INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

COMMISSION INTERNATIONALE POUR LA CONSERVATION DES THONIDES DE L'ATLANTIQUE

COMISIÓN INTERNACIONAL PARA LA CONSERVACIÓN DEL ATÚN ATLÁNTICO

*photo courtesy: ©Iñigo Onandia -AZTI

ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA

(ICCAT GBYP)

PHASE 4

EC GRANT AGREEMENT SI2.646831

GBYP SCIENTIFIC AND TECHNICAL FINAL REPORT FOR PHASE 4

April 10, 2015

ICCAT – Calle Corazón de Maria 8, 6° - 28002 Madrid – España

ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA (ICCAT GBYP)

PHASE 4

FINAL REPORT

INDEX

ICCAT ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA (GBYP)
FINAL REPORT FOR PHASE 4 (2013-2015)
EU GRANT AGREEMENT SI2.646831

EXECUTIVE SUMMARY

The Atlantic-wide research programme on bluefin tuna (GBYP) officially begun on October 2009, but it was practically initiated on March 2010. The fourth phase of GBYP activities began in March 2013 and was extended up to 23 February2015, including (a) continuation of data mining, recovery and elaboration, (b) biological and genetic sampling and analyses, (c) tagging, including awareness and rewarding campaign, (d) aerial survey on bluefin spawning aggregations and (e) further steps of the modelling approaches. The extension period after 2014 was used for improving few activities, due to the budget restrictions and an insufficient budget for beginning a new phase.

A very impressive amount of data was recovered in the first four Phases, covering a period from 1509 to 2009, all available for the normal ICCAT procedures and officially presented to ICCAT meeting on BFT data and then to SCRS in 2013 and in 2014. Additional data sets were reviewed in 2014, concerning a first two sets of trade, auction and market data. Under data recovery, it was possible to get the first analytical results of very ancient bluefin tuna vertebras collected in several areas, data which are very useful for defining several points in genetics. Furthermore, data mining activities allowed knowing historical iconography and data which were unavailable for scientists so far.

The aerial survey on spawning aggregation was carried out only in 2013 but not in 2014, due to a lack of sufficient funding. For the first time and with many logistic problems the survey was extended to most of the Mediterranean areas but the results confirmed the major concentration of bluefin tuna spawners were found in the areas already defined at the beginning of GBYP. The few concentrations noticed outside these areas allowed for considering a limited extension of the main areas for future surveys. Anyway, the results confirmed the good selection made since the first Phase of GBYP and the fact that the presence of bluefin tuna is increasing.

The conventional tag seeding in these four Phases was quite successful, implanting a total of 24,395 tags of various types on 16,718 bluefin tunas of various size. and the recovery is improving. The miniPATs implanted since 2011 provided very interesting results, which open new perspectives in our understanding of bluefin tuna behaviour, but now tagging should be extended to the eastern Mediterranean. The double tagging for studying the best type of spaghetti tag to be used for bluefin tuna is providing the first results, with not so many differences about the three tag types. The tag recovery and reporting is also considerably improving. A total of 284 tags of various types have been recovered during the first four Phases of GBYP but the recovery rate is still low for various reasons. A first field tag awareness activity was carried out in 2014 for supporting the normal activity carried out by the GBYP coordination.

The large participations of scientific institutions to the biological and genetic studies are also providing some

interesting preliminary results. The sampling was quite successful, providing a high number of various tyopes of samples (tissues, spines, otoliths). Several types of genetic analyses and micro-chemical analyses have been conducted so far, along with some innovative studies on the otoliths shape and the first data are demonstrating a noticeable difference between WBFT and EBFT, but also several differences in various areas. Further analyses are needed for confirming or not if these differences will indicate any possible sub-populations of bluefin tuna The micro-chemical analyses are showing some important inter-annual variability in the two main stock components in various areas of the Atlantic and this will require a deep attention for the implication in any modelling approach.

In terms of modelling, the GBYP initially focused on risk analysis to identify the main perceived sources of uncertainty related to assessment and advice, then other preliminary studies were carried out and now, after the meeting in Gloucester in 2013, the work for developing new approaches for a more focused management finally started. In 2014 GBYP had a Modelling Coordinator and a Modelling Expert Technical Assistant. Furthermore, it was finally possible to establish the ICCAT GBYP Core Modelling Group, and its first meeting was in December, revisiting the Modelling plan. These are important steps, involving various SCRS scientists and experts, for finally trying to move from the current system to a most advanced one.

As a matter of fact, even in this difficult and extended Phase, the GBYP is fulfilling all its obligations, reaching all objectives as planned, besides the limited availability of funds which reached so far only about 49% of the approved budget for the same period of time. The problem of ensuring a stable funding was raised again by both the Steering Committee and the SCRS, but so far it was not possible for the Commission to find an agreed solution for this problem, which is particularly relevant for a multiyear research programme such us the GBYP.

KEYWORDS

Bluefin tuna, ICCAT, historical data, market data, biological analyses, tagging, genetics, maturity, microchemistry, aerial survey, modelling, 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 officially approved by the ICCAT Commission in 2008 was 19, 075,000 Euro in six years, with the engagement of the European Union and some other ICCAT Contracting Parties to contribute to this programme in 2009 and in the following years. The initial year had costs for 653,874 Euro (against the original approved figure of 890,000 Euro), the second phase had costs for 2,318,849 Euro (against the original figure of 3,390,000 Euros), while the third phase had costs for 1,769,262 Euro (against the original approved figure of 5,845,000 Euro). The fourth phase had a total budget of 2,875,000 Euros (against the original approved figure of 5,195,000 Euros) and had costs for 2,819,556 Euro. The overall GBYP operating budget for the first four phases (estimating the full budget was used in Phase 4), then the total reaches 7,561,541 (against the original figure of 15,320,000 euro), equal to about 49.36% of what was decided by the Commission. These sequential budget reductions had an obvious impact on all activities carried out so far.

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. Other CPCs joined the funders in Phase 3 and 4, but some of them did not paid their contribution, even limiting the use of available funds, because the EU has a maximum percentage of contribution of 80%. Several private or public entities[1] provided funds or in kind support (see Section 12 of this report for the details). The GBYP activities of the first two Phases were presented to the SCRS and the ICCAT Commission in 2010, 20111 and 2012 and they were officially approved.

The third phase (7 months) officially initiated on June 20, 2012 (SI2.625691) and was officially concluded on January 19, 2013. The GBYP activities Phase 3 were presented to the SCRS and the ICCAT Commission in 2012 and they have been approved.

The fourth phase (about 18 months as originally planned) of GBYP officially initiated on March 6, 2013, after the signature of the Grant agreement for co-financing the GBYP Phase 4 (SI2.643831) by the European

[1] 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). In kind contributions were provided by Aquastudio Research Institute (IT), Balfegó Grup (SP), Carloforte Tonnare PIAMM (IT), Federcoopesca (IT), IEO–Fuengirola (SP); INRH –Tangier (MO), Maromadraba SARL and Es Sahel (Fuentes Group)(MO), Oceanis srl (IT), Mr. Roberto Mielgo Bregazzi (SP), the Stanford University (USA), the University of Cagliari (IT), the WWF Mediterranean Programme and the GBYP Coordinator.

Commission and then it was extended for a total of 23 months.

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

A first report of the GBYP activities in Phase 4 up to September 2013 was provided by the document SCRS/2013/144, while a second report for the activities up to September 2014 was provided to the SCRS and the Commission by the documents SCRS/2014/051.

2. **Coordination activities**

In the first part of the Programme, the staff was composed by the GBYP Coordinator, the Coordinator assistant (up to March 2014) and one contracted technician for data management (up to 2 January 2014). In the second part of Phase 4, because of budget constraints and other reasons, the staff was reduced to the Coordinator only. The ICCAT Secretariat provided the necessary support for the GBYP activities.

A total of **44 reports** were produced in the framework of ICCAT GBYP in Phase 4. Several additional documents and reports have been also provided by GBYP for the needs of the Steering Committee for its meetings. A total of **58 scientific papers** have been produced in Phase 4 (list in **Annex I**), while others will be published later on. The copies are in separate volumes (separate Annex 1a, b, c and Annex 2a, b, c).

A total of 9 Calls for Tenders were issued in Phase 4. A total of 25 contracts have been released to various entities (**Annex II**). In total, the number of contracts provided by GBYP in the first 4 Phases is 73, including 83 entities, localised in 23 different countries; many hundreds of researchers and technicians have been working so far in the various GBYP activities; this large and open participation to ICCAT GBYP activities is considered to be one of the best results of this research programme. The coordination staff participated in 19 meetings in various countries in Phase 4 (**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, as well as the Statistical Department.

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 outside meetings: two in Tenerife (SP) in May and one in Gloucester (US) in July. The coordination work required much more that 30,000 e-mails (received or mailed). All these efforts and the heavy workload behind have been compensated by the results of the various activities.

In the first part of 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 and 2014.

The budget items included under the GBYP Coordination activity in Phase 4 were: Coordination staff salaries and benefits, Steering Committee, External Review, Travels, Equipment, Consumables and ICCAT Secretariat Overhead. The original budget (amendment no. 1) for the Coordination activity was 670,475.00 euro. The total revised budget is **600,244.88** euro. The final costs are **573,216.13** euro.

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).

3.0 Data mining and data recovery

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 that those currently available, recovering data from many sources, including archives having difficulties for the access. The data mining activity can include also the recovery of old genetic and biological data. 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; old data will allow also for a better understanding and for improving our knowledge about Atlantic bluefin tuna.

So far, the GBYP objectives set for data recovery and data mining in these four Phases have been largely accomplished.

3.2 Data recovery in Phase 4

The objective which was set for data recovery and data mining in Phase 4 has been accomplished. The report was provided on 21 January 2015 (report no. 9 in the list in Annex 1). Partial reports were provided on 16/12/2013, 13/05/201414/07/2014and 06/08/2014, and by SCRS/2013/169, SCRS/2013/073, SCRS/2013/078, SCRS/2013/143, SCRS/2013/144 and SCRS/2014/167.

Following the recommendations of the Steering Committee, the initial 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 in those areas. 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, attended also by Dr. Saadet Karakulak (Istanbul University), 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 additional historical data will be detected. The frank and very professional cooperation of the Turkish team was very useful for adopting 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 additional and new 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 but then one offer was not finalised for local difficulties of the tender. As a matter of fact, the objectives were re-conducted to the original area and a contract was issued for recovering ancient genetic data from samples collected at the beginning of the XX century in the central-eastern Mediterranean and in the Marmara Sea, collected by Prof. Massimo Sella and stored at the University of Bologna. The samples were recovered and the preliminary results of the genetic analyses were presented at the SCRS in September 2014.

The contract with the University of Bologna was further extended, without changing the budget, for including in the preliminary analyses also some very ancient tuna samples recovered in Spain, thanks to their availability. During the time of the contract, a very important discovery was done in Istanbul, where many thousand vertebras of bluefin tuna were found in a huge storage of the University, coming from an excavate along the Bosporus for a new Metro station and a ferry harbour (SCRS/2014/167). Once successfully testing if it was possible extracting any genetic material, several of these precious samples will be possibly analysed in Phase V.

Furthermore, following the recommendation of the GBYP Steering Committee and the SCRS BFT Species Group, GBYP carried out a difficult work for setting a team able to analyse the many trade and auctions data provided as a gift in kind to GBYP in Phase 3. A part of the expert team, in a second step, decided not to

cooperate. Finally, after many discussions and negotiations, a contract was provided to an external expert who analysed in details all the many data sets, following very carefully all the instructions provided by the TORs and the result of this huge work was presented at the SCRS BFT Data Preparatory Meeting in May (SCRS/2014/042). Two important sets of data were selected as "reliable", while a third set would need additional efforts, particularly for cross-checking the data with the BCD. The SCRS BFTDPM had acknowledged the quantity and quality of the work carried out on the trade, auction and market data, setting further provision for their official incorporation in the SCRS data base. The SCRS decided not to set further checks for the first two data sets, which automatically implies that these data will be incorporated in the ICCAT BFT data base, after identifying the proper structure of this new part of the data base by the Secretariat.

In addition to the activities already planned, many historical data on tuna traps were donated by Ph.D. Jean-Marc Fromentin (IFREMER) to ICCAT GBYP. These data were provided on an excel file, having 10 spreadsheets. The data cover the period 1525-2000; they include 25 traps from several countries, concerning 1,569,939 bluefin and an undefined amount of tons (partial or annual total catch). Several of these data, obtained during the ICCAT GBYP data mining activities, have been already included in the ICCAT BFT data base from other archives and the previous GBYP data mining activity and, for this reason, the "new" data need to be carefully checked against the official data base. This work, which was not planned in Phase 4, will be carried out in Phase 5 if a data analyst support will be made available for GBYP.

3.3 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**. The numbers on the two tables do not include the data recently donated to ICCAT GBYP, mentioned in the last paragraph of the previous point 3.2.

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

a. For 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, 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), overlapping and conflicts were fully identified and finally resolved, all other catch and effort data will be directly incorporated in the ICCAT BFT Data Base. The documents SCRS/2014/142 shows the work done for cross-checking the data in the XX century from bait-boat fishery in the Bay of Biscay. For the actions recommended in points c) and d), the GBYP and the Secretariat worked with the Statistical Correspondents and the national scientists of each CPC concerned; overlapping and conflicts were fully identified and finally resolved (as communicated to the SCRS Data Preparatory Meeting on May 2014) in most of the cases, while a few others are still waiting for clarifications by the CPCs scientists or authorities and there will be again presented to the next BFT Data Preparatory Meeting for pointing out the few and minor pending data issues. Catch/effort data for the period prior to 1950 were 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/2013/169. A few conflicts were noticed and these were further discussed according to the procedures in place. All other GBYP catch data including those for the period prior to 1950 were added to the ICCAT BFT Task I data base.

3.4 Trade, auction and marked data validation

One of the objective set for Phase 4 was the validation of the several data sets including millions of trade, auction and market data, which were provide as in-kind donation to GBYP in previous Phases. These data were deeply discussed by the SCRS BFT Species Group and a strategy was recommended. The GBYP Steering Committee elaborated very detailed terms of reference that were largely discussed with the interested parties. Besides all many efforts and commitments, the contradictory validation was not possible following the lack of availability by one institutional entity and, in agreement with the Steering Committee recommendation, the validation was carried out by an external expert. The first overview of the analyses was presented to ICCAT on 27 April 2014, some comments were provided by the Secretariat to the expert and then the draft report was reviewed, taking all comments into account. The final report about this validation work was presented to the SCRS Data Preparatory meeting in May 2014 (the data recovered are included in **Table 1** and **Table 2**). Many data were considered fully reliable and then fully validated, while other were selected and identified for additional validation against statistical documents and BCDs, a work which needs much more additional time

and efforts, with the strict cooperation of the CPCs concerned, national experts and the ICCAT Secretariat. The SCRS Data Preparatory meeting "recommended the creation of a group of experts (to be established by the Group rapporteurs, the Secretariat and the GBYP coordinator during the September species group meeting) to review and fully validate the trade data compiled and presented in document SCRS/2014/042 for use in the 2015 stock assessment. The Group acknowledged the important work of preliminary validation carried out by the external expert contracted by GBYP".

The SCRS BFT Species Group meeting passed the decision about this further request to the SCRS Plenary, which decided not to go on with any further validation; therefore, the two first data sets were automatically considered fully validated and they will be incorporated in the ICCAT BFT data base after defying the proper data base structure of these peculiar data sets. This will be done in Phase 5, but these data are already sitting in a separate data base at the ICCAT Secretariat and available for any scientific use by SCRS scientists.

3.5 Additional data mining activities

Some additional data mining activities were carried out in Phase 4, without any budget cost, with the objective of further increasing the knowledge about the bluefin tuna fishery.

Dr. Fonteneau (SCRS/2013/076) tentatively used the observers data in farms for improving the estimation of purse-seine catch-at-size, by back-calculating the bluefin tuna size data at the harvesting, finding that these data provides an overview which is very different from the bulk of size data provided by someone in the last 15 years and that were used in all previous assessments.

Other analyses of farmed bluefin tuna data were provided by SCRS/2013/83 and SCRS/2014/040, while analyses of data collected from stereo video cameras are provided by SCRS/2013/096 and SCRS/2014/141.
Historical data mining concerned the finding of the oldest printed image of a tuna trap fishery /SCRS2013/140), the distribution of bluefin tuna fishery in classical historical ages (SCRS/2013/141) and the investigation about a previously unknown bluefin tuna fishery in the Canarey Islands in the first part of the XX century (SCRS/2014/050).

4.0 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. The original GBYP programme included a total of three annual surveys over a maximum of three different areas, but this was later modified by the Steering Committee and the statistical study revealed that under the best possible conditions a minimum of six surveys will be necessary for detecting a trend. So far, the

GBYP objectives initially set for the aerial survey on spawning aggregations in these four Phases have been largely accomplished.

Two surveys on four selected areas have been carried out in GBYP Phase 1 and Phase 2. In Phase 2 the protocols were changed by the Steering Committee and it was made mandatory the use of bubble windows on all aircrafts. 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 covers 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, following the views of the SC (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 2012 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 in 2013.

The immediate and detailed information for the SCRS was provided by document SCRS/2013/144.

4.2 The 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 was planned (**Figure 2**). 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 noticed in spring 2013 were not included in the survey for security reasons.

The design was revised by 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 relevant 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 a new design 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, and this was very useful during the operative survey.

Again, the GBYP Steering Committee revised the protocols for the aerial survey, making mandatory the rotation of the two scientific spotters on the same aircraft, the use of bubble windows and the use of a declinometer.

4.3 The aerial survey for bluefin tuna spawning aggregations in Phase 4

Four contracts were awarded after the Call for Tenders GBYP 03/2013. 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. Turkey requested the mandatory presence of a national observer on board and this consequently reduced the number of ICCAT scientific observers to one only. 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, include in some cases the military ones. 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 in real time. The survey was carried out using a total of 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 in length and then it was possible improving the number of surveys in the remaining part of these areas, thanks to additional tracks provided in real time. Strong winds, scarce visibility and military activities were additional operative problems that caused the delay for completing the survey within the schedule in some areas. The final survey area is showed on **Figure 3**.

It is important to note that this very extended aerial survey (the most complex in the world so far on a single marine species), never tried or made so far 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 team which carried out the same analysis in previous years. The GBYP staff carried out a quality check 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 initially selected by GBYP for conducting the surveys in 2010 and 2011 (**Figure 4**), confirming the full validity of the initial choice based both on deep scientific knowledge and recent fishery data obtained by a VMS analyses of the purse-seiners activities in the years 2007-2009. Only very few sightings were made in other areas where spawners usually travel not so close to the surface and most of those sightings were of juvenile tunas.

Claims about the mandatory use of declinometers were provided by all spotters, reporting that checking the declinometer for getting a precise angle quite often implied missing additional sightings. The delayed time schedule had consequences in some areas, because the spawning aggregations were found already split in smaller schools. The objectives set for this survey were largely attained.

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 km^2. This survey was considered quite cost/effective, another good result obtained also thanks to some complimentary flight time or specially reduced costs we had.

The main results for the areas surveyed in 2010, 2011 and 2013, with comparative data, are showed on **Table 3**. It is quite evident that the problems for conduting 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 higest increase in presence was in area C (Tyrrhenian Sea) and fishery anecdotical information is confirming this situation. The presence of some extremely 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 showed 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 GBYP Coordination, on the opportunity of the last GBYP Steering Committee meeting on 10-12 February 2015, presented a SWOT analysis for assessing the possibility of carrying out a very complex calibration exercise requested by the SC (Annex 1, document no. 19). This document was discussed by the Steering Committee and was accepted, recommending not to carry out this calibration.

A further data elaboration was requested in the very last part of GBYP Phase 4 by the Steering Committee on 12 February 2015. It was done by extending the contract to the same team which made the previous data elaboration and the final report was provided on 20 February 2015 (Annex 1, document no. 20). The analyses concerned the difference in sighting made by the professional spotters and scientific spotters, with a clear prevalence of the first ones (78.6% of the sightings), by type of aircraft and then analysing the results with and without bubble windows. According to this last analysis, sightings with bubble windows clearly increase, particularly in the sea stripe closer to the aircraft (**Table 5**).

4.5 Recommendations for future actions for the aerial survey

The main recommendations from the GBYP Coordination related to the aerial survey for future steps are the followings:

a) The methodology for the survey design applied in 2010, 2011 and 2013 (i.e. equally spaced parallel lines and DISTANCE approach) 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 or five years) to assess possible variability over the time; if surveys are going to be done annually or bi-annually, the recommendation again is to concentrate all efforts on the known and previously surveyed main 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 and biases.

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 BFT for future surveys; extend the northern border of the C-inside subarea slightly as there was a concentration of off-effort sightings right outside this sub-area; possibly slightly extend the E-inside east boundary.
f) Allocate more effort to future surveys, allowing for more passages and for the CV reduction.
g) Possibly keep the same pilots and spotters on the same area, with the objective to have a constant bias over the years; their personal capabilities for assessing the schools (personal CV) can be detected by comparing the assessment of the same schools provided independently by the professional spotter and the scientific spotter on the same side of the aircraft; additional calibrations can be done using an external expert for recording all individual assessments by each spotter at the same time.
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 allows for and increasing quality of the results and for getting more reliable trends.

The GBYP Steering Committee, at its meeting in September 2014, adopted a new figure for the areas to be surveyed in the next aerial survey, which include the recommendation in the previous point c), but reshaping most of the areas and requesting again an extended survey. (**Figure 5**)

5.0 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. All details are in document SCRS/2014/048.

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 Sea[2].
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).

[2] Additional elements will be provided by the GBYP biological and genetic sampling and analyses.

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 initial, short-term GBYP objective was to implant 30,000 conventional tags and 300 electronic tags in three years in the eastern Atlantic, with a total budget of 9,765,000 euro; the mandatory tag awareness and rewarding campaigns were not included. So far, with only 33.14% of the funds, GBYP deployed 80.79% of the conventional tags and 49.33% of the electronic tags, a very cost/effective result, thanks to many joined efforts; furthermore, the awareness and rewarding campaigns were also included in the activity. It is very clear that the general objectives sets for the tagging activities in these first four Phases were largely accomplished so far, taking into account the reduced available budget.

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 in Sardinia) and in the Tyrrhenian Sea (Italian Purse seiner), while tagging for BFT juveniles be limited to Bay of Biscay, Strait of Gibraltar (Spanish bait boats) and an experimental tagging in the Adriatic Sea (purse seines and cages). 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 .

Additional complimentary tagging activities within the GBYP framework were carried out in Sardinian traps, in Maltese cages and by sport fishing.

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 (implanted in Morocco and in the Mediterranean Sea)

b) 8 mini-PATs by the Stanford University (US) (implanted in Morocco)

c) 8 acoustic tags provided by Stanford University (US) (implanted in Morocco)

d) 5 mini-PATs by the St. Andrews Biological Station (implanted in Canada)

d) 1 mini-PAT by Aquastudio Research Institute (IT).

5.3 Tagging activities

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), by purse seine for adults in the Tyrrhenian Sea and by purse-seine and cages in the Adriatic Sea for juveniles. The contracts were provided to a Spanish Consortium headed by AZTI for the baitboat-based tagging (SCRS/2014/136), to an international Consortium headed by INRH with the participation of WWF MedPO for the Moroccan traps(SCRS/2013/196), to an Italian consortium headed by COMBIOMA for the Sardinian traps (SCRS/2013/180), to an Italian consortium headed by UNIMAR for the purse-seine based tagging in the Tyrrhenian Sea (SCRS/2013/096 and SCRS/2014/189) and to a Croatian Company, Kali Tuna, for the purse-seine/cages tagging in the Adriatic Sea. Further tagging activities were carried out on a complimentary base in 2013 and 2014 by Dr. Miguel Nieves dos Santos - IPMA (in Portuguese traps), in 2014 by COMBIOMA (Sardinian tuna traps), in 2013 and 2014 by Oceanis (Malta cages and one Sardinian tuna trap, SCRS/2014/130) and by sport anglers in various areas. All the reports and scientific papers are on http://www.iccat.int/GBYP/en/tagging.htm . The updated situation of the tagging activities is showed on **Table 6**.

In total, at the moment, the total number of bluefin tunas tagged so far in all Phases of GBYP are 16718, and a total of 24395 tags of various types have been implanted (**Table 7**).

Figure 6a shows the progression of the ICCAT GBYP tagging activities in the various years, clearly showing the yearly improvements. **Figure 6b** shows the percentage distribution of tags implanted in the various geographical areas, up to 23 February 2015.

The ICCAT GBYP electronic tagging with mini-PATs in Phase 4 was carried out on juveniles in the Bay of Biscay and in the Strait of Gibraltar, on juveniles in the Adriatic Sea and on adults in the Moroccan Atlantic. 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, 3 and for Phase 4 have been already provided to SCRS and the Commission in 2012, 2013 and 2014. Further results were provided to the Tenerife SCRS Meeting in May 2013, at the SCRS BFT Data Preparatory Meeting in May 2014 and at the SCRS BFT Species Group in September 2014.

It is important to note that several premature detachments[3] were noticed for mini-PATs since the beginning; this problem was discussed with various specialists and with the manufacturer Company. Different anchors were supplied by Wildlife Computers in Phase 4 and used by GBYP contractors and the situation is improving. The full analyses of the detachments will be possibly provided when the last tag will be finally recovered.

The preliminary maps of the mini-PATs deployed by GBYP in the various areas and popped-off in Phase 4 are on **Figures 7** to **10**. The data from tags which transmitted corrupted data or those staying for less than 10 days at sea are not included in those figures.

Some of the juvenile tunas electronically tagged in the Bay of Biscay are confirming that their movements in the short period are usually much extended, while one specimen showed extensive movements over a longer period of time; other remained in the same area. The juveniles electronically tagged in the Gulf of Lion shows a permanence in the Western Mediterranean Sea; only one specimen moved towards the Southern Mediterranean area, possibly for its first spawning.

Those juveniles and young bluefin tuna electronically tagged in the Strait of Gibraltar had many varieties of movements: some of them remained closer to the Strait of Gibraltar, while others had more extensive movements and some of these latter reached well-known spawning areas. 84% of the tunas tagged underwater and 35 % of the tunas tagged on board in Moroccan traps (the analysis was done limiting the data to the tags staying more than 3 weeks in liberty) entered into the Mediterranean and these data maybe show a biased behaviour for those tagged on board, but these data should be further confirmed by additional tagging, because the total number of tags is still low.

The adult pre-spawners which were tagged in the Moroccan traps showed a general behaviour very similar to the one noticed in Phase 2 and Phase 3: a considerable percentage of individuals (39% for the tags remaining more than 3 weeks in liberty) did not entered into the Mediterranean Sea for spawning during the spawning season and remained in Atlantic areas, independently from the tagging technique; this confirms the high interest of getting more data from this area. The preliminary data analyses of some selected tags presented during the Tenerife meeting showed the relevance of this tagging activity either for confirming spawning behaviour evidences or for calculating the time at the surface. This last point is very useful for better calibrating the aerial survey data in future analyses, as it was originally planned.

A first tentative of jointly analyse electronic tag data was done in the last part of Phase 4, working together with the WWF-MedPO team which is cooperating with GBYP (SCRS/2014/184). The first results are showed on

[3] The full analyses will be carried out in Phase 5, because in some cases it is not clear if the premature detachment was a real one or a catch and it is necessary to deeply examine all detailed data sets for better defining the various situations.

Figure 11. This preliminary analyses provided the opportunity for a first tentative of having maps showing the use of habitat in the various seasons (**Figure 12**) and a potential use of various parts of the Mediterranean Sea for spawning (**Figure 13**) but this last analyses should be further refined when more data will be provided by additional tags.

One electronic tag deployed by the University of Stanford in Morocco within the GBYP framework popped-off in Greenland on September 2014 (**Figure 14**); this tag confirmed in real time the return of bluefin tuna in the Greenland waters after many decades, something that was also confirmed by occasional catches in the same area at the same time. In the very last part of Phase 4 (8 February 2015), it was possible to get the data from another of the tag implanted by the University of Stanford in Moroccan traps in 2014 and this tag popped-off in the Terranova Bank; another tag implanted by the same team popped-off on the same day, in the area between the Canary Islands and Cape Blanco (Mauritania), but the full tracks are still not available.

In 2013, for the first time within the GBYP activities, a first tentative trial of implanting pop-up tags in juveniles in the Adriatic Sea was enforced and the results shows that all fish except one remained in the Adriatic Sea, while one went SE of Malta in January 2014 (**figure 15**).

It will be particularly important to investigate the behaviour and the origin of the fish going to Moroccan traps before getting there and particularly in the last part of winter and the first part of spring. Anecdotic information collected by GBYP confirms that bluefin tuna is still partly distributed in several parts of the southern Atlantic Ocean, but scientific data are missing for various reasons.

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

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 15,750 posters of various sizes (A1, A3 and A4) and more than 18,000 stickers were produced so far; two posters and all stickers were revised in 2014. All posters are also available on the ICCAT-GBYP web page http://www.iccat.int/GBYP/en/AwCamp.asp . A capillary distribution of the tag awareness material was carried out directly by GBYP, sending copies to all stakeholders such as: Government Agencies, scientific institutions, tuna scientists, tuna industries, fishers, sport fishery federations and associations, the RFMOs and MEDAC and other RACs concerned; the coverage was complete in the ICCAT Convention area, including also non-ICCAT countries and entities fishing in the area. The map clearly shows the distribution effort (**Figure 16**).

The ICCAT-GBYP web page has the full list of contacts http://www.iccat.int/GBYP/images/mapamunditicks.jpg .

The GBYP staff actively participated every year to the formation of ICCAT ROPs, with a specific focus on tag awareness and tag recovery, but also for having reports of any natural mark in bluefin tuna harvested in farms. In 2014 the formation of ICCAT ROPs was further improved and their reporting rate also improved.

Following the Steering Committee recommendation, a Call for tenders was launched and awarded in 2014. The Consortium in charge has the objective to further promote the tag awareness to all stakeholders in the main fishing areas in the eastern Atlantic and the Mediterranean, with a major attention to farms and traps, through direct contacts, promoting also the dissemination of press releases and videos. The field activities were completed within Phase 4. The basic material was provided to the contractor by GBYP. The final report is on http://www.iccat.int/GBYP/Documents/TAGGING/PHASE%204/_Tag_Awareness_Report_2014.pdf .

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 (along with the strong tag awareness activity) was very useful for considerably improving the tag reporting.

5.6 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 ICCAT ROPs.

The first report of ICCAT GBYP tag recovery activities in Phase 4was provided on document SCRS/2013/177, while updated data are provided by the document SCRS/2014/048. While examining the results of the ICCAT GBYP tag recovery/reporting activities, it is very important to consider that about 92% of the conventionally tagged fish in Phases 2-4 were juveniles (age 0-3); about 70% were surely immature fish (age 0-2) and then it is

difficult for these fish to be caught in a short time by most of the fisheries, particularly taking into account the ICCAT minimum size regulation. Up to the 23rd of February 2015 (end of Phase 4), there have been 284 tags recovered by GBYP as follow:

- 181 Conventional Spaghetti tags
- 74 Conventional Double/Single barb spaghetti (billfish) tags
- 18 External Electronic "mini-PATs" tags
- 7 Internal Electronic "Archival" tags
- 4 Commercial ("trade") Japanese bluefin tuna tag.

The distribution of tag recovered by area and fishery[4] is showed on **Table 8**, while the first set of data is showed on the maps in **Figures 17** to **20**. The data on these last figures are partial, because the GBYP data expert ceased her function on 2 January 2014; all tag recovery data collected in 2014 and in the first part of 2015 (Phase 4) were duly recorded on temporary files and they will be incorporated in the ICCAT GBYP bluefin tuna tag data base in Phase 5.

The important tag reporting improvement registered after the beginning of the tagging and tag awareness activities by ICCAT GBYP is impressive: the average ICCAT recovery for the period 2002-2009 was only 0.77 tags per year, while during GBYP tag recovery activities the average was 54.97 tags per year[5], with 7,788% increase **Table 9** and **Figure 21**). The year 2014, when tagging activities were carried out in many areas and tag awareness activities were already settled and further expanded, GBYP recovered a total of 110 tags, about 38.7% of the total over the whole period. We have to note that, for the first time in ICCAT bluefin tuna tagging activities, the number of tags recovered and reported from the Mediterranean Sea is higher than any other area, representing 63.2% of the total. This is the clear evidence that GBYP tag awareness campaign is producing positive effects.

It is extremely difficult and almost impossible at the moment to define a recovery rate for GBYP conventional tagging activities, taking into account that most of the conventionally tagged tunas were juveniles and they will be possibly available in most of the fisheries within the ICCAT Convention area only in future years. Whenever we consider, as a preliminary exercise, the number of tags recovered so far in comparison with the number of GBYP tags deployed, the provisional recovery rate is only 1.16%, but this rate is clearly negatively biased by the juvenile ages of more than 92.4% of the tagged fish, and positively biased by the presence of non-GBYP implanted tags. At the same time, it is impossible assessing the recovery rate of tags which were not deployed by ICCAT GBYP, because ICCAT does not have in its tag data base the complete number of implanted tags by each

[4] For comparison purposes, but also because the data were not previously reported, we included in the table also the tags recovered by ICCAT between 2002 and 2009, before GBYP. These tags were only 7 (4 spaghetti, 1 double barb spaghetti and 2 internal archival).

[5] Considering 2010 as a full year (even if GBYP initiated its activities in March 2010) and the tag recovered before 23 February 2015 (0.167 of a year).

tagging entity, due to the lack of mandatory rules for informing ICCAT about tag deployments in the ICCAT convention area..

The number of tags reported by two important activities in the Eastern Atlantic and in the Mediterranean Sea (purse-seiners/cages and tuna traps) are surprisingly very low. The purse-seine fishery is historically the most productive in the last decades, reaching over 70% of the total catch in some years; since 1999, almost all catches are moved to cages and then to fattening farms and these activities are strictly monitored by ICCAT observers (ROPs). Consequently, the GBYP was supposed to have a high tag recovery and reporting rate from purse-seiners/farms, but the data are showing a different reality: so far, only two Spanish farms (Balfegó and Fuentes), two Maltese farms (ADJ Tuna Ltd and Fish & Fish Ltd) and one Greek farm (Bluefin Tuna Hellas SA) had recovered 39 tags, of various types (28 spaghetti, 8 double-barbs tags, 3 internal archival tags). Even considering that most of the recent tagging activities were targeting juveniles, the recovery and reporting rate is unrealistically too low (13.4% of the total), but it seems that this percentage is slowly growing in the last year. The same considerations can be done for the traps, because only one Spanish tuna trap (Tarifa) and 1 Italian trap (Carloforte) had reported 5 tags to ICCAT within the period taken into account (2 spaghetti, 1 double-barbs tag, 2 internal archival tags). Even in this case, the recovery and reporting rate (1.7% of the total) is unrealistically too low. A similar consideration is applicable even to the long-line fishery; including both the bluefin tuna targeted fishery and the many long-liners targeting other pelagic species having the bluefin tuna as a by-catch (26 tags in total, 14 spaghetti, 10 double-barbs tags and 2 internal archival tags, equal to 8.8% of the total). We are aware that many other tags are recovered but not reported and this fact, well known since many decades, is clearly affecting both the efforts and the analyses. The possible reasons for the low report rates from these fisheries are detailed on the document SCRS/2013/177.

Interesting information is slowly coming from the tunas double tagged (**Table 10**): so far a total of 70 double tagged fish were recovered (equal to 0.91% of the total double tagged fish) and 59 of them had still both tags on; 7 fish had only the billfish (double-barb) tag on, while 4 fish had only the single barb spaghetti on. According to these first data, it seems that both types of tags are quite resistant with a slight prevalence (94.3%) of the double barb against the single barb ones (90%).

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 tag 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, with an important additional workload. 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. The SCRS BFT Data Preparatory Meeting in May 2014 recommended the following: “Given the substantial number of tags that have been deployed on Atlantic Bluefin

tuna, much of which has not been made available through ICCAT, the Group recommended that all electronic tagging data be submitted to ICCAT in the format approved by the Ad Hoc SCRS working group on tagging to be made available for analyses by April, 2015. In this regard, the Group supports the previous recommendation from the Biological Parameters Meeting (2013, Tenerife)".

6.0 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, while the activities for Phase 3 were presented by the documents SCRS/2013/189 and SCRS/2013/089. This report includes the results of Phase 4 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 4 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

The activities in previous GBYP Phases have been clearly able to accomplish their objectives (**Table 10**). 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 4, carried out by an international Consortium headed by AZTI including 13 institutions and 8 subcontractors was reported in detail in the various contractual deliverables[6] and was officially reported to SCRS in September 2014, within the GBYP report. Other two contracts were released at the end of 2014 (Mediterranean Spain and Sicily) for collecting additional YOY samples; originally it was supposed to release other 4 contract (Bay of Biscay, Ligurian Sea, Malta and Turkey), but YOY were not there in most of the

[6] Preliminary reports, due to scientific confidentiality issues, are not available on the ICCAT GBYP web page, while final reports are available there after their final approval.

places, while the contract in Malta was not released due to the refusal of permit for the YOY sampling to the local contractor by the Maltese Fishery authorities.

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. Other documents were preliminary presented at the SCRS BFT Data Preparatory meeting in May 2014.

The total number of samples reported by the Consortium was much higher than the target: +43.22% for the specimens to be sampled and +17.08% for the number of samples; this achievement was made possible thanks to the ICCAT Rec.11-06, which allowed collecting samples even outside the fishing season. The Libyan samples mentioned in the previous report SCRS/2013/189 were made available in Phase 4, as planned, though the Maltese colleagues working within the Consortium. The late beginning of the activity made impossible the collection of gonad samples in 2013 and this fact was duly taken into account on the planning. Additional technical and logistic problems were noticed by the Consortium, particularly again for sampling juveniles in Malta in 2013 and for exporting the samples from Turkey.

Additional 89 bluefin tuna YOY were sampled in the last part of 2014; the sampling included both otoliths and tissue for genetic analyses.

6.2.1 Micro-chemical analyses

After the preliminary discrimination between WBFT and EBFT carried out in Phase 2 and 3, and after defining a new baseline, the **micro-chemical analyses** of the otoliths in Phase 4 were concentrated mostly on Atlantic areas, trying to better define the mixing between the two main stocks.

The analyses on $\delta^{13}C$ and $\delta^{18}O$, carried out on 327 otoliths, show a large majority (94%) of western origin tunas in the NW Atlantic areas, a 100% presence of eastern origin fish in North Atlantic in samples collected in 2011 and 83% in those collected in 2012, while the situation in the Ibero-Moroccan area shows a certain variability between years and areas (Canary and Moroccan traps), but with a clear majority of eastern Atlantic fish. This information, when adding the results from the analyses concerning the Moroccan samples in the previous Phase, shows a clear and marked interannual variability of the components (**Table 11**), and then a variable mixing rate that should be further followed and investigated, particularly for management purposes and for developing MSE approaches. The situation in the Mediterranean Sea and in the Straits of Gibraltar appears more stable, with almost 100% of eastern Atlantic fish (only in 2011 there was a very minor percentage of western Atlantic components, <1%, maybe due only to analytical procedures). Even if the previous GBYP report discusses in a deeper way this part, in general the micro-chemical analyses carried out so far provide various elements for

improving our understanding of the Atlantic bluefin tuna components, but more samples, in different years and from more areas should be necessary for having more solid results, possibly assisted by a parallel genetic analyses, particularly taking into account the marked interannual variability of the components (**Figure 22**).

Further micro-chemical analyses were carried out on trace elements in the otoliths edge, which are able to further determine the bluefin tuna movements. In this case, after analysing 154 samples from various areas and ages, the difference between the western Atlantic and the eastern Atlantic was clear, even if less if compared to the results mentioned in the previous paragraph, while several differences were noticed within the Mediterranean and even some Atlantic components were found in samples from southern Sicily (see the final report provided by AZTI) (**Figure 23**).

A further type of micro-chemical analyses concerned the elemental composition in otoliths of young-of-the-year (YOY) bluefin tunas within the Mediterranean, having the objective to possibly have additional elements for discriminating the natal origin of the young fish. According to the elements taken into account in the preliminary analyses, which was carried out on a total of 60 samples (20 per area), it seems possible discriminating the natal origin among the three areas (western, central and eastern Mediterranean Sea), with some overlapping data (**Figure 24**).

Additional micro-chemical analyses were carried out on $\delta^{13}C$ and $\delta^{18}O$ along the otoliths transect, trying to understand the bluefin tuna movements between the Mediterranean Sea and the western North Atlantic. The preliminary test carried out on 10 fish caught in 2009 in the Bay of Biscay and in 2010 in Spanish traps, showed in some cases promising data, which are potentially able to describe their migration between the two areas in different years.

6.2.2 Genetic analyses

The **genetic analyses** carried out in Phase 4 (also thank to the study carried out under the data mining item, which included historical samples) are clearly showing 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 and in 2013 and therefore, with the most advanced techniques, in Phase 4 on 165 samples, confirm a clear difference between the western stock and the eastern stock. At the same time, there are minor differences within the eastern stock. The DNA analyses were conducted were only on larvae and YOY by RAD sequences (**Figure 25**) and by DAPC (**Figure 26**).

Further genetic analyses were carried out on ancient adult specimens, collected partly under the data mining item and partly thanks to additional very ancient vertebras provided by Spanish colleagues. The results are showing some differences within the Mediterranean Sea (**Figure 27** to **29**) under different assumptions of ancestral populations, while a marked difference is evident between the western Atlantic bluefin tuna and the eastern Atlantic and Mediterranean samples (**Figure 30** to **32**). These first results should be further investigated, because

a mixing within the Mediterranean is also clear and, as a consequence, possible sub-populations in various Mediterranean areas will need a better confirmation.

Even if further analyses are necessary for confirming and possibly more identify various sub-populations, it is clear that the availability of information from many different sources (aerial survey, environmental data, genetics, microchemistry, etc.) possibly contribute all together in increasing our understanding of the results of sophisticated analyses.

6.2.3 Otolith shape analysis

Along this line, the biological studies in Phase 4 were reinforced with a new research item, the **otolith shape analyses**, quite innovative and which was considered as a further tool for discriminating the various population components. The first trial was carried out on 422 otoliths and the preliminary results are showing that at least one of the parameters (the circularity) varies significantly between regions see the final report of the Consortium about GBYP biological studies), but all first samples were not including any from northern or western Atlantic or from Atlantic Morocco or Canary Islands and this integration will result very useful in future additional work for a better understanding of the results (**Figure 33**). Taking into account that this innovative technique used for bluefin tuna seems promising, the research team is proposing a much higher sampling of both juveniles and spawners in the various areas with the objective to have a broader overview; then, it should be very useful to compare the results of the otolith shape analysis with the genetic and the microchemical ones, trying to detect all necessary correlations.

6.2.4 Ageing calibration

Following the recommendations of both the SCRS and the GBYP Steering Committee, an **ageing calibration** exercise was carried out in 2014, incorporating this first trial in the same research contract of the other biological studies. A reference set of images of both sliced otoliths and spines, with confidential references, were prepared and made available to all participants. A Call for cooperation was launched on April 28, 2014 and 16 different institutions (32 scientists from 11 countries) subscribed this first trial, coordinated by Dr. Rodriguez Marin (IEO). Finally, 13 institutions from 9 countries were able to provide their readings on time for the elaboration and the results are quite promising. The first results showed a good agreement in ageing otoliths from medium fish between expert and non-expert[7] readers, while ageing the juvenile or young adult specimens showed some differences. Differences were more marked in ageing the spines, while discrepancies were noticed depending on the type of light used for age readings (**Figure 34** and 35). According to this first and important international cooperative experience, it seems very relevant to further developing refinements and apply them in future years. The results were made available to SCRS (SCRS/2014/150).

[7] Non-expert readers were anyway scientists having a good experience in ageing determinations, but not for bluefin tuna.

6.2.5 Other biological studies

The GBYP coordination carried out a comprehensive and critical review of all prediction models (for spawners, juveniles and even larvae) currently available for the bluefin tuna. The result of this study, having no impact on the budget, was presented to the SCRS in 2014 (SCRS/2014/102).

Another activity, which was not included in the official list of Phase 4 at the beginning, concerns the recovery of many old ICCAT BYP tissue samples, that were finally detected at the University of Girona (SP) and at the National Ocean Service in Charleston (USA). The number of samples is quite important and these might improve all the analyses carried out by GBYP in future years. The idea to move all samples to the same sample bank used for GBYP samples and then made them available to all SCRS scientists was not possible and therefore these old ICCAT BFT samples were now moved to the NOAA SWFC in Panama City, under the condition to make them available for SCRS and GBYP studies. NOAA will develop a simple procedure for using them.

7.0 Modelling approaches

The ICCAT-GBYP Modelling activities in the first part of Phase 4 strictly followed those recommended by the GBYP Steering Committee, endorsed by ICCAT-SCRS and approved by the ICCAT Commission.

Four contracts were awarded in Phase 4 under the Modelling Programme in support of BFT Stock Assessment: i.e. I) Quantitative Risk Assessment, II) Statistically based stock assessment methods, III) Support to BFT Stock Assessment (Modelling Coordinator) and IV) Support to BFT Stock Assessment (MSE Technical Assistant). No bids were submitted for the Call for tenders concerning the Development of biological hypotheses for the use of MSE (Management Strategy Evaluation).

The final reports of the first two contracts are already available on the ICCAT GBYP web pages and were presented at the SCRS BFT Species Group meeting.

7.1 Objectives

Under the GBYP the modelling programme addresses 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 were consistent with the objectives.

In Phase 4, two meetings were held on modelling approaches: a first one in May 2013 in Tenerife (Spain) for preparing a 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 (USA), 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 4 activities for modelling in support of BFT stock assessment

The first two final reports concerning Modelling approaches in Phase 4 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. In Phase 4 the risk analysis was quantitatively modelled using the initial qualitative work carried out during Phase 3. The development of such a quantitative risk analysis was 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.

The GBYP Bluefin tuna rebuilding plan uses stochastic projections that do not capture all the uncertainty associated with stock assessment/ management variables. This could mean that the outcomes predicted by the projections are more optimistic or pessimistic than those that will be achieved in practice. A methodology was

sought to capture stakeholder perceptions of particular uncertainties that should be included in stock assessments of Bluefin tuna and then to provide preliminary quantification of their relative importance impact on achieving management objectives. Ultimately, this will allow risk-based scenarios to be specified for the Operating Models (OM) used as part of a Management Strategy Evaluation and enable the SCRS and the GBYP Steering Committee to prioritise research. Given that the combinations of scenarios for inclusion in an MSE can grow exponentially with each extra variable, it may not be possible to evaluate the quantitative impact of all sources of uncertainties identified, or even prioritised. Therefore discussions with assessment scientists were conducted to reduce the initial list to those variables most amenable for further evaluation using simpler quantitative modelling approaches such as elasticity or scenario-based sensitivity analysis. In elasticity analysis the proportional change of derived values relative to changes in the input parameters allows the relative impact of the different inputs to be evaluated.

Having determined which of the uncertainties have greater impact on derived values, measured using a utility function, discussions can be initiated with the stakeholders to elicit which of the shortlisted uncertainties should have priority for further quantitative investigations. Finally, a representative 'reference' set of Operating Models can be selected based on analysis of interactions among uncertainties. The plausibility weights for this reference set of OMs provide another opportunity to engage stakeholders, and to elicit their views as to how robustness trials with the MSE should be 'tuned'. Having thus established an MSE framework, other sources of uncertainty from the qualitative analysis stage can be quantitatively addressed but it is still unlikely that every single one can be given a quantitative treatment. Therefore, elicitation process will also serve to document what is missing from the quantitative risk assessment, giving a more transparent and comprehensive view of uncertainties in the scientific advice to managers and other stakeholders (see documents SCRS/2014/101).

7.2.2 Statistically based stock assessment methods

The work carried out under this item was the following:

a) examining the opportunity of using a statistical catch at age for Bluefin tuna stock evaluation,

b) highlighting the structure and the assumptions of the chosen statistical model (iSCAM developed by S. Martell [Martell, 2012])

c) running a simulation study for evaluating the quality of the estimation procedure,

d) producing operational codes for running a stock evaluation on Bluefin Tuna east stock with a statistical catch at age model,

e) comparing the results with the results presented in previous stock assessment. 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 results obtained with iSCAM are consistent with the results described in [SCRSGroup, 2012] and obtained using a virtual population analysis. Furthermore, as iSCAM used the stock recruitment relationship in the last phase of estimation, the recruitment may be almost freely estimated as in a VPA approach.

Some of the parameters have to be fixed and can't be estimated with the data available for this study. iSCAM may be more finely tuned using more expertise on the studied stock; this expertise may be included as a prior for example but also uses to propose more adequate choices. By instance, the catch at age data show strong pattern, this may correspond to a known change in the selectivity and should be included in the model.

On the other hand, the mortality rate is a key parameter and has been chosen constant throughout ages, but recent development of iSCAM should allow to use a mortality rate varying with age and produce results closer from the previous stock assessment. iSCAM also proposes some prediction of the evolution of the stock according to fixed TAC policy. The code using this possibility of iSCAM is also available.

Running iSCAM on BFTE will require more precise tuning of the parameters. The improvement obtained with a fine tuning will not circumvent the issue of the amount of noise (estimated by iSCAM) in the data. This high level of noise in the data may produce biased estimates on the key parameters and in any case this variability in the recruitment process and in the observed abundance indices makes the stock assessment difficult. However this variability cannot be omitted and has to be considered.

Therefore, using a Bayesian framework, would allow to include prior information and to produce predictive interval which account for both uncertainty described by the model and its variances parameters and uncertainty on those parameters itself. Taking all sources of uncertainty into consideration would help to develop decision analysis process under uncertainty and should be strongly recommended.

7.2.3 Assistance to bluefin tuna stock assessment: Modelling coordinator

After the Call for tenders, this contract was provided to CSIRO (Australia), which made available Ph.D. Campbell Davies for coordinating the GBYP modelling work, following the Modelling Plan. The initial delay for releasing the Call, due to the procedures for extending and revising the GBYP Grant Agreement, had a further delay caused by the complex contractual procedures in CSIRO and the consequent negotiations. These delays, along with an heavy workload of the Modelling Coordinator in spring 2014, prevented the duly provision of the Modelling work plan to the SCRS BFT Data Preparatory Meeting and then the full schedule was revised in emergency, in order to go on with the work and the related recruitment of the MSE Technical Assistant. The Modelling Coordinator provided detailed TORs for the MSE Technical Assistant and participated to the selection.

The revised Modelling Work Plan for the period 2014-2018 was provided at the beginning of June 2014, while the revised table was provided on 31 July 2014. Both documents were presented to SCRS. Various telephone conferences were held with the ICCAT staff for discussing the details.

According to the TORs, the GBYP Modelling Coordinator proposed a Core Modelling Group and the names were discussed at approved by ICCAT Secretariat. The Core Modelling Group was chaired by Campbell Davies,

while the members are Polina Levontin, Richard Hillary, Toshihide Kitakado, Yukio Takeuchi, Haritz Arrizabalaga, Doug Butterworrth and Tom Carruthers Clay Porch, and, *ex-officio*, David Die (SCRS Chair), Clay Porch (WBFT Rapporteurs), Sylvain Bonhommeau (EBFT Rapporteurs), Laurie Kell (ICCAT Population Dynamic Specialist), Paul De Bruyn (ICCAT Statistical Department), Antonio Di Natale (GBYP Coordinator) and Pilar Pallarés (ICCAT Scientific Coordinator). The role of the Core Modelling Group is defined as follows:

a) Provide technical oversight and advice on the MSE process to the SCRS
b) Provide annual review of progress against work plan and report to SCRS and Commission
c) Review technical contributions and outputs to the work program and advise the secretariat on satisfactory completion of tendered contracts.
d) Advise the secretariat and GBYP Steering Committee on out-of-session revisions to work program, where necessary and appropriate.

The GBYP Modelling Coordinator, together with the GBYP Coordinator and the ICCAT Secretariat organised the ICCAT GBYP Core Modelling Group meeting included in Phase 4 planning on 1-4 December 2014.

The final report of this meeting included also all necessary deliverables, a revised table of all ICCAT GBYP Modelling activities up to 2018 and the budget that was considered necessary by the Group for fulfilling all necessary activities. The full report is available on http://www.iccat.int/GBYP/en/modelling.htm

7.2.4 Assistance to bluefin tuna stock assessment: MSE Technical Assistant

After the Call for tenders, released with an initial delay as reported above, this contract was provided to an expert from Canada (Dr. Thomas Carruthers), who was in charge to develop the Operating Model and MSE framework and related code, working directly with the Modelling Coordinator and in consultation with the ICCAT Secretariat, the core Modelling Group and MP modellers. The first operative meeting between the expert and the Modelling Coordinator was held in Seattle on 28 June 2014, with the objective to discuss the work plan and details of the Operating Model.

A second meeting was held at the ICCAT Secretariat on July 14-17, 2014, discussing in details the first steps of the modelling work and for agreeing about the working procedures. The Modelling Coordinator participated by telephone conference.

A third meeting was held during the Core Modelling Group meeting, where he provided the necessary deliverables.

The plan is to continue this part of the modelling work also in next GBYP Phases.

8.0 Mid-term Review

A full mid-term review of ICCAT-GBYP was carried out in Phase 4, as requested by the Commission and the SCRS, 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 may 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 was distributed to SCRS, the GBYP Steering Committee and the Commission. The reviewers recognized the important improvements in scientific knowledge obtained by GBYP in the first parts of the programme. Specifically, the reviewers recognized that “on the whole, the GBYP did yield an impressive increase in scientific investigations into Atlantic BFT, delivering much of the background scientific evidence crucial to conducting and improving stock assessments and ultimately management advice” and that “the investment in coordination of the programme through ICCAT is another shining example of good practice”. The reviewers, in their report, provided also an extensive range of proposals for improving the research in the following years. The report is available on http://www.iccat.int/GBYP/Documents/RESEARCH/GBYP_Mid-Term_Review2013.pdf .

Most of the points raised by the reviewers, concerning individual current or future activities of GBYP were answered by the GBYP Steering Committee in its report of September 2013 (http://www.iccat.int/GBYP/en/scommittee.htm).

9.0 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 60 ICCAT GBYP RMA certificates have been issued in 2013, using 4,392.8 kg of bluefin tuna, while only 9 RMA certificates have been issued in 2014, using a total of 887.8 kg. RMA used quantities in 2013 were officially communicated to ICCAT Statistical Department for the inclusion in the official ICCAT BFT catch table (see document SCRS/2014/142), while the RMA used in 2014 was already officially transmitted to ICCAT with the objective of updating the total catch table before the 2015 BFT Data Preparatory meeting. The RMA data for 2014 will be included in the necessary SCRS paper for the earlier meeting on BFT.

10.0 Cooperation with the ICCAT ROP

The GBYP coordination, together with the ICCAT Secretariat, is maintaining and improving the contacts with the ICCAT ROP observers, for strengthening the cooperation and providing opportunities. The ICCAT 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. The GBYP Coordinator is regularly participating to the ICCAT ROP observers training courses, specifically training them for the tag recovery and reporting. ICCAT GBYP tag awareness material is regularly provided to ICCAT ROPs.

11.0 Steering Committee Activities

The GBYP Steering Committee in Phase 4 was composed by the Chair of SCRS, Ph.D. David Die, the BFT-W Rapporteur, Ph.D. Clay Porch, the BFT-E Rapporteur, Ph.D. Sylvain Bonhommeau (who replaced Ph.D. Jean-Marc Fromentin from December 2013), the ICCAT Executive Secretary, Mr. Driss Meski, and the external expert, Ph.D. Tom Polacheck, who was contracted for this duty for Phase 4.

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

The Steering Committee, for the first time, proposed a plan for extending the GBYP up to 2021, which included also a new vision of its research components, including a draft recommendation for ensuring a stable funding (SCRS/2014/194). The document was submitted to the SCRS in 2014, who recommended its approval to the

Commission. The Commission, at its meeting in November 2014, approved the new plan for the GBYP as it was proposed but the draft recommendation for ensuring the stable funding was not approved.

The activity of the Steering Committee included continuous and constant e-mail contacts with the GBYP coordination, which provided the necessary information. In Phase 4 the Steering Committee held one meeting on 28-29 September 2013, a second meeting during the SCRS BFT Species Group on 24 September 2014 and a third meeting on 10-12 February 2015. The latest report is still to be finalised at the date of this GBYP 4th Phase report. All reports of all GBYP Steering Committee meetings are available on http://www.iccat.int/GBYP/en/scommittee.htm .

12.0 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. The annual budgets are on http://www.iccat.int/GBYP/en/Budget.htm

So far, up to the first three Phases, GBYP received and used only 46.84% of the funds originally approved for the same time period (4,742,086.02 euro against 10,125,000 euro). Including Phase 4 (provisional data), the available funds will be equal to 49.34% (7,561,541 euro against 15,320,000 euro) of the budget originally approved for the first 4 Phases (but with the difference that they were always considered as 4 years, while now the effective duration is 5 years).

In Phase 4, the budget had the following donors (in order of contribution):

European Union (grant agreement)	Euro	2,300,000.00
United States of America (donation, 2013)	Euro	193,693.34
Kingdom of Morocco (donation)	Euro	104,755.27
Japan (donation)	Euro	94,491.61
Turkey (donation according to quota)	Euro	43,863.40
Tunisia (donation according to quota, 2014)*	Euro	39,397.10
Canada (grant agreement)	Euro	38,108.60
Norway (donation)	Euro	20,000.00
Croatia (donation, 2013)	Euro	18,077.61
Egypt (donation according to quota)*	Euro	3,104.65
Chinese Taipei (donation)	Euro	3,000.00
Korea (donation according to quota, 2013) *	Euro	3,000.00
Iceland (donation according to quota)	Euro	2,508.42
Popular Republic of China (donation according to quota, 2013) *	Euro	1,000.00

*the donation was lower than the amount requested by the ICCAT Secretariat according to the quota.

Further contributions for Phase 4 according to quota were requested to Algeria, Albania, Libya and Syria, but they were never provided to ICCAT GBYP so far. Other CPCs contributed only for one of the two years included in Phase 4. Contributions for previous GBYP Phases are still pending for Korea, Libya and Tunisia.

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.

Several CPCs and entities (USA, Morocco, Japan, Turkey, Canada, Norway, Egypt, Iceland, Korea, China, Tunisia and Chinese Taipei) provided additional funds in 2014 that will be used in Phase 5.

The lack of a stable and reliable multi-year funding system is one of the major problems for GBYP since the beginning of the programme, because this fact prevents a proper planning of all activities and contracts at the beginning of each Phase. The GBYP Steering Committee and the SCRS several times recommended the adoption of a more stable funding system, but all proposals submitted so far by the ICCAT Secretariat or some CPCs to the Commission (i.e.: scientific quota, contribution proportional to quota, etc.) were never approved.

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:

- ✓ Aquastudio Research Institute (EU-Italy), donation in kind of 1 miniPAT, estimated value 3,900 euro (2014).
- ✓ Asociación de Pesca, Comercio y Consumo Responsable de Atún Rojo (EU-Spain): Euro 6,000.00 (for GBYP in Phase 1).
- ✓ Association Marocaine de Madragues (Morocco), donation in kinds of a social dinner in Tangier; estimated value not defined (for the Symposium on Trap Fishery).

- ✓ Carloforte Tonnare PIAMM (EU-Italy), donation in kind of several tunas for biological sampling and tagging; estimated value not defined (Phase 4).
- ✓ COMBIOMA, University of Cagliari EU-Italy), donation in kind for tagging underwater and logistics in Sardinian traps; estimated value not defined (Phase 4).
- ✓ Departement de la Pêche Maritime, DPMA/DPRH (Morocco), Rabat (MO), essential administrative and logistic support for tagging in Moroccan traps in Phase 2, 3 and 4.
- ✓ Federcoopesca, Roma (EU-Italy), donation in kind, providing 5 extra days of a purse-seiner time for tagging; estimated value not defined (Phase 4, 2013).
- ✓ Grup Balfegó (EU-Spain), 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. (EU-Spain): 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, 3 and 4.
- ✓ Hopkins Marine Station of the Stanford University (USA), donation in kind of 7 acoustic tags and 8 miniPATs analysis and logistics in Morocco; estimated value not defined but over 80,000 Euro (Phase 4, 2013 and 2014).
- ✓ Jean-Marc Fromentin, Ph.D., IFREMER (EU-France), a collection of tuna trap data from 1525 to 2000, estimated value not defined (for Data Recovery and Data Mining, Phase 4).
- ✓ Institute National de Recherche Haulieutique, Tangier (Morocco), donation in kinds of logistic support and staff assistance for tagging in Morocco: estimated value to be defined (for GBYP Tagging in Phase 2, 3 and 2014).
- ✓ Instituto Español de Oceanografia, Fuengirola (EU-Spain), donation in kinds of staff assistance for tagging in Morocco: estimated value not defined (for GBYP Tagging in Phase 2).
- ✓ Maromadraba SARL and Es Sahel (Fuentes Group) (Morocco), 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, 3 and in 2014).
- ✓ Mielgo Bregazzi Roberto (EU-Spain), donation in kinds of many millions 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 (Japan), donation of bluefin tuna samples from the central Atlantic fishery: estimated value not defined (for GBYP biological and genetic analyses in Phase 2, 3 and 4).
- ✓ Oceanis srl (EU-Italy), donation in kind for tagging underwater and logistics in Maltese cages and a Sardinian trap; estimated value not defined (Phase 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).
- ✓ GBYP Coordinator, donation of many thousands of old catch data; estimated value not defined (Phases 3 and 4).

13.0 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. The texts of the GBYP pages were revised, improved and updated on August 2013.

14.0 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. The SCRS in 2014 provided the updated recommendations for Phase 5 and future years that were approved by the Commission in November 2014.
In addition, based on the outcomes of all GBYP Phase conducted so far, 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, considering the need of having a sufficient number of years for obtaining the necessary results, a programme revision is necessary, finding the right balance among funding possibilities, research needs and duration. The GBYP funding system shall be better defined, stabilised 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; several data conflicts were resolved, but some others must be revised as soon as possible by the concerned CPCs and national scientists. Market and auction data were partly validated according to the recommendation provided by the SCRS Data Preparatory Meeting in 2014 and made available to scientists as soon as possible (it is necessary to create a new dedicated data-base in ICCAT). Now it seems finally possible to recover genetic data from ancient samples coming from the Marmara Sea, possibly representing the ancient bluefin tuna population which was usually migrating from/to the Black Sea and the analyses of these samples is recommended for possibly solving the uncertainties about this sub-population. If reliable additional data about LL BFT fisheries in the Mediterranean in the last decade, not already included in official task 2 data, will be detected, then these data should be recovered and used for improving our understanding of this fishery.
c) Aerial survey: it is considered essential continuing the survey on spawning aggregations in selected areas, for providing a trend to be used in advanced models; a minimum of 6/7 years of survey is needed; data should be tested for standardisation. It is necessary avoiding as much as possible additional changes in the design of the areas and in the survey strategy, in order to reduce the variability and make data fully comparable. The prediction model using the SST data should be further developed and improved.

d) Tagging: electronic tagging should be strongly improved, while conventional tagging should be carried out taking advantage of the experiences in the first part of Phase 4. In particular, electronic tagging should be carried out in the eastern Mediterranean. The tag awareness activity shall be firmly continued, improving media communication. Tag data analyses shall be one of the first priorities. A new dedicated data base should be developed at the ICCAT Secretarita for including all detailed data coming from electronic tags. A recommendation for mandatory informing ICCAT about all tag release will be very useful and should be considered both by SCRS and the Commission.

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. Ageing calibration exercise shall be continued. The recovery of old ICCAT BYP samples should be defined and protocols should be set for allowing their use.

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.

The major recommendation provided by the Steering Committee, endorsed by the SCRS and approved by the Commission in 2014 was the extension of GBYP up to 2021 and the restructuration of the main activities under new chapters. The revised time table for an extended and revisited ICCAT GBYP programme, according to the research needs identified by the Steering Committee, the minimum number of years needed for obtain trends for fishery independent data and the calendar adopted by the SCRS for the new Modelling approaches is here attached. The first year of the programme (2009) was not included, due to the lack of activity. The fishery independent data shall be collected continuously also in future years, while tagging should be done periodically.

ICCAT GBYP REVISED RESEARCH PROGRAMME

ACTIVITY	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coordination												
Data mining and recovery												
Biological studies												
Aerial survey*												
Tagging activities*												
Fishery independent indices*												
Modelling												
ABFT GBYP Conference												

* Aerial survey and tagging activities have been included under the item "Fishery independent indices" for the next years.

Annex I. List of reports and scientific papers in GBYP Phase 4

List of deliverables produced within the framework of GBYP contracts and activities in Phase 4 (mid-term reports will not be included in the final copies when the final report is available; interim reports cannot be published):

1. Coordination: Mid-term Review – Final report: Mid-term review of the ICCAT Atlantic-wide research Programme on Bluefin Tuna. Fonteneau A., Suzuki Z., Payne A.I.L.: 24 p.
2. Coordination: Steering Committee – ICCAT GBYP Steering Committee Report, Madrid, 28-29 September 2013: 17 p.
3. Coordination: Steering Committee – ICCAT GBYP Steering Committee Report, Madrid, 24 September 2014: 4 p.
4. Data recovery, data mining and data analyses - Report no. 1, 16/12/2013: Historical genetic samples collected in old times in the Eastern Mediterranean Sea, in the Marmara Sea or in the Black Sea, including the genetic analyses of these samples. University of Bologna, 2 p.
5. Data recovery, data mining and data analyses - Report no. 2, 13/05/2014: Historical genetic samples collected in old times in the Eastern Mediterranean Sea, in the Marmara Sea or in the Black Sea, including the genetic analyses of these samples. University of Bologna, 8 p.
6. Data recovery, data mining and data analyses – Extra Report no. 1, 14/07/2014: Successful extraction of high quality tuna DNA from ancient remains: An assessment of quality and quantity using qPCR techniques and Sanger sequencing. University of Bologna, 9 p.
7. Data recovery, data mining and data analyses – Extra Report no. 2, 06/08/2014: Report about the discovery of ancient tuna bones and the mission to Istanbul. University of Bologna, 3 p.
8. Data recovery, data mining and data analyses – Final Report, 27/01/2015: Historical genetic samples collected in old times in the Eastern Mediterranean Sea, in the Marmara Sea or in the Black Sea, including the genetic analyses of these samples. University of Bologna, 22 p.
9. Data recovery, data mining and data analyses - Trade, Auction and market data: Report, 24/04/2014: Weight/Size structure of Atlantic Bluefin Tuna fished and/or ranched in the Mediterranean and Northeast Atlantic during the period 1995 to 2014 as revealed by trade, market & corporate biometric data. Mielgo-Bregazzi R., 42 p. + various annexes.
10. Aerial survey on spawning aggregations – Report, 19/04/2013: Short-term contract for the aerial survey design of the Atlantic-wide Research Programme for Bluefin Tuna (ICCAT-GBYP Phase 4 - 2013). Alnilam S.A., Madrid, 21+26+20 p.
11. Aerial survey on spawning aggregations – Report, July 2013: ICCAT Bluefin tuna aerial survey 2013, Final report of surveys carried out in Block A (GBYP sub-area). Grup Air Med (Spain), 34 p. + various annexes.
12. Aerial survey on spawning aggregations – Report, July 2013: Bluefin tuna aerial survey GBYP 03/2013 Research Programme, Area B. Air Périgord and Action Communication (France), 15 p.
13. Aerial survey on spawning aggregations – Report, 2 August 2013: Aerial survey on spawning aggregations, Atlantic-wide Research Programme for Bluefin Tuna. Final report, sub-areas C, D and F. UNIMAR (Italy), 36 p. + various annexes.
14. Aerial survey on spawning aggregations – Report, 12 July 2013: GBYP 2013 Atlantic-wide Research Programme for Bluefin Tuna, Area E, Italian FIR only. Final Report. Air Périgord and Action Communication (France), 15 p. + various annexes.

15. Aerial survey on spawning aggregations – Report, August 2013: Atlantic-wide Research Programme for Bluefin Tuna. Final report Area E. Périgord Travail Aérienne (France), 22 p. + various annexes.

16. Aerial survey on spawning aggregations – Report, 2 August 2013: Atlantic-wide Research Programme for Bluefin Tuna. Prospeccion aérienne de concentration de *Thunnus thynnus*. Rapport final de mission, zone G. Périgord Travail Aérienne (France), 52 p. + various annexes.

17. Aerial survey on spawning aggregations – Report, 13 September 2013: Elaboration of 2013 data from the aerial survey on spawning aggregations. Final report. Alnilam S.A. (Spain), 33 p. + various annexes.

18. Aerial survey on spawning aggregations – Tentative SWOT analysis for the calibration of ICCAT GBYP aerial survey. Presented to the GBYP Steering Committee. A. Di Natale, 10 February 2015: 1-11.

19. Aerial survey on spawning aggregations – Further elaboration of the data From the aerial survey on spawning aggregations of the Atlantic-wide Research Programme on Bluefin Tuna (ICCAT GBYP – Phase 4), requested by the GBYP Steering Committee. Alnilam Investigaciones S.A., February 20, 2014, 8 p.

20. Biological Studies: Meetings – Report of the 2013 Bluefin tuna meeting on biological parameters. Tenerife, Spain, May 7 to 13, 2013: 75 p.

21. Biological Studies – 30 April 2014: Short-term contract for the biological and genetic sampling and analyses (ICCAT GBYP 02/2013) within the GBYP (Phase 4). Updated preliminary report. AZTI on behalf of the Consortium, 42 p.

22. Biological Studies – 15 September 2014: Rodríguez-Marín E., Di Natale A., Quelle P., Ruiz M., Allman R., Bellodi A., Busawon D., Farley J., Garibaldi F., Ishihara T., Koob E., Lanteri L., Luque P.L., Marcone A., Megalofonou P., Milatou N., Pacicco A., Russo E., Sardenne F., Stagioni M., Tserpes G., Vittori S., Report on the age calibration exchange within the Atlantic-wide Research Programme for Bluefin Tuna (ICCAT GBYP): 19 p.

23. Biological Studies – 15 September 2014: Short-term contract for the biological and genetic sampling and analyses (ICCAT GBYP 02/2013) within the GBYP (Phase 4). Final Report. Coord. H. Arrizabalaga, AZTI on behalf of the Consortium, 86 p.

24. Biological Studies – 9 September 2014: Short-time contract for the biological sampling: Collection of BFT YOY samples within the framework of the Atlantic-wide research programme for bluefin tuna (ICCAT GBYP – Phase 4 – 03b/2014). Final Report, Dr. Massimiliano Valastro: 9 p.

25. Biological Studies – 4 December 2014: Short-time contract for the biological sampling: Collection of BFT YOY samples within the framework of the Atlantic-wide research programme for bluefin tuna (ICCAT GBYP – Phase 4 – 03a/2014). Final Report, AZTI: 8 p.

26. Tagging programme – Report, 30 July 2013: Marquage conventionnel et marquage électronique de thons rouges adultes dans des madragues situées dans l'océan Atlantique Est, dans les eaux marocaines. Rapport Final Révisée. INRH, Maromadraba (Morocco), WWF-MedPO, 32 p. + various annexes.

27. Tagging programme – Report, 19 July 2013: Task E, Conventional tagging of adult bluefin tunas in traps in the Mediterranean Seas, Sardinian waters, Final report. COMBIOMA, Compagnia Tonnare Sardegna, Carloforte Tonnare PIAM (Italy), 39 p. + various annexes.

28. Tagging programme – Report, December 2013: Conventional tagging of juvenile and/or adult bluefin tunas by purse-seiners in the Tyrrhenian Sea, Final report. UNIMAR on behalf of the Consortium (Italy), 33 p. + various annexes.

29. Tagging programme – Report, 5 February 2014: Tagging Programme 2013, Objective C, TAGAT, Tagging of Adriatic Tunas, Final Report. KALITUNA D.o.o. (Croatia), 32 p. + various annexes.

30. Tagging programme – Report, 10 February 2014: final report on the activities led in the framework of the ICCAT/GBYP Phase 4 Tagging Program – Objective A. AZTI on behalf of the Consortium (Spain), 17 p. + various annexes.

31. Tagging programme (complimentary activities) – Report, 16 April 2014: Tagging experimental activity of bluefin tuna individuals using the original applicator (SMAT) and biometric tracking through a synchronized underwater video recording system in Malta. Final report. Oceanis srl (Italy) and Fish and Fish Ltd (Malta), 24 p. + various annexes.

32. Tag awareness programme – Interim progress report, 15 July 2014: ICCAT GBYP 01/2014, Field tag awareness activities. COFREPECHE on behalf of the Consortium: 9 p.

33. Tag awareness programme – Final report, 15 September 2014: ICCAT GBYP 01/2014, Field tag awareness activities. COFREPECHE on behalf of the Consortium: 124 p.

34. Modelling approaches – Report of the 2013 Meeting on bluefin tuna stock assessment methods. Glouchester, MA, USA, July 20 to 22, 2013: 11 p.

35. Modelling approaches – Final report, 15 January 2014: Report for ICCAT GBYP 04/2013. Etienne M.P., Carruthers T., McAllister M. (France, Canada), 36 p.

36. Modelling approaches – Final report, Specifying and weighting scenarios for MSE robustness trials. Levontin P., Leach A.W., Holt J., Mumford J.D. (UK), 22 p.

37. Modelling approaches – Interim report, 6 June 2014: BFT MSE Program Review. Davies C. (Australia), 3 p.

38. Modelling approaches – Interim report, 1 July 2014: Notes from ABT MSE Initial Planning Meeting. Davies C. (Australia), 2 p.

39. Modelling approaches – Interim report, 22 July 2014: BFT MSE Core Modelling Group. Davies C. (Australia), 2 p.

40. Modelling approaches – Interim report, 31 July 2014: Summary Work Programme. Davies C. (Australia), 2 p.

41. Modelling approaches – Evaluating management strategies for Atlantic bluefin tuna. PPT. December 5, 2014. Tom Carruthers, 33 p.

42. Modelling approaches – Final report, 05/02/2015. Report of the first GBYP Core Modelling Group. Davies C. (including the deliverable from Tom Carruthers).

43. SCI-APP.5-2013 – Anonimous, ICCAT Atlantic-wide research programme for bluefin tuna (GBYP), Activity Report for 2013 (extension of Phase 3 and first part of Phase 4). 5 p.

44. SCI-APP.5-2014 – Anonimous, ICCAT Atlantic-wide research programme for bluefin tuna (GBYP), Activity Report for the first part of Phase 4 (2013-2014). 11 p.

List of Scientific Papers – Phase 4

1. Anonymous, 2014, Report of the 2013 Bluefin tuna meeting on biological parameters. Tenerife, Spain, May 7 to 13, 2013, SCRS/2013/014, Collect. Vol. Sci. Pap ICCAT: 70(1): 1-159.
2. Anonymous, 2014, Report of the Bluefin tuna stock assessment methods meeting. Gloucester, USA, July 20 to 22, 2013, SCRS/2013/018, Collect. Vol. Sci. Pap ICCAT: 70(1): 160-189.

3. Di Natale A., Idrissi M., Justel Rubio A. , 2014a, Bluefin catch and size historical data recovered under the Atlantic-wide research programme for bluefin tuna (ICCAT-GBYP phases 1 - 3). SCRS/2013/073, Collect. Vol. Sci. Pap. ICCAT, 70(1): 241-248.
4. Di Natale A., Idrissi M., Justel Rubio A., 2014b, ICCAT-GBYP activities for improving knowledge on bluefin tuna biological and behavioural aspects. SCRS/2013/074, Collect. Vol. Sci. Pap. ICCAT, 70(1): 249-270.
5. Fonteneau A., 2014, On the potential use of size measurements by observers in the farm for the estimation of Mediterranean BFT Catch at size. SCRS/2013/076 , Collect. Vol. Sci. Pap. ICCAT, 70(1): 284-288.
6. Justel-Rubio A., Ortiz M., Parrilla A., Idrissi M., Di Natale A., 2014, Preliminary review of ICCAT bluefin tuna conventional tagging database. SCRS/2013/078, Collect. Vol. Sci. Pap. ICCAT, 70(2): 299-320.
7. SCRS/2013/079 - Biometric relationships and condition of Atlantic bluefin tuna (*Thunnus thynnus*) from the North-East Atlantic and Mediterranean Sea. Rodriguez-Marin E., et al. (presented but not published).
8. Rodriguez-Marin E., Luque P.L., Quelle P., Ruiz M., Perez B., Macias D., Karakulak S., 2014, Age determination analyses of Atlantic bluefin tuna (*Thunnus thynnus*) within the Biological and Genetic Sampling and Analysis Contract (GBYP). SCRS/2013/080, Collect. Vol. Sci. Pap. ICCAT, 70(2): 221-231.
9. SCRS/2013/081 - An attempt of validation of the Atlantic bluefin tuna age using dorsal fin spines. Rodriguez-Marin E., et al. (presented but not published).
10. Ortiz M., Justel Rubio A., Gallego J.L., 2014, Review and preliminary analyses of farm harvested size frequency samples of eastern bluefin tuna (*Thunnus thynnus*). SCRS/2013/083, Collect. Vol. Sci. Pap. ICCAT, 70(2): 338-356.
11. SCRS/2013/089 - Origin of Atlantic bluefin tuna in the Atlantic Ocean and Mediterranean Sea using d13C and d18O in otoliths. Rooker J., Fraile I., Arrizabalaga H. , Kimoto A., Sakai O. , Abid N., Neves M. , Karakulak S. , Macías D. , Addis P. , Deguara S., Tinti F. (presented but not published).
12. SCRS/2013/090 - First Results on reproduction of East Atlantic bluefin tuna out of GBYP-MUBI phase 3 Project. Macías D., Murua H., Gómez-Vives M.J. , Saber S. , Fraile I. ,Addis P. , Medina A. , Rodríguez-Marín E. , Arrizabalaga H. (presented as PPT but not submitted).
13. Mariani A., Dell'Aquila M., Scardi M., Costa C., 2014, Feasibility study to assess the utilization of stereo-video systems during transfer of Atlantic bluefin tunas (*Thunnus thynnus*) to evaluate their number and size. SCRS/2013/096, Collect. Vol. Sci. Pap. ICCAT, 70(2): 401-421.
14. Di Natale A., 2014, Iconography of tuna traps: the discovery of the possible oldest printed image of a tuna trap. SCRS/2013/140, Collect. Vol. Sci. Pap. ICCAT, 70(6): 2820-2827.
15. Di Natale A., 2014, The ancient distribution of tuna fishery: how coins can improve our knowledge. SCRS/2013/141, Collect. Vol. Sci. Pap. ICCAT, 70(6): 2828-2844.
16. Örenc A.F., Ünver M., Düzcü L., Di Natale A., 2014, Tentative bluefin tuna data recovery from the Ottoman Archives, the Maritime Museum Archives and the Archives of the Istanbul Municipality. SCRS/2013/143, Collect. Vol. Sci. Pap. ICCAT, 70(2): 447-458.
17. Di Natale A., Idrissi M., Justel Rubio A., 2014, ICCAT Atlantic-wide Research Programme for Bluefin Tuna 2013. (GBYP). Activity report for 2013 (extension of Phase 3 and first part of Phase 4). SCRS/2013/144, Collect. Vol. Sci. Pap. ICCAT, 70(2): 459-498.

18. Justel-Rubio A., Ortiz M., Palma C., Gallego J.L., Di Natale A., Idrissi M., 2014. Preliminary Evaluation of the Total Catch Removals Eastern Bluefin tuna. A comparison of the GBYP and ICCAT Task I databases. SCRS/2013/169, Collect. Vol. Sci. Pap. ICCAT, 70(2): 518-536.
19. de la Serna J.M., Godoy D., Belda E., Sanchez R., Majuelos E., 2014, Análisis de los resultados de la campaña de marcado de atún rojo (*Thunnus thynnus*) del "Tagging GBYP-ICCAT 4ª Fase" realizada en el Estrecho de Gibraltar durante 2012. SCRS/2013/172, Collect. Vol. Sci. Pap. ICCAT, 70(2): 537-542.
20. Di Natale A., Idrissi M., Justel Rubio A., 2014, ICCAT-GBYP Tag Recovery Activities (up to September 2013). SCRS/2013/177, Collect. Vol. Sci. Pap. ICCAT, 70(2): 299-320.
21. Fonteneau A., Suzuki Z., Payne A.I.L., 2014, Mid-term review of the ICCAT Atlantic-wide research Programme on Bluefin Tuna. SCRS/2013/178, Collect. Vol. Sci. Pap. ICCAT, 70(2): 565-584.
22. Addis P., Secci M., Sabatini A., Palmas F., Culurgioni J., Pasquini V., Cau A., 2014, Conventional tagging of bluefin tunas in the trap fishery of Sardinia (W-Mediterranean): a critical review. SCRS/2013/180, Collect. Vol. Sci. Pap. ICCAT, 70(2): 585-591.
23. Abid N., Talbaoui M., Benchoucha S., El Arraf S., El Fanichi C., Quílez-Badia G., Tudela S., Rodríguez López N. A., Cermeño P., Shillinger G., Benmoussa K., Benbari S., 2014, Tagging of Bluefin tuna in the Moroccan Atlantic trap "Essahel" in 2013: Methodoly and preliminary results. SCRS/2013/196, Collect. Vol. Sci. Pap. ICCAT, 70(2): 663-672.
24. SCRS/2014/020 - Identification of the major sensitivities in the East Atlantic and Mediterranean bluefin assessment. Kell L.T.
25. SCRS/2014/025 - Which Came First? The Chicken, The Egg or The Tortilla? Kell L.T., Jean-Marc Fromentin J.M., Szuwalski C.S.
26. SCRS/2014/036 - Evaluation Of Model Free Harvest Control Rules. An Example North Atlantic Bluefin Tuna Management Strategy. Kell L.T., Hillary R., Fromentin J.M., Bonhommeau S.
27. SCRS/2014/038 - Evaluation of an Atlantic bluefin tuna otoliths reference collection. Busawon D.S., Rodriguez-Marin E., Lastra Luque P., Allman R., Gahagan B., Golet W., Koob E., Siskey M., Ruiz Sobrón M., Quelle P., Neilson J., Secor D.H.
28. SCRS/2014/040 - Review and analyses of farm harvested size frequencies frequency samples of eastern bluefin tuna (*Thunnus thunnus*). Ortiz M., Justel-Rubio A., Gallego J.L.
29. SCRS/2014/042 - Weight/Size structure of Atlantic Bluefin Tuna fished and/or ranched in the Mediterranean and Northeast Atlantic during the period 1995 to 2014 as revealed by trade, market & corporate biometric data. Mielgo-Bregazzi R., 42 p.
30. SCRS/2014/047 - Review of the historical and biological evidences about a population of bluefin tuna (*Thunnus thynnus* L.) in the eastern Mediterranean and the Black Sea. Di Natale A., 26 p.
31. SCRS/2014/048 - Di Natale A., Idrissi M., Review of the GBYP tagging activities. 18 p.
32. SCRS/2014/050 - An unknown bluefin tuna fishery and industry in Tenerife (Canary Islands, Spain) in the early XX century: the Florio's enterprise. Di Natale A., 22 p.
33. SCRS/2014/051 - ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP), Activity Report for the first part of Phase 4 (2013-2014), Di Natale A., 50 p.

34. SCRS/2014/052 - Review of bluefin tuna, *Thunnus thynnus* (L.), catches made by the Spanish baitboat fleet in the Bay of Biscay during the 20th century, Cort J.L., Artetxe I., Santiago J.
35. SCRS/2014/053 - Length and weight relationships for Atlantic Bluefin tuna (*Thunnus thynnus*). Enrique Rodríguez-Marín E., Ortiz de Urbina J.M., Abid N., Alot E., Andrushchenko I., Deguara S., Di Natale A., Gatt M., Golet W., Karakulak S., Kimoto A., Macias D., Quelle P., Saber S., Miguel N. Nieves dos Santos M., Walter J., Zarrad R., 19 p.
36. SCRS/2014/101 - Specifying and weighting scenarios for MSE robustness trials. Levontin P., Leach A.W., Holt J., Mumford J.D., 22 p.
37. SCRS/2014/102 - Match and mismatch: a few thoughts about the available bluefin prediction models for the Mediterranean area. Di Natale A.
38. SCRS/2014/115 - Kell L.T., Bonhommeau S., Simple Catch-At-Age and Size Analyses For Atlantic Bluefin.
39. SCRS/2014/136 - de la Serna J.M., Godoy D., Belda E., El Arraf S., Majuelos E., Sanchez R., Mengual J., Saber S., Muñoz P., Campaña de marcado convencional y electrónico de atún rojo realizada en el Estrecho de Gibraltar según el diseño adoptado por el programa de investigación GBYP-ICCAT y desarrollado en el "Tagging GBYP-ICCAT 4ª Fase, 2013". 9 p.
40. SCRS/2014/130 – Cozzolino G., Pignalosa P., Lombardo F., Bluefin tuna (*Thunnus thynnus*) experimental tagging activity by new applicator (SMAT) and biometric data survey by a synchronised scuba-video tape system. Malata Channel – Portoscuso, Sardinia. 27 p.
41. SCRS/2014/141 – Ortiz M., Preliminary review of bluefin tuna (*Thunnus thynnus*) size and weight measure taken with stereo video cameras at caging operations in the Mediterranean Sea in 2014. 10 p.
42. SCRS/2014/142 - Di Natale A., Report on the use of Research Mortality Allowance by ICCAT GBYP in 2012, 2013 and 2014.
43. SCRS/2014/150 - Rodríguez-Marín E., Di Natale A., Quelle P., Ruiz M., Allman R., Bellodi A., Busawon D., Farley J., Garibaldi F., Ishihara T., Koob E., Lanteri L., Luque P.L., Marcone A., Megalofonou P., Milatou N., Pacicco A., Russo E., Sardenne F., Stagioni M., Tserpes G., Vittori S., Report on the age calibration exchange within the Atlantic-wide Research Programme for Bluefin Tuna (ICCAT GBYP): 20 p.
44. SCRS/2014/151, Cort J., Estruch V., Di Natale A., Abid N., De la Serna J.M., Una relación talla-peso estacional para el atún rojo, Thunnus thynnus (L.), del Atlántico oriental y Mediterráneo. 30 p.
45. SCRS/2014/154 – Garibaldi F., Bluefin tuna (Thunnus thynnus) size composition in the western Ligurian Sea (Western Mediterranean) for the period 1990-2013. 5 p.
46. SCRS/2014/166 - Vanderlaan A.S.M.., Jech J.M., Weber T.C., Rzhanov Y., Lutcavage M.E., Direct assessment of juvenile bluefin tuna: integrating sonar and aerial survey results in support of fishery-independent surveys. 9 p.
47. SCRS/2014/167 – Puncher G.N., Onar V., Yaşar Toker N., Tinti F., A multitude of Byzantine era bluefin tuna and swordfish bones uncovered in Istambul, Turkey. 6 p.
48. SCRS/2014/184 - Quílez-Badia G., Ospina-Alvarez A., Sainz Trápaga S., Di Natale A., Abid N., Cermeño P., Tudela S., The WWF/GBYP multi-annual bluefin tuna electronic tagging programme (2008-2013): repercussions for management. 17 p.
49. SCRS/2014/189 - Mariani A., Dell'Aquila M., Valastro M., Buzzi A., Scardi M., Conventional tagging of adult bluefin tunas (*Thunnus thynnus*) by purse-seiners in the Mediterranean. Methodological notes. 12 p.

50. SCRS/2014/194 – ICCAT GBYP Steering Committee, Time to plan for the future of GBYP. 11 p.
51. Anonymous, 2014, ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP), Activity Report for 2013 (last part of Phase 3 and first part of Phase 4). ICCAT Report for the biennial period 2012-2013, part II (2013), Vol. 2, Appendix 5: 293-298.
52. Rooker J.R., Arrizabalaga H., Fraile I., Secor D.H., Dettman D.L., Abid N., Addis P., Deguara S., Karakulak S.F., Kimoto A., Sakai O., Macías M., Neves dos Santos M., 2014, Crossing the line: migratory and homing behaviors of Atlantic bluefin tuna. Marine Ecology Progress Series, 504: 265-276.
53. Leach, A.W., Levontin, P., Kell L.T., Holt, J., Mumford, J.D., in press, Identification and prioritization of uncertainties for management of Eastern Atlantic Bluefin Tuna (*Thunnus thynnus*). Marine Policy.
54. Fraile I., Arrizabalaga H., Rooker J.R., 2014, Origin of Atlantic bluefin tuna (*Thunnus thynnus*) in the Bay of Biscay**.** ICES Journal of Marine Science; doi:10.1093/icesjms/fsu156.
55. Fraile I., Arrizabalaga H., Koelling M., Groeneveld J., Deguara S., Neves Santos M., Macías D., Addis P., Karakulak S., Dettman D.L., Rooker J.R., in press, The imprint of anthropogenic CO2 emissions in Atlantic bluefin tuna otoliths. Submitted to: Global and Planetary Changes: 23 p.
56. Cort J., Estruch V., Di Natale A., Abid N., De la Serna J.M., Neves dos Santos M., in press, On the variability of the length-weight relationship for Atlantic bluefin tuna, *Thunnus thynnus* (L.). Fishery Science & Aquaculture, 2015, 45 p.
57. Quílez-Badia G., Ospina-Alvarez A., Sainz Trápaga S., Di Natale A., Abid N., Tudela S., in press, even consecutive years of electronic tagging on Bluefin tuna in the East Atlantic and Mediterranean: New clues on habitat use, migratory behavior and population structure. Ecology Letters (2015), 30 p.
58. Puncher G.N., Cilli E., Morales A., Onar V., Massari F., Cariani A., Tinti F., in press, Rediscovering our relationship with the sea: Unlocking the evolutionary history of the mighty bluefin tuna using novel paleogenetic techniques and ancient tuna remains. Mares Conference, Olão (Portugal), November 2014.

Annex II: GBYP contracts issued in Phase 4.

ICCAT GBYP CONTRACTS AND MEETINGS (PHASE 4)

ICCAT GBYP COODINATION

PHASE	YEAR	BUDGET €	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule		COST €	DELIVERABLES		
						initial date	final date		REPORT	SCRS PAPERS	OTHERS
4	2013-2014	30.000,00	direct contract	*ICCAT GBYP Steering Committee - External Member*	Ph.D. Tom Polacheck, e-mail: runningtide.tom@gmail.com	21/03/2013	09/12/2014	30.000,00			X

ICCAT GBYP DATA RECOVERY

PHASE	YEAR	BUDGET €	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule		COST €	DELIVERABLES		
						initial date	final date		REPORT	SCRS PAPERS	OTHERS
4	2013 - 2014	20.000,00	06/2013	*Data recovery - Genetic analyses of ancient bones* - Dep. Biol.Geol., Genet. Env. Sc. - University of Bologna - Italy	Fausto Tinti, e-mail: fausto.tinti@unibo.it	22/10/2013	10/09/2014	13.000,00	1		
		50.000,00	direct contract	*Validation and Analyses of Trade, Auction and Market data provided to GBYP* - Roberto Mielgo Bregazzi - Spain	Robetrto Mielgo Bregazzi e-mail: robertomielgo1@telefonica.net	11/11/2013	05/05/2014	27.250,00	1	1	data on excel files

ICCAT GBYP AERIAL SURVEY

PHASE	YEAR	BUDGET €	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule		COST €	DELIVERABLES		
						initial date	final date		REPORT	SCRS PAPERS	OTHERS
4	2013 - 2015	9.000,00	direct contract	Aerial Survey Extended Design- Alnilam Investigación y Conservación SA - Spain	Ana Cañadas, e-mail: anacanadas@alnilam.conm.es	10/04/2013	25/04/2013	9,000.00	1		
		19.000,00		*GBYP Aerial Survey Training Course* - ICCAT	Antonio Di Natale e-mail: antonio.dinatale@iccat.int		04/06/2013	11,708,06	1		
		460000,00	03/2013	*Aerial Survey on Spawning Aggregations - Sub-area A* - Grup Air Med - Spain	Javier Hevia, e-mail: javier@grupairmed.com	17/05/2013	02/08/2013	73,625.00	1		data on excel file
			03/2013	*Aerial Survey on Spawning Aggregations - Sub-areas E and G* - Périgord Travail Aerién - France (+1 subcontract to France)	Christian Gonzaléz, e-mail: christiangonzalez@aliceadsl.fr	17/05/2013	02/08/2013	245.718,25	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)	Adriano Mariani, e-mail: unimar@unimar.it or mariani.a@unimar.it	17/05/2013	02/08/2013	124,915.00	1		data on excel file
			03/2013	*Aerial Survey on Spawning Aggregations - Sub-area B* - Action Communication SARL - France	Alexis Giordana, e-mail: ag@actionair-environnement.com	17/05/2013	02/08/2013	47,460.00	1		data on excel file
		10.000,00	direct contract	*Aerial Survey Data Analyses - Alnilam Investigación y Conservación SA - Spain*	Ana Cañadas, e-mail: anacanadas@alnilam.conm.es	14/08/2013	20/09/2013	6,000.00	1		data on excel files
			direct contract	*Aerial Survey Further Data Analyses - Alnilam Investigación y Conservación SA - Spain*	Ana Cañadas, e-mail: anacanadas@alnilam.conm.es	16/02/201	20/09/2013	1,915,00	1		data on excel files

ICCAT GBYP TAGGING PROGRAMME

PHASE	YEAR	BUDGET €	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule		COST €	DELIVERABLES		
						initial date	final date		REPORT	SCRS PAPERS	OTHERS
4	2013 - 2014	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)*	Nicolas Goñi, e-mail: ngoni@azti.es	20/06/2013	23/12/2013	500,000.00	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)*	Adriano Mariani, e-mail: unimar@unimar.it or mariani.a@unimar.it	19/04/2013	23/12/2013	148,450.00	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)*	Neven Cinoti, e-mail: neven.cinoti@kali-tuna.hr	19/04/2013	23/12/2013	92,135.00	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*	Pierantonio Addis, e-mail: addisp@unica.it	19/04/2013	23/12/2013	90,000.00	1		data on excel file
			01/2013	*GBYP Tagging Programme 2013, tagging adults in tuna traps in Atlantic Morocco - Institut National de Recherche Haulieutique - Morocco, as leader of a Consortium including 3 Moroccan Institutions*	Noureddine Abid, e-mail: noureddine.abid65@gmail.com	19/04/2013	23/12/2013	127,812.00	1		data on excel file

ICCAT GBYP BIOLOGICAL SAMPLING AND ANALYSES

PHASE	YEAR	BUDGET €	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule		COST €	DELIVERABLES		
						initial date	final date		REPORT	SCRS PAPERS	OTHERS
4	2013 - 2014	365000,00	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)	Haritz Arrizabalaga, e-mail: harri@azti.es	21/10/2013	12/09/2014	356.942,86	3	1	data on excel files
			03a/2014	Collection of YOY BF samples	AZT - Haritz Arrizabalaga, e-mail: harri@☼azti.es	06/10/2014	05/12/2014	11.000,00	1		samples
			03b/2014	Collection of YOY samples	Massimiliano Valastro, e-mail: bubuval@hotmail.com	06/10/2014	05/12/2014	4.000,00	1		samples

ICCAT GBYP MODELLING APPROACHES

PHASE	YEAR	BUDGET €	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule		COST €	DELIVERABLES		
						initial date	final date		REPORT	SCRS PAPERS	OTHERS
1	2010	0	-	-				0			
4	2013-2014	20.000,00	04/2013	Quantitative *Risk Assessment - Support to BFT Stock Assessment* - Imperial College Consultants Ltd - UK	John Mumford, e-mail: j.mumford@imperial.ac.uk	24/05/2013	13/12/2013	18,600.00	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	Prof. Murdoch McAllister, e-mail: m.mcallister@fisheries.ubc.ca	24/07/2013	13/12/2013	9,500.00	1	1	
			04/2013	Development of Biological Hypotheses for the Use within MSE (no bids have been submitted)	-			-			
		25.000,00		GBYP Core Modelling Group Meeting	Antonio Di Natale e-mail: antonio.dinatale@iccat.int	December 2014		14.339,00	1		
		30.000,00	01/2014	*Support to BFT Assessment (Coordinator)* - CSIRO - Australia	Ph.D. Campbell Davies, e-mail: campbell.davies@csiro.au	24/03/2014	20/02/2015	20.150,00	2	2	
		50.000,00	02/2014	*Support to BFT Assessment* - Dr. Tom Carruthers - Canada	Thomas Robert Carruthers, e-mail: t.carruthers@fisheries.ubc.ca	23/06/2014	20/02/2105	42.984,00	1	1	

ICCAT GBYP MID-TERM REVIEW

PHASE	YEAR	BUDGET €	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule		COST €	DELIVERABLES		
						initial date	final date		REPORT	SCRS PAPERS	OTHERS
4	2013	50,000.00	05/2013	*Mid-Term Review - Andrew Payne, PhD*	Andrew Payne, e-mail: j.mumford@imperial.ac.uk	05/08/2013	15/09/2013	16.500,00	1	1	
				Mid-term Review, Alain Fonteneau, PhD	Alain Fonteneau, e-mail: alain.fonteneau@ird.fr	06/08/2013	15/09/2013	11.500,00			
				Mid-term Review, Ziro Suzuki, PhD	Ziro Suzuki, e-mail: zsuzuki@affrc.go.jp	06/08/2013	15/09/2013	16.000,00			

Annex III: List of meetings and activities attended by GBYP

No.	date	place	Meeting or activity	Motivation
1	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
2	7-13/05/2013	Tenerife (SP)	SCRS - 2013 BFT Meeting on biological parameters review	Presentation of all the ICCAT-GBYP data sets (Phases 1 to 3 / 2010-2012)
3	13-16/05/2013	Tenerife (SP)	SCRS - Meeting on GBYP Modelling Approaches	Supervision of the meeting for preliminary draft of the GBYP modelling future plans
4	17-20/05/2013	Larache (MO)	2013 BFT Conventional & electronic tagging (Phase 4)	Delivery of all tagging equipment and supervising of the electronic tagging
5	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.
6	10-22/07/2013	Gloucester (USA)	SCRS - 2013 Meeting on Bluefin Tuna stocks assessment methods	Supervision of the work to be done for ICCAT-GBYP modelling (Phases 4 and on)
7	13-15/09/2013	Isla Cristina (SP)	2013 Meeting of Tuna Trap Captains	Presentation of GBYP research activities. (nop)
8	23-24/09/2013	Madrid (SP)	SCRS Sub-Committee on Statistics	GBYP data recovery issues
9	15-27/09/2013	Madrid (SP)	SCRS BFT Species Group	Overview of the GBYP activities, historical data, tags and other BFT subjects
10	28-29/09/2013	Madrid (SP)	GBYP SC meeting	Presentation of the GBYP activities and plans in Phase 4 and plan for Phase 5
11	30/09-4/10/2013	Madrid (SP)	SCRS Plenary	Presentation of the GBYP activities and plans
12	5-7/10/2013	Favignana (IT)	Settimana delle Egadi, Tonni e Tonnare	Presentation of the GBYP data recovery activity on tuna traps. (nop)
13	18-25/11/2013	Cape Town (SA)	23rd Regular Meeting of the Commission	
14	12/03/2014	Sevilla (SP)	Las almadrabas y el atún rojo en un contexto de crisis. Universidad de Sevilla.	Seminar about the history of tuna traps. (nop)
15	5-10/05/2014	Madrid (SP)	SCRS – BFT Data Preparatory Meeting	Presentation of GBYP tagging activities and scientific papers
16	12-13/09/2014	Isla Cristina (SP)	2014 (XIII) Meeting of Tuna Trap Captains	Review of literature about tuna traps (nop)
17	22-26/09/2014	Madrid (SP)	SCRS BFT Species Group	Overview of the GBYP activities, other BFT subjects
18	29/09-03/10/2014	Madrid (SP)	SCRS Plenary	Overview of the GBYP activities
19	10-17/10/2014	Genova (IT)	19th Special Meeting of the Commission	Overview of the GBYP activities

NOTE: nop = non official participation; the meeting was attended on personal behalf and without costs for the programme.

Table 1. Total data recovered by GBYP in Phase 1, Phase 2, Phase 3 and the first part of Phase 4. The additional trap data provided in Phase 4 are still to be checked and were not included.

TOTAL PHASES 1 to 4	origin	1st Total	Total data
# Records	OG	87,761	509,620
	TP	30,923	
	TAMD	311,415	
	FARM	49,354	
	GEN	172	
	DTBV	29,995	
BFT (no.)	OG	34,753	26,377,340
	TP	23,247,666	
	TAMD	825,485	
	FARM	49,354	
	GEN	172	
	DTBV	2,219,910	
BFT (t)	OG	114,596	1,191,312
	TP	744,227	
	TAMD	80,408	
	FARM	474	
	DTBV	251,607	
#Fish sampled	OG	94,932	3,197,443
	TP	7,610	
	TAMD	825,485	
	FARM	49,354	
	GEN	152	
	DTBV	2,219,910	
Legenda: OG = Other Gears; TP = Trap; TAMD = Trade, Auction nd Market Data; FARM = Farmed tunas; GEN= Genetic; DTBV = Data To Be Validated			
Note: TAMD data include 29,995 records, 2,219,910 bft (no.) and 251,607 t to be further checked and validated.			

Table 2. Total data recovered by GBYP in Phase 1, Phase 2, Phase 3 and the first part of Phase 4 by century (<1500-1900) and by decade (1900 onwards) (TP = Traps; OG = Other gears; TAMD* = Trade, Auction and Market data, provisional; FARM = data provided by farms; GEN = Historical genetic samples; DTBV = trade, auction and marked data to be further validated).

	year	<1500	1500	1600	1700	1800	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	TBA	DTBV
# Records	OG						9	10	87	11.509	15.616	29.992	17.946	6.201	1.781	1.174	3.210	236		
	TP		252	171	211	6.100	3.005	4.353	6.705	2.301	1.021	1.040	2.032	184	777	1.221	1.548		3	3
	TAMD*																		311.415	
	FARM															851	18.492	30.021		
	HGEN	20						60	60		2				30					
	DTBV																			28.170
BFT (no.)	OG													107	70	9.937	21.559	3.080		
	TP		3.978.087	1.292.782	425.335	4.472.749	1.613.889	1.883.967	2.971.129	2.013.583	1.787.209	1.566.956	614.611	51.510	178.743	204.806	186.199		6.111	6.111
	TAMD*																		825.485	
	FARM															851	18.492	30.021		
	HGEN	20						60	60		2				30					
	DTBV																			2.219.910
BFT (t)	OG						44	163	601	2.497	6.057	29.059	14.842	24.461	17.880	17.086	1.704	203		
	TP					141.907	40.327	70.723	75.579	83.592	86.204	111.417	71.842	11.981	8.755	19.568	15.306	711		
	TAMD*																		80.408	
	FARM															207	268			
	DTBV																			251.607
#Fish sampled	OG											18.614	18.548	9.053	804	18.569	28.000	1.344		
	TP							153	170							2.225	5.062			
	TAMD*																		825.485	
	FARM															851	18.492	30.021		
	HGEN	20						60	60		2				10					
	DTBV																			2.219.910

Table 3. Comparison of main aerial survey 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		
Sub-area	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^{-2})	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 - Frequency distribution of perpendicular distances from the transect line for all aircrafts. Blue = with flat windows, orange = with bubble window

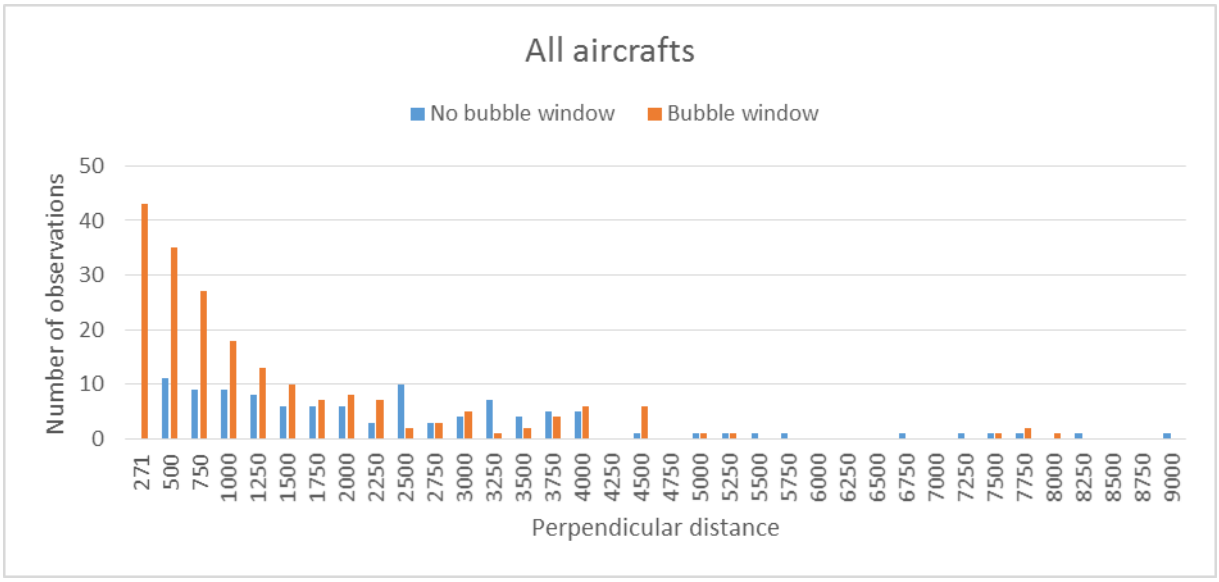


Table 6 – Details on the number of Bluefin tuna tagged with various types of tags in Phase 4 and on the number of the various types of tags implanted in the various areas.

	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.
Canada	6	0	1	0	0	0	0	5	0	0	0	0	0
Bay of Biscay	3009	1403	0	0	0	0	1599	7	0	0	0	0	0
Morocco*	273	129	0	7	0	0	121	8	0	7	0	0	1
Portugal	116	17	11	0	0	0	88	0	0	0	0	0	0
Strait of Gibraltar***	2681	1251	6	0	0	0	1418	6	0	0	0	0	0
West Med. **	420	70	343	0	0	0	7	0	0	0	0	0	0
Central Med. ****	1308	675	135	0	0	0	479	7	0	0	12	0	0
		3545	**496**	**7**	**0**	**0**	**3712**	**33**	**0**	**7**	**12**	**0**	**1**
GRAND TOTAL	**7813**	**SUBTOTAL = 4019**					**SUBTOTAL = 3694**						

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Canada	11	0	6	5	0	0
Bay of Biscay	4615	3009	1599	7	0	0
Morocco*	417	258	129	22	0	8
Portugal	204	139	65	0	0	0
Strait of Gibraltar	4105	2669	1430	6	0	0
West Med. **	427	77	350	0	0	0
Central Med.	1806	1154	633	7	12	0
	11585	**7306**	**4212**	**47**	**12**	**8**

Table 7. Details on the number of Bluefin tuna tagged with various types of tags in all Phases of GBYP 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.	% by area
Canada	6	0	1	0	0	0	0	5	0	0	0	0	0	**0,0%**
Bay of Biscay	7701	4173	1	3	0	0	3493	18	0	0	13	0	0	**46,1%**
Morocco*	283	129	0	12	0	0	121	13	0	7	0	0	1	**1,7%**
Portugal	116	17	11	0	0	0	88	0	0	0	0	0	0	**0,7%**
Strait of Gibraltar***	5561	2254	43	0	0	0	3212	22	5	0	23	2	0	**33,3%**
West Med. **	1646	931	358	0	0	0	352	5	0	0	0	0	0	**9,8%**
Central Med.	1405	772	135	0	0	0	479	7	0	0	12	0	0	**8,4%**
		8276	**549**	**15**	**0**	**0**	**7745**	**70**	**5**	**7**	**48**	**2**	**1**	
GRAND TOTAL	**16718**	**SUBTOTAL = 8811**					**SUBTOTAL = 7807**							**100,0%**

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED					
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	% by area
Canada	11	0	6	5	0	0	**0,0%**
Bay of Biscay	11225	7697	3494	21	13	0	**46,0%**
Morocco*	432	258	134	32	0	8	**1,8%**
Portugal	204	139	65	0	0	0	**0,8%**
Strait of Gibraltar***	8618	5491	3075	27	25	0	**35,3%**
West Med. **	2002	1284	713	5	0	0	**8,2%**
Central Med.	1903	1251	633	7	12	0	**7,8%**
TOTAL	**24395**	**16120**	**8120**	**97**	**50**	**8**	**100,0%**
%	**100%**	**66,1%**	**33,3%**	**0,4%**	**0,2%**	**0,0%**	

no tagging in Eastern Mediterranean!

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

Table 8. Details of tag recovery by area (upper table) and by fishery (lower table), in numbers and percent (updated on 23 February 2015).

Fishing Area / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
East Atl	53	28	9	2	1	93	31,96
Med	129	45	5	5		184	63,23
North Atl	1	2		1	2	6	2,06
West Atl	2			1	1	4	1,37
Unknown			4			4	1,37
Grand Total	185	75	18	9	4	291	100
%ge	63,6%	25,8%	6,2%	3,1%	1,4%	100,0%	

Fishery -Gear / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
BB	93	45				138	47,42
FARM	28	8		3		39	13,40
HAND	4	4				8	2,75
LL	14	10		2		26	8,93
LLHB		1				1	0,34
NF			13	1	4	18	6,19
PS	4	2	1			7	2,41
RR	3	1				4	1,37
SPOR	11					11	3,78
TN	1	1				2	0,69
TP	1			1		2	0,69
TRAP	2	1		2		5	1,72
TROL	7	2				9	3,09
UNCL	17		4			21	7,22
Grand Total	185	75	18	9	4	291	100

Table 9. Tag recoveries by year and type of tag. The years in yellow are those before GBYP. The tag awareness campaign was initiated in 2011 and therefore effects are visible from 2012.

Recovery Year / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Commercial Tags	Grand Total	%
2002	1	1		1		3	1,03
2006	1			1		2	0,69
2008	1					1	0,34
2009	1					1	0,34
2010	3					3	1,03
2011	8		1			9	3,09
2012	36	7	6	1	1	51	17,53
2013	60	28	8	2	1	99	34,02
2014	72	32	1	3	2	110	37,80
<23 Feb 2015	2	7		1		10	3,44
Undefined (2012 or 2013)			2			2	0,69
Grand Total	185	75	18	9	4	291	100

Table 10. Detail of the recoveries from double tagged bluefin tunas (GBYP only) (updated on 23 February 2015). The upper table shows the resilience of each type of tag.

Release	Spaghetti tag only	Double Barb Tag only	Both	TOTAL FISH	TOTAL TAGS
2011	0	2	5	7	12
2012	3	3	31	37	68
2013	1	2	23	27	49
Total	4	7	59	70	**136**
%	5,71	10,00	84,29	100	

RcCode: 2conv	both recovered				
	Year of Recovery				
Year of Release	**2012**	**2013**	**2014**	**2015**	**TOTAL FISH D/T**
2011	1	3	2	0	6
2012	5	15	10	0	30
2013		6	15	2	23
TOTAL	6	24	27	2	59
%	10,17	40,68	45,76	3,39	100

Table 10. Samples collected and analyses carried out by the Consortium headed by AZTI in GBYP Phase 4, with the target and percentages of achievement. Additional YOY BFTs were sampled under different contracts at the end of 2014.

item	*Target no.*	*Achievement no.*	*% of achievement*	*No. considering 10% tolerance*
Bluefin tuna individuals sampled (1)	1210	1733	143.22	n.a.
Biological & Genetic Sampling (2):				
Genetic samples (muscle/fin)	1110	1712	154.23	n.a.
Otoliths	910	1052	115.60	n.a.
Spines	1160	959	82.67	954
Total biological and genetic samples	*3180*	*3723*	*117.08*	*n.a.*
Biological & Genetic Analyses (3):				
Genetic analyses (SNP validation)	192	188	97.92	173
Genetic analyses (new genotypes)	576	165	28.65	518
Genetic analyses (RAD-seq)	60	165	275	n.a.
Microchemical analyses (stable hisotopes)	190	324	170.5	n.a.
Microchemical analyses (trace elements)	210	154	73.33	189
Microchemical analyses (YOY addit. sets)	100	60	60	90
Otolith shape	300	422	140.67	n.a.
Age readings (intercalibration)(3 x each)	100	100	100	n.a.
Total biological and genetic analyses	*1728*	*1578*	*91.32*	*1555*
TOTAL (1+2+3)	6118	7034	114.97	n.a.

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

Sampling area	Phase	year	no.	PREDICTED ORIGIN		
				% East BFT	% West BFT	% SD
Central North Atlantic	3	2010/2011	177	70	30	±6.5
Central North Atlantic (W of 45°W)	4	2102	18	6	94	±7.8
Central North Atlantic (Bay of Biscay)	3	2010/2011	262	99	1	±1
Central North Atlantic (E of 45°W)	4	2011	28	100	0	±0
Central North Atlantic (E of 45°W)	4	2012	150	83	17	±6.4
Atlantic Morocco	3	2011	32	27	73	±15.6
Atlantic Morocco	4	2012	49	100	0	±0
Atlantic Morocco	4	2013	59	98	2	±4.3
Canary Islands	4	2013	23	79	21	±14.0
Strait of Gibraltar	3	2010/2011	190	100	0	±0
Balearic Islands (West Mediterranean)	3	2010/2011	39	100	0	±0
Sardinia (West Mediterranean)	3	2010/2011	20	100	0	±0
Adriatic Sea (Central Mediterranean)	3	2010/2011	47	100	0	±0
Malta (Central Mediterranean)	3	2010/2011	82	100	0	±0
Turkey (East Mediterranean)	3	2010/2011	48	99	1	±2.9

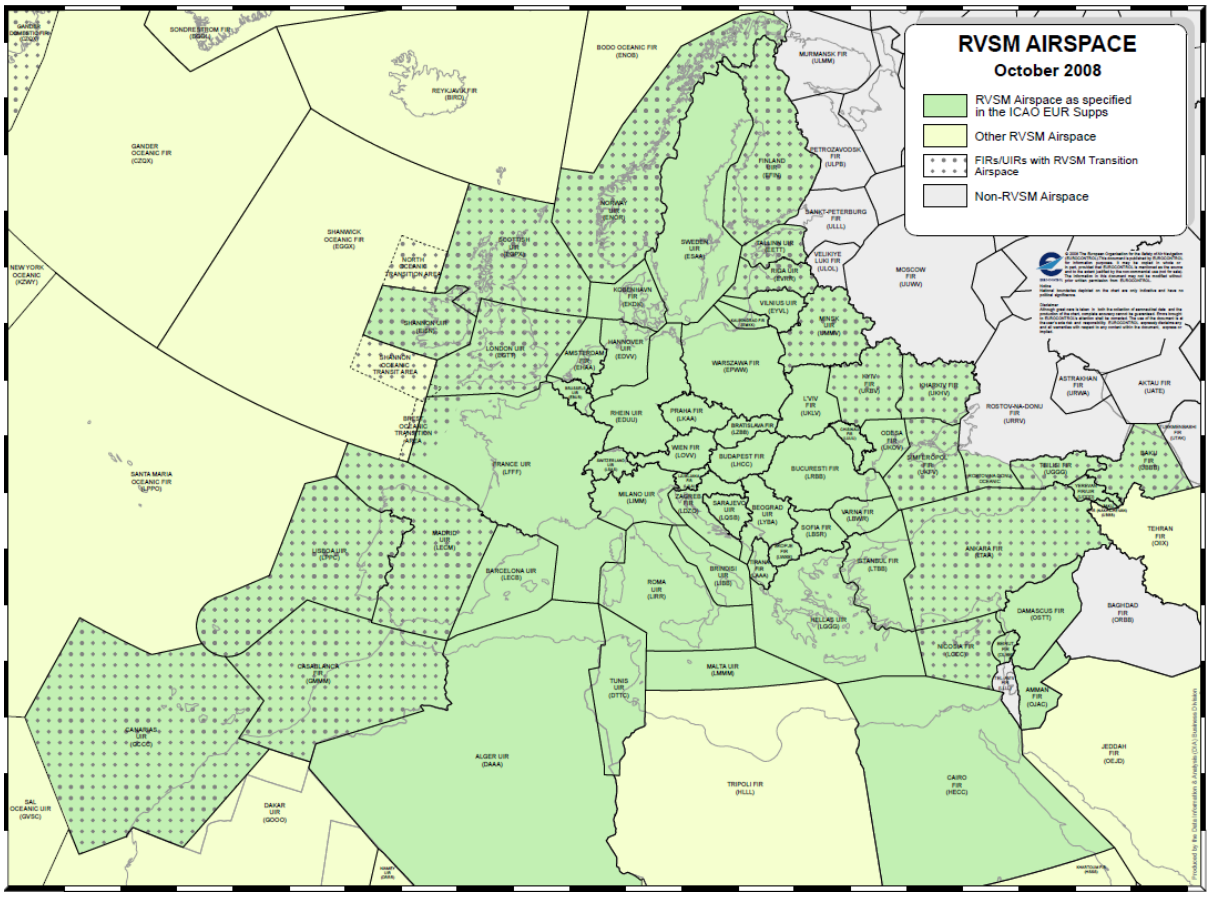


Figure 1 – Boundaries of the national air-spaces in the Mediterranean Sea (the Black Sea is excluded), showing the complexity of operating in a geographical area with 24 Countries (16 are ICCAT CPCs), with various rules.

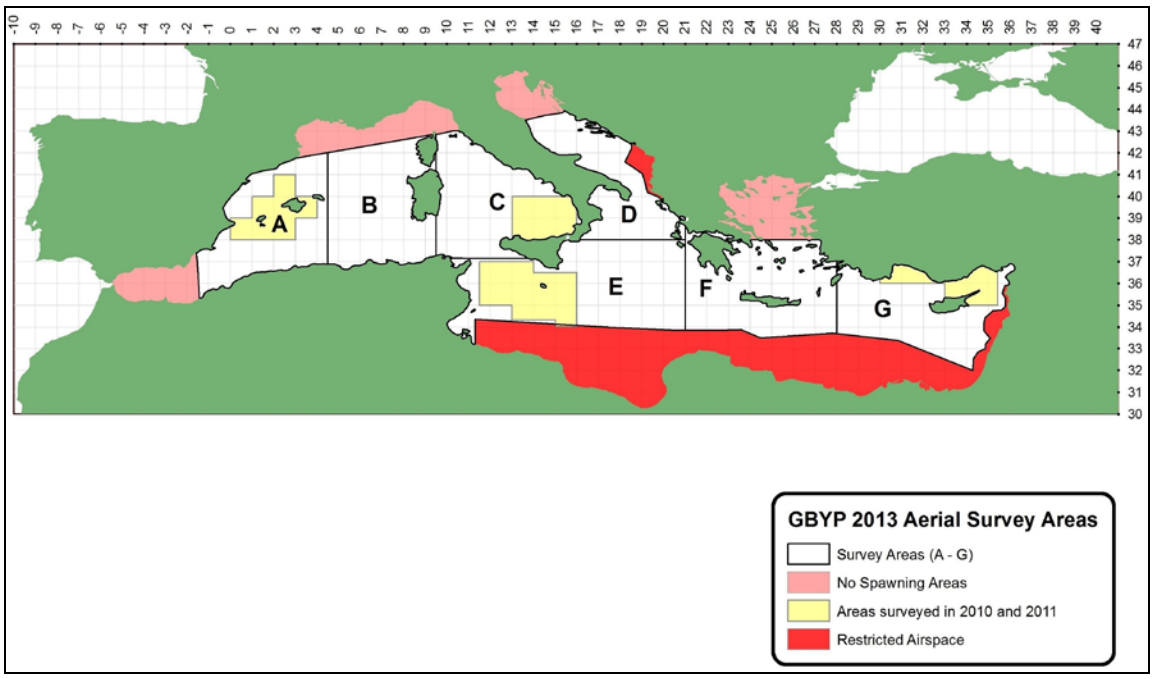


Figure 2 – Map used for elaborating the aerial survey design in 2013, based on the potential opportunities of getting the flight permits by the various CPCs and coastal States concerned. The letters in bold identify the various areas used by GBYP.

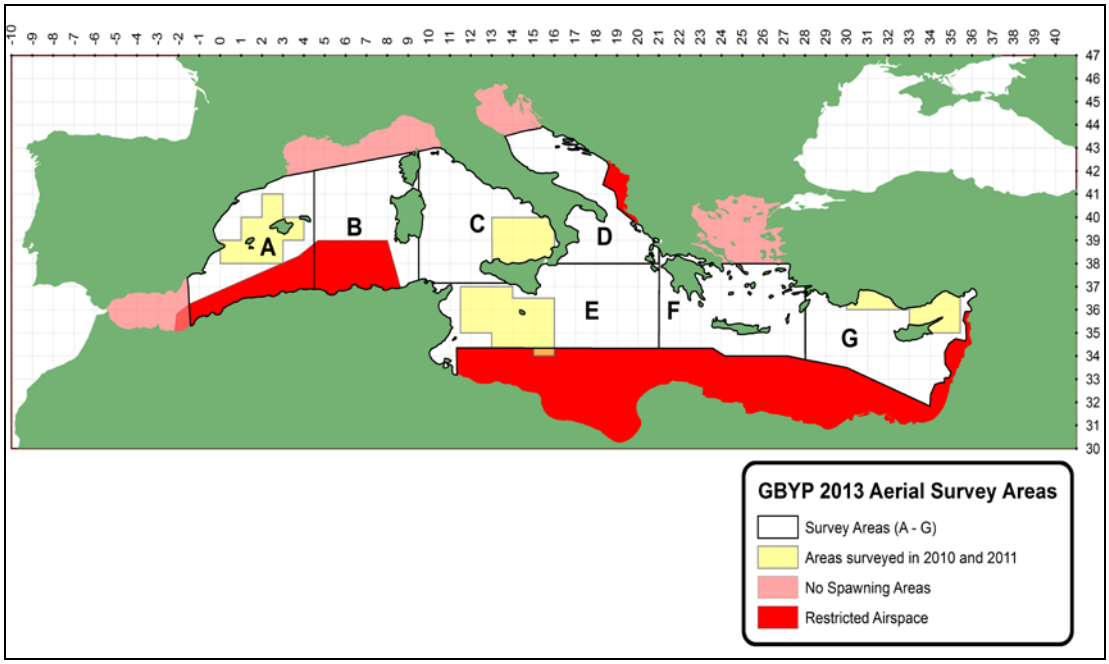


Figure 3 – Map showing the areas on which it was possible to have permits for the aerial survey in 2013 (white and yellow zones). The letters in bold identify the various areas used by GBYP.

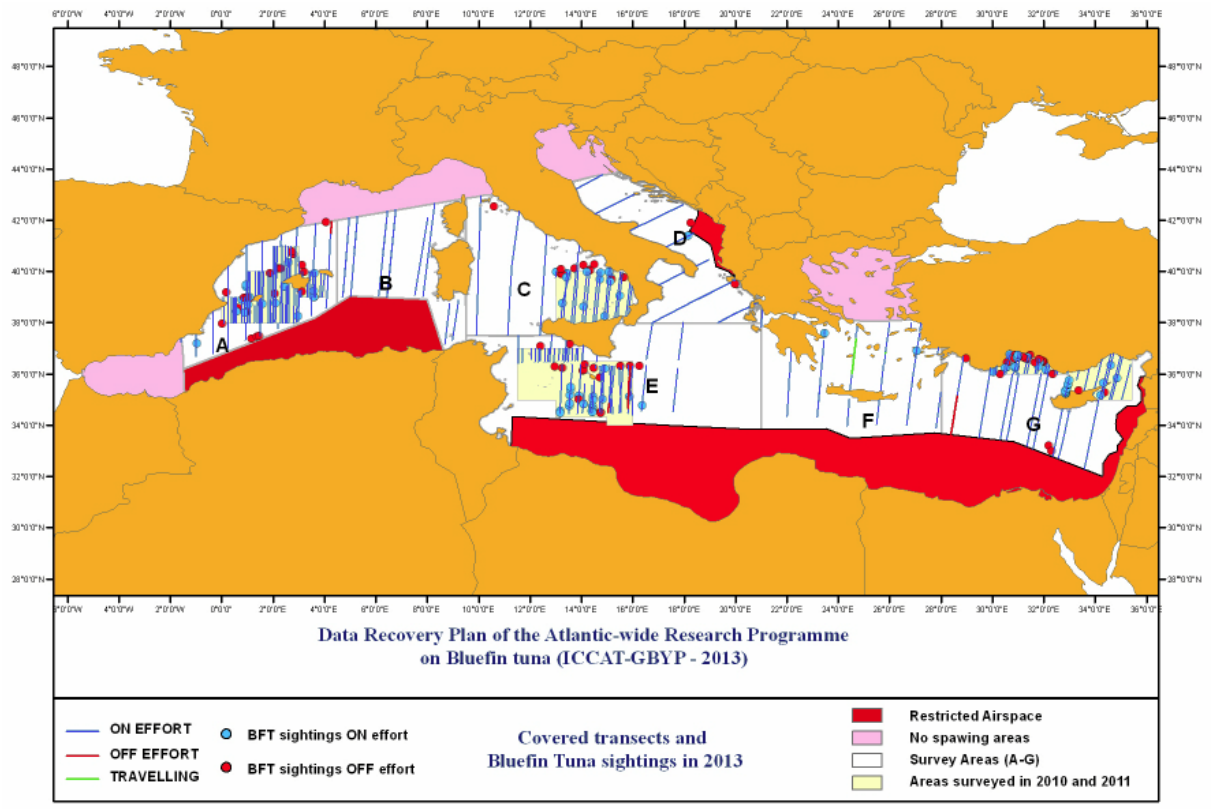


Figure 4 – Sightings of bluefin tuna (on and off effort) during the 2013 GBYP aerial survey on spawning aggregations.

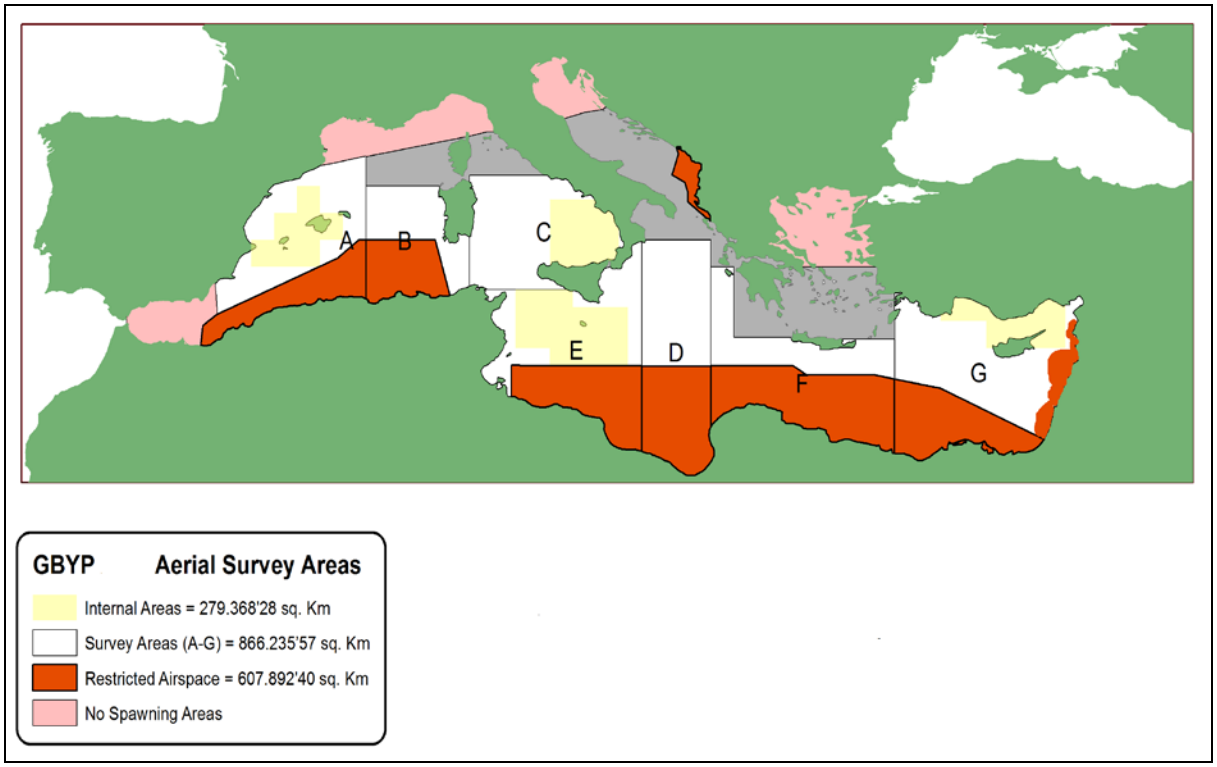
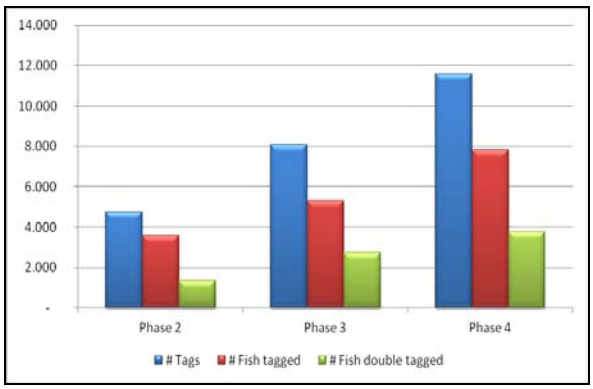


Figure 5 – Map recommended by the GBYP Steering Committee for the next aerial survey. Most of the areas were reshaped and "internal" areas have been enlarged.



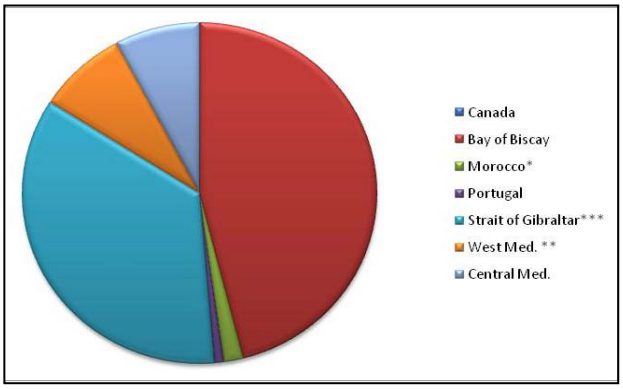


Figure 6a (left). Progression of the ICCAT GBYP tagging activities in the various Phases. **Figure 6b (right)**. Percentage distribution of tags implanted in the various geographical areas by GBYP, up to Phase 4.

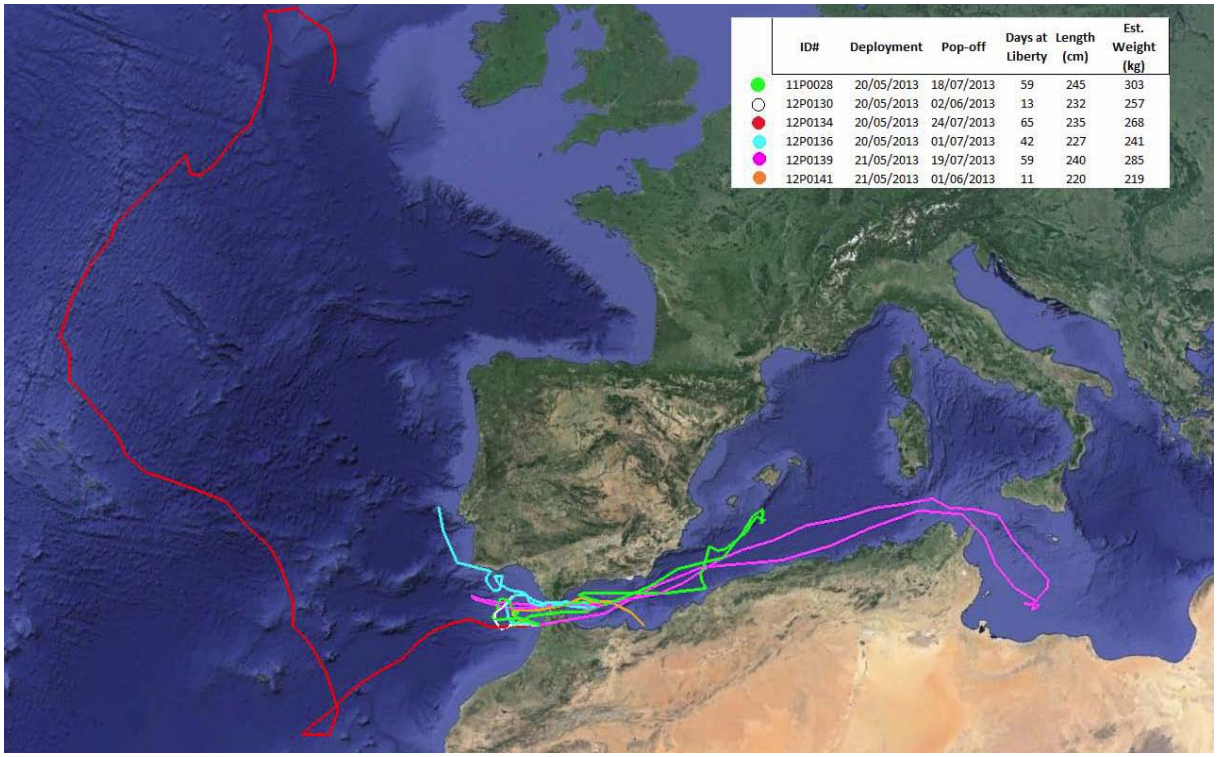


Figure 7. Tracks of adult bluefin tunas tagged with mini-PATs in the Moroccan traps in GBYP Phase 4 (2013).

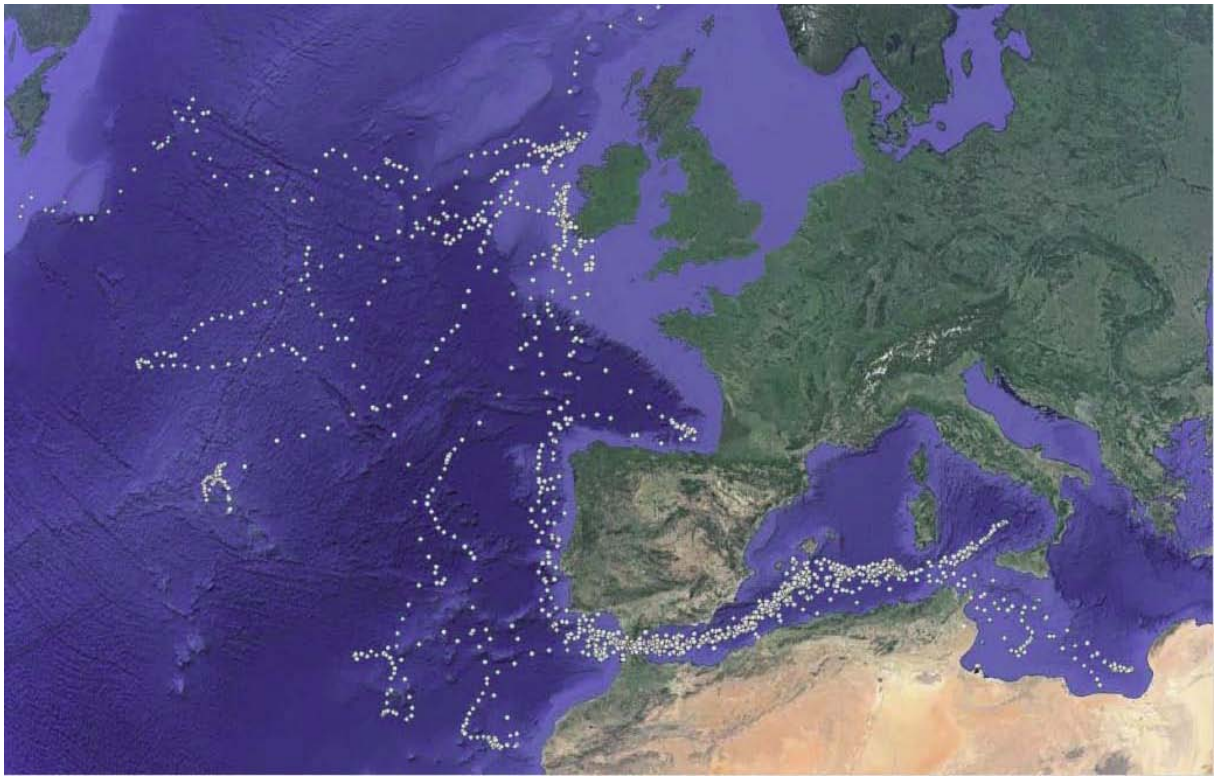


Figure 8. Tracks of 13 mini-PATs deployed by GBYP and WWF (SCRS/2014/184).

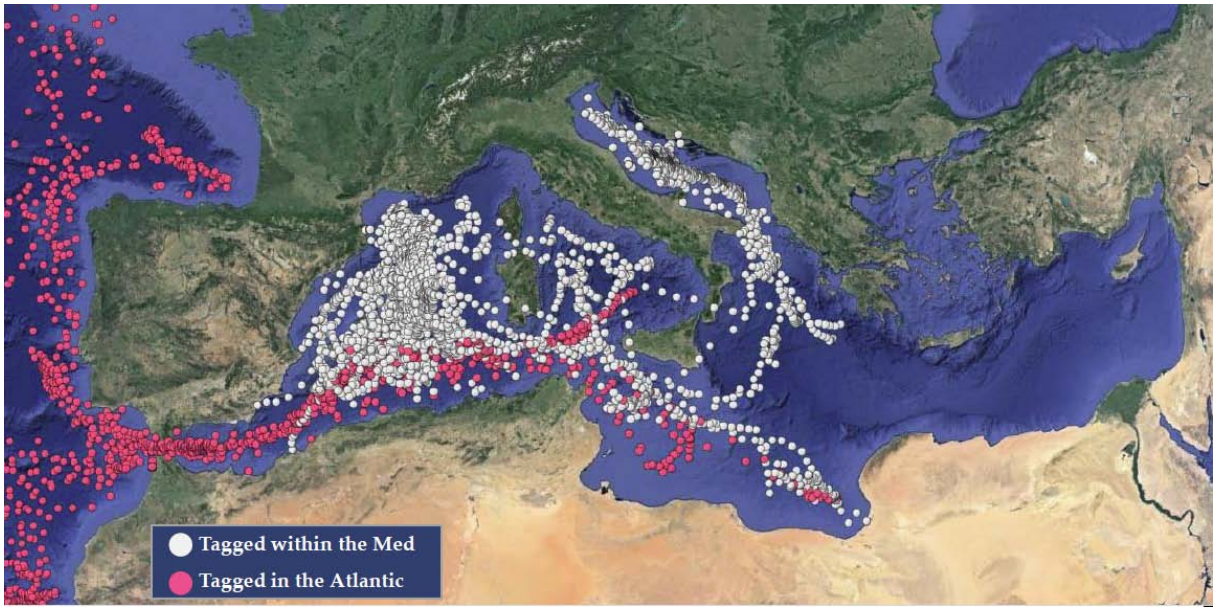


Figure 9. Tracks of mini-PATs deployed by both GBYP and WWF in various years (SCRS/2014/184). It seems clear that no bluefin tuna ever went to the eastern Mediterranean Sea.

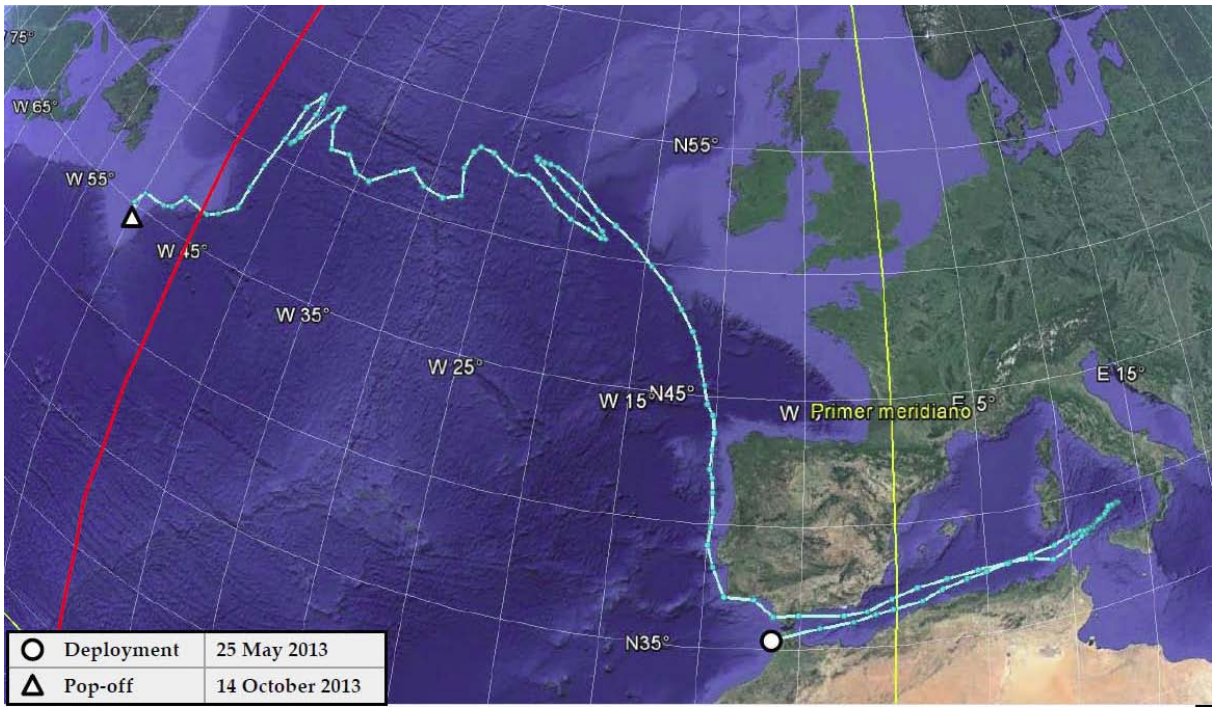


Figure 10. Track of one mini-PAT deployed by GBYP and WWF in the Moroccan trap of Larache in 2013 (SCRS/2014/184). This fish spawned in the Tyrrhenian Sea and then travelled up to Newfoundland.

Figure 11. Daily positions of **(a)** the tuna tagged within the Mediterranean (N = 39), i.e. 38 deployed with pop-up tags (white dots) and one with an archival tag (orange dots). Tuna weight ranging from 12 up to 250 kg. Time-span ranging from 18 up to 304 days at liberty (pop-ups) and up to 391 (archival). **(b)** those giant tuna (all but one over 2 m CFL) tagged in the Atlantic coast of Morocco which entered the Mediterranean during the spawning season and then performed the trophic migration into the Atlantic Ocean (N = 11). Time-span ranged from 42 up to 300 days at liberty. And **(c)** the tuna tagged in the Mediterranean (N = 39, white dots) and the tuna tagged in the Atlantic coast of Morocco which visited the Mediterranean Sea at some point while having their tag attached (N = 17, red dots).

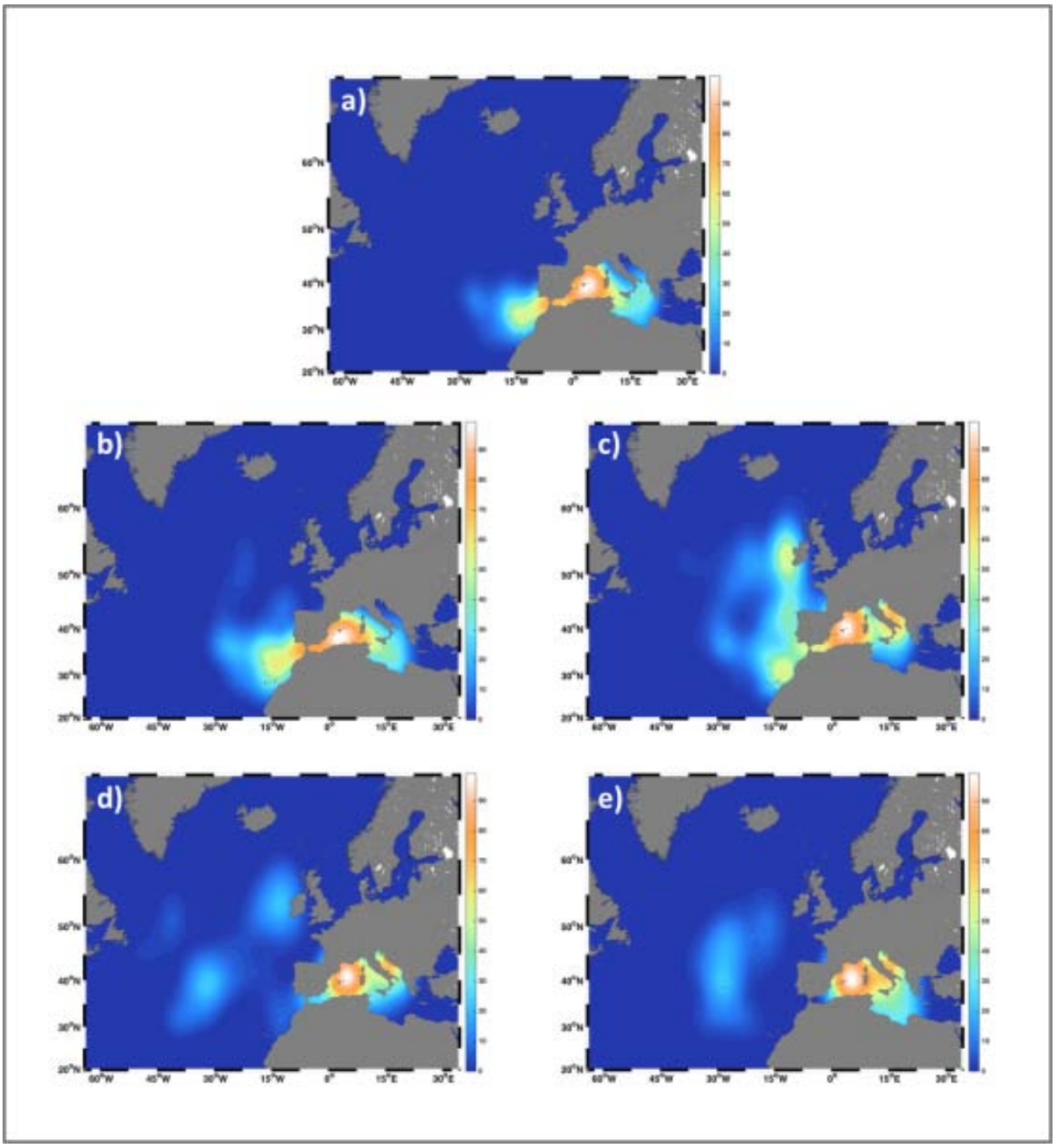


Figure 12. Seasonal Utilization Distributions (UDs) of all bluefin tuna analyzed in this study (N = 66). The locations of the tunas were examined for the (a) spawning period (i.e. May 15 to July 15) and the seasonal periods of (b) spring, (c) summer, (d) autumn and (e) winter. UDs were computed using the Kernel method through the ad hoc method ($h = Sigma*n^{(-1/6)}$, $Sigma = 0.5*(sd(x)+sd(y))$). The graphs show the UDs cumulative frequencies up to 99.9% (the color attributed to a given percentage p applies to areas comprised between p and p–1.62% isopleths).

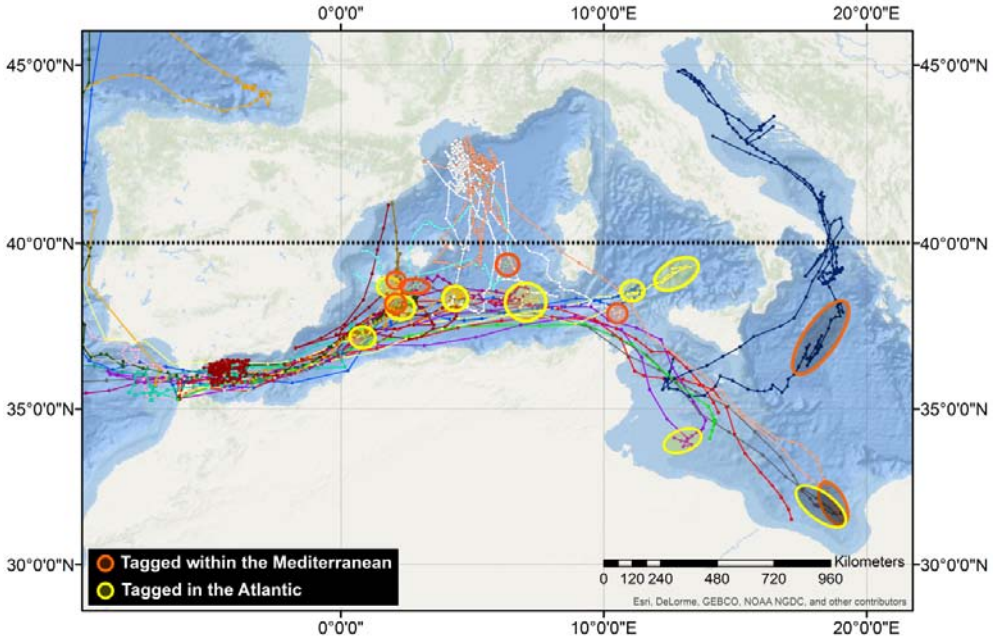


Figure 13. Places where tunas showed potential reproductive behavior. Orange areas represent those individuals tagged within the Mediterranean basin and yellow areas are for those tagged in the Atlantic coast of Morocco. Dashed white line is the 40^{o} N parallel.

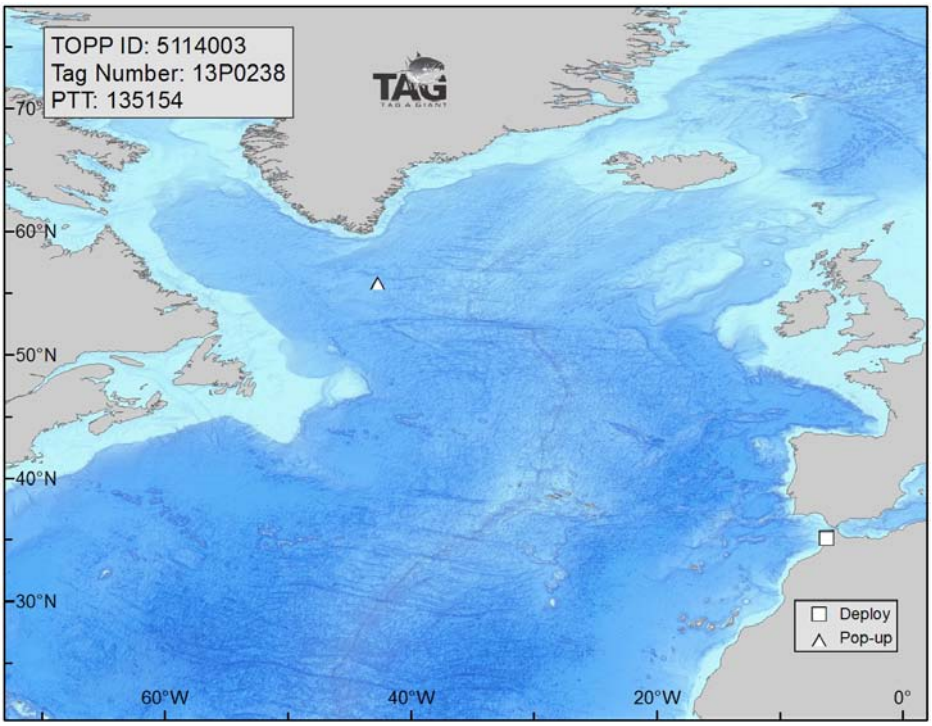


Figure 14. Release and pop-off positions of a tag implanted in Morocco by the University of Stanford which went to Greenland for the first time in the last decades.

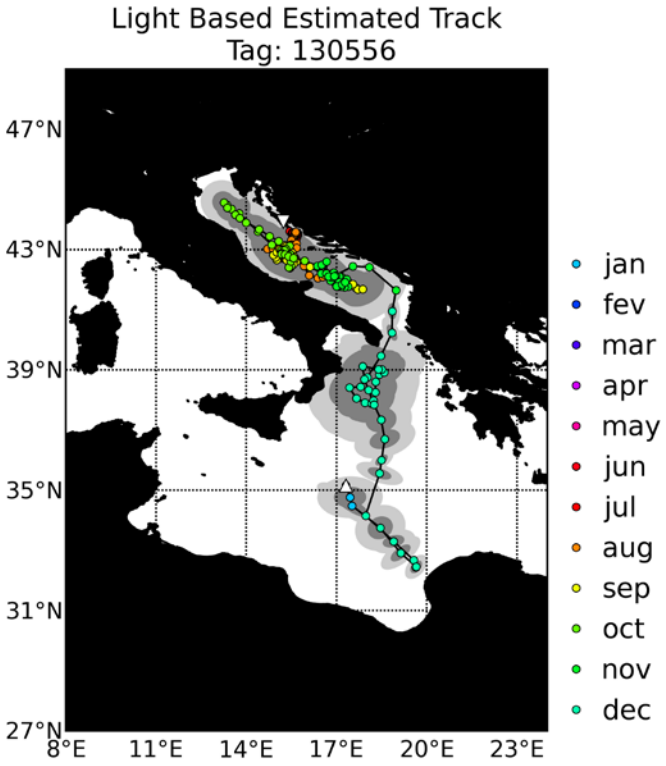


Figure 15. Track of one mini-PAT deployed by GBYP in the Adriatic Sea in 2013. This fish was the only one going to the Libyan waters.

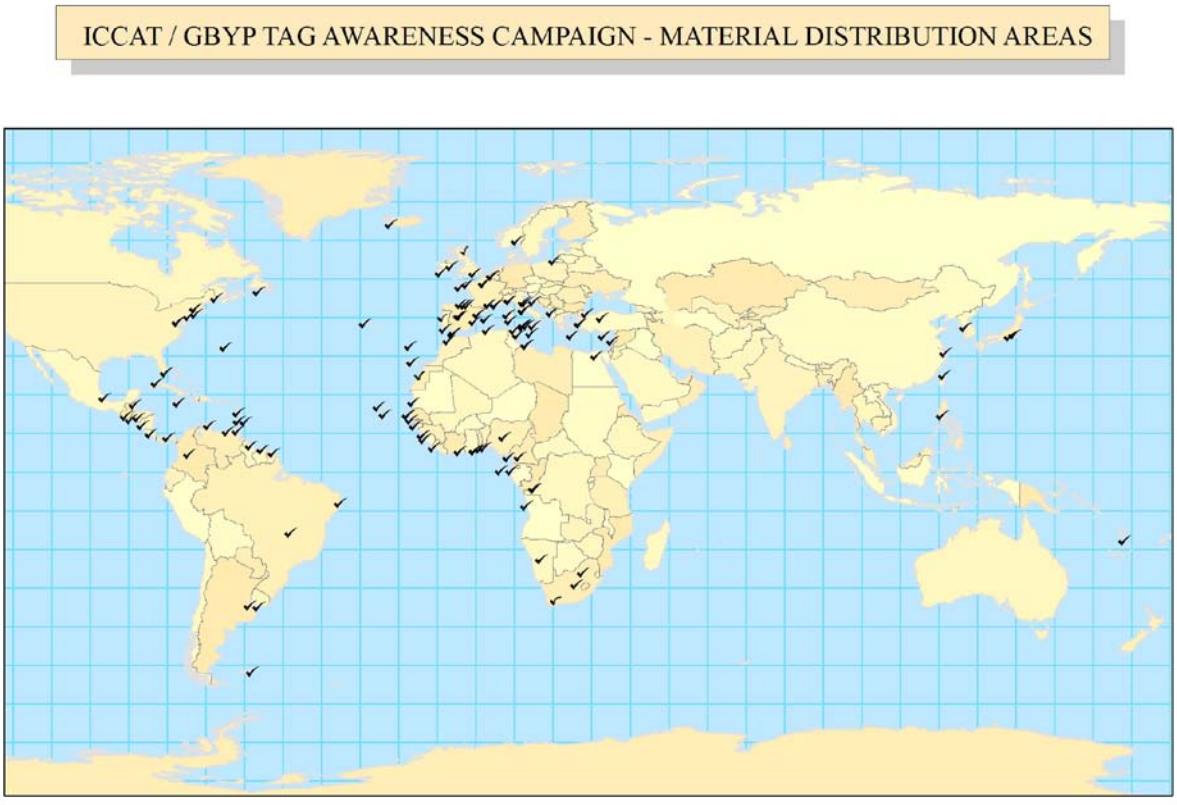


Figure 16 – Overview of the localities where the ICCAT-GBYP tag awareness material was distributed so far.

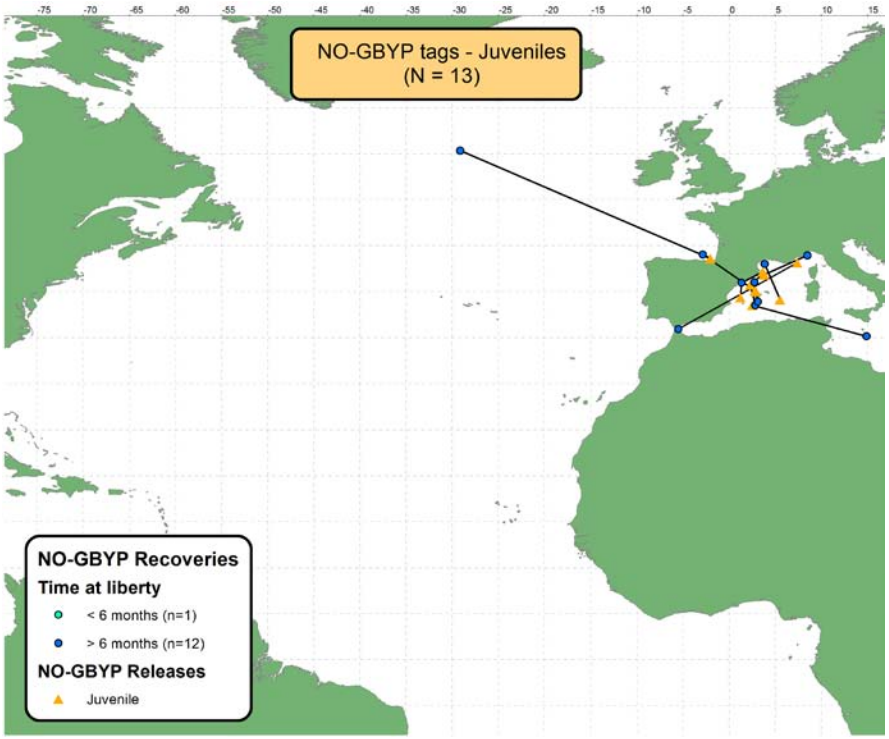


Figure 17. Trajectories of conventional tags implanted on juvenile bluefin tuna by non-GBYP programmes and recovered by ICCAT (mapped data are still incomplete, because the ICCAT GBYP data base will be updated for the last recoveries in2014 and 2015 in Phase 5).

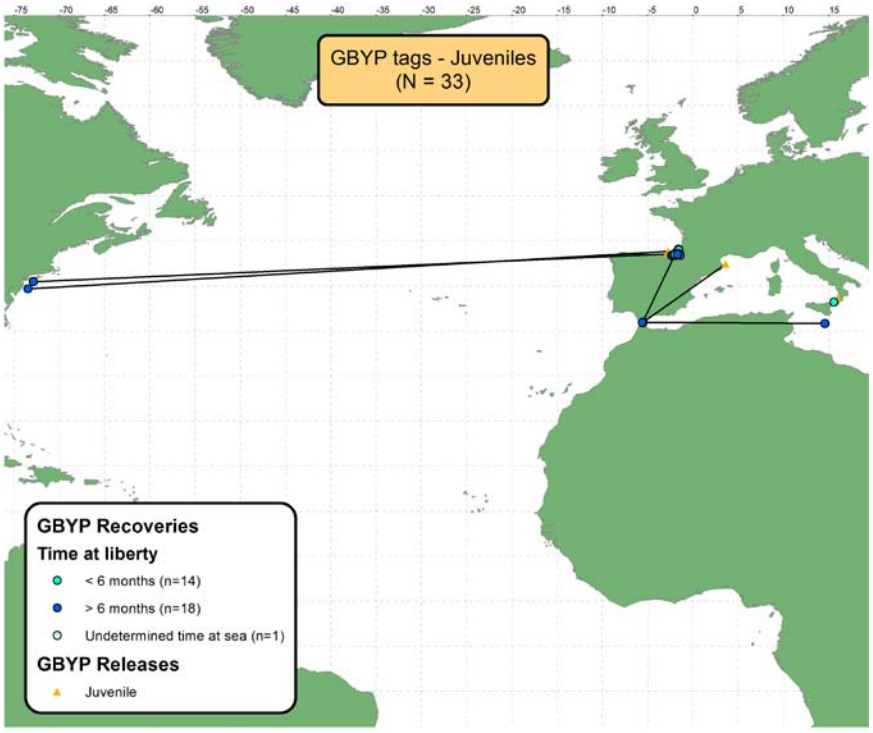


Figure 18. Trajectories of conventional tags implanted on juvenile bluefin tuna by GBYP and recovered by ICCAT (mapped data are still incomplete, because the ICCAT GBYP data base will be updated for the last recoveries in2014 and 2015 in Phase 5).

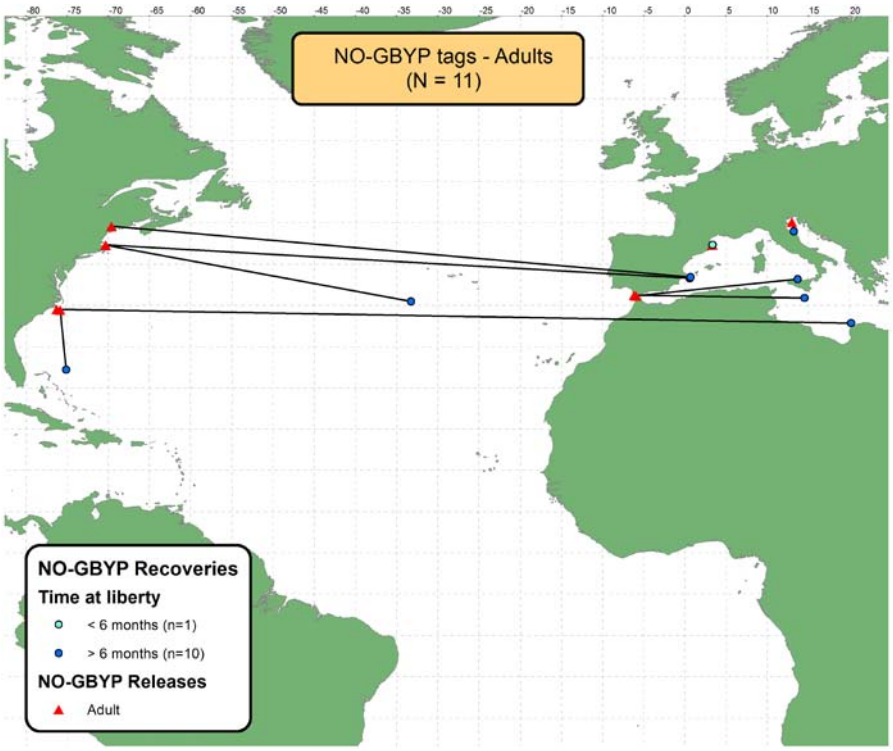


Figure 19. Trajectories of conventional tags implanted on adult bluefin tuna by non-GBYP programmes and recovered by ICCAT (mapped data are still incomplete, because the ICCAT GBYP data base will be updated for the last recoveries in2014 and 2015 in Phase 5).

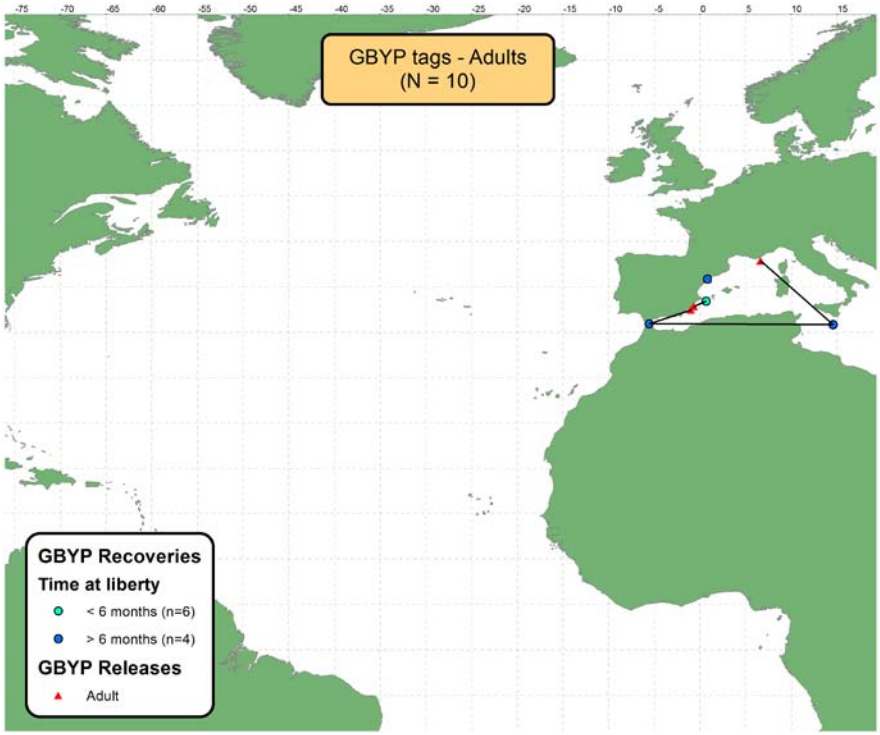


Figure 20. Trajectories of conventional tags implanted on adult bluefin tuna by GBYP and recovered by ICCAT (mapped data are still incomplete, because the ICCAT GBYP data base will be update for the last recoveries in2014 and 2015 in Phase 5).

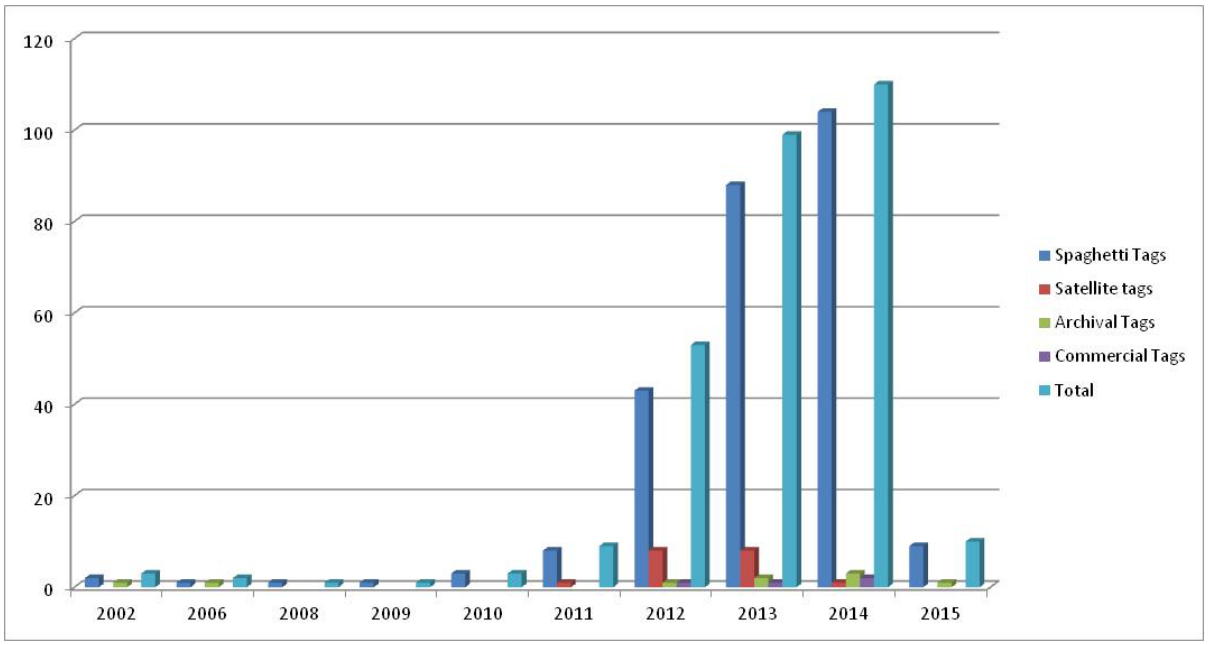


Figure 21. progression of tag recoveries by tag type over the recent years. GBYP begun in 2010, but the GBYP tag awareness programme was initiated in 2011, showing effects from 2012.

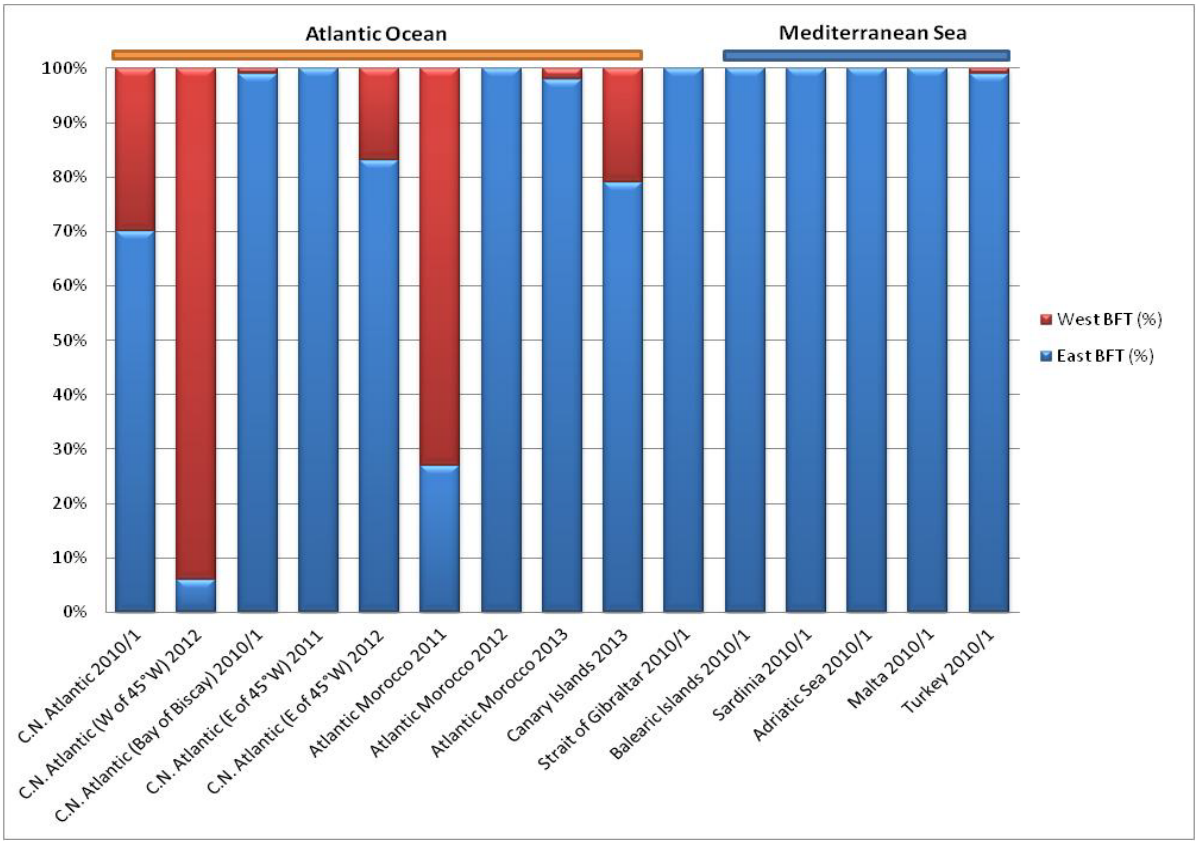


Figure 22. Graphic presentation of maximum likehood prediction of the origin of bluefin tuna collected from various areas and analysed in Phase 3 and Phase 4. Estimates are given by percentages and mixed-stock analyses (HISEA program) was run under bootstrap mode with 1000 runs to obtain standard deviations (~error) around estimated percentages (from the final reports of Phase 3 and 4 provided by the Consortium headed by AZTI).

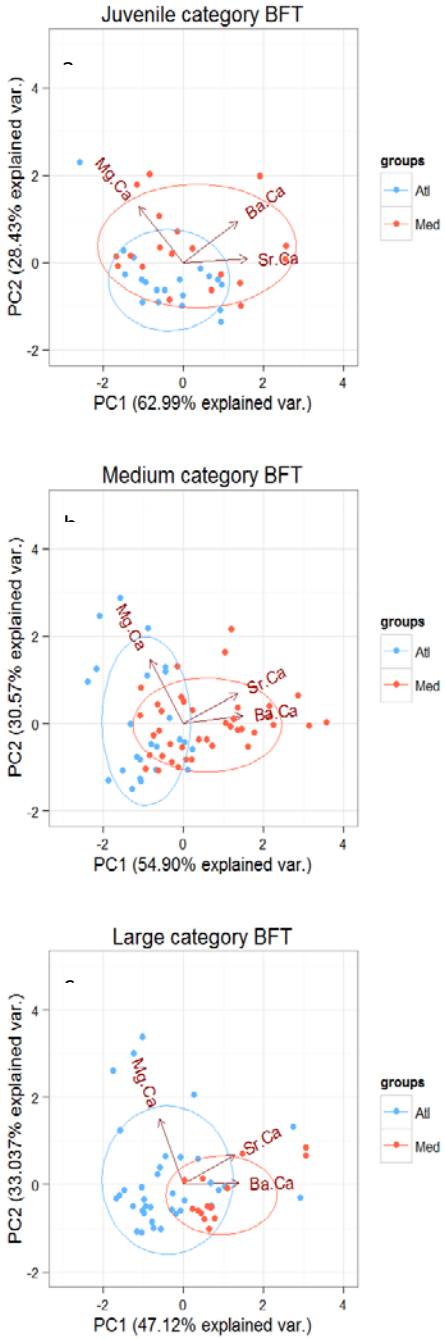


Figure 23. Principal Component Analysis (PCA) biplot for trace element concentration measured at the edge of BFT otoliths collected in different regions of the Atlantic Ocean and Mediterranean Sea by size categories. Arrows represent the correlation of the element: Ca ratios with the first two dimensions of the PCA (PC1 and PC2), and the points correspond to the PC1 and PC2 scores of each observation, with normal confidence ellipses (68%). (upper) Biplot of elemental signatures of Atlantic Ocean (including Strait of Gibraltar) and Mediterranean Sea for juvenile BFT category (< 25 Kg); (middle) Biplot of elemental signatures of Atlantic Ocean (including Strait of Gibraltar) and Mediterranean Sea for medium category (25-100 Kg) bluefin tuna ; (bottom) Biplot of elemental signatures of Atlantic Ocean (including Strait of Gibraltar) and Mediterranean Sea for large BFT category (>100 Kg).

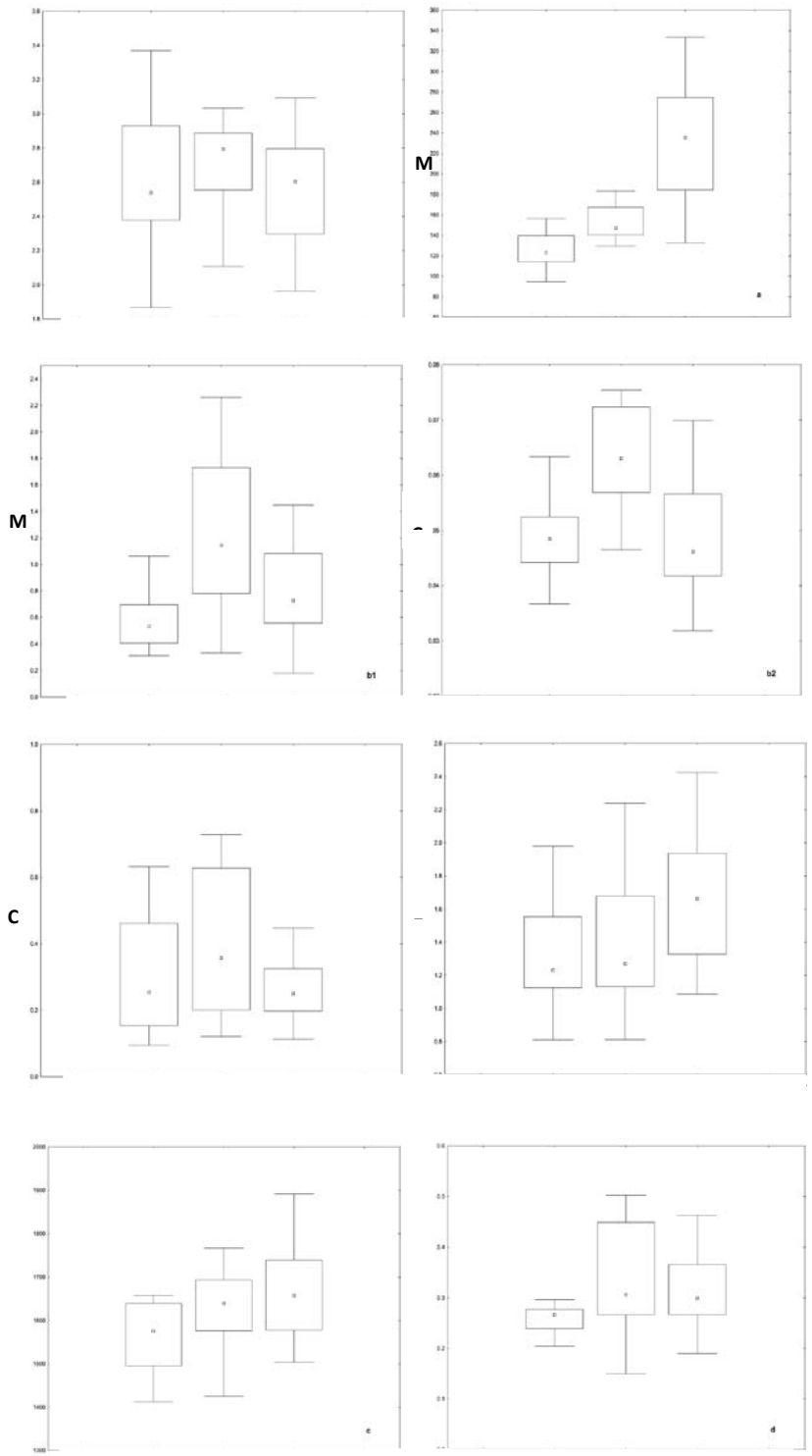


Figure 24. Box-plots comparing element: Ca distribution in otoliths of YOY bluefin tuna from western, central and eastern Mediterranean Sea. First line: eastern Mediterranean significantly different from central and western Mediterranean ($p<0.05$). Second line: central Mediterranean significantly different from western and eastern Mediterranean ($p<0.05$). Third line: eastern Mediterranean significantly different from western Mediterranean ($p<0.05$). Fourth line: western Mediterranean significantly different from central Mediterranean ($p<0.05$).

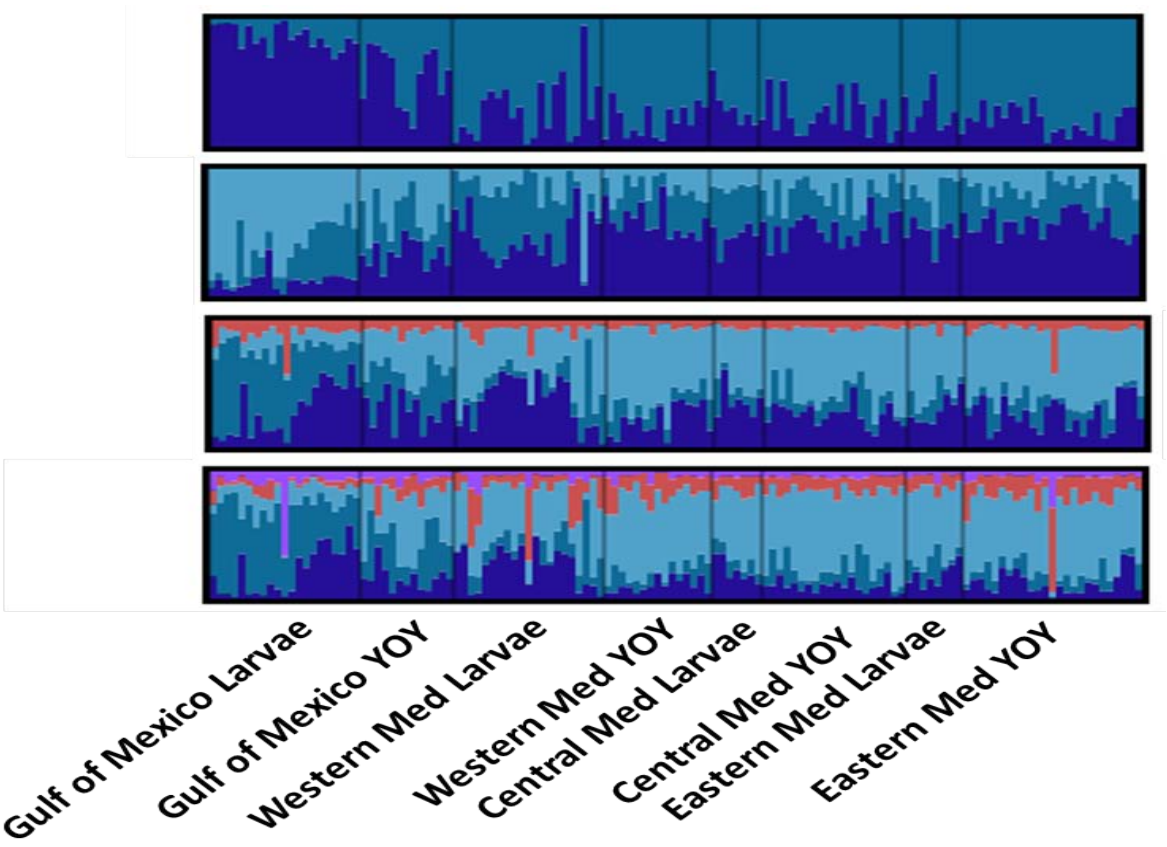


Figure 25. Graphic representation of individual ancestry using Structure software. Each bar represents one individual and each color, its degree of belonging to each inferred group.K varies from 2 to 5 from top to down.

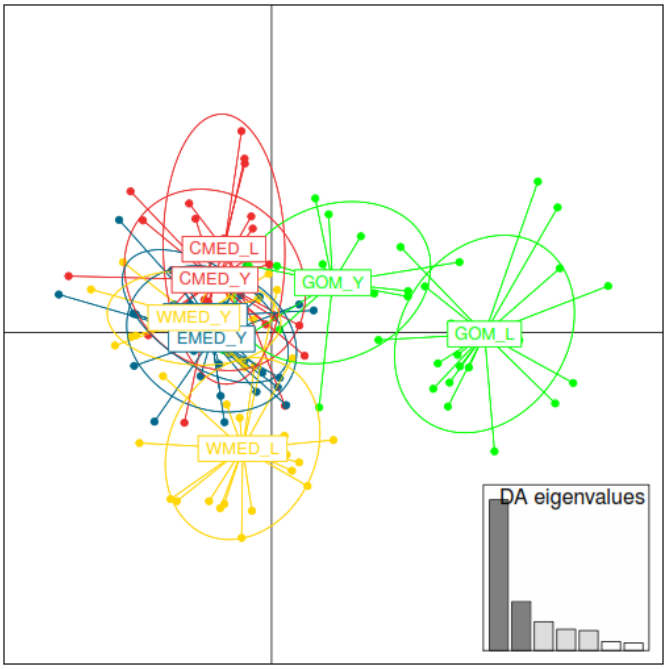


Figure 26. DAPC analysis of 130 samples assuming 8 distinct groups.

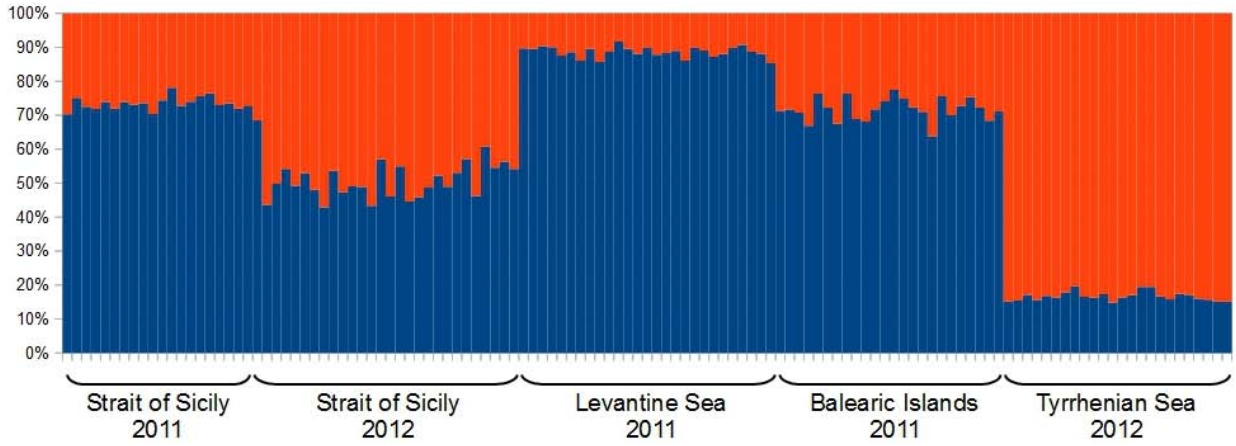


Figure 27. STRUCTURE analysis of 123 BFT collected from the Mediterranean Sea using a subset of 48 SNPs from the validated 96 SNP panel developed by the BGSA Genetics Consortium. The model used assumes 2 ancestral populations.

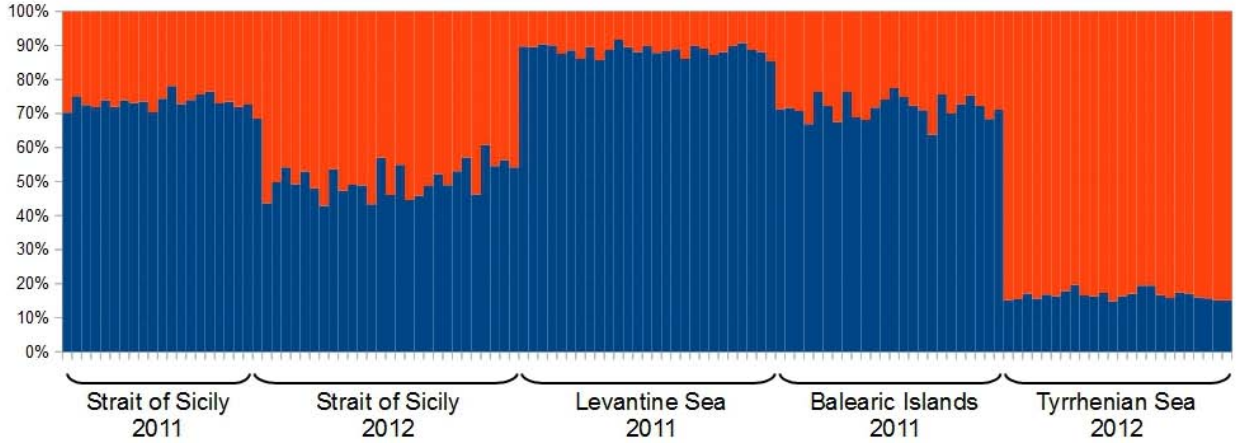


Figure 28. STRUCTURE analysis of 123 BFT collected from the Mediterranean Sea using a subset of 48 SNPs from the validated 96 SNP panel developed by the BGSA Genetics Consortium. The model used assumes 3 ancestral populations.

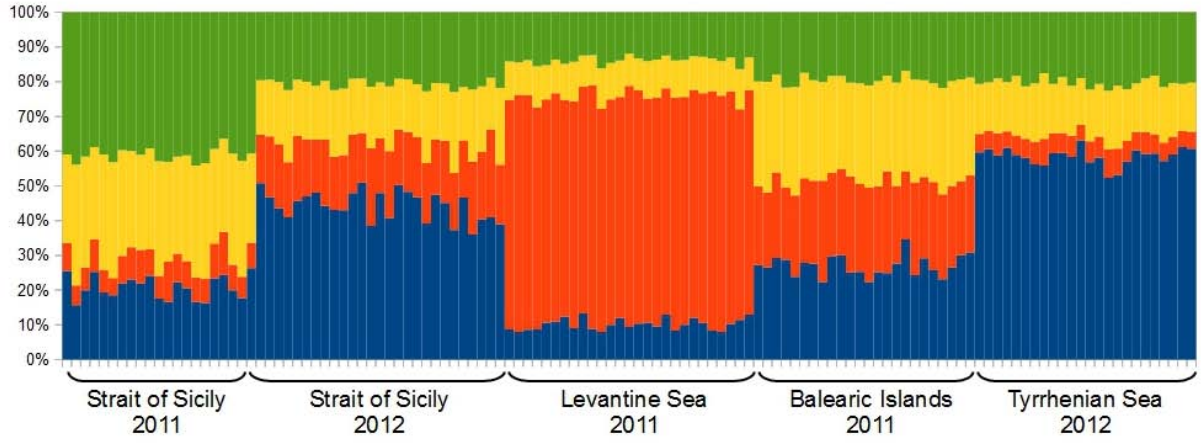


Figure 29. STRUCTURE analysis of 123 BFT collected from the Mediterranean Sea using a subset of 48 SNPs from the validated 96 SNP panel developed by the BGSA Genetics Consortium. The model used assumes 4 ancestral populations.

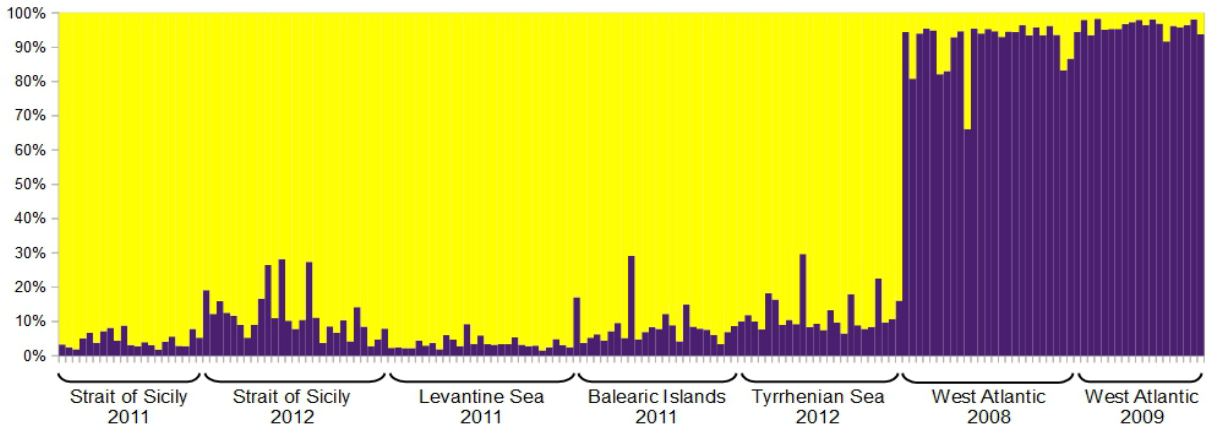


Figure 30. STRUCTURE analysis of 167 BFT from the Mediterranean and Western Atlantic using a subset of 59 SNPs from the 96 SNP panel developed by the BGSA Genetics Consortium. The model used assumes 2 ancestral populations.

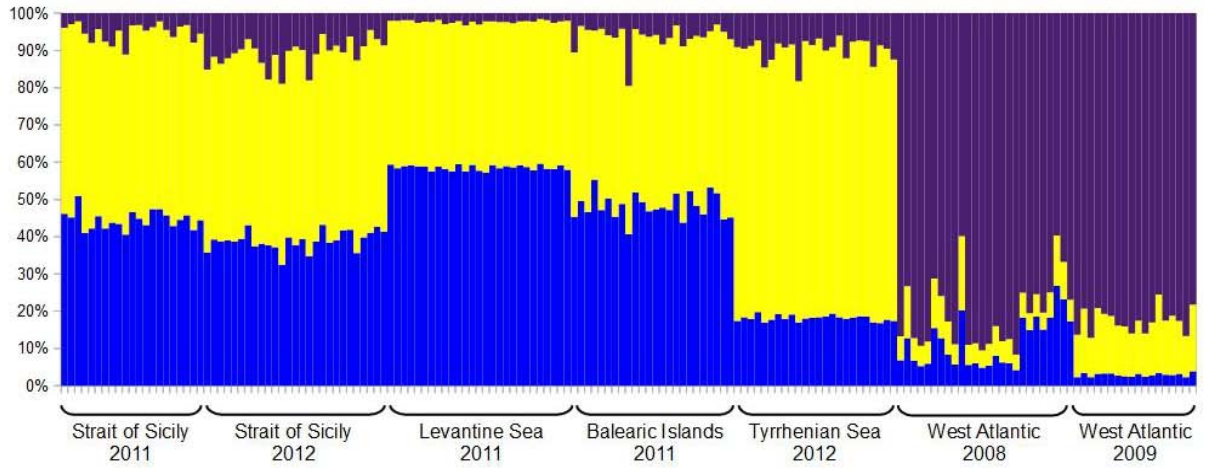


Figure 31. STRUCTURE analysis of 167 BFT from the Mediterranean and Western Atlantic using a subset of 59 SNPs from the 96 SNP panel developed by the BGSA Genetics Consortium. The model used assumes 3 ancestral populations.

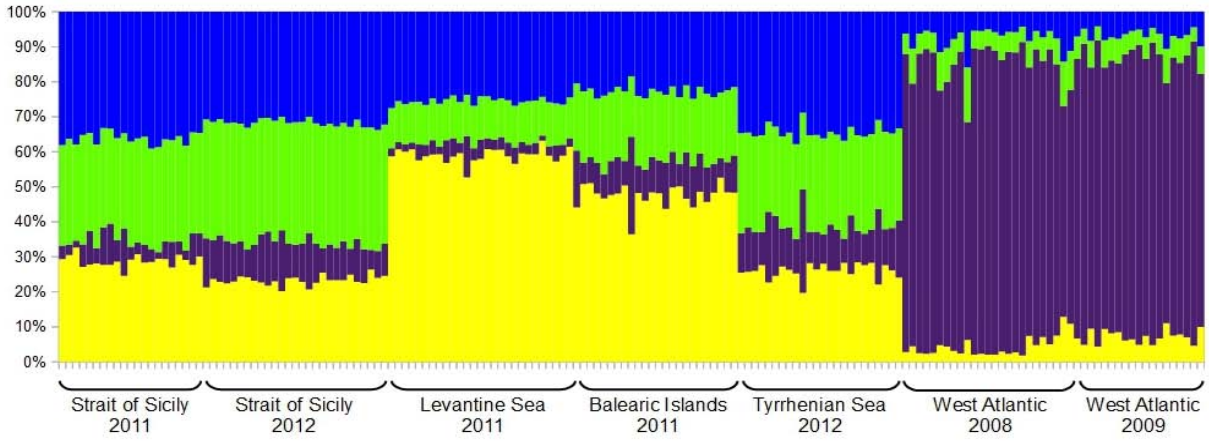


Figure 32. STRUCTURE analysis of 123 BFT collected from the Mediterranean Sea using a subset of 48 SNPs from the validated 96 SNP panel developed by the BGSA Genetics Consortium. The model used assumes 4 ancestral populations.

	EAST	MIXED	WEST	%correct
EAST	103	66	66	44
MIXED	10	18	6	53
WEST	5	4	21	70
Total	118	88	93	47

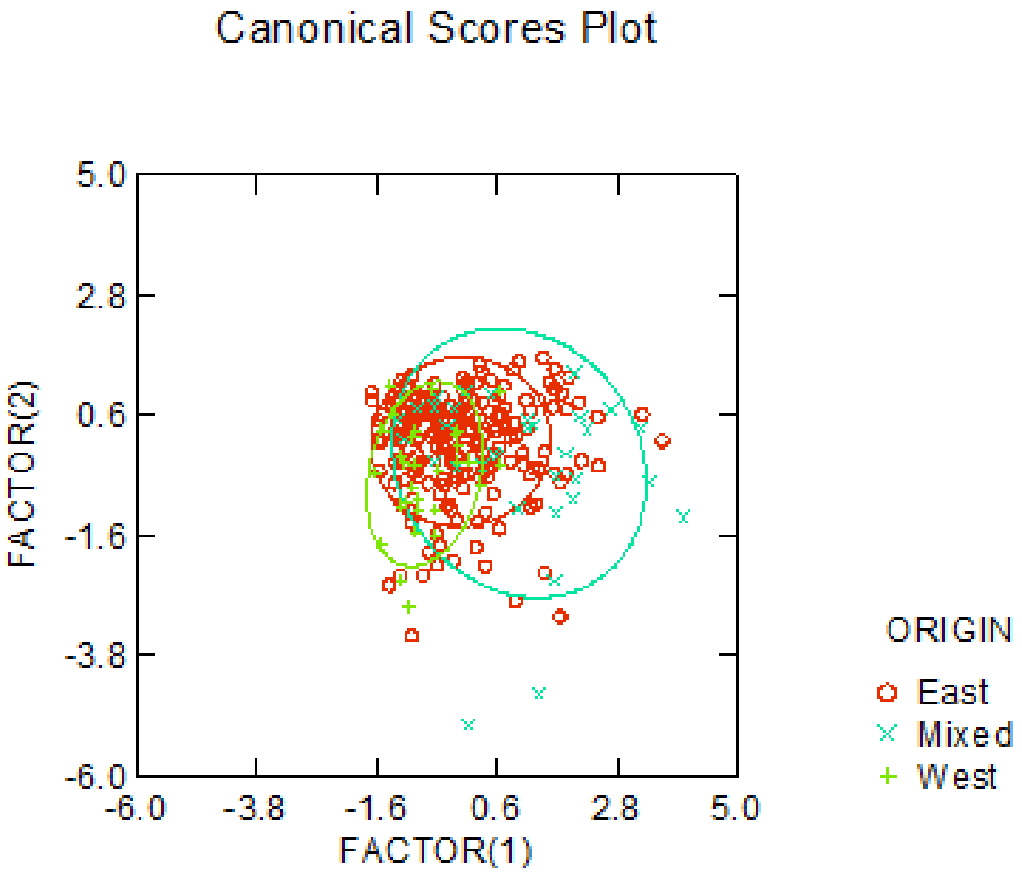


Figure 33. (upper table) Jacknife classification matrix from the discriminant function analysis (large size stratum), using PC's 1, 4 and 6 to discriminate between bluefin according to assumed nursery origin. (lower graph) Canonical scores plot from the discriminating function analysis (large size stratum), using PC's 1, 4 and 6 to discriminate bluefin according to assumed nursery origin.

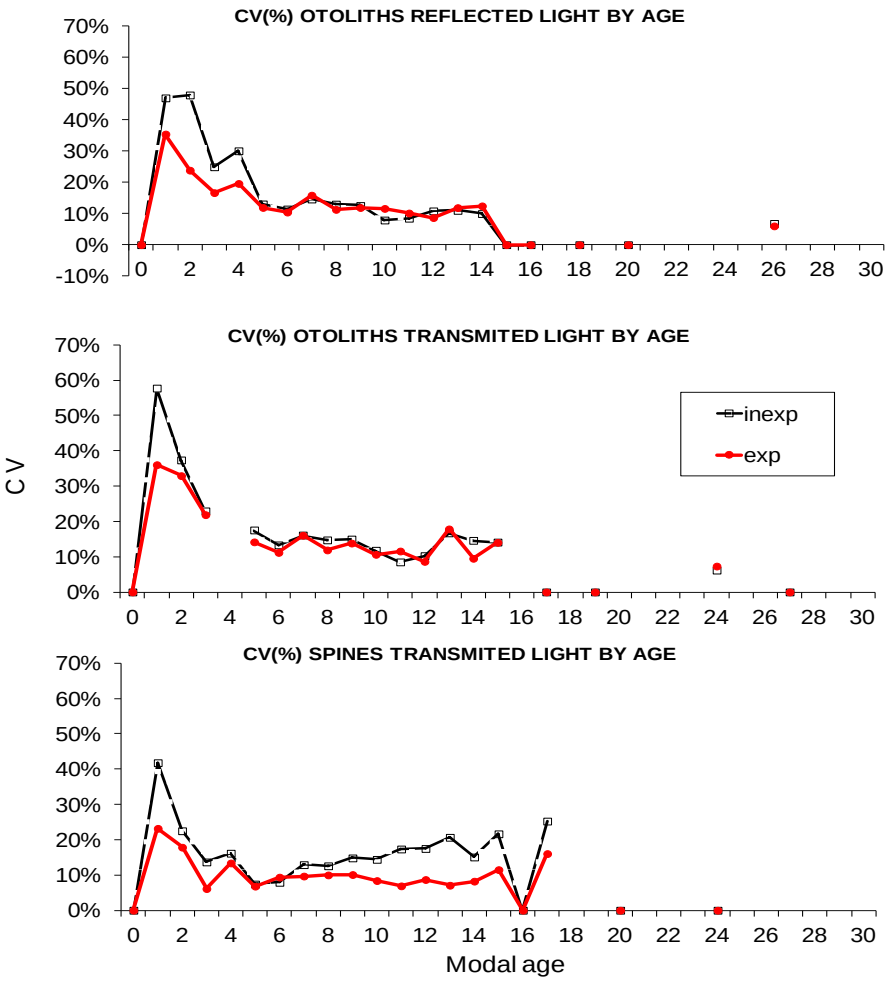


Figure 34. CV (%) trend by age and by calcified structure/type of light and reader experience (exp= experienced, inexp= inexperienced).

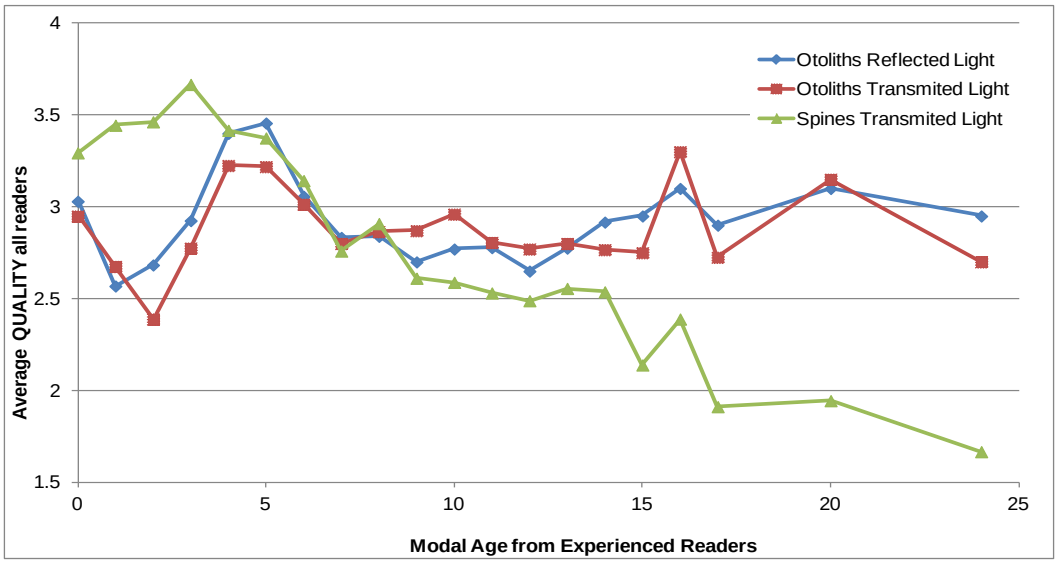


Figure 35. Average quality by CS/light type versus experienced reader modal age. Readability Code: 1=Pattern present-no meaning, 2=Pattern present-unsure with age estimate, 3=Good pattern present-slightly unsure in some areas, 4=Good pattern-confident with age estimate.