figure 8**) and one for those having more extensive movements (**Figure 9**): some of these latters reached well-known spawning areas.

The adult pre-spawners which were tagged in the Moroccan traps showed a general behavior 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. The preliminary data analyses of some selected tags presented during the Tenerife meeting showed the relevance of this tagging activity either for confirming spawning behavior 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.

This year, 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 will be analysed whenever all data will be available.

It will be particularly important to investigate the behavior 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.

5.4 Tag awareness campaign

This 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 13,000 posters of various sizes (A1, A3 and A4) and more than 15,000 stickers were produced so far; all posters are also available on the ICCAT-GBYP web page. A capillary distribution of the tag awareness material was carried out, sending copies to all stakeholders such as: Government Agencies, scientific institutions, tuna scientists, tuna industries, fishers, sport fishery federations and associations and the RFMOs and RACs

⁴ 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.

concerned; the coverage was complete in the ICCAT Convention area, including also non-ICCAT countries and those countries or entities fishing in the area. The map clearly shows the distribution effort (**Figure 13**). The ICCAT-GBYP web page has the full list of contacts <http://www.iccat.int/GBYP/en/AwCamp.asp>.

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. The SCRS and the ICCAT Commission were informed about the campaign, while direct information was also provided to the World Congress of Sport Fishing Federations in 2012. 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.

5.5 Tag reward policy

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 is contributing for providing better tag reporting results.

5.5 Tag recovery and tag reporting

This activity is the final result of the activities listed in points 5.3 and 5.4. For further improving the results, meetings with ICCAT ROPs were organised, further informing them about the ICCAT-GBYP tag recovery activity and asking them to pay the maximum attention to tags (and to natural marks) when observing harvesting in cages or any fishing activity at sea. Special information forms have been provided to ROPs.

The first report of ICCAT-GBYP tag recovery activities is provided on document SCRS/2013/177. While examining the results of the ICCAT-GBYP tag recovery/reporting activities, it is very important to consider that 92.3% of the conventionally tagged fish in Phases 2 and 3 were juveniles (age 0-3); 70.5% 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 2013, there have been 109 tags recovered (74 deployed by GBYP and 35 deployed by other tagging programmes) as follow:

- 76 Conventional “Spaghetti” tags
- 19 Conventional “Double/Single barb” tags from double tagged fish
- 10 External Electronic “mini-PATs” tags
- 3 Internal Electronic “Archivals” tags
- 1 Commercial “Trade” bluefin tuna tag.

The tags were recovered by area as follow:

1. East Atlantic: 53 tags (48.6%): 32 Spaghetti tags, 16 double tags and 5 miniPATs,
2. Mediterranean Sea: 47 tags (43.1%): 40 Spaghetti, 3 double tags, 3 miniPATs and 1 Archival,
3. North Atlantic: 4 tags (3.7%): 2 Spaghetti, 1 Archival and 1 Trade,
4. West Atlantic: 3 tags (2.8%): 2 Spaghetti ones and 1 Archival,
5. Unknown area: 2 tags (1.8%), all miniPATs⁵

The distribution of tag recovered by fishery is showed on **Table 8**, while the first set of data is showed on the maps in **Figures 14 to 17**.

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 2005-2010 was only 2 tags per year, while the average of the GBYP tagging activities (2011, 2012 and part of 2013) provides an average of 33 tags per year, with 1550% increase. The year 2012, the first after the tag awareness activity, had a total of 54 tags reported to ICCAT, about 50% of the total over the whole period. It is possible that 2013 recoveries will be at a similar level at the end of the year. This is the clear evidence that GBYP tag awareness campaign is producing positive effects.

⁵ These are tags reported after a long fishing campaign, and the recovery location was not available. The location will be defined when the manufacturer will be able to recover the data stored inside the tags.

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 in 2011 and 2012, then currently the provisional recovery rate is 0.6% (74/12810), but this rate is clearly negatively biased by the juvenile ages of more than 92.3% 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 we don't have the number of implanted tags by each tagging entity.

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/farms, but the data are showing a different reality: so far, only one Spanish Farm (Balfegó), one Maltese farm (Azzopardi) and one Greek farm (Hellas) had recovered some tags, of various types. Even considering that most of the recent tagging activities were targeting juveniles, the recovery and reporting rate is unrealistically too low. The same considerations can be done for the traps, because only one Spanish tuna trap (Tarifa) had reported tags to ICCAT within the period taken into account. Even in this case, the recovery and reporting rate 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. The possible reasons for the low report rates from these fisheries are detailed on the document SCRS/2013/177.

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. That is essential because recoveries can be logically reported to ICCAT at any time and it is not always easy, rather time/effort consuming finding the entity which implanted the tags if data are not properly stored. GBYP staff had experienced a lot of difficulties in recovering the tag release data in several cases. 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.

6. Biological and Genetic Sampling and Analyses

The GBYP biological sampling design was the one provided by the Institut National de Recherche Haulieutique (INRH - Morocco) on March 2011. The final approved version is available on the ICCAT-GBYP web site: http://www.iccat.int/GBYP/Documents/Biological_Sampling_Plan_GBYP_2011.pdf

Some of the activities concerning the biological sampling and analyses have been already preliminary presented to SCRS and the Commission in 2012. This report includes the final results of Phase 3 activities.

6.1 Objectives

The main objective of this task was to improve understanding of key biological and ecological processes through broad scale biological sampling of live fish to be tagged and dead fish landed (e.g. gonads, muscles, otoliths, spines, etc.), histological analyses to determine bluefin tuna reproductive state and potential, and biological and genetics analyses to investigate mixing and population structure. In particular, Phase 3 objective was pursuing the work to better define the population structure of Atlantic Bluefin Tuna (*Thunnus thynnus*), with a particular attention to the age structure and the probable sub-populations identification.

6.2 Activities

Phase 3 activity was clearly able to accomplish its objective (**Table 9**). Of course, the activities in following Phases of GBYP are set for completing and improving the preliminary results and for better defining some issues, such as mixing between the two current stocks and the sub-population hypothesis, which may require several years of data and many analyses, depending on the available budget.

The biological activities for Phase 3, carried out by an international Consortium headed by AZTI including 12 institutions and 5 subcontractors was reported in detail Deliverable D (issued on February 17, 2013). All activities for the biological studies in Phase 3 (final report) are now available on http://www.iccat.int/GBYP/Documents/BIOLOGICAL%20STUDIES/PHASE%203/Bio_Consortium_FinalReport_GBYP_Phase3.pdf.

As requested by the Bluefin tuna Species Group, the SCRS and the GBYP Steering Committee, an SCRS meeting was organized in May 2013 in Tenerife for reviewing the bluefin tuna biological parameters and the report is available on http://www.iccat.int/Documents/Meetings/Docs/2013-BFT_BIO_ENG.pdf. The results are also on documents SCRS/2013/074, SCRS/2013/080, SCRS/2013/089, SCRS/2013/94, all presented at the Tenerife meeting.

The total number of samples was higher than the target (141%); an achievement made possible thanks to the ICCAT Rec.11-06, which allowed collecting samples even outside the fishing season. Additional 150 biological samples collected by the Libyan scientists are not included in the official report provided by the contractor. GBYP was informed by one member of the Consortium that these Libyan samples were moved to Malta and stocked there in the last part of 2012. They will become available for the analyses in Phase 4 and officially included in the biological data base. The late beginning of the activity had particularly affected the gonads sampling of mature gonads, because the spawning period was already initiated when the activity was conducted. Additional technical and logistic problems were noticed by the Consortium, particularly for sampling juveniles in Malta and for exporting the samples from Turkey.

Among the most relevant results, the genetic analyses are clearly showing and confirming the genetic characteristics and difference between the specimens from the Western Atlantic and the Eastern Atlantic. After the studies carried out in 2011, the additional results obtained in 2012 seem able to better identify at least two sub-populations inside the Mediterranean (**Figure 18**): one temporarily called “Western Mediterranean” (which includes tunas from the western and central Mediterranean, including the Adriatic Sea) and the other temporarily called “Eastern Mediterranean” (which is possibly generated by the ancient sub-population of bluefin tuna which inhabited the Black Sea and the Marmara Sea up to the ‘70s and which possibly displaced in the Eastern Mediterranean after the ecological crisis of the Black Sea). The analyses showed a problem among age 0 fish from the Eastern Mediterranean, because there was a Western Mediterranean component, which created a discrepancy with the full Eastern Mediterranean identification of the bluefin tuna larvae.

In this case, the broader view of GBYP is able to provide a possible justification, thanks to the aerial survey carried out in 2011 and the environmental data collected daily in the same period. According to these field observations, an anomalous oceanographic condition, coupled with strong winds south of Malta, caused the presence of a large area of stable hot waters in the western part of the Eastern Mediterranean, between Cyrenaica and the southern part of Italy and the western part of Greece. In this area, the stable conditions of hot surface waters allowed for a deep surface thermocline; this fact induced a considerable number of bluefin tuna spawners, usually spawning in the central Mediterranean, to move eastward and possibly spawn in this large area north of Cyrenaica. This opportunity possibly caused the presence of some “western Mediterranean” age 0 fish in 2012 in areas where “Eastern Mediterranean” tunas were usually distributed (the right food chain is anyway available for juvenile bluefin tuna even in that area, where there is traditionally a high availability of small pelagic species). Even if further analyses are necessary for confirming and more precisely define the various sub-populations, it is clear that the availability of information from many different sources (aerial survey, environmental data, genetics, microchemistry, etc.) may sometimes contribute in increasing our understanding of the results of sophisticated analyses.

The **microchemistry analyses**, carried out on 897 otoliths (600 from Phase 2 and 297 from Phase 3), also provided again very useful and interesting results, further discriminating the two main bluefin tuna populations according to the individual origin of each fish: western and eastern Atlantic Ocean. During GBYP Phase3, the baseline historically used to estimate mixing proportions was updated and improved, and both Phase 2 (n=600) and Phase 3 (n=400) samples were re-analyzed using the new baseline. Of the 400 otoliths analysed in Phase3, 297 correspond to mixed areas and the rest (103) correspond to the baseline estimates. The results are given as percentages (**Figure 19**).

It is very interesting to further define the results according to the scientific knowledge on the distribution, biology and ethology of Atlantic bluefin tuna. As a matter of fact, the results from the Central-North Atlantic confirm the current knowledge, which shows a partial mixing of the Western and Eastern bluefin tuna. The data of the Bay of Biscay show an almost total presence of juveniles from the Eastern Atlantic stock, with very marginal components of Western Atlantic migrants. The samples collected in Moroccan traps (East Atlantic-

West African coast) are extremely interesting, because they show a major Western Atlantic component which is not well known in terms of migration; adding to these data the results of the electronic tagging and the doubts about the bluefin tuna living in South Atlantic, it is very clear that this area needs much more attention in future years and the sampling should be strongly improved, aiming at improving our understanding of the various components. The results from the various areas of the Mediterranean Sea show a total component of East Atlantic bluefin tuna, except, in 2012, for a marginal component of Western Atlantic tuna in the inner part of the Mediterranean, the Turkish area. Even if it is difficult to clearly identify the reason for this presence, looking at the historical distribution of the tuna traps, it is evident that, at the beginning of the XX century, there were some traps in East Libya and in Egypt fishing for bluefin tuna coming at least from the Western Mediterranean and these tunas, in the traps of Tripolitania, had also an undefined component coming from the Atlantic through the Strait of Gibraltar. Then, it is not impossible that a tuna from the Western Atlantic may reach from time to time even the extreme Eastern Mediterranean. Of course, it will be necessary in next years to increase both sampling and tagging, for better defining also this situation and the possible mixing rate.

The **ageing analyses** provided a second GBYP data set for age-length key (ALK), in addition to the set obtained in 2011, which can be used in future assessments, together with all other available ALK data. The ageing analysis in 2012 was carried out on 315 samples (more than the target of 250): 157 age determinations were carried out by using otoliths and 158 by using spines. Many additional samples (a total of 1789 otoliths and 1443 spines) have been collected and those not used for the analyses in 2012 were stocked together with previous samples collected in 2011 for future analyses. The target objective for sampling 10 specimens by 10 cm length range was nearly achieved, but not for all age classes. **Figure 20a** shows the ALK obtained from otoliths, while **Figure 20b** shows the ALK from spines. **Figure 21** provides the comparison between ALK from otoliths and spines.

The **gonads analyses** were carried out on 158 samples, from the 351 ovaries and testes collected which represent more than the target and almost the double of the samples collected in 2011, but only a portion of these samples were collected just before, during or just after the usual spawning period. Sampling in some traps provided biased results, because the tunas were kept inside the trap for several weeks, due to quota issue. The results obtained in 2012 are confirming again most of the current knowledge about the spawning season of the eastern Atlantic stock. In future years, sampling well outside the usual spawning season should be avoided. A continuous sampling immediately before, during and after the main spawning season in various areas may confirm extended or non-typical spawning seasons in some years, when the oceanographic conditions show this possibility.

The closing administrative procedures for Phase 3 biological studies have been extremely delayed by some members of the Consortium, creating many problems for releasing the contract for Phase 4 and also because of some potential conflicts of interests. Due to these problems, the administrative procedures for closing the contract were finalised only on September 9, 2013.

Following the recommendations of the GBYP Steering Committee, a Call for tenders for both sampling and analyses was issued in 6 March 2013, receiving one single offer from a large Consortium of 13 entities and 7 sub-contracted entities, belonging to 13 countries. The ICCAT Selection Committee reviewed the offer and found some problems, recommending also that the new contract won't be released until Phase 3 is totally technically and administratively completed. The Selection Committee noticed that ageing was not included since the beginning in the offer, but there was not any budget room for launching a dedicated and separate Call for tenders in Phase 4. A last revised proposal was submitted on September 11, 2013. For all these reasons, the final decision about the biological contract in Phase 4 was deferred for the discussion and the decision to the GBYP Steering Committee in September 2013.

7. Modelling approaches

The ICCAT-GBYP activity on Modelling Approaches in the last part of Phase 3 and the first part of Phase 4 strictly followed the course recommended by the GBYP Steering Committee, endorsed by ICCAT-SCRS and approved by the ICCAT Commission.

Four contracts have been awarded under the Modelling Programme in support of BFT Stock Assessment: I) Qualitative & Quantitative Risk Assessment, II) Statistical conversion of catch-at-size to catch-at-age, III) Auto-regressive imputation of catch-at-age data and IV) Statistically-based stock assessment methods to be used for raising reported catch data. No bids were submitted for the Call for tenders concerning the Development of biological hypotheses for the use of MSE (Management Strategy Evaluation).

In addition to these three contracts, one more contract was awarded to an external expert after the GBYP Steering Committee meeting in December 2012: Assessment of the feasibility of a large-scale aerial survey of BFT spawning aggregations in all the Mediterranean Sea for obtaining useful fishery-independent indices for the purpose of Operating Models.

The reports are included in Deliverables E.1 (presented to SCRS in 2012), E.2 (received on January 8, 2013), E.3 (received on January 21, 2013), E.4 (received on January 18, 2013) and E.5 (received on January 15, 2013).

7.1 Objectives

Under the GBYP the modelling programme is addressing objective 3:

- Improve assessment models and provision of scientific advice on stock status through improved modelling of key biological processes (including growth and stock-recruitment), further developing stock assessment models including mixing between various areas, and developing and use of biologically realistic operating models for more rigorous management option testing.

In addition, in 2012 the Commission requested the SCRS (Doc. No. PA2-617A/2012 COM) to conduct a stock assessment in 2015 and to:

- a) Develop a new assessment model allowing the inclusion of the last updated knowledge on the biology and ecology of bluefin tuna, in particular life-history parameters, migration patterns, and aiming at identifying and quantifying uncertainties and their consequences on the assessment results and projections.
- b) Release a stock status advice and management recommendations, supported by a full stock assessment exercise, based on the new model, additional information and statistical protocols mentioned in points above and on which basis all actions may be adopted and updated by the Commission through the management plan to further support the recovery.

In further addition, the GBYP Steering Committee requested an external report in order to analyse the power to detect population trends that consider additional variance, to obtain data that could be used as fishery independent indices for operating models

The GBYP activities in the first Phases was consistent with the objectives.

In Phase 4, two meetings were held on modeling approaches: a first one in May 2013 in Tenerife for preparing a first discussion draft document (see:

http://www.iccat.int/GBYP/Documents/MODELLING/PHASE%204/tenerife_Modelling.pdf,

and

http://www.iccat.int/GBYP/Documents/MODELLING/PHASE%204/Tenerife_gbyp-modelling_draft_proposal.pdf)

and a second in July in Gloucester, where a detailed planning of bluefin tuna modeling activities have been agreed for the submission to SCRS (see the report on

http://www.iccat.int/Documents/Meetings/Docs/2013_BFT_METHODS_REP_ENG.pdf.

7.2 Phases 3 and 4 activities for modelling in support of BFT stock assessment

All reports concerning Modelling approaches in Phase 3 are already available on <http://www.iccat.int/GBYP/en/modelling.htm>.

7.2.1 Risk analysis

The objectives of this work package are to identify the main sources of uncertainty related to stock assessment and management. The risk analysis conducted under Phase 2 identified the main sources of uncertainties of concern to members of the SCRS. Under Phase 3 this work was extended to managers.

For Phase 4 the risk analysis will be quantitatively modeled using the initial qualitative work carried out during Phase 3. The development of such a quantitative risk analysis is to evaluate the relative importance of the different sources of uncertainty. In particular in helping to design scenarios used in the management strategy evaluation of the alternative management procedures with respect to meeting management objectives.

7.2.2 Catch data

Three non-parametric stochastic imputation approaches that provide a means of imputing Atlantic bluefin tuna length frequency data are described and tested by cross-validation.

The multivariate normal ‘distance’ model that randomly imputes data using a multinomial probability function, offered the best predictive capacity by some margin. All imputation methods operate most successfully when nearby (in time and space) length observations are imputed preferentially.

The multivariate normal imputation approach described offers a basis for quantifying uncertainty from data processing by means of repeated-imputation inference (running multiple stock assessments from multiple imputed data sets).

By imputing data that are specific to time and region, the approach offers the basis for applying multiple growth curves (for cohort slicing for example) where applicable. Additionally, uncertainty from aging may be simultaneously incorporated into the same repeated-imputation inference framework. A number of patterns in the data provide evidence of possible errors in the Task II dataset for Atlantic bluefin tuna, for example, identical length samples replicated in adjacent areas and times.

While the imputation approach appears to perform reasonably well (assuming the data are reported correctly) future improvements could include the incorporation of greater variability among imputations and further optimization of code to improve computation time (by extending the code to be compatible with parallel processing packages, for example).

7.2.3 Conversion of size to age

This contract reviewed the available methods for estimating catch-at-age data from catch-at-size information. Two main groups of methods were considered, i.e. those based on the classic Age-Length Key (ALK) method, for which the ALKs produced can only be applied to the same population from which the catch-at-size samples were drawn, and those based on the inverse ALK method, which don't have this restriction.

A total of 7 methods were considered, and are described on the paper that accompanies the report. The methods will be used during the next BFT SCRS data meeting in May 2013 to evaluate the benefits of different stock assessment methods and biological sampling programmes.

7.2.4 Use of aerial survey data for operating models

According to a specific request of the GBYP Steering Committee, this contract assessed the feasibility of a large-scale survey on bluefin tuna spawning aggregations in all the Mediterranean Sea for obtaining useful data for operating modeling purposes.

A key assumption is the relationship between effort and CV. If there is no over-dispersion, $CV = \sqrt{n}/n$, where n is proportional to effort. The study assumed that variance of n is $2 \times n$ to account for some over dispersion but this is simply a scalar here. Therefore, CV is proportional $\sqrt{\text{effort}}/\text{effort}$. This relationship should be explored more fully and empirically using re-sampling methods by first combining the data from the original replicates and then re-calculating the variances.

There are factors that influence additional variance (e.g. due to variability in availability due to proportion of schools at the surface) and among them some will be related to environmental conditions and other factors that will vary spatially and temporally.

Another problem with the choice of scenario is that the analysis assumes that there is perfect knowledge already of the density outside the area. This is not the case. A better procedure would have been to calculate CVs for each survey design based on the different scenario, i.e. the CV that would be expected if the scenario on which that design was based was wrong but one of the other scenario was right, i.e. the risk of a specific design with the wrong scenario. This resulted in a matrix of CV's. This also means that using an adaptive survey design may be useful since after a few years the densities outside the areas will be better known, factors affecting the CVs due to school size and sighting should be better understood, and the population structure hypotheses developed, all of which will influence the optimal design.

Also for operational reasons the survey design is likely to change from that used in the report. While this would not be expected to change the general conclusions it will require the analysis to be re-conducted prior to a survey going ahead.

In this study it is assumed that the survey will be used as an index of abundance independently of a stock assessment model. However, the GBYP will hopefully develop new stock assessment methods which would use the index as an input in which case the power to detect trends may be improved.

The study provided the necessary inputs and scenarios to the GBYP Steering Committee (on the basis of the best available data and assumptions) for adopting the recommendation for Phase 4 activities.

7.3 Further actions on modeling

A Call for tenders was issued in Phase 4, including three activities: a) quantitative risk assessment, b) a study on statistically based stock assessment methods and, c) development of biological hypotheses for the use within MSE. Two contracts were awarded and the results should be available at the end of Phase 4.

An outlining of future modelling activities is being developed (in the form of an EU FP7 Framework Project Document), in which objectives, milestones and deliverables are presented. In this document the work is subdivided into work packages with clear responsibilities for the GBYP, SCRS and the ICCAT Secretariat.

The main work to be done in Phase 4 is to develop an Operating Model (OM) for use as part of Management Strategy Evaluation (MSE). The plan was recommended by the Gloucester meeting (see document http://www.iccat.int/Documents/Meetings/Docs/2013_BFT_METHODS_REP_ENG.pdf) and will be discussed by SCRS.

8. Mid-term Review

A full mid-term review of ICCAT-GBYP was carried out in Phase 4 with the following TORs:

- For each of the scientific components, review the progress to date relative to the basic objectives for that component taking into account the available resources;
- For each of the scientific components, review the appropriateness and adequacy of the design, implementation and results to date and suggest possible modifications or additions that would improve the accuracy, precision, robustness and/or cost-efficiency of the work being conducted taking into account logistical, feasibility and administrative considerations;
- For each of the scientific components and taking into account the results to date, provide guidance on the timeframe and resources required (and the trade-off between these).
- Provide an overview of the interrelationships, priority and reasonable timeframes for the various components in terms of their contribution to the improvement of the stock assessments, the provision of management advice and the general scientific knowledge of bluefin tuna, taking into account the current resources
- Provide suggestions for improvements in the logistical and administrative arrangements for future activities taking into account constraints under which the program must operate.
- Provide a general review of the current chain of decisions (BFT Species Group, Steering Committee, SCRS and Commission), underlying the objective to provide suggestions for improvements and independence, taking into account the respective roles and components and the institutional prerogatives of the two statutory bodies (SCRS and Commission).

The review, carried out by PhD Alain Fonteneau, PhD Andrew L. Payne and PhD Ziro Suzuki, after the Call for tenders 05/2013 issued on 30 April 2013, was concluded in September 2013 and the full report will be distributed to SCRS, the GBYP Steering Committee and the Commission; it will become available on the ICCAT-GBYP web-page after the approval by the Commission. The reviewers recognized the important improvements in scientific knowledge obtained by GBYP in the first parts of the programme. The reviewers, in their report, provided an extensive range of proposals for improving the research in the following years.

9. Legal framework

The enforcement of the ICCAT Rec. 11-06, which allows for a “research mortality allowance” of 20 tons for GBYP and for the use of any fishing gear in any month of the year in the ICCAT Convention area for GBYP research purposes, finally helped GBYP in carrying out both tagging and biological sampling activities. As in 2012, the ICCAT Secretariat issued the circular #2279/2013 on 28 May 2013, detailing the procedures and the list of authorized entities for the use of the ICCAT GBYP Research Mortality Allowance.

A total of 61 ICCAT-GBYP RMA certificates have been issued in Phase 3, using a total of 4,332.8 kg of bluefin tuna. A total of 29 ICCAT-GBYP RMA certificates have been issued so far in Phase 4, using 3,530.4 kg of bluefin tuna in 2013 (provisional data).

10. Cooperation with the ROP

The GBYP coordination, together with the ICCAT Secretariat, is maintaining and improving the contacts with the ROP observers, for strengthening the cooperation and providing opportunities. The ROP observers are engaged for directly checking bluefin tuna at the harvesting for improving the tag recovery and reporting and for noticing any natural mark. Specific forms were provided to ROP.

11. Steering Committee Meetings

The GBYP Steering Committee is currently composed by the Chair of SCRS, Ph.D. Josu Santiago, the BFT-W Rapporteur, Ph.D. Clay Porch, the BFT-E Rapporteur, Ph.D. Jean-Marc Fromentin, the ICCAT Executive Secretary, Mr. Driss Meski, and/or his Deputy Executive Secretary, and an external expert, Ph.D. Tom Polacheck, who was contracted for this duty.

The Steering Committee members have been constantly informed by the GBYP about all the initiatives and consulted by e-mail on many issues.

The activity of the Steering Committee included continuous and constant e-mail contacts with the GBYP coordination, which provided the necessary information. The Steering Committee held one meeting in the last part of Phase 3, from 12 to 14th of December 2012, and is going to hold its first meeting of Phase 4 the 28-29th of September 2013. All reports of all GBYP Steering Committee meetings are available on <http://www.iccat.int/GBYP/en/scommittee.htm>.

12. Funding, donations and agreements.

The Atlantic-wide Research Programme for Bluefin Tuna, according to the Commission decision in 2009, is voluntary funded by several ICCAT CPCs. In Phase 4, the programme funding should be provided by the following CPCs and entities (in order of contribution):

| | | |
|--|------|--------------|
| European Union (grant agreement) | Euro | 2,000,000.00 |
| United States of America (donation) | Euro | 204,000.00 |
| Kingdom of Morocco (donation) | Euro | 59,993.00 |
| Japan (donation) | Euro | 52,741.61 |
| Tunisia (donation according to quota)* | Euro | 48,920.96 |
| Libya (donation according to quota)* | Euro | 43,397.10 |
| Turkey (donation according to quota) | Euro | 25,763.81 |
| Canada (grant agreement) | Euro | 22,110.85 |

| | | |
|---|------|-----------|
| Norway (donation) | Euro | 20,000.00 |
| Croatia (donation) | Euro | 18,077.61 |
| Algeria (donation according to quota)* | Euro | 6,656.86 |
| Korea (donation according to quota) * | Euro | 3,727.16 |
| Egypt (donation according to quota)* | Euro | 3,104.65 |
| Chinese Taipei (donation) | Euro | 3,000.00 |
| Popular Republic of China (donation according to quota) * | Euro | 1,767.54 |
| Albania (donation according to quota)* | Euro | 1,554.18 |
| Syria (donation according to quota)* | Euro | 1,554.18 |
| Iceland (donation according to quota)* | Euro | 1,433.18 |

*to be received at the moment of the preparation of the report

The ICCAT Secretariat is covering the missing part of the co-funding agreed within the EC Grant for the residual amount, in order to reach the reduced budget established for Phase 4 (Euro 2,500,000.00).

The Atlantic-wide Research Programme for Bluefin Tuna is a very complex programme and its activities concern all stakeholders. As a consequence, the GBYP needs the cooperation of all stakeholders and all countries to fulfil its duties in the best possible way. This need was perfectly identified by SCRS and the Commission during the preliminary evaluation of the Programme. Therefore, GBYP is managing to work with all stakeholders, making them aware of the programme and its activities and getting them directly involved when necessary.

A formal agreement of collaboration for research activities to be developed under the GBYP and particularly on tagging was established with the WWF Mediterranean Programme (WWF-MedPO) on 28 April 2011. A formal agreement of collaboration for research activities to be developed under the GBYP and particularly on acoustic tagging was established with the Hopkins Marine Station of the Stanford University on 15 May 2013.

GBYP, in these first four phases, continued to work constantly on this diffused network. This activity helped the Programme to get donations and practical supports, which sometimes was destined for a precise activity. Here following is the list, in alphabetic order:

- ✓ Asociación de Pesca, Comercio y Consumo Responsable de Atún Rojo (SP): Euro 6,000.00 (for GBYP in Phase 1).
- ✓ Association Marocaine de Madragues, donation in kinds of a social dinner in Tangier; estimated value to be defined (for the Symposium on Trap Fishery).
- ✓ Departement de la Pêche Maritime, DPMA/DPRH, Rabat (MO), essential administrative and logistic support for tagging in Moroccan traps in Phase 2, 3 and 4.
- ✓ Grup Balfegó (SP), donation in kinds of tuna heads prepared for sampling otoliths; estimated value: Euro 300,00 (for the GBYP Operational Meeting on Biological Sampling in Phase 2).
- ✓ Grupo Ricardo Fuentes e Hijos S.A. (SP): Euro 10,000.00 (for the Symposium on Trap Fishery in Phase 2) and the practical support for tagging in Moroccan traps in Phase 2 and 3.
- ✓ Institute National de Recherche Haulieutique, Tangier (MO), donation in kinds of logistic support and staff assistance for tagging in Morocco: estimated value to be defined (for GBYP Tagging in Phase 2 and 3).
- ✓ Instituto Español de Oceanografía, Fuengirola, donation in kinds of 3 PATs and staff assistance for tagging in Morocco: estimated value to be defined (for GBYP Tagging in Phase 2).
- ✓ Maromadra S.A.R.L and Es Sahel (Fuentes Group), donation in kind of divers working time, vessels support and sailors, for tagging in Morocco; estimated value: Euro 6,000.00 (for GBYP Tagging in Phase 2 and 3).
- ✓ Mielgo Bregazzi Roberto (SP), donation in kinds of many thousands of individual tuna data from auctions, estimated value: 50,000.00 Euros (for GBYP Data Recovery in Phase 2) and 300,000 Euros (for GBYP Data Recovery in Phase 3).
- ✓ National Research Institute for Far Seas Fisheries, Shimizu (JP), donation of bluefin tuna samples from the central Atlantic fishery: estimated value to be defined (for GBYP biological and genetic analyses in Phase 2, 3 and 4).
- ✓ WWF Mediterranean Programme (WWF MedPO), donation in kinds of 24 miniPATs, analysis and logistics in Morocco; estimated value: Euro 80,400.00 (for GBYP Tagging in Phase 2 and 3).

12. GBYP web page

The ICCAT-GBYP web page, which was created in the last part of Phase 1, is usually regularly updated with all documents produced by GBYP; in some cases, due to the huge workload, some set of documents are posted all together. Documents are posted only after their revision and final approval. It was revised, improved and updated on August 2013.

13. Recommendations

The GBYP Steering Committee and the various GBYP meetings provided a list of recommendations on various issues; several of them are essential for fulfilling the duties. Various recommendations have been evaluated by the SCRS in September 2012, and some of them were retained and proposed to the ICCAT Commission in November 2012.

In addition, based on the outcomes of last part of Phase 3 and first part of Phase 4, GBYP considers essential better defining the following points:

- a) Evolution of the Atlantic-Wide Research Programme for Bluefin Tuna: according to the current situation, which demonstrated the impossibility to reach the funding level approved by the ICCAT Commission for the various years of the GBYP and, as a consequence, the impossibility to carry out the various activities as originally planned, and the need to have a sufficient number of years for obtaining the necessary results, a programme revision is now necessary, finding the right balance among funding possibilities, research needs and duration. The funding system shall be better defined and improved, in order to ensure the regular development of the activities.
- b) Data recovery and data mining: Task II data will be finally included in the ICCAT BFT data base; the few conflicting Task I data must be revised as soon as possible by the concerned CPCs and national scientists. Market and auction data shall be revised and made available to scientists as soon as possible.
- c) Aerial survey: it is considered essential continuing the survey on spawning aggregations in selected areas, for providing a trend to be used in models; the prediction model using the SST data should be further developed.
- d) Tagging: electronic tagging should be strongly improved, while conventional tagging should be carried out taking advantage of the experiences in Phase 4. The tag awareness activity shall be firmly continued, improving media communication.
- e) Biological and genetic sampling and analyses: sampling should be continued, covering the less sampled areas; the analyses of the available samples should be improved; age analyses should be cross checked for validation.
- f) Modelling: new additional efforts should be devoted for finding the best approaches for using fishery independent data and innovative approaches for better quantify uncertainties. The proposed plan should be adopted and enforced as soon as possible.

Additional recommendations will be provided by the GBYP Steering Committee and the SCRS in 2013.

14. Deliverables

The list of the deliverables produced in this first part of GBYP Phase 3 according to the EC Grant Agreement **SI2.625691** is provided in **Annex II**.

Acknowledgments

The GBYP would like to warmly acknowledge the very supporting efforts made by all the colleagues of the ICCAT Secretariat staff to allow the Atlantic-Wide Research Programme for Bluefin Tuna to stay on schedule, besides of the short time available for carrying out all the necessary duties, sometimes under a very short notice. In particular, the GBYP caused a considerable increase of workload to the ICCAT Administration and we would like to officially acknowledge the continuous, professional and generous support we are still having.

The GBYP also acknowledges the strong collaboration of the GBYP Steering Committee, who responded very often in real time, particularly on very difficult scientific and practical issues.

A particular note of thank is for all ICCAT-GBYP contractors, which worked sometimes under a tight time schedule and for difficult tasks, making possible the results obtained by GBYP.

List of deliverables and scientific papers in GBYP Phase 3

List of deliverables produced within the EC Grant Agreements n. SI2.625691

1. A. Report on the use and enforcement of GBYP Research Mortality Allowance in Phase 3: 1-9.
2. B.1a Report on the ICCAT-GBYP Data Mining & Recovery Plan, Phase 3: Exploratory trials on Ottoman and other Turkish Archives (by A. F. Örenç, M. Ünver and L. Akgünlü, January 8, 2013) : 1-15 + 1-25 (fig.).
3. B.2a Questionnaire and survey on GBYP data recovery perspectives: Independent Opinion *Pro-Veritate* (presented by GBYP Coordination to the GBYP Steering Committee on December 12, 2012): 1-12.
4. C.1a1 Report on the ICCAT-GBYP Phase 3 Tagging Programme (by the Consortium for Tagging, January 20, 2013): 1-34 + 1-16 (Annexes).
5. C.1a2 Summary of the electronic tagging activities carried out in cooperation with WWF-MedPO: 1-4.
6. C.3 Summary Table on the ICCAT-GBYP Tag Recovery Activity (February 20, 2013): 1.
7. D. Report on the GBYP Biological and Genetic Sampling and Analyses in 2012 (by the Consortium for Biogenetic Activities, February 5, 2013, and partly revised afterwards): 1-99 + 1-17 (Appendix).
8. E.1. Reports on ICCAT-GBYP Technical meeting on Modelling Approaches: 3 SCRS documents:
 1. SCRS/2012/029: A catch curve analysis for East Atlantic Mediterranean Bluefin Tuna: 1-8.
 2. SCRS/2012/030: A length-based indicator for East Atlantic Mediterranean Bluefin Tuna: 1-9.
 3. SCRS/2012/186: Projections for East Atlantic Mediterranean Bluefin Tuna: 1-10.
9. E.2. Report on the ICCAT-GBYP Modelling Approaches: Risk Assessment – Eliciting uncertainties in GBYP (by A.W. Leach, P. Levontin, J. Holt and J.D. Mumford, January 8, 2013): 1-24.
10. E.3. Report on the ICCAT-GBYP Modelling Approaches in Support to Bluefin tuna Stock Assessment: Non-parametric stochastic imputation of length composition data for Atlantic Bluefin tuna; Description and cross-validation of imputation methods (by T. Carruthers, January 21, 2013) : 1- 14.
11. E.4. Report on the ICCAT-GBYP Modelling Approaches in Support to Bluefin tuna Stock Assessment. ALKr: a R package of methods based on age-length keys to estimate the age structure of fish populations (by A.G. Murta, J.F. Loff, M. Neves and L. Wise, January 18, 2013): 1- 25.
12. E.5 Report on the ICCAT-GBYP Contract for assessing the feasibility of a large-scale aerial survey on bluefin tuna spawning aggregations in all the Mediterranean Sea for obtaining useful data for operating modeling purposes (by A. Cañadas and J.A. Vázquez, January 15, 2013): 1-18 + 5 tables.
13. ICCAT-GBYP Steering Committee Reports in Phase 3:
 - Report of the *Ad horas* meeting of the GBYP Steering Committee; Madrid - September 07, 2012: 1-3;
 - Report of the GBYP Steering Committee meeting; Sète – December 12-14, 2012: 1-24.
14. GBYP Scientific and Technical Final Report for Phase 3 Activities. 6 March 2013: 1-37.

List of Scientific Papers – Phase 3

1. SCRS/2012/029 A catch curve analysis for East Atlantic Mediterranean Bluefin Tuna. Kell L.T., Bonhommeau S., Fromentin J.M., Ortiz M., 8 p.
2. SCRS/2012/030 A length-based indicator for East Atlantic Mediterranean Bluefin Tuna. Kell L.T., Bonhommeau S., Fromentin J.M., Palma C., 9 p.
3. SCRS/2012/116 Review and preliminary analysis of size frequency samples of bluefin tuna (*Thunnus thynnus*) 1952-2010. Justel Rubio A., Ortiz M., 22 p.
4. SCRS/2012/125 Preliminary analyses of the ICCAT VMS data 2010-2011. Justel Rubio A., Parrilla A., Ortiz M., 19 p.
5. SCRS/2012/139 ICCAT-GBYP Atlantic-wide Research Programme for Bluefin Tuna 2012. GBYP Coordination detailed activity report on Phase 2 (last part) and Phase 3 (first part). ICCAT Secretariat (Di Natale A., Idrissi M.), 54 p.
6. SCRS/2012/140 ICCAT-GBYP Aerial Survey: juveniles *versus* spawners. A SWOT analysis for both perspectives. ICCAT Secretariat (Di Natale A., Idrissi M.), 11 p.
7. SCRS/2012/141 BFT catch and size historical data recovered under the ICCAT Atlantic-wide Research Programme for Bluefin Tuna (Phases 1 and 2). ICCAT Secretariat (Di Natale A., Idrissi M., Justel Rubio A.), 34 p.
8. SCRS/2012/142 The mystery of Bluefin tuna (*Thunnus thynnus*) presence and behavior in the central southern Atlantic in recent years. Di Natale A., 12 p.
9. SCRS/2012/143 Preliminary information on GBYP pop-up tagging activities in Morocco in 2012. Quílez-Badía G., Cermeño P., Sainz Trápaga S., Tudela S., Di Natale A., Idrissi M., Abid N., 9 p.
10. SCRS/2012/149 Eastern Bluefin Tuna (*Thunnus thynnus*, L.): Reproduction and Reproductive Areas and Season. Piccinetti C., Di Natale A., Arena P., 20 p.
11. SCRS/2012/186 Projections for East Atlantic Mediterranean Bluefin Tuna. Kell L.T., Bonhommeau S., Fromentin J.M., Ortiz M., Walter J., 10 p.
12. SCI/2012/036 ICCAT-GBYP Operational Meeting on tagging, biological and genetic sampling and analyses (Madrid, April 17-18, 2012), 25 p.
13. In press: The ICCAT-GBYP Tagging Programme for Bluefin Tuna. Di Natale A., 35 p. (presented to the IOTC Indian Ocean Tagging Symposium and in press on: Fisheries Research.

GBYP contracts included in the last part of Phase 3 and in the first part of Phase 4

| ICCAT-GBYP CONTRACTS AND MEETINGS (final part of PHASE 3 to first part of PHASE 4) | | | | | | | | | |
|--|------|-----------|------------------------------|--|------------------|------------|--------|--------------|---------------------|
| ICCAT-GBYP DATA RECOVERY | | | | | | | | | |
| PHASE | YEAR | BUDGET € | CALL FOR TENDERS or ACTIVITY | RETAINED PROPOSAL | working schedule | | REPORT | DELIVERABLES | |
| | | | | | initial date | final date | | SCRS PAPERS | OTHERS |
| 3 | 2012 | 10.000,00 | 05/2012 | Exploratory data mining in the Ottoman Archives - Ali Fuat Orenç- Turkey | 08/12/2012 | 14/01/2013 | 1 | | data on excel file |
| 4 | 2013 | 20.000,00 | 06/2013 | Data recovery 2013 - tbd | | | | | |
| | | 50.000,00 | tbd | Market data analyses 2013 - tbd | | | | | |
| ICCAT-GBYP AERIAL SURVEY | | | | | | | | | |
| PHASE | YEAR | BUDGET € | CALL FOR TENDERS or ACTIVITY | RETAINED PROPOSAL | working schedule | | REPORT | DELIVERABLES | |
| | | | | | initial date | final date | | SCRS PAPERS | OTHERS |
| 4 | 2013 | 9.000,00 | | Aerial Survey Extended Design- Alnilam Investigación y Conservación SA - Spain | 10/04/2013 | 25/04/2013 | 1 | | |
| | | 19.000,00 | | GBYP Aerial Survey Training Course - ICCAT | | 04/06/2013 | 1 | | |
| | | 460000,00 | 03/2013 | Aerial Survey on Spawning Aggregations - Sub-area A - Grup Air Med - Spain | 17/05/2013 | 02/08/2013 | 1 | | data on excel file |
| | | | 03/2013 | Aerial Survey on Spawning Aggregations - Sub-areas E and G - Périgord Travail Aérien - France (+1 subcontract to France) | 17/05/2013 | 02/08/2013 | 1 | | data on excel file |
| | | | 03/2013 | Aerial Survey on Spawning Aggregations - Sub-areas C, D and F - Consorzio Unimar - Italy (+ 2 subcontracts to Italy) | 17/05/2013 | 02/08/2013 | 1 | | data on excel file |
| | | | 03/2013 | Aerial Survey on Spawning Aggregations - Sub-area B - Action Communication SARL - France | 17/05/2013 | 02/08/2013 | 1 | | data on excel file |
| | | 10.000,00 | tbd | Aerial Survey Data Analyses - Alnilam Investigación y Conservación SA - Spain | 14/08/2013 | 20/09/2013 | 1 | | |
| ICCAT-GBYP TAGGING PROGRAMME | | | | | | | | | |
| PHASE | YEAR | BUDGET € | CALL FOR TENDERS or ACTIVITY | RETAINED PROPOSAL | working schedule | | REPORT | DELIVERABLES | |
| | | | | | initial date | final date | | SCRS PAPERS | OTHERS |
| 4 | 2013 | 500000,00 | 01/2013 | GBYP Tagging Programme 2013, tagging with baitboats in the Bay of Biscay and the Straits of Gibraltar - Fundación AZTI - Spain, as leader of a Consortium including 5 Spanish Institutions (+ 3 subcontracts) | 20/06/2013 | 23/12/2013 | 1 | | data on excel file |
| | | 485000,00 | 01/2013 | GBYP Tagging Programme 2013, tagging adults with purse-seine in the Tyrrhenian Sea - Consorzio Unimar - Italy, as leader of a Consortium including 3 Italian Institutions (+ 1 subcontract to Italy) | 19/04/2013 | 23/12/2013 | 1 | | data on excel file |
| | | | 01/2013 | GBYP Tagging Programme 2013, tagging juveniles with purse-seine in the Adriatic Sea - Kali Tuna d.o.o. - Croatia, (+ 1 subcontract to Croatia) | 19/04/2013 | 23/12/2013 | 1 | | data on excel file |
| | | | 01/2013 | GBYP Tagging Programme 2013, tagging adults in tuna traps in Sardinia - Centro di Competenza sulla Biologia Marina - Italy, as leader of a Consortium including 3 Italian Institutions | 19/04/2013 | 23/12/2013 | 1 | | data on excel file |
| | | | 01/2013 | GBYP Tagging Programme 2013, tagging adults in tuna traps in Atlantic Morocco - Institut National de Recherche Halieutique - Morocco, as leader of a Consortium including 3 Moroccan Institutions | 19/04/2013 | 23/12/2013 | 1 | | data on excel file |
| ICCAT-GBYP BIOLOGICAL SAMPLING AND ANALYSES | | | | | | | | | |
| PHASE | YEAR | BUDGET € | CALL FOR TENDERS or ACTIVITY | RETAINED PROPOSAL | working schedule | | REPORT | DELIVERABLES | |
| | | | | | initial date | final date | | SCRS PAPERS | OTHERS |
| 4 | | 300000,00 | 03/2013 | GBYP Biological and Genetic Sampling and Analyses 2011- Fundación AZTI - Spain, as leader of a Consortium including 13 Institutions (3 Spain, 3 Italy, 1 Croatia, 1 France, 1 Ireland, 1 Japan, 1 Malta, 1 Morocco, 1 USA (+ 7 subcontracts, 2 Italy, 1 Spain, 1 Turkey, 1 Belgium, 1 Mexico and 1 Algeria) | tbd | 10/01/2014 | 1 | 1 | data on excel files |
| ICCAT-GBYP MODELLING APPROACHES | | | | | | | | | |
| PHASE | YEAR | BUDGET € | CALL FOR TENDERS or ACTIVITY | RETAINED PROPOSAL | working schedule | | REPORT | DELIVERABLES | |
| | | | | | initial date | final date | | SCRS PAPERS | OTHERS |
| 1 | 2010 | 0 | - | - | | | | | |
| 3 | 2012 | 25.000,00 | 02/2012 | Risk Assessment - Preliminary Assessment of Uncertainties in GBYP, Identifying risks and their relative importance - Imperial College Consultants Ltd - UK | 09/09/2012 | 11/01/2013 | 1 | 1 | |
| | | 25.000,00 | 03/2012 | Statistical Conversion of Catch-at-size to Catch-at-age - Intituto Português do Mar e da Atmosfera, and JFL Consultoria Estatística - Portugal | 16/10/2012 | 11/01/2013 | 1 | 1 | |
| | | | 03/2013 | Auto-Regressive Imputation of Catch-at-age Data (ARICA) - Ph.D. Thomas Robert Carruthers - Canada | 16/10/2012 | 11/01/2013 | 1 | 1 | |
| | | 10.000,00 | Technical meetings | Assessing the feasibility of a large-scale aerial survey on bluefin tuna spawning aggregations in all the Mediterranean Sea for obtaining useful data for Operating Model purposes - Alnilam Investigación y Conservación SA - Spain An evaluation of the implications of population structure on the current bluefin tuna advice framework | 21/12/2012 | 19/01/2013 | 1 | | |
| 4 | 2013 | 20.000,00 | 04/2013 | Quantitative Risk Assessment - Support to BFT Stock Assessment - Imperial College Consultants Ltd - UK | 24/05/2013 | 13/12/2013 | 1 | 1 | |
| | | 60.000,00 | 04/2013 | Statistically based stock assessment methods - Prof. Murdoch McAllister, Ph.D. Thomas R. Carruthers -Canada - and Prof. Marie-Pierre Etienne - France | 24/07/2013 | 13/12/2013 | 1 | 1 | |
| | | | 04/2013 | Development of Biological Hypotheses for the Use within MSE (no bids have been submitted) | | | | | |
| ICCAT-GBYP MID-TERM REVIEW | | | | | | | | | |
| PHASE | YEAR | BUDGET € | CALL FOR TENDERS or ACTIVITY | RETAINED PROPOSAL | working schedule | | REPORT | DELIVERABLES | |
| | | | | | initial date | final date | | SCRS PAPERS | OTHERS |
| 4 | 2013 | 50.000,00 | 05/2013 | Mid-Term Review - Andrew Payne, PhD | 05/08/2013 | 15/09/2013 | 1 | 1 | |
| | | | | Mid-term Review, Alain Fonteneau, PhD | 06/08/2013 | 15/09/2013 | | | |
| | | | | Mid-term Review, Ziro Suzuki, PhD | 06/08/2013 | 15/09/2013 | | | |

Annex III

List of meetings and activities attended by GBYP coordination staff (*) or external invited experts (**)

| date | place | Meeting or activity | Motivation and participation |
|------------------|--------------------|---|---|
| 28/10- 4/11/2012 | Mauritius | IOTC Symposium on Tuna Tagging | Presentation of the GBYP tagging and tag awareness activities (A. Di Natale*) |
| 12-19/11/2012 | Agadir (MO) | 18th Special Meeting of the Commission | Presentation of the GBYP activities and plans in Phase 3 and plan for Phase 4 (A. Di Natale*, M. Idrissi*) |
| 12-14/12/2012 | Sète (FR) | GBYP SC meeting | Presentation of the GBYP activities and plans in Phase 3 and plan for Phase 4 (A. Di Natale*, M. Idrissi*) |
| 03-04/04/2013 | Istanbul (TK) | Meeting with the specialists at the University of Istanbul for analysing the further possibilities for exploring the ancient archives for data mining | Analysis of data already recovered and discussion about future activities (A. Di Natale*) |
| 7-13/05/2013 | Tenerife (SP) | 2013 BFT Meeting on biological parameters review | Presentation of all the ICCAT-GBYP data sets (Phases 1 to 3 / 2010-2012) (A. Di Natale*, M. Idrissi*) |
| 13-16/05/2013 | Tenerife (SP) | Meeting on GBYP Modelling Approaches | Supervision of the meeting for preliminary draft of the GBYP modelling future plans (A. Di Natale*) |
| 17-20/05/2013 | Larache (MO) | 2013 BFT Conventional & electronic tagging (Phase 4) | Delivery of all the tagging equipment and supervising of the electronic tagging (M. Idrissi*) |
| 04/06/2013 | Madrid (SP) | ICCAT-GBYP Training course on Aerial Survey | Training for pilots, professional spotters and scientific observers working for the GBYP aerial survey. (A. Di Natale*, M. Idrissi*, A. Justel Rubio*, A. Cañadas**, J.A.Vasquez**) |
| 10-22/07/2013 | Gloucester (USA) | 2013 Meeting on Bluefin Tuna stocks assessment methods | Supervision of the work to be done for ICCAT-GBYP modelling (Phases 4 and on) (A. Di Natale*) |
| 13-15/09/2013 | Isla Cristina (SP) | 2013 Meeting of Tuna Trap Captains | Presentation of GBYP research activities (A. Di Natale*) |
| 23-24/09/2013 | Madrid | SCRS Sub-Committee on Statistics | GBYP data recovery issues (A. Di Natale*, M. Idrissi*, A. Justel Rubio*, M. Ortiz, C. Palma) |
| 15-27/09/2013 | Madrid | SCRS BFT Species Group | Overview of the GBYP activities, historical data, tags and other BFT subjects (A. Di Natale* M. Idrissi*, A. Justel Rubio*) |
| 28-29/09/2013 | Madrid | GBYP SC meeting | Presentation of the GBYP activities and plans in Phase 4 and plan for Phase 5 (A. Di Natale*, M. Idrissi*) |
| 30/09-4/10/2013 | Madrid | SCRS Plenary | Presentation of the GBYP activities and plans (A. Di Natale*, M. Idrissi*) |

Table 1. Total data recovered by GBYP in Phase 1, Phase 2 and Phase 3. (TP = Traps; OG = Other gears).

| TOTAL PHASE 1 + PHASE 2 + PHASE 3 | | Total | Total OG+TP |
|-----------------------------------|----|------------|-------------|
| # Records | OG | 87,761 | 118,684 |
| | TP | 30,923 | |
| BFT (n) | OG | 34,753 | 23,282,419 |
| | TP | 23,247,666 | |
| BFT (t) | OG | 114,596 | 858,823 |
| | TP | 744,227 | |
| # Fish Sampled | OG | 94,932 | 102,542 |
| | TP | 7,610 | |

Table 2. Total data recovered by GBYP in Phase 1, Phase 2 and Phase 3 by centuries (1500-1900) and by decades (1900 onwards) (TP = Traps; OG = Other gears).

| | | 1500 | 1600 | 1700 | 1800 | 1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | Blank |
|---------------|----|---------|---------|--------|---------|---------|---------|---------|---------|---------|---------|--------|-------|--------|--------|--------|------|-------|
| #Records | OG | | | | | 9 | 10 | 87 | 11509 | 15616 | 29982 | 17946 | 6201 | 1781 | 1174 | 3210 | 236 | |
| | TP | 252 | 170 | 211 | 6100 | 3005 | 4353 | 6705 | 2301 | 1021 | 1040 | 2032 | 184 | 777 | 1221 | 1548 | | 3 |
| BFT (n) | OG | | | | | | | | | | | | 107 | 70 | 9937 | 21559 | 3080 | |
| | TP | 3978087 | 1292782 | 425335 | 4472749 | 1613889 | 1883967 | 2971129 | 2013583 | 1787209 | 1566956 | 614611 | 51510 | 178743 | 204806 | 186199 | | 6111 |
| BFT (t) | OG | | | | | 44 | 163 | 601 | 2497 | 6057 | 29059 | 14842 | 24461 | 17880 | 17086 | 1704 | 203 | |
| | TP | 0 | | | 141907 | 40327 | 70723 | 75579 | 83592 | 86204 | 111417 | 71842 | 11981 | 8755 | 19568 | 22332 | | |
| #Fish sampled | OG | | | | | | | | | | 18614 | 18548 | 9053 | 804 | 18569 | 28000 | 1344 | |
| | TP | | | | | | 153 | 170 | | | | | | | 2225 | 5062 | | |

Table 3. Comparison of main results on effort, encounter rates and density of schools, and mean and total weight and animal abundance in the inside subareas, between 2010, 2011 and 2013.

| Year | 2010 | | | | 2011 | | | 2013 | | | | TOTAL | | |
|---|---------------|----------|---------------|----------|-----------------|----------------|-----------|---------------|-----------|-----------------|-----------------|-----------|-----------|---------|
| | A inside | C inside | E inside | G inside | A inside | C inside | E inside | A inside | C inside | E inside | G inside | 2010 | 2011 | 2013 |
| Date | 1-Jun / 2-Jul | 5-29-Jun | 3-Jun / 3-Aug | 5-30-Jun | 15-Jun / 11-Jul | 19-Jun / 8-Jul | 13-29-Jun | 6-Jun / 6-Jul | 18-28-Jun | 22-Jun / 12-Jul | 20-Jun / 15-Jul | | | |
| Survey area (km ²) | 62,264 | 52,461 | 90,796 | 55,248 | 62,264 | 52,461 | 100,471 | 62,194 | 54,177 | 82,054 | 56,329 | 260,769 | 215,196 | 254,754 |
| Number of transects | 52 | 45 | 42 | 55 | 131 | 77 | 65 | 76 | 37 | 108 | 27 | 194 | 273 | 248 |
| Transect length (km) | 6.301 | 8.703 | 5.288 | 3.482 | 7.977 | 8.771 | 11,429 | 6,807 | 2,791 | 4,371 | 1,700 | 23,774 | 28,177 | 15,669 |
| Effective strip width x2 (km) | 9.66 | 2.92 | 9.66 | 2.92 | 7.03 | 7.03 | 0.66 | 4.6 | 4.6 | 4.6 | 4.6 | 2.9 / 9.7 | 0.7 / 7.0 | 4.6 |
| % Coverage | 97.8 | 48.4 | 56.3 | 18.4 | 90 | 118 | 7.5 | 50.3 | 23.7 | 24.5 | 13.9 | 57 | 58 | 28.3 |
| Number of schools | 7 | 6 | 19 | 31 | 11 | 10 | 35 | 13 | 11 | 20 | 12 | 63 | 56 | 56 |
| Encounter rate of schools | 0.0011 | 0.0007 | 0.0036 | 0.0089 | 0.0014 | 0.0011 | 0.0031 | 0.0018 | 0.0039 | 0.0046 | 0.0071 | 0.0027 | 0.0020 | 0.0036 |
| %CV encounter rate | 51 | 43 | 39 | 25 | 32 | 31 | 24 | 42 | 44 | 47 | 41 | 20 | 47 | 23 |
| Density of schools (1000 km ⁻³) | 0.157 | 0.237 | 0.508 | 3.05 | 0.196 | 0.162 | 3.98 | 0.447 | 0.742 | 3.164 | 2.343 | 0.909 | 1.956 | 1.804 |
| %CV density of schools | 55 | 53 | 44 | 40 | 37 | 36 | 26 | 51 | 49 | 54 | 48 | 30 | 25 | 34 |
| Mean weight (t) | 127.1 | 124.2 | 50.6 | 62.1 | 84.8 | 42.7 | 102.8 | 90.1 | 189.0 | 4.2 | 3.3 | 85.9 | 94.9 | 22.6 |
| %CV mean weight | 8 | 5.6 | 25 | 13 | 26 | 44 | 27 | 32 | 22 | 103 | 62 | 15 | 11 | 51 |
| Mean cluster size (animals) | | | | | 789 | 291 | 1,275 | 439 | 1,536 | 111 | 272 | | 1,211 | 302 |
| %CV mean cluster size | | | | | 26 | 31 | 32 | 35 | 19 | 108 | 57 | | 12 | 43 |
| Total weight (t) | 1,244 | 1,540 | 2,335 | 10,434 | 1,033 | 364 | 44,837 | 1,083 | 6,633 | 949 | 436 | 15,553 | 46,234 | 9,100 |
| %CV total weight | 56 | 53 | 51 | 42 | 43 | 54 | 41 | 40 | 59 | 96 | 68 | 30 | 40 | 45 |
| Total abundance (animals) | | | | | 9,616 | 2,477 | 549,276 | 12,194 | 61,725 | 28,819 | 35,911 | | 561,369 | 138,650 |
| %CV total abundance | | | | | 43 | 46 | 42 | 45 | 53 | 99 | 63 | | 41 | 35 |

Table 4. Results of ICCAT-GBYP extended aerial survey carried out in 2013, concerning both the “inside” (areas previously surveyed in 2010 and 2011) and “outside” areas (new extended areas surveyed for the first time in 2013).

| Sub-area | 2013 'inside' | 2013 'outside' | TOTAL |
|---|------------------|-------------------|-----------|
| Survey area (km ²) | 254,754 | 1,303,470 | 1,558,224 |
| Number of transects | 248 | 130 | 378 |
| Transect length (km) | 15,669 | 13,278 | 28,947 |
| Effective strip width x2 (km) | 4.6 | 4.6 | 4.6 |
| % Coverage | 28.3 | 4.7 | 8.5 |
| Number of schools | 56 | 12 | 68 |
| Encounter rate of schools | 0.0036 | 0.0009 | 0.0024 |
| %CV encounter rate | 23 | 69 | 23 |
| Density of schools (1000 km ⁻²) | 1.804 | 0.323 | 0.565 |
| %CV density of schools | 34 | 76 | 41 |
| Mean weight (t) | 22.6 | 5.5 | 15.0 |
| %CV mean weight | 51 | 75 | 46 |
| Mean cluster size (animals) | 302 | 432 | 364 |
| %CV mean cluster size | 43 | 49 | 37 |
| Total weight (t) | 9,100 | 2,988 | 12,088 |
| %CV total weight | 45 | 65 | 38 |
| Total abundance (animals) | 138,650 | 181,980 | 320,629 |
| %CV total abundance | 35 | 86 | 53 |

Table 5. Details on the number of Bluefin tuna tagged with various types of tags in Phase 3 and on the number of the various types of tags implanted in the various areas.

| | 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 Mediterranean | 313 | 210 | 11 | 0 | 0 | 0 | 87 | 5 | 0 | 0 | 0 | 0 | 0 |
| Central Mediterranean | 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 Mediterranean | 405 | 298 | 102 | 5 | 0 | 0 |
| Central Mediterranean | 97 | 97 | 0 | 0 | 0 | 0 |
| | 8070 | 5264 | 2728 | 40 | 38 | 0 |

Table 6. Details on the number of Bluefin tuna tagged with various types of tags in Phase 4 (up to September 21, 2013) and on the number of the various types of tags implanted in the various areas.

| | 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 | 3000 | 1382 | 0 | 0 | 0 | 0 | 1611 | 7 | 0 | 0 | 0 | 0 | 0 |
| Morocco* | 265 | 129 | 0 | 7 | 0 | 0 | 121 | 0 | 0 | 7 | 0 | 0 | 1 |
| Strait of Gibraltar | 1262 | 303 | 5 | 0 | 0 | 0 | 954 | 0 | 0 | 0 | 0 | 0 | 0 |
| West Mediterranean** | 219 | 11 | 201 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| Central Mediterranean | 1239 | 671 | 71 | 0 | 0 | 0 | 478 | 7 | 0 | 0 | 12 | 0 | 0 |
| | | 2496 | 277 | 7 | 0 | 0 | 3171 | 14 | 0 | 7 | 12 | | 1 |
| GRAND TOTAL | 5985 | SUBTOTAL = 2780 | | | | | SUBTOTAL = 3205 | | | | | | |

| | TOTAL NUMBER OF TAGS | TAGS IMPLANTED | | | | |
|-----------------------|----------------------|----------------|-------------------|-----------|-----------|----------|
| | | FT-1-94 | FIM-96 or BFIM-96 | Mini-PATs | Archivals | Acoustic |
| Bay of Biscay | 4618 | 3000 | 1611 | 7 | 0 | 0 |
| Morocco* | 401 | 258 | 121 | 14 | 0 | 8 |
| Strait of Gibraltar | 2216 | 1257 | 959 | 0 | 0 | 0 |
| West Mediterranean** | 215 | 0 | 215 | 0 | 0 | 0 |
| Central Mediterranean | 1736 | 1149 | 568 | 7 | 12 | 0 |
| | 9186 | 5664 | 3474 | 28 | 12 | 8 |

Table 7. Details on the number of Bluefin tuna tagged with various types of tags in all Phases of GBYP (up to September 21, 2013) and on the number of the various types of tags implanted in the various areas.

| | 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 | 7692 | 4152 | 1 | 3 | 0 | 0 | 3505 | 18 | 0 | 0 | 13 | 0 | 0 |
| Morocco* | 275 | 129 | 0 | 12 | 0 | 0 | 121 | 5 | 0 | 7 | 0 | 0 | 1 |
| Strait of Gibraltar | 4142 | 1306 | 42 | 0 | 0 | 0 | 2748 | 16 | 5 | 0 | 23 | 2 | 0 |
| West Mediterranean** | 1445 | 872 | 216 | 0 | 0 | 0 | 352 | 5 | 0 | 0 | 0 | 0 | 0 |
| Central Mediterranean | 1336 | 768 | 71 | 0 | 0 | 0 | 478 | 7 | 0 | 0 | 12 | 0 | 0 |
| | | 7227 | 330 | 15 | 0 | 0 | 7204 | 51 | 5 | 7 | 48 | 2 | 1 |
| GRAND TOTAL | 14890 | SUBTOTAL = 7572 | | | | | SUBTOTAL = 7318 | | | | | | |

| | TOTAL NUMBER OF TAGS | TAGS IMPLANTED | | | | |
|-----------------------|----------------------|----------------|-------------------|-----------|-----------|----------|
| | | FT-1-94 | FIM-96 or BFIM-96 | Mini-PATs | Archivals | Acoustic |
| Bay of Biscay | 11228 | 7688 | 3506 | 21 | 13 | 0 |
| Morocco* | 416 | 258 | 126 | 24 | 0 | 8 |
| Strait of Gibraltar | 6729 | 4079 | 2604 | 21 | 25 | 0 |
| West Mediterranean** | 1790 | 1207 | 578 | 5 | 0 | 0 |
| Central Mediterranean | 1833 | 1246 | 568 | 7 | 12 | 0 |
| | 21996 | 14478 | 7382 | 78 | 50 | 8 |

Table 8. Details of tag recovery by fishery, in numbers and percent.

| Fishery -Gear / Tags | Spaghetti Tags | Single/Doube Barb Tags | External Elec. Tags | Internal Elec. Tags | Commercial Tag | Grand Total | %ge |
|----------------------|----------------|------------------------|---------------------|---------------------|----------------|-------------|-------------|
| Bait Boat | 22 | 11 | 0 | 0 | 0 | 33 | 30,3% |
| Farms | 15 | 1 | 1 | 0 | 0 | 17 | 15,6% |
| Non-fishermen | 5 | 0 | 8 | 1 | 1 | 15 | 13,8% |
| UNCL | 14 | 0 | 1 | 0 | 0 | 15 | 13,8% |
| Long line | 8 | 3 | 0 | 1 | 0 | 12 | 11,0% |
| TROL | 4 | 2 | 0 | 0 | 0 | 6 | 5,5% |
| Sport & Recr. | 3 | 0 | 0 | 0 | 0 | 3 | 2,8% |
| Purse seine | 2 | 1 | 0 | 0 | 0 | 3 | 2,8% |
| Trammel | 1 | 1 | 0 | 0 | 0 | 2 | 1,8% |
| Trap | 1 | 0 | 0 | 1 | 0 | 2 | 1,8% |
| Rod & Reel | 1 | 0 | 0 | 0 | 0 | 1 | 0,9% |
| Grand Total | 76 | 19 | 10 | 3 | 1 | 109 | 100% |

Table 9. Samples collected and analyses carried out by the Consortium in GBYP Phase 3, with the target and percentages of achievement.

| <i>item</i> | <i>Target no.</i> | <i>Achievement no.</i> | <i>% of achievement</i> | <i>% considering 10% tolerance</i> |
|--|-------------------|------------------------|-------------------------|------------------------------------|
| Bluefin tuna individuals sampled (1) | 1750 | 2843 | 162.45 | n.a. |
| Biological & Genetic Sampling (2): | | | | |
| Genetic samples (muscle/fin) | 1550 | 2763 | 178.25 | n.a. |
| Otoliths | 1450 | 1789 | 123.38 | n.a. |
| Spines | 1250 | 1443 | 115.44 | n.a. |
| Gonads | 250 | 351 | 140.4 | n.a. |
| Biological & Genetic Analyses (3): | | | | |
| Genetic analyses | 1000 | 1152 | 115.2 | n.a. |
| Microchemical analyses | 400 | 400 | 100.00 | n.a. |
| Age readings (otoliths) | 130 | 157 | 120.77 | n.a. |
| Age readings (spines) | 120 | 158 | 131.67 | n.a. |
| Histological analyses | 60 | 158 | 263.33 | n.a. |
| TOTAL (2+3) | 6210 | 8371 | 134.79 | n.a. |
| Total Biological & Genetic Sampling | | | | |
| | 4500 | 6346 | 141.02 | n.a. |
| Total Biological & Genetic Analyses | | | | |
| | 1710 | 2025 | 118.42 | n.a. |

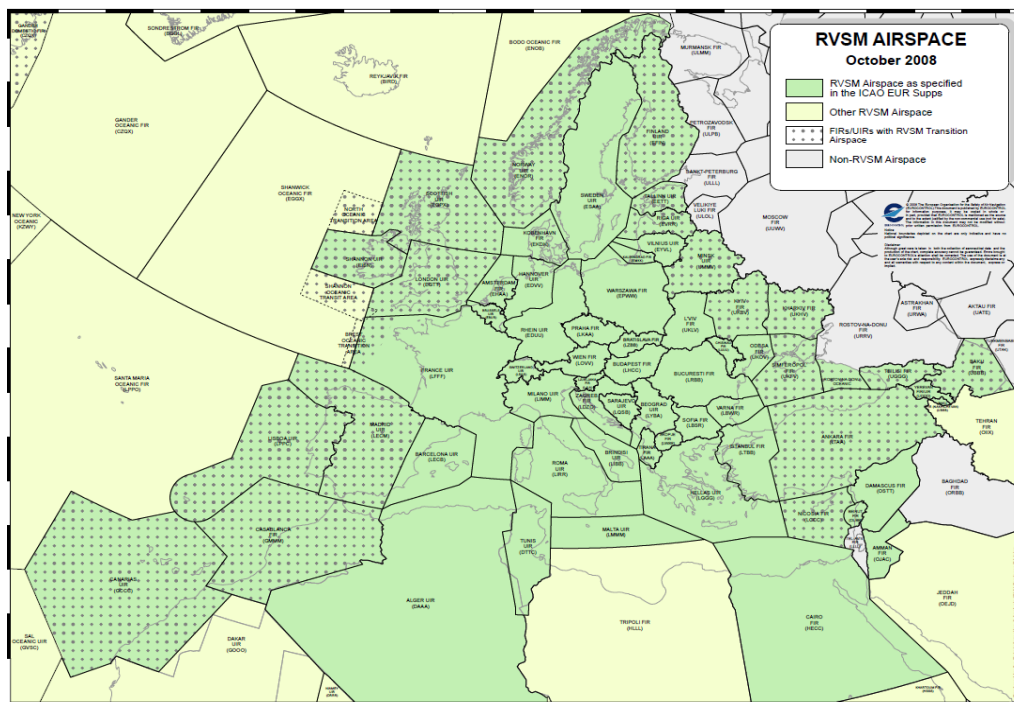


Figure 1. Boundaries of the national air-spaces in the Mediterranean Sea (the Black Sea is excluded), showing the complexity of operating in a geographical area with 24 Countries (16 are ICCAT CPCs), with various rules.

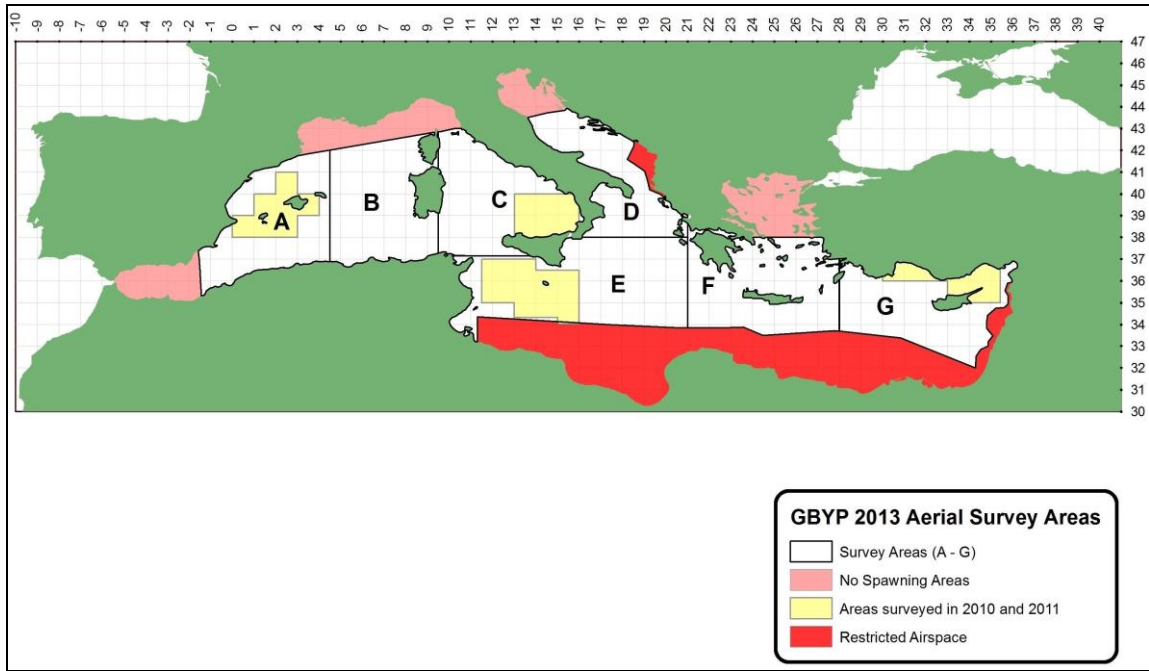


Figure 2. Map used for elaborating the aerial survey design in 2013, based on the potential opportunities of getting the flight permits by the various CPCs and coastal States concerned. The letters in bold identify the various areas used by GBYP.

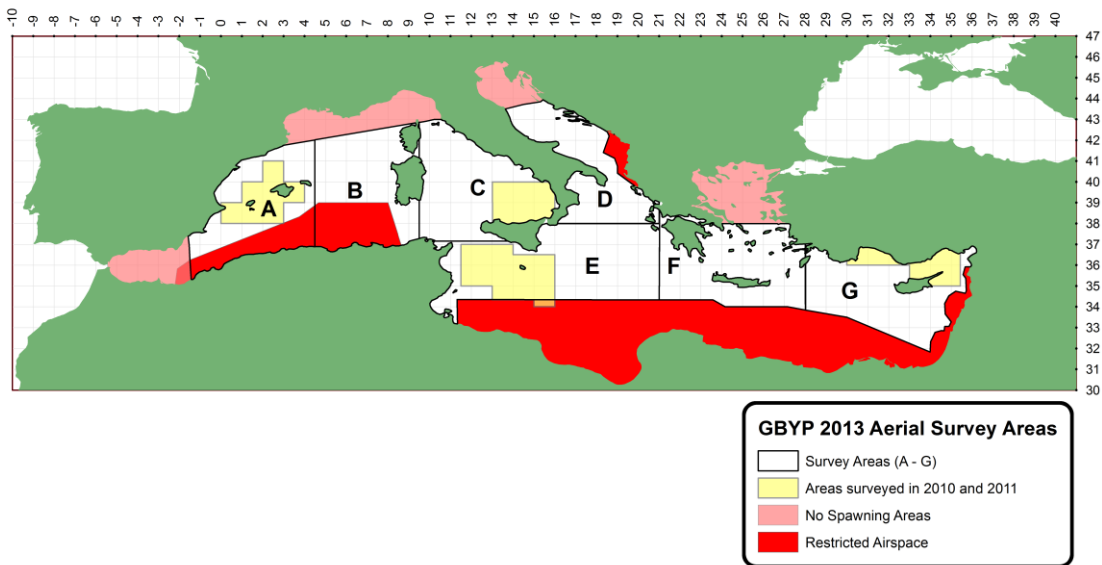


Figure 3. Map showing the areas on which it was possible to have permits for the aerial survey in 2013 (white and yellow zones). The letters in bold identify the various areas used by GBYP.

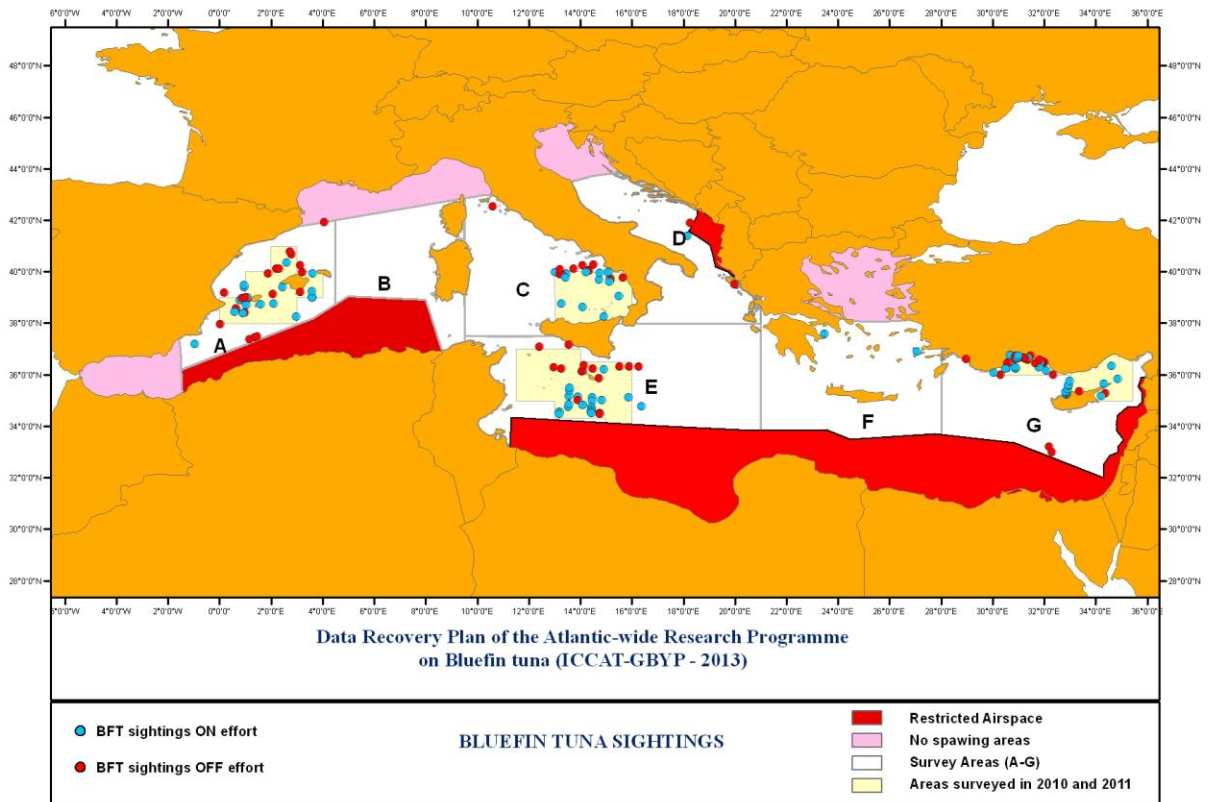


Figure 4. Sightings of bluefin tuna (on and off effort) during the 2013 GBYP aerial survey on spawning aggregations.

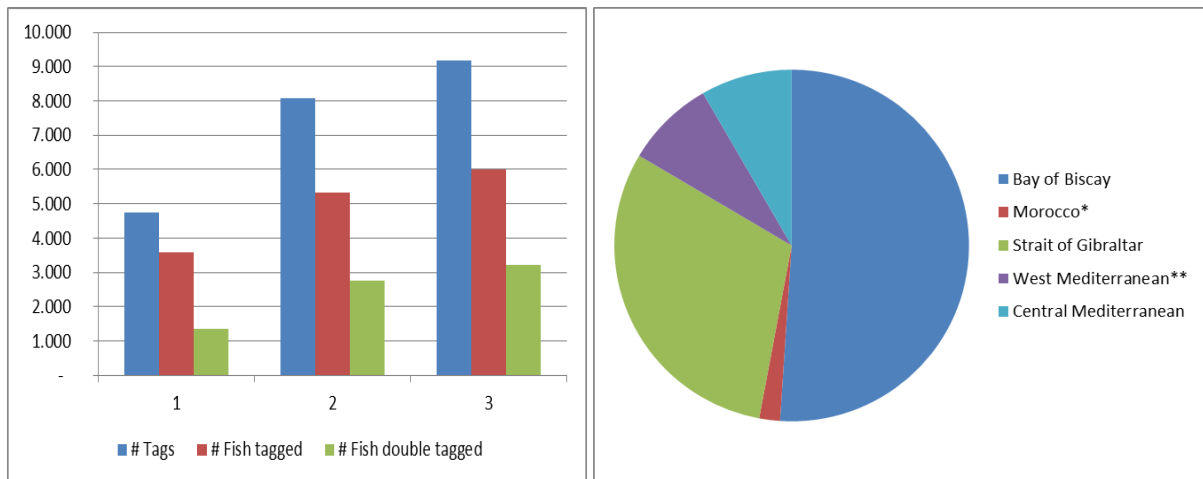


Figure 5a (left). Progression of the ICCAT GBYP tagging activities in the various years. **Figure 5b (right).** Percentage distribution of tags implanted in the various geographical areas by GBYP, up to September 2013.

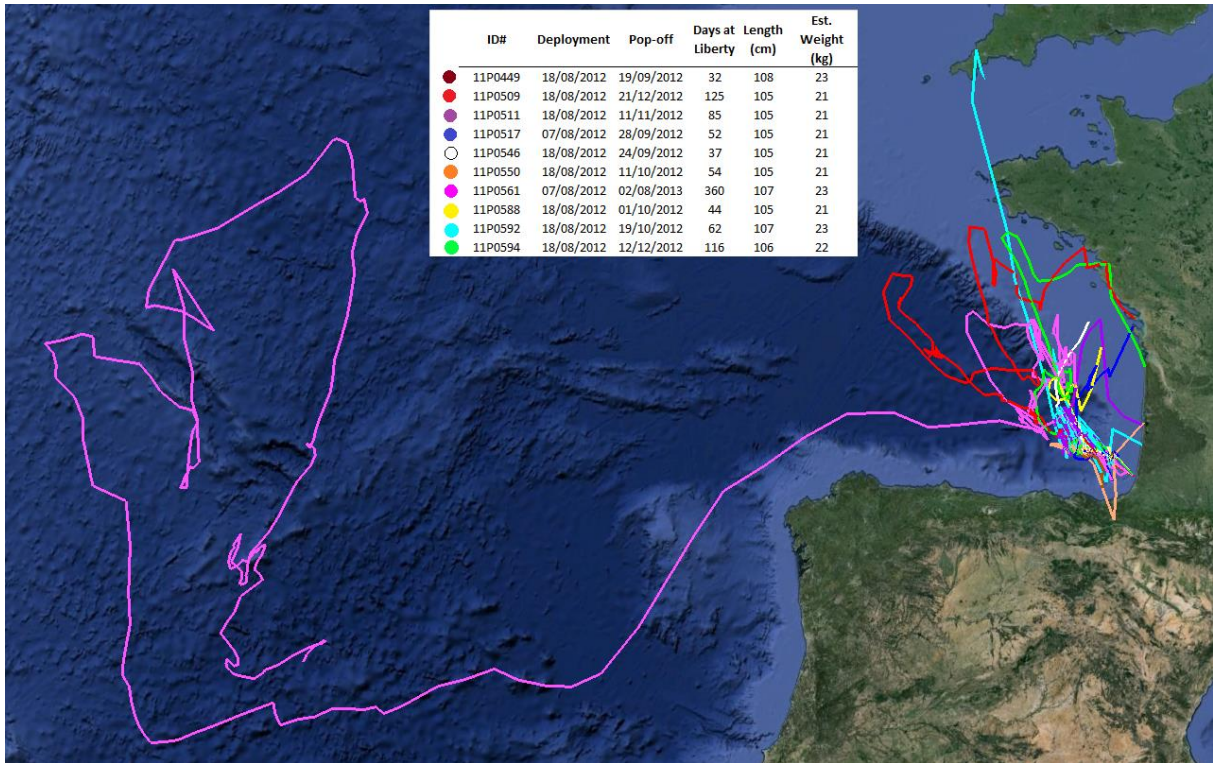


Figure 6. Tracks of juvenile bluefin tunas tagged with mini-PATs in the Bay of Biscay in GBYP Phase 3.

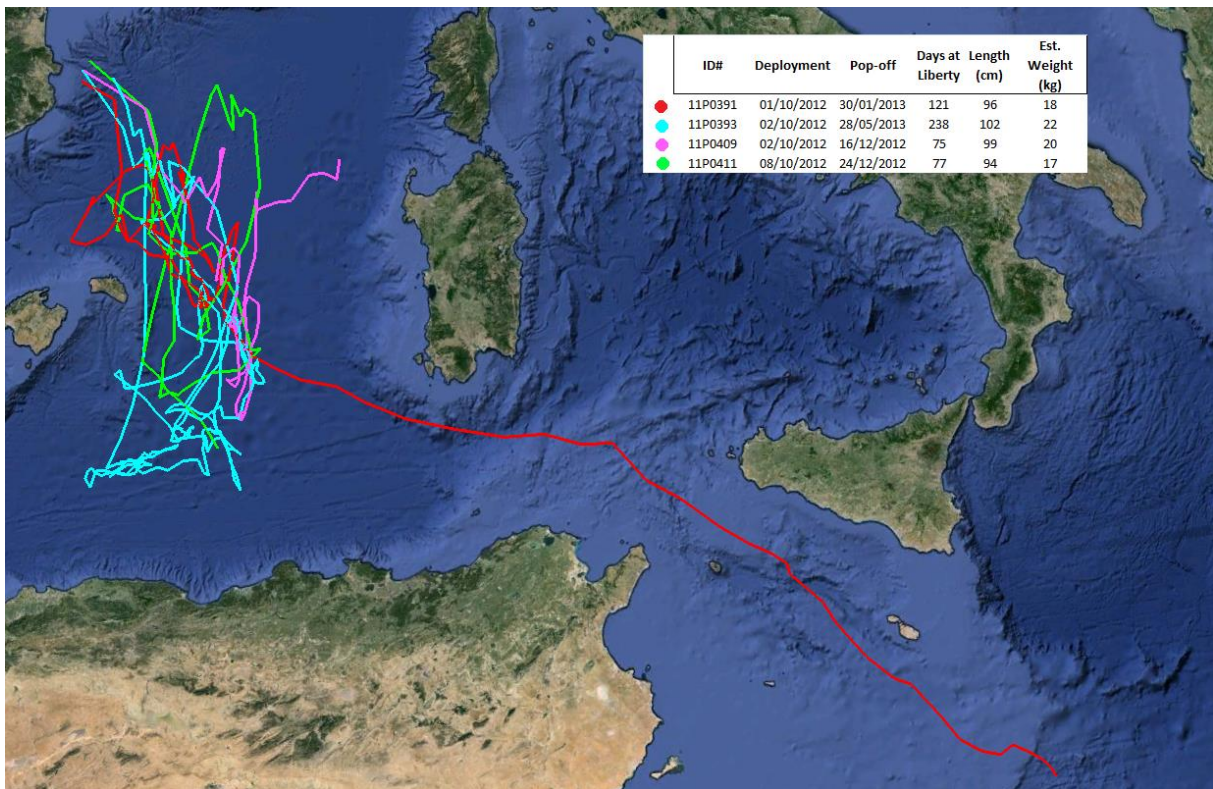


Figure 7. Tracks of juvenile bluefin tunas tagged with mini-PATs in the Gulf of Lion in GBYP Phase 3.

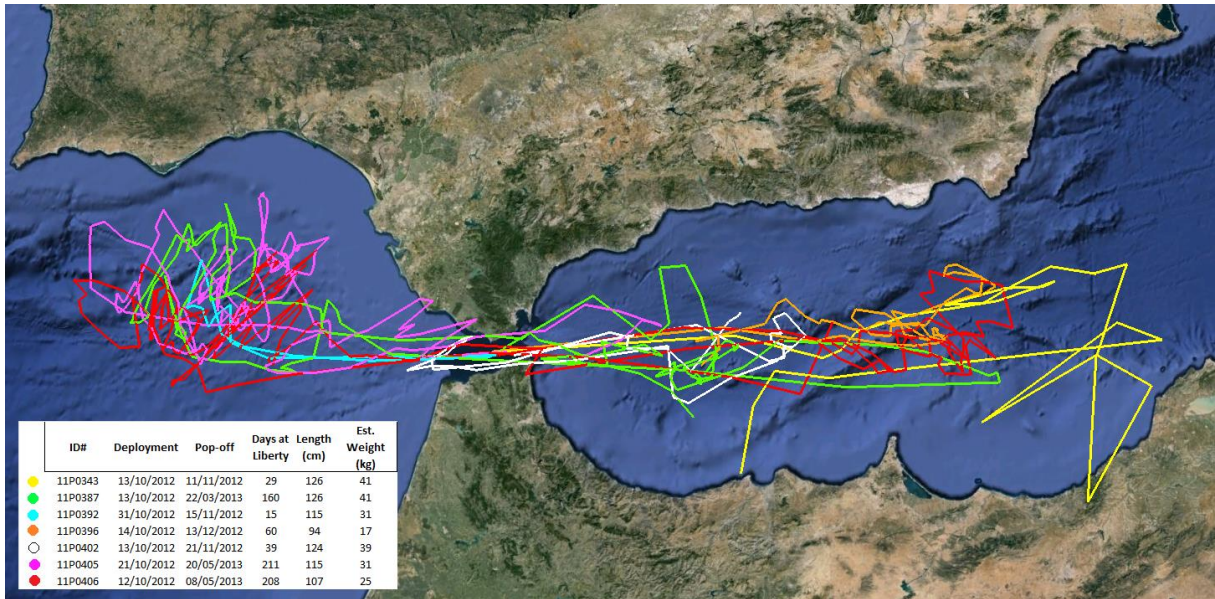


Figure 8. Tracks of juvenile/young bluefin tunas tagged with mini-PATs in the Strait of Gibraltar in GBYP Phase 3, which stayed in the areas close to the Strait over the observed period of time.

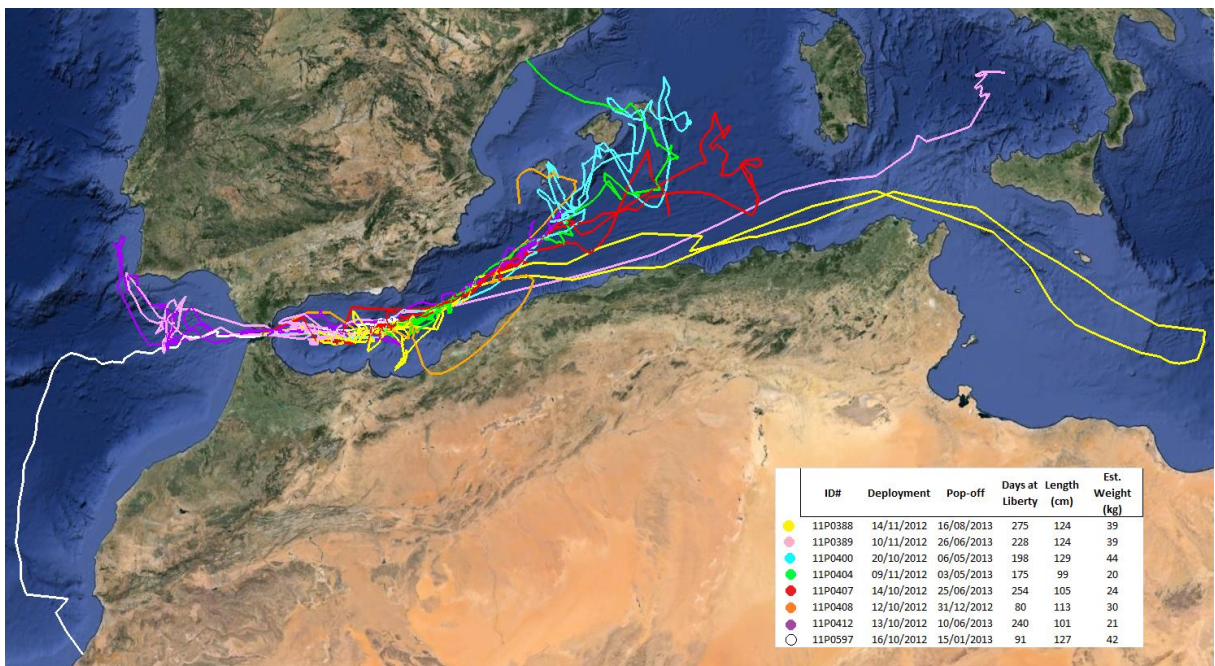


Figure 9. Tracks of juvenile/young bluefin tunas tagged with mini-PATs in the Strait of Gibraltar in GBYP Phase 3, which showed more long-distance movements over the observed period of time.

| ID# | Deployment | Pop-off | Days at liberty | Length (m) | Est. weight (kg) |
|---------|------------|------------|-----------------|------------|------------------|
| 08A0386 | 14/5/2012 | 2/6/2012 | 19 | N/A | 200-300 |
| 09P0437 | 14/5/2012 | 5/6/2012 | 22 | 2.51 | 326-405 |
| 11P0533 | 14/5/2012 | 14/6/2012 | 31 | 2.26 | 207 |
| 11P0138 | 14/5/2012 | 31/7/2012 | 78 | N/A | 200-300 |
| 08A0390 | 14/5/2012 | 16/8/2012 | 94 | N/A | 200-300 |
| 11P0375 | 16/5/2012 | 21/6/2012 | 36 | 2.06 | 157 |
| 11P0363 | 16/5/2012 | 20/6/2012 | 35 | 2.03 | 150 |
| 11P0372 | 16/5/2012 | 24/6/2012 | 39 | 2.38 | 242 |
| 11P0378 | 16/5/2012 | 20/6/2012 | 35 | 2.65 | 334 |
| 11P0134 | 14/5/2012 | 17/9/2012 | 126 | 2.47 | 271 |
| 11P0133 | 16/5/2012 | 26/9/2012 | 135 | N/A | 200-300 |
| 11P0530 | 14/5/2012 | 24/10/2012 | 163 | N/A | 200-300 |
| 11P0150 | 14/5/2012 | 19/1/2013 | 250 | 2.54 | 294 |
| 11P0531 | 14/5/2012 | 19/1/2013 | 250 | 2.43 | 258 |

• 14 tags

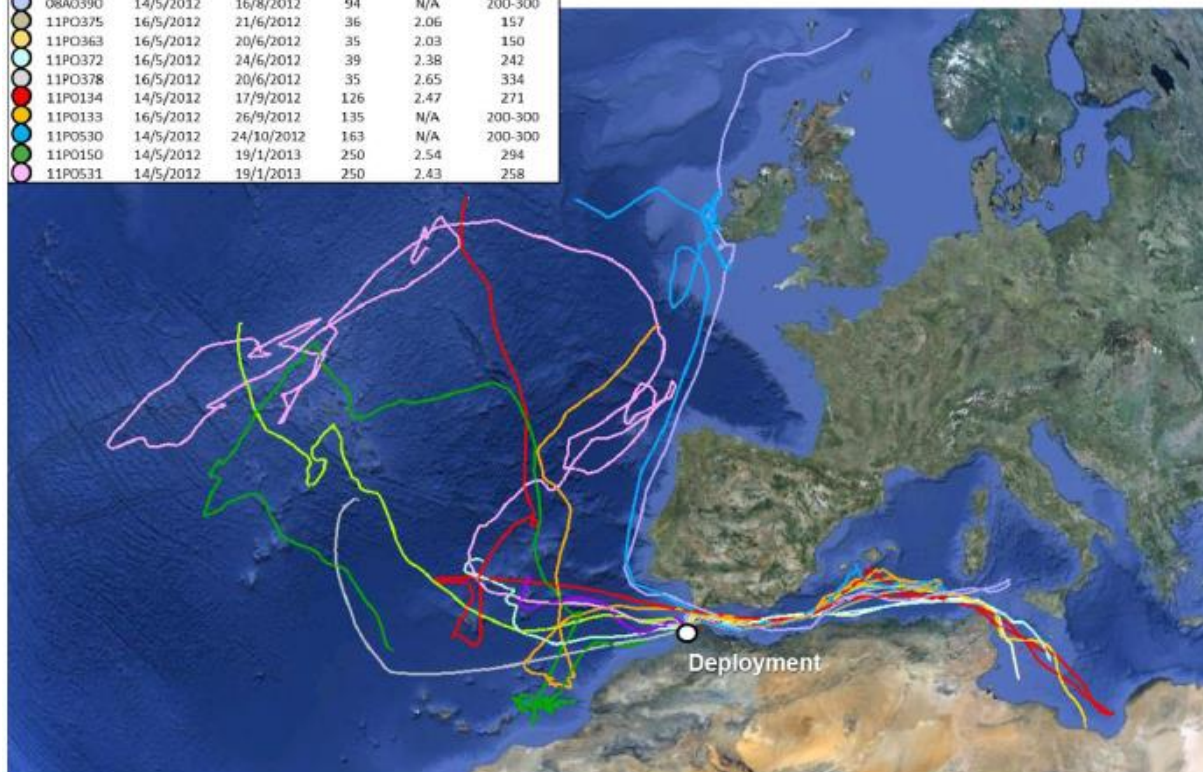


Figure 10. Tracks of adult bluefin tunas tagged with mini-PATs in the Moroccan traps in GBYP Phase 3.

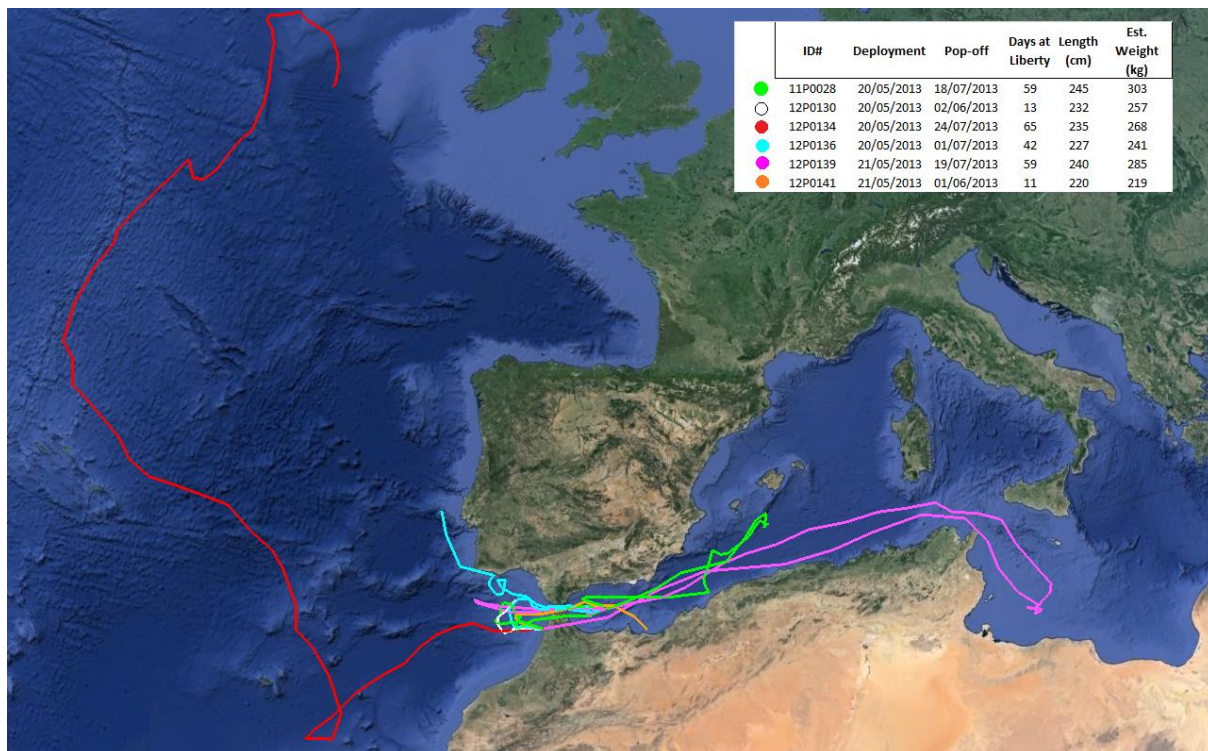


Figure 11. Tracks of adult bluefin tunas tagged with mini-PATs in the Moroccan traps in GBYP Phase 4.



Figure 12. Pop-off location of several mini-PATs deployed by GBYP in Phase 4 in various areas, which were not processed by CLS up to 15 September 2013.

GBYP AWARENESS CAMPAIGN CONTACTS



Figure 13. Overview of the localities where the ICCAT-GBYP tag awareness material was distributed so far.

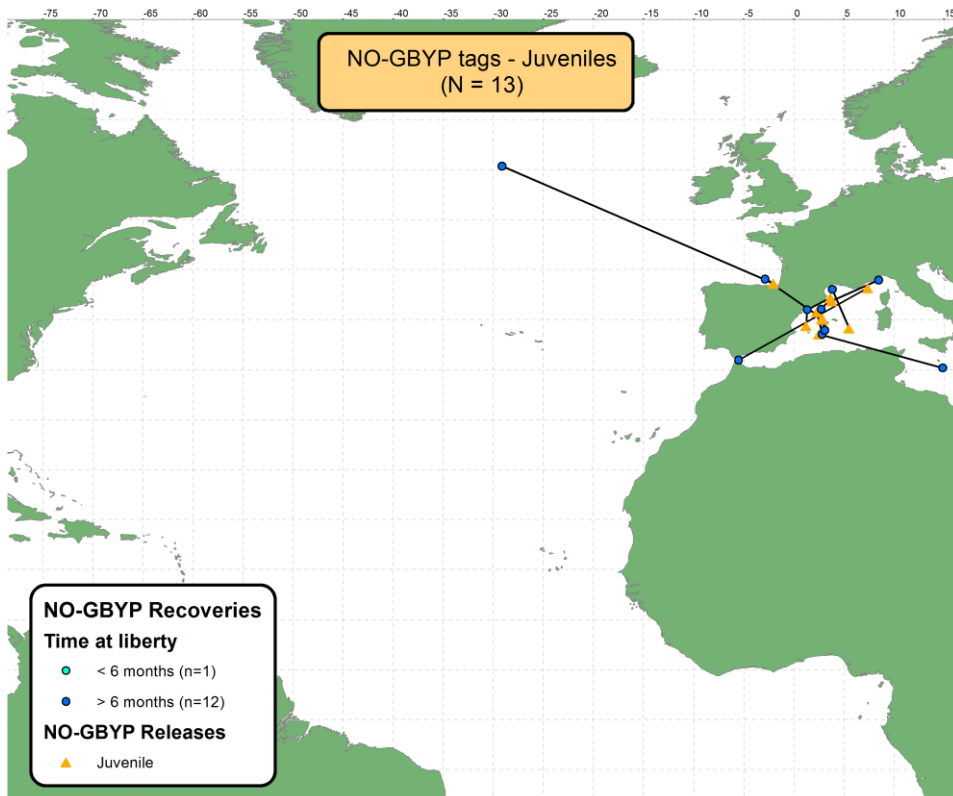


Figure 14. Trajectories of conventional tags implanted on juvenile bluefin tuna by non-GBYP programmes and recovered by ICCAT in the period 2005-2013.

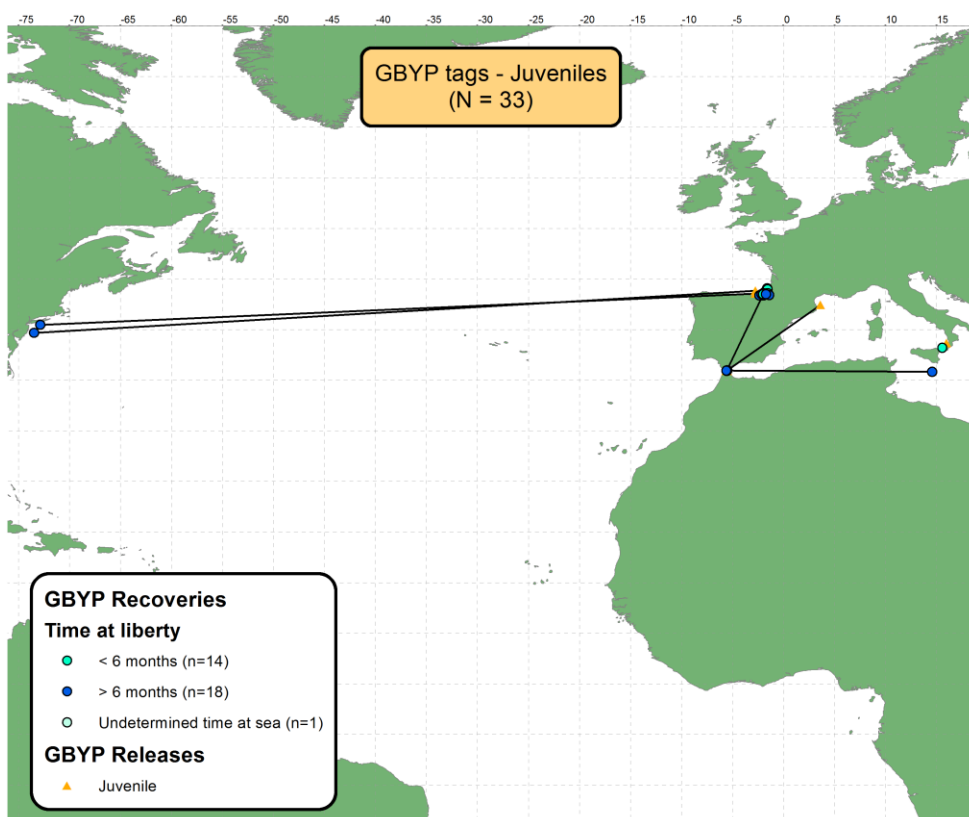


Figure 15. Trajectories of conventional tags implanted on juvenile bluefin tuna by GBYP and recovered by ICCAT in the period 2005-2013.

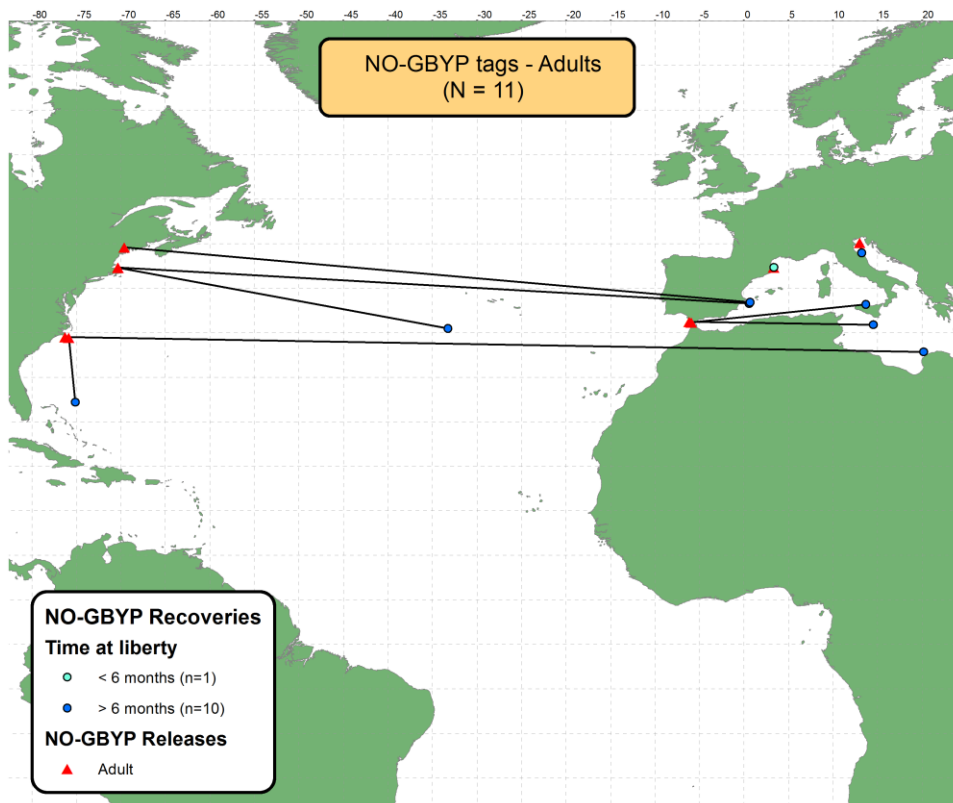


Figure 16. Trajectories of conventional tags implanted on adult bluefin tuna by non-GBYP programmes and recovered by ICCAT in the period 2005-2013.

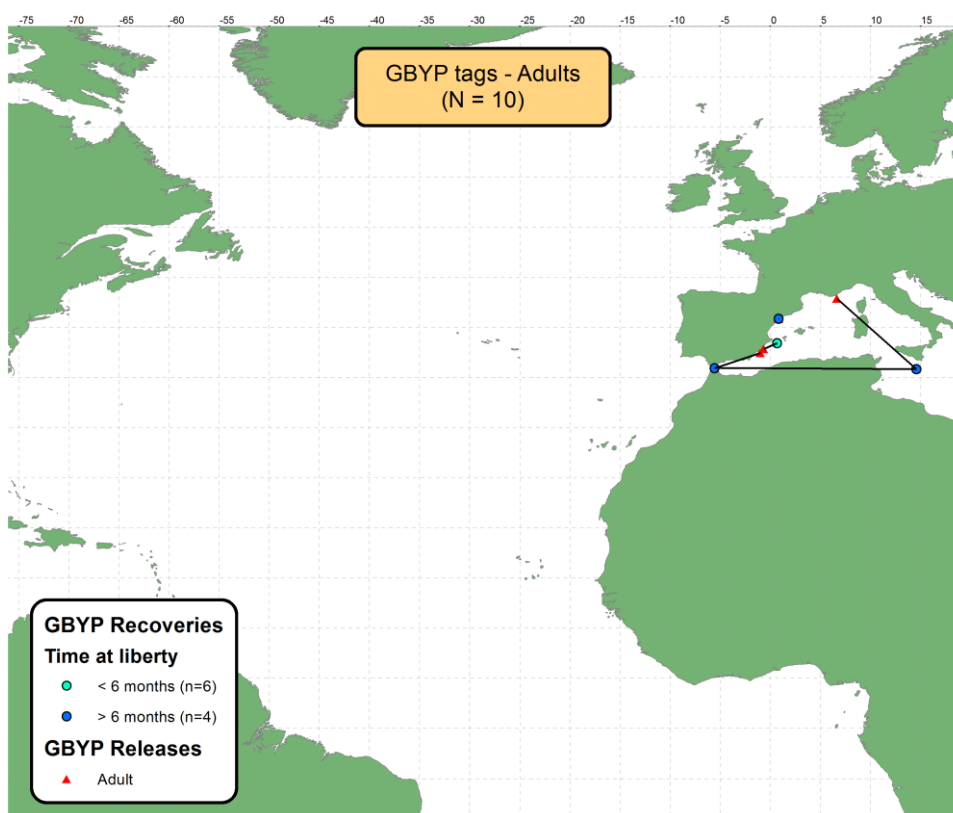


Figure 17. Trajectories of conventional tags implanted on adult bluefin tuna by non-GBYP programmes and recovered by ICCAT in the period 2005-2013.

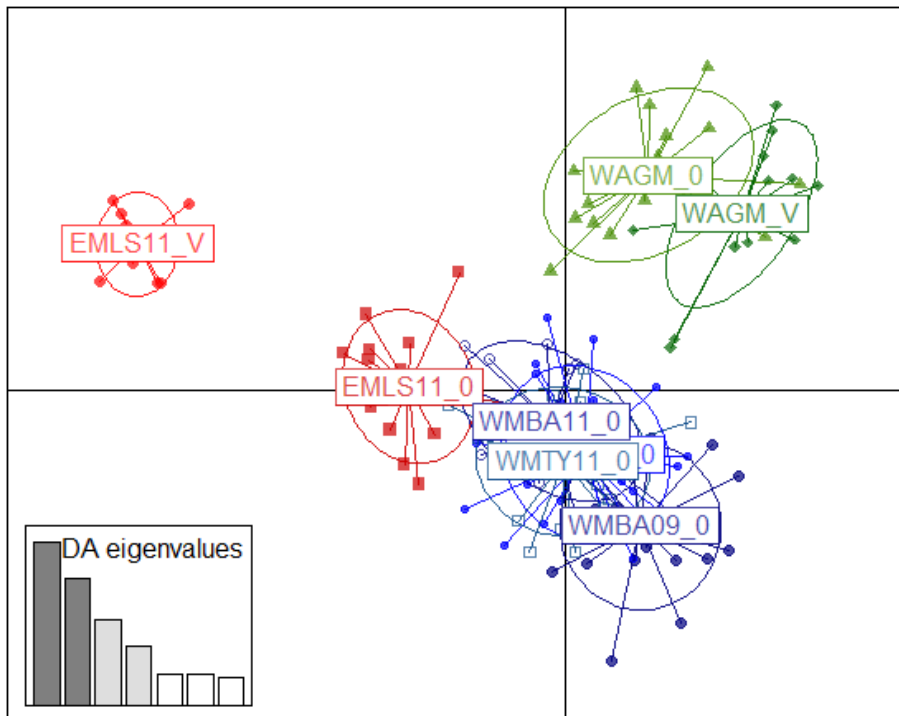


Figure 18. Clustering analysis using DAPC based on the eight reference samples and a restricted subpanel of 96 SNP. Three clusters can be seen, roughly coinciding with the expected spawning groups, with an improved separation of the Eastern Mediterranean Age-0 sample from the Western Mediterranean reference samples, even if yet not clustering with the Eastern Mediterranean Larvae sample.

| | C.N.ATLANTIC | BAY OF BISCAY (N.E.ATLANTIC) | E.ATLANTIC (NW.AFRICA) | STRAIT OF GIBRALTAR | BALEARIC (W.MED) | SARDINIA (C.MED) | ADRIATIC (C.MED) | MALTA (S.C.MED) | TURKEY (E.MED) | TOTAL |
|----------|--------------|---------------------------------|---------------------------|------------------------|---------------------|---------------------|---------------------|--------------------|-------------------|-------|
| EAST (%) | 70 | 99 | 27 | 100 | 100 | 100 | 100 | 100 | 98 | |
| WEST (%) | 30 | 1 | 73 | 0 | 0 | 0 | 0 | 0 | 2 | |
| Number | 177 | 262 | 32 | 190 | 39 | 20 | 47 | 82 | 48 | 897 |

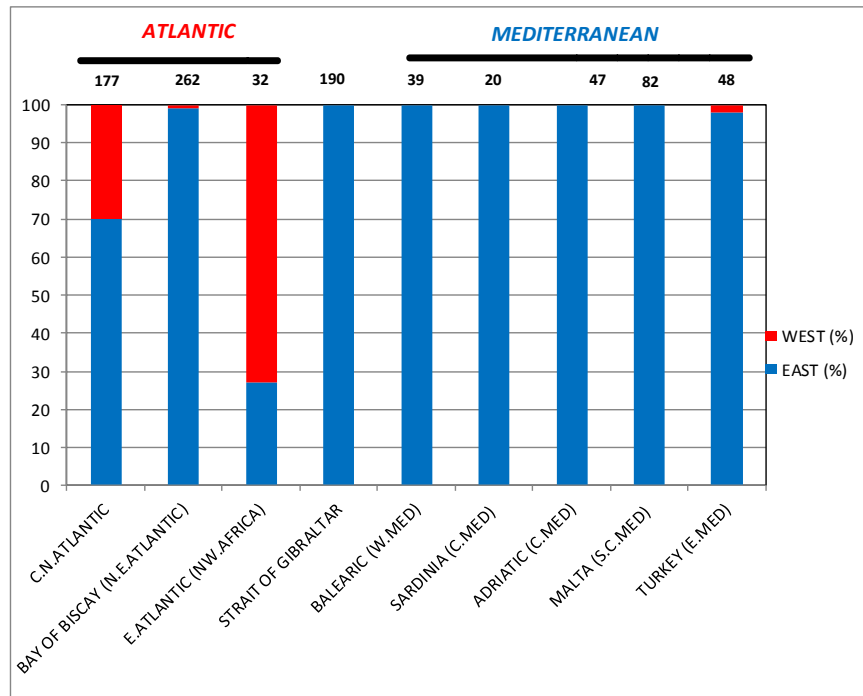


Figure 19. Summary of predicted origin of medium (25-100 kg) and large (>100 kg) bluefin tuna from the Atlantic Ocean and Mediterranean Sea in 2012. Sample size is provided for each area.

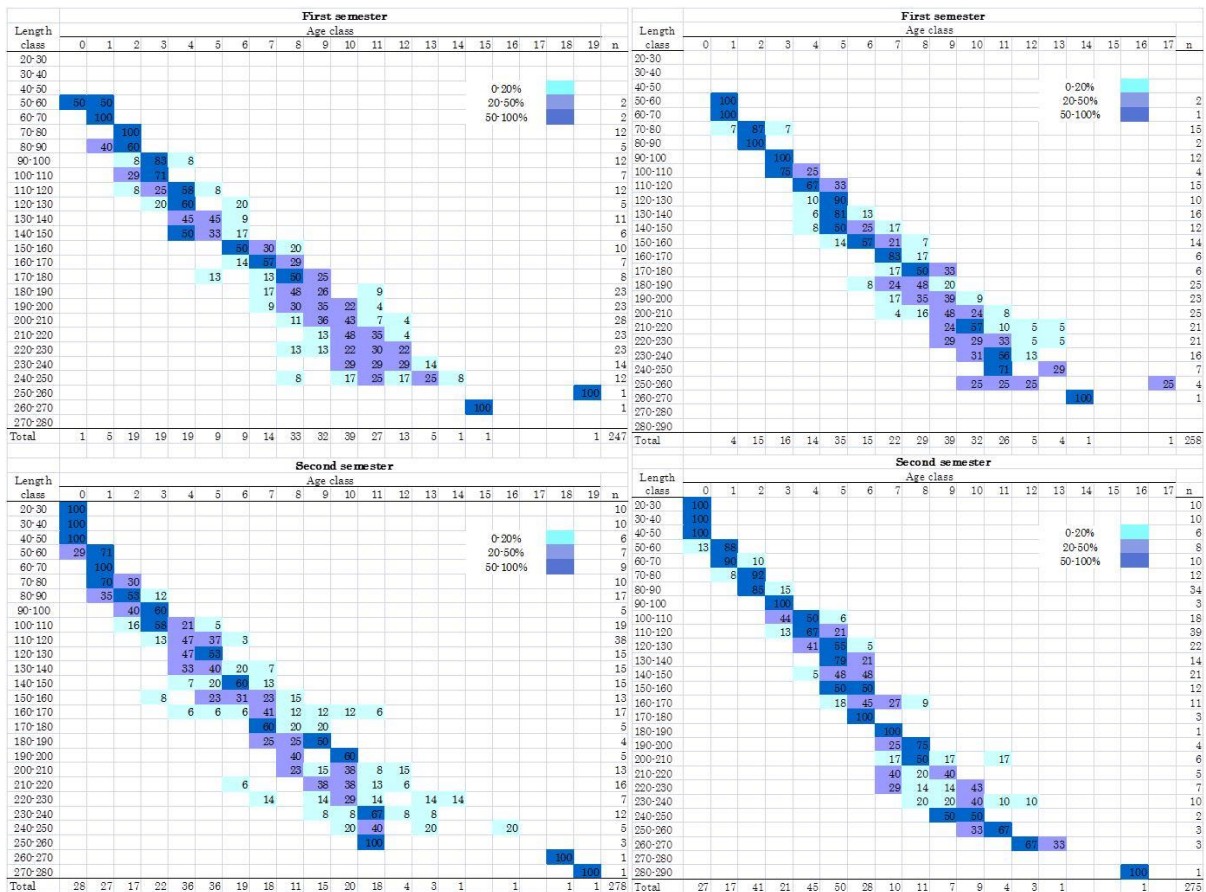


Figure 20. Age-length key based in age interpretation from Atlantic bluefin tuna otoliths (20a, left) and spines (20b, right) sections, by semester, in 2012. Numbers represent percent by number by length class (SFL, cm).

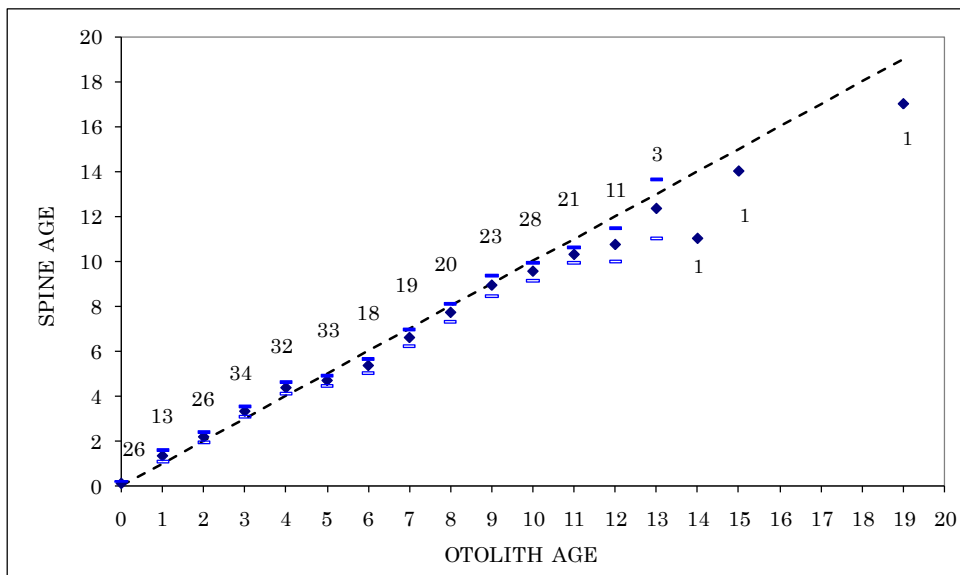


Figure 21. Bias comparison between spines and otoliths age readings in 2012. Spines age readings are presented as the mean age and 95% confidence interval corresponding to otolith age readings (numbers above values represent number of calcified structures used; total number of paired structures: 310).