ICCAT ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA (GBYP) ACTIVITY REPORT FOR THE LAST PART OF PHASE 7 AND THE FIRST PART OF PHASE 8 (2017-2018)

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SUMMARY

The ICCAT GBYP Phase 7 has been developed between 21 February 2017 and 20 February 2018. Phase 8 began on 21 February 2018 and will be active in principle until 20 February 2019. As in previous years, GBYP program has promoted and funded during its seventh Phase several activities in the following lines: (a) data mining, recovery and elaboration, (b) biological studies, (c) aerial survey on spawning aggregations, (d) tagging, including awareness and rewarding campaign and (e) further steps of the modelling approaches. These main lines have been maintained in Phase 8, and further specific activities have been already launched on these topics. The present report summarizes the final results of the activities carried out in GBYP Phase 7 and describe the activities initiated in Phase 8, and their preliminary results, if available.

RÉSUMÉ

La phase 7 du GBYP de l'ICCAT s'est déroulée du 21 février 2017 au 20 février 2018. La phase 8, qui a commencé le 21 février 2018, se déroulera en principe jusqu'au 20 février 2019. À l'instar des années précédentes, le programme GBYP a encouragé et financé au cours de sa septième phase plusieurs activités dans les domaines suivants : (a) exploration, récupération et élaboration de données, (b) études biologiques, (c) prospection aérienne des concentrations de reproducteurs, (d) marquage, y compris campagne de sensibilisation et de récompense et (e) étapes des approches de modélisation. Ces axes principaux ont été maintenus au cours de la phase 8 et d'autres activités spécifiques ont déjà été lancées dans ces domaines. Le présent rapport résume les résultats finaux des activités menées dans le cadre de la phase 7 du GBYP et décrit les activités entreprises au cours de la phase 8, ainsi que leurs résultats préliminaires, si disponibles.

RESUMEN

La fase 7 del ICCAT GBYP se ha desarrollado entre el 21 de febrero de 2017 y el 20 de febrero de 2018. La fase 8 empezó el 21 de febrero de 2018 y continuará, en principio, hasta el 20 de febrero de 2019. Como en años anteriores, el GBYP ha fomentado y financiado durante su séptima fase diversas actividades: (a) minería, recuperación y elaboración de datos, (b) estudios biológicos, (c) prospección aérea de concentraciones de reproductores, (d) marcado, lo que incluye una campaña de concienciación y recompensas y (e) más avances en los enfoques de modelación. En la fase 8 se han mantenido estas líneas principales y ya se han iniciado más actividades específicas relacionadas con estos temas. El presente informe resume los resultados finales de las actividades llevadas a cabo en la fase 7 y describe las actividades iniciadas en la fase 8 y sus resultados preliminares, si los hay.

KEYWORDS

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

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1. Introduction

The ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP) was officially adopted by 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;
c) assessment models and provision of scientific advice on stock status.

The GBYP activity is being supported by a twin programme BTRP carried out by NOAA-NMFS, which focuses its research activities on the western Atlantic Ocean. It was initially envisaged as a 6 years programme, but 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. A new plan for the GBYP activities to be done during these additional years was approved along with the extension. Consequently, the donors maintained their contributions, allowing the continuity of the programme. For the first eight phases, covering nine years, the total operative budged of GBYP has been 14,862,448 Euros which represents the 78% of what it was initially approved by the Commission for just 6 years (19,075,000 Euros).

The general information about GBYP activities and its results, as well on budgetary and other administrative issues of GBYP programme, from the very beginning of the programme till nowadays, is available from ICCAT GBYP webpage (https://www.iccat.int/GBYP/en/). All the relevant documents related to the programme development, including final reports of every activity and derived scientific papers, annual reports to SCRC and European Union, as well GBYP workshops or Steering Committee meetings reports, are also easily available from the GBYP webpage.

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 ended on 20 February 2018.

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

European Union (grant agreement)	Euro	1,447,191.00
Japan (donation according to quota)	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
United States of America (donation)[2]	Euro	50,000.00
Libya (donation according to quota)[3]	Euro	41,406.40
Canada (service agreement)	Euro	20,448.50
Norway (donation)	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

The quantity finally spent from UE contribution was 1,274,181.32€, since some envisaged activities could not be completed due to “force majeure” reasons.

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. An amendment to the initial Phase 7 proposal was submitted to EU on December 2017 and finally approved, after several modifications, on March 2018. The final report for Phase 7, including final results, was submitted the European Union on April 2018 and definitively approved on June 2018.

The eight phase of the ICCAT 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.

[2] The donation of USA in Phase 7 was 82,220.77 euro, which was used partly for Phase 7 and partly for Phase 8.
[3] The donation of Libya in Phase 7 was 143,418.84 euro, which was used partly for Phase 7 and partly for following phases.

In Phase 8, the budget had the following funders (in order of contribution already received or committed):

European Union (grant agreement)	Euro	1,400,000.00
Kingdom of Morocco (donation according to quota)	Euro	66,898.53
Japan (donation according to quota)	Euro	59,139.54
Tunisia (donation according to quota)	Euro	54,883.78
Libya (donation according to quota)	Euro	46,942.83
Turkey (donation according to quota)	Euro	36,692.99
United States of America (donation)	Euro	32,220.77
Norway (donation)	Euro	19,195.00
Chinese Taipei (donation)	Euro	3,000.00
Popular Republic of China (donation according to quota)	Euro	2,050.03

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 8 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 present report summarizes the coordination activities carried out up to now within these two phases, providing a general view of the programme status and its management, but focuses on describing the main scientific activities carried out along within GBYP Phase 7 and summarizing the final results of the associated studies, and in describing the activities already launched within Phase 8, as well their preliminary results.

2. Coordination activities and general issues of GBYP programme management

2.1 Personnel involved in GBYP coordination and management

2.1.1 GBYP Steering Committee

The GBYP Steering Committee in the Phases 7 and 8 was composed by the Chair of SCRS (David Die), the BFT-W Rapporteur (Gary Melvin and later, from June 2018, John Walter), the BFT-E Rapporteur, (Ana Gordoa), the ICCAT Executive Secretary (Driss Meski and later, from July 2018, Camille Jean Pierre Manel) and one contracted external expert (Ivan Katavic, from March 2018).

2.1.2 GBYP Coordination team

Within GBYP phases 7 and 8 the Coordination team have been composed by one Coordinator, one Coordinator Assistant (Stasa Tensek) and one Data Base Specialist (Alfonso Pagá). Due to retirement of the former Programme Coordinator, Dr. Antonio Di Natale, at the end of Phase 7, a new Coordinator, Dr. Francisco Alemany was appointed, who assumed the responsibility from 15th January 2018.

In addition to the day to day administrative tasks carried out by the Coordination team, it must be pointed out that such tasks directly involve also most of ICCAT Secretariat personnel from all the Departments, including the Executive Secretary and the Assistant Executive Secretary, and that this support is essential for GBYP management.

2.2 GBYP Steering Committee and GBYP coordinator activities

The Steering Committee members have been constantly informed by the GBYP coordination team about all the initiatives and they are regularly consulted by e-mail on many issues. A detailed report on the status of GBYP activities is provided on a monthly basis to the Steering Committee by the GBYP Coordinator. Moreover, the activity of the Steering Committee includes continuous and constant e-mail contacts with the GBYP coordination team.

In Phase 7 the Steering Committee held two meetings. The first, focussed on discussing various aspects of the programme and providing guidance for adapting the plan for Phase 7, was held on 7-8 March 2017. The second meeting was held on 15-16 February 2018 and it was dedicated to the review of the activities carried out in the Phase 7 and planning of the future activities for Phase 8. In Phase 8, the SC held a first meeting on 18-19 April 2018, focused on discussing in detail the forthcoming activities. The minutes of all these GBYP SC meetings are available from GBYP web page.

In addition to the coordination tasks related to activities developed under contracts or agreements and other day to day communication tasks with different stakeholders, during Phase 8 GBYP coordinator have carried out some additional specific coordination activities, as a coordination meeting on GBYP tissue bank and biological data database held at AZTI lab in Pasaia on May 2018, permanent coordination with and support to the BFT otoliths readings calibration exercise leaded by IEO experts from Santander IEO lab and a coordination meeting with personnel of ALNILAM, enterprise in charge of aerial surveys data analysis, held on August 2018 at ICCAT headquarters.

2.3 Research Mortality Allowance

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, enabled GBYP to carry 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). For the purpose of covering all the activities of GBYP Phase 7, it was updated on 19 June 2017 (no. 0964/2017), with the list of 39 entities and then again on 12 September 2017 (no. 1386/2017) with the list of 43 entities. In Phase 8, the initial circular was issued on 10 May 2018 (no.502/2018) with the list of 17 entities and it was updated on 18 July 2018 (no.695/2018) with the list of 26 entities.

A detailed report on the use of GBYP RMA from 2012 up to the first part of 2017 was presented to the 2017 SCRS Species Group meeting (document SCRS/2017/208).

Finally, in Phase 7 a total of 772 RMA certificates were issued, using a total of 1,319.74 kg corresponding to 553 fish (mean weight 2.39 kg). Most of the forms were issued for bluefin tuna caught for sampling purposes in Eastern Mediterranean using hand line, although they corresponded to 177.32 kg only, given that most of these fish were young of the year. Considering the weight, the highest percentage of RMA was issued for juvenile fish caught on farms in Adriatic, within the framework of a study on the mortality caused by different types of hooks.

In Phase 8, up to 31August 2018, a total of 3 certificates have been issued, corresponding to 4 fish with a total weight of 525 kg.

2.4 Cooperation with the ROP

Along GBYP Phases 7 and 8 the GBYP coordination team, together with the ICCAT Secretariat, have been improving the contacts with the ICCAT ROP, for strengthening the cooperation and exploring further synergies. The ICCAT ROP observers have been 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 to this end has been provided to ROP. 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 has been extended also to genetic sampling in Phases 7 and 8, after assessing both their availability and the good-will of the tuna farm owners. Equipment for carrying out such biological sampling have been provided to ROPs by GBYP.

2.5 GBYP web page

Along Phase 7 the ICCAT-GBYP web page was regularly updated, with the necessary support from ICCAT Secretariat personnel, with all documents produced by GBYP, after their revision and final approval.

In GBYP Phase 8, within the framework of the ICCAT web page improvement process carried out along the last year, the GBYP web page (https://www.iccat.int/GBYP/en/index.asp) have been also deeply restructured. It is worth mentioning that a search tool (https://www.iccat.int/GBYP/en/search.asp) has been incorporated to facilitate the identification and downloading of GBYP documents.

2.6 GBYP activities management

A total of 7 Calls for Tenders, 2 official invitations and 1 request for offers were released in Phase 7. As a result, a total of 17 contracts were awarded to various entities (**Annex 1a**) and 2 purchase orders were processed. In Phase 8, up to 31 August 2018, 5 additional calls for tenders and 3 invitations have been announced, and a total of 16 contracts have been awarded to date to various entities (**Annex 1b**).

Within the framework of ICCAT GBYP Phase 7 a total of 63 reports were produced. Several additional documents and reports were also issued by the ICCAT GBYP for the needs of Steering Committee meetings. A total of 33 scientific papers were produced in Phase 7 (**Annex 2a**). In the first part of Phase 8 a total of 24 reports have been produced, along with 6 scientific papers (**Annex 2b**).

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.

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

3.1 Data mining and data recovery

The objective of GBYP 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. Such activities can include also the recovery of old or recent rough data on BFT ecology or biological parameters, relevant for BFT evaluation and management, which had not been made available for BFT evaluation purposes. In general, they will allow for a better understanding of the long-time catch series by gear, improving the data available for the assessments.

3.1.1 GBYP data recovery 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 the two remaining were awarded a contract. Both contracts 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.

Specifically, one contract provided recovery of the LL datasets for the years 2014-2016, being related to a total catch of 4,958 Bluefin tunas and a total weight of 231,719 kg. In addition, 4,958 of those Bluefin tunas had 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 provided.

The summary of the data recovered in the Phase 7 is shown by **Table 1**. The details on the data recovery in the first part of Phase 7 have already been 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 (scientific paper 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 (in the paper SCRS/2017/119).

Following a specific request from the ICCAT Statistical Department before the 2017 SCRS Bluefin tuna data preparatory meeting, the GBYP made all possible efforts 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 papers (SCRS/2017/166 and SCRS/2017/169), which were submitted at the SCRS Bluefin Tuna Assessment Session.

Moreover, the GBYP supported the BFT *Data Preparatory Meeting* held in Madrid on 6-11 March 2017, directly providing 7 papers (documents 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.

3.1.2 GBYP Data Recovery in Phase 8

Three data recovery activities are being carried out within GBYP Phase 8: a) recovery of old data on BFT catches in several Italian traps data, b) recovery of data on tuna catches from ICES reports and c) obtainment of electronical tags datasets deployed by Stanford University in 2016 and 2017.

a) Already in Phase 7, GBYP was informed that there might be a possibility of recuperation of some original data on bluefin tuna catches in Italian traps, directly from the owner's registers, that haven't been included in the ICCAT database so far. For that purpose, in Phase 8, GBYP started investigating the real content on the available data, especially in terms of trap locations and years for which the catch series were available. Once it was confirmed that this data would cover several holes in the database and would correct some of the estimates already included in the ICCAT DB, and given that the price for their recovery was reasonable, the Steering Committee recommended initiating the activity. For that purpose, a contract invitation was submitted to Ph.D. Antonia Mangano.

The activity has been carried out along summer 2018 and the draft final report submitted on 31 August 2018. Finally, data on daily or annual catches from 5 Italian tuna traps have been transcribed from original hand written registers and transferred to ICCAT DB forms. The recovered set of data consist specifically in:

- Daily catch data of tuna trap "Tonnara del Secco", near San Vito Lo Capo (Trapani, Sicily), from twenty years between 1912 and 1965. Data are referred to all species captured by the trap, which operated for many years as a mixed trap between a "Tonnara" and a "Tonnarella", targeting also smaller tuna species.
- Annual catches of tuna trap "Tonnara del Secco" between 1880 and 1979, with few missing years.
- Daily catch data of tuna traps located in Magazzinazzi and Scopello for the year 1918.
- Annual catches of tuna trap Flumentorgiu (Sardinia), for 35 years between 1755 and 1900.
- Annual catches of tuna trap Baratti (Tuscany), for the periods 1879-1893; 1901-1905 and 1912-1921, including by catches of other species

Some of these data have already been available, but were obtained from the other, less reliable source, and are currently under review.

b) Another potential set of data identified within Phase 7 were the data on bluefin tuna caches contained in reports of ICES Bluefin Tuna Species Group, from 1960s and 1970s. It was recommended to recover these data at the Data Preparatory Meeting in 2017, because apparently they have never been reported to ICCAT. The use of these data had been restricted by ICES until 2017 when ICCAT finally obtained the permission for their use. Copies of the reports were found in ICCAT library, as part of the Dr. Rodriguez-Roda personal library. The GBYP database specialist have taken care of converting the data into electronic format compatible with ICCAT database. The gathered data set contain information on a large number of bluefin tuna landings by different entities in 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. More details are given in the paper SCRS/2018/176.

The summary of the data recovered within the framework of the activities a) and b) are given in the **Table 2**.

c) GBYP also received a direct offer for providing datasets on electronic tags from Ph.D. Barbara Block, who had already provided a similar service, under an ad hoc contract, in Phase 6. These new data set refer to 41 electronic tags deployed in 2016-2017 off Canada and in 2017 off Ireland, with a mean duration on fish of 190 days (much higher than the mean of satellite tags within GBYP database). Considering the great value these datasets have for the purpose of determining the level of mixing between Eastern and Western bluefin tuna stocks and the fact they are directly used by the MSE operating model, the Steering Committee recommended getting the data, under the similar conditions (unit price) as in 2016. For that purpose, a contract with Stanford University have been signed on August 2018.

3.2 Aerial Survey on Bluefin Tuna Spawning Aggregations

ICCAT GBYP Aerial Survey on Bluefin spawning aggregations was initially identified by the Commission as one of the three main research objectives of the Programme, in order to provide fishery-independent trends on the minimum SSB. However, due to different reasons, as budget and logistic limitations, different opinions about the best sampling strategies, and even about the reliability and usefulness of the results from these aerial surveys, among SCRS and GBYP SC members, unfortunately this activity has not been developed regularly and has not followed homogenous methodologies and sampling strategies along the successive GBYP Phases (see previous GBYP annual reports and GBYP aerial surveys final reports). Summing up, aerial surveys on selected spawning areas were carried out in Phase 1 and 2, and then the activity was suspended in Phase 3. An extended aerial survey, covering 90% of Mediterranean sea surface, was realized in 2013, at the beginning of Phase 4, but due to budget constrains the aerial survey was suspended again in 2014, during the extension period of Phase 4. An extended survey, similar to that carried out in 2013, was developed in 2015, within Phase 5, revealing 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.

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 main recommendation coming out from the power analysis was 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. The ICCAT GBYP Steering Committee suspended again the aerial survey in the year 2016, basing 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 a potential alternative, which was to conduct a comprehensive survey restricted to relatively limited areas within the Mediterranean that can be adequately surveyed with the available resources. A basic assumption of this approach is that to provide a useful index of abundance the proportion of the adult stock within the survey areas during 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 was also reiterated the request that a sort of calibration should be necessary. 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, which will provide standardised results and short series possibly usable both for the assessment and the MSE process. Consequently, the aerial survey activity was resumed on Phase 7.

3.2.1 Aerial survey in Phase 7

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 had 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 2017 aerial surveys for Bluefin tuna in the Mediterranean Sea, as well as the ones in previous years, were 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), 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. 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.

A training course for pilots, professional spotters and scientific observers was organised at the ICCAT Secretariat in Madrid and 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 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. 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). Data elaboration report was provided in real time, therefore allowing the results and a paper (SCRS/2017/149) to be submitted at the SCRS Bluefin tuna Assessment Session just two weeks after the conclusion of the field activities.

The coverage was very good in all areas, 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 aerial survey in 2017 was in general 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.

The results showed that the total surveyed area was 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). The number of Bluefin tuna schools detected on effort (91) was the highest so far, confirming a good presence of the species.

The detailed results of the ICCAT GBYP survey in Phase 7 have already been 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.

3.2.2 Aerial survey in Phase 8

The aerial survey in Phase 8 was carried out on the same 4 preferential spawning areas already defined in the previous Phases, using the same design and methodology than in 2017 in order to get standardized results comparable with previous series (**Figure 1**). For a purpose of data elaboration, a call for tenders was issued and the contract was awarded to the only entity that submitted the offer, Alnilam, which has participated in all previous GBYP aerial surveys as well. In addition to data elaboration, the contractor also provided updated versions of the Protocol and Forms for this year aerial survey. Moreover, the contractor provided materials and acted as tutor at the training course that was organized for members of the aerial survey crews.

The training survey was held in the ICCAT headquarters on 16 May 2018, with the participation of all the contracted pilots, professional spotters and scientific observers. A total of 17 participants attended the course. As in the previous years, the members of the crews were instructed in detail on methodology for performing an aerial survey, they were given details on previous surveys and they were trained on how to follow the protocol and fill out the forms, including practical examples.

In 2018, three companies were awarded for carrying out the aerial surveys, which were the ones that submitted their offer following the call for tenders. All these companies had previous experience in GBYP aerial survey and they were familiar with the particularities and possible problems of each area of the survey. The survey in Area A (Balearic Sea) was done by Spanish company "Grup Air Med", while the surveys in Areas C (southern Tyrrhenian) and Area E (central-southern Tyrrhenian Sea) was done by Italian companies Unimar and Aerial Banners. As concerns Area G, it was done by French company "Action Air Environnement". Similarly to previous years, the Turkish government insisted on including a national observer as a member of the crew on board. The Turkish observer, with previous experience of performing GBYP aerial survey in the area, acted as a scientific observer.

The surveys have been carried out within the period from 28 May to 29 June 2018, on the 4 areas simultaneously, although the actual number of effective days and days on standby depended on weather conditions in each area.

This year, as in 2017, data were delivered from each area on a weekly basis, and they were immediately checked for any potential problem or error in order to solve it in a real time. In general, the survey was successful, although there were some minor problems due to unfavourable weather conditions and delays in obtaining the flight permits and restricted air space.

The overall analysis has shown that the survey design generally worked very well, and homogeneous coverage was achieved in all areas, despite the aforementioned temporal disruptions or delays due to restriction on flight over some zones because of military/political/rescue operations reasons. Data collection worked much better than in previous surveys and it seems to be improving each year.

In 2018 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. As in previous years, data were analysed using Distance software. Overall, a total of 47,361 (CV = 33.8%) tonnes and 361,995 (CV = 28.6%) individuals of Bluefin tuna were estimated in all the spawning sub-areas together (see **Table 3**). In Area A **(Table 4)** there was 7% less effort in 2018 than the mean effort of 2010 to 2017. However, there was 53% more sightings on effort this year than the mean of the previous 5 years and this was the year with most sightings in Area A so far. All encounter rates, total weight and total number of animals were much higher in 2018 than in the mean of the previous years (except encounter rate in 2017), showing an increase up to 85%. The fact that the encounter rates and final estimates are much higher than the previous years when at the same time there was similar effort in 2018 than the rest of the years, indicates that there was a real increase of BFT in area A in 2018 in respect to the previous 5 years. In this area there was already an important increase in 2017 in comparison to the previous years, but the increment is much larger in 2018.

In area C **(Table 5)**, there was approximately half the amount of effort than in 2010 and 2011, but double than in 2013 and 2015 and similar than in 2017. However, the amount of sightings of BFT was similar to the mean of the previous years but much less than in 2017 (for similar amount of effort). The encounter rate of groups, total abundance and total weight are similar to the mean of 2010-2017, but much lower than in 2017 and 2013 taken individually.

Area E **(Table 6)** had a much smaller number of sightings of BFT in 2015, 2017 and 2018 with respect to 2010, 2011 and 2013, not corresponding exactly to the variations of effort. For example, in 2011 there were only 125 km more of effort than in 2018 but there were 75% more sightings; or in 2018 there was 51% more effort than in 2013 but there were 45% more sightings in 2013. Overall, 2015 was the year with the lowest encounter rate, total weight and total abundance, and 2011 the year with much larger abundance and total weight. 2018 is similar to 2013 in terms of final total abundance but also similar to 2017 in terms of total weight.

Area G **(Table 7)** was not surveyed in 2011, and mean school size was not recorded in 2010, so comparisons are more limited than for the other areas. There was 13% less effort and 51% less sightings than in 2017. Overall, there was 29% more effort in 2018 than the mean for 2010-2017, but the same amount of sightings, and much smaller mean weight and school size, resulting in 80% smaller total weight and 68.5% lower abundance than the mean for 2010-2017.

Overall, there has been similar amount of effort in 2018 as in the five previous surveys (only 9% more than the mean), and 10% more sightings **(Table 8).** The mean weight is 25% smaller than the mean for 2010-2017 (113) and the mean school size is 73% smaller than the mean (1018). The total weight in 2018 is 47% larger than the mean 2010-2017, and the total abundance is 31% larger than the mean for the 5 previous years. However, the total abundance estimate for 2018 (361,995) is very similar to 2017 (346,272), so total abundance has not really changed overall from last year to this one, although distribution has. For example, in 2018 abundance in area A has been much higher than in previous years, but contrastingly in area E has been much lower than in 2017. Therefore, it can be hypothesized that the distribution pattern may have changed due to environmental conditions that may have affected the timing and spatial patterns of the genetic migration.

Given the strong inter-annual and spatial variability in the different components (encounter rate of groups, mean weight and mean school size), there is no clear pattern discerned in weight and/or abundance among years and areas. Understanding of the variability of the environmental conditions that affect the distribution and abundance of BFT, across years and areas, might provide better understanding of the variability in observed distribution and abundance. However, an in deep analysis of the results carried out within an ad hoc meeting between Alnilam specialists and GBYP Coordination team to discuss these issues has shown that this would not be enough to generate reliable and coherent time series, since other sources of bias have been detected, as striking differences in the observation patterns among professional and scientific spotters. Consequently, it was concluded that the

development of habitat models allowing to standardize the observations, accounting for the effect of the environmental variability among areas and years, was recommendable, but that some type of calibration exercises should also be designed and developed in the next GBYP phases to improve the reliability of GBYP aerial surveys outputs, as previously recommended by GBYP SC. Moreover, it was also agreed that other methodological questions should be addressed to optimize the surveys and overcome some of the detected problems, as changes in the shape of the surveyed areas, some of which are not optimal neither for the logistic nor for the biological point of view, as area A, and changes in the structure and working methodology of the observer's teams, which would permit to minimize the potential sources of bias, as the use of only one type of spotters working on similar conditions (using all of them bubble windows in the back of the plane, and that one of the members of the crew be dedicated exclusively to data recording, allowing the spotters to be concentrated only in observation tasks).

Some further details about 2018 GBYP aerial survey results are included in the publication (SCRS/2018/175).

3.3 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.

The specific objectives of the GBYP tagging activity on the medium term were, as stated in the document SCRS/2014/048 (Di Natale & Idrissi, 2015):

1. Validation of current stock units, and improve knowledge on potential sub-stock units and mixing
2. Estimate fishing mortality (M) and or natural mortality (Z) by age/age-groups
3. Estimate natural growth rates
4. Estimate tag recovery rates by fishery, making use of the observer programmes in the Mediterranean
5. Evaluate habitat-utilisation, movement patterns, maturity-dependent distribution and spawning-ground use of Atlantic bluefin tuna (ABFT) from electronic tag data

This line of research has faced two important problems which have prevented or limited the fully achievement of these initial objectives. One is the very low recovery rate of conventional tags, which impede the use of these data to estimate reliable mortality rates. Because of that GBYP SC, decided to cancel the conventional tagging program in Phase 4, maintaining only complementary conventional tagging activities by providing tags and tagging equipment to different institutions or organizations which ask for this support, as well as maintaining the awareness and rewards campaigns and the data base integrating all the results from recovered tags. The second major problem has been the relatively short time on fish of most of the electronic pop up tags, which limits the usefulness of the recorded data to achieve the stated objectives. The premature releases are attributable to different factors, 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 not fully adequate for BFT. These potential problems have been addressed through 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.

Detailed information about GBYP tagging activities, including actions on tag awareness campaigns and rewarding policy, along the successive phases of the programme can be found in the related activity reports and scientific papers, as well in the GBYP annual reports to UE and SCRS, which can be downloaded from https://www.iccat.int/GBYP/en/ .

3.3.1. Tagging activities in 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. To this end, another 10,000 conventional tags were purchased, to be deployed in current and following phases.

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. Due to some logistical problems and unfavourable weather conditions, only 18 tags were deployed – 4 in Denmark and 14 in Sweden. The tags were deployed during September and the fishing gear used for tagging was rod and reel, while an auxiliary boat that was chartered and used for moving the tagging team within the tagging area. Adult Bluefin tunas were 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 within a GBYP tagging activity in Morocco. The reasons for the return of Bluefin tuna into 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 2017 GBYP tagging activities will possibly help understanding these migration patterns and specific behaviour, because this was the first time bluefin have been tagged in the waters around Denmark and Sweden. Up to 11September 2018, a total of 15 of these tags have already popped off, while 3 are still deployed. It is worth mentioning that one of these tags has pop-up on September 3rd 2018, after 359 days on fish, at Skagerrak, very near to the location where it was deployed. The available tracks from the tags deployed in Skagerrak in 2017 are shown in the **Figure 2** in light blue colour.

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 (pin-broke). Nevertheless, although the deployments were short, they showed that the majority of tagged individuals from Portuguese traps moved towards northern Atlantic, while one moved towards the Azores. As concerns the deployments in 2017, all the electronic tags have already popped off and all off their tracks are already available. The tracks from the tags deployed in Portugal in 2017 are shown in the **Figure 2** in green colour.

As regards conventional tags, within Phase 7 “spaghetti” tags, along with applicators and the tagging protocols and forms to report tagging operations were delivered to various institutions. The number and locations of deployed conventional tags are detailed in **Table 9**.

The first electronic tag data base has been developed in Phase 7, along with the Shiny application which allows for the visualization of the tracks and temperature and depth parameters. A description of this DB was presented as SCRS/2017/192.

As a complimentary activity in Phase 7, the Steering Committee decided to include the study on biological response of bluefin tuna to recreational fishing by catch and release method. The study was done by Croatian Institute of Oceanography and Fisheries (IZOR) and it was completely funded by Croatian Sport Sea Fishing Association. Although the study didn’t suppose any financial implication for GBYP, the incidental mortality occurred within was accounted against GBYP Research Mortality Allowance, in line with the provisions of the Rec.11-06. The total RMA used for this activity was 838.55 kg. The goal of this study was to determine mortality rate, behaviour and sub-lethal wounds of juvenile tuna caught with different types of fishing tools and subsequently released in controlled cage conditions, in order to observe their recovery and behaviour during 29 days of intensive feeding. Conducted research showed that hooking damages range from superficial injuries, most often on peripheral parts of jaw, skin and operculum to serious wounds. It is believed that the place of hooking is the primary factor that affects the mortality of the fish caught by this method. However, the severity of the injury proved to be directly influenced by type and characteristics of hook used. Straight J-shaped hook, with point of hooking that is parallel to the arm of the hook, contributed to higher caught fish mortality rate due to serious injury, while the use of circle hooks resulted in highest number of jaw hooking and superficial injuries to skin and operculum. This confirms earlier results which state that barbless circle hooks have important role in fish preservation. The study resulted in several conclusions and recommendation which might be implemented with a view to reduce premature mortality in early days posterior to implementing the tag. In this way, the risk of losing valuable equipment could be reduced, which might eventually improve tagging results.

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) at the end of Phase 5. It was a new approach to estimate the SSB abundance and other important population parameters that is currently applied for some fish species (including sharks), including some tunas. 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. For the purpose of obtaining the advice on close-kin tagging of Atlantic bluefin tuna, a feasibility study was done by The Commonwealth Scientific and Industrial Research Organisation (CSIRO) from Australia. 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. Although 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. In the Phase 7, the enhanced sampling for adults and juveniles was continued, but no other activities regarding CKMR were carried out.

3.3.2 Tagging activities in the first part of Phase 8

As recommended by the Steering Committee, the tagging activities carried out under contract on specific agreements in the Phase 8 were limited again to the deployment of electronic tags, keeping the deployment of conventional tags only as a complimentary activity. In addition to 22 electronic tags that have already been purchased in the Phase 8, in 2018 GBYP acquired additional 25 tags (7 of them were both with 50% discount due to the physical return of recovered tags). The producer also added 13 warranty replacement tags for pin broke. Given that the purchase order was done commonly with other order from the Secretariat and therefore included high number of the tags, a special quality discount from the manufacturer of $200 per tag was obtained. All tags were of type MiniPAT made by Wildlife Computers.

The specific objective of GBYP tagging programme in Phase 8 was improving the estimations of the degree of mixing of western and eastern bluefin tuna stocks along the different statistical areas and throughout the year, specifically considering the current needs of the MSE modelling process. To this end, the Steering Committee decided to concentrate tagging activities in the North Sea and/or Celtic Sea and in Southern Portugal area. After publishing the call for tenders, 4 offers were received, but due to the budget constraints only 2 from them have been awarded. The contract for tagging of 30 bluefin tunas in Portuguese traps was awarded to Tunipex, the same company that has already carried out GBYP tagging activities in previous phases of the Programme. The other contract was awarded to the Marine Institute of Ireland for deploying of 10 tags in the Celtic area. It has to be noted that Marine Institute met the costs of staff for this activity, including reporting and data management. In addition to the two contracts, the Memorandum of Understanding was signed between ICCAT GBYP and the Institute of Marine Research of Norway, for deploying of 20 tags in western Norway. According to the MOU, while the costs of the tag deployment would be covered by the IMR, ICCAT would provide the electronic tags and assume the cost of satellite transmission. The resulting data will be shared between the two institutions.

Tagging operations in Southern Portugal traps were carried out successfully on August 2018, whereas tagging campaigns in Celtic Seas and Norwegian coasts have just started on 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 GBYP RMA in case of BFT casualties during tagging operations and the use of GBYP Argos system account for data transmission. Specifically, National Institute for Aquatic Resources (DTU Aqua) of Denmark and the Italian branch of WWF Mediterranean Marine Initiative have been included in the 2018 GBYP list of institutions that can make use of RMA. WWF has recently deployed several satellite in the Western Mediterranean which are associated to GBYP Argos system account, so the resulting data will be directly integrated in GBYP database. DTU Aqua has already agreed to share the resulting information with GBYP.

As regards conventional tags, within Phase 8 “spaghetti” tags, along with applicators and the tagging protocols and forms to report tagging operations were delivered to various institutions (**Table 10**). Moreover, conventional tags and related equipment was also delivered to the teams in charge of satellite tags deployment, since in this phase they have been asked to carry out a double tagging whenever possible, implanting conventional tags besides the satellite tags. The number and location of deployed conventional tags is detailed in **Table 11**. The number of

tags recoveries reported so far by geographical area is detailed in **Table 12**, while **Table 13** shows recoveries by year. The resulting data have been included in the ICCAT tagging database, making them available to scientific community for analysis.

In addition to the Shiny application developed in Phase 7 for visualization of the tracks and temperature and depth parameters (SCRS/2017/192), new application was developed in Phase 8 (**Figure 3**) 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 publication SCRS/2018/174). Both applications get the data from the GBYP electronic tag database developed in Phase 7. The Shiny application proves to be very handy, allowing instant visualisation of tag movements, comparison or data visual search. It can also contribute to identifying season-related and maturity related-migration patterns. Currently the GBYP electronic tag database is kept on the personal computer and it cannot be remotely connected. The Shiny application is also only locally run. Up to now, only data on time spent by fish in the different statistical areas has been delivered to the responsible of 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 to the scientific community and hence promoting deeper analysis of the gathered information, with the aim of generating information useful for improving the BFT management.

3.4 Biological Studies

The main objectives of the ICCAT Atlantic-Wide Bluefin Tuna Research Programme (ICCAT GBYP) are to improve: (a) the understanding of key biological and ecological processes, (b) current assessment methodology, (c) the management procedures, and (d) advice. Key tasks to achieve these objectives are biological sampling and analyses, which provide indispensable data for conducting the bluefin stock assessment and MSE process, in line with the aforementioned objectives.

Consequently, one of the core activities of ICCAT GBYP are the so called Biological Studies, which ICCAT GBYP started in 2011, maintaining a biological sampling programme covering the main bluefin fisheries and funding a series of studies based on the analysis of these samples, as histological analyses to determine bluefin tuna reproductive state and potential or microchemical and genetics analyses to investigate mixing and population structure, namely to define the population structure of Atlantic bluefin tuna (*Thunnus thynnus*), with a 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 have already been presented to SCRS and the Commission in 2017 (SCRS/2017/139).

3.4.1 Activities in Phase 7

After initial activities, the activities in following Phases of GBYP were 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.

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 be continued. The Steering Committee identified the priorities to be carried out within Phase 7, while other activities were postponed.

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. As regards the sampling of the adults in farms the experience from the previous year demonstrated that it can be a useful strategy for obtaining the needed adult

samples from the spawning areas. Thus, in 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 specimens 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 including maintaining the GBYP Tissue Bank, sampling, analyses and even a special research study of reproductive biology of tuna in the Slope Sea (NW Atlantic). Given the budget limitations, some activities could not be 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.

Following the request coming from the SCRS BFT Species Group and the recommendation made by Steering Committee, a first workshop on the reproductive biology of the Atlantic Bluefin Tuna was held within Phase 7, aiming at identifying the feasible priorities of biological studies which could be carried out within the GBYP, especially in Phase 8, and preparing the larger workshop on BFT reproductive biology in Phase 8.

3.4.1.1 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 included the appropriate storage of all samples already collected and new ones that arrived in Phase 7, their delivery to the entities in charge of the analysis and the posterior receipt. Also, it included the eventual relabelling of the samples according to the protocol and the management and the regular update of the samples database.

In addition to maintenance of the Bank, during Phase 7, Shiny application (**Figure 4**) 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. The application allows the user to interactively visualize and filter the database of available samples, and download the data associated to the selection.

3.4.1.2 Sampling

Sampling in Phase 7 was performed by the various entities that operate under different contracts – the Consortium headed by AZTI, the Consortium headed by UNIBO, Balfegó & Balfegó, Taxon Estudios Ambientales and AquaBioTech. In addition, opportunistic sampling was done by ICCAT-ROPs and tagging teams. 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) were the priority for the collection of otoliths, spines and genetic samples. A special attention was 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.

Around 3600 bluefin tuna individuals were sampled in Phase 7[4]. From these, 1562 individuals were collected by the Consortium, while others individuals were sampled under the additional contracts, mainly the ones for sampling adults on farms. All the data on samples collected this year have already been merged with the general samples database and stored in tissue bank. **Table 14** shows the number of bluefin tuna sampled in each strata (area/size class combination).

In the Eastern Mediterranean, 154% of the target number of individuals (YOY and adults) were sampled. The sampling for YOY in the Levantine Sea was above the original plan, and it was carried out mostly in the area near the Turkish-Syrian border. The sampling of adult individuals was also above target. Sampling done by ROPs was especially successful in this area, with 275 adult individuals collected. Like in previous phases, the success rate of getting otoliths from these fish is very low, due to the way they kill them (bullets use to break them into many pieces).

As for the Central Mediterranean, the targets for sampling adults were reached, while sampled YOY individuals were well below target, due to their apparent disappearance from this area.

In the Western Mediterranean, the total targets for sampling individuals were reached, including fish from all sizes, but predominantly YOY. The sampling of adult individuals in Sardinia was successful. The individuals were tracked during the processing of their heads in order to sample their otoliths. However, the sampling of YOY in the Tyrrhenian was below the target. The sampling of YOY in the Ligurian Sea was also below the target, but this was compensated with samples from larger individuals (mostly medium sized).

In the area around Gibraltar, the targets for medium sized fished were reached. In addition, 100 YOY were sampled in the Atlantic part of the Strait of Gibraltar, despite this was not planned originally, because it is not common to find YOYs in that area. Sampling in Portugal was also successful.

In the Central Atlantic, the number of samples, all belonging to large size fish, was by far beyond the original expectation, which will potentially allow for interesting insights into mixing of stocks and their inter-annual variability. Furthermore, as in Phase 6, unexpected samples from Norway were obtained again, since the Institute of Marine Research provided samples from 248 large individuals that were collected using their own funds.

The unusual presence of very small bluefin tuna YOYs was noticed in 2017 in areas where this is not common. It was firstly noticed in the second part of August in some areas where these small sizes are not usually present, like in the southern part of the Iberian Peninsula (both in Atlantic Spain and Portugal), in the Canary Islands and in the central-northern Adriatic Sea. The exact natal origin of this very young fish is unknown, but the GBYP has been able to collect some samples, which will be analysed in the future. The possible reasons for this phenomenon might be specific oceanographic and climatological conditions in 2017, as presented in the scientific paper SCRS/2017/216.

3.4.1.3 Analyses

As has already been mentioned, due to the limited budget, this year the main priority was 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 were 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 developing a genetic test for sex assignment. The age determination analyses were performed on 2000 otoliths that had not been read before. In addition, reading and counting of daily rings was carried out on 20 YOY to establish their birthdate.

Otolith chemistry analyses

Although initially it was not planned to carry out this task due to the lack of funds, given that some sampling activities couldn't be completed anyway, the contract with the Consortium headed by AZTI was amended in order to include some otolith chemistry analyses instead. These analyses were limited to 50 otoliths, which were analyses for stable carbon and oxygen isotopes ($\delta^{13}C$ and $\delta^{18}O$).

[4] As some sampling activities took place rather later in the Phase, some samples are yet to be verified before integrating them into the database and therefore the final numbers of collected samples is still not available

The results from previous phases suggested 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 western coast of Morocco. To assess the spatial and temporal variability of mixing proportions, in the Phase 6, the otoliths collected in Moroccan coast in 2016 were analysed.

$\delta^{13}C$ and $\delta^{18}O$ were measured in the otolith cores of bluefin tuna from Atlantic coast of Morocco and compared to baseline populations from the Mediterranean Sea and Gulf of Mexico. Mixed-stock analyses using MLE procedure indicated that catches in 2016 were comprised entirely by the Mediterranean population (100% of eastern origin fish). Mixing rate estimates in the coast of Morocco using this methodology 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 (**Figure 5**). 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.

Genetic analyses

Due to limited budget in Phase 7, these activities were limited to 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 assignment, which were carried out by the Consortium headed by the University of Bologna.

Annotation and comparison of bluefin tuna reference against other tuna genomes will allow better functional characterisation of tuna genomes. Moreover, the genomic reference will be used for the mapping and positioning of current and future genomic markers, allowing comparison between markers dataset and analyses and the validation of population structure results. These genomic resources could be ultimately translated to improve the current management and exploitation of the species, with a special focus on rearing conditions in fattening cages, eventual reproduction in captivity and broodstock management.

Within this activity, a genome-wide annotation of protein-coding genes was performed and 41,508 protein-coding genes were identified. The quality of the annotation was enhanced by incorporating transcriptomic data, obtained from different sources, into the gene prediction pipeline to guide and support the identification of candidate gene. The resulting gene annotations were assessed by comparison of predicted protein sequence with proteins from other species, showing a high rate of similarity with those of other fishes (97% of predicted proteins mapped to Teleostei Uniref90 reference clusters), supporting the good quality of these gene annotations. 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 (**Figure 6**), molecular function (**Figure 7**) and cellular component (**Figure 8**), with a total of 13,915 different GO terms. Moreover, sequence analysis tools were adopted to complement functional annotation with protein features (secretory signal peptides, mitochondrial-targeting peptides and/or transmembrane domains) and annotations of GO cellular component terms.

Within the genetic tasks, special attention was paid to investigating in the bluefin tuna genome the presence of candidate genes for sex-related traits. It was investigated in the BFT genome by searching for sequence similarity with candidate sex-determining genes characterized in previous studies in *T. orientalis* and other bony fishes (as zebrafish, cod, medaka, Patagonian pejerrey, fugu, rainbow trout, turbot, Yellowtail). Only 3 out of the 35 candidate genes and markers did not find a match on the assembled BFT genome. All other sequences were located each in different scaffolds, not supporting the identification of a well-defined sex-determining region in the BFT genome. However, these results 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.

Age determination analyses

Due to the problems encountered so far for ageing large quantities of otoliths, it was decided to dedicate a special effort in Phase 7 for ageing a total of 2000 Bluefin tuna otolith samples of various size classes, previously stored in the ICCAT GBYP tissue bank that haven't been aged so far. The ageing was done by Fish Ageing Services from Australia.

The otoliths were 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 was carried out by two different readers for all samples, while a third expert reader provided reading of 10% of the otoliths for a quality control. An image of each otolith section was provided with zones marked, by using Leica M80 with 20 times magnification. Both sides (dorsal and ventral lobes) were used to come up with an interpretation. Opaque zones were counted and measurements were marked and measured on the ventral arm along a transect from the first Apex and the ventral tip close to the distal edge of the otolith. (**Figure 9**). Opaque zones were marked at end of the zones. Finally, the age-length-key was developed (**Figure 10**).

Daily ageing

The analysis was performed on 20 YOYs caught in Mediterranean in 2016, 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. The size of these fish was larger than expected size suggested that they might have been born before the assumed spawning season (before mid-May). The study was done by the Consortium headed by AZTI.

Daily age reading was carried out using a transversal section of the otolith, as shown in **Figure 11**. The methodology is laborious, since the section is obtained essentially by sanding the otolith until the daily rings around the nucleus and border of the otolith are visible in a thin section. In young individuals this can be obtained in a single plain, but in larger individuals it might require sequential sanding and reading to cover the complete life history of the individual. Each otolith was read at least two times, and sometimes up to 3 or 4 times. Two final values were given for each otolith, and the final age assigned to each individual was the average of the available estimates.

The results of otolith daily rings reading indicate that all these fish were born in June-July period, rejecting the original hypothesis, although confirming that the growth rates can vary a lot between individuals born in the same season. Specifically, one group of individuals sampled in August in the Tyrrhenian presented an apparently abnormal quick growth.

3.4.1.4 Study in the Slope Sea

In Phase 7, the Steering Committee recommended giving priority, among other activities, to a special research activity focused on filling knowledge gaps in Bluefin tuna reproductive biology in the NW Atlantic (i.e. Slope Sea and surroundings); 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. This study was designed to 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. The study was done by the Social and Environmental Entrepreneurs (Project Tag a Tiny).

Some previous analyses indicated that the endocrine profiles of the fish sampled in the Slope Sea (spawning in the late summer) might be different from those from GOM (spawning earlier). The intention in this study was to obtain endocrine profile (gonadotrophins quantity in the pituitary gland, hypothalamus and liver) of the BFT sampled in SW Nova Scotia in order to identify the spawning period, consistent with the presence of larvae in the North Slope Sea. However, due to logistic constraints the sampling targets were not reached and the study was cancelled. Anyhow, the other main objective of this activity, to create a collection of slides for histological analysis from gonads samples available in LPRC and NOAA Panama, was fully accomplished. The analysis of these samples were finished after the end of Phase 7, as envisaged, and the final results will be presented within the framework of the GBYP workshop on BFT reproductive biology that is going to be held on November 2018 at ICCAT headquarters.

3.4.1.5 Workshop on bluefin tuna reproductive biology

The first ICCAT GBYP Workshop on Atlantic bluefin tuna reproductive biology was held during 14 and 15 February 2018, at ICCAT Headquarters in Madrid. It included participation of 7 scientists, apart from Steering Committee members and GBYP Coordination team. One of the objectives of the meeting was identifying the feasible priorities of studies related to reproductive biology 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 agenda drafting and the identification of the most adequate experts to participate as invited speakers.

The participants of the workshop identified seven research activities to be possibly done within the framework of the GBYP in Phase 8, which were suggested to the Steering Committee for their consideration. As regards the extensive workshop on bluefin tuna reproductive biology that is going to be held in Phase 8, the participants recommended that it should be conceived in such a way that it should answer or provide inputs on the following topics: 1) planning of the activities to be carried out within the GBYP biological studies in Phase 9, 2) affirming or rejecting the hypothesis of substantial differences in bluefin tuna reproductive biology between the eastern and western stocks and 3) identifying methods for estimation of the percentage of individuals contributing to spawning by age and area. In addition, they drafted a tentative agenda for the Workshop to be held in Phase 8, identifying the principal topics and recommended a list of scientist to participate as invited speakers. In order to address the controversy on the reproductive parameters currently used for the assessment of the bluefin tuna eastern and western stocks, the participants recommended that a reference report be elaborated by independent experts, reviewing the available information and drawing conclusions on this issue. It was envisaged to carry out this activity prior to the Workshop in Phase 8. The report of this workshop is available as document SCRS/2018/013.

3.4.2 Activities in the first part of Phase 8

The specific objectives of the Biological Studies stated for Phase 8 are keeping an ICCAT 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 getting improved knowledge on reproductive parameters of bluefin tuna.

With that aim, a call for tenders for biological studies was issued in May 2018, for maintenance and management of ICCAT GBYP Tissue Bank, collecting tissue samples and otoliths and performing analyses – both microchemistry analyses of otoliths and genetic analyses of tissue samples. The Call also asked for elaboration of comprehensive study on results of stock assignment analyses already conducted within the GBYP in order to provide a complete set of plausible hypotheses about stock structure consistent with the data for the MSE operational model.

Two contracts were awarded for carrying out the biological studies in Phase 8, one to the Consortium led by AZTI for both sampling, microchemical and genetic analyses of biological samples and Tissue Bank maintenance, and the other one to University of Bologna – BiGeA- for sampling only. Sampling activities were rather reduced this year and concentrated on samples from potential mixing areas in Atlantic and some additional ones from the Mediterranean Sea. The task of maintaining the Tissue Bank has been again entrusted to AZTI, that has been managing it since the beginning of the Programme.

In addition, sampling of adult bluefin tuna is being performed in the farms. After call for tenders, contracts for that purpose were awarded to two enterprises. One was AquaBioTech, from Malta, for providing samples from at least 300 specimens from the Southern Tyrrhenian Sea and at least 300 specimens from the Central/Southern Mediterranean Sea. The other one was Taxon, from Spain, for providing samples for at least 300 specimens fished in the Balearic Sea. Additional samples are also provided by ICCAT ROPs and by tagging teams.

Regarding samples analyses, the contract was provided to the Consortium headed by AZTI for individual population assignment of bluefin tuna caught in potential mixing zones in Atlantic by using both otolith microchemistry stable isotope analyses and genetic RAD-seq derived SNPs analyses. In addition, the Consortium will carry out the special analysis exploring the presence of a possible "third" population of Atlantic bluefin tuna in the Slope Sea. For that purpose, genetic analysis based on SNPs will be performed on 39 larvae collected in the Slope Sea and their genetic differentiation from Gulf of Mexico and Mediterranean samples will be explored. The Consortium will as well perform additional analyses in order to refine Mediterranean baseline used in integrated method for stock discrimination. The set of plausible hypotheses about stock structure consistent with MSE operational model will be performed, by using as a basis the individual origin assignments obtained by different methods and aggregated by geographic area and year. In Phase 8, additional study will be performed 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 and the recommendations of Steering Committee, a special review of current assumptions on reproductive parameters of Eastern and Western bluefin tuna stock was requested, with the special focus on discrepancies between the assumed ages of first maturity and identification of feasible methods for determining spawning fraction. Two independent reviewers have been contracted for this purpose: Dr. Jessica Farley (CSIRO, Australia) and Dr. Seiji

Ohshimo (Seikai National Fisheries Research Institute, Japan). The final version of this review is envisaged to be presented at the GBYP Workshop on BFT reproductive biology, to be held on 26-28 November 2018 in Madrid, whereas a preliminary version of the report is presented as publication SCRS/2018/013. The workshop will concentrate on different topics with reference to bluefin tuna reproductive biology and will provide dedicated presentations of various previously identified key-note speakers.

Within GBYP Phase 8 Biological studies the GBYP coordinator proposed to GBYP SC to award a contract to try to develop a genetic test for BFT sex assignment, taking advantage of the first works in this line carried out within Phase 7. However, in spite of recognizing the usefulness of such study, the GBYP SC linked its development within Phase 8 to funds availability. Therefore, the possible launching of the Call has been postponed till getting more precise information about the final costs of other priority activities already planned in the initial proposal.

Regarding ageing related activities, the Phase 8 proposal included specific budgets for carrying out, similarly to Phase 7, the reading of 2000 otoliths by Fish Ageing Services, and a calibration exercise of BFT otoliths readings. However, at the beginning of Phase 8 GBYP coordinator was informed that some researchers, including the specialists that have been providing to SCRS the BFT ALKs along the last years, had already organized a wide international calibration exercise on this topic focused mainly on assessing the observed discrepancies between age readings from spines and otoliths, especially in young specimens. Therefore, to prevent any overlapping, it was decided to support this initiative and postpone the envisaged GBYP calibration exercise till the ongoing exercise be finished. Moreover, since this activity, whose results 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 with Fish Ageing Services (FAS) till such new improved protocol for BFT otoliths interpretation be agreed and endorsed by SCRS, in order to ensure that FAS use it as reference for carrying out the new readings. Given that FAS used its own criteria for interpreting the set of 2000 otoliths analysed within Phase 7, the GBYP Phase 8 calibration exercise will be centred in the analysis of part of this otolith collection, in order to ensure that the ALK provided by FAS in Phase 7 is comparable to previous ALK used for BFT stock assessment. Moreover, this new calibration exercise should provide information, as correction factors if considered necessary, to ensure that these previous ALK are comparable to the ones that should be generated by applying the new protocols for BFT otoliths interpretation arising from the aforementioned calibration exercise.

In addition to these activities dealing with annual growth, the GBYP SC member Ana Gordoa offered to perform the daily ageing of 50 otoliths free of charge, in order to continue the study initiated in Phase 7 in greater depth and obtain more conclusive results. Pursuant to her offer, GBYP SC decided to provide her with the required samples (52 YOYs of 2016).

3.5 Modelling approaches

The initial ICCAT GBYP objective in relation to modelling activities was to carry out operating modelling studies from year 4, with a total budget of 60000€. However, following the recommendations of the Steering Committee and the SCRS, the ICCAT GBYP carried out many modelling activities since Phase 2. It is 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 and the SCRS, and endorsed by the Commission.

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 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 previous Phases were consistent with these objectives, within the timeframe set by the Modelling MSE Core Group.

3.5.1. Modelling in Phase 7

3.5.1.1 Modelling technical assistant

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

The objectives for modelling activities under GBYP Phase 7 were the following:

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 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. In this regard, a number of major milestones were achieved in this Phase.

As concerns the operational modelling, the M3 model was updated from 1.3 through to 1.7, 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 core modelling group. The summary was presented on the document SCRS/2017/223. The 36 reference and 4 robustness operating models were included in the ABT-MSE R package (v2.3.0) for use in MP testing. Finally, a functionality was added to specify the operating models of the R package using the MCMC posterior samples of the fitted M3 models (a better characterization of parameter uncertainty and cross-correlation).

Regarding MSE development, the R package was updated with the performance table function and an MSE performance metrics plot to standardize the outputs of user MSE runs, consistent with the performance metrics of the updated trial specifications document. In addition, standardized operating model fitting reports were updated following feedback from the Core Modelling Group including a new, additional OM comparison report. All of the latest R code, data and objects were into the R package (ABTMSE v2.3.0) with complete documentation for all functions, objects and data to be used in MSE analyses (**Figure 12**). The raw data, R scripts, Reports, help documentation and the R package were assembled in a single directory which can be downloaded from either the ICCAT GitHub repository or a Google drive.

As regards documentation, the paper SCRS/2017/224 was presented, showing the design and implementation of new MPs in the R package. In addition, other paper was drafted, introducing the ABT-MSE R package and its capabilities, which was presented as document 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 (v1.7) and ABT-MSE R package (v2.3) were updated with new tutorials and examples of MP development. The 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. Finally, software design documentation was updated for the latest version of the ABT-MSE R package (v2.3.0).

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'.

The ABT-MSE Package was completed within the Phase 7, and made available for use by Stakeholders in the development and testing of Management Procedures. It was envisaged that the next phase of the MSE process should focus on the development and testing by stakeholders of management procedures. Due to diversity in their skillset, background and experience, it was considered that each user was likely to require different levels and types of technical support. In order to promote the work of stakeholders in developing management procedures it was decided to support or provide tools to aid in the production of SCRS papers documenting their research, providing a transparent and citeable account of the project research that may also benefit other users. Therefore, the ICCAT GBYP Core Modelling MSE Group, in its 6th meeting, recommended the contract of the external modelling expert to be continued in GBYP Phases 8 and 9, which was endorsed by GBYP SC.

3.5.1.2 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 had 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 was 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 Github. 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 in Madrid on 25-26 September 2017, back-to-back to the SCRS Bluefin tuna Species Group meeting. The group discussed MSE trial specifications and updated them according to the decisions. The report on refined conditioning of OMs was considered as well. Conducted conditioning was confirmed as adequate, the models to be used to generate future abundance index data were approved and it was decided to revise and refine procedures for conditioning robustness trials. Finally, the Group discussed future plans. It also discussed the need to involve specialists from different CPCs in the CMMG particularly from geographical areas which are not currently represented in the Group, so enhance the likely acceptance of a final MP proposed through extending "ownership" of the proposal. The necessity of securing a number of candidate MP developers to work using the package developed towards proposing CMPs to the planned 2018 intersessional meeting was stressed. The Group recommended that Tom Carruthers be one of those developers. Participants in the meeting indicated the likely availability of such developers from a number of CMPs.

The Group developed an updated schedule for the next activities:

1. About April 2018 the various developers of CMPs meet to compare results and agree on refinements to take their CMPs further.

2. The September 2018 bluefin session narrows the set of CMPs based on their performance across the various OMs.

3. A first stakeholder-scientist interaction takes place during a Panel 2 intersessional meeting in about February 2019 to discuss desired MP properties and performance, informed by results from this first set of CMPs.

4. A subsequent meeting of the CMMG takes place to consider the results of CMP amendments informed by that stakeholder-scientist interaction.

5. If needed, a second stakeholder-scientist interaction takes place during a further Panel 2 intersessional meeting in about July 2019.

6. 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.

7. A proposed set of CMPs is presented to the Commission at its 2019 meeting for a selection there of a final MP.

3.5.1.3 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 from 15 to19 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 the document SCRS/2017/146.

3.5.1.4 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.

GBYP data were used for drafting 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.

3.5.2 Modelling in the first part of Phase 8

In Phase 8 the contract for modelling approaches was again awarded to Dr. Tom Carruthers (Blue Matter Science, Canada), for providing support to bluefin tuna stock assessment, who initiated the work on MSE and modelling in 2014. The main objectives for this year were ensuring the OM scenarios agreed by the ICCAT GBYP Core Modelling and MSE Group 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.

It is important for the BFT Species Group and the Commission to gain experience in conducting 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 option on the basis of actual projections rather than abstract concepts. The initial MP design and performance statistics, however, should be few, informative and based on axes such as stock status, safety, stability and yield.

The specific tasks defined in the Phase 8 were the following:

1. Refine the software package following feedback from users at the 2018 ICCAT Bluefin Tuna and North Atlantic Swordfish MSE Meeting.
2. Maintain the meta-database of operating model data inputs.
3. Continue to develop help-documentation and tutorials to assist stakeholders in CMP development.
4. Work with stakeholders to assist them to develop CMPs, and also the Contractor himself is to develop a CMP.
5. Produce MSE visualization tools such as a revised Shiny App and Bayesian Belief Network.
6. Produce a scientific manuscript on a multi-stock management procedure to be presented as scientific communication to ICCAT SCRS Species Groups 2018 meeting.
7. Produce a scientific manuscript on 'Strategies and Tactics in the Campaign for Sustainability of Atlantic Bluefin Tuna to be presented as scientific communication to ICCAT SCRS Species Groups 2018 meeting.
8. Assist in documenting the deliberations of meetings taking this MSE process forward in a manner that records developments in some detail.

BFT Species Group held the MSE intersessional meeting on 16-20 April 2018, partly together with Swordfish Species Group. During the meeting, the Bluefin tuna Core Modelling Group 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 preliminary basis. The Group shared the experiences with the coding package and discussed its possible amendments and associated trials. Several other topics were discussed and the further CMP refinement schedule was drafted, as well as priority actions identified including closer consideration of stock mixing, B_{MSY} calculations, future recruitment scenarios, abundance indices, and definition of key uncertainties. GBYP supported the attendance to this meeting of the GBYP CMG coordinator, Dr. Doug Butterworth, and the CMG expert Dr. Carmen Fernández.

The Standing Working Group on Dialogue between Scientists and Managers hold a meeting on 21-23 May 2018, including an agenda item specific to bluefin tuna MSE. The objective of this meeting was to initiate input from stakeholders to assist in future refinement of candidate management procedures. It was recognized that the original road map adopted by the Commission was too ambitious, because the Bluefin tuna Species Group, whose involvement is crucial at this stage, will have to meet several times to advance their work, given the complexity of MSE. The estimated delay in the timeline for bluefin tuna is at least six months, which should allow ICCAT to remain on track to consider candidate MPs for possible adoption in 2020. GBYP supported the attendance to this meeting of the GBYP CMG coordinator, Dr. Doug Butterworth.

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, will be presented within BFT SCRS Species Group session.

Table 1. Data recovered in Phase 7 from historical traps (TRAP) and Italian longlines.

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 2. Data recovered in Phase 8.

Fishing period	Gear	Fishing area/Trap Name	ICCAT CPC	BFT total catch (n)	BFT total catch (tons)	individual fish data (size or weight)
1880-1965	TRAP	Secco	EU.ITA	42.699	5.071	
1918	TRAP	Magazzinazzi	EU.ITA	2.175	369	
1918	TRAP	Scopello	EU.ITA	1.184	249	
1755-1900	TRAP	Flumentorgiu	EU.ITA	54.766	9.310	
1879-1921	TRAP	Baratti	EU.ITA	1.504	35	
1974, 1976	TRAP	Northwest Atlantic	CAN	578	190	578
1964	TRAP	Central Mediterranean	LBY	14.912	9	14.912
1971-1972, 1974-1976	PS	Northwest Atlantic	CAN	11.018	8,3	11.018
1968-1978	RR	Northwest Atlantic	CAN	5.678	246,7	5.678
1964	MWT	North Sea	EU.DEN	112	9	112
1976-1978	MWT	North Sea	EU.DEN-EU.SWE	31	10,1	31
1973, 1975-1977	HAND	Northwest Atlantic	USA	1.919		1.919
1973, 1975	HARP	Northwest Atlantic	USA	225		225
1962-1964, 1966-1970, 1974-1978	PS	Northwest Atlantic	USA	116.923	44	116.923
1973, 1975, 1977-1978	RR	Northwest Atlantic	USA	4.470	2,8	4.470
1975, 1978	UNCL	Northwest Atlantic	USA	2.327	70,1	2.327
total Phase 8				**260.521**	**15.624**	

Table 3. Mean school size, density and total weight and abundance of bluefin tuna for each subarea in 2018, in reference with aerial survey. All data refer to on effort-observations.

Year	A	C	E	G	Total (sum)	Total (mean)
Survey area (km^2)	61,933	53,868	93,614	47,719	257,135	
Transect length (km)	5,560	4,832	8,933	3,984	23,308	
Effective strip width x2 (km)	1.43	1.43	1.43	1.43		1.43
Area searched (km^2)	7,959	6,917	12,788	5,702	33,365	
% coverage	12.9	12.8	13.7	11.9		13.0
Number of schools ON effort	25	8	11	23	67	
Abundance of schools	384	36	45	103	568	
%CV abundance of schools	30.6	45.6	41.2	30.7	22.5	
Encounter rate of schools	0.0045	0.0017	0.0012	0.0058		0.0029
%CV encounter rate	20.8	36.3	30.9	23.0		13.6
Density of schools (1000 km^{-2})	6.198	0.660	0.481	2.163		2.208
%CV density of schools	30.6	45.6	41.2	30.7		22.5
Mean weight (t)	98.6	140.8	97.0	6.9		84.5
%CV weight	28.4	58.8	26.1	46.6		24.4
Mean cluster size (animals)	663	1,222	1,013	208		643
%CV abundance	23.9	39.9	24.8	39.3		18.5
Density of animals (km^{-2})	4.110	0.807	0.487	0.450		**1.420**
%CV density of animals	37.2	62.8	46.1	48.5		28.4
Total weight (t)	**37,861**	**5,007**	**4,369**	**709**	**47,946**	
%CV total weight	40.3	74.9	47.3	53.1	33.4	
L 95% CI total weight	17,658	1,317	1,798	365	25,283	
U 95% CI total weight	81,183	19,040	10,613	1,897	90,921	
Total abundance (animals)	**254,552**	**43,466**	**45,600**	**21,474**	**365,091**	
%CV total abundance	37.2	62.8	46.1	48.5	28.4	
L 95% CI total abundance	125,322	13,998	19,214	8,092	211,128	
U 95% CI total abundance	517,039	140,079	107,869	51,779	631,334	

Table 4. Results for all aerial surveys in overlap area A.

Year	2010	2011	2013	2015	2017	2018	Total (sum)	Total (mean)
Survey area (km^2)	61,933	61,933	61,933	61,933	61,933	61,933		61,933
Transect length (km)	6,118	7,838	6,807	4,109	4,981	5,560	35,412	5,902
Effective strip width x2 (km)	2.96	1.36	3.0	3.9	2.9	1.4		
Area searched (km^2)	18,130	10,660	20,398	15,961	14,369	7,959	87,477	14,580
% coverage	29.3	17.2	32.9	25.8	23.2	12.9		23.5
Number of schools ON effort	8	10	10	6	22	25	81	13.5
Abundance of schools	25	58	30	23	95	384		103
%CV abundance of schools	55.4	35.9	36.1	43.4	30.8	30.6		
Encounter rate of schools	0.0013	0.0013	0.0015	0.0014	0.0044	0.0045		0.0023
%CV encounter rate	54.5	33.8	35.1	41.1	25.9	20.8		
Density of schools (1000 km^{-2})	0.402	0.938	0.490	0.372	1.531	6.198		1.655
%CV density of schools	55.4	35.9	36.1	43.4	30.8	30.6		
Mean weight (t)	131.25	122.43	194.1	160.7	133.9	98.6		140.158
%CV weight	6.2	19.2	23.8	11.7	34.9	28.4		
Mean cluster size (animals)		678.1	611	825	754	663		706
%CV abundance		27.9	26.0	11.0	33.6	23.9		
Density of animals (km^{-2})		0.636	0.299	0.307	1.155	4.110		1.301
%CV density of animals		45.4	44.5	44.7	39.7	37.2		
Total weight (t)	**3,587**	**4,371**	**3,539**	**4,712**	**12,693**	**37,861**		**11,127**
%CV total weight	56.5	46.2	40.6	42.0	40.9	40.3		
L 95% CI total weight	1,251	1,807	1,624	2,132	5,848	17,658		
U 95% CI total weight	10,285	10,577	7,710	10,414	27,551	81,183		
Total abundance (animals)		**39,399**	**18,542**	**19,002**	**71,520**	**254,552**		**80,603**
%CV total abundance		45.4	44.5	44.7	39.7	37.2		
L 95% CI total abundance		16,540	7,913	8,195	33,620	125,322		
U 95% CI total abundance		93,850	43,445	44,060	152,141	517,039		

Table 5. Results for all aerial surveys in overlap area C.

Year	2010	2011	2013	2015	2017	2018	Total (sum)	Total (mean)
Survey area (km^2)	53,868	53,868	53,868	53,868	53,868	53,868		53,868
Transect length (km)	8,487	8,826	2,791	2,739	4,911	4,832	32,586	5,431
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	2.9	1.4		
Area searched (km^2)	25,150	12,004	8,364	10,640	14,242	6,917	77,316	12,886
% coverage	46.7	22.3	15.5	19.8	26.4	12.8		23.9
Number of schools ON effort	6	10	10	3	15	8	52	8.7
Abundance of schools	12	45	64	13	57	36		38
%CV abundance of schools	45.7	33.4	34.3	62.0	28.8	45.6		
Encounter rate of schools	0.0007	0.0011	0.0036	0.0009	0.0031	0.0017		0.0016
%CV encounter rate	44.6	31.2	33.1	60.5	23.6	36.3		
Density of schools (1000 km^{-2})	0.217	0.833	1.196	0.239	1.058	0.660		0.701
%CV density of schools	45.7	33.4	34.3	62.0	28.8	45.6		
Mean weight (t)	124.17	38.87	173.5	190.0	202.5	140.8		144.967
%CV weight	5.6	44.4	22.1	19.9	21.9	58.8		
Mean cluster size (animals)	733	291	1,285	1,533	1,453	1,222		1,086
%CV abundance	36.5	30.7	17.0	19.0	17.2	39.9		
Density of animals (km^{-2})	0.182	0.242	1.536	0.366	1.539	0.807		0.779
%CV density of animals	59.2	45.3	38.3	64.9	33.3	62.8		
Total weight (t)	**1,596**	**1917**	**11,370**	**2,665**	**11,547**	**5,007**		**4,387**
%CV total weight	46.9	54.9	40.8	65.1	35.5	74.9		
L 95% CI total weight	652	661	5,161	802	5,829	1,317		
U 95% CI total weight	3,904	5,557	25,049	8,856	22,874	19,040		
Total abundance (animals)	**9,797**	**13,059**	**82,763**	**19,708**	**82,886**	**43,466**		**41,947**
%CV total abundance	59.2	45.3	38.3	64.9	33.3	62.8		
L 95% CI total abundance	3,187	5,446	39,399	5,958	43,597	13,998		
U 95% CI total abundance	30,016	31,317	173,860	65,192	157,580	140,079		

Table 6. Results for all aerial surveys in overlap area E.

Year	2010	2011	2013	2015	2017	2018	Total (sum)	Total (mean)
Survey area (km^2)	93,614	93,614	93,614	93,614	93,614	93,614		93,614
Transect length (km)	13,137	10,192	4,381	2,566	6,705	8,933	45,914	7,652
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	2.9	1.4		
Area searched (km^2)	38,930	13,862	13,129	9,969	19,445	12,788	108,121	18,020
% coverage	41.6	14.8	14.0	10.6	20.8	13.7		19.2
Number of schools ON effort	29	45	20	3	9	11	117	19.5
Abundance of schools	63	304	135	20	44	45		102
%CV abundance of schools	31.5	24.1	34.8	58.0	36.4	41.2		
Encounter rate of schools	0.0022	0.0044	0.0046	0.0008	0.0013	0.0012		0.0025
%CV encounter rate	29.9	21.0	33.6	56.3	32.4	30.9		
Density of schools (1000 km^{-2})	0.678	3.246	1.447	0.213	0.466	0.481		1.088
%CV density of schools	31.5	24.1	34.8	58.0	36.4	41.2		
Mean weight (t)	110.14	118.05	11.0	50.2	102.3	97.0		81.452
%CV weight	33.9	19.2	66.0	99.5	51.2	26.1		
Mean cluster size (animals)	1,015	1,715	361	507	848	1,013		910
%CV abundance	19.0	21.5	67.3	97.9	33.2	24.8		
Density of animals (km^{-2})	0.787	5.566	0.522	0.108	0.395	0.487		1.311
%CV density of animals	37.8	32.3	75.7	113.8	49.9	46.1		
Total weight (t)	**7,681**	**37,851**	**1,517**	**1,093**	**4,457**	**4,369**		**9,495**
%CV total weight	47.1	32.2	74.6	115.2	63.4	47.3		
L 95% CI total weight	3,155	20,342	390	75	1,413	1,798		
U 95% CI total weight	18,698	70,432	5,899	15,857	14,062	10,613		
Total abundance (animals)	**73,676**	**521,085**	**48,884**	**10,126**	**36,927**	**45,600**		**122,716**
%CV total abundance	37.8	32.3	75.7	113.8	49.9	46.1		
L 95% CI total abundance	35,741	279,620	12,363	727	14,559	19,214		
U 95% CI total abundance	151,880	971,060	193,280	141,020	93,662	107,869		

Table 7. Results for all aerial surveys in overlap area G.

Year	2010	2011	2013	2015	2017	2018	Total (sum)	Total (mean)
Survey area (km^2)	56,211		56,211	56,211	56,211	47,719		56,211
Transect length (km)	3,790		2,081	859	4,581	3,983	15,295	3,059
Effective strip width x2 (km)	2.96		3.00	3.9	2.9	1.4		
Area searched (km^2)	11,231		6,236	3,335	13,215	5,702	39,789	7,958
% coverage	20.0		11.1	5.9	23.5	11.9		14.5
Number of schools ON effort	33		12	2	45	23	115	23
Abundance of schools	150		108	22	191	103		115
%CV abundance of schools	28.1		39.7	70.9	23.5	30.7		
Encounter rate of schools	0.0087		0.0058	0.0015	0.0098	0.0058		0.0075
%CV encounter rate	26.3		38.7	69.5	16.6	23.0		
Density of schools (1000 km^{-2})	2.674		1.924	0.399	3.398	2.163		2.111
%CV density of schools	28.1		39.7	70.9	23.5	30.7		
Mean weight (t)	63.621		4.0	9.0	16.5	6.9		19.996
%CV weight	12.7		40.2	66.7	31.5	46.6		
Mean cluster size (animals)			336	600	809	208		488
%CV abundance			36.7	66.7	31.9	39.3		
Density of animals (km^{-2})			0.646	0.239	2.756	0.450		1.023
%CV density of animals			54.1	97.3	40.1	48.5		
Total weight (t)	**10,507**		**440**	**220**	**3,157**	**709**		**3,007**
%CV total weight	32.1		56.5	97.3	39.3	53.1		
L 95% CI total weight	5,643		151	25	1,495	365		
U 95% CI total weight	19,561		1,285	1,965	6,669	1,897		
Total abundance (animals)			**36,316**	**13,448**	**154,939**	**21,474**		**56,544**
%CV total abundance			54.1	97.3	40.1	48.5		
L 95% CI total abundance			12,995	1,506	72,366	8,092		
U 95% CI total abundance			101,490	120,070	331,731	51,779		

Table 8. Results for all aerial surveys in all areas combined.

Year	2010	2011	2013	2015	2017	2018	Total (sum)	Total (mean)
Survey area (km^2)	265,627	209,416	265,627	265,627	265,627	257,135		265,627
Transect length (km)	31,532	26,856	16,060	10,272	21,178	23,308	129,206	21,534
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	2.9	1.4		2.6
Area searched (km^2)	93,442	36,525	48,127	39,904	61,096	33,365	334,307	52.08
% coverage	35.2	17.4	18.1	15.0	23.0	13.0		20.3
Number of schools ON effort	76	65	52	14	91	67	365	60.8
Abundance of schools	250	388	338	78	387	568		335
%CV abundance of schools	22.8	19.9	21.5	38.9	20.2	22.5		
Encounter rate of schools	0.0024	0.0024	0.0032	0.0014	0.0043	0.0029		0.0028
%CV encounter rate				20.2	11.6	13.6		
Density of schools (1000 km^{-2})	0.942	1.852	1.274	0.295	1.457	2.208		1.261
%CV density of schools	22.8	19.9	21.5	38.9	23.4	22.5		
Mean weight (t)	87.9	101.1	22.6	272.2	82.3	84.5		**108.420**
%CV weight	16.8	27.5	51.0	41.4	19.2	24.4		
Mean cluster size (animals)	791	1,275	582	1,548	895	643		**956**
%CV abundance	18.6	37.3	18.5	40.5	17.0	18.5		
Density of animals (km^{-2})		**2.7388**	**0.702**	**0.234**	**1.304**	1.420		**1.161**
%CV density of animals		29.9	29.4	39.1	25.9	28.4		
Total weight (t)	**23,371**	**44,139**	**16,866**	**8,690**	**31,855**	**47,946**		**28,811**
%CV total weight	25.6	28.7	30.3	35.3	26.7	33.4		
L 95% CI total weight	14,243	25,315	9,343	4,398	19,018	25,283		
U 95% CI total weight	38,347	76,964	30,447	17,169	53,355	90,921		
Total abundance (animals)		**573,543**	**186,505**	**62,284**	**346,272**	**365,091**		**269,528**
%CV total abundance		29.9	29.4	39.1	25.9	28.4		
L 95% CI total abundance		321,620	105,320	28,766	209,816	211,128		
U 95% CI total abundance		1,022,800	330,270	134,860	571,473	631,334		

Table 9. Number of tags deployed within Phase 7.

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Canada	431	0	431	0	0	0
Bay of Biscay	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.	20	20	0	0	0	0
Central Med.	300	224	76	0	0	0
East Med.	0	0	0	0	0	0
North Sea	34	16	0	18	0	0
	831	**266**	**507**	**58**	**0**	**0**

Table 10. Complementary conventional tagging – Spaghetti tags delivered so far in the Phase 8.

Quantity	Institution	Country
1000	The Italian Federation Sport Fishing (FIPSAS)	ITALY
1000	Government of Canada (Fisheries and Oceans)	CANADA
50	Marine Institute	IRELAND
150	Associacio Catalana per a una Pesca Responsable (ACPR)	ESPAÑA
150	WWF Mediterranean Marine Initiative	ITALY
25	National Institute of Fisheries Science	KOREA
50	Institute of Marine Research	NORWAY
250	Technical University of Denmark	DENMARK

Table 11. Number of tags deployed so far within Phase 8.

	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	0	0	0	0	0	0
Morocco	0	0	0	0	0	0
Portugal	60	30	0	30	0	0
Strait of Gibraltar	0	0	0	0	0	0
West Med.	0	0	0	0	0	0
Central Med.	11	11	0	0	0	0
East Med.	0	0	0	0	0	0
North Sea	0	0	0	0	0	0
	71	**41**	**0**	**30**	**0**	**0**

Table 12. Geographical distribution of the areas where the tag recoveries occurred, in numbers and percent, by type of tag (up to 1 September 2018).

Fishing Area / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Acoustic Tags	Commercial Tags	Grand Total	%
East Atl	85	46	13	1		1	146	19,44
Med	327	150	11	15	4		507	67,51
North Atl	26	21	6			2	55	7,32
West Atl	11	26		1		1	39	5,19
Unknown			4				4	0,53
Grand Total	449	243	34	17	4	4	751	100
%ge	59,8%	32,4%	4,5%	2,3%	0,5%	100,0%	100,0%	

Table 13. 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	0,40
2011	8		1				9	1,20
2012	36	7	6	1		1	51	6,79
2013	60	28	9	2		1	100	13,32
2014	72	30	1	3		2	108	14,38
2015	68	46	3	3	1		121	16,11
2016	99	56	4	3	1		163	21,70
2017	83	65	5	3	2		158	21,04
2018	20	11	3	2			36	4,79
Undefined (2012 or 2013)			2				2	0,27
Grand Total	449	243	34	17	4	4	751	100

Table 14. Number of bluefin tuna sampled in Phase 7 by area and size class.

		Age 0	Juveniles	Medium	Large	Total
		<3 kg	3-25 kg	25-100 kg	>100 kg	
Eastern Mediterranean	Levantine Sea	358		130	248	736
Central Mediterranean	East Sicily and Ionian	52				52
	Malta	2			435	437
Western Mediterranean	Balearics		1	19	887	907
	Ligurian Sea	17	2	29		48
	Sardinia		1	80	135	216
	Tyrrhenian Sea	83			187	270
Gibraltar	Gibraltar	100		109	3	212
Northeast Atlantic	Portugal (Algarve)				30	30
Central North Atlantic	Central and North Atlantic				384	384
North Sea	Norway				241	241
	TOTAL	**612**	**4**	**367**	**2550**	**3533**

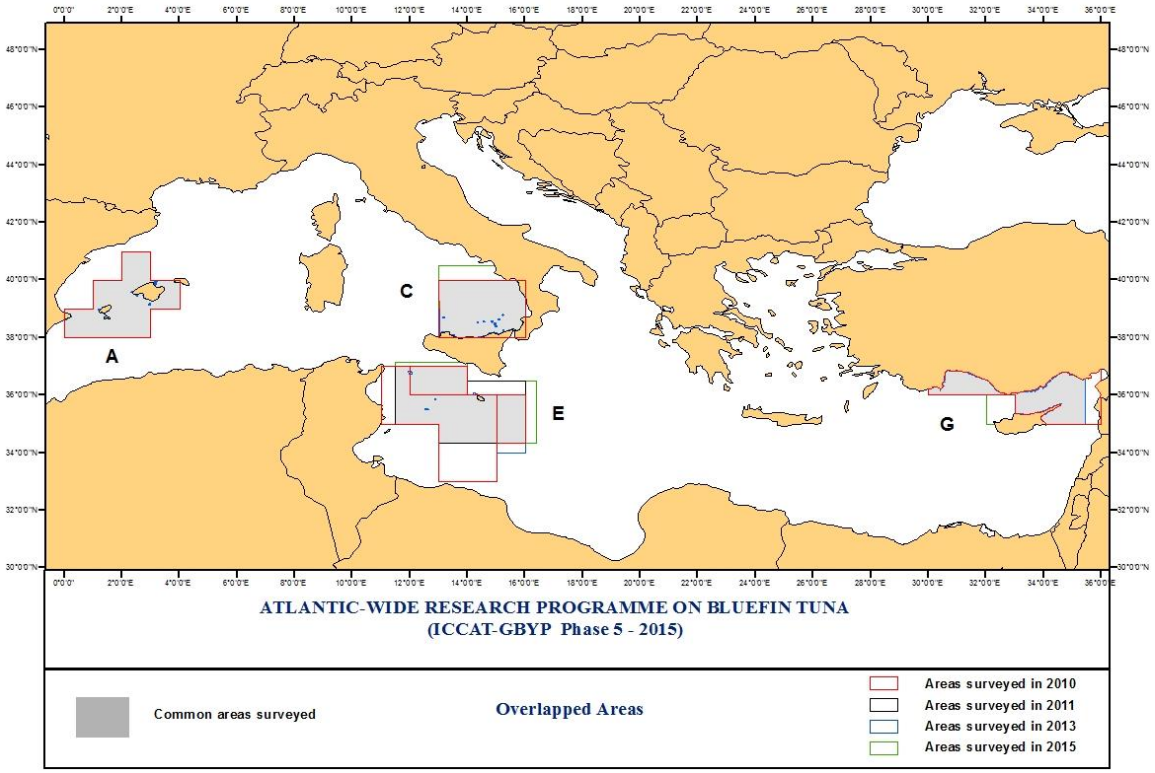

Figure 1. Overlapped areas for four GBYP aerial surveys (2010-2015). The same areas were surveyed in 2017 and 2018.

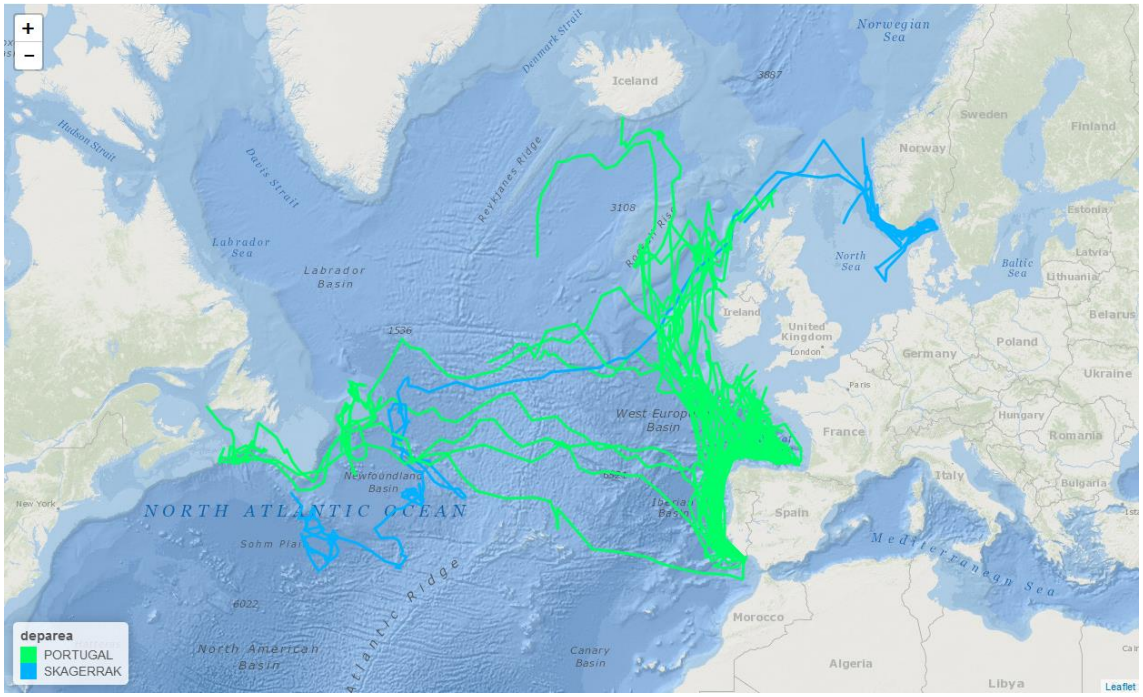

Figure 2. Available tracks from the electronic tags deployed within GBYP Phase 7.

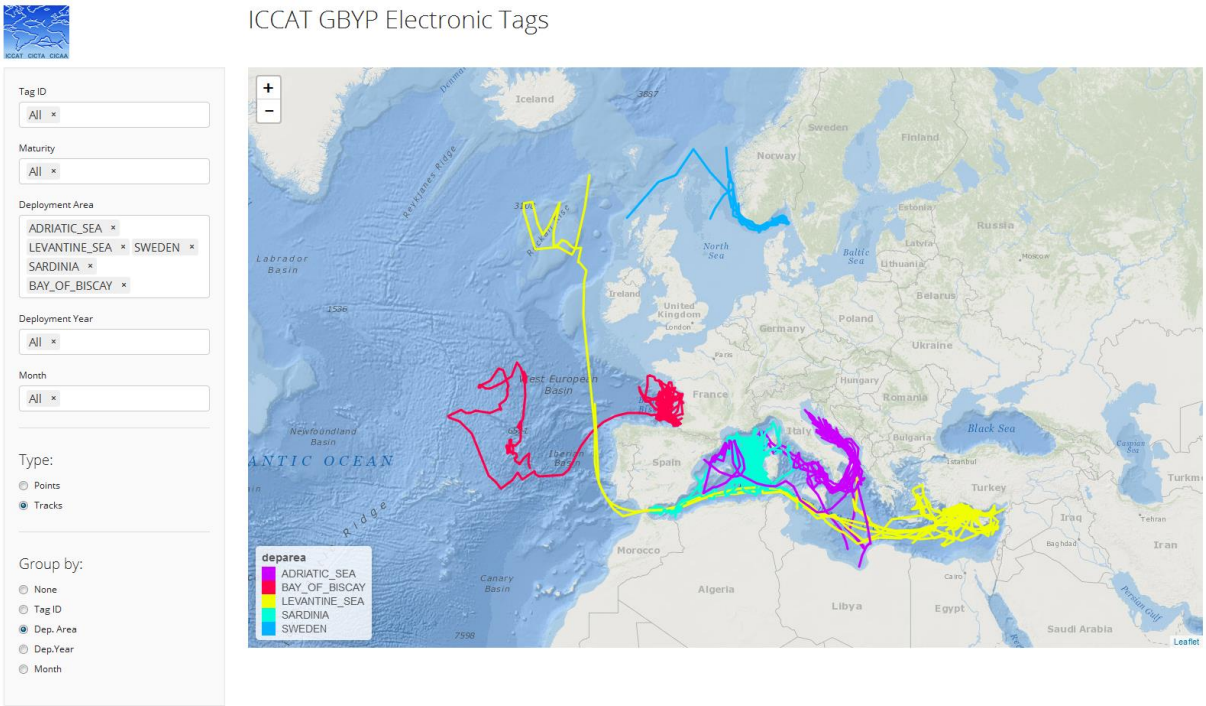

Figure 3. The interface of the ICCAT GBYP Electronic Tags Shiny Application.

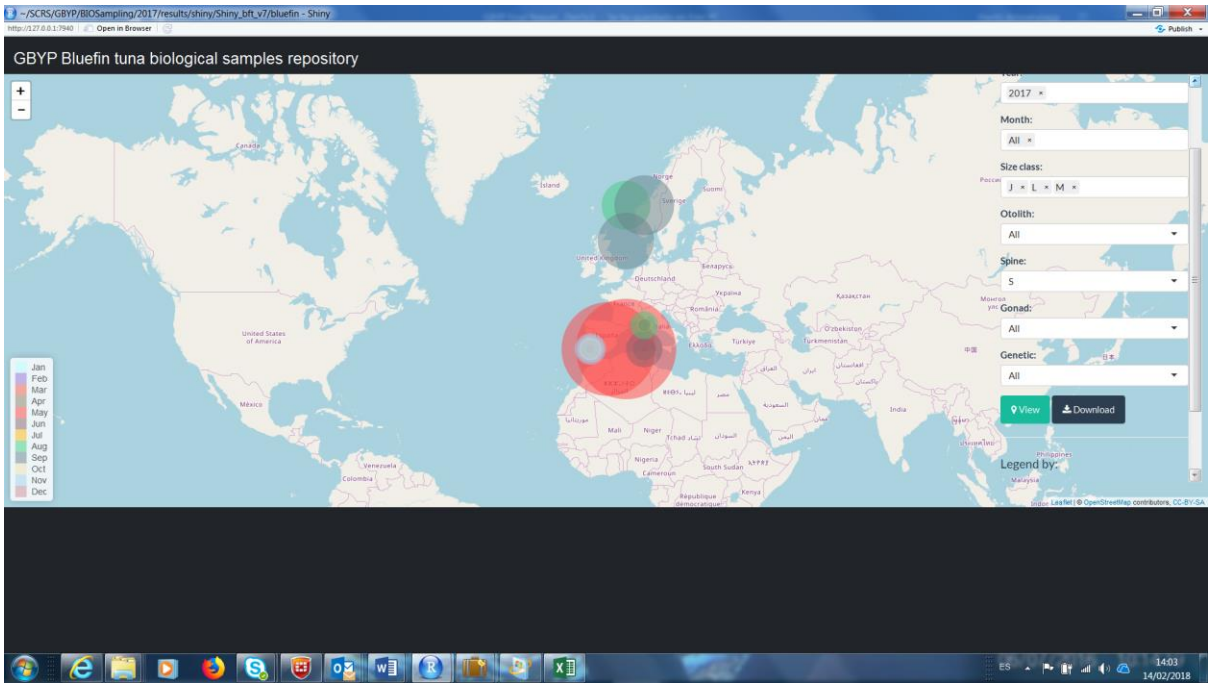

Figure 4. Shiny application developed to visualize available biological samples in the GBYP Tissue Bank.

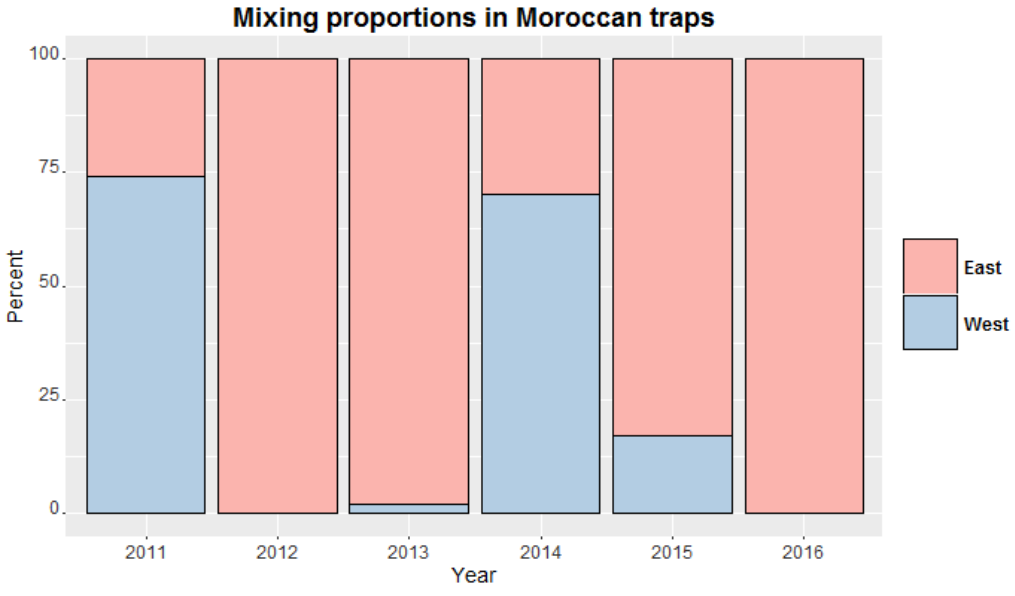

Figure 5. Interannual variation of the mixing proportions in the western African coast (Moroccan traps) estimated by Maximum Likelihood Estimator (HISEA program).

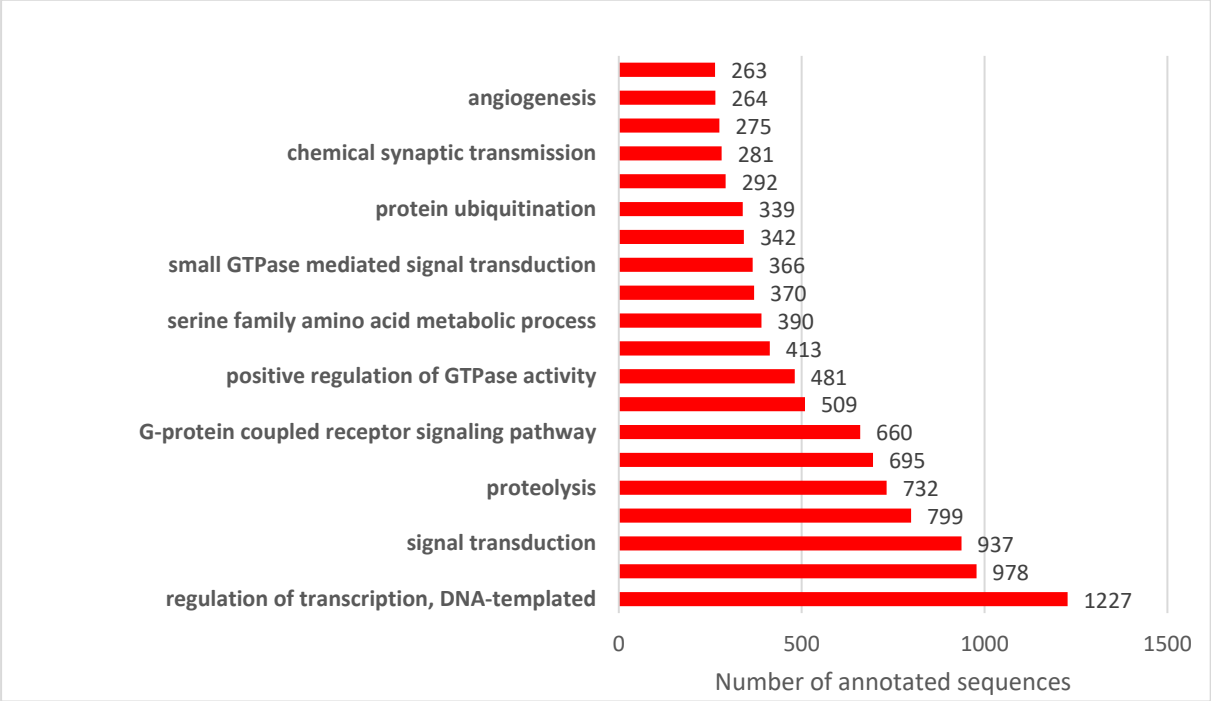

Figure 6. Distribution of the 20 most abundant GO biological processes annotated on BFT protein sequences using homology-based approaches.

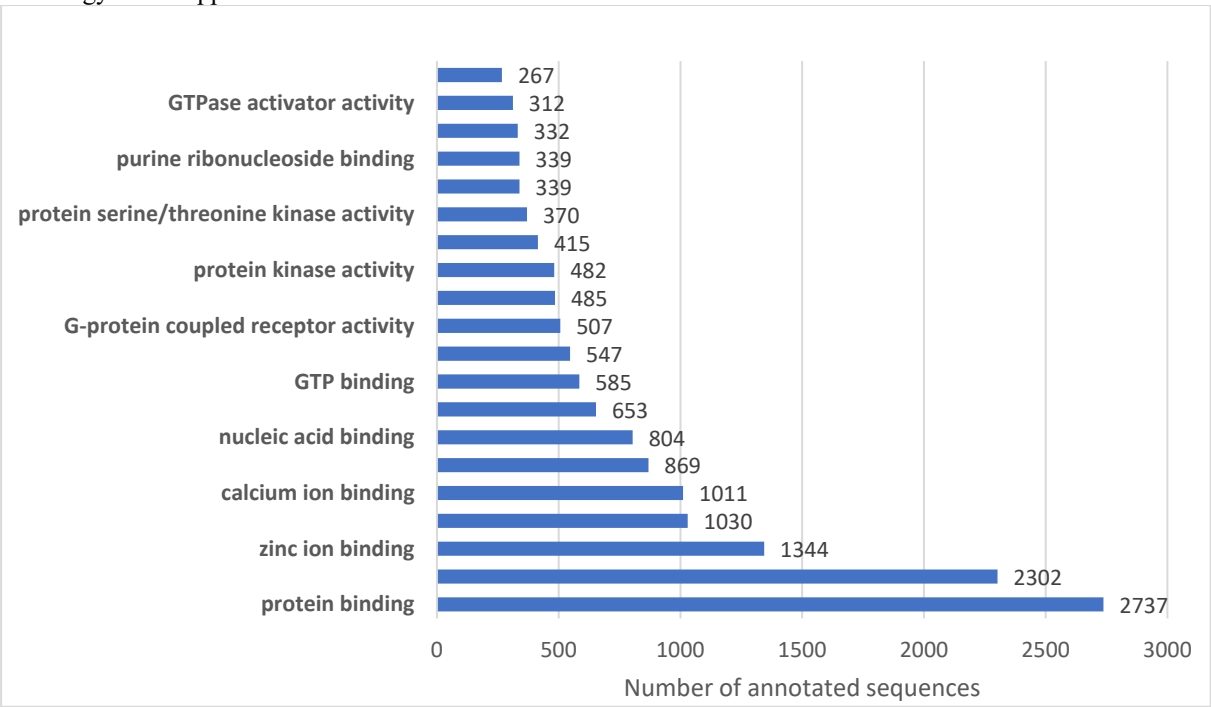

Figure 7. Distribution of the 20 most abundant GO molecular functions annotated on BFT protein sequences using homology-based approaches.

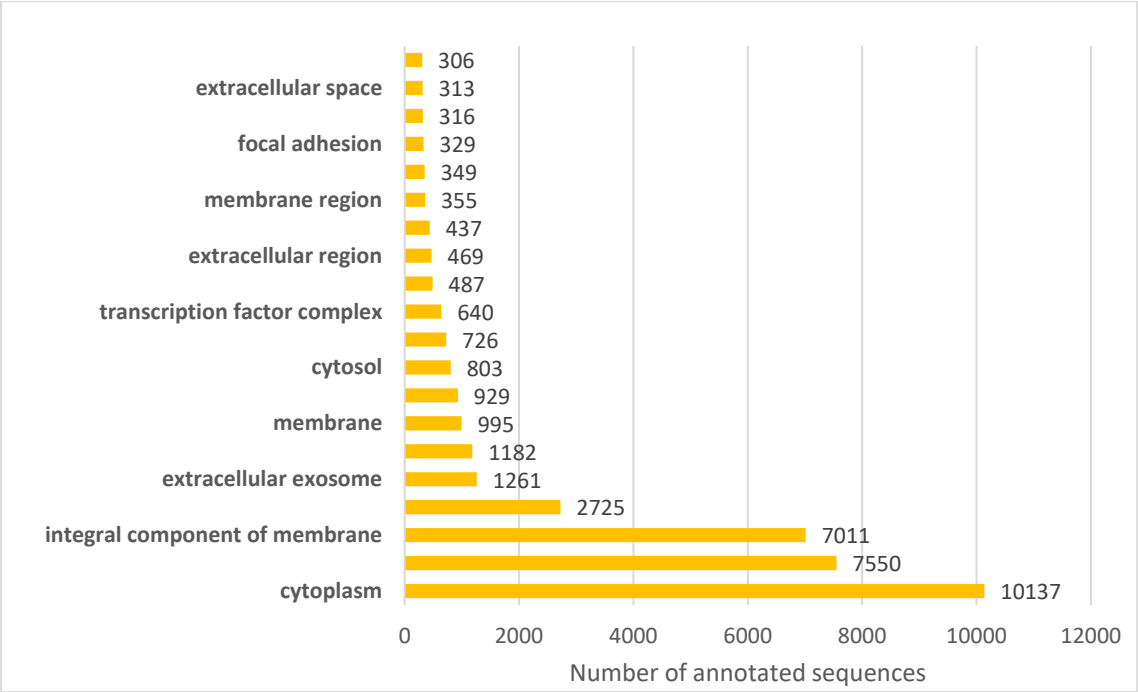

Figure 8. Distribution of the 20 most abundant GO cellular components annotated on BFT protein sequences either by homology-based approaches or predictive tools.

Figure 9. Example of an image of an otolith section with the first Apex indication and zones marked.

Row Labels	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Grand Total
15	1																					1
20	4																					4
25	9																					9
30	10																					10
35	5																					5
40	33	1																				34
45	19																					19
50	21																					21
55	8	43	1																			52
60		44	1																			45
65		6	1																			7
70		5	3																			8
75		12	17																			29
80		9	21	1		1																32
85			14	1																		15
90			9	1																		10
95			11	6																		17
100			16	27	3																	46
105			4	27	4																	35
110			5	21	7	1																34
115			1	18	22	11	2	1														55
120				8	11	17	3	1														40
125				1	10	12	4		4													31
130				1	9	14	11	1	1													37
135				1	2	8	4							1								16
140				1	3	5	2	4		1												16
145					10	8			3													21
150					7	7	2	1				1										18
155					7	13	3	1	1													25
160					1	5	3	3	2	1												15
165						1	5	1	2													9
170						2		4	2													8
175						1	1	4	2			1										9
180							1	9	4				1									15
185							1	17	15	1												34
190							2	9	23	5	2	2	1									44
195							1	7	20	25	9	2										64
200								5	27	22	12	9	1		2							78
205								3	21	26	26	12	7	2								97
210					1				6	29	30	21	6	3		2						98
215								1	6	28	28	23	9	3	1							99
220								1	5	27	31	26	23	5	3		2					123
225									2	15	31	42	29	9	2	2						132
230									2	6	17	44	37	18	7							131
235									2	6	11	28	57	12	4	2						122
240										3	10	27	31	9	4	4	1	2				91
245											5	8	21	9	2	2						47
250										1	4	6	8	11	2	3	1					36
255											1	1	3	2	2	5		1	2			17
260													3		3		2		1		1	10
265											1			1			1					3
270																			1			1
275												1										1
Grand Total	110	120	104	114	97	106	45	73	150	196	218	254	237	85	32	20	7	3	4		1	1976

Figure 10. Age length key developed by reading of 1976 otoliths by Fish Ageing Services in 2017.

Figure 11. Transversal section of the YOY otolith with visible daily rings.

ABTMSE-package {ABTMSE} R Documentation

Atlantic Bluefin Tuna Management Strategy Evaluation

Description

Testing management systems for Atlantic Bluefin Tuna

Details

Package: ABTMSE
Type: Package
Version: 2.3
Date: 2018-01-08
License: GPL-2
Depends: methods

Author(s)

Tom Carruthers <t.carruthers@fisheries.ubc.ca>

References

http://www.iccat.int/Documents/CVSP/CV072_2016/n_7/CV07201782.pdf
http://www.iccat.int/Documents/CVSP/CV072_2016/n_7/CV07201796.pdf

Examples

```
library(ABTMSE)
loadABT()
sfInit(parallel=TRUE,cpus=detectCores())   # initiate the cluster
#myMSE<-new('MSE',OM_example,Bad_Obs,MPs=list(c("MeanC","MeanC")))
plot(myMSE)
getperf(myMSE)
Tplot(myMSE)
sfStop()
```

ABT-MSE: Atlantic Bluefin Tuna Management Strategy Evaluation (v2.3)

ICCAT Atlantic Wide Research Programme for Bluefin Tuna (GBYP)

Tom Carruthers (t.carruthers@fisheries.ubc.ca)

2018-01-29

Figure 12. (a) Complete R package for MP testing ABT-MSE with (b) Package ABT-MSE user guide.

Annex 1a

GBYP contracts issued in Phase 7

ICCAT-GBYP CONTRACTS (PHASE 7)								
ICCAT GBYP DATA RECOVERY								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
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**		**COST €**	**NOTES**
					initial date	**final date**		
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	164.398,03 €	
		02/2017	*Aerial Survey* - Unimar-Italy and Aerial Banners-Italy	Adriano Mariani, e-mail: a.mariani@unimar.it	19/05/2017	19/07/2017	71.779,41 €	
		02/2017	*Aerial Survey* - Action Air Environnement - France	Alexis Giordana, e-mail: agiordana@action-air.net	15/05/2017	19/07/2017	119.699,18 €	
		cost reimbursement	*Aerial Survey Training Course*		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**		**COST €**	**NOTES**
					initial date	**final date**		
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	60.282,89 €	
		07/2017	*Tagging programme (Area B)* - Tunipex S.A. - Portugal, as leader of consortium including one more Portuguese institution	Alfredo Poço, e-mail: alfredo@tunipex.eu	11/07/2017	28/12/2017	43.500,00 €	
		purchase order	*Tagging awareness campaign* - Refurbishment of T-shirts - Fun Fashion - Spain	Juan Carlos Vázquez, e-mail: funfashiont@gmail.com	14/12/2017	15/02/2018	3.582,00 €	
		purchase order	*Tagging programme* - Purchase of conventional tags - Floy Tag & Manufacturing - USA	Betsy Amick, e-mail: betsy@floytag.com	15/12/2017		5.896,54 €	Original cost $ 6.725
ICCAT GBYP BIOLOGICAL SAMPLING AND ANALYSES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
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	95.940,66 €	
		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	34.745,20 €	
		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	66.343,10 €	Original cost AU$ 97.580
		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	132.470,32 €	
		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	109.369,25 €	
		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	42.104,38 €	
		cost reimbursement	*ICCAT GBYP Planning Workshop on BFT Reproductive Biology*		14/02/2018	15/02/2018	11.688,11 €	
ICCAT GBYP MODELLING APPROACHES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
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		15/05/2017	19/05/2017	3.602,12 €	
		cost reimbursement	*ICCAT GBYP Core Modelling and MSE group* meeting		19/07/2017	23/07/2017	4.382,80 €	

Annex 1b

GBYP contracts issued in the first part of Phase 8

ICCAT-GBYP CONTRACTS (PHASE 8)								
ICCAT GBYP COORDINATION								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
8	2018-2019	01/2018	*Steering Committee External Expert* - Ivan Katavic - Croatia	Ivan Katavic, e-mail: katavic@izor.hr	16/03/2018	20/02/2019	15.000,00 €	
ICCAT GBYP DATA RECOVERY								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
8	2018-2019	08/2018	Data recovery plan - Antonia Mangano - Italy	Antonia Mangano, e-mail: antonia.mangano@libero.it	18/07/2018	01/09/2018	9.800,00 €	
		09/2018	Electronic tags data recovery - Stanford University, USA	Barbara Block, e-mail: bblock@stanford.edu	31/08/2018	30/09/2018	8.000,00 €	
ICCAT GBYP AERIAL SURVEY								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
8	2018-2019	02/2018	*Aerial survey data elaboration* - Alnilam - Spain	Ana Cañadas, e-mail: anacanadas@alnilam.com.es	27/04/2018	20/02/2018	22.275,00 €	
		03/2018	*Aerial Survey* - Grup Air-Med - Spain	Francisco Javier Hevia Bousoño, e-mail: javier@grupairmed.com	18/05/2018	18/07/2018	116.690,00 €	
		03/2018	*Aerial Survey* - Unimar-Italy and Aerial Banners-Italy	Adriano Mariani, e-mail: a.mariani@unimar.it	16/05/2018	18/07/2018	187.208,00 €	
		03/2018	*Aerial Survey* - Action Air Environnement - France	Alexis Giordana, e-mail: agiordana@action-air.net	27/04/2018	18/07/2018	141.414,00 €	
		cost reimbursement	*Aerial Survey Training Course*	Francisco Alemany, e-mail: francisco.alemany@iccat.int	16/05/2018	16/05/2018	9.545,55 €	
ICCAT GBYP TAGGING PROGRAMME								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
8	2018-2019	07/2018	*Tagging programme (Area A)* - The Marine Institute - Ireland	Paul L. Conolly, e-mail: Paul.Connolly@Marine.ie	30/07/2018	04/12/2018	25.280,00 €	
		07/2018	*Tagging programme (Area B)* - Tunipex S.A. - Portugal	Alfredo Poço, e-mail: alfredo@tunipex.eu	03/08/2018	04/12/2018	44.500,00 €	
ICCAT GBYP BIOLOGICAL SAMPLING AND ANALYSES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
8	2018-2019	04/2018	*Sampling for BFT adults* - AquaBioTech Ltd - Malta	Simeon Deguara, e-mail:dsd@aquabt.com	06/06/2018	10/02/2019	88.300,00 €	
		04/2018	*Sampling for BFT adults* - Taxon Estudios Ambientales S.L. - Spain	Antonio Belmonte Ríos, e-mail: antonio.belmonte@taxon.es	01/06/2018	10/02/2019	40.000,00 €	
		06/2018	*Biological studies* - Fundación AZTI - Spain, as leader of a Consortium including 8 more institutions (2 Italy (1 w/o budget), 2 Spain, 1 USA (w/o budget), 1 Ireland, 1 Japan (w/o budget), 1 France (w/o budget) (+ 4 subcontracts: 1 Norway, 1 Portugal, 1 USA, 1 Spain)	Haritz Arrizabalaga, e-mail: harri@azti.es	27/06/2018	10/02/2019	217.507,00 €	
		06/2018	*Biological studies* - University of Bologna - Italy, as leader of a Consortium including 2 more institutions (1 Italy - w/o budget, 1 Canada-w/o budget)	Alessia Cariani, e-mail: alessia.cariani@unibo.it	18/07/2018	10/02/2019	44.000,00 €	
		10/2018	*Bluefin tuna E/W spawning stock differences - CSIRO, Australia*	Jessica Farley, e-mail: jessica.farley@csiro.au	16/08/2018	28/11/2018	6.000,00 €	
		10/2018	*Bluefin tuna E/W spawning stock difference*- Seikai-NFRI, Japan	Seiji Oshimo, e-mail: oshimo@affrc.go.jp	31/08/2018	28/11/2018	6.000,00 €	
ICCAT GBYP MODELLING APPROACHES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
8	2018-2019	05/2018	*Modelling Approaches: Support to Bluefin Tuna Stock Assessment* - Blue Matter Science - Canada	Thomas Robert Carruthers, e-mail: t.carruthers@fisheries.ubc.ca	26/04/2018	20/02/2019	115.000,00 €	

Annex 2a

List of reports and scientific papers in GBYP Phase 7

List of deliverables produced within the framework of GBYP contracts and activities in Phase 7. Interim reports and software products, which are not included in the GBYP annual final reports nor are available directly through GBYP web page, being only available upon request, are marked in yellow.

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 – May 2017. Sampling strata and needs for Biological studies in Phase 7. GBYP Coordination: 1-2.
18. Biological studies – 28 June 2017. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Short report.Taxon Estudios Ambientales SL: 1-7.
19. Biological studies – 11 October 2017. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Short report.Taxon Estudios Ambientales SL: 1-9.
20. Biological studies – 14 December 2017. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Short report.Taxon Estudios Ambientales SL: 1-9.
21. Biological studies – 2 February 2018. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Final report.Taxon Estudios Ambientales SL: 1-50.

22. 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.
23. Biological studies – 18 September 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Short report. Balfegó & Balfegó SL: 1-3.
24. Biological studies – 29 January 2018: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Short report. Balfegó & Balfegó SL: 1-3.
25. Biological studies – 6 February 2018: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Final report. Balfegó & Balfegó SL: 1-3.
26. Biological studies – 16 June 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1.
27. Biological studies – 15 September 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1-3.
28. Biological studies –21 November 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1.
29. Biological studies –7 February 2018: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Final report. AquaBiotech Ltd: 1-9.
30. Biological studies – 19 September 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-1), Short report. Consortium represented by AZTI: 1-7.
31. Biological studies –6 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-1), Short report. Consortium represented by AZTI: 1-8.
32. Biological studies –15 February 2018. Short term contract for biological studies (ICCAT GBYP 08/2017-1), Final report. Consortium represented by AZTI: 1-36.
33. Biological studies – 31 August 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Short report. Consortium represented by University of Bologna: 1-8.
34. Biological studies –20 September 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Short report. Consortium represented by University of Bologna: 1-19.
35. Biological studies –7 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Short report. Consortium represented by University of Bologna: 1-21.
36. Biological studies –8 February 2018. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Final report. Consortium represented by University of Bologna: 1-33.
37. Biological studies – 29 September 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Short report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-4.
38. Biological studies – 6 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Short report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-6.
39. Biological studies – 6 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Short report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-6.
40. Biological studies – 12 February 2018. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Final report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-9.
41. Biological studies – 15 February 2018. Report of the ICCAT GBYP Planning Workshop on the Bluefin Tuna Reproductive Biology, provided as SCRS/2018/013, Anon.: 1-12.
42. Coordination –08 March 2017: ICCAT GBYP Steering Committee Meeting, Report, 1-5.
43. Coordination –15 February 2018: ICCAT GBYP Steering Committee Meeting, Report, 1-14.
44. Data recovery – 23 May 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017a), Preliminary short report. Necton: 1-1.
45. Data recovery – 4 July 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017a), Final report. Necton: 1-4.
46. Data recovery – 7 July 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017b), Final report. Ricerca Mare Pesca: 1.
47. Meetings – March 2017, ICCAT Bluefin tuna data preparatory meeting 2017, Report, Anon: 1-60.
48. Meetings – July 2017, ICCAT Bluefin tuna stock assessment meeting, Report, Anon: 1-106.
49. Meetings – July 2017, ICCAT Bluefin tuna stock assessment meeting, Addendum to the Report, presented as SCRS/2017/188. Anon: 1-6.
50. Meetings – October 2017, Standing Committee on Research and Statistics (SCRS), Report, Anon: 1-465.
51. Modelling approaches – 11 March 2017: ICCAT GBYP Core Modelling and MSE Group, Fourth Meeting, Report. Anon: 1:4.
52. Modelling approaches – July 2017: ICCAT GBYP Core Modelling and MSE Group, Fifth Meeting, Report. Anon: 1:7.
53. Modelling approaches – September 2017: ICCAT GBYP Core Modelling and MSE Group, Sixth Meeting, Report. Anon: 1:39.

54. 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, A. *et.al*: 1-19.
55. Modelling approaches– 17 July 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Progress report 6 including workplan. Tom Carruthers: 1-6.
56. Modelling approaches– 9 October 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Progress report 7. Tom Carruthers: 1-4.
57. Modelling approaches– 17 November 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Progress report 8. Tom Carruthers: 1-4.
58. Modelling approaches– 17 November 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Final report. Tom Carruthers: 1-13.
59. Tagging – 17 August 2017: Short term contract for the Tagging programme 2017 (Area A) (ICCAT GBYP 07/2017), Progress report. Tunipex, S.A: 1-21.
60. Tagging – 19 October 2017: Short term contract for the Tagging programme 2017 (Area A) (ICCAT GBYP 07/2017), Final report. Tunipex, S.A: 1-21.
61. 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.
62. Tagging – 29 November 2017: Short term contract for the Tagging programme 2017 (Area C) (ICCAT GBYP 04/2017), Final report. The consortium represented by the Technical University of Denmark, S.A: 1-18.
63. Complementary activities - 14 February 2018: Biological response of bluefin tuna (*Thunnus thynnus*) to recreational sport fishing by catch and release. Institute of Oceanography and Fisheries (IZOR): 1-6.

List of Scientific Papers – Phase 7

1. Anonymous, 2017, Report of the ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (ICCAT GBYP), Activity report for the last part of Phase 6 and the first part of Phase 7 (2016-2017), including a general overview of the activities up to 2017. SCI-037/2017
2. Ben Mhamed, A., Nielsen, A., Kell, L., 2017, Eastern bluefin tuna stock assessment using SAM. SCRS/2017/146
3. Cañadas, A., Cañadas, A., Aguilar de Soto, N., Aissi, M., Arcangeli, A., Azzolin, M., B-Nagy, A., Bearzi, G., Campana, I., Chicote, C., Cotte, C., Crosti, R., David, L., Di Natale, A., Fortuna, C., Frantzis, A., Garcia, P., Gazo, M., Gutierrez-Xarxa, R., Holcer, D., Laran, S., Lauriano, G., Lewis, T., Moulins, A., Mussi, B., Notarbartolo di Sciara, G., Panigada, S., Pastor, X., Politi, E., Pulcini, M., Raga, J.A., Rendell, L., Rosso, M., Tepsich, P., Tomás, J., Tringali, M., Roger, Th., 2018, The challenge of habitat modelling for threatened low density species using heterogeneous data: The case of Cuvier's beaked whales in the Mediterranean. In Ecological Indicators, Volume 85, 2018, Pages 128-136, ISSN 1470-160X, https://doi.org/10.1016/j.ecolind.2017.10.021.(http://www.sciencedirect.com/science/article/pii/S1470160X17306581)
4. Carruthers, T., Butterworth, D., 2017, ABT-MSE: An R package for Atlantic bluefin tuna management strategy evaluation. SCRS/2017/225
5. Carruthers, T., Butterworth, D., 2017, Performance of example management procedures for Atlantic bluefin tuna. SCRS/2017/224
6. Carruthers, T., Butterworth, D., 2017, Summary of the reference set of conditioned operating model for Atlantic bluefin tuna. SCRS/2017/223
7. Carruthers, T., Di Natale, A., Lauretta, M., Pagá García, A., Tensek, S., 2017, Migratory behaviour of Atlantic bluefin tuna entering the Mediterranean. SCRS/2017/131
8. Di Natale, A., 2017, An updated bibliography on bluefin tuna trap fishery. SCRS/2017/119
9. Di Natale, A., Cañadas, A., Vázques-Bonales, J.A., Tensek, S., Pagá García, A., 2017, Report of the ICCAT GBYP Aerial survey for bluefin spawning aggregations in 2017. SCRS/2017/149
10. Di Natale, A., Lino, P.G., López Gonzalez, J.A., Neves dos Santos, M., Pagá García, A., Piccinetti, C., Tensek, S., 2017, Unusual presence of small bluefin tuna YOY in the Atlantic ocean and in other areas. SCRS/2017/216
11. 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 6 and the first part of the Phase 7. SCRS/2017/139
12. Di Natale, A., Tensek, S., Pagá García, A., 2017, Report on the use of Research Mortality Allowance by ICCAT GBYP in 2012-2016 and the first part of 2017. SCRS/2017/208
13. Kell, L., Ben Mhamed, A., Rouyer, T., Kimoto, A., 2017, An evaluation of bias and prediction skill for the east Atlantic bluefin stock assessment. SCRS/2017/124
14. Kerr, L.A., Morse, M.R., Cadrin, S.X., Galuardi, B., 2017, Application of an Atlantic bluefin tuna operating model to generate pseudodata for stock assessment testing. SCRS/2017/177
15. Macias, D., Palma, C., Rodriguez-Marín, E., 2017, Revision of Atlantic bluefin tuna Task I nominal catches from Spain. SCRS/2017/169

16. Morse, M.R, Cadrin, S., Kerr, L., Secor, D., Siskey, M., Arrizabalaga, H., Hanke, A., Porch, C., 2017, An updated analysis of bluefin tuna stock mixing. SCRS/2017/190
17. Morse, M.R., Kerr, L.A, Cadrin, S.X, 2017, Simulating Virtual population analysis of mixed Atlantic bluefin tuna stocks. SCRS/2017/178
18. Ortiz, M. and Palma, C., 2017, Review and preliminary analyses of size frequency samples of bluefin tuna (Thunnus thynnus). SCRS/2017/166
19. Pagá-García, A., Di Natale, A., Tensek, S., 2017, Overview of the bluefin tuna data recovery by GBYP in last part of Phase 6 and the first part of Phase 7. SCRS/2017/191
20. Rodriguez-Marin, E., Quelle, P., Ruiz, M., Ceballos, E., Aillound, L.E., 2017, Direct ageing for constructing age-length keys and reestimation the growth curve for East Atlantic and Mediterranean bluefin tuna. SCRS/2017/170
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22. Apostolaki, P., Pearce, J., Barbari, A., Beddington, J., 2017, Alternative Catch Estimates From Market and Third Party Data. SCRS/2017/013
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24. Fraile, I., Arrizabalaga, H., Kimoto, A., Itoh, T., Abid, N., Rodriguez-Marín, E., Rooker, J., 2017, Estimating the contribution of Atlantic bluefin tuna subpopulations in the north Atlantic ocean over the last 6 years. SCRS/026/2017
25. 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., 2017, Genetic assignment of Atlantic bluefin tuna feeding aggregations to spawning grounds. SCRS/2017/027.
26. 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., 2017, Integrated analysis for Atlantic bluefin tuna origin assignment. SCRS/2017/028
27. Vidal Bonavila, J., 2017, Las Almadrabas de Corona de Aragon en los Siglos XVI y XVII. SCRS/2017/031
28. Di Natale, A., 2017, Tentative recovery of historical bluefin tuna catches in the Black Sea: the Bulgarian catches 1950-1971.SCRS/2017/039.
29. 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., 2017, Another Peculiar Situation For YOY Of Bluefin Tuna (Thunnus thynnus) In The Mediterranean Sea In 2016. SCRS/2017/040.
30. Di Natale, A., Tensek, S., Pagá García, A., 2017, The Disappearance of Young-Of-The-Year Bluefin Tuna from the Mediterranean Coast in 2016: Is It an Effect of the Climate Change? SCRS/2017/041.
31. Tensek, S., Pagá García, A., Di Natale, A., 2017, ICCAT GBYP Tagging Activities In Phase 6. SCRS/2017/042.
32. Pagá García, A., Di Natale, A., Tensek, S., 2017, Historical and Recent Data of Sicilian Traps: The Complexity of Data Recovery and Interpretation. SCRS/2017/043.
33. Galuardi, B., Cadrin, S.X., Arregi, I., Arrizabalaga, H., Di Natale, A., Brown, C., Lauretta, M., Lutcavage, M., 2017, Atlantic Bluefin Tuna Area Transition Matrices Estimated From Electronic Tagging and SatTagSim. SCRS/2017/045.

Annex 2b

List of reports and scientific papers in the first part of GBYP Phase 8

List of deliverables produced within the framework of GBYP contracts and activities in the first half of Phase 8Phase 7. Interim reports and software products, which are not included in the GBYP annual final reports nor are available directly through GBYP web page, being only available upon request, are marked in yellow.

1. Aerial Survey – 15 May 2018: Short term contract for aerial survey training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 02/2018), Aerial survey protocol. Alnilam Research and Conservation Ltd: 1-17.
2. Aerial Survey – 15 May 2018: Short term contract for aerial survey training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 02/2018), Aerial survey forms. Alnilam Research and Conservation Ltd: 1-3.
3. Aerial Survey – 16 May 2018: ICCAT GBYP Administrative rules for the Aerial survey, Presentation for the Training Course. ICCAT GBYP Coordination: 1-14.
4. Aerial Survey – 16 May 2018: ICCAT GBYP Aerial Survey objectives and approach, Presentation for the Training Course. ICCAT GBYP Coordination: 1-14.
5. Aerial Survey – 16 May 2018: Short term contract for aerial survey training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 02/2018), Power Point presentation for the Aerial Survey Training Course 2018. Alnilam Research and Conservation Ltd: 1-89.
6. Aerial Survey – 16 May 2018: Training Course for the ICCAT GBYP Aerial survey for bluefin spawning aggregations, List of participants. ICCAT GBYP Coordination: 1-2.
7. Aerial survey- 13 July 2018. Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 03/2018-b) – Final report for Areas C and E. Unimar and Aerial Banners: 1-31.
8. Aerial survey- 14 June 2018. Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 03/2018-c) – Final report for Area G. Action Air Environnement: 1-35.
9. Aerial survey-7 July 2018, Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 03/2018-a) – Final report for Area A. Grup Air Med: 1-35.
10. Aerial Survey – 30 August 2018: Short term contract for aerial survey training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 02/2018), Final report. Alnilam Research and Conservation Ltd: 1-25.
11. Biological studies – 18 July 2018. Short term contract for biological studies (ICCAT GBYP 06/2018-a). Sampling protocol for GBYP biological sampling. Consortium led by AZTI: 1-19.
12. Biological studies – May 2018. Sampling strata and needs for Biological studies in Phase 8. GBYP Coordination: 1-2.
13. Biological studies – 27 July 2018. Short term contract for biological studies (ICCAT GBYP 06/2018-a). Preliminary report. Consortium led by AZTI: 1-8.
14. Biological studies – 31 August 2018. Short term contract for biological studies (ICCAT GBYP 06/2018-b). Preliminary report. Consortium led by UNIBO: 1-4.
15. Biological studies – 29 June 2018. Short term contract for biological studies –sampling of adults (ICCAT GBYP 04/2018-b). Preliminary report. AquaBioTech: 1.
16. Biological studies –16 July 2018. Short term contract for biological studies –sampling of adults (ICCAT GBYP 04/2018-a). Preliminary report. Taxon: 1-7
17. Coordination –19 April 2018: ICCAT GBYP Steering Committee Meeting, Report, Anon: 1-8.
18. Data recovery – 30 July 2018. Short term contract for the data recovery plan (ICCAT GBYP 08/2018) – Preliminary report. Antonia Mangano: 1-2.
19. Data recovery – 20 August 2018. Short term contract for the data recovery plan (ICCAT GBYP 08/2018) – Final report. Antonia Mangano: 1-3.
20. Meetings – 20 April 2018: ICCAT Bluefin Tuna Species Group Intersessional Meeting, Anon: 1-68.
21. Meetings – 23 May 2018, ICCAT Fourth meeting of the Standing Working Group to enhance dialogue between fisheries scientists and managers (SWGSM), Report, Anon: 1-32.
22. Modelling – 2 July 2018. Short term contract for modelling approaches (ICCAT GBYP 05/2018) – Technical Report of the 2018 ICCAT Bluefin Tuna and North Atlantic Swordfish MSE Meeting. Blue Matter Science: 1-10.
23. Modelling – 25 June 2018. Short term contract for modelling approaches (ICCAT GBYP 05/2018) – Workplan for Phase 8. Blue Matter Science: 1-2.
24. Modelling – 6 June 2018. Short term contract for modelling approaches (ICCAT GBYP 05/2018) – Progress report 9. Blue Matter Science: 1-2.

List of Scientific Papers – Phase 8

1. Alemany, F., Tensek, S., Pagá García, A., 2018, ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) Activity report for the last part of Phase 7 and the first part of the Phase 8. SCRS/2018/171
2. Anonymous, 2018, 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. SCI-036/2018
3. Farley, J. and Ohshimo, S., 2018, Review and Insights into the Differences in Reproductive Parameter Estimates between Eastern and Western Atlantic Bluefin Tuna Stocks. SCRS/2018/172
4. Tensek, S., 2018, Shiny Application for Visualisation of Movements of Electronic Tags Deployed Within ICCAT GBYP. SCRS/2018/174
5. Tensek, S., Pagá García, A. and Alemany, F., 2018, Preliminary Analysis of Bluefin Tuna Depth and Temperature Preferences Revealed By ICCAT GBYP Electronic Tags. SCRS/2018/173
6. Vázquez Bonales, J.A., Cañadas A., Alemany, F., Tensek, S. and Pagá García A., 2018, ICCAT GBYP aerial survey for bluefin tuna spawning aggregations in 2018. SCRS/2018/175