**REPORT OF THE ICCAT ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA
(ICCAT GBYP)**

*(Activity report for the last part of Phase 7 and the first part of Phase 8 (2017-2018),
including a general overview of the activities up to 2018)*

1. Introduction

The ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP) was officially adopted by the SCRS and the ICCAT Commission in 2008, and it started officially at the end of 2009, with the objectives of improving a) basic data collection, including fishery independent data; b) understanding of key biological and ecological processes and c) assessment models and provision of scientific advice on stock status. It was initially envisaged as a 6 year programme, but in 2014 the Commission, acknowledging the importance of the programme for bluefin tuna management, endorsed the GBYP Steering Committee and the SCRS recommendations (documents SCRS/2014/194 and SCI-05/2014) for extending the GBYP activities up to 2021. Consequently, the donors have maintained their budgetary support (EU 80%, other donors 20%) since then, allowing the continuity of the programme. The general information about GBYP activities and its results, as well on budgetary and other administrative issues of the GBYP programme, from the very beginning of the programme till today, are available on the [GBYP webpage](). All the relevant documents related to the programme development, including final reports of every activity and derived scientific papers, Annual Reports to the SCRS and European Union, GBYP workshops or Steering Committee meetings reports, are also readily available on the GBYP webpage.

The seventh phase of the GBYP officially started on 21 February 2017 following the signature of the Grant agreement for the co-financing of the GBYP Phase 7 (SI2.752957) by the European Commission and ended on 20 February 2018. The activities carried out during the first six months of Phase 7 and their preliminary results were presented to the SCRS and the Commission in 2017 (SCRS/2017/139) and approved. The eighth phase of the GBYP officially started on 21 February 2018, following the signature of the Grant agreement for co-financing of the Phase 8 (SI2.777629) by the European Commission and will end on 20 February 2019.

The activities planned within both phases have been or are being developed without any major problems, implementing successfully the respective workplans stated in the proposals submitted to the EU. Therefore, it can be concluded that GBYP has continued to be, in spite of budgetary cuts, a very successful programme from an operative point of view, providing a huge amount of information that is potentially useful for the achievement of the general objectives of the programme. However, it must be recognized that several problems, both structural ones affecting the general performance of the programme and other more specific ones, affecting some of the main lines of activity, have been detected. Some of these problems have been repeatedly highlighted by the GBYP Coordinator, by the GBYP Steering Committee (hereinafter GBYP SC) and even by the contracted external experts who carried out independent evaluations of the programme in 2013 (Phase 4) and 2016 (Phase 6), but unfortunately many of them have not been solved yet. Because of that the GBYP SC, at its last two meetings, held in February and April 2018, discussed this issue again, concluding that a new global review and evaluation of the programme achievements should be carried out by external experts, in collaboration with the GBYP Coordination Team, in order to produce information that is relevant for improving the management of the programme and guarantee wider achievement of the programme objectives in a near future. As a first step to this end the new GBYP Coordinator, with the assistance of the GBYP Coordination Team and taking advantage of all the documentation that is already available on this issue, initiated this global review by identifying general and specific problems and exploring possible solutions, and then proposing a new strategic approach for the planning of the next GBYP Phases.

Thus, the present report summarizes the main scientific activities carried out throughout GBYP Phase 7 and those launched during the first part of Phase 8, and the final or preliminary results of the associated studies, as well as the related coordination activities. In addition, it also presents the first conclusions from the global evaluation of the programme initiated within Phase 8 by the GBYP Steering Committee and the GBYP Coordination Team, including identification of general problems and possible solutions to be taken into account in the planning of the next and further phases of the GBYP. Moreover, it also includes a proposal of activities to be carried out within Phase 9, for the consideration and eventual support of the SCRC.

2.   Coordination activities and general issues of GBYP programme management

The GBYP SC is currently composed of the SCRS Chair, the West bluefin tuna Rapporteur, the East bluefin tuna Rapporteur, the ICCAT Executive Secretary and the external expert. While the external expert was not contracted in Phase 7, in Phase 8, Dr. Ivan Katavic was contracted for the purpose.

The GBYP Coordination Team was composed of the Coordinator, Assistant Coordinator and Database Specialist. Due to the retirement of the former Programme Coordinator, Dr Antonio di Natale at the end of Phase 7, Dr Francisco Alemany was appointed as new Coordinator, who assumed responsibility from 15 January 2018.

The GBYP SC held two meetings within Phase 7 (March 2017 and February 2018) and a further two meetings were held in Phase 8 (April 2018 and September 2018), mainly dedicated to the review of the previous Phase and planning of the current one. In Phase 8, the GBYP SC meetings recorded that some CPCs had expressed some concerns about the programme results. This was mainly attributed to the fact that lately the Programme has not been successful in communicating all the achievements made to the ICCAT scientific community and the Commission. The SC recognized that the programme reached a critical moment when some important changes in the management had to be introduced and the future activities had to be re-planned in order to guarantee the best use of available resources and the highest cost/benefit ratio as regards the achievement of the general objectives. Therefore, it was decided to develop a new communication strategy and to carry out a new global review of the programme to identify the current problems preventing full achievement of the objectives and explore ways to optimize the management of the programme. Based on the results of this review and current assessment priorities, the GBYP SC considered that the SCRS should develop a recommendation with respect to the programme, to be presented to the Commission at the Annual meeting.

The GBYP SC members have been constantly informed by the GBYP Coordination Team about the status of the activities through detailed reports provided on a monthly basis, and they are regularly consulted by e-mail on many issues.

The GBYP Coordination Team, with the advice of the GBYP SC and the direct help of ICCAT Secretariat staff, managed a total of 7 Calls for tenders, two official invitations and one request for offers in Phase 7. As a result, a total of 17 contracts were awarded to various entities and two purchase orders were processed. In Phase 8, up to 31 August 2018, five additional Call for tenders and three invitations have been announced, and a total of 16 contracts have been awarded to date.

Other relevant coordination tasks have been those related with:

-    Research Mortality Allowance: To cover the potential mortality caused by GBYP related sampling activities in the second part of Phase 7, the list of organizations allowed to make use of RMA was updated on 12 September 2017 (No. 1386/17), including 43 entities. In Phase 8, the initial Circular was issued on 10 May 2018 (No. 502/18) including 17 entities and it was updated on 18 July 2018 (No. 695/18) including 26 entities. In Phases 7 and 8 a total of 772 and 3 RMA certificates were issued, respectively.

-    Cooperation with the ROP: Alongside GBYP Phases 7 and 8 the ICCAT ROP observers have engaged directly in checking bluefin tuna at harvesting to improve tag recovery and reporting and identifying the right people to provide the rewards for the recovered tags. Moreover, they have registered and reported any natural marks and taken biological samples for genetic studies. Specific forms and equipment to carry out these tasks have been provided to ROPs.

-    GBYP web page: Phase 7 the GBYP Web page was regularly updated, and in GBYP Phase 8 the GBYP webpage was extensively restructured, incorporating a document search tool to facilitate identification and downloading of GBYP documents.

2.1 Financial aspects

So far, in the first seven Phases, GBYP received and used only 68.62% of the funds originally approved for the six-year period (€13,091,190 against €19,075,000). In Phase 7, the budget had the following funders (in order of contribution already received): European Union (grant agreement) €1,274,181.32; Japan (donation according to quota) €57,024.88; Tunisia (donation according to quota) €53,447.40; Turkey (donation according to quota) €52,972.61; United States (donation) €50,000.00; Kingdom of Morocco (donation) €50,000.00; Libya (donation according to quota) €41,406.40; Canada (grant agreement) €20,448.50; Norway (donation) €20,000.00, Chinese Taipei (donation according to quota) €3,000.00; China (P.R.) (donation according to quota) €1,931.09; Iceland (donation according to quota) €1,566.12.

Further amounts were residuals of previous GBYP Phases and they were used to better balance the EU contribution and to compensate costs that were not covered by EU funding in 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.

Due to the fact that some activities could not be completely developed by some contractors, as a result of causes of *force majeure* (i.e. study of endocrine hormones in the Slope Sea) or activities expenses were not properly justified, the final amount spent was lower than approved.

In Phase 8 the donors have provided the following funds (in order of contribution already received or committed): European Union (grant agreement) €1,400,000.00, Kingdom of Morocco (donation according to quota) €66,898.53, Japan (donation according to quota) €59,139.54, Tunisia (donation according to quota) €54,883.78, Libya (donation according to quota) €46,942.83, Turkey (donation according to quota) €36,692.99, United States (donation) €32,220.77, Norway (donation) €19,195.00, Chinese Taipei (donation) €3,000.00, China (P.R.) (donation according to quota) €2,050.03.

Up to now the envisaged activities are being developed without major problems.

The approved budget for Phase 7 and Phase 8 is summarised in the **Table 1**. The actual costs of Phase 7 are also provided.

3.   Summary of Phase 7 and Phase 8 GBYP activities and results by main line of research

The GBYP activities developed or launched from October 2017 to September 2018 and their main results have been presented to the SCRS Bluefin Tuna Species Group as document SCRS/2018/171. Such activities and results are summarized below by main line of research.

3.1 *Data mining and data recovery*

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 database, concerning both recent and historical data, which causes a large amount of substitutions in the assessment process, increasing uncertainties.

In Phase 7 the recovery of some recent or historical catch datasets was performed to support the improvement of the assessment of analytical work and the MSE process. Two contracts were awarded, both for recovering recent data from the Italian longline fisheries, including catches by vessel, area and day, partly with effort data (SCRS/2017/191). In addition to these data recovery activities, the GBYP provided an additional key for interpreting the historical trap data (SCRS/2017/043). Furthermore, an updated bibliography for the bluefin tuna traps was made available to the SCRS Bluefin Tuna Species Group (SCRS/2017/119). Moreover, following a specific request from the ICCAT Statistics Department, GBYP carried out an extensive analysis of the available literature on the bluefin tuna fishery data from the Black Sea, whose results were reported to the ICCAT Statistics Department and to the 2017 ICCAT Bluefin Tuna Data Preparatory Meeting (Madrid, 6-11 March) (SCRS/2017/039). These GBYP data were used also for two additional papers (SCRS/2017/166 and SCRS/2017/169), which were submitted at the 2017 ICCAT Bluefin Tuna Stock Assessment Meeting (Madrid, 20-28 July). Moreover, the GBYP supported the Bluefin tuna Data Preparatory Meeting, 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 following papers SCRS/2017/019, SCRS/2017/027, SCRS/2017028 and SCRS/2017/045.

In Phase 8 three data recovery activities have been carried out: a) recovery of old data on bluefin catches in several EU-Italy traps data, b) recovery of data on tuna catches from ICES reports and c) obtainment of electronic tags datasets deployed by Stanford University in 2016 and 2017.

The first activity has recently finished, providing data on daily or annual catches from five Italian tuna traps. The second activity has been completed by the GBYP database specialist, providing a total of 4,653 registers containing information on bluefin tuna landings by different entities in the Atlantic and Mediterranean from 1962 to 1978, including the details on flag, geographical location, fishing gear and biological data (length and/or weight), by year, month or even week (SCRS/2018/176). The third activity is ongoing. It will provide rough data from 41 electronic tags deployed in 2016-2017 off Canada and in 2017 off Ireland, with a mean duration on fish of 190 days.

3.2   Aerial Survey on Bluefin Tuna Spawning Aggregations

The 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. However, due to different reasons, this activity has not been developed regularly and has not followed homogenous methodologies and sampling strategies throughout the successive GBYP Phases (see previous GBYP annual reports and GBYP aerial surveys final reports). Fortunately, for the first time, the two last GBYP aerial surveys have been developed following the same standardized methodology.

The aerial survey was resumed in Phase 7, after being cancelled in Phase 6, on the four overlapping areas (Balearic Sea, southern Tyrrhenian Sea, central-southern Mediterranean Sea and Levantine Sea) which had been already defined and standardised in the previous analyses. It was designed using the software DISTANCE, the "industry standard" software for line and point transect distance sampling, as equal spaced parallel lines (transects) which should be surveyed four times (4 replicates). Prior to the activity, the training course for pilots, professional spotters and scientific observers was organized at the ICCAT Secretariat in Madrid and the updated GBYP Protocol for Aerial Survey for Bluefin Tuna Spawning Aggregation and the details for filling the sighting forms were presented. The aerial survey was successfully carried out from an operative point of view, although facing numerous logistical problems. A data elaboration report was provided in real time, therefore allowing to submit a paper detailing the results to the 2017 ICCAT Bluefin Tuna Stock Assessment Meeting (SCRS/2017/149). The number of bluefin tuna schools detected on effort (91) was the highest so far, confirming a good presence of the species. For the very first time, the series of the GBYP aerial survey data was used in the MSE and the OM, while the Bluefin Tuna Species Group considered that it is still limited in number of years for it to be used in the assessment.

The aerial survey in Phase 8 was carried out on the same four preferential spawning areas already defined in the previous Phases, using the same design and methodology as in 2017. There were a total of 87 sightings of bluefin tuna, from which 79 could be used for fitting the detection function and 67 that were used later for determining the abundance. The results indicate that there was a real increase of bluefin tuna in area A in respect to the previous five years, continuing the increasing trend already observed in 2017, whereas areas C and E were rather similar to previous years. In contrast, in Area G an important decrease was observed of 80% in total weight and 68.5% in abundance compared to the mean for 2010-2017. Detailed results have been presented in the document SCRS/2018/175.

With the aim of improving data analysis and survey methodology, a meeting was held in September 2018 between Alnilam specialists and the GBYP Coordination Team. It was concluded that it would be recommendable to develop habitat models that account for the effect of environmental variability among areas and years, which would allow for standardization of observations. In addition, it was recommended that some type of calibrations exercise should also be designed and developed in the next Phase of the GBYP to improve the reliability of GBYP aerial survey outputs, as previously recommended by the GBYP SC. Moreover, it was also agreed that other methodology issues should be addressed to optimize the surveys and overcome some of the problems detected, such as optimization of delimitation of surveyed areas, and changes in the structure and working methodology of the teams of observers, which would permit minimization of potential sources of bias.

3.3 Tagging activity

According to the general programme, after the adoption of the GBYP Tagging Design and GBYP Tagging Manual in Phase 1, it was planned to begin the tagging activity in the GBYP Phase 2 and to continue 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.

The specific objectives of the GBYP tagging activity in the medium term were as follows:

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

Unfortunately, up to now, this line of research has faced two important problems which have prevented or limited the full achievement of these initial objectives. One is the very low recovery rate of conventional tags, which impeded the use of these data to estimate reliable mortality rates. Due to this, the GBYP SC, decided to cancel the conventional tagging programme in Phase 4 and focus on electronic tagging instead, maintaining only complementary conventional tagging activities by providing tags and tagging equipment to different institutions or organizations, as well as maintaining the awareness and reward campaigns and the database, integrating all the results from recovered tags. The second major problem has been the relatively short time of most of the electronic pop up tags on fish, which limits the effectiveness of the recorded data to achieve the stated objectives. The premature releases are attributable to different factors, such as, technological problems of the tags, fishing activities, death of the fish after tagging and, in general, probably the use of equipment and tagging methodologies which are not fully adequate for bluefin tuna. These potential problems have been addressed in different ways, as the use in Phase 8 on a new reinforced model of MiniPat satellite tag designed to minimize "pin broke" problems, selection of tagging areas with lower fishing pressure and exploring and applying whenever possible improved tagging methodologies.

As recommended by the Steering Committee, the tagging activities in Phase 7 were limited again to the deployment of electronic tags, keeping the deployment of conventional tags only as a complimentary activity. A contract was awarded for the deployment of 20 PSATs in waters near Sweden and 20 in waters near Denmark. A second contract was awarded to tag 40 bluefin tunas in EU-Portugal traps. The results were suboptimal, given the high number of premature releases, mostly due to the technical failure of the electronic tags (pin-broke). Nevertheless, although the deployments were short, they showed that the majority of tagged individuals from EU-Portugal traps moved towards the northern Atlantic, while one moved towards the Azores.

As regards conventional tags, 10,000 conventional "spaghetti" tags were purchased to be deployed in the ongoing and subsequent phases. The number and location of conventional tags deployed, as well the number of conventional tag recoveries reported during this period by geographical area are detailed in the document SCRS/2018/171. The resulting data have been included in the ICCAT tagging database, making them available to scientific community for analysis.

In Phase 7 the first electronic tag database was developed, along with a Shiny application which allows for the visualization of the tracks and temperature and depth parameters. A description of this database was presented as SCRS/2017/192.

As a possible alternative to conventional tagging or as an additional tagging approach, the GBYP Steering Committee recommended to explore and evaluate close-kin genetic tagging (Close Kin Mark Recapture, CKMR) at the end of Phase 5. Consequently, an initial feasibility study was carried out by The Commonwealth Scientific and Industrial Research Organisation (CSIRO) from Australia. Following this, the CSIRO informed that it was not unavailable to carry out the second part of the feasibility study in Phase 7 (as planned), which included a realistic cost estimation of the CKMR study, due to a considerable workload but also to the need to further check the CKMR technique applied to tunas. In any case, the GBYP Steering Committee decided to start collecting the necessary samples so as to assess in practical terms the feasibility and actual costs of carrying out a CKMR study for EBFT. Thus, enhanced sampling was carried out within the biological studies for both juveniles and adults in the major spawning areas, starting from Phase 6 and continued in Phase 7, but no other CKMR related activities were carried out.

Tagging in Phase 8 has again focused on deployment of electronic tags, keeping the deployment of conventional tags only as a complimentary activity. Considering the current needs of the MSE modelling process the specific objective of GBYP tagging programme in Phase 8 has been improving the estimations of the degree of mixing of western and eastern bluefin tuna stocks in the different statistical areas and throughout the year. To this end, two contracts were awarded, one for tagging 30 bluefin tunas in Portuguese traps, and the second one for deploying 10 tags in the Celtic area. In addition a Memorandum of Understanding was signed between GBYP and the Institute of Marine Research of Norway, for deploying 20 tags in western Norway. Tagging operations in Southern Portuguese traps were carried out successfully in August 2018, whereas tagging campaigns in Celtic Seas and Norwegian coasts have just started in September 2018.

It is worth mentioning that besides these activities carried out under formal GBYP contracts or agreements, GBYP has supported e-tagging activities carried out independently by other institutions, by allowing the use of the GBYP RMA in the case of BFT casualties during tagging operations and the use of the GBYP Argos system account for data transmission. Resulting tagging datasets will be shared with GBYP and, along with other electronic tag datasets, will be used for the MSE process.

As regards conventional tags, within Phase 8 "spaghetti" tags, along with applicators and the tagging protocols, forms to report tagging operations were delivered to various institutions and the teams in charge of deployment of satellite tags. The resulting data have been included in the ICCAT tagging database, making them available to scientific community for analysis.

A new Shiny application was developed in Phase 8 for visualization of multiple tracks on the interactive map, including filtering and grouping according to several criteria. More details on this activity are presented in the communication SCRS/2018/174. In addition, a preliminary analysis of bluefin tuna depth and temperature preferences revealed by electronic tags was also carried out (SCRS/2018/173). Up to now, only data on time spent by fish in the different statistical areas has been delivered to the person responsible for the MSE modelling to determine the mixing rates between East and western stocks. However, a clear data policy to define the conditions of access to the GBYP etags database will be agreed shortly, allowing the direct use of these data from electronic tagging by the scientific community and hence promoting deeper analysis of the information gathered, with the aim of generating information that is useful for improving BFT management.

Throughout the reported period, the tag awareness campaigns and reward policy from the previous phases have been maintained; a reward of €1000 is given for recovery of electronic tags and €50 or a dedicated T-shirt for conventional tags.

3.4 Biological studies

The main objective of this task is 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, namely to define the population structure of Atlantic bluefin tuna (*Thunnus thynnus*), with particular attention to the age structure and the probable sub-populations identification. All the activities carried out in previous Phases and the first part of Phase 7 concerning the biological sampling and analyses were presented to the SCRS and the Commission in through the document SCRS/2017/139.

Sampling in Phase 7 was performed by the various entities that operated under different contracts. It was also carried out in farms, since the experience from the previous year demonstrated that it can be a useful strategy for obtaining the needed adult samples from the spawning areas. Opportunistic sampling was also performed by ICCAT-ROP observers. 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. As a result of the aforementioned sampling activities around 3600 bluefin tuna individuals were sampled, and the resulting samples stored properly in the GBYP tissue bank. It is worth mentioning that a Shiny application was developed to facilitate the inspection of available samples in bank and to aid sample selection following different criteria to help better design future experiments and analyses.

As for the samples analyses, due to the limited budget in Phase 7, priority was given to different activities from the usual ones. Therefore, the activities that had already been initiated in earlier phases of the GBYP, such as 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 for contracting of some additional genetic analyses that have not been carried out so far on bluefin tuna. These activities included the analysis of transcriptomic and genomic data exploiting previous available data for defining the genomic variability of the species and experimental trials for developing a genetic test for sex assignment. In addition, a special study was contracted in the Slope Sea and surroundings, for trying to fill knowledge gaps in bluefin tuna reproductive biology in the NW Atlantic; with the expectation that the results might add additional evidence to the existence of a further spawning area in this part of the Atlantic Ocean. The age determination analyses were performed on 2000 otoliths that had not been read before and the results are already available, although pending calibration. In addition, reading and counting of daily rings was carried out on 20 YOY to establish their birthdate.

Following the request coming from the SCRS BFT Species Group and the recommendation made by the Steering Committee, a first limited workshop on the reproductive biology of the Atlantic bluefin tuna was held within Phase 7. One of the objectives of the workshop was identifying the feasible priorities of biological studies which could be carried out within the GBYP, especially in Phase 8, while the other one was preparing the larger biological workshop in Phase 8, including the drafting the agenda and identification of the most adequate experts to participate as invited speakers.

Some of the most relevant results in Phase 7 were the following:

- Otolith microchemistry analyses showed that mixing rate estimates in the coast of Morocco varied considerably in preceding years, with catches in 2011 and 2014 dominated by the western population and catches in 2012, 2013 and 2015 dominated by the Mediterranean population. The results for 2016 confirm that mixing of the two populations occurs at variable rate, but Mediterranean bluefin tuna may be the principal contributors to the fishery in Moroccan traps.

- A massive ageing of otoliths previously collected and stored in the GBYP Tissue Bank has been initiated, but the results are still to be calibrated before using them for development of the bluefin age length key.

- The daily ageing analysis of some young of year bluefin tuna which were larger than expected indicated that all the fish were born during the known spawning season in the Mediterranean Sea, confirming that the growth rates can vary a lot between individuals born in the same season.

- A genome-wide annotation of protein-coding genes was performed and 41,508 protein-coding genes were identified. All the 41,508 predicted BFT proteins were subjected to functional annotation and 63% of the candidate sequences (26,151 protein) were associated to functions assigned by accurate homology-based approaches according to the standard catalogue of Gene Ontology (GO), covering, with different proportions, the three ontology aspects: biological process, molecular function and cellular component, with a total of 13,915 different GO terms.

- The specific study on the presence of candidate genes for sex-related traits provided a first preliminary identification of putative regions prone to be further investigated using data from BFT individuals of known sex. To develop a test for sex identification, further work, based on known sex individuals, should be carried out.

- A collection of slides for histological analysis from bluefin tuna gonads samples collected in the Slope Sea and surroundings was compiled and analysed, while the results will be presented within the framework of the GBYP workshop on BFT reproductive biology that is going to be held in November 2018.

The specific objectives of the biological studies stated for Phase 8 were keeping an GBYP tissue bank able to provide the samples required to carry out the studies necessary for improving the understanding of key biological and ecological processes affecting BFT, providing updated, representative and reliable ALKs useful for BFT stocks assessment and providing accurate and reliable estimations of mixing rates between BFT western and eastern stocks. Apart from those, GBYP in Phase 8 focuses also on obtaining improved knowledge on reproductive parameters of bluefin tuna. Both microchemistry analyses of otoliths and genetic analyses of tissue samples were resumed in this Phase.

Due to the cancellation of Close Kin study, sampling activities have been reduced this year and concentrated on samples from potential mixing areas in the Atlantic and some additional ones from the Mediterranean Sea.

In addition, sampling of adult bluefin tuna in farms has continued. Sample analyses this year will be focused on individual population assignment of bluefin tuna caught in potential mixing zones in the Atlantic by using both otolith microchemistry stable isotope analyses and genetic RAD-seq derived SNPs analyses, including special analysis to explore the presence of a possible "third" population of Atlantic bluefin tuna in the Slope Sea. Additional analyses will be performed in order to refine the Mediterranean baseline used in the integrated method for stock discrimination. The set of plausible hypotheses about stock structure consistent with the MSE operational model will be tested, by using as a basis the individual origin assignments obtained by different methods and aggregated by geographic area and year. In Phase 8, an additional study will be developed on samples collected in Norway in order to explore their origin and cohort composition.

Pursuant to the conclusions of the Preparatory Workshop on bluefin reproductive biology held in Phase 7 two independent experts have been contracted to review the current assumptions on reproductive parameters of eastern and western bluefin tuna stock and the review was presented to the Bluefin Tuna Species Group (SCRS/2018/172).

As regards ageing related activities, the Phase 8 proposal included specific budgets for carrying out, similarly to Phase 7, the reading of 2000 otoliths and, additionally, a calibration exercise of BFT otoliths readings. However, since a group of specialists that were elaborating BFT ALKs in the last years, had already organized a wide international calibration exercise on this topic, it was decided to support this initiative and postpone the envisaged GBYP calibration exercise until the ongoing exchange has been finished. Moreover, since this activity, the results of which are presented as SCRS/2018/127 has resulted in an improved protocol for BFT otoliths interpretation (SCRS/2018/126), it has been also decided to postpone the contract for massive otolith ageing until such new improved protocol for BFT otoliths interpretation has been agreed and endorsed by the SCRS. Moreover, a further calibration exercise, involving both sets of otoliths already aged and those used for elaborating previous ALK will be developed within Phase 8 to ensure that such previous ALK is comparable to the ones that should be generated by applying the new protocols for BFT otoliths interpretation arising from the aforementioned calibration exercise. Consideration should be given to conducting an ageing workshop following SCRS general recommendations to the Commission and conclusions from the recent calibration exchange.

3.5 Modelling approaches

Following the recommendations of the Steering Committee and the SCRS, the GBYP carried out many modelling activities since Phase 2. The modelling programme addresses the GBYP programme general objective 3, it is "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 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.

To achieve these objectives the GBYP Core Modelling MSE Group (CMG) was created in 2014, with the initial specific objectives of: 1. collate, manage and synthesise new data and information collected through the GBYP programme and other appropriate sources; 2. facilitate consultation and capacity building on Reference Points, Harvest Strategies and MSE for bluefin for the SCRS and Commission; 3. develop, document and maintain an integrated MSE modelling platform and 4. facilitate the evaluation, selection and adoption of harvest strategies for bluefin that meet the objectives of ICCAT, as specified by the SCRS and Commission.

The GBYP activities in the previous Phases were consistent with these objectives, within the timeframe set by the CMG.

The contract for developing the Operating Model and MSE framework and related code was awarded to the same expert who initiated this work in Phase 4. The focus of the work in Phase 7 was the production of a fully documented working MSE framework including all finalized operating models (both reference and robustness) to allow stakeholders to develop and test their own Management Procedures. The software was updated in order to accommodate the requirements of the reference and robustness operating models. The Trial Specifications and the meta-data base were also updated to include new OM definitions, performance metrics and data sources. All reference operating models were fitted to data and presented to the CMG (documents SCRS/2017/223, SCRS/2017/224 and SCRS/2017/225). Other peer-review paper on description and testing a multi-stock, multi-index management procedure designed specifically for Atlantic bluefin tuna was drafted as well. The user guides for M3 and ABT-MSE R package were updated with new tutorials and examples of MP development. In order to promote the work of stakeholders in developing management procedures, it was recommended that the contract of the external modelling expert be continued in GBYP Phases 8 and 9.

Within the framework of the Phase 7, a technical meeting on modelling and MSE was held in Madrid from 15 to 19 May 2017, including a working group to develop a stock assessment model (SAM) for East Atlantic and Mediterranean bluefin tuna. In this meeting the working group used a state-space SAM as a new approach to evaluate the impact of uncertainty. Additionally, a comparison of the results of VPA and SAM was conducted. To evaluate the robustness of SAM a range of diagnostics and scenarios was ran according the 2017 Bluefin Tuna Data Preparatory Meeting (document SCRS/2017/146).

GBYP data were used for drafting the following scientific papers in connection with bluefin tuna stock assessment: SCRS/2017/124, SCRS/2017/177, SCRS/2017/190, SCRS/2017/178 and SCRS/2017/170.

The main objectives in Phase 8 were ensuring the OM scenarios agreed by the CMG can be run, that third parties can use the operating model to evaluate candidate management procedures of their own specifications and to provide a set of agreed summary statistics that can be used by decision makers to identify the management procedures, including data and knowledge requirements, that robustly meet the management objectives. The contract for modelling approaches was extended to the same expert.

In April 2018, the MSE intersessional meeting of the BFT Species Group was held, partly together with the Swordfish Species Group, where the CMG presented their work and obtained feedback from the SCRS focusing on adjustments to the bluefin tuna operating models. The MSE trial specification document was updated and several initial candidate management procedures were proposed and tested on a preliminary basis. The Group shared the experiences with the coding package and discussed its possible amendments and associated trials. At the meeting, it was decided to formalize the creation of the BFT MSE Technical Group. In addition, the meeting of the Standing Working Group to Enhance Dialogue between Fisheries Scientists and Managers, was held in May 2018, with an agenda item specific to bluefin tuna MSE.

The latest outputs from GBYP MSE modelling activities, as specifications for MSE trials for bluefin tuna in the North Atlantic and an ABT-MSE Operating model fitting report, were presented in documents SCRS/2018/133 and SCRS/2018/134).

4. Preliminary results of the GBYP programme global internal review: identified general problems and potential solutions. New strategic approach and proposed activities for GBYP Phases 9.

4.1 Structural problems and potential solutions

GBYP has achieved many successes through the dedication of the former GBYP coordinator, his assistants; the indispensable help of the ICCAT Secretariat staff and the advice from GBYP SC (see GBYP Mid-term review 2013 and GBYP second review 2016). Nonetheless, as is the case with any broad, international and multidisciplinary research programme, it is necessary to evaluate its performance, identify areas for improvement and to make strategic adjustments.

To meet objectives to improve basic data collection, understand key biological and ecological processes and provide scientific advice for sustainable management of Atlantic bluefin tuna, the GBYP has initiated a broad review of the programme intended to identify strengths and weakness. This will facilitate building the strategic plan for the next Phases of GBYP.

In consequence, the first step is to outline the major problems and potential solutions, summarized as follows:

4.1.1 Funding

Issue:

1. Annual nature of GBYP funding does not permit strategic investment in activities of a continuous nature such as long-term surveys and compresses the timeframe of calls for tender, research activities and completion into a single year.
2. Decrease in the annual budgets from €2,875,000 in Phase 4 to €1,750,000 in Phase 8.
3. Funding relies upon voluntary contributions.

Potential solutions:

1. Build dedicated research funding into the Annual ICCAT Budget and/or CPC's Contribution.
2. Create dedicated Monitoring/Research Quota (SCRS/2016/21, SCRS/2014/194) to fund ongoing research.
3. Longer than annual funding commitments.

4.1.2 Planning

Issue:

1. Research priorities shift with differing needs, changing funding levels require altering or cancelling certain projects, methods for carrying out research change over time and unforeseen circumstances cause certain activities to diverge from initial expectations.
2. Lack of precise indicators to evaluate programme achievements.

Potential solutions:

1. Implement standard project planning methods (e.g. Logframe approach), to define specific objectives linked to specific activities designed to achieve short-, mid- or long-term objectives with explicit performance criteria.
2. More direct involvement of SCRS experts in planning of research and related activities, through ad hoc workshops or taking advantage relevant SCRS meetings to inform about GBYP matters.
3. Add a second independent external expert to GBYP SC.
4. Implement a clear decision making process.

4.1.3 Coordination

Issue:

1. Limited and insufficiently detailed coordination between SCRS, GBYP SC, GBYP and CPC.
2. Inconsistent or incomplete guidance from the Steering Committee due to limited time for review.
3. Lack of formal mechanisms to ensure coordination between GBYP and CPC-specific research programs.

Potential solutions:

1. Reinforce the membership of the GBYP Steering Committee, strengthen involvement of SCRS experts in the GBYP programme and dedicate more time to GBYP matters within SCRS meetings.
2. Improve synergies between GBYP and CPC-specific research programs.
3. Ensure that GBYP research activities represent more homogenously the geographic extent of the Convention area.
4. Hold an annual coordination meeting between the GBYP Steering Committee and Coordination Team and representatives of national programs such as NOAA Bluefin Tuna Research Program (BTRP), Canada DFO, Mexico, National Research Institute of Far Seas Fisheries and other national research programs.

4.1.4 Communication

Issue:

1. From the feedback received from some CPCs it is clear that GBYP achievements have not been always fully understood or disseminated.

Potential solutions:

1. Publish periodic leaflets by GBYP phase intended for Commission officers, Head Delegates, scientists, Cooperating Parties and Fishing Entities which details results and progress.

2. Promote wider dissemination of results to the scientific community through peer reviewed publications resulting from GBYP workshops, both review papers involving as co-authors all the scientists that have participated in a given line of research and monographies on a given topic.

4.1.5 Data dissemination policy

Issue:

1. Lack of a clear data policy, both regarding the mechanisms to store and manage the data generated by GBYP activities and criteria to make this information publicly available.

Potential solutions:

1. Devote special efforts to the development and implementation of such databases to house and disseminate data.

2. SCRS should adopt a clear data policy to define the mechanisms to make use of GBYP data and biological samples.

4.2 New strategic approach for next GBYP phases

Aiming at overcoming the aforementioned structural problems, the first step to improve the capability of the GBYP programme to provide the scientific basis for meeting the Commission objectives for bluefin tuna in a cost effective way should be the development of a new strategic plan. Next, a detailed work plan stating short, mid and long term objectives, including a clear roadmap of actions to be carried out and performance metrics, should be designed and implemented.

To this end, the GBYP Steering Committee should commit to designing such strategic plan and, once agreed, develop a detailed work plan for the forthcoming GBYP Phases.

4.3 Proposal for GBYP Phase 9 activities

The ICCAT GBYP Steering Committee recommends the following activities for Phase 9 with a provisional budget of €1,750,000.

a) Data recovery and data mining: This activity should be limited to sets of data that are really useful and relevant for improving the current BFT management.

b) Aerial survey: As a first step, it should be designed a calibration and validation study, including a feasibility study for its practical implementation in one of the main spawning areas. Next, a calibration and validation exercise should be carried out at the beginning of the spawning season. In parallel, an in-depth review of available data from previous surveys should be carried out to identify and quantify the potential sources of bias. Consequently, an improved GBYP aerial surveys sampling strategy and methodology protocol should be developed. Finally, the aerial survey should be carried out on the four overlapping areas considering the outputs of the previous tasks.

c) Tagging: Firstly, an extensive and deep analysis of available information on electronic tags performance should be carried out to identify the causes of current problems limiting the time spent on fish.

Next, a new GBYP tagging protocol should be elaborated. Electronic tagging should continue, applying the newly developed protocol, focusing the distribution of tags according to the emerging needs set by the SCRS. Tag awareness activity should be continued.

d) Biological and genetic sampling and analyses: An ad hoc workshop should be organized involving the different actors carrying out BFT sampling activities, to look for synergies and prevent any duplication, as well as to define priorities, proposing as the main deliverable a new sampling and biological analysis proposal, which should be used as a reference for implementing such activities in Phase 9. The biological data generated up to now by GBYP should be integrated in a relational database designed to this end. Field sampling should be continued in the prioritized areas and gears. The analyses of the available samples should be improved, particularly for microchemistry, genetics and ageing, the latter taking into account the dedicated effort carried out in Phase 8.

e) Modelling: The development of the ICCAT BFT MSE process should continue according to the outputs of the BFT MSE Technical Group. The modelling capacity building shall be further improved through training workshops and scientist exchanges.

Table 1. Approved budget and actual costs of GBYP Phase 7 and approved budget for Phase 8.

	Phase 7		Phase 8
	Approved budget	Actual costs	Approved budget
Coordination	€415,745.00	€371,485.40	€328,000.00
Data recovery	€25,000.00	€24,032.92	€30,000.00
Aerial survey	€405,000.00	€389,565.05	€433,000.00
Biological studies	€580,000.00	€533,056.14	€619,000.00
Tagging	€262,000.00	€199,817.22	€166,000.00
Modelling	€121,240.00	€91,935.70	€174,000.00
Total	**€1,808,985.00**	**€1,609,892.43**	**€1,750,000.00**