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ICCAT ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA (GBYP) ACTIVITY REPORT FOR THE LAST PART OF PHASE 6 AND THE FIRST PART OF PHASE 7 (2016-2017)

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SUMMARY

The Atlantic-wide research programme for Bluefin tuna (GBYP) officially begun in October 2009. The Phase 6 was carried out in the period 2016-2017. Phase 7 began on 21 February 2017 and will be active until 20 February 2018. Activities in the Phase 6 included (a) continuation of data mining, recovery and elaboration, (b) biological studies, (c) tagging, including awareness and rewarding campaign and (d) further steps of the modelling approaches, while in the Phase 7 all the activities continued. The aerial survey, which was in the Phase 6 suspended by the Steering Committee, was resumed in Phase 7 and it was very successful.

RÉSUMÉ

Le Programme de recherche sur le thon rouge englobant tout l'Atlantique (ICCAT-GBYP) a commencé officiellement ses activités en octobre 2009. La phase 6 a été menée au cours de la période 2016-2017. La phase 7, qui a commencé le 21 février 2017, sera active jusqu'au 20 février 2018. Les activités de la phase 6 comprenaient (a) la poursuite de l'exploration, récupération et élaboration des données ; (b) les études biologiques ; (c) le marquage, y compris les campagnes de sensibilisation et de récompense et (d) les étapes ultérieures des approches de modélisation, tandis que dans la phase 7 toutes les activités se sont poursuivies. La prospection aérienne, qui avait été suspendue par le Comité directeur pendant la phase 6, a repris au cours de la phase 7 et a donné d'excellents résultats.

RESUMEN

El Programa de investigación sobre atún rojo para todo el Atlántico (GBYP) comenzó oficialmente en octubre de 2009. La fase 6 se llevó a cabo en el periodo 2016-2017. La fase 7 empezó el 21 de febrero de 2017 y continuará hasta el 20 de febrero de 2018. Las actividades de la fase 6 incluyeron (a) la continuación de la minería, recuperación y elaboración de datos, (b) estudios biológicos, (c) marcado, incluidas campañas de concienciación y recompensas, (d) más pasos en los enfoques de modelación, mientras que en la fase 7 las actividades han continuado. La prospección aérea, que en la fase 6 fue suspendida por el Comité directivo, se reinició en la fase 7 y fue un gran éxito.

KEYWORDS

Bluefin tuna, ICCAT, historical data, market data, biological analyses, tagging, genetics, maturity, microchemistry, aerial survey, modelling, Mediterranean Sea, Atlantic Ocean

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1. Introduction

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

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

The total budget of the programme was estimated at about 19 million Euros in six years, with the engagement of the European Union and some other Contracting Parties to contribute to this programme in 2009 and in the following years; the budget officially approved by the ICCAT Commission in 2008 was 19,075,000 Euro for 6 years. The initial year had costs for 653,864 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 1,769,363 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 final costs were 2,819,557 Euros. The fifth phase had a total budget of 2,125,000 Euros (against the original approved figure of 3,345,000 Euros) and final costs were 1,995,787 Euros. The sixth phase had a total budget of 2,125,000 Euros and the final cost were 1,945,137 Euros. The seventh phase has a total budget of 1,808,985 Euros. The overall ICCAT GBYP operating budget for the first seven phases, covering eight years (a total of 13,311,541 Euros) is about 69.79% of what it was supposed to be (the 19,075,000 Euros approved by the Commission) for just 6 years. Several private or public entities[2] provided few additional funds or in kind support. These budget reductions had an impact on all activities carried out so far.

Taking into account the above reported figure, in 2014 the GBYP Steering Committee (documents SCRS/2014/194 and SCI 005/2014) and the SCRS recommended extending the GBYP activities up to 2021 and this proposal was endorsed by the Commission during its meeting on November 2014, along with the SCRS report.

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 (Algeria, Tunisia, Egypt, Iceland and Korea) joined the first funders in the following Phases, while Phase 7 was co-funded by the European Union, Libya, Japan, Tunisia, Turkey, Morocco, Canada, Chinese Taipei, Popular Republic of China and Iceland, in order of contribution. Some of CPCs did not paid fully or partly their contribution (sometimes even after the commitment), further limiting the use of available funds, because the EU has a maximum percentage of contribution of 80% under the firm condition to duly obtain the remaining 20%.

The sixth phase of the ICCAT GBYP officially started on 21 February 2016 following the signature of the Grant agreement for the co-financing of the ICCAT GBYP Phase 6 (SI2.727749) by the European Commission and ended on 20 February 2017. The partial results were presented to the SCRS and the Commission in 2016 (SCRS/2016/193) and they have been approved. The final report for Phase 6 has been officially approved by the European Union.

The seventh phase of the ICCAT GBYP officially started on 21 February 2017 following the signature of the Grant agreement for the co-financing of the ICCAT GBYP Phase 7 (SI2.752957) by the European Commission and will end on 20 February 2018.

The ICCAT Commission, in its meeting in Genova (Italy) on November 2014 approved the extension of the GBYP up to 2021 as included in the SCRS report, following the recommendations of the GBYP Steering Committee and the SCRS. A new plan for the GBYP activities to be done during these additional years was approved along with the extension.

For the purpose of independently reviewing the work carried out to date within the scope of ICCAT GBYP and evaluating the effectiveness of this complex research programme, as required by the Commission in 2015, a large comprehensive review of the first five Phases of ICCAT GBYP was carried out at the beginning of the Phase 6 and the results were presented to the SCRS 2016 Plenary and to the Commission at its 2016 Special Meeting (SCRS/2016/192), and the final opinion of the reviewers was very positive.

[2] Additional financial contributions to GBYP were provided by Asociación de Pesca, Comercio y Consumo Responsable de Atún Rojo (SP) and by Grupo Ricardo Fuentes e Hijos s.a. (SP). In kind contributions were provided by Aquastudio Research Institute (IT), Balfegó Grup (SP), Carloforte Tonnare PIAMM (IT), Federcoopesca (IT), Ph.D. Jean Marc Fromentin (France), IEO–Fuengirola (SP); INRH –Tangier (MO), Maromadraba SARL and Es Sahel (Fuentes Group) (MO), Oceanis srl (IT), Ph.D. Molly Lutcavage (US), Mr. Roberto Mielgo Bregazzi (SP), the Stanford University (USA), Unimar (IT), the University of Cagliari (IT), Wildlife Computers Inc. (USA), the WWF Mediterranean Programme and the GBYP Coordinator.

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.

2. Coordination activities

In the first part of the Programme, the staff was composed by the GBYP Coordinator, the Coordinator assistant (from March 2011 to March 2014) and one contracted technician for data management (from October 2011 to December 2013). In the second part of Phase 4 the staff was reduced to the Coordinator only, while the previous staff level was resumed from May 2015 (see **Table 1**). The ICCAT Secretariat provided always the necessary support for the GBYP activities, including also the important administrative duties, and this support has been essential and extremely useful.

The GBYP Coordination activity had so far a total cost of 2,395,429 Euro[3], including many components and also all costs for the Steering Committee and the two reviews. This cost represents 18% of the total GBYP operative budget for the first 7 Phases.

A total of 8 Calls for Tenders, and 3 official invitations were released in Phase 6, along with 1 call for applications to the training course. A total of 20 contracts have been awarded to various entities (**Annex Ia**). 9 additional calls for tenders have been announced to date in the first part of Phase 7 and a total of 16 contracts have been awarded to date to various entities in Phase 7 (**Annex Ib**).

In total, 132 contracts have been awarded under the ICCAT GBYP up to the first part of Phase 7 to 102 entities, located in 24 different countries; many hundreds of researchers and technicians have been involved to date in the various ICCAT GBYP activities. This extensive and open participation in ICCAT GBYP activities is considered to be one of the best results of this research programme.

A total of 54 reports were produced in the framework of Phase 6 of the ICCAT GBYP. Several additional documents and reports have also been issued by the ICCAT GBYP for the needs of Steering Committee meetings; a total of 50 scientific papers were produced in Phase 6 (**Annex IIa**). A total of 18 reports have been produced in the first part of Phase 7, along with 17 scientific papers (**Annex IIb**). The total number of reports produced by GBYP up to the first part of Phase 7 is 265, and 238 scientific papers have been published so far by various scientists who used the GBYP data. This important number of technical and scientific papers and reports is another important result of the Programme.

The coordination staff participated in 10 meetings in various countries in Phase 6 (7 were already reported in the previous GBYP report), and to 10 meetings in the first part of Phase 7, up to September 2017 (**Annex III**).

As usual, the administrative and desk work behind all these duties was huge 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 since the beginning of this programme.

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 various CPCs concerned. A continuous assistance, 7/7 days 24/24h, was necessary for solving various problems, emergencies and operational difficulties.

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 period 2013-2017.

In conformity with the Atlantic-Wide Bluefin Research Programme (GBYP) adopted by the SCRS and the Commission for Phase 6 and 7, the following research initiatives have been conducted, completed or initiated (see also **Annex I**).

[3] The cost includes 357.985 Euro in Phase 7, an amount which might be different at the end of the Phase.

3. Data mining and data recovery (final part of Phase 6 and first part of Phase 7)

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 previously 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 improving our knowledge about Atlantic Bluefin tuna.

The total budget for data mining and data recovery was 600,000 euro for activities in 3 years; so far, the total expenditures have been 612,801 euro[4] for 8 years of activities (102.13 % of the original budget), recovering much more data that it was set at the beginning). This amount represents 4.6% of the total GBYP funds received so far. The data recovered so far in all ICCAT GBYP Phases are included in **Table 2** and **Table 3**. Therefore, the GBYP objectives set for data recovery and data mining in these first Phases have been largely accomplished.

3.2 Data recovery in Phase 6

3.2.1 Recent and historical catch data recovery

ICCAT GBYP issued one Call for Tenders under this activity in the beginning of the Phase 6, awarding 3 contracts. One contract was for recovering recent long-line data (by area, vessel, day, effort, and catch in kg and number, length and weigh individual frequencies), a second one for additional recent long-line data with the same details and for additional historical trap data, and a third one for trying the recovery of historical catch data in the Canary Islands zone. No proposals have been received from other ICCAT areas.

In the second part of the Phase, GBYP discovered that an important Ph.D. thesis was carried out at the University of Tarragona in 2015 on tuna traps in the Kingdom of Aragon and many of these traps were not in the ICCAT GBYP historical data sets. After a recommendation of the Steering Committee, it was decided to provide an invitation to the author and, following a positive response, a direct contract was awarded for recovering these additional datasets.

LL and TRAP Bluefin tuna data recovered in Phase 6 account for a total of 2,666,971 kg and 13,264 fish, while the data from the Canary Islands concerns a total of 36,877 kg of Bluefin tuna, but many data needs a further analysis, because most are related to not-well defined tuna species. All data were provided on the Excel forms, in the format used by the ICCAT Statistical Department.

The data sets recovered from Mediterranean LL for the years 2002-2015 (which are additional data sets not already available in the ICCAT data base) include catches by vessel, area and day, partly with effort data (no. of hooks/day) and are related to a total catch of 11,070 Bluefin tunas and a total weight of 112,875 kg. In addition, 11,059 Bluefin tunas have individual length or weight or both.

The data sets recovered for ancient Italian traps for the period 1823-1922 were extracted from additional original documents recently discovered and they fill some temporal gaps in already existing data series, for 13 traps. The data varies from trap to trap, from daily catches by fishing operation ("mattanza" to total year catch). The trap data are related to only 8,463 Bluefin tuna in number, and 2,554,096 kg, because in most of the cases, only the total catch in weight was recorded on the original documents. The difficulties for recovering these data was considerable. These data sets for long lines and historical traps are additional to those already recovered in previous GBYP Phases.

The data sets recovered in the Canary Islands were extracted from ancient registers of various Spanish factories in Tenerife, La Gomera and Las Palmas, providing various types of data by year, month or even day, sometimes by number of fish and/or weight by specie and by factory. The data recovered are related to various tuna species, to be further analysed in detail, and includes for sure at least a total of 36,877 kg of Bluefin tuna catches. A main problem concerns unidentified tuna species related to the number or weight of mixed tuna species which arrived to the salting and canning factories. Additionally it was possible to recover information related to the vessels fishing in the Canary area, but was impossible to relate each vessel with their correspondent catch. Catches were possibly obtained by hand lines (HAND) or pelagic trawls (MWT).

[4] The cost includes 60,000 Euro in Phase 7, an amount which might be different at the end of the Phase.

The data recovered for the former Kingdom of Aragon comprises the detailed datasets for the several tuna traps located in Sicily, Sardinia, Valencia and Catalonia mostly in the XVI-XVII century, but extending some data up to the beginning of the XIX century. Data were recovered for following traps in Sicily: Favignana, Formica, Bonagia and "Tonnara dell'Ursa"; in Sardinia: Pula, Carbonara, Pixini, Porto Scuso, Porto Palla, Santa Caterina di Pittinuri, Le Saline, Cala Vignola, San Marco, Porto Pi, Capo Bianco, Cala Agustina, Isola Piana and Argentiera; in Valencia: Benidorm, El Palmar and Xàbia; and for one trap in Catalunia: l`Hospitalet de l'Infant. These traps were elected for the data recovery because not only these series were the most complete and detailed ones, but also because they were among the most productive traps in the area in the examined period. These historical trap data cover the period between 1580 and 1823, with 243 years having data; a total of 2,602,051 Bluefin tuna were included, along with 323,139 tons of catches.

An overview of the Bluefin tuna data recovery in the first part of the Phase 6 is given in the paper SCRS/2016/150**,** already presented at the SCRS BFT Intersessional meeting.

3.2.2 Electronic tag data recovery

The electronic tagging carried out by ICCAT GBYP in previous Phases showed a very high complexity of the Bluefin tuna movements and these data, along with the results obtained from the GBYP biological studies, are also showing mixing in areas where it was not demonstrated before. Since the ICCAT GBYP tagging data alone are obviously not sufficient for describing the complexity of movements and behaviour of BFT in its distribution area, either for the short timeframe of GBYP activities or for the limited number of electronic tags deployed so far, the SCRS recommended to recover all available data sets from electronic tags deployed by several institutions in previous years, with the objective to have a comprehensive overview of BFT movements. Several data sets have been voluntary provided so far to the two experts in charge of assembling these data in a homogenous manner (Dr. Matthew Lauretta on behalf of the SCRS BFT Species Group and Dr. Thomas Carruthers on behalf of GBYP Core Modelling MSE Group). These data have been used for "feeding" the MSE process, which is currently under further developed.

Being aware of additional important e-tags data sets, the ICCAT GBYP Steering Committee recommended to release formal invitations for providing these data sets to the GBYP, with the objective of incorporating these additional data in an organized system and providing them to the SCRS and to the GBYP Modelling Expert. Following the invitation, Ph.D. Molly Lutcavage decided to provide the many e-tags data sets she has directly to the experts, without any cost for GBYP, while Ph.D. Michele Deflorio responded that the e-tags data sets will be provided in the future, only after publishing all data, even if these data were collected using EU funds.

Finally, the only contract was awarded to the Stanford University (Prof. Barbara Block), for providing the available electronic tags datasets. Consequently, 392 electronic data sets were provided from the Stanford University Tag-A-Giant (TAG) research program. The tag data files include all meta data, processed tracks, and the raw files from the tags.

All data provided have been transferred to the modelling experts (Lauretta and Carruthers) in timely manner and are used for feeding the MSE – OM model.

3.2.3 Trade, auction and market data evaluation

As agreed by the SCRS, the part of trade, auction and market data, which were validated by an external expert contracted by the GBYP in Phase 4, were officially considered fully validated, without the need of forming any specific expert group for further data examination, as initially planned.

Data sets, in their original format did not comply with the requirements for the direct incorporation into the ICCAT data base and therefore an additional work needed to be undertaken to modify and adapt them accordingly, in Phase 5. The GBYP Coordination made some minor modifications in the content and modified the format of the data, following the precise instructions and requirements of the ICCAT Statistical Department and provided the processed data to ICCAT, for incorporating them in the ICCAT data base.

The remaining part of the trade, auction and market data sets, which were not considered fully reliable because they were not validated ("form 3" of the sets), are kept in a separate data base, which is not public, and are subject to possible additional validation against statistical documents, BCDs or other support documentation, a work which would need much more additional time and efforts, and that would require the strict cooperation of the CPCs concerned, national experts and the ICCAT Secretariat.

According to the request made by the ICCAT GBYP Core Modelling MSE Group during its last meeting in Monterey, the data coming from the first two data sets that were validated so far, limiting them to those Bluefin tunas having RW and GGW individual data and considered reliable, were analysed and submitted by GBYP to the SCRS Bluefin tuna Intersessional Meeting in 2016 (SCRS/2016/142) for improving the size frequencies for the EBFT.

In July 2016, the ICCAT GBYP Steering Committee, in line with the comments provided by the second external review of the GBYP, recommended further analysing all three market data forms for possibly assessing the total removals by year. The SC recommended awarding an external contract for this purpose. In August 2016, a Call for Tenders was released with the goal to re-analyse the market, auction and trade datasets, identify the reliable ones and provide the estimation of the total level of possible catches of Atlantic Bluefin tuna that entered into the market for each year covered by the data, ideally by stock and under various hypotheses, including the expected CVs by year, for further analyses of the SCRS BFT Species Group. After selection, a contract was provided to MRAG (UK).

The results from the analysis of all three datasets highlighted differences between the official catch statistics (Task I) used for stock assessment and catch estimates derived from the 3 new datasets (**Figure 1**). Those differences are more evident for the earlier years (before 2008) with estimated catches being much lower than official statistics while they were very close to (but still lower than) Task I data for the recent years. The lack of BCD data before 2008 could be one of the reasons for the higher differences in that period, while the fish going directly to local markets might possibly explain the negative differences. The analysis also showed that there is considerable ambiguity with regards to records of caged fish as the 3 Forms included a number of records showing fish transferred to cages but with no corresponding records of fish harvested after the fattening period. However, it is not clear whether this is due to records missing from the 3 datasets analysed or if it reflects actual discrepancies.

The latter issue creates uncertainty in the interpretation of the records and our analysis has provided results under different combinations of data to capture that. Uncertainty in the estimated catches also comes from a number of other sources, including values of fattening ratios, conversion factors and allocation of fish to different fattening groups.

With regards to representativeness, the extent to which each Form captures the fishing activity varies but all of them have some gaps in the data they hold. Although the three Forms hold data that are largely complementary, gaps still remain even after the three Forms are combined (e.g. they do not include catches from Japanese vessels or EBFT fish going to the Japanese market through third-non-EU countries; furthermore, fish going to local markets outside Japan are possibly little represented). Several records of fish traded by triangulations in western Atlantic cannot be analysed in detail without the direct cooperation of the countries concerned. For all these reasons, the results of the analysis are considered to represent an underestimate of total catches or removals. The length distribution frequencies are shown on **Figure 2**.

Full results were made available by the document SCRS/2017/013 which has already been presented at the SCRS Bluefin tuna Data Preparatory meeting in March 2017.

3.2.4 Support to Mauritania

In line with the recommendation made by the SCRS, which has been endorsed by the Commission, ICCAT GBYP organized a training course in the Islamic Republic of Mauritania in order to improve data and information collection about Bluefin tuna in the area. For that purpose, a memorandum of understanding was signed between the ICCAT Secretariat and the Institut Mauritanien de Recherches Océanographiques et des Pêches. The short course was held in Nouadhibou on 13-14 July 2017 and it addressed all the particularities about information and data collection, the reporting according to the SCRS requirements, and how to fill the submission forms, necessary for enforcing the ICCAT Rec. 14-04. All organization costs, travels and per-diems were covered by the ICCAT GBYP, which also provided dedicated forms and the financial support for the organization of the data collection.

3.3 Data recovery in Phase 7

3.3.1 The GBYP support to the SCRS Bluefin Tuna Data Preparatory meeting.

The GBYP support to the SCRS Bluefin tuna Data Preparatory meeting (6-11 March 2017) has been substantial, directly providing 7 papers (SCRS/2017/013, SCRS/2017/031, SCRS/2017/039, SCRS/2017/40, SCRS/2017/041, SCRS/2017/042 and SCRS/2017/043). Furthermore, the GBYP data have been used for the papers SCRS/2017/019, SCRS/2017/027, SCRS/2017028 and SCRS/2017/045.

3.3.2 The GBYP Data Recovery activity in Phase 7

ICCAT GBYP issued one Call for Tenders under this activity at the beginning of the Phase 7, in order to recover existing datasets which are not currently incorporated in the ICCAT database on Bluefin tuna, to support the improvement of the assessment analytical work and the MSE process. As a priority for the data mining in Phase 7, ICCAT GBYP Steering Committee identified the recovery of the recent or historical catch datasets.

Respective to this Call, three offers were received, one of which was later withdrawn and two remaining were awarded a contract. Both contract were for recovering recent data from the Italian long-line fisheries. The datasets include catches by vessel, area and day, partly with effort data (no. of hooks/day) and were provided on the Excel forms, in the format used by the ICCAT Statistical Department.

One contract provided recovery of the LL datasets for the years 2014-2016 and is related to a total catch of 4,958 Bluefin tunas and a total weight of 231,719 kg. In addition 4,958 Bluefin tunas have individual length or weight or both. The other contract provided the recovery of additional LL datasets for the years 2011, 2012 and 2016, which included a total catch of 15,744 Bluefin tunas and a total weight of 844,850 kg, out of which 3,172 individuals were sampled and their individual weigh or length data were provided.

The summary of the data recovered in the Phase 7 is shown by **Table 4**. The details on the data recovery in the last part of the Phase 6 and in the first part of Phase 7 and are presented in paper SCRS/2017/191.

In addition to these data recovery activities, the GBYP provided an additional key for interpreting the historical trap data, using the history of the Sicilian traps (the most documented in the Mediterranean area) for exemplifying the various problems over the centuries (SCRS/2017/043). Furthermore, an updated bibliography for the Bluefin tuna traps, including also video and audio documents, for a total of 2,245 titles, was made available to the SCRS Bluefin Tuna Species Group (SCRS/2017/119).

The GBYP recovered also some old ICES papers from the ‘70s, but all those seven papers had some restriction for using the data. A formal request was sent to ICES in March and finally the use of the data was authorized by the ICES Editor on 7 September 2017. After checking the data against those existing in the ICCAT BFT Data Base, the GBYP will recompile in the electronic format the data sets which are not already included in the ICCAT BFT data base and the files will be provided at the end of Phase 7.

Following a specific request provided by the ICCAT Statistical Department before the 2017 SCRS Bluefin tuna data preparatory meeting, the GBYP made all possible effort for recovering the available additional Bluefin tuna fishery data from the Black Sea. Therefore, in 2017, the GBYP carried out an extensive analysis of the available literature, trying to get any possible numerical information about those fisheries but the final result was limited to a series of Bulgarian historical catches, that were reported to the ICCAT Statistical Department and to the SCRS Bluefin tuna data preparatory meeting in March 2017, with the document SCRS/2017/039.

The GBYP data were used also for two additional paper (SCRS/2017/166 and SCRS/2017/169), which were presented to the SCRS Bluefin Tuna Assessment Session (20-28 July 2017).

4. Aerial Survey on Bluefin Tuna Spawning Aggregations

4.1 Objectives and overview of the Aerial Survey for Bluefin tuna spawning aggregations up to Phase 5

ICCAT GBYP Aerial Survey on Bluefin spawning aggregations was initially identified by the Commission as one of the three main research objectives of the Programme, in order to provide fishery-independent trends on the minimum SSB. The original GBYP programme included only a total of three annual surveys over a maximum of three different areas, but this plan was later modified by the Steering Committee and the statistical study revealed that under the best possible conditions a very minimum of six surveys will be necessary for detecting a trend with an acceptable CV level. The total original budget, set for 3 surveys in 3 areas, was 1,200,000 euro; the costs for carrying out the first 5 surveys in much more areas (up to 4 main “internal” areas and 7 “external” areas) are about 2,024,056 euro[5] (168.67% of the original budget, but with much more than the double of the activities initially planned). This amount represents 15.21% of the total GBYP funds used so far. Therefore, the GBYP objectives initially set for the aerial survey on spawning aggregations in these first Phases have been largely accomplished.

[5] The cost includes 388,000 Euro in Phase 7, an amount which might be different at the end of the Phase.

Two surveys on four selected areas have been carried out in GBYP Phase 1 and Phase 2, with many transect replicates. In Phase 2 the protocols were partly 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 extended survey was conducted in 2013 and the results were presented to the SCRS and the Commission. This was the first extended aerial survey conducted over more than 60% of the Mediterranean Sea, under very difficult situations, and using a budget that was not proportionally increased for keeping the same effort realised in previous surveys on the four main areas; therefore, the replicates in the main areas (defined as "inside") were much less, while they were reduced to the minimum in the additional areas (identified as "outside"). Even in this survey, security and permits problems have been serious constraints.

Due to severe budget constraints, it was impossible to carry out any aerial survey in 2014, during the extension period of Phase 4.

The GBYP Steering Committee, in September 2014, included again an extended aerial survey within the activities of Phase 5; this survey included 7 extended areas and 4 main areas. In the very last part of Phase 4, after the meeting of the GBYP Steering Committee in February 2015, a further analysis of the previous data was requested, for better assessing any variance possibly induced by the use of bubble windows since 2011 and the various types of aircrafts, and the study was included in the final report of GBYP Phase 4 for the EU. The possible use of a calibration exercise was discussed at the same meeting and a first draft on a SWOT analyses was presented by the GBYP coordination (SCRS/2015/143). This preliminary document was therefore discussed by mail with some well-known experts in aerial survey (Phil Hammond and Greg Donovan), who shared the contents, and therefore revised and presented to SCRS at the 2015 BFT Species Group meeting. The main results of the SWOT analysis indicates that a calibration for an aerial survey which uses so many pilots and spotters of different nationalities is not feasible, also taking into account the many legal constraints. Furthermore, a calibration limited to the rotation of scientific spotters (when feasible) would concern only one of the many variance factors which can bias an aerial survey. The GBYP Steering Committee, after many discussions, finally confirmed the agreement to include again the extended aerial survey in the activities of Phase 5.

The surface to be surveyed in 2015 was about 1,284,859 km^2 (312,491 km^2 of "inside" areas and 972,368 km^2 for "outside" areas), representing about 54.35% of the whole surface of the Mediterranean Sea, a surface never covered by any other scientific survey in the Mediterranean so far. Furthermore, this last survey covered about 87.6% of the total potential areas where spawning of Bluefin tuna may even occasionally occur. The total length of transects was 25,493 km (14,404 km in "inside" areas and 11,079 km in "outside" areas.

Strong winds, scarce visibility, Bluefin tunas travelling well below the surface (many purse-seiners got most of the catches by fishing with sonar in 2015) due to abnormal extreme oceanographic conditions[6] and military activities have been operative and environmental constraints that caused troubles for the survey in some areas.

The survey revealed that most of the school sightings were concentrated in the areas initially selected by GBYP for conducting the surveys in 2010 and 2011 (which were also the "inside" areas of the extended survey), confirming the full validity of the initial choice based on scientific knowledge and recent fishery data obtained by a VMS analyses of the purse-seiners activities from 2007 to 2009. Only very few sightings were made in other areas where spawners usually travel not so close to the surface.

Additionally, during Phase 5, an analysis on overlapping "inside" areas over the four surveys (**Figure 3**) was carried out, because it was supposed that looking at the same areas over the differ years may possibly provide a more homogenous and standardised comparison, even if further standardisation might be necessary, because the number of replicates or coverage was different in the various surveys. It was noticed a large inter-annual variability as well as geographical variability (variable concentrations in variable areas) among the various surveys. Overall, pooling all areas together, there is again a strong interannual variability both in terms of total weight and density of animals (and taking into account that sub-area G was not surveyed in 2011, the variability may be even larger). In 2010 the total weight (density of animals not being available due to the lack of information on cluster size on that year) was almost half as that in 2011, but still much larger than in 2013; in 2015 we observed the highest total weight of all years, much larger than in 2011. In terms of abundance of animals, 2011 has the largest estimate (and even more considering that area G was not surveyed that year), decreasing to around one third in 2013 (considering only A, C and E) but increasing again to less than two thirds in 2015.

[6] See document SCRS/2015/154, considering that July 2015 was the hottest so far in the Mediterranean Sea in the history of oceanographic records.

Clearly, these are the “normal” variance factors when carrying out an extended survey in a fixed period (which was set according to the peak of Bluefin tuna spawning in June, as it is known since a couple of centuries. This effect shold be smoothed in a sufficiently long series of surveys if oceanographic conditions get close to the usual average over most of these years.

In the last part of Phase 5, a power analysis and a cost benefit analysis for the aerial survey on spawning aggregations was done in order to have a more focused overview of the works carried out so far within the GBYP and have further details for adopting the best research strategy in Phase 6. The analysis showed that the average cost per km on effort in the GBYP survey was quite low (between 10.14 and 11.23 euro/km) when the survey was carried out only over the main spawning areas, while it increased in a considerable manner when the strategy was turned toward an extended survey covering most of the Mediterranean Sea (from 17.91 to 18.81 euro/km). This relevant increase in the last two extended surveys was due almost exclusively to the extremely complex logistic for surveying the “outside” areas, something that no other survey had faced so far. The comparison of costs with other aerial surveys that have been carried out for which cost data were made available showed that the GBYP cost (even if the effective transect length was the highest) are the lowest among all recent aerial surveys carried out in the European or Mediterranean area for various marine species.

The main recommendation coming out from the power analysis is that a reduction of the coefficients of variations, at several levels (encounter rates, school size, detection function and additional variances) is required to be able to detect trends in population abundance within an acceptable time frame. Furthermore, increased coverage in terms of kilometers of tracks (which means several replicates) on effort should be necessary. Tables of different cost analysis and power analysis have been provided for the purpose of evaluating the level of power (and therefore coverage) that could be achieved in the future aerial surveys, in correlation with the available level of financial resources.

4.2 Suspension of the aerial survey in Phase 6

According to the decision of the ICCAT GBYP Steering Committee adopted by e-mail, the aerial survey for the spawning aggregations was suspended again in the year 2016. The Steering Committee based the decision on the assumption that the financial resources are not sufficient for carrying out an adequate survey (i.e. in terms of survey effort that would be required to achieve a reasonable CV) again on the entire or in most of the area in the Mediterranean Sea where spawners/adults may occur. Additionally, it pointed out large logistical, political and administrative constraints that would more than likely prevent such an extended survey from being adequately implemented, even if very much larger financial resources were available.

Later, the Steering Committee identified the potential alternative to conduct a comprehensive survey restricted to relatively limited areas within the Mediterranean that can be adequately surveyed with the available resources. In order for this approach to provide a useful index of abundance, the proportion of the adult stock within the survey areas during the survey needs to be relatively constant. This is essential so that changes and trends in the actual size of the population can be distinguished from inter-annual variability in the utilization of the areas being surveyed. It also reiterated the request that a sort of calibration should be useful. The SC considered the recommendation that this alternative be adopted and the surveys be restricted to the four core overlapping areas that had been included in all the four previous surveys (**Figure 3**), which will provide standardised results and short series possibly usable both for the assessment and the MSE process.

The external reviewers of the GBYP, in Phase 6, also acknowledged the many efforts and the low cost of the GBYP aerial survey, along with the constraints and limits. They also recommended to continue the survey on the four main areas as the only possible alternative to a future Close-kin Genetic Tagging for providing a fishery-independent index.

4.3 Aerial survey in Phase 7

Following the express request of the European Union, the leading financial contributor of the GBYP, and the recommendation of the Steering Committee, the aerial survey was resumed in Phase 7 on the four overlapping areas (Balearic Sea, southern Tyrrhenian Sea, central-southern Mediterranean Sea and Levantine Sea) which have been already defined and standardised in the previous analyses, in order to provide at least a short series possibly usable both for the assessment and the MSE process. Due to the very tight schedule, it was recommended to monitor the survey data in real time, for detecting any possible bias or problem, immediately correcting the survey reporting and have the final report, as well as the index of abundance available for the SCRS BFT Stock Assessment Session. The budget originally planned for the aerial survey in 2017 was only 388,000 euro, well below the usual necessary level, due to a general budget restriction for Phase 7.

A first call of tenders was released at the very beginning of the Phase 7, for obtaining the Aerial Survey 2017 design, the revision of both the protocol and the sighting forms, the assistance to the training course and the survey data analyses. Only one bid was received, from the company that has already participated in this activity in the previous phases of the Programme (Alnilam Investigation and Conservation Ltd), and the contract was awarded.

The 2017 aerial surveys for Bluefin tuna in the Mediterranean Sea, as well as the ones in previous years, was designed using the software DISTANCE, the "industry standard" software for line and point transect distance sampling, based on: the four defined survey areas (survey areas A, C, E and G, see **Figure 4**), target survey time available (equivalent to about 32,000 km), time for circling over detected schools to estimate their size (set at 10%), and time for flying in between lines (set between 10 and 15% depending on the line separation in each block). The survey was designed as equal spaced parallel lines (transects), which were placed mostly in a north-south direction to be approximately perpendicular to the coast in most blocks (**Figure 5**). According to the design, each area had four replicates, while extra additional replicates were included in the design in case of time or budget availability. The comprehensive ICCAT GBYP aerial survey design for 2017 is available on line http://www.iccat.int/GBYP/Documents/ASURVEY/PHASE%207/Aerial_Survey_Design_2017.pdf

Following the drafting of the aerial survey design, another Call for tenders was released, for carrying out the survey in the four areas. Three companies were awarded the contracts: a Spanish company (Grup AirMed) was awarded for area A (Balearic Sea) and area E (southern-central Mediterranean Sea), two Italian companies working together (Unimar and Aerial Banners) for areas C (southern Tyrrhenian Sea) and a French company (Action Air Environnement/Action Communication) for area G (Levantine Sea).

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 and many daily difficulties encountered for various reasons. All companies received the necessary permits, even if some permits had to follow a complex procedure, due to some peculiar situations.

A training course for pilots, professional spotters and scientific observers was organised at the ICCAT Secretariat in Madrid, on 15 May 2017; it was attended by 22 fellows (for the first time, including the Turkish national observer), trained by an external expert (Dr. J.A. Vázquez) and by the GBYP Coordinator. During the training course, the GBYP Coordination carried out an independent assessment of the estimation and identification capacities of each participant, using a visual tool specifically developed by GBYP. The updated ICCAT GBYP Protocol for Aerial Survey for Bluefin Tuna Spawning Aggregation, the details for filling the sighting forms and the instructions for the administrative parts were circulated among the contractors immediately after the course.

The updated protocol and forms were developed in cooperation with the GBYP Coordination Team and are available on the web (http://www.iccat.int/GBYP/Documents/ASURVEY/PHASE%207/Aerial_Survey_Protocol_2017.pdf and http://www.iccat.int/GBYP/Documents/ASURVEY/PHASE%207/Aerial_Survey_Form_2017.xlsx). The updated form now has 51 field, with a total of 172 entries and it is considered possibly the most complete available among all aerial surveys for marine animals.

4.3.1 Aerial survey activities

This year, due to the reduced budget, it was necessary again to fit the survey effort with the available budget. Therefore, the transect length was initially set at 32,000 km, potentially allowing a maximum of four replicates in each area; according to the previous experience, this could have resulted either in more replicates if the stand-by days are nil or in less replicates if the stand-by days are higher than the forecast (max 25%). This design transect length was much higher than the effective average of the previous surveys (2010, 2011, 2013, 2015) of 21,180 km.

The schedule for beginning the aerial survey was set on 29 May 2017 and the 1st of July was set as the limit for concluding the field activities. As a matter of fact, the aerial survey field activities initiated on 29 May in area E, on 30 May in areas A and C, and on June 6 in area G, due to the complexity of the permit procedures and the travel days. The survey ended on June 14 in area C, on June 26 in areas A and G and on July 2 in area E (both the initial and ending dates do not include the days needed for reaching the base airport in each area and those for returning to the home airport). Therefore, the total number of days for effectively carrying out the survey were different in each area: 29 in area A, 16 in area C, 34 in area E and 21 area G.

The aircrafts were a Partenavia P68V (GBYP ID: ICCAT 1) in area A, a Partenavia P68V (ICCAT ID: ICCAT 2), and a Partenavia P68C-TC (GBYP ID: ICCAT 6) in area C, a Partenavia P68C (GBYP ID: ICCAT 3)[7] in area E and a CESSNA 337 Sky-master push-pull (GBYP ID: ICCAT 4) in area G. Therefore, we had three areas A, C and E) covered by high-wings twin side engines aircrafts and one area (G) covered by a high-wings push-pull engines aircraft. All aircrafts have been equipped with bubble windows, two additional GPS connected to the computer and declinometers. Each crew had a professional pilot who was also a professional observer, then a professional observer and two scientific observers (except in area G where a scientific observer was substituted by the Turkish national observer).

The factors affecting the survey in each area were different and **Table 5** graphically shows the activities in each area, including the days on stand-by and the motivations. In total, over 101 days of activities (29 in area A, 16 in area C, 35 in area E and 21 in area G), the number of days in stand-by was 35, equal to 34.6% against a preliminary estimation of 25%; including the days with partial activity, then the total reaches 37.5 days, equal to 37.1%. The percentage of stand-by days by area was 41% in area A, 19% in area C, 41% in area E and 29% in area G. This high number of days in stand-by was caused by many factors but mostly by the wind (30% in total), that affected several areas during this period (mostly the Balearic area and the central-southern Mediterranean Sea). This problem affected also the stabilisation of the thermocline in some parts of these areas, particularly when the wind continued over several days. Other motivations for the stand-by have been the lack of fuel in area E (a well-known recurrent problem in Malta over the years which is difficult to solve, due to the lack of Avgas in several airports close to the area or to the need of a higher rank pilot licence to land in Pantelleria, another airport where Avgas is available), accounting for 4%, the military activities in area G and some problem to the aircraft in area C (both accounting for 1% each). As a matter of fact, there was another motivation that only partly appears in **Table 5**, and this was the poor visibility in area G, which induced also to adopt a different approach for the strip size; this limited visibility, generated by a peculiar environmental situation, caused 19% of days of limited operational activity in the survey in area G.

In general, in 2017, the aerial survey worked much better than in all previous years, from all points of view and besides the usual problems. At the beginning it was necessary to discuss and solve the problems with the national authorities concerned; the problems were related to the permits in three FIRs, the potential security risks in three areas, the potential problems linked to possible interferences with rescue of migrants in one area and with military activities and operations in two areas, but at the end everything was solved by the GBYP Coordination working together side-by-side with the contracted companies concerned and with the extremely supportive local authorities. The problems during the field activities were discussed and solved in real time.

4.3.1 Aerial survey results

In previous ICCAT GBYP aerial surveys, the data analyses were available usually at the end of the year. For the very first time and thanks to the new strategy adopted by the GBYP Coordination, it was possible to get the data elaboration report in real time, therefore allowing the results and a paper (SCRS/2017/149) to be presented SCRS Bluefin tuna Assessment Session just two weeks after the conclusion of the field activities.

The coverage was very good in all areas (**Table 6**), for a total of 265,626 km^2, even if it was not possible to reach the total length of the transects set at the beginning, due to several motivations. As a matter of fact, at the end the final effective transect length was 21,178 km, equal to the average in previous surveys. This evidence confirms again the right choice of limiting the survey to the four overlapping areas for getting comparable and standardised results. In 2017, according to the parameters and diagnostics of the detection function, the effective strip width was defined at 1.4 km in all areas, due to the limited visibility in area G.

The results for all the aerial surveys carried out so far in the overlapping areas are shown in **Table 7** (for Balearic Sea), **Table 8** (for Southern Tyrrhenian Sea), **Table 9** (for central-southern Mediterranean Sea) and **Table 10** (for Levantine Sea). The summary table showing combined results of all overlapping areas for all 5 years of aerial survey performed by ICCAT GBYP is given in the **Table 11**.

The weather and oceanography conditions are extremely important for the aerial survey, particularly in the Mediterranean Sea, where oceanography factors are essential components for the spawning activities. The general geography of the Mediterranean area, with so many different coasts and hundreds of isles, naturally creates many different meteorological situations, over the more that 2.5 million Km^2 of the Mediterranean; these conditions may clearly affect the operational side of the survey. At the same time, the oceanography is quite complex as well, with effects on the distribution, the reproductive biology and behaviour of the Bluefin tuna, and this year it revealed a further interesting change in the distribution and concentration of the Bluefin tuna schools (a lower concentration in area E), which was mirrored by the adaptive strategy of the purse-seine fishing fleets.

[7] Due to a problem in the fuel reservoir in the first part of the survey in area C, it was necessary to substitute the aircraft with the reserve one.

The combined data for the four areas surveyed in 2017 are shown on **Table 12** and it is very clear that the aerial survey in 2017 was very successful, even taking into account the reduced budget availability, which imposed a reduced number of replicas compared to years when the budget was much higher, and considering also the unfavourable weather conditions in some areas, which limited both the operations and the effective strip width. Besides the practical problems, most of which are unpredictable but always within the usual *alea* of a wide field activity, the activity this year has been a win-win one.

The results show that the total survey area was equal to 265,627 km^2, for a final effective transect length of 21,178 km and a total effective area searched of 29,834 km^2. This last number is just the result of the reduced effective strip width (1.4 km, imposed mostly by the reduced visibility in one area), because, as a matter of fact, the searched area was much larger. The number of Bluefin tuna schools detected on effort (91) has been the highest so far, confirming a good presence of the species. The map showing the distribution of the Bluefin tuna sightings by area, on effort and off effort, during the survey in 2017, is provided by **Figure 6**.

The abundance of schools (387) was one of the highest so far, almost the same than the highest value (388) registered in 2011 and much higher than the average. The encounter rate of schools (0.0043) was the highest so far, about the double than the average. The density of schools (1.457/1000 km^2) has been the second highest so far, well over the average. The mean weight of the schools was 82.3 tons, below the average, for a high presence of young spawners. The density of animals (1.304 km2) has been the second highest, even in this case over the average. The main parameters, the total weight (31,855 tons) and the total abundance of fish (n=346,272) have been both the second highest so far, well over the average (**Figure 7** graphically shows the results in all surveys for the density of fish and schools, the total abundance and the total weight).

The detailed results of the ICCAT GBYP survey are presented in the paper SCRS/2017/149. For the very first time, the series of the ICCAT GBYP aerial survey data was used in the MSE and the OM, while the BFT SG considered that it is still limited in number of years for its use in the assessment. The results obtained by the ICCAT GBYP aerial survey in 2017 confirms the validity of the methodology and the need to continue the aerial survey in the following years.

5. Tagging activity

According to the general programme, after the adoption of the ICCAT GBYP Tagging Design and GBYP Tagging Manual in Phase 1, it was planned to begin the tagging activity in GBYP Phase 2 and continue it in the following Phases. The tag awareness and recovery programme was also launched in Phase 2 and continued in the following Phases, including a new tag rewarding policy. All details up to the last part of the Phase 6 are in document SCRS/2017/042, which has already been presented at the 2017 Bluefin Tuna Data Preparatory Meeting.

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[8].
b) Estimate the natural mortality rates (M) of Bluefin tuna populations by age or age-groups and/or total mortality (Z).
c) Estimate tagging reporting rates for conventional tags, by major fishery and area, also using the observer programs currently deployed in the Mediterranean fisheries (ICCAT ROP-BFT).
d) Evaluate habitat utilization and large-scale movement patterns (spatio-temporal) of both the juveniles and the spawners.
e) Estimate the retention rate of various tag types, due to contrasting experiences in various oceans.

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

[8] GBYP biological and genetic sampling and analyses results indicate that there is no structuring within the BFT in the Mediterranean.

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 absolutely necessary tagging design study and protocol, as well as the tag awareness and rewarding campaigns, were not included in this initial budget. So far, with only 50.95% of the funds (a total of 4,975,482 euro[9], equal to 37.38% of the total GBYP funds received so far), GBYP deployed so far 85.96 % of the conventional tags (25,787) and 129.33 % of the electronic tags[10] (388 in total; 326 mini PATs, 50 internal archival tags and 8 acoustic tags); furthermore, the tagging design and protocols, the awareness and rewarding campaigns were included in the activity carried out so far, while they were not included in the initial activities. It is very clear that the general objectives sets for the tagging activities in these first Phases were largely accomplished so far, even without considering the proportion of the available budget.

The updated situation of the tagging activities in Phase 7 is shown on **Table 13**. In total, up to 19 September 2017, the total number of Bluefin tunas tagged so far in all Phases of GBYP are 18,407, and a total of 26,171 tags of various types have been implanted (**Table 14**). 43.27% of the tagged fish were double tagged (against an objective of 40%).

Figure 8a shows the progression of the ICCAT GBYP tagging activities in the various years, clearly showing the yearly improvements up to 2014 and the remarkable reduction from Phase 5, due to the cancellation of the conventional tagging (but always maintaining the complimentary conventional tagging activities). **Figure 8b** shows the percentage distribution of tags implanted in the various geographical areas, up to 19 September 2017.

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. The details of the materials and tags acquired so far by ICCAT GBYP or donated by various institutions are on SCRS/2017/042.

5.3 Tagging activities in Phase 6

In Phase 6, the ICCAT GBYP Steering Committee decided to proceed exclusively with the electronic tagging activities, keeping the conventional tagging only as a complimentary activity. It was decided to focus the attention for the first part of the tagging on the eastern Mediterranean Sea, where recent tagging activities were limited to the last GBYP ones in 2015, in the Moroccan traps, where all recent tagging activities showed variable behaviour of the Bluefin tuna passing in this area and in the Sardinian area where electronic tagging was carried out in 2015 at the beginning of the spawning seasons. In the first part of the tagging activities, a total of 53 electronic pop up tags were implanted on adult Bluefin tunas in these areas.

The second part of the tagging activities was intended to be carried out in the Strait of Messina (central Mediterranean Sea), where tagging activities on “resident tunas” were not been carried out before, in the Portuguese traps, where Bluefin tuna moving into the Atlantic after spawning can be tagged and the sea off Ireland, where some tagging was carried out in the past. The contract for tagging off Ireland was released but it was cancelled before the signature. 24 e-tags were implanted in Portugal and another 15 in the Strait of Messina. It is important to note that 3 of the PSATs deployed in the Strait of Messina were kindly donated by the WWF and the tagging data results will be shared. Another 3 donated tags are to be deployed in the following phases.

The preliminary results of the tagging activities in Phase 6 show the important number of premature detachments. The reason for this probably lies in the high fishing pressure, the same problem that we faced in the Phase 5, as already discussed in the paper SCRS/2016/138. Additionally, this year the PSAT tags supplied by Wildlife Computers, which were used for the ICCAT GBYP tagging, were technically modified in terms of adding the automatic release device situated in the tag tether. As recognized by the manufacturer, a great deal of the premature detachments was due to the broken pin, which was more sensible than it should have been according to the technical specifications. As a matter of fact, out of 92 tags deployed in Phase, 25 detached because of the broken pin. The negotiation process with the producer has been initiated and the producer in August recalled and replaced the malfunctioning tags that hadn’t been deployed yet and provided more robust ones. Additionally, the producer agreed that all tags already implanted, that have released before their scheduled pop-off date due to this technical failure mode, will be replaced free of charge, compensating the damages with a double replacement for each tag.

[9] The cost includes 290,000 Euro in Phase 7, an amount which might be different at the end of the Phase.

[10] Considering the on-going electronic tagging activities in the North Sea (40 miniPATs, 18 deployed so far) and the complimentary electronic tagging from Korea (12 tags), the percentage of electronic tags deployed till the end of Phase 7 might reach 141%.

According to the results of the tags data processing, it seems that in 2016 all tunas tagged in Morocco entered immediately into the Mediterranean Sea for spawning. This is different from the tagging results in previous years showing only a proportion of tagged tunas entering the Mediterranean, while the others stayed in the Atlantic Sea. The previous results are consistent with the results providing from the GBYP Biological Studies, showing each year different proportion of tunas in Morocco belonging to the eastern and western stock; therefore, we suspect that all tunas tagged in Morocco in Phase 6 should be EBFT. The tunas tagged in Portugal showed a different pattern, heading towards the North Atlantic feeding areas. These were expected results, having in mind that these tunas were tagged after the spawning season; it is important to notice that one of the Bluefin tuna tagged in Portugal showed a different displacement from the others, moving toward the Azores. The Bluefin tunas tagged in Sardinia stayed in the western Mediterranean, which is a behaviour similar to what have been already observed in 2015, when none of the tunas tagged in Sardinia had left the Mediterranean Sea. Regarding the Bluefin tunas tagged in the Levantine Sea, the observed behaviour is the same as the last year. Although the majority of tags detached in a short period of time which didn't provide us the chance to record the displacements of these tunas after spawning, it seems that the majority were heading west, and some tunas reached western Mediterranean areas before their tag popped off. The Bluefin tunas tagged in the Strait of Messina mostly stayed in the area of Central Mediterranean. This was expected behaviour having in mind that these tunas were tagged after the spawning season and therefore included only Mediterranean "resident tunas", those overwintering in the Mediterranean Sea. The tracks of all electronic tags deployed by GBYP in Phase 6 are showed on **Figure 11**.

An analysis of the ICCAT GBYP Electronic Tags data was performed by the GBYP team in Phase 6 and the results were presented by SCRS/2016/138. The analysis was done on 193 tags implanted by the time (tags deployed between 2011 and 2015), not including those deployed in Phase 6, out of which 173 datasets were available. An analysis of the displacement of the fish was also performed, using the data provided by the conventional tags and the results have already been presented in the paper SCRS/2016/143.

Following a specific recommendation of the GBYP Steering Committee, a contract was given to CLS for reprocessing of 107 tag datasets at the end of Phase 6. CLS is the company that processed all ICCAT GBYP electronic tag datasets so far, using the special algorithm developed by them for calculating the maximum probable geolocations out of raw data on light, depth and temperature. Since the beginning of the ICCAT GBYP tagging programme, CLS algorithm has been improved, therefore providing results in slightly different format. In order to have the all results in the same format and therefore comparable, a re-processing of older tags was carried out, by using the newest algorithm.

A Call for tenders was also released in Phase 6 for tag awareness purposes, for producing the short video and the spot propaganda on ICCAT GBYP tagging activities, specially focusing on their contribution to the scientific knowledge, the sustainability of fisheries and the available rewards.

5.4 Tagging activities in the first part of Phase 7

As recommended by the Steering Committee, the tagging activities in the Phase 7 were limited again to the deployment of electronic tags, keeping the deployment of conventional tags only as a complimentary activity.

The attention for the first part of the tagging programme in the Phase 7 was focused in the northern Atlantic and in the North Sea. Only one contract was awarded, for the deployment of 20 PSATs in waters near Sweden and 20 in water near Denmark. The tags will be possibly deployed from September till the end of October, depending on the presence of the Bluefin tuna. The fishing gear to be used for tagging will be the rod and reel, while an auxiliary boat will be chartered and used for moving the tagging team within the tagging area. Adult Bluefin tunas will be tagged on board or along the side of the boat by expert taggers.

The Bluefin tuna was first spotted again in the Norwegian waters in 2012, after decades of absence, and the GBYP had the opportunity to get the first information in real time, thanks to a fish tagged by our team in Morocco. The reasons for the return of Bluefin tuna in the Nordic waters are currently unknown, but it is important to note that mackerels were quite abundant in these last years in the same waters. In 2016, the Bluefin tuna was noticed also in the Swedish waters, not far from the coast. It is suspected that the Bluefin tuna going to the North Sea is almost exclusively of eastern origin. The tagging will possibly help understanding these migration patterns and specific behaviour, because this will be the first time Bluefin will be tagged in the waters around Denmark and Sweden. The information from the released tags will possibly provide the complementary data to the current electronic tags database and extend its coverage to new northern areas.

Following the recommendation of the Steering Committee, a second call for tenders was released, for the tagging activities in the Portuguese traps and in the Strait of Messina. Only one contract was awarded, for tagging 40 Bluefin tunas in the Portuguese traps. These traps capture mostly tunas moving into the Atlantic after spawning in the Mediterranean Sea, but in 2017 they got also incoming fish. As reported above, tagging has already been done there in 2016, but the results were suboptimal, given the high number of premature releases, mostly due to the technical failure of the electronic tags. Nevertheless, although the deployments were short, they showed that from Portuguese traps, the majority of tagged individuals moved towards northern Atlantic, while one moved towards the Azores. The results of the tags deployed in Portuguese traps in 2016 have been presented in SCRS/2017/042. As concerns the first 40 deployments in 2017, so far 33 miniPATs had already popped off; 4 fish moved towards the North Sea, 1 reached the Gulf of St. Lawrence (Canada), other 2 moved towards the Canadian waters, one reached the coast of Island, 1 moved south reaching the Canary Islands, while the others moved to various areas of the North Atlantic. The tagging activities in the North Sea (Denmark and Sweden) are still going on, but 13 fish have been tagged up to September 19; one tag deployed in Denmark and one deployed in Sweden had already popped-off, possibly due to a post release mortality. **Figure 12** shows the location of all electronic tags deployed by GBYP in Phase 7 which popped-off up to 19 September 2017.

The total duration of the tags implanted so far by GBYP (= days at liberty) was 782 days in average (min. 1, max 2102 days) for the conventional tags and 48 days in average for the electronic tags (min 1, max 360 days).

In August 2017, the Korean National Institute of Fisheries Sciences informed the GBYP that they are going to deploy 12 electronic tags (2 miniPATs and 10 SPATs) during their 2017 fishing campaign for Bluefin Tuna in the Atlantic Ocean, and the data will be kindly shared with the ICCAT GBYP, providing additional scientific knowledge.

Following the request of the Bluefin Species Group expressed during the SCRS Bluefin Tuna Data Preparatory Meeting in March 2017, a brief study was performed in order to get a deeper insight into the migratory patterns of the Bluefin entering the Mediterranean and the results are presented in SCRS/2017/131. This paper shows the distribution of both conventional tags and electronic tags that were deployed in the Atlantic Ocean and in the Strait of Gibraltar when they have been recovered or popped-off in the Mediterranean Sea. For better understanding the geographical distribution of those migrant fish, it was decided to divide the Mediterranean in five different areas and then asses the presence. Most of the tags are reported from the Strait of Gibraltar, while the percentage in other areas (Med Gate, Balearic and Central Med) is lower. The lowest percentage is in the eastern Mediterranean, due to many factors, including the W-E “filter” which accounts for the accumulation of fishing activities and the low tag reporting rate. It is confirmed that migrant fish are able to reach every part of the Mediterranean Sea, possibly with different abundance and with interannual variability. Further analyses of the tag data will be necessary, as well as a better reporting of natural marks, which inform us about the migration from the central-southern Atlantic.

A new and useful electronic tag data base with a Shiny application has been developed by GBYP in Phase 7 and it is now available for the SCRS scientists (SCRS/2017/192). The application allows for an easy visualisation of the data and particularly the tracks.

5.5 Tag awareness campaign and reward policy

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

Posters are now present in most of the ports where Bluefin tuna are usually or potentially landed, in tuna farms, tuna traps, industries, sport fishers clubs, fishers associations, bars where fishers are usually going, local port authorities and on many fishing vessels. Some articles were also promoted and they have been published on newspapers and magazines.

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

The GBYP staff actively participated every year (except in 2016 because it was not authorised) to the training 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.

A short video propaganda on ICCAT GBYP tagging activities, along with a spot, were produced in Phase 6. The videos and spots were translated in 8 languages and were already presented at the SCRS meeting in September 2016. While it is now available for free download, it is envisaged to develop the ICCAT GBYP Bluefin tuna tagging visibility campaign and use these video materials for this purpose, by distributing them to main TV stations and other media in Mediterranean CPCs. Some CPCs had already used the videos on national television channels. All videos are uploaded on YouTube as a preview (https://www.youtube.com/channel/UCK25VrRxTajo-7I0AQbNQxw) and their download in the high quality is easily available on request. For better informing all ICCAT CPCs and scientists about the possibility to freely use these videos and spots, the ICCAT Secretariat released the Circular no. 0361/2017 (on 1 March 2017), with all the details. So far, the GBYP videos had 3,127 visualisations in 71 countries.

According to the recovery data, the combined strategy of both more important rewards and the awareness activities resulted in considerably improving the tag reporting compared to previous times.

5.6 Tag recovery and tag reporting

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

While examining the results of the ICCAT GBYP tag recovery/reporting activities, it is very important to consider that about 90% of the conventionally tagged fish in Phases 2-4 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 by most of the fisheries, particularly taking into account the ICCAT minimum size regulation and the fact that the baitboat fishery in the Bay of Biscay in the last years was almost nil, because fishermen sold their quota to other fisheries. Furthermore, the institutional GBYP conventional tagging campaign was suspended in Phase 5, 6 and 7, while the complimentary conventional tagging activities were continued.

Since the first year of the GBYP and up to 19 September 2017, there have been 648 tags recovered by GBYP. The GBYP recoveries are summarized as follow:

- 396 Conventional “Single-barb” spaghetti tags (61.11% of the total)
- 206 Conventional “Double-barb” (two types) spaghetti tags (31.79% of the total)
- 26 External Electronic “mini-PATs” tags (4.01% of the total)
- 13 Internal Electronic “Archival” tags (2.01% of the total)
- 3 Acoustic tag (0.46% of the total)
- 4 Commercial “Trade” Bluefin tuna tag (0.62% of the total)

The distribution of tag recovered by area and fishery is shown on **Table 15** and **Table 16**.

The number of tags reported by two important commercial activities in the Eastern Atlantic and in the Mediterranean Sea (purse-seiners/cages and tuna traps) is 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 purse-seine catches (and, in recent years, also most of the trap 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: the farms had recovered 90 tags, of various types (63 single-barb spaghetti, 18 double-barb spaghetti, 1 PSAT, 5 internal and 1 acoustic), while 23 were recovered from purse-seiners (15 single-barb spaghetti, 6 double-barb spaghetti, 1 PSAT and 1 internal). Even considering that most of the last conventional tagging activities were targeting juveniles, the recovery and reporting rate for these activities is still too low (13.89% of the total reported tags for the farms and 3.55% for the purse-seiners). The same conclusions can be stated for the traps, because they have reported only 17 tags to ICCAT within the period taken into account (8 single-barb spaghetti, 7 double-barb spaghetti, 2 internal archival). Even in this case, the recovery and reporting rate (2.62% of the total recovered tags) is still too low, even if it increased in the past year. 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 (66 tags in total, 40 single-barb spaghetti, 24 double-barb spaghetti and 2 internal, equal to 10.19% of the total). The possible reasons for the low reporting rates from all these relevant fisheries have been already discussed at the document SCRS/2013/177.

The important tag reporting improvement registered after the beginning of the tagging and tag awareness activities by ICCAT GBYP is impressive (**Table 17**[11] and **Figure 10**): the average ICCAT recovery for the period 2002-2009 was only 0.88 tags per year, while during GBYP tag recovery activities the average was 87.37 tags per year, resulting in 9,928% increasing. The first significant increase in the rate of the tag recoveries was recorded in 2014, when GBYP recovered a total of 108 tags. Such a success should probably be attributed, not only to the recent tagging activities, but to the settled tag awareness campaign as well. In the year 2015, a total of 121 tags were recovered, in spite of the fact that conventional tagging was almost suspended in that year and that in 2014, due to budget constraint, it was poorly done. In 2016 the recovery reached the peak, with 162 tags of various types. In 2017, up to the 19 September, 92 tags have been recovered (an amount which is more than the double of the tags reported for the same partial period in 2016). The total recovery rate, for all types of tags, is currently 2.48%. 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. Considering that reported tags from the Mediterranean were almost nil before GBYP, this is the clear evidence that GBYP tag awareness campaign is producing positive effects.

It is extremely difficult 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 now 2.34%, but this rate is clearly negatively biased by the juvenile ages of about 90% of the tagged fish. At the same time, it is impossible assessing the recovery rate of tags which were not deployed by ICCAT GBYP, because ICCAT does not have the insight in the total number of implanted tags by each tagging entity in the ICCAT area. Anyway, for the first time in the ICCAT history of Bluefin tuna tagging, the recovery rate is well above 2% and this fact represents another success.

Interesting information is slowly coming from the double tagged tunas (**Table 18**): up to 19 September 2017, a total of 323 tags were recovered from 202 double tagged fish and both tags have been recovered from 121 fish (59.9% of the double tagged fish recoveries). 39 fish had only the billfish (double-barb) tag on, while other 42 fish had only the single barb spaghetti on. According to these first data, it seems that both types of tags (single barb and double barb) are more or less equally resistant, with a slightly higher resilience for the single barb ones (80.69% against 79.21%). The shedding rate is now at 40.1%. The tag recovery rate for all double tagged fish by GBYP is currently 2.59%, and even in this case the percentage is for the first time above the 2%.

Reiterating what it was said in the first part of the ICCAT GBYP, 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 should be mandatory. That is essential because recoveries can be logically reported to ICCAT at any time and it is not always easy, rather time/effort consuming, finding the entity which implanted the tags if data are not properly stored. As usual, the GBYP staff had experienced a lot of difficulties in recovering the tag release data in several cases, with a considerable additional workload. At the moment this tag release communication to the ICCAT Secretariat is not mandatory, but it should be, because it has a general interest, including for the various entities and institutions carrying out this activity. An ICCAT Recommendation for this important issue would be very useful.

5.7 Close-kin genetic tagging

As a possible alternative to the conventional tagging or as additional tagging approach, the ICCAT GBYP Steering Committee recommended to explore and evaluate the close-kin genetic tagging (Close Kin Mark Recapture, CKMR). It is a new approach to estimate the SSB abundance and other important population parameters that is currently applied for some fish species (including sharks), some marine mammals species, for the southern Bluefin tuna and that will be possibly applied also for the Pacific Bluefin tuna. CKMR uses information on the frequency and distribution in space and time of closely genetically related individuals in samples of tissue from live or dead animals.

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[11] 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).

For the purpose of obtaining the advice on close-kin tagging and a feasibility study, a call for tenders was released in the last part of the Phase 5, and the contract was awarded to The Commonwealth Scientific and Industrial Research Organisation (CSIRO) from Australia. Due to the important delay linked to time constraints for the conclusion of Phase 5, the original terms of reference were split in two parts by the Steering Committee: a first part of the feasibility study to be done during Phase 5 and, depending to the availability of funds, the possible follow up which would be done in Phase 6.

Given the fact that CSIRO provided its report with considerable delay and with some problems in the contents, the Steering Committee decided to have a refined and revised report in Phase 6, before going on with the dedicated genetic workshop and the second part of the CKMR feasibility study, originally planned in Phase 7. The purpose of the workshop is the interchange of the knowledge and technics on BFT genetics for close-kin purposes, especially having in mind the recent discoveries in the field which might somehow reduce the costs of the analyses. It was planned that it would be attended by the experts in genetics who have previous experience in analysing BFT samples within the GBYP and the ones that have experience on analysing genetic for the southern Bluefin tuna CKMR. The report concerning the preparation of the workshop for CKMR genetic possibly better describes the current problems of this technique when it is applied to a species having a so large distribution area.

When the revised report for the first part of the feasibility study was provided by CSIRO along with the report for programming the workshop on CKMR genetics, the CSIRO also stated its unavailability for carrying out the second part of the feasibility study in Phase 7 (as it was planned), due to a considerable workload but also to the need to further check the CKMR technique applied to tunas. At the same time, due to the same reasons, they proposed to move at least to Phase 8 both the second part of the feasibility study and the workshop

Given that it was not possible for the contractor to provide a realistic costing for the CKMR study in this primary stage, the GBYP Steering Committee decided anyway to start collecting the necessary samples as much as possible, also for practically assessing the feasibility and the real costs for carrying out a CKMR study for EBFT, starting from Phase 6. An enhanced sampling was done within the Biological studies for both juveniles and adults in the major spawning areas, also for testing the sampling problems and not only the real costs. As a first result, sampling for adult spawners in the spawning areas resulted feasible in the Balearic area, in the southern Tyrrhenian Sea and in the central-southern Mediterranean, but with much higher costs compared to those very optimistically hypothesized in the first part of the CKMR feasibility study, while sampling of adults in the Levantine Sea was only partly feasible, due to the difficulties encountered in the Turkish area by the local scientists. For the YOY, in 2016 there was a peculiar situation in the Mediterranean Sea (SCRS/2017/041), which prevented a full sampling in most of the areas.

In the Phase 7, the enhanced sampling for adults and juveniles was continued, but no other activities regarding CKMR are envisaged.

5.8 Catch and release study

Following a proposal made by the Croatian Institute for Oceanography and Fisheries, titled "Response of the Bluefin tuna to sport and recreational fishing by catch and release method", and after receiving a positive feedback from the Steering Committee, this complimentary research activity was included in GBYP Phase 7. It will follow the provisions of the Rec.11-06 and any mortality which might occur during the activity will be accounted against the GBYP RMA quota.

The main goal of this study is to investigate the impact of the catch and release methods on stress related behaviour and survival of Bluefin tuna and an additional aim is to monitor the recovery of the stressed fish in cage. During the purse seine fishing season (May/June 2017), 100 specimens of BFT ranging from 8 to 30 kg (approximately 1.2 t) were envisaged to be caught by purse seine in the central Adriatic and placed into a floating cage. The number and the size of the fish in the cage was estimated by stereoscopic camera (SC) system and verified by fishing inspection and the ROP. Following a period of acclimatization, at the onset of the feeding, the caged tuna was fished by big-game standard fishing methods, in parallel with adjusted ones. All hooked fish was inspected for the type of injures and marked with different colored signs attached on the leader line to indicate the fishing methods used for each one, in order to be able to follow each treated fish during the recovery.

A further element of this project is to complete a database on juvenile BFT. These data will include details on size frequencies provided by a stereo-camera system and the length/weight data from dead fish, in addition to the size/age/ maturity data when possible. The otoliths, dorsal fin rays and tissue for genetics were also envisaged to be provided when possible. The information obtained will be analyzed and interpreted, and the main findings will be made available to the SCRS.

6. Biological Studies

The initial, short-term ICCAT GBYP objective approved by the Commission in 2008 was to collect samples from 12,000 fish (including western Atlantic and the Japanese catches and markets) and carry out ageing and genetic studies, and micro-constituent analyses in three years in the eastern Atlantic and Mediterranean, with a total budget of 4,350,000 Euros. So far, with only about 59.75% of funding (2,598,925 euro[12], equal to 19.53% of the total funds received so far), the ICCAT GBYP collected samples from 9183 fish up to Phase 5, while additional 3,588 fish were sampled in Phase 6, bringing the total to 12,771 fish, equal to 106.4% of the initial target (12,000 fish); the collection of samples from 2,130 fish has been already contracted in Phase 7[13], bringing the total to 124.2% of the initial objective. Furthermore, the GBYP carried out aging, aging calibration, genetic and micro-constituent analyses; also, the sampling design and protocols, and the otolith shape analyses were included in the activity carried out so far, even if they were not included in the initial plan. It is very clear that the general objectives sets for the biological studies in these first Phases were largely accomplished so far, a result which is even more important when taking into account the proportion of the available budget.

The GBYP biological sampling design was the one provided by the Institute 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%20STUDIES/PHASE%202/Rapport%20final%20design%20echantillonnage%20biologique%20ICCAT-GBYP.pdf).

A new stratification was agreed in 2016 and then updated in 2017 (http://www.iccat.int/GBYP/Documents/BIOLOGICAL%20STUDIES/PHASE%207/ICCAT_GBYP_Sampling_Strata_2017.xlsx)

All the activities carried out in previous Phases and the first part of Phase 6 concerning the biological sampling and analyses have already been presented to SCRS and the Commission in 2016 (SCRS/2016/193).

6.1 Objectives

The main objective of this task was originally 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, 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 any possible sub-populations identification.

6.2 Activities in Phase 6

The activities in previous GBYP Phases have been clearly able to accomplish their objectives. 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.

Following the recommendations of the Steering Committee and the SCRS, the GBYP plan for Phase 6, biological studies were planned mainly as the continuation of the activities already started in earlier phases. Sampling was extended to areas and fisheries not covered or poorly covered in previous Phases, according to the ICCAT GBYP sampling design. A particular attention was devoted to the collection of otoliths and to ageing studies with the objective of developing an updated ALK and otolith collection was made mandatory in all contracts. Additionally, the special effort was put into sampling of adult BFT in farms, because they were underrepresented in the previous Phases and a larger number of adult tuna is needed for the purpose of not only developing the annual age-length key, but also for assessing the feasibility of the close kin genetic tagging.

Regarding the biological analyses of the samples, the activities were aimed at continuation of the studies already initiated in the previous phases, but with the additional task to compare, for the first time, single nucleotide polymorphisms (SNPs) analyses and microsatellites analyses, using the same samples, as it was agreed during the Symposium in Monterey. This specific activity provided a sort of calibration for the genetic analyses. At the same time, funds were devoted for carrying out a larger number of analyses and use most of the samples already collected in previous Phases. According to the recommendation of the Steering Committee, a special effort was devoted into the attempt to age the otoliths that have been collected during various phases of the Programme, but haven’t been read nor aged so far.

[12] The cost includes 539,000 Euro in Phase 7, an amount which might be different at the end of the Phase.

[13] In addition to the contracted sampling, an additional opportunistic sampling has been officially agreed with the ICCAT ROP.

In addition to these activities, the Steering Committee recommended to initiate an enhanced sampling activity of adult spawners fished in the four main spawning grounds in the Mediterranean Sea, with a double objective: a) improving in a considerable manner the otoliths and tissues samples and b) practically test bot the feasibility and the real costs in order to have more parameters for the second part of the feasibility study for CKMR. After preliminary contacts with all tuna farms, another invitation for sampling was released to the entities managing Bluefin tuna farms in Spain, Malta and Turkey, for sampling adult Bluefin tuna in the major spawning areas within the Mediterranean Sea. After receiving the proposals, three contracts were released. One contract was signed with Balfegó & Balfegó (EU-SP) for sampling 150 specimens from Balearic Sea, another contract was signed with the consortium headed by Taxon Estudios Ambientales (EU-SP) for sampling 170 specimens from the Balearic Sea and the third one with the consortium headed by AquaBioTech (EU-ML) for sampling 300 individuals from the southern Tyrrhenian Sea and 300 from the central/southern Mediterranean Sea. There was no proposal received from the Turkish farms or even from the Turkish Government and therefore the sampling of adults from the Levantine Sea was intended to be accomplished through the regular sampling performed yearly by a Consortium carrying out other components of the Biological Studies.

Following the release of the Call for tenders for biological studies, two bids were received: one for performing both sampling and analyses and the other for a limited sampling only. After negotiation and following an agreement between the two tenderers, a contract for biological studies in Phase 6 was again awarded to the Consortium headed by AZTI (EU-SP), having this year 14 partners and 6 subcontractors, belonging to 11 different countries, for carrying out both biological sampling and analyses.

Following a specific recommendation of the GBYP Steering Committee, a separate Call for tenders was released for reading and aging of 2000 otoliths already collected in Phase 6. Besides several preliminary contacts with various laboratories, no bids have been received and therefore this activity was suspended.

Pursuant to the recommendation of the Steering Committee and the ICCAT SCRS in 2015, GBYP in Phase 6 organized a dedicated Workshop on larval studies and surveys. The workshop was held at the ICCAT headquarter in Madrid, on 12-14 September 2016 and was attended by around 20 eminent scientists in Bluefin tuna larval biology from EU, USA and Japan. The workshop was considered quite successful and very useful even by the SCRS BFT Species Group. The report was presented as SCRS/2016/206.

6.2.1 Sampling

A total of 3,588 Bluefin tuna individuals have been sampled in Phase 6. From these, 1721 individuals were sampled under the additional contracts for sampling adults on farms, while 1867 individuals were collected by the Consortium. All the data on samples collected this year have already been merged with the general samples database and stored in the ICCAT GBYP tissue bank. **Table 19** shows the number of Bluefin tuna sampled in each strata (area/size class combination) in Phase 6.

The original plan, according to the contract, was to acquire samples from 2375 individuals (1375 individuals by the Consortium members and 1000 individuals by the tagging teams and other contracts addressing specific sampling in tuna farms). Thus the overall current sampling status represents 151% of the target in terms of total number of individuals. By size class, the objectives for juvenile, medium and large fish were accomplished (>100%, >100% and 191% of the target respectively), but the final sampling for age 0 remains only at 50% with respect to the original target. It is necessary to note that no sampling for juveniles and medium size fish was planned, but some 11/101 individuals have been finally sampled in the Levantine Sea, East of Sicily and Ionian Sea, Sardinia, Tyrrhenian, Portugal and the Central Atlantic. With respect to adults, the overall target has been exceeded. Although sampling in the Levantine Sea and Sardinia were below the target, this was compensated by other areas where the target was exceeded (Malta, Balearics, Tyrrhenian, Portugal and the Central Atlantic), as well as areas where no sampling of adults was originally planned but some samples were finally obtained (East Sicily and Ionian Sea, Gulf of Gabes, Norway and Canada).

In the Eastern Mediterranean, sampling was below original plan for several reasons. The lower than expected number of YOY in the Levantine Sea in 2016 was due to, among other possible reasons, the bad weather conditions and the prevailing disputes in Syria that did not allow normal fishing operations of small boats close to the border. Sampling of adults was far below the target this year as well, due to the internal problems in access to the farm. As for the Central Mediterranean, although the sampling target was reached, it was not possible to collect any YOY sample from Malta, due to the delay in issuing the national permit and bad weather conditions. Sampling in Western Mediterranean worked particularly well this year. Although the total number of samples was far above the target, the collection of the target number of YOY samples was not accomplished in this area. Sampling in the Atlantic went quite well and large and medium size Bluefin tuna samples were obtained from Morocco, Portugal, Norway and Canary Islands. The YOY sampling in Canary Islands also encountered problems in 2016.

Disappearance of YOY Bluefin tuna from the coastal areas where they usually are distributed from late summer to autumn was confirmed by various scientists and fishermen, with a displacement to offshore waters. The possible reasons for this phenomenon are specific oceanographic and climatological conditions in 2016, as presented in the scientific paper SCRS/2017/040 and SCRS/2017/041.

6.2.2 Otolith chemistry analyses

Otoliths of Atlantic Bluefin tuna have proven to be a highly effective tools to study the population structure and migratory pathways. Over fish's life, otoliths grow by accumulating new material in concentric layers around the central nucleus. Examining the chemical composition of different portions of otolith informs about where fish have been at various life-stages. During Phase 6, otolith chemistry was used to answer different questions related with the ecology and stock structure of Atlantic Bluefin tuna.

6.2.2.1 Determining nursery origin of Bluefin tuna captured in potential mixing zones

The results from previous phases suggest that western origin contributions were negligible in the Mediterranean Sea, Bay of Biscay and Strait of Gibraltar, but mixing rates could be important in the central North Atlantic, Canary Islands and the western coast of Morocco, with relevant interannual differences. In order to assess the spatial and temporal variability of mixing proportions, otoliths collected in areas with potential western contribution were analysed for stable carbon and oxygen isotopes ($\delta^{13}C$ and $\delta^{18}O$).

Stable isotopes were measured in the otolith cores of Bluefin tuna from four locations in the Atlantic Ocean: 1) central North Atlantic Ocean (west of 45ºW), 2) central North Atlantic Ocean (east of 45ºW), 3) Atlantic coast of Morocco and 4) Canary Islands. **Table 20** summarises the attained results by region and sampling year in Phase 6.

The results from Phase 6, compared to the results obtained in the previous phases of the project, indicate that mixing rates between east and west originated fish show important interannual variability in all observed areas, further confirming the previous results. This information is extremely useful for better calibrating the mixing in the OM and the MSE, but also for a possible improved assessment.

The presence of no-eastern origin and no-western origin Bluefin tunas in the samples (or, as usually defined, "unassigned samples") is a part of the results which needs further studies and efforts, because they can potentially indicate fish born in other areas outside the two main spawning grounds (GOM and MED), or other problems or simple uncertainties. As stated many times even by the SCRS BFT Species Group, it is extremely important to have a well-defined baseline (based exclusively on larvae and YOY, the only life stages which can provide a certain identification of the origin when collected in the spawning grounds), maintaining it over the years as reference.

6.2.2.2 Individual origin assignment

During Phase 6, individual classification techniques were applied to isotope $\delta^{13}C$ and $\delta^{18}O$ values to predict the origin (Gulf of Mexico or the Mediterranean Sea) of 125 Bluefin tunas at individual scale. For this purposes were used the samples already analysed in Task 1 (Determining nursery origin of Bluefin tuna captured in potential mixing zones) – those from central North Atlantic Ocean (west of 45ºW), central North Atlantic Ocean (east of 45ºW), Atlantic coast of Morocco and Canary Islands.

Isotope $\delta^{13}C$ and $\delta^{18}O$ values of Bluefin tuna otoliths were statistically analyzed and individuals were assigned to source populations with associated levels of probability. Among the classification methods tested with the baseline dataset, it has been shown that Quadratic Discriminant Function Analysis (QDFA) performs the best attaining the highest classification accuracy. Thus, QDFA was used to provide posterior probabilities for each pair of $\delta^{13}C$ and $\delta^{18}O$ values.

Individual origin assignments based on QDFA suggest that population mixing occurs in all studied regions at variable rates. Overall, mixing proportions using QDFA yield higher western contributions than MLE with proportions from QDFA often varying by at least 10% from estimates generated with the MLE approach (**Table 21**). However, considering the confidence intervals around those averages (i.e. mean+-2*s.d), the results are generally concordant.

6.2.2.3 Discrimination of nursery areas within the Mediterranean Sea by trace element and stable isotope composition in young-of-the-year Bluefin tuna and origin assignation of individuals from Bay of Biscay

The results from previous phases suggested that trace element composition might allow discriminating the Atlantic Bluefin tuna from different spawning areas of the Mediterranean Sea. In 2011, YOY signatures were distinct among eastern and western nurseries within the Mediterranean[14], allowing discrimination of these two major Mediterranean areas.

Due to significant interannual variation in the chemical signatures in the Mediterranean Sea, building a multiyear baseline for elemental signature is necessary when using trace element chemistry for classification of several year-classes. During Phase 6, stable isotope (δ13C and δ18O) and trace element analyses have been carried out on young-of-the-year (YOY) fish captured in the Balearic Sea, southern Tyrrhenian Sea, east of Sicily and Levantine Sea during 2013. Additionally, existing baseline was used to assign origin of 60 juvenile individuals of the 2011 cohort caught in the Bay of Biscay, for which otoliths were available. The results, within the limits of the reduced number of samples, provide a first insight on which Mediterranean spawning area contributes most to this important feeding area of the northeast Atlantic in the studied years.

Ten isotopes (Li7, Mg24, Ca43, Mn55, Fe56, Co59, Ni60, Cu63, Zn66, Sr88 and Ba138) were measured in each otolith by the LA-ICPMS system. Once trace element analyses were completed, stable isotope analyses were performed on the same otolith. Multivariate statistics were used to determine the "within Mediterranean" nursery origin of Bluefin tuna captured in the Bay of Biscay. HISEA software was used under bootstrap mode with 1000 runs to generate maximum likelihood estimates of mixed-stock proportions in the Bay of Biscay.

The results (**Table 22**) suggest that the majority of Bluefin tuna captured in the Bay of Biscay were originated in the central or western Mediterranean Sea. Nevertheless, this hypothesis is based on a very limited number of analyses, and it is likely that the total number of contributing sources is not included in the baseline nursery signature, and/or that the baseline does not fully characterize the variability of each nursery ground. Extending this work by expanding the baseline in number of individuals and including additional nursery grounds for which YOY otoliths are available (e.g. Ligurian Sea and Maltese waters) might provide further insight.

The results of this research show that discrimination of nursery grounds within the Mediterranean Sea is possible using otolith chemistry. However, given the interannual variability in the oceanographic conditions, discrimination capability may vary from year to year. Therefore, the origin determination should be adapted to each of the reference years. Bluefin tuna from the 2011 cohort can be assigned to the two major Mediterranean basins as initially defined (eastern Mediterranean and central-western Mediterranean), whereas discrimination among the four main nursery grounds is possible for Bluefin tuna born in 2013 (**Figure 13**).

6.2.3 Genetics

Genetic studies in Phase 6 included the origin assignment of the samples collected in the potentially mixing areas using RAD-seq derived SNPs, a work that has already been initiated in the previous phases of the GBYP and microsatellite genotyping of reference samples in the Mediterranean, which was done for the first time in this phase.

6.2.3.1 Origin assignment of juveniles and adults captured at feeding aggregations throughout the Atlantic and over different years

This task consisted on deciphering the map of ABFT mixing in the Atlantic. Two main activities were done: 1) assessing the validity of the optimal minimal SNP panel developed in Phase 5 on spawning adult reference samples, which includes calculating correct assignment rates of currently available panel and developing a strategy to improve these assignments, and 2) genotyping the minimal best available SNP panel in adults from feeding aggregations, which included DNA extraction of about 1000 individuals and processing in a Fluidigm Assay.

355 reference samples (10 larvae and 181 spawning adults from the Gulf of Mexico and 164 spawning adults from the Mediterranean) that have already been genotyped in Phase 5, were analyzed to calculate the assignment power of the currently available RAD-seq derived panel. In addition, 256 of the spawning adult samples used to assess the validity of the panel (179 from the Gulf of Mexico and 87 from the Mediterranean) were RAD-sequenced in

[14] The discrimination initially adopted by the analysts for these analyses included the Balearic Sea, the western Mediterranean in general, the Tyrrhenian Sea, the Ionian Sea and the central-southern Mediterranean Sea in the "western Mediterranean", while the south-eastern Mediterranean Sea, the Levantine Sea and the Aegean Sea in the "eastern Mediterranean". This assumption does not discriminate among the three major spawning areas (Balearic Sea, southern Tyrrhenian Sea and central-southern Mediterranean Sea) within the "western Mediterranean".

order to increase the reference baseline of the Gulf of Mexico from which candidate traceability suitable SNPs are selected. From the RAD-seq catalogs including all already generated samples, the SNPs with the highest F_{ST} values among Northwest Atlantic (including Gulf of Mexico larvae and Cape Hatteras young of the year) and Mediterranean larvae and young of the year were selected.

For each individual, assignment scores (i.e. probability of belonging to each of the baseline populations) have been calculated. For panel validation, assignment scores were calculated for the new 356 reference samples on 96 SNP using a leave-one-out approach with a baseline of 690 individuals, that is, 355 previously genotyped plus 336 newly genotyped individuals (356 genotyped minus 20 that failed) excluding the one being assigned. For determining origin of mixed samples, assignment scores were calculated for the 96 SNP set on 940 samples using the combined set of 691 reference samples (246 from the Gulf of Mexico and 435 from the Mediterranean) as baseline; results are provided considering both 70% and 90% thresholds as "unassigned".

Assignments of new Mediterranean samples based on the 48 SNPs that best differentiate among Mediterranean areas resulted in 15-25% correct assignment rate (**Figure 14),** confirming that finding SNPs that distinguish the Mediterranean locations is difficult as suggested by the non-genetic differentiation among them. For this reason, SNPs that differentiate among Mediterranean areas where not included in subsequent steps. Also, for the selection of final 96 SNP set, only those that discriminate among Gulf of Mexico and Mediterranean where considered; Cape Hatteras samples (only 16 young of the year) were excluded for being slightly different from the Gulf of Mexico (see report of Phase 5) and for having chances of arising from another spawning ground. Additional analyses including larvae from Cape Hatteras are required to solve the question of the origin of samples collected in this area. Genotyping of the final set of 96 SNPs in 356 spawning adult samples resulted in 20 samples failing for more than 50% of the SNPs. Average genotyping rate in remaining individuals and SNPs of 99%.

The set of the best 96 SNPs derived from the RAD-seq analyses was validated in 336 (356 minus 20 whose genotyping failed) newly genotyped spawning adults from the main spawning areas. Using these adults as new reference test samples, new assignment rates were calculated **(Figure 15**). Using 90% as a threshold, 71% of the samples of Gulf of Mexico and Mediterranean origin are correctly assigned and 13 and 2% are incorrectly assigned, respectively. Unassigned samples are 16 and 27% for Gulf of Mexico and Mediterranean respectively. Decreasing assignment score threshold to 70% reduces the number of unassigned samples (5 and 10% for Gulf of Mexico and Mediterranean respectively), but increases the number of incorrect assignments (to 17 and 6% respectively).

From these results and under the current hypothesis of only two possible origins (Gulf of Mexico and Mediterranean), it can be derived that in an assay with samples of unknown origin i) from those assigned to the Gulf of Mexico, 3-6% would come from the Mediterranean, ii) from those assigned to the Mediterranean, 18% would come from the Gulf of Mexico and iii) from those considered unassigned, 40% and 60% would come from the Gulf of Mexico and the Mediterranean respectively. This means that, among the assigned individuals, there will be a slight underestimation of the proportion of GOM origin.

Samples from twelve different locations throughout the Atlantic have been analyzed and the results are given in the **Figure 16**. Genomic DNA was successfully extracted from 940 individuals, which have been genotyped and assigned to origin.

In both, the GBS and RAD-seq analyses, the number Gulf of Mexico reference samples used for SNP selection was low, meaning that discriminant SNPs were being selected from a few individuals that do not capture the whole genetic diversity of the species. Indeed, self-assignments (that is, assignments on the samples used for SNP selection and or as baseline) provide very high assignment rates (>98% success in the case of RAD-seq) suggesting that the SNPs selected are very good at assigning the samples that were used to select them, but not that good for assigning new samples. This also highlights that reliable assignment success rates should be calculated in new samples, that is, those not used for SNP selection or as baseline. Additionally, the recent discovery of potential new spawning grounds (Slope Sea near Cape Hatteras) could make the assignment to origin even more complicated. Analyses based on more reference samples including larvae and YOY from Cape Hatteras could shed light in this issue.

6.2.3.2 Microsatellite genotyping of reference samples in the Mediterranean

After a discussion at the Bluefin tuna Future Symposium in Monterey (USA), held in the first part of 2016, this task aimed to provide a clear-cut evidence for BFT population structure fulfilling the gap represented by the microsatellite genotyping of reference samples in the Mediterranean at an extensive spatial scale and across a short-term temporal scale to check interannual stability of genetic structure. In fact, previous microsatellite analyses on BFT have never been conducted on experimental designs accomplishing simultaneously the use of reference samples (Larvae or Young-of-the-Year) collected during the same spawning season (from June to September) of multiple consecutive years in the same Mediterranean spawning subareas [Balearic Sea, Tyrrhenian Sea, Central Southern Mediterranean Sea (Sicily/Malta), Levantine Sea].

In addition, this task aimed to overwhelm the methodological constraints represented by the use of a limited number of microsatellite loci (< 20) in the previous analyses and by the use of panels of microsatellites largely different among studies carried out including both the Mediterranean and Gulf of Mexico samples that prevent any fully reliable comparative issue. Thus, a pan-Atlantic study based on a large panel of microsatellite loci (> 20) used to genotype reference samples from both ascertained spawning areas is considered necessary to assess genetic differences within and between each area and provide clear-cut evidence for population structure both in the Mediterranean and in the Gulf of Mexico.

After reviewing literature and primer databases (e.g. http://tomato.bio.trinity.edu) as well as by contacting US and EU scientists, 33 BFT-specific microsatellite loci already used to genetically profile Gulf of Mexico, Atlantic and Mediterranean reference and non-reference samples have been selected. The setup of laboratory protocols for multiplexed PCR and genotyping conditions has been realized in silico and hence experimentally tested at the BMR-genomics service provider.

Preliminary results showed very low, and mostly not significant, differentiation among the samples from various spawning grounds within Mediterranean. The total lack of differentiation among all analyzed samples was further confirmed by the cluster analysis, by the results of DAPC, by the Bayesian approach developed in BAPS (**Figure 17**) and then again confirmed by results of DAPC (**Figure 18**).

At the end, also the AMOVA analyses displayed the lack of genetic structuring; they indicated that the largest part of the genetic variance is to be attributed to differences among individuals within samples (>99%). No significant differentiation was retrieved when samples were grouped according to the year of collection (2012 vs 2013) or the area of sampling (WMED-BA, WMED-TY, CMED-SI, and EMED-LS) (**Table 23**).

The results obtained with the present experimental design are straightforward to affirm that *T. thynn*us in the Mediterranean is spatially and temporally structured in a panmictic population with high level of genetic connectivity. The analysis of samples of YOY collected over the four main areas of spawning and density of early life stages (e.g. larvae and small-sized YOY: WMED: Balearic Islands; CMED: South Tyrrhenian and Sicilian Channel; EMED: Levantine Sea) and over two consecutive years (2012 and 2013) represents the most solid genetic survey carried out since now for testing the population structure in the Mediterranean BFT using polymorphic species-specific microsatellite loci. This type of molecular markers has proven to be of high resolving power in detecting subtle genetic differentiation in marine fish (see Hauser et al. 2008). All the statistical tests performed, robustly and consistently indicated that genetic differences in BFT Mediterranean reference samples were null or near null.

The lack of genetic heterogeneity recently revealed by the genetic survey carried out by Antoniou et al. (2017) combining data from 16 microsatellite loci and hundreds of genome-wide SNPs obtained from adult farmed BFT collected over Western, Central and Eastern Mediterranean, and by Riccioni et al. (2017) using EST-linked microsatellite loci on medium and large BFTs from the same areas are coherent with the pattern here obtained and with the null genetic heterogeneity detected.

This analyses further corroborated the results of other previous analyses (using SNPs) indicating there is no BFT population structure within the Mediterranean Sea.

6.2.4 Otolith shape analyses

Previous studies showed that variation in otolith shape is useful for discriminating between adult (>200cm) Bluefin tuna from the eastern and western Atlantic. The baseline samples used in that study comprised of 50 adult fish from the Canadian fishery (Gulf of St Lawrence, Newfoundland and the Scotian Shelf) and 50 adult fish from the central Mediterranean (Malta) collected during the spawning season. An objective of GBYP Phase 5 and 6 was to refine the baselines used to characterise the western and eastern stocks by including adults from the Gulf of Mexico spawning grounds and adults from a wider geographical range within the Mediterranean collected during the spawning season (May and June). The sampling also targeted a broader size range of fish (>170cm).

The task aimed to use shape analysis of otolith outlines to distinguish between the two spawning populations to determine if otolith shape descriptors provide a reliable marker of spawning origin and to use this classification to determine the likely origin of estimate stock composition of mixed samples collected in the Atlantic in 2011, 2012 and 2013.

Seventy nine samples of unknown spawning origin were obtained from the GBYP database. These fish were collected from three locations in the eastern Atlantic: the Straits of Gibraltar, the coast of Portugal and Morocco in 2011, 2012 and 2013. These individuals were chosen for inclusion in this analysis because stable isotope measurements were also available allowing comparison of assignments in the subsequent integrated analysis task.

The classification functions developed from the baseline samples were used to assign these individuals to populations.

Previous studies discriminated between Bluefin tuna from the western (Canada) and eastern Atlantic (Malta) with a classification success of 82% (83% for the western samples and 82% for the eastern samples). In this analysis using baseline samples from the Gulf of Mexico spawning grounds and additional sites within the Mediterranean, the classification success decreased to 76% for the western Atlantic and 80% for the Mediterranean. The original baseline samples from Canada and Malta may have had more distinct environmental histories (e.g. have resided in the west or east Atlantic for the majority of their lives) compared to the more extensive baselines used in the current analysis. Although there is significant variation in otolith shape between the Gulf and Mexico and the Mediterranean spawning populations, a classification function based on otolith shape descriptors alone provides only moderate discrimination between the groups.

Regarding mixed analysis, the misclassification rate (out of bag error) associated with the random forest model was 28%. When individuals in the mixed samples were assigned to populations using the random forest model of shape descriptors, the percentage of fish that were estimated to be of Mediterranean origin was lower than that previously reported **(Table 24).** The probabilities of group membership was <70% for the majority (73%) of the individuals.

The analysis of the refined baseline samples confirms that there is considerable overlap in otolith shape between the two spawning populations. On its own, otolith shape does not provide a sufficiently reliable marker of spawning origin and estimates of stock composition based on otolith shape are subject to a large degree of error. It appears that due to the strong influence of environmental history on otolith shape, the technique may be a more powerful for characterising contingents within both populations that follow different migration pathways.

6.2.5 Integrated approach to stock discrimination

Various genotypic and phenotypic population markers have been used to distinguish between Bluefin from the eastern and western Atlantic. However, there is a degree of uncertainty associated with each method of population assignment. In GBYP Phase 5, comparisons of individual assignments using genetics, isotopes and otolith shape methods revealed disagreement between the three methods. It may be possible to improve overall accuracy of stock assignment by using a combination of population markers in an integrated stock mixture analysis. This task employed the data and material produced by the integrated analysis task from Phase 5 and additional data generated by other tasks in Phase 6 to develop a multi-marker method for discriminating between Bluefin tuna from the Gulf of Mexico and Mediterranean spawning populations.

In the baseline samples, 57 of the Gulf of Mexico fish and 102 of the Mediterranean fish were analysed using chemistry (d13C, d18O), shape and genetics. For the genetic analysis nucleotide sequences were available for 48 individual SNP loci. Gene frequencies were compared between the two populations using Chi square analysis. Loci which varied between populations were included as categorical predictors in three classification models using random forest: a) genetics only; b) chemistry and genetics; c) chemistry, shape and genetics. The classification error associated with each model was compared using out of bag estimates of error rates.

The three way integrated model (chemistry, shape and genetics) did not improve the classification success (error rate 5.1%). This again suggests that the otolith shape measurements do not provide complementary information about natal origin but may provide an alternative indicator of migratory history. Combining chemistry and genetics improved the mean individual assignment probabilities by 6% for the Gulf of Mexico samples and 0.92% for the Mediterranean samples compared to the chemistry only model. Improvements relative to the genetics only model were 14% for the Gulf of Mexico samples and 20% for the Mediterranean samples. This shows that Rad SNP genotypes can complement stable isotope measurements and improve the accuracy of natal origin estimates. The baseline samples used in this analysis showed relatively large differences in stable isotope measurements with little overlap between the Gulf of Mexico and Mediterranean samples. The influence of each variable in a combined model is shown in a **Figure 19.**

6.2.6 Age determination analyses

The biological analysis of this project included direct ageing to obtain age composition of Atlantic Bluefin tuna catches and age composition of the population structure samples. The Bluefin tuna Species Group has emphasized the need for annual age length keys (ALKs) because it was found that cohorts of Bluefin tuna can be more easily detected and followed when annual ALKs were used.

In previous phases of the project, a stratified sampling by size class, geographical location, month of harvest and fishing gear was used in the selection of samples to obtain a robust ALK for 2011. In the Phase 6 the activity of aging was carried out on the available hard parts already collected in 2012 in order to produce two annual ALKs with good sampling coverage. In the Phase 6 the existing 2012 ALK, which already had 39 calcified structures read in previous phases, was completed with the analysis of 325 new ones.

In the 2012 ALKs, built with the otolith samples analyzed in the current phase and in previous ones, sizes unusually low for ages 8 and 9 are also observed, coming from different catch locations (although most of them from the Mediterranean). This fact is also observed in the spine ALK (**Figure 20**). Those specimens correspond to the 2002/2003 year classes, which have been considered to be extraordinary abundant. This lower length at age may be related to an effect of density-dependence and/or to a lower growth in the Mediterranean Bluefin tuna. No differences were observed in the mean SFL by age for both structures based ALKs, although the otoliths ALK presented greater length variability by age.

The different ALKs built by ocean/sea present also some variability of sizes by age and numerous length bins without age. It is necessary to analyze a greater number of samples so that the annual keys by ocean/sea have an adequate number of samples per size. Mean length at age differences were observed for ages 6 to 9 between both ALKs and with ICCAT adopted growth curve, with higher values for the Atlantic Ocean based ALK. A high standard deviation also appeared at ages 8 and 9, notably in the Mediterranean ALK.

6.2.7 Larval studies

Larval surveys were included in the preliminary list of GBYP research activities recommended by the SCRS at the early beginning of the GBYP approval process, even if with a low priority. Later on, the Commission excluded any larval survey from the programme, even if the first discussion on the budget included the larval studies for three years. The exclusion was shared also by the GBYP Steering Committee.

Studies carried out during the past years on early life stages of top predator species, as tunas, demonstrated that these studies could be useful for improving our understanding of the population dynamics of harvested stocks. This reflects the hypothesis that early life dynamics is one of the main drivers influencing population fluctuations. This information has been incorporated since years in the WBFT stock assessment, particularly as relative abundance indices of the spawning stock. Therefore, there is the potential for scientists to contribute with additional indices and data streams that could contribute to stock assessments, such as larval survival index; spawning and larval habitat quality predictions; population genetic structure, abundance estimates and stock mixing (through kinship analysis).

Under the context of ecosystem-based fisheries management, early life history studies can provide understanding of the structure and trophodynamics of plankton assemblages and sources of environmental variability that can feed into ecosystem models. They can also provide indicators of the plankton assemblages that are relevant for ecosystem-based fisheries management and the effects of climate change, if sufficient data about all main components can be provided.

Pursuant to the recommendation of the Steering Committee and the ICCAT SCRS in 2015, GBYP organized a dedicated Workshop on larval studies and surveys in Phase 6. The workshop was held at the ICCAT headquarter in Madrid, on 12-14 September 2016 and was attended by around 20 eminent scientists in Bluefin tuna larval biology from EU, USA and Japan.

During the workshop, a review of the available knowledge on the Bluefin tuna early stages was presented, for both the Mediterranean Sea and the Gulf of Mexico, along with the results from the latest studies. Current and recent research project were presented and the sampling methodologies that were followed in each study were discussed in detail, as well as common problems that were encountered. A special attention was put on the spawning and larval habitat, as well as on environmental dependencies. The difficulties for morphologically identifying Bluefin tuna larvae were deeply discussed, even if some doubts are still to be solved according to some scientists, while there are no doubts when it is possible to have a genetic analysis. The progress and limits in using the larval index was also discussed, as well as its potential use as an abundance index for the purpose of the Bluefin tuna stock assessment. The GBYP presented an overview of potential research needs and opportunities for the larval surveys in the document SCRS/2016/176.

The participants also discussed the possibilities for carrying out a joint larval study, with standardised methodology on all spawning grounds in the Mediterranean. It might also provide information on early stages of ICCAT species other than Bluefin tuna and therefore contribute to the assessment of different stocks. Terms of reference of the future larval survey working group were drafted, identifying the goals and initial work plan, with the intention for this new group to be presented in the SCRS meeting and therefore available to different species working groups.

The report is provided as SCRS/2016/206.

6.3 Activities in Phase 7

Due to the reduced overall budget for the Phase 7, not all the activities already initiated in the previous phases of the biological studies could have been continued. The Steering Committee recommended the priorities for this Phase, while other activities were postponed. So far, one call for tenders and two invitations have been released for the GBYP biological studies in the Phase 7.

Pursuant to the inputs of the SCRS BFT Species Group and the specific recommendation of the Steering Committee, taking into account that the Call for tenders issued in Phase 6 for ageing many otoliths received no bids, the invitation for improving the ageing capacities of the ICCAT GBYP has been directed to the Fish Ageing Services ltd from Australia, a well-reputed institution. The Fish Ageing Services accepted the invitation and the contract was awarded for ageing of 2000 otoliths previously stored in the ICCAT GBYP tissue bank that haven't been aged so far.

Another invitation was sent for sampling for adult Bluefin tuna in farms. This activity represents the continuation of the activity already initiated in the Phase 6, which was recommended by the Steering Committee in order to complement the feasibility study for the close-kin genetic tagging and provide enough samples for the development of an annual ALK. While YOY were successfully sampled in some areas in previous years, sampling of adults from spawning areas has been sometimes problematic. According to the experience from the previous year, sampling of the adults in the farms can be a useful strategy for obtaining the needed adult samples from the spawning areas. In both Phase 6 and Phase 7 the invitation for sampling was sent to tuna farms in Spain, Malta and Turkey, but no positive answer was received from Turkey. Three offers were received from the other areas, from the same companies that have already been engaged in this activity in the Phase 6, and were all awarded a contract. AquaBioTech Ltd from Malta was contracted for providing samples from at least 300 specimen from the southern Tyrrhenian Sea and at least 300 specimens from the central/southern Mediterranean Sea. Taxon Estudios Ambientales SL was contracted for providing samples from 170 specimens and Balfegó & Balfegó for providing samples from 150 specimens, both from the Balearic Sea.

The Call for tenders for biological studies was released afterwards and it included a broad list of activities from sampling and analyses to special research study of reproductive biology of tuna in the Slope Sea (NW Atlantic). Given the budget limitations, some activities could not have been funded in this Phase and the contracts were awarded on the base of single activity or even by the individual component of the activity. In total, three contracts were awarded. One contract was awarded to a consortium headed by AZTI for sampling, maintenance of the tissue bank and YOY ageing. The other contract was awarded to a consortium headed by University of Bologna for complementary sampling and some limited and very specific genetic analyses. The third contract was awarded to the Social and Environmental Entrepreneurs (Project Tag a Tiny) for BFT reproductive studies in the Slope Sea.

Following the request of the ICCAT SCRS BFT Species Group and the ICCAT GBYP Steering Committee, the GBYP finalized an agreement with the Company (MRAG) in charge of the ICCAT-ROP for the opportunistic sampling to be performed by ROP observers, covering just the costs for the sampling material. This activity was initiated in the Phase 7 as a trial to assess the feasibility and the possible cost per year. ROPs have been engaged in collecting small tissue samples of all accessible Bluefin tuna individuals at the harvesting in farms or when dead Bluefin tunas were taken on board of vessels having an ICCAT observer on duty.

6.3.1 Maintenance and management of the ICCAT GBYP tissue bank

The ICCAT GBYP tissue bank is stored in the AZTI laboratory since the beginning of the GBYP biological sampling activities. In Phase 7, as detailed in the previous paragraph, AZTI was awarded a contract for the maintenance and management of the sample bank, in continuation with the activity in previous years. This task includes the appropriate storage of all samples already collected and those that will arrive, their delivery to the entities in charge of the analysis and the posterior receipt. Also, it includes the eventual relabelling of the samples according to the protocol and the management and the regular update of the samples database. This year also an interactive interface was contracted, for easier searching through the samples catalogue.

6.3.2 Sampling

Sampling in Phase 7 has been performed by the various entities that operate under different contracts. YOY and adult Bluefin tuna from the main spawning areas in the Mediterranean (Balearic Sea, southern Tyrrhenian Sea, southern central Mediterranean Sea and Levantine Sea) have been the priority for the collection of otoliths, spines and genetic samples. A special attention has been devoted for the collection of samples by size classes and strata that had been under-represented in the samples from previous years, with the goal of collecting at least 10 samples for each 10 cm length class and stratum. It was envisaged to collect samples for more than 2000 individuals.

6.3.3 Analyses

As has already been mentioned, due to the limited budget, this year the main priority has been given to activities different than the usual genetic and microchemical analyses. Therefore, the activities already initiated in earlier phases of the ICCAT GBYP, like microchemical analyses on otoliths for stable isotopes and genetic analyses using RAD-seq methodology and SNPs have been postponed to the following phase. Nevertheless, the budget allowed contracting some additional genetic analyses, that hasn't been done so far on Bluefin tuna. These activities includes the analysis of transcriptomic and genomic data exploiting previous available data for defining the genomic variability of the species and experimental trials for genetic sex determination. This task will be performed by a consortium headed by the University of Bologna.

6.3.4 Ageing

Due to the problems encountered so far for ageing large quantities of otoliths, a dedicated effort will be done in Phase 7, ageing a total of 2000 Bluefin tuna otolith samples of various size classes. The otoliths will be prepared for age reading by single section cut on low speed saw. This method, although more expensive, allows preserving the section and keeping it useful for further micro-chemical analyses. The ageing will be carried out by two different readers for all samples, while a third expert reader will work on 10% of the otoliths for a quality control.

Additional ageing will be performed on 20 YOY samples collected in Phase 6 for which the SCRS requested the reading of daily increments, with the objective to better understand the age of the most extreme components in this atypical year class.

6.3.5 Special research in the Slope Sea

In Phase 7, the Steering Committee recommended giving priority, among other activities, to the special research activity which includes studies for trying to fill knowledge gaps in Bluefin tuna reproductive biology in the NW Atlantic (i.e. Slope Sea and surroundings); the results might add additional evidence to the existence of a further spawning area in this part of the Atlantic Ocean. This study will include, in particular, conventional histology (microscopic inspection of gonads) combined with new endocrine immunoassays (measuring of the quantity of pituitary gonadotropins in the tissue of Bluefin tuna) for the Bluefin tuna captured in the NW Atlantic.

6.3.6 Other activities for the Biological studies

Following the same approach used in previous years, the GBYP collected real-time information about the presence of Bluefin tuna YOY in the various areas, with a double objective: a) monitoring the recruitment of Bluefin tuna and the apparent abundance, and b) notice any anomaly or any peculiar situation, passing the related information to the SCRS Bluefin tuna Species Group for future reminder. In August and September 2017 it was noticed the massive presence of very small Bluefin tuna YOY in some Atlantic areas (SCRS/2017/216).

7. Modelling approaches

The initial, short-term ICCAT GBYP objective which was approved by the Commission in 2008 was to carry out new modelling approaches studies from year 4 (for 3 years of activities), with a total budget of 600,000 Euros. So far, with 117.5% of the funds (a total of 704,848 Euros[15], equal to 5.3% of the total GBYP funds received so far), the ICCAT GBYP carried out many modelling activities since Phase 2 (in 7 years of activities so far), following the recommendations of the Steering Committee and the SCRS. It is very evident that the general objectives set for the modelling studies in these first Phases were largely accomplished so far, but the amount of effort for this activity was clearly underestimated when the GBYP was conceived. Furthermore, the modelling plan was fully revised and now it has been extended up to 2021 as recommended by the GBYP Core Modelling MSE Group, by the SCRS and as it was endorsed by the Commission.

The final reports of the modelling activities were presented at the SCRS BFT Species Group meeting and are available on the ICCAT GBYP web pages http://www.iccat.int/GBYP/en/modelling.htm.

[15] The cost includes 174,000 Euro in Phase 7, an amount which might be different at the end of the Phase.

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.

The GBYP activities in the first Phases were consistent with the objectives, within the timeframe set by the Modelling MSE Core Group.

7.2 Phase 6 activities for modelling in support of BFT stock assessment

Activities in the Phase 6 were mainly continuation of the work already started in the previous phases. A follow up contract for the MSE technical assistant was provided to Dr. Tom Carruthers, the same expert who initiated the work, for developing the Operating Model and MSE framework and related code. According to the recommendation of the Steering Committee, a contract for a MSE coordinator was suspended, given its low priority in this Phase.

An ICCAT GBYP multi-annual modelling work plan was proposed at the Monterey CMMG meeting, based on the conclusions of the Gloucester meeting. A main objective of MSE is to provide advice that is robust to uncertainty, and requires a number of steps:

1. Identification of management objectives and mapping these into statistical indicators of performance or utility functions;

2. Selection of hypotheses for considering in the Operating Model (OM) that represents the simulated versions of reality;

3. Conditioning of the OM based on data and knowledge, and weighting of model hypotheses depending on their plausibility;

4. Identifying candidate management strategies and coding these as Management Plans;

5. Projecting the OM forward in time using the MPs as a feedback control in order to simulate the long-term impact of management (Ramaprasad, 1983); and

6. Identifying the Management Plan that robustly meet management objectives.

These steps require the engagement of stakeholders to evaluate alternative management actions and the risks of not meeting management objectives. An OM (Operating Model, a mathematical simulation model) has to be coded up to allow the consequences of the improvement of knowledge, collection of data and implementation of management measures to be evaluated.

This requires the OM to be implemented in software. Therefore under previous phases of the GBYP M3 a prototype OM has been implemented and is available in the software repository https://github.com/ICCAT/abft-mse. This allows multiple developers to collaborate on its development. In addition a manual has been provided which forms the basis of a Software Development Plan (SDP) for future development.

The next stage in the development of the OM requires test units to be developed to ensure that the code is fit for use. In particular, to ensure that resource dynamics in the OM are implemented as agreed by Bluefin WG and the Core Modelling MSE Group (CMG). This requires that the individual source code procedures and modules together with associated control data, usage procedures, and operating procedures, can be tested. This will also help to avoid errors when the code is revised, and when collaboration involves multiple developers.

The objectives for the activities in GBYP Phase 6 were the following:

1. Continue the development of the Operational Model (OM) based on the Management Strategy Evaluation (MSE) trial specifications document.

2. Develop a test unit to validate the age-based movement model.

3. Work with third parties to add Management Plans (MPs) to the MSE framework including empirical control rules and simple stock assessment methods.

4. Run the MSE in collaboration with BFT Species group.

5. Collaborate with SCRS to develop interactive graphics (i.e. Shiny apps) to communicate MSE results to stakeholders based on the performance metrics of the trial specifications document.

6. Work with others to update and maintain the meta database of the available Bluefin data and knowledge https://github.com/ICCAT/GBYP-MetaDB

7. Work with SCRS to help develop 3 prototype examples.

During the BFT Data Preparatory Meeting in July 2016, the progress of simulation testing a multi-stock model with age-based movement was presented as a paper SCRS/2016/144. The issues arising from the preliminary conditioning of operating models for BFT were presented as well, and are available as SCRS/2016/145.

Following the decision of the ICCAT SCRS on building modelling capacities, GBYP organized a short training course on Virtual Population Analysis (VPA) with theory and application to Bluefin tuna. It was held in Miami, (USA), from 6-10 February 2017.

7.2.1 Modelling technical assistant

A contract for developing the Operating Model and MSE framework and related code was provided to the Blue Matter Science (to be developed by Dr. Thomas Robert Carruthers) in Phase 6, who continued the modelling technical work initiated in Phase 4 and further developed in Phase 5 (under a contract to the University of British Columbia, CAN, but always under the direct responsibility of the same expert).

The focus of this contract was finalizing the technical aspects of the operating modelling and producing a user-friendly and fully functional MSE framework that could provide a basis for feedback and collaboration from a wider group of stakeholders. In this regard, a number of major milestones were achieved in this contract. Following the data preparatory meeting the fleet structure and data formats were finalized and the meta-database was updated. The fishery, survey, tagging and stock of origin data were formatted for use with the operating model. A SCRS paper that provides a full account of the derivation of the ‘master index’ that is central to the operational modelling was also provided presented on the BFT Species Group. The online meta-data summary was linked to the corresponding sources of data in the GitHub repository.

With regards to operating models, a final operating model structure Modifiable Multistock Model - (M3 v1.3) was designed following feedback from the Core Modelling Group including a new model initialization by stock reduction analysis to account for catches before 1960. The new operating model was simulation tested to check for coding errors, identifiability and to establish suitable data weightings and the trial specifications document was updated following feedback from the Core modelling group. M3 software design specifications were developed, as well as the M3 user guide.

Regarding the MSE development, the 18 reference operating models were fitted to data and reproducible R scripts were made available that describe this process. A standard operating model fitting report was developed in R markdown and these were generated for each reference operating model. A comprehensive set of R functions were developed to allow for the simple and rapid design of operating models, fitting of operating models to data, design of management procedures, specification of performance metrics and the running of Management Strategy Evaluation. All of the R code, data and objects were compiled into a single R package (ABTMSE) with complete documentation for all functions, objects and data to be used in MSE analyses. The raw data, R scripts, Reports, help documentation and the R package were assembled in a single directory which can be downloaded from the ICCAT GitHub repository. The ABTMSE Software design specifications v2.1.0. have been provided.

As regards to the documentation, an extensive user guide was developed in R Markdown that describes the file structure, the project and guides users through the various functions of the R package including worked examples of the 7 steps of MSE development. Also, a fully documented website was produced using 'pkgdown' that can act as the front page of the ICCAT ABFT-MSE repository and has links to various documentation including all the functions and objects of the R package.

7.2.2 ICCAT GBYP Core Modelling MSE Group (Phase 6)

The role of the ICCAT GBYP Core Modelling and MSE 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.

A third meeting of the ICCAT GBYP Core Modelling MSE Group was held at ICCAT headquarters in Madrid on 14-15 November 2016. This meeting aimed to review the work done by the Core modelling group since the last meeting of the group that was held in Monterey in February 2016. The Core modelling group reported extensively on progress to the Bluefin tuna working group in July 2016, at which time the final decisions on data to be used for the conditioning of the operating model were agreed upon in nearly all respects. At the SCRS species group meeting in September 2016, the Core modelling group provided a summary of progress but there was limited opportunity for detailed discussions.

The Group reviewed and further discussed the recommendations that were given on the tRFMO meeting which preceded this one (from 1-3 November). It was recognized that ABFT OM is amongst the most complex of such existing models. It is also recognized that it is important to show stakeholders that what kind of uncertainties are incorporated in the model, and that they cover hopefully most of the common major uncertainties. The group also recognized that MSE can also be used to show managers the benefits of various research activities. Those benefits may include economic factors or be qualitative such as improve confidence in management. It was also suggested that it would be desirable to start considering the inclusion of MSE as a topic for a CAPAM workshop. The Group examined the MSE trials (North Atlantic Bluefin MSE trials specification document, including performance statistics and their relation to Kobe plot measures) and discussed methods to prioritize the importance of different sources of uncertainty to develop a hierarchy of MSE trials. The conditioning of trials were also reviewed, based on the 2014 VPA assessment which was used as a base case and it was finally confirmed.

Regarding the future commitments, it was decided that the ICCAT GBYP Core Modelling MSE group prepare a brief document explaining the final decisions made for the OM to the BFT data preparation meeting for endorsement. At this meeting hopefully at least three groups will be identified to develop candidate MPs.

7.2.3 VPA Training course

Following the recommendation of the ICCAT SCRS on building modelling capacities, endorsed by the Commission in 2015, and the recommendation of the Steering Committee, the GBYP organized a short training course on Virtual Population Analysis (VPA) with theory and application to Bluefin tuna. It was held in Miami, USA from 6-10 February 2017, in the premises of the Rosenstiel School of Marine and Atmospheric Science (RSMAS), which very kindly hosted the course. Out of 13 candidates that applied for the training course, 11 were selected, mainly based on the availability to participate in the 2017 Bluefin tuna stock assessment exercise. The Course was taught by three experienced instructors: Ph.D. Laurence Kell, Ph.D. Clay Porch and Ph.D. Ai Kimoto[16], who very generously provided their support (**Figure 21**).

[16] The Japanese Government kindly sponsored all costs for Dr. Kimoto.

The course provided an introduction to the mathematical theory behind tuned virtual population analysis, the calculation of biological reference points, and projecting the abundance of the stock for a range of scenarios , e.g. for different catch quotas and model assumptions. Participants worked in teams to develop simple assessment and projection models in Excel and to learn the basic concepts. Afterwards, they operated in a workshop environment similar to an actual Bluefin tuna stock assessment where they were prepared for the 2017 assessment by conducting their own analyses using the VPA-2BOX and PRO-2BOX software, and prepared a summary of the proposed management advice. Techniques for modeling two intermixing stocks were discussed. Exercises were conducted in both MS Excel and R. VPA and the assumptions behind were introduced and explained, focusing on data requirements, assumptions, uncertainty, diagnostics, interpretation of results and advice. Examples were mostly based on the last Bluefin assessment.

The course prepared participants to:

- Conduct exploratory data analyses of the types of data required to provide advice.
- Understand the assumptions underpinning stock assessment.
- Be aware of how uncertainty impacts the robustness of advice.
- Participate fully in the preparation for the ICCAT stock assessment working group
- Help in formulating advice

7.3 Phase 7 activities for modelling in support of BFT stock assessment

7.3.1 Modelling technical assistant

Following the recommendation of the GBYP Steering Committee, a contract for developing the Operating Model and MSE framework and related code was extended to Dr. Thomas Robert Carruthers (under a contract to Blue Matter Science), who initiated this work in Phase 4.

The objectives for modelling activities under GBYP Phase 7 are:

i) Ensure the Operational Model (OM) implements the trials as specified by the 2016 CMG report.

ii) Use the test unit to validate the age-based movement model.

iii) Work with third parties to add Management Plans (MPs) to the MSE framework including empirical control rules and simple stock assessment methods

iv) Run the MSE in collaboration with BFT Species group.

v) Collaborate with SCRS and others (e.g. tRFMOS) to develop interactive web based graphics to communicate MSE results to decision makers and stakeholders.

vi) Work with others to update and maintain the meta database of the available Bluefin data and knowledge https://github.com/ICCAT/GBYP-MetaDB

The work in the Phase 7 will include continuing development of the OM and maintenance of the following:

1. Updated Repository with full tracking including version control for software development https://github.com/ICCAT/abft-mse containing the OM.

2. Update of SDP (Software Development Plan) that will be reviewed by external experts, as agreed at Monterey meeting

3. Test Unit so that code can be validated

4. Meta Database summarising all parameters and assumptions used https://github.com/ICCAT/GBYP-MetaDB

5. Evaluation of Management Procedures implementation by 3rd parties. Written up as SCRS papers and code available in repository

It is important for the BFT Species Group and the Commission to gain experience in conducting of MSE. Major interactions with decision makers and stakeholders will best be conducted using results from stocks of interest to illustrate trade-offs, so that they can choose between tangible options on the basis of actual projections rather than abstract concepts. The initial MP design and performance statistics, however, should be few, informative and based axes such as ‘stock status’, 'safety', 'stability' and 'yield'.

Three SCRS documents were produced for the SCRS BFT Species Group in Phase 7, presenting various aspects of the modelling work conducted within the ICCAT GBYP framework (SCRS/223, SCRS/2017/224 and SCRS/2017/225).

The ICCAT GBYP Core Modelling MSE Group, in its 6th meeting, recommended the contract of the external modelling expert to be continued in GBYP Phase 8 and 9.

7.3.2 ICCAT GBYP Core Modelling MSE Group

There were institutional replacements in the membership of the ICCAT GBYP Core Modelling and MSE Group (ex ICCAT GBYP Core Modelling Group) in the last years, taking into account the two GBYP Core Modelling and MSE Coordinators, the new SCRS Chair and the new rapporteurs. The Group in Phase 7 has the following members: Tom Carruthers (expert and MSE Technical Assistant), Polina Levontin, Richard Hillary, Toshihide Kitakado, Haritz Arrizabalaga, Doug Butterworth and *ex-oficio* members: David Die (SCRS Chair), Clay Porch (ABFT Chair), Gary Melvin (WBFT Rapporteur), Ana Gordoa (EBFT Rapporteur), Laurie Kell (ICCAT Population Dynamics Specialist), Paul De Bruyn (ICCAT Research and Statistics Coordinator), Antonio Di Natale (ICCAT GBYP Coordinator) and Miguel Neves dos Santos (ICCAT Assistant Executive Secretary).

A fourth meeting of the Group was held in Madrid on 11 March 2017, back to back with the SCRS Bluefin tuna data preparatory session. It was decided to call an *ad horas* meeting of a Group for preparing a proposal for taking the current MSE work forward and use the opportunity to inform about it the scientists that were already been attending the other meeting. The future schedule was also proposed.

A fifth meeting of the Group was held on various occasions back-to-back with SCRS Bluefin tuna Stock assessment session (in Madrid, 19-23 July 2017, then extended to the 28th). During the meeting, the importance to use the various sets of GBYP data in the OM has been pointed out. The Group, revising what it was discussed at the Monterey meeting, decided to make publically accessible the software developed by the MSE expert, using the ICCAT web site. The public can now access the software on https://github.com/ICCAT/abft-mse/wiki. It was confirmed that the 5-year GBYP aerial survey index will be included in the OM, being the last report already available, as agreed. Carruthers was asked to review the various points according to the notes provided by the Group and present the updated runs and the new documents. The Group recommended to use OM7 as the best case run.

A sixth meeting of the Core Modelling MSE Group was held planned back-to-back to the SCRS Bluefin tuna Species Group meeting in September 2017 in Madrid.

The last CMMG developed an updated workplan for the next activities:

Next Steps

- Presenting the summary of the GBYP Modelling MSE work carried out so far to the Commission meeting.
- Involve specialists from different CPCs in the CMMG particularly from geographical areas which are not currently represented in the Group.
- Agreeing and weighting Operating Model Scenarios.
- Identifying candidate management strategies and coding these as Management Procedures by third party teams.
- Identifying the Management Procedures that robustly meet management objectives.

Candidate Management Procedures:

- Possibly in April 2018 the various developers of CMPs will meet to compare results and agree on refinements to take their CMPs further.
- In September 2018, the SCRS BFT Species Group will narrow the set of CMPs based on their performance across the various OMs.
- Propose an intersessional meeting of Panel 2 to the Commission in 2018, to be held in the first part of 2019, as a first stakeholder-scientists interaction to discuss desired MP properties and performance, informed by results from the first set of CMPs.
- A subsequent meeting of the CMMG takes place to consider the results of CMP amendments informed by that stakeholder-scientist interaction.
- If needed, a second stakeholder-scientist interaction takes place during a further Panel 2 intersessional meeting in about July 2019.
- A meeting of the CMMG takes place before the September 2019 Bluefin session to finalise a small number on CMPs to present to the Commission
- Table a proposed set of MP options to Commission at its 2019 meeting to allow them to make a final selection at that time

7.3.3 Technical meeting and workshop on modelling/MSE

Within the framework of the Phase 7, a technical meeting was organized on modelling and MSE. It was held in Madrid in a week of 15-19 May 2017 and it included a working group to develop SAM Assessment for East Atlantic and Mediterranean Bluefin Tuna**.** This group was formed by Laurie Kell, population dynamics expert in ICCAT Secretariat and two external participants: Anders Nielsen and Abdelouahed Ben Mhamed.

The assessment of the Mediterranean and Atlantic Bluefin tuna has always been conducted using the VPA approaches. The uncertainties around the estimates of such approaches make difficult the provision of scientific advice. In this meeting the working group used a state-space stock assessment model SAM as a new approach to evaluate the impact of uncertainty. Additionally, a comparison of the results of VPA and SAM was conducted, based on the 2014 datasets and the preliminary 2017 datasets. To evaluate the robustness of SAM a range of diagnostics and scenarios was ran according the 2017 Bluefin data preparatory meeting. The summary of the meeting and its findings were provided by SCRS/2017/146.

7.3.4 Use of GBYP data in the BFT Stock Assessment, in the MSE and in the OM

One of the principal objectives of the GBYP is to improve the basic data for their use in the various assessment and modelling approaches. At the beginning the data collected under the various activities by the GBYP suffered several delays before finally entering into the ICCAT system, but later, after refining the procedures for incorporating the data in the ICCAT Statistical department, most of the data were duly incorporated and several size and effort data were used in the 2014 stock assessment.

In the following Phases, the data were moved into the system almost in real time, after being accepted by the ICCAT SCRS Subcomstat, while others were provided directly to the specialist identified by the SCRS BFT Species Group. In the first part of Phase 7 the great majority of the GBYP data were used in the 2017 Bluefin Assessment, in the MSE and in the OM. **Table 25** shows the details.

8. Legal framework

The enforcement of the ICCAT Rec. 11-06, which allows for a “research mortality allowance” of 20 tons/year 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, helped the GBYP in carrying out both tagging and biological sampling activities. The ICCAT Secretariat, on 22 May 2012, issued a first circular (no. 2296/2012), establishing the rules and the details for the enforcement of Rec.11-06, including the official form for reporting the RMA and the first list of authorized institutions (20 entities). Another circular (no. 2279/2013) was issued on 28 May 2013, including 33 authorised entities. The third circular (no. 2180/2014) was issued on 23 April 2014, with a list of 36 authorised entities. The forth circular (no. 3203/2015) was issued on 26 May 2015, with a list of 32 entities. The sixth circular (G-0745/2016) was issued on 10 June 2016, with the list of 20 entities. For the purpose of covering all the activities in the second part of GBYP Phase 6, it was updated on 10 October 2016 (no. 1356/2016), with the list of 31 entities and then again on 29 November 2016 (no. 1574/2016) with the list of 32 entities. A new circular (no. 964/2017) was issued on 19 June 2017, including 33 entities. An updated circular (no. 1386/2017) was issued on 12 September 2017, including 43 entities.

A total of 315 ICCAT GBYP RMA certificates have been issued from 2012 to 1 September 2017, using 12,358.15 kg of Bluefin tuna (equal to 2004 fish). RMA certificates were issued in Phase 6, using a total of 856.01 kg corresponding to 550 fish, while 14 certificates were issued in 2017, using a total of 838.55 kg, corresponding to 89 fish. RMA used quantities in previous years (5,039.49 kg in 2012, 4,392.76 kg in 2013, 887.78 kg in 2014, 324.71 kg in 2015, 874.86 kg in 2016 and 838.55 kg used so far in 2017) were officially communicated to ICCAT Statistical Department for the inclusion in the official ICCAT BFT catch table. The RMA data were also passed to the SCRS Subcommittee of Statistics (SCRS/2017/208).

The ICCAT CPCs, in general, supported from a practical point of view the GBYP field activities, as established by the Commission. Only few exceptions were noticed about the late issuing of the permit for carrying out biological sampling activities in some areas in some years.

9. Cooperation with the 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, but also for noticing and reporting any natural mark. Specific forms were provided to ROP. The GBYP Coordinator regularly participating to the ICCAT ROP observers training courses up to 2015, specifically training them for the tag recovery and reporting. ICCAT GBYP tag awareness material is regularly provided to ICCAT ROPs.

The contacts between ICCAT ROPs and ICCAT GBYP are usually in real time, always through the ICCAT Secretariat, which is duly informed of all contacts and procedures. ICCAT ROPs are also helping for identifying the right persons for providing the rewards for the recovered tags.

ICCAT ROPs are improving their tag reporting year after year and this cooperation was also extended to genetic sampling, after assessing both their availability and the good-will of the tuna farm owners. This activity was initiated in the Phase 7 as a trial to assess its feasibility and the possible cost (limited to the sampling equipment and the shipment cost). And ROP observers have been engaged in collecting small tissue samples of all accessible Bluefin tuna individuals at the harvesting in farms or when dead Bluefin tunas were taken on board of vessels having an ICCAT observer on board.

10. Steering Committee Meetings

The GBYP Steering Committee in the Phase 6 and Phase 7 was composed by the Chair of SCRS, Ph.D. David Die, the BFT-W Rapporteur, Ph.D. Gary Melvin, the BFT-E Rapporteur, Ph.D. Sylvain Bonhommeau (who was replaced by Ph.D. Ana Gordoa from January 2017), the ICCAT Executive Secretary, Mr. Driss Meski, and the external expert, Ph.D. Tom Polacheck, who was contracted for this duty in Phase 6. His contract was not extended to the Phase 7. **Table 26** shows the different composition of the ICCAT GBYP Steering Committee since the beginning of the programme (according to the official contracts for the external member only). The changes in the SC members, which are logical according to the current institutional components, sometimes created different views for some GBYP activities.

The Steering Committee members have been constantly informed by the GBYP about all the initiatives and they are regularly consulted by e-mail on many issues. A monthly report is regularly provided to the Steering Committee by the GBYP Coordinator. The activity of the Steering Committee included continuous and constant e-mail contacts with the GBYP coordination, including all the necessary information.

In Phase 6 the Steering Committee held one meeting (on 30-31 July 2016), discussing various aspects of the programme, providing guidance and opinions for adapting the plan for Phase 6. The meeting defining the activities for the Phase 7 was held at the beginning of the Phase, in Madrid on 07-08 March 2017.

11. 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 seven Phases, GBYP received and used only about 69.79% of the funds originally approved for the same time period (13,311,541 euro[17] against 19,075,000 euro).

In Phase 6, the budget had the following funders (in order of contribution):

European Union (grant agreement)	Euro	1,556,109.92
United States of America (donation)	Euro	90,000.00
Japan (donation)	Euro	62,860.40
Turkey (donation according to quota)	Euro	57,138.43
Tunisia (donation according to quota)	Euro	52,512.33
Libya (donation according to quota)	Euro	50,000.00
Kingdom of Morocco (donation)	Euro	50,000.00
Norway (donation)	Euro	20,000.00
Canada (service agreement)*	Euro	19,105.85

[17] For Phase 7, due on-going activities, the amount is based on the budget.

Albania (donation according to quota)	Euro	2,125.00
Korea (donation according to quota)	Euro	4.442.65
Chinese Taipei (donation)	Euro	3,000.00
Popular Republic of China (donation according to quota)	Euro	2,106.80
Iceland (donation according to quota)	Euro	1,708.54

In Phase 7, the budget had the following funders (in order of contribution already received or committed):

European Union (grant agreement)	Euro	1,447,188.00
United States of America (donation)	Euro	82,220.77
Libya (donation according to quota)	Euro	110,429.60
Japan (donation)	Euro	57,024.88
Tunisia (donation according to quota)	Euro	53,447.40
Turkey (donation according to quota)	Euro	52,972.61
Kingdom of Morocco (donation)	Euro	50,000.00
Canada (service agreement)*	Euro	21,425.30
Norway	Euro	20,000.00
Chinese Taipei (donation)	Euro	3,000.00
Popular Republic of China (donation according to quota)	Euro	1,931.09
Iceland (donation according to quota)	Euro	1,566.12

Further amounts were residuals of previous GBYP Phases and they were used for better balancing the EU contribution and for compensating costs which were not covered by the EU funding in the various Phases. Additional eventual residuals from the amounts provided in Phase 7 will be used for the following Phases of GBYP. Contributions for the current and previous GBYP Phases are still pending from some ICCAT CPCs.

The lack of a stable and reliable multi-year funding system is one of the major problems for GBYP, 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 discussed but they were never approved. The uncertainties linked to the funding at each Phase are creating operational problems since the beginning of the programme, because it is difficult to plan all activities and provide all necessary contracts when the effective funding will be certain and confirmed only at the very end of each Phase. This fact implies a continuous attention to the effective budget availability at each step of the programme by the Coordination and the impossibility to operate with multi-year contracts for multi-year activities.

The Atlantic-wide Research Programme for Bluefin Tuna is a very complex programme and its activities concern all stakeholders. When it was approved by the Commission, the reason was that this programme is necessary for improving the scientific knowledge about this species and this is the difficult and challenging work that GBYP is carrying on, following the strategy recommended yearly by the Steering Committee and the SCRS, but also by the Commission. 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 and then reinforced by the mid-term evaluation and by the second external review. Therefore, GBYP is managing to work with all stakeholders, keeping them aware of the programme and its activities and getting them directly involved when necessary.

Here following is the list of donors to GBYP, in alphabetic order:

- ✓ Aquastudio Research Institute, donation in kind of 1 miniPAT, estimated value 3,500 euro (2014).
- ✓ Asociación de Pesca, Comercio y Consumo Responsable de Atún Rojo (SP): Euro 6,000.00 (for GBYP in Phase 1).
- ✓ Association Marocaine de Madragues, donation in kinds of a social dinner in Tangier; estimated value not defined (for the Symposium on Trap Fishery).
- ✓ Carloforte Tonnare PIAMM, donation in kind of several tunas for biological sampling and tagging; estimated value not defined (Phase 4).
- ✓ COMBIOMA, University of Cagliari, donation in kind for tagging underwater and logistics in Sardinian traps; estimated value not defined (Phase 4).
- ✓ Departement de la Pêche Maritime, DPMA/DPRH, Rabat (MO), essential administrative and logistic support for tagging in Moroccan traps in Phase 2, 3, 4 and 5.
- ✓ Federcoopesca, Roma, donation in kind, providing 5 extra days of a purse-seiner time for tagging; estimated value not defined (Phase 4, 2013) and donation in kind of the electronic and conventional tagging activity in Phase 5 (estimated value to be defined).

- ✓ Fromentin Jean-Marc, Ph.D., IFREMER: a collection of tuna trap data from 1525 to 2000, estimated value not defined (for Data Recovery and Data Mining, Phase 4).
- ✓ Grup Balfegó (SP), donation in kinds of tuna heads prepared for sampling otoliths; estimated value: Euro 300,00 (for the GBYP Operational Meeting on Biological Sampling in Phase 2).
- ✓ Grupo Ricardo Fuentes e Hijos S.A. (SP): Euro 10,000.00 (for the Symposium on Trap Fishery in Phase 2) and the practical support for tagging in Moroccan traps in Phase 2, 3, 4 and 5.
- ✓ Hopkins Marine Station of the Stanford University, donation in kind of 7 acoustic tags and 8 miniPATs analysis and logistics in Morocco; estimated value not defined (Phase 4, 2013 and 2014).
- ✓ Institute National de Recherche Haulieutique (INRH), Tangier (MO), donation in kinds of logistic support and staff assistance for tagging in Morocco: estimated value to be defined (for GBYP Tagging in Phase 2, 3, and 4).
- ✓ Instituto Español de Oceanografia, Fuengirola, donation in kinds of staff assistance for tagging in Morocco: estimated value not defined (for GBYP Tagging in Phase 2).
- ✓ Lutcavage Molly, Ph.D.,Scool of Environment, University of Massachusetts (USA), donation of data from 697 e-tags; estimated value not defined (for GBYP Modelling in Phase 6).
- ✓ Maromadraba SARL and Es Sahel (Fuentes Group), donation in kind of divers working time, vessels support and sailors, for tagging in Morocco; estimated value: Euro 6,000.00 (for GBYP Tagging in Phase 2, 3, 4 and 5).
- ✓ Mielgo Bregazzi Roberto (SP), donation in kinds of many thousands of individual tuna data from auctions, estimated value: 50,000.00 Euros (for GBYP Data Recovery in Phase 2) and 300,000 Euros (for GBYP Data Recovery in Phase 3).
- ✓ National Institute of Fishery Science, Busan (Republic of Korea), donation of the output data from 12 electronic tags (2 miniPATs and 10 SPATs) to be deployed in Phase 7, estimated value not defined.
- ✓ National Research Institute for Far Seas Fisheries, Shimizu (JP), donation of many hundreds Bluefin tuna samples from the central Atlantic fishery: estimated value not defined (for GBYP biological and genetic analyses in Phase 2, 3, 4 and 5); complimentary support for travel and accommodation costs for several Japanese scientists for participating in various GBYP meetings and activities.
- ✓ Oceanis srl, donation in kind for tagging underwater and logistics in Maltese cages and Sardinian traps; estimated value not defined (Phase 4).
- ✓ UNIMAR, Rome (IT), donation of data sets from 9 e-tags (for GBYP Modelling in Phase 5).
- ✓ Wildlife Computers Inc., donation in kind of additional 25 miniPATs for compensating the problems created by the pin-broke.
- ✓ 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). Donation in kind of 6 miniPATs and 2 experimental e-tags; estimated value 40,000 euro (for tagging in the Strait of Messina in Phase 6).
- ✓ WWF Netherlands, complimentary support for the costs of an additional tagger during the tagging activities in the North Sea, estimated value not defined (Phase 7).
- ✓ GBYP Coordinator, donation of many thousands of old catch data; estimated value not defined (Phases 3, 4 and 5).

The list does not include other entities which provided complimentary tagging activities for conventional tags.

12. GBYP web page

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

The ICCAT Secretariat provided all the necessary support for the ICCAT GBYP web pages.

Annex Ia: GBYP contracts issued in Phase 6.

ICCAT-GBYP CONTRACTS (PHASE 6)								
ICCAT GBYP COORDINATION								
PHASE	YEAR	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule initial date	working schedule final date	COST €	NOTES
6	2016-2017	01/2016	*Second review of the ICCAT GBYP* - MRAG Ltd. - United Kingdom	John Pearce, e-mail: j.pearce@mrag.co.uk	27/04/2016	30/07/2016	49.950,00 €	
		direct contract	*ICCAT GBYP Steering Committee external member* - Ph.D. Tom Polacheck	Tom Polacheck, e-mail: runningtide.tom@gmail.com	31/07/2016	20/02/2017	17.000,00 €	2.000 € for travel
ICCAT GBYP DATA RECOVERY								
PHASE	YEAR	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule initial date	working schedule final date	COST €	NOTES
6	2016-2017	02/2016	*Data recovery plan* - Ph.D. Marta Gonzales Herrera - Spain	Marta Gonzales Herrera, email: martaglezher@gmail.com	27/04/2016	08/07/2016	7.500,00 €	
		02/2016	*Data recovery plan* - Necton Soc.Coop. A r.l. - Italy	Antonio Celona, e-mail: info@necton.it	30/05/2016	08/07/2016	17.100,00 €	
		02/2016	*Data recovery plan* - Ricerca Mare Pesca s.c.a.r.l. - Italy	Marcello Bascone, e-mail: marcellobascone@libero.it	18/05/2016	08/07/2016	12.610,00 €	contracted for 18.280,00 €
		13/2016	*Data recovery plan* - Ph.D. Judit Vidal Bonavila - Spain	Judit Vidal Bonavila, e-mail: juditvb88@gmail.com	12/12/2016	17/02/2016	8.000,00 €	
		04/2016	*Electronic tag data recovery* -Board of Trustees of the Leland Stanford Junior University - USA	Barbara A. Block, e-mail: bblock@stanford.edu	15/07/2016	31/08/2016	50.000,00 €	
		10/2016	*BFT Trade, market & auction data analyses* - MRAG Ltd - United Kingdom	John Pearce, e-mail: j.pearce@mrag.co.uk	04/10/2016	31/01/2017	27.475,00 €	
		MOU	*BFT data recovery in Mauritania, including training* - l'Institut Mauritanien de Recherches Océanographiques et des Pêches (IMROP) - Mauritania	Beyahe Meisse, e-mail: beyahem@yahoo.fr	12/07/2016	22/09/2016	4.201,35 €	contracted for 10.000,00 €
ICCAT GBYP TAGGING PROGRAMME								
PHASE	YEAR	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule initial date	working schedule final date	COST €	NOTES
6	2016-2017	03/2016	*Tagging programme (Area A)* - The Faculty of Fisheries, University of Istanbul - Turkey and Unimar Soc.Coop. - Italy	Saadet Karakulak, e-mail: karakul@istanbul.edu.tr; Adriano Mariani, e-mail: a.mariani@unimar.it	30/05/2016	31/07/2016	133.166,75 €	contracted for 140.425,00 €
		03/2016	*Tagging programme (Area B)* - Institut National de Recherche Halieutique - Morocco, as leader of consortium including one more Moroccan institution and one Spanish institution	Nouredinne Abid, E-mail: noureddine.abid65@gmail.com	30/06/2016	31/07/2016	116.125,00 €	
		03/2016	*Tagging programme (Area C)* - Centro di Competenza Sulla Biodiversita Marina- Italy, as leader of Consortium including one more Italian institution	Piero Addis, e-mail: addisp@unica.it	30/05/2016	31/07/2016	55.000,00 €	
		08/2016	*Tagging programme (Area A)* - Unimar Soc.Coop - Italy	Adriano Mariani, e-mail: a.mariani@unimar.it	15/07/2016	31/12/2016	71.046,77 €	contracted for 77.655,00 €
		08/2016	*Tagging programme (Area B)* - Tunipex S.A. - Portugal, as leader of consortium including one more Portuguese institution	Alfredo Poço, e-mail:E-mail: alfredo@tunipex.eu	01/08/2016	31/12/2016	27.500,00 €	
		05/2016	*Tag awareness activities* - Malvalanda SL - Spain	María del Puy Alvarado Landa, e-mail: tamara@malvalanda.com	23/06/2016	23/09/2016	66.070,00 €	contracted for 63.000,00 €
		continuation of the contract	*Advice on close-kin genetic tagging study* - The Commonwealth Scientific and Industrial Research Organisation (CSIRO) - Australia	Robin Thomson, e-mail: Robin.Thomson@csiro.au	23/12/2016	16/02/2017	36.500,00 €	original cost 50.000,00 AU$
ICCAT GBYP BIOLOGICAL SAMPLING AND ANALYSES								
PHASE	YEAR	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule initial date	working schedule final date	COST €	NOTES
6	2016-2017	07/2016	*Sampling for BFT adults* - AquaBioTech Ltd - Malta, as the leader of consortium including three more Maltese institution	Simeon Deguara, e-mail:dsd@aquabt.com	01/08/2016	17/02/2017	94.134,73 €	contracted for 96.162,00 €
		07/2016	*Sampling for BFT adults* - Balfegó & Balfegó S.L. - Spain	Begonya Mèlich Bonancia, e-mail: bmelich@grupbalfego.com	01/08/2016	10/02/2017	32.827,53 €	contracted for 34.898,00 €
		07/2016	*Sampling for BFT adults* - Taxon Estudios Ambientales S.L. - Spain, as a leader of consortium including one more Spanish institution	Antonio Belmonte Ríos, e-mail: antonio.belmonte@taxon.es	15/07/2016	10/02/2017	40.921,92 €	contracted for 41.100,00 €
		09/2016	*Biological studies* - Fundación AZTI - Spain, as leader of a Consortium including 13 more institutions (1 Spain, 4 Italy, 1 Malta, 1 Ireland, 1 Turkey, 1 Portugal, 1 Morocco (w/o budget), 1 France (w/o budget), 1 Japan (w/o budget), 1 USA (w/o budget) (+ 6 subcontracts: 1 Croatia, 1 France, 1 Italy, 1 Spain, 1 Turkey and 1 USA)	Haritz Arrizabalaga, e-mail: harri@azti.es	23/09/2016	16/02/2017	359.811,27 €	contracted for 404.683,00 €
		cost reimbursement	*ICCAT GBYP Workshop on bluefin tuna larval studies and surveys (Madrid, Spain)*	Antonio Di Natale, e-mail: antonio.dinatale@iccat.int	12/09/2016	14/09/2016	5.526,01 €	
ICCAT GBYP MODELLING APPROACHES								
PHASE	YEAR	CALL FOR TENDERS or ACTIVITY	RETAINED PROPOSAL	main contact	working schedule initial date	working schedule final date	COST €	NOTES
6	2016-2017	06/2016	*Modelling Approaches: Support to Bluefin Tuna Stock Assessment* - The University of British Columbia - Canada	Thomas Robert Carruthers, e-mail: t.carruthers@fisheries.ubc.ca	30/05/2016	21/02/2017	111.000,00 €	original cost 116.820 USD + travels
		cost reimbursement	*ICCAT GBYP Core Modelling Group Meeting (Madrid, Spain)*	Antonio Di Natale, e-mail: antonio.dinatale@iccat.int	04/11/2016	05/11/2016	13.926,36 €	
		cost reimbursement	*ICCAT GBYP short training course on VPA for Atlantic bluefin tuna (Miami, USA)*	Antonio Di Natale, e-mail: antonio.dinatale@iccat.int	06/02/2017	10/02/2017	39.772,57 €	call for tenders 12/2016
		cost reimbursement	*External expert assistance for DPM and assessment - Ph.D.* Abdelouahead Ben Mhamed - Morocco	Abdelouahed Ben Mhamed, e-mail: a.benmahamed@mail.com	04/11/2016	05/11/2016	2.219,00 €	

Annex Ib: GBYP contracts issued in the first part of Phase 7.

ICCAT-GBYP CONTRACTS (PHASE 7)								
ICCAT GBYP DATA RECOVERY								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule initial date**	**working schedule final date**	**COST €**	**NOTES**
7	2017-2018	03/2017	*Data recovery plan* - Necton Soc.Coop. A r.l. - Italy	Antonio Celona, e-mail: info@necton.it	21/06/2017	07/07/2018	6.500,00 €	
		03/2017	*Data recovery plan* - Ricerca Mare Pesca s.c.a.r.l. - Italy	Marcello Bascone, e-mail: marcellobascone@libero.it	02/06/2017	07/07/2018	17.500,00 €	
ICCAT GBYP AERIAL SURVEY								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule initial date**	**working schedule final date**	**COST €**	**NOTES**
7	2017-2018	01/2017	*Aerial survey design* - Alnilam - Spain	Ana Cañadas, e-mail: anacanadas@alnilam.com.es	24/04/2017	31/07/2017	25.000,00 €	
		02/2017	*Aerial Survey* - Grup Air-Med - Spain	Francisco Javier Hevia Bousoño, e-mail: javier@grupairmed.com	16/05/2017	19/07/2017	164.930,00 €	
		02/2017	*Aerial Survey* - Unimar-Italy and Aerial Banners-Italy	Adriano Mariani, e-mail: a.mariani@unimar.it	19/05/2017	19/07/2017	74.090,00 €	
		02/2017	*Aerial Survey* - Action Air Environnement - France	Alexis Giordana, e-mail: agiordana@action-air.net	15/05/2017	19/07/2017	136.161,00 €	
		cost reimbursement	*Aerial Survey Training Course*	Antonio Di Natale, e-mail: antonio.dinatale@iccat.int	15/05/2017	15/05/2017	8.521,28 €	
ICCAT GBYP TAGGING PROGRAMME								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule initial date**	**working schedule final date**	**COST €**	**NOTES**
7	2017-2018	04/2017	*Tagging programme* - Technical University of Denmark, as leader of a Consortium including 2 more institutions (1 Sweden, 1 Netherlands)	Brian MacKenzie, e-mail: brm@aqua.dtu.dk	28/06/2017	04/12/2017	87.952,00 €	
		07/2017	*Tagging programme (Area B)* - Tunipex S.A. - Portugal, as leader of consortium including one more Portuguese institution	Alfredo Poço, e-mail:E-mail: alfredo@tunipex.eu	11/07/2017	28/12/2017	43.500,00 €	
ICCAT GBYP BIOLOGICAL SAMPLING AND ANALYSES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule initial date**	**working schedule final date**	**COST €**	**NOTES**
7	2017-2018	05/2017	*Sampling for BFT adults* - AquaBioTech Ltd - Malta, as the leader of consortium including three more Maltese institution	Simeon Deguara, e-mail:dsd@aquabt.com	02/06/2017	10/02/2018	98.072,00 €	
		05/2017	*Sampling for BFT adults* - Balfegó & Balfegó S.L. - Spain	Begonya Mèlich Bonancia, e-mail: bmelich@grupbalfego.com	29/06/2017	10/02/2018	36.171,35 €	
		05/2017	*Sampling for BFT adults* - Taxon Estudios Ambientales S.L. - Spain, as a leader of consortium including one more Spanish institution	Antonio Belmonte Ríos, e-mail: antonio.belmonte@taxon.es	24/05/2017	10/02/2018	40.000,00 €	
		09/2017	Ageing 2000 otoliths - Fish Ageing Services - Australia	Kyne Krusic Golub, e-mail: kyne.krusicgolub@fishageingservices.com	12/06/2017	10/02/2018	$ 97.580,00	
		08/2017	*Biological studies* - Fundación AZTI - Spain, as leader of a Consortium including 9 more institutions (2 Italy, 1 Malta, 1 Turkey, 1 Spain, 1 USA (w/o budget), 1 Ireland (w/o budget), 1 Japan (w/o budget), 1 France (w/o budget) (+ 4 subcontracts: 1 Turkey, 1 Portugal, 1 Italy, 1 Spain)	Haritz Arrizabalaga, e-mail: harri@azti.es	10/07/2017	15/02/2018	132.597,91 €	
		08/2017	*Biological studies* - Social and Environmental Entrepreneurs - Tag a Tiny Programme - USA	Molly Lutcavaga, e-mail: melutcavage@gmail.com	10/07/2017	15/02/2018	127.800,00 €	
		08/2017	*Biological studies* - University of Bologna - Italy, as leader of a Consortium including 1 more institution (Italy)	Alessia Cariani, e-mail: alessia.cariani@unibo.it	10/07/2017	15/02/2018	42.109,38 €	
ICCAT GBYP MODELLING APPROACHES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule initial date**	**working schedule final date**	**COST €**	**NOTES**
7	2017-2018	06/2017	*Modelling Approaches: Support to Bluefin Tuna Stock Assessment* - Blue Matter Science - Canada	Thomas Robert Carruthers, e-mail: t.carruthers@fisheries.ubc.ca	24/04/2017	21/02/2018	83.000,00 €	
		cost reimbursement	*External expert assistance for DPM and assessment* - Abdelouahed Ben Mhamed and Anders Nielsen	Antonio Di Natale, e-mail: antonio.dinatale@iccat.int	15/05/2017	19/05/2017	3.500,00 €	approximate cost
		cost reimbursement	*ICCAT GBYP Core Modelling and MSE group meeting*	Antonio Di Natale, e-mail: antonio.dinatale@iccat.int	19/07/2017	23/07/2017	4.382,80 €	

Annex IIa. List of reports and scientific papers in GBYP Phase 6

List of deliverables produced within the framework of GBYP contracts and activities in Phase 6 (interim reports and software products will not be included in the final copies; technical interim reports and draft final reports are not listed; interim reports cannot be published):

1. BFT Data Preparatory Meeting – 29 July 2016, Report of the 2016 ICCAT Bluefin Data Preparatory Meeting, Anon: 1-60
2. Coordination – August 2016: Second Review of the ICCAT Atlantic-Wide Research Programme on Bluefin Tuna , Final report, provided as SCRS/2016/192, MRAG: 1-122
3. Coordination - 31 July 2016: ICCAT GBYP Steering Committee Meeting, Report, 1-25.
4. Data recovery –20 May 2016: Short-term contract for the data recovery plan (ICCAT/GBYP 02/2016), Short report #1. Marta Gonzales Herrera:1-3
5. Data recovery – 08 July 2016: Short-term contract for the data recovery plan (ICCAT/GBYP 02/2016), Final report. Marta Gonzales Herrera:1-8
6. Data recovery –29 May 2016: Short-term contract for the data recovery plan (ICCAT/GBYP 02/2016), Short report. Necton: 1
7. Data recovery –20 August 2016: Short-term contract for the data recovery plan (ICCAT/GBYP 02/2016), Final report. Necton: 1-3
8. Data recovery – 22 August 2016: Short-term contract for the data recovery plan (ICCAT/GBYP 02/2016), Final report, Ricerca Mare Pesca: 1-3
9. Data recovery – 25 September 2016: Short term contract for the data recovery programme – Electronic tag data recovery (ICCAT GBYP 04/2016), Final report. Stanford University Hopkins Marine Station: 1-17
10. Data recovery – 22 November 2016, Short term contract for the BFT trade, market and auction data analysis (ICCAT GBYP 10/2016) – Inception report – MRAG Ltd: 1-19
11. Data recovery – January 2017, Short term contract for the BFT trade, market and auction data analysis (ICCAT GBYP 10/2016) – Final report – MRAG Ltd: 1-56
12. Data recovery – 7 February 2017, Short term contract for the data recovery plan (ICCAT GBYP 13/2016), Final report, Judit Vidal Bonavila: 1-10
13. Data recovery – September 2016, Report on programme IMROP-ICCAT/GBYP, Report, IMROP: 1-16
14. Data recovery – 13-14 July 2016- Programme de collecte de données et d'informations sur le thon rouge en Mauritanie, Training course, List of participants, 1-2
15. Biological studies – 4 August 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-1), Preliminary report #1. Taxon: 1-5
16. Biological studies – 26 September 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-1), Preliminary report #2. Taxon: 1-8
17. Biological studies – 4 November 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-1), Preliminary report #3. Taxon: 1-10
18. Biological studies – 24 February 2017: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-1), Final report. Taxon: 1-57
19. Biological studies – 30 August 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-2), Short report #1, AquaBioTech Ltd.:1
20. Biological studies – 19 September 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-2), Short report #2, AquaBioTech Ltd.:1
21. Biological studies – 15 December 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-2), Short report #3, AquaBioTech Ltd.:1
22. Biological studies – 02 March 2017: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-2), Final report, AquaBioTech Ltd.:1-9
23. Biological studies – 11 August 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-3), Short report #1, Balfego & Balfego:1-2
24. Biological studies – 16 September 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-3), Short report #2, Balfego & Balfego:1-3
25. Biological studies – 13 December 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-3), Short report #3, Balfego & Balfego:1-2
26. Biological studies – 14 February 2016: Short-term contract for biological studies – Sampling for adults (ICCAT/GBYP 07/2016-3), Final report, Balfego & Balfego:1-3
27. Biological studies – 7 November 2016 :Short-term contract for biological studies (ICCAT GBYP 09/2016), Short report #1-3, AZTI-Técnalia: 1-9
28. Biological studies – 16 February 2017 :Short-term contract for biological studies (ICCAT GBYP 09/2016), Final report, AZTI-Tecnalia: 1-101
29. Biological studies – 14 September 2016: Report of the ICCAT GBYP Workshop on Bluefin tuna larval studies and surveys, provided as SCRS/2016/206, Anon: 1-20
30. Modelling approaches – 12 July 2016. Short-term contract for support to BFT assessment (ICCAT GBYP 06/2016), Progress report, Tom Carruthers: 1-6

31. Modelling approaches – 20 February 2017. Short-term contract for support to BFT assessment (ICCAT GBYP 06/2016), Final report, Tom Carruthers: 1-13
32. Modelling approaches – August 2016. Simulation Testing A Multi-Stock Model With Age-Based Movement, provided as SCRS/2016/144, Report. Tom Carruthers: 1-9
33. Modelling approaches – August 2016. Issues Arising From The Preliminary Conditioning Of Operating Models For Atlantic Bluefin Tuna, provided as SCRS/2016/145, Report. Tom Carruthers: 1-9
34. Modelling approaches – 10 January 2017., ABTMSE Software Design Specifications v2.1.0, Tom Carruthers: 1-7
35. Modelling approaches – 6 January 2017., M3 Software Design Specifications V1.3, Tom Carruthers: 1-6
36. Modelling approaches – 6 January 2017., Modifiable Multistock Model (M3) Users Guide V1.3, Tom Carruthers: 1-16
37. Modelling approaches – February 2017, Calculating population-wide spatial and seasonal relative abundance indices for Atlantic Bluefin tuna for use in operational modelling, provided as SCRS/2017/019, report. Tom Carruthers: 1-11
38. Modelling approaches – 4-5 November 2016, ICCAT GBYP Core Modelling and MSE Group, third meeting, report from the meeting, Anon: 1-8
39. Modelling approaches – 6-10 February 2017, Capacity building for modelling approaches – Virtual Population Analysis (VPA): Theory and application to Atlantic Bluefin tuna, Training course, Agenda, 1-3
40. Modelling approaches – 6-10 February 2017, Capacity building for modelling approaches – Virtual Population Analysis (VPA): Theory and application to Atlantic Bluefin tuna, Training course, List of participants, 1-2
41. Tagging – 1 August 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 03/2016 Task C), Final report. COMBIOMA: 1-28
42. Tagging – 15 July 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 03/2016 Area B), Final report. INRH: 1-29
43. Tagging – 17 June 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 03/2016 Area A), Short report #1, Istanbul University and Unimar: 1-3
44. Tagging – 30 June 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 03/2016 Area A), Short report #2, Istanbul University and Unimar: 1-5
45. Tagging – 29 July 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 03/2016 Area A), Final report, Istanbul University and Unimar: 1-24
46. Tagging – 23 August 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 08/2016, Area B), Short report. Tunipex: 1-17
47. Tagging – 20 September 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 08/2016, Area B), Final report. Tunipex: 1-21
48. Tagging – 14 August 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 08/2016, Area A), Short report #1. Unimar: 1-2
49. Tagging – 20 September 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 08/2016, Area A), Short report #2. Unimar: 1-2
50. Tagging – 31 December 2016. Short term contract for the Tagging programme 2016 (ICCAT/GBYP 08/2016, Area A), Final report. Unimar: 1-22
51. Tagging – February 2017, Short term contract for reprocessing of satellite pop up tag data, Final report, CLS: 1-220
52. Tagging CKMR– 8 February 2017, Continuation of the short term contract for the advice on Close-Kin Mark Recapture for estimating abundance of eastern Atlantic Bluefin tuna: a scoping study, Updated final report, CSIRO: 1-34
53. Tagging CKMR– 15 February 2017, Continuation of the short term contract for the advice on Close-Kin Mark Recapture for estimating abundance of eastern Atlantic Bluefin tuna: Genotyping issues for CKMR on Atlantic Bluefin tuna, CSIRO: 1-19
54. Tag Awareness Campaign – 20 February 2017: All videos on YouTube https://www.youtube.com/channel/UCK25VrRxTajo-7I0AQbNQxw/videos?shelf_id=0&view=0&sort=dd (screenshot).

List of Scientific Papers – Phase 6

1. Brophy, D., Arrizabalaga, H., Fraile, I., Haynes, P., Kitakado, T., Hanke, A., 2016, Comparative Analysis of Individual Origin Assignments for Bluefin Tuna Sampled Within GBYP. Documents SCRS/2016/128 (withdrawn)
2. Quelle, P., Rodriguez-Marin, E., Ruiz, M., Gatt, M., Arrizabalaga, H., 2017, Age-Length Keys Availability For Atlantic Bluefin Tuna Captured in The Eastern Management Area. Col. Vol. Sci. Pap. ICCAT, 73(6): 2026-2036.
3. Rodriguez-Marin, E., Quelle, P., Ruiz, M., Busawon, D., Golet, W., Dalton, A., Hanke, A., 2016. Updated Comparison of Age Estimates from Paired Calcified Structures From Atlantic Bluefin Tuna. Document SCRS/2016/134 (withdrawn).

4. Hanke, A., Guénette, S., Lauretta, M., 2017, A Summary of Bluefin Tuna Electronic and Conventional Tagging Data. Document SCRS 2016/135 (withdrawn).
5. Tensek, S., Di Natale A., Pagá García, A., 2017, ICCAT GBYP PSAT Tagging: The First Five Years. Col. Vol. Sci. Pap. ICCAT, 73(6): 2058-2073.
6. Pagá García, A., Palma, C., Di Natale, A., Tensek, S., Parrilla, A., De Bruyn, P., 2017, Report on Revised Trap Data Recovered by Iccat Gbyp Between Phase 1 To Phase 6. Col. Vol. Sci. Pap. ICCAT, 73(6): 2074-2098.
7. Di Natale, A., Tensek, S., Celona, A., Garibaldi, F., Oray, I., Pagá García, A., Quilez Badía, G., Valastro, M., 2017, A Peculiar Situation for YOY of Bluefin Tuna (*Thunnus thynnus*) In the Mediterranen Sea in 2015. Col. Vol. Sci. Pap. ICCAT, 73(6): 2099-2111.
8. Di Natale, A., Tensek, S., Pagá García, A., 2017, Studies on Eastern Atlantic Bluefin Tuna (Thunnus thynnus) Maturity – Review Of Old Literature. Col. Vol. Sci. Pap. ICCAT, 73(6): 2112-2128.
9. Di Natale, A., Bonhommeau, S., De Bruyn, P., Die, D., Melvin, G.D., Mielgo Bregazzi, R., Pagá García, A., Palma, C., Porch, C., Takeuchi, Y., Tensek, S., 2017, Bluefin Tuna Weight Frequencies From Selected Market And Auction Data Recovered by GBYP. Col. Vol. Sci. Pap. ICCAT, 73(6): 2129-2149.
10. Di Natale, A., Pagá García, A., Tensek, S., 2017, Bluefin Tuna (*Thunnus thynnus*) Growth and Displacements Derived from Conventional Tags Data. Col. Vol. Sci. Pap. ICCAT, 73(6): 2150-2163.
11. Carruthers, T., Kell, L., 2017, Simulation Testing A Multi-Stock Model With Age-Based Movement. Col. Vol. Sci. Pap. ICCAT, 73(6): 2164-2170.
12. Carruthers, T., Kell, L., 2017, Issues Arising From The Preliminary Conditioning Of Operating Models For Atlantic Bluefin Tuna. Col. Vol. Sci. Pap. ICCAT, 73(6): 2171-2182.
13. Di Natale, A., Pagá García, A., Tensek, S., 2017, Overview of the Bluefin Tuna Data Recovery in Gbyp Phase 6. Col. Vol. Sci. Pap. ICCAT, 73(6): 2195-2201.
14. Cort, J.L., Estruch, V.D., 2017, Analysis of the Length–Weight Relationships for the Atlantic Bluefin Tuna, *Thunnus thynnus* (L.). Col. Vol. Sci. Pap. ICCAT, 73(6): 2222-2254.
15. Di Natale, A., 2017, Scientific Needs for a Better Understanding of the Atlantic Bluefin Tuna (Thunnus thynnus) Spawning Areas Using Larval Surveys. Col. Vol. Sci. Pap. ICCAT, 73(7): 2255-2279.
16. Sissenwine, M., Pearce, J., 2017. Second review of the ICCAT Atlantic-wide research programme on Bluefin tuna (ICCAT GBYP Phase 6-2016). Col. Vol. Sci. Pap. ICCAT, 73(7): 2340-2423.
17. Di Natale, A., Tensek, S., Pagá García, A., 2017, ICCAT Atlantic-wide research programme for Bluefin tuna (GBYP) activity report for the last part of Phase 5 and the first part of Phase 6 (2015-2016). Col. Vol. Sci. Pap. ICCAT, 73(7): 2424-2503.
18. Carruthers, T., Kell, L., 2016. Beyond MSE: Opportunities in the application of the Atlantic Bluefin tuna operating models. Col. Vol. Sci. Pap. ICCAT, 73(7): 2543-2551.
19. Carruthers, T., 2017. Imputing stock-of-origin for electronic tags using stock-specific movements. Col. Vol. Sci. Pap. ICCAT, 73(7): 2552-2556.
20. Anonymous 2017. Report of the ICCAT GBYP Workshop on Bluefin tuna larval studies and surveys. Col. Vol. Sci. Pap. ICCAT, 73(7): 2557-2573.
21. Polacheck, T., Melvin, G., Porch, C., 2017. Some thoughts of the future of the GBYP. Col. Vol. Sci. Pap. ICCAT, 73(7): 2581-2590.
22. García, A., 2016, Bluefin Larval Research Highlights and Milestones: Results from the TUNIBAL Years and Its Consequent Collaborative Projects. Presentation SCRS/P/2016/029
23. Laiz-Carrión R., Uriarte A., Quintanilla J.M. and García, A., 2016, Comparative trophic Ecology of Larvae of Atlantic Bluefin Tuna (Thunnus thynnus) from NW Mediterranean and Gulf of Mexico spawning areas: the ECOLATUN project. Presentation SCRS/P/2016/030
24. Laiz-Carrión R., Uriarte A., Quintanilla J.M. and García, A., 2016, Using Bluefin tuna eggs and pre-flexion larvae as an estimate of maternal stable isotopes. Presentation SCRS/P/2016/031
25. Rodríguez-Ezpeleta, N., Díaz-Arce, N., Alemany, F., Deguara, S., Franks, J., Rooker, J.R., Lutcavage, M., Quattro, J., Oray, I., Macías, D., Valastro, M., Irigoien, X., Arrizabalaga, H., 2016, A Genetic Traceability Tool For Differentiation Of Atlantic Bluefin Tuna (Thunnus thynnus) Spawning Grounds. SCRS/P/2016/032
26. Galuardi, B., Cadrin, S.X., Arregui, I., Arrizabalaga, H., Di Natale, A., Brown, C., Lam, C.H., Lutcavage, M., 2016, Using SatTagSim To Provide Transition Matrices For Movement Inclusive Models. SCRS/P/2016/033
27. Di Natale, A., Tensek, S., Pagá García, A., 2016, Review progress made by the GBYP and Phase 6 programme. Presentation SCRS/P/2016/039
28. Alemany, F., García, A., Reglero, P., Laíz-Carrion, R., Rodríguez, J.M., Pérez-Torres, A., Blanco, E., Hidalgo, M., Álvarez-Berastegui, D., 2016. Two pillars for Larval index application: right taxonomic identification and representative sampling. Problems and potential solutions. Presentation SCRS/P/2016/050
29. Alvarez-Berastegui, D., Ingram, W., Hidalgo, M., Tugores, M.P., Reglero, P., Aparicio-González, A., Ciannelli, L., Juza, M., Mourre, B., Pascual, A., López-Jurado, J.L., García, A., Rodríguez, J.M., Tintoré, J., Aleman, F., 2016, Bluefin tuna spawning and larval habitat, environmental dependencies, modelling and application to assessment. Presentation SCRS/P/2016/051

30. Ortega, A., de la Gandar, F., 2016, ABFT larval rearing and juvenile production in captivity. Presentation SCRS/P/2016/052
31. Ingram, G.W.Jr., Álvarez-Berastegui, D., Rasmuson, L., Lamkin, J., García, A., Alemany, F., Malca, E., Reglero, P., Balbín, R., Tintoré, J., 2016, Development of Larval Atlantic Bluefin Tuna Indices. Presentation SCRS/P/2016/053
32. Lamkin, J., Gerard, T., Shulzitski, K., Rasmuson, L., Malca, E., Privoznik, S., Zygas, A., Ingram, G.W.Jr, 2016, Integrated ecosystem science approach to understanding Bluefin Tuna habitat in the Western Atlantic. Presentation SCRS/P/2016/054
33. Malca, E., Muhling, B., Gerard, T., Tilley, J., Franks, J., Lamkin, J., Garcia, A., Quintanilla, J.M., Ingram, W., 2016, Comparative Growth Dynamics Of Bluefin Tuna Larvae From The Gulf of Mexico And The Mediterranean. Presentation SCRS/P/2016/055
34. Rasmuson, L., Lamkin, J., Gerard, T., Shulzitski, K., Privoznik, K., Malca, E., Muhling, B., Vidal, A., Reglero, P., Alvarez-Berastgui, D., 2016, Individual Based Modelling Of Larval Bluefin In The Gulf of Mexico. Presentation SCRS/P/2016/056
35. Reglero, P., Abascal, F., Alemany, F., Medina, A., Blanco, E., de la Gándara, F., Ortega, A., Alvarez-Berastegui, D., Balbín, R., Juzá, M.., Kernec, M., Mourre, B., Tintoré, J., 2016, The effect of temperature and dispersal on Bluefin tuna larval survival: applications in the Mediterranean Sea. SCRS/P/2016/057
36. Shulzitski, K., Lindo-Atichati, D., Quintanilla, J., Malca, E., Walter, J., García, A., Laiz-Carrión, R., Lamkin, J., Gerard, T., Rasmuson, L., Privoznik S., 2016, Development of a mechanistic link between larval growth variability and the environment for Atlantic Bluefin tuna (*Thunnus thynnus*). Presentation SCRS/P/2016/058
37. Takasuka, A., Robert, D., Shoji, J., Sirois, P., Fortier, L., Oozeki, Y., Garcia, A., 2016, Summary of the symposium/workshop on growth-survival paradigm in early life stages of fish: controversy, synthesis, and multidisciplinary approach. Presentation SCRS/P/2016/059
38. Karakulak F.S., Oray I.K., Addis P., Yildiz T., Uzer U., 2016. Morphometric differentiation between two juvenile tuna species (*Thunnus thynnus* (Linnaeus, 1758) and *Euthynnus alletteratus* (Rafinesque, 1810)) from the eastern Mediterranean Sea. J. Appl. Ichthyol., 32: 516-522.
39. Apostolaki, P., Pearce, J., Barbari, A., Beddington, J. (in press). Alternative Catch Estimates from Market and Third Party Data. Document SCRS/2017/013: 18 p.
40. Carruthers, T. (in press). Calculating population-wide spatial and seasonal relative abundance indices for Atlantic Bluefin tuna for use in operational modelling. Document SCRS/2017/019: 11 p.
41. Fraile, I., Arrizabalaga, H., Kimoto, A., Itoh, T., Abid, N., Rodriguez-Marín, E., Rooker, J. (in press). Estimating the contribution of Atlantic Bluefin tuna subpopulations in the North Atlantic Ocean over the last 6 years. Document SCRS/2017/026: 7 p.
42. Rodríguez-Ezpeleta, N., Díaz-Arce, N., Addis, P., Abid, N., Alemany, F., Deguara, S., Fraile, I., Franks, J., Hanke, A., Itoh, T., Karakulak, S., Kimoto, A., Lauretta, M., Lino, P.G., Lutcavage, M., Macías, D., Ngom, Sow, F., Notestad, L., Oray, I., Pascual, P., Quattro, J., Richardson, D.D., Rooker, J.R., Valastro, M., Varela, J.L., Walter, J., Irigoien, X., Arrizabalaga, H. (in press). Genetic assignment of Atlantic Bluefin tuna feeding aggregations to spawning grounds. Document SCRS/2017/027: 9 p.
43. Brophy, D., Duncan, R., Hickey, A., Abid, N.; Addis, P., Allman, R., Walter III J.F., Coelho, R., Deguara, S., Rodriguez Ezpeleta, N., Fraile, I., Karakulak, S., Arrizabalaga, H. (in press). Integrated analysis for Atlantic Bluefin tuna origin assignment. Document SCRS/2017/028: 11 p.
44. Vidal Bonavila, J. (in press). Las Almadrabas de Corona de Aragon en los Siglos XVI y XVII. Document SCRS/2017/031: 17 p.
45. Di Natale, A. (in press). Tentative recovery of historical Bluefin tuna catches in the Black Sea: the Bulgarian catches 1950-1971. Document SCRS/2017/039: 7 p.
46. Di Natale, A., Tensek, S., Celona, A., Garibaldi, F., Macias Lopez, D.A., Oray, I., Ortega García, A., Pagá García, A., Potoschi, A., Tinti, F. (in press). Another Peculiar Situation for YOY of Bluefin Tuna (*Thunnus thynnus*) In the Mediterranean Sea In 2016. Document SCRS/2017/040: 10 p.
47. Di Natale, A., Tensek, S., Pagá García, A. (in press) The Disappearance of Young-Of-The-Year Bluefin Tuna from the Mediterranean Coast in 2016: Is It an Effect of the Climate Change? Documents SCRS/2017/041: 11 p.
48. Tensek, S., Pagá García, A., Di Natale, A. (in press). ICCAT GBYP Tagging Activities in Phase 6. Document SCRS/2017/042: 12 p.
49. Pagá García, A., Di Natale, A., Tensek, S. (in press). Historical and Recent Data of Sicilian Traps: The Complexity of Data Recovery and Interpretation. Document SCRS/2017/043: 12 p.
50. Galuardi, B., Cadrin, S.X., Arregi, I., Arrizabalaga, H., Di Natale, A., Brown, C., Lauretta, M., Lutcavage, M. (in press). Atlantic Bluefin Tuna Area Transition Matrices Estimated from Electronic Tagging and SatTagSim. Document SCRS/2017/045: 20 p.

Annex IIb. List of reports and scientific papers in the first part of GBYP Phase 7

List of deliverables produced within the framework of GBYP contracts and activities in Phase 7 (interim reports and software products will not be included in the final copies and they are marked in yellow; technical interim reports and draft final reports are not listed; interim reports cannot be published):

1. Aerial Survey – 17 March 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Aerial survey design. Alnilam Research and Conservation Ltd: 1-68.
2. Aerial Survey – 16 May 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Aerial Survey Protocol 2017. Alnilam Research and Conservation Ltd: 1-17.
3. Aerial Survey – 16 May 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Aerial Survey Forms 2017. Alnilam Research and Conservation Ltd: 1-3.
4. Aerial Survey – 15 May 2017: ICCAT GBYP Administrative rules for the Aerial survey, Presentation for the Training Course. ICCAT GBYP Coordination: 1-29.
5. Aerial Survey – 15 May 2017: ICCAT GBYP Aerial Survey objectives and approach, Presentation for the Training Course. ICCAT GBYP Coordination: 1-49.
6. Aerial Survey – 15 May 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Power Point presentation for the Aerial Survey Training Course 2017. Alnilam Research and Conservation Ltd: 1-90.
7. Aerial Survey – 15 May 2017: Training Course for the ICCAT GBYP Aerial survey for Bluefin spawning aggregations, List of participants. ICCAT GBYP Coordination: 1-2.
8. Aerial Survey – 17 July 2017: Short term contract for the aerial survey for Bluefin spawning aggregations (ICCAT GBYP 02/2017a), Final Report for Areas A and E. Grup Air-Med: 1-65.
9. Aerial Survey – 19 July 2017: Short term contract for the aerial survey for Bluefin spawning aggregations (ICCAT GBYP 02/2017b), Final Report for Area C. Unimar and Aerial Banners: 1-26.
10. Aerial Survey – 17 July 2017: Short term contract for the aerial survey for Bluefin spawning aggregations (ICCAT GBYP 02/2017c), Final report for Area G. Action Air Environnement: 1-42.
11. Aerial Survey – 06 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 1. Alnilam Research and Conservation Ltd: 1-3.
12. Aerial Survey – 13 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 2. Alnilam Research and Conservation Ltd: 1-4.
13. Aerial Survey – 20 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 3. Alnilam Research and Conservation Ltd: 1-7.
14. Aerial Survey – 27 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 4. Alnilam Research and Conservation Ltd: 1-7.
15. Aerial Survey – 04 July 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 5. Alnilam Research and Conservation Ltd: 1-5.
16. Aerial Survey – 18 July 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Final report. Alnilam Research and Conservation Ltd: 1-25.
17. Biological studies – 04 July 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Short report. Balfegó & Balfegó SL: 1-2.
18. Biological studies – 16 June 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1.
19. Biological studies – 15 September 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1.
20. Biological studies – 28 June 2017. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Taxon Estudios Ambientales SL: 1-7.
21. Biological studies – 31 August 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-2), consortium represented by University of Bologna: 1-8.
22. Biological studies – May 2017. Sampling strata and needs for Biological studies in Phase 7. GBYP Coordination: 1-2.
23. Coordination –08 March 2017: ICCAT GBYP Steering Committee Meeting, Report, 1-5.
24. Data recovery – 23 May 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017a), Preliminary short report. Necton: 1-1.

25. Data recovery – 4 July 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017a), Final report. Necton: 1-4.
26. Data recovery – 7 July 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017b), Final report. Ricerca Mare Pesca: 1.
27. Meetings – March 2017, ICCAT Bluefin tuna data preparatory meeting 2017, Report, Anon: 1-60
28. Modelling approaches – 11 March 2017: ICCAT GBYP Core Modelling and MSE Group, Fourth Meeting, Report. Anon: 1:4.
29. Modelling approaches – May 2017: Eastern Bluefin Tuna Stock Assessment Using SAM, Report of the Technical Meeting and Workshop on modelling/MSE, provided as SCRS/2017/146. Ben Mhamed *et.al*: 1-19.
30. Modelling approaches– 17 July 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Progress report including workplan. Tom Carruthers: 1-6.
31. Modelling Approaches – 19-28 July 2017: ICCAT GBYP Core Modelling and MSE Group, Fifth Meeting, Report. Anon: 1:7.
32. Modelling Approaches – 25-26 September 2017: ICCAT GBYP Core Modelling and MSE Group, Sixth Meeting, Report. Anon: 1:39.
33. Tagging – 17 August 2017: Short term contract for the Tagging programme 2017 (Area A) (ICCAT GBYP 07/2017), Draft final report. Tunipex, S.A: 1-47.
34. Tagging – 17 September 2017: Short term contract for the Tagging programme 2017 (Area C) (ICCAT GBYP 04/2017), Progress report. The consortium represented by the Technical University of Denmark, S.A: 1-3.

List of Scientific Papers – Phase 7

1. Galuardi B., Cadrin S.X., Arregi I., Arrizabagala H., Di Natale A., Brown C., Lutcavage M. (in press). A Comparison and validation of simulated eastern and western Atlantic Bluefin tuna distributions. American Fishery Society 2017 Annual Meeting.
2. Carruthers, T., Di Natale, A., Lauretta, M., Pagá García, A., Tensek, S. (in press). Migratory behaviour of Atlantic Bluefin tuna entering the Mediterranean. Document SCRS/2017/131: 15 p.
3. Di Natale, A., Tensek, S., Pagá García, A. (in press). ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) Activity report for the last part of Phase 6 and the first part of the Phase 7. Document SCRS/2017/139: 72 p.
4. Ben Mhamed, A., Nielsen, A., Kell, L. (in press). Eastern Bluefin tuna stock assessment using SAM. Document SCRS/2017/146: 19 p.
5. Di Natale, A., Cañadas, A., Vázques-Bonales, J.A., Tensek, S., Pagá García, A. (in press). Report of the ICCAT GBYP Aerial survey for Bluefin spawning aggregations in 2017. Document SCRS/2017/149: 32 p.
6. Ortiz, M. and Palma, C. (in press). Review and preliminary analyses of size frequency samples of Bluefin tuna (*Thunnus thynnus*). Document SCRS/2017/166: 14 p.
7. Macias, D., Palma, C., Rodriguez-Marín, E. (in press). Revision of Atlantic Bluefin tuna Task I nominal catches from Spain. Document SCRS/2017/169: 4 p.
8. Rodriguez-Marin, E., Quelle, P., Ruiz, M., Ceballos, E., Aillound, L.E. (in press). Direct ageing for constructing age-length keys and reestimation the growth curve for East Atlantic and Mediterranean Bluefin tuna. Document SCRS/2017/170: 9 p.
9. Kerr, L.A., Morse, M.R., Cadrin, S.X., Galuardi, B. (in press). Application of an Atlantic Bluefin tuna operating model to generate pseudodata for stock assessment testing. Document SCRS/2017/177: 86 p.
10. Morse, M.R., Kerr, L.A, Cadrin, S.X (in press). Simulating Virtual population analysis of mixed Atlantic Bluefin tuna stocks. Document SCRS/2017/178: 15 p.
11. Pagá-García, A., Tensek, S., Di Natale, A. (in press). Overview of the Bluefin tuna data recovered by GBYP in the last part of Phase 6 and the first part of Phase 7. Document SCRS/2017/191: 8 p.
12. Tensek, S. (in press). ICCAT GBYP Electronic tags database goes Shiny. Document SCRS/2017/192: 10 p.
13. Di Natale, A., Tensek, S., Pagá García, A. (in press). Report on the use of Research Mortality Allowance by ICCAT GBYP in 2012-2016 and the first part of 2017. Document SCRS/2017/208: 12 p.
14. Di Natale A., Lino P.G., López González J.A., Neves dos Santos M., Pagá García A., Piccinetti C., Tensek S. (in press). Unusual presence of small Bluefin tuna YOY in the Atlantic Ocean and in other areas. Document SCRS/2017/216: 4 p.
15. Carruthers T., Butterworth D. (in press). Summary of a reference set of conditioned operating models for Atlantic Bluefin tuna. Document SCRS/2017/223: 16 p.
16. Carruthers T., Butterworth D. (in press). Performance of examples management procedures for Atlantic Bluefin tuna. Document SCRS/2017/224: 9 p.
17. Carruthers T., Butterworth D. (in press). ABT-MSE: a R package for Atlantic Bluefin tuna Management Strategy Evaluation. Document SCRS/2017/225: 6 p.

Annex III: List of meetings and activities attended by GBYP coordination staff or external invited experts in the last part of Phase 6 and in the first part of Phase 7

No.	date	place	Meeting or activity	Motivation
1	3-7/10/2016	Madrid (SP)	SCRS Plenary	Overview of the GBYP activities.
2	1-3/11/2016	Madrid (SP)	Tuna RFMOs MSE Meeting	Presentation of the GBYP MSE work
3	4-5/11/2016	Madrid (SP)	ICCAT GBYP Core Modelling MSE Group meeting	Review of the advances and programme for the last part of GBYP Phase 6 and for Phase 7.
4	06-11/03/2017	Madrid (SP)	Bluefin Tuna Data Preparatory Meeting	Overview of the GBYP activities.
5	07-08/03/2017	Madrid (SP)	ICCAT GBYP Steering Committee Meeting	Planning of Phase 7 activities
6	11/03/2017	Madrid (SP)	Ad horas meeting of the ICCAT GBYP Core Modelling and MSE Group (IV)	MSE tuning
7	15-19/05/2017	Madrid (SP)	Technical Working Group to develop SAM Assessment for East Atlantic and Mediterranean Bluefin Tuna	Alternative BFT stock assessment methods
8	15/05/2017	Madrid (SP)	Training course for crew members of the Aerial Survey for Blufin Spawning Aggregations	Obligatory training for ICCAT GBYP aerial survey
9	19/07/2017 and 23/07/2017	Madrid (SP)	Meeting of the ICCAT GBYP Core Modelling and MSE Group (V)	MSE Tuning
10	20-28/7/2017	Madrid (SP)	Bluefin Tuna Stock Assessment Meeting	Updated BFT data requirements
11	8-10/9/2017	Isla Cristina (SP)	Arráez y Sotarráez. XVI Encuentro de Capitanes de Almadraba	Presentation of the GBYP historical trap data and interpretation. (nop)
12	25-26/9/2017	Madrid (SP)	SCRS Subcommittee of Statistics	Submission of recovered data and RMA
13	27-29/09/2017	Madrid (SP)	SCRS BFT Species Group	Overview of the GBYP activities, other BFT subjects

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

Table 1. ICCAT GBYP staff over the various years of the programme.

GBYP STAFF		2010	2011	2012	2013	2014	2015	2016	2017
name	role								
Antonio DI NATALE	coordinator								
M'Hamed IDRISSI	assistant								
Ana JUSTEL RUBIO	data expert								
Stasa TENSEK	assistant								
Alfonso PAGÁ GARCÍA	data expert								

Table 2. Total data recovered by GBYP from Phase 1 to Phase 7.

TOTAL PHASES 1 to 7	origin	data	total data
# Records	OG	102,011	500,080
	TP	36,557	
	TAMD	311,415	
	FARM	49,364	
	HGEN	733	
BFT (no.)	OG	80,589	30,355,240
	TP	29,220,326	
	TAMD	1,004,228	
	FARM	49,364	
	HGEN	733	
BFT (tons)	OG	123,043	1,705,688
	TP	1,501,762	
	TAMD	80,408	
	FARM	475	
	HGEN	-	
# BFT sampled (size and/or weigth or historical genetics)	OG	114,116	997,288
	TP	7,610	
	TAMD	825,485	
	FARM	49,364	
	HGEN	713	

Legend: OG = Other Gear; TP = Trap; TAMD = Trade, Auction and Market Data; FARM = Farmed tunas; HGEN = Historical Genetic samples;

Table 3. Total data recovered by GBYP from Phase 1 to Phase 7 by century (<1500-1900) and by decade (1900 onwards).

TOTAL PHASES 1 to 7																		
DATA TYPE	Year / source	<1500	1500	1600	1700	1800	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
# Records	OG						9	10	222	13,518	105	15,822	30,212	18,264	1,905	1,174	10,197	10,573
	TRAP		352	1,220	844	6,265	3,005	4,360	6,727	2,301	1,188	1,021	1,040	2,032	780	3,868	1,554	
	TAMD																249,132	62,283
	FARM															851	18,492	30,021
	HGEN	145						110	155			2			30			291
BFT (no.)	OG													204	42	9,937	28,199	42,207
	TRAP		4,216,840	5,239,018	1,370,723	4,548,109	1,613,889	1,883,967	2,971,685	2,013,583	1,002,661	1,787,209	1,566,956	614,611	70	204,806	186,199	
	TAMD														178,743		660,388	165,097
	FARM															851	18,492	30,021
	HGEN	145						110	155			2			30			291
BFT (tons)	OG						44	163	601	2,497	6,056	6,057	29,059	14,492	17,880	17,086	26,848	2,260
	TRAP		21,784	454,322	157,638	154,439	40,327	72,010	76,801	83,592	127,009	86,204	111,417	71,873	8,761	19,568	15,306	711
	TAMD																64,326	16,082
	FARM															207	268	
	HGEN																	
# BFT sampled (size and/or weigth or historical genetics)	OG												18,614	18,548	804	18,569	34,365	23,216
	TRAP							153	170							2,225	5,062	
	TAMD																660,388	165,097
	FARM															851	18,492	30,021
	HGEN	145						110	155			2			10			291

Legenda: OG = Other Gear; TRAP = Tuna Trap; TAMD = Trade, Auction and Market Data; FARM = Farmed tunas; HGEN = Historical Genetic samples

Table 4. Data recovered in Phase 7 from historical traps (TRAP) and Italian longliners (LL).

Fishing period	Gear	Fishing area/ Trap name	ICCAT CPC	BFT total catch (n)	BFT total catch (tons)	Individual fish data (size or weight)	number of vessels
1599-1817	TRAP	Favignana	EU-IT	17,750	1,331		
1599-1818	TRAP	Formica	EU-IT	23,541	1,766		
1599-1823	TRAP	Bonagia	EU-IT	3,171	238		
1592-1705	TRAP	Pula	EU-IT	12,526	940		
1591-1595	TRAP	Carbonara	EU-IT	505,582	85,949		
1594-1602	TRAP	Pixini	EU-IT	210,637	13,691		
1595-1654	TRAP	Porto Scuso	EU-IT	54,999	3,575		
1595-1654	TRAP	Porto Palla	EU-IT	12,894	838		
1597-1654	TRAP	Santa Caterina Pittinuri	EU-IT	5,208	339		
1598-1654	TRAP	Le Saline	EU-IT	21,819	1,418		
1604-1654	TRAP	Cala Vignola	EU-IT	148,895	9,678		
1603-1606	TRAP	San Marco	EU-IT	28,443	1,849		
1606-1608	TRAP	Porto Pi	EU-IT	9,143	594		
1604-1608	TRAP	Capo Bianco	EU-IT	11,345	1,929		
1611-1654	TRAP	Cala Agustina	EU-IT	611,914	104,026		
1632-1640	TRAP	Argentiera	EU-IT	331,454	56,347		
1702-1705	TRAP	Isola Piana	EU-IT	9,743	738		
1588-1613	TRAP	Ursa	EU-IT	8,203	533		
1583-1646	TRAP	Xàbia	EU-SP	14,643	952		
1612-1659	TRAP	Palmar	EU-SP	180,085	11,706		
1602	TRAP	Hospitalet Infant	EU-SP	329,708	21,431		
1580-1589	TRAP	Benidorm	EU-SP	50,339	3,272		
TOTAL TRAP DATA				**2,602,042**	**323,139**		
2011-2012, 2016	LL	Adriatic Sea	EU-IT	6942	234	163	9
2014-2016	LL	Ionian Sea	EU-IT	2463	116	2463	13
2016	LL	Sardinia	EU-IT	253	11	243	3
2011-2012, 2016	LL	Strait of Sicily	EU-IT	7062	433	2492	22
2011-2012, 2014-2016	LL	Tyrrhenian Sea	EU-IT	3982	283	2769	33
TOTAL LL DATA				**20,702**	**1,077**	**8,130**	
total PH 6 and 7				**2,622,744**	**324,216**	**8,130**	

Table 5. General overview of the aerial survey field activities by area, including the motivations for stand-by.

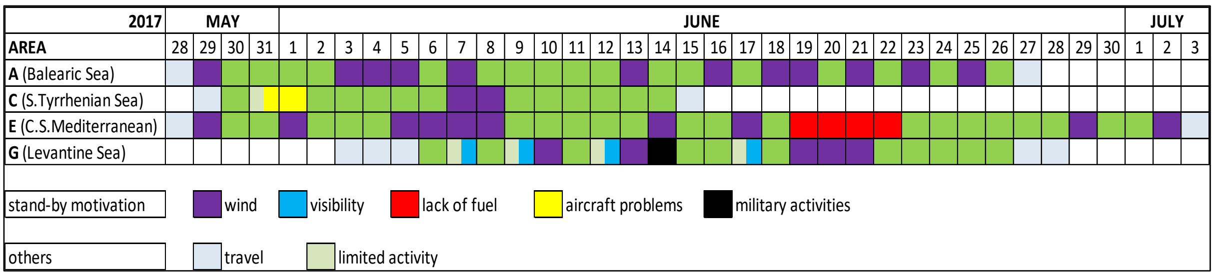


Table 6. Areas, number and total length of transects and number of sightings of Bluefin tuna for each surveyed sub-area.

Area	Area (km^2)	Number of transects	Length of transects on effort (km)	Number of observations (after truncation) Detection Function	Number of observations (after truncation) Abundance estimate
A	61,933	26	4,981	40	22
C	53,868	25	4,911	16	15
E	93,614	30	6,705	10	9
G	56,211	55	4,581	61	45
Total	265,626	136	21,178	127	91

Table 7. Survey details for the surveys carried out so far in Area A (Balearic Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	**2010**	**2011**	**2013**	**2015**	**2017**	**Total (sum)**	**Total (mean)**
Survey area (km^2)	61,933	61,933	61,933	61,933	61,933	309,665	61,933
Transect length (km)	6,118	7,838	6,807	4,109	4,981	29,852	5,970
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	18,130	10,660	20,398	15,961	7,017	72,166	14,433
% coverage	29.3	17.2	32.9	25.8	11.3		23.3
Number of schools ON effort	8	10	10	6	22	56	11.2
Abundance of schools	25	58	30	23	95	231	46
%CV abundance of schools	55.4	35.9	36.1	43.4	30.8		
Encounter rate of schools	0.0013	0.0013	0.0015	0.0014	0.0044		0.00198
%CV encounter rate	54.5	33.8	35.1	41.1	25.9		
Density of schools (1000 km^{-2})	0.402	0.938	0.490	0.372	1.531		0.747
%CV density of schools	55.4	35.9	36.1	43.4	30.8		
Mean weight (t)	131.25	122.43	194.1	160.7	133.9		148.462
%CV weight	6.2	19.2	23.8	11.7	34.9		
Mean cluster size (animals)		678.1	611	825	754		717
%CV abundance		27.9	26.0	11.0	33.6		
Density of animals (km^{-2})		0.636	0.299	0.307	1.155		0.599
%CV density of animals		45.4	44.5	44.7	39.7		
Total weight (t)	**3,587**	**4,371**	**3,539**	**4,712**	**12,693**		**5,780**
%CV total weight	56.5	46.2	40.6	42.0	40.9		
L 95% CI total weight	1,251	1,807	1,624	2,132	5,848		
U 95% CI total weight	10,285	10,577	7,710	10,414	27,551		
Total abundance (animals)		**39,399**	**18,542**	**19,002**	**71,520**		**37,116**
%CV total abundance		45.4	44.5	44.7	39.7		
L 95% CI total abundance		16,540	7,913	8,195	33,620		
U 95% CI total abundance		93,850	43,445	44,060	152,141		

Table 8. Survey details for the surveys carried out so far in Area C (southern Tyrrhenian Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	**2010**	**2011**	**2013**	**2015**	**2017**	**Total (sum)**	**Total (mean)**
Survey area (km^2)	53,868	53,868	53,868	53,868	53,868	269,340	53,868
Transect length (km)	8,487	8,826	2,791	2,739	4,911	27,754	5,550
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	25,150	12,004	8,364	10,640	6,918	63,076	12,615
% coverage	46.7	22.3	15.5	19.8	12.8		23.4
Number of schools ON effort	6	10	10	3	15	44	8.8
Abundance of schools	12	45	64	13	57		38
%CV abundance of schools	45.7	33.4	34.3	62.0	28.8		
Encounter rate of schools	0.0007	0.0011	0.0036	0.0009	0.0031		0.0016
%CV encounter rate	44.6	31.2	33.1	60.5	23.6		
Density of schools (1000 km^{-2})	0.217	0.833	1.196	0.239	1.058		0.709
%CV density of schools	45.7	33.4	34.3	62.0	28.8		
Mean weight (t)	124.17	38.87	173.5	190.0	202.5		145.808
%CV weight	5.6	44.4	22.1	19.9	21.9		
Mean cluster size (animals)	733	291	1,285	1,533	1,453		1,059
%CV abundance	36.5	30.7	17.0	19.0	17.2		
Density of animals (km^{-2})	0.182	0.242	1.536	0.366	1.539		0.773
%CV density of animals	59.2	45.3	38.3	64.9	33.3		
Total weight (t)	**1,596**	**1,917**	**11,370**	**2,665**	**11,547**		**4,387**
%CV total weight	46.9	54.9	40.8	65.1	35.5		
L 95% CI total weight	652	661	5,161	802	5,829		
U 95% CI total weight	3,904	5,557	25,049	8,856	22,874		
Total abundance (animals)	**9,797**	**13,059**	**82,763**	**19,708**	**82,886**		**41,643**
%CV total abundance	59.2	45.3	38.3	64.9	33.3		
L 95% CI total abundance	3,187	5,446	39,399	5,958	43,597		
U 95% CI total abundance	30,016	31,317	173,860	65,192	157,580		

Table 9. Survey details for the surveys carried out so far in Area E (central-southern Mediterranean Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	**2010**	**2011**	**2013**	**2015**	**2017**	**Total (sum)**	**Total (mean)**
Survey area (km^2)	93,614	93,614	93,614	93,614	93,614	468,070	93,614
Transect length (km)	13,137	10,192	4,381	2,566	6,705	36,981	7,396
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	38,930	13,862	13,129	9,969	9,446	85,335	17,067
% coverage	41.6	14.8	14.0	10.6	10.1		18.2
Number of schools ON effort	29	45	20	3	9	106	21.2
Abundance of schools	63	304	135	20	44		113
%CV abundance of schools	31.5	24.1	34.8	58.0	36.4		
Encounter rate of schools	0.0022	0.0044	0.0046	0.0008	0.0013		0.0029
%CV encounter rate	29.9	21.0	33.6	56.3	32.4		
Density of schools (1000 km^{-2})	0.678	3.246	1.447	0.213	0.466		1.210
%CV density of schools	31.5	24.1	34.8	58.0	36.4		
Mean weight (t)	110.14	118.05	11.0	50.2	102.3		78.338
%CV weight	33.9	19.2	66.0	99.5	51.2		
Mean cluster size (animals)	1,015	1,715	361	507	848		889
%CV abundance	19.0	21.5	67.3	97.9	33.2		
Density of animals (km^{-2})	0.787	5.566	0.522	0.108	0.395		1.476
%CV density of animals	37.8	32.3	75.7	113.8	49.9		
Total weight (t)	**7,681**	**37,851**	**1,517**	**1,093**	**4,457**		**10,520**
%CV total weight	47.1	32.2	74.6	115.2	63.4		
L 95% CI total weight	3,155	20,342	390	75	1,413		
U 95% CI total weight	18,698	70,432	5,899	15,857	14,062		
Total abundance (animals)	**73,676**	**521,085**	**48,884**	**10,126**	**36,927**		**138,140**
%CV total abundance	37.8	32.3	75.7	113.8	49.9		
L 95% CI total abundance	35,741	279,620	12,363	727	14,559		
U 95% CI total abundance	151,880	971,060	193,280	141,020	93,662		

Table 10. Survey details for the surveys carried out so far in Area G (Levantine Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	**2010**	**2011**	**2013**	**2015**	**2017**	**Total (sum)**	**Total (mean)**
Survey area (km^2)	56,211		56,211	56,211	56,211	224,844	56,211
Transect length (km)	3,790		2,081	859	4,581	11,311	2,827
Effective strip width x2 (km)	2.96		3.00	3.9	1.4		2.81
Area searched (km^2)	11,231		6,236	3,335	6,453	27,256	6,814
% coverage	20.0		11.1	5.9	11.5		12.1
Number of schools ON effort	33		12	2	45	92	23
Abundance of schools	150		108	22	191		118
%CV abundance of schools	28.1		39.7	70.9	23.5		
Encounter rate of schools	0.0087		0.0058	0.0015	0.0098		0.0081
%CV encounter rate	26.3		38.7	69.5	16.6		
Density of schools (1000 km^{-2})	2.674		1.924	0.399	3.398		2.099
%CV density of schools	28.1		39.7	70.9	23.5		
Mean weight (t)	63.621		4.0	9.0	16.5		23.280
%CV weight	12.7		40.2	66.7	31.5		
Mean cluster size (animals)			336	600	809		582
%CV abundance			36.7	66.7	31.9		
Density of animals (km^{-2})			0.646	0.239	2.756		1.214
%CV density of animals			54.1	97.3	40.1		
Total weight (t)	**10,507**		**440**	**220**	**3,157**		**3,581**
%CV total weight	32.1		56.5	97.3	39.3		
L 95% CI total weight	5,643		151	25	1,495		
U 95% CI total weight	19,561		1,285	1,965	6,669		
Total abundance (animals)			**36,316**	**13,448**	**154,939**		**68,234**
%CV total abundance			54.1	97.3	40.1		
L 95% CI total abundance			12,995	1,506	72,366		
U 95% CI total abundance			101,490	120,070	331,731		

Table 11. Results for all ICCAT GBYP aerial surveys in all overlapping areas combined.

Year	2010	2011	2013	2015	2017	Total (sum)	Total (mean)
Survey area (km^2)	265,627	209,416	265,627	265,627	265,627	1,288,135	265,627
Transect length (km)	31,532	26,856	16,060	10,272	21,178	105,898	21,173
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	93,442	36,525	48,127	39,904	29,834	166,041	33,208
% coverage	35.2	17.4	18.1	15.0	11.2		12.89
Number of schools ON effort	76	65	52	14	91	298	59.6
Abundance of schools	250	388	338	78	387		288
%CV abundance of schools	22.8	19.9	21.5	38.9	20.2		
Encounter rate of schools	0.0024	0.0024	0.0032	0.0014	0.0043		0.0028
%CV encounter rate				20.2	11.6		
Density of schools (1000 km^{-2})	0.942	1.852	1.274	0.295	1.457		1.086
%CV density of schools	22.8	19.9	21.5	38.9	23.4		
Mean weight (t)	87.9	101.1	22.6	272.2	82.3		113.212
%CV weight	16.8	27.5	51.0	41.4	19.2		
Mean cluster size (animals)	791	1,275	582	1,548	895		1018
%CV abundance	18.6	37.3	18.5	40.5	17.0		
Density of animals (km^{-2})		**2.7388**	**0.702**	**0.234**	**1.304**		**1.245**
%CV density of animals		29.9	29.4	39.1	25.9		
Total weight (t)	**23,371**	**44,139**	**16,866**	**8,690**	**31,855**		**24,984**
%CV total weight	25.6	28.7	30.3	35.3	26.7		
L 95% CI total weight	14,243	25,315	9,343	4,398	19,018		
U 95% CI total weight	38,347	76,964	30,447	17,169	53,355		
Total abundance (animals)		**573,543**	**186,505**	**62,284**	**346,272**		**292,151**
%CV total abundance		29.9	29.4	39.1	25.9		
L 95% CI total abundance		321,620	105,320	28,766	209,816		
U 95% CI total abundance		1,022,800	330,270	134,860	571,473		

Table 12. Results for all ICCAT GBYP aerial surveys in all overlapping areas and in total in 2017.

Year	**A**	**C**	**E**	**G**	**Total (sum)**	**Total (mean)**
Survey area (km²)	61,933	53,868	93,614	56,211	265,627	
Transect length (km)	4,981	4,911	6,705	4,581	21,178	
Effective strip width x2 (km)	1.4	1.4	1.4	1.4		1.4
Area searched (km²)	7,017	6,918	9,446	6,453	29,834	
% coverage	11.3	12.8	10.1	11.5	11.2	
Number of schools ON effort	22	15	9	45	91	22.8
Abundance of schools	95	57	44	191	387	96.8
%CV abundance of schools	30.8	28.8	36.4	23.5	20.2	
Encounter rate of schools	0.0044	0.0031	0.0013	0.0098		0.0043
%CV encounter rate	25.9	23.6	32.4	16.6		11.6
Density of schools (1000 km⁻²)	1.531	1.058	0.466	3.398		1.457
%CV density of schools	30.8	28.8	36.4	23.5		23.4
Mean weight (t)	133.9	202.5	102.3	16.5		82.3
%CV weight	34.9	21.9	51.2	31.5		19.2
Mean cluster size (animals)	754	1,453	848	809		895
%CV abundance	33.6	17.2	33.2	31.9		17.0
Density of animals (km⁻²)	1.155	1.539	0.395	2.756		**1.304**
%CV density of animals	39.7	33.3	49.9	40.1		25.9
Total weight (t)	**12,693**	**11,547**	**4,457**	**3,157**	**31,855**	
%CV total weight	40.9	35.5	63.4	39.3	26.7	
L 95% CI total weight	5,848	5,829	1,413	1,495	19,018	
U 95% CI total weight	27,551	22,874	14,062	6,669	53,355	
Total abundance (animals)	**71,520**	**82,886**	**36,927**	**154,939**	**346,272**	
%CV total abundance	39.7	33.3	49.9	40.1	25.9	
L 95% CI total abundance	33,620	43,597	14,559	72,366	209,816	
U 95% CI total abundance	152,141	157,580	93,662	331,731	571,473	

Table 13 – Details on the number of Bluefin tuna tagged with various types of tags in Phase 7 and on the number of the various types of tags implanted in the various areas (updated on 19 September 2017).

Phase 7

	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED						
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+Acoustic+Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0
Bay of Biscay (a)	0	0	0	0	0	0	0	0	0	0	0	0	0
Morocco*	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	46	6	0	40	0	0	0	0	0	0	0	0	0
Strait of Gibraltar***	0	0	0	0	0	0	0	0	0	0	0	0	0
West Med. **	1	1	0	0	0	0	0	0	0	0	0	0	0
Central Med. ****	119	82	37	0	0	0	0	0	0	0	0	0	0
East Med.	0	0	0	0	0	0	0	0	0	0	0	0	0
North Sea	13	0	0	2	0	0	0	11	0	0	0	0	0
		89	**37**	**42**	**0**	**0**	**0**	**11**	**0**	**0**	**0**	**0**	**0**
GRAND TOTAL	**179**	**SUBTOTAL = 168**					**SUBTOTAL = 11**						

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Canada	0	0	0	0	0	0
Bay of Biscay (a)	0	0	0	0	0	0
Morocco*	0	0	0	0	0	0
Portugal	46	6	0	40	0	0
Strait of Gibraltar	0	0	0	0	0	0
West Med. **	1	1	0	0	0	0
Central Med.	119	82	37	0	0	0
East Med.	0	0	0	0	0	0
North Sea	24	11	0	13	0	0
	190	**100**	**37**	**53**	**0**	**0**

Table 14. 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 (updated on 19 September 2017).

All GBYP Phases (2, 3, 4, 5 ,6 & 7) (up to 18/09/2017)		FISH SINGLE TAGGED					FISH DOUBLE TAGGED							
	ALL FISH 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	308	0	303	0	0	0	0	5	0	0	0	0	0	1.7%
Bay of Biscay (a)	7701	4173	1	3	0	0	3493	18	0	0	13	0	0	41.8%
Morocco*	365	129	48	45	0	0	121	14	0	7	0	0	1	2.0%
Portugal	280	23	39	64	0	0	154	0	0	0	0	0	0	1.5%
Strait of Gibraltar***	5561	2254	43	0	0	0	3212	22	5	0	23	2	0	30.2%
West Med. **	1695	933	377	28	0	0	352	5	0	0	0	0	0	9.2%
Central Med.	2434	855	1042	32	0	0	479	15	0	0	12	0	0	13.2%
East Med.	50	0	0	50	0	0	0	0	0	0	0	0	0	0.3%
North Sea	13	0	0	2	0	0	0	11	0	0	0	0	0	0.1%
		8367	**1853**	**224**	**0**	**0**	**7811**	**90**	**5**	**7**	**48**	**2**	**1**	
GRAND TOTAL	**18407**	**SUBTOTAL = 10444**					**SUBTOTAL = 7964**							100.0%

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED					
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	% by area
Canada	313	0	308	5	0	0	1.2%
Bay of Biscay	11225	7697	3494	21	13	0	42.9%
Morocco*	515	258	183	66	0	8	2.0%
Portugal	434	145	225	64	0	0	1.7%
Strait of Gibraltar***	8618	5491	3075	27	25	0	32.9%
West Med. **	2051	1286	732	33	0	0	7.8%
Central Med.	2941	1334	1548	47	12	0	11.2%
East Med.	50	0	0	50	0	0	0.2%
North Sea	24	11	0	13	0	0	0.1%
TOTAL	**26171**	**16222**	**9565**	**326**	**50**	**8**	**100.0%**
%	**100%**	**62.0%**	**36.5%**	**1.2%**	**0.2%**	**0.0%**	

Table 15. Geographical distribution of the areas where the tag recoveries occurred, in numbers and percent, by type of tag (up to 19 September 2017).

Fishing Area / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Acoustic Tags	Commercial Tags	Grand Total	%
East Atl	80	44	11	1		1	137	21.14
Med	284	125	10	11	3		433	66.82
North Atl	22	20	1			2	45	6.94
West Atl	10	17		1		1	29	4.48
Unknown			4				4	0.62
Grand Total	396	206	26	13	3	4	648	100
%ge	61.1%	31.8%	4.0%	2.0%	0.5%	100.0%	100.0%	

Table 16. Details of tag reported to ICCAT GBYP by fishery, in numbers and percent, up to 19 September 2017.

Fishery -Gear / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Acoustic Tags	Commercial Tags	Grand Total	%
BB	189	97					286	44.14
FARM	63	18	1	5	3		90	13.89
HAND	22	12	1				35	5.40
LL	38	22		2			62	9.57
LLHB	2	2					4	0.62
NF			13			4	17	2.62
PS	15	6	1	1			23	3.55
RR	16	28		2			46	7.10
SPOR	11	1					12	1.85
TN	1	1					2	0.31
TRAP	8	7		2			17	2.62
TROL	13	5					18	2.78
UNCL	18	7	10	1			36	5.56
Grand Total	396	206	26	13	3	4	648	100

Table 17. BFT tags reported by year to GBYP (yellow shading means tags reported to ICCAT prior to GBYP).

Recovery Year / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Acoustic Tags	Commercial Tags	Grand Total	%
2002	1	1		1			3	
2006	1			1			2	
2008	1						1	
2009	1						1	
TOT 2002-2009	4	1	0	2	0	0	7	
2010	3						3	0.46
2011	8		1				9	1.39
2012	36	7	6	1		1	51	7.87
2013	60	28	9	2		1	100	15.43
2014	72	30	1	3		2	108	16.67
2015	68	46	3	3	1		121	18.67
2016	99	56	3	3	1		162	25.00
2017	50	39	1	1	1		92	
Undefined (2012 or 2013)			2				2	0.31
Grand Total	396	206	26	13	3	4	648	100

Table 18. Details of the tag recoveries from double tagged Bluefin tunas (GBYP only) (updated up to 19 September 2017).

Release	Spaghetti tag only	Double Barb Tag only	Both	TOTAL FISH	TOTAL TAGS
2011	1	5	5	11	16
2012	10	9	41	60	101
2013	24	12	59	95	154
2016	1	1	1	3	4
2017	6	12	15	33	48
Total	42	39	121	202	**323**
%	20.79	19.31	59.90	100	

RcCode: 2conv	both recovered						
	Year of Recovery						
Year of Release	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**TOTAL FISH D/T**
2011	1	3	2	0	0	3	9
2012	5	15	10	3	7	6	46
2013		6	15	17	19	8	65
2014				1	0		1
2016					1		1
2017							
TOTAL	6	24	27	21	27	17	122
%	4.92	19.67	22.13	17.21	22.13	13.93	100.00

Table 19. Number of Bluefin tuna sampled in Phase 6 by area and size class. Empty cells indicate that no sampling was planned in that stratum. Green cells indicate strata where no sampling was planned, but some sampling was finally accomplished.

		Age 0	Juveniles	Medium	Large	Total		
		<3 kg	3-25 kg	25-100 kg	>100 kg		Target	%
Eastern Mediterranean	Levantine Sea	36		95	14	145	350	41%
Central Mediterranean	East Sicily and Ionian	0		50	50	100	150	67%
	Adriatic Sea		50			50	50	100%
	Malta	0			345	345	450	77%
	Gulf of Gabes				229	229	0	>100%
Western Mediterranean	Balearic	218			546	764	425	180%
	Southern Spain	72				72	0	>100%
	Ligurian	20				20	50	40%
	Sardinia			6	21	27	50	54%
	Tyrrhenian Sea	113	19	108	499	739	600	123%
North Sea	Norway				200	200	0	>100%
East Atlantic-West African coast	Morocco				50	50	50	100%
	Madeira, Canary Islands	6			50	56	100	56%
Northeast Atlantic	Portugal			3	52	55	50	110%
	UK, Ireland				2	2	0	>100%
Central North Atlantic	Central and North Atlantic			16	668	684	50	1368%
North-Western Atlantic	Canada (Gulf Saint Lawrence)				50	50	0	>100%
	TOTAL	465	69	278	2776	3588	2375	151%

Table 20. Maximum likehood predictions of the origin of Bluefin tuna analysed in Phase 6. Estimates are given as percentages and mixed-stock analysis (HISEA program) was run under bootstrap mode with 1000 runs to obtain standard deviations around the estimated percentages

			Predicted Origin based on MLE			
Region	Year	N	FL (cm)	% East	% West	% SD
Central N. Atlantic (west of 45°W)	2014	16	125-275	77.6	22.4	± 19.3
Central N. Atlantic (east of 45°W)	2014	13	148-267	96.8	3.2	± 7.5
Morocco	2015	50	194-259	84.3	16.7	± 9.9
Canary Islands	2015	23	216-251	86.3	13.7	± 14.3
Canary Islands	2016	44	206-260	80.6	19.4	± 10.3

Table 21. Quadratic Discriminant Function Analyses predictions of the origin of Bluefin tuna analyzed in the Phase 6. Estimates are given as percentages and individual origin assignments were grouped by region and years.

			Predicted Origin based on QDFA	
Region	Year	N	% East	% West
Central N. Atlantic (west of 45°W)	2014	16	62.5	37.5
Central N. Atlantic (east of 45°W)	2014	13	84.6	15.4
Morocco	2015	50	70	30
Canary Islands	2015	23	73.9	26.1
Canary Islands	2016	44	72.7	27.3

Table 22. Optimal combination of elements and classification accuracy (estimated by LDA) of YOY Bluefin tuna otoliths for 2011 and 2013 cohorts. Area codes correspond to Levantine Sea (LS), southern Tyrrhenian Sea (TY), east Sicily (SI) and Balearic Sea (BA).

Group division	Optimal combination of elements	Year	Classification accuracy
East (LS) / West (BA, TY, SI)	Ba + Li + Mg	2011	100%
East (LS) / West (BA, TY, SI)	Ba + Li + Mn + Sr	2013	91%*
LS / SI / TY / BA	Mg + Mn + Sr + Zn	2013	76%*

Table 23. Results of the analysis of molecular variance (AMOVA).

Source of variation	% of variance	F index	P-value
2clusters			
(WMED_BA_2012+WMED_TY_2012+CMED_SI_2012+EMED_LS_2012)/(WMED_BA_2013+WMED_TY_2013+CMED_SI_2013+EMED_LS_2013)			
among clusters	0.01	F_{CT} = 0.00060	0.48387+-0.01965
Among samples within clusters	0.06	F_{SC} = 0.00055	0.49756+-0.01874
Among individuals within samples	99.94	F_{ST} = 0.00005	0.47605+-0.01547
4clusters			
(WMED_BA_2012+WMED_BA_2013/WMED_TY_2012+WMED_TY_2013/CMED_SI_2012+CMED_SI_2013/EMED_LS_2012+EMED_LS_2013)			
among clusters	-0.02	F_{CT} = -0.00017	0.57674+-0.01380
Among samples within clusters	0.07	F_{SC} = 0.00072	0.42326+-0.01436
Among individuals within samples	99.94	F_{ST} = 0.00056	0.49658+-0.0135

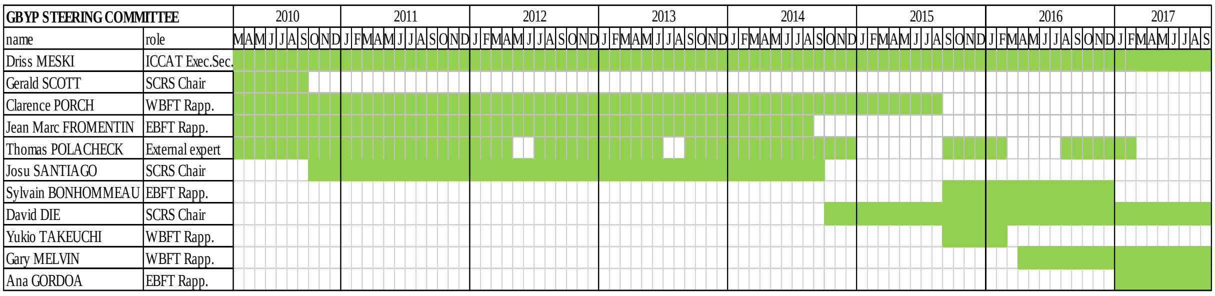
Table 24. Summary of Bluefin tuna mixed samples that were assigned to putative populations using a classification function based on otolith shape descriptors.

	2011	**2012**	**2013**	**% east new baselines**	**% east Brophy et al 2015**
GI	198.5 - **1**			100	94.3*
MO	230.5 *220-241* **2**	209.9 *187-225* **18**	214 *176-236* **30**	66.0	78.6
PO	207 *183-235* **16**	210.8 *191-281* **12**	- - **0**	78.6	91.4

Table 25. Details about the use of GBYP data up to the first part of Phase 7 in the stock assessment, in the MSE and in the OM.

USE OF ICCAT GBYP DATA UP TO THE FIRST PART OF PHASE 7		
Activity	**use in the BFT Stock Assessment**	**use in the BFT MSE and OM**
Data mining and data recovery	size data, historical trap data, BB data, historical maturity data, non-GBYP electronic tagging data recovered by GBYP	size data, LL CPUE, historical trap data, BB data, non-GBYP electronic tagging data recoverd by GBYP, historical genetic data
Aerial survey on BFT spawning aggregation	data available, but not used so far (5 surveys, too short series)	yes
Tagging	conventional tag data, growth data from tagging, GBYP electronic tag data	conventional tag data, electronic tag data, mixing determination by area
Biological studies	genetic and microchemical data (mixing), ALK, reproductive characterististics, L/W correlation	genetic and microchemical data (mixing by area), ALK, reproductive characteristics, L/W correlation
Modelling approaches	SAM application, VPA training course	MSE and OM development, Modelling Multi-Year Plan

Table 26. Composition of the ICCAT GBYP Steering Committee since the beginning of the programme.



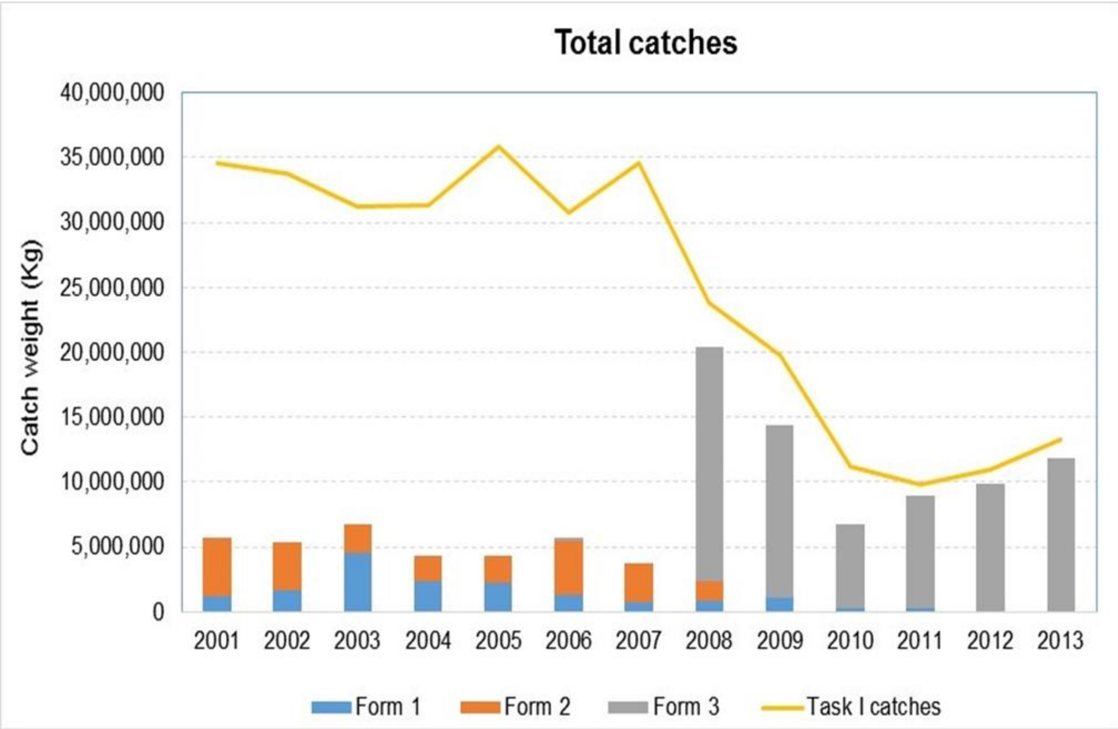


Figure 1. Estimated catches of Eastern Atlantic Bluefin tuna as a result of analysis of 3 auction/market datasets compared to ICCAT official statistics (Task 1).

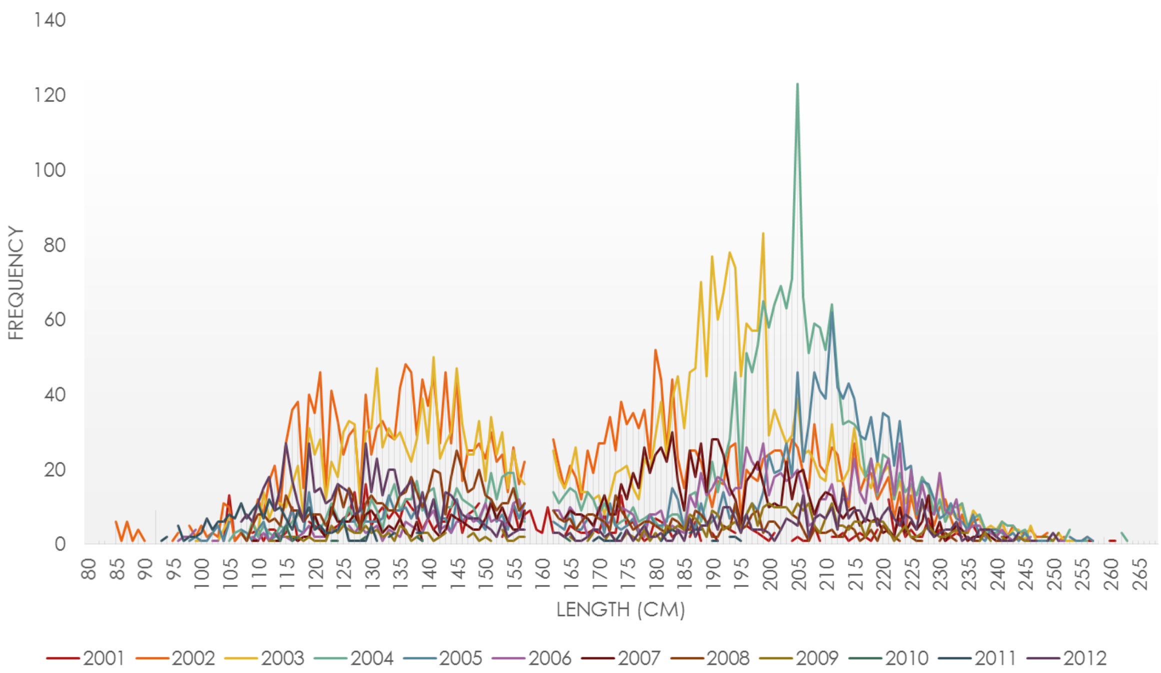


Figure 2. Bluefin tuna length distribution frequencies from auction/market data, as a result of analysis of all 3 forms.

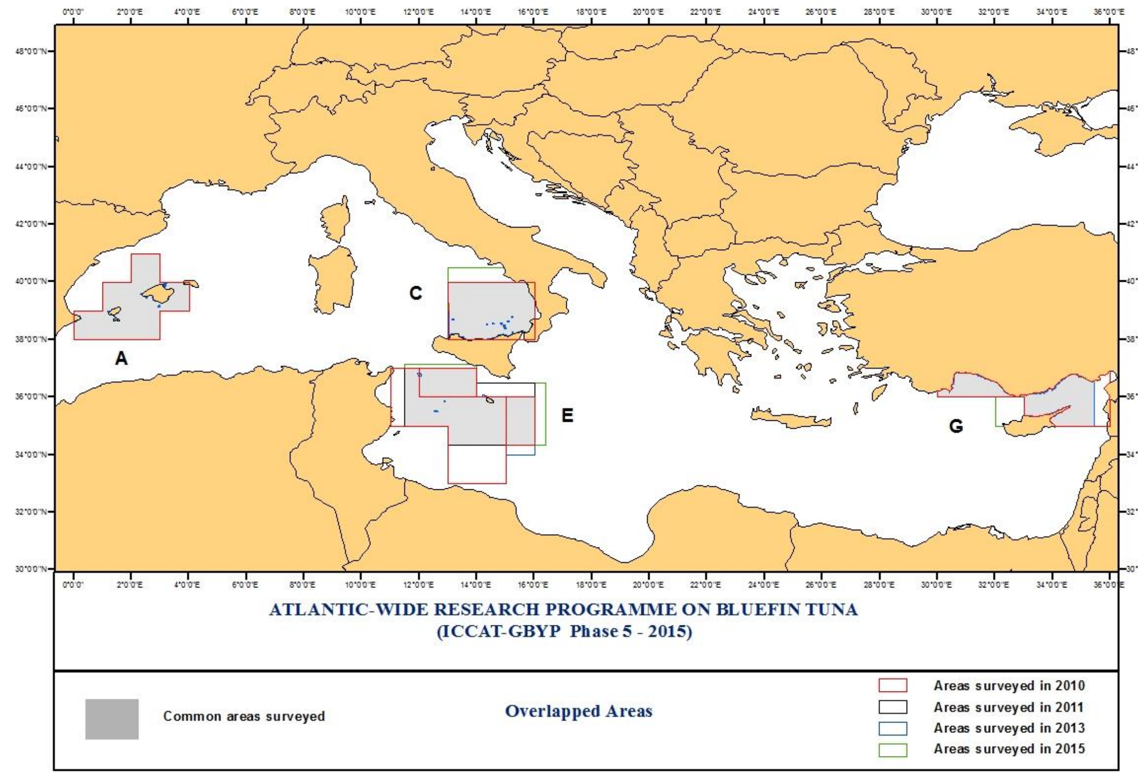


Figure 3. Overlapped areas for four GBYP aerial surveys.

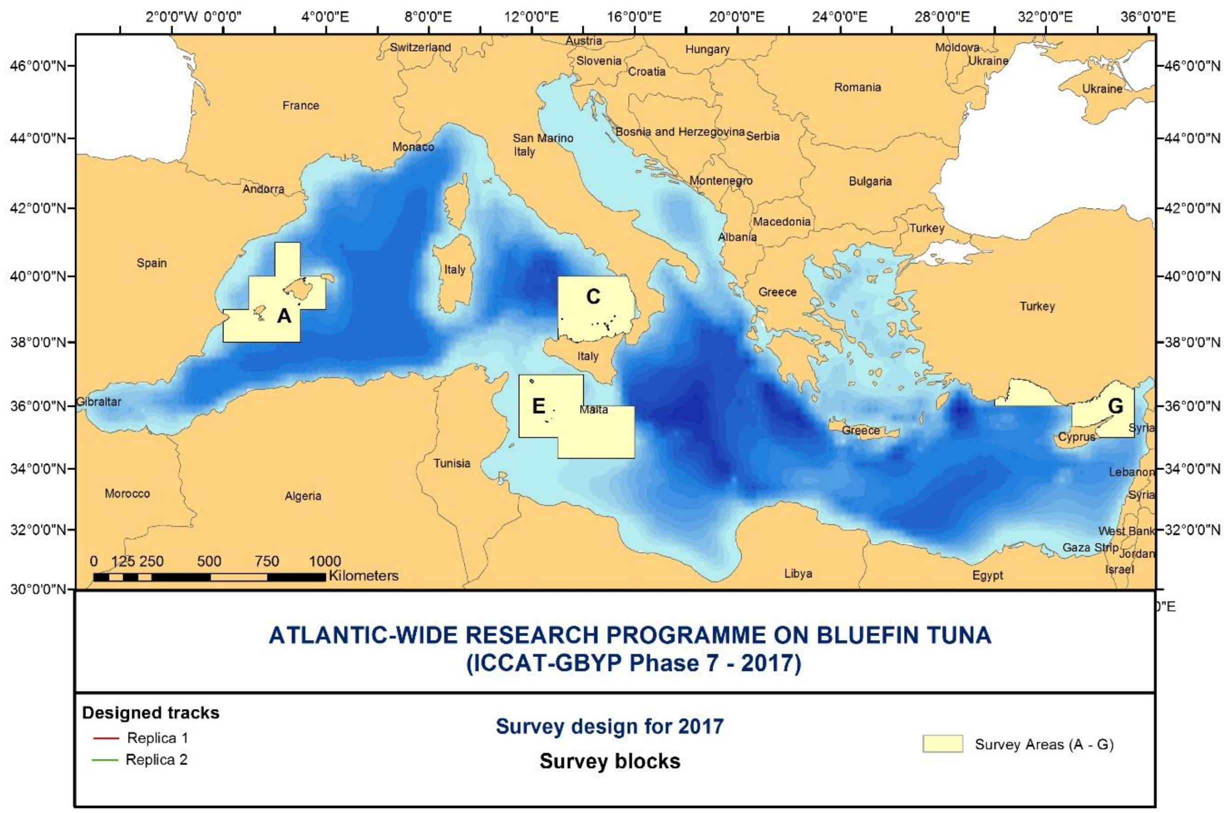


Figure 4. Four areas identified for the aerial survey in 2017. They correspond to the overlapping areas in all previous surveys and to the most important Bluefin tuna spawning areas in the Mediterranean Sea.

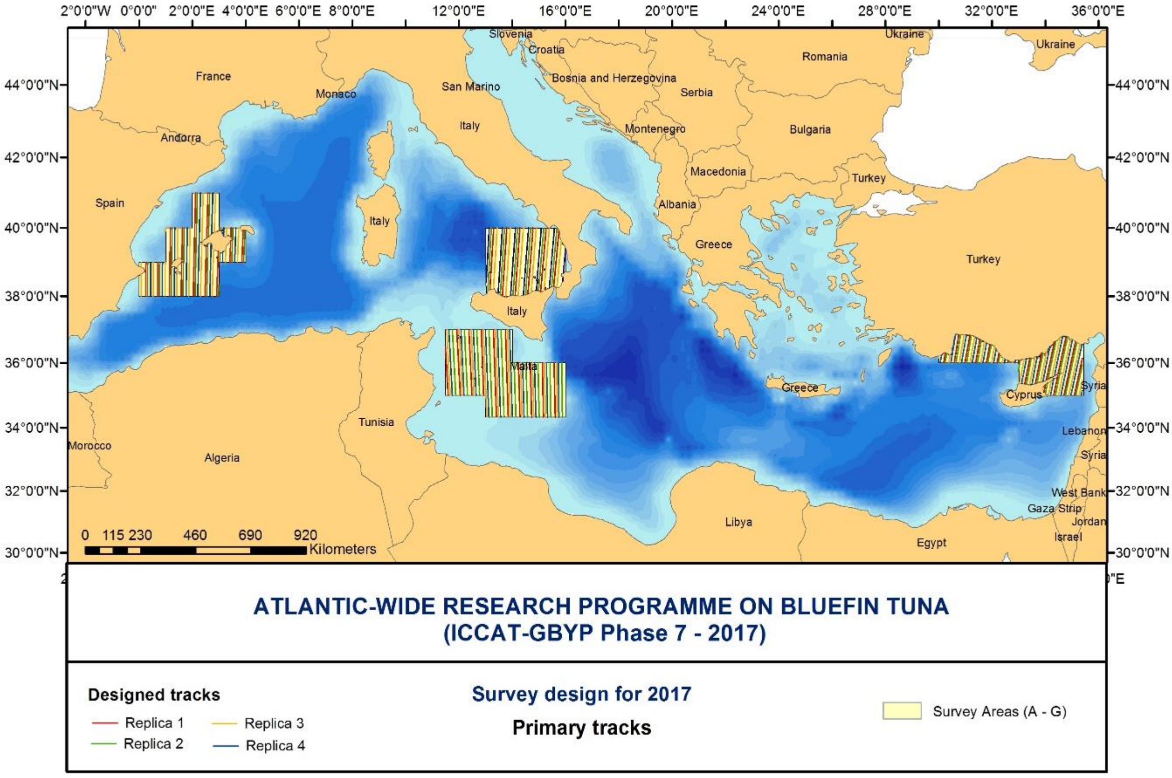


Figure 5. The transect design for the four areas to be surveyed by GBYP in 2017. Each area has four replicates, while extra replicates are not showed on this figure.

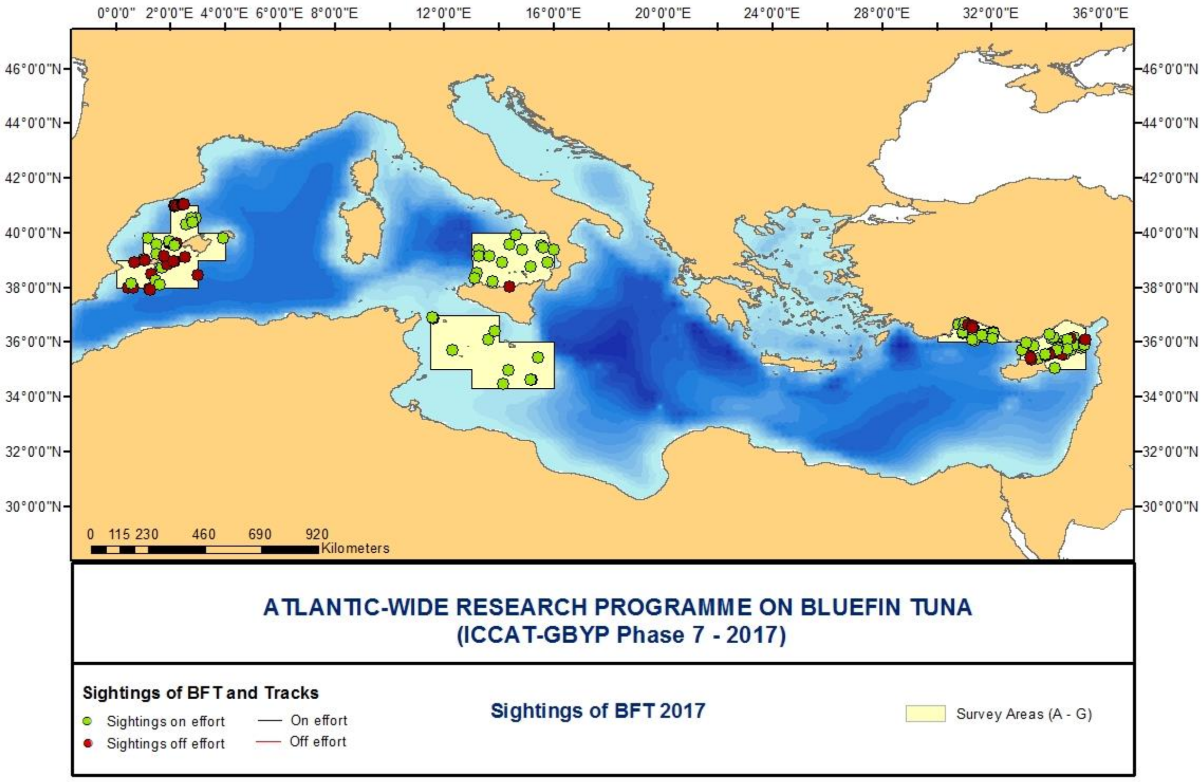


Figure 6. Distribution of the sightings of Bluefin tuna on and off effort during the ICCAT GBYP Aerial Survey for spawning aggregations in 2017.

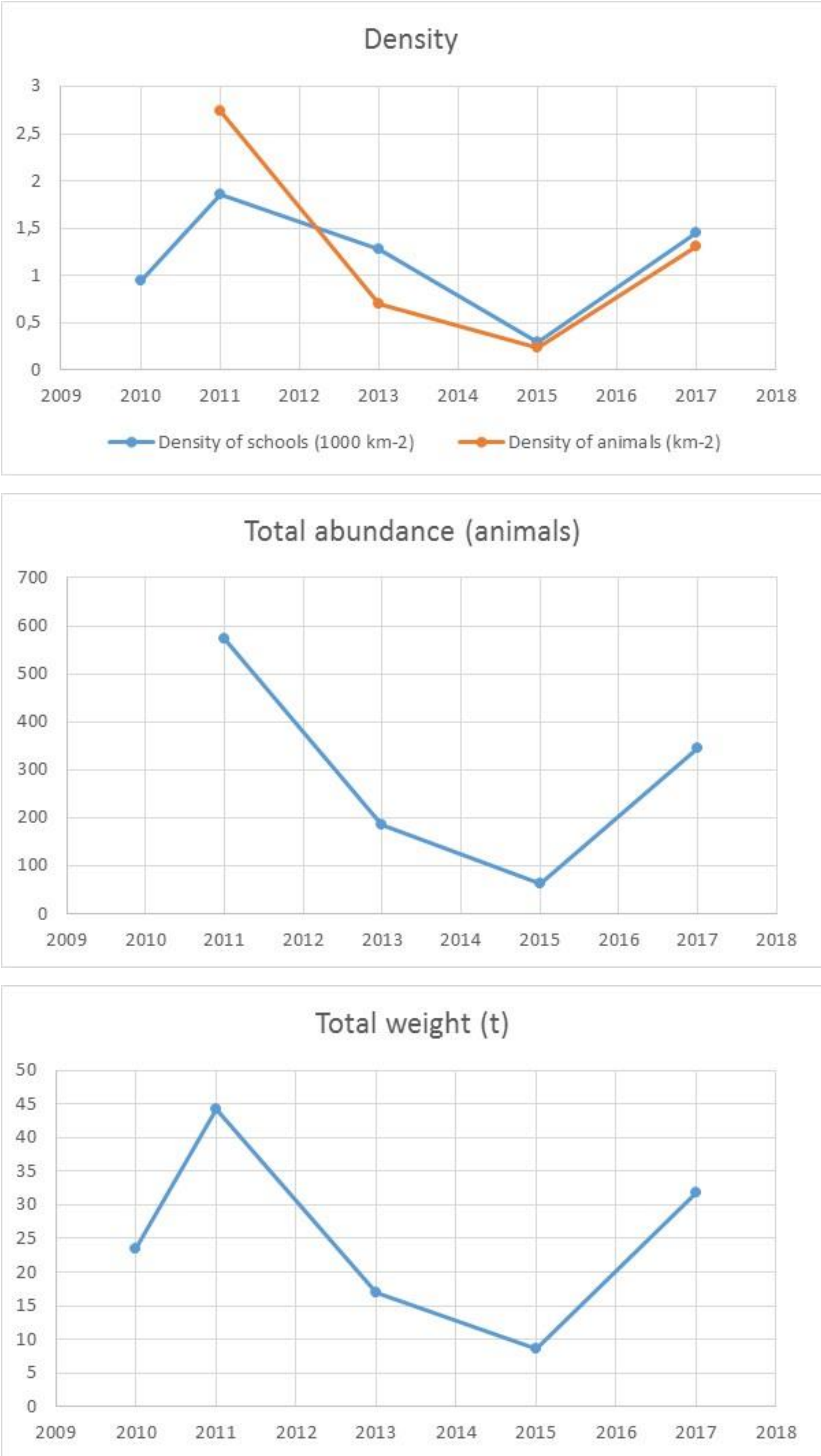
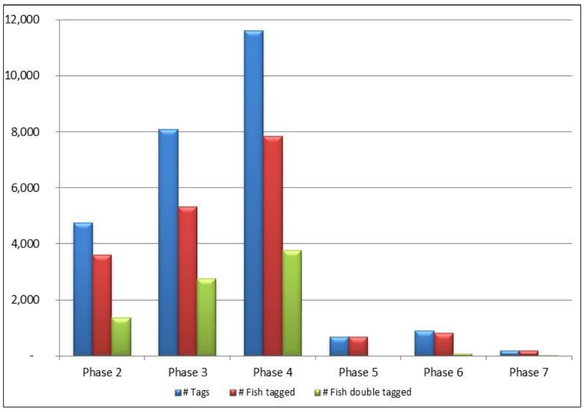


Figure 7. Graphic plots of the main results of the five ICCAT GBYP Aerial surveys on Bluefin tuna spawning aggregations for the density of schools and animals (top), the total abundance of fish (middle) and the total weight in tons (bottom).



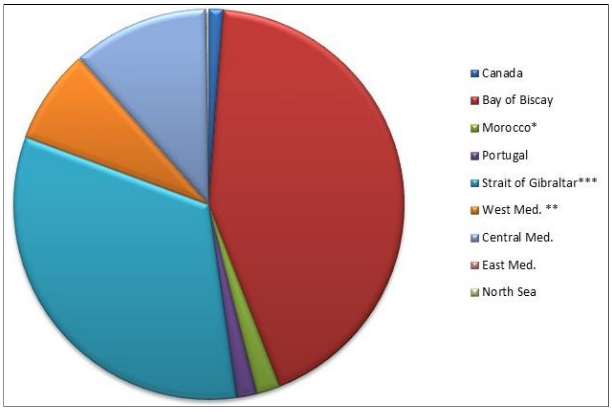


Figure 8a (left). Progression of the ICCAT GBYP tagging activities in the various Phases. **Figure 8b (right)**. Percentage distribution of tags implanted in the various geographical areas by GBYP, up to 19 September 2017.

Figure 9. The distribution of the ICCAT GBYP tagging awareness campaign – material distribution areas.

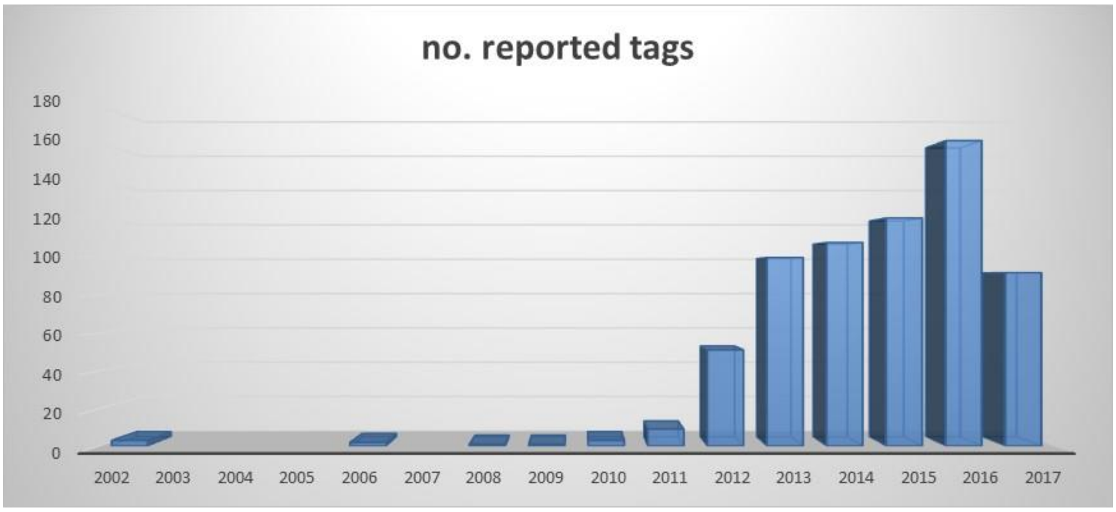


Figure 10. Number of Bluefin tuna tags reported to ICCAT by year, up to 19 September 2017.

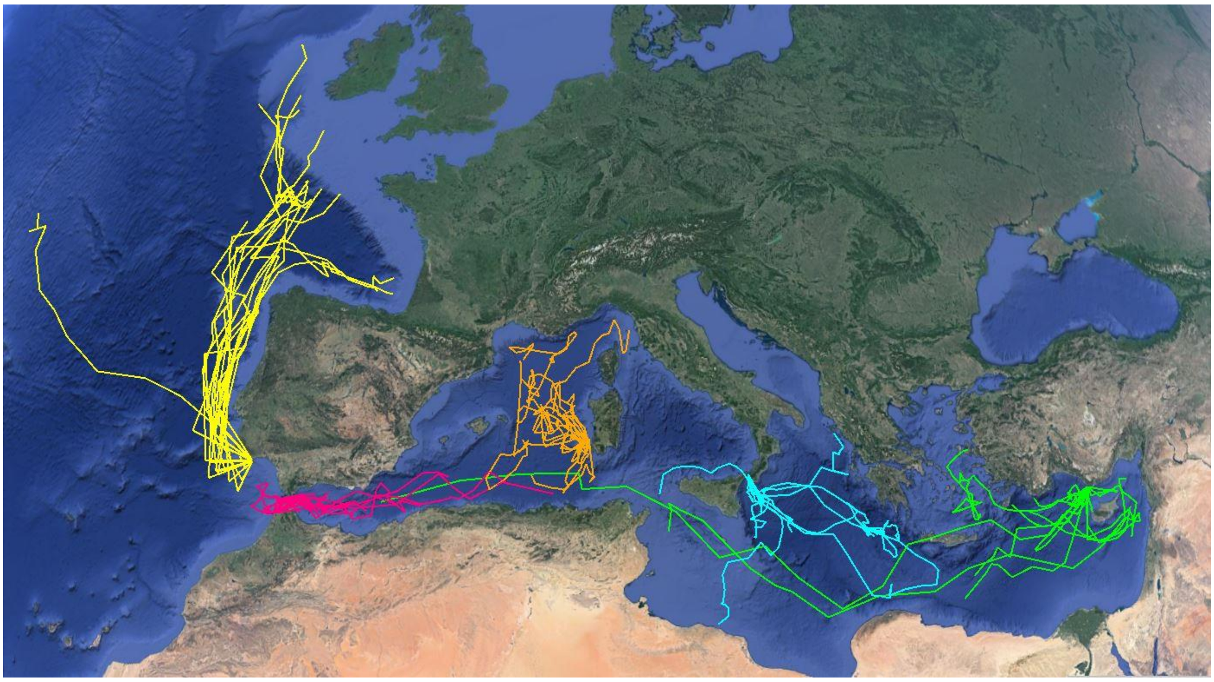


Figure 11. Tracks of the Bluefin tunas tagged by miniPATs by GBYP in Phase 6.

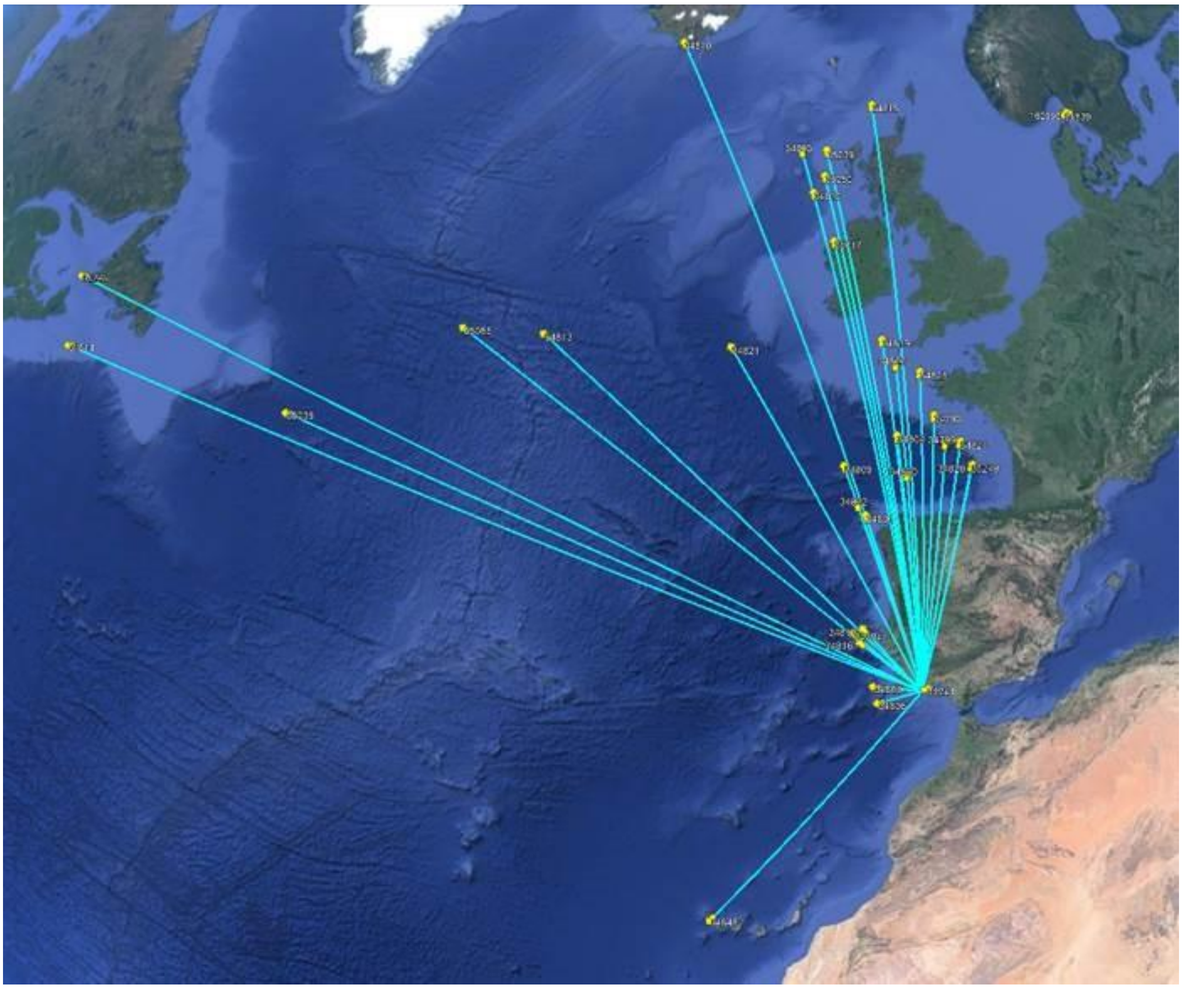


Figure 12. E-tags pop-off locations of the Bluefin tunas tagged by GBYP in Phase 7, up to 19 September 2017.

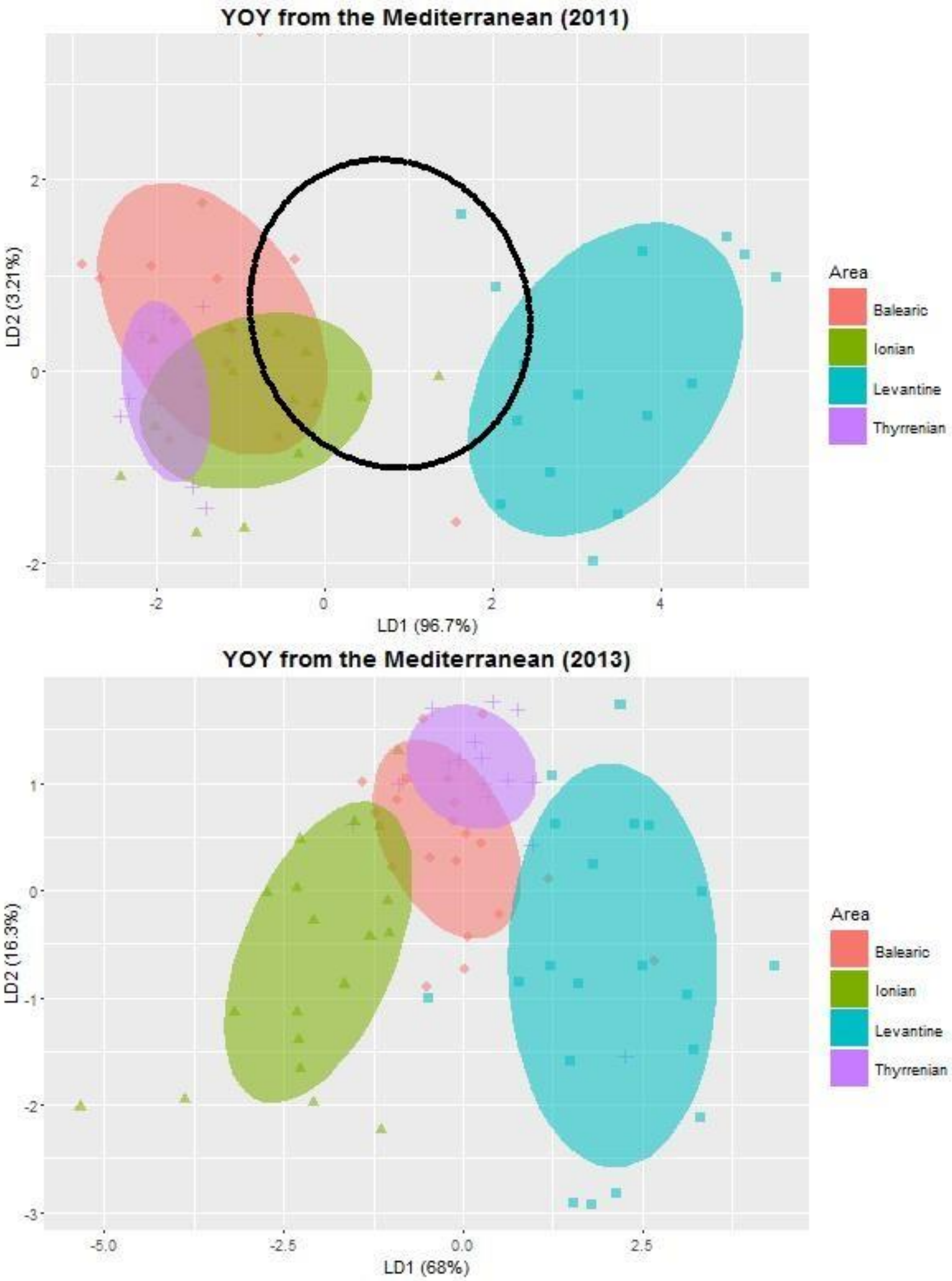


Figure 13. Discriminant analysis of trace element concentration in otoliths of YOY Bluefin tuna from the Mediterranean nursery grounds along with otolith near-core signature from juvenile Bluefin tuna (2011 year class) of unknown origin collected in the Bay of Biscay(black circle).The ellipses mark 1 SD (67%) confidence levels for the underlying populations.

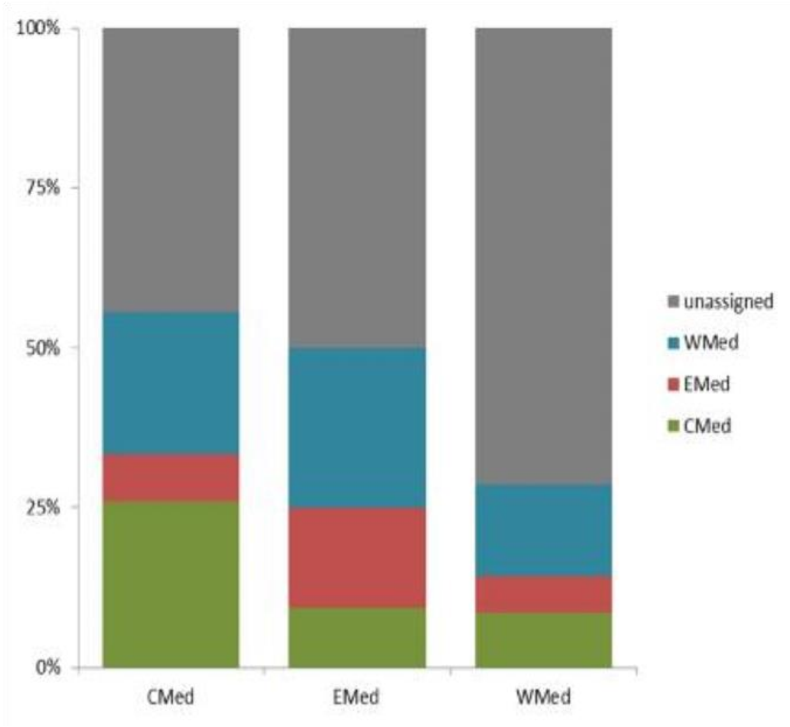


Figure 14. Assignment rates of 114 newly genotyped individuals for 46 SNPs (48 selected to differentiate among Mediterranean populations minus 2 that failed). Individuals with assignment score lower than 90% are considered unassigned.

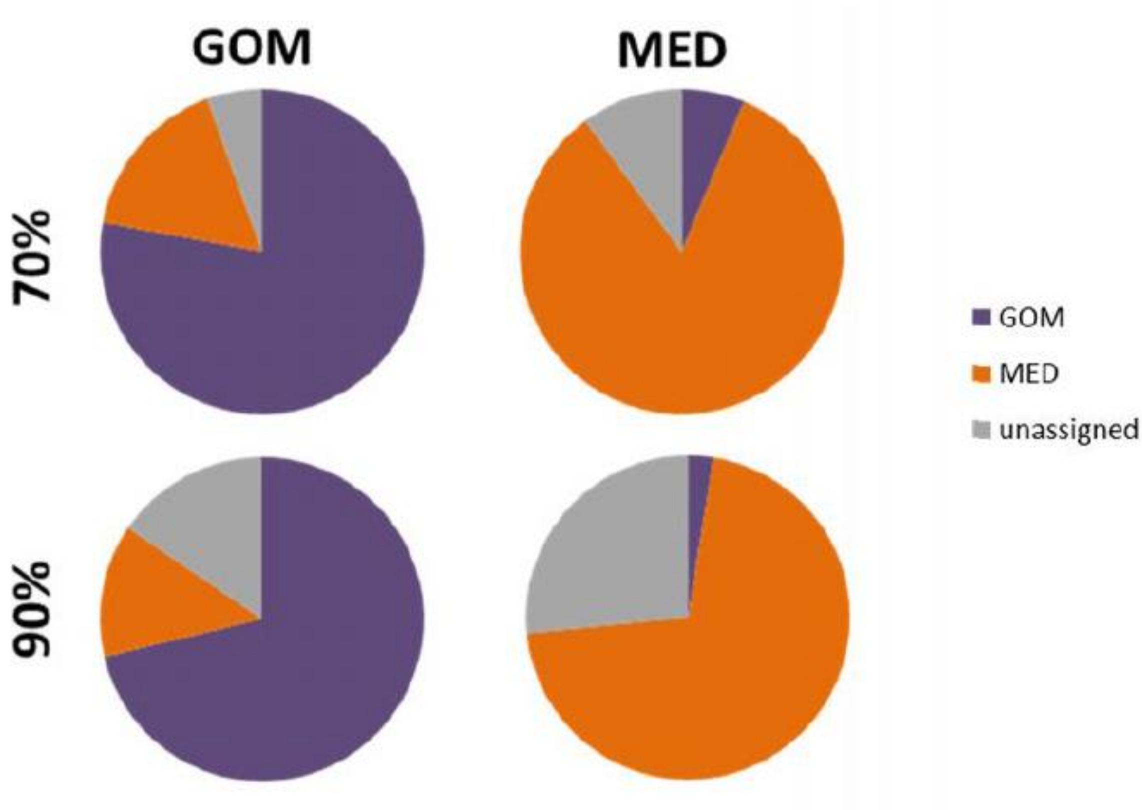


Figure 15. Assignment of Gulf of Mexico (GOM) and Mediterranean (MED) samples based on the best performing 96 RAD-seq derived SNP spanel when samples with assignment scores higher than 70% (above) or 90% (below).

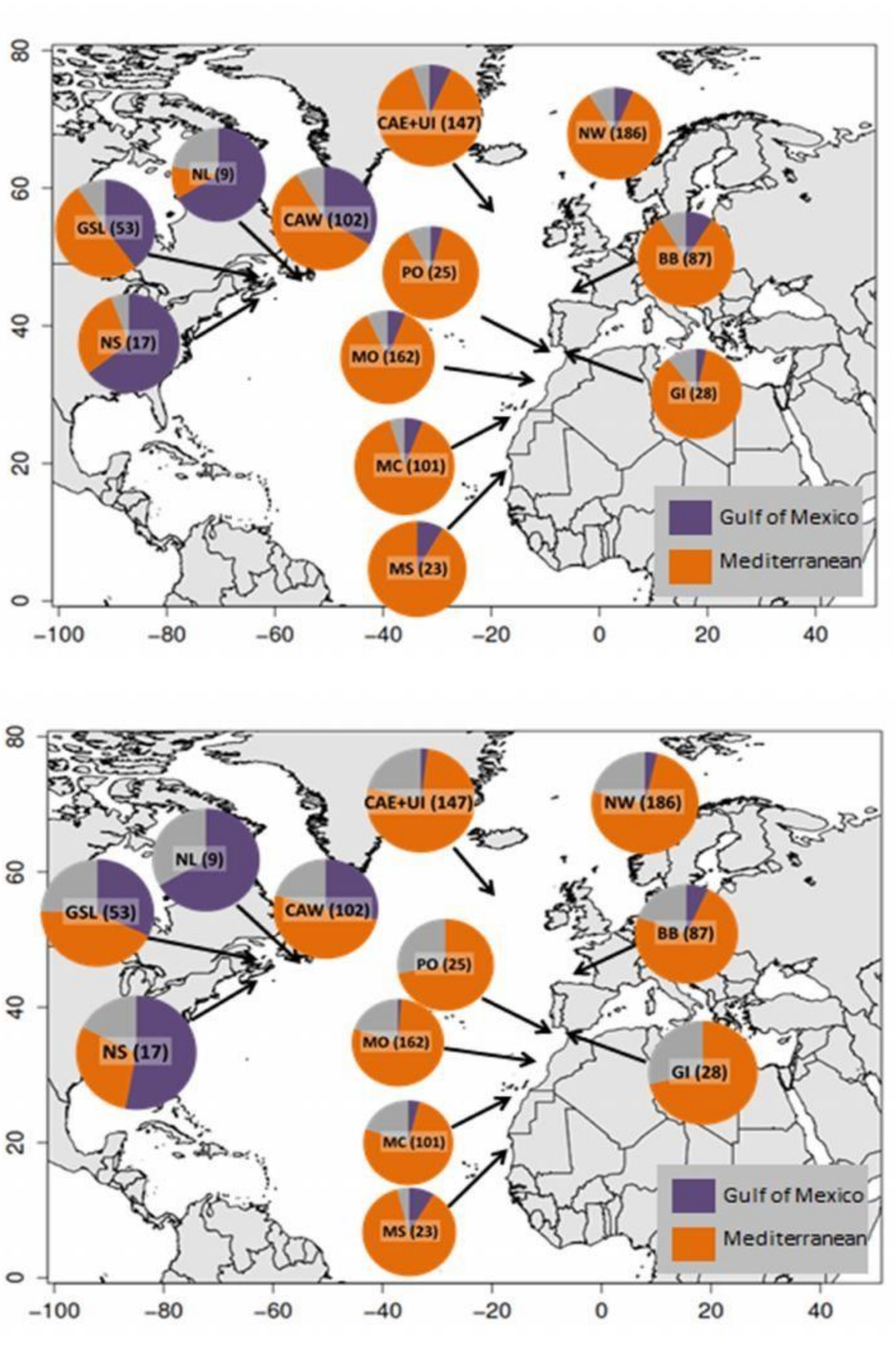


Figure 16. Percentage of samples belonging to each spawning component from the ones captured in each location, with assignment scores of 70% (panel A) and 90% (panel B); numbers in parenthesis indicate number of samples per location: Norway (NW), Bay of Biscay (BB), Portugal (PO), Strait of Gibraltar (GI), Morocco (MO), Canarias (MC), Mauritania (MS), Central Atlantic (east of 45ºW, CAE),Central Atlantic (west of 45ºW, CAE), Newfoundland (NL), Gulf of Saint Lawrence (GSL), Nova Scotia (NS).

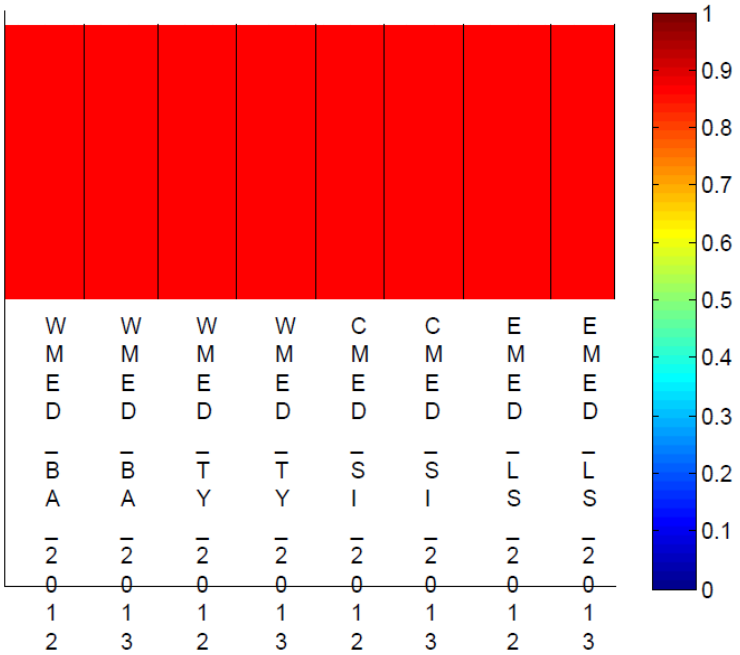


Figure 17. Results of the admixture analysis realized with BAPS.

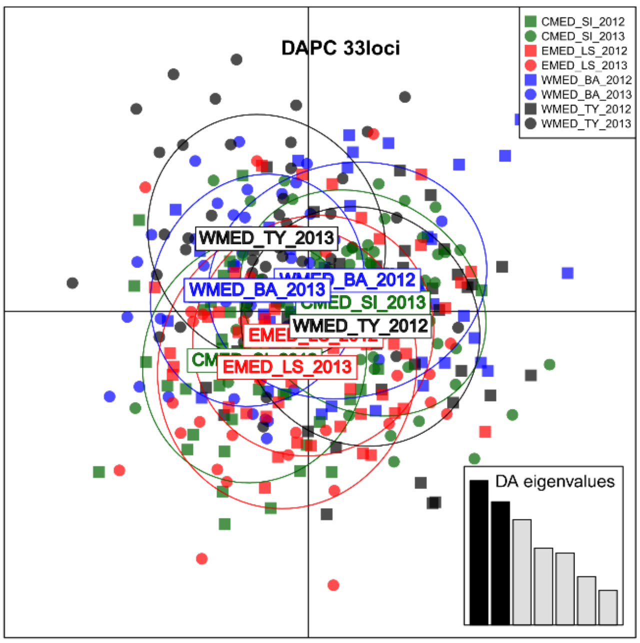


Figure 18. Results of the DAPC analysis performed with Adegenet.

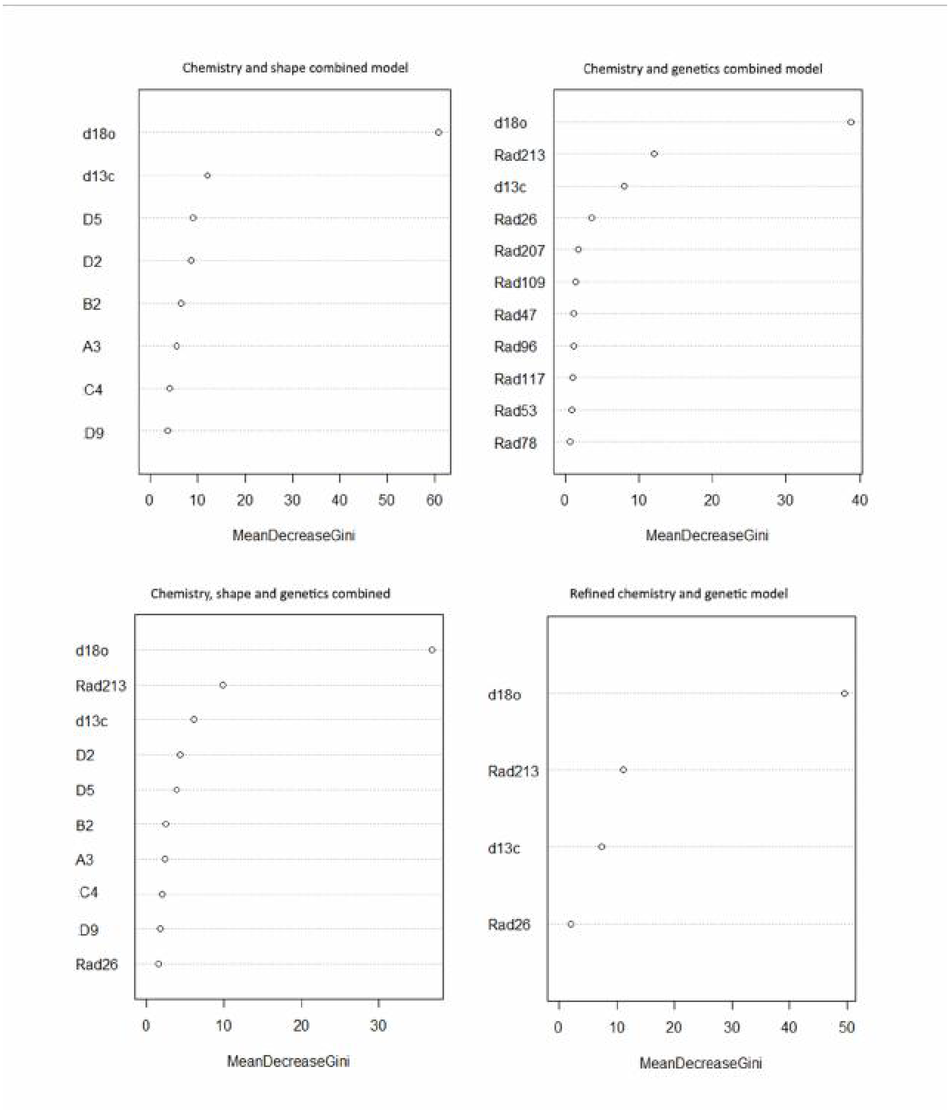


Figure 19. Variable influence plots showing the relative importance of each of the variables in the combined chemistry and shape model (top left), the combined chemistry and genetic model (top right), the combined chemistry, shape and genetics model (bottom left) and the final refined chemistry and genetic model which produced the lowest error rate (bottom right).

Otoliths Estimated age

SFL (cm)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total n
40-50	100																			6
50-60			100																	1
60-70		83	17																	6
70-80		17	33	50																6
80-90			40	60																5
90-100			67	33																3
100-110			17	50	33															6
110-120					60	20	20													5
120-130					14	57	29													7
130-140				5	14	23	36	9	9	5										22
140-150					11	6	11	17	33	22										18
150-160					5	15	30	40	10											20
160-170							15	46	31		8									13
170-180								44	22	22	11									9
180-190								25	17	8	17	25	8							12
190-200								4	30	43	17	4								23
200-210								6	16	32	16	16	4	8	2					50
210-220								11	11	20	18	31	4	2		2				45
220-230									8	16	20	44	8	4						25
230-240									18	6	18	29	6	6	6	12				17
240-250									7	21	14		29		7		14		7	14
250-260													25	50	25					4
260-270													33		33				33	3
270-280																100				1
280-289																		100		1
Total	6	6	9	11	12	14	21	35	44	51	34	42	14	9	5	4	2	1	2	322
Mean SFL	41	65	81	94	127	136	142	173	188	201	211	215	229	222	237	237	245	281	256	
SD SFL	0.8	5.6	16	17	16	11	14	24	31	24	17	12	23	22	23	25	1.7		9.7	

0-20%
20-50%
50-100%

Spines Estimated age

SFL (cm)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total n
40-50	93	7																		14
50-60	17	83																		6
60-70		100																		12
70-80			100																	13
80-90		8	67	25																12
90-100			29	57	14															14
100-110			8	69	23															13
110-120				38	46	15														13
120-130				6	65	29														17
130-140				5	18	55	23													22
140-150					12	35	41	6	6											17
150-160						33	41	19	7											27
160-170							38	31	15	15										13
170-180							23	31	38	8										13
180-190							20	40	10	30										10
190-200								19	38	25	19									16
200-210								3	38	41	7	10								29
210-220									5	55	27	5		9						22
220-230									11	33	56									9
230-240											17	67	17							6
240-250											20	40	20	10	10					10
250-260												50					50			2
260-270														25	75					4
270-280																				0
Total	14	19	26	27	28	34	33	22	30	37	19	13	3	4	4	0	1	0	0	314
Mean SFL	42	63	82	103	121	139	153	173	191	204	217	230	240	236	258		251			
SD SFL	4.7	6.4	7.5	11	13	12	14	16	20	15	13	17	4.9	26	8.8					

0-20%
20-50%
50-100%

Figure 20. Age length key for Atlantic Bluefin tuna caught in 2012 built up with samples coming from several phases of the project. Numbers represent percent by number by 10 cm length class (straight fork length, SFL). Upper table for otoliths and bottom table for spines. Mean SFL and standard deviation (SD) by age are shown.

Figure 21. Instructors and participants to the ICCAT GBYP training course on Virtual Population Analysis held in Miami (USA) in Phase 7, together with the SCRS Chair.