INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

COMMISSION INTERNATIONALE POUR LA CONSERVATION DES THONIDES DE L'ATLANTIQUE

COMISION INTERNACIONAL PARA LA CONSERVACION DEL ATUN ATLANTICO

ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA

(ICCAT GBYP)

PHASE 9

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

PHASE 9

FINAL REPORT

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1. Introduction

1.1. Background

The Atlantic-Wide Research Programme for Bluefin Tuna was officially adopted by the ICCAT Commission in 2008, endorsing the SCRS Chair's report on Bluefin Tuna Research Priorities and Potential costs. In 2009 the SCRS advised the Commission that, in order to substantially improve the scientific advice, such program would focus on the improvement of basic data collection through data mining, understanding of key biological and ecological processes and assessment models and provision of scientific advice on stock status.

During the Commission Meeting in 2009, a number of Contracting Parties expressed a willingness to make extra-budgetary contributions to such a Programme with a view towards initiation of activities related to different priorities: Programme coordination, data mining, aerial surveys and tagging design studies, with additional research activities to be undertaken in the following years. The provision to accept additional contributions from various entities and private institutions or companies was also agreed.

GBYP (Grand Bluefin Tuna Year Programme) was then adopted as official acronym of the research programme. Given that budgetary contributions would be provided annually the Programme have been implemented by annual Phases. To facilitate its coordination and management a post of Programme Coordinator was created and a Steering Committee (SC) was set.

It was initially envisaged as a 6 year 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.

The GBYP activity is being supported by a twin programme, the BTRP, funded by NOAA-NMFS and addressed to USA research teams, which focuses its research activities on the western Atlantic Ocean.

The general information about GBYP activities and its results from the very beginning of the programme till nowadays, as well on budgetary and other administrative issues, 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 therefrom.

1.2. Objectives

Considering the priorities stated initially by SCRS, the Steering Committee set as the main objective of the GBYP the improvement of the knowledge and understanding of the Atlantic bluefin tuna (*Thunnus thynnus*) stocks and populations. Aiming at the achievement of this general objective, the following specific objectives were set:

a) Improving basic data collection through data mining developing methods to elaborate these data and to estimate sizes of fish caged, development of fisheries-independent surveys and implementing a large-scale scientific tagging programme.

b) Improving understanding of key biological and ecological processes through electronic tagging experiments to determine habitat and migration routes, broad scale biological sampling of live fish and dead fish landed (e.g. gonads, liver, otoliths, spines, etc.), histological analyses to determine bluefin tuna reproductive state, biological and genetics analyses to investigate mixing and population structure; and ecological processes, including predator-prey relationships;

c) Improving 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 among areas, and developing and use of biologically realistic operating models for more rigorous management option testing.

1.3. Project management

The GBYP Steering Committee has the role to guide and refine the Programme. It is composed by the SCRS chair, W-BFT rapporteur, E-BFT rapporteur, one external member and the ICCAT Executive Secretary or his deputy. It should be pointed out that the changes in the SC members, derived from those in the institutional components, sometimes resulted different views for some GBYP activities, which affected the continuity of some lines of research.

Steering Committee is regularly informed and consulted by the GBYP Coordinator for all relevant issues. The Steering Committee meets not less than once a year, to verify the activities done, refine the Programme, propose follow-up of the Programme and adopt the budget.

The GBYP coordination team carries out the day to day tasks related to the implementation of the project, including the elaboration of the calls for different types of contracts, the reports on the different GBYP meetings and the programme annual and executive reports.

Furthermore, the GBYP coordination participates, or provides scientific support whenever requested, in national or international initiatives which are potentially able to increase the effectiveness of the GBYP and the achievement of its objectives. For example, since 2010 the Coordinator has been part of the Evaluation Committee of the NOAA BTRP.

1.4. Annual budget

The GBYP is funded by voluntary contributions of CPCs and other entities, as Chinese Taipei and ICCAT Secretariat. Among CPCs, EU provides 80% of total budget. In addition, several private or public entities also provided few additional funds or in-kind support. The budget is set annually, by phase. The evolution of the total budget along the Programme, by type of activity, is shown in Table 1 (in euro):

Table 1. GBYP Budget by type of activity, per Phase

	Phase 1	Phase 2	Phase 3	Phase 4	Phase5	Phase 6	Phase 7	Phase 8
Coordination	210,000	453,000	225,000	600,245	342,000	383,000	415,745	312,500
Data Recovery	200,000	149,000	30,000	40,250	20,000	165,000	25,000	58,000
Aerial Survey	300,000	465,000		518,426	519,500		405,000	494,500
Biological Studies		505,000	430,000	364,000	363,000	556,000	580,000	583,000
Tagging	40,000	890,000	1,175,000	1,229,979	669,500	844,000	262,000	159,000
Modelling		40,000	65,000	122,100	211,000	177,000	121,240	143,000
FINAL	**750,000**	**2,502,000**	**1,925,000**	**2,875,000**	**2,125,000**	**2,125,000**	**1,808,985**	**1,750,000**

It must be pointed out that this annual and variable funding scheme, instead of a multi-year and more stable funding system, is one of the major problems for GBYP, because this fact makes difficult a mid and long term planning of the activities, which would be for sure more efficient. The GBYP Steering Committee and the SCRS several times recommended the adoption of a more stable funding system, but all proposals submitted so far by the ICCAT Secretariat or some CPCs to the Commission (i.e.: scientific quota, contribution proportional to quota, etc.) were discussed but they were never approved. The uncertainties linked to the funding at each Phase are creating operational problems since the beginning of the programme, because it is difficult to plan all activities and provide all necessary contracts when the effective funding for a given Phase is confirmed only at the very end of the previous one. This fact implies a continuous attention to the effective budget availability at each step of the programme by the Coordination team and Steering Committee and the impossibility to operate with multi-year contracts for multi-year activities.

It should be mentioned that the total budget of the programme officially approved by the ICCAT Commission in 2008 was 19,075,000 Euro in six years, with the engagement of the European Union and

some other ICCAT Contracting Parties to contribute to this programme in 2009 and in the following years. The overall GBYP operating budget for the first eight Phases, covering nine years (a total of 15,860,985 Euros) is only about 83% of what it was supposed to be for just six years only. These budget reductions had an impact on all activities carried out so far.

1.5. Programme review

For the purpose of independently reviewing the work carried out to date within the scope of ICCAT GBYP and evaluating the effectiveness of this complex research programme, in 2013 a mid-term review of the Programme was carried out by the team of independent scientist. Other large comprehensive review of the first five Phases of ICCAT GBYP was carried out at the beginning of the Phase 6 and the results were presented to the SCRS 2016 Plenary (document SCRS/2016/192) and to the Commission at its 2016 Special Meeting. Both documents are available at GBYP webpage.

1.6. Research mortality allowance

The enforcement of the ICCAT Rec. 11-06, which allows for a "research mortality allowance" (RMA) 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 issues a circular letter establishing the rules and the details for the enforcement of the Rec.11-06, including the official form for reporting RMA and the list of authorized institutions. The list is updated whenever necessary, at least once a year. All information received through RMA forms is regularly entered in the database specially designed for that purpose, which is maintained by GBYP and the quantities of used RMA are yearly reported to the SCRS.

2. Budget in Phase 9

The ninth Phase of the ICCAT GBYP officially started on 1 January 2019 following the signature of the Grant agreement for the co-financing of the ICCAT GBYP Phase 9 (SI2.795824) by the European Commission. Initial duration of the Phase was one year, but it was extended for four months, thus officially ending on 30 April 2010.

The request for amending the GBYP Phase 9 Grant agreement was submitted to the European Commission and it was approved on 17 December 2019. The main motivations for requesting the amendment was to adjust to the period of bluefin fishing and harvesting operations, which condition many GBYP activities as biological sampling, samples analyses and growth in farms studies. In addition, the budget was somehow modified in order to better address the current research needs and provide optimal use of available funds. It must be pointed out that such modifications and time extension did not imply any change in the total budget for GBYP Phase 9, which remained fixed at 1,750,000€, with an EU contribution of 1,400,000€.

It is worth to mention that the GBYP Phase 9 overlapped with Phase 8 for almost nine months (January-September 2019, and with Phase 10 for four months (January-April 2020). It has made a bit more complex the GBYP program management, but it has been possible to develop in parallel the different phases without major problems, since each phase has a well-defined work-plan and budget, and hence every cost can be assigned univocally to the activities detailed in the respective Grant Agreements.

A first report of the GBYP activities in Phase 9 up to September 2019 was provided to the BFT Species Group (Annex 1b, document no. 6 presented as) and the SCRS (Annex 1a, document no. 20, Annex 1b, document no. 9). The final report of Phase 9 activities will be submitted to SCRS and at the Commission before September 2020.

In Phase 9, the budget had the following funders when the proposal was presented (in order of contribution already received or committed):

European Union	1,400,000.00 €
United States of America	165,330.24 €
Japan	56,060.18 €

Tunisia	50,887.30 €
Turkey	41,428.12 €
Libya	34,294.50 €
Syria	1,999.66 €
ICCAT Secretariat	10,000.00 €
TOTAL BUDGET	**1,750,000.00 €**

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 9 or further contributions from other CPCs will be used for the following Phases of GBYP. It should be noted that some contributions for the current and previous GBYP Phases are still pending from several ICCAT CPCs.

3. Programme Coordination in Phase 9

3.1. Steering Committee

The Steering Committee in the Phase 9 was composed by the SCRS chair (Dr. Gary Melvin), the Western BFT rapporteur (Dr. John Walter), the Eastern BFT rapporteur (Dr. Ana Gordoa), the ICCAT Executive Secretary (Mr. Camille Jean Pierre Manel) and the external expert. The contract for the external member of the Steering Committee was signed in April 2019 with Dr. Ivan Katavic, professor at the Croatian Institute for Oceanography and Fisheries.

During the Phase 9, only one SC meeting has been held, on 24 September 2019. It focused on the last activities of the Phase 9 and planning of Phase 10, including also a lot of issues the SC needed to take decision about. It was also decided to elaborate the amendment proposal for Phase 9 Grant Agreement. The report is available in Annex 1a (document no. 19). Other decisions were taken via email, following the regular correspondence held between the GBYP Coordinator and GBYP SC members for all relevant issues.

3.2. Coordination Team

In the Phase 9 the Coordination Team has been composed by the GBYP Coordinator (Dr. Francisco Alemany), the Assistant Coordinator (Mrs. Stasa Tensek) and the Database specialist (Mr. Alfonso Pagá). It should be pointed out that the ICCAT Secretariat provided the technical and administrative support for all GBYP activities on a daily basis.

3.3. Project management activities

During Phase 9, a total of 6 calls for tenders and 6 official invitations were released, which resulted in a total of 19 contracts awarded to various entities (Annex 2). A total of 26 reports were produced in the framework of ICCAT GBYP in Phase 9 (Annex 1a). A total of 9 scientific papers have been produced in Phase 9 (list in Annex 1b), while others will be published in the following months. So far, the GBYP has produced in total, over the first 9 Phases, 369 activity reports and 292 scientific papers.

Other routine project management activities have been the actions related to GBYP Research Mortality Allowance, the Tag awareness and reward program, the regular communication with the Steering Committee members and the updating of the GBYP web page.

Regarding RMA, during 2019 the Research Mortality Allowance was used for covering the incidental death of 10 specimens of bluefin tuna, all of which occurred during tagging campaigns, which equals to a total of 1068 kg. These were reported through 8 RMA forms.

In addition to the coordination tasks related to activities developed under these contracts or agreements and other day to day communication tasks with different stakeholders, the GBYP coordination team participated in all ICCAT meetings focused on bluefin tuna and in the SCRS second workshop on collaborative work to assess sea turtle bycatch in pelagic longline fleets (South Atlantic ocean and Mediterranean sea, held in Malaga, Spain, between 27 and 31 January, 2020).

Moreover, GBYP coordination team has organized two important workshops within this Phase: the technical workshop on electronic tagging deployment methods, attended by 25 participants from 14 countries, held in Olhão (Portugal) in July 2019, and broader workshop on BFT tagging that was going to be held in Madrid in March 2020, involving around 50 researchers representing 30 institutions. Unfortunately, the latter was cancelled in the last moment due to concerns over the rapid spread of the respiratory illness COVID-19 caused by the coronavirus SARS-CoV-2. The training for the 2019 aerial surveys crew members was organized as well. The GBYP coordinator also participated in the training course for ROP observers, giving a talk to stress the importance of ICCAT observers for the Biological Studies and Tag recovery GBYP activities. Finally, on the margins of the 26th Regular Meeting of the Commission, a side event was organized for presenting the latest activities and results of the GBYP Programme, especially focusing on the growth in farms study. For this occasion, various posters and a tri-fold brochure were elaborated (Annex 1a, document no. 27).

4. Activities in Phase 9

4.1. Data Mining, recovery and management

The initial objective of this GBYP line was to fill the many gaps existing in several data series currently present in the ICCAT data base, concerning both recent and historical catch or catch by size data, which causes a large amount of substitutions in the assessment process, increasing uncertainties, by focusing on data recovery activities. In general, these recovered data have allowed for a better understanding of the long-time catch series by gear, improving the data available for the assessments. In the last years such activities have included 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 yet for BFT evaluation purposes. From Phase 8 onwards this line of research has broadened its scope, focusing on the design and implementation of a data management system based on relational databases integrating all available data from GBYP activities and connected with other relevant ICCAT DBs.

4.1.1. Data Mining, recovery and management in Phase 9

The original plan of activities in Phase 9 included a specific budget related to the data recovery, specifically recovery of detailed electronic tags datasets. Nevertheless, since no new datasets were available from contacted teams, this activity was cancelled, which was reflected in the Amendment to the Grant agreement.

The work-plan included also in-house work to be carried out directly by GBYP coordination team, focusing in the compilation, consolidation and standardization of data from stereo-cameras reported to ICCAT in previous years. These tasks are described in detail in the chapter 4.4.2 Study on BFT growth in farms.

4.2. Stock indices (Aerial Surveys)

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 and different opinions about the best sampling strategies between successive SC members, this activity has not been developed regularly and has not followed homogenous methodologies and sampling strategies. 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 the 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. An extended survey, similar to that carried out in 2013, was developed in 2015. In addition, in 2015 a reanalysis of all data up to that point was carried out, taking into reference only four overlapped areas (the Balearic Sea, the Tyrrhenian Sea, the Southern-Eastern Mediterranean and the Levantine Sea) and making some further corrections, thus producing standardized 4 years series of fisheries independent index. In 2016 the survey was suspended, basing the decision of the Steering Committee on the assumption that the financial resources were not sufficient for carrying out an adequate survey. The aerial survey activity was resumed in 2017 and 2018, on four overlapped areas only, using the same methodology already established in 2015, producing two more years of standardized index.

In 2018 an exhaustive analysis of the methodologies applied and results obtained in previous surveys was carried out by the GBYP Coordination team in order to detect, and consequently prevent or minimize any potential sources of bias that could affect the accuracy of the results. Consequently, it was considered< that some actions should be carried out to improve the precision and accuracy of aerial surveys in a future and also the reliability of the results from previous surveys, as development of calibration exercises among spotters, further refining the current survey protocols to minimize the potential sources of bias as much as possible, to develop methods to consider environmental influence on the aerial index estimations, to reanalyze the available time series of data from aerial surveys taking into account the new potential

sources of bias detected, to consider the influence of environment on aerial survey index estimation and, finally, to explore the possibility of carrying out validation exercises for aerial surveys.

4.2.1. Aerial survey campaign 2019

The aerial survey in Phase 9 was carried out on the same 4 preferential spawning areas already defined in the previous Phases (Figure 1), using the same design and methodology as in previous years, except for the slight change in the Area A in order for it to better fit the real distribution of bluefin tuna spawners and optimize flight times. For a purpose of data analyses, 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.

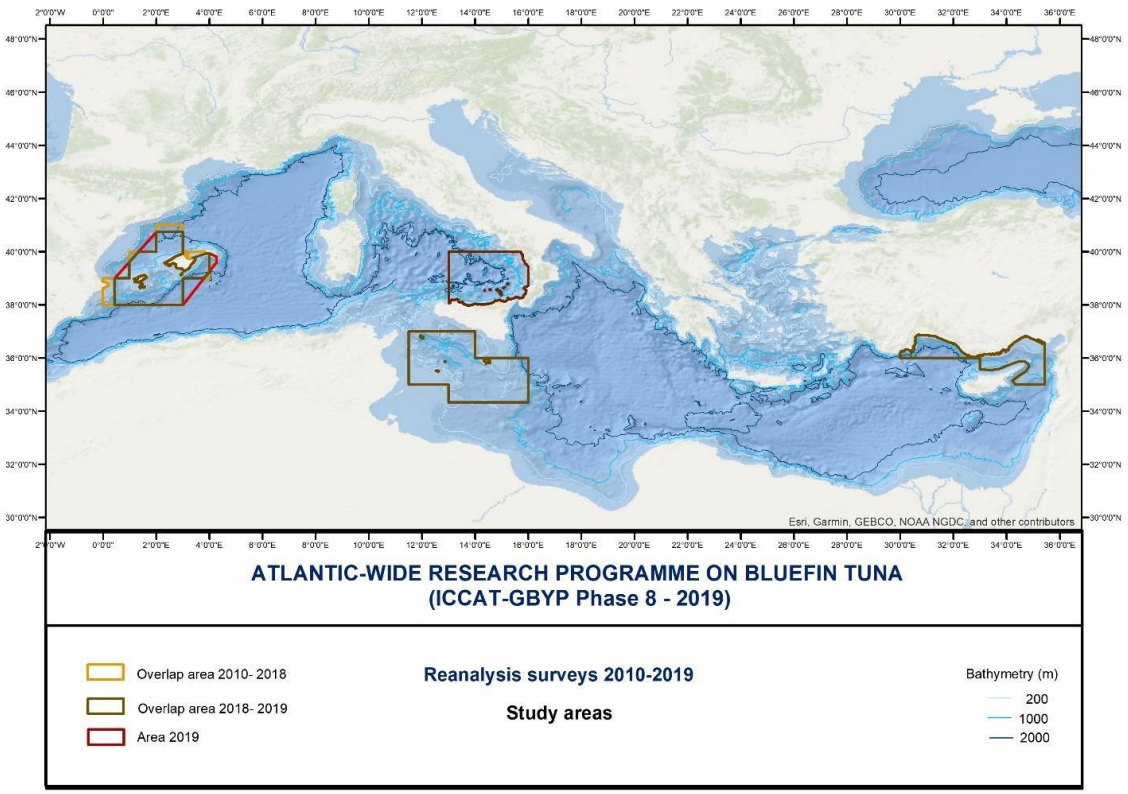

Figure 1. GBYP Aerial survey on spawning aggregations: study areas with special reference to new design of Area A

In addition to data elaboration and analyses, the contractor also provided updated versions of the Protocol (Annex 1a, document no. 1) and Forms (Annex 1a, document no. 2) for this year aerial survey and the updated design of the survey, due to the slightly changed definition of Area A. Moreover, the contractor provided materials and acted as tutor at the training course that was organized for members of the aerial survey crews. Finally, given the changes in the methodology, all historical GBYP aerial survey data was re-analysed to produce standardized series of the abundance index. Additionally, the data were cleaned to ensure that all refer to adult and not to juvenile bluefin tuna.

a) Training course

The training survey was held in the ICCAT headquarters on 22 May 2019, with the participation of all the contracted pilots, professional spotters and scientific observers. A total of 16 participants attended the course. The list of participants is available in Annex 1a, document no. 4. 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. The presentation is available in Annex 1a, document no. 3.

b) Field surveys

In 2019, three companies were awarded for carrying out the aerial surveys, which were the ones that submitted their offers following the call for tenders. All these companies had previous experience in GBYP aerial surveys and 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 survey in Area C (southern Tyrrhenian) was done by Italian companies Unimar and Aerial Banners. As concerns Area E (central-southern Tyrrhenian Sea) and Area G (Levantine Sea), they were surveyed by French company "Action Air Environnement". Similarly to previous years, the Turkish government asked for 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 were 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. As in previous two years, data were delivered from each area on a weekly basis, and they were immediately checked for any potential problem or error 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. The main problem was the restriction of the air space applied by Malta, for the first time in the GBYP aerial surveys, over its Fisheries Management Zone (25 nm around the islands), which was not revoked in spite local aerial authorities were directly contacted to explain that these are purely scientific surveys and the data gathered are only delivered to ICCAT for management purposes and that local fishing authorities confirmed this point.
In general, it can be said that 2019 the aerial surveys generally worked very well, and homogeneous coverage was achieved in all areas despite some temporally disruptions or delays for several reasons. The final reports are available in Annex 1a, documents no. 5-8.

c) Data elaboration and analyses

Data collection worked better than in previous surveys, consolidating the improvement observed along the last years of the time series. The weekly review of the data collected helped in great deal to detect small issues at an early stage and correct them for the rest of the survey. The data on school size were recorded in two ways: estimated number of animals in the school and estimated total weight in kgs. of the school. Both were used as a measure of school size in analysis, performing two analyses to consider both measures of school size.

In 2019 an optimized design of zone A was developed, taking into account the distribution of bluefin tuna spawners during the spawning season., keeping the total square kilometers similar to facilitate the standardization of data with previous years.

In addition, the whole available data set from 2010 to 2019 has been fully revised from the original data files, allowing to detect a few errors that went undetected before. The main different processes for refining the base data were fine-scale readjustment of the overlap areas and effort tracks, revised assignments to adult/juvenile categories and recovery of missing data, re-checking the use of bubble windows and creation of parallel datasets to be analysed independently for cluster size, and then repeated for weight. Special attention was paid to the revision of the assignments to category small, in order to detect those sightings that could correspond to juvenile fish, which shouldn't be included in an index directed to estimate the spawning stock biomass.

Considering this improved data base, the aerial survey indices were recalculated for all the areas and years in a homogeneous way, introducing also some methodological improvements in the data analysis process, resulting in new more accurate and fully standardised index time series. Therefore, two index time series for the period 2010-2019 were provided. One was calculated considering all animals recorded, regardless of their size, following the same methodology series used till 2018, to make the new series directly comparable to the previous one. The second was calculated removing the juveniles, to provide a new, fully standardized and more reliable aerial survey index time series for future assessments.

It must be pointed out that differences in index values attributable to the inclusion or exclusion of juvenile individual are in general almost negligible. As seen in the tables above, the difference in total abundance and weight between all bluefin tuna and reproductive adults only is minimal and therefore not significant

(well within their respective 95% Confidence Intervals), being the juveniles a tiny proportion of the whole. This is true for areas A, C and E and for all the areas together. However, in area G most of the animals were juveniles, and a difference in estimates is much more obvious. Nevertheless, the proportion of the number of animals and weight in area G with respect to the other three areas is minimum, so it hardly makes any difference in the total estimate. Final results are shown in Table 2.

Table 2. Results of the re-analysis for adult individuals of BFT using the overlap areas between 2010 and 2019.

	Total: All areas together						
Area	**2010**	**2011**	**2013**	**2015**	**2017**	**2018**	**2019**
Survey area (km2)	234,099	195,311	234,099	234,099	234,099	234,099	234,099
Transect length (km)	29,166	25,442	13,886	11,634	19,356	22,829	22,325
Probability of detection	0.22128	0.22128	0.22128	0.16185	0.16185	0.16185	0.16185
Effective strip width x2 (km)	2.34158	2.34158	2.34158	1.66706	1.66706	1.66706	1.66706
Area searched (km2)	314,992	274,774	149,969	119,833	199,367	235,139	229,942
% coverage	134.6	140.7	64.1	51.2	85.2	100.4	98.2
Number of schools ON effort	59	48	38	18	47	51	39
Abundance of schools	165.93	241.75	459.74	186.81	373.17	363.87	290.45
%CV abundance of schools	23.84	29.32	33.86	37.00	30.86	22.72	24.48
Encounter rate of schools	0.00202	0.00189	0.00274	0.00155	0.00243	0.00223	0.00175
%CV encounter rate	20.82	19.77	19.44	23.32	16.18	14.93	17.41
Density of schools	0.00071	0.00124	0.00196	0.00080	0.00159	0.00155	0.00124
%CV density of schools	23.84	29.32	33.86	37.00	30.86	22.72	24.48
Expected weight (T)	1.941	0.745	0.311	133.699	70.724	58.240	43.990
%CV weight	18.61	34.86	45.43	58.46	36.29	27.84	31.46
Expected cluster size (animals)	1897.7	752.5	294.8	722.4	463.1	421.9	317.0
%CV abundance	18.59	34.57	46.24	58.34	35.11	27.24	29.99
Density of weight (km-2)	1.41	0.90	0.55	106.69	112.74	90.53	54.58
%CV density of weight	30.22	31.67	36.73	51.16	24.10	23.33	27.38
Density of animals (km-2)	1.345	0.931	0.579	0.577	0.738	0.656	0.393
%CV density of animals	30.45	31.34	36.51	50.84	22.33	22.53	25.71
Total weight (T)	12,779	12,788	10,534	24,977	26,392	21,192	12,777
%CV total weight	26.98	29.84	31.25	51.16	24.10	23.33	27.38
L 95% CI total weight	7,574	7,158	5,764	9,609	16,546	13,480	7,532
U 95% CI total weight	21,561	22,847	19,253	64,924	42,098	33,316	21,673
Total abundance (animals)	314,885	181,923	135,523	134,961	172,801	153,524	92,081
%CV total abundance	30.45	31.34	36.51	50.84	22.33	22.53	25.71
L 95% CI total abundance	174,720	99,018	67,334	52,216	111,998	99,147	55,999
U 95% CI total abundance	567,495	334,241	272,767	348,832	266,613	237,726	151,413

When looking at each area separately, there didn´t seem to be a clear pattern downwards or upwards, except in area A, where a positive trend is observed in the last years. It seemed there was a negative correlation between areas C and E with opposite trends when comparing consecutive years. This could indicate that the spawners in these two areas should be potentially considered as only one area in the analysis. When examining all areas together, there seems to be a downward trend, but this is mainly due to a very high abundance estimation in only one area, the area G (Turkish waters), in 2010, no observed in subsequent years. In any case, there is not enough power in the data (because of the large uncertainty) to determine if it is real or not, and the contradictory trends in the different areas makes it more confusing to interpret.

The CVs generally increased slightly for the adults only datasets because the number of observations is smaller. The main way to reduce the estimated CVs in future surveys is to increase the number of sightings, to reduce the CVs of the encounter rate. This can be achieved simply by increasing the amount of searching effort (transect length), which implies increasing costs, or by more efficient searching. The efficiency can be increased in future surveys excluding for example the very shallow waters (e.g. 0-100m) where no BFT adults are seen, or even whole areas where no one or few adults schools are observed, as area G. Another way would be to better match the seasonality of the survey in each area with the spawning peak in this specific area, or focusing the effort in areas where spawning habitat models predict higher probability of the presence of spawners. The final report is available in Annex 1a, document no. 9.

4.2.2. Improvement of the GBYP aerial survey sighting methodology

a) Calibration exercise

For the purpose of improving the reliability of results of aerial surveys, in Phase 8 a direct contract for improved aerial survey sighting protocols and of spotter's calibration survey was issued to company Alnilam, due to their proven theoretical skills and experience in bluefin tuna aerial surveys.

The Contractor provided a design for an aerial survey calibration/validation exercise, which was carried out in the Balearic sea at the end of the 2019 GBYP aerial survey, within Phase 9, with the main objective to calibrate the sightings of the professional spotters who have already participated in several previous GBYP aerial surveys.

The calibration exercise was carried out in the zone A (Balearic Sea) between 29 June and 8 July 2019. It was done by a single aircraft carrying, apart from a pilot and a scientific coordinator, 4 professional spotters. The exercise consisted in assessing the number and total weight of animals whenever a school of bluefin tuna was spotted. All spotters were required to provide their individual estimates for the purpose of their subsequent comparison. Apart from that, in a research laboratory, a complementary exercise was carried out following the same principle but using a set of photos. This exercise was performed in coordination with an acoustic/larval survey performed in the same area with the aim to compare the estimates of the same bluefin tuna school using different methodologies and, if possible, validate the aerial estimates using sonar estimates. Unfortunately, although 18 observations of bluefin tuna schools were made during aerial survey, none of these were close enough to the research vessel equipped with sonar. The comparison between aerial and sonar estimates was only possible for the tuna contained in a cage during transport to a farm. The complete results of the calibration exercise are available in Annex 1a, document no. 10 and as a scientific paper in Annex 1b, document no. 8.

b) Habitat modelling

The analysis of aerial survey data showed the strong inter-annual and spatial variability in the different components (encounter rate of groups, mean weight, and mean school size) and, consequently, no clear patterns in spawning stock abundance. These inconsistencies might have been caused, among other factors, by environmental conditions that affected the timing of migration, the spatial distribution at sub-regional scales and vertical distribution of bluefin tuna spawners, which have resulted in certain areas in a high variability in the abundance indices from aerial survey that probably do not reflect that of spawning stock biomass.

As a way of contributing to the reduction of uncertainty in stock assessment and providing robust management advice, it was decided, following GBYP Steering Committee advice, that the GBYP programme should support the development of bluefin tuna habitat models, focusing on the characterization of spawning habitats and paying special attention to the eastern Atlantic bluefin tuna stock. The aim of these modelling activities would be, firstly, to establish the basis for standardizing indices that can be affected by the spatial and temporal variability of spawning, such as the aerial survey index and, secondly, to provide information about potential spawning habitats that could optimize the design of sampling activities to detect and/or characterize further bluefin tuna spawning areas.

To this end, GBYP launched a call for tenders in January 2020. Only one bid was received, but the Evaluation Committee concluded it did not completely meet the objectives and consequently it was not awarded. It was recommended that the call be relaunched, but due to the Phase 9 timeframe, it would have to be launched within the subsequent Phase.

4.3. Tagging

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.

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.

4.3.1. Tagging campaigns in 2019

As recommended by the Steering Committee, the tagging activities carried out under contract on specific agreements in the Phase 9 were limited again to the deployment of electronic tags, keeping the deployment of conventional tags only as a complimentary activity. In addition to 18 electronic tags that had already been purchased in 2018 and that could not be deployed because of “force majeure” reasons, in 2019 GBYP acquired another 18 tags (4 of them were both with 50% discount due to the physical return of recovered tags). The producer also added 4 warranty replacement tags for tags with pin broke. Given that the purchase order was done jointly with orders from other Secretariat science programmes, and therefore included high number of 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 objectives of the 2019 campaign was to improve the estimations of the degree of mixing of western and eastern Atlantic bluefin tuna stocks in the different statistical areas over the year cycle, specifically considering the current needs of the MSE modelling process. To this end, the Steering Committee decided to concentrate tagging activities in the North or Norwegian Sea and/or Celtic Sea. After publishing the call for tenders, 2 offers were received and were both awarded. The Marine Institute, from Ireland, presented an offer for tagging of 15 individuals in the coastal waters near Ireland, during September and November, using angling s as fishing method. Other offer came from the Technical University of Denmark (DTU-Aqua), for deploying 15 tags in Skagerrak from August to October, using rod and reel.

Tagging off Ireland was carried out in October/ November 2019 with 12 individuals tagged and released All fish were tagged off the Donegal coast within sight of shore. Two vessels were used during the tagging period i.e. the Leah C and Deep Blue. These vessels are equipped with transom doors to bring fish on board with specialized gear, fighting chairs to land the fish. aAll 12 fish were captured using angling methods and squid spreader bar lure setups. On board, the team performed individual tasks e.g. placing of wet cloth over the eyes of the fish to keep the fish calm, constant irrigation of the gills with a hose pumping fresh saltwater, insertion of the PSAT into the dorsal musculature using a titanium tag dart with retention loop. Two other numbered marker tags (spaghetti tags) were also applied to aid in recovering information form tagged fish. Fish were measured and small samples of tissue were removed for genetic analyses. As quickly as possible the fish were then released back into the water. The onboard procedure takes approximately 3 to 5 minutes. Bad weather conditions during the period available for electronic tagging caused some planned tagging trips to be cancelled and hindered the efforts of the taggers.

Although a total of 19 trips were undertaken (19 boat days), vessels had to return to port early in some circumstances due to the adverse weather conditions, additionally these weather conditions made spotting of busting tuna more difficult due to increased sea state. Nonetheless, no significant problems were encountered during tagging operations and no modifications were made to the tagging protocols. The final report is available in Annex 1a, document no. 26.

Tagging in Skagerrak was done under a framework of a Scandinavian Bluefin Marathon in waters near Denmark and Sweden at the end of August and beginning of September 2019. This project relied heavily on the participation and dedication of experienced big game anglers who volunteered their time to safely catch and tag bluefin tunas by rod and reel. Fifteen tunas were then tagged with a pop-up satellite tag as well as a spaghetti conventional tag. Fish were measured and small samples of tissue were removed for genetic analyses. All the tunas were caught using rod and reel, typically using balloons and drifting. Baits were largely mackerel with some garfish. When a tuna was gaffed by the anglers, it was swum 5-10m from the boat at app. 2 knots to facilitate recovery of the tuna. The tuna was then transferred with a rope to the tagging boat where tagging and sampling was performed. As soon as the tuna's mouth was out of water, it was continuously ventilated with fresh seawater using a large pump; the tuna's eyes were covered with a wet dark microfiber towel. Tuna was tagged, sampled (fin clip, blood sample and muscle biopsy) and the hook was removed. It was then measured and then released back into the water. Generally, all tagging, sampling and release was done within 2 minutes. The final report is available in Annex 1a, document no. 25.

In addition, in July 2019, 7 electronic tags were deployed Olhão, Portugal, as a part of a practical session of the Workshop on electronic tagging deployment methodologies (see point 4.3.2.a).

The available tracks (on 20 May 2020) from electronic tags deployed in 2019 are shown in Figure 2.

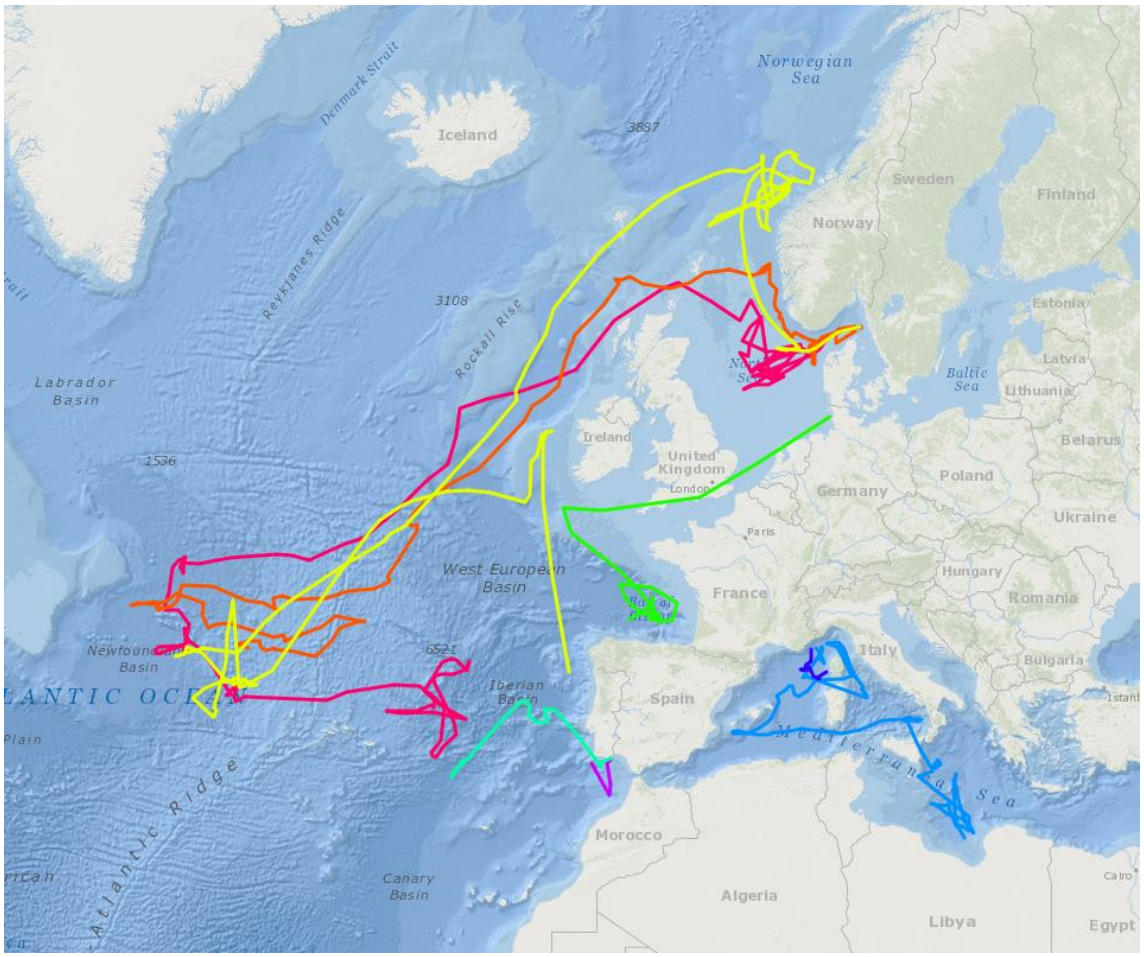

Figure 2. The available tracks (on 20 June 2020) from electronic tags deployed in 2019

It should be pointed out that in 2019 the obtention of data from electronic tags was greatly hindered by a tag transmission problem affecting Wildlife Computer tags Mini PATs produced from the second half of 2018 onwards. When low quality transmissions due to lower than usual number of days transmitting after pop-up were detected the manufacturer was contacted asking for explanations, and this correspondence revealed that they had changed the type of battery used in previous years and the new battery might have demonstrated somewhat lower performance. The manufacturer initially recognized that the tags were potentially affected and accepted to replace all the tags not yet deployed. Nevertheless, in the case of already deployed ones, they only accepted to replace the ones battery issue could be unequivocally demonstrated by the data, arguing that in other cases various other reasons could explain the short transmission times.

It is worth mentioning that probably thanks to the methodological improvements in GBYP tagging operations, as the use of a new type of reinforced tether with titanium darts and the ad hoc workshop on satellite tags deployment methodologies held within this GBYP Phase 9 (see point 4.3.2.a), the time on fish of the tags deployed in the last two years has improved a lot, with several tags remaining on fish the whole programmed year, for the first time in GBYP tagging campaigns. For this reason, many of the tags deployed within phase 9 are still on fish.

Besides the 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, the Italian branch of WWF Mediterranean Marine Initiative have been included in the 2019 GBYP list of institutions that can make use of RMA. WWF has recently deployed several satellite tags in the Western Mediterranean which are associated to GBYP Argos system account, so the resulting data will be directly integrated in GBYP database.

As regards conventional tags, within Phase 9 “spaghetti” tags, along with applicators and the tagging protocols and forms to report tagging operations were delivered to various institutions (Table 3). In addition, 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.

Table 3. Number of conventional tags and other tagging equipment and material sent to different collaborators in Phase 9 (from February 2019 until March 2020)

Country	Institution	Conventional tags	Applicators		Awareness
			Conventional	Electronic	Posters
CANADA	Goverment of Canada (Fisheries and Oceans)	800	50		
EU.DENMARK	Technical University of Denmark	100	4	2	
EU.ESPAÑA	Associacio Catalana per a una Pesca Responsable (ACPR)	150	50		
EU.IRELAND	Marine Institute	1500	90	2	30
EU.ITALY	Alleanza Pescatori Ricreativi	100	4		
EU.ITALY	WWF Mediterranean Marine Initiative	150	25		
NORWAY	Directorate of Fisheries	400	28		

In Phase 9, a total of 293 tags were deployed on 250 bluefin tuna individuals (Table 4 and 5). The level of tagging was much lower than in the beginning of the Programme, since the conventional tagging was cancelled by the Steering Committee in Phase 4, keeping it only as a complementary activity. In total, from the beginning of the Programme up to 1 March 2020, more than 20 thousand bluefin tuna individuals were tagged, using more than 28 thousand tags of different types (Table 6 and 7).

Table 4. Number fish tagged during Phase 9 (from February 2019 until March 2020)

	ALL FISH TAGGED	FISH SINGLE TAGGED		FISH DOUBLE TAGGED	
		FT-1-94	FIM-96 or BFIM-96	Mini-PATS + Conv.	Mini-PATS + 2Conv.
Portugal	7	0	0	7	0
West Med.	46	46	0	0	0
Central Med.	135	86	49	0	0
North and Celtic Seas	62	0	35	18	9
TOTAL	**250**	**132**	**84**	**25**	**9**
		SUBTOTAL = 216		**SUBTOTAL = 34**	

Table 5. Number fish tagged during Phase 9 (from February 2019 until March 2020)

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED		
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs
Portugal	14	7	0	7
West Med.	46	46	0	0
Central Med.	135	86	49	0
North and Celtic Seas	98	11	60	27
TOTAL	**293**	**150**	**109**	**34**

Table 6. Number of fish tagged since the beginning of GBYP (up to 1 March 2020)

	ALL FISH TAGGED	FISH SINGLE TAGGED			FISH DOUBLE TAGGED						
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+ Acoustic+ Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.
Canada	1826	0	1821	0	0	5	0	0	0	0	0
Bay of Biscay (a)	7715	4173	15	3	3493	18	0	0	13	0	0
Morocco	365	129	48	45	121	14	0	7	0	0	1
Portugal	347	53	39	94	154	7	0	0	0	0	0
Strait of Gibraltar	5561	2254	43	0	3212	22	5	0	23	2	0
West Med.	1809	1047	377	28	352	5	0	0	0	0	0
Central Med.	2820	1137	1145	32	479	15	0	0	12	0	0
East Med.	99	49	0	50	0	0	0	0	0	0	0
North and Celtic Seas	228	96	45	4	30	34	19	0	0	0	0
GRAND TOTAL		**8938**	**3533**	**256**	**7841**	**120**	**24**	**7**	**48**	**2**	**1**
	20770	**SUBTOTAL = 12727**			**SUBTOTAL = 8043**						

Table 7. Number of tags implanted since the beginning of GBYP (up to 1 March 2020)

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Canada	1831	0	1826	5	0	0
Bay of Biscay	11239	7697	3508	21	13	0
Morocco	515	258	183	66	0	8
Portugal	508	182	225	101	0	0
Strait of Gibraltar	8618	5491	3075	27	25	0
West Med.	2165	1400	732	33	0	0
Central Med.	3326	1616	1651	47	12	0
East Med.	99	49	0	50	0	0
North and Celtic Seas	330	153	120	57	0	0
TOTAL	**28631**	**16846**	**11320**	**407**	**50**	**8**

4.3.2. Methodological improvements

a) Workshop on electronic tagging deployment methodologies

With the aim to improve the tagging results, and particularly to increase the electronic tag retention rate, it was decided to organize a Workshop on bluefin tuna e-tagging methodology. The Workshop was held from 2-5 July 2019 in IPMA laboratory in Olhão, Portugal and it was attended by 25 experts in bluefin tuna tagging, most of which have already participated in GBYP electronic tagging campaigns. During the workshop, the electronic tags deployment methodology was discussed, and previous BFT e-tagging experiences were shared between the experts. The Workshop also included practical sessions at Tunipex facilities, which were led by Mr. Robert Schallert, who was specially contracted for that purpose, through the Ocean Foundation. Mr. Schallert has a long experience in deployment of electronic tags as being a part of the Tag-A-Giant team, at Stanford University (Block Lab, Hopkins Marine Station), whose electronic tags deployment methodologies have been very successful along the last decades, as demonstrated by large retention rates of their tags. Among other things, it was concluded that the choice of anchor type and tethering material is crucial for ensuring longer retention rates. Titanium anchors should not be too sharp or flexible to avoid them pulling out of the muscle too quickly and the use of a retention loop with a second anchor was highly recommended. The outputs from this workshop are being used as a reference for developing a new GBYP e-tagging protocol, which will be completed and presented in GBYP phase 10.

During the practical sessions of the Workshop, a total of 9 electronic tags were deployed in the Portuguese trap. The tagged fish were not released immediately, but left observed for a few days inside the net instead. This strategy proved extremely useful for recovering the valuable material after an incidental death of a tagged fish. In this case, the incidental mortality was quite high, including 2 fish out of 9, probably due to the poor condition of the fish captured when they are leaving the Mediterranean after spawning, as those captured in the Portuguese traps in summer.

b) Workshop on bluefin tuna tagging

A broad Workshop on bluefin tuna tagging was programmed in the Phase 9 as well, and was going to take place in March 2020, but it was postponed in the very last moment, when it was already fully organized and even travels and per diems of invited key speakers had been already paid, due to the quick evolution of coronavirus pandemics in Madrid along the first two weeks of March. Specifically, the workshop was initially scheduled for 11-13 March 2020 in Madrid and it was cancelled only a few days before, on 8 March 2020.

The aim of the Workshop was reaching a broad consensus about the strategic planning of future and the best use of the already available information, with the specific objectives to identify gaps in movement transitions and life history that can be addressed by strategic electronic tags deployments and to draft terms of reference for conducting joint analyses of the combined tagging datasets. In addition to invited speakers, the participation to workshop was open to any interested scientist. The provisional agenda included:

1. Overview of available data
2. Plenary talks by invited key speakers
3. Gap analysis of key life history transitions that are not well informed.
   a) gaps in tag transitions in the current MSE mixing models (known unknowns)
   b) gaps in knowledge (unknown-unknowns, what are we missing about life history?)
4. Draft design for further tagging to fill in gaps
5. Planning for joint analyses
   a) draft MOU on joint analytical work
   b) develop teams to conduct joint analysis of data

It is envisaged to resume the organization of the workshop once the global situation allows it.

4.3.3. Tag recoveries

a) Tag awareness and reward policy

This activity is considered essential for improving the low tag reporting rate existing so far in the Eastern Atlantic and the Mediterranean Sea. The tag awareness material was produced in 12 languages, considering the major languages in the ICCAT convention area and those of the most important fleets fishing in the area: Arabic, Croatian, English, French, Greek, Italian, Japanese, Mandarin, Portuguese, Russian, Spanish and Turkish. Several thousands of posters of various sizes (A1, A3 and A4) and stickers were produced so far and distributed to all major stakeholders, such as Government Agencies, scientific institutions, tuna scientists, tuna industries, fishers, sport fishery federations and associations in the area. In addition, in 2016 two short propaganda videos on ICCAT GBYP tagging activities were produced, which are available in 8 languages through YouTube.

The ICCAT GBYP tag reward policy has been considerably improved since the beginning of the program, with the purpose of increasing the tag recovery rate. The current strategy includes the following rewards: 50€/ or a T-shirt for each spaghetti tag; 1000 € for each electronic tag; annual ICCAT GBYP lottery (September): 1000 € for the first tag drawn and 500 € each for the 2nd and 3rd tag drawn. According to the recovery data, this policy (along with the strong tag awareness activity) was very useful for improving the tag reporting rate.

For further improving the results, meetings with ICCAT ROPs have been organized periodically, further informing them about the ICCAT GBYP tag recovery activity and asking them to pay the maximum

attention to tags when observing harvesting in cages or any fishing activity at sea, which have resulted in an increase of recoveries by ICCAT observers in farms.

b) Tag recovery and reporting

The important tag reporting improvement registered after the beginning of the tagging and tag awareness activities by ICCAT GBYP is impressive: the average ICCAT recovery for the period 2002-2009 was only 0.88 tags per year (7 tags reported in 8 years), while during GBYP tag recovery activities the average was 88.21 tags per year (860 tags in 9 ¾ year). The first significant increase in the rate of the tag recoveries was recorded from 2012. Such a success should probably be attributed, not only to the recent tagging activities, but to the settled tag awareness campaign as well. In the year 2019, a total of 158 tags were recovered (Figure 3). It should be stressed that, in last couple of years, for the first time in ICCAT bluefin tuna tagging activities, the number of tags recovered and reported from the Mediterranean Sea is higher than any other area. Considering that reported tags from the Mediterranean were almost nil before GBYP, this is the clear evidence that GBYP tag awareness campaign is producing positive effects.

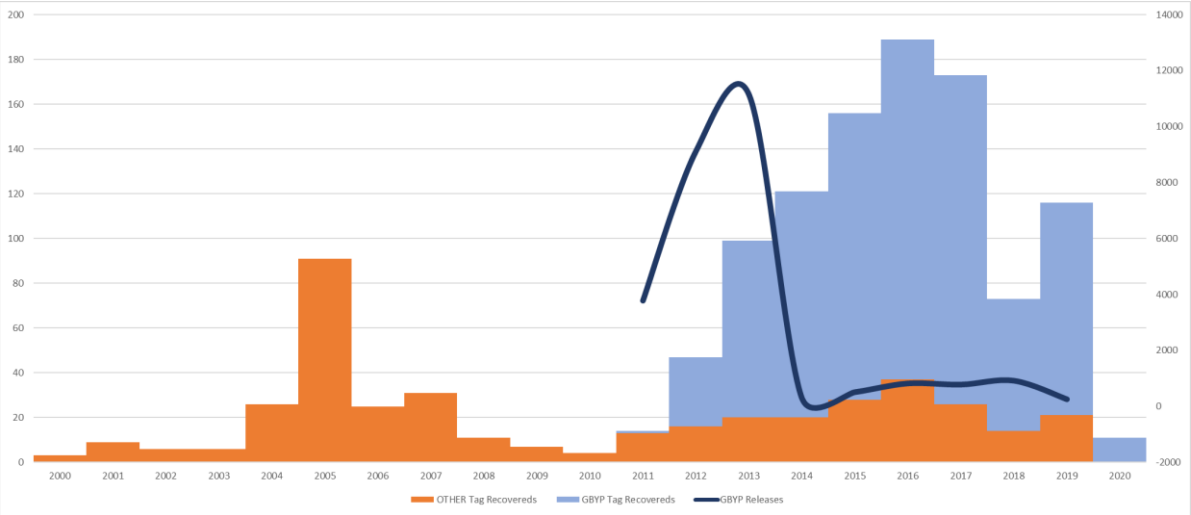

Figure 3. Annual trend of bluefin tuna tag recoveries reported to ICCAT since 2002 (up to 1 March 2020)

As for the study of conventional tags shedding rate, tags were recovered from 447 double tagged fish (up to 1 March 2020). According to the results (Table 8), it seems that both types of tags (single barb and double barb) are more or less equally resistant, with the slight better resilience for the double barb.

Table 8. Tag recoveries from double tagged fish by type

Release	Spaghetti tag only	Double Barb Tag only	Both	TOTAL FISH	TOTAL TAGS
2011	5	7	11	23	34
2012	18	26	49	93	142
2013	33	23	79	135	214
2016	1	2	1	4	5
2017	7	13	15	35	50
2018			1	1	2
Total N	**64**	**71**	**156**	**291**	**447**
Total percent	**22%**	**24%**	**54%**		

4.4. Biological Studies

One of the core activities of ICCAT GBYP are 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 microchemical and genetics analyses to investigate mixing and population structure, with a particular attention to the age structure and the probable sub-populations identification.

Bluefin tuna biological samples are stored in the GBYP Tissue Bank, which is maintained by AZTI. The information on available samples can be obtained through an interactive web application, especially designed for that purpose on https://aztigps.shinyapps.io/bluefin/.

The objectives of the Biological Studies initially stated for Phase 9 were 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. In addition, GBYP continued with the broad study to determine BFT growth in farms.

There were also two workshops related to biological studies planned to be held within Phase 9, one on close-kin methods and the other one on larval index surveys, but both were cancelled/postponed due to the covid-19 outbreak. Larval index surveys coordination workshop was intended to facilitate coordination between different CPCs national studies. It was planned to be held in Mazzara de Vallo, Italy in April. The Workshop on potential use of close kin methods for the assessment was planned to provide insight in new achievements of the method and evaluate its potential use on Eastern BFT stock. It was to be held in La Valetta, Malta, also in April 2020.

4.4.1. Biological sampling and analyses

As done in previous GBYP phases, a call for tenders was issued 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. Only one offer was received, which was awarded. The contract was signed with AZTI, as leader of a Consortium which included 8 more institutions. In addition, a call for tenders was published for sampling of adult bluefin tuna individuals in the farms. Three offers were received for this concept, out of which two were awarded a contract. Taxon Estudios Ambientales SL was contracted for sampling 300 individuals fished in the Balearic Sea and AquaBioTech was contracted for sampling 300 individuals from the South Tyrrhenian Sea and other 300 from the Central/Southern Mediterranean Sea.

The activities in Phase 9 were mostly directed to resolving the Atlantic bluefin tuna population structure and mixing. In particular, one of the most important uncertainties to resolve was related to the understanding of the implications of the new spawning grounds in the Atlantic Ocean (Slope Sea, Bay of Biscay). The priority has been given to mixing analyses to provide accurate information and clear alternative hypotheses to the MSE process.

Thus, the sampling activity proposed to be conducted was similar to that of Phase 8 and limited to potential mixing areas for adults, such as Central Atlantic, Canarias and Morocco. The main objective of the proposed sampling scheme was to complete the sampling conducted in previous Phases in order to provide the necessary material (in terms of sample number and quality) for the various types of analyses envisaged in this and future Phases of the GBYP program. Tasks related to the review of larval collections in Bay of Biscay, to confirm and provide new insights on the BFT spawning in this area, as well a feasibility study to evaluate the potential use of the larvae sampled within the surveys currently developed for estimating a larval index of SSB in the Balearic sea for several types of genetic studies were also performed. As regards sampling large individuals for constructing the age length key, which was one of

the priorities identified by the Bluefin Species Group, it was decided to focus the effort of the Consortium in collecting hard parts from the individuals from Atlantic Ocean, while the sampling of individuals in the Mediterranean will be carried out within other activities, mainly through the contracts for sampling adults in the farms. It should be mentioned that this task in the future might be achieved through national sampling programs, such as those developed in relation to EU Data Collection Framework.

As concerns biological analyses, it was decided to combine both genetic and microchemical analyses on the same sample, if possible, to take advantage of the synergies between both approaches to determine the stock of origin. To this end, it was envisaged to generate an improved baseline for the RAD-seq method for origin assignment and expand the number of analysed bluefin tuna individuals from the Atlantic Ocean, with the final aim of improving the mixing proportions accuracy. It was as well planned that microchemical analyses continue with origin assignment of individuals caught in potential mixing zones. Also, a specific study on YOY in Mediterranean continued aiming to discriminate their nursery areas, by means of analysis of trace elements and stable isotopes.

Genetic analysis (RAD-seq) of more than 500 bluefin tuna individuals captured in the Slope Sea, including larvae, were also performed in order to determine the contribution of the Mediterranean and Golf of Mexico population to the Slope Sea population. In addition, high resolution stable isotope analysis were performed in order to identify resident and migratory contingents within the Mediterranean population.

Regarding ageing, a contract was signed with Fish Ageing Services for age estimates of a collection of 2000 bluefin tuna otoliths that had been gathered and mounted for age determination analyses within phase 8. The age estimation was done by 2 readers, ageing all samples once independently and then, considering the first two readings, agreeing on a final age assignment. In addition, a third reader from another laboratory performed a 10% re-reading for inter-laboratory comparison. The final read included collection of zone distance measurement and classification of edge type. This year also a special study was carried out on smaller number of previously aged samples to investigate the position of first annuli. Finally, the daily aged estimates in the same otoliths were compared using different techniques (transverse versus frontal sections).

In addition, in Phase 9 it has been carried out a calibration of otolith age estimates provided by Fish Ageing Services (FAS) and a new and more complete otolith reference collection has been created. For that purpose, 10% of otoliths already read by FAS were reread by six research laboratories, in line with the reviewed protocol. Additionally, both sets, physical sections and digital images were used to construct a reference collection using the consensus age obtained from readings. These tasks have been performed by the ageing group of experts of the SCRS BFT species group within the framework of the Consortium headed by AZTI, and the results will be presented at the 2020 SCRS BFT Species Group meetings.

The final reports are available in Annex 1a, documents no. 11-13. The main specific activities carried out in relation to biological sampling and analysis of biological samples and their more relevant results are summarized below:

a) Biological sampling

During Phase 9, following sampling protocols agreed in earlier Phases, the consortium sampled a total of 747 bluefin tuna (1 YOY, 4 juvenile fish, 101 medium sized fish and 641 large fish) from different regions (107 from the Strait of Gibraltar, 50 from Morocco, 31 from Portugal, 56 from the Canary Islands, 184 from Norway, 314 from the Central North Atlantic and 5 from the Bay of Biscay). In total, 1079 biological samples (322 otoliths, 154 fin spines and 603 genetic samples) were collected by the Consortium and incorporated into the tissue bank. The consortium also received samples from other ICCAT contracts with tagging teams and farm operators. In total, 4427 biological samples (1600 otoliths, 598 fin spines and 2229 genetic samples from 2941 individuals were collected. The total number of bluefin tuna individuals and samples collected in the Phase 9 is shown in Tables 9 and 10.

Table 9. Total number of bluefin tuna sampled in Phase 9 by area and size class

		Size-class sampled				Responsible
		Age	**Juvenile**	**Medium**	**Large**	
		<3	**3-25 Kg**	**26-100**	**>100**	
Strait of Gibraltar	Gibraltar	1		90	16	UCA
East Atlantic- West African coast	Morocco				50	AZTI (INRH)
	Canary Islands				56	IEO
Northeast Atlantic	Portugal			9	22	AZTI (IPMA)
	Bay of Biscay		4	1		AZTI
Central North Atlantic	Central and North			1	313	NRIFSF
Norwegian Sea/North Sea	Norway				184	AZTI (IMR)
Western Mediterranean	Balear Sea				201	ROP
	Balear Sea			7	268	TAXON
	Sardinia			14	41	TAXON
	Tyrrhenian		13	82		NGBFT
	Tyrrhenian				283	ABTL
Central Mediterranean	South Sicily				19	NGBFT
	Malta				804	ABTL
Eastern Mediterranean	Levantine Sea			267	195	AKUA
TOTAL nº of individuals		**1**	**17**	**450**	**2473**	

Table 10. Total number of samples collected in Phase 9 by area and tissue type

		Tissue				Sampler
		Otolith	**Spinee**	**Muscle/fin**	**Total**	
Strait of Gibraltar	Gibraltar	1		107	108	UCA
East Atlantic- West African coast	Morocco	50		50	100	AZTI
	Canary Islands	55		56	111	IEO
Northeast Atlantic	Portugal			31	31	AZTI
	Bay of Biscay		1	4	5	AZTI
Central North Atlantic	Central and North	190		190	380	NRIFSF
Norwegian Sea/North Sea	Norway	26	153	165	344	AZTI
Western Mediterranean	Balear Sea			201	201	ROP
	Balear Sea	262	275	275	812	TAXON
	Sardinia	55	55	55	165	TAXON
	Tyrrhenian	95	95	95	285	NGBFT
	Tyrrhenian	216		255	471	ABTL
Central Mediterranean	South Sicily	19	19	19	57	NGBFT
	Malta	631		726	1357	ABTL
Eastern Mediterranean	Levantine Sea	?	?	?		AKUA
TOTAL		**1600**	**598**	**2229**	**4427**	

b) Biological analyses

The most relevant results from each type of analysis are summarized below:

Otolith microchemistry

Regarding otolith microchemistry, new carbon and oxygen stable isotope analyses were carried out in 129 otoliths of Atlantic bluefin tuna captured in the Central North Atlantic in 2016, to determine their nursery area. δ13C and δ18O values measured in otolith cores indicated that these samples were dominated by eastern origin individuals. The comparative analysis with previous Phases (Figure 4) suggests that mixing of the two populations occurs at variable rate, but Mediterranean bluefin tuna may be the principal contributors to the Japanese fishery operating in the central North Atlantic.

Figure 4. Interannual variation of the mixing proportions east and west of the 45ºW boundary estimated by Maximum Likelihood Estimator (HISEA program).

Within the Mediterranean Sea discrimination of Eastern Mediterranean nursery was possible in 2011 using otolith trace element concentration, but differences among the nursery areas in 2013 were not statistically significant. The similarity of elemental concentrations among the three areas hampers our ability to estimate the origin of bluefin tuna from the 2013 cohort.

High-precision secondary ion mass spectrometry (SIMS) was used to provide, for the first time, high resolution estimates of oxygen stable isotopes (δ18O) along otolith growth transects from Atlantic bluefin tuna. Measurements were markedly lower than the values previously obtained using IRMS, which is consistent with reports from other species and is likely due to methodological differences. δ18O signatures in individuals from the same environment (Mediterranean farms) showed considerable variability, which reduce the accuracy of life history reconstructions. Nonetheless, examination of relative patterns between individuals indicated substantial variability in environmental histories during the first few months of life. The results support the hypothesis that some individuals are retained within homogenous water masses during early life, while others are exposed to wide variation in water chemistry. Possible evidence of trans-Atlantic migration of adult fish was also recorded in some otolith chemistry profiles.

Genetic analyses

An improved baseline for the 96 SNP existing traceability tool integrating genome-wide genetic background of the included samples has been generated, considering information on population dynamics complexity of Atlantic bluefin tuna. Improved assignment rates were obtained using the new genetic-informed baseline which, together with the original baseline, was used to assign genetic origin of >2400 samples from feeding aggregations including 470 newly genotyped samples, completing the mixing map of the Gulf of Mexico and Mediterranean genetic components along the Atlantic. Assignments using

the new genetic-informed baseline produced higher assignment rates than those calculated using the original location-informed baseline, both analyses confirming high mixing in Western locations. Besides, when using the genetic-informed baseline (Figure 5) lower proportions of unassigned samples were obtained. Addition of the newly genotyped samples completing the mixing map along the North Atlantic Ocean confirmed previously observed patterns, revealing strong mixing of eastern and western genetic origin individuals in the west Atlantic. Indeed, the Mediterranean genetic profile was majoritarian at every sampled location except for Nova Scotia (NS) and Newfoundland (NL).

Regarding the population structure of Atlantic bluefin tuna, gene-flow from the Mediterranean Sea into the Gulf of Mexico, most likely through the Slope Sea, was confirmed analyzing RAD-seq data from 535 individuals

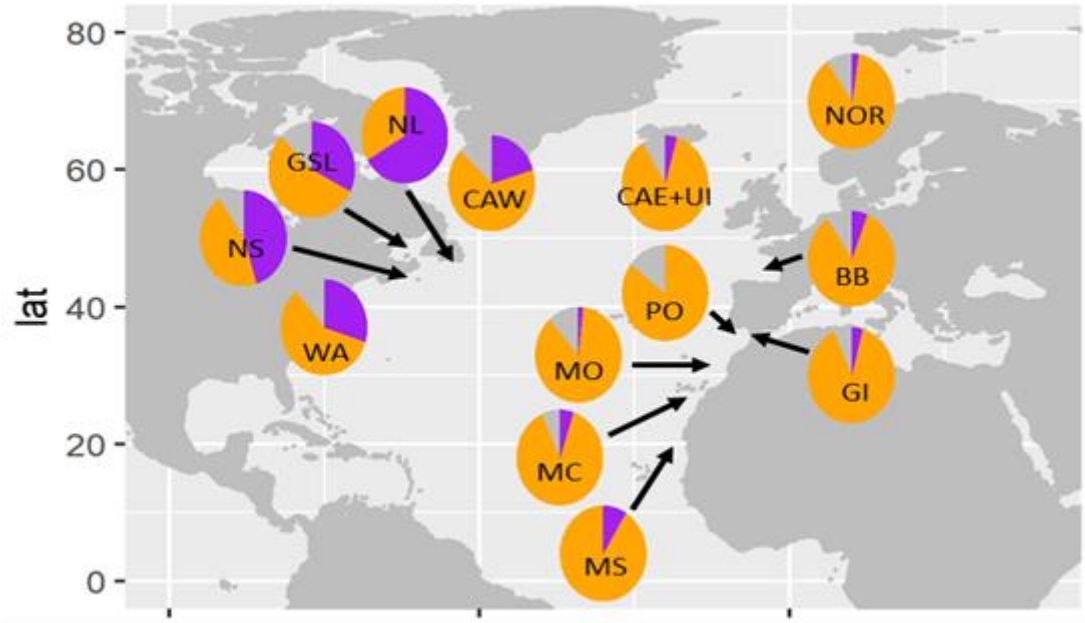

Figure 5. Percentage of samples belonging to the Gulf of Mexico (purple) and the Mediterranean Sea (orange) assessed using the 96 SNP traceability panel and the newly generated genetic-informed baseline at different feeding grounds along the North Atlantic: Norway (NOR), Bay of Biscay (BB), Portugal (PO), Strait of Gibraltar (GI), Morocco (MO), Canarias (MC), Mauritania (MS), Central Atlantic (east of 45ºW, CAE), Central Atlantic (west of 45ºW, CAW), Newfoundland (NL), Gulf of Saint Lawrence (GSL), Nova Scotia (NS), West Atlantic (WA).

Previous studies supporting the presence of two populations of Atlantic Bluefin Tuna (ABFT) have allowed the development of a traceability SNP panel that assigns individuals to their stock of origin, which is very relevant for ABFT management. Yet, more in-depth analyses have shown that the population dynamics of ABFT is more complex than a pure homing behaviour to the two main spawning grounds (the Mediterranean and the Gulf of Mexico), with feeding aggregates mixing in the Atlantic. First, individuals with Mediterranean genetic background are found within the Gulf of Mexico and, second, the Slope Sea constitutes a genetically intermediate population, which might explain why some individuals cannot be assigned to either population and why some Gulf of Mexico individuals are assigned to the Mediterranean Sea. Initially, these unassignments and misassignments were thought to be a methodological bias, but recent results suggest that they might be due to a more complex population structure in ABFT that is not considered by the genetic assignment method.

Since the current mixed stock model used for management purposes does not acknowledge that individuals from both stocks can interbreed, the consequences of doing so should be evaluated. In addition, it is not clear what is the contribution of the individuals born in the Slope Sea to each of the two main stocks as there is no way to differentiate them genetically. Thus, in order to better understand the

migration and reproductive behaviour of ABFT and to develop an improved traceability panel that takes these new findings into account, additional analyses are envisaged.

Ageing related analysis

Fish Ageing Services successfully finished the reading of a set of 2000 otoliths which were prepared for reading in Phase 8. It has to be mentioned that cutting of otoliths in 2 sections allowed using of the other section for microchemical analyses. The final report is available in Annex 1a, document no. 28.

The readings show a high coherence, since a single more prominent cohort can be followed consistently along the years (Figure 6), and the resulting length at age data also show a coherent growth curve (Figure 7).

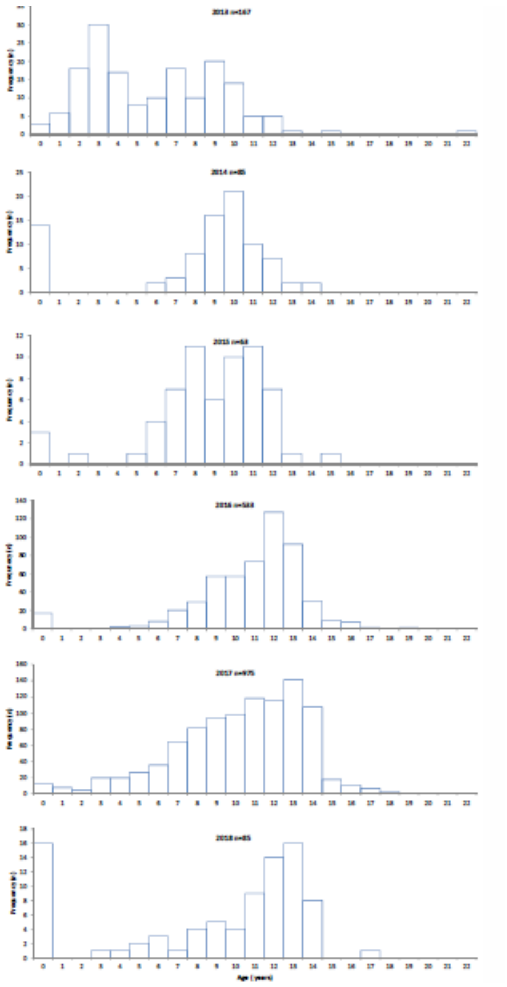

Figure 6. Age composition by year of capture.

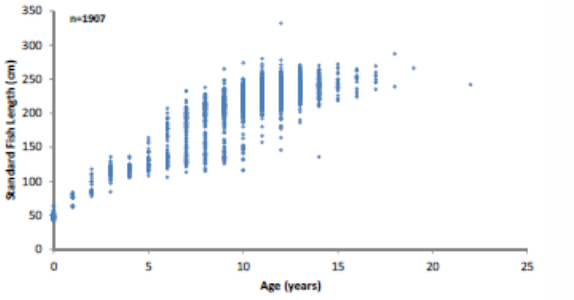

Figure 7. Length at age of analysed specimens.

However, some systematic bias in these results in relation to estimations from other experts were detected in the calibration exercise, as explained above, and hence a final revision of these data will be carried out within phase 10 before using this data set for management purposes.
The otolith calibration exercise consisted s reading a sub-sample of 10% of the otoliths previously aged by FAS, by six research centres, to determine a measure of inter-laboratory precision. The findings showed that the band count was similar between Fish Aging Services (FAS) and the group of laboratories involved in direct ageing of Atlantic bluefin tuna otoliths. This is reflected by an acceptable precision between both readings. However, there was a one-year bias starting from 10 years of age in the count of bands in older specimens, with a lower count by FAS compared to the rest of the laboratories. This bias seems to be due to the fact that FAS counts the bands in a different area of the ventral arm of the otolith compared to other laboratories. Counting is slightly different if done on either side of the arm of the otolith, therefore, it is important to use the same reading area in the ventral arm. A reference scale helps identifying the first annual band and consequently the following first annual bands. Given these results, a new reference collection with consensus ages and following the ICCAT reviewed reading protocol is being created.

Larvae identification in the Bay of Biscay

Recently, ABFT larvae were found in the Bay of Biscay (Rodriguez, 2019, Poster "The Southern Bay of Biscay: A Spawning Ground for *Thunnus thynnus* and *Sarda sarda*?", presented at 43rd Annual Larval Fish Conference, May 2019, Palma de Mallorca)demonstrating that ABFT spawns, at least occasionally, in this area. For that reason, the search for ABFT larvae in samples collected in past surveys in the Bay of Biscay was proposed as one of the biological analyses to be carried out within Phase 9. The species identification was performed on historical samples preserved in ethanol, collected outside the continental platform, where the probability to find an ABFT was considered to be higher. All larvae were extracted and identified through microscopic identification and genetic sequencing for confirmation. Among the 7,017 larvae checked for ABFT from 368 samples, preserved in ethanol, one larva collected in August 2009 was identified as bluefin. This sample was taken west of Santander (43º37'61N 4º10'92 W) in august 2009 in a mean sea surface temperature of 21.6ºC and a mean sea surface salinity of 34.88. This larva could not have been transported in any way into this area from the Mediterranean Sea spawning ground. So, it provides a further evidence of BFT spawning in this region. However, further studies should be conducted, based on plankton hauls specifically designed to target tuna larvae, to evaluate the importance of this new spawning ground.

Feasibility study on the use of larvae from current larval surveys in the Balearic Sea for genetic analysis

This study has demonstrated that the larvae from the replicate of the Bongo 90 hauls from previous Balearic Islands larval surveys, preserved in Cytoscan (ethyl alcohol, normally 96% denaturalized with some methanol, isopropyl alcohol and butanone, which were expected able to provide massive numbers of larvae for future genetic studies, as those related to the application of the "Close-kin" approach, are not suitable for this type of genetic analyses. It should be still determined if this is because the direct effect of some of the denaturalizing agent on larval DNA, or it is because these larvae are temporary transferred to water while sorting, and this could have been caused the degradation of DNA. However, since previous studies had shown that larvae sorted on board and placed directly in pure ethanol, were suitable for genetic analyses, the methodology for ichthyoplankton samples preservation and sorting within the Balearic Sea tuna larval surveys was changed, introducing the use of pure ethanol for preserving one of the replicates from Bongo 90 hauls, from which BFT larvae for genetic analyses should be sorted directly. Finally, a total of 339 bluefin tuna larvae from 22 stations sampled in 2018 and 2019 surveys following this new methodology were genetically analyzed within this study, confirming its suitability for genetic analyses. Thus, it could be concluded that thanks to these methodological improvements in samples preservation and handling, larval surveys could provide useful material for genetic analyses, even for those studies which require a high number of larvae, as the close kin approach.

4.4.2. Study on BFT growth in farms

Pursuant to special request by the Commission towards the SCRS to provide an update on the potential growth rates of Bluefin tuna in farming/fattening facilities, with the aim of improving the coherence within the growth rates derived from eBCD, GBYP was committed to carry out a broad study on this topic, involving ad hoc experiments in selected farms along the eastern Atlantic and Mediterranean.

Following the successful preparatory work finished in Phase 8, the activity in Phase 9 continued by implementation of field and desk work for base data generation, including preliminary and partial data analysis. With that purpose, 5 contracts with farms and/or research institution to carry out studies in 5 representative areas: Tunipex in Portugal, Balfegó in Spain, AquaBioTech in Malta, Pelagos Net Farma in Croatia and Akua Group in Turkey.

Among these initially contacted farms only Tunipex and Pelagos Net Farma accepted to carry out a broad tagging experiments, since their special characteristics, as the possibility of separating easily small groups of fish for tagging operations without disturbing the whole caged population or the fact of working only with juvenile fishes more easily handled for tagging operations, respectively, allowed to expect low mortalities associated to tagging operations.

Therefore, in addition to the individual growth approach required by the Re. 18-02, aiming at providing comparable growth rates estimations among different areas, which is also required by Rec. 18-02, a common methodology based on the intensive monitoring of one or two cages in each farm, containing the widest possible caged fish length distributions, has been implemented in all the areas. This monitoring include, in addition to the initial estimation of the length distribution in the cage through the official measurement with stereo-cameras, bimonthly or seasonal additional measurements with stereo-cameras, a daily record of environmental parameters and food supply and the record of real length and weight data from all the fish in the monitored cage at harvesting. This will allow to determine the season growth in length through Modal Progression Analyses, relate this growth rates with environmental parameters and determine the mean gain in weight and length of each one of the modal length groups present in each monitored cages. These studies will be completed within phase 10, when the fish will be harvested. As an example of the type of information these studies are providing the Figure 8 below show the detectable growth in length of the different modal groups present in one of the monitored cages after two months of farming.

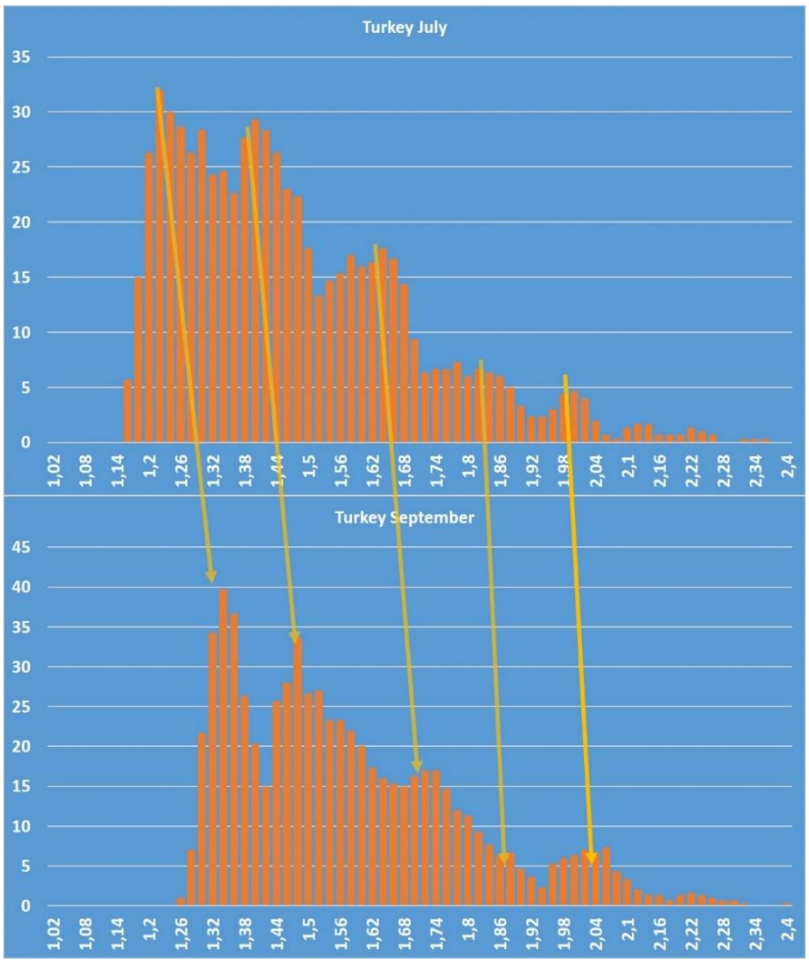

Figure 8. Length distributions from stereo-camera measurements in Akua group selected cage in July and September 2019.

The study in Portugal and Croatia also used this approach but, as mentioned above, included also tagging of part of the fish in the monitored cages as well, to get individual growth data. The final reports are available in Annex 1a, documents no. 14-18. In addition to the study dedicated to growth, in AkuaGroup farm in Turkey the biological sampling activity was carried out on more than 400 bluefin tuna individuals. The final report is available in Annex 1a, document no. 29.

The study in Portugal was focused on tagging adult bluefin tuna and intensive monitoring of selected cages. Between June and August 2019, 89 adult bluefin tunas were individually weighted, measured, double tagged, and returned to the cage for fattening. Unfortunately, a total of 37 were found dead after tagging, therefore representing a mortality of nearly 42%. Between one month and 4 months following the tagging date, tagged fish were deliberately harvested, weighed, and measured and whenever possible biological samples were collected. In addition to high mortality of tagged fish, which was probably induced by a bad initial condition of fish, lots of external tags were lost, thus hindering the obtention of reliable results. The limited results obtained show high variability in individual growth rates, which probably may be attributable to differences in recovery times.

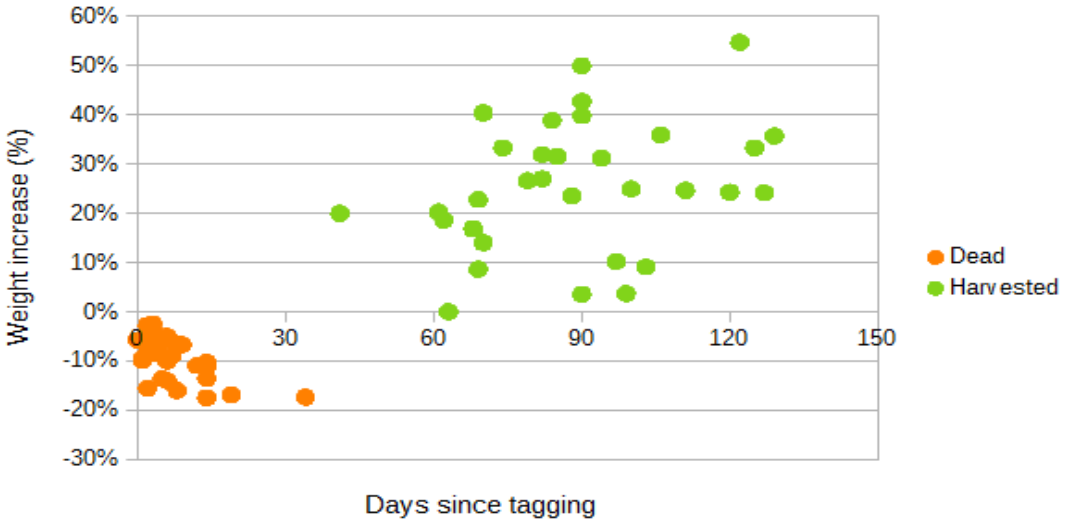

Figure 9. Weight increase as a proportion of initial weight with time after tagging

The study in Croatia included tagging juvenile bluefin tuna and intensive monitoring of selected cages. Contrastingly to tagging in Portugal, the tagging trial developed in Croatian farms on juvenile fish was very successful, probably due to the fact that small fish can be quickly captured with hooks and are easy to handle. Fish were tagged injecting internal pit tags, causing minimal injuries. Moreover, fish were also injected with oxytetracicline for daily growth studies validation, and giving that it is also an antibiotic, it seems that has prevented infections in tagged fish, increasing survival rated. In fact, from 206 two/three years old tagged specimens, only 2 died some days after handling. The individual growth data will be available by 2021, when these fish is harvested.

In parallel with field activities, in-house work was initiated at ICCAT Secretariat in close collaboration between Department of Research and Statistics and GBYP Coordination team. It was oriented to the consolidation of data reported from stereo-cameras to ICCAT (2014-2018), since due to differences in the format of the report between CPCs and/or years, the data needed to be compiled and standardized before making any further analysis. This first step will allow to develop an operative relational data base, linking data on estimated initial lengths and weights from stereo-cameras at caging with measures of real final weighs and lengths at harvesting from e-BCD system, as well VMS data, allowing broad studies on the growth of caged fish in all the areas were BFT farming takes place along Phase 10, at the same time that provides crucial information for stock assessment (length distributions of the captures of purse-seine fisheries).

Finally, the combination of all the information on growth rates generated by these different approaches with the info about farming methodologies gathered trough the ad hoc questionnaire submitted by all the ABFT farms and the direct detailed monitoring of environmental parameters and food supply in selected cages will also allow to explore the causes of potential variability among growth rates in different regions at several time and space scales.

Following activities, to be developed within the Phase 10, will include the continuity of experiments initiated in 2019, whenever necessary, as well as the development of new pilot studies in Atlantic and Mediterranean farms, using acoustic and IAS techniques, allowing accurate (even on daily basis if required) measurement of the growth of caged fishes, both in length and weight.

4.5. Modelling

The modelling programme addresses the GBYP general objective 3, which is to "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".

Initially, it was planned that GBYP start with carrying out operational modelling studies only from the year 4, but following the recommendation of Steering Committee and SCRS, the modelling activities already started from the year 2. It became evident that this line of study has greater importance than perceived in the moment when GBYP was conceived and that the amount of effort for this activity is much larger than initially considered. In addition, the MSE process being embarked upon by ICCAT has been an important initiative which represents a significant investment of time and resources by the Commission, CPCs and scientists involved.

4.5.1. MSE development expert

In Phase 9 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 in 2019 were:

- To ensure the OM scenarios agreed by the CMG in 2016 and revised in 2017, 2018 and 2019 by the Technical MSE Group (formerly CMG) and the MSE BFT Group, can be run;
- That third parties can use the OM to evaluate candidate MPs (CMPs) of their own specifications; and
- To provide a set of agreed summary statistics that can be used by decision makers to identify the MP, including data and knowledge requirements, that robustly meets the management objectives.

This contract saw the final adjustments to model configuration and data weighting. Over the course of 5 revisions, including more than 100 individual changes to the input data and model, an estimation model was developed in November and presented in December that could pass necessary red-face tests and span the range of uncertainties of the reference set operating models and recreate the scenarios of the robustness set operating models.

In 2019 a series of tasks were completed, as follows:

- Data processing checks.
- Engage in dialogue with data providers to confirm that the data are processed correctly for M3 OM conditioning.
- Update Trial Specifications document.
- Updated M3 model to version 5.
- New reference set OMs coded and fitted.
- New robustness set OMs coded and fitted.
- Fit interim grid OMs, sensitivity runs and the existing robustness set OMs.
- Updated ABT-MSE framework.
- Fully debug and add M3-ABTMSE check mode.
- Check and implement basis for transforming biennial estimates of variance and correlation in recruitment.
- Update OM report to include estimated movement probabilities, observed tag recaps and recruitment.
- Add latest interim grid OMs and robustness OMs to the package.
- Incorporate further performance statistics agreed by the March 2019 Panel 2 meeting in the package.
- SCRS paper with results for multiple alternative Master indices.

- SCRS paper on a simple model-based CMP.
- Develop an SCRS paper fully defining protocols for CMP tuning.

All deliverables were completed, with the exception of the updated Shiny App which requires finalized reference set and robustness set operating models and CMPs. In addition to the contracted tasks, more than 100 changes were made in the model and data, following requests from the Bluefin Tuna Working Group. The MSE framework is complete but all components downstream of the Management Procedures and the Management Objectives are currently not finalized (Figure 10). The final report is available in Annex 1a, document no. 23, while the Specifications for MSE Trials for Bluefin Tuna in the North Atlantic are available as document 24. The scientific document SCRS/2019/021 on Quantifying the Impact on Estimates of Recruitment Trends of Previously Unreported Catches of Age-0 Bluefin Tuna in The Mediterranean is available in Annex 1b, document no. 1.

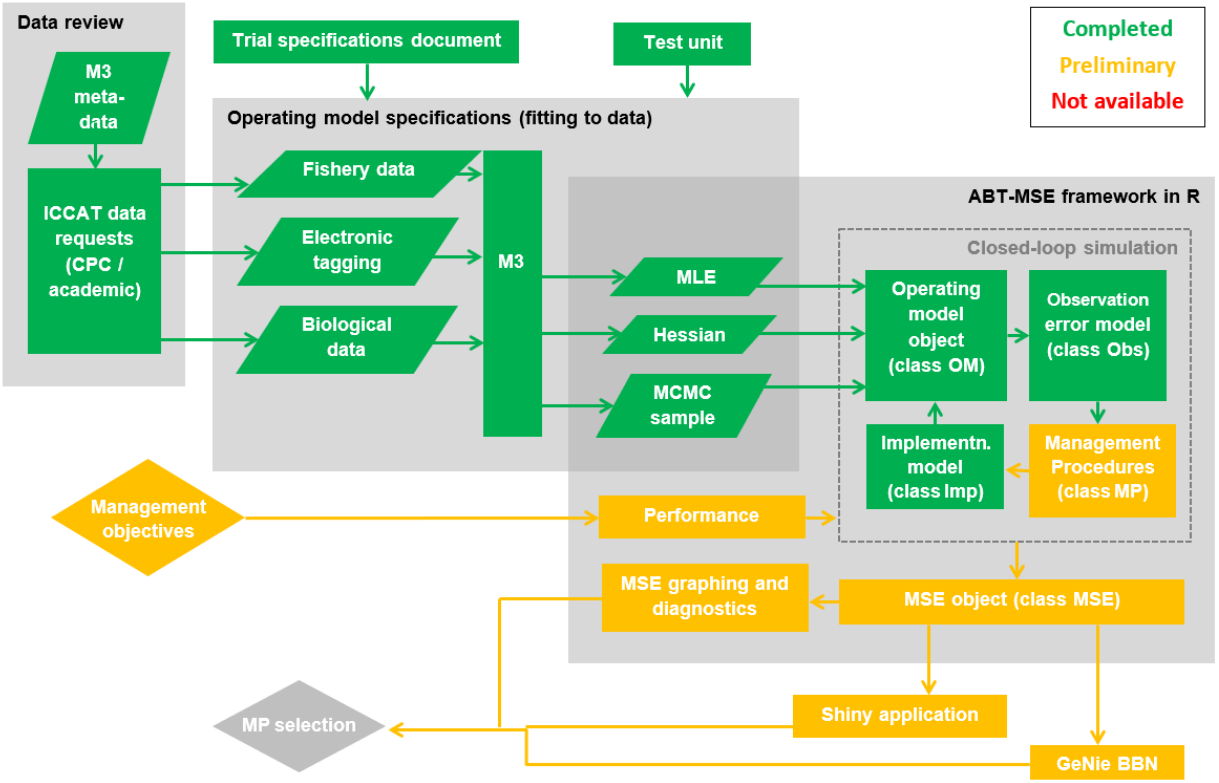

Figure 10. Current status of the components of the ABT MSE framework showing the preliminary nature of Management Procedures and Management objectives (and hence all components downstream).

4.5.2. BFT MSE Technical Group

In order to support the important and complex MSE development by an effective coordinating body with the required technical expertise and appreciation of needs of the SCRS and Commission, in 2014 the GBYP Core Modelling and MSE Group was created. The Steering Committee provided its terms of reference and recommended the membership of the Group. The Group was intended to provide technical oversight and advice on the MSE process and review technical contributions and outputs of the work program. From December 2014 to 2017 the Group held 6 meetings. During the MSE intersessional meeting on 16-20 April 2018, it was decided to formalize the creation of the BFT MSE Technical Group, which, unlike Core Modelling Group, would be open to all interested ICCAT scientist, without restriction to participation. Therefore, GBYP Core Modelling Group was dissolved and it was succeeded by the BFT MSE Technical Group. Nevertheless, although this Group was not formally constituted within the framework of Programme GBYP, it has continued to providing its support, by covering the travel expenses, whenever

needed, for participating in MSE related meetings of the members of the previous MSE Core Modelling Group.

The reports from these meetings of MSE Technical group in Phase 9 are available in Annex 1a, documents no. 21-22.

5. Overall GBYP use of data and results

One of the principal objectives of the GBYP is to improve the basic data for their use in the various assessment and modelling approaches. Several types of data obtained by GBYP have been specially formatted and subsequently incorporated in the databases maintained by the ICCAT Secretariat. Other data, that could not be incorporated due to inexistence of a specific database, have been maintained and analysed separately and the final results have been provided directly to SCRS. The data provided by GBYP have been used for the bluefin tuna stock assessment in both 2014 and 2017 and are currently used for the purpose of MSE.

Here below are listed some of the greatest achievements and contribution of the Programme, by line of investigation:

Data mining

- Size data
- LL CPUE
- Historical trap data
- BB data
- Non-GBYP electronic tag data recovered by GBYP
- Historical maturity data
- Historical genetic data

Aerial survey on BFT spawning aggregation

- A 7 years long series of fisheries independent index for adult BFT in 4 spawning areas in the Mediterranean

Tagging

- Conventional and electronic tag data
- Growth data from conventional tags
- Mixing determination (MSE areas movement matrices)
- BFT temperature and depth preferences revealed by electronic tags
- Recoveries of tags deployed by other teams on BFT
- Development of improved tagging protocols

Biological studies

- Length/weight correlation
- Reproductive parameters
- Age length key
- Population structure
- Genetic and microchemical studies for stock assignment
- Mixing determination (MSE areas)
- Development of stock of origin assignment methods
- BFT tissue bank with on-line accessible inventory
- Workshop on BFT reproductive biology
- Workshop on BFT larval studies
- Development of sampling protocols
- Development of otolith reading protocols
- Development of otolith cutting protocols

Modelling and MSE

- Development of ABT-MSE analysis software
- OM development
- SAM application
- VPA training course

- Financial support for organization of BFT MSE technical group meetings, including participations of modelling coordinator and several experts

It is also worth mentioning that so far GBYP has awarded 166 contracts to 95 entities, localized in 22 different countries, involving therefore a work of many hundreds of researchers and technicians. This large and open participation to ICCAT GBYP activities is also considered an important achievement of this research programme.

Annex 1. List of reports and scientific papers in Phase 9

a) List of deliverables and reports produced within the framework of GBYP contracts and activities

1. Aerial survey – May 2019. Short-Term Contract for the Aerial Survey Design, Protocol, Training Course, Real Time Data Monitoring, Data Analysis and Data Re-Analysis (ICCAT GBYP 07/2019), Aerial survey protocol. Alnilam Research and Conservation: 1-17.
2. Aerial survey – May 2019. Short-Term Contract for the Aerial Survey Design, Protocol, Training Course, Real Time Data Monitoring, Data Analysis and Data Re-Analysis (ICCAT GBYP 07/2019), Aerial survey forms. Alnilam Research and Conservation: 1-3.
3. Aerial survey – 17 May 2019. Short-Term Contract for the Aerial Survey Design, Protocol, Training Course, Real Time Data Monitoring, Data Analysis and Data Re-Analysis (ICCAT GBYP 07/2019), Power Point presentation for the Aerial Survey Training Course 2018. Alnilam Research and Conservation Ltd: 1-101.
4. Aerial Survey – 22 May 2019: Training Course for the ICCAT GBYP Aerial survey for bluefin spawning aggregations, List of participants. ICCAT GBYP Coordination: 1.
5. Aerial Survey - 15 July 2019, Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 04/2019-a) – Final report for Area A. Grup Air Med: 1-36.
6. Aerial survey- 17 July 2019. Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 04/2019-b) – Final report for Area C. Unimar and Aerial Banners: 1-21.
7. Aerial survey- 15 June 2019. Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 04/2019-c) – Final report for Area E. Action Air Environnement: 1-46.
8. Aerial survey- 12 June 2018. Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 04/2019-c) – Final report for Area G. Action Air Environnement: 1-37.
9. Aerial survey – January 2020. Short-Term Contract for the Aerial Survey Design, Protocol, Training Course, Real Time Data Monitoring, Data Analysis and Data Re-Analysis (ICCAT GBYP 07/2019), Aerial survey analysis final report. Alnilam Research and Conservation: 1-94.
10. Aerial survey – 30 July 2020. Short-Term Contract for the Implementation of the Aerial Surveys Calibration and Validation Exercise (ICCAT GBYP 15/2019), Final report. Grup Air-Med: 1-35.
11. Biological studies – 10 April 2020. Short term contract for biological studies (ICCAT GBYP 06/2019). Final report. Consortium led by AZTI: 1-107.
12. Biological studies – Marzo 2020. Short term contract for biological studies –sampling of adults (ICCAT GBYP 12/2019-a). Final report. Taxon: 1-14.
13. Biological studies – 20 December 2019. Short term contract for biological studies –sampling of adults (ICCAT GBYP 12/2019-b). Final report. AquaBioTech: 1-9.
14. Biological studies – 31 December 2019. Short term contract for growth in farms study (ICCAT GBYP 09/2019-a). Final report. Tunipex: 1-16.
15. Biological studies – December 2019. Short term contract for growth in farms study (ICCAT GBYP 09/2019-b). Final report. AquaBioTech Limited: 1-8.
16. Biological studies – 16 December 2019. Short term contract for growth in farms study (ICCAT GBYP 09/2019-c). Final report. Balfegó & Balfegó: 1-6.
17. Biological studies – January 2020. Short term contract for growth in farms study (ICCAT GBYP 09/2019-d). Final report. Pelagos-net farm d.o.o.:1-34.
18. Biological studies – March 2020. Short term contract for growth in farms study (ICCAT GBYP 09/2019-e). Final report. Akuagroup: 1-57.
19. Coordination – 24 September 2019: ICCAT GBYP Steering Committee Meeting, Report, Anon: 1-6.
20. Meetings - October 2019, Report of the Standing Committee on Research and Statistics (SCRS), Anon: 1-459.
21. Meetings – July 2019, Report of the 2019 Second Intersessional Meeting of the ICCAT Bluefin Tuna MSE Technical Group (St. Andrews, Canada, 23-27 July 2019). Report. Anon: 1-22.
22. Meetings – September 2019, Report of the 2019 Third Intersessional Meeting of the ICCAT Bluefin Tuna MSE Technical Group (Madrid, Spain, 19-21 September 2019). Report. Anon: 1-25.

23. Modelling – 17 December 2019. Short term contract for modelling approaches (ICCAT GBYP 01/2019) – Final report. Blue Matter Science: 1-11.

24. Modelling – 11 January 2020. Specifications for MSE Trials for Bluefin Tuna in the North Atlantic. Version 19-06. Anon: 1-45.

25. Tagging – December 2019. Short term contract for the Tagging Programme 2018 - Skagerrak (ICCAT GBYP 16/2019-a). Final report. Technical University of Denmark: 1-9.

26. Tagging – December 2019. Short term contract for the Tagging Programme 2018 – Celtic Sea (ICCAT GBYP 16/2019-a). Final report. Marine Institute: 1-30.

27. Coordination – 2019. GBYP leaflet. 1-2.

28. Biological Studies – May 2020. Short term contract for the biological studies – Ageing (ICCAT GBYP 17/2019). Final report. Fish Ageing Services: 1-69.

29. Biological studies – March 2020. Short term contract for growth in farms study (ICCAT GBYP 09/2019-e). Final report of Biological Sampling Activity. Akuagroup: 1-17.

b) List of scientific documents produced within the framework of GBYP activities or based on GBYP data

1. Carruthers, T. and Butterworth, D., 2019. Quantifying the Impact on Estimates Of Recruitment Trends Of Previously Unreported Catches Of Age-0 Bluefin Tuna In The Mediterranean (SCRS/2019/021). Col. Vol. Sci. Pap. ICCAT, 76(1): 34-37.

2. Busawon D.S., Addis P., Allman R., Bellodi A., Garibaldi F., Ishihara T., Karakulak S., Lastra Luque P., Quelle P., and Rodriguez-Marin E., 2019. Evaluation of Atlantic bluefin tuna otolith ageing protocols (SCRS/144/2019). Col. Vol. Sci. Pap. ICCAT, 76(2): 147-171.

3. Di Natale A., Addis P., Garibaldi F., Piccinetti C., and Tinti F., 2019. The Italian annotated bibliography on bluefin tuna (Thunnus thynnus, Linnaeus, 1758) (SCRS/2019/153). Col. Vol. Sci. Pap. ICCAT, 76(2): 172-353.

4. Di Natale A., Macias D., and Cort J.L., 2019. Atlantic bluefin tuna fisheries: Temporal changes in the exploitation pattern, feasibility of sampling, factors that can influence our ability to understand spawning structure and dynamics (SCRS/2019/154). Col. Vol. Sci. Pap. ICCAT, 76(2): 354-388.

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Annex 2. GBYP Contracts issued in Phase 9

ICCAT GBYP COORDINATION				
CALL FOR TENDERS or ACTIVITY	**RETAINED PROPOSAL**	**working schedule**		**COST**
		initial date	**final date**	
2/2019	Steering Committee External Expert - Ivan Katavic (Croatia)	04/04/2019	31/12/2019	15.000,00 €
ICCAT GBYP AERIAL SURVEY				
CALL FOR TENDERS or ACTIVITY	**RETAINED PROPOSAL**	**working schedule**		**COST**
		initial date	**final date**	
4/2019A	Aerial survey zone A - Grup Air Med (Spain)	23/05/2019	17/07/2019	116.690,00 €
4/2019B	Aerial survey zone C – Unimar (Italy) and Aerial Banners (Italy)	22/05/2019	17/07/2019	73.442,00 €
4/2019C	Aerial survey zones E and G - Action Communication (France)	23/05/2019	17/07/2019	239.674,00 €
7/2019	Aerial survey design and data analysis - Alnilam Investigacion y Conservacion (Spain)	22/05/2019	09/09/2019	33.275,00 €
15/2019	Aerial survey calibration exercise - Grup Air Med (Spain)	21/06/2019	10/09/2019	66.790,00 €
Cost reimbursement	Aerial survey training course	22/05/2019	22/05/2019	7.469,99 €
ICCAT GBYP TAGGING PROGRAMME				
CALL FOR TENDERS or ACTIVITY	**RETAINED PROPOSAL**	**working schedule**		**COST**
		initial date	**final date**	
16/2019A	Tagging in Skagerrak - DTU Technical University of Denmark	08/08/2019	09/12/2019	10.000,00 €
16/2019B	Tagging in the Celtic Sea - Marine Institute (Ireland) (+subcontract: Ireland)	13/08/2019	01/04/2020	36.080,00 €
10/2019	Advice on electronic tags deployment – Robert Schallert - Ocean Foundation (USA)	11/07/2019	10/07/2019	8.000,00 €

ICCAT GBYP BIOLOGICAL SAMPLING AND ANALYSES				
CALL FOR TENDERS or ACTIVITY	**RETAINED PROPOSAL**	**working schedule**		**COST**
		initial date	**final date**	
12/2019B	Sampling for BFT adults - AquaBioTech Ltd (Malta) – (+2 subcontracts: Malta)	11/07/2019	31/12/2019	78.900,00 €
12/2019A	Sampling for BFT adults - Taxon Estudios Ambientales S.L. (Spain) (+1 subcontract: Spain)	11/07/2019	31/12/2019	49.672,87 €
06/2019	Biological studies - Fundación AZTI - Spain, as leader of a Consortium including 8 more institutions (2 Italy, 2 Spain, 1 USA (w/o budget), 1 Ireland, 1 Japan (w/o budget), 1 France (w/o budget) (+ 7 subcontracts: 1 Norway, 1 Portugal, 1 Morocco, 1 USA, 1 1 France, 1 Spain, 1 Sweden)	11/06/2019	10/04/2020	275.599,00 €
17/2019	Ageing of otoliths - Fish Ageing Services (Australia)	02/08/2019	29/02/2020	53.258,46 A$
9/2019A	Tunipex Emprese de Pesca de Tunideos (Portugal) (+1 subcontract: Portugal)	03/06/2019	31/12/2019	89.200,00 €
9/2019B	AquaBioTech (Malta)	03/06/2019	31/12/2019	28.250,00 €
9/2019C	Balfego & Balfego (Spain)	11/07/2019	31/12/2019	10.500,00 €
9/2019D	Pelagos Net Farma (Croatia)	03/06/2019	31/12/2019	46.811,00 €
9/2019E	Aqua Group Su Urunleri (Turkey)	10/06/2019	31/12/2019	36.114,04 €
ICCAT GBYP MODELLING APPROACHES				
CALL FOR TENDERS or ACTIVITY	**RETAINED PROPOSAL**	**working schedule**		**COST**
		initial date	**final date**	
1/2019	Modelling Approaches: Support to Bluefin Tuna Stock Assessment - Blue Matter Science - Canada	15/04/2019	30/12/2019	94.250,00 €